THE LOWER AND MIDDLE PALAEOLITHIC IN THE MIDDLE EAST AND NEIGHBOURING REGIONS

Basel Symposium, mai 8-10 2008

Jean-Marie LE TENSORER, Reto JAGHER & Marcel OTTE (eds.)

Publié avec le soutien du FNRS

ERAUL 126

Études et Recherches Archéologiques de l'Université de Liège

Liège, 2011

Le Tensorer J.-M., Jagher R. & Otte M. - *The Lower and Middle Palaeolithic in the Middle East and Neighbouring Regions*. Proceedings of the Basel symposium (mai 8-10 2008). Liège, ERAUL 126, 329 p.

Composition
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Mise en forme
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Editions ERAUL, Service de Préhistoire, ULg

ERAUL

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D/2011/0480/14
ISBN 978-2-930495-12-5

Illustration première de couverture : biface provenant des plus anciens nieveaux de Nadaouiyeh en Syrie (photo : Erwin Jagher, Basel).
Illustration quatrième de couverture : the participants in the courtyard of "Hotel Rochat", venue of the 2008 Basel Symposium.

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PREFACE

Jean-Marie LE TENSORER & Reto JAGHER
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Over the last several years, archaeological discoveries have multiplied spectacularly in the Near and Middle East. Within the current debate regarding human origins, its spread across Eurasia and the origin of cultures with the appearance of modern humans, the results obtained by large international teams in this vast politically sensitive region deserved to be compared. We ourselves felt the need to place our experiences in common after 25 years of excavations in the El Kowm region in Central Syria. Thus the idea arose to organize a conference enabling researchers to find themselves in a convivial climate allowing freedom of exchange, far from the constraints of geopolitics foreign to science.

In May 2008, this dream was realized. At the initiative of the Institute for Prehistory and Archaeological Science at the University of Basel, an international colloquium entitled *The Lower and Middle Palaeolithic in the Middle East and Neighbouring Regions* brought together eighty students, scientists and senior researchers from 12 countries (Syria, Israel, Saudi Arabia, Iran, Japan, Switzerland, Germany, France, the United States, Great Britain, Ukraine and Belgium) in this Rhenanian city. Through over thirty communications presented over three intensive work days, we had the ambition to sketch a summary of ancient prehistory in the Levant, then to expand and compare this with neighbouring regions across the vast area from the Black Sea to Iran and to the confines of the Arabian Peninsula. In sum, like the expansion of concentric rings on a tranquil pond, to follow from the Levantine heartland the spread and metamorphosis of cultures, their interactions and evolutions. Most of the presentations concentrated on the classical region between the Euphrates and Palestine with important discoveries made in Syria and Israel in the last two decades. Iran and Yemen have also been largely addressed. Finally, some more synthetic communications offered interesting comparisons with the Caucasus and the Ukraine. An initial goal was achieved as the reader can judge the results in the present volume.

Many questions were debated over these three days. When did the first hominids leave Africa; what were the environmental conditions; can we identify causes for this "Out of Africa" phenomenon? How many successive phases of dispersal occurred in the Near and Middle East? What kinds of hominids were in-

Depuis quelques années les découvertes archéologiques se sont multipliées au Proche et au Moyen-Orient de façon spectaculaire. Dans le débat actuel des origines de l'humanité, de sa dispersion dans l'Eurasie, de la genèse des cultures à l'apparition des hommes modernes, les résultats obtenus par de grandes équipes internationales dans cette vaste région politiquement délicate méritaient d'être confrontés. Nous-mêmes ressentions le besoin de mettre en commun nos expériences après 25 ans de fouilles dans la région d'El Kowm, en Syrie centrale. L'idée est donc naturellement venue d'organiser une rencontre permettant aux chercheurs de se retrouver dans un climat convivial permettant une grande liberté d'échange, loin des contraintes pesantes d'une géopolitique étrangère à la Science.

C'est ainsi qu'en mai 2008 le rêve s'est réalisé. A l'initiative de l'*Institut de Préhistoire et Science de l'Archéologie* de l'Université de Bâle, un colloque international intitulé *The Lower and Middle Palaeolithic in the Middle East and Neighbouring Regions* réunissait dans la ville rhénane 80 étudiants, scientifiques et chercheurs renommés originaires de 12 pays (Syrie, Israël, Arabie Saoudite, Iran, Japon, Suisse, Allemagne, France, Etats-Unis,, Grande-Bretagne, Ukraine et Belgique). Au travers d'une trentaine de communications réparties sur trois journées de travail intensif nous avions l'ambition d'esquisser un bilan de la Préhistoire ancienne des régions levantines, puis de l'étendre et le comparer aux régions limitrophes sur le vaste domaine allant de la Mer Noire à l'Iran, puis aux confins de la péninsule arabique. En somme, à la façon des ondes concentriques se propageant sur le miroir d'une eau tranquille, suivre à partir du noyau levantin la diffusion des cultures et leurs métamorphoses, leurs interactions et leur devenir. En fait, la majorité des travaux se concentrèrent sur la région classique de l'Euphrate à la Palestine au travers des importantes découvertes réalisées en Syrie et en Israël dans ces deux dernières décennies. L'Iran et le Yémen furent aussi largement abordés. Enfin, quelques communications plus synthétiques permirent d'intéressantes comparaisons avec le Caucase et jusqu'en Ukraine. Un premier but était atteint, le lecteur pourra juger des résultats dans le présent volume.

De nombreuses questions furent débattues au cours de ces trois journées. Quand les premiers hommes ont-ils quitté l'Afrique ; quelles étaient les conditions environnementales ;

volved in these different expansions? The phases of transitions between the Lower and Middle Palaeolithic and then the question of the arrival of modern humans and the appearance of the Upper Palaeolithic also led to passionate discussions. Fundamental questions on behaviour, resource management and cultural variability, were essentially addressed in the context of the Middle Palaeolithic which has many more sites than the very early periods, enabling a better approach to these phenomena. Throughout these topics, the problem of chronology, dating and correlation is imposed as a major theme in the in the effort to establish of a solid chronostratigraphic framework.

Several strong lines emerge from these researches. By its "strategic" location at the crossroads of three continents, the Near East played a fundamental role in the origin of European and Asian cultures. While the earliest traces of human populations are found in Africa, new discoveries in the Levant reopen questions related to human dispersal in the Old World. "Out of Africa" stands for several waves of expansion going off around two million years ago. The routes that enabled archaic hominids to spread in Eurasia have been in the focus of intense research that proved the Near East being a preferred passage toward Asia and Europe. In this context, during the Palaeolithic, the region extending across the modern territories of Syria, Lebanon, Israel and Jordan occupied a geographically privileged position. Until recently, sites scattered along the corridor outlined by the Syro-African rift valleys (i.e. the Dead Sea, Jordan, Beqaa and Orontes), indicated that the first hominids used this natural passage to move to the north. However, the more eastern routes through the "desert" were not considered at all for such early periods.

Fieldwork carried out for what will soon be thirty years by the Institute for Prehistory and Archaeological Science in Basel, within the framework of a close Syro-Swiss collaboration, have enabled the renewal of our understanding the settlement in Central Syria. In the El Kowm region, near Palmyra, a number of long Palaeolithic sequences being excavated allowed a detailed reconstruction of cultural and environmental evolution over almost two million years. The outcome of these researches is extensively developed in this volume. Originally, as we have said, the desire to present the results of our research in Syria to the scientific community was one of the major motivations for the conference in Basel. This involved comparing the El Kowm sequence with those in neighbouring regions in order to make connections between human behaviours in steppe- or desert zones and other more "favourable" biotopes, especially the Libano-Israeli coastal area. Subsequently, the comparison of the Levant with more distant territories in the Caucasus and Yemen, but also Iran and Mesopotamia, enabled identification of strong lines concerning the definition of supra-regional cultural entities and relationships between human groups separated by thousands of kilometres.

Of the more than thirty communications presented at Basel, some of our colleagues were unable to prepare papers for inclusion in this volume. Nevertheless, with the twenty-five contributions presented in the following pages, we hope that the reader will find some new paths touching on the Early and Middle Palaeolithic in the Near East and the origins of modern humans.

peut-on envisager des causes à cet Out of Africa ? Combien y eut-il de phases successives de dispersions humaines dans le Proche et le Moyen Orient ? Quels types humains furent les acteurs de ces différentes expansions ? Les phases de transitions entre le Paléolithique ancien et moyen puis la question de l'arrivée de l'homme moderne et de l'apparition du Paléolithique supérieur ont également donné lieu à des discussions passionnantes. Des questions fondamentales sur le comportement, sur l'exploitation des ressources ou la variabilité des cultures furent essentiellement abordées dans le cadre du Paléolithique moyen dont les gisements beaucoup plus nombreux que dans les périodes très anciennes permettent une meilleure approche de ces phénomènes. Tout au long des travaux, le problème de la chronologie, des datations et des corrélations s'est imposé comme thème majeur dans l'établissement d'un bilan chronostratigraphique solide.

Quelques lignes fortes émergent de ces travaux. De par sa situation aujourd'hui encore "stratégique", au carrefour de trois continents, le Proche-Orient a joué un rôle fondamental dans l'origine des cultures européennes et asiatiques. Si les plus anciennes traces de peuplements se trouvent bien en Afrique, de nouvelles découvertes dans le Levant relancent les questions relatives aux dispersions humaines dans l'ancien monde. La sortie d'Afrique correspond à plusieurs vagues d'expansion qui débutèrent voilà environ deux millions d'années. Les voies qui permirent aux hommes archaïques de se répandre en Eurasie font l'objet d'intenses recherches qui prouvent que le Proche-Orient fut un passage privilégié en direction de l'Asie et de l'Europe. Dans ce contexte, au Paléolithique, la région s'étendant sur les territoires actuels de la Syrie, du Liban, d'Israël et de la Jordanie occupait une position géographique privilégiée. Jusqu'à ces dernières années, des gisements parsemant le couloir que constituent les vallées de la Mer morte, du Jourdain et de la Beqaa, indiquaient que les premiers hommes avaient utilisé vers le nord ce passage naturel résultant des mouvements tectoniques du grand rift syro-africain. On ne pensait pas alors que les routes orientales plus désertiques aient été empruntées à des époques aussi anciennes. Les recherches entreprises depuis bientôt trente ans par l'*Institut de Préhistoire et Science de l'Archéologie* de Bâle, dans le cadre de missions archéologiques syro-suisses ont permis de renouveler nos connaissances sur le peuplement de la Syrie centrale. Dans la région d'El Kowm, près de Palmyre, plusieurs grandes séquences paléolithiques en cours de fouille permettent de reconstituer en détail l'évolution culturelle et environnementale des deux derniers millions d'années. Les résultats de ces travaux sont largement développés dans ce volume. A l'origine, nous l'avons dit, le désir de présenter à la communauté scientifique les résultats de nos recherches en Syrie fut l'un des buts majeurs du projet du congrès de Bâle. Il s'agissait de confronter la séquence d'El Kowm à celle des régions avoisinantes afin d'établir des comparaisons entre les comportements humains en zone steppique ou désertique et dans d'autres biotopes plus "favorables", notamment les faciès côtiers libano-israéliens. Dans un deuxième temps, la comparaison du Levant avec les territoires lointains du Caucase ou du Yemen en passant par l'Iran et la Mésopotamie a permis de dégager quelques lignes fortes concernant la définition de groupes culturels supra-régionaux et des relations entre des cultures distantes de milliers de kilomètres.

Sur la trentaine de communications présentées à Bâle, certains de nos collègues n'ont pas eu la possibilité de concrétiser leurs intéressantes observations dans le volume présenté ici. Cependant avec les 25 contributions publiées dans les pages suivantes, nous espérons que le lecteur trouvera quelques pistes nouvelles touchant au Paléolithique ancien et moyen du Proche-Orient et aux origines des hommes modernes.

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Basel Symposium (May 8-10 2008).
Liège, ERAUL 126, 2011, p. 9-10.

EDITOR'S NOTE

Marcel OTTE
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It is a great honour and joy for us to be able to publish and make available the research projects written up after the conference in Basel, organised by my old friend, Professor Jean-Marie Le Tensorer and his team, as friendly as they are efficient and competent! Finding Syria as the central theme of these researches also constitutes for me a return to my distant youth since I made my début first in Lebanese context at Jacques Tixier's excavations at Ksar Aqil and immediately after my own at the tell of Qalat El'Mudiq near Hama in Syria where I worked several seasons under the responsibility of my friend, Professor Jean Balty. Even then (at the start of the 1970s), Sultan Muhensen had shown me the superb artefacts coming out of the pits in the El Kowm Basin. The vagaries of life separated me (temporarily, I hope) from this region to which my heart remains attached. That is to say that I was happy to again see this group of fabulous sites during later visits, too short, in particular those directed by my old "accomplice" Éric Boëda.

The conference in Basel thus presented itself in my view under the best auspices: centred on a key region too often overlooked, organised by an open-minded team, itself often forgotten, and in especially the conference was opened to entirely new perspectives and, in my view, of extreme richness for knowledge of Palaeolithic civilisations of the three converging continents. This is, however, the simple effect of geography but much more, radically new openings between worlds separated by ideologies, the vagaries of history and the persistent and sterile ostracism that still persists, more in the mind than in reality. So, In Basel, we were able to meet on neutral ground and in perfect cordiality representatives from Israel, Syria, Iran, Saudi Arabia, the United States, Japan, Ukraine, Germany, France, England and Switzerland of course, to which was mixed a little Belgian...

The most striking aspect was for me this meeting of different worlds, often ignored or even despised by one another: such is the magic of the Swiss alone. Comparisons between Obi-Rakhmat (Uzbekistan) and the Caucasus were earth-shattering for me: areas so close and so misunderstood finally met. It was the same for the relationships between the Iranian Zagros and the Levant: on the map, the sites are so close and yet remain so distant in the literature, information exchanges, reasoning and palaeocultural reconstructions. Obviously, I am thinking of the

C'est pour nous un grand honneur et une grande joie de pouvoir éditer et diffuser les travaux rédigés à la suite de l'excellente rencontre de Bâle, organisée par mon ami de toujours, le Professeur Jean-Marie Le Tensorer, entouré de son équipe, aussi sympathique qu'efficace et compétente ! Retrouver la Syrie comme point central à ces recherches constitue aussi pour moi comme un retour à ma lointaine jeunesse puisque j'y fis mes premières armes, d'abord dans le cadre libanais des fouilles de Jacques Tixier à Ksar'Aqil, tout de suite suivies par les miennes propres au tell de Qalat El'Mudiq près de Hama, en Syrie cette fois où j'avais pu travailler pendant plusieurs campagnes sous la responsabilité de mon ami, le Professeur Jean Balty. À ce moment-là déjà (début des années septante) Sultan Muhensen m'avait montré les superbes pièces provenant des puits du bassin d'El Kown. Les aléas de l'existence m'ont écarté (provisoirement j'espère) de cette région où mon cœur était pourtant resté accroché. C'est dire si je fus heureux de revoir cet ensemble de sites fabuleux lors de trop courtes visites ultérieures, en particulier sous la conduite de mon vieux "complice", Éric Boëda.

La rencontre de Bâle se présentait donc à mes yeux sous les meilleures auspices : centrée sur une région-mère, trop souvent oubliée, organisée par une équipe aux ouvertures d'esprit très larges, elle aussi, souvent oubliée, et surtout la rencontre fut ouverte selon des perspectives totalement neuves et, à mes yeux, d'une extrême richesse pour l'intelligence des civilisations paléolithiques des trois continents qui y convergent. Il ne s'agissait pas d'ailleurs de simples effets géographiques mais, bien davantage, d'ouvertures radicalement neuves entre des mondes écartelés par les idéologies, les aléas de l'histoire et les ostracismes tenaces et stériles qui y subsistent encore, davantage dans les esprits que dans les faits. Ainsi, à Bâle, avons-nous pu voir se rencontrer en terrain neutre et en parfaite cordialité, des représentants d'Israël, de Syrie, d'Iran, d'Arabie Saoudite, des Etats-Unis, du Japon, d'Ukraine, d'Allemagne, de France, d'Angleterre et de Suisse bien-sûr, auxquels s'était mêlé un petit Belge…

La notion la plus éclatante fut pour moi la rencontre de ces mondes, très souvent méconnus, voire méprisés, les uns des autres : telle est la magie des Suisses, et d'eux seuls seulement. Les comparaisons entre Obi-Rahmat (Ouzbékistan) et le Caucase furent pour moi comme des tremblements de terre : des relationships between the "Baradostian" and the "Ahmarian", which in my view should be grouped in the nebulous "Proto-Aurignacian", so important for the spread of modern humans in Europe but also, it appears, elsewhere; north to the Altai, southeast to Pakistan, southwest to the Negev. Yet all of the other periods were mutually enriched, such as the Acheulean, so brilliantly illustrated at Nadaouiyeh in Syria, recently discovered in Iran, pushing its tentacles to the Caucasus, Anatolian Kurdistan and along the southern margin of Asia, from Bab el Mandeb at Ormuz, and from there to the Indian sub-continent. Such cultural diffusion is thus found brilliantly presented, enriched and understood, at least in its fundamental mechanisms.

Yet, for me, the principal pivot of this conference was the revelation, already detected in the Arabian plate. In an old televised police program ("The last five minutes"), Commissioner Bourreille always finished by saying "Bon sang, mais c'est bien sûr!" (Good grief, but of course!) and hit his fist in his hand, leaving the watchers ("five minutes") to reconstruct with him the series of events leading to the crime (a kind of French Hercule Poirot). During the Pleistocene, this Arabian plate was an enormous demographic reservoir: steppes rich in game instead of the deserts of today, extending their fertility to herbivores as far as the eye could see. Different international teams have "taken a bite" on the edges of this succulent, immense and untouched cake: French, English, American, German or Swiss but also of course local Arabian experts. They have all come out with a harvest of dreams: Acheulean and especially "Levalloisian" abound, to such a point that we could ask whether the sites of the Levant, far from being limited to a corridor would be rather the margins of the Palaeolithic Atlantis still largely unknown… Since this exhilaration, presented in the sweetness, simplicity and even modesty of the speakers who in this way somewhat shaped me, a fixed idea has remained and developed in my mind: what was the role of this gigantic territory in all of the other regions that surround it? A little like a black hole in the universe, have we not been blinded by this evidence? The Arabian plate, today almost empty of people, may have on the contrary formed an unlimited reservoir for demographic and cultural changes the interactions of which we cannot understand without it.

At least, the Acts of this conference will present some of the components of this endless tangle; we are thus happy and proud to include it in the ERAUL series of the University of Liège, between non-French Francophones, but open and tolerant all the same… Good reading and in friendship.

zones si proches et si méconnues se rencontraient enfin. Il en fut de même pour les relations entre le Zagros iranien et le Levant : sur la carte, les sites sont si proches et restent pourtant si éloignés dans la littérature, dans l'échange des connaissances, dans les raisonnements et dans les reconstitutions paléoculturelles. Évidemment, je pense aux relations entre "Baradostien" et "Ahmarien", à mes yeux à rassembler dans la nébuleuse "proto-aurignacienne", si importante pour la diffusion des hommes modernes en Europe mais aussi, semble-t-il, ailleurs : vers le nord jusqu'à l'Altaï, vers le sud-est jusqu'au Pakistan, vers le sud-ouest jusqu'au Néguev. Mais toutes les autres périodes furent ainsi mutuellement enrichies, tel l'Acheuléen, si brillamment illustré à Nadaouiyeh en Syrie, récemment découvert en Iran, poussant ses tentacules jusqu'au Caucase, au Kurdistan anatolien et le long de la frange méridionale de l'Asie, de Bab el Mandeb à Ormuz, de là au sous-continent indien. Cette diffusion culturelle s'est ainsi trouvée brillamment illustrée, enrichie et comprise, au moins dans ses mécanismes fondamentaux.

Pourtant, pour moi, le pivot principal de cette rencontre fut la révélation, déjà subodorée de la plaque arabique. Dans une émission policière télévisée de jadis ("les cinq dernières minutes"), le commissaire Bourreille finissait inlassablement par dire "Bon sang, mais c'est bien sûr !" et il se tapait le poing dans la main, laissant aux téléspectateurs ("cinq minutes") pour reconstituer, avec lui, la série d'évènements ayant mené au crime (sorte d'Hercule Poirot à la française). Cette plaque arabique a constitué au pléistocène un réservoir démographique énorme : des steppes giboyeuses à la place des déserts actuels, étendaient leur fertilité aux herbivores à perte de vue. Diverses équipes internationales ont "mordu" les marges de ce gâteau succulent, immense et vierge : français, anglais, américains, allemands ou suisses et bien-sûr les experts arabes locaux. Elles en sont toutes sorties avec une moisson de rêves : Acheuléen et, surtout, "Levalloisien" y abondent, à un point tel que l'on peut se demander si les sites du Levant, loin de se réduire à un corridor ne seraient pas plutôt les marges de cette Atlantide paléolithique encore largement méconnue… Depuis cet étourdissement, présenté dans la douceur, la simplicité, l'humilité même des orateurs qui m'ont ainsi quelque peu ménagé, une idée fixe demeure et se développe dans mon esprit : quelle fut la part de ce gigantesque territoire dans toutes les autres régions qui l'entourent ? Un peu comme une tache noire au fond de l'Univers, n'avons-nous pas été aveuglés par cette évidence ? La plaque arabique, aujourd'hui quasi déserte, a pu au contraire constituer un réservoir sans fond aux flux démographiques et culturels dont on a tant de mal à comprendre les interactions ailleurs, sans elle ?

Au moins, les "Actes" de ce colloque présenteront-ils certaines composantes de cet écheveau sans fin, nous sommes donc heureux et fiers de les glisser parmi la série des ERAUL de Liège, entre francophones non-hexagonaux mais ouverts et tolérants tout de même… Bonne lecture et amitiés.

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ACKNOWLEDGMENTS

Jean-Marie LE TENSORER & Reto JAGHER
University of Basel

The Basel conference and the publication of these acts could not have taken place without the financial support of institutions and the precious and voluntary assistance of our collaborators.

We express our gratitude to our two principal partners: the *Swiss National Science Foundation* which has unceasingly supported us since the beginning of our work in Syria, and the *Tell Arida Foundation* which has endowed our mission with a remarkable infrastructure at El Kowm. In the field, our gratitude also goes to the *General Directorate of Antiquities and Museums of Syria* for its constant aid and collaboration.

This conference could not have taken place without the assistance of the *Freiwillige Akademische Gesellschaft Basel* and the *Federal department of Foreign Affairs* (in particular, HE Jacques de Watteville, former ambassador in Syria).

We address a special thanks to the Government of Basel-Stadt, in the person of Councillor Christoph Eymann, head of the *Department of Education*, for his warm official reception in the town-hall. We are also grateful to the University and its chancellor Antonio Loprieno for his support and his address at the opening of the symposium.

Finally, we turn now to our very dear collaborators whose work made this conference possible. Dorota Wojtczak ensured the preparation and coordination of the conference and the hard secretarial work indispensable to the success of such an event. We also thank Daniel Schuhmann for his technical assistance in the preparation of the abstract volume and his job as webmaster of the conference's homepage. In addition, our gratitude goes to Ruth Mienert who took on the role of gofer wherever needed before and during the conference, for being a perfect assistant for all editorial concerns and a mindful reader during the preparation of the papers. We are also grateful to Brigitte Heitz for solving all the puzzles in financial management and Hélène Le Tensorer who volunteered to edit the conference abstract volume. There is also Tomas Hauck to be mentioned for his input during the initial phase of preparing the conference.

Finally, we would like to express our full esteem to all of the reviewers who uncomplainingly and patiently replied to our re-

Le congrès Bâle et la publication de ses actes n'auraient pu avoir lieu sans le soutien financier d'institutions et l'aide précieuse et bénévole de nos collaborateurs.

Nous exprimons notre gratitude à nos deux partenaires principaux : le *Fonds national suisse de la recherche scientifique* qui n'a jamais cessé de nous soutenir depuis le tout début de nos travaux en Syrie et la Tell Arida Foundation qui a doté notre mission d'infrastructures remarquables à El Kowm. Sur le terrain, notre reconnaissance va également à la *Direction Générale des Antiquités et Musées de Syrie* pour son aide et sa collaboration sans faille.

Le colloque de Bâle n'aurait pu se tenir sans l'aide de la *Freiwillige Akademische Gesellschaft Basel* et du *Département fédéral des affaires étrangères*, (tout particulièrement en la personne de S.E. Jacques de Watteville, ancien ambassadeur en Syrie).

Nous adressons un remerciement spécial au gouvernement de Bâle-Ville, notamment à Monsieur le Conseiller Christoph Eymann, Chef du Département de l'Education, pour la réception officielle qu'il a organisée à l'Hôtel de Ville. Nous sommes également très reconnaissant à l'Université et à son Recteur, le Professeur Antonio Loprieno pour son soutien et son introduction chaleureuse à l'ouverture du symposium.

Enfin, nous nous tournons maintenant vers nos chers collaborateurs dont le travail a permis la tenue du congrès. Dorota Wojtczak a assuré la préparation et la coordination du colloque et le lourd travail de secrétariat indispensable au succès d'une telle manifestation. Nous remercions également Daniel Schuhmann pour son aide technique dans la préparation du volume des résumés du congrès et son travail de webmaster sur le site de la conférence. Notre gratitude va aussi à Ruth Mienert, véritable coursier, utile à tous avant et pendant le congrès, puis parfaite assistante en ce qui concerne l'édition et la préparation des actes du colloque. De même, nous sommes très reconnaissant à Brigitte Heitz pour son aide précieuse à démêler les questions financières et à Hélène Le Tensorer pour son travail bénévole si utile dans l'édition du volume des résumés. Thomas Hauck doit aussi être spécialement mentionné pour sa collaboration active durant la phase de préparation du congrès.

peated requests. Some of them really got involved in the primal editing of the present papers. We would also like to mention the ERAUL team at the University of Liège, especially Emmanuel Delye, who finally made it possible to get this volume finished. Last but not least we would like to express our gratitude to Professor Marcel Otte, our dear friend since a very long time, for his broadminded offer to publish this volume of the Basel Symposium in the *Etudes et Recherches Archéologiques de l'Université de Liège*.

Enfin, nous voudrions exprimer notre reconnaissance à tous les réviseurs des articles qui patiemment et sans complaintes ont répondu à toutes nos requêtes. Plusieurs d'entre eux ont réellement été impliqués dans l'édition du présent volume. Nous aimerions également mentionner tout spécialement l'équipe d'ERAUL de l'Université de Liège, notamment Emmanuel Delye, qui en fait ont permis la finalisation de ce volume.

Pour finir, nous nous tournons vers notre cher ami de longue date, le Professeur Marcel Otte, à qui nous tenons à exprimer notre gratitude pour son offre spontanée et généreuse de publier ce volume des actes du symposium de Bâle dans sa prestigieuse série des Etudes et Recherches Archéologiques de l'Université de Liège.

J.-M. Le Tensorer, R. Jagher & M. Otte (eds.). *The Lower and Middle Palaeolithic in the Middle East and Neighbouring Regions.*
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Liège, ERAUL 126, 2011, p. 13-24.

THE CORE-AND-FLAKE INDUSTRY OF BIZAT RUHAMA, ISRAEL : ASSESSING EARLY PLEISTOCENE CULTURAL AFFINITIES

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Introduction

Since its discovery, Bizat Ruhama has drawn the attention of Paleolithic archaeologists because of its unique industry. The first scholars studying the lithic artifacts from the site were participants of the Nahal Shiqma archaeological survey (Lamdan *et al.* 1977). They described the industry as composed of "unique tools, which are very difficult to classify by conventional typological means" (Lamdan *et al.* 1977:55). In order to emphasize its exceptional nature, the industry had been assigned to a separate cultural unit called the Nagilan, after the name of the nearby Tel Nagila (Ronen 1979). The age of the site was unknown, but according to the stratigraphic position and simplicity of the tool forms it was assigned to the Lower Paleolithic (Lamdan *et al.* 1977; Ronen 1979).

The excavations conducted at the site in 1996 and subsequent lithic studies (Ronen *et al.* 1998; Zaidner 2003a; Zaidner *et al.* 2003) confirmed that the industry of Bizat Ruhama has no clear parallels among known Lower Paleolithic sites in the Southern Levant, which usually show Acheulian affinities (e.g. Bar-Yosef 1998; Goren-Inbar 1995; Ronen 1979). The characteristics of the lithic assemblage excavated during the 1996 campaign can be summarized as follows:
1. Absence of handaxes and handaxes' preparation flakes.
2. Flake-oriented, rather than core-tool-oriented technology.
3. Small size of the flakes, many of which were subsequently modified.

Especially, the small size of the artifacts was viewed as the major characteristic distinguishing Bizat Ruhama from other Lower Paleolithic assemblages in the Levant and beyond, and was used for comparison with other industries (Burdukiewicz & Ronen 2003; Derevianko 2009). The industry was often called "microlithic", not only to emphasize the small size of the artifacts, but also to link it to the "microindustrial complex" of the Lower Paleolithic in Europe (Burdukiewicz & Ronen 2003; Derevianko *et al.* 2000; Derevianko 2009).

Recent dating efforts led to a breakthrough in the understanding of the Bizat Ruhama industry. The site is now robustly dated to the Matuyama paleomagnetic chron (1.96-0.78 Ma), based on paleomagnetic and faunal evidence (Dassa 2002; Laukhin *et al.* 2001; Yeshurun *et al.* in press; Ron & Gvirtzman 2001; Ronen *et al.* 1998; Zaidner *et al.* 2010). According to this evidence, Bizat Ruhama is an Early Pleistocene site representing one of the earliest records of hominin presence outside of Africa.

Currently, the Eurasian Early Pleistocene archaeological record is extremely fragmentary. Large assemblages of Early Pleistocene artifacts in primary depositional context were reported only from Dmanisi (Georgia) and 'Ubeidiya (Israel) (Bar-Yosef & Goren-Inbar 1993; Bar-Yosef & Tchernov 1972; de Lumley *et al.* 2005; Gabunia & Vekua 1995; Gabunia *et al.* 2000). In other Early Pleistocene occurrences either the number of artifacts or the size of excavated/available for excavations areas are very small, or the context of the artifacts is questionable (Ronen 1991a; Arzarello *et al.* 2006; Carbonell *et al.* 1999, 2008; Chauhan 2009; Dennell 2009; Oms *et al.* 2000; Santonja & Villa 2006). At present, Bizat Ruhama and Dmanisi are the only large Early Pleistocene core-and-flake assemblages discovered in Europe and south-western Asia. The scarcity of other evidence makes the prospects of studying the paleoecology, the technological behavior, and the cognitive and motor skills of Bizat Ruhama hominins paramount for understanding the earliest hominin adaptations in Eurasia.

It is from this standpoint that a new field project was launched at the site in 2004. The excavations (2004-5) had two major goals: firstly to provide large lithic assemblages for a detailed technological study, and secondly to verify the primary context of these assemblages. This paper focuses on a few general aspects of the newly studied assemblages. Following a general description of the industry, it discusses the question of the small size of the artifacts - the feature previously viewed as the main characteristic distinguishing between Bizat Ruhama and other Lower Paleolithic industries in the Levant and beyond. Finally, based on the new data, the paper assesses the place of Bizat Ruhama industry within the Lower Paleolithic record.

The site and the excavations

Bizat Ruhama is located at the fringe of the Negev desert, on the southern part of the Israeli coastal plain, 25 km east of the

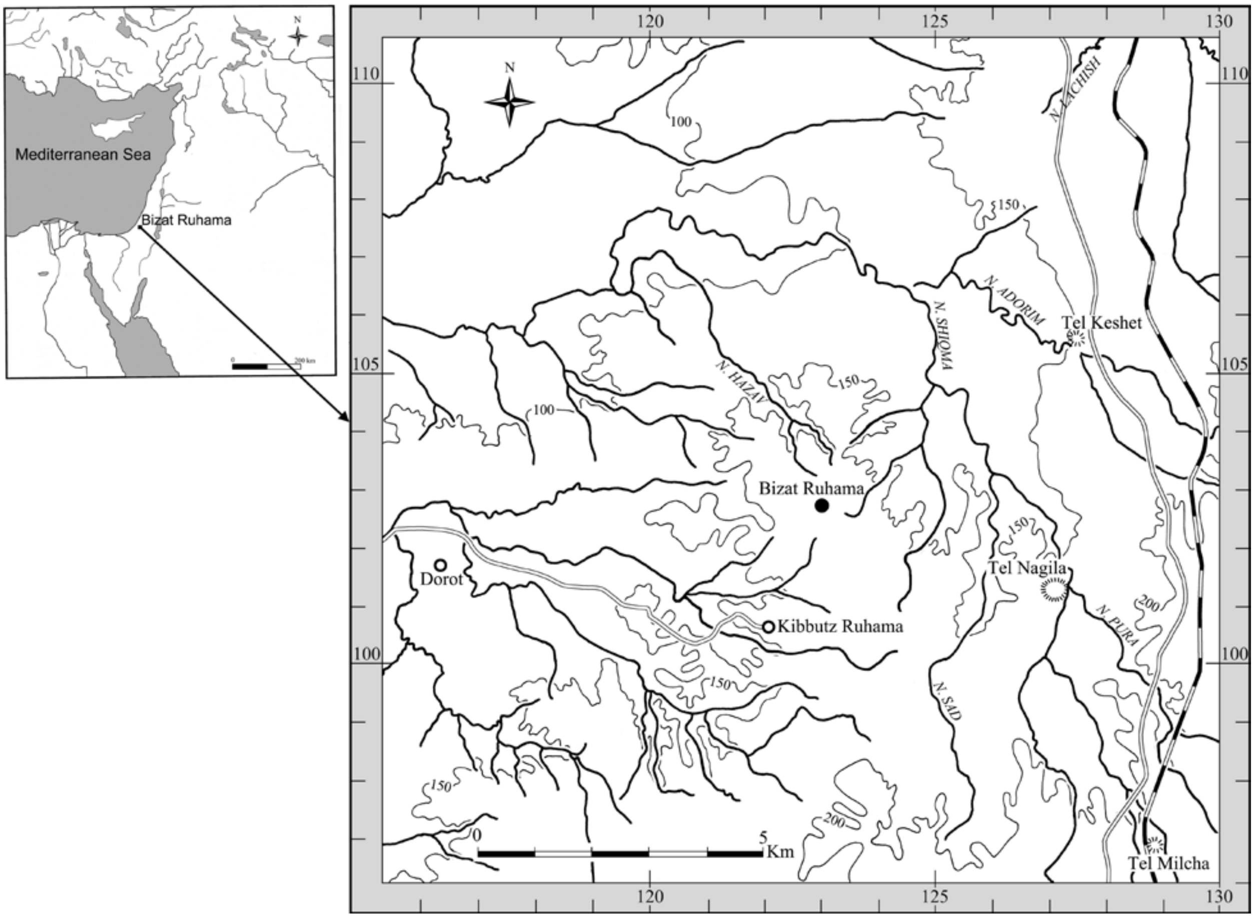

Figure 1 - Location map.

present Mediterranean shoreline. The area is characterized by a landscape built of low undulating loess and hamra hills (160-190 m.a.s.l), intersected by a number of badland fields. The archaeological layer was discovered at the bottom of one of these fields located between Nahal (stream) Shiqma and Kibbutz Ruhama (fig. 1).

OR T4, excavated in the western part of the site, the characteristic sandy layer with few bones and a single flake was detected underlying 1.5 meter of clay deposits, suggesting that the artifact-bearing deposit extended to the west of 1996 excavation area, where it is buried under massive (up to 15 m thick) clay and loess deposits. BR T6, excavated in the eastern part of the

Area	Size of the area (square meters)	Finds	Density of the lithics (per square meter)	Bottom of the archaeological layer (below datum)	Microstratigraphy
BR AT5	25	Lithics 701 Bones ~1000	28	~4.55 m	Sandy layer is ca 0.3-0.5 m thick. Contact with grayish black clay and with hamra is diffuse.
BR 1996	11	Lithics 993 Bones ~50	82.5	~ 5.13 m	Sandy layer is 0.2 m thick. Contact with grayish black clay and with hamra is sharp. The top contact is finely laminated –with alternating sand and clay laminae.
BR T1	2	Lithics 44 Bones – only few small splinters	22	~4.95 m	Sandy layer is 0.3 m thick. Gray-yellowish gray sand is gradually getting partly-colored with greenish-gray and purple-red patches at the bottom. Contact with grayish black clay and with hamra is diffuse.
BR T2	4	Lithics 149 Bones – few small splinters	37.3	~5.4 m	The yellowish-gray sand is highly disturbed by clay and yellow sand lenses and pockets. The contact with hamra is sharp and erosional.
BR T3	1	Lithics 28 Bones 20	28	~4.15 m	Sandy layer is 0.25 m thick. Contact with grayish black clay and with hamra is diffuse.

Table 1 - Size of the excavated areas, density of the finds and microstratigraphy.

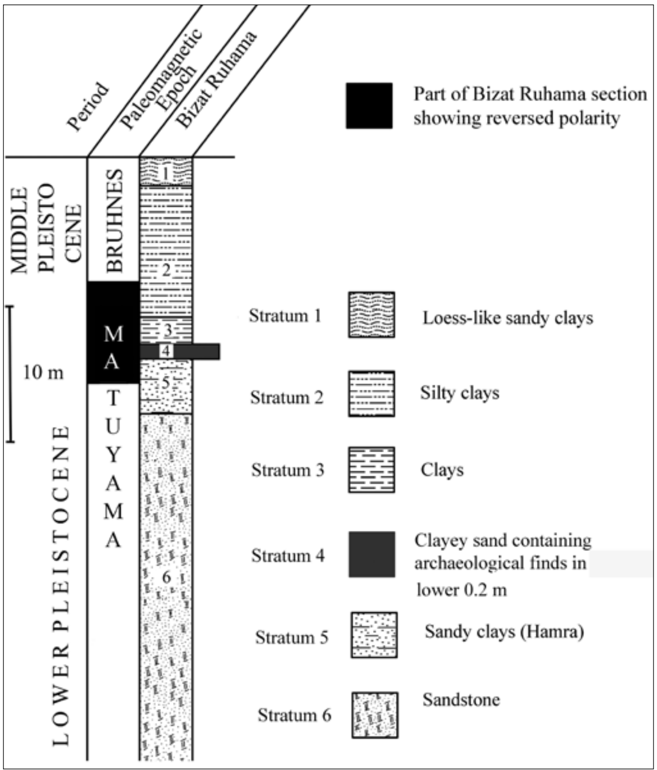

Figure 2 - Bizat Ruhama composite stratigraphic section. Composite stratigraphical chart is based on study of Bizat Ruhama type-section (strata 1-5; Ronen *et al.* 1998; Laukhin *et al.* 2001; Mallol *et al.* 2011) and on Bar-Yosef 1964.

site, probably marks the south-eastern border of the archaeological occurrence. Here, the archaeological layer was washed away by post-occupational flows that deposited sand and clay on top of the hamra.

The results of the spatial reconnaissance allow for reconstructing the overall extent of the site. The thick black line on figure 4 marks the border of the archaeological occurrence. The occupation level and characteristic artifacts were not found east of this line. West of the line artifacts and bones appear in patches of varying density. On the west and north-west the archaeological deposit is buried under 10-15 meters of paleosols and loess, making it difficult to discern its western and northern boundaries. Given this, the minimally estimated extension of the artifact-bearing layer is of few thousands square meters.

The site was excavated in three trenches (BR T1, BR T2, and BR T3) and an area of 25m² (BR AT5) (figs. 3, 6). The excavations were conducted at the locations where, during the survey, concentrations of artifacts and bones were recorded. The lithics were found in different densities in all excavated areas (tab. 1). The bones were only found to be well preserved in BR AT5 and BR T3. In BR AT5 lithics and bones appear together in a ca. 15cm thick layer over a total excavated area of 25m² (see Yeshurun *et al.* in press for a full account of the faunal remains). Flint microdebitage and bone splinters appear as well. Scarce microfaunal remains were also found.

In all the excavated areas artifacts appear in the lower part of the sandy layer close to, or immediately on the contact with the underlying hamra (Zaidner *et al.* 2010). It should be emphasized that although the general stratigraphy is similar to the one established by Laukhin *et al.* (2001), variations in thickness and in nature of transition between the hamra and artifact-bearing sand occur in the areas excavated in 2004-05 (tab. 1). The variations in microstratigraphy are probably due to the unevenness of the hamra surface on which the artifacts were accumulating. The hamra surface was encountered at different elevations along the outcrops of both channels and in the excavated areas (tab. 1).

The settlement pattern of the site could only be briefly discussed at this stage. Geological and faunal evidence indicate that hominins inhabited inter-dune depressions in an open homogeneous semi-arid environment with no evidence for river or lake in the immediate surroundings during the occupation (Mallol *et al.* 2011, Yeshurun *et al.* in press, Zaidner *et al.* 2010). The archaeological remains occur over an extensive surface in distinct layer at an essentially identical elevation. Most of this area, however, is still covered by 2-4 meters of clay (Stratum 3). Based on minimal estimation of the site's extent, less than 5% were excavated and the excavation areas opened to date should be viewed as probes only. Combined results of the survey and excavations show that artifacts are not evenly distributed over the entire exposure of the artifact-bearing deposit. At this stage it seems reasonable to view the site as a series of repeated occupations over relatively short period of time (see Mallol *et al.* 2011, Zaidner *et al.* 2010).

The lithic industry

The excavations conducted at Bizat Ruhama in 1996 and 2004-05 have yielded relatively large lithic assemblages (tab. 2). Together with the artifacts collected during earlier surveys, the Bizat Ruhama assemblage consists of ca. 3000 artifacts. The entire assemblage was subjected to in-depth technological and experimental studies (Zaidner in preparation). Here I present the general account of the assemblages excavated in 1996 and 2004-05 (N=1918). All the knapping activities performed at the site were aimed at producing flakes, many of which were subsequently modified. Thus, the knapping at the site is classified as debitage in the sense of Inizan *et al.* (1999). The Bizat Ruhama lithic industry as presented in table 2-5 is a combination of well-known, previously described technological types (e.g. cores, flakes, Clactonian notches, Clactonian notch waste flakes etc.) with newly introduced categories (e.g. anvil flakes, flakes with trimmed edges etc.).

Raw materials

The most frequent types of rock used at Bizat Ruhama were Senonian-Paleocene, brecciated (Mishash Formation) and Eocene, fine-grained (Adulam Formation) chert pebbles (Zaidner *et al.* 2003). In the vicinity of the site, both occur in conglomerate exposures of the littoral Pleshet Formation. Today, the nearest available exposures of the Pleshet Formation are located some 2.5 km to the east of Bizat Ruhama. Since the Plio-Pleistocene sediments in the area are covered by Middle/Upper Pleistocene loess and clays it is reasonable to suggest that during the occupation, the conglomerates were more extensively exposed and could occur closer to the site.

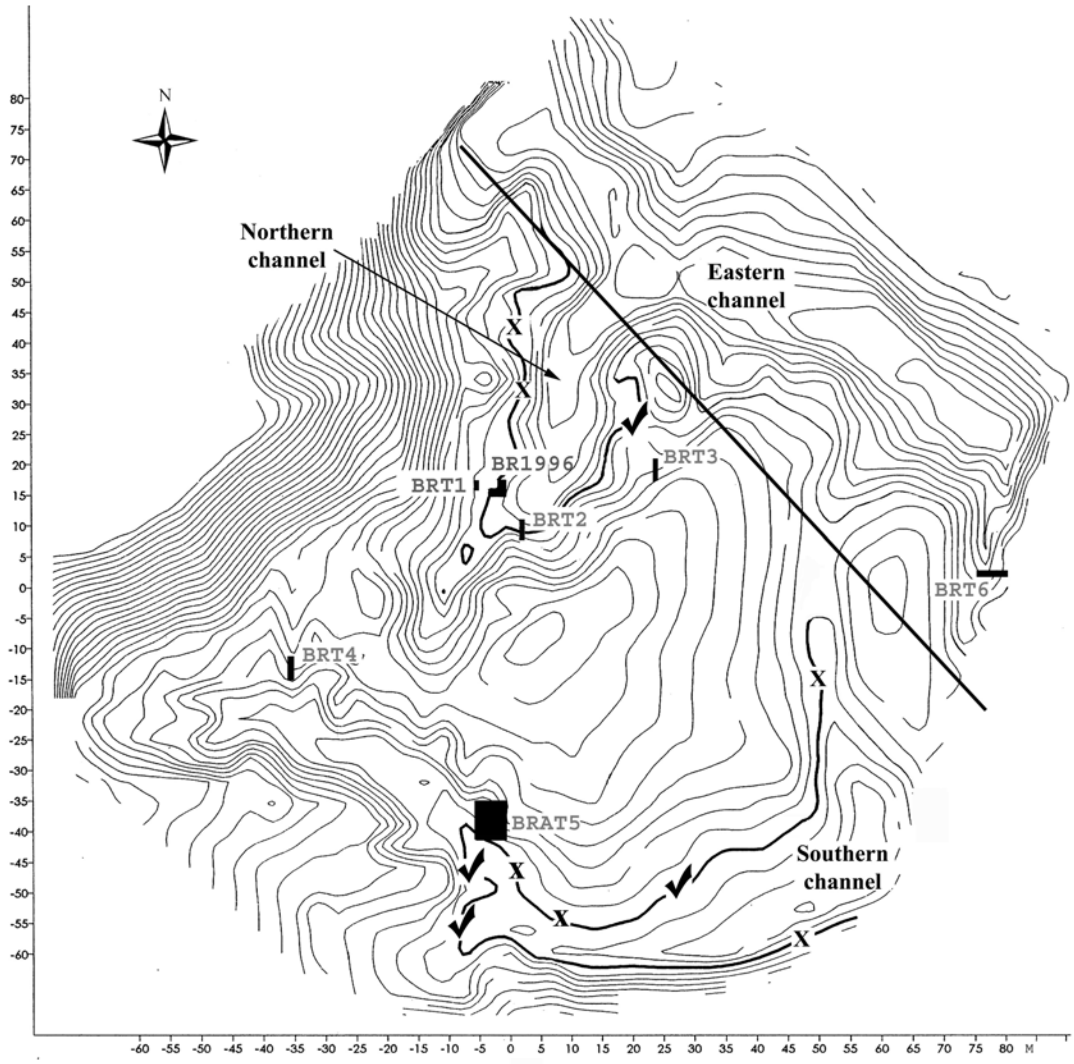

Figure 3 - Plan of the site. Note: BR 1996 means Bizat Ruhama, 1996 season of excavations. BR AT5, BR T1, BR T2, BR T3, BR T4, BR T6 – 2004-05 excavated areas and trenches. ✓ – Sampled locations with in situ artifacts or bones. X – Sampled locations without artifacts or bones. Thick curved black lines mark a contour of the erosional channels along which archaeological layer is exposed. The black line stretching from NW to SE marks the eastern border of the archaeological occurrence.

	BR AT5		BR 1996		BR T1		BR T2		BR T3		BR T4	BR T6	Total
Pebbles	17	2%	23	2%	5	11%	8	5%	1	4%			**54**
Hammerstones	2	0%	1	0%									**3**
Anvils		0%			1	2%							**1**
Flaked pieces	38	5%	69	7%	6	13%	17	11%	1	4%		1	**132**
Detached pieces	297	42%	399	40%	21	47%	60	40%	14	50%	1		**792**
Further knapped flakes	205	29%	431	43%	9	20%	58	39%	5	18%			**708**
Clactonian notch waste flakes and retouch flakes	137	20%	20	2%	1	2%	3	2%	7	25%			**168**
Desilicified pieces and chunks	5	1%	50	5%	2	4%	3	2%		0%			**60**
Total	**701**		**993**		**45**		**149**		**28**		**1**	**1**	**1918**

Table 2 - Composition of the lithic assemblages.

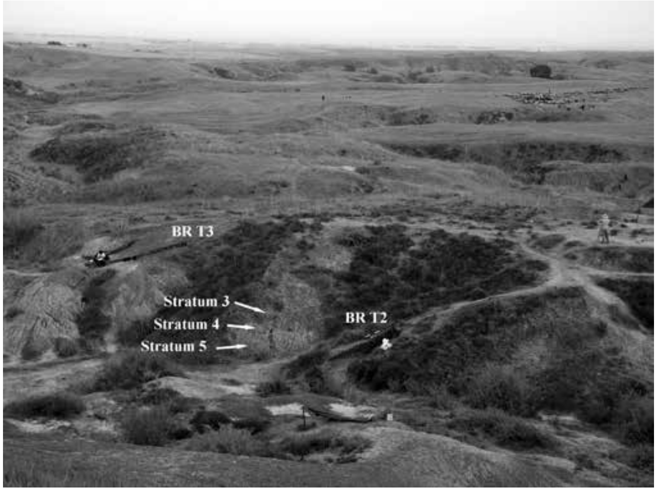

Figure 4 - Bizat Ruhama site. The northern channel during the 2004 season of excavation.

Figure 5 - Bizat Ruhama site. The southern channel during the 2005 season of excavation.

The pebbles in Pleshet Formation exposures are highly rounded and do not provide good knapping angles (fig. 7). The size of the pebbles differs significantly according to their lithology (tab. 6). Eocene chert pebbles are very small; none of them is larger than 80 mm. Brecciated chert pebbles are significantly larger with many specimens larger than 150 mm. As discussed below, the size and shape of the raw materials had a crucial impact on the knapping methods and techniques as well as on the size of the artifacts.

Pounded Pieces and Unmodified

The group includes unmodified pebbles, hammerstones and one 18 cm long flat limestone pebble presumably used as an anvil. Three pebbles 7-8 cm long exhibiting concentrated percussion damage on one of the edges were interpreted as hammerstones. More than 70% of the unmodified pebbles are 1.5-3 cm long.

Flaked Pieces (FPs)

This term was introduced by Isaac (1986) to include all pieces from which flakes were removed including retouched pieces. It is much less in use recently, since most authors prefer to separate between cores and retouched flakes (e.g. Shea & Bar-Yosef 1998; Sahnouni 2006; de la Torre *et al.* 2003; Roche *et al.* 1999). In Bizat Ruhama, due to the simplicity in core forms, the large number of broken pebbles and the high frequency of exhausted and shattered cores or core fragments (tab. 3), the term was retained to include all forms from which flakes were detached. "Further knapped flakes" (see below) are excluded from this category.

Broken/tested pebbles

This category includes broken pebbles and pebbles with few small removals. Noteworthy is a size of the most of the pieces in the category, which do not exceed 3 cm.

Choppers

Choppers are exceptionally rare in the assemblages. Only two bifacial choppers were found in BR 1996 (fig. 8:2). Both exhibit sinuous and not well shaped worked edges, suggesting that they were cores for removing flakes rather than configured tools.

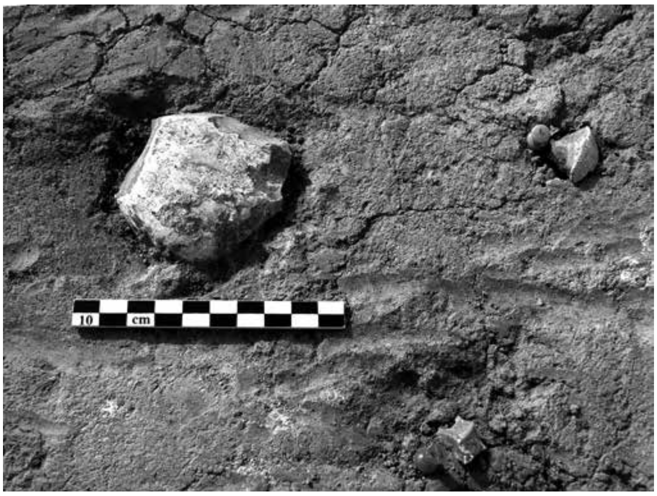

Figure 6 - Excavated surface in BR AT5.

Figure 7 - Chert pebbles found at the site, 1 brecciated chert pebble found in BR 1996, 2 Eocene chert pebble found in BR AT5.

Flaked pieces	BR AT5	BR 1996	BR T1	BR T2	BR T3	BR T6	Total
Broken pebbles	10 26%	14 20%	3 50%	5 29%			**32**
Choppers	0%	2 3%					**2**
Cores	15 39%	10 14%	1 17%	7 41%		1	**34**
Bipolar cores	6 16%	10 14%	0%	1 6%			**17**
Exhausted cores	7 18%	33 48%	2 33%	4 24%	1		**46**
Total	**38**	**69**	**6**	**17**	**1**	**1**	**132**

Table 3 - Flaked Pieces assemblages.

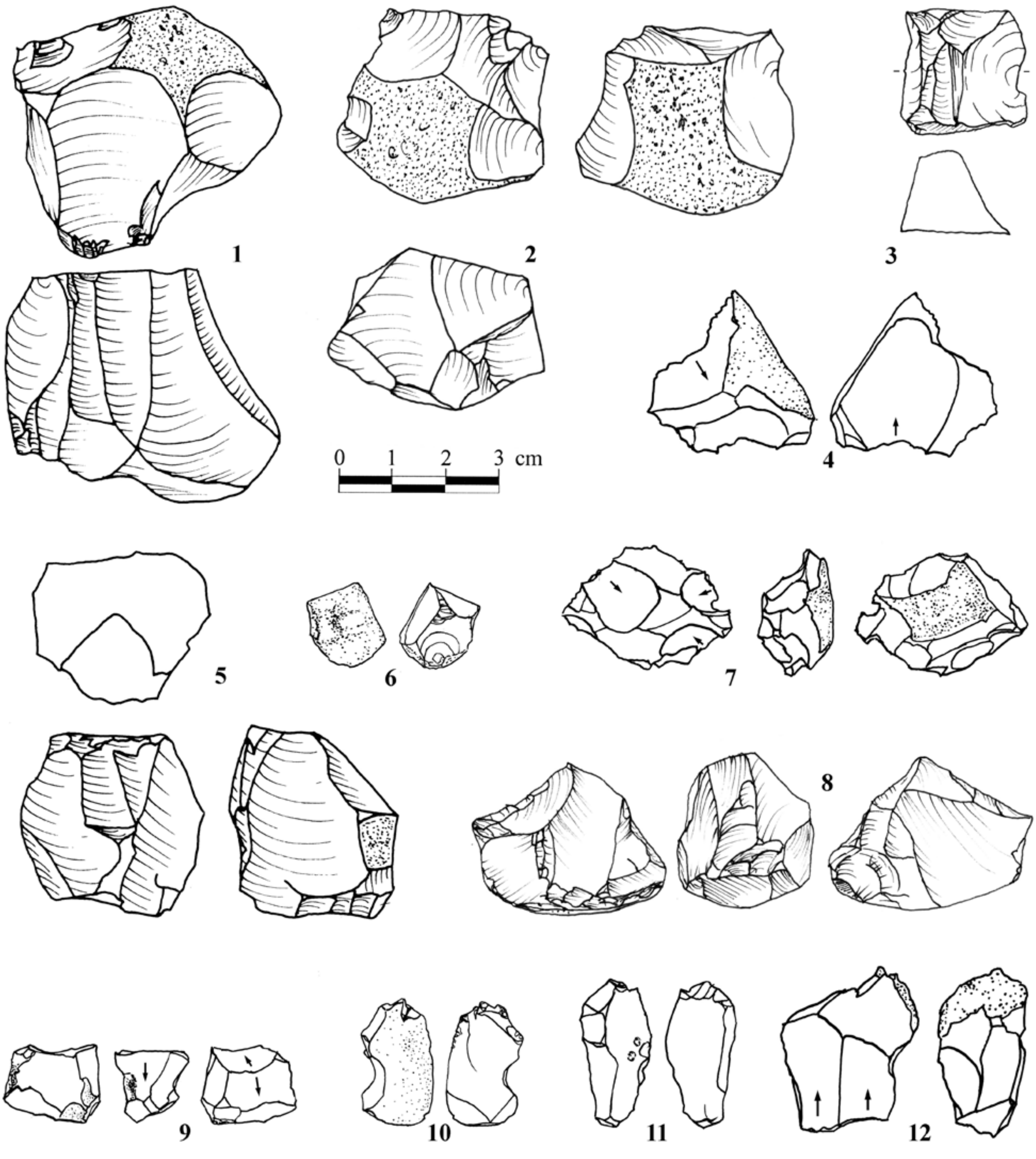

Figure 8 - 1: unifacial unidirectional core, 2: chopper, 3: clactonian notch, 4, 12: flaked flakes (arrows mark post-detachment removals), 5: bipolar core, 6, 10-11: bipolar flakes, 7, 9: exhausted cores (arrows mark scars of the small flakes removed on the final stage of the reduction), 8: multifacial multidirectional core.

Cores

The Bizat Ruhama assemblages include 43 cores knapped by a number of flaking methods. Both bipolar and free-hand hard hammer technique were used at the site. The choice of the methods and techniques was largely determined by the size and the shape of the available pebbles. Thus, probably because of the rounded shapes, the natural surfaces of the pebbles were not used as striking platforms. Instead, the striking platforms were prepared by a single blow splitting the pebble in two halves or removing an opening flake. Although the same methods and techniques were used during the knapping of both raw material types, Eocene chert was more frequently knapped by bipolar technique (fig. 8:5-6, 10, 12). This chert is by far more common among bipolar cores (62.5%) than among other types of cores (32.4%). The predominant use of the bipolar technique during the knapping of the Eocene chert cores is clearly linked to the small size of pebbles.

Larger pebbles were reduced by unifacial unidirectional, multifacial unidirectional, multifacial multidirectional and preferential surface methods. During unifacial and multifacial unidirectional reduction methods a series of 2-5 flakes were removed from a single platform (fig. 8:1). Multifacial multidirectional reduction involved constant opportunistic rotation of the cores in search for appropriated angles (fig. 8:8). Preferential surface cores show more complicated patterns of exploitation with a clear hierarchy between striking platform and flaking surface. They are made on relatively flat pebbles and show a number of unidirectional removals and signs of rectification of the striking platform. Only three such cores were found in the assemblages (1 in BR AT5 and 2 in BR 1996). Many of the cores were intensively reduced resulting in a high number of exhausted core forms.

Exhausted cores

Many cores in Bizat Ruhama assemblage were knapped to the point where the knapping methods and techniques could not be identified. These are small and heavily reduced pieces, which often lack identifiable striking platforms and debitage surfaces. Some of them bear a few scars of small and thin flakes removed from the cores on the last stage of the reduction before their abandonment (fig. 8:7, 9). The length of those scars is 1-2 cm; they are shallow and sometimes reminiscent of Clactonian notches in the characteristic concave shape of the edge.

Exhausted cores are especially dominant in BR1996 (tab. 3). Their presence in the studied assemblages is most likely a result of utilization of small pebbles conjoined with high level of core reduction intensity.

Detached Pieces (DPs)

The distribution of flake types according to breakage patterns is presented in table 4. The DP's assemblages contain only a small number of complete flakes in all excavated assemblages. Most of the flakes are thick and have steep edges. Opening flakes are rare and flakes with cortical platform are virtually absent. The absence of the latter is a result of the core reduction method in which the cortical surface of the pebble was not used as striking platforms. Angular fragments are dominant in all assemblages. Experimental study suggests that the high frequency of broken DPs is a characteristic outcome of the bipolar flaking (Zaidner, in preparation). Similar results were obtained in other experimental studies as well (Kuijt *et al.* 1995; Jeske & Lurie 1993; Amick & Maudlin 1997).

Further Knapped Flakes

The secondary knapping of the flakes in Bizat Ruhama assemblages was a highly common practice (tab. 2). Many of the flakes were further knapped, broken or notched. In BR1996 and BR T2 "further knapped flakes" outnumber unmodified Detached Pieces.

The flakes were knapped by a number of techniques. They were frequently used as cores for free-hand removal of thin small flakes (flaked flakes in table 3; fig. 8:4, 12). The number of flaked flakes is highest in BR 1996 (tab. 5). Usually 1-3 thin flakes were removed from either the ventral or dorsal faces. In other cases flakes were knapped or broken on an anvil, creating a number of broken fragments (Anvil Flakes in table 5). Anvil flakes show signs of the impacts on the intersection of ventral/lateral and dorsal/lateral surfaces that according to knapping experiments were produced during flake knapping on an anvil (Zaidner, in preparation).

Detached pieces	**BR AT5**		**BR 1996**		**BR T1**		**BR T2**		**BR T3**		**BR T6**	**Total**
Complete flakes	89	30%	93	23%	2	10%	15	25%	4	29%		**203**
Proximal fragments	51	17%	60	15%	5	24%	7	12%	3	21%		**126**
Distal and mesial fragments	41	14%	69	17%	7	33%	8	13%	4	29%		**129**
Lateral fragments	18	6%	35	9%			3	5%	1	7%		**57**
Siret fragments	19	6%	18	5%	1	5%	5	8%				**43**
Angular fragments	79	27%	124	31%	6	29%	22	37%	2	14%		**233**
Total	**297**		**399**		**21**		**60**		**14**			**791**

Table 4 - Detached Pieces assemblages.

Further knapped pieces	BR AT5		BR 1996		BR T1		BR T2		BR T3		BR T6	Total
Flaked flakes	2	1%	21	5%			4	7%				**27**
Anvil flakes	44	21%	73	17%			13	22%				**130**
Anvil flakes?	14	7%	41	10%			4	7%	1	20%		**60**
Clactonian notches	68	33%	139	32%	5	56%	18	31%				**230**
Flakes with trimmed edge	77	38%	157	36%	4	44%	19	33%	4	80%		**261**
Total	**205**		**431**		**9**		**58**		**5**			**708**

Table 5 - Further Knapped Detached Pieces assemblages.

	N	Min.	Max.	Mean	Std. Dev.
Becciated chert	149	18.9	235.2	80.35	43.36
Eocene chert	59	13.8	86.3	39.32	17.28

Table 6 - Length im mm of the pebbles collected during the survey conducted around the site in 2001 (Zaidner 2003a).

		Brecciated flakes	Eocene flakes	Flaked flakes
Techno-logical Length	N	80	111	12
	Min.	13.5	8.4	17.9
	Max.	54.2	67.5	60.7
	Mean	26.39	20.3	35.3
	Std. dev.	8.72	7.06	16.48
Maxi-mum length	N	88	124	27
	Min.	17.1	12.9	17.8
	Max.	60.2	67.9	63.1
	Mean	28.79	24.26	33.43
	Std. dev.	9.47	6.48	11.48

Table 7 - Length in mm of selected artifact categories in Bizat Ruhama lithic assemblages.

A large group of flakes was further modified by Clactonian notching. Many of the Clactonian notches were shaped by relatively large removals similar in size to the scars on flaked flakes (fig. 8:3). The technological differences between the two are vague and it is possible that some of the Clactonian notches were cores for the production of small sharp flakes as well. The last type of modification consists of signs of rough trimming on the flake edges (tab. 3). It is unclear how intentional the trimming is, since similar signs can be produced unintentionally during anvil breakage of the flakes (e.g. Bergman *et al.* 1987; Crovetto *et al.* 1994; Longo *et al.* 1997; Peretto 1994; Zaidner in preparation). In fact, the entire spectrum of "retouch" morphologies identified in Bizat Ruhama assemblages could be produced unintentionally, as shown during experimental knapping of the flakes on an anvil. Thus, previous descriptions of the industry as containing high number of retouched flakes (Ronen *et al.* 1998; Zaidner *et al.* 2003) are questionable, given the results of the recent study.

Clactonian notch waste flakes and retouch flakes

Small thin flakes with specific morphology were identified as Clactonian notch waste flakes. Clactonian notch waste flakes are 1.5-3 cm in maximum dimensions. The flakes are usually wider than they are long. In some cases the butt is the widest and thickest part of the flake. In BR AT5 137 such flakes were found. Most of them are complete and show no sign of physical abrasion.

The significance of the artifacts size in light of the recent studies

The 1996 season of excavations indicated that Bizat Ruhama industry is composed of diminutive artifacts (Ronen *et al.* 1998; Zaidner 2003a; Zaidner *et al.* 2003). Only a few pieces larger than 5cm were found (Zaidner 2003b). During the 2004-05 seasons of excavation a number of larger pebbles, cores and flakes were unearthed. Among the largest are a limestone pebble (18 cm long) interpreted as an anvil in BR T1, a large core fragment (11 cm long) found in 2004 during cleaning of BR 1996 section and a large core 22 cm long exhibiting scars of 4 small flakes removed from one of the edges found in BR T6. All together, the evidence now indicates that large pebbles were available and were knapped. However, the majority of the artifacts found during 2004-05 excavations are still smaller than 3 cm.

The size of Bizat Ruhama artifacts was previously used as a major consideration in assessing the genesis of the industry and establishing its place among Lower Paleolithic taxonomic units (Burdukiewicz & Ronen 2003; Derevianko 2009; Ronen 1979; Ronen *et al.* 1998; Zaidner *et al.* 2003). The site was often discussed as part of the "microlithic complex" of the Lower Paleolithic (Burdukiewicz & Ronen 2003; Derevianko *et al.* 2000; Derevianko 2009). The more recent studies reported here indicate that artifacts dimensions in Bizat Ruhama are influenced by the size of the available raw materials, the intensity of flaking, and the selection of larger flakes for further knapping. Among 1500 Detached Pieces in the assemblages the technological length could be measured only for 203 complete flakes. Other Detached Pieces are either broken, or, more significantly, were further knapped. Among 708 further knapped flakes the technological length could be determined only for a few. Nonetheless, the evidence suggests that the largest flakes were chosen for further knapping. For instance, the mean maximum length of flaked flakes is significantly higher than the maximum length of complete unmodified flakes (tab. 7; Kolmogorov-Smirnov test: Z = 2.37; p = 0.000). The length values of anvil flakes, which size was significantly diminished by breakage on an anvil, are only slightly lower than the length values of complete flakes. Thus, it is likely that the selection of the large flakes for secondary reduction biased the average length of complete flake assemblages toward the smaller values.

The intensity of the core reduction is another reason for the small dimensions of the artifacts. The cores constitute only 14-40% of the Flaked Pieces in the assemblages. Many pieces in the FPs' category are exhausted cores that are considerably smaller than the cores (tab. 7). The intensity of the reduction is evident in the very little cortex that exhausted cores exhibit on their surfaces (fig. 9). Given the small size of the used pebbles the absence of cortex on many of them is especially remarkable. Such an intensive reduction undoubtedly affected the size of the Detached Pieces.

The evidence for the influence of raw material size on the size of the artifacts is clearly visible while comparing the length values of Eocene and brecciated chert complete flakes (tab. 7). Because of the tiny size of the pebbles, Eocene chert flakes are significantly shorter than brecciated chert flakes (Kolmogorov-Smirnov test: Z = 2.04; p = 0.000). All in all, the available evidence indicates that the small size of the pebbles together with the desire of the knappers to maximize the raw material exploitation led to the small dimensions of Bizat Ruhama artifacts.

It should be emphasized that the length of Bizat Ruhama artifacts does not differ much from values recorded in other Early Pleistocene sites. A short survey of the published data shows that both Acheulian and Oldowan techno-complexes contain sites with very small flakes. In fact, the brecciated chert flakes in Bizat Ruhama are longer than flakes in many other Pliocene/Early Pleistocene assemblages in the Levant and Africa, which were never previously linked to the "microlithic complex". For example, both other Early Pleistocene sites in the Levant, ʻUbeidiya and Evron Quarry, contain assemblages with complete flakes shorter than brecciated chert flakes in Bizat Ruhama (fig. 10). Unlike Bizat Ruhama, both sites contain handaxes and core-tools and show Acheulian affinities (Bar-Yosef & Goren-Inbar 1993; Bar-Yosef 1998; Ronen 1991b; Tchernov *et al.* 1994). Some Plio-Pleistocene sites in Africa, identified as Oldowan, also show length values lower than brecciated chert flakes in Bizat Ruhama (fig. 10). The small size of the flakes in many Oldowan assemblages was previously noted by other authors as well (Barsky 2009; Ludwig & Harris 1998). In some of these sites (Fejej FJ-1a, Omo sites, FtJi1, Senga 5), as in Bizat Ruhama, the size of the artifacts was clearly predetermined by the small size of the used pebbles (de la Torre 2004; Ludwig & Harris 1998; Harris *et al.* 1987; Barsky 2009; Merrick & Merick 1976).

The place of the Bizat Ruhama industry in the context of the Lower Paleolithic record

The study indicates that Bizat Ruhama is a core-and-flake industry lacking traces of biface production or any other form of bifacial knapping. With the results of new studies at the site, there is sufficient evidence to claim that Bizat Ruhama industry is not a part of Acheulian techno-complex. The 2004-05 fieldwork and subsequent interdisciplinary studies finally confirmed that the absence of Acheulian tools is not the result of a biased sample or post-depositional erosion (Zaidner *et al.* 2010). Bizat Ruhama is a spatially extensive site with lithic industry composed of approximately 3000 artifacts and exhibiting no Acheulian technological traits in any of the excavated assemblages. Furthermore, the absence of bifaces cannot be explained by absence of suitable raw materials. Some pebbles and cores found during the excavations are large enough to shape a biface. Moreover, pebbles suitable for biface production were found in all exposures of the Pleshet Formation sampled during the raw material survey (Zaidner 2003a, b). And finally, handaxes from locally available raw materials were produced in Bizat Ruhama area during the Middle Pleistocene. For instance, in the Middle Pleistocene site of Nahal Hesi, located 4 km north from Bizat Ruhama, local limestone and brecciated chert pebbles were used for production of handaxes, while small Eocene pebbles were used for production of flake tools.

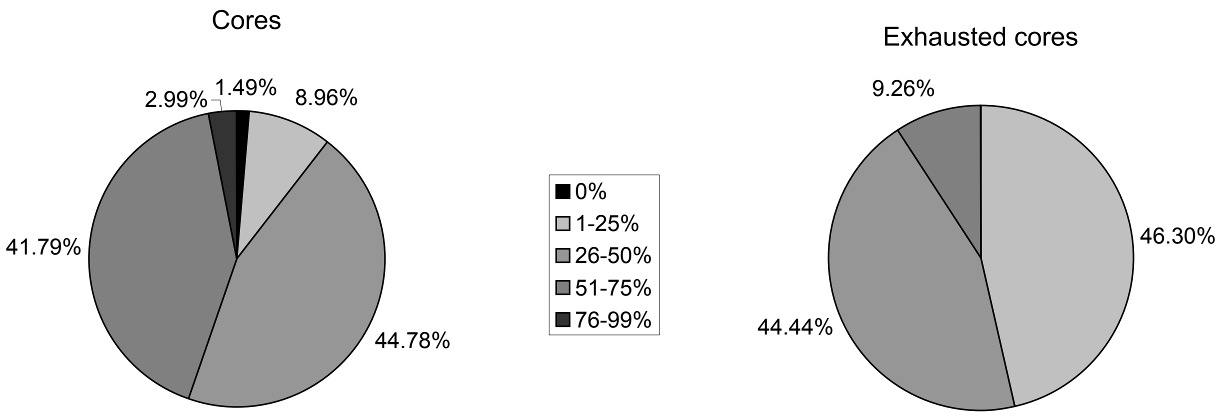

Figure 9 - Chert pebbles found at the site, 1 brecciated chert pebble found in BR 1996, 2 Eocene chert pebble found in BR AT5.

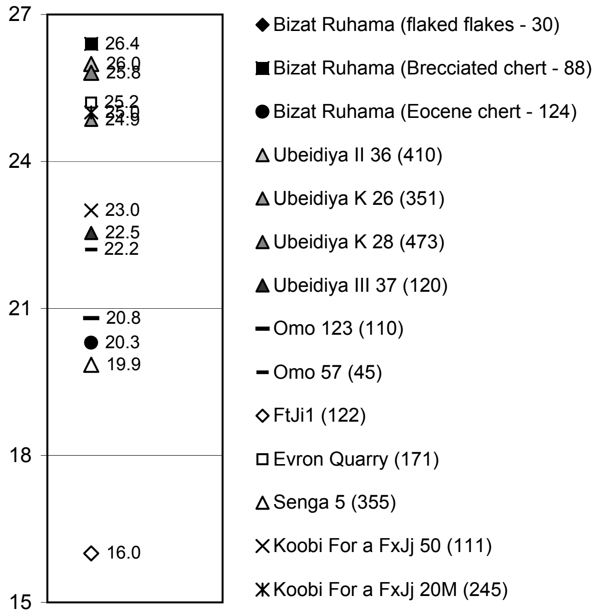

Figure 10 - Average length in mm of whole flakes from selected Early Pleistocene assemblages in the Levant and Plio-Pleistocene assemblages from Eastern and Central Africa. The number in parentheses is the total number of measured artifacts. The data for Ubeidiya, Koobi Fora, Omo, Senga 5 and FtJi1 are from Bar-Yosef & Goren-Inbar 1993; Isaac & Harris 1997; de la Torre 2004; Harris *et al.* 1987; Merrick & Merrick 1976. The data for Senga 5 and FtJi1 includes whole flakes and broken fragments.

Previous suggestions that Bizat Ruhama might be linked to the "microlithic complex" identified in the eastern and northern Europe do not hold true against the recent evidence. First, Bizat Ruhama is much earlier than the European microlithic sites, dated to the second half of the Middle Pleistocene (Burdukiewicz & Ronen 2003). Second, the size of the lithic artifacts in Bizat Ruhama is a feature of economical character closely linked to the availability of the raw materials, and thus cannot be used to establish cultural affinities. And third, as it was highlighted above, the small size of the artifacts is a feature common to many other Plio-Pleistocene lithic assemblages.

The evidence that has accumulated during the last decade indicates that the earliest sorties out-of-Africa were made by hominins possessing Oldowan-like core-and-flake technologies at ca. 1.8-1.7 Ma (Ferring *et al.* 2008; de Lumley *et al.* 2005; Zhu *et al.* 2004), preceding the first Acheulian assemblages in Africa (Asfaw *et al.* 1992; Roche *et al.* 2003; Semaw *et al.* 2008). The chronological context and the absence of Acheulian tools suggest that Bizat Ruhama may belong to one of these Oldowan out-of-Africa sorties. The recent studies broadened our understanding of the Oldowan. Its technological, geographical and chronological boundaries had been extended by research in the last few decades (e.g. papers in Hovers & Braun 2009). The Oldowan is now considered to be a wide technological phenomenon preceding the emergence of Acheulian technology, dated to Pliocene and Early Pleistocene, and present in the African continent, the Levant and possibly southern Europe and China as well. Bizat Ruhama with its Early Pleistocene age and relatively simple core technology seems to match well within the variability of the Oldowan techno-complex.

Concluding remarks

The results of the recent excavations and studies at Bizat Ruhama revealed the significance of the site to the study of Early Pleistocene hominin adaptations in Eurasia. The site contains lithic and faunal remains in primary anthropogenic context and exhibit evidence for a number of roughly contemporaneous occupations. Bizat Ruhama hominins inhabited inter-dune depression in an open homogeneous semi-arid environment with no evidence for river or lake in the immediate surroundings during the occupation.

The lithic technology is characterized by free-hand and bipolar techniques reduction of the small pebbles in order to obtain flakes which were often further knapped. Core-tools are virtually absent and intentionally retouched tools are probably very few. The small size of the artifacts at the site is a feature of economic nature and cannot be used for establishing cultural affinities. The dimensions of Bizat Ruhama artifacts are by no means exceptional for the Pliocene and Early Pleistocene. In fact many of the sites from these periods in Africa and the Levant show similar or lower length values. All in all, Bizat Ruhama's lithic industry fits well within the Oldowan techno-complex and, thus, represents one of the earliest occurrences of the Oldowan technology outside of Africa.

Acknowledgements

I thank to organizers for the invitation to participate in the symposium. The 2004-05 excavation seasons at Bizat Ruhama were generously funded by the L.S.B. Leakey Foundation. I wish to express my gratitude to Avraham Ronen for his guidance, permission to study the material from the 1996 season of excavations, permission to study Evron Quarry material and support through the years. Many thanks to all the volunteers and students who participated in the project. Fig. 4 is modified after Ronen et al. 1998. I thank Mina Weinstein-Evron, György Lengyel, Reuven Yeshurun and Erella Hovers for constructive and helpful comments, which significantly improved the original draft.

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NEW ACHEULIAN LOCALITY NORTH OF GESHER BENOT YA´AQOV – CONTRIBUTION TO THE STUDY OF THE LEVANTINE ACHEULIAN

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Introduction

A new Acheulian locality was discovered north of the famous site of Gesher Benot Ya´aqov (GBY) as a result of a massive drainage operation of the Jordan River in 1999. The site comprises rich surface collection and a preliminary test excavation that enabled reconstruction of the stratigraphy of the site's layers. The lithic assemblage resembles that of the nearby GBY Acheulian site and is dominated by numerous basalt handaxes and cleavers. However, the assemblage has some marked differences from that of GBY, enlarging our understanding of the Levantine Acheulian variability. An Ar/Ar date was established for the basalt flow underling the Acheulian living floor exposed in the test excavation. This date is one of the only radiometric dates by Levant and enables better chronological control of the GBY large flake Acheulian chronology.

The NBA site

In its outlet from the Hula Valley, in the Northern Dead Sea Rift, the Jordan River cuts through layers of sediments ranging in age from the Pliocene to the Holocene. Numerous drainage operations took place in this area from the 1860s onward, with the purpose of lowering the water level of Lake Hula in order to free agriculture land. Archaeological remains retrieved from these operations lead to the identification of the area of Gesher Benot Ya´aqov (the bridge of the daughters of Jacob - GBY) as a location of great archaeological potential (Goren-Inbar *et al.* 2002; Sharon *et al.* 2002; Stekelis 1960). In the last century, drainage operations have lowered the channel of the river by more than six meters. Further drainage work during the early 1970s and most recently in 1999, has deepened the river bed even further.

During the fall of 1999, the Kinneret Drainage Authority once again undertook a large-scale operation to deepen the Jordan River at its outlet from the Hula Valley. This operation caused massive damage to the already badly disturbed archaeological and geological layers in the area (Sharon *et al.* 2002 for a detailed discussion). In the course of the work, large quantities of Acheulian tools and fossil bones were identified along the river, in the area now known as GBY North of Bridge Acheulian (NBA). The find spot (coordinates 33° 00' 53"N and 35° 37' 46"E) is located on both banks of the Jordan River, about 500 m north of Benot Ya´aqov Bridge, at about 60 m above sea level (fig. 1). The GBY excavation, carried out by Goren-Inbar

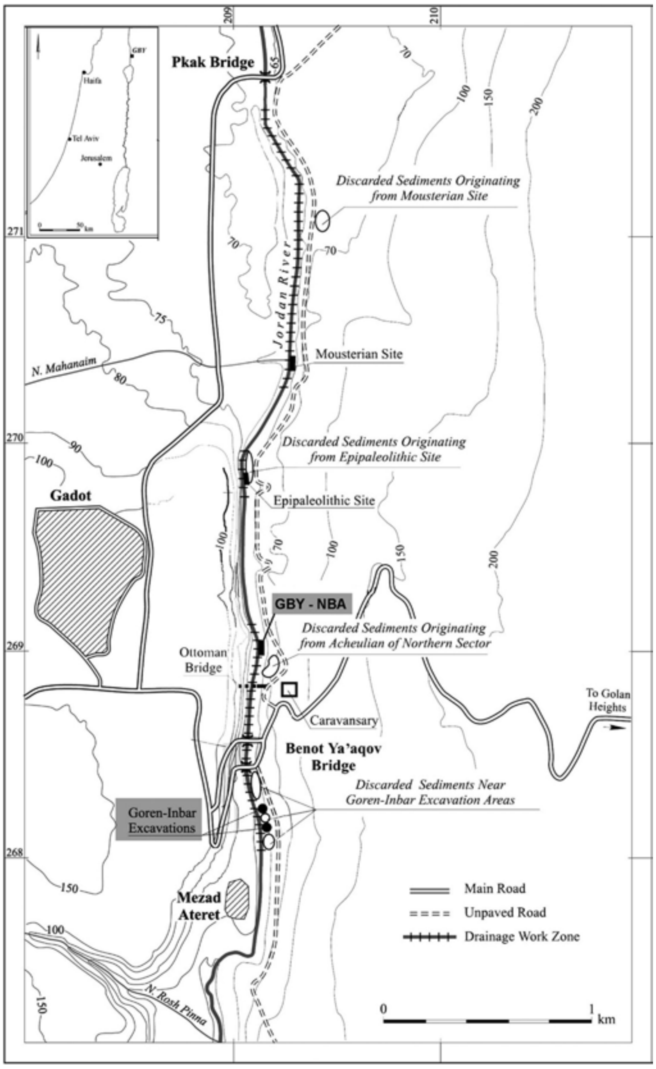

Figure 1 - Location map of NBA and other archaeological sites in the vicinity of the Benot Ya´aqov Bridge.

between 1989 and 1997 (Goren-Inbar *et al.* 2000), is located a few hundred meters south of this area (fig. 1). A detailed account of the site and its finds is published elsewhere (Sharon *et al.* 2010.). This paper aims to highlight some of the NBA lithic assemblage characteristics and their significance for our understanding the Levantine Acheulian.

Stratigraphy and Ar/Ar Dating

The geological and stratigraphic data of this study were obtained from a series of sections that were cut into the east bank of the Jordan River, geological cores that were drilled to a depth of 10 meters along the river, and from drawings and geological interpretation of the sections and cores. The Benot Ya´akov Formation (BYF) tool-bearing layers at this locality are deposited on top of a basalt flow, approximately 4 m thick. This basalt flow is covered by a layer of gray basaltic sand within which the Acheulian living floor was exposed, baring tools and bones in mint condition (fig. 3: Layer 4 in section 02-5). The upper part of this section (fig. 3: Layer 3 in section 02-5) comprises a conglomerate of boulder-to-pebble sized basalt and small flint clasts, in which heavily rolled Acheulian artifacts are abundant. In many instances, breakage is evident on handaxe tips, and tool edges are notched, indicating transportation in a high-energy stream environment.

Hundreds of bifaces and other stone artifacts, as well as animal bones, were collected from piles of sediments resulting from the drainage operation (fig. 2). It is unknown how many archaeological layers they represent, however, based on the collections' diversity and preservation state, it is clear that the origins of the NBA assemblage lie in several different depositional environments. It can also be argued that the tools that were found in mint condition originated from a primary context, as was attested by the finds from the living floor of Section 02-5. During a geo-archaeological survey in the year 2002, three sections of the Jordan River bank were cleared, and their geology studied (fig. 3). In one of these sections (Section 02-5), an Acheulian living floor, with 10 bifacial tools, many flakes, and some bones was exposed in an area of 1.5 sq m (fig. 4). The small excavation area (2 m²) exposed at section 02-5 is the basis for many of the observations presented below. It yielded an in situ assemblage of many Acheulian tools that provided a source of observations that are not based on surface collected artifacts alone.

Three samples from the basalt flow underlying Section 02-5 were sent for radiometric Ar/Ar dating at CNRS Geosciences Laboratoris, Azur, Canada. The resulting ages for these samples enable the determination of the age of the basalt flow underlying the Section 5-02 Acheulian living floor to 664 ± 20 Ka (see Sharon *et al.* 2010 for details). In order to use the age of the underlying basalt as a constraint on the living floor age it is essential to estimate the time elapsed between the formation of the basalt flow and the occupation of the Acheulian layer in section 5-02. Since the basalt appears to be unweathered and no traces of erosion are present, it can be argued that this basalt flow was covered by sediments shortly after its formation. The tools and bones excavated from this layer are also very fresh and were most probably covered quickly by the overlaying sandy sediments.

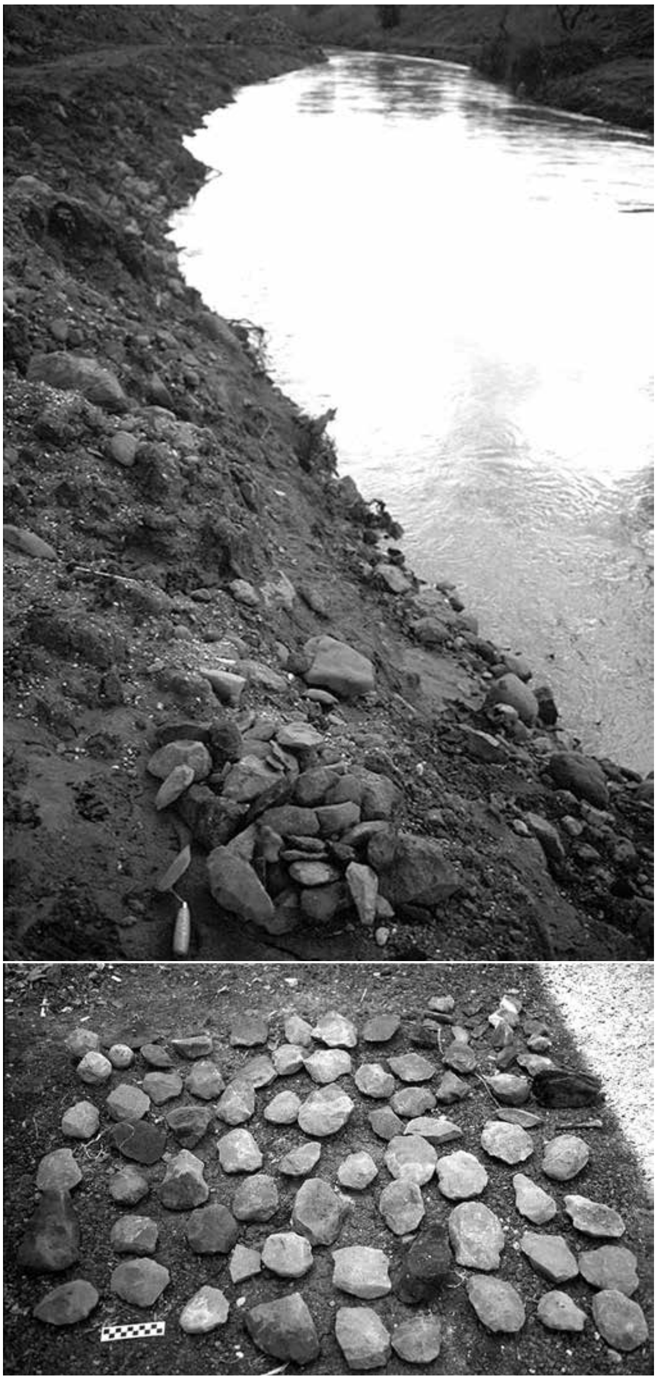

Figure 2 - Top: pile of bifacial tools on the east bank of the Jordan River at NBA, December 1999. Bottom: artifact collection (during a twenty minute visit in the summer 2000) of Acheulian bifaces, bones (upper right), and spheroids (upper left). after Sharon 2007.

The lithic assemblage from NBA resembles the assemblage excavated at GBY in most of its aspects (typology, technology, raw material preference and more). A magneto-stratigraphic study of the type section at the GBY excavation identified the Matuyama-Brunhes chron boundary in Layer II-14, 4 m below the base of Layer II-6, establishing the age of those assemblages as somewhat younger than 780,000 ka (Goren-Inbar *et al.* 2000). The overall similarity in the lithic assemblages between the Layer II-6 at GBY and the lithic assemblage from NBA, combined with the Ar/Ar dates presented here, contribute to our understanding of the span of time during which the GBY

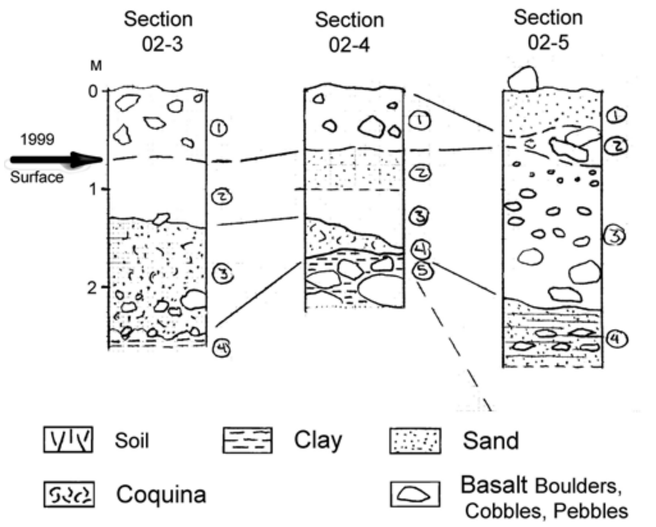

Figure 3 - Jordan River, east bank sections 02-3, 02-4 and 02-5 (drawing by C. Feibel).

Figure 4 - Excavation of Acheulian living floor in NBA section 02-5, looking east (scale 10 cm) after Sharon 2007.

type of Acheulian existed on the banks of the Paleo-Hula Lake. In summary, although at this stage we can not eliminate other possibilities, we suggest an age of ca 660 ka for the Acheulian living floor at the NBA locality.

The Lithic Assemblage

The bifacial tools

The assemblage of bifacial tools from NBA comprises 193 handaxes and 98 cleavers that were collected from the Jordan River banks and from the piles of sediments dug in this locality (figs. 5-7). In addition, 8 handaxes and 5 cleavers were excavated from Section 02-5. The tools were studied using the methodology applied to the bifacial tools from GBY (see details in Goren-Inbar & Saragusti 1996; Sharon 2007). The NBA handaxes and cleavers are similar in dimension to the bifacial tools excavated at GBY (fig. 8).

The types of raw material used for the production of bifacial tools at NBA and their frequencies are presented in table 1. The dominance of basalt as raw material used for biface production at NBA generally resembles the frequencies recorded for the excavated assemblage from the GBY Acheulian site (Goren-Inbar *et al.* 2000; Goren-Inbar & Saragusti 1996; Sharon 2007). Nevertheless, while in the excavated assemblages from GBY the percentage of flint tools never exceeds a few percent, the NBA assemblage includes over 30% flint handaxes. This fact can be explained by collection bias (flint handaxes are more notable) and perhaps also by the higher durability of flint in the accumulation condition of the NBA sediments. Indeed, many of the flint handaxes are heavily battered and probably originate from the conglomerate in the top of the section (see discussion in Grosman *et al.* in press).

	Cleavers		Handaxes	
	N	%	N	%
Flint	2	1.8	68	31.3
Basalt	110	98.2	149	68.6
Total	112	100	217	99.9

Table 1 - Raw material usage at NBA bifacial tools by morpho-types.

The size of the NBA bifacial tools

The descriptive statistics for the bifacial tools from NBA are presented in table 2. As previously discussed elsewhere (Sharon 2007), the site's bifacial tools fall well within the range of Acheulian bifaces made on large flakes worldwide. It was shown that over 90% of the complete bifacial tools sampled from many sites worldwide fall in the range between 10 and 20 cm in their maximal length. The NBA tools follow this observation.

The Technology of bifacial tool production

As with all other aspects of the biface assemblage, the technology used for the production of bifacial tools at NBA is similar to the technology applied at GBY. In general terms, giant cores were most likely knapped and large flakes were detached and later used as blanks for the production of both handaxes and cleavers by means of bifacial retouch. When suitable flakes were achieved, the bifaces were shaped by a minimal retouch that, in most cases, involved only the thinning of the bulb of percussion (Goren-

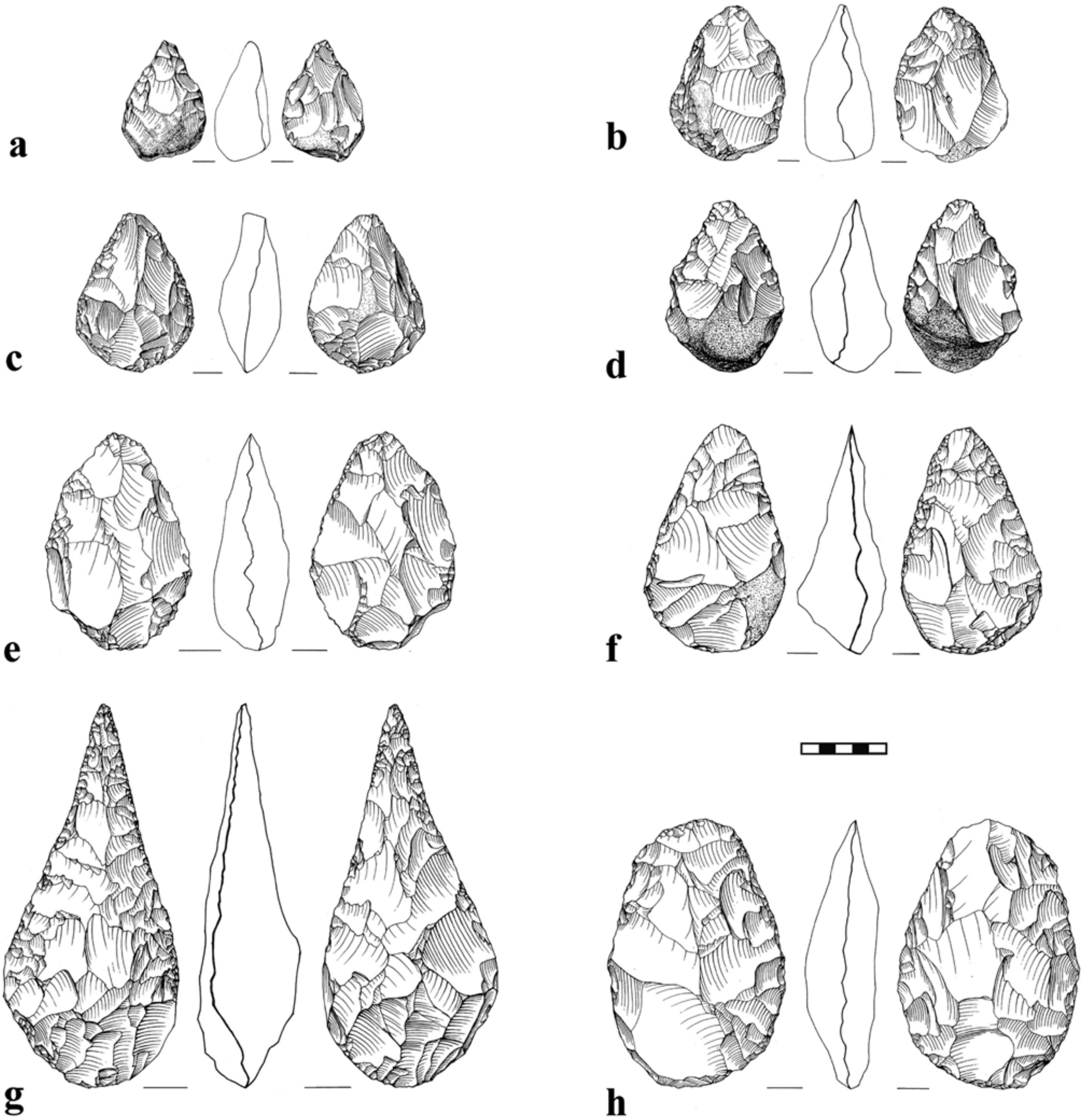

Figure 5 - Flint handaxes from NBA.

		Length (mm)	Width (mm)	Thickness (mm)	Circum-ference (mm)	Weight (gr.)
Handaxe	N	110	110	110	8	109
	Mean	123.79	84.13	43.11	368.63	471.4
	S.D	28.4	13.85	8.42	52.26	229.52
	Minimum	57	47	15	261	85
	Maximum	232	116	65	427	1147
Cleaver	N	83	83	83	13	83
	Mean	133.87	94.25	39.05	371.77	569.72
	S.D	20.52	11.98	6.57	48.63	183.1
	Minimum	87	64	26	261	233
	Maximum	221	154	59	463	1235

Table 2 - Descriptive statistics for NBA bifacial tools (complete tools only).

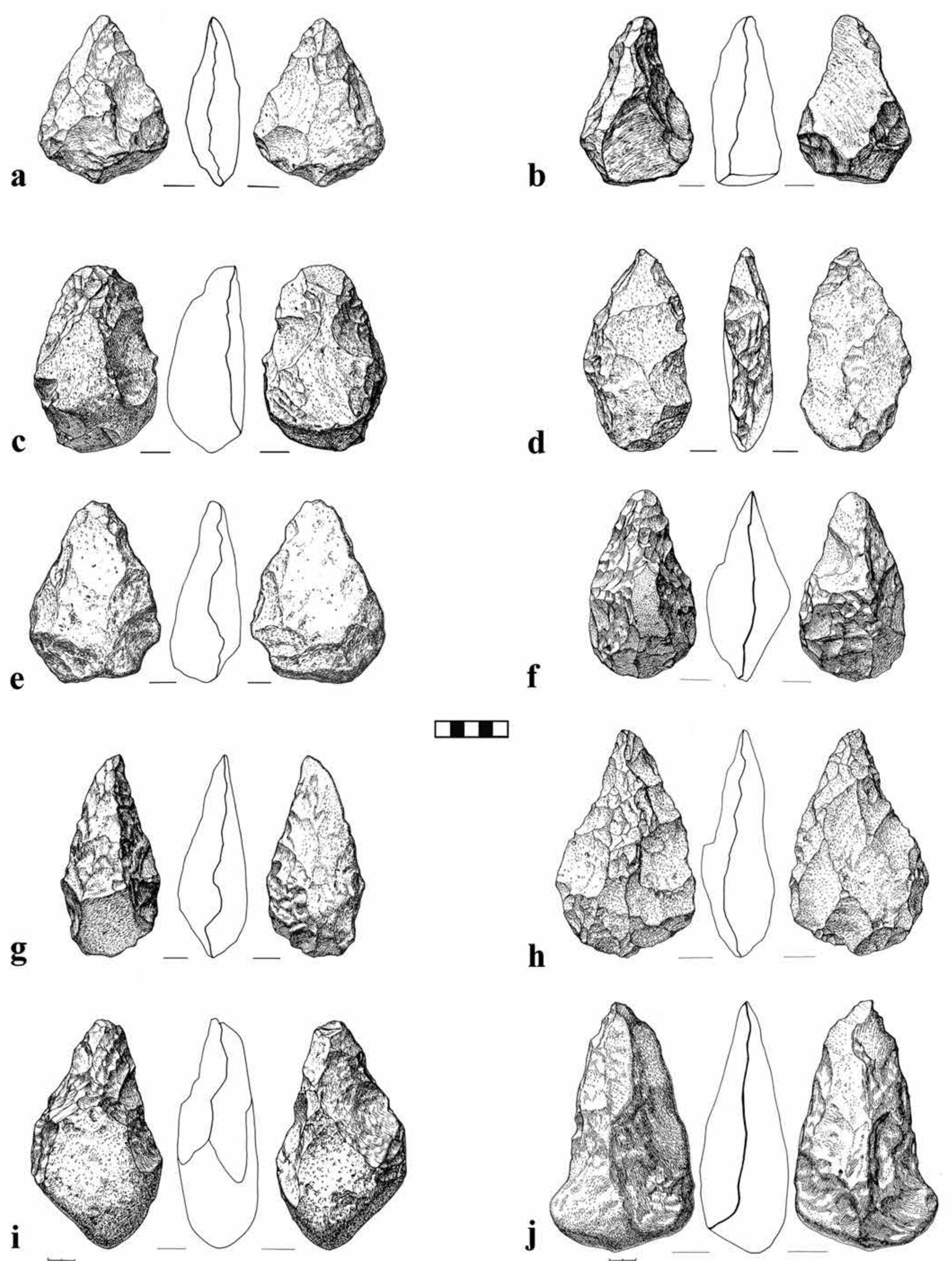

Figure 6 - Basalt cleavers from NBA.

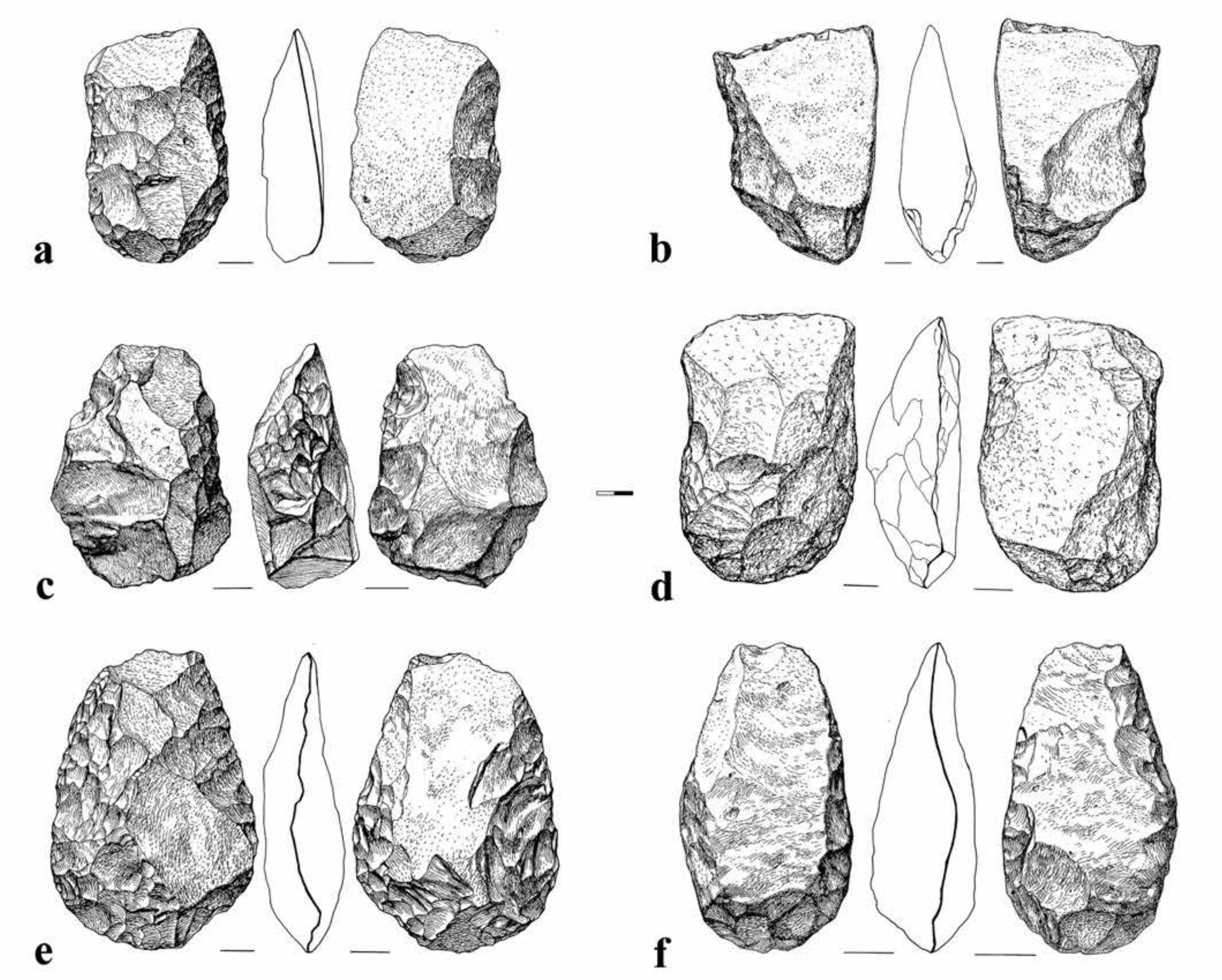

Figure 7 - Basalt handaxes from NBA.

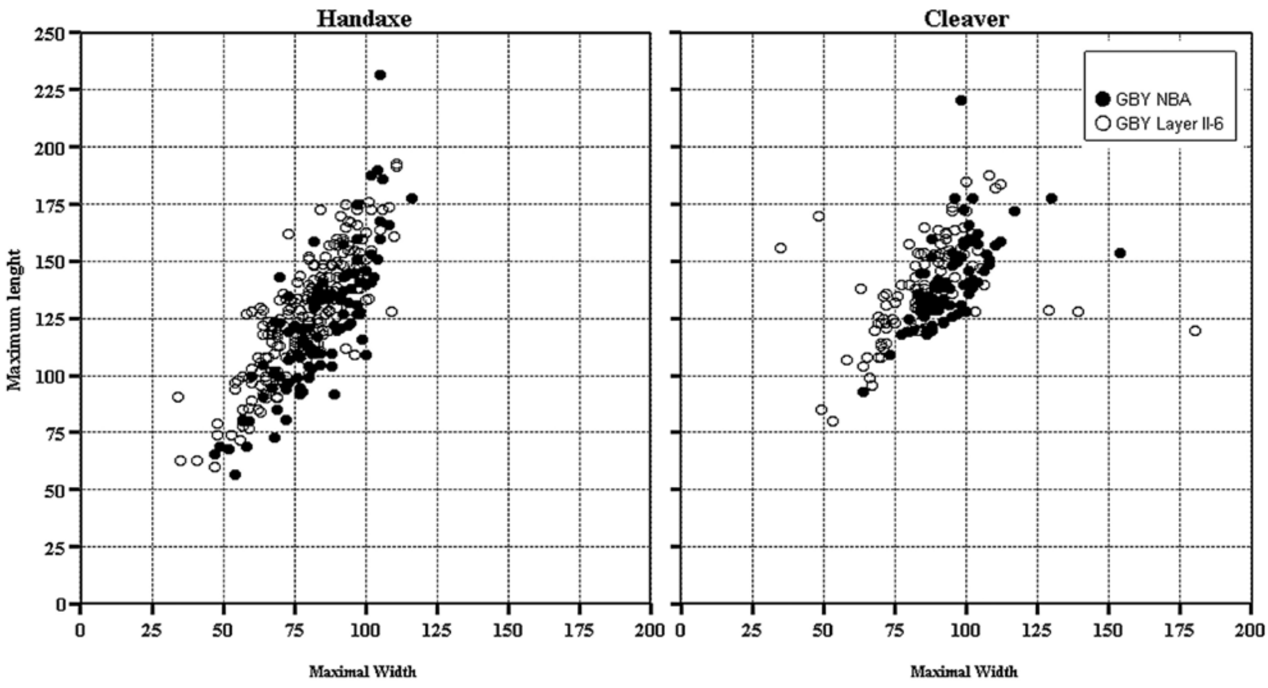

Figure 8 - Length to width scatter diagrams for bifaces from GBY and NBA.

Inbar & Saragusti 1996; Madsen & Goren-Inbar 2004; Sharon 2007). On a finer scale, some differences between the GBY and the NBA sites can be observed that can extend our knowledge of the technology used by the GBY knappers for their bifacial tool production. These aspects are discussed below.

Un-modified large flakes

The lithic assemblage of NBA is characterized by the presence of high frequencies of large basalt flakes. The small assemblage excavated from Section 5-02 is very rich considering the size of excavation. Figure 9 presents the size of the unshaped flakes from this assemblage as reflected by their length and breadth. The data clearly show that most of the flakes from Section 5-02 are larger than 8 cm. Small sized flakes seem to be nearly absent from the assemblage. The size and shape of the flakes (fig. 9) indicate that they were produced from giant cores. Such a high frequency of large, unshaped flakes was not observed in any of the GBY site layers, where small flakes are always present in much higher numbers and large flakes ares scarce. Of course, both the area of excavation and the size of the sample are too small to allow any definitive conclusion, yet the high frequency of large flakes might suggest that the NBA assemblage represents a scenario in which we are closer to the source of raw material or at least to where large flakes were knapped. This is in contrast to the GBY site that represents, in most of its layers, a behavior that includes the introduction of mainly finished tools into the site, at least some distance from the place where the large flake blanks were produced (Goren-Inbar & Sharon 2006).

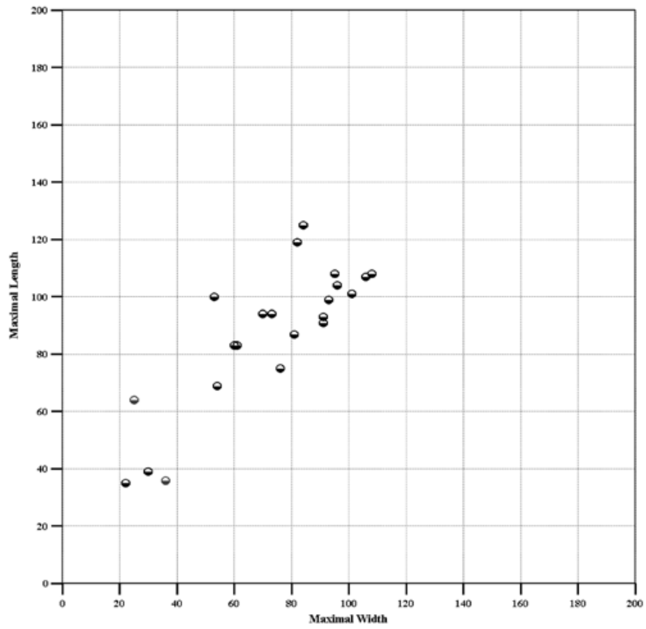

Figure 9 - Size of all (complete & broken) NBA Section 5 flakes.

The spheroids from NBA

A unique find within the Acheulian assemblage of NBA is the nine spheroids and three sub-spheroids collected from the site's vicinity (Sharon *et al.* 2002). None of these tools was excavated in situ, however, their presence is the first evidence for their appearance within the GBY-area Acheulian tool kit. Six of the spheroids are modified on limestone and the other three on basalt. The spheroids (fig. 10) are of medium size and in most cases well made and rounded. They have many facets and almost no evidence for battering. The small sample size and the fact, that none of them was excavated in situ, does not permit any further discussion. Their presence at the site, especially when compared to the absolute absence of spheroids from the GBY excavated assemblage, widens our knowledge of the GBY Acheulian tool kit and might suggest that these tools were associated with special activities that were not taking place at GBY but did occur at NBA.

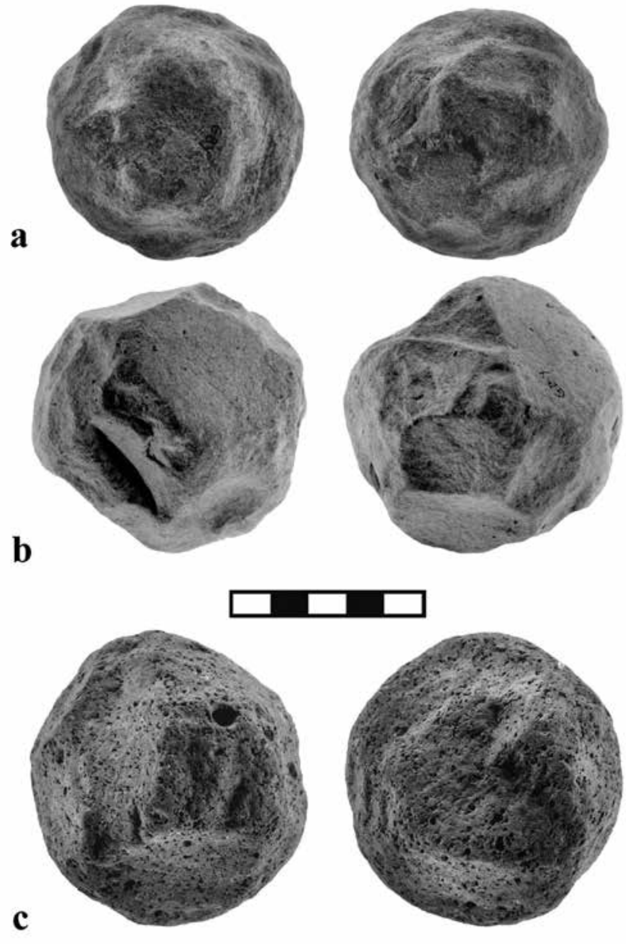

Figure 10 - Three spheroids from NBA; a & b - limestone; c - basalt.

Significance of the NMO site

The Acheulian location north of the Benot Ya´aqov Bridge was in the 1930s and explored by all pioneering archaeologists working in the GBY area. In recent years, the research focus shifted largely to the rich locality south of the bridge. Drainage work executed in 1999 heavily damaged all of the Benot Ya´aqov vicinity and unearthed many finds from the locality north of the bridge. The results of surveys and small excavations conducted to study and evaluate the results of this drainage operation were discussed in this paper.

The date established for the Acheulian site of GBY is based on the presence of the Matuyama/Brunhes chron boundary (780 Ka) in the layers of the section exposed at the site. The Ar/Ar date of 650 Ka determined for the NBA basalt flow located immediately below the Acheulian living floor of Section 5-02 enables us to place an additional chronological marker for the large flake based Acheulian of the GBY area. It seems that the duration of the Acheulian in the GBY area was well over the original estimate of 100,000 yrs for the section known from the type site of GBY (Goren-Inbar *et al.* 2000). During this lengthy time period, the lithic tradition observed in the different localities remained unchanged.

The NBA lithic assemblage resembles that of GBY in all its main features. The sites are similar in raw material usage frequency, particularly in the use of basalt as the primary raw material for biface production. The presence of many cleavers in the assemblage and the shape of the handaxes indicate close typological resemblance between the two assemblages. Size similarity was also observed between these two assemblages (Sharon 2007). It is safe to argue, therefore, that the two assemblages belong to the same Acheulian entity known as large flake Acheulian, as described from GBY (Goren-Inbar & Saragusti 1996; Sharon 2007).

However, some differences can be observed between the NBA and the GBY assemblages, which form the main contribution of the NBA to the expansion of our knowledge of the Acheulian behavior at the site. On a technological level, the presence of many large, unmodified, basalt flakes within the excavated assemblage of Section 5-02 suggests that the NBA locality is closer to the place where large flakes were produced than GBY. The small sample size and small excavated area allow only limited conclusions at the current stage of research. The presence of spheroids at NBA, which are totally absent from GBY, adds this tool type to the GBY area Acheulian "tool kit" and suggests that their occurrence is attached to special and restricted activity areas, apparently absent from other GBY localities.

The main contribution of the NBA assemblage comes from the confirmation of some aspects of the GBY lithic industry and from the few but marked differences that do appear between the assemblages. These differences attribute a better insight into the behavior and ways of life of Acheulian hominins on the shores of the Paleo-Hula lake during the Early Middle Pleistocene. The site of GBY has been the only example for large flake Acheulian in the Levant between the Egyptian Western Sahara Desert (Haynes *et al.* 1997; Haynes *et al.* 2001) and Turkey (Bar-Yosef 1998; Goren-Inbar 1995; Sharon 2007). Due to the Ar/Ar date retrieved for the NBA site, it is now possible to determine that large flake based Acheulian existed in the Northern Dead Sea Rift at least between 780 and 650 Ka BP. It is very unlikely that no other site belonging to the same lithic tradition existed in the Levant during this long time period. The fortunate geological and geo-morphological circumstances that exposed the GBY layers enabled a glimpse into this cultural phase of the Acheulian probably deeply buried in other parts of the Levant. The finds from the NBA site clearly place its inhabitants within the GBY Acheulian entity. They expand our knowledge of their technology, tool kit and behavior as well as the time period their culture existed. The primary challenge for our understanding of the place of the GBY Acheulian tradition in its regional context, as well as for the Out of Africa tempo and geography lies in the discovery, excavation and dating of new sites belonging to the large flake Acheulian tradition.

Acknowledgements

I wish to thank Shmuel Belitzkey who made many of the geological observations related to the NBA site and who lead a survey of the area during 1999. Craig Feibel and Bo Madsen participated in the 2002 survey and excavation. Artifacts were drawn by Leonid Zaidner. Gabbi Laron took the photographs of the NBA tools. The Israel Antiquity Authority financially and logistically supported the surveys. This work was supported by the Israel Science Foundation Center of Excellence (Grant No. 300/06). Special thanks to Prof. Naama Goren-Inbar.

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THE LOWER PALAEOLITHIC IN SYRIA

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Introduction

Since the 1970s, the archaeology of the Lower Palaeolithic in the Levant has become an amalgam of different approaches adding a plethora of unequal pieces to the overall puzzle. The intention of the present paper is to re-launch the discussion of the Lower Palaeolithic in Syria and adjoining areas beyond traditional concepts. It is not the intention of the authors to criticise different approaches of our colleagues, but we try to overcome some traditional models that are in dire need of revision. Therefore we refrain from extensive quotes as the aim is to launch constructive discussions and not to raise polemics. In this respect bibliographical referencing is limited to the necessary minimum.

For its size, the Levant offers an unrivalled wealth of Palaeolithic sites of all periods. A comparable density and variety of sites is quite unique on a global scale. The geographic setting, within the crossroads of the Old World offers unique possibilities for understanding early human behaviour on a broad database, permitting us to understand cultural variability in a limited space and over a very long time scale. Despite the potential influences of distant settlement areas into the Levant, but also vice versa, specific local traditions can be identified throughout its history. It is beyond this paper to go into the details of influences from outside the Levant and their cultural impact on neighbouring areas. Ideas and technological concepts obviously went back and forth, making the Levant a kind of turntable. It was not the melting pot one could expect, but kept throughout the ages a strong and proper cultural identity.

Traditionally the Levantine Palaeolithic has been perceived in a Eurocentric conception. Since the beginning of Palaeolithic archaeology along the eastern Mediterranean, beginning in the late nineteenth century, Europe was undeniably the centre for prehistoric research where the basic concepts of Old Stone Age archaeology and Quaternary geology were developed. Researchers working in the Levant relied on their European experience to unravel the Levantine Palaeolithic. Many labels and affiliations established at that time still cling to the respective materials today. Qualitative arguments were more important than quantitative evidence. In this manner, statistically questionable inventories became keystones, as indices of artefact categories permitted comparison and classification. In many cases, indices were computed against basic statistical rules. Also clear numerical inventories are only available for a few selected sites, impeding a reasonable reassessment of the corpus in question. Furthermore the political situation in the second half of the twentieth century restricted scientific co-operation, as international boundaries became a considerable obstacle for research. Exchange was only possible through publications and informal personal contacts. Therefore local schools prevailed on either side of the political divide, going their separate ways. This may explain to a certain extent the partitioned approaches for the Palaeolithic of the Levant.

History of research

Despite a longstanding tradition of Palaeolithic research since the end of the nineteenth century in what was then Ottoman Syria, the first discoveries of Lower Palaeolithic sites within today's boundaries date back to the year 1900 (Morgan 1927). Research on the Lower Palaeolithic resumed in the 1930s (Burkhalter 1933). In the same period, from 1931 to 1933, Alfred Rust conducted his prestigious excavations at Yabrud (Rust 1950) laying an important base for further investigations. Another breakthrough was van Liere's (1961) studies on the Quaternary of Syria, which permitted the discovery and subsequent excavations of the Latamne sites (Modderman 1964; Clark 1966). These efforts were resumed in the mid 1970s by an interdisciplinary team of prehistorians and geomorphologists under the auspices of the French CNRS. The team of F. Hours, L. Copeland, P. Sanlalaville, J. Besançon and S. Muhesen established most of what is known today about Lower Palaeolithic sites in Syria. Within a rather short time period, a number of carefully selected regions were investigated: in 1976 the Nahr el Kebir near Lattakia (Sanlaville 1979), in 1977 the Middle Orontes valley (Besançon *et al.* 1993), in 1978 the area around Raqqa on the Euphrates (Copeland 2004), in 1979 the Menbij sector, again on the Euphrates (Copeland 2004) and in 1980 the desert area around El Kowm (Besançon *et al.* 1981). In later years, these survey were completed in 1989 with the area around Tartous on the Mediterreanean coast (Besançon *et al.* 1994). In consequence of those screenings, a number of Acheulean sites were

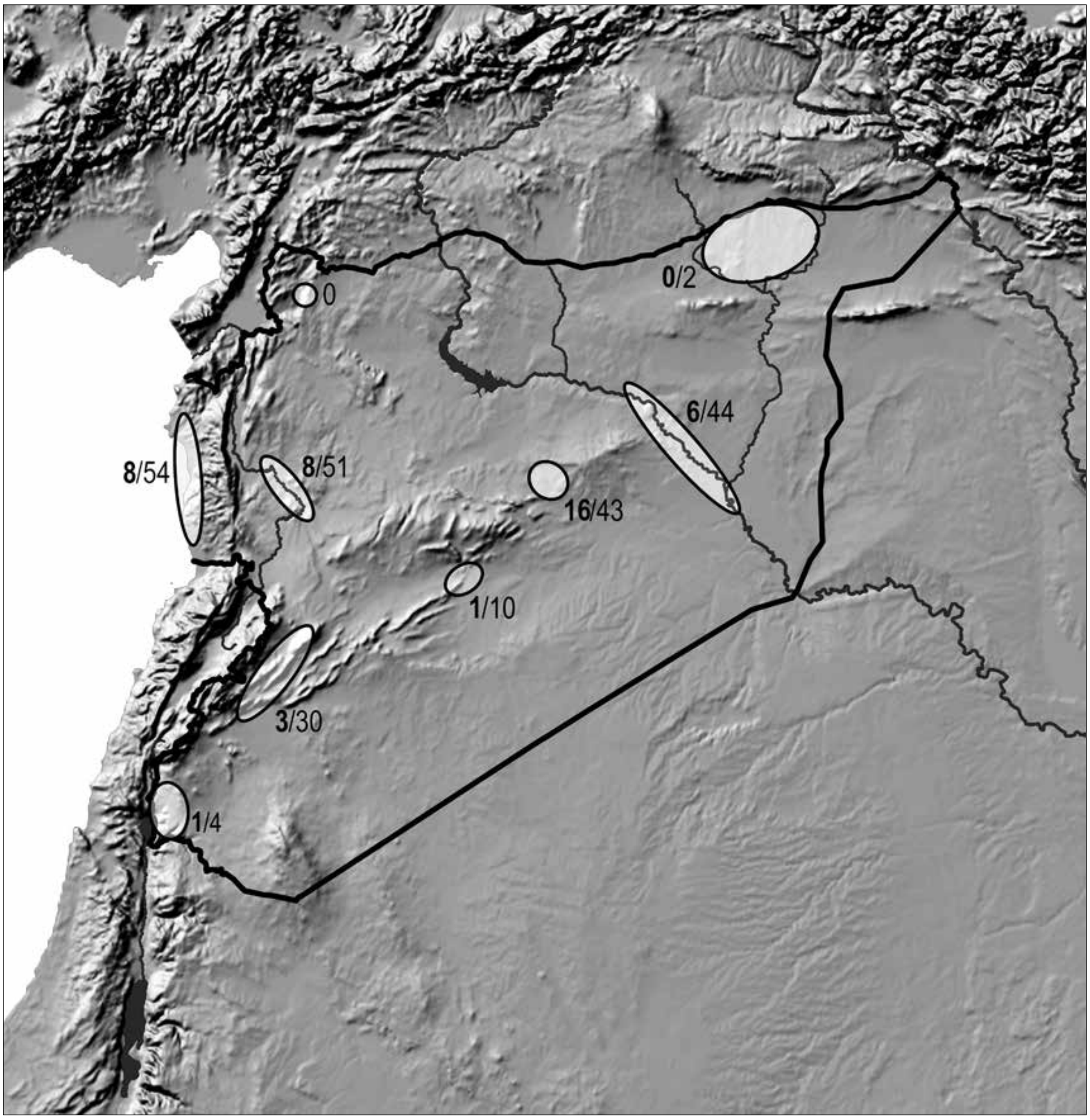

Figure 1 - Map of Syria with location of main Palaeolithic surveys or investigations with a strong focus on that period. Bold numerals stand for the number of sites with hand axes n>20; normal typography indicates the number of sites with hand axes.

excavated: in 1979 and 1981 Gharmachi Ib (Muhesen 1985), from 1989 to 2003 Nadaouiyeh Aïn Askar (Jagher 2011), from 1996 to 1998 El Meirah (Boëda *et al.* 2004), and soundings were carried out 1989 in Juwal Aïn Zarqa and in 1991 in Qdeïr Aïn Ojbeh by J.-M. Le Tensorer and S. Muhesen.

The results of these surveys were published with unequal intervals between field work and publication for different reasons, amongst them, the premature death in 1987 of Francis Hours, the mastermind and moving spirit of this research group. A final summary, reassessing all these results, has never been edited. However, results were included in interim syntheses in expectation of the concluding publications. The current appreciation of the Lower Palaeolithic in Syria has remained a patchwork, without later synthesis or revision. The understanding of the fundamental argumentation through existing publications is ambiguous.

Today, more than a generation later, those results can be seen in a different light. The spirit and background of that time (i.e. the mid 1970s) has to be recalled in order to understand the implications of this research. Geomorphological studies as a reference for the relative age of the archaeological materials were based on the classical quadrinomial concept of the Pleistocene in the sense of Penck and Brückner (1909). With such an approach, mapping of fluviatile terraces was simplified, but had a limited chronological resolution. On the other hand, archaeologists depended at that time on the "short chronology" presuming, the end of the Acheulean to be in the final stages of the "Riss-glaciation" (i.e. Marine Isotope Stage 6) with a model age at that time of around 150,000 years BP (actual models now put the same transition around 350,000 years). Furthermore, in keeping with the mainstream in archaeology, the perception of cultural development depended on a strongly evolutionary conception, going progressively from primitive to elaborate tools and from basic to complex technologies. The fundamental approach was that archaeological materials can be classified in their chronological order along these guidelines. In that spirit, a complex framework of cultural evolution, particularly for the late Acheulean, was devised. With growing experience not only was the relative chronological scheme refined, but also contemporaneous regional groups were defined. In many cases cultural attributions based on limited collections and observations were substantiated by cross-referencing with other sites. Once labelled, sites remained in the general discussion without questioning their value for further synthesis. Most of all, the system lacked a sound chronological control as all these discoveries were either surface discoveries or represented only one single phase site.

With the excavations at Nadaouiyeh Aïn Askar, the traditional model was seriously challenged. The complex stratigraphy of that site eventually revealed seven distinct Acheulean facies in a definite chronological sequence (Jagher 2011). Against expectations, the most elaborate and standardised hand axes turned out to be the oldest and the expected "progressive artefact associations" were not substantiated at all. Against this evidence the conventional understanding of the Syrian Acheulean needs a profound revision (fig. 2).

conventional chronology	
Middle Palaeolithic	Levalloiso-Mousterian
	Hummalian
Acheuleo-Yabroudian	Yabrudian
Acheuléen final	Nad-A
	Nad-C
	Nad-T
	Nad-D
Acheuléen récent évolué	Nad-F
	Nad-E
Acheuléen récent	Nad-B
Acheuléen moyen	Nad-X

Nadaouiyeh stratigraphy	
Nad-A	Epi-Acheulean
Levalloiso-Mousterian	Middle Palaeolithic
Hummalian	
Yabrudian	
Nad-T	Levantine Upper Acheulean
Nad-B	
Nad-C	
Nad-D	
Nad-E	
Nad-F	
Nad-X	Levantine Lower Acheulean

Figure 2 - Confrontation the conventional chronology of the Syrian Upper Acheulean to the sequence present in the Nadaouiyeh stratigraphy.

Out of Africa and the beginnings of hand axes.

Hand axes are one of the "guide fossils" for the "out of Africa" dispersal of early hominids. In fact the oldest known hand axes appear about 1.6 million years ago in Eastern Africa (e.g. Asfaw *et al.* 1992; Isaac & Isaac 1997; de Lumley & Beyene 2004). However, in almost all of these sites, the hand axe is a very rare instrument. Basically these materials are a in strong tradition with earlier core and flake industries. The very low numbers clearly show that hand axes had a minor meaning for their makers. This is also the case for the early sites in the Levant,such as Ubeidiya and El Kowm (Le Tensorer *et al.* 2011). We may ask, provocatively, but why did hand axes not take a stronger hold in the early African Acheulean for more than half a million years until they became a dominating feature?

In a purely evolutionary concept, one brilliant mind would have been responsible for the invention of this icon of the Lower Palaeolithic. Contrary to biological evolution, in cultural history a multiple origin in the sense of congruent inventions leading to the same solution is possible and no contradiction, but quite the reality. The manipulation of stone material obeys the same universal physical laws, permitting just a limited technological repertoire. In later periods of prehistory, congruent evolutions are generally accepted (e.g. blade technologies, foliated tools and so on). Why could that not happen also in earlier periods? It has to be kept in mind that the invention of the hand axe, a quite generic tool in its basic concept, needed neither particular technical skills nor superior cognitive capacities beyond the possibilities of the time. Basically, hominids already out of Africa were not much duller than their cousins next out of the cradle of humankind. In such an environment a multiple origin of the hand axe is also conceivable.

In fact, the archaeological evidence is undisputable: the oldest stone tools are known from Eastern Africa, from where they spread within a surprisingly short period around the Old World. But is that sufficient to affiliate all further "big inventions" from the area of origin? If so, East Africa should have been at the height of technological invention (at least concerning lithic technologies), a worldwide "leadership" that is not confirmed by the archaeological evidence. Hence a multi-regional approach is as possible as an exclusively African provenance for hand axes. In a purely evolutionary approach, the earliest appearance would designate the origins, but human culture is not submitted to biological laws. Anachronisms and convergent development are both possible and are no contradiction, as human behaviour is complex and unpredictable.

Nomenclature

Lower Palaeolithic: the core and flakes traditions

The concept of the "Lower Palaeolithic", issued from the classical tripartite classification and terminology of the nineteenth century (de Mortillet 1883), however it comprises more than 85% of human history. This modest term combines quite different cultures and traditions in a huge geographic range during an extremely long period. Lithic traditions changed slowly from the original core and flakes concepts. Most of these early technologies kept their archaic aspect over a long time. Despite archaeologists' concepts, changes were neither universal nor synchronous or in a consequent progression. Instead of accurate observations, scholars relay rather on academic concepts adopted by the scientific community. A classical example in this domain for the Lower Palaeolithic is the question of mode 1 and mode 2 (Clark 1969) which is still vigorous today. There is often confusion between biological evolution and cultural history that only share a common time axis. However, culture is not a biological constant, but the product of a multitude of stimuli from nature and human imagination slowing or accelerating cultural change independent of time and space.

The reasoning that cultural development and biological evolution are strongly interconnected is a widespread, but never really confirmed, concept, with strong ties between hominid taxa and the evolutionary level of stone tools. However, the fossil evidence, including the Levant, is ambiguous. It may support such models: e.g. the Nadaouiyeh hominid shows more anatomical affinities to its East Asian cousins than to its African or European contemporaries (Le Tensorer *et al.* 1997; Jagher *et al.* 1997), however, the material culture is entirely oriented to hand axes, that are nearly completely benign to the biological counterparts. Also the Levantine Neanderthals, contrary to their European brothers, utterly abandoned the hand axe in their cultural repertoire.

In conventional terminology, the Lower Palaeolithic comprises the archaic lithic traditions, i.e. the core and flakes technological complexes in an early stage, and the hand axe civilisation is labelled as Acheulean in a more recent phase. The former are difficult to characterise, especially in small collections, as diagnostic tools are rare. These early archaic industries, distinguished by generic tools and basic technologies, constrict detailed classifications. With the appearance of hand axes, discoveries with this index are called Acheulean. This term, suggesting a shared identity indeed encompasses quite different cultural expressions e.g. the Ubeidiya inventories, the Gesher-Latamne complex or the highly elaborated hand axes from Nadaouiyeh, just to cite a few Levantine examples.

A short digression on the label "Acheulean"

In archaeology, the term "Acheulean" comprises a plethora of meanings, covering a wide range of applications; it can be a purely chronological indication (in a wider or a closer sense) implying a concise time span or not, it can be a technological specification, it may allude to cultural entities in a generic or general definition, it can be only a particular cultural trait such as specific artefact categories (i.e., hand axes), it may hint at the cognitive capacities of their makers, it may allude to a particular population group or be used in a taxonomic sense, or simply as a way of life. In short, it is an all- purpose expression wherever hand axes are involved. The attribute "Acheulean" was even given to post-Acheulean industries evoking Acheulean traditions such as "Acheulo-Yabrudian" or "Moustero-Acheulean", just as examples from the Levant.

Even if the hand axe is the icon of the Acheulean and to some extent of the Lower Palaeolithic, rarely is the question asked how important they really were to their makers. Instead of clear numbers, frequencies are given in terms such as an "elevated percentage" and so on. But what is the value of such expressions? In a context of few, "some" may be already "a lot". It is somewhat like the question of how many swallows make a summer, as the simple definition, hand axes equal Acheulean, falls short of the reality. With such lax handling, the term loses a good deal of its significance and easily produces misunderstandings, if no specifications or further definitions are given about the particular meaning of the concept.

This disparate situation was already criticised by Paola Villa in 1983: "We use the term 'Acheulian' to cover a too-long and too-little-known phase of human prehistory. It is not a master-key to the past; it is a trap for unpatterned data, old collections, and stray finds. Like a Mother Goddess, the Acheulian embraces a multitude of orphans. Such a wide label has been useful in the past, expressing a need for synthetic organization of data above fragmented antiquarian interests. It is now an ambiguous generalization which is being used to suggest cultural relationships where only similarities of technological level should be implied" (Villa 1983:23). To this very day, there is little to be added to that statement.

Quantitative versus qualitative approach

In the past, the qualitative typological approach to Palaeolithic cultures was much favoured by archaeologists as the direct comparison between sites was a generally approved method. The quantitative notion was neglected to a large extent, or generally reduced to expressions like "elevated" or "low percentage", but rarely presenting the numeric base. This procedure made it possible to include small samples in a wider discussion without difficulties and permitted one to integrate almost every site into a synthesis.

In this respect, the Nadaouiyeh Aïn Askar excavations clearly unveiled the pit-falls of the just qualitative estimation of Acheulean inventories. This site produced hand axes in such numbers that serious statistical analysis became possible (Jagher 2000, 2005). Without going into details here, a number of mathematical and empirical tests was carried out do determine the minimal size for a representative sample. In order to make a sound statement about a hand axe inventory concerning formal aspects (typology, morphometry, technology etc.), and potential comparisons with other sites, about 50 individuals are necessary at least. In cases of a strong heteromorphy or a broader metrical variance this may be considerably higher. As a rule of thumb, with 75 individuals, the chances are fair for a serious assessment of a material as statistical evaluation becomes reproducible within a reasonable range.

Empirical experience revealed that for entities with an exceptionally good standardization of shapes, samples of more than two dozen may give a fair idea in general. This applies to highly elaborated techniques and, on the other hand, for extremely basic execution, i.e. inventories where strict uniformity strikes the eye immediately. Everything else needs a much broader base, such as stated above, to measure the variability.

The rather high number of hand axes necessary for an assessment has to be seen against the background that each hand axe is individually manufactured on a random blank. Hence accurate reproduction is only possible with a limited potential. Currently applied typological classifications and differentiations clearly transgress the feasibilities of the makers. The existing typologies, in fact, are academic concepts, feigning neat classifications that fall short of the intentions of the original makers.

Chronological framework

Indirect observations, such as the Dmanissi discoveries, hint at a long human history in the Levant. The earliest well confirmed human presence in the Levant dates back about 1.6 million years in the site of Ubeidiya in Israel (Belmaker 2006:12).

They belong to an archaic Palaeolithic dominated by a core and flake technology comparable to the Oldowan of eastern Africa. Analogous industries in Syria are known from Hummal and Aïn al Fil (Le Tensorer 2009). The presence of hand axes in some of the layers in Ubeidiya (and also in Hummal) earned this site the label "Acheulean". The frequency of hand axes is usually low throughout the Ubeydia levels, with a few exceptions. The basic aspect of the industry is archaic and clearly dominated by core tools (choppers, spheroids etc.) and retouched flakes. As stated above, the generic designation Acheulean is not helpful. In all, hand axes make up a mere 7% of the shaped tools all over the site (Bar-Yosef & Goren-Inbar 1993). For the Syrian sites of the same period the statistical base impedes further considerations beyond a descriptive level (Wegmüller 2011). The label Oldowan is as inapplicable for the presence of hand axes as is Acheulean for their scarcity. The term Proto-Acheulean better describes the situation. This is consistent with the first hand axe traditions in eastern Africa, where hand axes do only occasionally exceed more than 10% of the shaped tools.

The situation changes clearly with the appearance of the "middle Acheulean" in the conventional terminology. Existing definitions clearly picture this entity in the Levant with its classical sites of Gesher Benot Yaakov and Latamne and associated discoveries. Hand axes and assorted artefacts are the dominant tools in this group, presenting a standardised style of shaping the hand axes which are consistently of respectable size. At least the Gesher cleavers display a strong African influence. How far this applies to the whole group has yet to be demonstrated. In the following, we name this group the Levantine Lower Acheulean (i.e. what is traditionally the Middle Acheulean or Acheuléen moyen) as the historical tripartite system should be abandoned for being unfounded. The chronology of the Levantine Lower Acheulean is subject to discussion. At Gesher it clearly dates around 780 ka (Goren-Inbar *et al.* 2000). Recent palaeontological estimations suggest an even older age for Latamne, possibly around 1 ma (Bar-Yosef & Belmaker 2010). The end of the Levantine Lower Acheulean can tentatively be placed around 600 ka (see below).

Consistently for the classical Acheulean in the Bilad As Sham, the term Levantine Upper Acheulean is proposed. The prefix Levantine is added in order to define clearly the separation from other Acheulean groups. The beginnings of the Levantine Upper Acheulean are subject to speculation. However, a progressive age model for the Nadaouiyeh Aïn Askar site suggests an age of about 550 ka for the oldest levels which clearly belong to an "upper Acheulean". Given that age, and the striking conceptual difference from the preceding Levantine Lower Acheulean, the advent of the Levantine Upper Acheulean can be placed around 600 ka. Its end coincides with the advent of the Yabrudian complex about 350 ka ago based on a conservative interpretation of the evidence from Tabun and Qesem cave (Mercier *et al.* 2003, Gopher *et al.* 2010).

The transition to the Yabrudian complex is drastic with profound replacements in the tool set concerning formal and technological aspects. In fact the change to the Yabrudian complex is much more radical than that from the Lower to the Upper Acheulean, which was more a question of style than technological concepts. The enduring presence of hand axes during the Yabrudian complex must not be regarded as proof of a strict Acheulean origin in the same reasoning as the Proto-Acheulean is not forcibly the direct ancestor of the Lower Acheulean. Their alignment along the timeline suggests a perfect although sketchy succession. But this is only one of several possible explanations and without further arguments one should be careful with premature interpretations.

"Acheulean" sites in Syria

A survey of published data reported the occurrence of an astonishing 238 reputedly Acheulean locations in Syria including in some cases sites with several layers (tab. 1). For 41 places (i.e., 17%), it is only known that hand axes were found, but no precise numbers are given. The vast majority of the remainder consist of just a few hand axes and in general only some sparse other findings, with the bifaces being the only diagnostic object(s). More than half of the claimed Acheulean discoveries produced less than half a dozen hand axes and from 76% of the so called "Acheulean" sites less than one dozen of handaxes were recovered. Observations with one to two dozens of handaxes were made only at 9 places. Only 34 sites with a clear hand axe component, i.e. more than two dozens of bifaces, are present. Half of them have been excavated, the remaining 17 locations are known through surface collections. Complete inventories including precise numbers hand axes, retouched flake and core tools (i.e. choppers, chopping-tools and associated artefacts) are available for 113 sites (i.e. 47%). For the remainder information is incomplete.

The tendency of incomplete data and small numbers of artefacts is representative for the whole Levant, where isolated discoveries of hand axes were readily attributed to the "Acheulean". It has to be noted that nearly all of all these discoveries are surface collections with little information about the taphonomic context of these sites. During surface surveys, hand axes are readily spotted and recognised as such even when badly eroded (Jagher 2011). The associated débitage is rarely given the same attention. Furthermore, surface sites tend to be palimpsests of different occupations. In such a case, hand axes are usually detached from the remainder and attributed to the Acheulean as alleged guide fossils for this period.

Hand axes in the Post-Acheulean cultural entities of the Near East are much less frequent than in the preceding periods. When comparing the total number of hand axes clearly associated with the Acheulean and the ones attributed to the Post-Acheulean from excavated or systematically surveyed sites throughout the Levant, there is a chance of four to one that a hand axe actually is Acheulean. However, it is doubtful if this simple relation can be attributed to isolated discoveries. Isolated discoveries of handaxes, that is sites with less than a dozen handaxes (i.e. 76% of the originally claimed discoveries), have to be considered as minor sites with an indicative value only. Their significance for landscape archaeology has yet to be confirmed.

The Early Palaeolithic in Syria

Early industries discovered within very old Pleistocene formations attributed to the Qm III and Qf IV stages, show quite

site	hand axes	pebble tools	ret. flakes	cores	source
Coast					
Al Aliah 1	●	--	--	--	Conard & Kandel 2006
Al-Bassatin 1	●	--	--	--	Besançon et al. 1994
Aqarib	●	--	--	--	Besançon et al. 1994
Ard el-Basa	●	--	--	--	Besançon et al. 1994
Ard Hamed 4	226	18	55	121	Muhesen 1985
Ar-Roueiss	●	--	--	--	Besançon et al. 1994
Bano	●	--	--	--	Conard & Kandel 2006
Beit Kamouni	●	--	--	--	Besançon et al. 1994
Cheikh Daher	●	--	--	--	Besançon et al. 1994
Dahr el-Fallah	●	--	--	--	Besançon et al. 1994
Deir el-Hajjar	●	--	--	--	Besançon et al. 1994
Hosein al-Bahr	●	--	--	--	Besançon et al. 1994
Huraisun	>2	--	--	--	Tomsky 1982
Jabala	1	--	--	--	Tomsky 1982
Jdeideh	6	0	2	5	Muhesen 1985
Jedeide 2	●	--	--	--	Conard & Kandel 2006
Karm as-Sabi	●	--	--	--	Besançon et al. 1994
Mouqaa El Hami	50	11	32	--	Muhesen 1985
Nahr al Abrache	●	--	--	--	Besançon et al. 1994
Nahr al Mudiq	3	--	--	--	Tomsky 1982
Nahr Hraissoun	●	--	--	--	Besançon et al. 1994
Nahr Ismalié	●	--	--	--	Burkhalter 1933
Nahr Markié	●	--	--	--	Burkhalter 1933
Nahr Merqiye	1	--	--	--	Besançon et al. 1994
Qalaat Faraoun	1	--	--	--	Besançon et al. 1994
Qalaat Yahmour	21	--	●	--	Tomsky 1982
Ramit Sagher 1	●	--	--	--	Besançon et al. 1994
Ramit Sagher 2	●	--	--	--	Besançon et al. 1994
Sasnyeh	●	--	--	--	Burkhalter 1933
Sauda	●	--	--	--	Tomsky 1982
Simirian	●	--	--	--	Besançon et al. 1994
Tartus	12	--	--	--	Tomsky 1982
Taryé	●	--	--	--	Burkhalter 1933
Tell Akho	●	--	--	--	Besançon et al. 1994
Wadi Arab	●	--	--	--	Besançon et al. 1994
Nahr al Kebir					
Ash Shir / Esh Shir	●	--	--	--	Tomsky 1982
Ayak	1	--	--	--	Tomsky 1982
Bdamyun 1-3	6	--	--	--	Tomsky 1982
Berzine	51	5	14	50	Sanlaville ed. 1979
Cheikh Mohammed	13	4	1	2	Sanlaville ed. 1979
Dahr El Ayani	10	2	1	3	Sanlaville ed. 1979
Dahr Ouadi Hassane	2	1	1	4	Sanlaville ed. 1979
El Hakimé	1	0	0	1	Sanlaville ed. 1979
Fidio II	3	0	1	2	Sanlaville ed. 1979
Fidio III	25	29	13	83	Sanlaville ed. 1979
Hinnadi	>5	--	--	--	Tomsky 1982
Jabal Jibtaa	64	19	11	45	Sanlaville ed. 1979
Jbarioun Carrière	16	0	12	9	Sanlaville ed. 1979
Jebel Idriss I&II	1	2	0	4	Sanlaville ed. 1979

site	hand axes	pebble tools	ret. flakes	cores	source
Jebel Idriss IIIa	10	9	4	14	Sanlaville ed. 1979
Khéllalé 2	1	1	0	4	Sanlaville ed. 1979
Khellalé 4	42	8	12	44	Sanlaville ed. 1979
Khéllalé 5	10	1	5	8	Sanlaville ed. 1979
Mchaïfret es Samouk	11	27	14	50	Sanlaville ed. 1979
Nahr El Arab B	14	11	28	41	Sanlaville ed. 1979
Roudo inf.	7	0	3	18	Sanlaville ed. 1979
Roudo sup.	109	19	13	39	Sanlaville ed. 1979
Sinnjuwan	2	--	--	--	Tomsky 1982
Sitt Markho	6	7	0	13	Sanlaville ed. 1979
Snoubar	1	0	0	0	Sanlaville ed. 1979
Souayate inf.	11	2	16	5	Sanlaville ed. 1979
Souayate sup.	20	1	3	11	Sanlaville ed. 1979
Squoubine	1	0	0	1	Sanlaville ed. 1979
Orontes valley					
Acharne Plain	20	41	11	117	Copeland & Hours 1993
Arbain II	4	--	--	--	Tomsky 1982
Arzé	1	1	0	8	Copeland & Hours 1993
Ghab 4a	1	0	4	18	Copeland & Hours 1993
Ghab 5	7	2	3	13	Copeland & Hours 1993
Gharmachi 1b	140	38	86	532	Muhesen 1985
Gharmachi Nord	2	0	2	0	Muhesen 1985
Gharmachi Sud	9	4	0	0	Muhesen 1985
Gharmarchi 1a	5	17	19	36	Copeland & Hours 1993
Halfaya	3	0	0	1	Copeland & Hours 1993
Hama 3	5	2	3	4	Copeland & Hours 1993
Hama 6	1	0	0	0	Copeland & Hours 1993
Hama 7a & 7b	1	2	2	0	Copeland & Hours 1993
Hama Süd-Ost	5	--	--	--	Tomsky 1982
Hanifa	3	3	2	3	Copeland & Hours 1993
Jarniya	●	--	--	--	Tomsky 1982
Jinnata	2	0	1	0	Copeland & Hours 1993
Jisr Ash Shungur	3	--	--	--	Tomsky 1982
Jrabiyat 1	1	1	2	1	Copeland & Hours 1993
Jrabiyat 2	11	7	1	18	Copeland & Hours 1993
Jrabiyat 3	25	7	13	21	Copeland & Hours 1993
Jrabiyat 4	19	12	12	19	Copeland & Hours 1993
Jrabiyat 6a	48	7	6	16	Copeland & Hours 1993
Jrabiyat 6b	62	0	1	5	Copeland & Hours 1993
Kazu	●	--	--	--	Tomsky 1982
Khattab 1	2	0	0	0	Copeland & Hours 1993
Khattab 1-x	5	0	0	0	Copeland & Hours 1993
Latamé, living floor	99	54	136	75	Clark 1966
Latamné Quarries	36	56	27	75	Copeland & Hours 1993
Mahardé 1	6	3	1	13	Copeland & Hours 1993
Mahardé 2	1	5	0	1	Copeland & Hours 1993
Mradiye	1	0	0	0	Copeland & Hours 1993
Nahr El Arab A	●	--	--	--	Copeland & Hours 1993
Nahr Es Sarout	1	3	3	6	Copeland & Hours 1993
Qadib El Ban 1&2	1	2	3	1	Copeland & Hours 1993
Qanateir	1	0	0	0	Copeland & Hours 1993
Rastan	1	24	3	39	Copeland & Hours 1993

Table 1 - Inventory of hand axe sites in Syria: -- no data; • presence confirmed but no numbers available.

site	hand axes	pebble tools	ret. flakes	cores	source
Saene Et Tinat	3	1	0	3	Copeland & Hours 1993
Tahun Semaan 1	1	0	2	19	Copeland & Hours 1993
Tahun Semaan 2&3	15	3	0	2	Copeland & Hours 1993
Tahun Seman 2	23	12	27	155	Copeland & Hours 1993
Tahun Seman 3	3	3	0	33	Copeland & Hours 1993
Tell Khasselate 2	1	5	0	4	Copeland & Hours 1993
Tulul Defai	28	3	27	377	Copeland & Hours 1993
Wadi Gharmachi	3	0	0	0	Copeland & Hours 1993
Wadi Gharmachi	6	0	0	0	Copeland & Hours 1993
Wadi Krah	1	1	--	--	Copeland & Hours 1993
Zaitiyé 1	1	24	3	1	Copeland & Hours 1993
Zaitiyé 2	5	1	1	9	Copeland & Hours 1993
Zakat 1	1	2	0	--	Copeland & Hours 1993
Zakat 2	12	4	0	29	Copeland & Hours 1993
Damascus-Nebek area					
Ashrafiya	•	--	--	--	Tomsky 1982
Hami (Barada Tal)	6	--	--	--	Tomsky 1982
Ma'aloula - 01	1	--	--	--	Conard & Kandel 2006
Ma'aloula - 02	1	--	--	--	Conard & Kandel 2006
Ma'aloula - 03	1	--	--	--	Conard & Kandel 2006
Ma'aloula - 04	1	--	--	--	Conard & Kandel 2006
Ma'aloula - 05	1	--	--	--	Conard & Kandel 2006
Ma'aloula - 06	1	--	--	--	Conard & Kandel 2006
Ma'aloula - 07	1	--	--	--	Conard & Kandel 2006
Ma'aloula - 08	1	--	--	--	Conard & Kandel 2006
Ma'aloula - 09	1	--	--	--	Conard & Kandel 2006
Ma'aloula - 10	1	--	--	--	Conard & Kandel 2006
Ma'aloula - 11	1	--	--	--	Conard & Kandel 2006
Ma'aloula - 12	1	--	--	--	Conard & Kandel 2006
Ma'aloula - 13	1	--	--	--	Conard & Kandel 2006
Malula	1	--	--	--	Tomsky 1982
Mazza	2	--	--	--	Tomsky 1982
Nebek	600	--	--	--	Tomsky 1982
Qatana, Wadi Jarkas	•	--	--	--	Tomsky 1982
Ras Al Ain, Sail Al Blat	2	--	--	--	Tomsky 1982
Wadi Skifta I	2	--	--	--	Tomsky 1982
Wadi Skifta I	30	--	--	--	Tomsky 1982
Wadi Skifta II	3	--	--	--	Tomsky 1982
Yabrud K'S. 11	3	--	110	--	Rust 1950
Yabrud K'S. 12	22	--	37	--	Rust 1950
Yabrud K'S. 17	5	--	36	--	Rust 1950
Yabrud K'S. 18	8	--	52	--	Rust 1950
Yabrud K'S. 19	1	--	37	--	Rust 1950
Yabrud K'S. 23	3	--	33	--	Muhesen 1981
Yabrud K'S. 24	4	--	108	--	Muhesen 1981
Palmyra					
Jerf Ajla	7	--	--	--	Tomsky 1982
Locality 41	1	--	--	--	Akazawa 1979
Locality 59	1	--	--	--	Akazawa 1979
Locality 60	33	0	--	6	Akazawa 1979
Locality 63	1	--	--	--	Akazawa 1979

site	hand axes	pebble tools	ret. flakes	cores	source
Locality 71	1	--	--	--	Akazawa 1979
Locality 72	1	--	--	--	Akazawa 1979
Locality 76	1	--	--	--	Akazawa 1979
Qaryatain	1	--	--	--	Tomsky 1982
Suhna (Sukhne)	1	--	--	--	Tomsky 1982
El Kowm					
"Faustkeil" (n° 151)	1	--	--	--	El Kowm records
Aïn Beni Ali (n° 8)	5	--	--	--	El Kowm records
Dahr El Asfar (n° 6)	5	--	--	--	El Kowm records
Dahr El Asfar-C (n° 61)	5	--	--	--	El Kowm records
El Kowm site 113	1	--	--	--	El Kowm records
El Kowm site 124	3	--	--	--	El Kowm records
El Kowm site 125	2	--	--	--	El Kowm records
El Kowm site 131	1	--	--	--	El Kowm records
FSK-Dorota (n° 158)	1	--	--	--	El Kowm records
Grande Sebkha (n° 5)	1	--	--	--	El Kowm records
Houpe (n° 123)	8	--	--	--	El Kowm records
Hummal (n° 7)	8	--	--	--	El Kowm records
Juwal Aïn Al Zarqa	101	0	31	38	El Kowm records
Mazraat Osman (n° 37)	5	--	--	--	El Kowm records
Meirah	78	0	0	0	Boëda et al. 2004
Nadaouiyeh est	8	--	--	--	El Kowm records
Nadaouiyeh ouest	6	--	--	--	El Kowm records
Nadaouiyeh A	46	4	18	36	Nadaouiyeh records
Nadaouiyeh B1	59	27	11	67	Nadaouiyeh records
Nadaouiyeh B2	69	22	6	40	Nadaouiyeh records
Nadaouiyeh T	70	12	0	13	Nadaouiyeh records
Nadaouiyeh C	147	12	17	1	Nadaouiyeh records
Nadaouiyeh D (s.l.)	264	0	6	18	Nadaouiyeh records
Nadaouiyeh Da	217	0	16	25	Nadaouiyeh records
Nadaouiyeh Db	105	0	9	•	Nadaouiyeh records
Nadaouiyeh Dc	233	0	19	•	Nadaouiyeh records
Nadaouiyeh Dd	191	0	13	•	Nadaouiyeh records
Nadaouiyeh E	227	4	24	6	Nadaouiyeh records
Nadaouiyeh F	73	0	2	0	Nadaouiyeh records
Nadaouiyeh X	14	--	--	--	Nadaouiyeh records
Point-H (n° 98)	2	--	--	--	El Kowm records
Point-J (n° 99)	1	--	--	--	El Kowm records
Point-M (n° 100)	1	--	--	--	El Kowm records
Qalta 3 (n° 148)	2	--	--	--	El Kowm records
Qdeïr Aïn Ojbeh	597	3	48	50	El Kowm records
Qdeïr Sud	35	--	--	--	El Kowm records
SW-Tell Abiod (n° 138)	4	--	--	--	El Kowm records
Tell Abiad-B (n° 18)	3	--	--	--	El Kowm records
Wadi Aouiej (n° 104)	4	--	--	--	El Kowm records
Wadi El Faidan (n° 32)	5	--	--	--	El Kowm records
Wadi Fatayah (n° 15)	5	--	--	--	El Kowm records
Wadi Qdeïr (n° 21)	4	--	--	--	El Kowm records
Wadi Qdeïr C (n° 23)	2	--	--	--	Hours 1986
Euphrates valley					
Abu Jeboya	1	0	0	4	Copeland 2004

Table 1 - (continued): Inventory of hand axe sites in Syria: -- no data; • presence confirmed but no numbers available.

site	hand axes	pebble tools	ret. flakes	cores	source
Abu Kamal	•	--	--	--	Tomsky 1982
Ain Abou Jema	23	6	0	69	Copeland 2004
Aïn Jemaa	23	6	--	--	Muhesen 1981
Ain Tabous	16	6	0	43	Copeland 2004
Aïn Tabous	14	6	--	--	Muhesen 1981
Aiyasha	•	--	--	--	Tomsky 1982
Chiné West 1	2	0	54	112	Copeland 2004
Chioukh Faouqani II	1	1	0	1	Copeland 2004
Chioukh Faouqani III	6	0	3	9	Muhesen 1985
Chioukh Faouqani IV	2	3	1	22	Copeland 2004
Chnine	4	34	17	--	Malenfant 1976
Dadate V & VII	2	1	2	4	Copeland 2004
Deir N.1 *et al*	3	0	--	4	Copeland 2004
Der az Zor	•	--	--	--	Tomsky 1982
Dibsi	•	•	--	--	Tomsky 1982
Hajji Ismail A-C	5	0	3	24	Copeland 2004
Hamadin	20	4	--	--	Muhesen 1981
Hamadine	22	2	1	58	Copeland 2004
Hammam Kebir II	21	2	1	22	Copeland 2004
Helouandji I & II	22	5	6	47	Copeland 2004
Helouandjii	4	0	8	22	Copeland 2004
Maadan 1	5	1	--	20	Copeland 2004
Mahsannli III	7	0	4	0	Copeland 2004
Majra Srir II	6	0	5	10	Copeland 2004
Maskina (Meskene)	1	--	--	--	Tomsky 1982
Raqqa	•	--	--	--	Tomsky 1982
Rhanamate I	9	0	0	1	Copeland 2004
Sabouniyeh inf.	3	0	0	1	Copeland 2004
Sahel	1	0	0	1	Copeland 2004
Sebkha	2	2	0	6	Copeland 2004
Tchakmakli 1	3	0	0	2	Copeland 2004
Tellik III	5	0	0	6	Muhesen 1985
Wadi Abou Chahri 5	1	1	0	1	Copeland 2004
Wadi Abu Chahri 1	4	0	1	3	Copeland 2004
Wadi Abu Chahri 2	1	0	0	4	Copeland 2004
Wadi Abu Chahri 3	8	1	9	69	Copeland 2004
Wadi Rmeili I	7	2	2	13	Muhesen 1985
Wadi Rmeili III	10	2	3	14	Muhesen 1985
Khabour & Sajour valleys					
Al-Rasho	1	--	•	•	Nishiaki 1992
Arab Hassan I	13	11	--	--	Muhesen 1981
Dadat 1	1	6	--	--	Muhesen 1981
Kirbet al-Qadir	1	--	•	•	Nishiaki 1992
Majra Kebir 1	2	3	--	--	Muhesen 1981
Majra Seghir 1	19	14	--	--	Muhesen 1981
Qara Yaqoub I	59	2	10	29	Muhesen 1985
Southern Syria					
Dara	9	--	--	--	Tomsky 1982
Golan	•	--	--	--	Tomsky 1982
Tell Shabab	1	--	--	--	Tomsky 1982
Turunja	•	--	--	--	Tomsky 1982

Table 1 - (continued): Inventory of hand axe sites in Syria: -- no data; • presence confirmed but no numbers available.

a wide distribution throughout Syria from the Mediterranean coast (Nahr el Kebir), along the Orontes river probably also in the Euphrates valley. Beyond their relative age, dating clearly to the Lower Pleistocene, these discoveries remain difficult to characterise, as the census of artefacts in most cases is low and diagnostic objects are rare. Nearly all these materials elude a precise archaeological appreciation. The differentiation between mode 1 and mode 2 as it has been proposed in the past, is difficult to maintain given the low statistical base of most Syrian sites. However, hand axes made in an archaic style are clearly represented at several of these sites (e.g. Cheikh Mohammed, Sitt Markho, Mahardé 2, Fidio II, Nahr El Kebir). Most of the other sites do no more permit than the conclusion of an undisputable early human presence.

Nevertheless these discoveries demonstrate an early and widespread human occupation. Previously proposed age estimations of these sites have to be handled with care, as these were model ages issued with chronological concepts other than those in use today (i.e. the quadrinomial Quaternary). Also their relative contemporaneity is delicate to establish as the correlation of the Quaternary formations is based on geomorphological observations that are difficult to correlate directly from one river system to the next. Nevertheless, these early sites reflect a widespread human presence during the early Pleistocene at least along the major river systems. The data available for most are too sparse to draw a detailed picture. However, they clearly demonstrate the scientific potential for further investigations.

Recent discoveries in the El Kowm area also revealed significant early settlement activities in the central Syrian Desert Steppe (Le Tensorer *et al.* 2011). The stratified sites of Hummal and Aïn al Fil produced substantial materials, permitting a better diagnosis of these industries (Wegmüller 2011). Besides the archaic aspect of the lithics, preliminary datings and palaeontological observations confirm their great antiquity which can be estimated to be as old as Ubeidiya. The geographical settings of these two sites, far from ecologically favoured areas, point clearly to a much more widespread human occupation in the Levant during that time and a much more versatile behaviour than was previously thought.

In addition to a core and flake technology the Hummal site produced a very small number of hand axes featuring a quite progressive style of manufacture for such ancient tools. These hand axes are made in a first-grade flint material, contrary to their rather coarse counterparts from Ubeidiya, In fact, the quality of the raw materials is often underestimated, as industries using poor raw materials easily develop an archaic aspect.

The Acheulean

The Levantine Acheulean is clearly dived into two distinct periods. The quality of manufacture of the hand axes clearly separates the older from the younger phase. Basically both focus on the façonnage for making their tools. Retouched flakes are rare in either stage. In fact hand axes are the dominant type among shaped artefacts. In their fundamental essence, the older and younger Acheulean are very similar and share the same concepts despite striking differences in the appearance of their hand axes.

Levantine Lower Acheulean

The Levantine Lower Acheulean (formerly the *Acheuléen moyen*) is the first real hand axe tradition in the Bilad Ash Sham. It is readily recognised even in rather small samples by the style of manufacture of hand axes and their respectable size. Hand axes and associated tools are abundant. An African influence is present in the numerous typical cleavers on huge flakes made of basalt in Gesher Benot Yaakov (alias Gisr Banat Yaqub). Farther north this feature completely disappears from the archaeological evidence. Either this is a chronological phenomenon or due to the available raw materials. In the northern sites hand axes are made exclusively of flint nodules preventing the production of large flakes suitable for making cleavers.

The Levantine Lower Acheulean is quite consistent in its style of manufacturing hand axes all over its distribution area, reaching from Israel into Turkey and from the coast deep into the desert steppes of the interior. From Syria quite a number of sites are known from that period. The characteristic traits of Lower Acheulean hand axes in the past have been overestimated and the status of a number of supposedly Levantine Lower Acheulean sites has to be revised before confirmation.

By their excellent diagnostics Lower Acheulean hand axes can be ascertained even when present in quite small numbers. Against the requirements postulated above, Lower Acheulean sites can be identified with certainty with as few as a dozen hand axes. On that basis, seven sites can be certainly attributed to the Levantine Lower Acheulean (e.g. Latamne [Clark 1966; Copeland *et al.* 1993], Meirah [Boëda *et al.* 2004], Jabal Jibtaa [Copeland & Hours 1979:62], Berzine [Copeland & Hours 1979:65], Khéllalé 4 [Copeland & Hours 1979, 1993] Nad-X [Jagher 2004], with a number of candidates needing further confirmation.

Compared with the subsequent Levantine Upper Acheulean the earlier phase remains poorly known. So far only two sites of the Levantine Lower Acheulean, Latamne and Mheira (El Kowm area), have been excavated in Syria (Moddermann 1964; Clark 1966; Boëda *et al.* 2004).

The concept of regional differentiations proposed for the Levantine Lower Palaeolithic arose from an overestimation of sites with a limited number of artefacts. Wide variations are an inherent phenomenon among small samples and are a natural statistical effect. Human perception values differences more than common traits, a biological constant of our species, to which also scientists are subject. Therefore, traditional concepts based on small numerical evidence have to be considered with care. This goes particularly for the idea of a Lower Acheulean lacking hand axes, which was suggested on the basis of very small collections retrieved in situ from middle Pleistocene fluvial deposits of the Orontes and Euphrates. With less than 52 artefacts retrieved per site, as it is the case for all these claims, a definite statement is difficult.

Levantine Upper Acheulean

The Levantine Upper Acheulean presents a sharp break with the Levantine Lower Acheulean in the manufacture of its hand axes, which become smaller and much more elaborate. Albeit sizes clearly diminish (fig. 3) and volumes shrink in favour of thin sections, the concept of core tools, including not only classical hand axes but also lesser forms such as pièces bifaciales Façonnage is the central theme in these materials, with only an intermittend ans unsystematic flake production. Consequently, flake tools are rare. It is striking that in many sites denticulates and notches are the most common flake tools. A personal reassessment of some of these materials showed the presence of natural edge damage to a certain degree. Hence, the published data reflects an overestimation of human activity over natural phenomena.

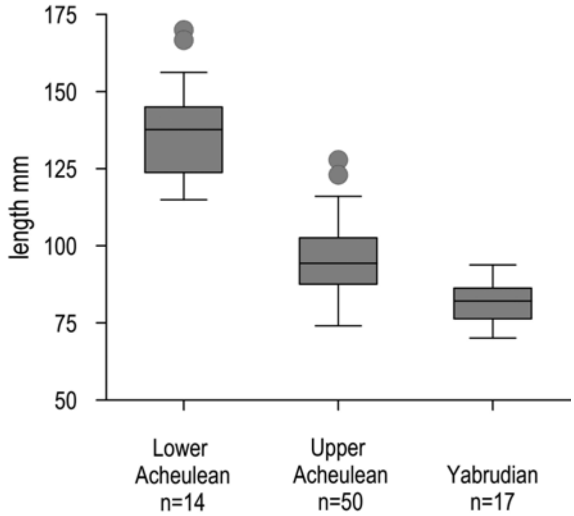

Figure 3 - Variation of mean length of hand axes. Only sites with at least 20 measurements are considered.

The same goes for the claims of complex flake technologies (i.e., Levallois). A short reappraisal of the so-called Defaian sites, known for the apparent coexistence of hand axes and Levallois débitage, clearly revealed a palimpsest situation. The theory of an evolution from hand axe technologies to Levallois débitage cannot be supported with the Syrian evidence. The presence of possible Levallois flakes in Acheulean contexts is rather to be seen in the manufacturing waste of hand axes than in a proper production (Copeland 1995). Until the emergence of the Levallois concept in the Levant as a stable production scheme can be established, one has to wait for the end of the Yabrudian period. Consequently Acheulean hand axes can hardly be a stimulus in the invention of that specific technique. Albeit the surface of a Levallois core and the face of a hand axe present some morphological affinities, the maintenance and exploitation of the volume is submitted to completely different constraints, the most prominent being that hand axes are bifacial tools. Levallois-like flakes in an Acheulean context are a morphological congruence suggesting inherence where there is none.

Compared with the Lower Acheulean, the subsequent period shows an astonishing proliferation of sites almost by a factor of eight, based on the same scale as for the Lower Acheulean (i.e. a minimal number of a dozen hand axes). With such a rich legacy, stylistic variation becomes clearly discernible among sites of the Upper Acheulean. In an earlier attempt this observation was structured along a typo-chronological conception including regional divisions, especially in the final stages. Diversification within the late Acheulean is not only present in Syria, but is an inherent trait of the whole Levantine Upper Acheulean. A key site for understanding the noticed variability is Nadaouiyeh Aïn Askar, with seven distinct facies of the Upper Acheulean (Jagher 2011). Changes occurred swiftly in many cases within a surprisingly short period. These mutations concern a multitude of aspects such as the style of manufacture or formal standardisation of hand axes, the repertoire of shapes, the sense of symmetry or the neglect of any of standardisation and the importance of small bifacial tools. All these elements appear and vanish at random along the time axis and defy any logical succession. This could be the key to why previous attempts at a chrono-typological structuring of the Levantine Upper Acheulean have failed. By its nature, the Nadaouiyeh stratigraphy is incomplete, with substantial hiatuses leaving room for imagination. In fact the neighbouring sites of Qdeïr Aïn Ojbeh and Juwal Aïn Zarqa elude a clear classification according to the Nadaouiyeh scheme, despite a good geo-chronological control among the three sites and rich assemblages of the former two.

Other Syrian sites of the Upper Acheulean, such as Muqaa El Hami, Qara Yaqub, Jrabiat 6a & 6b, Roudo and Ard Hamed, which withstand a clear attribution to the Nadouiyan scheme. However, the discoveries of Gharmachi Ib feature a strong affinity with the facies Nadaouiyeh-B (Nad-B). Beyond the Syrian context, the Nadaouiyeh observations are recognisable in Um Qatafa on the West Bank (Neuville 1931, 1951), presenting a close homology between layer E1 to Nad-E, D2 to Nad-D and Da to Nad-B. In Azraq (Jordan), particularly at Aïn Soda, a very similar industry to the facies Nad-D was discovered (Rollefson *et al.* 1997). Both sites share a strong presence of specific cleaver-like hand axes (Azraq cleavers), made with a uni- or bifacial single or multiple tranchet blow on ovate hand axes with a clearly offset base from sub-parallel or slightly convergent sides. Both sites share a keen sense for a refined style in execution and a comparable spectrum of shapes of hand axes. Tranchet-blow cleavers should not be confused with the true (African) cleavers, as they are derived by a secondary modification from true hand axes (Jagher 2011). Comparable tools are rare in the other Levantine Upper Acheulean but are occasionally reported in younger periods (Matskevich 2006).

Despite the heterogeneity of the Levantine Upper Acheulean, these observations show a well established cultural versatility in a time when cultural development was thought to be sluggish and little inspired. In fact the Levantine Upper Acheulean, despite its fixation on the façonnage technique and strong preference of hand axes, was a most dynamic culture with a strong evolutionary momentum. The hand axe was indeed a leitmotif, but not the only aspect of that culture with a surprising contrast of tradition and innovation.

The Post-Acheulean – the end of the hand axe era in the Levant

The question of the end of the lower Palaeolithic is somewhat controversial: the issue is whether the Yabrudian is Lower or Middle Palaeolithic. If we consider only the hand axes, there is a certain "Acheulean" element present to some extent. From a qualitative approach there is no question about that. However, the proportion of hand axes is by far smaller than in the Upper Acheulean. The concept of façonnage definitely has a different condition if the quantitative aspect is considered. In fact, the Yabrudian clearly prefers the débitage approach to produce the supports for its tools, whereas the façonnage is merely an accessory phenomenon clearly of lesser importance than in previous periods.

The change between the Levantine Upper Acheulean and the Yabrudian is profound. Why the Upper Acheulean disappeared after a successful and long lasting proliferation in all regions of the Levant is unclear. Climatic change is probably not the only culprit (in fact there is a marked rise of global temperatures between 340 and 330 ka, at the limit of MIS 10 and 9). However, the Upper Acheulean went through several and severe climate changes during its existence without much effect. Whether the Acheulean just faded away, giving way to new settlers, or if an inherent momentum triggered this change or was an influence from neighbouring populations, is open to debate.

In any case the Yabrudian features few if any common traits with the Upper Acheulean. Hand axes, much less popular than before, are the only potential link. However, they differ in size from the earlier ones and show different forms that are rare or unfamiliar in preceding cultures (fig. 4). The concepts of an "Acheulo-Yabrudian" emanated from the Yabrud excavations, where levels with higher and lower percentages of hand axes are interstratified (Rust 1950; Bordes 1955). Conspicuously layers with the prefix "Acheulo" are the ones that produced only small quantities of artefacts, hence an assessment on a weak statistical base. In fact such short inventories are difficult to estimate, as their composition is rather fortuitous and barely reflects the intentions of their makers. Ultimately the Yabrudian is a less "Acheulean" entity than one may think, it is not the exceptions that make the definitions, but it is the mainstream that counts. In this case it is the abandonment of façonnage as the central theme in favour of débitage and retouched flakes.

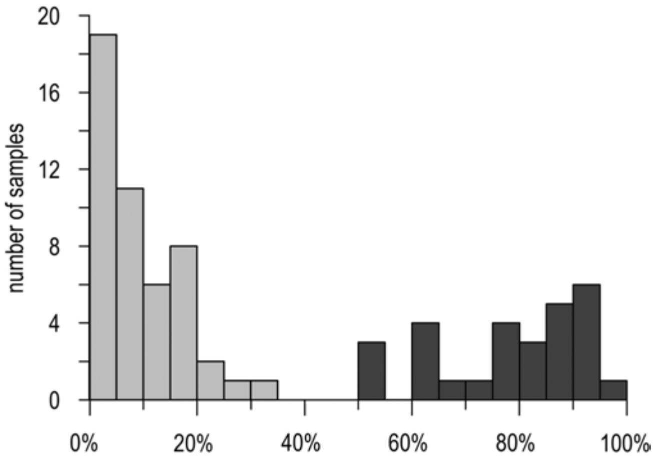

Figure 4 - Proportion of hand axes in relation to retouched flakes, dark grey: Acheulean sites (n=28), light grey; post-Acheulean sites (n=48). Only sites with more than 100 pieces are considered.

The question of the "Tayacian"

While dealing with the Lower Palaeolithic in the Levant inevitable one comes across the "Tayacian". The term "Tayacian" was first introduced into the Levant by Dorothy Garrod during her Tabun excavations (Garrod & Bate 1937). Since its initial definition in the early 1930s (Breuil 1932), its assessment has proved difficult. With the years the "Tayacian" became a kind of receptacle of the same kind as has been outlined in this paper for the Acheulean (see chapter *A schort digression on the Label "Acheulean"*), for classifying poorly defined lithic collections devoid of (or poor in) characteristic artefacts combined with a generic débitage. The lack of apparent character is the connective peculiarity of these materials. But is that enough to establish a stringent cultural link between respective sites?

Considering the chronological situation of reportedly "Tayacian" sites in the Levant, the situation remains blurred. At Um Qatafa the "Tayacian" predates a Levantine Upper Acheulean. Recent investigations of the lower part of the Tabun stratigraphy challenge the label "Acheulean" for unit XIV or layer F. In fact the materials from these levels barely differ from those of the Yabrudian (Ronen *et al.* 2011). In any case the Tabun Acheulean is not in accordance with our definitions of the Levantine Upper Acheulean, hence the position of the "Tayacian" has to be reviewed. In Bezez cave the situation is comparable to Tabun with the "Tayacian" predating the Yabrudian. For the Shemsian in Jabrud IV chronological evidence is absent. For the coastal sites of Ras Beirut only geomorphological observations are available, impossible to integrate in an archaeological chronology.

This sobering review clearly demonstrates the disparate situation. In such a case the term "Tayacian" has merely a descriptive value for poorly defined inventories. It is difficult to maintain an independent cultural entity on the base of such inconsistent data.

Conclusions

The Lower Palaeolithic indisputably has a very long and prestigious human history in the Levant. For Syria we are just beginning to get a glimpse of these periods through the ongoing excavations and studies in Hummal and Aïn al Fil, both in the geographic heartlands of the country. The Levantine Lower Acheulean, whose beginnings can be placed around one million years BP, shows in some areas of the Levant a clear African influence (Gesher Benot Yaacov) that is lacking farther north (e.g. Joubb Jenine and Latamne). Geographically the sites of the Levantine Lower Acheulean cover a wide range in Syria, encompassing a large range of biotopes, reflecting the high degree of adaptability of these early hunters and gatherers. It seems probable that the arrival of the Levantine Lower Acheulean reflects a new wave of human immigration into the Eastern Mediterranean region. In any case its lithic culture was clearly different from its contemporaries in Europe. This separation continues all along the subsequent Levantine Upper Acheulean. The change between the Lower and Upper Levantine Acheulean perhaps 600 ka ago is substantial, however, it may be a local

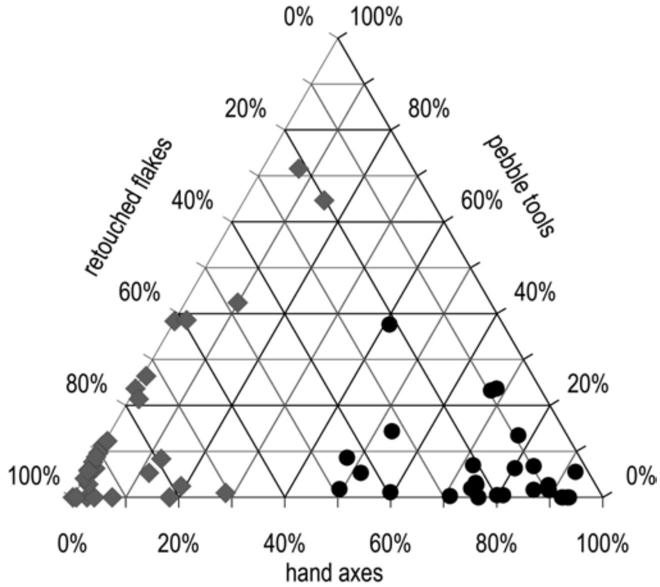

Figure 5 - Comparison of tool sets during MIS 13-11 (i.e. ~530-375 ka) in the Levant (black dots) and Europe (grey diamonds). Only sites with more than 100 tools are respected.

evolution from the regional cultural substratum of the Lower Acheulean. A direct African input is not detectable. To what extent the Levantine Upper Acheulean radiated into the Taurus and Caucasian Mountains, or extended to the south, goes beyond the scope of this paper. Especially the Levantine Upper Acheulean, with its consistently high percentage of hand axes (fig. 5), perfectly matches the stereotype of the Acheulean, being really rich in hand axes, a cliché that scarcely fits European discoveries where hand axe proportions are consistently lower than in the Levant (Jagher 2011). Surprisingly for such a remote period, the Levantine Upper Acheulean culture is extremely versatile, producing a considerable number of distinct chronological facies with a strong persisting cultural identity in the background. The observed changes could happen in quite a short time as data from Nadaouiyeh Aïn Askar suggest. The Levantine Upper Acheulean province is the oldest original cultural entity on the shores of the Eastern Mediterranean. There are no indications of a new human immigration at the beginnings of the Levantine Upper Acheulean that may have evolved locally from the Levantine Lower Acheulean. The end of the Acheulean seems to have come quite fast, for whatever reasons. The subsequent "Yabrudian-Mugharan group" is a clear rupture with the long lasting lithic concepts of the Acheulean. If it was an inherent dynamic, or influence from abroad, or the immigration of new human groups, or if environmental factors played a role, is a matter for debate. In any case, in that time there occurred several profound changes in lithic traditions as débitage replaces façonnage and new technologies with blade production appear (Amudian and Pre-Aurignacian). It is challenging to explain the apparent coexistence of such different traditions within such a small geographic region. Surprisingly in that period the obvious difference between Europe and the Levant disappeared to a large extent. Any mutual exchange remains to be established yet, despite some congruent development (i.e. the Yabrudian-Quina question).

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INNOVATIVE HUMAN BEHAVIOR BETWEEN ACHEULIAN AND MOUSTERIAN: A VIEW FROM QESEM CAVE, ISRAEL

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Introduction

Qesem Cave is a sediment-filled karstic chamber cave some ~20 x 15m in size and ~10m high, located 12 km east of the Mediterranean. The excavation exposed a ~7.5m archaeological sequence. Subsidence, erosion, fracturing, deposition of various sediments and cementation were continuous or recurrent within Qesem Cave during the Middle Pleistocene, constantly changing the cave's landscape and conditions and finally acting as post-depositional agents shaping the preset cave and its sediments (Frumkin *et al.* 2009).

The stratigraphic sequence was divided into two parts – the lower (ca. 3m thick), consists of sediments with clastic content and gravel, and the upper (ca. 4.5m thick), of cemented sediment with a large ash component. The lower part was deposited in a closed karstic chamber cave, while the upper part was deposited when the cave was more open as indicated by the presence of calcified rootlets (Karkanas *et al.* 2007). The use of fire at the site is apparent not only by burnt bones and flints, but also by the presence of ash in the sediments. The micromorphological study indicates that fire was habitually used in the upper part of the sequence and present but less common in the lower part (Karkanas *et al.* 2007).

Intensive 230Th/234U dating on speleothems suggests human occupation starting ca. 400 kyr and ending prior to 200 kyr (Barkai *et al.* 2003; Gopher *et al.* 2010). This is supported by unpublished TL dates.

Qesem Cave yielded rich and well preserved faunal assemblages and lithics. The Qesem Cave sequence was assigned to the Acheulo-Yabrudian complex (hence forth AYCC) defined by Rust (1950). The AYCC included three major industries – Acheulo-Yabrudian dominated by handaxes and Quina scrapers; the Yabrudian dominated by Quina scrapers; and the Pre-Aurignacian/Amudian dominated by blades and shaped blades (Bar-Yosef 1994; Copeland 2000; Garrod 1956, 1970; Goren-Inbar 1995; Jelinek 1982, 1990; Monigal 2002; Ronen & Weinstein-Evron 2000). One of the most interesting aspects of this complex was the industry dominated by blade production

Figure 1 - Laminar items from Qesem Cave – Blade dominance at a glance.

(Garrod & Bate 1937; Rust 1950; Garrod & Kirkbride 1961) – the Pre-Aurignacian/Amudian.

Pre-Aurignacian/Amudian (hence forth Amudian) assemblages in the Levant are scarce and have been recovered in only a few sites (e.g. Garrod & Bate 1937; Garrod & Kirkbride 1961; Jelinek 1990; Rust 1950; Skinner 1970; and see Copeland 2000).

Stratigraphically, the AYCC postdates the Acheulian cultural complex of the Lower Palaeolithic period and predates the Mousterian cultural complex of the Middle Palaeolithic period, correlating to Jelinek's "Mugharan Tradition" (Jelinek 1990). Albeit some apparent difficulties, radiomentric, absolute dates indicate the same scenario (Gopher *et al.* 2010).

It is within this framework, between Acheulian and Mousterian, that we will try to shortly present the major innovations

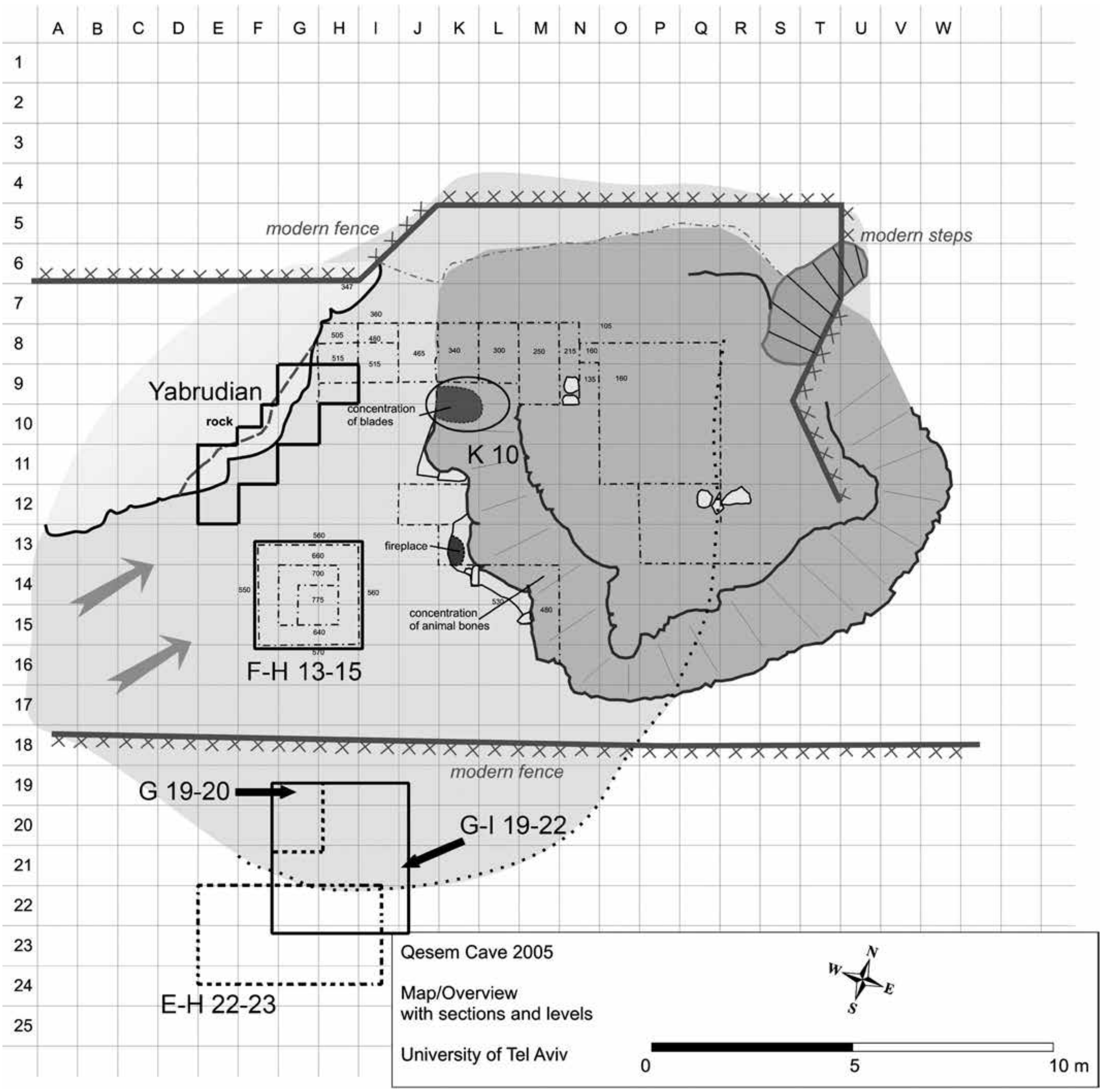

Figure 2 - A plan view of Qesem Cave with indication of the spatial location of the Amudian and Yabrudian assemblages presented in the paper. The areas marked by square numbers are Amudian. The location of two of the Yabrudian assemblages is specifically indicated.

of Qesem Cave and their significance to a better understanding of Middle Pleistocene human behavior. We concentrate on the lithic aspect although other finds of Qesem Cave that may contribute to this end will be mentioned and briefly discussed. The discussion will enlarge on the significance of Qesem Cave in the framework of the larger AYCC.

The lithic aspect of Qesem Cave

The lithic assemblages recovered at Qesem Cave during the salvage 2001 seasons and the 2004-2008 seasons is over 100,000 items of which we studied in detail over a half. These cover spatially different parts of the cave and generally all of its major stratigraphic units. The density of lithic finds per cubic meter is usually around 2000 items while is specific cases, like Square K/10 it reaches over 9000 items per one cubic meter.

The lithic industrial sequence of the cave is mostly blade-dominated (Gopher *et al.* 2005) and attributed to the Amudian industry (fig. 1). Recently, Yabrudian, scraper-dominated was assemblages were recovered and recognized in well defined parts of the cave. In this paper we briefly present the Amudian and comment on the Yabrudian (fig. 2).

The Amudian industry

Raw material

A variety of high quality flints was used at Qesem Cavae. A study of raw material procurement strategies (quarrying versus surface collection) has been conducted using a method based on measuring the cosmogenic isotope 10Be (Verri *et al.* 2004, 2005). Flint artifacts from the Late Lower Paleolithic cave sites of Tabun (E) and Qesem were sampled and analyzed. The results have shown that deep mined flint was used already around 400,000 years ago. Both sites also show use of flint extracted from shallow mined sources and collected from the surface. The results of an additional series of analyses show not only that some of the flint at Qesem Cave was quarried but that this quarried material was used for specific purposes (Boaretto *et al.* 2009). This indicates an intimate knowledge of the environment and the resources in the landscape around the cave. Preliminary surveys indicated the presence of potential raw material sources at the wadi slopes and wadi beds near Qesem Cave as well as in situ deposits of fractured flint blocks a few km from the cave. Raw material appears as rounded, amorphous or flat small fragmented slabs. The later were preferred for blade production.

Amudian blade production

The most innovative aspect of the Qesem Cave lithics is systematic blade production. One of the Amudian lithic assemblages from Qesem cave was published recently (Barkai *et al.* 2005). This assemblage together with four additional assemblages studied recently (N=ca. 25,000 items) and insights from knapping experiments of Amudian blades conducted by Ron Shimelmitz in the framework of a Ph.D. program in the Institute of Archaeology, Tel Aviv University, are summarized here (for details see Barkai *et al.* 2009). It is important to note that the whole Chaîne Opératoire of blade production was recovered in the cave including, raw material blocks/nodules, cores, core trimming elements, debitage, shaped items, used items and various (resharpening and retooling) spalls.

The basic concepts of Amudian blade production technology practiced at Qesem Cave are as follows:

The Qesem Cave knappers preferred relatively small, flat and thin (ca. 10cm long and up to 5cm thick) nodules with cortex on both faces for blade production (fig. 3:1). Blade cores and raw material blocks found within the cave's strata indicate frequent use of small and flat nodule fragments, most probably split by the elements from large flat nodules as reflected by the weathered and patinated breakage/cleavage plains characterizing the cores and the nodules found at Qesem Cave. These cleavage plains are usually in a ~90 degree angle to the intended production surface at the narrow side of the nodule and thus serve as readily available striking platforms. Similar nodules and nodule fragments were found in the vicinity of Qesem Cave and were used in the knapping experiments.

The technique used was direct hard-hammer percussion. Blades were removed by powerful follow-through blows that occasionally removed parts of the distal end (base) of the core and resulted in an over-passing end termination. The blows were mostly delivered at the inside of the striking platform and not close to the edge of the core as indicated by thick platforms and large protruding bulbs of percussion.

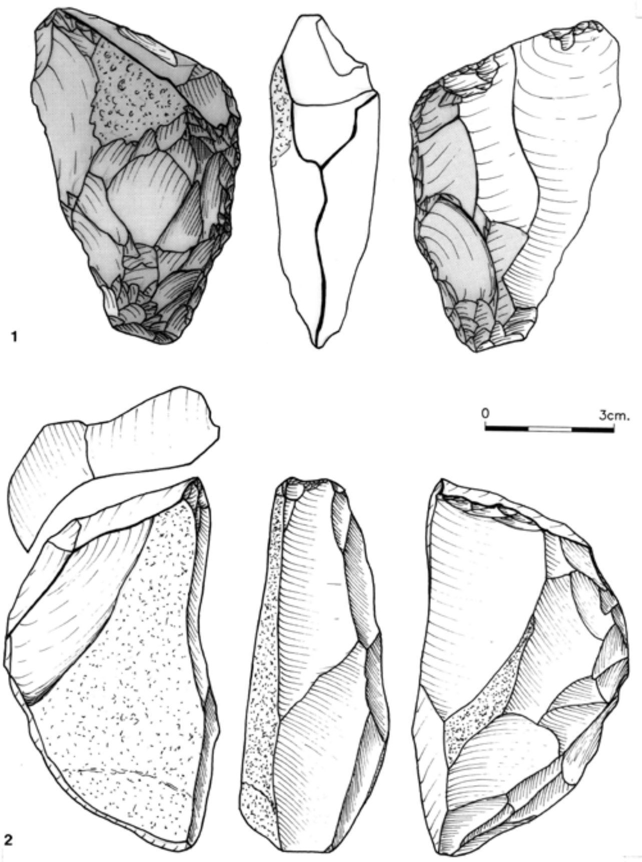

Figure 3 - 1: Patinated handaxe transformed into a blade core from Qesem Cave, 2: typical blade core on flat nodule fragment from Qesem Cave.

Cores were minimally prepared prior to blade production. Cortex was not removed in advance and many of the blades (especially the NBK's and primary blades but many of the "central" blades as well), carry a strip of cortex at one of the lateral edges or at the distal end (figs. 4-5). Striking platforms were mostly prepared by a single removal at the initial stage of preparation while the use of natural, unprepared (corticated or old cleavage surfaces) is common as well. Production surfaces were mostly created at an angular corner of the selected flat nodule thus enabling the removal of the first cortical blades following existing ridges with no investment in shaping the production surface and creating primary guiding ridges for blade production.

Core maintenance during blade production was minimal. Core convexities were maintained by the removal of over-passing items that removed small parts of the core's distal end (base) and maintained the desired angle between the striking platform and the production surface throughout systematic blade production. The fact that many blades bear a distal over-passing end termination seems to indicate that in the Amudian blade technology target blanks served as core maintenance elements as well. While the systematic, sequential removal of over-pas-

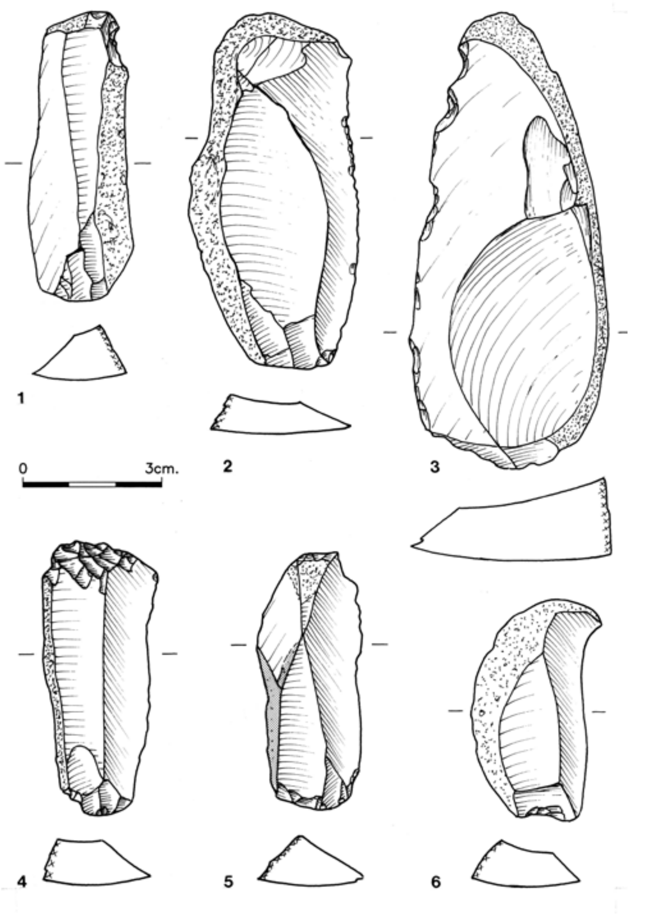

Figure 4 - Naturally backed knives with overpassing end termination from Qesem Cave.

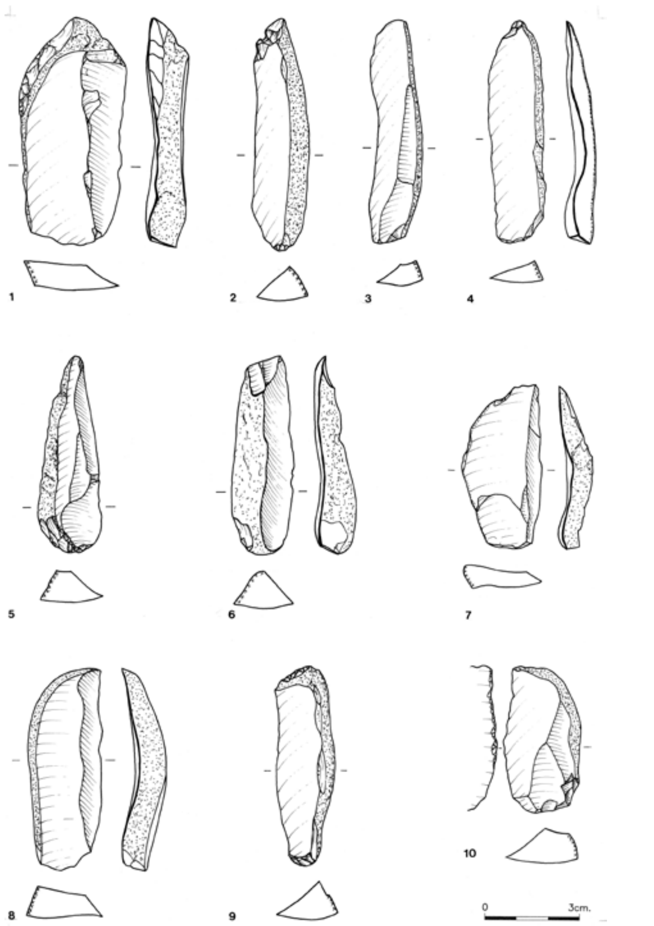

Figure 5 - Naturally backed knives from Qesem Cave, items 8-10 have an overpassing end termination.

sing blades enabled continuous production with minimal maintenance, some of these blades removed a substantial part of the core's distal end and lateral edges and can thus be regarded as items removed to control core convexities. It is indeed sometimes difficult to differentiate target blanks with a "minor" overpassing end termination from a true over-passing blades aimed at correcting the angle between the striking platform and the production surface, since in the Amudian technology practiced at Qesem Cave, blank production and core maintenance were achieved by a single blow. In some cases ridges were prepared and maintained and striking platforms were renewed by core tablets or faceting flakes, but this is rather uncommon.

Laminar items (a general term for the three types of blades) produced included primary blades, NBK's and common/central blades, all part of a single continuous production sequence.

Blades are characteristically short (mostly between 41-60mm) and thick (mostly between 6-13mm). Striking platforms are usually plain and thick, and bulbs of percussion are pronounced.

Naturally Backed Knives and central blades are the most conspicuous blade categories in the Amudian industry at Qesem Cave.

The Amudian blade reduction sequence led to a high percentage of laminar items in the assemblages (25-58% of the debitage and shaped items) with a minimal reduction of non-blade by products.

The use of blades

A use-wear stduy was performed on the lithics retrieved from square K/10 (Lemorini *et al.* 2006). The best preserved 253 items were studied and diagnostic traces were found on 74 artifacts including 37 shaped items and 37 unshaped items. In the case of the former, the wear traces were mostly found on the unshaped (non-retouched) parts of the items. The major activity recognized was cutting (58% of the diagnostic items) followed by scraping activities (25% of the diagnostic items). The cutting is associated with the working of soft material, mainly fleshy tissues. The unshaped edges were used for the different cutting activities, while shaped edges were more often used for scraping. The use of these cutting tools was not intensive and items were discarded after a short time. The results demonstrate the efficiency of NBK's as cutting tools and can be summarized as follows:

1) Considering the age of the site, the state of preservation is outstandingly high and permits a detailed functional reconstruction.

2) The major use of blades in the studied assemblage was in butchering. The use wear is mainly related to cutting and defleshing of soft tissues. There is a correlation between working edge morphology (straight edge) and cutting activities.

3) The use of blades for cutting tasks seems to have been short,

as indicated by the degree of development of wear traces and the general lack of resharpening.

Additional typological comments

• Blade tools are dominant in the Amudian assemblages (24%-61% of the tools) including a variety of retouched and backed blades (fig. 6) as well as burins and endscrapers.
• Handaxes are very few (only 5 in all excavated assemblages).
• Scraper frequencies vary between assemblages (1-10% of the tools).
• Polyhedrons – made of limestone, appear in small numbers in a specific location in space and stratigraphy.

A comment on recycling

Recycling of lithic artifacts is quite common at Qesem Cave including the use of patinated old items and the reuse of old flakes in many different ways. One interesting way is what we call "cores on flakes" (fig. 7). These are flakes used as cores to produce small, double ventral products, removed from their ventral face – very specific small flakes. Preliminary results of a use wear analysis on these flakes indicate the use of these small flakes for cutting soft tissues. Another interesting example is a patinated hanaxe transformed into a blade core (fig. 3:2).

Summary of Amudian assemblages

Thorough studies of Amudian lithics, usually on small samples, have been undertaken for Tabun (Jelinek 1990; Monigal 2001, 2002; Wiseman 1993), Yabrud I (Vishnyatsky 2000), Abri Zumoffen (Copeland 1983), and Masloukh (Shmookler 1983). Qesem Cave is a significant addition to this list with large Amudian assemblages.

We summarize our results as follows: The Amudian industry of Qesem Cave is characterized by systematic blade production and a major component of shaped blades as well as Naturally Backed Knives. Alongside blade production, flakes also appear in the Amudian as well as some side scrapers and single handaxes (Barkai *et al.* 2005).

The blades reflect strict standards of raw material procurement and an established and crystallized "Chaîne Opératoire" for blade production, shaping, use and discard.

Amudian blades at Qesem Cave were reduced from specific flat nodule fragments and small nodules that were either collected or quarried from the sub-surface (Verri *et al.* 2004, 2005; Barkai *et al.* 2009; Buaretto *et al.* 2009). These nodules enabled the implementation of the Amudian conception of blade production, i.e. serial production of cutting implements, preferably with one cortical, steep lateral edge and an opposed sharp edge, with very little effort invested in core preparation and maintenance (some sort od Debitage Direct, e.g. Meignen 2007). Amudian blade knappers developed a very efficient technology for the production of cutting tools that looks very simple at first glance, but is actually sophisticated and highly effective. Blank production and core convexities were achieved by follow-through blows constantly removing overpassing and debordant laminar items.

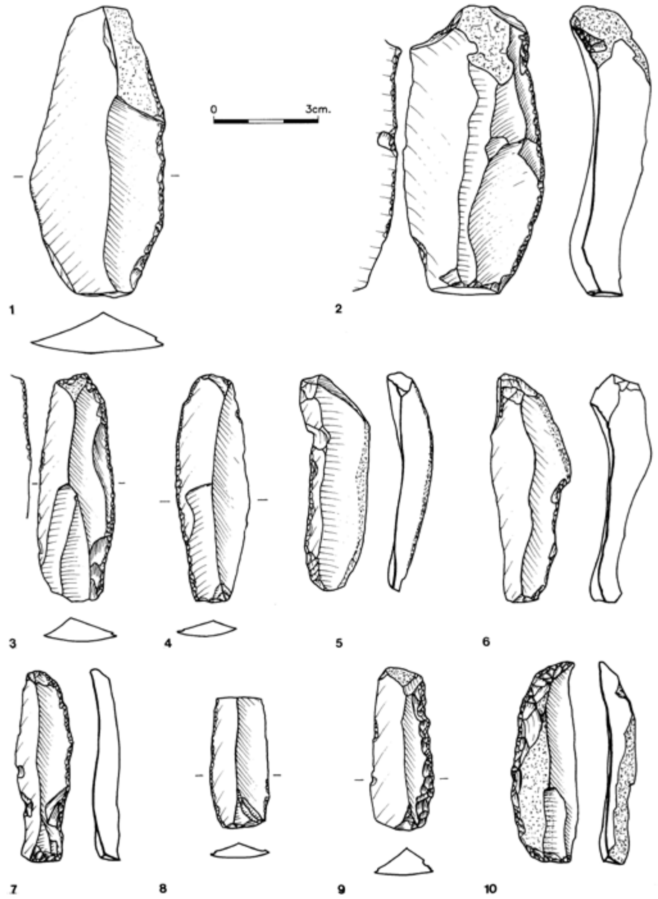

Figure 6 - Shaped laminar items from Qesem Cave.

This blade technology supplied large numbers of cutting tools with relatively few by products.

Amudian blades were mostly used in cutting, butchering and defleshing activities on soft tissues and were practically conceived as disposable tools, cut and throw-away implements (Lemorini *et al.* 2006).

The Yabrudian industry

Recently, we realized that Qesem Cave includes another component of the AYCC – the scraper dominated Yabrudian industry. This indicates variability and more complex human behavior in the cave rather than specialized blade-related activities only.

The Yabrudian is limited to two well defined parts of the cave (fig. 8) and seems to be contemporaneous with the Amudian. One of these areas was further excavated in summer 2008 and stratigraphic as well as sedimentological studies are now underway focusing on the nature of the Yabrudian occupational area and its position vis a vis the Amudian. A speleothem embedded within the Yabrudian layer was dated by Th/U to ca. 300 kyr (Gopher *et al.* 2010) and a series of dosimeters was inserted in the area to enable further TL and ESR dating.

Technological and typological aspects

The Yabrudian assemblages are conspicuous in two respects; one, the dominance of scrapers in the shaped items (almost

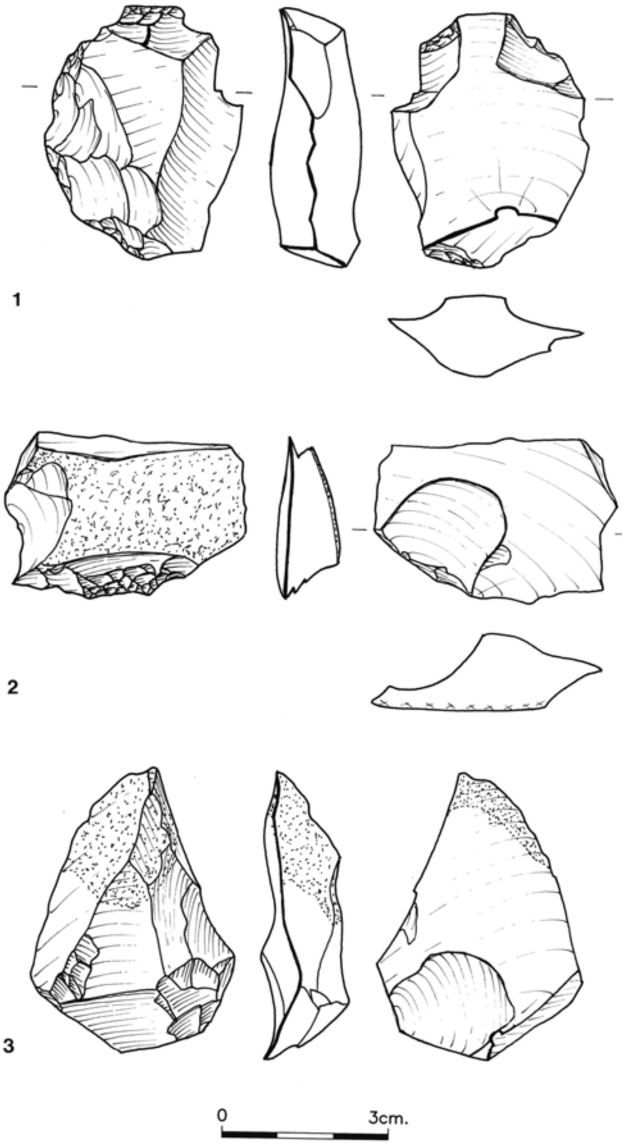

Figure 7 - Cores on flakes from Qesem Cave, removals are from the ventral face.

50%), and two, the scarcity of blades. A few preliminary comments can be made on the scrapers:

- They are made on thick flakes including transversal and dejeté flakes (fig. 9).
- A sample of eight scrapers showed that these are made on raw materials with low 10Be content, indicating either quarrying or collecting raw material from primary geological sources or shortly exposed.
- Resharpening and retooling of scrapers at the site is evident both by typical removals on some of the scrapers and by the presence of characteristic spalls.
- As opposed to the case of blade production, the "Chaîne Opératoire" for scraper production cannot be followed in the cave. We may assume that the flakes or finished scrapers were imported into the cave.

We reiterate the fact that the Yabrudian assemblages do include small numbers of blades and they seem to be quite similar to the Amudian blades and by the same token, the Amudian in-

Figure 8 - The "shelf" area - a Yabrudian activity area at the north-western side of Qesem Cave. The sediments below the shelf yielded scraper-dominated assemblages while adjacent assemblages are dominated by blades.

cludes a few scrapers and they are similar to those found in the Yabrudian. It is of importance to note that at present no handaxes were found within the Yabrudian assemblages.

Faunal remains

The faunal assemblages are rich and well preserved throughout the stratigraphy and the dominant hunted species is fallow deer. Other species include aurochs, horse, wild pig, tortoise and red deer. Not all body parts of fallow deer are present (the trunk is under represented and cranial elements over represented), indicating that carcasses were first processed out of the site and only selected parts were brought to the cave. Cut marks were found on the bones and indications of marrow extraction were recognized (Gopher *et al.* 2005; Lemorini *et al.* 2006; Stiner *et al.* 2009). Many bones show burning signs. Faunal remains are now being prepared for publication.

Discussion

Qesem Cave

The relative chronology of Qesem Cave is based on comparative lithics and stratigraphy of parallel sites in the region and

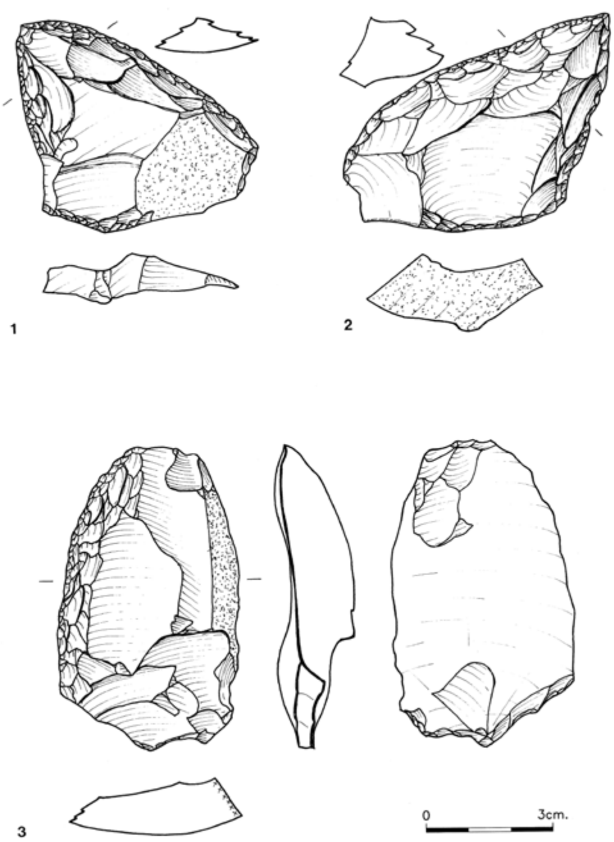

Figure 9 - Typical Yabrudian scrapers from Qesem Cave.

it indicated that Qesem Cave is clearly part of the Acheulo-Yabrudian complex, i.e. between Acheulian and Mousterian. The absolute chronology based on a large set of U-series dates (Barkai *et al.* 2003; Gopher *et al.* 2010), shows a general range of 400-200 kyr. Preliminary unpublished TL readings show a range of 360-230 kyr.

Qesem Cave was repeatedly visited by Hominins during the Middle Pleistocene, as early as 400 kyr ago when the cave was a large empty karstic chamber and until slightly prior to 200 kyr ago when anthropogenic sediments filled the cave almost completely. The human use of Qesem Cave is related to the AYCC with no indication of earlier or later activities. The stratigraphic sequence of ca. 7.5 meters can be characterized by three major cultural traits repeatedly found from bottom to top: the first is systematic blade production [with an age starting around ca. 400 kyr (Barkai *et al.* 2003; Gopher *et al.* 2010) this is one of the oldest systematic blade production industries known], the second is the habitual use of fire and the third is the dominance of fallow deer within the fauna. It is the coexistence of these three aspects that reveals the uniquness of the Qesem Cave Amudian.

It is beyond the accidental that large numbers of blades appear together with large numbers of fallow deer body parts. It seems likely that Amudian blades at Qesem Cave were mostly used in butchering these prey animals. The habitual use of fire too might be connected to the consumption of meat at the site due to the abundance of burnt bones at the site (Stiner *et al.* 2009). Stray hand-axes and small numbers of scrapers found in Amudian assemblages might indicate a wider range of activities than blade-related tasks, but the dominance of blades reflects their centrality in the Amudian of Qesem Cave. As for the Yabrudian component, it may reflect yet another activity related to the consumption and use of animals taking place on-site, most probably at the very same time that the other activities took place. This may suggest that Qesem Cave was not a specialized hunter's camp but rather a home base where space division reflects different activity areas.

The Acheulo-Yabrudian complex – a general view

The AYCC is, in our view the latest part of the Lower Paleolithic following the Acheulian and preceding the Mousterian and Qesem Cave is an integral part of this complex.

The special stance of Qesem Cave within the AYCC stems from the fact that while the Amudian aspect usually constitutes a small component within the AYCC stratigraphy, hardly separated from overlying and underlying Yabrudian and Acheuleo-Yabrudian layers (Garrod 1970; Rust 1950:28-34), the Qesem Cave sequence shows a major Amudian component throughout its thick stratigraphic sequence. However, the presence of a Yabrudian component in the cave is now clearly established and we are thus obliged to engage in the discussion on variability within the AYCC. Actually, variability within the AYCC was never discussed thoroughly as was the case with the Mousterian debate (e.g. Binford 1973; Bordes 1961, 1973; Bordes & Bordes 1970; Dibble 1991; Mellars 1970, 1986) although it provides a glance into similar problems at much earlier dates. Although a detailed discussion is beyond our scope here, we might as well make a few comments.

Sites of the AYCC such as Tabun (E) and Yabrud I show assemblages dominated by handaxes and/or scrapers with only low numbers of blades or no blades at all, and assemblages, usually quite small in scale, dominated by blades. This was interpreted by the pioneers of AYCC studies as a reflection of the presence of different human groups in the Levant, each characterized by a different lithic industry (Garrod 1956; Rust 1950). Another interpretation claimed that this possibly reflects a different array of activities for each such assemblage/industry (e.g. Jelinek 1990). The possibility of intra-site contemporaneous, activity-related industries was also briefly mentioned as an option for Yabrud I and in a more pronounced manner at the site of Abri Zumoffen (Garrod 1970; Garrod & Kirkbride 1961; Solekci & Solecki 1986).

The contemporaneity of the different industries within the AYCC was derived from the geological logic of interfingering. The successive alternating lithic industries, i.e. layers or sublayers, appearing with no repeated order in the different sites, were viewed as indicating the contemporaneity of independent industries (facies). Each site has generally been considered as a sequence of successive industries while the different industries have been presented as alternating entities within the general, large scale AYCC.

Although Yabrudian-Amudian coexistence at Qesem Cave is now a viable option since both appear in the same elevations, it still needs confirmation and will be the focus of field work and sediment analysis in the comming years. This, in turn may support a spatially related interpretation of the variability at Qesem Cave suggesting different activity areas within the cave. Notwithstanding the typological differences between the Amudian and Yabrudian assemblages, the two share, as mentioned above, major technological traits - i.e. typical Amudian blades were produced on a small scale in the Yabrudian while typical Yabrudian scrapers appear in small numbers in the Amudian.

In a general framework, the Acheuleo-Yabrudian Cultural Complex as an independent cultural entity would be summarized as follows:
• Time frame: 400-200 kyr.
• Space: Levant (Israel, Lebanon and Syria).
• Three major distinctive industries expressing both inter-site (regional) variability and/or possible intra-site activity-related variability.
• Lithic complexity is reflected in the presence of handaxes, Quina scarpers and blades showing intra and inter-assemblage variability.
• Flint procurement is variable including both quarrying and surface collection.
• Fire was habitually used leaving massive ash accumulations.
• Hunting and butchering of medium sized (and large) mammals was common.
• Hominin: unknown

As a major entity of the late Lower Paleolithic of the region, between Acheulian and Mousterian, the AYCC shows both patterns of continuity and change:
• Acheulian cultural traits that did not continue in the AYCC are Acheulian large and small flake tool traditions.
• Acheulian cultural traits that continued in the AYCC, but never made it to the Moustrerian, include mainly the long tradition of handaxes production.
• Acheulian cultural traits that continued in the AYCC and in the Mousterian include the use of fire; hunting and butchring and flint quarrying.
• Unique AYCC innovations unknown in the Acheulian that did not continue to the Mousterian include systematic none-Levallois blade production – an innovative lithic, blade production "running ahead of its time" (although non Levallois blade production trajectories are known from early Middle Paleolithic contexts, these are different in conception than the Amudian blade technology (e.g. Mignen 2000, 2007) ; the production of Quina scrapers; and special butchering tool-kits.
• The Levallois technology is absent in AYCC assemblages (Qesem Cave, Tabun Cave, Yabrud I). This is an interesting issue considering the fact that a growing data base indicates that this technology had its origins in the late Acheulian. Thus the Levallois technology seems to have skipped the AYCC and became dominant in the later Mousterian.

Considering all this we may view the cultural complex between Acheulian and Mousterian as an independent, long, creative and innovative cultural entity reflecting dynamic human behavior and flexible local adaptations.

In recent years the habitual use of fire, systematic hunting and butchering techniques, division of space in human occupation sites (specific activity and discard areas), blade production and we may add recycling of stone, were, amongst other aspects, viewed as behaviors practiced by modern humans in the Middle Paleolithic Mousterian starting ca. 200 kyr ago. The possible Lower Paleolithic origins of these sets of human behavior have become a research focus only in recent years. The late Lower Paleolithic layers of Qesem Cave, Israel, yielded rich, exceptionally well preserved lithic and faunal assemblages as well as evidence for the habitual use of fire providing an opportunity to suggest that the origins of some of these patterns of human behavior were indeed pre Mousterian (<200 kyr). Moreover, the new discovery of hominin teeth at Qesem Cave, at present under study, provides an opportunity to assess evolutionary processes concerning the shift from *Homo erectus* (*sensu lato*) to modern humans and may shed new light on such patterns of modern human behavior.

Acknowledgements

The Qesem Cave project is supported by grants of the Israel Science Foundation, CARE archaeological foundation, Leakey Foundation, Wenner Gren Foundation and the Thyssen Foundation.

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THE MUGHARAN TRADITION RECONSIDERED

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Introduction

Jelinek's concept of "Mugharan Tradition" is reviewed. The temporal scope originally proposed for the Mugharan tradition would span the entire pre-Mousterian sequence in Tabun Cave, including, from top, the Yabrudian, Amudian and Acheulian cultures. Here we show that contrary to Jelinek's assumptions, the Acheulian of Tabun (Garrod's layer F) was not attained in his excavations. Hence, the concept of Mugharan Tradition bears solely on the Yabrudian/Amudian part of the Tabun sequence.

Following D. Garrod's excavations (1929-34), the lithic assemblages in Tabun cave are known to contain, from the base upward, Tayacian, Acheulian, Yabrudian (Rust 1950), Amudian (Garrod 1956) and Mousterian cultures (Garrod & Bate 1937). Garrod excavated the central chamber of Tabun and left her main stratigraphical section (E-W) in the southern end of the chamber (figs. 1 and 2). The central part of Garrod's main section was re-excavated by Jelinek (1967-1972) (fig. 3) (Jelinek *et al.* 1973). The excavation stretched from around Garrod's Datum line down to 10 m below datum. The geological/stratigraphical colomn exposed by Jelinek was divided into 14 major units (Jelinek *et al.* 1973) (fig. 4). Units I through IX correrspnd to Garrod's Mousterian. Units X – XIII correspond to Garrod's Yabrudian and Amudian. Unit XIV, Jelinek's lowest, could not be easily fitted into Garrod's sequence (Jelinek *et al.* 1973:173).

Unit XIV is a compact whitish sediment 2.5 m thick on the west side of the swallow hole (fig. 6) with no visible counterpart elsewhere in the cave. In Garrod's view, this sediment formed the basal part of her layer E, the Yabrudian (fig. 4). A major unconformity separates Unit XIV from the overlying Unit XIII (fig. 5). In view of this major unconformity, Jelinek excluded Unit XIV from the overlying part of layer E and assigned it, alternatively, to Garrod's layer G (Tayacian) and later, to her layer F (Acheulian). Unit XIV was even considered to have no counterpart in Garrod's sequence (Jelinek *et al.* 1973:173).

There were two difficulties in assigning Unit XIV to Garrod's layer G. One difficulty was that Layer G around the swallow hole is ca. 2.5 m lower than Unit XIV slightly to the west (figs 6 and 7). To resolve this altimetric difficulty, Jelinek proposed that a subsidence (tectonical?) occurred east of Unit XIV, leaving unit XIV in its original position (Jelinek *et al.* 1973:173). The other difficulty was the lithic assemblage. According to Garrod, the Tayacian of Layer G contained no bifacial implements while Unit XIV did contain bifaces. This typological discrepancy was apparently resolved when Jelinek discovered a few bifacial artifacts in a Cambridge museum drawer assigned to Tabun Layer G (Jelinek 1982a:1375). In Jelinek's eyes, this museum evidence outweighed both Garrod's field observations (Garrod & Bate 1937:89) and Neuville's observations at Umm-Qatafa (Neuville 1951:35) where the Tayacian assemblages also contained no bifacial implements. With Garrod's Layer G now considered by Jelinek Acheulian, Jelinek concluded that Unit XIV was part of Tabun's Acheulian (Jelinek 1982:67)

The Mugharan Tradition

Analysing the lithic assemblages unearthed by him, Jelinek concluded that units XI through XIV, comprising as he believed the Acheulian, Yabrudian and Amudian, form a single cultural tradition. Jelinek proposed to name the new tradition "Mugharan", from Wadi el-Mughara (=valley of the caves) where Tabun is located. The Mugharan tradition would consist of a lithic industry with fluctuating ratios of handaxes, racloirs and blades (fig. 8) (Jelinek 1982) forming three more or less distinct facies. The biface-rich assemblages were termed Mugharan of Acheulian facies, the racloir-rich ones, Mugharan of Yabrudian facies and the blade-rich assemplage became Mugharan of Amudian facies. The techno-typological facies within the Mugharan Tradition would reflect, according to Jelinek, adaptation to changing climatic conditions with the handaxe-rich, Acheulian facies appearing during cold periods and the racloir-rich, Yabrudian facies during warm periods (Jelinek 1982a:1373). The adaptation of the blade-rich Amudian facies was not specified.

According to the presently known chronology of Tabun deposits (tab. 1), the time slot alloted for the Mugharan in Jelinek's model is between about 600 and ca. 250 ka BP (Grün & Stringer 2000; Laukhin *et al.* 2000; Mercier *et al.* 2000; Mercier & Valladas 2003; Rink *et al.* 2004; Coppa *et al.* 2005). We are not concerned here with the techno-typological considerations at the base of

Figure 1 - Tabun Cave 2008 (photo A. Ronen).

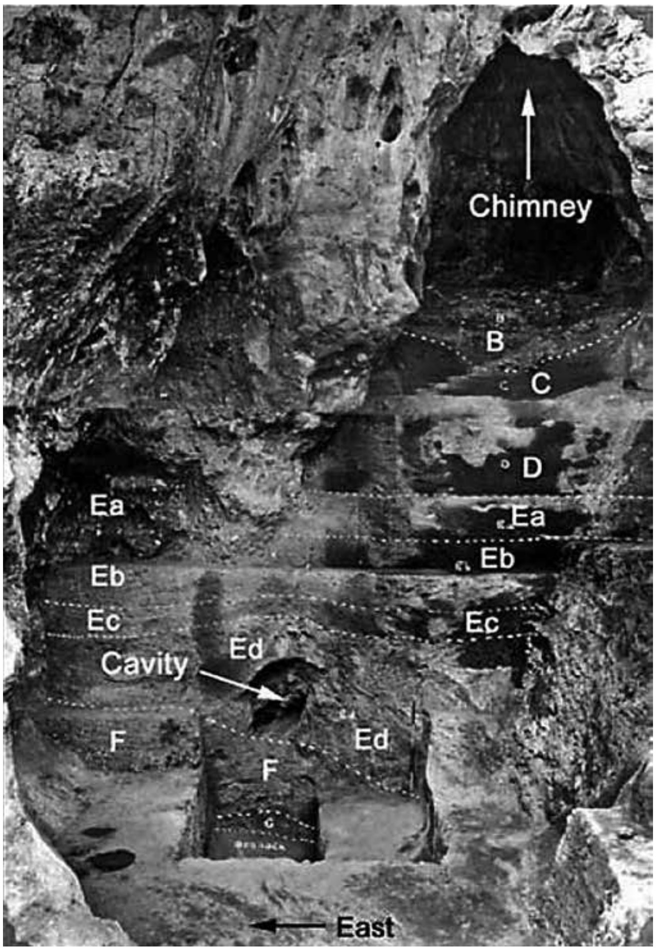

Figure 2 - Garrod's main profile 1934 (Garrod & Bate 1937).

Jelinek's model. We examine the place of Unit XIV in Jelinek's model and the alleged inclusion of the Acheulean in the Mugharan Tradition.

Unit XIV

Following Jelinek, the excavation of Tabun was undertaken by Ronen (fig. 3) down to the rim of the swallow hole 12.20 m below datum and to 15.40 m in the swallow hole, affecting Yabrudian (Garrod's E), Acheulean (Garod's F) and Tayacian (Garrod's G) deposits (Ronen & Tsatskin 1995; Ronen *et al.* 2000; Gisis 2008). The Amudian and Mousterian beds were not excavated by Ronen. Unit XIV was excavated by Ronen in squares 31, 32 and 33 between elevations 8.50 and 10.00 m below datum, within the zone previously excavated by Jelinek (fig. 3). Ronen also excavated further west of Jelinek's area, adjacent to the west wall of the cave in squares 45a – d. In squares 45a – d the top part of Unit XIV was excavated, between elevations 7.8 and 9 m below datum (figs. 3 and 9). To avoid confusion with Jelinek's layer numbers, the Yabrudian Layers in Ronen's excavations were numbered from 200 (fig. 7), the Acheulean ones from 300 and the Tayacian, from 400 (Gisis 2008) (tab. 2 and 3).

The most significant markers of the Yabrudian at Tabun are, following Ronen's analyses, a high ratio of Yabrudian scrapers (dejeté and tranversal, types 21-24 in Bordes' list) and a low

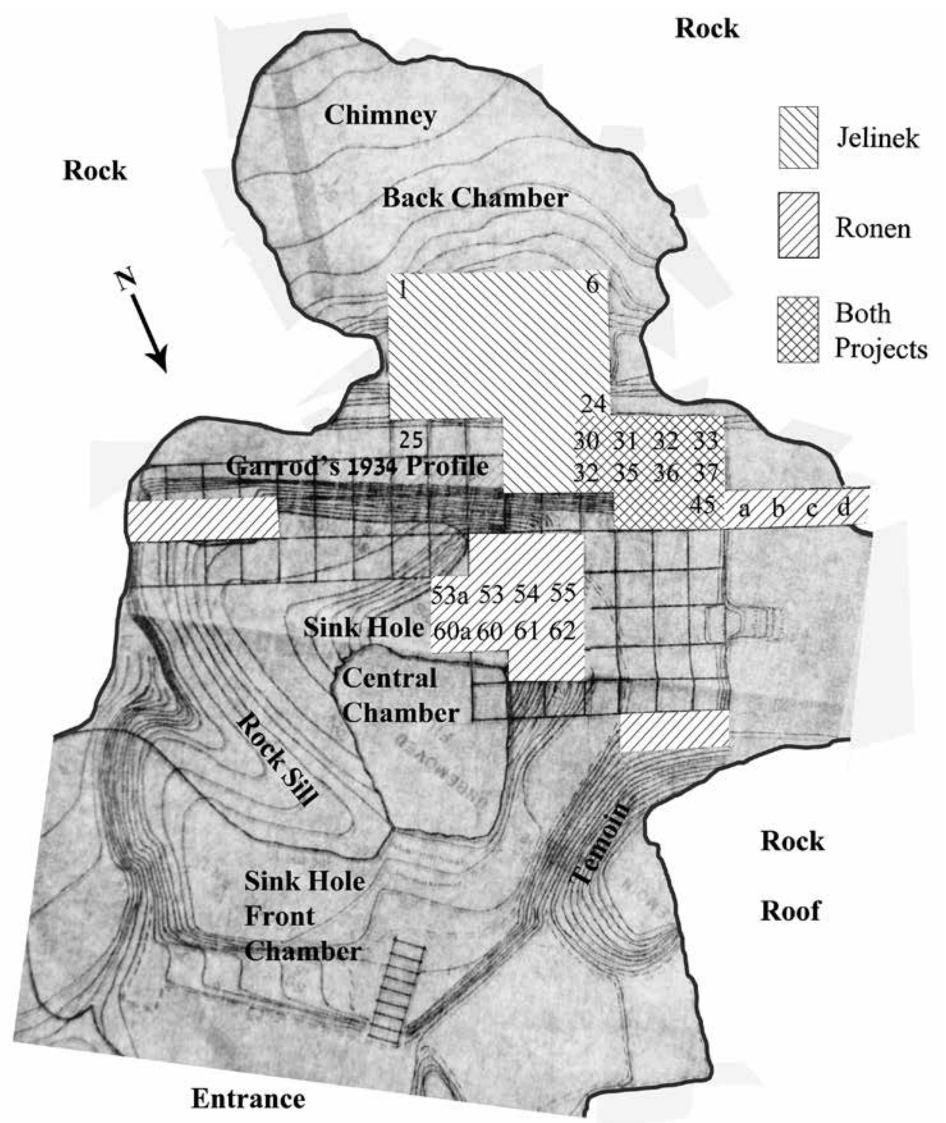

Figure 3 - Tabun plan, squares excavated by Jelinek and by Ronen.

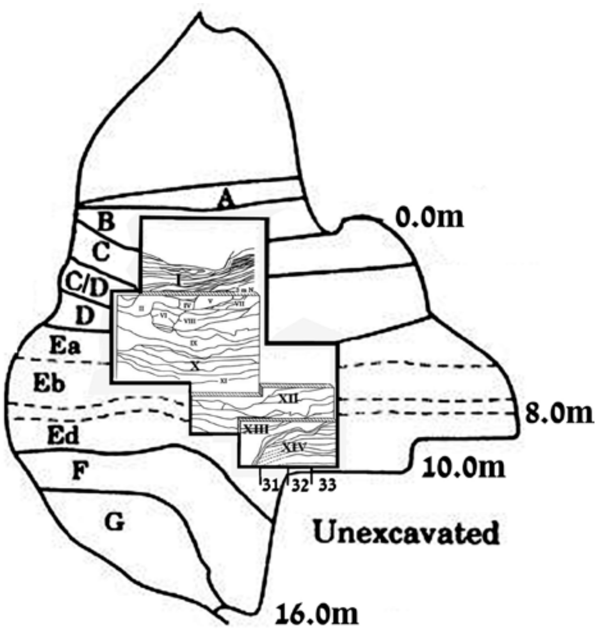

Figure 4 - Composite E-W profile of Jelinek's excavations 1967-1972 within Garrod's main profile (after Jelinek *et al.* 1973).

ratio of handaxes (IBif). The Acheulean at Tabun is inversely characterised by the absence of Yabrudian scrapers and a high handaxe ratio. It is worth noting that both Acheulean and Yabrudian at Tabun are entirely non-Levallois.

We present here the lithics of Unit XIV from Square 33 between elevation 8.50 and 10 m below datum (N=1414) (fig. 6). Due to the sedimentological homogeneity of unit XIV, the bulk was divided in four subdivisions from 33-1 (the uppermost) through 33-4 (fig. 10). Sub-divisions 33-2 and 33-3 are presented in tables 2 and 3. Sub-divisions 33-1 and 33-4 contain, respectively, 41 and 34 modified items, too few to be analyzed. As shown by Tables 2 and 3, subdivisions 33-2 and 33-3 are clearly placed in the Yabrudian, in accordance with Garrod's original interpretation (figs. 11 and 12).

Figure 5 - Unit XIV with unconformity and the SW corner of square 33. Looking west on west profiles of squares 33, 39 and 45.

Figure 6 - Unit XIV. Provenience of lithics analyzed in square 33 between elevation 8:50 and 10 m (N=1414).

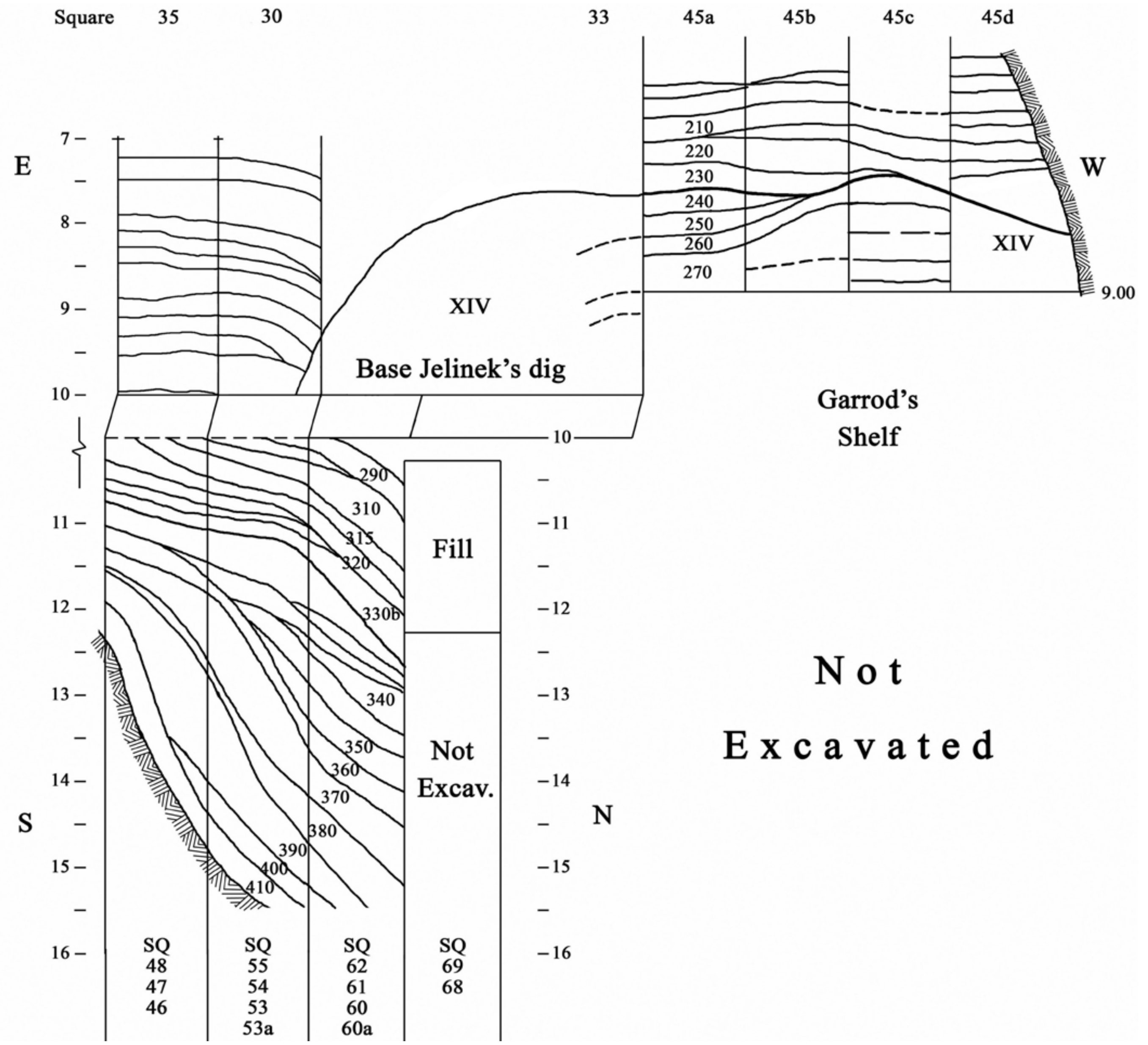

Figure 7 - Synthetic section of Tabun. 400 layers = Tayacian; 300 = Acheulian; 200 = Yabrudian. Note: below 10 m, looking West. Above 10 m, looking South.

Garrod Layer	Jelinek Unit	Mean EU ESR age (ka)	Mean LU ESR age (ka)	Combined ESR and US age (ka)	TL Mean age (ka)	RTL	Sediment
Chimney		-	-	-	-	-	Terra Rosa
B		82 ± 14 (6) 102 ± 17 (1)	92 ± 18 (6) 122 ± 16 (1)	90^{+30}_{-16} (6) 104^{+33}_{-18} (1)	-	-	soil
C	**I**	120 ± 16 (1)	140 ± 21 (1)	135^{+60}_{-30} (1)	165 ± 16 (4)	-	
D	**II**	133 ± 13 (1)	203 ± 26 (1)	143^{+41}_{-28} (1)	196 ± 21 (4)	-	Silt
	V				222 ± 27 (4)	-	
	IX				256 ± 26 (4)	-	
Ea	**X**	176 ± 22 (1)	213 ± 32 (1)	208^{+102}_{-44} (1)	267 ± 22 (4)	-	Sand
	XI				264 ± 28 (4)	-	
Eb	**XII**	180 ± 32 (1)	195 ± 37 (1)	-	324 ± 31 (4)	-	
Ec	**-**	198 ± 51 (1)	220 ± 63 (1)	-	-	-	
Ec-Ed	**XIII**	262 ± 32 (5)	330 ± 43 (5)	387^{+49}_{-36} (5)	302 ± 27 (4)	-	
F	**XIV**	-	-	-	415 ± 27 (3)	-	
G		-	-	-	-	610 ± 150 (2) 630 ± 160 (2)	

Table 1 - Chronology of Tabun layers (Zviely *et al.* 2009).

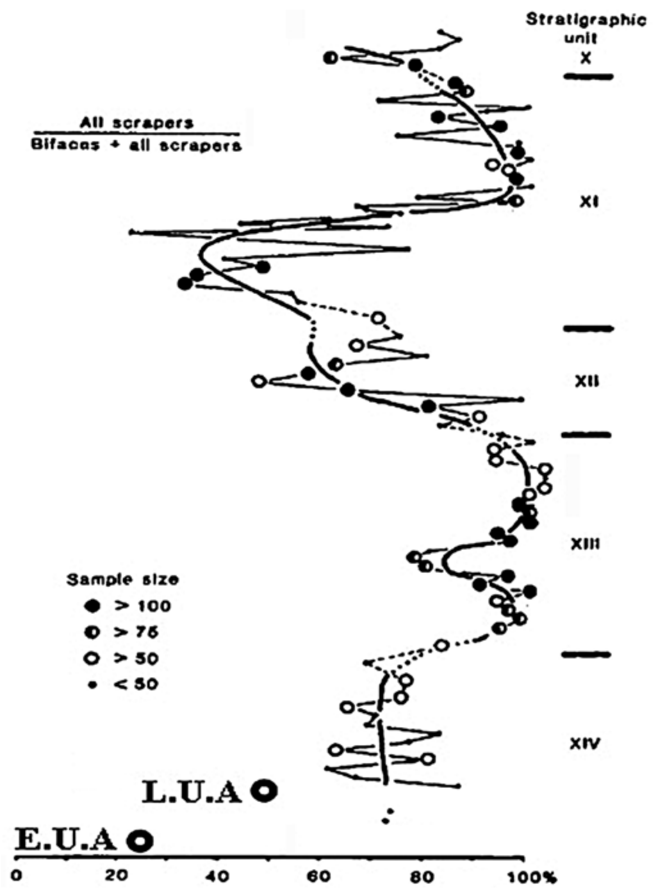

Figure 8 - The fluctuating Mugharan Tradition (Jelinek *et al.* 1973), amended (ULA, ELA = Upper and Lower Upper Acheulian. Gisis 2008).

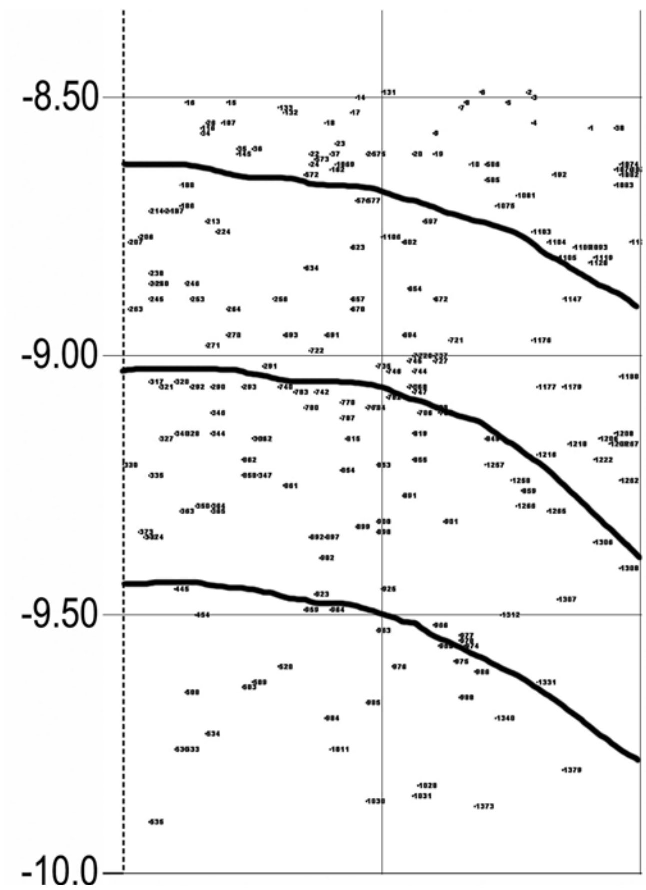

Figure 10 - Schematic subdivision of Unit XIV (a 20-cm thick S-N slice) in square 33 between 8.50 and 10 m below datum (33-1, top).

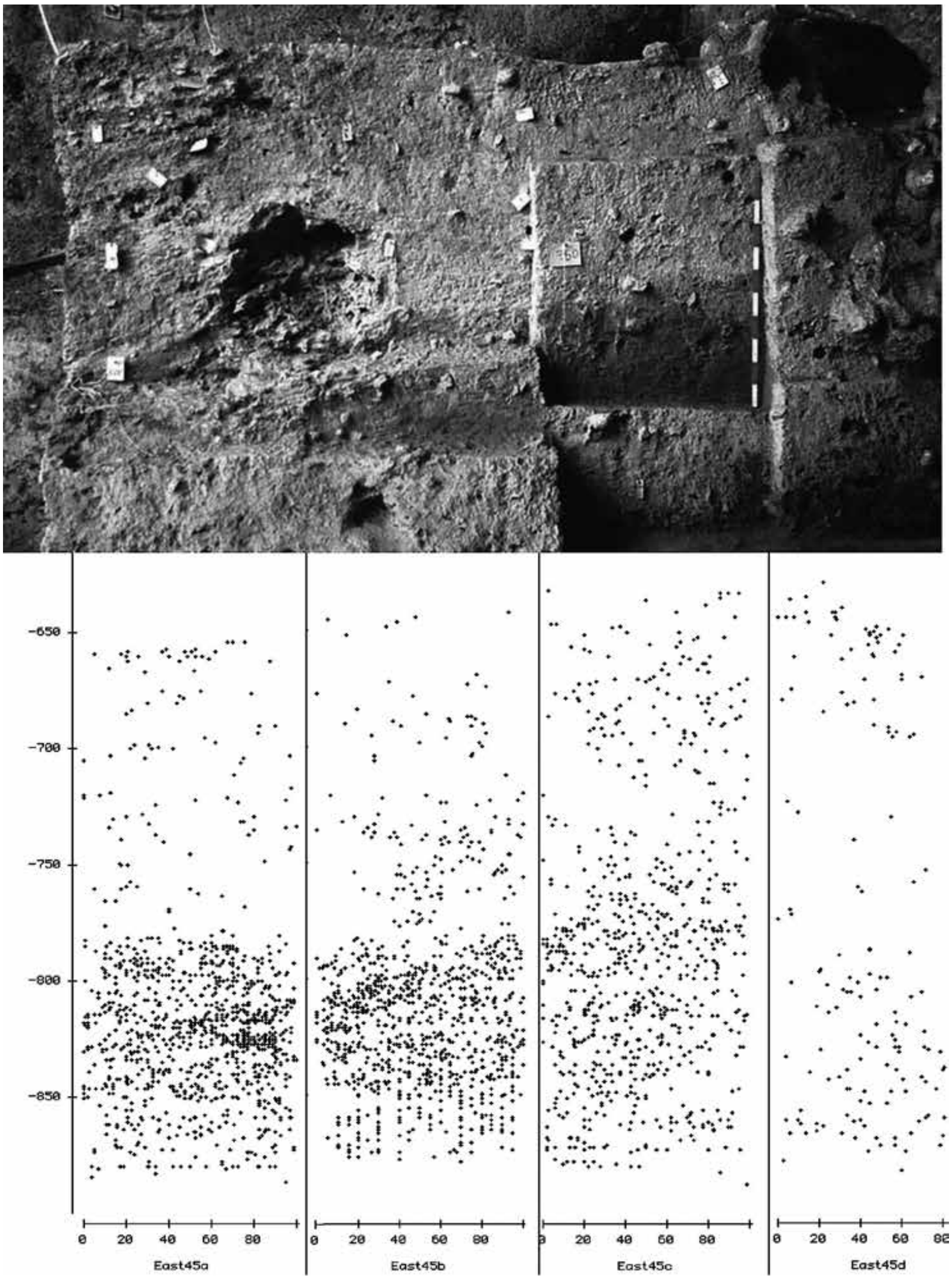

Figure 9 - Squares 45a-d (looking South) and location of finds. Finds above Unit XIV are sparse.

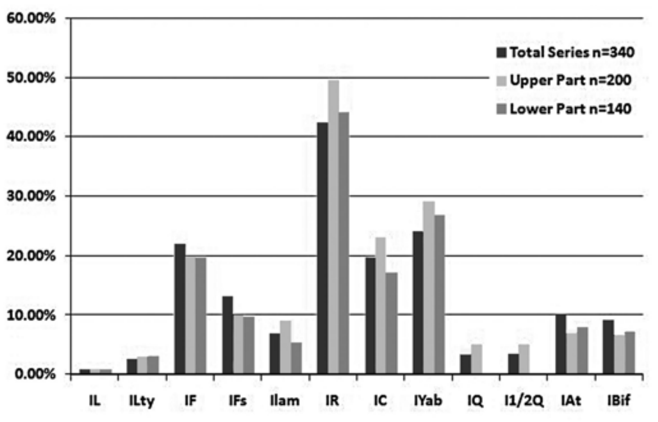

Figure 11 - Major Indices of Unit XIV lithic assemblages from square 33 between elevation 8:50 and 10 m below datum.

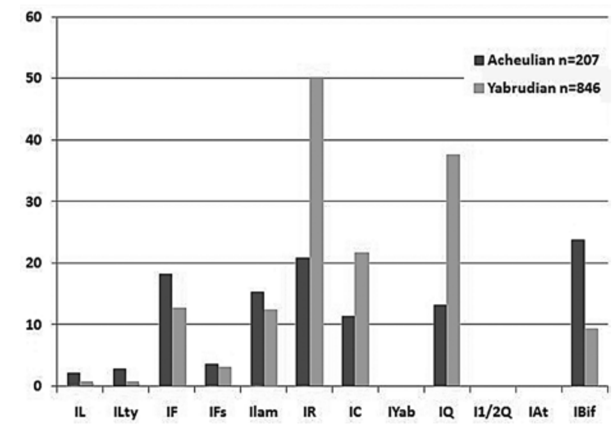

Figure 12 - Major Indices of Acheulian and Yabrudian assemblages at Tabun, Ronen's excavations (Gisis 2008).

	Acheulian		Unit XIV					
Square	**48**		**45a-d**		**33**			
Layer	**320**		**250**		**33-2**		**33-3**	
1 Levallois flake	4	2.8%	1	0.5%	5	2.3%	2	1.3%
2 Atypic Levall. flake	1	2.6%	1	0.5%		0.0%		
3 Levallois point			1	0.5%	1	0.5%		
5 Pseudo Levallois point			2	1.0%				
8 Limace	1	0.7%						
9 Racloir, simple straight	6	4.2%	8	4.0%	9	4.2%	6	4.0%
10 Racloir, s. convex	18	12.5%	39	19.6%	26	12.2%	11	7.4%
11 Racloir, s. concave	1	0.7%	8	4.0%	2	0.9%	1	0.7%
12 Racloir, double straight			1	0.5%				
13 Racloir, d. straight-convex	1	0.7%	2	1.0%	1	0.5%	1	0.7%
14 Racloir, d. straight-concave		0.0%	2	1.0%				
15 Racloir, d. convex	1	0.7%	3	1.5%	2	0.9%		
17 Racloir, d. convex-concave			1	0.5%				
18 Racloir, convergent straight					2	0.9%		
19 Racloir, conv. convex					4	1.9%		
20 Racloir, convergent concave					2	0.9%		
21 Racloir dejetè	1	0.7%	10	5.0%	8	3.8%	2	1.3%
22 Racloir, transverse-straight	1	0.7%			1	0.5%		
23 Racloir, transverse-convex			4	2.0%	9	4.2%	4	2.7%
24 Racloir, transverse-concave			3	1.5%	3	1.4%		
25 Racloir, on ventral face	4	2.8%	5	2.5%	6	2.8%	5	3.4%
27 Racloir, thinned back					1	0.5%		
28 Racloir, alternating retouch	3	2.1%			1	0.5%	6	4.0%
29 Racloir, bifacial retouch					1	0.5%		
30 Grattoir	4	2.8%	3	1.5%	4	1.9%	10	6.7%
31 Atypical grattoir	5	3.5%	7	3.5%	4	1.9%	2	1.3%
32 Burin	9	6.3%	3	1.5%	10	4.7%	12	8.1%
33 Atypical burin	5	3.5%	4	2.0%	4	1.9%	1	0.7%
34 Awl	3	2.1%			2	0.9%	2	1.3%
35 Atypical awl			2	1.0%	3	1.4%	1	0.7%
36 Backed knife					1	0.5%	1	0.7%
37 Atypical backed knife	1	0.7%	1	0.5%				
38 Natural backed knife	35	24.3%	41	20.6%	14	6.6%	12	8.1%
39 Raclette	2	1.4%	2	1.0%	3	1.4%		0.0%
40 Truncation	7	4.9%	2	1.0%	4	1.9%	7	4.7%
42 Notch	7	4.9%	7	3.5%	18	8.5%	8	5.4%
43 Denticulate	3	2.1%	14	7.0%	14	6.6%		
44 Alternate burin-edge	1	0.7%					4	2.7%
45 Retouch on ventral face	1	0.7%					1	0.7%
51 Tayac point					1	0.5%	1	0.7%
54 Notch on end	2	1.4%						
59 Chopper	1	0.7%						
61 Inverse chopper	1	0.7%	3	1.5%			1	0.7%
62 Miscellaneous	1	0.7%	6	3.0%	5	2.3%	6	4.0%
65 Emiroid		0.0%					2	1.3%
66 Disc		0.0%			2	0.9%	4	2.7%
67 Retouched flakes	14	9.7%	13	6.5%	40	18.8%	36	24.2%
Total	**144**		**199**		**213**		**149**	
Handaxes	38		18		12		15	

	Acheulian	Unit X I V		
Square	**48 ***	**45 ***	**33**	
Layer	**320**	**250**	**33-2**	**33-3**
No	**98**	**145**	**159**	**100**
IR	36.73	60	49.06	36
IC	19.38	31.72	24.53	15
Iyab	20.4	38.62	29.56	17
I 21-24	2.04	11.72	13.21	6
GIII	34.69	15.17	20.13	36
GIV	10.2	14.22	20.11	12
IBif	27.94	7.64	7.02	13.04

Table 3 - Restricted Indices (Types 38 and 67 are omitted) of Acheulian and Unit XIV assemblages at Tabun, Ronen's excavations (Gisis 2008).

Conclusions

Jelinek's excavations down to 10 m below Datum have only attained Garrod's Yabrudian layer E without reaching the underlying layers F or G. Hence the proposed "Mugharan Tradition" is only valid within Garrod's Yabrudian (ca 450 - 250 ka BP). Contrary to Jelinek's interpretation, the terms "Mugharan" and "Yabrudian" are synonymous.

Table 2 (left) - Type list of Acheulian and Unit XIV assemblages at Tabun, Ronen's excavations.

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RECENT PROGRESS IN LOWER AND MIDDLE PALAEOLITHIC RESEARCH AT DEDERIYEH CAVE, NORTHWEST SYRIA

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Introduction

The Dederiyeh cave in northwest Syria is one of the rare Palaeolithic sites presently being excavated in the northern Levant. It is known for its Neanderthal fossils found in the 1990s, the discovery having been documented in a series of publications (Akazawa & Muhesen 2002; Akazawa *et al.* 2004; Kondo *et al.* 2006 and references therein). On the other hand, the archaeological aspects of this cave, mainly the Palaeolithic lithic industries, have not been published in detail. The initial excavations between 1989 and 2001 were mostly conducted in one area (the chimney area), while in 2003, a new research programme was introduced, aiming at conducting extensive excavations in the other areas of this large cave site so that the complete prehistoric sequence of the Dederiyeh cave would be clarified (Nishiaki *et al.* 2005, 2006, 2008). The excavations since 2003 consequently have revealed that the Dederiyeh cave was occupied not only during the Neanderthal period, or the late Middle Palaeolithic (late Levantine Mousterian), but also during the late Epi-Palaeolithic (Natufian), the earlier Middle Palaeolithic (earlier Levantine Mousterian), and even the terminal Lower Palaeolithic (Yabrudian). At the same time, the systematic analyses of the lithic assemblages discovered with the Neanderthal fossils from the previous seasons have also made progress in these years. Here, we will provide an overview of the archaeological evidence currently available for the Lower and Middle Palaeolithic sequence of the Dederiyeh cave.

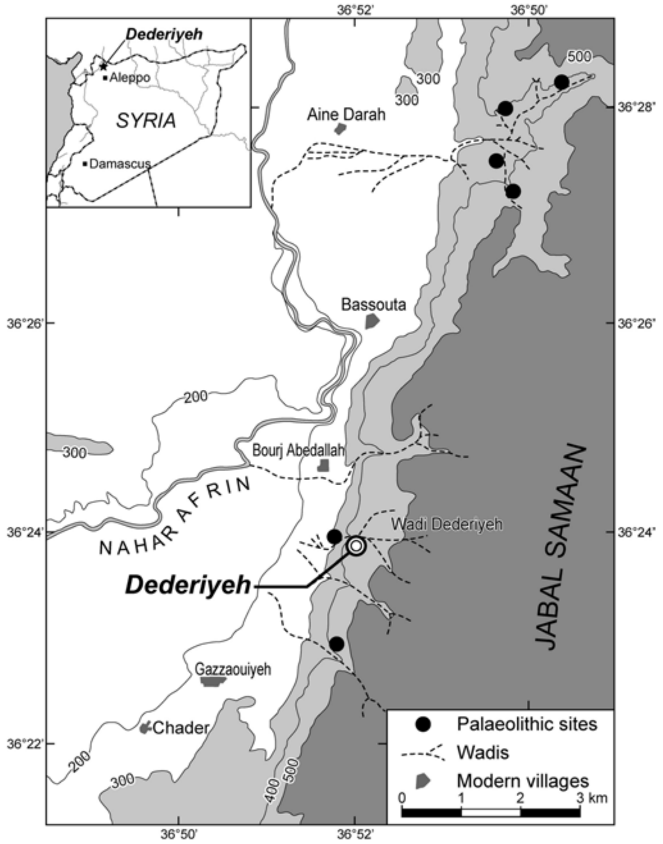

Figure 1 - Location of the Dederiyeh cave and related Palaeolithic sites in Jabal Samaan.

The site and excavations

The Dederiyeh cave is situated in the western plateau of Jabal Samaan, approximately 60 km northwest of Aleppo, Syria (fig. 1). It is located on the left bank of Wadi Dederiyeh, one of the tributaries of the Afrin River running west. The altitude is approximately 450 m. This cave has two openings: the main entrance faces Wadi Dederiyeh, while the other one is a natural chimney, approximately 5 m × 10 m in plan, located deep within the cave and open to the sky on the plateau side. It is a very large cave, one of the largest known in the Levant, measuring approximately 60 m long, 10 to 25 m wide, and approximately 10 m high. The cave in fact consists of three internally connected major chambers (fig. 2), designated as the entrance, central and chimney areas, for the sake of convenience. The cave floor inclines from the chimney toward the entrance areas by 15 to 20° (fig. 3), with relatively flat surfaces in some parts (Oguchi & Fujimoto 2002).

The excavations of the first (1989–1990 and 1993–2001) and the subsequent (2003–2008) campaigns conducted by a Japan-Syria joint mission demonstrated that Palaeolithic remains were distributed over almost the entire areas of the cave. Especially rich were the areas close to the main entrance and the chimney. The area between them, the central area, revealed rather sparse occupations. The excavations also indicated that the different

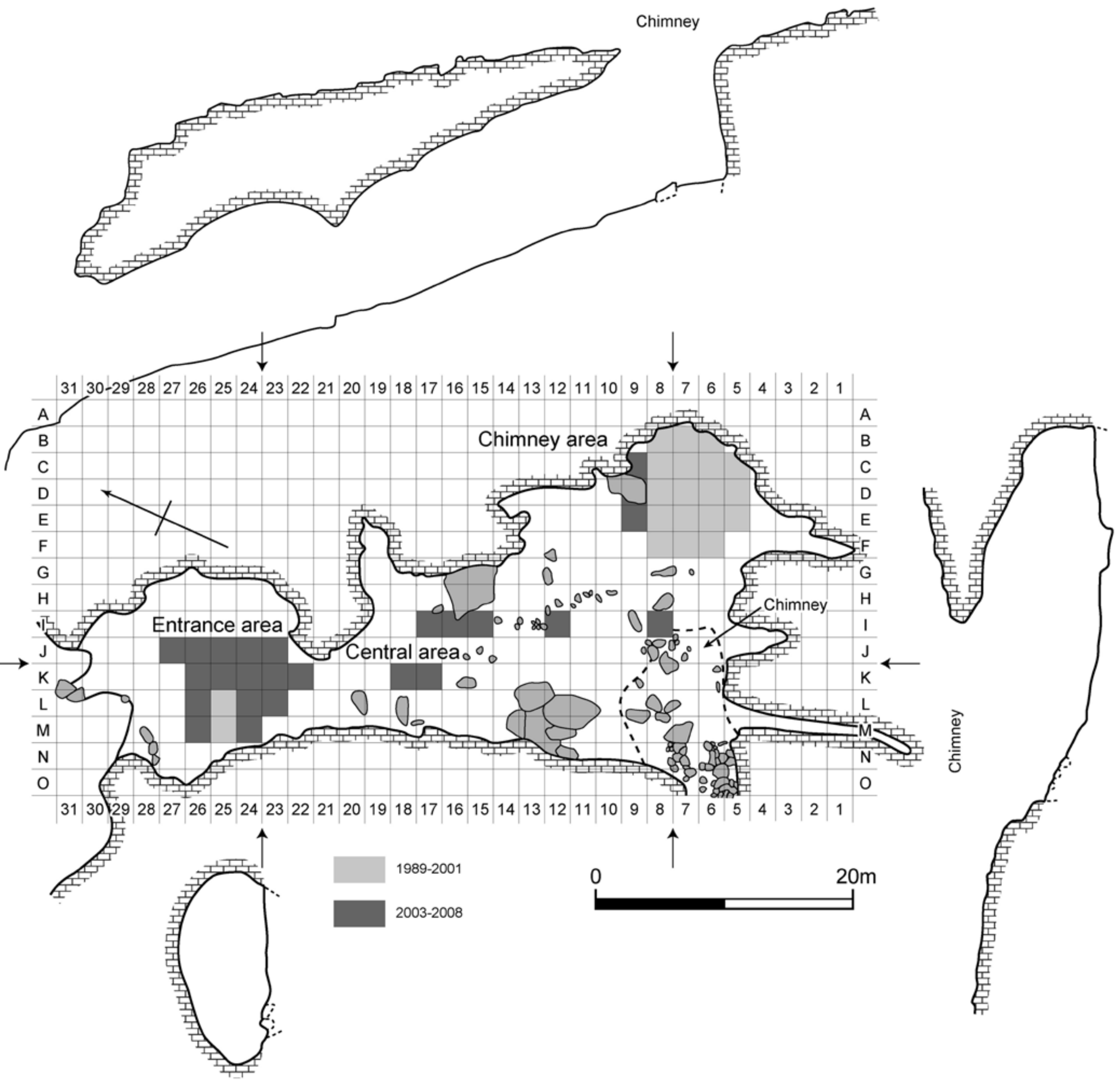

Figure 2 - Ground plan and excavated areas of the Dederiyeh cave.

areas of the cave were occupied in different periods. While the occupations of the chimney and the central areas were principally confined to the late Middle Palaeolithic, the entrance area was evidently occupied for a longer period, starting from the end of the Lower Palaeolithic (see below).

Middle Palaeolithic

The chimney area

The cave floor below the chimney is covered with cone-shaped deposits including plenty of limestone boulders and rubble. The excavations were conducted along a relatively flat-roofed eastern formation. A total of eighteen 2 m × 2 m squares were excavated between 1989 and 2001, resulting in the exposure of bedrock in Squares E/F6–8 approximately 4 m below the surface (fig. 2). Aside from modern disturbances and historical pits on the top, the remaining deposits of this area were exclusively dated from the Middle Palaeolithic, consisting of fifteen stratified geological layers. At least five layers, distributed well in this sequence from Layers 11 to 3, yielded Neanderthal fossils, including those from two burials (Akazawa & Muhesen 2002). This strongly suggested that all the cultural remains recovered from this area belonged to the Neanderthals.

In the current campaign, being conducted since 2003, an additional four squares have been excavated in this area (fig. 2). The excavations of Squares E9–C9 testified that the well-preserved Middle Palaeolithic occupation floors containing a number of hearths were distributed further north. On the other hand, Square I8 yielded either disturbed or nearly sterile Middle Palaeolithic deposits only, delineating the western limit of the distribution of the primary Middle Palaeolithic deposits in this area.

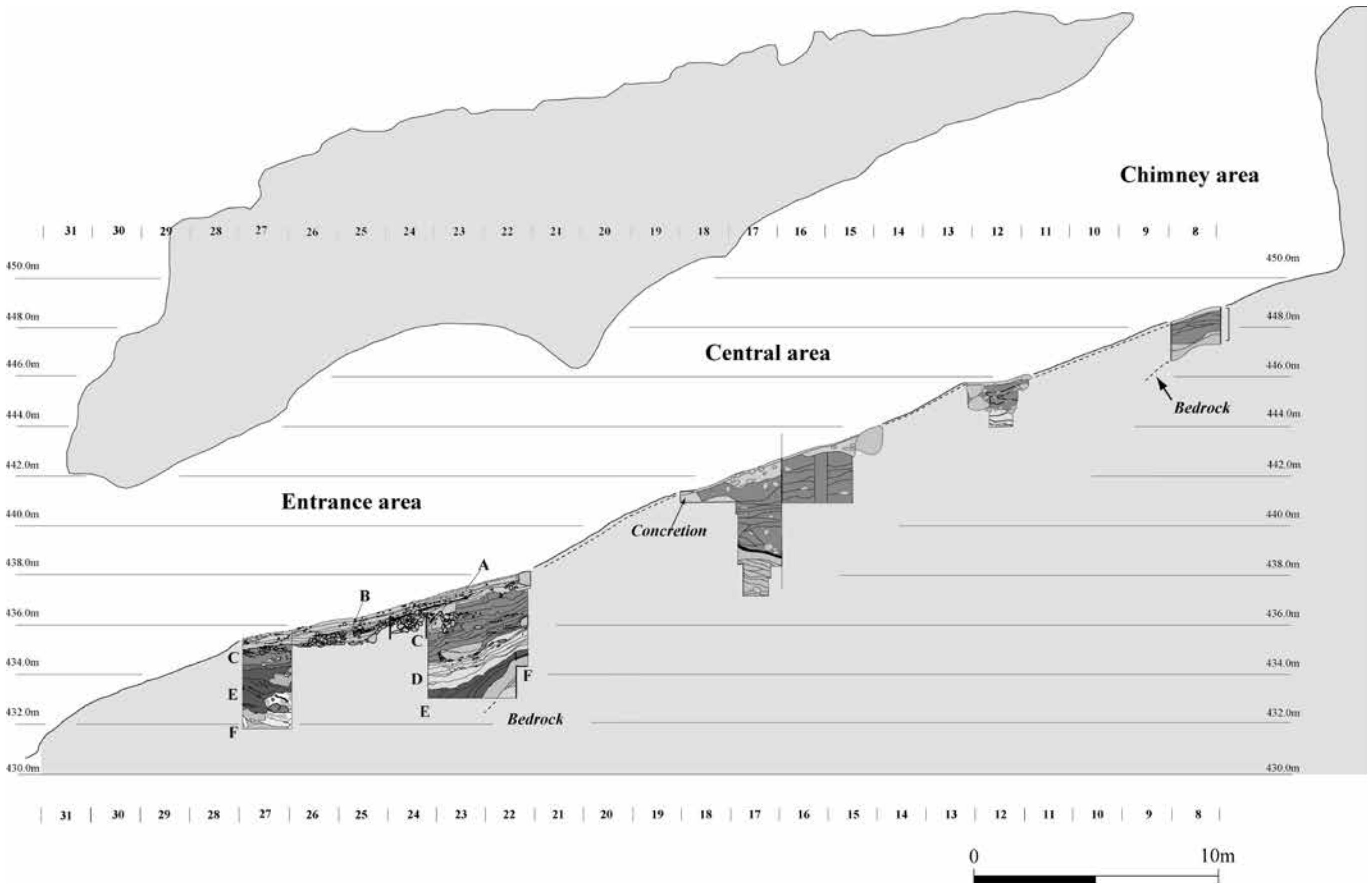

Figure 3 - Longitudinal section of the Dederiyeh cave.

More than 100,000 Middle Palaeolithic artifacts have been recovered from this area, mainly from the upper layers. The artifact density markedly decreased from Layer 12 downwards, and the lowest layer, approximately 1-m thick sediments of Layer 15, was almost sterile. This pattern is considered to reflect the changes in the occupational intensity in relation to the formation processes of the chimney. A sedimentological analysis of the cave deposits indicated that the soil flow from the chimney to this area was moderate in the lowest layers, but it dramatically increased in Layers 11 to 7, probably due to the occurrence of an abrupt enlargement of the chimney in this period (Oguchi & Fujimoto 2002:53-54). The chimney enlargement would no doubt have brought the Neanderthals easier access and more sunlight to their habitation zone.

The techno-typological aspects of the lithic assemblages from the chimney area have been only briefly mentioned in the previous publications. Akazawa *et al.* (2002:30) have stated that all the assemblages belonged to the Levallois-based Levantine Mousterian and that there could have been a chronological change over the layers, marked by the abundance of Upper Palaeolithic-type tools such as burins and end-scrapers in the upper layers. Muhesen (2004:40) has reported that the assemblages of all the layers exhibited similar techno-typological traits, i.e., rich in short broad Levallois points, assignable to the Tabun B-type Late Levantine Mousterian.

In order to describe the nature of the assemblages in further detail, a systematic lithic analysis was recently started; a collection of 45,391 flint artifacts has been examined thus far (Nishiaki *et al.* 2007). The major results, which largely confirmed the above preliminary statements, were as follows. The assemblages clearly indicated a Levantine Mousterian entity, characterized by the frequent use of the Levallois method (fig. 4:1-9). Their Levallois indices ranged between 20 and 25 for the different layers. It was estimated that each Levallois core produced approximately 20 or even more desired products, though significantly varying in number among the different layers, thus indicating the consistent employment of the recurrent Levallois method (Boëda 1995). The products were generally small in size. The average length of unretouched Levallois flakes was at most approximately 4 cm throughout the layers. The majority of the blank shapes were flakes, with a certain number of short Levallois points and blades. Elongated Levallois points were sparsely present throughout the sequence. The blade indices (Bordesian ILam) ranged approximately from 10 to 15. The common type of dorsal scar patterns for Levallois pieces was the convergent flaking type (ca. 40 to 50%), which was followed by multiple and parallel flaking. In short, the assemblages here were comparable with those of the Tabun B-type industry, or the late Levantine Mousterian (Copeland 1975; Bar-Yosef 1998, 2000), characterized by the widespread production of short Levallois points and flakes using the convergent, recurrent Levallois flaking method.

In addition, a continuous but clearly observable diachronic change in the Levallois technology was also noted. Convergent flaking, reportedly typical of the Tabun B-type industry, be-

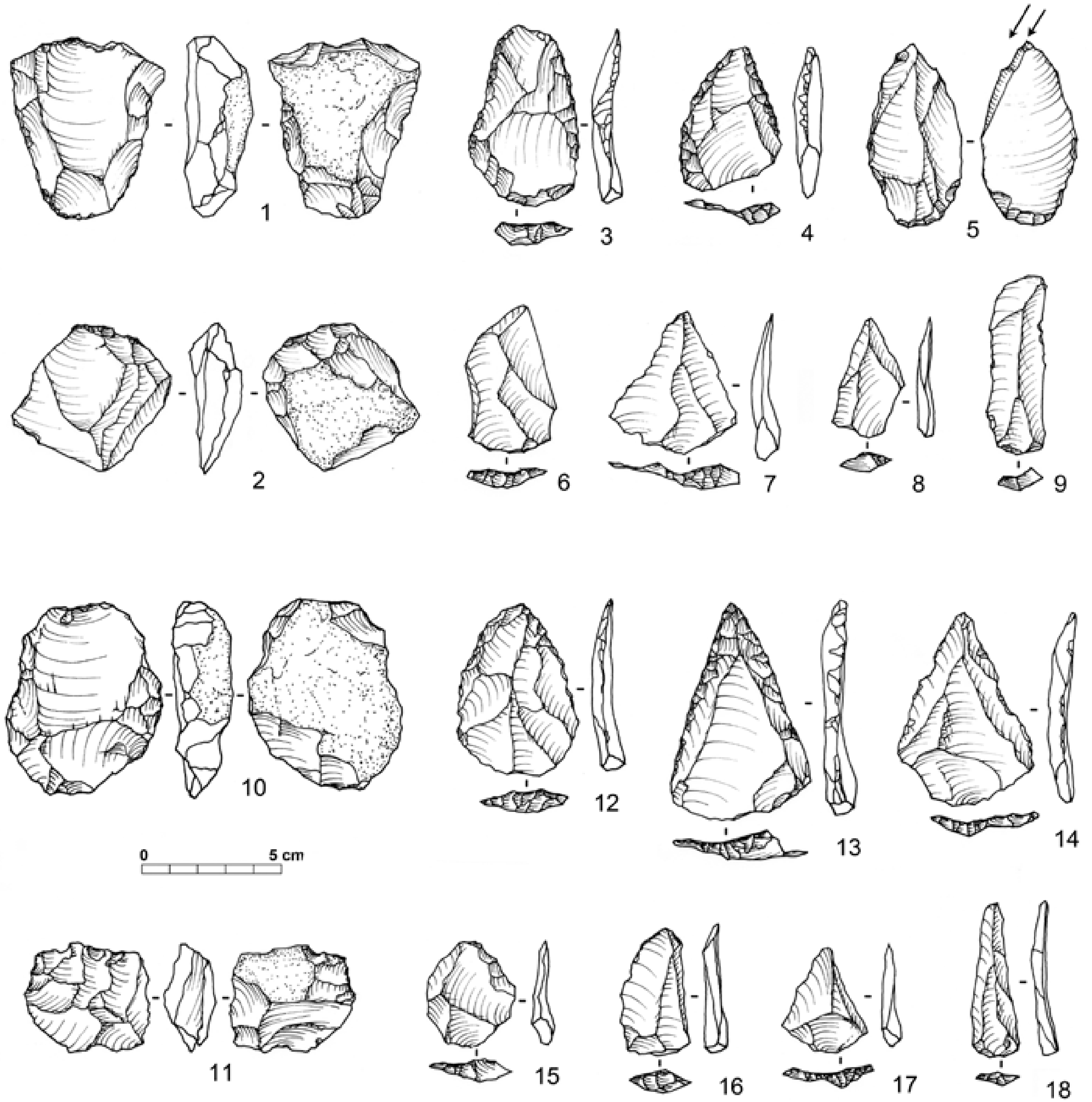

Figure 4 - Levantine Mousterian artifacts from the Dederiyeh cave. 1-9: the chimney area; 10-18: the central area.

came sparse in the upper layers, where parallel flaking increased (ca. 20 to 25%). In accordance with this trend, the proportion of Levallois blades slightly increased at the expense of the Levallois points in the upper layers. In the tool assemblages, the originally noted trend that the tools of the Upper Palaeolithic types (fig. 4:5) increased in number in the later levels (Akazawa *et al.* 2002) was confirmed. This suggested that the sequence of the chimney area in this cave could be used to monitor the diachronic industrial changes within the Late Levantine Mousterian in the northern Levant.

Reliable radiometric dates for this Mousterian sequence have not been made fully available. Preliminary TL dates are as yet too varied (Muhesen 2004:43), and the samples used for OSL dating are still under processing. The only available dates at this point are those obtained through AMS radiocarbon dating. They indicate a minimum date of approximately 50,000 years BP for Layers 2 and 3 (Akazawa *et al.* 2002:20). The analysis of the faunal remains, which indicated a climatic change from dry to humid conditions that started in the period corresponding to Layer 11 and accelerated upwards from Layer 6, may help estimate the dates (Griggo 2002). Importantly, a similar environmental change was suggested from the sedimentological analysis as well (Oguchi & Fujimoto 2002), which related the abrupt chimney enlargement in Layers 11 to 7 to the humid conditions and the decrease in soil inflow and erosion in the upper layers to an increase in the amount of vegetation due to climatic wetting. Considering the strong affinities of the lithic assemblages with the late Levantine Mousterian, this climatic change might be related to Oxygen Isotope Stages 4 to 3, a period to which most of the Neanderthal sites in the Levant such as Kebara and Amud belong (Bar-Yosef 2000; Shea 2003).

The central area

A series of soundings was carried out in 2003 on the slope between the chimney and the entrance areas to explore the distribution of Palaeolithic cultural deposits (fig. 2; Nishiaki *et al.* 2005). The one conducted at the maximum depth was located in Square K17, approximately 5 m below the cave floor, but none of those conducted in the six squares reached the bedrock (fig. 3). All the squares revealed a thin layer corresponding to the Iron Age–Byzantine period at the top, and Middle Palaeolithic deposits at the bottom. The upper portion of the latter was distinguished by coarse-grained reddish brown soil containing plenty of limestone rubble. According to the stratigraphic mapping of the layer at the maximum depth in Square K17, however, the amount of limestone rubble sharply decreased downwards, and below approximately 3.5 m, dark brown silt-like sediments often mixed with orange brown ones, and white and black patches appeared. Lithic artifacts and animal bones were found in abundance only in the upper portion, while the lower portion yielded merely a few artifacts and micro-fauna.

The lithic artifacts indicated the use of a Levallois-based technology, comprising assemblages dominated by short Levallois points and small flakes and blades, often manufactured by the convergent Levallois core reduction method (fig. 4:10-18). The general techno-typological features were principally indistinguishable from those of the Late Levantine Mousterian assemblages recovered from the chimney area. It was also noted that the artifacts often exhibited irregular edge damages and even traces of water abrasion, which indicated their secondary depositional contexts. At least some of the Middle Palaeolithic artifacts in this area were therefore considered to have been transported from other areas of the cave, most probably from the chimney region, by natural causes. The absence of any anthropogenic features such as hearths also suggested that this portion of the cave was not a primary habitation zone in the Middle Palaeolithic.

The entrance area

The area designated as the entrance area constituted a distinct chamber, approximately 15 m × 15 m in plan, with a vaulted dome approximately 10 m high (fig. 2). It is connected nowadays to the central area region via a round tunnel-like passageway with a diameter of 5 to 7 m. Two test squares (L24 and M24) in the 1989-1990 seasons revealed Epi-Palaeolithic Natufian layers (Akazawa *et al.* 2002:31), but further excavations of this area had been suspended. Large-scale excavations of this area started in 2003, opening seventeen 2 m × 2 m squares. It was soon found that massive Natufian stone constructions extensively covered this area. While these constructions have continued to be the main focus of careful investigations to date (Nishiaki *et al.* in press), two deep sounding areas were also set up beside them to examine the lower levels. Squares K22/23 were then excavated down to approximately 4.5 m deep in 2003–2008, and Square J27, down to approximately 3.5 m from the surface in 2005 (fig. 3). These soundings established six major stratigraphic units in this area. Unit A consists of occupation layers of the Iron Age to the Islamic period, and Unit B corresponds to the Natufian constructions. Units C to E belong to the Middle Palaeolithic, below which are situated the terminal Lower Palaeolithic layers of Unit F.

A complete sequence was obtained in Squares K22/23. The youngest Middle Palaeolithic unit, Unit C, up to 2.2 m thick, basically revealed reddish brown soil layers with plenty of limestone rubble. At the base of this unit was situated a large limestone rock 1.8 m long, presumably due to the collapse of the roof or the inner wall of this chamber. Unit D, on the other hand, was characterized by dark brown to grayish brown soil layers containing little limestone rubbles or gravel. It was approximately 1 m thick. Patches of reddish and bluish-grey ash were occasionally noted. The oldest unit, Unit E, consisted of layers of relatively soft, homogeneous dark grey sediments. It was approximately 40 cm thick at the chimney side of K22, with increasing thickness toward the entrance side. On the other hand, the stratigraphy of Square J27, 6 m away from K22/23, was somewhat different. The Middle Palaeolithic deposits of J27 consisted of Unit C, approximately 70 cm thick, and Unit E, more than 2 m thick. Unit D was apparently missing there, indicating the occurrence of erosion below Unit C, which was obvious from the stratigraphic discontinuity. The resemblance of the sedimentological characteristics of Unit C with those of the chimney and the central areas indicated that erosion might have occurred along the opening of the chimney and/or the inner wall of the entrance chamber, which must have caused significant soil and water inflow. It was also noted that all the layers of K22/23 and those of Unit C of J27 were inclined toward the entrance side, while the Unit E layers of J27 were tilted backwards (fig. 3). This suggested the formation of a sinkhole underneath the central portion of this area.

The lithic artifacts recovered from this area were relatively few. Unit C thus far has produced 101 specimens, whereas Units D and E have yielded 176 and 364 specimens, respectively, including chips and tiny thermal fragments collected through dry-sieving. The scarcity of the Unit C material was striking for its relatively rich volume of deposits. Moreover, most of the lithic artifacts of Unit C were recovered from its upper portion, and the lower part was nearly sterile. The techno-typological features of Unit C assemblages were wholly comparable to those of the chimney Mousterian. The frequent use of the convergent recurrent Levallois flaking method (35.7%; n=28) and the widespread production of short points/triangular flakes were diagnostic (25.0%), and hence this assemblage was also assigned to the Tabun B-type Levantine Mousterian. However, the earlier two assemblages, although both obviously based on the Levallois technology, displayed markedly different features (fig. 5). First, the Levallois products from Units D and E were significantly larger, approximately 5 cm long on average, in contrast to the small size of the products recovered from Unit C and the chimney (cf. fig. 4). The differences in the core size were also remarkable. Second, dissimilarities existed in the use of Levallois technology. The Levallois pieces (n= 41) recovered from Unit D assemblage (fig. 5:3-6) were characterized by a multiple

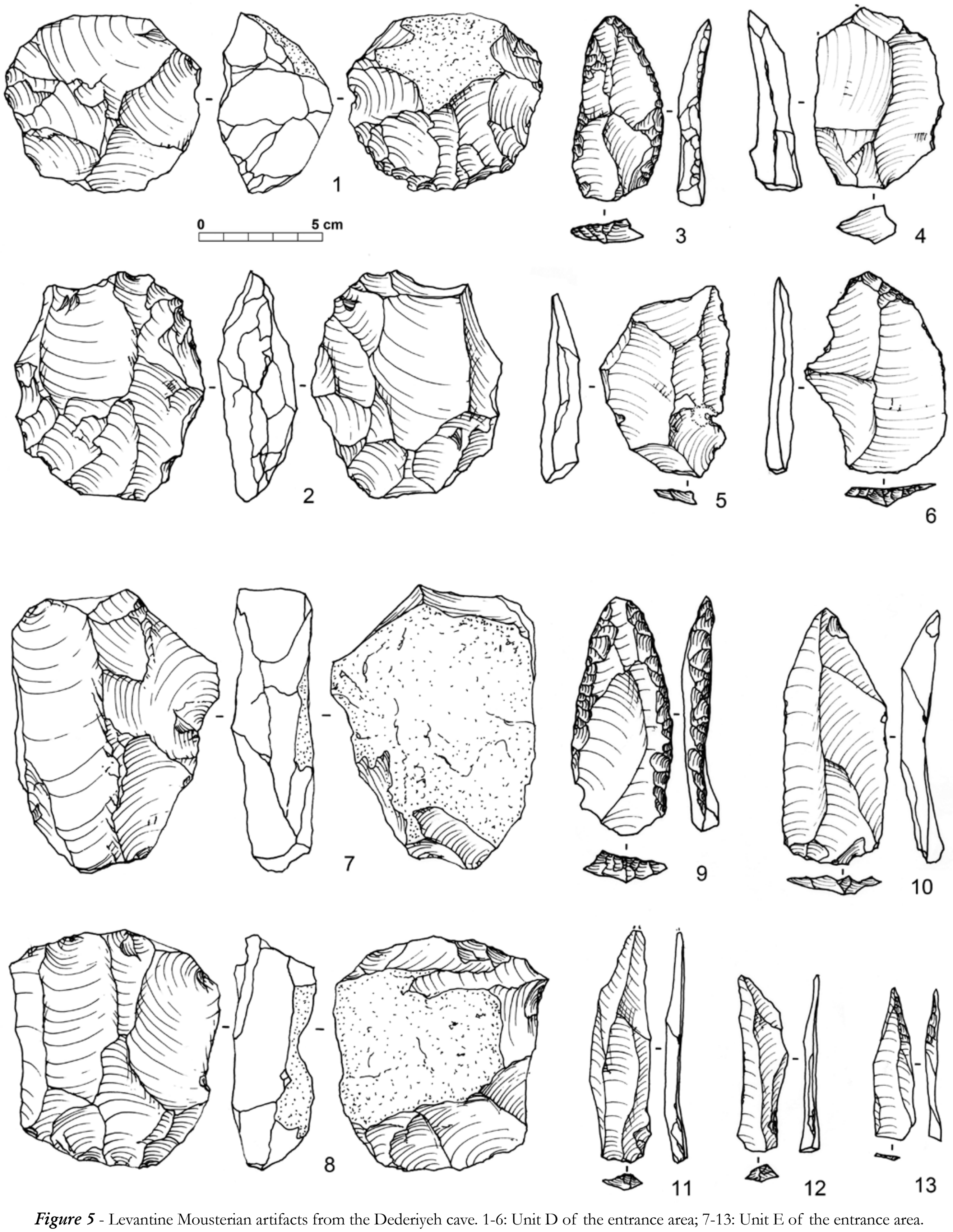

Figure 5 - Levantine Mousterian artifacts from the Dederiyeh cave. 1-6: Unit D of the entrance area; 7-13: Unit E of the entrance area.

dorsal scar pattern (66.7%), and convergent flaking was rarely observed (7.7%). Likewise, flake blanks were predominantly observed (85.4%), whereas short points typical of the Tabun B-type industry were rare (2.4%). The blade index itself was low (7.3). Conversely, the Unit E Levallois assemblage (n=91) contained a large number of Levallois blanks with parallel and convergent flaking (61.9%; fig. 5:9-13). Moreover, the blade index for the entire assemblage of this unit was higher (23.9) than that for Units C (14.4) and D (7.3). The prevalence of elongated blanks was particularly notable among the Levallois products (46.2%).

Given the stratigraphic contexts, the Unit D and E assemblages recovered from the entrance area predate the Late Levantine Mousterian represented by the Unit C assemblage (Tabun B-type), and they postdate the Yabrudian of Unit F (see below). The Mousterian industries of this time period have been divided into Tabun C-type and D-type in the central Levant, which are considered to have occurred successively with reference to the stratigraphic evidence of the Tabun cave (Copeland 1975; Jelinek 1982; Shea 2003). However, the applicability of this Tabun model to the other parts of the Levant is yet to be established (cf. Muhesen 2004; Mustafa & Clark 2007). The Unit D and E assemblages of the Dederiyeh cave have therefore provided an important opportunity to explore this issue in the northern Levant. Although the sample size is small at present, it is interesting to note that the general patterns of the Levallois technology employed in Units D and E resembled those in Tabun C- and D-type industries, respectively. Yet, it was also noted that there exist some typological anomalies that do not fit with the original definitions at the Tabun cave. For instance, the Unit E assemblage included few elongated retouched points and Upper Palaeolithic-type tools, which were said to be typical of the Tabun D-type industry in the central Levant (Copeland 1975). A further lithic analysis with larger samples from the latest season is currently in progress to compare the Unit D and E assemblages to Tabun C- and D-types in more detail. Radiometric dating is also required to determine their chronological placement. If indeed confirmed, the cultural sequence of the entrance area would suggest that the Tabun D-C-B diachronic change of the Levantine Mousterian industries could have occurred not only in the central Levant but also at the northern end of the Levant. Whatever the case, its careful analysis should contribute to clarifying previously undefined phases of the Levantine Mousterian in the northern Levant.

Lower Palaeolithic

The oldest cultural assemblages at the Dederiyeh cave were obtained from Unit F, the lowest layers of Squares K22/23 and J27. This stratigraphic unit comprised distinct and rather homogeneous layers that were yellowish-grey in color, sharply tilted toward the centre of this area. Unit F lay on the bedrock of Square K22, at a depth of approximately 4.5 m; the bedrock was not reached in the case of the other squares. The anthropogenic materials from this unit were mostly limited to flint artifacts. Animal bones, which were found in abundance in Units C and D and in a lesser degree in Unit E, were extremely rare in this unit. The paucity of animal bones in Unit F was true for all the squares, suggesting that this trend reflects differing sedimentary environments rather than a layer-wise indication of changes in human activity.

The on-going excavations have yielded several hundred flint artifacts, among which 255 specimens from the upper layers have been studied (fig. 6). Despite the stratigraphic proximity, the material radically differed from that obtained from the lowest Levantine Mousterian assemblage of Unit E. It indicated a non-Levallois thick flake industry, comparable to the Yabrudian of the Acheulo-Yabrudian complex of the terminal Lower Palaeolithic. The cores were observed to be either unprepared or prepared minimally; most of them had a globular or an irregular shape, retaining traces of a small number of flake removals from either the cortical surface or plain platforms (fig. 6:1-3). Apparently, each core yielded a small number of flakes only; that is, the number of flakes per core was less than 10, as is observed in the case of certain other Yabrudian assemblages (Shifroni & Ronen 2000). Blanks were predominantly cortical flakes, and blades were rare except for a few elongated flakes, probably produced unintentionally. The proportion of retouched tools was high, occupying about one-third of the small assemblage. More than two-thirds of the tools found were side scrapers; these included dejetés and transverse scrapers shaped with Quina-type retouch (fig. 6:4-6) and bifacially retouched pieces (fig. 6:8-10). Only a few bifaces were found. Tools representing the Upper Palaeolithic type, such as atypical burins and end scrapers, were also found, albeit very occasionally, in the collection examined thus far.

The Acheulo-Yabrudian complex is known to consist of at least three facies or industries: Acheulo-Yabrudian, Yabrudian, and Pre-Aurignacian/Amudian, each of which is defined by specific techno-typological features (Jelinek 1982; Barkai *et al.* 2009). The features of the Unit F assemblages at Dederiyeh, notably the dominance of side scrapers on non-Levallois flakes often made with Quina retouch, as well as the practical absence of bifaces and blade elements, fit well with those of the Yabrudian. The Yabrudian assemblages discovered at Dederiyeh, which is situated at the northern end of the Levant, are a significant addition to the inventory of Yabrudian materials, which hitherto have only been found in the central and southern parts of the Levant (see Ronen & Weinstein-Evron 2000). The well-defined stratigraphic context at this site enables a detailed examination of the industry, which will contribute to the interpretation of the considerable lithic variability observed in the Acheulo-Yabrudian complex (Barkai *et al.* 2009). Additionally, this observed geographic expansion of the Yabrudian to the northern part of the Levant may contribute to the understanding of the relationship between this industry and the contemporaneous industry located further north. Although the Yabrudian has been generally considered as an entity local to the Levant (Bar-Yosef 1994; Le Tensorer 2006), it has been suggested as having certain similarities with the "Proto-Charentien" in Anatolia; however, the details for this claim have not been fully clarified (Otte *et al.* 1998). Another interesting issue concerns the fact that the replacement of the Mousterian at Dederiyeh occurred in the absence of any early blade-rich industries such as the Pre-Aurignacian, Amudian, or Hummalian, which have often been discovered in stratigraphic proximity to the Yabruadian in the Levant. Whether this reflects real cultural processes or geological processes at Dederiyeh is, however, a subject of future investigation.

Conclusions

We have presented an outline of the Middle and Lower Palaeolithic evidence recently recovered from the Dederiyeh cave. The different sequences from different parts of the cave have al-

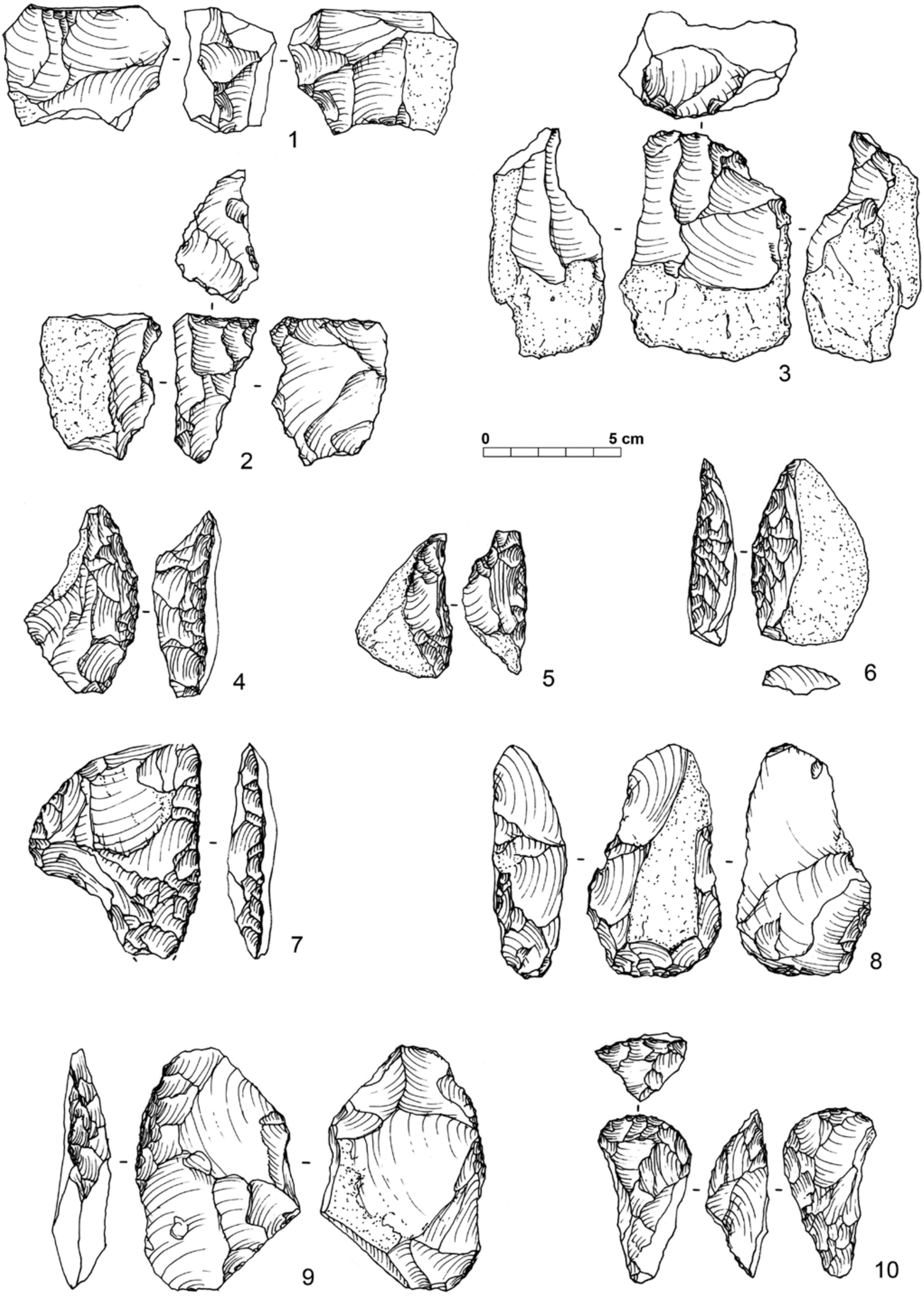

Figure 6 - Yabrudian artifacts from the Dederiyeh cave.

lowed us to reconstruct the occupational history of the Dederiyeh cave as follows. The Yabrudian occupations occurred on bedrock in the entrance area, followed by an earlier Middle Palaeolithic occupation. Until this stage, the vast inner portion of the cave was not occupied. Probably at the outset of the chimney enlargement and possibly the opening of the inner wall of the first chamber as well, which must have resulted in much more favourable conditions inside the cave, the entire area came to be occupied in the late Middle Palaeolithic, the period during which the Neanderthals made extensive use of the cave. The evidence of the Upper Palaeolithic occupations is presently missing, and the Epi-palaeolithic Natufian settlement marks the end of the Palaeolithic at the Dederiyeh cave.

This long Palaeolithic sequence makes the Dederiyeh cave undoubtedly a key site in the northern Levant as a valuable source for assessing the current prehistoric and anthropological models provided from other regions, notably the southern and the central Levant (Bar-Yosef 1998, 2000; Le Tensorer 2004), or for exploring the regional diversity of the Lower and Middle Palaeolithic industries in the Levant. The Yabrudian at the Dederiyeh cave enlarged its known distribution to the northern Levant. Its detailed examination should shed a new light upon the lithic variability of this period from perspectives beyond the southern Levant. With regard to the Middle Palaeolithic, the discovery of the earlier Levantine Mousterian assemblages will help to test the applicability of the Tabun D-C-B chronological changes in the Levantine Mousterian industries to regions outside the central Levant, enabling a discussion of the geographical and/or chronological distribution of the Neanderthals and early modern humans from the view-point of their lithic technology. In addition, the Late Levantine Mousterian evidence of the Dederiyeh cave has confirmed the association of the Tabun B-type industry with the Neanderthals. At the same time, the Late Levantine Mousterian of Dederiyeh displays a diachronic change within the Tabun B-type layers, which should be useful to refine the lithic chronology of this period, as well as to investigate the technological stability or innovations of the Neanderthals (Hovers 1998; Meignen 1991).

In order to exploit fully the significance of these wealthy Palaeolithic records at the Dederiyeh cave, it would be indispensable to acquire accurate radiometric dates; we are eagerly awaiting the results of the TL and OSL dating experiments presently in progress at laboratories.

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LE YABROUDIEN EN SYRIE: ÉTAT DE LA QUESTION ET ENJEUX DE LA RECHERCHE

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Summary - *Dating around 350,000 years, the Yabroudian is a regional archeaological culture of the Levant, stratigraphically situated between the Acheulean and the Mousterian. In Syria this facies is represented in several areas: in the Kalamoon, in central Syria (the region of El Kowm and Palmyra), in Bal'as and in the region of Afrin. The Yabroudian culture was described as a transitional lithic industry between the Lower and Middle Paleolithic, notably for the association of bifacial pieces and scalariform retouched scrapers. The Yabroudian is mainly oriented towards the production of thick flakes which havea wide and smooth platform, obtained by heavy percussion on stone. The use of the soft hammer was also employed for retouching and resharpening of the scrapers. Scalariform/yabroudian retouch is overwhelmingly dominant. Bifacial pieces are marginal and clearly distinct from Acheulean handaxes. These technical characteristics lead us to consider the Yabroudian as a specific culture, closer to the Middle Paleolithic than Lower Paleolithic.*

Introduction

Daté aux alentours de 350.000 ans, le Yabroudien est une culture régionale du Levant s'intercalant en stratigraphie entre l'Acheuléen et le Moustérien. En Syrie ce faciès est représenté dans plusieurs régions : dans le Kalamoon, en Syrie centrale (la région d'El Kowm et de Palmyre), dans le Bal'as et dans la région d'Afrin. Il a été décrit comme une industrie lithique de transition entre le Paléolithique inférieur et moyen, notamment en raison de l'association de pièces bifaciales et de racloirs à retouche scalariforme. Le Yabroudien présente un débitage orienté principalement vers une production d'éclat épais à talon large et lisse à la percussion dure en pierre. L'utilisation du percuteur tendre est néanmoins attestée dans les opérations de retouche et de réaffutage de racloirs. La retouche écailleuse scalariforme/yabroudienne domine très largement. Les pièces bifaciales présentes dans les assemblages sont marginales et nettement distinctes des bifaces acheuléens. L'ensemble de ces caractéristiques techniques nous incite à considérer le Yabroudien comme une culture à parte entière bien plus proche du paléolithique moyen que du paléolithique inférieur.

Historique des recherches sur le Yabroudien en Syrie

Cette industrie a été définie par Alfred Rust (Rust 1950) au cours des fouilles qu'il a menées entre 1930 et 1933, dans un abri sous roche creusé dans les falaises du Ouadi Skifta, près de la petite localité de Yabroud, à 80 km au nord de Damas. Par sa position chrono-stratigraphique entre des niveaux acheuléens et moustériens, le Yabroudien est classiquement considéré comme une industrie de transition entre le Paléolithique inférieur et le Paléolithique moyen. Lors de leur mise au jour, ces assemblages présentaient une typologie jusqu'alors inconnue au Levant. Pour A. Rust, le Yabroudien se définit par la présence d'un grand nombre de racloirs, déjetés et transversaux à retouches écailleuses scalariformes, réalisés sur des éclats courts et épais à talon lisse ou dièdre provenant de débitage non Levallois. Ainsi, A. Rust définit le Yabroudien par les industries sans biface trouvées à la base de la séquence stratigraphique de l'abri I. Il emploie également le qualificatif d'« acheuléo-yabroudien » pour les industries avec bifaces de la partie inférieure de la stratigraphie (Rust 1950). Les fouilles du site de Yabroud ont été reprises en 1963-1965 par R. Solecki qui a alors entrepris une vérification de la stratigraphie des Abris I, II et III et réalisé un sondage perpendiculaire à la tranchée de Rust, (Solecki & Solecki 1966).

En 1982/1983, L. Copeland et F. Hours ont étudié un premier inventaire des industries yabroudiennes du site de Hummal dans la région d'El-Kowm. Cet inventaire comportait 703 pièces (24 nucleus, 665 produits, 10 bifaces, 3 choppers et 1 percuteur (Copeland & Hours 1983). Il est très important de souligner que l'évaluation de cet inventaire est incertaine car les outils ont été ramassés pour une part en position secondaire et mélangés avec d'autres industries. Toujours dans la région d'El-Kowm, J.-M. Le Tensorer a effectué en 1983 une étude stratigraphique et sédimentologique du remplissage de Hummal. Il a pu contrôler la position stratigraphique du Yabroudien et démontrer son antériorité par rapport à l'Hummalien, et cela contrairement à ce qui a été supposé par Copeland et Hours (Le Tensorer, communication orale). Les fouilles récentes dans la région d'El-Kowm, comme celles d'Hummal, de Nadaouiyeh Aïn Askar, d'Umm el Tlel et de Aïn Jawal sont amenée à renouveler nos connaissances du Yabroudien.

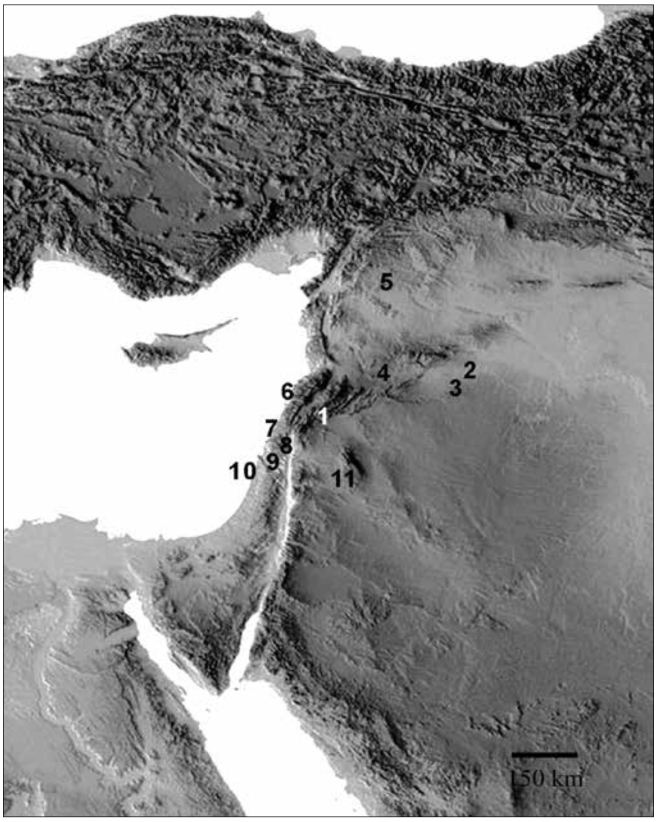

Figure 1 - Répartition des sites yabroudiens au Proche-Orient. 1, Yabroud; 2, El Kowm; 3, Palmyre; 4, Bal'as; 5, Dederiyeh; 6, Masloukh; 7, Adlun; 8, Zuttiyeh; 9, Aïn Musa; 10, Tabun; 11, Azraq; 12, Qesem Cave (carte réalisée par la Maison de l'Orient méditerranéen).

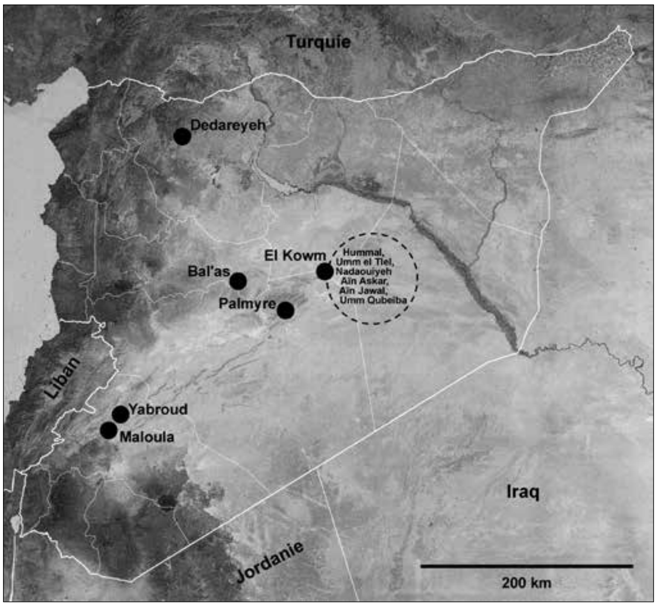

Figure 2 - Localisation des sites Yabroudiens en Syrie.

Le Yabroudien en Syrie

Répartition géographique

Le Yabroudien est reconnu uniquement sous ce nom au Proche-Orient. Cette culture semble limitée, dans l'état actuel des connaissances, à ce territoire : Syrie, Liban, Palestine et Jordanie (fig. 1). En Syrie (fig. 2), ce faciès est particulièrement représenté à; Yabroud (Rust 1950) Hummal (Al Qadi 2008), Umm El Tlel (Boëda 2001), Nadaouiyeh Aïn Askar (Le Tensorer *et al.* 1997), Aïn Jawal (Awad *et al.* 2010), Umm Qubeiba, Aïn Beni Ali, Aïn Chekh Ali (Copeland & Hours 1983), Bal'as (Al Qadi à paraître), Palmyre (observation personelle), Dédariyeh (Nishiaki *et al.* 2011), Maloula (Conard 2004). Au Liban, le gisement de Masloukh ainsi que deux abris, Bezez et Zumoffen, dans le village d'Adlun, ont livré des niveaux du Yabroudien. En Palestine, des niveaux yabroudiens sont connus à Tabun, Aïn Mussa et Zuttiyeh (Al Qadi 2008). En Jordanie, seul le bassin d'Azrak, a livré des industries attribuables au Yabroudien.

Yabroud, Hummal, Nadaouiyeh Aïn Askar et Umm el Tlel constituent les principales références en Syrie. Il s'agit également des sites dont les stratigraphies et les ramassages sont les plus surs. Ils se situent tous, à part Yabroud, dans la région d'El Kowm. Le site de Hummal possède la séquence la plus importante et actuellement la plus accessible bien que les couches ne soient pas très riches. La répartition actuelle des sites yabroudiens doit être nuancée par l'état de recherche en Syrie. Ainsi,

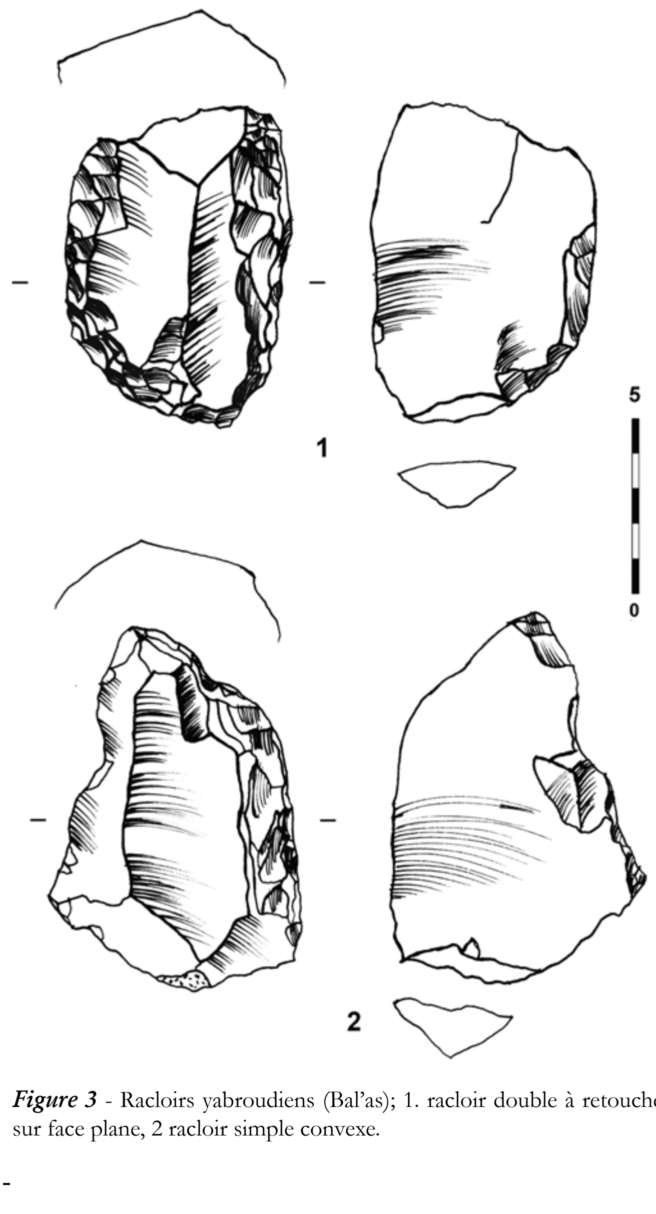

Figure 3 - Racloirs yabroudiens (Bal'as); 1. racloir double à retouche sur face plane, 2 racloir simple convexe.

de grande zones géographiques comme la moyenne vallée de l'Euphrate, ou encore la Palmyrénienne n'ont été que peu investi par des prospections systématiques.

Nouvelle indication géographique

Des prospections effectuées entre 1999 et 2003 dans la région de Maloula par l'équipe de l'Université de Tübingen et la direction générale des antiquités et des musées de Syrie montrent la présence du Yabroudien dans cette zone (Conard 2004). En mars 2005, une campagne de prospections préhistoriques organisées par l'Institut Français du Proche-Orient IFPO à Damas, sous la direction de Frédéric Abbès, a été effectuée dans la région nord de Palmyre. Lors de cette prospection des racloirs yabroudiens ont été recueillis attestant sa présence dans cette zone (observation personelle).

Dans le cadre d'un programme de recherche de la Maison de l'Orient de Lyon, intitulé "*Ba'las: l'occupation des zones arides durant la néolithisation*", dirigée par F. Abbès et Thaer Yartha, et dans lequel nous sommes en charge du volet Paléolithique, notre objectif a été d'identifier les cultures paléolithiques présentes dans le Bal'as. Lors de des prospections que nous avons menées, nous avons pu attester de la présence du Yabroudien par la découverte de plusieurs racloirs yabroudiens typiques (fig. 3) (Al Qadi à paraître).

Dans la région d'Afrin, T. Akazawa fait référence à des industries yabroudiennes, découvertes sur le site de Dedarieh (Nishiaki, et al. 2011). Contrairement à l'idée reçue qui liait toujours le Yabroudien aux grottes et aux abris sous roche (Ronen 2000) comme Yabroud, Tabun, Adlun et Zuttiyeh, les sites yabroudiens de la région d'El Kowm sont en plein air à l'emplacement de sources. C'est le cas aussi pour les sites du bassin d'Azraq en Jordanie. Donc, comme les autres cultures paléolithiques, le Yabroudien a occupé des environnements variés.

Chronologie

Le Yabroudien est traditionnellement considéré depuis son identification comme étant à la transition entre le Paléolithique inférieur et le Paléolithique moyen. Des datations des niveaux yabroudiens ont autrefois été obtenues sur plusieurs sites du Levant. Le site d'Hummal est un des sites qui a donné dans les années 1980 deux datations du Yabroudien qui sont à réviser (Hennig & Hours 1982; Oxford 1988b).

Nouvelles séries de datations

Une série de datations ESR du site de Yabroud, non encore publiées, ont été obtenues. Il s'agit de datations réalisées en 2001, à partir de trois dents d'équidés qui proviennent des fouilles de Solecki, des couches 18/19 (Porat *et al.* 2002). Ces couches sont définies par Rust comme un niveau situé à l'interface entre l'Acheuléo-Yabroudien et le Micoquien (Rust 1950). La moyenne d'âge des trois dents a déjà été publiée par Farrand en 1994 avec une date de 177 ± 20 ka (modèle EU) et 231 ± 19 ka (modèle LU), calculé par DATA (1994 ; communication personnelle de N. Porat). Ces âges ont été recalculés par ROSY software. Les âges pour les trois dents s'accordent entre eux. Donc ce n'est que la moyenne qui sera discutée. La date TL d'un silex brulé, provenant du même niveau (18) donne une moyenne d'âge de 195 ± 15 ka (Oxford Resarch Laboratory, 1990). Après 15 corrections proposées par Mercier & Valladas (1994), les dates TL ont été recalculées à 244 ±17 ka. Tenant compte des erreurs, cette date s'accorde bien avec toutes les dates obtenues sur les dents par ESR, mais particulièrement avec l'âge de 226 ± 15 ka du modèle CU qui nous semble le plus fiable. Les dates TL et ESR place le niveau 18-19 de Yabroud, au milieu de l'OIS 7 (Porat *et al.* 2002), c'est-à-dire Acheuléen supérieur/Acheulée-yabroudien.

A Tabun, une nouvelle série de datations a été entreprise ces dernières années (Rink *et al.* 2004). Parmi celles-ci une dent d'un daim (*Dama mesopotamica*) trouvée in situ dans une zone équivalente à la partie la plus basse de la couche Ed, attribuée au Yabroudien, a été datée par une combinaison de séries de datations de ESR/U-séries, de 387+49-36 ka BP. Cette date est en bonne concordance avec celle de la méthode TL qui a donné l'âge 340 ± 33 ka pour des niveaux similaires. Elle est aussi plus ancienne que les séries d'âges de ESR-U, réalisées dans le sédiment, attachées ou près du dosimètre.

Toujours à Tabun une révision des dates TL de l'unité XIII qui comporte de l'Acheuléo-Yabroudien a donné une date de 302 ± 27 ka qui nous semble logique pour le Yabroudien. Ce résultat est considéré une des datations les plus fiables car les sédiments de cette unités, et l'unité XIV qui contient de l'Acheuléen, sont fortement carbonatés, surtout dans la partie occidentale de la grotte où les échantillons ont été trouvées. En plus, le matériel n'a pas subi une évolution géochimique importante comme en témoigne la présence d'un os (Mercier 2003).

Des indications comparables pour les débuts du Yabroudien ont récemment été observés dans la Qesem Cave, également en Palestine, où les plus anciennes dates confirmés pour le Yabroudien sont de l'ordre de 320 ± 30 ka (Gopher *et al.* 2010).

Sur le site de Hummal, jusqu'à très récemment, l'absence de datations absolues nous avait mené à une réflexion d'ordre chronostratigraphique sur la séquence yabroudienne en relation avec les niveaux acheuléens supérieurs, sous-jacents. En se basant sur ces données, nous avions estimé que l'apparition du Yabroudien pouvait se situer aux alentours de -350 000 ans.

Aspects technologiques du Yabroudien

En Syrie, d'abord identifié par A. Rust dans le site éponyme, le Yabroudien a ensuite été reconnu sur le site d'Hummal et interprété comme une phase de transition entre les industries du Paléolithique inférieur et moyen (Le Tensorer 2006). L'industrie Yabroudienne comporte en effet un grand nombre de racloirs à retouches écailleuses scalariformes, réalisés sur des éclats courts et épais, de débitage non Levallois associé, à de rares bifaces, non acheuléens. À partir d'une analyse technologique que nous avons effectuée sur un matériel lithique restreint des industries yabroudiennes des sites d'Hummal et de Nadaouiyeh Aïn Askar en Syrie, nous allons tenter de mettre en évidence certains aspects technologiques de cette culture située chronologiquement sur ces sites entre les niveaux acheuléens et les niveaux hummaliens.

Notre analyse a concerné les différents éléments du débitage yabroudien ; les éclats corticaux et non corticaux (supports corticaux (fig. 4 et 5), supports non corticaux (fig. 4), directement liés au débitage. Les éclats de retouche, d'aménagement, de réaffutage et de façonnage, liés quant à eux à la transformation des supports produits. Les produits retouchés ainsi que les choix qui ont présidé à la sélection des supports pour être transformés ont également été analysés.

Cela nous a amené à clarifier plusieurs points. L'intention du débitage était d'obtenir des éclats larges et épais, à talon souvent lisse. La percussion directe au percuteur dur était la technique de taille généralement utilisée. L'utilisation du percuteur dur est bien attestée par la présence importante de talon lisse et large. Nous observons aussi les témoignages de l'utilisation du percuteur tendre parmi les éclats d'aménagement des racloirs (préparation des supports et installation des zones actives).

Les éclats produits, futurs supports à l'outillage ont été taillés à partir de nucléus à une ou plusieurs surfaces de débitage. Le plan de frappe peut être unique, ou encore être associé à d'autres plans de frappe. Ces données, quoiqu'encore limitées nous indiquent la souplesse d'exécution des débitages Yabroudiens pour un même objectif. Les nucléus peuvent être de morphologie bi-pyramidale, sub-triangulaire ou sub-circulaire (fig. 6). Ils sont dotés au minimum de 2 surfaces de débitage gérées selon une modalité d'exploitation de surface alternante continue ou discontinue. Les enlèvements d'éclat sont alors centripètes et latéraux. Les nucléus présentent ainsi des plans de fracturations subparallèles et sécantes. Certains nucléus portent en outre des enlèvements latéraux débordants, traduisant une volonté de production de support présentant un dos naturel.

Le Yabroudien et ses affinités avec le Moustérien de type Quina

Le Yabroudien s'apparente à une industrie européenne du Paléolithique moyen, le Moustérien de type Quina (Bordes 1955). Cette similitude concerne beaucoup d'éléments dans la gestion du débitage des deux industries comme la morphologie des supports, les retouches écailleuses scalariformes et les éclats d'aménagement, de réaffutage et de recyclage. Les retouches écailleuses scalariformes s'obtiennent par une succession d'enlèvements d'éclats volontairement réfléchis aux dépens d'un support épais. Selon la définition de F. Bordes sur le matériel du Moustérien de type Quina, la retouche écailleuse scalariforme "*se distingue de la retouche en écaille en ce que les retouches forment des 'marches d'escalier'*". En fait, ces explications concernant la modalité de l'obtention de la retouche Quina sont aussi valables pour les retouches scalariformes des industries yabroudiennes. Ces dernières sont dénommées "retouche Quina" par certains auteurs. Nous préférons cependant parler de "retouche scalariforme yabroudienne" pour le Proche-Orient et de "retouche Quina" pour les pièces européennes afin d'éviter tout risque d'anachronisme entre deux faciès culturels qui en dépit de similitudes demeurent différents. Le risque étant sinon, de finir par amalgamer deux réalités distinctes.

Dans sa thèse L. Bourguignon met en évidence le Moustérien de type Quina et sa nouvelle identité technologique et elle aborde une comparaison avec le Yabroudien en exposant plusieurs points d'apparenté entres ces deux industries (Bourguignon 1997).

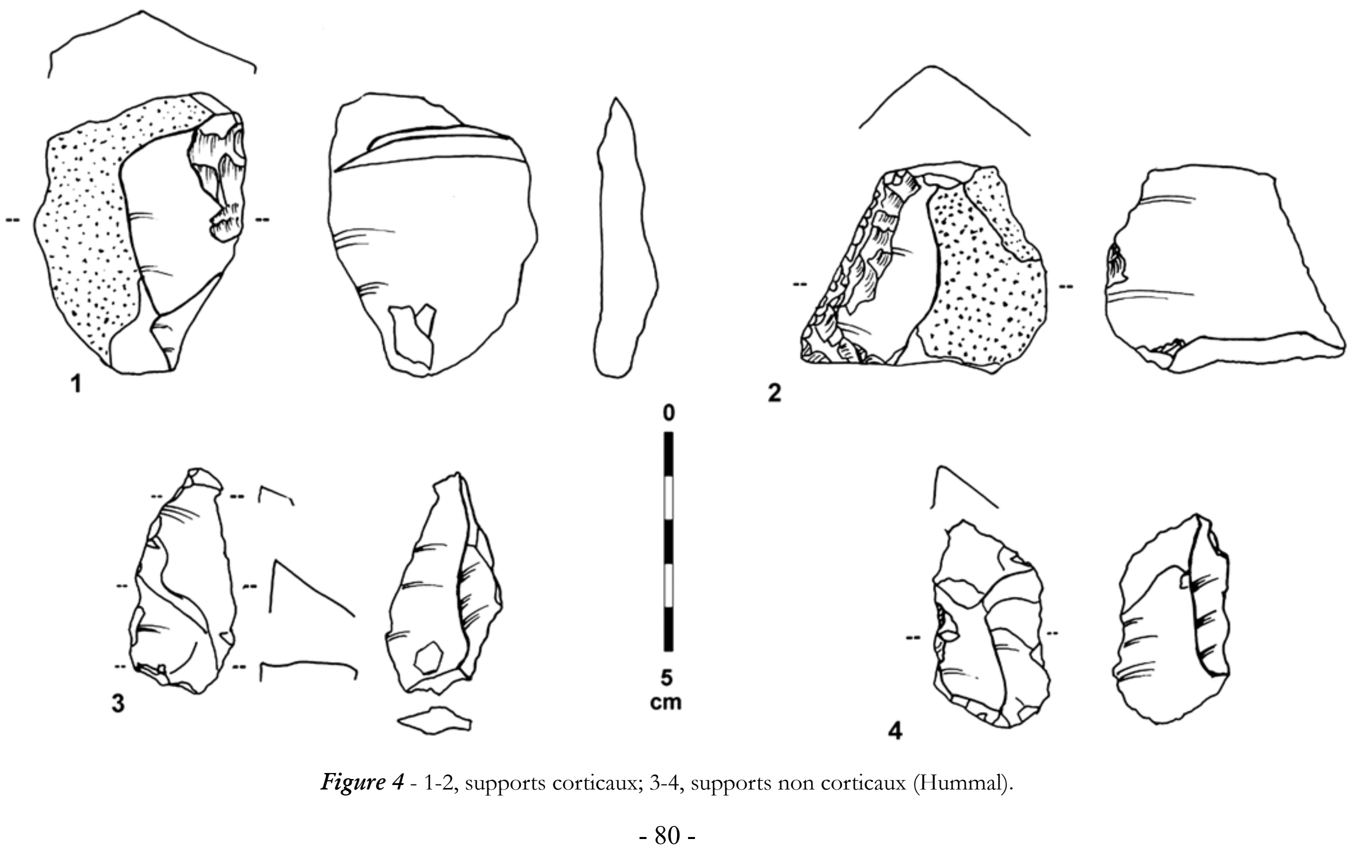

Figure 4 - 1-2, supports corticaux; 3-4, supports non corticaux (Hummal).

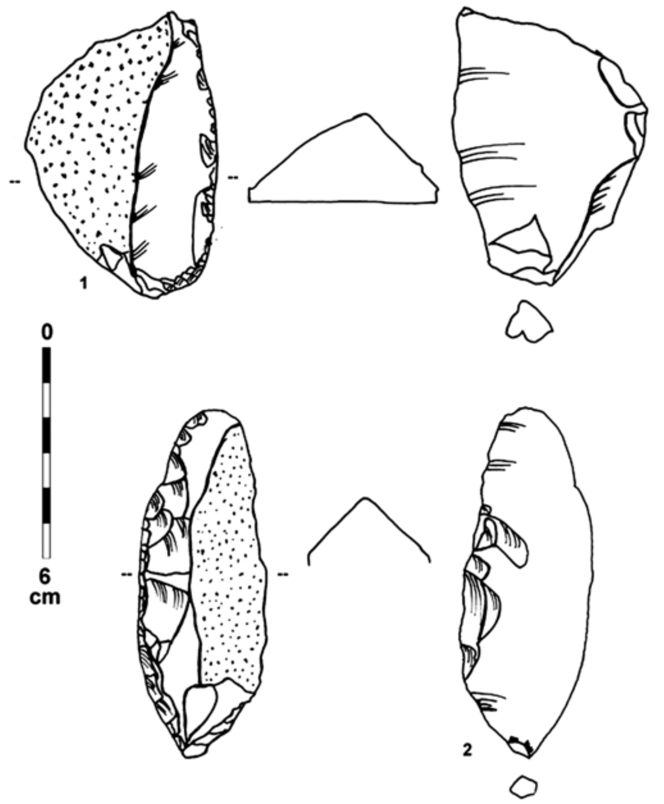

Figure 5 - 1-2, supports corticaux (Nadaouiyeh Aïn Askar).

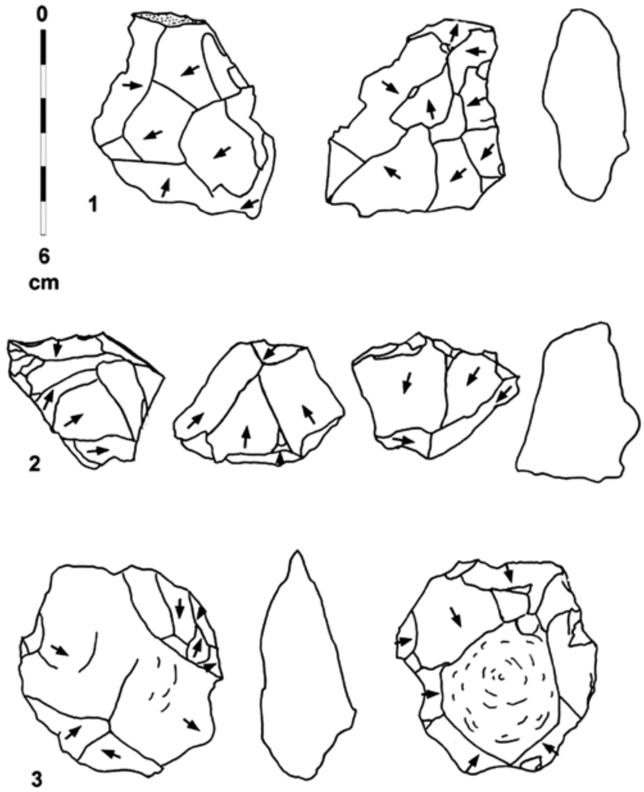

Figure 6 - 1, nucléus de morphologie sub-triangulaire; 2, nucléus de morphologie bi-pyramidale; 3, nucléus de morphologie sub-circulaire (Hummal).

On note, dans le matériel yabroudien d'Hummal et de Nadaouiyeh Aïn Askar, un pourcentage élevé des racloirs simples, transversaux et un peu moins de racloirs déjetés. Les racloirs de type "limaces" sont présents de manière modeste, ainsi que les racloirs doubles et convergents. Ces différents types de racloirs sont de dimensions relativement importantes. Pour l'ensemble de ces pièces, la retouche scalariforme yabroudienne domine d'une manière écrasante dans l'intégralité du matériel.

Les industries d'Hummal et de Nadaouiyeh Aïn Askar disposent en outre, d'une série d'éclats d'aménagement, de réaffutage et de recyclage de différentes dimensions que nous avons divisé en plusieurs types. Ces éclats présentent, dans leurs plans de détachement et leurs morphologies, des aspects similaires à ceux des industries Quina définies par L. Bourguignon (Bourguignon 1997).

Plus précisément, pour les éclats de réaffutages que nous avons identifiés dans le matériel d'Hummal, nous pouvons suivre le processus de retouche des racloirs par retouche écailleuse scalariforme (retouche yabroudienne). Ce processus de retouche, véritable "cycle" d'aménagement des racloirs, correspond tout à fait au cycle de la retouche Quina. Ainsi, si l'on se réfère à la terminologie établie par L. Bourguignon, l'éclat de retouche (affûtage) qui appartient au type 0 de L. Bourguignon (fig. 7:1), montre la première étape du cycle, en aménageant le premier rang de retouche des racloirs. La deuxième étape de ce cycle d'aménagement est indiquée par l'éclat de retouche (fig. 7:2) qui se situe au début du cycle (réaffutage), antérieurement au type III, IV, V et VI. L'éclat de façonnage (fig. 7:3) représente une étape plus avancée dans l'aménagement (raffutage), en reprenant un nouveau cycle, ou encore en effectuant un recyclage en vue d'un autre type de tranchant.

Un quatrième et un cinquième éclat, ceux de réaffutage, appartenaient au type IV de L. Bourguignon (fig. 7:5, 7). Cette étape complète le cycle d'aménagement et de recyclage du tranchant yabroudien. Un second éclat de type IV a été identifié dans le matériel d'Hummal. Celui-ci est légèrement fracturé sur son bord latéral droit. Il est repris en racloir simple droit par une retouche écailleuse scalariforme atypique sur son bord latéral gauche (fig. 7:6). Ce phénomène de reprise par la retouche de ce type de support est fréquent dans le Moustérien de type Quina et montre un autre élément de forte ressemblance entre le Yabroudien et le Moustérien de type Quina.

Le matériel yabroudien de la région d'El Kowm comporte également des pièces bifaciales. Il s'agit d'éclats-supports épais, aménagés partiellement par des retouches scalariformes et comportant souvent des dos (fig. 8). Leur morphologie les apparente plutôt à des racloirs-bifaces (supports typiques des racloirs yabroudiens, retouchés sur les deux faces par des retouches scalariformes). Cette modalité de façonnage bifaciale, semble différente de celle de l'Acheuléen qui implique un processus plus long de l'ébauchage à la finition et mettant en œuvre une construction volumétrique différente (structure plano-convexe et bi-convexe, d'après la notion de "biface support d'outil", Boëda *et al.* 1990).

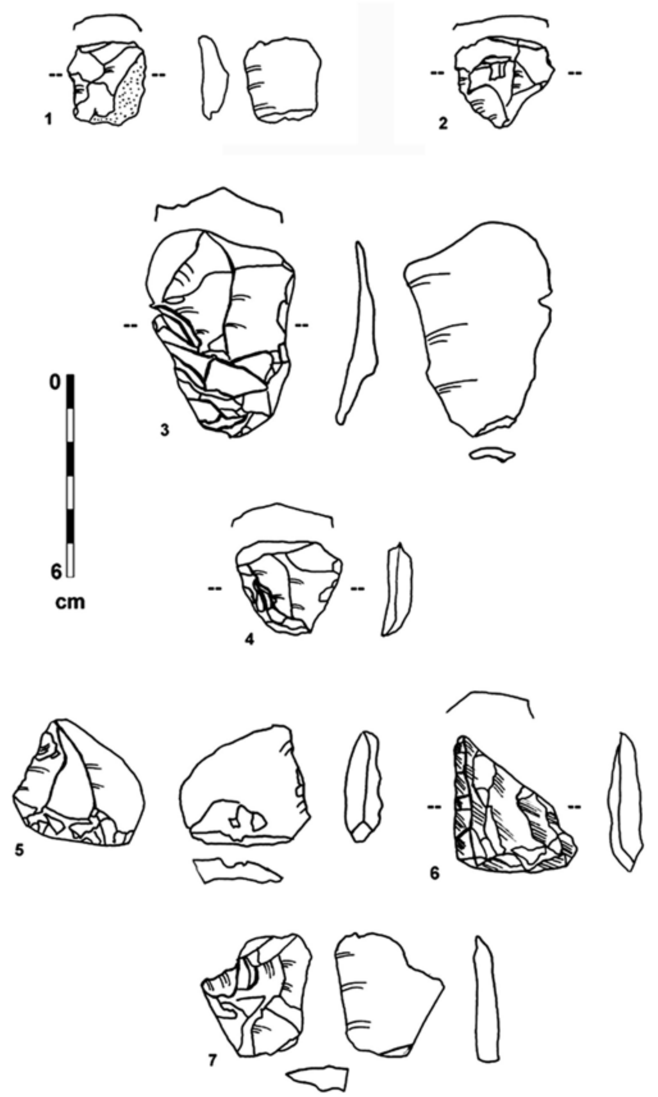

Figure 7 - Eclats de réaménagement et/ou de recyclages (Hummal). 1, éclat de type 0; 2, éclat de type 2; 3, éclat de type 3; 4, éclat de type 3; 5, éclat de type IV; 6, éclat de type IV; 7, éclat de type IV.

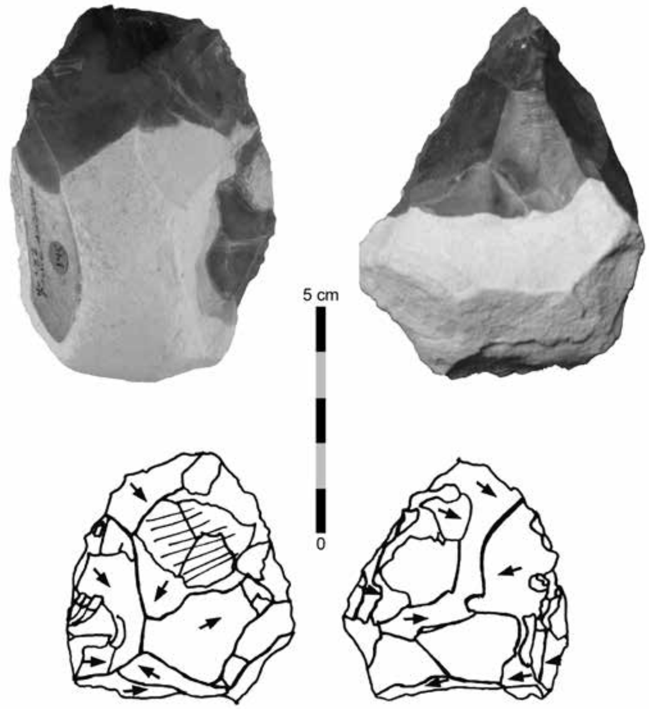

Figure 8 - 1, 3, pièces bifaciales (Hummal); 2, pièce bifaciale (Nadaouiyeh Aïn Askar).

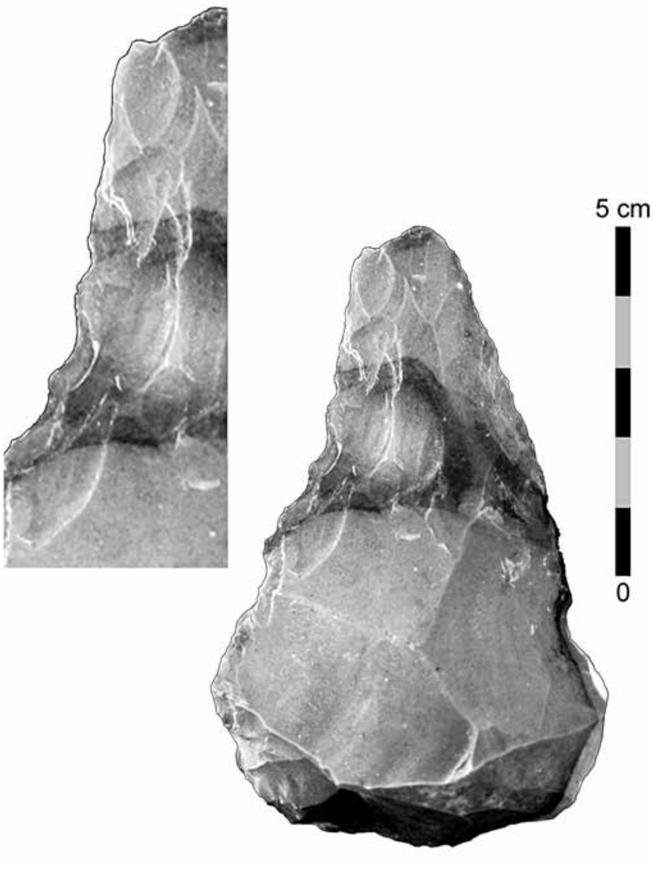

Figure 9 - Biface Acheuléen repris en retouche scalariforme (Nadaouiyeh Aïn Askar).

Les relations entre le Yabroudien et l'Acheuléen

Dans la première définition de Rust, les industries yabroudiennes ne comportaient que peu de bifaces, et lorsqu'elles en comportaient, elles prenaient le nom de "Acheuléo-Yabroudien". Cette appellation est demeurée pour qualifier des niveaux yabroudiens dominés par des racloirs et comportant des bifaces (à Yabroud, Rust 1950 et à Taboun, Jelinek *et al.* 1973). Ces observations ont poussé les préhistoriens à chercher l'origine de cette culture dans les industries de tradition acheuléenne et à considérer que le Yabroudien s'enracinait profondément dans l'Acheuléen (Hours *et al.* 1973). Une observation confortée en stratigraphie par la présence du Yabroudien dans des couches stratigraphiques plus récentes que l'Acheuléen.

Les industries yabroudiennes de Hummal et de Nadaouiyeh Aïn Askar comprennent quelques pièces façonnées, dites pièces bifaciales (pièces clairement non acheuléennes). Ces pièces sont reprises parfois en retouches scalariformes. En revanche, on note l'absence quasi totale des bifaces acheuléens typiques. Lorsqu'ils sont présents, il nous semble qu'il s'agit de la récu-

Figure 10 - Racloirs Yabroudiens découverts à Nadaouiyeh Aïn Askar, grandeur naturelle (photo E. Jagher, Bâle).

pération de bifaces acheuléens réaménagés par des retouches écailleuses scalariformes. Ainsi, à Nadaouiyeh Aïn Askar , un biface témoigne de ce type de récupération. (fig. 7).

Le Yabroudien continu en fait, une tradition plus ancienne de pièces façonnées sans pour autant devoir être assimilées à l'Acheuléen, dont il se distingue nettement. Il nous semble dès lors que le terme "Acheuléo-Yabroudien" devrait être remplacé par : Yabroudien ou "Yabroudien à pièces bifaciales". L'enjeu de ces terminologies est bien évidemment loin d'être neutre. Ainsi, en évoquant des retouches Quina ou encore l'aspect acheuléen des bifaces, on oriente tour à tour la culture Yabroudienne vers le paléolithique inférieur ou moyen en la résumant plus ou moins consciemment à une simple étape de transition sans véritable caractère propre.

Conclusion

Le Yabroudien en Syrie reste un faciès relativement méconnu. Les sites ayant livré des niveaux yabroudiens sont encore peu nombreux au regard des sites de l'Acheuléen et du Moustérien. Il a été considéré comme une industrie de transition entre le Paléolithique inférieur et moyen. Nous préférons cependant rester prudents quant à l'assimilation du Yabroudien, à une simple culture de transition en Syrie et dans l'ensemble du Proche-Orient. Une des particularités majeures de cette industrie est la similitude des débitages et de leur gestion avec les industries du paléolithique moyen.

Les industries yabroudiennes présentent des correspondances technologiques et typologiques avec des industries européennes du Paléolithique moyen du sud-ouest de la France comme le Moustérien de type Quina. Quelles sont les raisons d'une telle similitude entre le Yabroudien et le Moustérien de type Quina? Quelle est la relation entre ces deux industries, qui appartiennent à deux zones géographiques différentes très éloignées? Plusieurs explications pourraient être envisagées. Serait-ce dû à une migration? En l'absence de sites intermédiaires, aux aspects technologiques comparables, entre les deux zones géographiques, nous ne pouvons pas nous attacher à cette hypothèse. Serait-ce une invention similaire apparue au Proche-Orient et en Europe, à des époques différentes ? Cette seconde hypothèse est envisageable si l'on prend en considération les nouvelles datations du site du Petit Bost en Dordogne aux alentours de -320 000, Bourguignon *et al.* 2006), et celle de la grotte de la Baume Bonne en Haute Provence (aux stades isotopiques 8 à 10; entre 374 000 et 243 000 ans, Gagnepain & Gagaillard 2005). Ces questions restent néanmoins encore en suspens.

Dans le cadre de nos recherches, nous projetons l'étude des assemblages yabroudiens à une plus grande échelle, dans l'ensemble de la région levantine. Seules, des analyses technologiques répétées sur un maximum de sites archéologiques peuvent en effet permettre d'apporter des réponses quand au statut culturel réel du Yabroudien et de sa relation avec aussi bien le Paléolithique inférieur que moyen.

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THE CONTRIBUTION OF HAYONIM CAVE ASSEMBLAGES TO THE UNDERSTANDING OF THE SO-CALLED EARLY LEVANTINE MOUSTERIAN

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Introduction

The Palaeolithic in the Near East is well known for the production of a large component of elongated blanks, even if it is not a continuous phenomenon. This is the case from the earliest occurrences during the late Lower Palaeolithic to the classical Upper Palaeolithic, through the Early Middle Palaeolithic (the so-called Early Levantine Mousterian) which is the main topic of this paper.

As has long been recognized, blade production in southwestern Asia appeared quite early, in Pre-Aurignacian and Amudian industries, but at few known sites: Yabrud (Syria) (Bakdach 1982; Rust 1950) and Haua Fteah (Libya) (McBurney 1967) for the former, in Tabun (Garrod 1956), Abri Zumoffen/Adlun (Copeland 1975; Garrod & Kirkbride 1961), Zuttiyeh (Gisis & Bar-Yosef 1974), Maslouk (Skinner 1970) and more recently Qesem Cave (Barkai *et al.* 2003, 2005, this volume) for the latter. Both assemblages have been found interstratified in Acheulo-Yabrudian levels; they are included in the Mugharan tradition and therefore are traditionally considered as late Lower Palaeolithic, although some scholars have grouped them with Middle Palaeolithic (for instance, Jelinek 1982). Stratigraphically, they always follow the Acheulian but predate the Levallois Middle Palaeolithic (Levalloiso-Mousterian). The Amudian has been dated to 264 000 ± 28 000 y in the deep archaeological sequence of Tabun (Tabun unit XI [Mercier & Valladas 2003]). More recently, however, the discovery and dating of a new long Amudian sequence seems to indicate that this Lower Palaeolithic blade-geared industry could have started more than 380 000 years ago and lasted until 200 000 years ago (Barkai *et al.* 2003, 2005).

The Amudian/Pre-Aurignacian assemblages have always been described as non-Levallois technologies and therefore were considered as contrasting with the Early Levantine Mousterian. Often grouped together on the basis of their blady characteristics, their non-Levallois technology and chronological position (Garrod 1956, 1970; Vishnyatsky 1994), they actually differ in several technological and typological points (Bordes 1977; Copeland 1975, 1983a; Jelinek 1990; Meignen 1994; Monigal 2001, 2002; Vishnyatsky 2000). This is especially the case for their core-reduction strategies and retouched tool-kits dominated by Upper Palaeolithic tools in both industries. The latter are not of the same kind, however; burins, endscrapers and retouched blades for the Pre-Aurignacian, but mostly backed knives and some burins/endscrapers for the Amudian (Meignen 1994).

The case of the Hummalian, reported since its discovery to have a strikingly high proportion of blades (Hours 1982), is more controversial. It has sometimes been considered as part of the Lower Palaeolithic complex (Monigal 2001 and references therein). This is partially due to an initial erroneous interpretation of the stratigraphy (Besançon *et al.* 1981, 1982; Copeland 1985), but also to its uniqueness among blady assemblages at that time. Its stratigraphical position is now well established, following the field project directed by J.M. Le Tensorer (this volume). The finding that it is above the Acheuleo-Yabrudian of the El Kowm basin, and beneath the Levallois Middle Palaeolithic assemblages, is somewhat particular. This situation allows us to consider whether it is part of the earlier complex (together with Amudian and Pre-Aurignacian) or part of the Early Levantine Mousterian. Due to its striking similarities, in terms of core reduction strategies and tool-kits, with the Hayonim Lower E and F assemblages (recently studied and dated, *cf infra*), we consider it to be Early Middle Palaeolithic. Its stratigraphical position at the bottom of the Levantine Mousterian is in agreement with this hypothesis. Moreover radiometric dates previously published (Oxford Research Laboratory for Archaeology 1988, 1990) are now considered as unreliable, as environmental dosimetry measurements have shown problems of radioelement contamination in this area (Mercier & Valladas 1994). Preliminary results of a new radiometric dating programme in the context of the renewed excavations directed by J.M. Le Tensorer lend credibility to an early age for these industries (± 200 ka; Richter *et al.* 2011) and therefore confirm its contemporaneity with Hayonim lower E and F .

Unlike Amudian-PreAurignacian industries, more recent Early Middle Palaeolithic blade productions (the so-called Early Levantine Mousterian), when they are discovered in long archaeological sequences, are stratigraphically positioned above the Acheuleo-Yabrudian complex and at the bottom of the Middle Palaeolithic sequence (in the cases of Tabun unit IX (Jelinek

1975), Hayonim lower E and F (Bar-Yosef *et al.* 2005) and Hummal Ia (Copeland 1985); they can alternatively be found simply above the Acheuleo-Yabrudian complex (in the case of Abou Sif C-D (Neuville 1951), or at the bottom of the Mousterian sequence (Douara unit IV [Akazawa 1979; Nishiaki 1989]). In other sites, they occur uniformly through the full short stratigraphic sequence (Rosh ein Mor, Nahal Aqev (Marks 1976) and therefore they are difficult to place in the regional archaeological scheme.

This Early Levantine Mousterian entity, usually defined as having a relatively high component of elongated blanks, a wide range of Upper Palaeolithic tool types and/or elongated retouched points (depending on the scholars), along with typical Middle Palaeolithic tools, has been recognized for more than 50 years. But it is only recently, with the progress in lithic technological studies and radiometric dating, that the importance, diversity and duration of this entity has been better assessed.

In this context, an interdisciplinary research programme, directed by O. Bar-Yosef, L. Meignen and B. Vandermeersch, was undertaken in Hayonim cave, between 1992 and 2000, in order to establish a chronological frame and gain a better understanding of the lithic blady assemblages already recognized during previous excavations in this site (Arensburg *et al.* 1990; Bar-Yosef *et al.* 2005). This new excavation project allowed us to expose a thick Middle Palaeolithic sequence (more than 7 m deep) including layer Upper E, in which true recurrent Levallois flake and point reduction strategy has been identified, and layers Lower E and F characterized by the elongated blank production that we present here. The lower sequence (Lower E and F) has been recently dated from 230 000 to 160 000 y ago (Mercier *et al.* 2007). These Lower E and F levels were recovered in the classical stratigraphical position of the Early Levantine Mousterian, at the bottom of the Mousterian sequence and above an Acheuleo-Yabrudian level (layer G). The latter was only slightly explored at the base of a deep sounding (layer G). The bedrock was never reached during these excavations.

Before focusing on recent informations, a rapid overview of the way these elongated productions were previously recognized and considered is interesting. It should help to understand how our current classificatory framework was created and evolved through several generations of prehistorians.

Brief historical review

Interestingly, in the 1930s and 1940s (and even later), Garrod, based on her experience at the site of Tabun, put the emphasis mostly on the similarities between the lithic assemblages from her different Levalloiso-Mousterian layers (level B: Upper Mousterian; levels C-D: Lower Mousterian), which were identified in fact mainly on faunal characteristics (Garrod 1934; Garrod & Bate 1937). She considered the Tabun D level (now characterized by its elongated products) as "of Levallois tradition, which is not unlike that of Tabun B" (Garrod 1934 in Monigal 2002); the blady character was not included in her definition.

Conversely, in the 1950 and 1960s, based on lithic assemblages from Abou Sif (Neuville 1951), attention was mainly focused on the elongated retouched points, without specific chronostratigraphical meaning. Nevertherless, in Neuville's opinion, lithic assemblages from Abou Sif represented an early Mousterian facies which he considered at that time more or less unique typologically. For comparison, he mentionned the Tabun D assemblages but insisted on the presence in this site of more "normal" Mousterian tool types. Due to their original character, these Abou Sif lithic materials were isolated by contemporary prehistorians under the names of *Moustérien à pointes retouchées* (Perrot 1968), Abou Sif type (Skinner 1965) or Moustérien à pointes allongées retouchées (Howell 1959; Neuville 1951).

In the 1970s, renewed excavations by Jelinek in the key site of Tabun cave clearly established the chronostratigraphical position of these elongated productions, at the bottom of the Levalloiso-Mousterian sequence (Jelinek 1975). Researchers then focused on the early age of these elongated point assemblages (Hours *et al.* 1973) and the term Phase 1 was introduced by Copeland (1975). Thus, at that time, the general tendency was to insist on the chronological meaning of these assemblages, conceptualizing them in a unilinear model of evolution for the Middle Palaeolithic. Tabun Cave is then used as a key site for the Central Levant; but its relevance for the North and South Levant is considered as questionable for some scholars (see lively discussions between Copeland and Jelinek in the publication of the symposium *Préhistoire du Levant*, 1981a).

It is only at the beginning of the 1980s that the term "Early Levantine Mousterian" appeared in the literature, as equivalent to "Tabun D type" or "phase 1". Jelinek (1981b) as well as Marks (1981) introduced blades into the definition of this entity (interestingly their abundance was never clearly expressed in the definition of Garrod's layer D, her Lower Levalloiso-Mousterian, which she mainly characterized by points (Garrod & Bate 1937). Based on his large experience on Negev sites, Marks insisted on the frequent occurrence of Upper Palaeolithic tools in these blady assemblages, while Jelinek at that time still called it "Abou Sif type" (thus referring to the presence of elongated points).

Finally, since the mid 1970s, these Early Mousterian assemblages have been generally considered as quite homogeneous and related to the Levallois technology ("Levalloiso-Mousterian") (Bar-Yosef 1980; Copeland 1975; Jelinek 1982:92; Marks 1981; Shea 2001, 2003; Wallace & Shea 2006).

Marks & Crew (1972), and later Crew (1976) in his precursory work on Rosh ein Mor, largely documented the occurrence of prismatic cores, with "curved barrel shaped surfaces", alongside classical Levallois cores. Later, Bergman and Ohnuma (1983) insisted on the non-Levallois character of the blady assemblages from Hummal Ia, a striking industry discovered in the early 1980s (*contra* Copeland 1981; she later retracted her original opinion in favour of Bergman and Ohnuma's viewpoint (Copeland 2000). However all these relevant observations (presence of prismatic cores, prismatic blades, crested blades) were, for a long time, not taken into consideration because the conceptual framework for deciphering the different lithic production systems was not yet available and there was not yet a scientific interest for core reduction strategies and their social meaning ("*traditions techniques*"). The understanding of the Middle Palaeolithic lithic technology was still based at that time on a simplistic binary opposition between Levallois ("prepared core technology") and non-Levallois ("unprepared core technologies") (see, for instance, Copeland 1983b).

The next stage was reached with the development of the technological approach, and especially with the introduction of what is called in the French literature *conception volumétrique*, i.e., the geometric core construction and rules followed during the core exploitation in order to obtain specific end-products (Boëda 1988, 1994, 1995; Inizan *et al.* 1999). More precisely, Boëda (1988, 1990) pointed out differences between the Middle Palaeolithic Levallois method (conceptualized as a series of successive prepared flaking surfaces), and the Upper Palaeolithic Laminar concept (seen as a volume to be reduced in a continuous process). The latter is characterized by cores sometimes called "volumetric" in the recent literature (for instance, Monigal 2001:16-17) or "platform cores" (Conard *et al.* 2004).

At the beginning of the 1990s, this technological approach was developed on Middle Palaeolithic blady assemblages in the Levant. Since 1994, through the comprehensive study of characteristics of cores, end-products and by-products, several researchers have shown the presence of distinct core reduction strategies for the production of elongated blanks in the so-called Early Levantine Mousterian (Boëda 1995; Marks & Monigal 1995; Meignen 1994, 2000). In this context, Hayonim assemblages, recovered in well-controlled chronostratigraphical conditions during recent excavations, have played an important role, as they have been submitted to a detailed technological study and thus should be used as a general basis for deciphering the criteria on which different volumetric concepts/debitage methods could be identified.

Early Middle Palaeolithic blady assemblages

As was described before, Middle Palaeolithic blady assemblages located at the bottom of the Levantine Mousterian sequence are generally grouped under the name of Early Levantine Mousterian, or Tabun D type industries, or phase 1 Levantine Mousterian. When they are not recovered in long stratigraphical sequence and/or are not radiometrically dated, only their general similarity with this entity motivated prehistorians to name them "Early Levantine Mousterian" (for instance, Abou Sif, Sahba).

This Early Middle Palaeolithic is found in numerous sites throughout the Levant, with a large geographical repartition; it is known in different environments, on the coastal plain as well as in the marginal areas. In this paper, we consider not only Hayonim industries, on which initial research focused, but also several other previously studied blade-geared assemblages that were stratigraphically recovered and in several cases, recently dated, in order to discuss not only the technological entity to which they belong, but also their chronological relationships.

Recent technological studies have shown that this Early Middle Palaeolithic entity is less homogeneous and more complex than was previously thought. It clearly includes assemblages that embody variations in their reduction strategies as well as in their tool-kit composition (Meignen 2007).

These assemblages all share significant proportions of blady blanks (Ilam = 20 to 60%) but this elongated production is never exclusive (see also Monigal 2001:16, 2002:524). Short blanks (flakes and points) are always present, produced by an additional separate core reduction strategy, most often of the Levallois type (short Levallois points, for instance, in Hayonim, Abou Sif, Rosh Ein Mor, Douara IV). As a consequence of these coexisting reduction strategies in the same assemblage, the laminar index is never very high (between 20 to 60, the latter in the case of Hummal). Moreover, it should be stressed that high or low proportions of blades may also result from the function of the site in the territory: these implements could have been carried into the site – imported (for instance, in the case of Tabun unit IX, considered as ephemeral occupations) – or taken away – exported (possibly the case in some Negev sites). In order to evaluate better the core reduction strategy involved in those sites, all by-products and cores must be taken into account, not only the laminar index.

The blady component, for a long time characterized as solely Levallois, clearly results from diversified reduction systems. Recent technological studies (in Hayonim lower E and F (Meignen 2000, 2007), Rosh Ein Mor (Marks & Monigal 1995), Hummal Ia (Boëda 1995, 1997; Wojtczak this volume) give evidence, in each assemblage, for diverse geometric constructions of cores (*conceptions volumétriques*, *sensu* Boëda) resulting in different morphologies of end-products (blades and elongated points).

In these assemblages, while the classical recurrent Levallois core reduction performed on relatively flat flaking surfaces results in wide thin elongated products, often with facetted platforms, the Laminar method (as we defined it in Meignen 1998), identified in the form of semi-pyramidal and semi-prismatic cores (or platform cores, following Conard *et al.* 2004), results in narrow, thick blades, with triangular or trapezoidal sections, and frequently plain butts.

In Hayonim lower E and F, few characteristic Levallois cores (fig. 1:a) have been identified which demonstrate the henceforth classical Levallois structure, as defined by Boëda (1986, 1995). The method is recurrent, which means that a series of wide, thin elongated blanks, extending down the greater part of the core length, have been struck from prepared platforms at either one or two ends of the core (here the flaking is more often bidirectional). Conversely, the Laminar method has been identified by cores which demonstrate a configuration quite different from those resulting from the Levallois concept. These "volumetric" cores show markedly convex debitage surface (contrary to Levallois cores) from which elongated blanks are struck in series from one (sometimes two) striking platform(s).

Unidirectional cores, the most frequent, display a highly convex cross-section, with a flaking surface expanding to lateral edges around a large part of the core periphery (*débitage semi-tournant/tournant*, in the French literature) (fig. 1:c-e). This was allowed by the special preparation of the striking platform, where removals set up the necessary angle for exploiting lateral edges of the core (more than 50°, often close to 80-90°). Most often semi-pyramidal (or pyramidal), they are of different sizes, including small size (fig. 1:e), geared to the production of large to

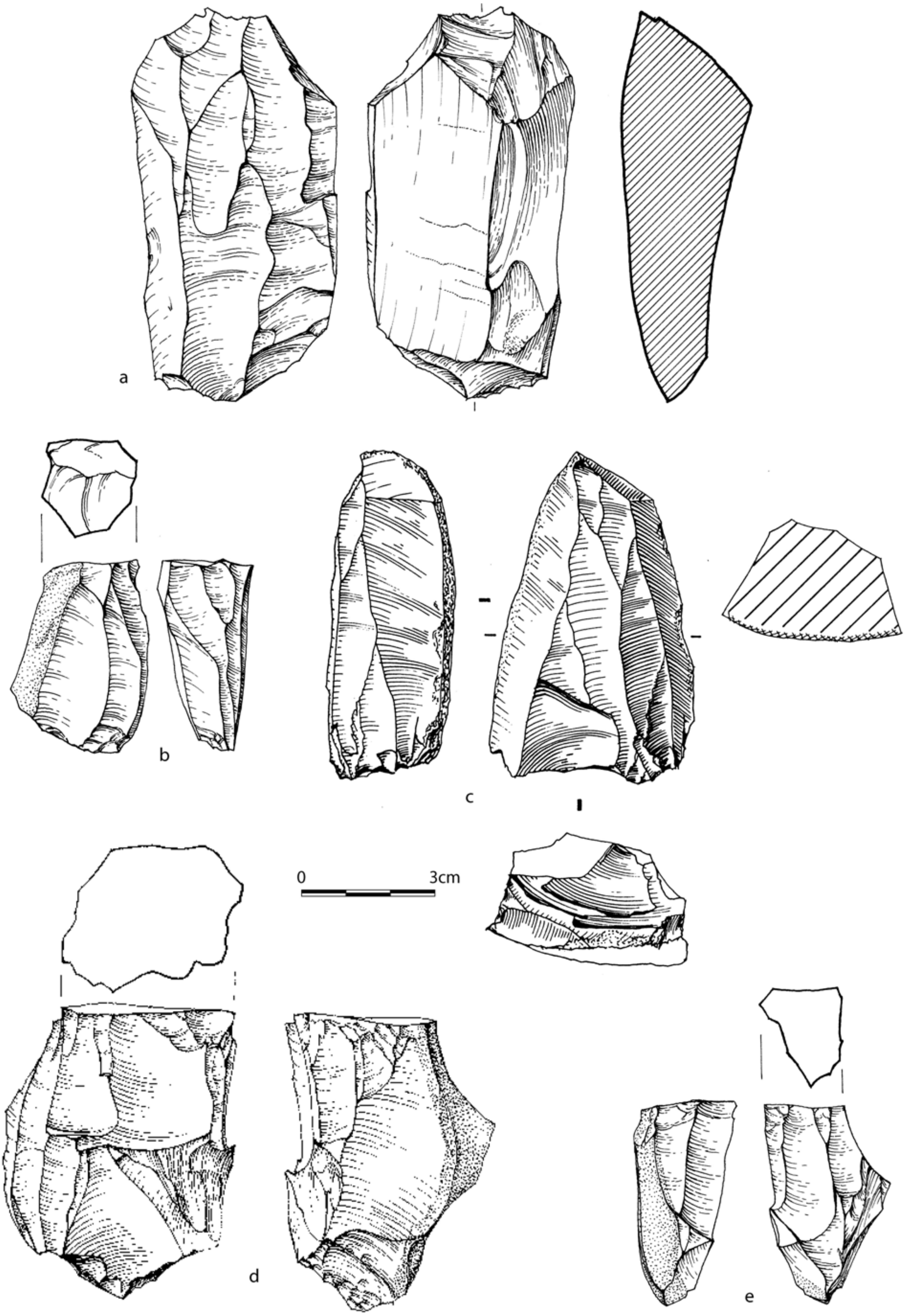

Figure 1 - Hayonim Lower E and F. a: cores, Levallois core (recurrrent bidirectional); b: Laminar core "semi-tournant", bidirectional, opposed twisted striking platforms; c-e: Laminar cores: "semi-tournant", unidirectional.

small blades, and even microblades, as recovered at Hayonim, for instance (fig. 4:d, f-g). Bidirectional core exploitation has been identified in the form of cores, with two opposed platforms slightly twisted ("off axis") (fig. 1:b; fig. 2). From these two striking platforms, two reduction surfaces (one along the widest face, the other along the narrow face of the block) are exploited, whose intersection creates the necessary convexities for the blank detachment. The resulting debitage surface is, as in the previous case, highly convex, and the morphology of the core is "semi-prismatic". Such bidirectional exploitation has been also identified by specific overshot blades which take off the opposite "off axis" striking platform (fig. 3:b-c). Crested blades have been sporadically involved in core shaping and maintenance (fig. 3:d).

The resulting end-products of this Laminar system are mostly narrow, thick blades of different sizes (fig. 4:a-c, e, g), including small blades/bladelets, the latter also eventually struck from "nucleiform burins" in the case of Hayonim (see, for instance, fig. 5:d). The characteristics of the striking platform (simple or absent preparation), the bulb of percussion (salient) and the ventral surface of the products suggest direct percussion by hard hammer.

Technological studies presently available show that, in most of Middle Palaeolithic blade-geared industries, the two reduction strategies (Levallois and Laminar methods), as described here in the Hayonim Lower E and F assemblages, coexisted in each assemblage but did not occur in equal frequencies (Meignen 2000, 2007). At sites such as Hayonim lower E and F, Hummal Ia (Hummal level 6, in Le Tensorer's excavations), and probably Abou Sif, end-products and cores from the Laminar concept seem to be dominant, even largely prevalent in the case of Hummal 6 (Wojtczac, this volume). Conversely, in other cases, the main emphasis of blade production is on the Levallois core reduction at the expense of the Laminar concept (Tabun IX (Meignen 2000; Monigal 2002:307); Rosh Ein Mor (Monigal 2002:307, contra Marks and Monigal 1995) (fig. 6), Nahal Aqev, and probably Douara IV). In Tabun IX, it seems that only the recurrent Levallois method has been involved (Meignen 1998, 2000; Monigal 2002:307).

Moreover these different prevailing core reduction strategies appear to be generally associated with varied retouched tool-kits. Regarding retouched tools, early Levantine Mousterian assemblages have been usually characterized, depending on the authors, by a relatively high proportion of elongated points (Copeland 1975; Jelinek 1981b; Marks 1981) and/or a wide range of Upper Palaeolithic tools (Bar-Yosef 1994; Marks 1981, 1992; Shea 2003) alongside the typical Mousterian tools (scrapers, denticulates and notches). More careful examination of the presently available data shows a more refined picture, however.

Some assemblages are clearly dominated, alongside classical Mousterian types, by elongated retouched points (fig. 7) and retouched blades, as described in Hummal Ia (Copeland 1985), Abou Sif (Neuville 1951) and Hayonim lower E and F (Meignen 1998, 2000, 2007) (fig. 8:a-c, e-g; fig. 9). These most distinctive elongated tools have often been heavily transformed by scalar retouch, which is localized at the tip and/or more or less spread along the lateral edges. In Hayonim as well as in Hummal and Abou Sif, the pointed tools grade from symmetrical retouched points (elongated Mousterian points), to asymmetrical points (also called "*pointes incurvées*" by Neuville [1951]) to backed, distally curving, pointed "knives" (Copeland 1985). The small range of elongated points with abrupt retouch, especially near the sharply-pointed tip, called "Hummalian points" in Hummal Ia (Copeland 1985, 2000:103), has also been recognized in Hayonim lower E and F. According to Copeland, they were quite rare in Abou Sif (1985:181). These tools are often fashioned on narrow thick elongated blanks struck according to the Laminar method. In these assemblages, Upper Palaeolithic tool types are rare. But it should be noted that in some units from Hayonim they are well represented in the form of true burins and nucleiform burins (fig. 5). Nevertheless, the Mousterian tool types (especially if we include the elongated retouched points) remain the most distinctive tools in these assemblages.

On the contrary, few assemblages happen to contain significant proportions of different Upper Palaeolithic tool types (burins, endscrapers, truncations, borers; IIIess index between 20 to 30; references in Monigal (2002, fig.12:2) and a lower ratio of elongated retouched points. In these assemblages, the latter are made on thinner, wide, elongated blanks with prepared striking platform. They are often only slightly retouched, in contrast with those of the first group. These more balanced tool-kits have been recognized in sites such as Rosh Ein Mor (Crew 1976), Ksar Akil XXVIII (if considered as Early Middle Palaeolithic [Marks & Volkman 1986; *contra* Meignen & Bar-Yosef 1992] and to a lesser extent (lower proportion of Upper Palaeolithic tools), in Nahal Aqev (Munday 1977) and Tabun IX (Jelinek 1975). Most of them seem to be developed in assemblages characterized by the prevalence of Levallois core reduction strategies for elongated production.

In fact these two separate groups of blade-geared assemblages defined on technological and typological criteria (schematically, predominance of the Laminar method/elongated retouched points and retouched blades versus prevalence of the Levallois method/Upper Palaeolithic tool types) have already been globally recognized by Monigal (2002) on the basis of lithic studies known at that time. She finally considered these two groups as two chronologically successive entities, with an abrupt technological break between them (Monigal 2002:529). Contrary to some authors who at that time had already placed the Hummalian in the Early Levantine Mousterian (for instance, Bar-Yosef 1998; Copeland 2000), on technological and typological criteria (non-Levallois technology as the sole reduction strategy; very elongated, thick, heavily retouched Mousterian points, and in general a pronounced Middle Palaeolithic character), she separated the Hummalian from the Early Levantine Mousterian and considered the former as a Lower Palaeolithic blade-producing industry. The Early Levantine Mousterian was then represented by the Negev and Tabun IX collections.

However, more recent studies of Hayonim Lower E and F assemblages, viewed in the context of presently available dates, allow us to reconsider this hypothesis. Our results demonstrate that these two groups are not clearly separated and certainly

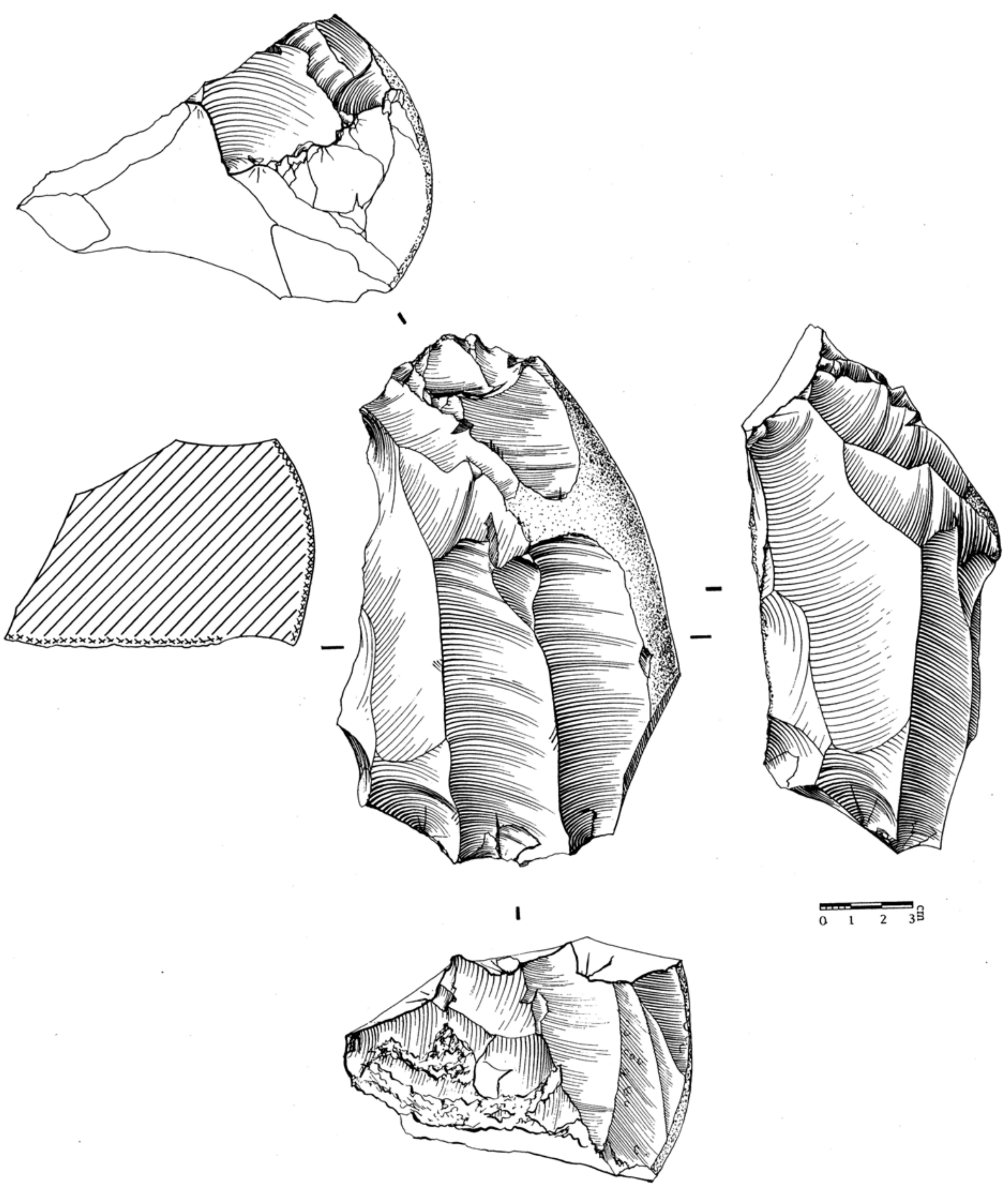

Figure 2 - Hayonim Lower E and F. Laminar core "semi-tournant", bidirectional, opposed twisted striking platforms.

not chronologically distinct. The more balanced picture of all blady assemblages we previously exposed, together with recently obtained results for Hayonim cave (Mercier *et al.* 2007) and Hummal level 6 (Richter *et al.* 2011) chronologies do not allow to separate strictly two different entities. Indeed, in all the assemblages, both reduction strategies (Laminar and Levallois) were involved in blade production, albeit not equally. Moreover the Upper Palaeolithic tool component, which characterized the Rosh ein Mor/Tabun group, appears to be represented as well in the assemblages dominated by the elongated retouched points, in the form of classical burins as we recently recognized them in Hayonim cave (fig. 5). These short comments already show that the suggested break between the two groups cannot be accepted even if some different trends can be identified. Moreover new dating results from Hayonim cave (Mercier *et al.* 2007), in which blady assemblages lasted for a long period of time, from 230 000 to 160 000 y ago, and those from Hummal level 6 dated from the same range of time, disprove the chronological succession of the two groups suggested by Monigal. Indeed, based on TL dates (Mercier *et al.* 1995; Mercier & Valladas 2003), the Levallois-dominated assemblages (also characterized by a developed Upper Palaeolithic tool kit) that Monigal con-

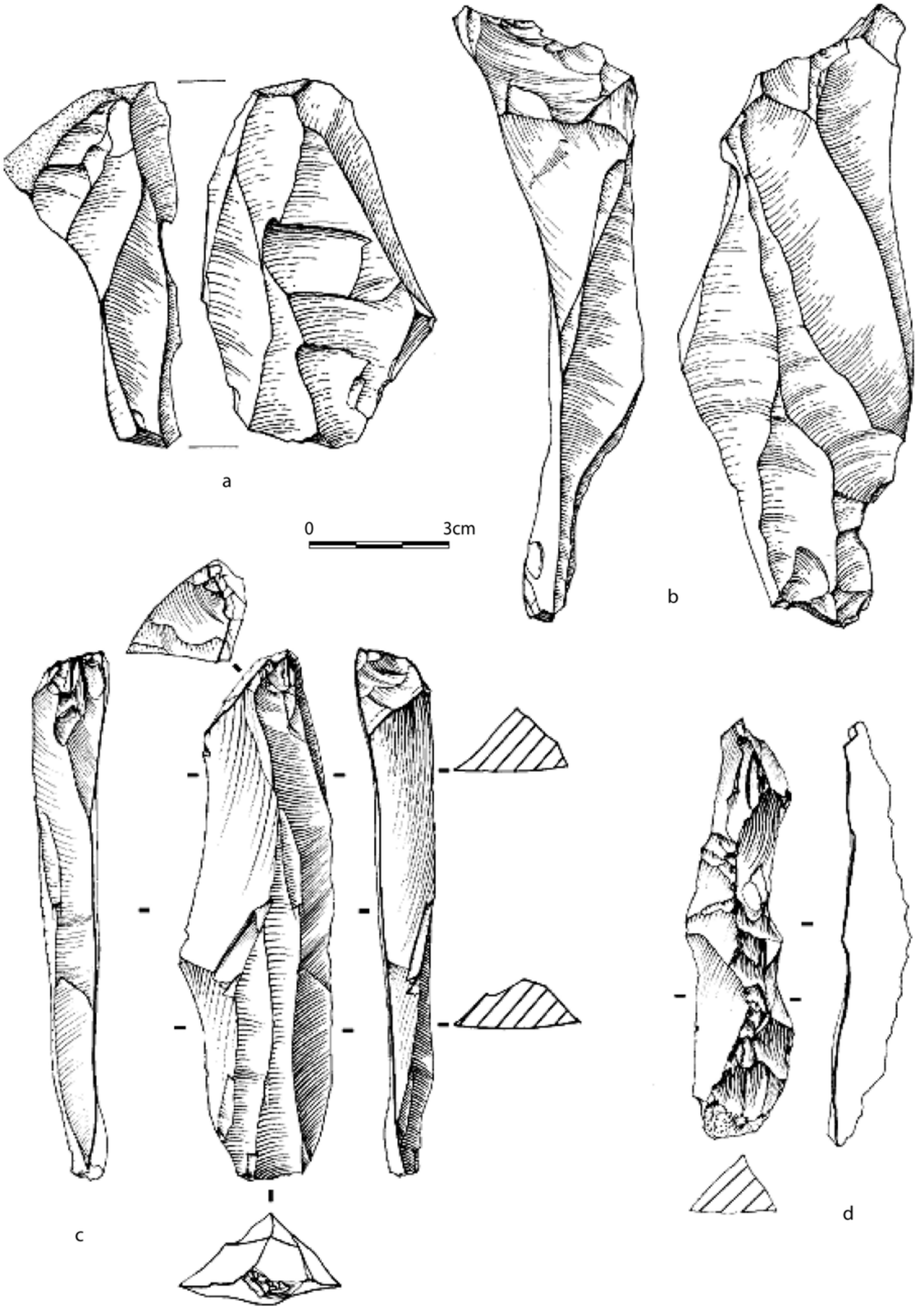

Figure 3 - Hayonim Lower E and F overshot products. a: from unidirectional core; b, c: from bidirectional cores, opposed twisted striking platforms; d: crested blade.

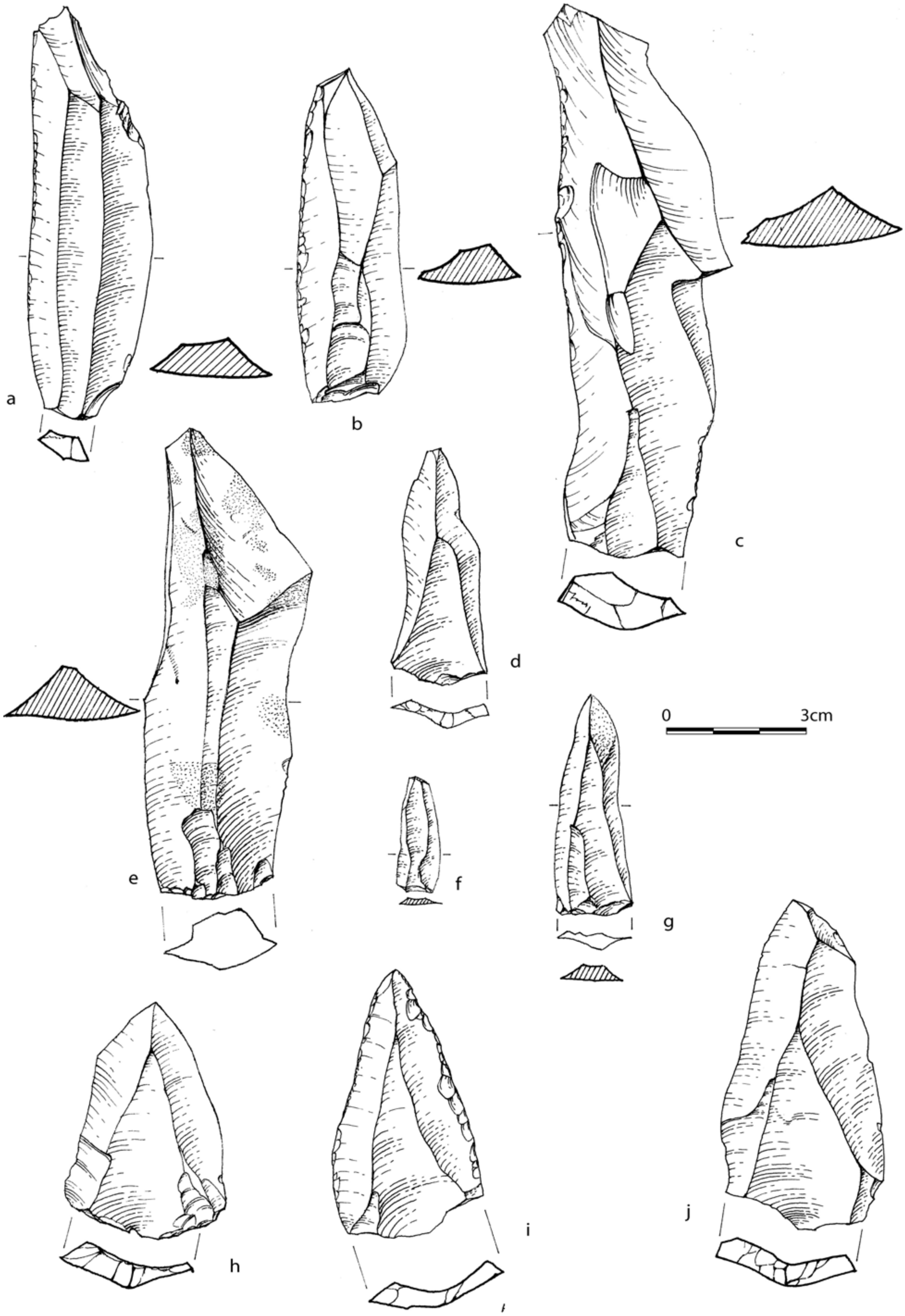

Figure 4 - Hayonim Lower E and F. a-c, e: narrow thick blades from the Laminar method; d, f, g: mall blades/"bladelets"; h-j: short triangular Levallois products.

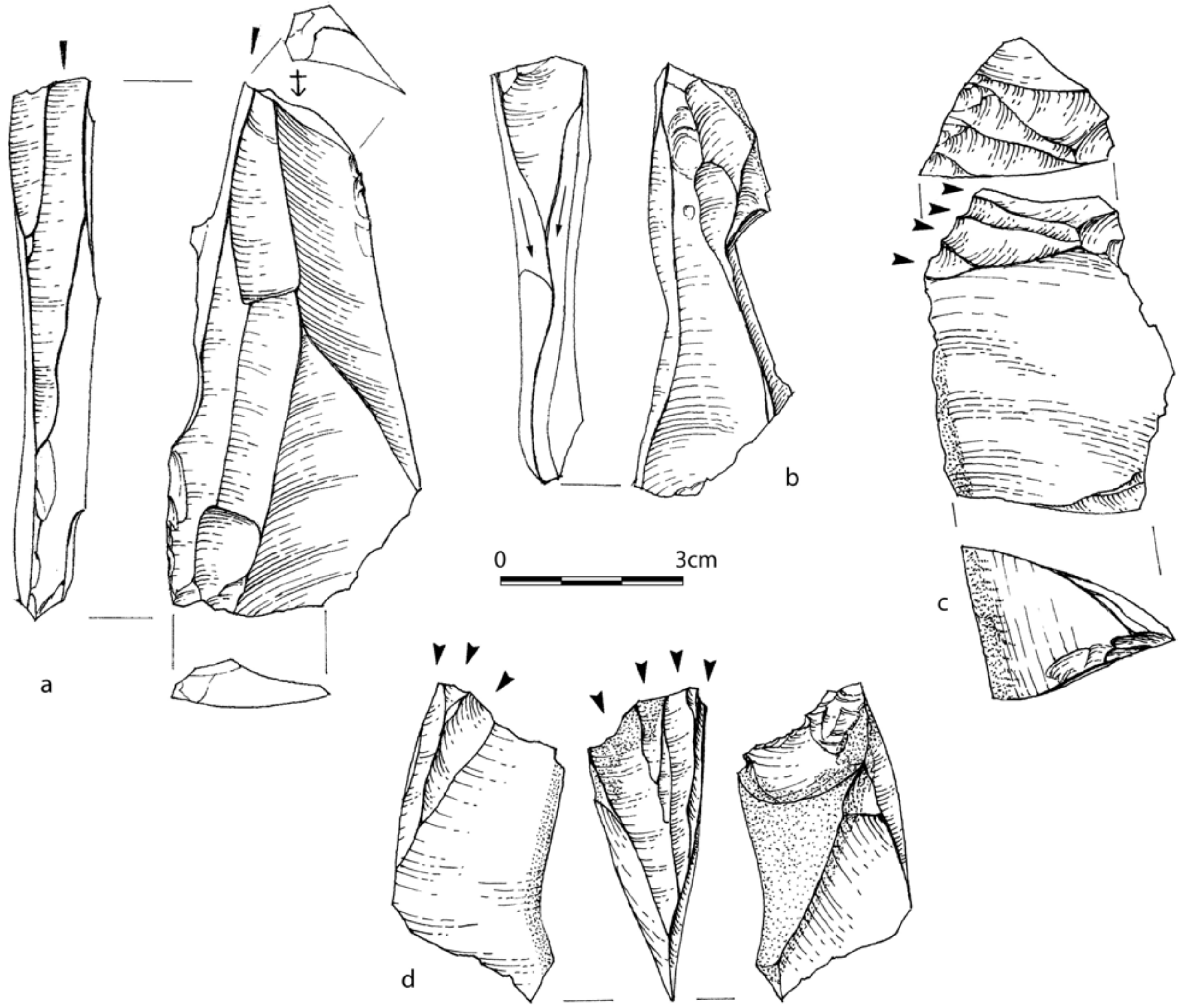

Figure 5 - Hayonim Lower E and F. Multiple burins and "nucleiform" burins.

sidered as the most recent entity, in fact predate (in Tabun unit IX: 270 000 y, Mercier & Valladas 2003) or are roughly contemporaneous (in Rosh Ein Mor : 200 000 y, Rink *et al.* 2003) with Laminar assemblages rich in elongated retouched points, such as those from Hayonim lower E and F (160 000–230 000 y, Mercier *et al.* 2007) and Hummal (± 200 000 y, Richter 2011).

Conclusions

In a first step, in the early 1990s, a few technological studies of the so-called "Early Levantine Mousterian" showed that distinct core-reduction strategies have been used in order to obtain the elongated blanks observed in this entity (Boëda 1995; Marks & Monigal 1995; Meignen 1998, 2000). More recently, still ongoing research programmes based on wider technological and chronological studies have drawn a new picture of this period.

As was described in Hayonim and other assemblages, two distinct reduction strategies involving both Levallois and non-Levallois (Laminar) concepts occured simultaneously in order to obtain the same "tool", at least from a typological point of view ("elongated point", "blade"). We thus can ask ourselves why two different core reduction strategies were used to produce the same tool? As was previously mentioned, the morpho-functional attributes of the end-products (blades and elongated points), i.e. their fonction, varied according to the core reduction involved. In order to test such an assumption, use-wear analysis was undertaken by S. Beyries (CEPAM, France) on a series of elongated tools from Hayonim layer F. This preliminary work schematically demonstrates that thick, robust and elongated retouched tools from the Laminar method were mainly used in hide and bone processing activities, while wider, thinner blanks from the Levallois reduction strategy were more often involved in butchery activities. The former group comprises quite intensively retouched implements, not a surprising result as they are used in activities with intrinsically high edge-attrition rates (Meignen & Beyries, oral presentation 2008). These first results clearly suggest that the aim of the two *chaînes opératoires* was not the same in terms of potential use, even though scholars have a tendency to put them under the same label.

Contrary to the prevailing idea, this early Middle Palaeolithic complex which developed from around 270 000 to 160 000 years ago, comprises quite diversified industries in which the blady component appears as the main common distinctive end-product. The most recent results highlight a mosaic of as-

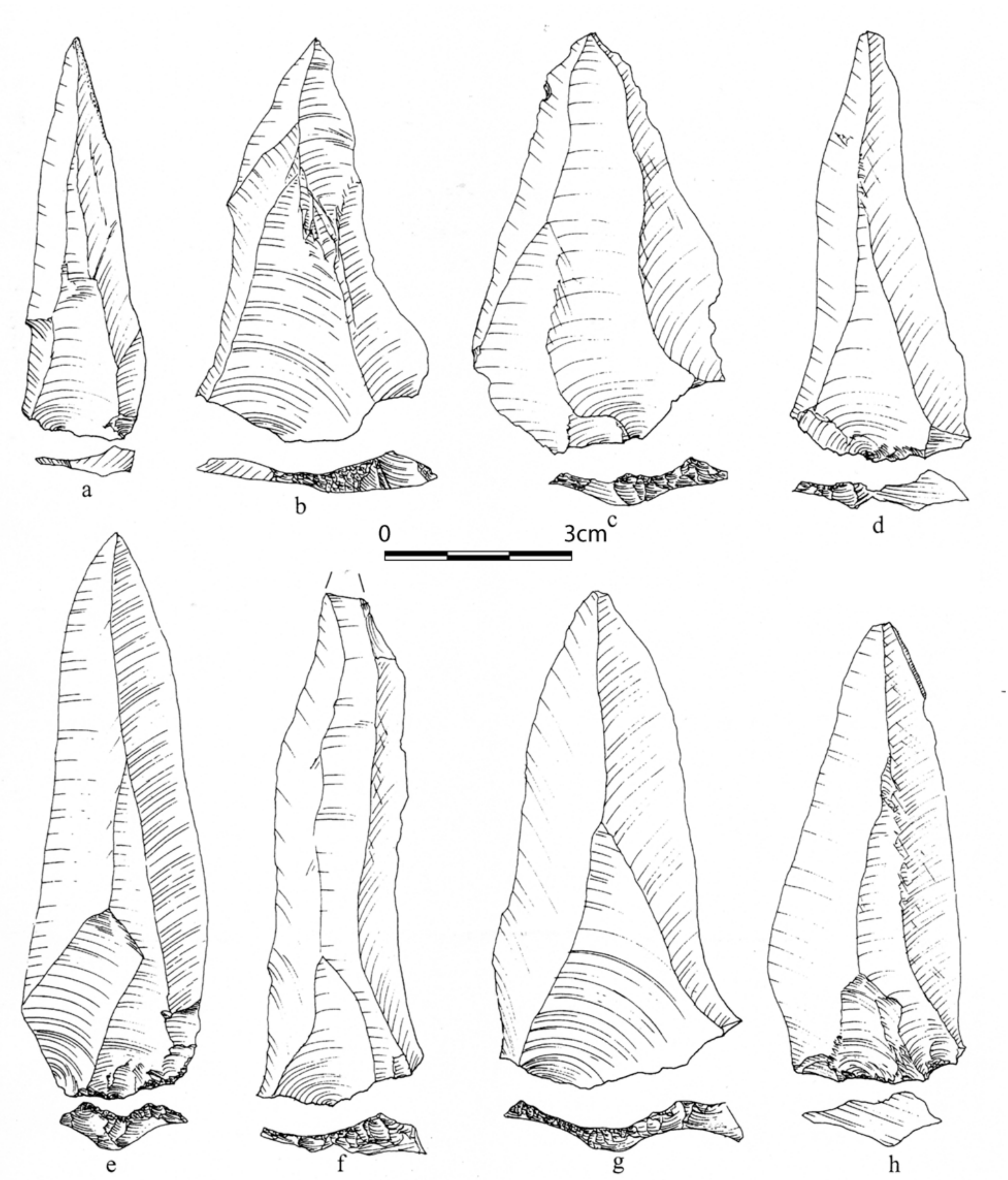

Figure 6 - Rosh Ein Mor, short and elongated triangular Levallois products (from Monigal 2002).

semblages combining both reduction strategies, Levallois and Laminar, in different proportions, each of them likely associated with special tool-kits. Thus the picture we have now is not of a large homogeneous entity, as is often described using designations such as "Early Levantine Mousterian", "Tabun D type" or "Levalloiso-Mousterian phase 1", but rather the co-existence, on a broad time scale, of human groups belonging to the same large "technical sphere" (Leptolithic tradition) and differentiating themselves by specific combinations in terms of technical systems and tool-kits. Interestingly, the heterogeneity recognized here is reflected in the repeated difficulties experienced by scholars during the previous decades in identifying the Levallois or non-Levallois character of assemblages such as those from Abou Sif and Hummal that we exposed in our brief historical review (*cf supra*).

As a consequence of this heterogeneity, it is no longer possible to subsume within a single term, such as "Tabun D type" or "Abou Sifian" (these two terms represent only part of the identified variability) or "Early Levantine Mousterian" (with its

Figure 7 - Thick elongated retouched points. a, b: Abou Sif (from Neuville 1951); c-e: Hummal 1a (from Copeland 1985); f-g: Hayonim lower E and F.

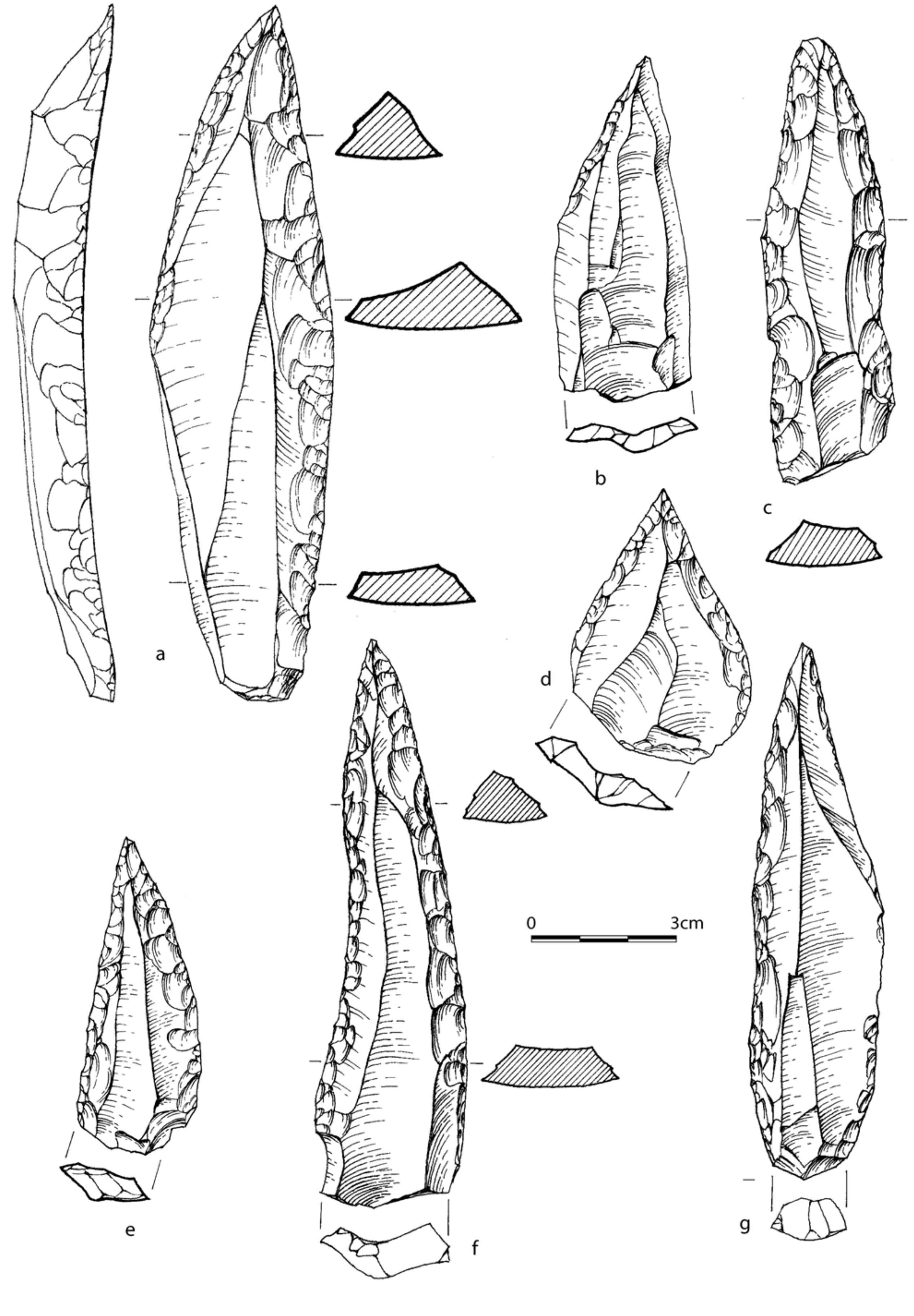

Figure 8 - Hayonim Lower E and F. a-c, e-g: elongated retouched points; d: short retouched point (Mousterian point).

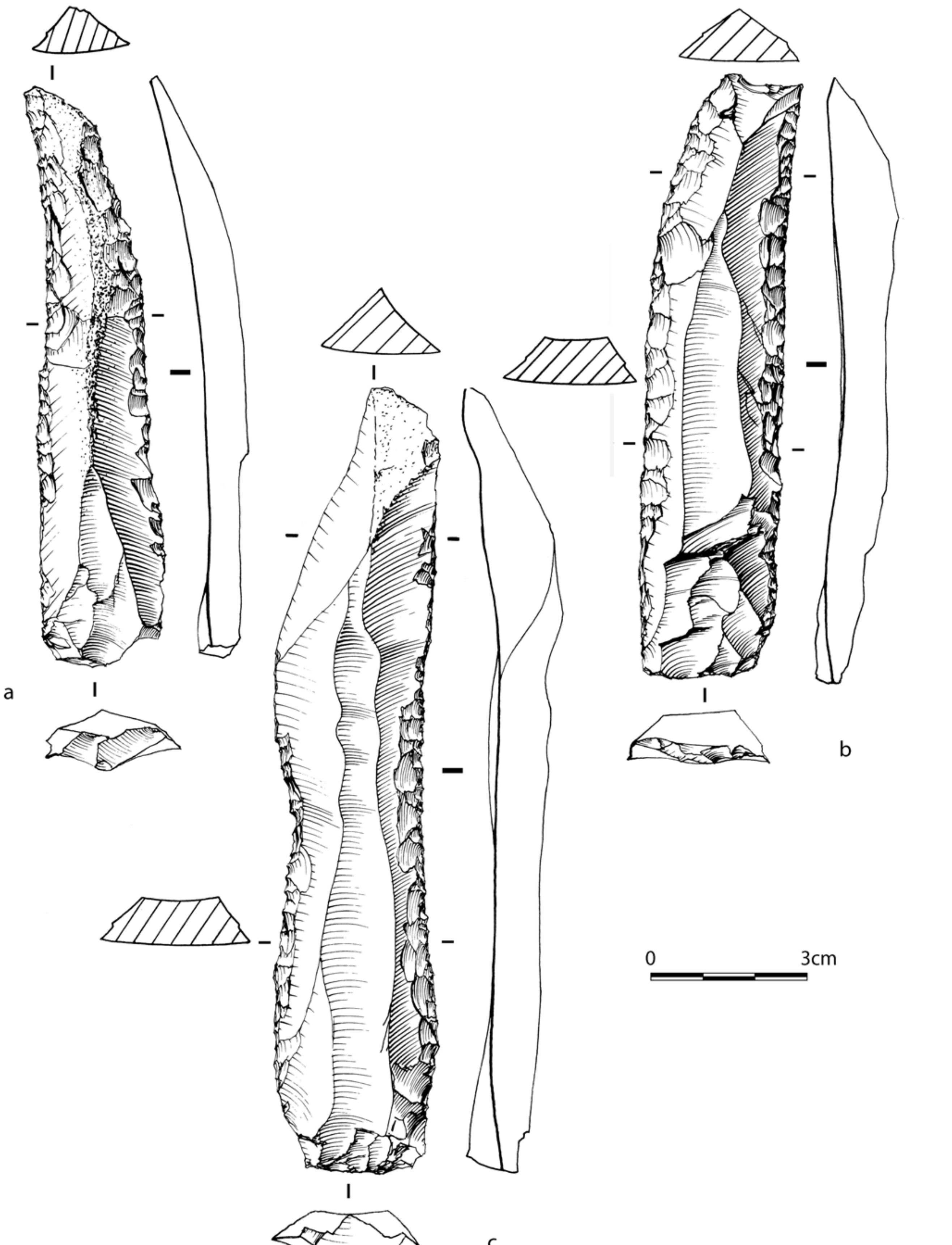

Figure 9 - Hayonim Lower E and F. a-c: retouched blades on narrow thick blanks.

chronological implications), all assemblages which only share the blady character but differ in terms of core reduction strategies, tool-kits and chronology.

In the present state of our knowledge, most of the systematic and intentional blade productions developed at an early date in the Middle Palaeolithic sequence. However, a few blade-oriented assemblages – such as Ain Difla and Nahal Aqev, which are technologically similar to "Early Levantine Mousterian" and thus are labelled as such – appear to be more recent (contemporary with Late Middle Palaeolithic) (Lindly & Clark 1987, Schwarcz *et al.* 1979), a statement that should be confirmed by more careful dating and stratigraphic control. Marks (1992) pointed out that the so-called "Early" Levantine Mousterian can be temporally late.

This suggests first that the presence of blade-geared assemblages should not be considered as a chronological criterion (as equal to Early Middle Palaeolithic), and also renders the current nomenclature inappropriate. In fact, we should avoid the term "Early Levantine Mousterian" for all these elongated assemblages and rather use a general term such as "Middle Palaeolithic blady assemblages", adding "early" or "late" when the chronostratigraphical position is known. We should be precise also about the main characteristic (predominance of elongated points and blades, frequent occurrence of UP tools). Then it will be easier to discuss the meaning of these differences, whether they are related to the techno-economical situation or are really significant in terms of technical traditions.

Finally it should be stressed that while the elongated products (retouched or not) obtained from diverse production systems are probably the most distinctive trait of these early Middle Palaeolithic assemblages, most of them also display a component of short blanks, struck from a separate core reduction, often using the Levallois method. This means that technical needs at that time were fulfilled by different *chaînes opératoires*. This indicates a complexity never reported for the following Middle Palaeolithic, during which the technical repertoire was finally focused on the Levallois method with all its internal variability in terms of modalities and end-products.

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CAPTURING A MOMENT: IDENTIFYING SHORT-LIVED ACTIVITY LOCATIONS IN AMUD CAVE, ISRAEL

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Introduction

Some fundamental principles of spatial organization are shared by extant humans regardless of ecological and cultural settings (David & Kramer 2001). Segregation of activities in space occurs in the context of mundane subsistence and maintenance activities and as a means of demarcating cultural and social relations within groups, e.g., by gender, age, familial relationships and social status (Binford 1978, 1982, 1998, 2001; Gargett & Hayden 1991; Hitchcock 1987; Kent 1990; O'Connell 1987; O'Connell *et al.* 1992; Yellen 1977). Evidence accumulated over the last two decades suggests that spatially-organized behavior within dwelling localities is not exclusive to recent modern humans, and that it possibly dates back to the early Middle Pleistocene (e.g., Alperson-Afil 2009; see also Pope & Roberts 2005).

Lithic and faunal concentrations in Middle Paleolithic (MP) occupation localities are seemingly structure-less, and were alleged to reflect the activities of small groups without clear social structure or definition of economic roles (Mellars 1989:358; see Mithen 1996:134-135; Stringer & Gamble 1993:152) or practicing higher levels of mobility (Hayden 1993). Yet a rapidly-growing body of evidence now indicates that by MP times, Eurasian hominins practiced differential intra-site spatial organization (for example, Adler *et al.* 2003; Alperson-Afil & Hovers 2005; Bonjean & Otte 2004; Hietala 2003; Speth 2006; Vaquero *et al.* 2001; Vaquero & Pasto 2001), argued in some cases to reflect modern spatial behavior (Balter 2009; Henry 2003; Henry *et al.* 2004). Such spatial patterning is most readily observed in 'high resolution' contexts, namely short-lived archaeological occurrences in which thin stratigraphic horizons remain well-defined and the anthropogenic signatures are nearly undisturbed (see Bailey 2007; Bailey & Galanidou 2009; Malinsky-Buller *et al.*, in press, for extensive literature on this issue). However, the majority of MP occupation sites present researchers with analytical challenges with regard to identifying spatial patterning and inferring its behavioral significance. Typically, the archaeological record in these sites constitutes a series of conflated remains from many episodes of occupation. This is especially true for the later Levantine MP in the region, when territorial constraints combined with ecological demands for specific forms of group mobility led to a settlement pattern of frequent repeated visits to locales within groups' territorial ranges (Hovers 2001). Even when discrete and obvious spatial features are apparent, they are still palimpsests representing several recurrent occupations (e.g., Kebara Cave; Hovers 2001; Meignen *et al.* 2006). In most late Levantine MP cave sites, spatial patterning is a latent feature of the archaeological record (Farizy 1994; Meignen 1994), calling for methods that "make apparent a structure that is otherwise not easily observed" (Read & Russell 1996:2). Such features may be discernible through detailed analyses of the distributions and spatial relationship between attributes of the various find classes averaging episodes of similar ways of using the site's space. Additionally, syn- and post-depositional site formation processes serve to blur the original distribution of physical remains of occupations that originally occurred over short and discrete spatio-temporal dimensions. Typically, a productive research strategy of inter- and intra- site settlement patterns in Levantine MP caves focused on long-term trends of variation and their causes rather than on attempts to identify and explain specific behaviors in space and time (Hovers 2001). Recent work on the lithic assemblages of Amud Cave provided an opportunity to address such issues from a different perspective.

The site

Amud Cave is situated on the margins of the Dead Sea Rift, about 5 km northwest of the Sea of Galilee in an east-facing cliff within the Amud drainage, at an elevation of 110m below mean sea level and some 30-35m above the present channel bed (Hovers *et al.* 1991, 1995). The cave is a karstic feature that developed along a tectonically-induced crack in the Middle Eocene limestone of the Bar-Kokhba formation (Zaltsman 1964). At present the cave consists of a small chamber (some 7x5 m), a large open 'middle' step (25x12 m), and a lower step that is actually a steep slope towards the channel bed (figs. 1 and 2). The current physical configuration of the cave is relatively recent and dates to the late Upper Pleistocene. Excavations at the site in 1961 and 1964, and again between 1991 and 1994 have established the existence and nature of the Middle Paleolithic occupations (Hovers 2004; Hovers *et al.* 1991, 1995; Inbar & Hovers 1999; Suzuki & Takai 1970).

Figure 1 - General view of Amud Cave from the East.

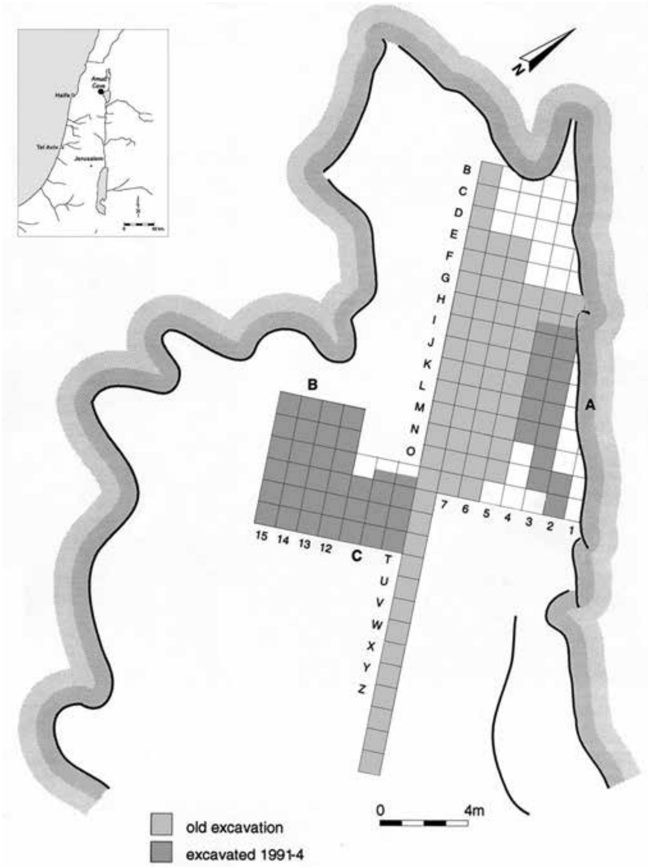

Figure 2 - Location map of Amud Cave and map of the excavated areas and of the excavation grid.

A cumulative 4.5 m thick column of sediments consists of Middle Paleolithic deposits (unit B), unconformably overlain by unit A, dated to the Holocene. Unit B was originally divided into four stratigraphic sub-units (B1–B4 top to bottom), with the lowest one deposited directly on bedrock (Chinzei 1970). This framework was confirmed in the course of the more recent excavations, with some further subdivisions of the stratigraphic sub-units into layers in the various excavation areas (Hovers 2004; Hovers *et al.* 1991). The Middle Paleolithic hominin remains were recovered from sub-units B1 and B2 in Area A (Hovers *et al.* 1995). Of these, two were identified as Neanderthals on the basis of their morphological characteristics (Hovers *et al.* 1995; Rak 1993; Rak *et al.* 1994).

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Sub-units B1, B2 and B4 are rich in stone artifacts (Hovers 2004) and faunal remains. Sediments of these layers are composed for the most part of ash derived from anthropogenic activity. In places, these sediments are reworked by geochemical and biological agents as well as human trampling, both on a stratigraphic macro-scale (Valladas *et al.* 1999) and a taphonomic, geochemical micro-scale (Hovers *et al.* 1991; Madella *et al.* 2002; Rabinovich & Hovers 2004; Shahack-Gross *et al.* 2008). Sub-unit B3, which consists of coarse-grained stony debris with little matrix, is archaeologically sterile and represents a hiatus in the human occupation of the cave, one that is clearly reflected in the radiometric age estimates. The occupations of subunits B1–B2 are estimated to have taken place within a relatively short time span ca. 55 Ka, whereas sub-unit B4 dates back to ca. 70 Ka (Rink *et al.* 2001; Valladas *et al.* 1999).

The cave's bedrock floor is rugged with an uneven topography. Along the M/N grid line a rock step runs northeast southwest and divided the cave's bedrock into two steps (i.e., the higher and middle steps; see above), separated by a steep slope ca. 1 m high. There are also rock ledges along the north and south walls. The boundaries of the northern ledge were completely exposed in the 1990s excavation. This ledge, 3-4 m wide and 1 m high above the cave's bedrock, terminates abruptly toward the south on a fault line (roughly the 4/5 grid line), and toward the east, roughly on the M/N grid line (figures 2 and 3). The whole central part of the cave is sunken relative to its elevated periphery.

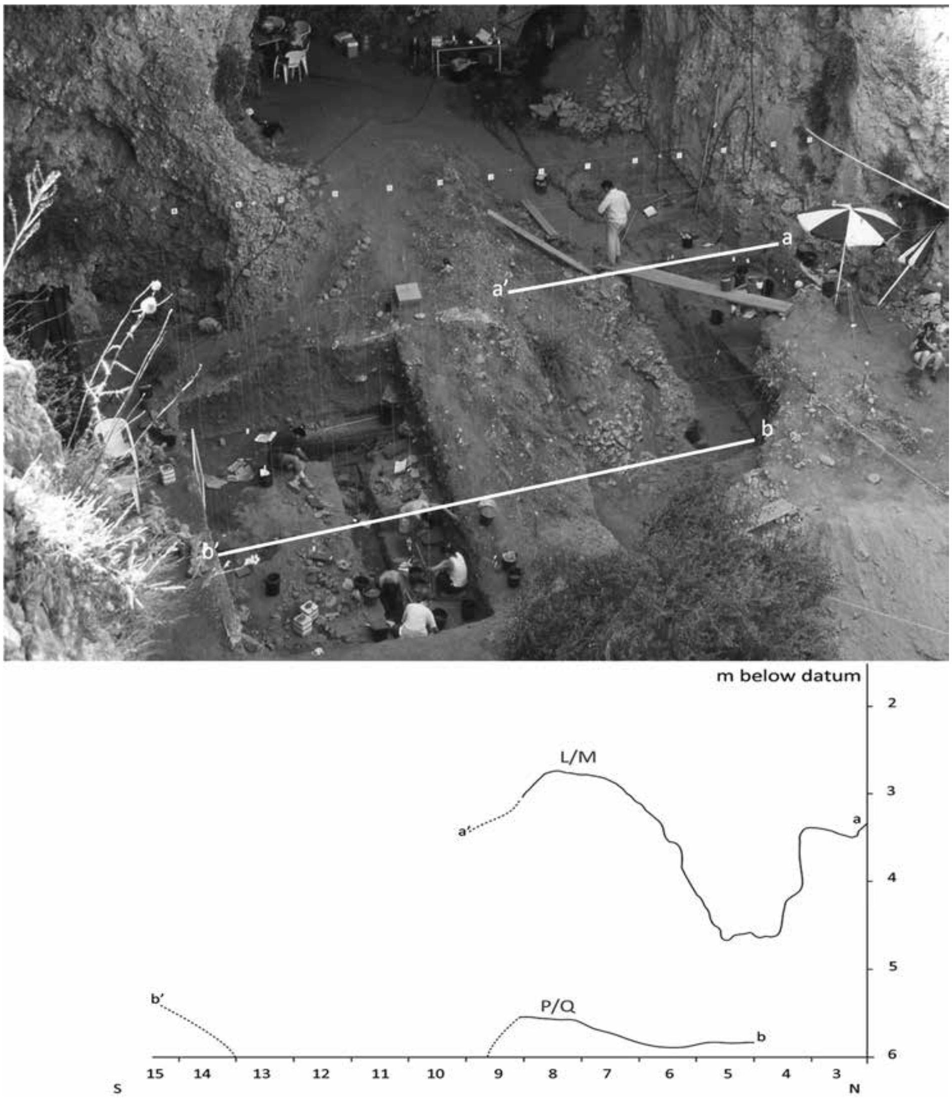

Figure 3 - (a) Areal view of the excavations in Amud Cave (1992), showing the areas of excavation and their physical configuration. The north face of the original excavation trench follows the steep face of the rock ledge along the north wall in Area A. (on the right). This photograph shows the cave prior to the removal of sediments in Area C and in the easternmost part of Area A. The location of bedrock profiles in figure 3b is shown. (b) Bedrock profiles along two grid lines, showing the configuration of the bedrock along a north south axis in two part of the cave. the horizontal axis shows grid squares, the vertical axis shows elevation below datum. Vertical and horizontal scale are not identical. (after Alperson-Afil & Hovers 2005).

This central part is further divided into two separate "basins" by a rocky projection that runs some 14 m on the upper step along the 8/9 grid line. It runs 5 m into the middle step, where it wedges out. Such a juxtaposition of bedrock features created natural divisions of the cave's space that was encountered by the site's first occupants. The shape and topography of the various areas changed as sediments and debris originating from human occupation and natural processes accumulated to form stratigraphic sub-units B4- B1.

Despite its complex depositional history, two aspects of the archaeological record of Amud Cave reveal spatial patterning which indicates that its Neandertal inhabitants assigned differential roles to these naturally-defined areas. First, all the hominin remains from this site, found in the two younger stratigraphic sub-units B1 and B2 (both dated ca. 55 Ka; Rink *et al.* 2001; Valladas *et al.* 1999), were retrieved from a topographically-elevated rock ledge running along the north-eastern wall of the cave. Hovers *et al.* (1995) considered and rejected the hypothesis that this distribution resulted from taphonomic and post-depositional causes and concluded that it was the outcome of intentional behavior on the part of the site's occupants. Second, Alperson-Afil & Hovers (2005) explored the presence of latent spatial features by examining the distribution of lithic technological attributes between the elevated rock ledge and the sunken central area of the cave during the time of accumulation of sub-unit B2. They have shown that the lithic assemblages from the two areas differed in their composition and in the states of breakage, burning and patination of various artifact categories. These authors suggested that the area along the wall was used for early stages of reduction and for discard of exhausted and broken artifacts, whereas in the central area lithic production focused on later stages of core reduction, core rejuvenation and (probably) the use of lithic artifacts in mundane extractive contexts. While these inferences are "coarse-grained", in the sense that they average an unknown number of events over space and stratigraphic time units, they demonstrate that spatial organization of lithic-aided activities was part of the behavioral repertoire at this site.

Alperson-Afil & Hovers (2005) have shown that micro-artifacts (<20 mm on the longest axis) served as meaningful markers of the organization of activities during the times of sub-unit B2. During a more recent analysis, we noticed that some particular technological classes of small-sized artifacts found in the periphery of the central area of the cave in the western part of Area B are spatially clustered within a specific stratigraphic horizon (sub-unit B4) and stand out against the general distribution of micro-artifacts in the cave. We present here a study of this spatial concentration, combined with a comparative analysis of its technological characteristics in relation to other typo-technological classes in the lithic assemblage. While analysis of the lithic assemblage of sub-unit B4 is still ongoing, data on the large debitage are sufficient for the purposes of this study. The lithic assemblage from sub-unit B1, the analysis of which has been complete, is used for comparative purposes (the frequencies of various artifacts classes reported in this article differ from those reported in Hovers [1998] because the samples have been expanded since the earlier publication).

Spatial distribution of micro-artifacts

Sorting of small artifacts from sub-units B1 and B4 is now complete, and the data presented pertain to the total sample of this type of artifacts. Some 95% of the small artifacts in B1 and 92% of those in B4 are micro-flakes (tab. 1), the others being unintentional thermal debris ("pot lids") and chunks. Only a tiny fraction of the hundreds of thousands of flakes bears distinctive technological characteristics. This study focuses on core management pieces (CMP; as defined in Hovers 1997, 2009), which are artifacts that attest to core re-organization and modification in the course of reduction, namely micro-CTE, small éclats débortants and ridge bladelets (fig. 4). As these items are associated with different core technologies (Levallois or Discoidal and blade production techniques, respectively) we also examined the presence and distributions of unretouched bladelets (defined according to the metric criteria used in Levantine Epi-Paleolithic research [L<50 mm, W<12 mm; see Bar-Yosef 1981]) and very small Levallois points. Other micro-artifacts that are clear indicators of technological practices are tiny Kombewa flakes, typically derived from the use of "Kombewa cores" (cores-on-flakes; Hovers 2007).

Table 2 shows the absolute numbers of these items in Areas B and A, out of the micro-artifact assemblages of sub-units B4 and B1 in these areas, respectively. (Note that sub-unit B4 was encountered also in Area C, but counts of technological micro-artifacts are low both absolutely and relative to excavation volume.) The frequencies of small CTE are extremely low within the micro-artifacts of Amud Cave. An examination of the distribution of these artifacts in Area B (fig. 5) further shows a clear spatial clus-

	B1		B4	
	N	%	N	%
Chunk (burned)	-	-	218	0.1
Chunk (not burned)	2,310	2.2	4,980	1.6
Pot lids	3,506	3.3	17,475	6
Complete micro-flakes (burned)	608	0.6	1,194	0.4
Complete micro-flakes (not burned)	8,254	7.8	12786	4.4
Broken micro-flakes (burned)	12,271	11.6	105,106	35.7
Broken micro-flakes (not burned)	79,137	74.6	151,864	51.7
TOTAL	**117,959**	**100**	**293,388**	**100**

Table 1 - Counts of micro-artifacts in sub-units B1 and B4.

	B1	B4
Burin spall	3	5
Unretouched bladelet	22	31
Core Trimming Element (CTE)	2	3
Éclat débortant	9	27
Ridge Bladelet	1	5
Point	1	2
Kombewa flake	8	4
Retouched	4	5
Cortical Back micro-flakes	-	1
TOTAL	**50**	**83**

Table 2 - Technologically diagnostic micro-artifacts in sub-units B1 (Area A) and B4 (only Area B). There are 5 additional *éclats débordants*, but no other types of core management pieces, in Area C. The analysis focuses only on the artifacts from Area B.

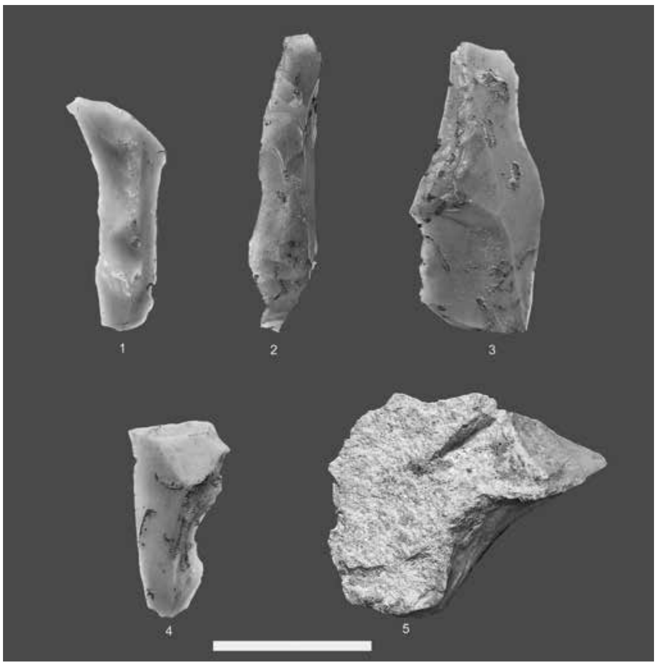

Figure 4 - Small core modification elements from sub-unit B4. 1-2: ridge bladelets; 3-4: *éclats débortants*; 5: Core Trimming Element. Scale bar is 1 cm. Compiled from photographs taken by Gabi Laron.

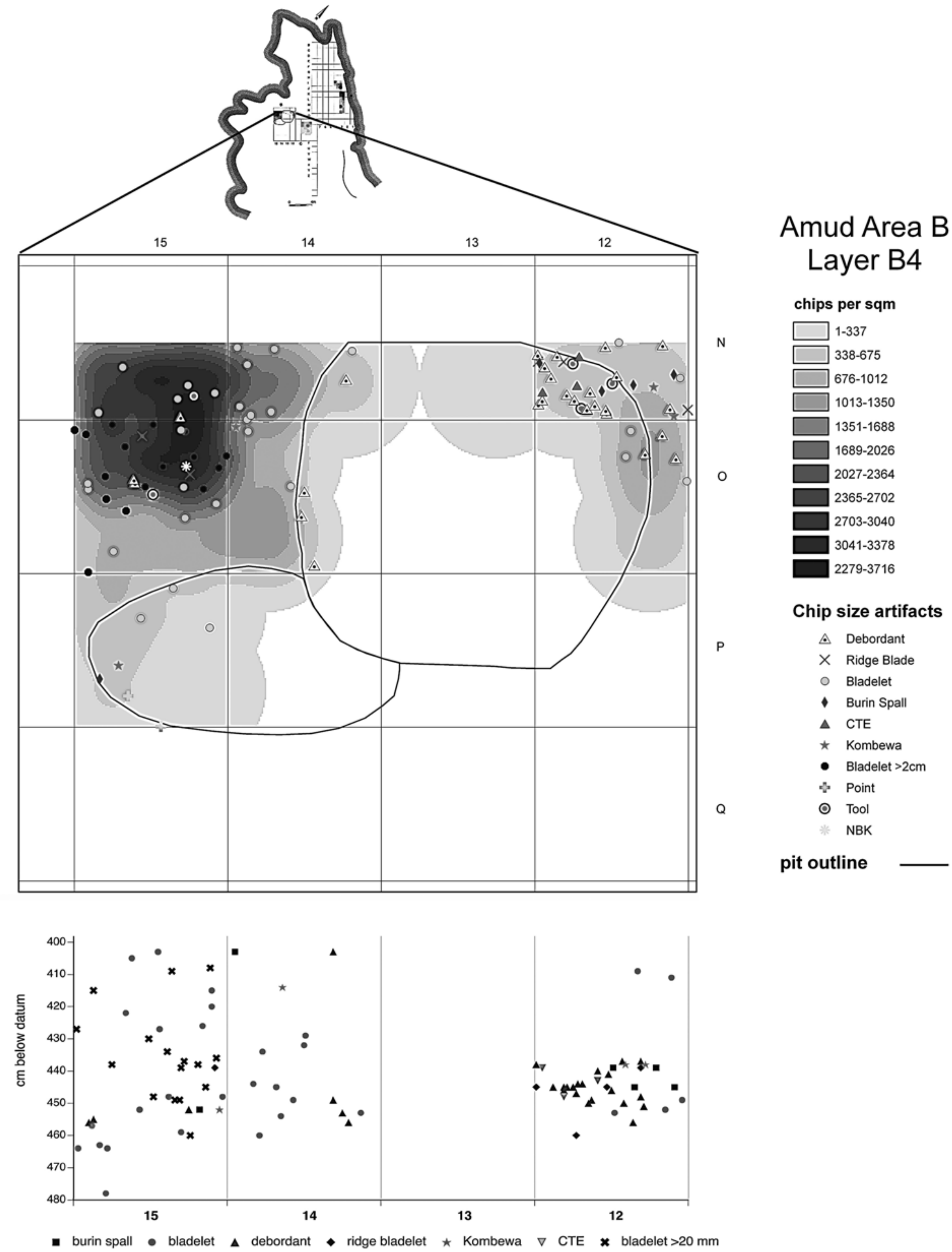

Figure 5 - The distribution of technological micro-artifacts in Area B. a: the lateral distribution of individual artifacts shown against a density map of all the micro-artifacts in sub-unit B4 in the area. The black lines show the contours of historical pits that cut through the Middle Paleolithic deposits. Finds of sub-unit B4 that are shown 'within' the pits are those that underlay them stratigraphically; b: vertical distribution of some categories of the individual artifacts shown in figure 5a. The distribution maps in this figure and in Figure 6 were created using ArcGIS Desktop 9.3.1. The density maps of micro-artifacts were created using GIS Kernel Density Tool in ArcGIS. Densities used in the maps are real densities as the number of micro-artifacts was calculated per excavated volume.

tering of certain types of the micro-artifacts. A clumped – both laterally and vertically – cluster is seen in square N12, where the majority of micro- éclats débordants and all of the very few CTE are concentrated within a vertical distance of ca. 10 cm. Note that the few éclats débordants in squares N-P15 occur within a very narrow vertical range. On the other hand, the majority of

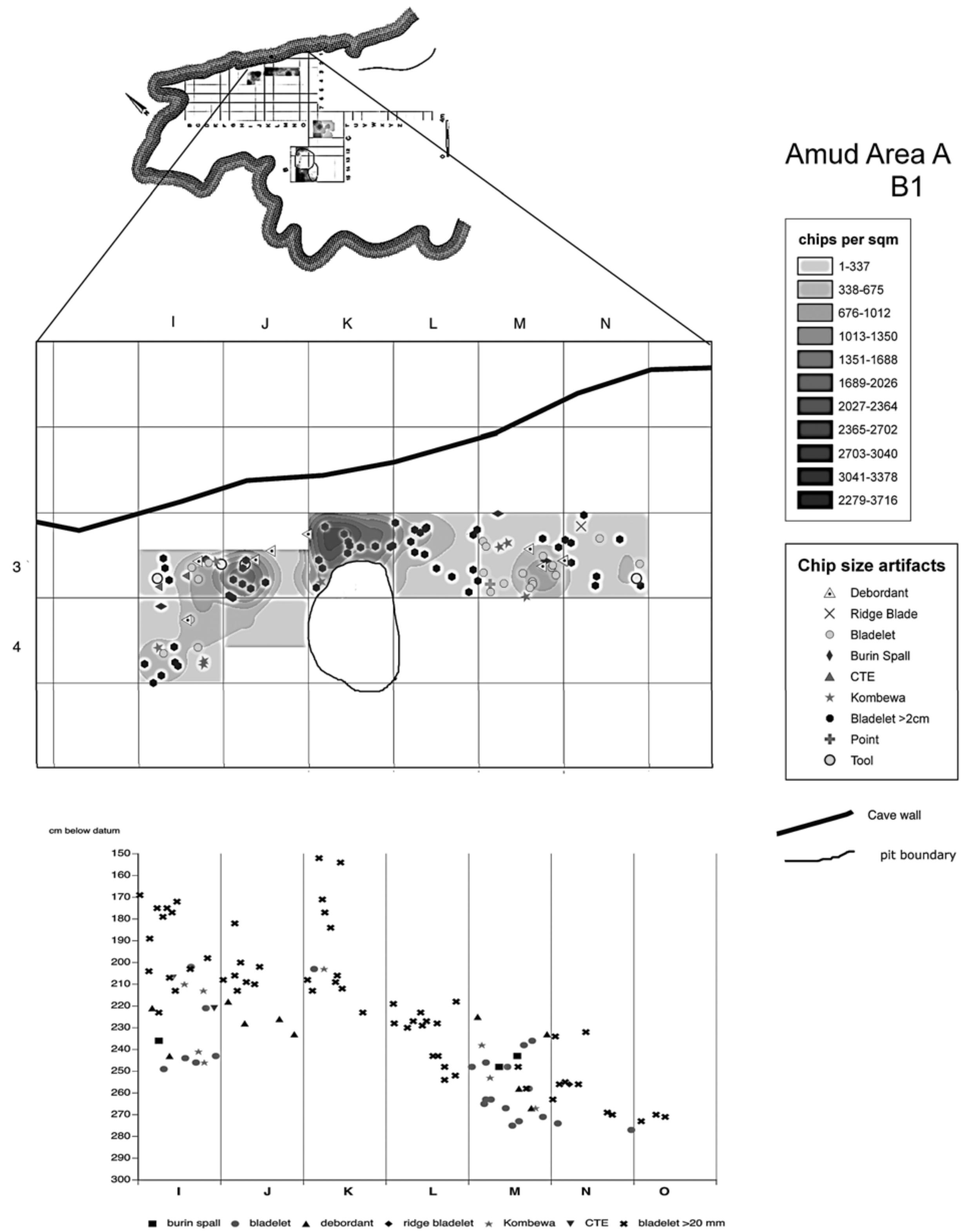

Figure 6 - The distribution of technological micro-artifacts in Area A. a: the lateral distribution of individual artifacts shown against a density map of all the micro-artifacts in sub-unit B1 in the area. Finds that are shown "within" the pits are those that underlay them stratigraphically; b: vertical distribution of some categories of the individual artifacts shown in figure 6. See caption of figure 5 for analytical procedures.

micro-bladelets and all of the larger bladelets are concentrated in squares N-P15, albeit over a larger vertical distance.

Given that background densities of micro-artifacts differ between the two clusters in Area B, the existence of clusters as such cannot be explained as a statistical artifact of numbers. (Statistical tests were rendered meaningless due to the small numbers of artifacts in the particular categories of micro-debitage). Moreover, one cannot explain the differential clustering of specific categories of micro-artifacts, as seen in figure 5, as

	Nodule cores+		Cores-on-flakes		Possible cores-on-flakes		All Cores	
	B1	B4	B1	B4	B1	B4	B1	B4
Frequency	33 (40.7)	8 (B)++ 31 (C)++ 39 (66.1)	33 (40.7)	5 (B)++ 10 (C)++ 15 (25.4)	15 (18.5)	1 (B)++ 4 (C)++ 5 (8.5)	N=81	N=59
Mean Length	43.2±11.4	43.9±10.1	49.5±12.9	48.8±12.4	49.4±11.4	34.7±8.0		
Meand Width	41.5±10.8	42.8±10.8	42.9±8.5	42.13±16.0	44.4±11.3	38.4±6.7		
Mean Thickness	19.5±6.7*	19.6±6.7**	15.7±4.2	13.6±5.0	17.7±4.5	13.1±3.1		
Length of last scar	24.9±10.9$^{\$}$	22.3±11.9$^{\wedge}$	22.2±10.8	22.3±10.3$^{\wedge\wedge}$	25.6±10.2$^{\$\$}$	16.7±3.1$^{\wedge\wedge\wedge}$		
Width of last scar	19.4±7.2$^{\$}$	23.3±8.8$^{\wedge}$	18.1±6.4	17.1±4.6	20.0±7.1$^{\$\$\$}$	19.7±7.2$^{\wedge\wedge\wedge}$		
Dominant last scar								
Mean Length							33.2±7.4	28.4±9.8
Min/Max values							23.3/58.8	12.0/44.8
Mean Width							23.0±7.7	24.6±7.3
Min/Max							16.6/50.5	12.2/39.9
Last Scar								
Mean Length							17.1±8.8	16.2±8.9
Min/Max							4.2/43.9	5.5/43.9
Mean Width							16.3±6.2	18.2±7.7
Min/Max							7.7/33.0	8.7/38.0

Table 3 - Characteristics of cores in the Amud Cave assemblages. + for this analysis, nodule cores are all Levallois and non-Levallois cores made on nodules and chunks. ++Area B and Area C, respectively; for this analysis, * n=32; ** n=38; $ n=28; $$ n=12; $$$ n=13; ^ n=34; ^^n=14; ^^^n=3.

	B1 (Area A)		B4 (Area B)		B4 (Area C)	
	Large	Micro-artifacts 1)	Large	Micro-artifacts 1)	Large	Micro-artifacts 1)
Éclats débordants	148 (51.4)	9 75.0)	114 (65.5)	27 (77.1)	114 (60.3)	5 (100.0)
Éclats outrespassés	18 (6.0)		4 (2.3)		20 (10.6)	
Combination 2)	4 (1.3)		1 (0.6)		1 (0.5)	
Ridge blades	2 (0.7)	1 (8.33)	5 (2.9)	5 (14.3)	8 (4.2)	
Other CTE	116 (38.9)	2 (16.66)	50 (28.7)	3 (8.6)	46 (24.3)	
Total CMP	**288** *(100.0)*	**12** *(100.0)*	**174** *(100.0)*	**35** *(100.0)*	*189 (100.0)*	**5** *(100.0)*
% CMP in assemblage	288/402 (7.2)	12/34 (35.3)	174/1886 (9.2)	35/55 (53.0)	189/2043 (9.3)	5/12 (41.7)
Micro-bladelet		22 (67.7)		31 (47.0)		7 (58.3)
Total micro-artifacts (in this analysis)		34 (100.0)		66 (100.0)		12 (100.0)
Bladelet 3)	60 (1.5)		16 (0.8)		4 (0.2)	
Unretouched blade 4)	594 (14.8)		134 (7.1)		187 (9.15)	

Table 4 - Frequencies of core management pieces by categories. Relative frequencies are shown in parentheses. 1: For data on micro-artifact frequencies see tables 1 and 2; 2: Combination of débordant and outrepassé on a single flake; 3: Items >20 mm, where L<50 and W<12 mm (percentage out of large debitage); 4: including Naturally Backed Knives of laminar proportions (percentage out of large debitage).

the result of natural processes that affected small-sized lithics selectively.

The situation differs in the deposits of sub-unit B1 in Area A (fig. 6). The linear outline of the excavated area probably distorts the geometry of spatial patterning and likely explains the linearity of the observed distribution of the larger bladelets; however it does not account for the two discontinuous clusters of micro-bladelets, for example. The vertical distribution of the selected micro-artifact classes, on the other hand, does not show clear clustering of the kind seen in Area B. The irregular "surface" of the distribution is due to the disturbed surface prior to excavation; the irregular lower outline is due to both biogenic and anthropogenic post-depositional disturbances and the uneven surface of the rocky ledge on which the sediments are deposited.

In this paper we do not attempt to explain the patterning in Area A, nor the differences between the areas. Rather, we use the comparison between the two areas and stratigraphic units to further explore the nature of the cluster in Area B. We hypothesize that the assemblages of Amud Cave do not incorporate large-scale, systematic production of micro-laminar or micro-Levallois elements resulting in micro-bladelets, micro-ridge blades or micro-Levallois points. If such were the case, we would expect higher frequencies of the micro-artifacts in the assemblages as well as evidence in the large-size component of the assemblage (e.g., cores for blade production and for the production of small items). This pertains also to the larger bladelets. If this hypothesis is not refuted by observations on the technological characteristics of the assemblages, the clusters in Area B should be addressed as unusual features within the cave's depositional sequence. We therefore examined characteristics of the lithic assemblage from sub-unit B1 and from the large samples of debitage and cores derived from sub-unit B4 in areas B and C. Our focus is on CMP and laminar/lamellar products, being the ones of interest in the current context, and on cores, from which such artifacts were presumably detached (tabl. 3 and 4).

The technological context of micro-artifacts in Amud Cave

In the absence of systemic refits, analysis of the Amud Cave assemblages relies on a detailed attributed analysis (e.g., Hovers 2009: appendices 2-3). The assemblages of Amud Cave are assigned to the Levantine Mousterian. The dominant formal flaking system is Levallois, with an emphasis on the production of flakes and triangular flakes (Hovers 1998, 2004; Ohnuma 1992). Elongated flakes and blades are relatively common in the upper stratigraphic sub-unit B1, but are never the dominant products (unretouched blades and blade-proportioned naturally backed knives are 14.8% of the total debitage).

As a rule, cores are under-represented in all the Amud assemblages. Amongst the cores, cores-on-flakes occur in relatively high frequencies in all the stratigraphic sub-units, particularly in sub-unit B1 (tab. 3; and see Hovers 2007). Regardless, part of the lithic reduction procedures took place on-site, as attested by the presence of CMP in all the assemblages (Alperson-Afil & Hovers 2005; Ekshtain 2001; Goder 1997; Hovers 1998). Nodule cores were typically modified using various Levallois flaking methods (63.6% of the nodule cores in B1; 60% in B4 (Area B), 90% in B4 (Area C). The use of preferential Levallois flake removals prior to core discard is more common in the B4 assemblage compared to B1 (fig. 7). Exploitation of cores-on-flakes in both assemblages was more commonly carried out by unipolar and convergent flaking, which may be related directly to the morphometric properties of the blanks.

By default, cores-on-flakes are thinner than nodule cores in each of the assemblages; however, they do not differ markedly

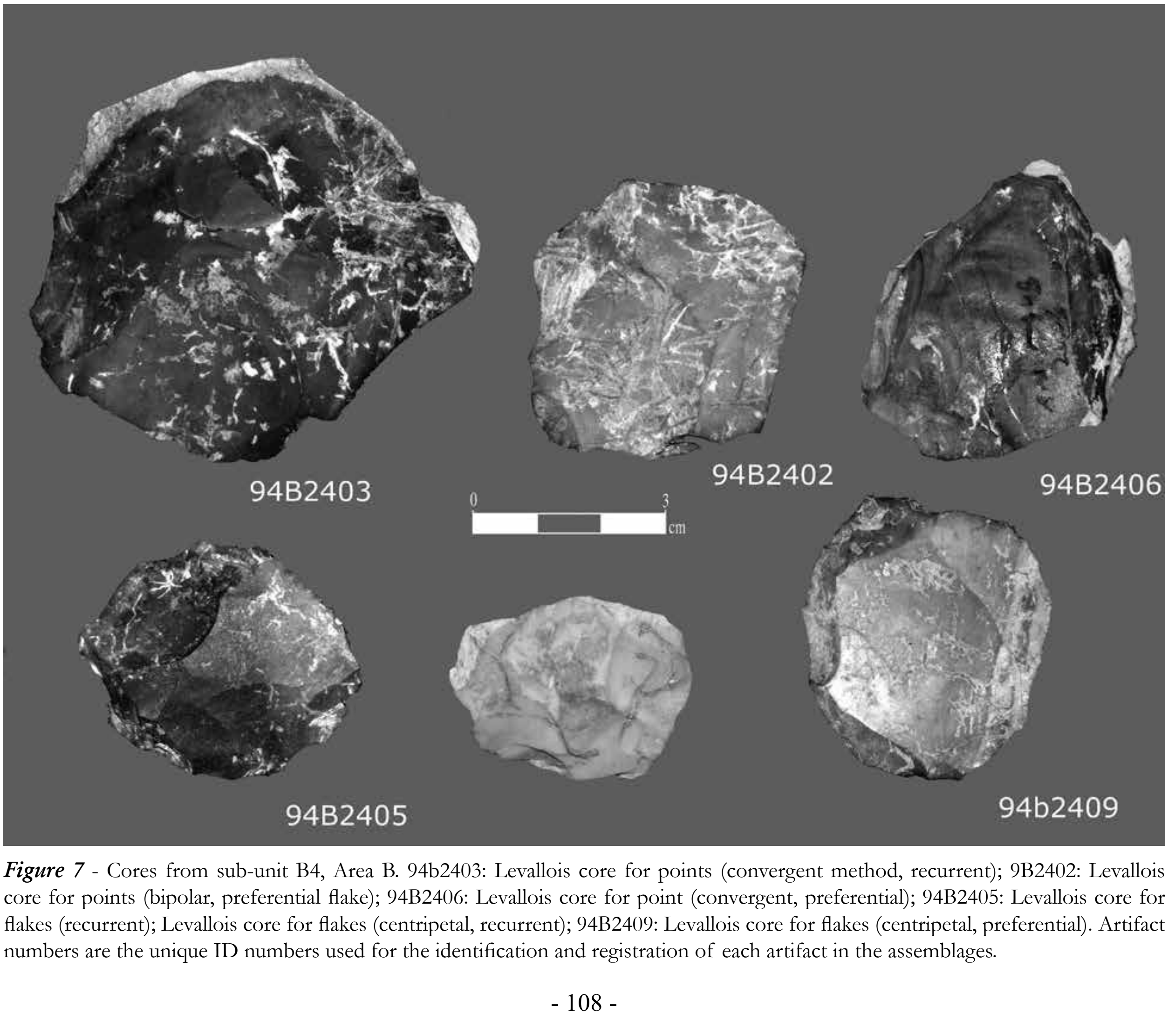

Figure 7 - Cores from sub-unit B4, Area B. 94b2403: Levallois core for points (convergent method, recurrent); 9B2402: Levallois core for points (bipolar, preferential flake); 94B2406: Levallois core for point (convergent, preferential); 94B2405: Levallois core for flakes (recurrent); Levallois core for flakes (centripetal, recurrent); 94B2409: Levallois core for flakes (centripetal, preferential). Artifact numbers are the unique ID numbers used for the identification and registration of each artifact in the assemblages.

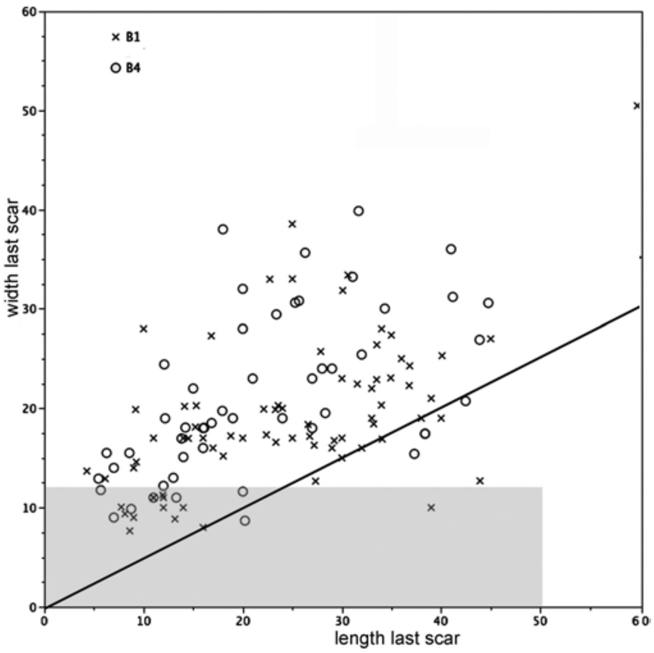

Figure 8 - Scatterplot of last removed negatives from cores in sub-units B1 and B4. The line shows the cutoff between blade- and flake-proportioned artifacts (below and above the line, respectively) for each length measurement. The gray rectangle marks the size range that define bladelets. Note the very few number of blade or bladelet negatives.

in their mean length and width (tab. 3). These data suggest that the exploitation of cores for Levallois flaking terminated when a certain size or proportion of the core was reached. Notably, when the largest Levallois ("dominant") flake was also the last one removed from the core, flakes from cores-on-flakes (as represented by the scar patterns on the core) were only marginally smaller than those removed from the nodule cores (the difference is not statistically significant). Cores-on-flakes very likely underwent much shorter reduction sequences than the nodule cores, yet their exploitation was terminated according to the same morphometric criteria that affected the use life of nodule cores (see Hovers 2007, 2009 on Amud and Qafzeh assemblages, respectively). Consistent with the paucity of non-Levallois blade cores, ridge blades are extremely rare in the large debitage, although some of the blades in this assemblage were produced through the use of laminar technologies (Ashkenazi 2005) similar to those identified in some early Levantine Mousterian assemblages (Meignen 2000). The majority of blades are morphological rather than technological blades, derived from Levallois flaking.

On both nodule and on-flake cores, reduction sometimes continued after the removal of the last "formal" flake, and small flakes were detached, a phenomenon known in other Levantine Mousterian assemblages (e.g., Goren-Inbar 1990; Hovers 2009). Many of these flakes fall within the size range of micro-artifacts (tab. 3, fig. 8) In the last stages of core reduction, as documented through the morphometrics of flake negatives on the cores, very few blade- or bladelet- proportioned artifacts were removed (fig. 8). Given the paucity of cores in the Amud assemblages on the one hand and the large number of micro-artifacts in the assemblages on the other (tab. 1), it is likely that the majority of micro-artifacts in these assemblages did not derive solely from the last stage of core reduction documented by flake negatives.

Bladelets appear in extremely low percentages among the micro-artifacts in both the B1 and B4 assemblages, and formal bladelet cores are completely missing. Only two cores with bladelet scars, one in each Area A (B1) and B (B4), were documented. The same holds for single platform, semi-rotated non-Levallois blade cores (e.g. fig. 9), which might have been also sources of bladelets.

In general, the relative frequencies of various CMP categories of micro-artifacts (tab. 4) mimic those seen in the large debitage. Within the large-size component of each stratigraphic sub-unit, éclats débordants are the major single type of CMP, followed by non-descript core trimming elements. However, while the large éclats débordants mostly derive from Levallois flaking (65.3%

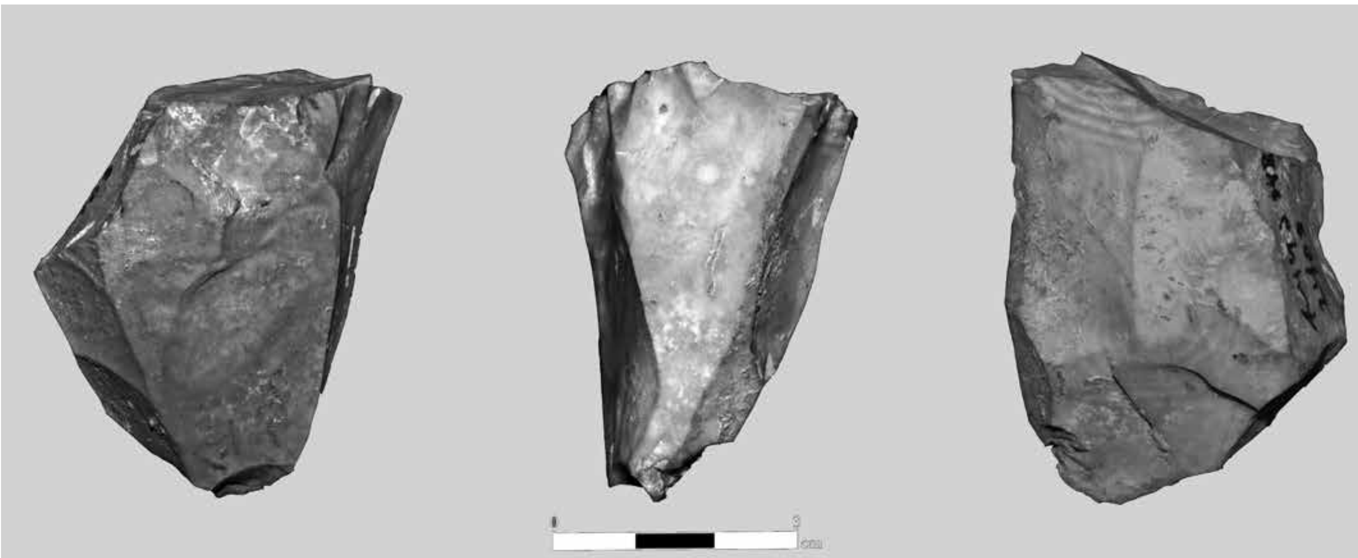

Figure 9 - Three views of a semi-rotated blade/let core (94b2408) from sub-unit B4, Area B.

in sub-unit B1 and 59.3% in sub-unit B4, Area B), the majority of micro-débordant flakes in Area B are non-Levallois. This difference is not an outcome of the size of the artifacts, since Levallois characteristics could be identified on other micro-artifacts in Amud Cave.

Discussion

Micro-artifacts in the Amud Cave assemblages seem to be part of the technological system practiced at the site, with Levallois being the dominant flaking system. The paucity of blade cores, ridge (crested) blades and the association of blades with a predominantly flake assemblage suggest that non-Levallois formal blade production was not a major goal of lithic reduction procedures in any of the Amud assemblages. Bladelet production appears to be a negligible, unsystematic procedure both quantitatively and technologically. This is a common feature of many Eurasian and African sites (e.g., Villa *et al.* 2005). In this respect Amud Cave differs from some Eurasian Middle Paleolithic assemblages where particular chaînes opératoires for small debitage, including bladelet production, were identified (e.g., Dibble & McPherron 2006; Slimak 1999, 2008). The situation in Amud also differs from that described, for example, in Sibudu Cave, South Africa, where bladelet production is regarded as a deliberate component of the technological system despite their small numbers in the assemblage (Villa *et al.* 2005). In the case of Amud Cave the hypothesis of incidental bladelet/micro-bladelet production as by-products of the main lithic production system(s) cannot be rejected and remains the most parsimonious explanation of the occurrence of these artifacts in the Amud assemblages.

Against this technological background, the concentration of bladelets and especially of micro-bladelets in the southern part of Area B stands out, despite their vertical dispersion. Similarly, the micro-éclats débordants in the tight cluster found in B4, Area B, stand out spatially as well as technologically when compared to their large-size counterparts in the same assemblage.

This combination of spatial and technological data leads to the suggestion that the latent spatial patterning revealed in our analysis is valid and related to behavior rather than taphonomic processes. Area B, on the periphery of the southern sunken "basin" in the cave, was used during B4 times for some specific activities. One such activity, constrained in space and time, related to the exploitation of small cores, or rejuvenation of exhausted cores that reached small dimensions. Another activity is linked to lithic production that led to an increased occurrence of bladelets; or a deliberate bladelet production in this part of the cave, contrary to other parts of the site. Either way, bladelet-related lithic activities are not as well constrained spatially as is the evidence for core modification, and probably do not represent a single event.

This interpretation of the data raises two issues on different levels of interpretation. First, there is the question of identifying the behavior(s) that led to the observed spatial patterning at the site. The second point touches upon the broader question of the relevance of localized, high resolution spatial patterns to the understanding of the broader behavioral processes that shaped the archaeological record.

The patterning of many of the technological characteristics identified in the spatial concentration of micro-CMP are consistent with models of childrens' lithic-related activities. A growing body of literature has recently focused on theoretical aspects of childhood as a social and cultural construct and reflected on the changing perceptions of this construct in paleoanthropological research (e.g., Baxter 2005, 2008; Brookshaw,2009; Högberg 2008; Kamp 2001; and references therein). Based on sociological, pedagogical, psychological and ethnographic studies, it has been argued that children were active members in prehistoric societies and were likely to have left their unique marks, creating a record that (theoretically at least) can be distinguished from that of adults. Learning of any technological activity occurs through observation, imitation of experienced producers and users of artifacts, and play. Hence production of material culture by novices and learners relies on social transmission of knowledge in a social context (Brookshaw 2009; Högberg 2008; She, 2006; Stout & Semaw 2006). Either explicitly or implicitly, children are presumed in most of these studies to have been novice stone knappers. Pigeot (1990) identified in the Upper Paleolithic site of Etiolles master stone knappers, occasional knappers, and novices, and suggested that one dwelling area in the site represented a context of educational stone knapping (for another example, see Roux *et al.* 1995).

These studies form the basis for expectations about stone tools made by children. Stone tools made or used by children are relatively small so as to fit the hands of their makers or users, but it should be shown that the 'microlithization' is not related to raw material scarcity, increased mobility or other factors that may adaptively select for small artifacts. Raw material will tend to be low-quality because inexperienced knappers are more prone to unintentional breakage and children as users tend more than adults to misplace or damage the artifacts they use or play with. This raises the possibility of equifinality between children's knapping and expedient lithic technology (Shea 2006). Högberg (2008) pointed out that children mimic the procedures they see when adults knap, so their products are likely to fall within the range of adult-made artifacts, but the technical skills will be notably different. Spatially, novice lithic production may take place in peripheral locations in relationship to more experienced or master knappers, as shown by Pigeot (1990) and Grimm (2000). On the other hand, the lithic-related activities of children in a habitation locality are also a form of site formation processes. When children pick raw material or artifacts for their lithic experiments, they may disrupt earlier deposits and mask the original spatio-technological patterning (e.g., Hammond & Hammond 1981).

The spatial cluster in Area B of Amud Cave meets many of these expectations when its location in the cave's space is considered and when it is evaluated against the technological make-up of the large-sized lithic assemblages. This is especially true of the tight cluster of micro-CMP, which show affinities with the overall technological concept of the assemblages in the cave, yet their production required a less formalized technological knowledge (i.e., non-Levallois flaking). As the dexterity necessary to grip and control small objects only develops (among modern humans) in ages 9-11, this may suggest that a novice(s) responsible for core modification by micro-éclats débordants was not a toddler. Recently, Ekshtain (2006) compared the frequencies of flaking accidents and the technological processes leading to them in Amud B1 and Qafzeh XIX, which are not situated near raw material sources, and in the site of Berigoule in France, located at the raw material source. Based on this analysis, she suggested that the relative paucity of flaking accidents in the Amud B1 assemblage compared to Berigoule may be ascribed to social restrictions on the access of inexperienced knappers to raw material. Such measures might have been necessary for the Amud Cave inhabitants due to the cave's location away from raw material sources and to the difficult access to the cave, which made unconstrained apprenticeship economically prohibitive.

A diametrically-opposed interpretation of the same phenomenon may be that production of these small artifacts, too, was the work of a more skilled knapper, given the motor skills that may have been necessary for its execution.

The technologically-distinct cluster of bladelets in Area B (fig. 5) suggests that bladelets production was deliberate to some degree, unlike the overall aspect of the B1 and B4 lithic assemblages. The occurrence of well-shaped tiny crested blades (fig. 4) and a relatively well-shaped blade/let core (fig. 9) would support such a scenario If that was the case, the cluster may show the presence of more experienced knapper(s) in this part of the cave. Given the vertical dispersion of the bladelets, it is difficult to tell whether this is a single flaking episode that had been subjected to taphonomic processes, or a number of repetitive flaking episodes that took place in the same area. While temporal resolution in this case is less satisfactory than for the cluster of tiny débortants flakes, these data do underline the specificity of this area in the cave in the context of a particular technological activity.

The suggestions that the cluster in Area B was produced by either skilled knappers or by novices are, of course, two polarized views of the specific activity that took place in this part of Amud Cave over a 'real time' span during the deposition of sub-unit B4. The nature of the archeological record is such that tests of expectations about children's activities are hardly ever conclusive (Shea 2006). Until such time when we can test each of these ideas, reconstructing the nature of these activities has to remain speculative at best. However, in the framework of this paper, the specific interpretation of the activity is secondary to the affirmation that a single activity area associated with particular technological practices is in fact recognizable within the dynamic depositional context of a site such as Amud Cave. Based on the extreme rarity of similar technological artifacts, we suggest that this might have been an episode of unique activity.

These results do not preclude the possibility that other activities took place in constrained areas of the cave during the time of any of the stratigraphic sub-units. Post-depositional processes may have homogenized many of these features into the coarser-grained record that is visible at Amud Cave. The cluster that we identified in Area B is therefore exceptional in the preservation of the unique behavioral signature. However, it may not be the only one that survived in this cave. Ongoing similar analyses, applied to other unusual categories of artifacts, may reveal additional areas of highly specific technological activities. It is perhaps paradoxical that in a site that has been intensively inhabited for several thousands of years at least, the signatures that might be easiest to pick up are those of unusual activities or of culturally non-conformist individuals.

This brings us to the second, more general question raised by the spatio-technological pattern revealed in Area B. Although prehistoric archaeology builds on the actions of individuals, it averages them by default into long-term temporal trajectories, thus providing the discipline with the time depth that is its forte. Bailey (2007:209), among others, warns that attempts to obtain the highest possible resolution and to recognize temporally and spatially restricted activities, "… may end up with individual episodes too small or limited in number to sustain any generalization…" It is of course true that when detached from a more general context, high-resolution occurrences should be suspected as historical anecdotes rather than true representations of long-term evolutionary trajectories (e.g., Speth & Clark 2006). The highly specific nature of the behavioral episodes that we discuss in this paper cannot and should not be expected to tie in directly with large-scale evolutionary trends. Yet if, as we suspect, additional spatio-technological "anecdotes" will be identified in the record of Amud Cave, we stand to gain a better perspective on behavioral variation, particularly on unusual, "out of the box" technological practices. Such specific occurrences may provide us with an understanding of the place (physically as well as culturally) of unusual individuals in the social matrix of the MP hominins that inhabited Amud Cave. Moreover, it may shed light on the variation that constitutes the building blocks of long-term change and on the processes of innovation and cultural transmission among the site's Neandertal occupants.

Our aim in this paper was to explore the conceptual and analytical options that can be used to recruit a coarse-grained record to address questions of social and cultural behaviors in a Levantine MP site. As preliminary as the current work is, we hope that it shows that such an endeavor, while certainly a tall order, is not a futile effort.

Acknowledgements

The research of lithic technology and the spatial studies at Amud Cave was supported by The Israel Science Foundation (grants 514/04 and 63/08) and Irene Levi-Sala CARE foundation. We are grateful to Nira Alperson, Adi Ben-Nun, Michal Birkenfeld and Ruhama Piperno for their advice and assistance with GIS-related issues. We thank Nuha Aga-Said, Hila Ashkenazi, Rebecca Biton , Yaron Cohen, Masha Krakowski, Maya Oron, and Zohar Turgeman for their help in sorting and analysis of Amud's huge lithic assemblages.

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LATE LEVANTINE MOUSTERIAN SPATIAL PATTERNS AT LANDSCAPE AND INTRASITE SCALES IN SOUTHERN JORDAN

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Introduction

Despite recent advances in understanding the biological relationship of modern humans and Neanderthals, we have yet to establish with any certainty the degree to which the patterned behaviors of Neanderthals may have differed from those of quasi-contemporary and succeeding human groups. Paleogenetic (Green *et al.* 2010; Noonan *et al.* 2006) and human paleontologic (Hublin 2009) evidence indicate that Neanderthals diverged from modern human populations between 270,000 and 440,000 years ago. The Neanderthal genome, also points to a small amount of gene flow from Neanderthal to ancestral non-African groups prior to their expansion into Eurasia (Green *et al.* 2010). This is attributed to the mixing of Neanderthals with immigrant African groups in the Near East some 50,000 to 80,000 years ago (Green *et al.* 2010). Morphological features of early modern humans in Europe also point to modest levels of assimilation of Neanderthals into an expanding African population sometime before 33,000 years ago (Trinkaus 2007).

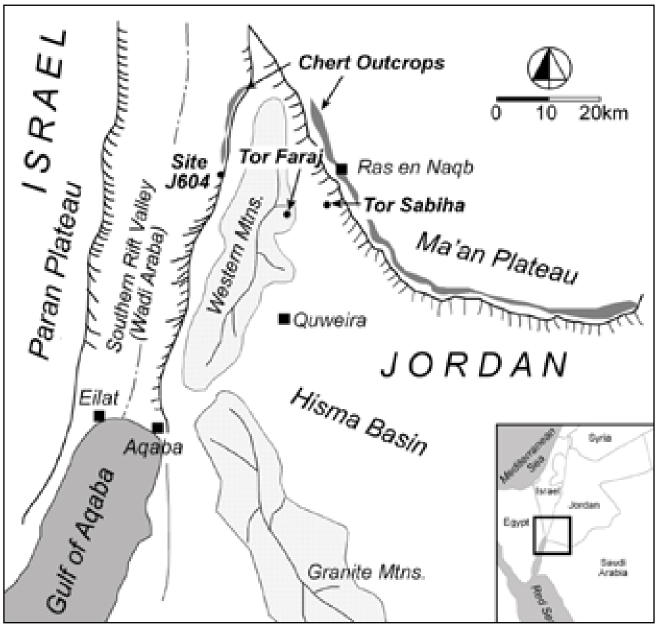

Figure 1 - Map of the study area showing site locations, landforms, and chert sources.

While we have a much more refined picture of the bioevolutionary aspects of Neanderthals than we did only a few decades ago, we still have little direct knowledge of such basic social dimensions as group size, composition, site structure and settlement-procurement patterns. What is so intriguing is to see how these behavioral features of Neanderthals compare to those of modern humans given the proposed biologic distance between these two hominin branches. In many ways this represents the ultimate level of the nature – nurture debate.

With these issues in mind, inter- and intra-site studies were undertaken at several Middle Paleolithic, Late Levantine Mousterian occupations situated along the edge of the Ma'an Plateau and Rift Valley in southern Jordan (Henry 1994; Henry 1995a; Henry *et al.* 2001; Henry 2003; Henry *et al.* 2004). The research centered on an integration of regional evidence of how groups exploited the Late Levantine Mousterian landscape coupled with site specific information on how the groups organized their behaviors within their living spaces.

Setting

The study area consists of four major landforms that fall away as steps from the Ma'an Plateau (~1,700masl) to the floor of the Rift Valley (~100masl) along a transect of about 35km (fig. 1 and 2). Beyond their striking differences in elevation, the landforms are largely associated with different bioclimatic zones and geologic substrates. Moreover, given the area's position as a land-bridge connecting Africa and Eurasia, the environmental zones represent remnants of biogeographic successions of continental scale. The high elevations of the plateau are associated with a degraded Mediterranean woodland of European association, the piedmont supports an Asiatic steppe, and the lower elevations of the broad plain of the Wadi Hisma and the flank and floor of the Rift Valley are covered in desert vegetation with African affinities. The inherent environmental diversity of the area is further enhanced by marked seasonality associated with a Mediterranean climate in which rainfall is confined to a short winter wet season followed by a long dry season.

From the perspective of Paleolithic research, another important feature of the study area is the restricted availability of

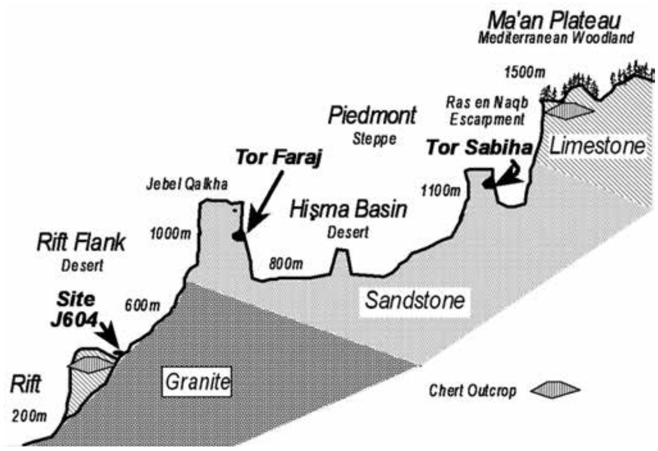

Figure 2 - Transect of the study area showing landforms, geologic substrates, plant communities, and selected site locations.

chert due to differences in geologic substrates. Extensive chert sources are found above ~1,500masl on the Ma'an Plateau and along the edge of the Rift Valley at elevations of ~200-400m in limestone formations. Chert from these sources varies widely in color, composition, and form, but most of the sources yield very high quality chert relative to knapping qualities. The greater part of the piedmont, Hisma, and Rift Valley are associated with sandstone and granitic substrates and lack chert sources. The large majority of chert varieties forming the artifact assemblages have been identified as to sources (Henry 2003:63).

Inter-site Patterns

Land-use strategies incorporating transhumance appear to have persisted in the area throughout prehistory and into recent times (Henry 1994, 1995a, 1995b). This is not surprising given that the different environmental zones are defined by elevational belts and the peaks in resources within the zones are seasonally staggered. Environmental and archaeological data suggest that during the Pleistocene groups spent the winter, wet periods at mid-low elevations and the driest part of the warm season at the highest elevations. This involved wintering in the low piedmont and Rift Valley, dependent on the severity of conditions, followed by an upland migration to the Ma'an Plateau with the on-set of the dry season.

Chronology, Hominin Association, Social Identity and Paleoenvironment

Only two of the Middle Paleolithic sites were dated, Tor Faraj and Tor Sabiha. Six assays derived from U-series and AAR on ostrich eggshell and TL on burnt chert place the two sites between 43.8 and 69kya with a mean point age of ~55.1 kya (Henry 2003:58-59). This age is consistent with other B-type Late Levantine Mousterian dates from the Levant (Henry 2003:58-59). Although no identifiable hominin fossil remains were recovered, within the Levant only Neanderthal remains have been found with this specific artifact assemblage association and time frame.

The assemblages from Tor Faraj and Tor Sabiha are characteristic of those from the other Middle Paleolithic sites recorded in the study area in two respects. First, all the assemblages are dominated by broad-based, triangular Levallois points with prominent chapeau de gendarme platforms and unidirectional, Y-convergent scar patterns; a hallmark of the B-type Late Levantine assemblages in the region. Second, artifacts displaying inverse retouch range from ~33-44% in contrast to 0-4% for other Levantine assemblages, excepting Kebara (Henry 1995a: 73). This unique feature points to a local stylistic element. In combination, the associated chronometrics, techno-typologies, specific reduction streams (*chaîne opératoire*) and retouch patterns of the assemblages in the study area point to their having been produced by Neanderthals belonging a regionally defined social unit, scaled in archaeological time.

Although faunal and pollen preservation in the deposits was generally poor, the remains of gazelle, bos, and equid, along with ostrich eggshell fragments, point to a generally arid setting, but with available surface water. Pollen (Emery-Barbier 1995) and phytolith (Rosen 2003) studies enhanced the environmental reconstruction in tracing a generally arid setting, but one more moist and cooler than that today. The Hisma and hilly uplands supported cool-season grasses and pockets of woodlands (alder, elm, and pine) forming what would be best described as a cool, moist steppe associated with a Mediterranean climate.

Settlement Structure

Within the Middle Paleolithic, eleven sites were identified at elevations ranging from ~280 masl to 1,400 masl. Sites in the highest (1200-1400masl) and lowest (280-340masl) elevational belts displayed several similar site features, but differed from sites situated in the mid-level elevational belt (900-1000 masl). Those sites found in the highest (Ma'an Plateau and high piedmont) and lowest belts (Rift Valley) exhibited relatively low site densities, small site areas, thin cultural deposits, low artifact densities and an emphasis on end-of-stream lithic processing. The mid-level elevational belt (low piedmont) yielded the highest site density, the largest sites, thickest cultural deposits, highest artifact densities, and a complete range of lithic processing activities. The identification of chert sources in the Rift Valley, lower piedmont (Humeima source) and Ma'an Plateau shows the sources to have been exploited at all of the sites in the study area, but by way of different procurement strategies.

The sites at the highest and lowest elevations are equally divided between open and rockshelter occupations, whereas only one of the seven mid-elevation sites was an open-air encampment. Taken together, these data suggest that small, highly mobile groups occupied the highest and lowest elevations for relatively short settlement segments. In contrast, mid-level elevations were associated with larger, longer-term occupations by larger groups over longer settlement segments.

Seasonal Data

The most direct evidence for seasonality comes from Rosen's (2003) study of phytoliths recovered from Tor Faraj. She found among the single-celled phytoliths a small, but consistent proportion of dendritic long-cells derived from the floral parts or seed husks of grasses. From this she concluded that Tor Faraj was probably occupied between February and June given that these are the months in which Mediterranean grasses flower and produce seeds. Other phytoliths, along with starch grains, point to the consumption of dates and pistachio nuts which similarly indicate a winter occupation, although restricted to earlier in the season. Interestingly, the dates must have been imported from palms growing in the Rift Valley given their intolerance of the colder temperatures of the lower piedmont.

Other clues to the season(s) of occupation for the sites comes from landscape evidence: elevation, availability of water, and exposures of sheltered settings. The sites situated at the highest settings, an open site on the plateau (>1,400asl) and the rock-shelter of Tor Sabiha in the high piedmont (~1,300asl) with an eastern exposure, were most likely occupied during the warm, dry season. Water at this time of year would have been available from springs along the edge of the plateau as it is today. The mid-level sites (900-1,00asl) are predominantly associated with rockshelters, all of which overlook drainages and have south-southwest exposures. Standing water is known to have been near Tor Faraj as evidenced by the phytoliths of cattails. Given the limited catchments of the drainages, water is likely to only have been available seasonally during the winter wet-season stretching into early spring and in agreement with the phytolith evidence. The two Rift Valley sites (Henry *et al.* 2001), situated at elevations between 288 and 340masl, are located on the shore of ancient Lake Gharandel (J603) and a prominent drainage, the Wadi Nukhayla (J603). Again, winter wet-season occupations would have been most likely, although unlike the mid-level sites, protection from the elements appears not to have been a concern. Site J603 is an open-air occupation and site J604 is exposed both to the west and east as the artifact distribution wraps around a rock outcrop overlooking the wadi.

Provisioning and Procurement Strategies

Differences in the lithic assemblages indicate that alternative provisioning strategies were associated with the different segments of the settlement cycle. In following Kuhn's (1995) concepts on provisioning, the longer-term occupations followed a logistical strategy of provisioning a place while ephemeral occupations used more opportunistic strategies linked to provisioning activities and individuals. The provisioning of a place is typically associated with the full range of lithic reduction activities from core shaping and blank production to tool manufacture, use, and recycling. In contrast, the provisioning of activities is typically linked to tool production in support of specific tasks, as needed, and thus while limited initial core shaping and blank production are involved, the process emphasizes end-of-stream reduction activities tied to tool fabrication, use, and maintenance. Finally, the provisioning of individuals demands little in the way of initial processing, but focuses principally on tool use and maintenance.

The excavations of Tor Sabiha and Tor Faraj produced large assemblages suitable for quantitative comparisons, but the other occupations (either deflated or deeply buried) yielded assemblages of <100 specimens, too small for reliable comparisons. The lithic assemblages of both Tor Faraj and Tor Sabiha are associated with complete reduction sequences, but they show

	Tor Faraj	Tor Sabiha
Elevation (masl)	900	1300
Exposure	S - SW	E
Site Area: Protected, Overall	136, 216	28, 116
Cultural Deposit (m)	>3	0.2-.3cm
N of Hearths	19	0
Artifact Density (0.1^2)	78	148
N of Artifacts	13, 286	6'663
% Cores [1]	2.2	0.6
% Primary Elements [1]	11.9	8.7
% Tools [2]	3.2	1.9
% Levallois Points [3]	23.5	41.1
% Chips [2]	70.1	60.6
Avg. Artifact Weight	18.5	14.7

Table 1 - A comparison of site and assemblage attributes of Tor Faraj and Tor Sabiha.

striking differences in emphasis (tab. 1). Tor Faraj exhibits much greater proportions of artifacts associated with initial processing (primary elements and cores), while Tor Sabiha displays a greater emphasis on final processing as evidenced by the higher proportions of points (Henry 1995b). Dimensional data for the assemblages also differ in pointing to greater on-site blank production (especially Levallois points) at Tor Faraj than Tor Sabiha where a good part of the assemblage appears to have been imported from off-site locations (Henry 1995a:64-65, Henry 1995b). Moreover, the artifact weights in the assemblages, an expression of portability, show those from Tor Faraj to be ~20% heavier than those of Tor Sabiha (tab. 1, Henry 1995a:113).

What is so surprising in these differences is that Tor Sabiha has abundant chert sources within its catchment, less than 2 km away, whereas the chert sources principally exploited from Tor Faraj are located out of its catchment some 22-35 km away. The combined evidence is clearly inconsistent with a distance-decay model in which artifact assemblages typically display greater reduction, as expressed in a progressive shift from an emphasis on initial to final processing, coupled with a decline in the size and weight of individual specimens with increasing distances from the chert sources.

The exception to the distance-decay model at Tor Faraj is thought to be attributable to a logistical procurement strategy in which the inhabitants of the site provisioned it as a place with the bulk importation of fist sized chert nodules from distant sources on the plateau. The size and shape of the nodules facilitated the production of Levallois points with little waste in material or expenditure of energy as evidenced by refits (Demidenko & Usik 2003). With as few as 5-6 removals, the nodules were prepared for the delivery of a Levallois point, a procedure that would have reduced the incentive for trimming the nodules at the chert sources. In contrast, Tor Sabiha appears to have been provisioned in support of activities and individuals. In the main, initial processing (core shaping and blank production) appears to have been conducted off-site, most likely centered

Chert Sources	Tor Faraj	Tor Sabiha
	%	%
Plateau Varieties 1-5	82	75
Plateau , All Other	4	13
Humeima	9	8
Rift Valley	5	4
Plateau 1	25.1	5
Plateau 2	11.1	2
Plateau 3	37.4	35
Plateau 4	6.9	11
Plateau 5	4	23

Table 2 - A comparison of the raw materials distributions recorded in the lithic assemblages of Tor Faraj and Tor Sabiha.

around activities that were expediently provisioned within the chert rich catchment. A comparison of the chert varieties that were exploited from the two sites shows that groups from Tor Faraj targeted fewer sources than the inhabitants of Tor Sabiha (tab. 2). This finds particular expression in the all other variety that represents chert that could not be assigned to a specific source and is >3 times more common in the Tor Sabiha assemblage.

Settlement Patterns and Implications

The patterned variability in the contexts and contents of the Late Levantine Mousterian sites in the study area suggests that Middle Paleolithic foragers ranged from the Ma'an Plateau to the Rift Valley in an annual cycle of transhumance. Most likely, the hominins responsible for the sites were Neanderthals in that in the Levant the fossil remains of Neanderthals have been dated between 42-70 Kya and associated exclusively with Middle Paleolithic assemblages of the B-Type Levantine Mousterian Industry, as are those of the study area. Embedded in the migrations were shifts in the residential mobility and sizes of foraging groups and changes in procurement strategies. This was expressed in (1) long-term winter camps in rockshelters of the lower piedmont supported through logistical provisioning, (2) occasional ephemeral winter camps in the Rift Valley, and (3) ephemeral warm season camps at high elevations on the plateau and upper piedmont in which groups dispersed into smaller social units that were sustained through local, opportunistic provisioning. These findings run counter to the prevailing notion that Neanderthals employed land-use strategies that were less productive than modern humans. Neanderthals are thought to have lacked the flexibility to adjust settlement-procurement patterns to variations in landscape and resources, especially in lacking logistical approaches to exploiting resources. The site contents and contexts of Tor Faraj and Tor Sabiha point to shifts in group size and mobility coupled with changes in procurement strategies.

Intra-site Patterns

Given the results of the inter-site comparisons, our research shifted to a high resolution intra-site investigation of Tor Faraj (Henry 2003; Henry *et al.* 2004) with a large block excavation fig. 3). The research was designed to test the proposition that modern human foraging strategies were followed by the Middle Paleolithic, most likely Neanderthal, occupants of the study area. This was addressed in two ways. First, the integrity of the local land-use model developed from inter-site comparisons was evaluated by comparing the site structure of the occupations at Tor Faraj with the complex structure predicted by the model for long-term, winter encampments in which groups had coalesced into larger demographic units. Such complex site structures typically display multiple hearths and variable activity areas representative of discrete tasks. In contrast, the simple site structure, that is thought by many to be representative of Middle Paleolithic sites, consists of a single central hearth, or no hearth at all, around which overlapping expedient, and often redundant tasks were undertaken. Relative to intra-site behavioral organization and cognition, the presence of a complex site structure implies that the occupants of a site were applying conceptual labels to certain places for conducting specific activities or tasks. Sleeping, food-preparation, butchering, initial tool fabrication and so forth would have been undertaken habitually in certain discrete places within a camp.

A second way of testing the proposition involved comparing the site structures of the living floors at Tor Faraj directly to archaeological and ethnographic examples of occupations of rock shelters by modern foragers. If the Levantine Mousterian occupants of the area were organizing their behaviors in an essentially modern fashion, we should expect the site structure identified at Tor Faraj to meet the expectations linked to the local settlement-procurement model and also resemble those site structures that are common to modern foragers.

In conjunction with the intra-site data obtained from the excavation of Tor Faraj over seasons in 1993and 1994, intra-site evidence was also drawn from an earlier (1979-80), albeit smaller excavation of Tor Sabiha. As at Tor Faraj, this intra-site evidence allows for evaluating the predicted site structure of Tor Sabiha based upon the occupation's placement in the settlement-procurement model. Unlike Tor Faraj, however, the inter-site data points to a short-term occupation by a small group supported through opportunistic provisioning strategies and this, in turn, would most likely be tied to a simple site structure.

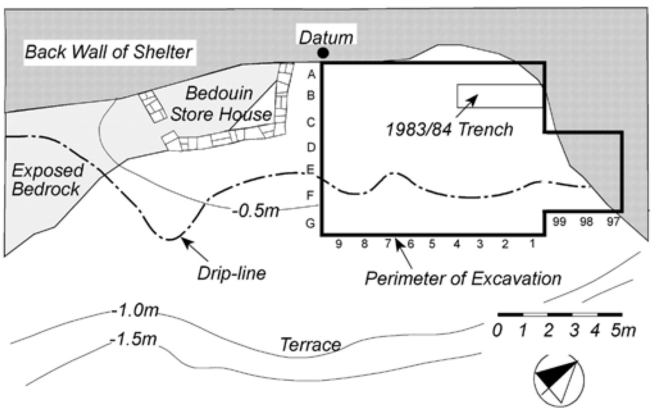

Figure 3 - Site plan of Tor Faraj showing the natural features of the rockshelter, the Bedouin store house, and the excavation block.

The block excavations at the two sites, quite different in size (Tor Sabiha -13m² and Tor Faraj - 67m²), revealed different compositions of cultural horizons. Whereas artifacts at Tor Sabiha were distributed within a single 20-30cm thick horizon, artifacts at Tor Faraj were concentrated in 10-15cm thick stratified horizons within a >3m thick cultural deposit. Numerous hearths (19) were associated with the cultural horizons at Tor Faraj, but none was found at Tor Sabiha.

The excavation methods followed at the two sites varied considerably. This was partly due to differences in research goals, but also to technical advances in archaeology. Tor Sabiha was excavated as part of a region-wide survey (32 km²) that resulted in discovery of 109 sites (Lower Paleolithic to Chalcolithic) involving test excavations at 32 of these and block excavations at six. The excavation of Tor Sabiha was conducted within a 1 m² grid (each unit divided into 50 cm x 50 cm quadrants) and dug in 5 cm arbitrary levels. In contrast, Tor Faraj, discovered and initially tested in 1983/84, was the focus of two seasons of research a decade later. Prompted by the results of the test excavation that had revealed thin horizons and hearth associations, perhaps indicative of living floors, the excavation emphasized high resolution recovery techniques (Gowlett 1997). The excavation followed a découpage approach proceeding with the excavation of 5 cm levels within a 1 m² grid further divided into 50cm2 quadrants. All artifacts >0.25mm, other objects (rocks, bones), and features were three-dimensionally plotted using a Sokia Set-6 total station for subsequent spatial analyses. Ultimately, this involved an attribute study of 3,126 artifacts and the refitting of 251 (8%) of these into 87 constellations. In addition to the high resolution procedures in the recovery and analysis of artifacts, phytolith, pollen, geochemical, floor temperature, and sunlight/shadow data were collected across the excavation block.

The Presence of Living Floors

The definition of site structure through the use of high resolution spatial analysis faces two important challenges. These involve establishing the degree to which the behavioral residuals (artifacts, manuports, and ecofacts) are in primary context and overcoming the palimpsest problem in isolating specific occupational events that encompassed relatively brief intervals of real-life time. A common criticism of intrasite spatial studies is that researchers often are too willing to view artifacts and associated evidence in primary context, as living floors, and thus appropriate for tracing site structure (Bailey 2007; Dibble *et al.* 1997; Stern 1993; Stevenson 1991). This "Pompeii Premise" (Ascher 1961:324; Binford 1981:196) ignores the wide range of processes, both cultural and natural, that may act to blur or confuse connections between past behaviors and their material residuals. In response, researchers have developed several ways to determine the degree to which archaeological materials experienced post-depositional disturbance. These include: the specific sedimentary processes that formed the artifact bearing deposit, the degree that artifacts are sorted by size, the orientation and plunge of the long-axes of elongated artifacts, the degree of weathering or ablation of the surfaces of artifacts, the spatial distributions of behaviorally meaningful artifacts, the distributions of artifacts in three-dimensional space, the distribution of refitted artifacts, and the presence and condition of archaeological features. These attributes have been used singly or in combination to establish the integrity of living floors (Isaac 1967; Rick 1976; Fuchs *et al.* 1977; Baumler 1985; Behm 1985, Schick 1986; Schiffer 1987; Petraglia 1993; Waters & Kuehn 1996; Straus 1997; Dibble *et al.* 1997; Shea 1999; Vaquero *et al.* 2001a, 2001b; Henry *et al.* 2004; McPherron *et al.* 2005).

Tor Sabiha

At Tor Sabiha the combined evidence suggests that the cultural horizon was sealed rapidly and experienced little post-depositional disturbance. The cultural material is found within a 30 cm thick layer (C) of a relict dune deposit formed from freshly weathered local, sandstone (Hassan 1995). The layer consists of a finely sorted sand, framed by sharp contacts, and lacks coarse grained lenses formed by winnowing episodes associated with sustained diastems or weathered surfaces. The chert artifacts exhibit fresh edges and little if any desilification, again suggestive of rapid burial and limited surface exposure. The orientation and inclination of the long axes of artifacts was not systematically recorded, but the data available indicate inclinations of 0-5° oriented to the SW, compared to the modern slope of ~15° to the SE.

While this may indicate some degree of disturbance from sheetwash (depending on the proportion of artifacts with a common orientation), the absence of size sorting shows this to have had only limited impact. The recovery of over 4,000 chips, representing ~60% of the assemblage, is a strong indicator that the cultural material is largely in primary context. The strong spatial co-variation of cores and primary elements also meets the criterion of behaviorally meaning artifact distributions. A refit study was not undertaken at Tor Sabiha, nor were features such as hearths found.

Tor Faraj

At Tor Faraj a more impressive array of evidence was gathered in an effort to evaluate the integrity of living floors. The processes of the formation of the shelter and its sedimentation with fine grained silts and sands acted to preserve archaeological evidence in primary context. The shelter was created by the differential weathering of sandstone bedrock that created an undercut in the cliff face. The deposit accumulated as a result of the episodic weakening and collapse of the brow of the overhang and an accumulation of predominantly wind-borne sediments behind the natural wall formed by fallen rubble from the brow.

The stratigraphy, revealed in the excavation of the upper 1.65 m of the 3.5-4 m deep deposit, gave no indication of a prolonged interruption of sedimentation. Four strata associated with the Levantine Mousterian occupation were identified underlying a modern (Bedouin herder) anthropogenic layer (A) and a layer containing a mixture of modern and prehistoric materials (B). The undisturbed prehistoric deposit included layers of aeolian silty sand (C and D2) separated by a layer of rockfall (D1) confined to an area near the drip-line. Another strata of fine silty sand (E) was exposed underlying Layer D2 in a deep sounding. A suite of five chronometric determinations derived from amino acid racemization, uranium series, and thermoluminescence dating techniques brackets layers C - D2 of the deposit to 49-69 Kya with an average age of ca. 55.1 ± 5.6 Kya (Henry 2003:18-19). This age range is very similar to dates of other Late Levantine Mousterian (B-type) occupations.

Bedding planes displayed by aeolian sediments, carbonate laminae, and disintegrated roof-fall trace a nearly level-bedded stratigraphy running parallel to the back-wall and beds inclined from 0-50 running perpendicular to this line. Hearths and ash lenses furnish additional confirmation of a nearly level to very gently sloping floor over the excavation area of ca. 67 m². The contacts between the fine silty sand deposits of Layers C and D2 are conformable, suggesting that their deposition was not separated by an extended period of surface stability or erosion. The laminae tracing the pulses of sedimentation within layers are typically fine grained and do show some cross-bedding. But, in lacking coarse-grain, lag deposits associated with extensive winnowing and long diastems, the deposit appears unlikely to have been exposed to sustained wind erosion. The presence of fragile hearths and ash lenses also points to little in the way of post-depositional disturbance.

During excavation and subsequent analysis, two occupational horizons were identified within the shelter's deposit based upon stratigraphic peaks in the densities of artifacts, hearths, and rocks. These were initially identified as Floor I (160-170 cm BD, Layer C & D1) and Floor II (levels 180-195 cm BD, Layer D2), but even at this stage of the research it was recognized that each of the two floors may have represented two or even three discrete occupational events (Henry 2003:260).

In order to check for post-depositional disturbance, the orientations of artifacts were recorded along their long axes in the direction of their smallest ends and grouped into twelve sectors of 15° each. In replication experiments, Schick (1986) found that post-depositional movement of artifacts from sheet-wash resulted in orientations disproportionately skewed toward the source of flow or perpendicular to the direction of flow depending on flow-rate. At Tor Faraj a minor "spike" in the orientations of artifacts does point up-slope, toward the back of the shelter, but this accounts for only 17.8% of the specimens and other orientations are relatively balanced (ranging from 6-11%) in their representation. Petraglia (1993) noted a similar orientation pattern (with spikes of 17-19%) at the French site of Abri Dufaure and he interpreted this as evidence for an intact, undisturbed deposit. In reporting upon artifact orientations and site formation processes at another French site, Pech de l'Azé IV, McPherron *et al.* (2005) note that the orientation data collected with a total station allow for tracing the slopes of paleosurfaces that are difficult to see even in the stratigraphic profiles. The artifact orientation data from Tor Faraj indicate that the deposit is in primary context with only minor post-depositional disturbance from low energy sheet-wash from the back of the shelter.

The chipped stone artifacts from the deposit show remarkably little weathering, an indication of rapid burial by fine sediments. Their edges are fresh and their surfaces display only slight patination or desilicification. An exception to this pattern appears in the area of the brow collapse that formed Layer D1. In this area artifacts were recovered resting at various angles on edges and ends, rather than flat as in the rest of the site, and they showed strong signatures (white speckled and milky surfaces) of desilicification. This is thought to reflect artifacts that had lodged into the crevices between the rocks from the roof-fall and were exposed to weathering for a much longer period of time than those buried in the fine sediments of Layers C and D2 deposited behind the rubble wall.

The refitting of artifacts was also employed to evaluate the integrity of the living floors (Demidenko & Usik 2003). Two hundred forty-seven artifacts were refitted into 87 constellations with an average artifact separation of slightly more than 1 m horizontal distance and 7.5 cm vertical distance. A more telling statistic, relative to the stratigraphic integrity of the deposit, is that only five artifacts (representing 2% of the refitted artifacts) show vertical separations exceeding 15 cm. The refits also inform us about the integrity of Floors I and II, in that only five refitted artifacts bridge the two living floors and these are the same five specimens that exceed 15 cm vertical separation. Three of these are stratigraphically inverted, relative to the other artifacts forming their constellations, and appear to have come from a small area disturbed by Bedouin construction activities that cut the floors in the northwest corner of the excavation block. One constellation in particular underscores the lack of post-depositional disturbance at Tor Faraj. This is represented by a burin with five of its small spalls (recovered from within a 2 m radius) that were refitted.

In addition to forming the foundation for the examination of site structure, the spatial patterns of behavioral residues also furnish a means of testing the integrity of living floors. Dibble *et al.* (1997) argue that behaviorally meaningful data should be expected to display a non-random distribution in the context of a living floor. At Tor Faraj, there are several lithic data-sets (chips, cores, Levallois points, side-scrapers, and notches) and other cultural residuals (hearths, manuports, phytoliths, and phosphorous concentrations) that are non-randomly distributed. The hearths, in the form of shallow fire-pits, perhaps provide the most definitive signature of an intact deposit. When the distributions of the cultural residues at Tor Faraj are examined contextually, it is evident that their spatial patterns resulted principally from the behaviors of the shelter's inhabitants and not from natural forces.

Spatial Patterns and the Palimpsest Problem

Although both Tor Sabiha and Tor Faraj appear to have suffered little in the way of natural post-depositional disturbances, there remains the problem of determining the number of occupational events represented at the sites. In such situations it is difficult to tease apart the remnants of individual occupations, stratigraphically (Straus 1997; Carr 1987; Galanidou 2000; Wadley 2006; Bar-Yosef *et al.* 2007). Yet if not separated by occupation, the cultural residue may, even at the highest resolution, represent a smear or mixture of real-life time events. Therefore, the contextual relationships identified from such a mixture of occupational events are likely to yield a blurred definition of site structure and an inaccurate reconstruction of prehistoric behaviors.

Tor Sabiha displayed a single concentration of artifacts in an area of 2-3 m², whereas Tor Faraj exhibited 4 concentrations of artifacts of 2-4 m² in each area. This, in part, may be explained by the difference in the excavated areas of the two sites (Tor Sabiha -13 m² and Tor Faraj - 67 m²), but the concentrations also show important qualitative differences. The concentration at Tor Sabiha, represented by the peak densities of cores, primary elements, points, and tools, indicates that the full reduction sequence from core shaping through tool fabrication was undertaken in that location.

In contrast, the artifact concentrations at Tor Faraj vary relative to the densities of artifact classes. Some concentrations contain high densities of cores and primary elements, but low point and tool densities, whereas other concentrations show just the reverse. Unlike Tor Sabiha, the artifact concentrations at Tor Faraj trace a spatial segregation of the reduction sequence into places associated with core shaping and blank production and other areas associated with tool use and abandonment. The study (Henry 2003, fig. 4) revealed a discrete central area (Area B) of the shelter in which tool use and maintenance were emphasized, and two peripheral areas in which core shaping and blank production formed the principal lithic processing activities (Areas A and C). Ancillary evidence, including the spatial distributions of hearths, phytoliths, phosphorus values, lithic wear data, and exposure to direct sunlight showed strong patterned co-variation with the three activity areas defined by the lithic data. These data-sets pointed to the central area having been used for the processing of plant (cattail, date, pistachio) and meat resources, coupled with tool fabrication, maintenance, and rejuvenation. Concentrations of grass phytoliths along the wall of the shelter in Area B were interpreted as bedding. In contrast, the two smaller peripheral activity areas contained evidence indicative of tasks associated with core shaping, blank production, and butchery. The fourth area (Area D) situated along the rock fall following the edge of the terrace, was thought to reflect a refuse dump because of its mixture of artifacts linked to initial and final processing, relatively low tool frequencies, and high frequencies of burnt artifacts in the absence of evidence for a hearth. Very high frequencies of phytoliths from woody plants along the rock fall were interpreted as a brush windbreak and fuel depot. Although the activity areas were defined by artifact concentrations, a strong spatial association was observed between the activity areas and hearths.

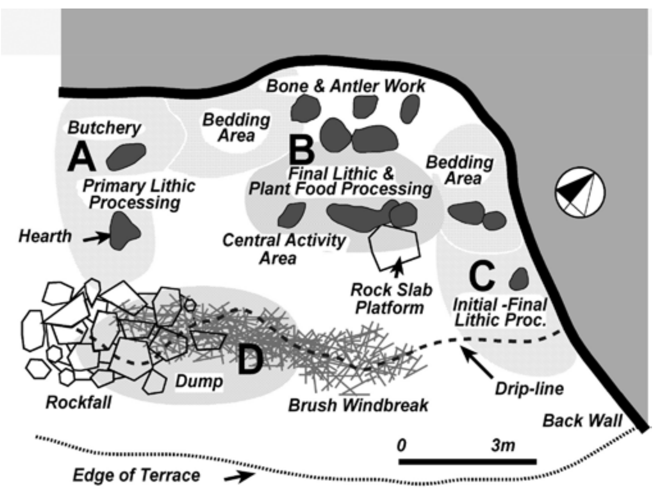

Figure 4 - Plan of Tor Faraj showing the locations of hearths and inferred activity areas associated with Floor II.

The spatial co-variation of hearths, artifacts, and other evidence appears to define living floors at Tor Faraj and the spatial associations of artifacts at Tor Sabiha may represent a similar thin slice of time, but how do we know if the associations resulted from single or multiple occupation events? Relative to Tor Sabiha, this question may never be answered, but at Tor Faraj insights into the contemporaneity of artifact spatial distributions were developed through an analysis of the positioning of hearths relative to one another (Hearth Pattern Analysis) and analyses of the spatial distributional patterns of artifacts surrounding the hearths (Ring and Sector Analysis).

Hearth Pattern Analysis

When the hearths of Tor Faraj were examined in relation to their density and distribution, it became clear that the initial stratigraphic definition of two living floors within the shelter should be refined. Specifically, the hearth information suggested that Floor II, with its 13 hearths, most likely represented more than one floor. Also, the regular spacing between hearths was especially revealing in separating this originally defined single floor into two floors, Floor II and Floor III.

Gamble (1986, 1991:12) noted that hearths recorded in ethnographic and archaeological encampments from around the world tend to be spaced about 3 m apart. Although Gamble's 3 m Rule has been refined by subsequent studies that indicate hearths to be more closely spaced, there nevertheless does appear to be a regular pattern in hearth spacing. In Binford's (1996:230) studies of "hearth centered" behaviors, he found that in addition to the regular patterns that delimited drop and toss zones, a "circle defined by the area occupied by seated persons surrounding the hearth" regularly measured 1.76 m in radius from the center of a hearth. Such a circular zone set aside for hearth-side activities would strongly influence the spacing of hearths relative to other hearths and also to the physical features (i.e., back-walls and drip-lines) of shelters. Human anatomical requirements for sitting and reaching, coupled with the limits of heat and light from the fire for conducting various tasks, are likely to have influenced the general regularity in the size of the hearth-side zone, but social preferences may also have played a role. Some years ago, Freeman (1978:113) observed that a stationary individual can conveniently reach an area of 2.5-3 m². If this is viewed as a circular area, it involves a diameter of ca. 180-194 cm, a dimension remarkably close to Binford's ethnographic observation. The distances between the hearths and their related activity zones would be largely determined by the degree to which each hearth's occupants desired social interaction (e.g., conversation or physically sharing tools and resources) or privacy. This is consistent with ethnographic evidence in which hearth function, e.g., cooking versus sleeping (Nicholson & Cane 1991) has been observed to influence hearth to hearth distance. Although not examining the distances separating hearths in her comparative study of ethnographic rockshelter sites, Galanidou (2000:247) found no relationship between the forms of hearths and their functions.

In order to compare these ethnographic regularities in hearth spacing to the hearths exposed in the Tor Faraj living floors, circles of 1.8 m radius, representing the estimated hearth-side activity zone noted by Binford and Freeman, were centered on each of the hearths. The basic logic of this analysis assumed that only a single hearth should command a hearth-side activity zone at the time of use; other hearths falling within the zone are presumed to have been used at another time and representative of a different occupational event. Moreover, a corollary to this line of thought would hold that hearths resting on or near the boundaries of other hearth-side activity zones would be likely to have been in use at the same time, thus explaining their regular pattern of spacing.

At Tor Faraj, an examination of the six hearths of Floor I shows Hearths 3, 6, and 21 to fall on or very near the boundaries of the hearth-side zones of others, whereas Hearths 2 and 7 fall within other hearth-side zones (fig. 5). Hearth 8 is an outlier spatially unrelated to the hearth-side zones of the others. This suggests that Hearths 2 and 7 represent a specific occupational event distinct from that of Hearths 3, 21, and 7. Beyond being positioned roughly equidistant from each other at a distance of about 2m from the centers of adjacent hearths, Hearths 3, 21, and 8 show their hearth-side zone to end with the backwall of the shelter. These patterns suggest that the six hearths of Floor I reflect two specific occupational events with Hearths 3, 6, and 21 seeing synchronous use, while Hearths 2 and 7 were used at another time or times. The precise length of time separating the use of the two sets of hearths is impossible to establish. The close proximity of the anomalously positioned hearths with patterned ones (i.e., Hearths 2 and 21, Hearths 6 and 7), however, may simply represent subtle repositions of hearths during a single interval of encampment in the shelter.

A similar analysis of the hearths for the original Floor II produced a significantly different picture (fig. 5). Five (Hearths 5, 9, 11, 1 or 18, and 14 or 15) of the thirteen hearths rested within the hearth-side zones of others. This information was consistent with the overall numbers of hearths for the "floor" in pointing to multiple occupations. In an attempt to refine the definition of the occupations, the hearths were separated into an upper group of ones in which their top elevations rested in levels 180 and 185 (labeled Floor II), and a lower group recorded in levels 190 to 200 (labeled Floor III). When these hearths were re-plotted as Floor II (upper group) and Floor III (lower group), they largely exhibited the regular pattern of spacing seen in Floor I (fig. 6). With the new groupings, only a single hearth for each floor (Hearth 9 of Floor II and Hearth 11 of Floor III) was found to violate the hearth-side zones of adjacent hearths.

While Hearth Pattern Analysis appears to offer a simple means of, at least, partially addressing the palimpsest problem, when combined with Ring and Sector Analyses our understanding of hearth related activity areas can not only be independently cross-checked, but also enhanced.

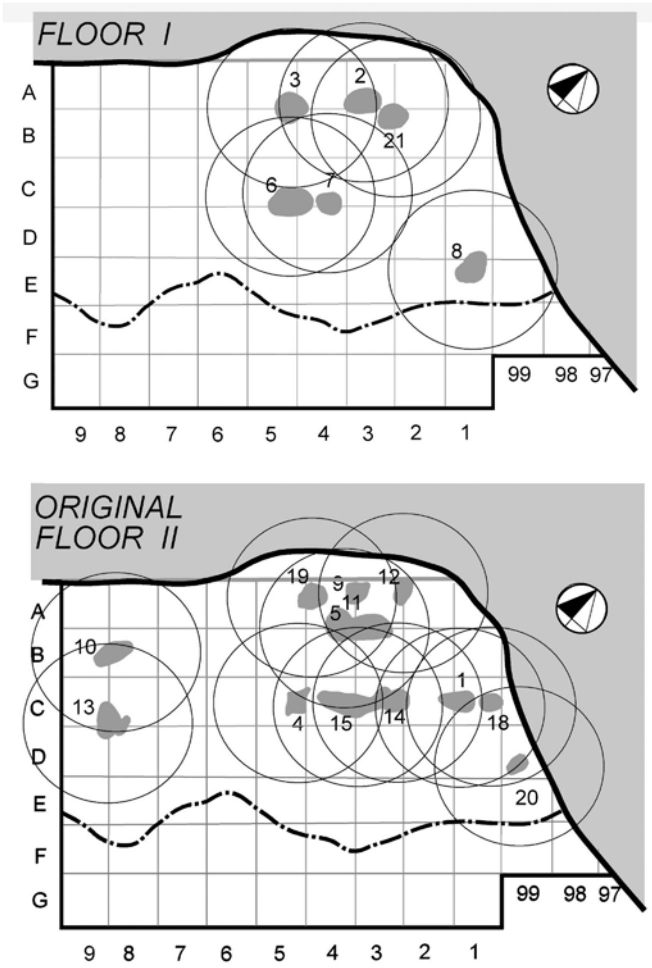

Figure 5 - The site plan of Tor Faraj showing the locations of hearths and their spacing for Floor I and original Floor II. The circles (1.8 m in radius) are drawn from the center of each of the hearths. Note the numerous overlaps in the hearth-side zones of hearths in Floor II.

Ring and Sector Analyses: Background

By mapping the positions of the hearths onto the distributions of other data-sets (e.g., phytoliths, phosphorous values, exposure to sunlight, varieties of lithic artifacts), earlier intrasite spatial studies (Henry 1998, 2003; Henry *et al.* 1996) found spatial co-variations with the hearths, but these earlier studies were unable to trace the detailed spatial patterns of artifact distributions within each of the hearth-side zones. Subsequent to these earlier research efforts, I learned of the Dutch archaeologist, Dick Stapert's (1989) "ring and sector" approach to the spatial analysis of hearths and a software, Analithic II (Boekschoten & Schweiger 1999-2004), that greatly facilitates its application. Application of Stapert's ring and sector analyses allowed for checking the hearth pattern results and enhancing our understanding of the number hearth-side occupants and their activities.

Stapert (1989, 1990a, 1990b, 1991/1992; Stapert & Street 1997) has employed his ring and sector method on several European sites to infer the presence of a dwelling wall beyond a hearth, the prevailing wind direction at the time of hearth use, the numbers of occupations attributed to a living floor, the numbers of persons using a hearth and even the likely gender composi-

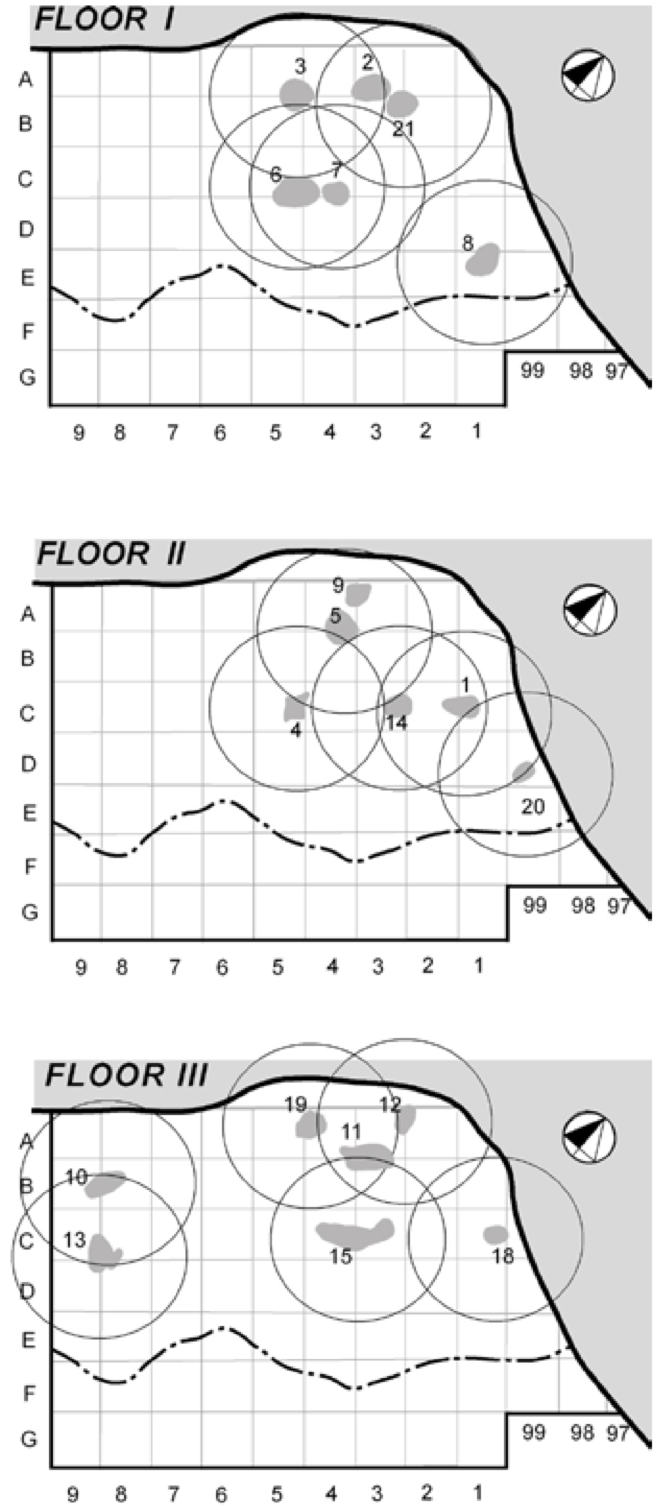

Figure 6 - The site plan of Tor Faraj showing the locations of hearths and their spacing for Floors I, II and III following the separation of Floor II. The circles (1.8 m in radius) are drawn from the center of each of the hearths. Note that the number of overlaps in the hearth-side zones of Floors II and III is significantly reduced.

tion of the users. At Tor Faraj, the objectives of analyzing the hearth-side zones by the ring and sector method were to better understand the numbers of persons using the hearths and the ways in which they were used. Moreover, this approach allowed for establishing wind direction at the time a hearth was used and this information indirectly provided an independent test for the

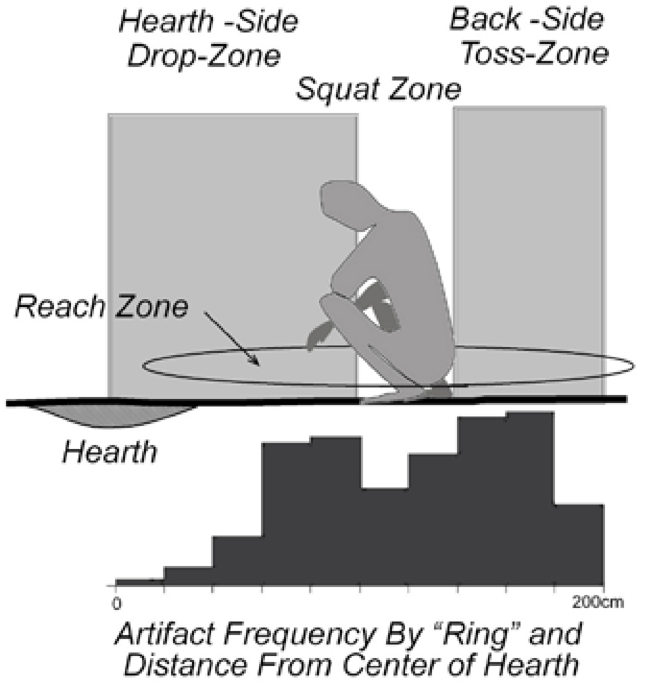

Figure 7 - A schematic illustration showing the spatial relationships of ring analysis and hearth-side zones. Note the typical low artifact densities in the near hearth area, the squat zone, and the rear edge of the toss zone.

synchroneity of the firing of multiple hearths as indicated by the hearth pattern study described earlier.

Stapert's (1989) ring analysis, drawing inspiration from Binford's concept of drop and toss zones about a hearth, involves a computation of artifact frequencies within concentric bands (rings) surrounding a hearth. The artifact frequencies of the rings are typically presented as a histogram that allows for a quick visual inspection of a hearth's ring profile (fig. 7). The radius of the circle established from a hearth's center and ring-width employed in the analysis is arbitrary. In his numerous studies, Stapert employed radii of 3 m - 7 m from hearth centers and ring widths of 0.5 m. Given the multiple, nearby hearths for the floors at Tor Faraj and hearth-side zones of 180-200 cm radius from hearth centers, a smaller scale, than that employed by Stapert, was used in the ring analysis. This consisted of a radius of 200 cm and ring-widths of 20 cm.

In contrast to the ring analysis, sector analysis traces the distributions of artifacts within the hearth-side zone by compass direction. Sectors are arbitrarily established as sweeps of equal degrees radiating from a hearth's center and extending to the edge of the circle that defines the hearth-side zone. In his studies, Stapert regularly employed six, 60 0 sweeps to define his sectors. At Tor Faraj eight sectors, each with sweeps of 45 0, were employed for the sector analysis and these are labeled relative to grid north. Stapert has principally used sector analysis to infer prevailing wind direction; the logic being that hearth-side occupants would have situated themselves on a hearth's windward side with their backs to the wind thus avoiding smoke and cinders. Beyond using sector analysis to determine prevailing wind direction and indirectly the probable synchroneity of hearth use at Tor Faraj, the analysis is also employed to provide information on the numbers of persons seated about a hearth. The reasoning here is simply that there should be a direct correlation between the number of hearth-side occupants and the number of sectors with high artifact frequencies.

Artifact data-sets from the initial study (Henry 2003; Hietala 2003; Henry & Hietala 2004) were reconfigured to reflect the three floors as defined by the hearth pattern study (i.e., Floor I - levels 160-170 BD; Floor II - levels 180 -190BD; and Floor III - levels 190 -195 BD). The specific artifact sub-sets selected for analysis with the software Analithic II for each of the floors was "All Artifacts", a category representing all of the chipped stone specimens that were recovered for the floor with exception to "Chips" (those specimens with a maximum dimension <30 mm and often considered as waste flakes). The reason for excluding the chips is that they were not plotted individually, but collected by unit quadrants of 0.25 m² (squares 50 cm on a side) and as such could not be meaningfully analyzed in a ring analysis using rings of 20 cm width (Stapert & Johansen 1995/96). The artifact sample recorded within the hearth-side zones of the three living floors totaled 2,577 specimens with 1,057 specimens coming from the hearths of Floor I, 1,146 specimens from those of Floor II, and 374 specimens from those of Floor III. This compares to 3,186 specimens that were recovered for the floors as a whole. Thus about 81% of all the artifacts found in the excavation of the three floors were found within the 2 m radius, hearth-side zones; a statistic that underscores the notion of hearth-centered activities.

Ring Analysis: Applied at Tor Faraj

The ring analysis at Tor Faraj revealed hearth profiles dominated by a bimodal artifact distribution (figs. 8, 9 and 10). Eleven of the hearths (Hearths 2, 3, 6, 8, 21, 4, 5, 20, 11, 15 and 18) showed a bimodal profile, two hearths (1 and 14) exhibited multi-modal profiles, two hearths displayed unimodal profiles (10 and 13), and two (19 and 12) contained samples too small for meaningful computation. In his studies, Stapert has observed a dichotomy in ring profiles broken between unimodal and bimodal ones. He suggests that the unimodal profiles were produced by a "centrifugal effect" linked to a high density of artifacts in the drop zone surrounded by a lower density of artifacts in the more outward lying toss zone (Stapert 1989). In contrast to the unimodal profile, he proposed that a bimodal ring profile reflects a "barrier effect" in which the high density drop zone was matched by a high density toss zone where artifacts accumulated against some kind of a barrier such as the wall of a structure.

Given the close proximity of neighboring hearths and the small scale of the hearth-side zones at Tor Faraj, the bimodal profiles on the floors of the shelter were unlikely to have been generated by walls of tents or windbreaks. Although some of the hearths positioned near the shelter's wall may reflect the barrier effect, this would not explain the bimodal profiles of those in the central area (e.g., 6, 7, and 15). An alternative explanation may rest in the lower density of artifacts in the immediate area under the persons sitting or squatting next to a hearth (fig. 7). This "squat zone" should contain relatively few artifacts when compared to the drop zone close to the hearth and the toss zone located beyond the squat zone. Even with the accumulation of artifacts within the same ring as the squat zone, but at the elbows and lateral to each of the hearth-side occupants, the effect of the artifact void immediately beneath a squatting person would result in a relatively lower net artifact density for the rings of the squat zone than in the surrounding rings.

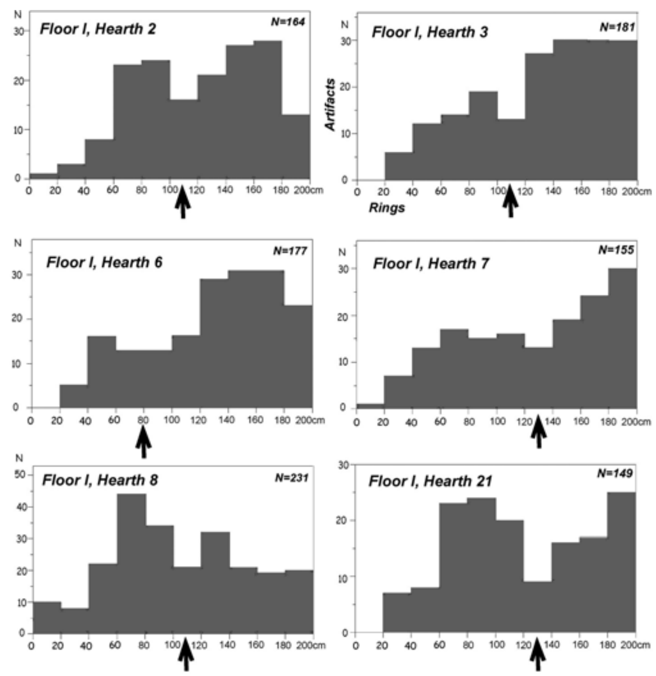

Figure 8 - Histograms of the ring profiles of hearths from Floor I. N = artifact number and the vertical arrow points to the center of the squat zone.

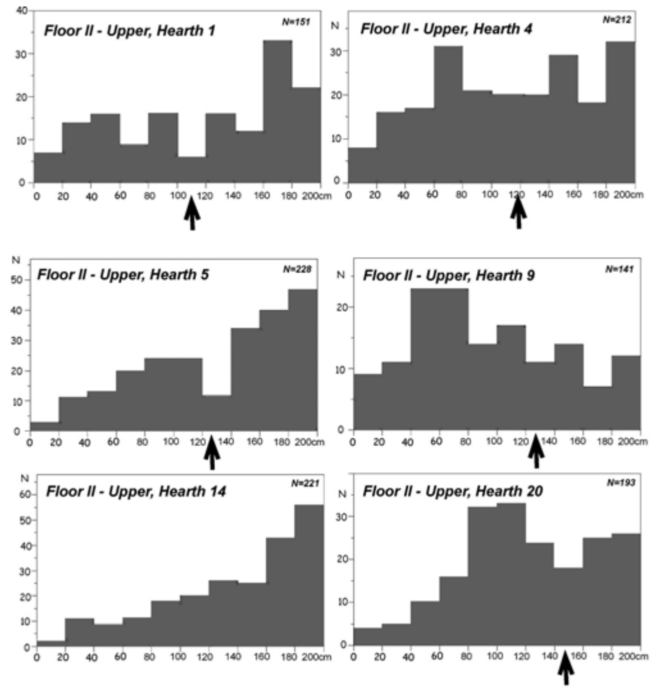

Figure 9 - Histograms of the ring profiles of hearths from Floor II. N = artifact number and the vertical arrow points to the center of the squat zone.

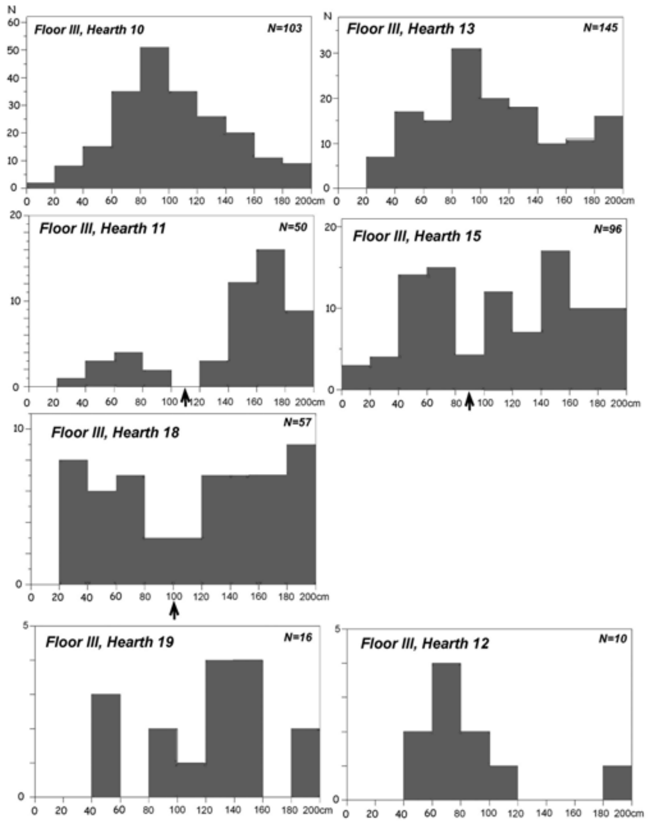

Figure 10 - Histograms of the ring profiles of hearths from Floor III. N = artifact number and the vertical arrow points to the center of the squat zone.

Most (46%) of the squat zones of the hearths at Tor Faraj appear in the 100-120 cm ring and the rest fall in the 80-100 cm (31%) and 120-140 cm (23%) rings. These metrics are remarkably consistent with Freeman's (1978:113) observation about the size of the area around a stationary person, within which objects could be manipulated and ultimately abandoned. When centered at 120 cm radius within the squat zone, such a reach zone of 90-97 cm radius fits uncannily well between the center of the hearth and the outer edge of the 2 m radius hearth-side zone. The presence of a squat-zone beginning about 1 m from the center of a hearth is also supported by the metrics of unimodal ring profiles at Tor Faraj (Hearths 10 and 13). In these the artifact density peaks in the drop zone within the 80-100 cm ring and then declines through the squat and toss-zones. Stapert's (1989:16-17) studies of unimodal ring distributions for eleven hearths at the French site of Pincevent (in which he employs a 50 cm ring width) are also consistent with such a squat-zone position in that all of the hearths show the peak artifact density in the 50-100 cm ring.

Sector Analysis: Applied at Tor Faraj

At Tor Faraj, those sectors displaying high frequencies of artifacts were viewed as proxies of the prevailing wind direction at the time a hearth was in use. In conducting sector analysis with the software Analithic II, the results are displayed as a circle which represents the mean value of the artifact frequencies of the sectors within the hearth-side zone and bars that indicate the artifact frequency of each sector. Those sectors with artifact frequencies less than mean are depicted as open bars inside the circle and those sectors with artifact frequencies greater than mean are shown as closed bars outside the circle.

The hearths of Floor I indicate a prevailing wind (relative to grid north) from the NWw for one burn and the SSE for another, those of Floor II suggest a predominant wind from the S and SE, and the hearths of Floor III point to a mix of wind directions (fig. 11). This information alone offers additional confirmation for the presence of three discrete floors as evidenced by prevailing winds from different directions for each floor, but a more detailed examination of the sector data furnishes an even greater understanding of specific real-time occupational events for each floor. The comparison of wind direction for hearths distributed across a living floor would appear to be uncomplicated, and this is likely so for an open-air occupation, but in rock shelters drafts are often channeled or deflected by the walls of the shelter. At Tor Faraj, winds blowing down the canyon from the west are funneled along the back wall of the shelter into the nook and exit to the southeast. This explains, in part, why the hearths in the nook and along the eastern wall show some indications of use in their N and NE sectors despite a prevailing northwestern wind. Similarly, Hearths 10 and 13 show wind from the NE sector as it is funneled out from the backwall after entering the shelter from the S –SE.

A comparison of the burn synchroneity identified in the hearth pattern analysis with the dominant wind directions for the hearths offers compelling evidence in support of the results of the hearth pattern study (fig. 12). In short, those hearths that were identified as having been used at the same time are likely to have enjoyed a common wind direction. And along the same lines, hearths burned at different times are more likely to have experienced different wind directions. Floor I shows that the three hearths (3, 6 and 21) indicated to have been used at the same time (Burn 1) in the hearth pattern analysis also experienced wind from a common direction as two adjacent sectors (6 and 7) were dominant. The other set of hearths (2, 7 and 6) from Floor I that was determined to have been fired at the same time shows a similar pattern with wind coming from the NE, as evidenced by dominant artifact densities in sectors 1 and 3. Floor II shows that the five hearths used at the same time were exposed to wind from the S, or perhaps SE, as evidenced by artifact peaks in adjacent sectors 3-6. Floor III displayed three sets of paired hearths of which those of Burn 1 and 2 were determined to have been fired at different times, but given the isolation of the third set, its time of use could not be established relative to the other hearths. When compared to wind direction, the Burn 1 set fails to show a common direction as seen in all the other examples, suggesting that the hearth pattern analysis is in error with respect to these two hearths. The hearths of Burn 2 and Burn 3, however, conform to expectations with hearths with common burn times sharing common wind directions. Moreover, the sector analysis offers a clue as to how the Burn 3 hearths may have fit into the burn sequence of Floor III. The dominant sectors of the hearths in Burn 3 match those of Burn 2 given the way in which wind entering the shelter from the SE wraps around the back-wall and exits from the NE (fig. 11).

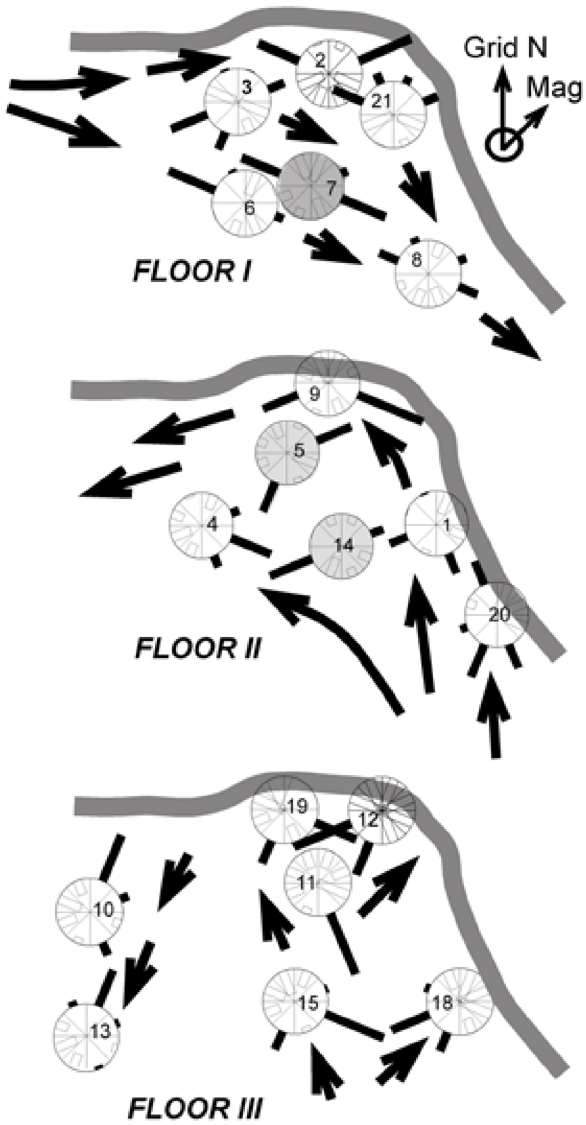

Figure 11 - Diagrams of the hearths of the three floors at Tor Faraj showing the wind directions inferred from variations in the frequencies of artifacts by sector. Note the differences in prevailing wind directions between floors. Multiple wind directions within a floor are thought to denote distinct occupations.

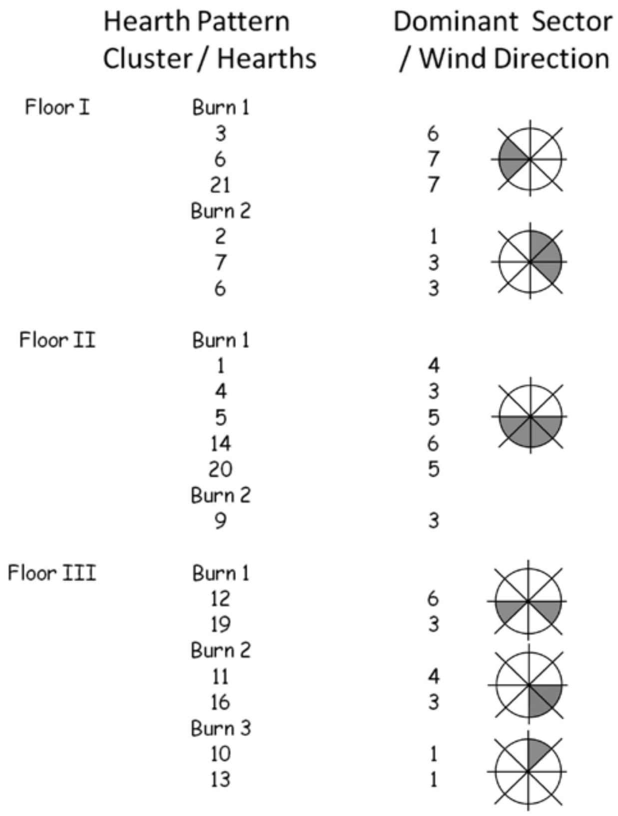

Figure 12 - Comparison of the hearths tied to specific burn events established through hearth pattern analysis and the dominant sectors, relative to artifact densities, of these hearths. Note that if wind direction is inferred from the dominant sector, those hearths associated with a specific burn event are also associated with a common wind direction with exception to Floor III, Burn 1.

Beyond tracing wind direction, a sector analysis of the hearth-side zone also provided a means of estimating the numbers of persons at a hearth. The reasoning here is simply that as additional occupants join a hearth they will leave behind behavioral residue (e.g., lithic artifacts) in the sectors that they occupy. Given human body dimensions, a person squatting at a hearth would likely leave material within one to two 45 0 sectors (fig. 13). Schematic diagrams (drawn to scale) that depict one, three and four persons occupying the 100-140 cm squat zone suggest that more than four persons would likely leave a high density of material in more than four sectors (fig. 13). In using sector patterns as a proxy of the number of hearth-side occupants, however, we need to keep in mind the differences in the body sizes and biomechanics of men, women, and children. For Floor I at Tor Faraj, only Hearth 21 and Hearth 8 display multiple, contiguous or nearby sectors with above average artifact frequencies; a pattern that would be expected for multiple persons positioned shoulder to shoulder around a hearth. While the sector pattern of Hearth 21 points to 3-4 persons having occupied the northern half of the hearth-side zone, the sector pattern of Hearth 8, with a low artifact density sector separating the two nearby high density sectors, is perhaps more consistent with 2-3 occupants situated around the northern portion of the hearth. In Floor II, Hearth 20 shows a similar pattern. Floor III lacks hearths displaying a high density of artifacts in four sectors, but four hearths (Hearths 10 , 13, 15, and 18) show a three sector pattern suggestive of 2-3 occupants each.

Site Structure and Implications

The intra-site study of Tor Sabiha defined a spatial co-variation in the peak densities of artifact classes connected to initial (cores, primary elements) and final (tools, points) lithic reduction. This implies a simple site structure of overlapping activities and is consistent with the intersite evidence for the site that points to a small, ephemeral occupation largely provisioned for activities. However, we presently have no way of knowing with certainty if the spatial distributions accurately trace a single occupational event or the combination of multiple, overlapping occupations, the palimpsest effect.

The research at Tor Faraj, emphasizing a high resolution spatial analysis, traced three stratified floors with discrete segregated activity areas indicative of a complex site structure. Several lines

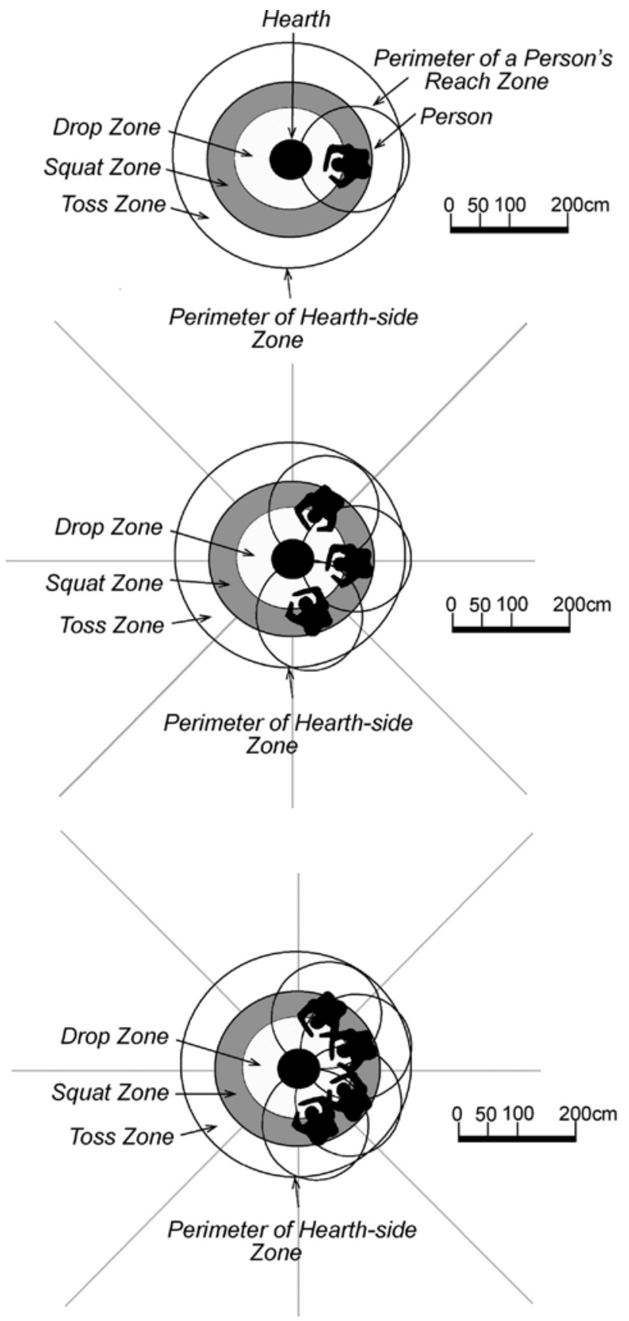

Figure 13 - A schematic of the structure of a hearth-side zone showing the relationships of the sub-zones and their metrics with one, three, and four-persons seated about a hearth.

of evidence were explored in the study to specifically evaluate the integrity of the living floors relative to post-depositional disturbance through natural agencies. These included the examination of the specific sedimentary processes that formed the artifact bearing deposit, the degree that artifacts were sorted by size, the orientation and plunge of the long-axes of elongated artifacts, the degree of weathering or ablation of the surfaces of artifacts, the spatial distributions of behaviorally meaningful artifacts, the distributions of artifacts in three-dimensional space, the distribution of refitted artifacts, and the presence and condition of archaeological features. In addition, novel approaches, involving Hearth Pattern Analysis and Ring and Sector analyses, were employed to assess the degree to which the palimpsest problem may have impacted the spatial integrity of the floors. These hearth- related approaches were also used in developing estimates for the numbers of hearth-side occupants and concomitant group sizes. In combination, the high resolution study showed the living floors to have integrity and represent very brief intervals of discrete occupational events.

Summary and Conclusions

Intersite and intrasite data collected from area-wide and site specific studies in southern Jordan point to behaviors not traditionally viewed as those associated with the Middle Paleolithic or Neanderthals. The area-wide research traced a transhumant settlement pattern in which Late Levantine Mousterian groups moved seasonally between low and high elevations accompanied by shifts in their group sizes, mobility levels, and provisioning strategies. Of particular importance here, was the apparent practice of supporting the long-term winter occupations of lower elevation rockshelters (such as Tor Faraj) by larger, coalesced groups through a logistical procurement strategy that involved the provisioning of a place. This was associated with the lithic processing of chert nodules imported in bulk from distant sources resting well out-side site catchments. High elevation encampments (such as Tor Sabiha), occupied by small, ephemeral groups were supported through opportunistic procurement that largely involved provisioning of activities from chert sources within the site catchment. These settlement- procurement strategies involved both adjustments and scheduling in the decision making of these Middle Paleolithic foragers and, in turn, this indicates both flexibility and planning depth in their thinking.

When combined with intrasite evidence the research suggests co-variation between the long-term winter occupations supported logistically and complex internal site structures defined by spatially segregated activities. In contrast, the small, ephemeral occupations situated at high elevations during the warm season and supported opportunistically appear to have been linked to a simple site structure, defined by a single locus of spatially overlapping activities. Although the critical evaluation of the presence of living floors did not provide unambiguous support for a floor at Tor Sabiha, diverse lines of evidence were consistent in pointing to the presence of three stratified floors at Tor Faraj.

This is important in that it is the complex site structure of the floors of Tor Faraj that is thought not to emerge until the Upper Paleolithic in modern human occupations. From the perspective of behavioral organization, the site structure at Tor Faraj suggests that the inhabitants of the shelter conceptually labeled specific places for conducting certain activities such as preparing and cooking foods, sleeping, initial or final lithic processing, butchering and so forth. The use of Area A, Floor II, for core shaping and blank production at Tor Faraj underscores the conceptual labeling of that locus. In addition to the initial core processing from nodules, thick flakes were returned to Area A for recycling as cores. Thus, chert nodules imported to the site from distant sources and thick flakes returned for recycling as cores were introduced to same place for shaping and blank (mostly Levallois point) production. This clearly indicates that the shelter's Archaic occupants conceptually labeled Area A as a specific place for primary processing regardless of the chert source and it seems highly unlikely that their reason for doing so was conditioned by the natural constraints of the shelter or the biomechanics or expedient behaviors of its occupants.

Researchers have speculated that various modes of behavior related to planning depth, land-use strategies and social organization were underdeveloped in Neanderthals, rendering them less successful when faced with competition from modern humans. The notion of a social brain (Dunbar 1998) provides another dimension to examine the ways in which Neanderthals organized their behaviors in comparison to modern humans, especially as this is related to group size and composition, settlement-procurement decisions, the use of living spaces, and fire (Dunbar *et al*. 2010). In many ways, these notions parallel those advanced by E.O. Wilson (1998) in which selective forces come to generate epigenetic rules (incest avoidance, innovation, status, territoriality, etc.) governing certain heritable behaviors or as in the concept of a social brain heritable predispositions for certain behaviors (e.g. group awareness, networking, altruism, management of fires, etc.). Where advances in our understanding of the Neanderthal genome may well trace some of the genetic origins of cognitive differences between Archaic and modern humans, such paleogenetic advances will ultimately need to be evaluated in conjunction with basic archaeological investigations involving regional, landscape approaches accompanied by high resolution recovery of behavioral events within thin slices of time. In the study presented here it seems clear that the hominins associated with the Late Levantine Mousterian sites in the study-area organized their behaviors at inter- and intra-site scales very much along the lines of modern humans.

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LEVALLOIS POINTS PRODUCTION FROM EASTERN YEMEN AND SOME COMPARISONS WITH ASSEMBLAGES FROM EAST-AFRICA, EUROPE AND THE LEVANT

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Introduction

The recent discovery of evidence for the production of Levallois points in Hadramawt, in the east of Yemen, marks a milestone in the development of definitions of the Palaeolithic in the Arabian peninsula. These industries, still undated, but very likely from the Middle Palaeolithic, are currently almost exclusively documented by cores found on the surface of several sites at the top of the Hadramawt limestone plateaus.

The scope of this paper is to structure, in a preliminary approach, the Levallois production schemes observed in Yemen. This work is based on a still limited corpus of materials and might be somewhat arbitrary. Further investigations will show which of the production schemes present in fact reflect the prevailing southern Arabian mainstream. This study of the last phases of production on the cores allowed six production patterns to be identified, which show the making of two types of Levallois points; the so-called "classical" points and "constructed" points. These patterns reflect a variability of production within the limited geographical area in which this study has been conducted.

Through a comparative approach with other sites of production of Levallois points in neighbouring and more distant regions (East Africa, the Levant and Europe), we attempt to determine to what extent the production of Levallois points displays technical, and therefore cultural, similarities in the Hadramawt and around the world.

Palaeolithic of Arabia

In-depth studies on the Palaeolithic in the Arabian Peninsula are relatively recent, compared with those in Europe, Africa or the Levant. In recent years, the multiplication of excavations and survey operations on surface sites in southern Arabia (Amirkhanov 2006; Crassard 2009a; Delagnes *et al.* 2008; Rose 2006) implies many discussions and reflections on the role that this region could have played during prehistory (Amirkhanov 2008; Crassard 2008a, 2008b, 2009a, 2009b; Marks 2008; Rose & Bailey 2008; Petraglia & Rose 2009).

As regards more particularly the Middle Palaeolithic, the first studies on lithic materials indicate a relatively abundant presence of remains from this period in Arabia. These vestiges are mainly evidenced by lithic industries of the Levallois tradition. They come mainly from surface sites and, in this case, their high degree of patina confirms Pleistocene dating without much doubt, although this criterion should be considered with caution (Crassard 2009a). The problem remains to date this material radiometrically and to be able to find archaeological contexts that combine Levallois production with human and faunal remains. This would associate the industries with a chrono-cultural frame and would allow us to learn more about the Middle Palaeolithic knappers' environment, as well as the nature of the population and its dispersal: what origins and what species? While awaiting more details, which will be provided by the excavation of stratified sites, it is essential to provide a first comparative element, at intercontinental and micro-regional scales, from our sole source of information: lithic industries, and more particularly the Levallois points industries, which are relatively convenient to identify and therefore to compare.

The production of Levallois points: definition and geographical distribution

The Levallois concept

The Levallois concept consists in producing in a predetermined manner flakes, blades or points, thanks to the implementation of different methods of flaking (*débitage*) involving technical traditions that can be understood from the study of reduction patterns (Boëda 1994). This concept of debitage was used for nearly 500,000 years, from the African Acheulean until the end of the Middle Palaeolithic, and even in an isolated way during the Upper Palaeolithic and the Holocene. Levallois flake production appears with the Acheulean, at isotopic stages 10 and 9, but is generalised to the Middle Palaeolithic from stage 8 (Delagnes *et al.* 2007). The Levallois concept has been widely described and illustrated through the study of various assemblages (e.g. Bordes 1961; Boëda 1991, 1994; Delagnes 1992; Van Peer 1992). Levallois production schemes are evidenced on different continents; in Europe, the Middle East and northeast Africa (e.g. Crew 1975; Meignen & Bar-Yosef 1988, 1991, 1992, 2004; Van Peer 1992; Dibble & Bar-Yosef 1995; Meignen 1995; Delagnes & Meignen 2006; Delagnes *et al.* 2007).

In the Arabian Peninsula, the presence of Levallois debitage has been relatively recently identified in Yemen, first by Caton-Thompson (1938, 1953) and then by Van Beek (Van Beek *et al.* 1963), Inizan (Inizan & Ortlieb 1987) and Amirkhanov (1991, 1994). Since then, archaeological studies, including surveys of surface sites, have reported the presence of Levallois debitage in Saudi Arabia in the Jubbah basin (Petraglia & Alsharekh 2003: 675, 677), in the United Arab Emirates in the region of Fili close to Sharjah (Scott-Jackson *et al.* 2008; Wahida *et al.* 2008), in the centre of the Sultanate of Oman with the Sibakhan facies and its rare unipolar convergent Levallois cores (Rose 2006), and in Yemen in Wadi Wa'shah, Wadi Sana and the region of Hadramawt in general (eastern Yemen: Crassard 2008a, 2009a), as well as in the foothills of the Western Highlands at the interface of the Tihamah coastal plain with the sites of Shibat Dihya, including SD1 site in Wadi Surdud (Delagnes *et al.* 2008). This last site apart, which is dated by OSL method to around 60 ka BP, the Levallois presence in Arabia is not precisely dated.

Definition of the Levallois points production

Within the Levallois concept, a relatively important variability exists in the implementation of knapping operations. Production objectives can also be varied and getting oriented to the obtainment of points. In this case we have to speak of the production of Levallois points (*débitage Levallois à pointes*), recurrent or not, which aims at the making of triangular flakes, sometimes standardised.

It was in 1961 that Bordes described for the first time the flaking of a Levallois point, from the cores and points encountered in different industries from northern France (Seine Maritime and Somme) and Jordan (the site of Abu Sif). Later, Bordes (1980) described the production of Levallois points according to two modalities of preparation; preparation by unipolar convergent removals, flaked from the striking platform of the future point, or a unipolar divergent preparation by removals made from a striking platform opposite to that of the future point. Bordes also resumed schemes defined on the "Nubian" cores (Guichard & Guichard 1965), of which two types have been distinguished. The first type corresponds to "a Levallois point core characterised by a special technique", which Bordes brings closer to the Levallois point cores with a preparation by two unipolar divergent removals from an opposite striking platform to that of the point, and a second type with an elaborated centripetal preparation on a block of triangular morphology from which will be produced a Levallois point, but not in a "classical" way (Guichard & Guichard 1965:68-69). For Bordes, the objective of this second scheme is not the production of a Levallois point, but a triangular flake. A few years later, a third production scheme was proposed for obtaining a Levallois point, while pointing out the existence of many variants (Inizan *et al.* 1995:69). This scheme is the production of a Levallois point resulting from a strict bidirectional preparation. More recently, from the material found on the site of Umm el-Tlel (Syria), Boëda illustrated the diversity of the procedures implemented for the production of points (Boëda *et al.* 1998). After analysing the points and sub-products, Boëda defined two main groups: the so-called "three hits" (*trois coups*) points (that we qualify here as "classical" points), which are distinguished from the "constructed" points in which different schemes coexist depending on the direction of the preparation removals. Furthermore, Boëda had previously proposed around 30 theoretical patterns of Levallois "three hits" points production, from an experimental corpus (Boëda 1982), an approach previously developed by Crew (1975). It is important to emphasise the heuristic value of such a study, allowing us to consider the variability of the Levallois concept despite the existence of a single objective, that is, the production of "classical" points.

Geographical distribution of Levallois points production

The production of Levallois points seems less geographically widespread than the production of Levallois flakes (fig. 1). It is especially attested in Eastern and Western Europe (OIS 7 and 6). At the Koulichivika site in Ukraine, and in the Bohunician in general (Meignen *et al.* 2004) the Levallois points show great morphological variation and are produced by the exploitation of the surface and then the thickness of the block, after a bidirectional or bipolar preparation. In the north of France, a few assemblages from open-air deposits have shown a production of Levallois points (Bordes 1954; Vallin 1988, 1992; Delagnes & Roppars 1996; Watté *et al.* 1999; Locht *et al.* 2000, 2001, 2002, 2003). Like the majority of the Levantine assemblages, the classical production scheme (unipolar convergent) is the more common; for instance, the lithic material from the site of Houppeville (Vallin 1988, 1992), the B assemblage from Le Pucheuil (Delagnes & Roppars 1996), the N2b layer at Bettencourt-Saint-Ouen (Locht *et al.* 2001; Locht 2002) or the sector 1 at Le Petit-Saule (Locht *et al.* 2003). Only the collection from Therdone site (189–167 kaBP, Locht *et al.* 2000) differs from this set of Levallois points from the north of France by the presence of a greater diversity of patterns of preparation of the convexities: preparation by unipolar convergent removals, sometimes reworked by distal removals; preparation by unipolar opposed and bidirectional removals; or preparation of the convexities by centripetal removals (Gadebois 2006). In the Rhone Valley, if some industries have points that are morphologically close to the Levallois point (at Mandrin, at Néron layer III: 43 ka BP and at Abri du Maras), their realisation seems to be far from the Levallois concept, according to Slimak (2004).

The production of Levallois points is relatively abundant and characteristic of some assemblages from the Levant (OIS 4 and 3), from the Lebanese sites of Ksar Akil (Meignen & Bar-Yosef 1998, 2004) and Bezez Cave (Copeland 1983), from the Israeli sites of Rosh Ein Mor (Marks & Crew 1972), Abu Sif (Neuville 1951; Copeland 1975), Tabun (Copeland 1975; Jelinek 1982; Meignen & Bar-Yosef 1988), Kebara (layers IX and X : 64–48 ka BP, Meignen 1995, Meignen & Bar-Yosef 1988, 1991, 2004; Meignen *et al.* 2006), Qafzeh XV (Hovers 1997) and Amud Cave (layer B1 : 58–53 ka BP, Watanabe 1968, Hovers 1998; Meignen 1995), or from Jordan at Tor Faraj/Tor Sahiba (69–44 ka BP, Henry 1995, 1998, 2003; Meignen 1995) and in Syria at Umm al-Tlel (65–50 ka BP for layer VI3b', Boëda *et al.* 1998). In most cases, concerning the production of elongated points or

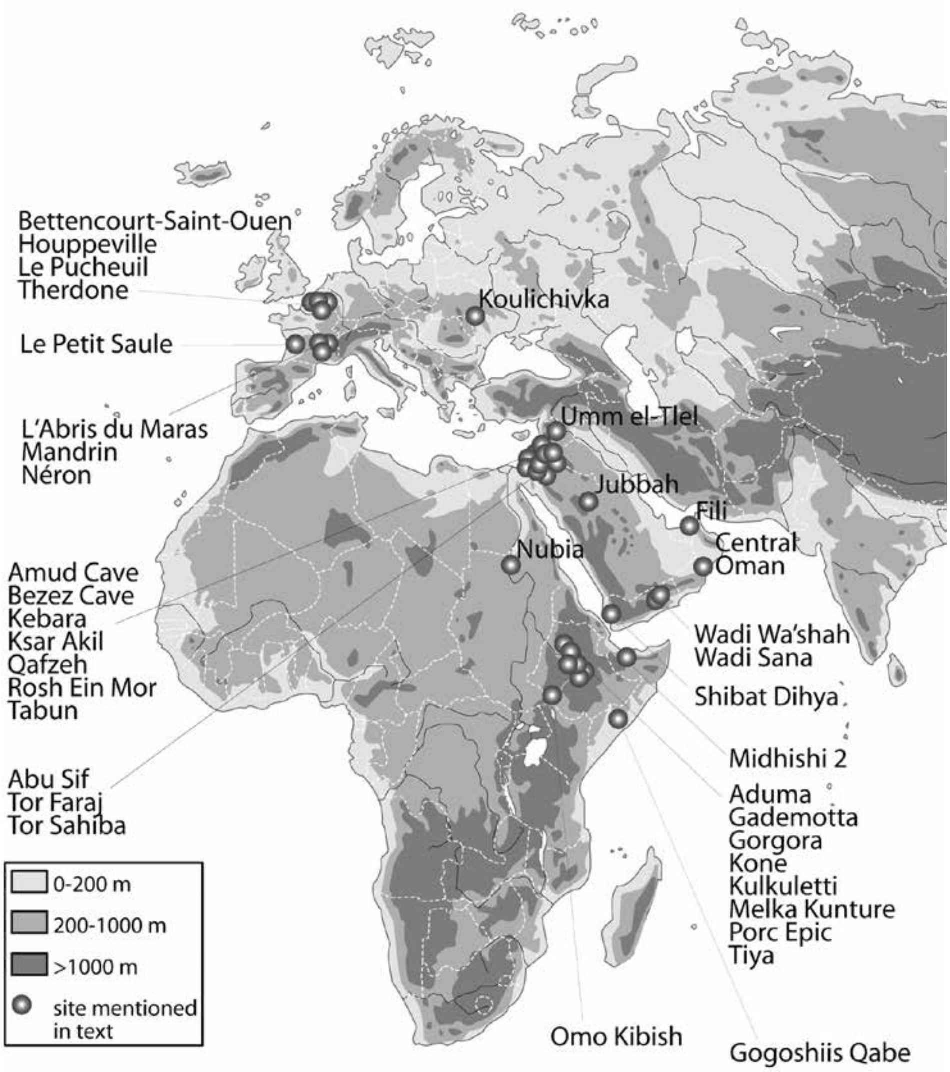

Figure 1 - sites mentioned in text, of the Levallois points productions.

shorter wide-based points, the convexity is created by a unipolar dominant removal, or sometimes by two proximal unipolar convergent removals, even if some of the Negev series testify to the existence of a preparation from the distal part (Meignen & Bar-Yosef 1988). The site of Umm el-Tlel seems characterised by more varied preparation schemes (mainly unipolar convergent, sometimes recurrent, centripetal, bipolar, orthogonal) (Boëda *et al.* 1998).

The production of Levallois points is also attested in Nubia and Egypt during the Middle Stone Age (with very little chronometric data, these are dated between 300 and 50 ka BP), but the evidence is much less abundant than in the Levant. Preparation types are very different from those encountered in Levantine deposits: either centripetal (in reference to Nubian debitage type 2) or unipolar from the distal part of the core (Guichard & Guichard 1965; Hours *et al.* 1973; Van Peer 1992). In the Horn of Africa, several sites have delivered assemblages featuring Levallois points. This is particularly the case in Ethiopia at the Gorgora rockshelter (no dating, Moysey 1943; Leakey 1943), or at Pork-Epic Cave (70–60 ka BP, Clark *et al.* 1984, Pleurdeau 2001), where they are uncommon and come from a unipolar convergent management, more rarely bipolar (Pleurdeau 2003), or of a Nubian type as at Kone (no dating, Kurashina 1978). Industries that have shown a significant number of Levallois points are known in northern Somalia at Midhishi 2 (no dating, Brand & Gresham 1989). Some points have been found at Omo Kibish (site AHS 195±5 ky, Shea 2008). The lack of technological descriptions of these finds means it is not always possible to determine which method was used to obtain these points.

In the East African MSA tradition, tools are characterised by points with unifacial and bifacial retouch on blanks likely Levallois, as is the case at Gademotta (ETH-72-8B before 276±4 ka BP, Wendorf & Schild 1974; Nubian at ETH-72-6 after 183±10 ka BP, Morgan & Renne 2008) and at Kulkuletti (200–300 ka BP, Wendorf & Schild 1974) and Tiya (surface, Joussaume 1995), Aduma (100–80 ky, Brooks *et al.* 2005), Melka Kunture (Garba III, Hours 1976), Gorgora (Leakey 1943) and in Somalia at Gogoshiis Qabe (no dating, Brand & Gresham 1989; Clark 1988). The great difference between these and the Levantine Middle Paleolithic is a much less systematic production of Levallois points during the East African MSA.

The production of Levallois points in Hadramawt, in the east of Yemen, presents a relative diversity of reduction patterns. Careful analysis of the material gathered during surveys allows us to complete the production models proposed by our predecessors and emphasises a greater diversity of the already known production modalities. Here, the proposed study details and refines the previously proposed nomenclature (Crassard 2009a), thanks to the contribution of new sites which were discovered during surveys in January 2008. In the future it will be interesting to confront the different reduction patterns in the production of Levallois points that are known in Hadramawt with a broader geographical context, in order to identify any technical similarities between these industries and those from East Africa, the Near East and Europe.

Production of Levallois points in Hadramawt region: context of discovery and presentation of the studied assemblage

Hadramawt, covering part of the centre and the east of Yemen, is a region of limestone plateaus formed during the Palaeocene and Eocene which can reach altitudes of more than 1000 m. Erosive activity over the millennia has formed an impressive network of canyons and steep valleys. Two main areas have been selected in this study; Wadî Wa'shah to the north and Wadî Sana to the south, two wadis located on either side of Wadî Hadramawt (or Wadî Masîlah), whose orientation follows a west–east axis.

The sites that have delivered cores for Levallois points are located at the top of the limestone plateaus. They were discovered during archaeological operations in two distinct projects; The Roots of Agriculture in Southern Arabia Project (RASA) in Wadî Sana and the French Archaeological Mission in Jawf-Hadramawt (HDOR) in Wadî Wa'shah. A total of 27 surface sites with artefacts reflecting the production of Levallois points have been studied (18 by HDOR and 9 by RASA fig. 2). They were mostly characterised by the discrete presence of lithic industries directly found on the surface. These Levallois debitage collections very rarely included typical Holocene pieces (arrowheads, less patinated lithic material). A few sites, however, delivered abundant material bringing together several lithic production phases (reduction flakes, Levallois flakes and points, etc.), but unfortunately in a context too uncertain to make an accurate study of all the vestiges. It has thus been decided to focus this study on some cores and points, and therefore on the very last visible phases of the Levallois production, visible through the removal scars on the abandoned cores. A total of 50 cores used for the production of Levallois points has been analysed, with the four Levallois points that have been collected. Well aware of the limits inherent in the almost exclusive analysis of cores in the general understanding of schemes of production, nevertheless it seemed interesting to deliver here our observations which, to our mind, participate in the recognition of a greater diversity of the schemes of production of Levallois points realised by prehistoric human groups.

Analysis of the cores for Levallois points from Hadramawt

In previous studies (Crassard 2007, 2008a, 2009a), the different procedures attested by the Levallois debitage in Hadramawt

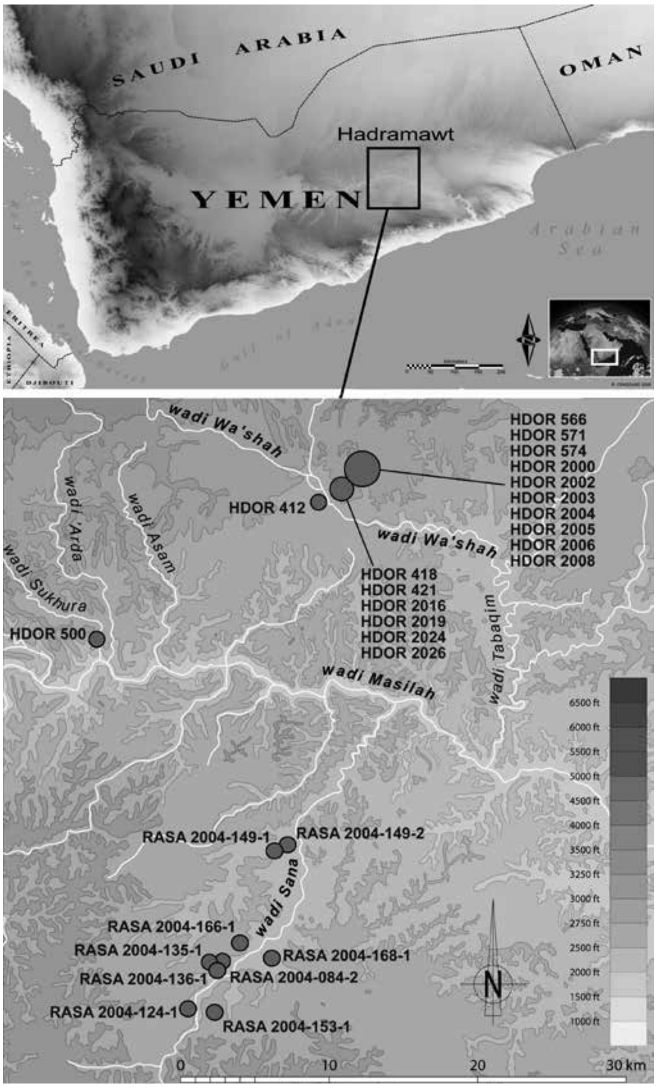

Figure 2 - Sites from Hadramawt, Yemen, where Levallois points production has been documented.

have been defined through three broad categories: Group A for the Levallois debitage with one (or two) preferential flakes, Group B for the Levallois debitage of points, and Group C for the centripetal recurrent Levallois debitage. Groups A and B include several modalities. We resume here Group B, which brings together the procedures for obtaining Levallois points. Thus, to the four previously identified schemes (B1, B2, B3 and B4, Crassard 2007), a fifth one has been added (B5), while group B2 has been associated with group B1.

The categories of points production have been established based on the direction of the preparation removals seen on the debitage surface of the cores. The categories are divided into subgroups based on the absence or presence of scars which accentuate the distal or lateral convexities by removals of more centripetal directions (fig. 3).

Thus, we find patterns corresponding to the "classical" points and to the so-called "constructed" points from Boëda's work. However, we preferred a first-level categorisation based on the direction of preparation removals because, regarding the material collected in Hadramawt, some production schemes of the

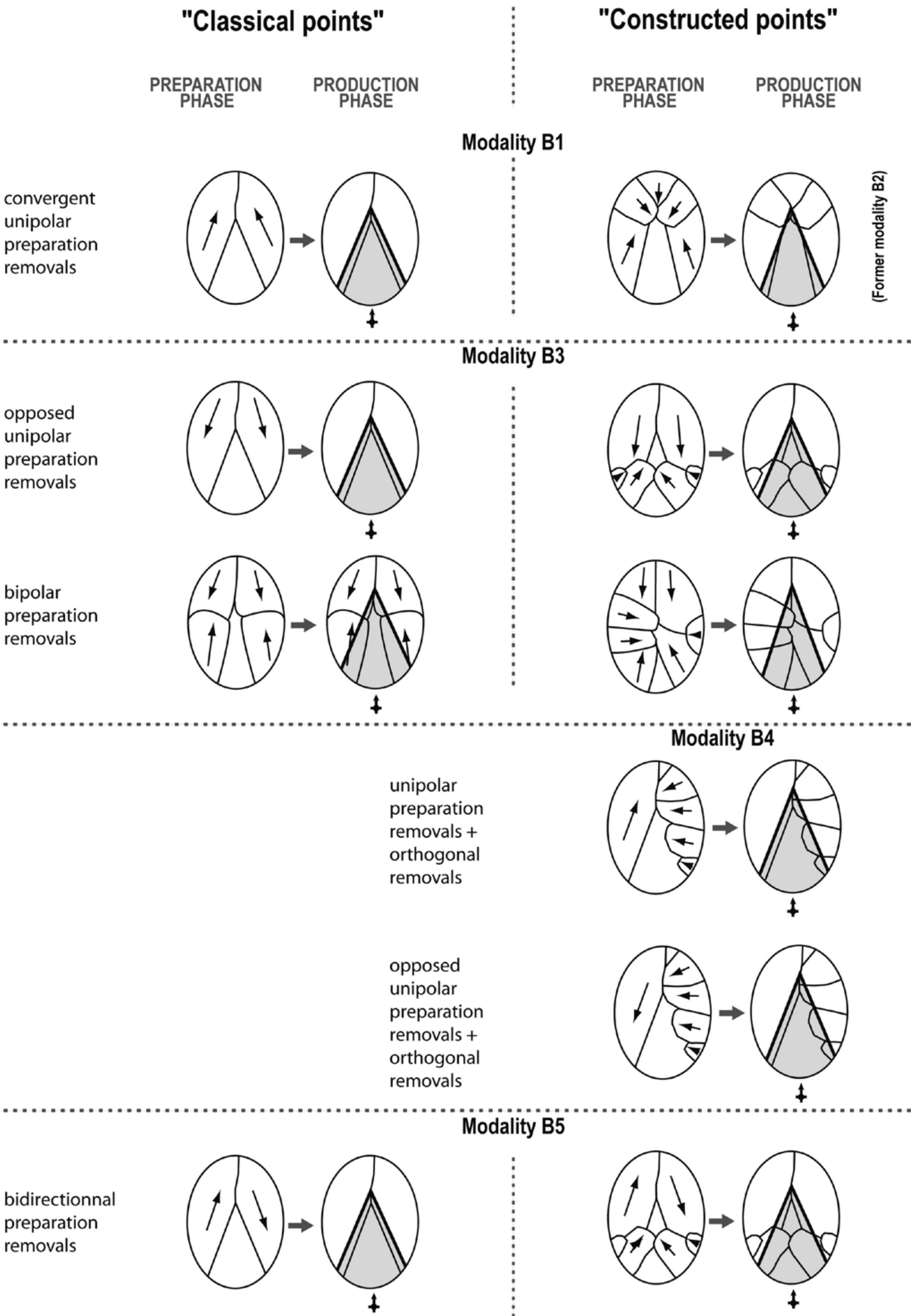

Figure 3 - Group B schemes.

so-called "constructed" points are more an improvement of the production of convexities prior to a truly independent conceptualisation of the production schemes of the "classical" points.

Scheme B1

This is the production scheme of the "classical" points and the one most commonly encountered. It is characterised by the prior production of two convergent unipolar removals from the proximal part of the core. These scars will prepare the lateral and distal convexities (HDOR 2000 No. 1 and 2003 No. 1). This is scheme B1 for "classical" points (fig. 4). In a few rare cases, the two convergent unipolar removals may be accompanied by a few removals that accentuate the distal convexity (RASA 2004-166-1, former scheme B2). They correspond to scheme B1 for "constructed" points (fig. 5).

Scheme B3

Two sub-schemes have been distinguished: B3 opposed unipolar and B3 bipolar.

Scheme B3 opposed unipolar

This first sub-scheme includes unipolar preparation removals from the distal part of the core. They are therefore opposed to the striking platform that will be used for extraction of the point. These two removals contribute to the creation of the distal and lateral convexities, and no other preparation is present. This is thus a production of "classical" points. However, the plunging negative of the point still present on one of the cores shows that the distal convexity is sometimes insufficient (HDOR 2000 No. 2). The cores can then benefit from a new preparation of convexities by some distal and/or lateral removals (HDOR 2005 No. 5). There is then a production of "constructed" points (fig. 6). Around the core HDOR 2005 No. 5, the two unipolar removals from the distal part are still visible, but the right lateral part has undergone a reorganisation of its convexity by the production of shorter flakes of a centripetal direction, which have here hinged. Two removals in the left proximo-lateral part probably allow accentuation of the convexity obtained by the first removal. In this case, the presence of secondary removals seems thus more related to a lack of convexity than to an independent scheme.

Scheme B3 bipolar

This second sub-scheme differs from the first by the presence of negatives of bipolar removals. It is somehow a mixture of schemes B1 and B3 unipolar described above. The convexity may thus be made by a series of multiple bipolar removals from the distal and proximal parts of the core (HDOR 2003 No. 8 and HDOR 2004 No. 1), thereby producing "classical" points (fig. 7). As with previous schemes, when lateral or distal convexities are not quite pronounced, a new phase of preparation is implemented and lateral or distal removals of a centripetal direction can thus overlap the first negatives of removals, thereby causing the knapper to consider the production of "constructed" points. In two of the cores belonging to this category, the lateral centripetal removals overlap bipolar scars, and two others feature lateral centripetal removals overlapped by unipolar or bipolar removals (HDOR 566 No. 1, fig. 8).

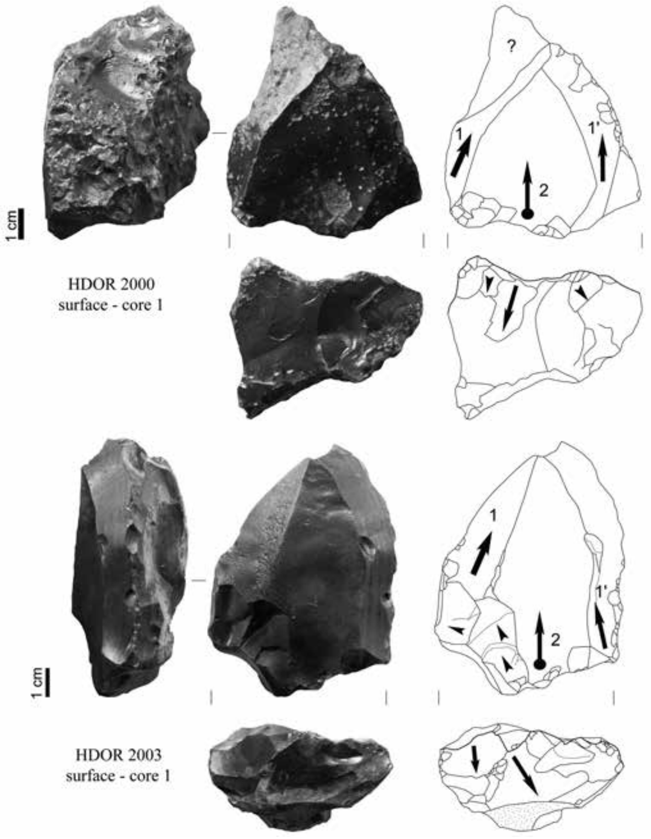

Figure 4 - Scheme B1, "classical" points.

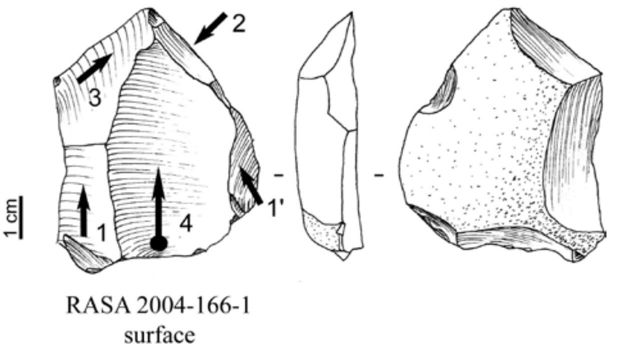

Figure 5 - Scheme B1, "constructed" points.

Scheme B4

By its characteristics, scheme B4 exclusively includes the modalities of production of "constructed" points. It is subdivided into two sub-schemes: B4 proximal and B4 distal (fig. 9).

Scheme B4 proximal

This scheme includes the preparation of a lateral convexity by a major invasive removal from the proximal part (HDOR 2003 No. 5) while the convexity of the opposite side is prepared by shorter removals of centripetal direction. The strict independence of this method from previous schemes is not obvious. The

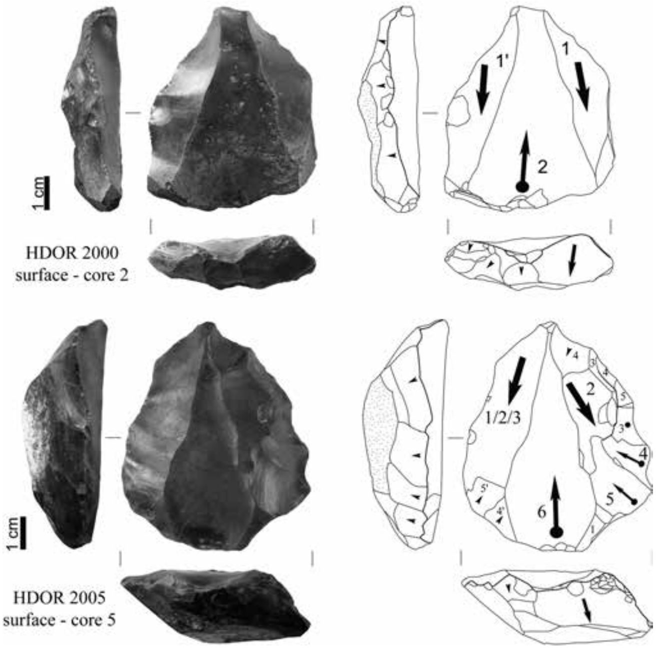

Figure 6 - Scheme B3 opposed unipolar: top, "classical" points; bottom "constructed" points.

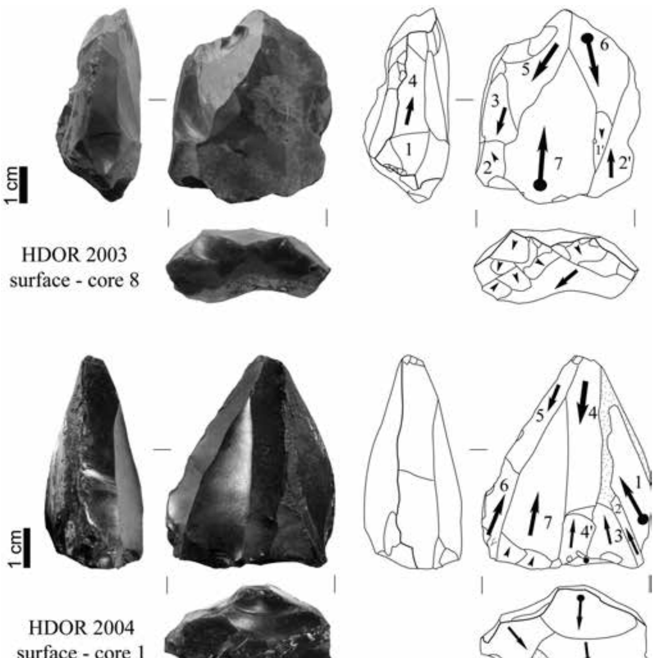

Figure 7 - Scheme B3 obipolar, "classical" points.

centripetal negatives may hide previous, more invasive, unipolar or bipolar removals.

Scheme B4 distal

These show the same preparation of convexities, but this time from the distal part of the core (HDOR 2004 No. 4).

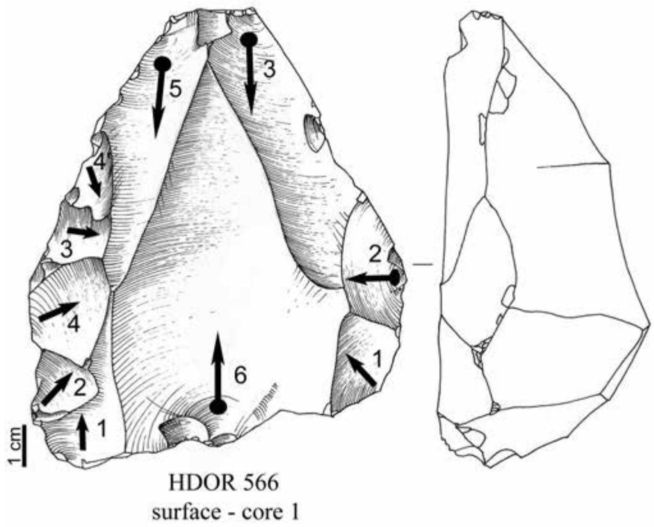

Figure 8 - Scheme B3 bipolar, "constructed" points.

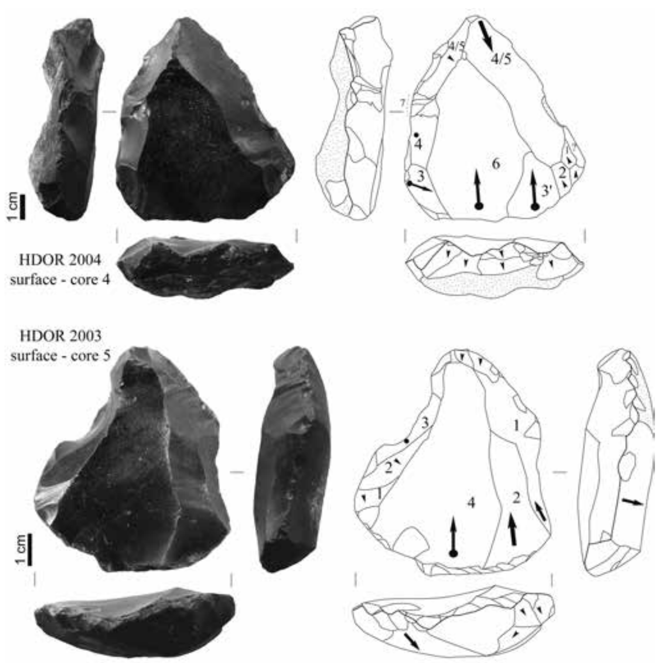

Figure 9 - Scheme B4.

Scheme B5

Its originality from previous schemes is in the preparation of a striking surface by two lateral bidirectional removals (production of "classical" points). One of the cores classified in this scheme could also testify to a recurrent production of bipolar points (HDOR 2003 No. 4).

This schema is fairly widespread (fig. 10) and may be supplemented by lateral removals, emphasising lateral convexities ("constructed" points production). Three cores pertaining to this scheme feature one or two more centripetal lateral removals (HDOR 2016 No. 2 and HDOR 2004 No. 5).

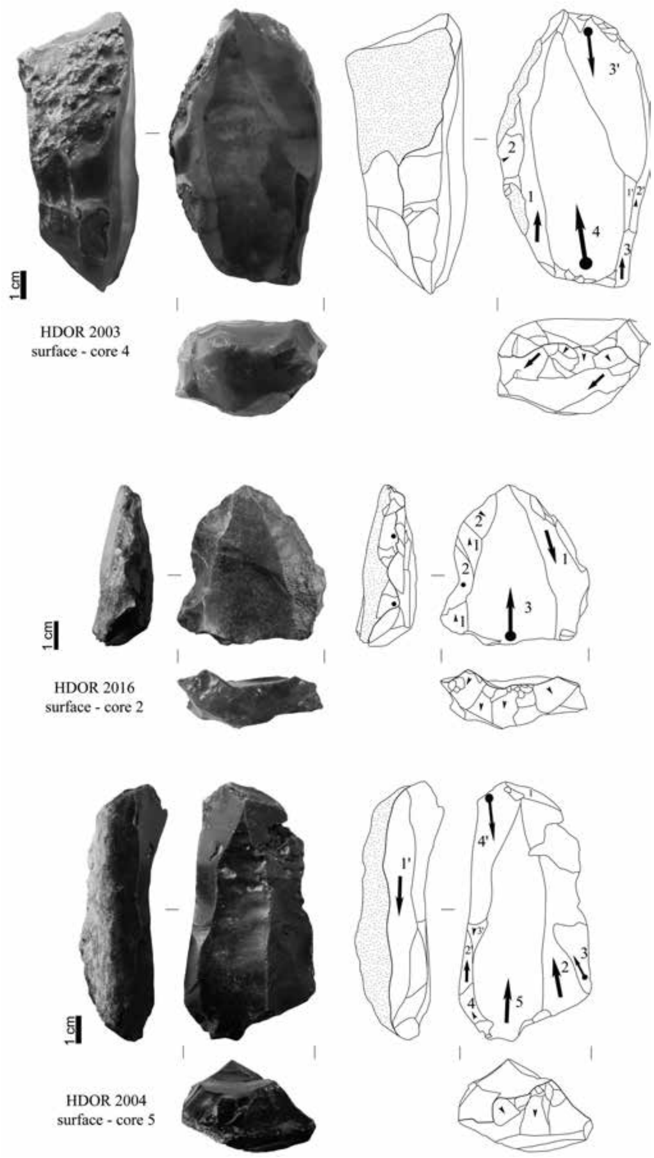

Figure 10 - Scheme B5.

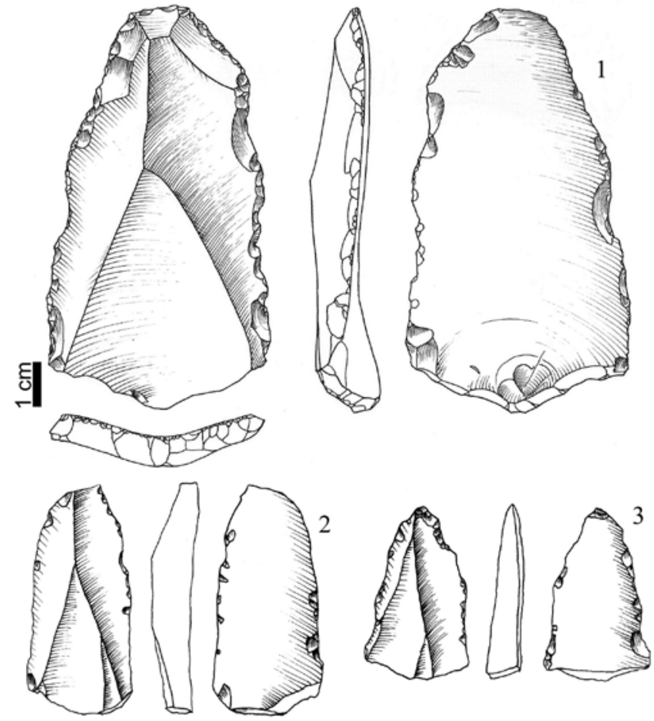

Figure 11 - Levallois points from Hadramawt, Yemen (2 and 3 are proximal fragments).

Production modality	"classical" points	"constructed" points	Total
B1	13	3	16
B3 unipolar	7	2	9
B3 bipolar	6	4	10
B4 proximal	-	1	1
B4 distal	-	4	4
B5	7	3	10
Total	33	17	50

Table 1.

Analysis of Levallois points

The points collected are very rare, just four. Their small number is due to the near absence of these pieces from the surveyed sites. They feature scars of unipolar convergent removals, linking them to the B1 group. One of them contains negatives of removals on the distal part which suggest a more sustained preparation of the distal convexity (potentially linked to the former scheme B2, i.e., scheme B1 for "constructed" points) (fig. 11).

Since the reference corpus of the Levallois points is extremely limited for Hadramawt, it seemed relevant to investigate the morphological and dimensional characteristics of the negatives of points, from the cores themselves. With regard to the morphological characteristics, the negatives of points observed on the cores are rather heterogeneous (fig. 12). A relatively large variation exists in the final shape of the resulting point, being long and thin, wide and short, wide and long, or short and thin. Analysis of the dimensional data (lengths and widths) for each method of production group does not particularly distinguish particular morphometric groups which could indicate a type of product for a particular method of production (fig. 13).

Thus, diversity of preparation schemes seems not to relate to any particular type of point. Accordingly, it is questionable if this diversity is due rather to the shape of the blocks of raw material, to some special technical knowledge, or to the final state of the debitage which does not allow us to identify the possible existence of the different stages of the schemes on a block due to the possibilities or the accidents of knapping that occurred.

Conclusions

Despite a limited number of cores, it was possible finally to identify many procedures for obtaining Levallois points. Such variation in the methods implemented for the production of Levallois points could, however, be typical to the Hadramawt region. At a regional scale, the presence of Levallois debitage

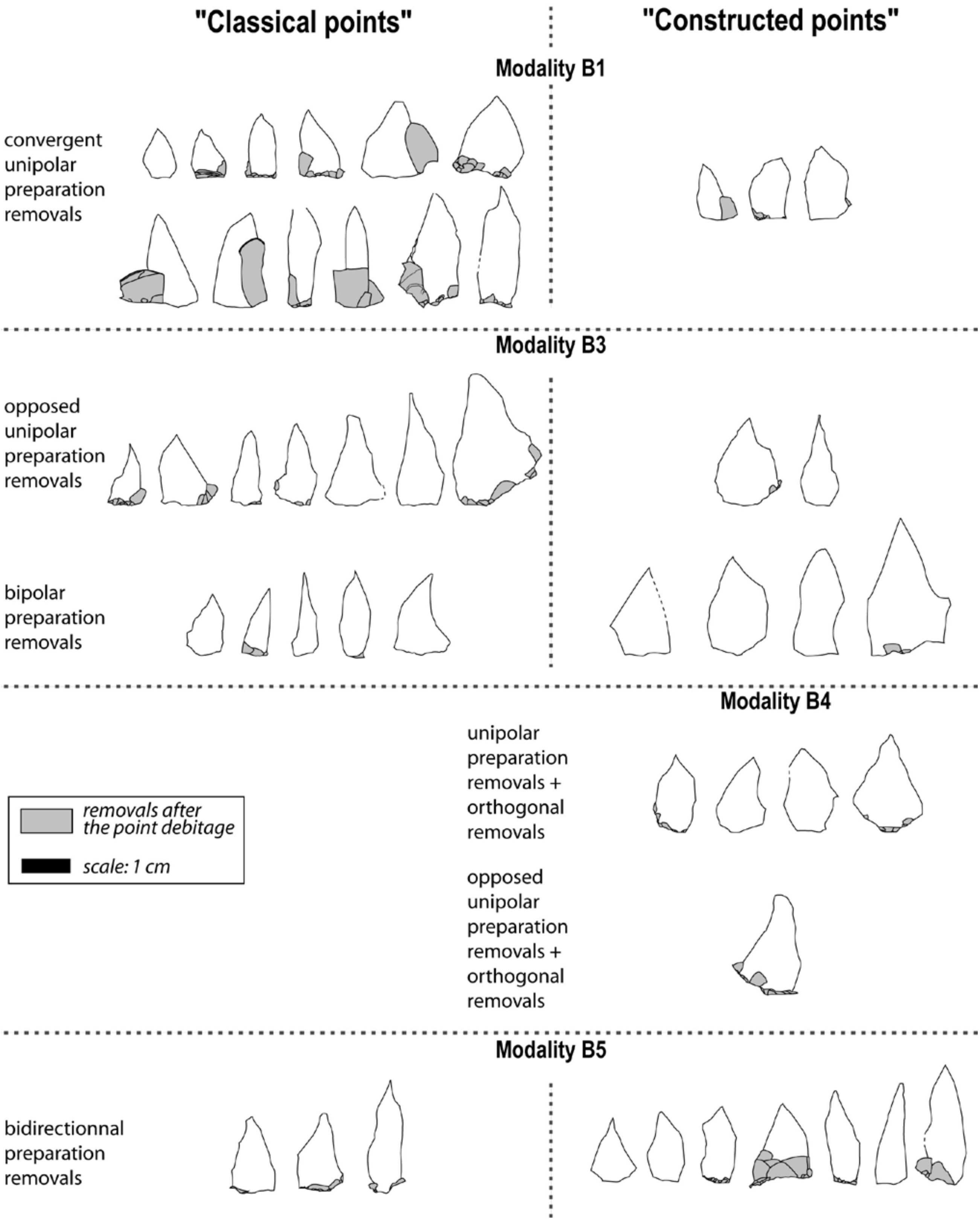

Figure 12 - Reconstructed shapes of Levallois points, from the analysis of the cores.

in general, for making points or not, can be explained by a diffusionist approach. Its presence in the plateaus in the east of Yemen could match the dispersal of the Levallois concept from the African coasts and/or from Levantine regions.
Furthermore, the possibility of an adaptive local development of the knapping modalities is quite likely. From an exogenous population base, future generations could very well have developed their own conceptual systems of preferential productions influenced by types of raw materials and technical or cultural traditions specific to those regions, which would explain the presence of a greater variation and even a greater diversity of knapping schemes in Hadramawt.

If the analysis of the scarce lithic material here cannot answer these questions, it does however offer a few elements of comparison with the assemblages from Africa and the Levant. The first dated archaeological data from Yemen and the first detailed comparisons thus tend to favour the hypothesis of the existence of an area of endemic development in southern Arabia, and this at different times of prehistory (Crassard 2008a, 2009a, 2009b).

Nevertheless it is fair to nuance the scope of this study on the material from Hadramawt region. Indeed, as the results of this analysis are based on a relatively small number of cores and just four points, it seems difficult to rule on the strictly independent character or not of the schemes described here. Do they attest to a real diversity of procedures in the production of Levallois points, or of a mere variation reflecting the adaptation by the knappers to the morphology of the blocks, to the stages of exhaustion of the exploited cores, and to the accidents of knapping? A common reflection with all researchers working on these issues may allow us to apprehend better the archaeological reality, at a micro and macro-regional scale, but also at a purely theoretical scale of the anthropology of techniques.

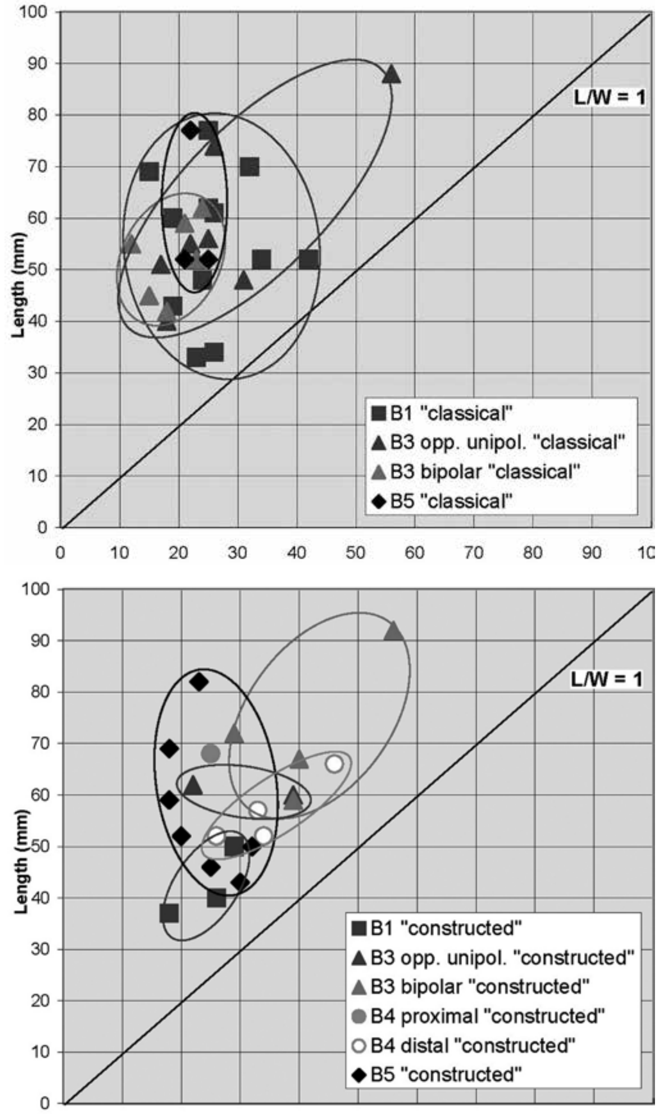

Figure 13 - Dimensions of the points by types (classical/ constructed).

Acknowledgements

We gratefully acknowledge the assistance provided by Dr Abdullah Bawazir, President of the General Organization for Antiquities and Museums of the Republic of Yemen, and his able staff, particularly Abdul-Rahman Assaqaf and Abdulaziz bin Aqil from Hadramawt region. Rémy Crassard thanks the directors of the RASA Project: Joy McCorriston, Erich Oches and Abdulaziz bin Aqil and of the French Archaeological Mission in Jawf-Hadramawt: Michel Mouton and Anne Benoist. For their comments on previous drafts and general discussion about South Arabian, European and East African prehistory, we gratefully acknowledge the help of Pierre Bodu, Anne Delagnes, Katja Douze, Marie-Louise Inizan, Reto Jagher, Liliane Meignen, Michael Petraglia and Jeffrey Rose. Rémy Crassard gratefully acknowledges the Fondation Fyssen and Céline Thiébaut the Fondation des Treilles, both for providing financial support.

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DEVELOPMENT OF A GEOSPATIAL DATABASE WITH WEBGIS FUNCTIONS FOR THE PALEOLITHIC OF THE IRANIAN PLATEAU

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Introduction

In this paper we present a concept for the storage, exchange, presentation and analysis of geospatial, environmental and archaeological data to study and assess Paleolithic settlement systems and subsistence strategies of the Iranian Plateau carried out in the Tübingen Iranian Stone Age Research Project (TISARP). We use Geographic Information Systems (GIS), database solutions and web based technologies to handle and process archaeological and physiographic information. The Project deals with a variety of variables and formats such as geology, geomorphology, landforms, and Paleolithic archaeology in vector and raster as well as table and text formats. The study presents a unique set of archaeological information sampled on the Iranian plateau and its physiographic settings. The structure of the system is aimed at exchanging information and to provide a platform to add information and discuss results and research on the Paleolithic of the Iranian Plateau. Hence, the system is designed to be an international central data focus of all kind of archaeological and related physiographic information to investigate and model with holistic approaches the early human settlement dynamics, subsistent and land use on the Iranian Plateau.

In the past few decades, environmental studies have shown an increasing importance for the interpretation of archaeological processes. In early studies it was already pointed out that the understanding of culture and behavior of ancient populations is related to the natural environment (Smyntyna 2003). Meanwhile for three decades, geoinformatic technologies such as Geographic Information System (GIS hereafter) image processing, remote sensing as well as database systems have been used to complement and enhance archaeological research (e.g. Kvamme 1999; Galiatsatos 2004). The geographical information systems have moved from the domain of computer specialist into the wider archaeological community, providing it with a powerful tool for research and data management (Conolly & Lake 2006). Modern archaeological science depends on large collections of diverse, mundane objects (such as potsherds, stone tools and debris, and animal and plant remains), rather than small collections of treasures (Snow *et al.* 2006). Researchers have used archaeological data sets, and diverse methods, to interpret prehistoric hunter-gatherer behavior in ecological context (Banks *et al.* 2006, 2008).

Modern Iran covers an area of 1.648.000 square kilometers in the Middle East including various environments and land forms, water and raw material resources and heterogeneous topography. Up till now numerous professional Paleolithic archaeological investigations were carried out in the main regions of the Zagros and the Alborz Mountains of Iran (see references cited in Smith 1986; Biglari 2001; Roustaei *et al.* 2004). However, we can point out only a few studies for the Central Plateau (Conard *et al.* 2006; Heydari-Guran & Ghasidian 2011; Biglari 2004). But, compared to the Levant, there is no clear picture of the Paleolithic periods in this part of the world. Most of the investigations were spatially very scattered and they often lacked a clear research design. Due to its pivotal geographic position, most probably, the Iranian Plateau was a major transit route of early humans moving from west to east. This transit route along the Iranian Plateau is bordered by the Persian Gulf and the Caspian Sea from the southern and northern sides (Heydari-Guran 2011) (fig. 1).

The aim of this project is to provide a platform to gather all types of geoinformation specifically, concerning the early human settlement dynamics, subsistence and land use for the Iranian Plateau.

Geospatial information and Paleolithic archaeology

Much, of the data that archaeologists recover is spatial in nature, or has an important spatial component (Wheatley & Gillings 2002). Many Prehistorians concerned with site distributions have noted that a geographical approach is fundamental to spatial analysis (Clark 1977). However, geographical theories of spatial organization have influenced some prehistoric applications, primarily through the concept that the environment presents economic challenges to which that the society must respond with rational planning. To address the objectives of this study highlighted above, a spatial database was created. Thereafter, we carried out geospatial analysis to examine the distri-

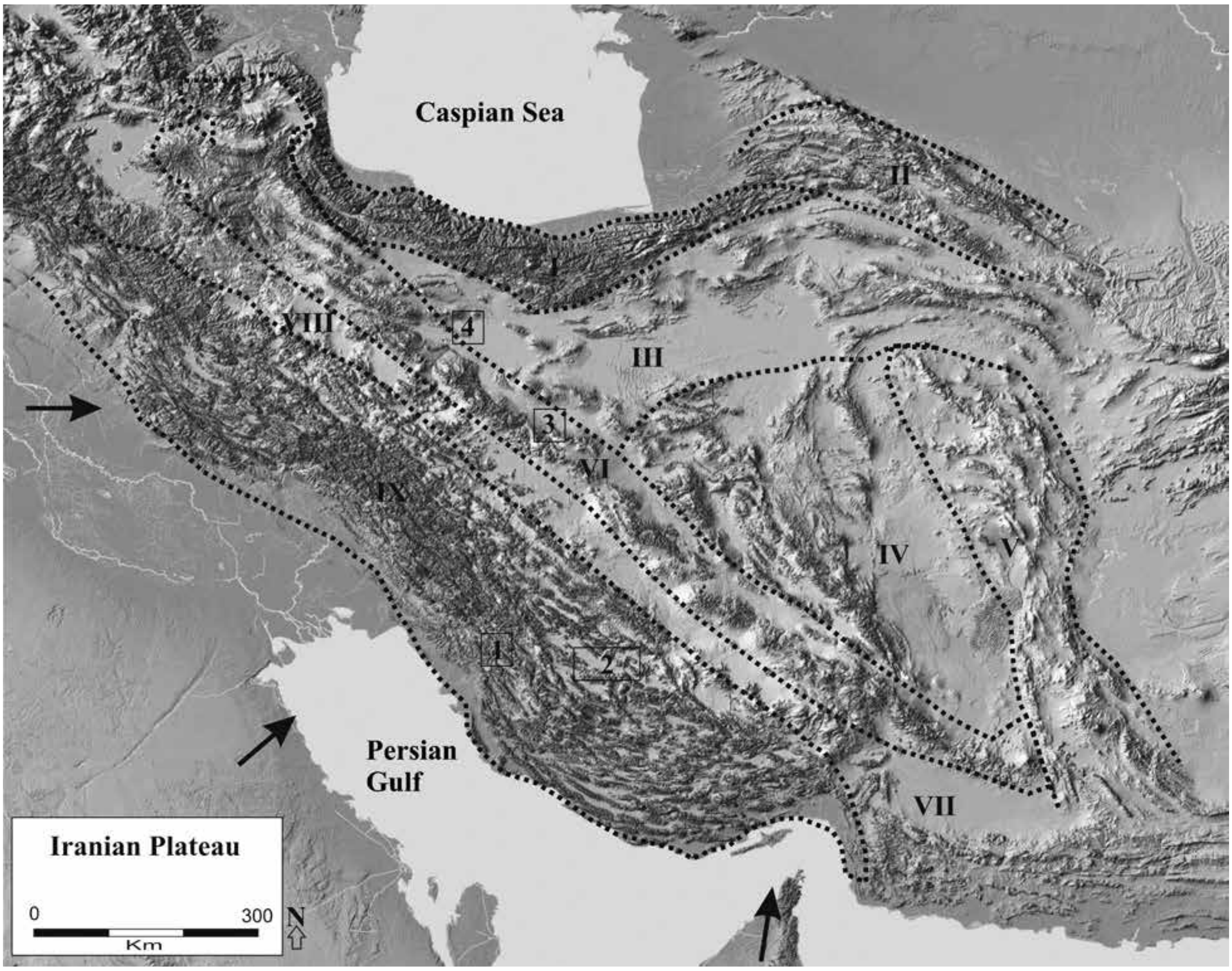

Figure 1 - Landscape structural division of the Iranian Plateau and the regions mentioned in the text. 1: Dasht-e Rostam, Gachsaran Region; 2: Marvdasht and Arsanjan Regions; 3: Arisman Region; 4: Zavyeh Region. I: Alborz Mountains; II: Kopeh Dagh Mountains; III: Central Plateau; IV: Lut desert; V: Eastern Iran; VI: Urumieh – Dokhtar volcanic belt: VII; Makran Mountains; VIII: Sanandaj – Sirjan metamorphic belt; IX: Zagros Mountains. The arrows indicate the most probably migration route of early human to the Iranian Plateau.

bution of Paleolithic sites and settlements across space and through time in relation to the environment. In table 1 some examples of this relationship lists.

The concept that we develop and the related structure for geodata handling, manipulation and presentation will be utilized to answer questions concerning the influence of environmental characteristics such as geology, landform (Heydari-Guran 2004, 2007; Heydari-Guran *et al.* 2009) and hydrology on settlement, dynamics and land use in different landscapes of the Iranian Plateau during Middle and Upper Paleolithic. Subsequently this knowledge we use to develop a predictive model using recorded topographical and geomorphological data to estimate the potential archaeological areas of uninvestigated regions. In this regard we will be able to increase our knowledge of the physical geography of the Iranian Plateau associated with Paleolithic occupations and work toward our goal of developing reliable predictive models.

Methods

In order to create the Paleolithic geoarchaeological database, we set up a spatial relational database realized with the software PostgreSQL (www.postgresql.org). Spatial data was preprocessed with open source software SAGA, R, and ESRI ARCGIS commercial packages. Preprocessing includes plausibility test, geocoding or transformation of data. To guarantee open access, we utilized the PostgrSQL Database with PostGIS support for spatial data objects (http://postgis.refractions.net) in combination with the UMN Mapserser (http://www.umn-mapserver.de). Thus, the data are available for a vast audience via internet. To address the aims of this study, large amounts of spatial data were collected, preprocessed, stored and analyzed. For this purpose all the available data from the previous Paleolithic excavations and surveys of Iran, were transferred to the web based GIS-database system. The latter one can be subdivided in four functional units after Wheatley & Gilling (2002:11):

① The Data Entry subsystem handles all of the tasks involved in the translation of raw data into an input stream of known and carefully controlled characteristics.

② The Spatial Database subsystem for storing spatial, topological and attribute information.

③ The Manipulation and Analysis subsystem takes care of all data transformations and carries out spatial analysis and modeling function.

④ The visualization and reporting subsystem returns the result

Spatial archaeological phenomenon	Geoecological explanation
Distribution of caves and rockshelter sites along the Zagros Mountains	Karstic formations and active tectonic structure
Seasonal hunter-gatherer camp sites within a heterogeneous landscape	Availability of resources
Reconstructing mobility strategies among Paleolithic societies in southern Zagros Mountains	Multi-seasonal or single seasonal occupation
Suggested "Nuclear Zone" for the late Paleolithic periods in the Zagros Mountains	Tendency of early humans to adapt to a specific natural environment
Distribution of open air Paleolithic sites in the Central Plateau of Iran	Existence of sand dunes, travertines and lacustrines deposits with a good archaeological preservation

Table 1 - Examples of relationship of Palaeolithic sites and their environment.

of queries and analyses to the user in the form of maps and other graphics as well as text.

The data entry is providing scanned, digitized, and measured data by Global Positioning Systems (GPS) or field survey. Therefore different data formats such as shapes for vector data, images for raster data and table formats for point data are offered. Data manipulation and analysis is guaranteed by interfaces to the open source statistical software packages as well as open source GIS software like SAGA. The system is implemented on a UNIX based platform (FreeBDS) as well as on windows based desktop computer systems running ESRI ArcMap 9 software, SAGA and R.

The database GIS environment contains two main components. The primary component is the ability graphically to display information that has at least two dimensional spatial attributes (e.g. both a northing and an easting coordinate). Any data that has a spatial component in terms of coordinates is georeferenced (Mickelson 2002). The second component is the geo-relational database. A geo-relational database contains georeferenced spatial data.

Materials and Paleolithic archaeological data acquisition strategy

The first analysis that we conducted to assess the spatial distribution of Paleolithic human settlements rely on Digital Elevation Model (DEM). The DEMs utilized in this first phase of the study are based on SRTM data that was pre-processed with ARCGIS to eliminate artifacts, sinks and no data areas. Then it was passed to SAGA where the terrain analysis was performed. The information yielded was fed into the database WEBGIS System.

This study requires a large detailed database of Paleolithic archaeological attributes of the study region. The database was constructed by acquiring all reasonably available and reliable information on the Paleolithic period. To include this information into the GIS database system a minimum constrain was the presence of spatial attributes or a local site identification code. The database that covers the study areas contains an inventory record on more than 800 Paleolithic archaeological sites and localities. Originally, these data were reported in journal articles, institutional reports and monographs by different authors. This Paleolithic information was coded in GIS (ArcMap 9) utilizing the native dBASE format.

Acquisition and development of environmental data layers

There are three approaches that may be taken to obtain environmental data for GIS projects: acquire existing data layers, collect environmental data directly from the field and construct new data layers from existing maps. Most of the data we collected was in analogue format such as topographical, geological and geomorphological maps. The primary data sources employed in this project are SRTM Digital Elevation Models (DEM) obtained by CIGIAR (http://srtm.csi.cgiar.org). A DEM is a cell-based or raster data layer. Each cell is assigned one elevation value. The DEMS used in this first phase of the study have a 90 m cell size. For a small area where exactly DEMS were generated from digitized topographic map contours with 90m resolution. By terrain analysis other environmental layers can be created from the DEM. Slope, aspect, hydrography (stream network), insolation (solar radiation), and ecological relevant indices like wetness index, transport capacity or stream power (Wilson & Gallant 2000). Moreover, data layers were entirely or partially generated from field work such as GPS points or way points.

Field work

The Tübingen Iranian Stone Age Research Project (TISARP) was established in 2004. From then, TISARP team conducted several field seasons during 2004-2007 in different parts of the country including Tehran, Esfahan, Fars and Kohgiluyeh-Boyerahmad provinces. The team first study area was the sand dunes of Qaleh Gusheh and the travertine localities that lay several kilometers north of Arisman in Esfahan province. Qaleh Gusheh is one small region within the Rig Boland, a belt of mobile sand dunes stretching over 200 km and lying northeast of the Karkas Mountains and southwest of the Latif Mountains. The vast majority of the Rig Boland has not been studied, and TISARP work in the Qaleh Gusheh region represents the first attempt to collect systematic data on the Stone Age sites in this area. Followed by the Paleolithic research done by S. Heydari-Guran, (Heydari-Guran & Ghasidian 2011) in 2004 which resulted to document 18 localities, the TISARP team has confirmed the

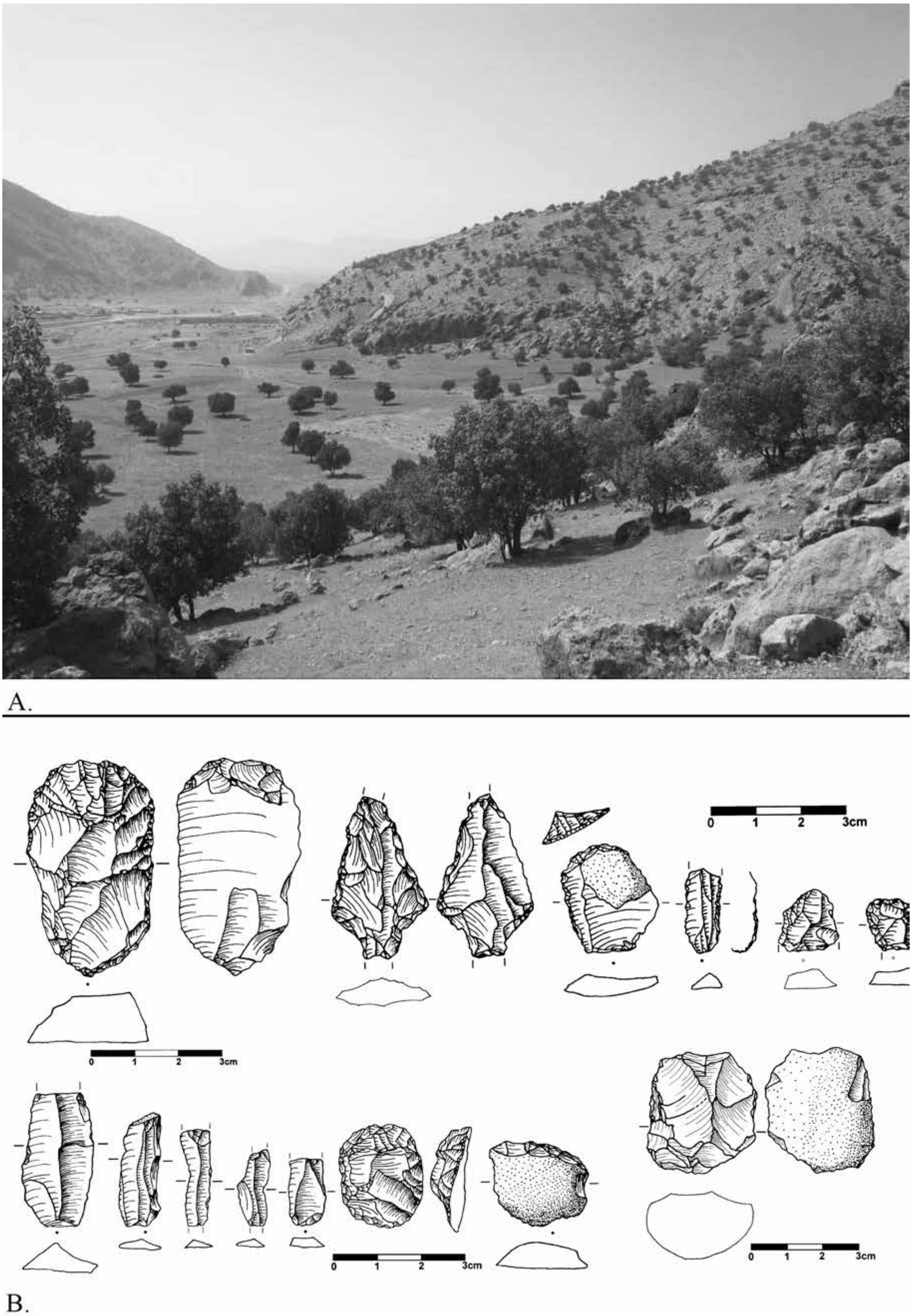

Figure 2 - A: Typical landscape of the Zagros Mountains. View to south overlooking the Baba Guri valley and Paleolithic rockshelter of Zard-Narenjo (Photo: S. Heydari-Guran); B: Examples of lithic artifacts from Dasht-e Rostam-Gachsaran, Southwestern Zagros Mountains of Iran.

high potential of the region during the Paleolithic time and added 8 more localities (fig. 2).

In Fars Province, the TISARP team focused on different regions of Sabz Mountain near the confluence of the Kur and

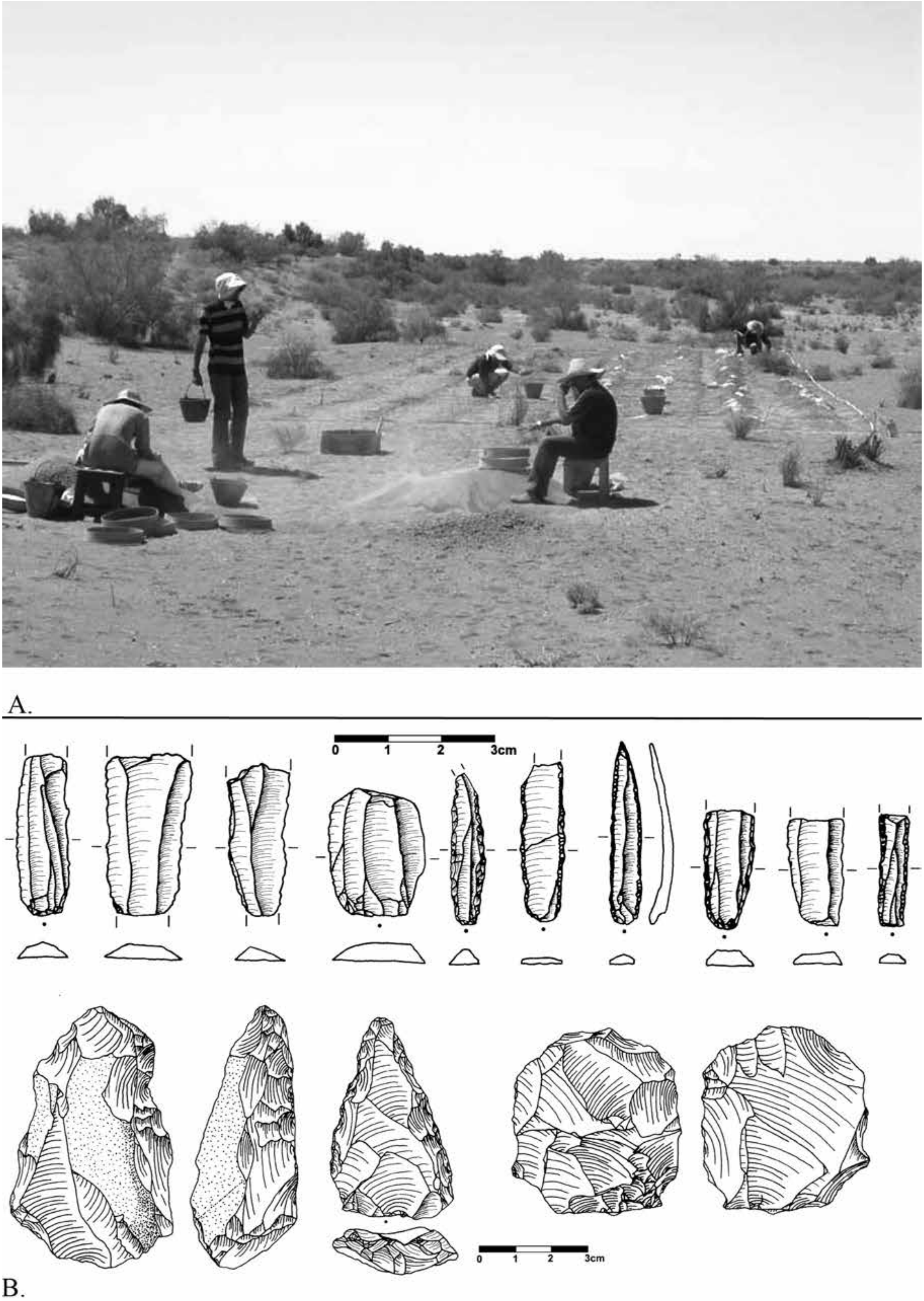

Figure 3 - A: View to east overlooking the Qaleh Gusheh 1; a Paleolithic open air site; Arisman sand dunes. (Photo: N. J. Conard); B: Examples of lithic artifacts from Qaleh Gusheh open air sites, the Central Plateau of Iran.

Sivand rivers, the Tang-e Bolaghi Valley west of the town of Pasargad, Nourabad and Dasht-e Rostam Regions which provided a wealth of new information. The Dasht-e Rostam Region consists of two Plains of Dasht-e Rostam I and II which are connected with the Yagheh Sangar Pass. Here, the numerous strategic sites overlooking the pass between Dasht-e Rostam I and II were attractive spots throughout much of the prehistoric and historic periods (Conard *et al.* 2006). The main focus of

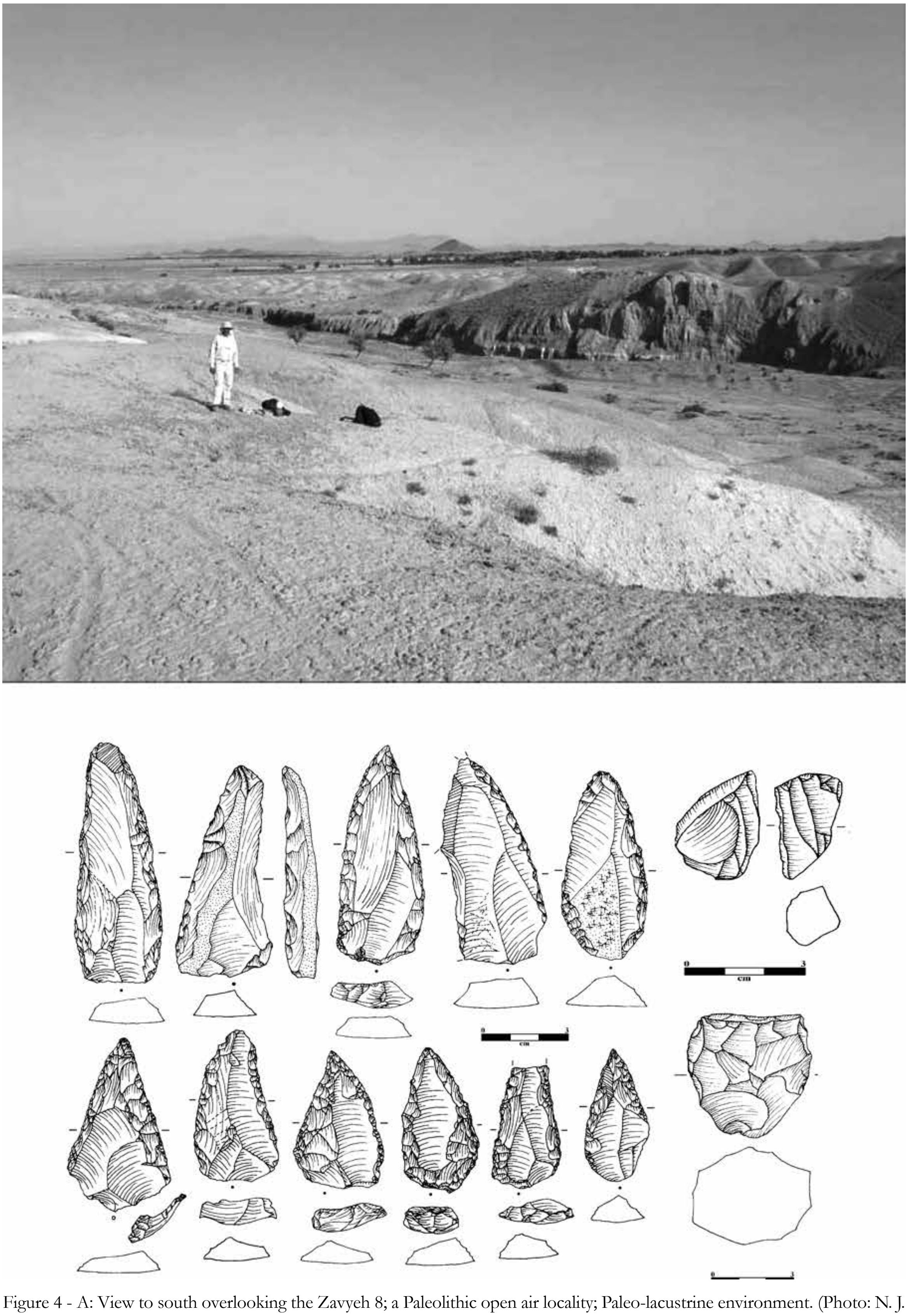

Figure 4 - A: View to south overlooking the Zavyeh 8; a Paleolithic open air locality; Paleo-lacustrine environment. (Photo: N. J. Conard); B: Examples of lithic artifacts from Zavyeh localities, North Central Plateau of Iran.

the TISARP team was the Dasht-e Rostam Region where totally we identified 121 Paleolithic localities. The research design emphasized the collection of artifacts and ecological data for establishing the natural and cultural history of the Dasht-e Rostam (Conard *et al.* in press). Excavating at one of the cave sites at Dasht-e Rostam called Ghar-e Boof during two seasons of 2006 and 2007 was significant for establishing an improved cultural stratigraphic framework for the Paleolithic of the southwestern Zagros and reconstructing Stone Age patterns of land use in this region (Conard *et al.* in press) (fig. 3).

In Kohgiluyeh-Boyerahmad Province, the TISARP team visited several sites to the east of Gachsaran and south of Basht Region including the Khanahmad and Sukhteh areas which were originally identified by A. Azadi of the ICAR in Gachsaran. The team added significantly to the previous lithic collections from these sites and confirmed the prevalence of Late Paleolithic material at both sites (Conard *et al.* 2006).

Building on earlier work by the members of the Tübingen Iranian Stone Age Research Project (TISARP) and other colleagues (Djamali *et al.* 2005; Conard *et al.* 2006; Heydari-Guran *et al.* 2009; Ghasidian *et al.* 2009), the 2006 field season documented the geological setting and cultural affiliation of Paleolithic sites in the Zavyeh Pleistocene lake basin in the Central Plain of Iran located at Tehran Province (fig. 4). This topic is relevant in the context of suggestions that central Iran has a limited settlement history and only a modest Paleolithic record (Smith 1986; Conard *et al.* 2007). The TISARP team plans to continue research in the above mentioned areas especially the Dasht-e Rostam Region and plans to extend the area of study in the framework of the present paper.

Towards a land geoecological classification and terrain analysis

In a large scale study, the Iranian Plateau has been divided into four main physiographic formations and structures as the settings of Paleolithic occupations such as: fluvial, desert, coastal and mountain (volcanic and sedimentary) terrains.

Among the different environmental characteristics, eight fundamental parameters are selected as a part of geoecological analysis which have played important role in the early human settlement systems and dynamics and subsistence strategies. These parameters which have been drawn from DEMs are:
① Elevation above sea level,
② Slope (gradient),
③ Aspect (direction of slope),
④ Curvatures,
⑤ Horizontal and vertical distances to river network,
⑥ Topographic wetness index,
⑦ Erosion deposition zones and
⑧ Stream power index.

As our work continues, these indices will allow us to separate different terrain units with specific process dominance. Other geoecological variables included: geological structure, raw material, climatic zone, geomorphology, maximum relief, soil texture and drainage and the density of marsh, swamp, spring and cliff.

Concluding remarks

The organization of this project was motivated by the important discoveries of Paleolithic caves, rockshelters and open air sites in Zagros Mountains and the Central Plateau of Iran during the field seasons of 2004-2007. The great amount of archaeological information of the Paleolithic sites in different geological contexts including karst topography, sand dunes, travertine and lacustrine formations (Heydari 2007) necessitate the organizing and processing in a data bank associating with the environmental parameters.

The database-web GIS platform is available on the internet under the following address www.roceeh.uni-tuebingen.de/TISARP.html. On the website we provide general information on fieldwork and a link to the web based database with GIS functions. On request we provide public access to the system where you can visualize the spatial data on the Paleolithic of the Iranian plateau.

Web-based geoinformatic tools are powerful exchange platforms and also provide strong analytical tools. Emerging geospatial database for the Iranian Plateau collaborates geoecological information with archaeological data in order to collating archival datasets, providing tools to help, locating, access and contribute data resources and producing regional maps for Paleolithic sites and their surroundings.

The application of geospatial database for Paleolithic sites will help to detect settlements patterns, and landuse in the entire region of the Iranian Plateau. GIS and its tools for geospatial analyses have not been used before for this region, and we look forward to testing relationships of Paleolithic sites and geoecological settings.

Acknowledgements

We wish to thank Professor Jean-Marie Le Tensorer the organizer of the Basel Symposium for Paleolithic Research for inviting us which this paper based on our presentation. We are very grateful to Andrew W. Kandel, for his valuable suggestions on the primary manuscript of this paper. We especially thank Dorota Wojtczak and Daniel Schuhmann for facilitating this publication and their supports. Many thanks go to the anonymous reviewers.

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THE LATE MIDDLE PALAEOLITHIC AND EARLY UPPER PALAEOLITHIC OF THE NORTHEASTERN AND EASTERN EDGES OF THE GREAT MEDITERRANEAN (SOUTH OF EASTERN EUROPE AND LEVANT): ANY ARCHAEOLOGICAL SIMILARITIES?

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Opening Remarks

The Levantine Palaeolithic contains a wealth of anthropological and archaeological data on the dispersal into and out of the region of both Early Modern Humans and Neanderthals. This paper will evaluate some possible interconnections between the eastern Mediterranean data and data on the south of Eastern Europe, the area that is actually geographically the northeastern Mediterranean, representing the so-called Great North Black Sea region with the Crimean peninsula and territories from the Lower Dniester river in the west, across the Lower Dnepr river and the Lower Don river, to the north-western Caucasus in the east (see Demidenko 2008a) (figs. 1 and 2). The comparisons we propose are for the Late Middle Palaeolithic (LMP) and Early Upper Palaeolithic (EUP), in the time range between ca. 55–48/47 and 32–28 ka, based on uncalibrated TL and/or C14 BP dates.

It is important to make such comparisons now because several previous comparisons and suggestions have already been made. First, after the pioneering Palaeolithic investigations in the Crimea and the Levant by G.A. Bonch-Osmolowski and D. Garrod in the 1920s and 1930s, some very general comparisons were made for both Middle Palaeolithic industries and Neanderthal remains in the two regions (e.g. Bonch-Osmolowski 1940; 1941, on the basis of data from the Kiik-

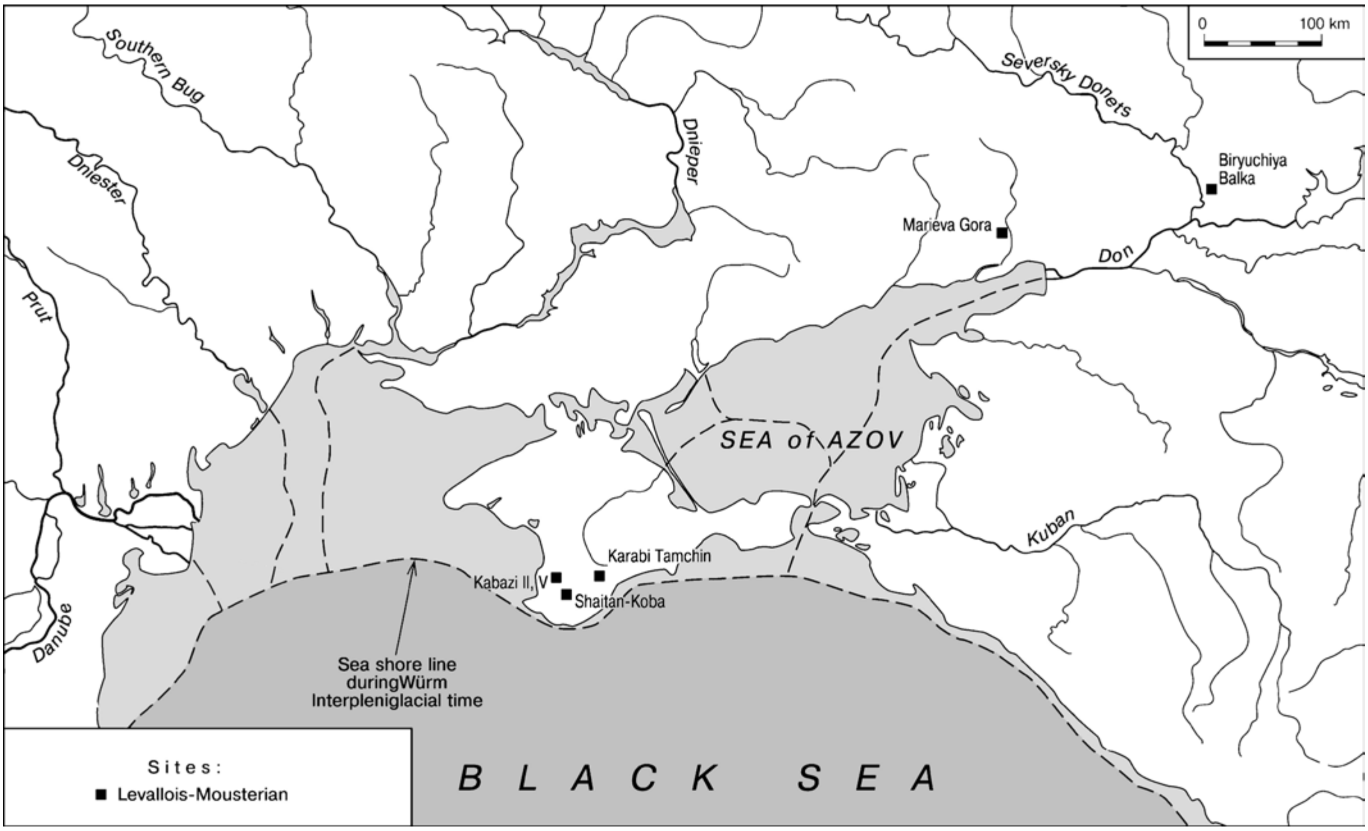

Figure 1 - Site location map of Great North Black sea region Levallois-Mousterian industry.

Figure 2 - Site location map of Great North Black sea region Early / Archaic Aurignacian industry.

Koba grotto). But that was at the time of initial acquisition of the concrete data, when each important site and its materials was almost always compared with other sites from all over the Old World. Second, the discovery of a "rather modern child" within the Middle Palaeolithic cultural bearing deposits at the Starosele site (Crimea) in the 1950s (Formozov 1958) caused some speculations on Middle to Upper Palaeolithic transition and migration ideas in the context of the Qafzeh and Skhul "Proto-Cro-Magnons" found with Middle Palaeolithic artifacts, and the presence of blady "Pre-Aurignacian" industries in the Levant (e.g. Howell 1958, 1959; Bordes 1960). After the later excavations at the Starosele site in the 1990s (Marks *et al.* 1997), it is now well established that the burials of modern humans there are of intrusive late-medieval character and they are not related to the site's Middle Palaeolithic cultural remains at all. At the same time, various "Pre-Aurignacian" industries, including the Hummalian one, as well as Qafzeh and Skhul Early Modern Humans of Tabun C-type Levantine Mousterian, are chronologically dated well prior to the real Transitional Middle to Upper Palaeolithic period – ca. 50–30 ka. Third, O. Bar-Yosef (1988, 1989) advanced a very reasonable migration hypothesis that the Neanderthals of Tabun B-type Levantine Mousterian arrived in the Levant from southeastern Europe under the pressure of MIS 4 harsh climatic conditions ca. 70 ka. The only problem, however, is that the idea from palaeogeographical and anthropological data, well based upon absolute chronology, lacks archaeological support in recognition of any Middle Palaeolithic industries similar to Tabun B-type Levalloiso-Mousterian – with Levallois point unidirectional convergent reduction – in southeastern Europe.

Taking into consideration all of the above, as well as the fact that human remains in the Great North Black sea region are of very limited character (Neanderthals are only known from the Micoquian archaeological context that is completely unknown in the Levant, whereas EUP human remains are restricted to a single Homo sapiens molar from the 1920s excavations of the Lower Aurignacian layer at Siuren I rock-shelter), the present paper will focus on exclusively archaeological data for the LMP and the EUP of these two Great Mediterranean regions.

In a general archaeological structure for the time period, the areas can be characterized as follows (see Chabai 2000, 2003, 2004; Demidenko 2008a). On the one hand, the Levantine record lacks LMP and EUP assemblages with any of the bifacial tool treatment traditions (Micoquian for LMP and Szeletian *sensu lato* for EUP) that are so characteristic for the south of Eastern Europe, while the latter area does not show any either Initial Upper Palaeolithic or Ahmarian assemblages. On the other hand, Levallois-Mousterian of LMP and Aurignacian of EUP are well known in both areas where they did not play, however, any, or any significant, role in the emergence of the first EUP industries.

Late Levallois-Mousterian

The Levantine record

Tabun-B type Levallois-Mousterian or Late Levantine Mousterian is geochronologically connected to MIS 4 and the early part of the MIS 3 time period (ca. 70–48/45 ka) and its human representatives appear to have been Neanderthals. Much of what is now known of the Levallois-Mousterian type and has influenced studies for the material understanding of other sites comes from the data of the multidisciplinary excavations at Kebara cave in Israel in 1982–1990, directed by O. Bar-Yosef and B. Vandermeersch (Bar-Yosef & Vandermeersch 1991; Bar-Yosef *et al.* 1992). The Levallois-Mousterian sequence of Units XII to VI is ca. 3.5 m thick there, being TL, ESR and AMS dated between ca. 64 and 48 ka BP. A Neanderthal KNH-2 burial was found at the base of Unit XI, and in Unit XII a very rich artifact record has allowed L. Meignen and O. Bar-Yosef much insight into the Late Levantine Mousterian archaeological context (Bar-Yosef & Meignen 1992; Meignen & Bar-Yosef 1991, 1992; Meignen 1995). Using the *chaine operatoire* concept and involving E. Boeda's Levallois method theory, they have extensively technologically analysed the Kebara artifacts. According to their data, the Kebara Levallois-Mousterian primary flaking technology was based on the Levallois *récurrent* unidirectional convergent method. This produces serially, from one core's flaking surface, both shortened broad-based Levallois points, having typically fine-faceted chapeau de *gendarme butts* and often *Concorde* arched lateral profiles, and various triangular flakes, although there was a general dominance of Levallois flakes within all the Levallois products there. Retouched tools are rather few in number, and often bear a peculiar ventral retouch on both Levallois products and some formal tools. By typology, the latter pieces are mainly represented by simple lateral scrapers, truncated-faceted pieces, denticulates, notches and burins. These characteristics of the Kebara Late Levantine Mousterian have also been applied by Meignen and Bar-Yosef to some other Levantine Mousterian site assemblages. The respective materials from Tor Faraj and Tor Sabiha (Jordan), Dederiyeh (Syria), Bezez and Ksar Akil (Lebanon), Amud, Sefunim and Erq el Ahmar (Israel) are accepted by many colleagues now as related to the Kebara materials representing Tabun-B type Levallois-Mousterian (e.g. Henry 2003a:17). Also, with all the questions related to the Kebara Levallois-Mousterian, the distinct position of the Tabun-B type Levallois-Mousterian within the Levantine Mousterian sequence has been established by Meignen and Bar-Yosef as being not just a facies of a common Tabun-C and B types industry, as was sometimes suggested before (see Ronen 1979; Jelinek 1981). Taking into consideration that not very many flint artifacts at all relate to a "small sample from those deposits that are assumed to be equivalent to the base of Layer B (our Beds 1–17)" for the 1967–1972 Tabun cave investigations (Jelinek 1982:79), and remembering that Layer B of the 1930–1932 excavations at Tabun cave "was almost entirely removed by Garrod", and hence why "a well-controlled collection is not available from the upper levels" of the site (Meignen & Bar-Yosef 1992:140), it is reasonable to view the 1980s excavations of the Kebara cave Levallois-Mousterian as etalon-like/reference assemblages for Late Levantine Mousterian.

At the same time, two subjects can be added to the discussions on the Kebara material. First, rather intensive refit and technological studies for Tor Faraj Levallois-Mousterian artifacts (Demidenko & Usik 2003) have indeed shown both striking technological and typological similarities to the Kebara materials, with some important technological reservations. Our studies did not allow us to agree with the *recurrent* removal of a series of Levallois products during one core exploitation phase that has been proposed for Kebara. Instead, all our objective data indicate flintworking using a *lineal* Levallois unidirectional convergent point method, where just one point is removed during one core exploitation phase and some other flaked debitage items represent just preparatory pieces within the technological process, while the phases can extend from two to as many as six for a core, showing true strict and multiple Levallois point production. Tracing different aspects of Levallois point primary reductions for the Tor Faraj artifacts, it was again clear to see the so-called technological law of Levallois point removal method, previously established by us (Demidenko & Usik 1995), where "the length of the inter-faceting ridge in the Y-arrete pattern will be always longer than the length of any subsequent point removed from the same working face", explaining why "preparations for the delivery of even broad-based points, that are relatively wide to their lengths, require that the preparatory removals be quite elongated, if not of blade proportions" (Demidenko & Usik 2003:152). Namely, remembering the technological law, it is no wonder that blades, being functionally preparatory pieces within the Levallois point reduction, account for 19.3% at Tor Faraj (Henry 2003b:68) and "sometimes form up to 25% of the blanks" for the different Tabun-B type Levallois-Mousterian assemblages (Bar-Yosef 2000:116). The Levallois point production actions involve the reduction of unmodified chert cobbles and various debitage pieces at Tor Faraj. Adding here multiple Levallois point production for a core, when each successive exploitation phase of a core gives points smaller in size, because of the core's size reducing through primary reduction processes, the Tor Faraj assemblage exhibits a full range of different sized Levallois points being, with maximum length from ca. 10 to ca. 2 cm long, with average length indications between 5 and 6 cm (Henry 2003b: table 4.7). Some small-sized Levallois points (2–3.5 cm long) have been removed from truncated-faceted pieces (Demidenko & Usik 2003: figs. 6.20-6.21) as well, demonstrating this function for a part of the latter pieces at Tor Faraj and quite possibly at Kebara, too.

Second, many colleagues who accept the Kebara Late Levantine Mousterian data after Meignen and Bar-Yosef, do not pay attention to some artifact variability throughout the Kebara cave Mousterian sequences, although that was to some extent constantly underlined by the site material investigators. First of all, the main reference Kebara Mousterian data originate from middle part of the Levallois-Mousterian sequence there – Units X and IX (see Meignen 1995). On other hand, the lowermost Units XII–XI feature the highest blade indices (22.9–20.2%) within the Kebara sequence and a "genuine bidirectional flaking occurs" at Unit XII (Meignen & Bar-Yosef 1992:136). On the other hand, the upper Units VIII–VII can be summarized here through the following features: not high blade indices (10.9–12%), the highest rates of Levallois flakes (78.4–73.8%) and the lowest rates of Levallois points (4.5–6.8%), as well as the lowest overall butt faceting (IFl = 59.1–58.2% and IFst = 54.1–53.1%) and chapeau de gendarme (9.2–6.7%) indices and the highest plain butt indices (19.4–20.9%) for Levallois products throughout the Kebara sequence, with also remarkably high proportions of Levallois products having a radial dorsal scar pattern (28.6–25.6%). The statistical minority of Levallois points for Units VIII–VII finds confirmation in the illustrations of the Kebara Mousterian artifact published by Meignen and Bar-Yosef (1991), where no one typical Levallois point was illustrated for the two upper Units. From the typological point of view, worth noting is also the highest ratio of Mousterian group tools (60.5%) and the lowest ratio of Upper Palaeolithic group tools (7.4%) in the Unit VII tool-kit for the Kebara Mousterian sequence analysed by Meignen and Bar-Yosef (1991: tabl. VII), remembering that Unit VIII contains just a few retouched tools. Adding to the Units VIII and VII the last undisturbed uppermost Mousterian Unit VI at Kebara cave with similar technological characteristics and TL and AMS dates of ca. 48 ka (Tostevin 2000:240-252, figs. A35-A39), it appears that the whole upper Levallois-Mousterian Unit package at Kebara cave (dated to ca.57–48/45 ka) is sufficiently different from the underlying Kebara Units X–IX, which reveal the Levallois unidirectional convergent point primary flaking method, and associated with them other Tabun-B type Levallois-Mousterian assemblages in the Levant. Unit VI features a rather complex Levallois flake primary flaking method involving, to a variable but still significant degree, unidirectional, radial and bidirectional reductions and, at the same time, an atypical Levallois point component there. Accordingly, a technological shift is seen from the Levallois unidirectional convergent point method into the Levallois flake method within the Late Levantine Mousterian sequence. Such technological change within the Late Levantine Mousterian is also possible to trace for one more Levantine site – Ksar Akil rock-shelter (Lebanon), where the flint assemblages of the uppermost Levallois-Mousterian levels XXVIA and XXVIB look similar to the Kebara uppermost Levallois-Mousterian (see, for the data, Marks & Volkman 1986). These levels also have a not very accurate date, but one that is still late for the Levantine Mousterian U-series date in 47 ± 9 ka (G-888174S) (Bar-Yosef 2000:130). If we accept Shea's reasonable assumption that ca. 50–45 000 years ago "the cold, dry conditions associated with the Heinrich 5 event are likely to have retracted Neanderthal settlement to woodland refugia along the Mediterranean coast" (Shea 2007a:472), there is no wonder that we see the Latest Levantine Mousterian near the coast at Kebara cave and Ksar Akil rock-shelter. This is much in contrast with the Kebara Units X–IX/Tabun-B type assemblages known to be distributed almost throughout the whole Levant, including the arid and semiarid zones in Syria and Jordan. At the same time, the very much traditional Middle Palaeolithic industrial characteristics of the Kebara and Ksar Akil Latest Levantine Mousterian assemblages mean that one cannot but admit the correctness of Bar-Yosef's (2000:116) following remark on the matter: "If a technological transition to the EUP took place locally, it is difficult to argue that it emerged from centripetal core preparation". Thus, the possibilities that Late Levantine Mousterian Neanderthals either became extinct there (Shea 2007a, 2007b; but see Hovers 2006) or migrated somewhere outside the Levant at about 48–45 ka seem to be important for the analysis. The latter possibility is worthy to be discussed in the light of Levallois-Mousterian presence in the south of Eastern Europe.

The Great North Black sea region

Interestingly enough, when the Latest Levantine Mousterian disappeared in the Levant, Levallois-Mousterian appeared in the Crimea (Ukraine) around 45 ka (see fig. 1; tab. 1), whereas before the present-day peninsula was only occupied by Micoquian Neanderthals from the time of the Last Interglacial. Malacofauna, microfauna and especially pollen data (Mikhailesku 2005; Markova 2005, 2007; Gerasimenko 2005, 2007; see also Chabai 2008a) for the kabazi II and V sites indicate the first appearance of Levallois-Mousterian humans during the Hosselo stadial of boreal to south-boreal forest-steppe with a prevalence of meadow-steppe associations and an increased role of xerophytes. Next, during the Hengelo interstadial, the landscape was dominated by a pine forest with some presence of birch, alder, hornbeam, oak, elm, lime, hazel and spindle-tree, when the climate was relatively warm. The hunted ungulate species were basically *Equus hydruntinus* and to significantly lesser degrees *Saiga tatarica*, *Bison priscus*, *Equus caballus* and *Cervus elaphus* (Patou-Mathis 2006, 2007). The Levallois-Mousterian industry was primarily identified as Western Crimean Mousterian (WCM), which has been studied for many years and became industrially and chronologically understandable thanks to the work of V.P. Chabai (1998a, 1998b, 2000, 2003, 2004, 2008a, 2008b, Marks & Chabai 2006). The Crimean Levallois-Mousterian record is now the best known on in situ materials from sites kabazi II, numerous levels of Unit II; kabazi V, Sub-Unit III/3 with six levels and Unit IV with three levels; karabi Tamchin, levels II/2 and III; and Shaitan-Koba, upper layer (see also Kolosov 1966, 1972; Yevtushenko 2004; Demidenko 2008b). In spite of some different location of sites, and variability of fauna and flint exploitation, the industry holds clear enough archaeological characteristics. Through chronological and industrial data the Crimean Levallois-Mousterian was subdivided by Chabai into early and late stages. The early stage lasted from the Hosselo stadial (ca. 45 ka) through the Hengelo interstadial to the Huneborg interstadial (ca. 35 ka), while the late stage is related to the Huneborg stadial and Denekamp/Arcy interstadial, surviving up to 30–28 ka. Archaeological distinction for the stages lies in a different presence of Levallois and Parallel volumetric primary reductions there, while typologically, they are similar with a dominance of side-scrapers (ca. 60%) with a leading role of simple lateral types, a moderate number of points (ca. 15–20%), as well as denticulates and notches (ca. 10–15% together), some occurrence of truncated-faceted pieces and a minor number of mostly atypical Upper Palaeolithic tool classes (end-scrapers, burins, truncated blades) with, at the same time, the absence of bifacial tool treatment traditions. The prime interest here is the early stage of Crimean Levallois-Mousterian (ca. 45–35 ka) with sites kabazi II, levels IIA/2 through II/7; kabazi V, Unit IV/levels 1–3; karabi Tamchin, levels II/2 and III; Shaitan-Koba, upper layer. Technologically, it is basically characterized by a complex Levallois method with centripetal, uni- and bidirectional, convergent technologies. High debitage faceting indices (IFl – ca. 60–70% and IFst – ca. 50%) and core lateral supplementary platforms illustrate careful preparation of the core striking platform and flaking surface for reduction of a diversity of debitage pieces, including Levallois flakes, many blades (15–25%), various flakes, *débordantes* and Levallois mainly atypical points (see figs. 3-5).

Although Chabai explains the appearance of the Levallois-Mousterian complexes in the Crimea as a result of human migration from the Middle Dniester river, seeing direct parallels with the Molodova I site Levallois-Mousterian, it is ne-

MIS	Geo-chronology	Vege-tation	Sites, levels	AMS / C^{14}	ESR	Technocomplexes, facies
Stage 3	Denekamp / Arcy interstadial	south-boreal forest-steppe	Buran Kaya III, B	OxA-6674, 28,52±0,46 OxA-6673, 28,84±0,46		Micoquian, Kiik-Koba
			Siuren I, Fb2 Siuren I, Ga Siuren I, H	OxA-5155, 29,95±0,7 OxA-5154, 28,45±0,6 OxA-8249, 28,2±0,44		Aurignacian
			Kabazi V, II/4-II/7			Micoquian, Ak-Kaya
			Prolom II, II Zaskalnaya V, I Kabazi V, III/1 Kabazi V, III/1A	Ki-10617, 28,1±0,35 Ki-10891, 28,85±0,4 Ki-10744, 30,08±0,35 OxA-X-2134-45, 30,98±0,22	30-26 <41	Micoquian, Starosele
			Kabazi II, A3A, A3B, A3C, A4 **Kabazi II, II/1A**		30±2	**Levallois-Mousterian, WCM**
	Huneborg stadial	boreal xeric grassland	Zaskalnaya VI, II Zaskalnaya V, II Kabazi V, III/2, III/2A	OxA-4131, 30,11±0,63 Ki-10893, 30,7±0,45 Ki-10607, 30,22±0,4 Ki-10743, 31,6±0,35		Micoquian, Ak-Kaya
			Prolom I, upper layer	GrA-13917, 30,51±0,58/0,53 GrA-13919, 31,3±0,63/0,58		Micoquian, Kiik-Koba
			Buran Kaya III, C	OxA-6869, 32,2±0,65 OxA-6672, 32,35±0,7		Eastern Szeletian
			Kabazi II, II/1 **Kabazi II, II/2** **Kabazi II, II/3** **Kabazi II, II/4** **Kabazi II, II/5** **Kabazi V, III/3-1 -- III/3-3A**	OxA-4770, 31,55±0,6 OxA-4771, 35,1±0,85 OxA-4858, 32,2±0,9 OxA-4859, 33,4±1		**Levallois-Mousterian, WCM**
	Huneborg interstadial	south-boreal forest-steppe	Prolom I, lower layer	Ki-10615, 33,5±0,4 Ki-10616, 35,2±0,45		Micoquian, Kiik-Koba
			Zaskalnaya VI, III	OxA-4772, 35,25±0,9 Ki-10609, 38,2±0,4 Ki-10894, 36,4±0,45		Micoquian, Ak-Kaya
			Kabazi II, II/6 **Kabazi II, II/7**			**Levallois-Mousterian, WCM**
			Zaskalnaya VI, IIIa	OxA-4132, 30,76±0,69 OxA-4773, 39,1±1,5 Ki-10610, 39,4±0,48		Micoquian, Ak-Kaya
	Hengelo interstadial	south-boreal forest-steppe	Кабази V, III/5-3B2 Starosele, 1	OxA-14726, 38,78±0,36 OxA-4775, 41,2±1,8 OxA-4887, 42,5±3,6	41,2±3,6	Micoquian, Starosele
			Kabazi II, II/7AB **Kabazi II, II/7C, II/7D, II/7E** **Kabazi II, II/8** **Kabazi II, II/8C, IIA/1**		36±3 44±5	**Levallois-Mousterian, WCM**
	Hosselo stadial	boreal xeric forest-steppe	**Kabazi V, IV/1-IV/3** **Kabazi II, IIA/2**			
			Chokurcha I, IV-I, IV-M			Micoquian, Ak-Kaya
			Chokurcha I, IV-O Zaskalnaya V, IV Zaskalnaya VI, IV	OxA-10877, >45,4 GrA-13916, >46,0 Ki-10611, >47,0		Micoquian, Starosele
	Moershoofd interstadial	south-boreal forest-steppe	Kabazi II, IIA/4			Micoquian, Ak-Kaya

Table 1 - MIS 3 chronology of the Crimean Middle and Early Upper Paleolithic (notations in bold type are related to Levallois-Mousterian complexes; modified after originals in Chabai 2008a, table 18-2).

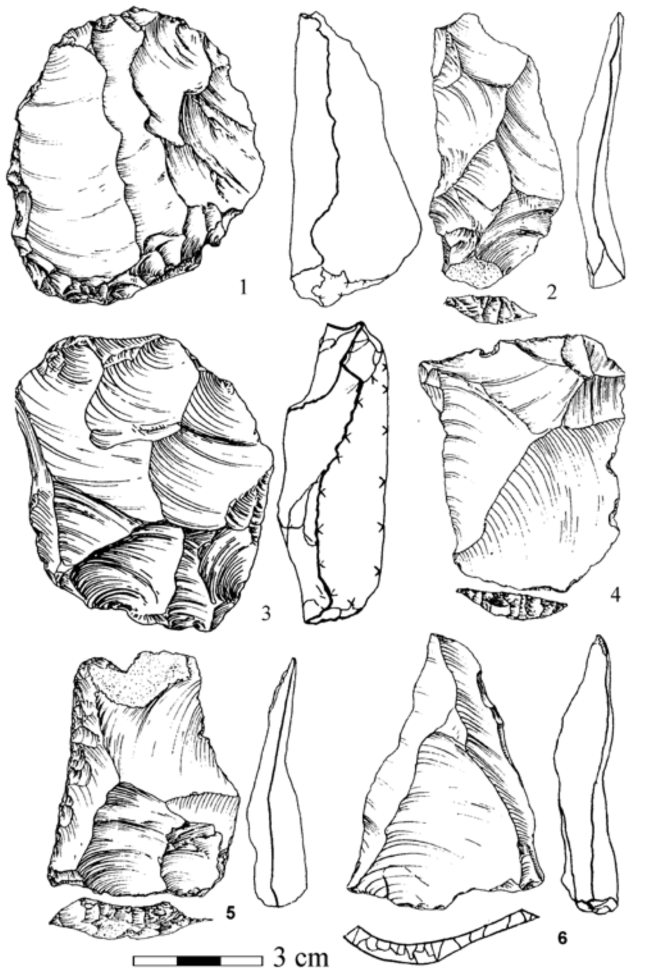

Figure 3 - Kabazi II site (Crimea). 1: unidirectional convergent core with lateral and distal supplementary platforms; 2: Levallois centripetal blade; 3: bidirectional core with lateral supplementary platforms; 4: Levallois centripetal flake; 5: simple concave side-scraper; 6: Levallois point (1-2 Unit II, level 7; 3, 6: Unit II, level 8; 4: Unit II, level 7C; 5: Unit II, level 8C) modified after originals in Chabai 2004.

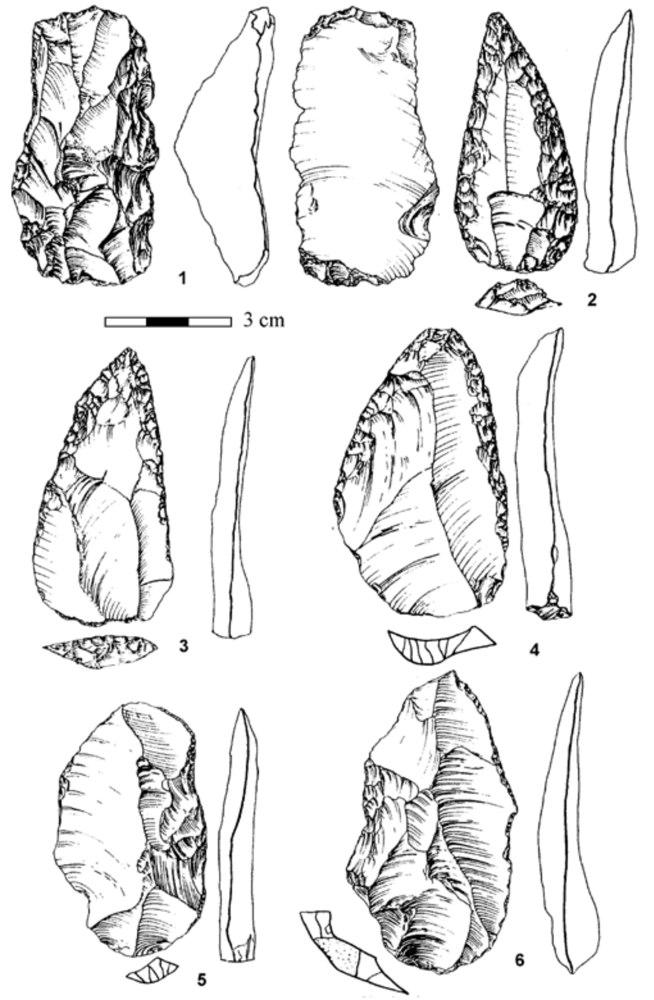

Figure 4 - Kabazi II site (Crimea). 1: bi-truncated-faceted denticulate; 2-3: sub-crescent points; 4: convergent semi-crescent side-scraper; 5-6: retouched enlèvement deux flakes (1, 3-6: Unit II, level 8; 2: Unit II, level 7AB) modified after originals in Chabai 2004.

vertheless important to compare the Crimean Early Levallois-Mousterian record with the Latest Levantine Mousterian for a better understanding of these two industrially and chronologically similar Mousterian events. Indeed, all the Crimean Early Levallois-Mousterian techno-typological features are present at the Latest Levallois-Mousterian assemblages at Kebara and Ksar Akil. Moreover, the proposed Levallois-Mousterian comparisons can be expanded at the expense of some Lower Don river region (Russia) Mousterian materials from the still poorly published Biryuchiya Balka sites 1a and 2, and the redeposited site of Marieva Gora, which look industrially similar enough to the Crimean Levallois-Mousterian (Demidenko 2008a). At the same time, the Middle Palaeolithic data from the north-western Caucasus do not indicate any Levallois-Mousterian presence there, being characterized by only Micoquian sites. Thus, Levallois-Mousterian humans did not occupy the south-eastern part of Great North Black sea region.

Remembering that the Latest Levallois-Mousterian disappearance in the Levant was no later than ca. 48–45 ka, the archaeological context of the Great North Black sea region in which the Levallois-Mousterian humans have been geochronologically coexisting is worth noting (tab. 1; Chabai 2000, 2003, 2004; Demidenko 2008a). Initially, they did coexist with Micoquian Neanderthals for the whole of their known time period in between ca. 45 and 30-28 ka. Then, during two Transitional/Early Upper Palaeolithic stages, the Levallois-Mousterian and Micoquian coexistence has been added, first, by Eastern Szeletian presence in the Crimea and the Lower Don river region (ca. 36/35–32/31 ka) and, second, by Aurignacian presence in the Crimea, the Lower Don river region and the north-western Caucasus (ca. 32/30–29/28 ka). The traced geochronological co-occurrence of the two LMP and two EUP industries in the region also shows the clear absence of any recognizable features due to mutual influence in their flint artifact materials which allows us to conclude their independent existence there. After 28 ka the Levallois-Mousterian, as well as the Micoquian, "retired from the stage" in the southern belt of the East European Palaeolithic record leaving no successors in the Upper Palaeolithic.

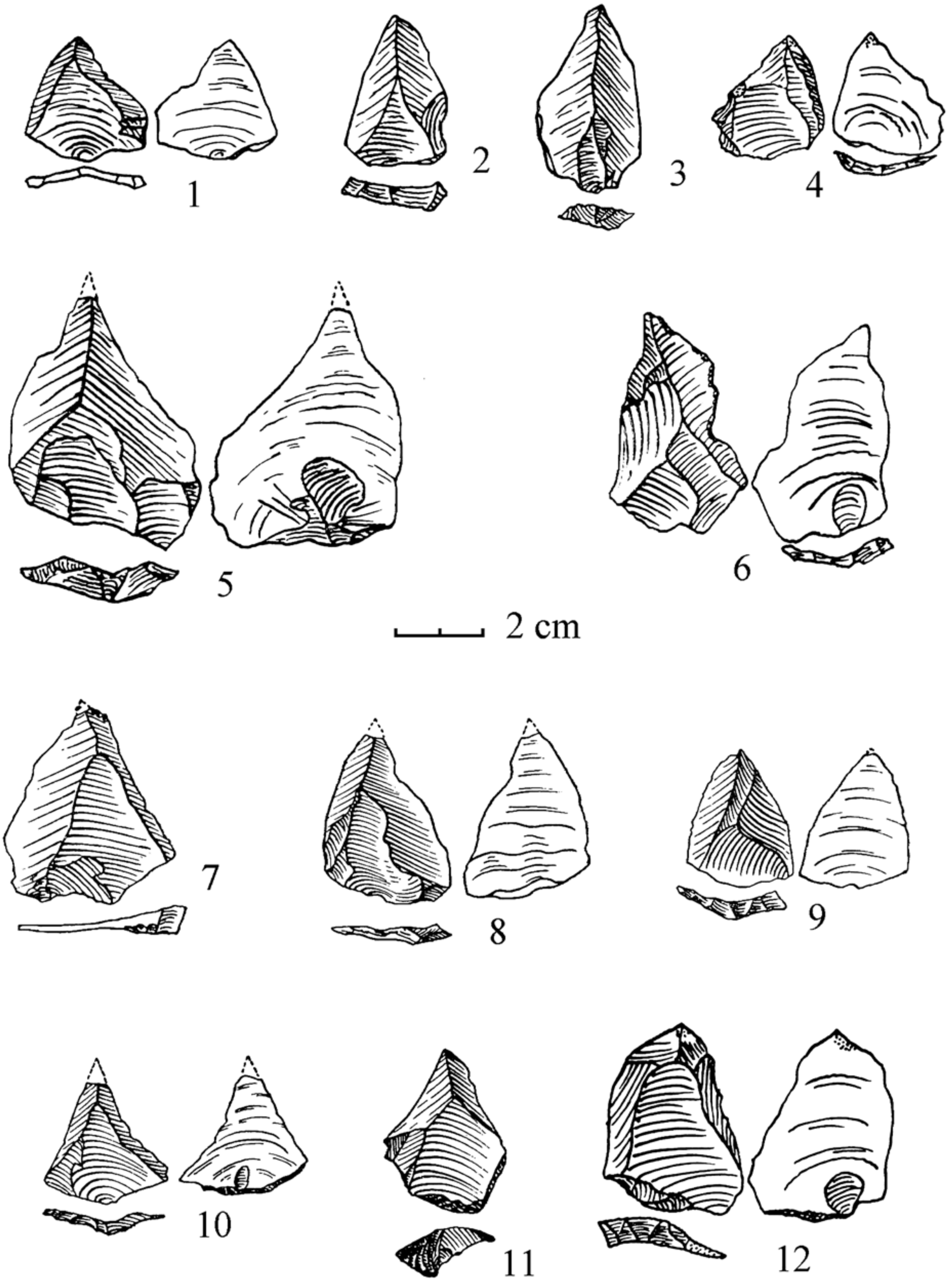

Figure 5 - Shaitan-Koba grotto (Crimea). 1-12: Levallois mostly atypical points (modified after originals in Kolosov 1966).

Aurignacian

The Great North Black sea region

Following the appearance of the Aurignacian in the Great North Black sea region, which is restricted to the last, second stage of the Transitional/Early Upper Palaeolithic period there (ca. 32/30–29/28 ka), and keeping in mind possible archaeological parallels with the Levantine Aurignacian data, the socalled Early/Archaic Aurignacian of Krems-Dufour type industry here is worth discussing. It includes Aurignacian materials from the four sites; the Siuren I rock-shelter, the 1920s excavations Lower layer/the 1990s excavations Units "H" and "G" (Crimea); Chulek I open-air site (Lower Don river region); kamennomostskaya cave, lower layer; and Shyrokiy Mys open-air site (north-western Caucasus) (fig. 2). According to the basic artifact techno-typological data, the Early/Archaic Aurignacian industry is characterized by the regular presence of both bladelet carinated cores and endscrapers but no, or rare, carinated burins, a prevalence of angle and truncation/lateral retouch burins over dihedral ones, the most typical of Dufour bladelets of the Dufour sub-type with alternate retouch, and the characteristic occurrence of some Font-Yves/Krems points among the "non-geometric microliths". Accordingly, the Early/Archaic Aurignacian assemblages of the Great North Black sea region find direct archaeological comparisons with the Aurignacian 0/ Proto-Aurignacian/Archaic/Primitive Aurignacian complexes with Dufour bladelets of Dufour sub-type that are well known in Europe. At the same time, some artifact peculiarities of the discussed Early/Archaic Aurignacian industry definitely subdivide it into the next two assemblage groups. One group is composed of the respective Siuren I and Chulek I find complexes.

The 1920s excavations Lower layer/1990s excavations Units "H" and "G" (five archaeological levels with some sub-levels) at Siuren I is a key site for understanding of the Early/Archaic Aurignacian in the region, which is why the data are presented in detail below (see also Demidenko 2001-2002, 2002; Demidenko & Otte 2000-2001, 2007). These are very representative flint artifact samples from a total excavated area of ca. 100 sq. m – about 15 500 pieces (including ca. 80 core-like pieces and ca. 800 tools) from the 1920s excavations and 5348 pieces (including 27 core-like pieces and 425 tools) from the 1990s excavations, having very clear Aurignacian 0 industrial characteristics. Technologically, it is characterized by a predominant primary flaking of bladelets and microblades (together 40.3–51.1% of all debitage pieces excavated in the 1990s, including tool blanks and core maintenance products) having mainly "on-axis" removal direction and flat/incurvate profiles from bladelet "regular" and "carinated" cores (fig. 6:1-2), and carinated, including thick shouldered/nosed types, end-scrapers (fig. 6:8, 11). At the same time, the quantity of blades is about half as much in comparison with bladelets and microblades. Typologically, the tool-kits correspond well to the observed technological trends. "Non-geometric microliths" (fig. 6:3-7) compose ca. 40% of the Lower layer tools from the 1920s excavations and from 50.0% to 67.6% of the tools from the 1990s excavations (five levels of Units "H"–"G"), without taking into account the Middle Palaeolithic Micoquian tool component there. The most typical among them are Early Aurignacian types with flat and semi-steep micro-scalar and/or micro-stepped retouch. These are alternative (55.3% in the 1920s Lower layer and 63.2–72% in the 1990s levels of Units "H"–"G") and ventral (3% in the 1920s Lower layer and 7–8.7% in the 1990s levels of Units "H"–"G) Dufour bladelets of Dufour sub-type, as well as Krems points with alternate and dorsal bilateral retouch (present in the 1920s Lower layer and in the 1990s Unit "H" (7%), levels "Gc1-Gc2" (2.5%) and "Ga" (11.1%)). The following types, in decreasing order of their frequency, represent indicative Upper Palaeolithic tools. Burins, mostly made on blades, are the best characterized by angle (fig. 6:12) and on truncation/lateral retouch types (fig. 6:10). The dihedral type of burins occupies a subordinate position with a remarkable occurrence only at the top of the 1990s Unit "G" archaeological sequence – levels "Gb1-Gb2" and "Ga". At the same time, it is worth noting the complete absence of carinated types among the 1990s Units "H"–"G" burins and their single representation among the 1920s Lower layer burins. End-scrapers show not numerous but typical Aurignacian carinated and thick shouldered/nosed pieces (fig. 6:8, 11) and serial simple flat items mostly made on unretouched blades (fig. 6:9). Retouched blades feature just the single occurrence of specimens with so-called "Aurignacian retouch". Scaled tools, truncations and perforators, although present, are not with any specific types and quantity. To the flint artifacts are added some bone tools: five points and 45 awls of the 1920s Lower layer and five points with flattened cross-sections and not clearly isolated tips and a single shouldered awl having a long sting, from the 1990s levels "Gc1-Gc2" and "Gb1-Gb2" (Demidenko & Akhmetgaleeva in press). Personal adornment pieces are also present: shell beads of Aporrhais pes-pelecani fossil marine molluscs and of river molluscs *Taeodoxus fluviatilis* L. and *Theodoxus transversalis* C. Pff. from both the 1920s Lower layer and the 1990s levels "Gc1-Gc2", "Gb1-Gb2" and "Ga". It is worth underlining the indicative presence of *Aporrhais pes pelicani* (fig. 6:13) among the Siuren I shell beads. M. Stiner's detailed analysis of shell beads for the Riparo Moshi rock-shelter (Liguria,

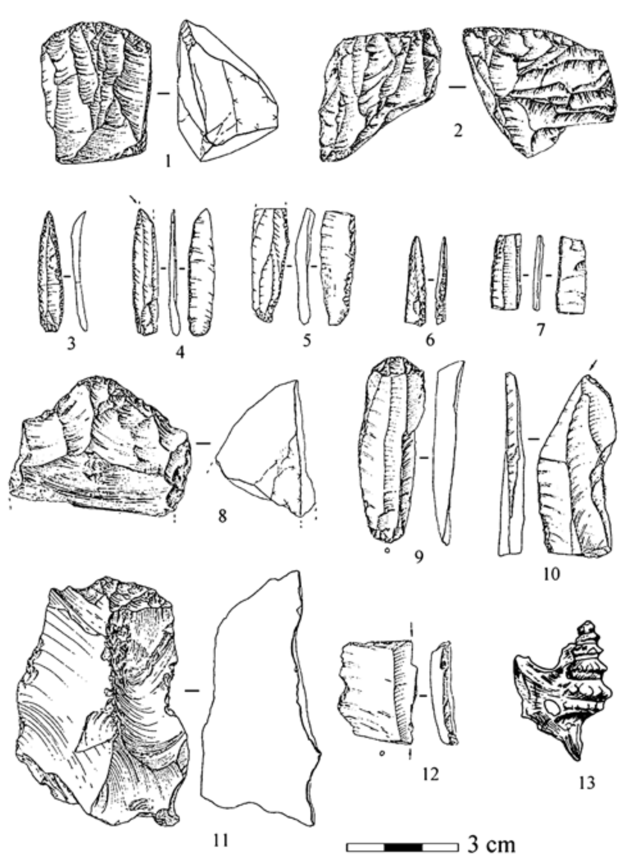

Figure 6 - Siuren I rock-shelter (Crimea). 1-2: bladelet "carinated" cores; 3-7: "non-geometric microliths"; 8, 11: thick shouldered end-scrapers; 9: simple flat end-scraper on blade; 10: burin on truncation; 12: double angle burin; 13: shell bead of *Aporrhais pes-pelecani* fossil marine mollusc (1, 3-5, 10-11: 1990s Unit "H"; 2, 6-7, 9: 1990s level "Gc1-Gc2"; 8, 12: 1990s level "Gb1-Gb2"; 13: 1920s Lower layer).

Italy) has shown the presence of Aporrhais pes pelicani species only in layer G with the kind of Early/Archaic Aurignacian industry discussed here, and not in any of the other numerous Palaeolithic layers there (Stiner 1999). This shell bead peculiarity once again connects the Siuren I Early/Archaic Aurignacian with the respective European Aurignacian assemblages.

Finally, the Siuren I Lower Aurignacian sequence, with two AMS dates for the lowermost Unit "H" (28 200 ± 440 BP – OxA-8249) and the uppermost level "Ga" (28 450 ± 600 BP – OxA-5154) and preliminar interstadial indications for microfauna and malacofauna data (Markova & Mikhailesku in preparation) is high likely geochronologically to date to the Arcy interstadial (ca. 30 ka).

Chulek I is a surface find spot with no cultural remains or organic materials preserved in situ (Gvozdover 1964). The site's relatively few flints (874 items) nevertheless do feature some definite Aurignacian 0 characteristics (Demidenko 2000-2001). In spite of the absence of carinated and thick shouldered/nosed end-scrapers, the assemblage is characterized by a pronounced unidirectional primary reduction (fig. 7:9-10) with production of mainly flat/incurvate in profile blades and bladelets, a significant predominance of burins on truncation/lateral retouch (fig. 7:1-4) over both angle and dihedral burins (mostly made on blades), the complete absence of any carinated burins and numerous, as for the tool-kit with 100 items, 39 "non-geometric microliths". The latter pieces are the most typologically indicative tool class. By strict typological subdivision, the microliths can be subdivided into the following types: nine Dufour pieces with alternate retouch (fig. 7:6-7), one Dufour piece with alternating retouch, three Dufour pieces with lateral ventral retouch, five Dufour pieces with bilateral ventral retouch (fig. 7:8), two Krems points with bilateral dorsal retouch (fig. 7:13-14), eight pseudo-Dufour pieces with lateral dorsal retouch, five pseudo-Dufour pieces with bilateral dorsal retouch, one bladelet with lateral ventral micro-notch, one bladelet with dorsal retouch at distal end, two bladelets with ventral thinning of their basal ends having no any lateral retouch, and, finally, two bladelets with thin dorsally backed lateral edges. Accordingly, the main body of microliths is composed of typical Aurignacian specimens – alternate (25.6%) and ventral (20.5%) Dufour bladelets of Dufour sub-type and bilateral dorsal Krems points (5.1%). Moreover, eleven microliths of both Aurignacian and non-Aurignacian types (28.2% of all 39 microliths or 35.5% of 31 Dufour and pseudo-Dufour bladelets) are characterized by the peculiar secondary treatment feature of a fine ventral thinning of their basal ends (an accommodation element for clamping microliths?) (fig. 7:6, 8). It has already been suggested that, "ventrally thinned 'non-geometric microliths' be called the Chulek-I type" (Demidenko 2000-2001:151). But the specific feature of Chulek I microliths is not a unique one and it can serve as a "typological bridge" to Western European Aurignacian 0/Proto-Aurignacian assemblages as some of them (e.g. Fumane grotto, Ancient Aurignacian levels in Italy, Broglio *et al.* 2005: fig. 9,30–35, 37, 39) do contain microliths with similar basal ventral thinning.

Thus, by both general and/or particular characteristics of flints and even non-flint artifacts, the discussed Siuren I and Chulek I

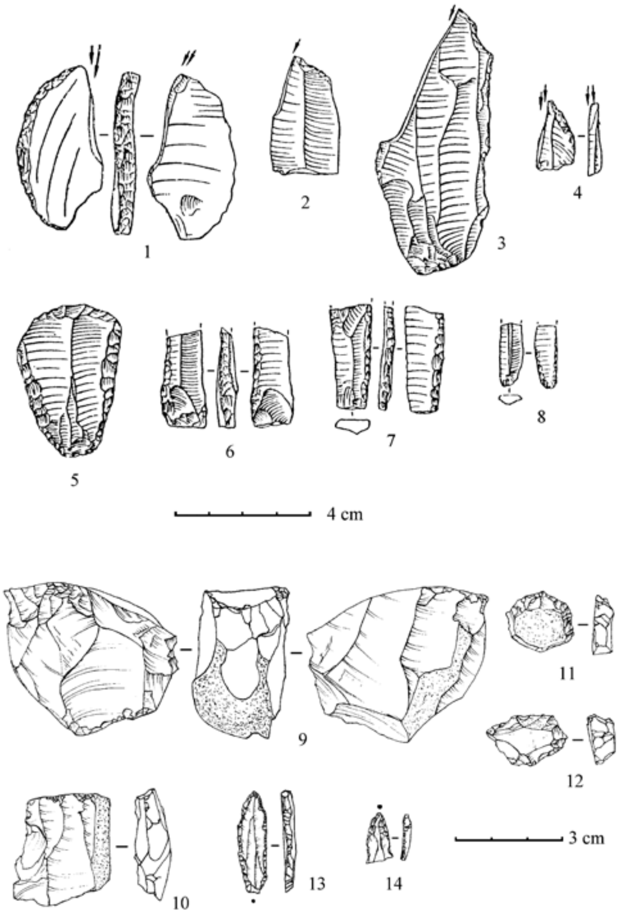

Figure 7 - Chulek I site (Lower Don River area). 1-4: burins on truncation; 5: fan-shaped end-scraper on flake; 6-7: alternate Dufour bladelets; 8: ventral bilateral Dufour bladelet; 9: bladelet "carinated" core; 10: bladelet single-platform core on blade's fragment; 11-12: small flat sub-circular end-scrapers; 13-14: Krems points (1-8: modified after originals in Gvozdover 1964).

materials fit well into the European Early/Archaic Aurignacian industry.

On the other hand, kamennomostskaya cave, lower layer and Shyrokiy Mys flint assemblages, still being within the industrial frameworks of the Early/Archaic Aurignacian, with Dufour bladelets of Dufour sub-type, do contain some artifact types and/or their characteristic numerical compositions that force us to look at the Levantine EUP record for some comparisons.

Kamennomostskaya cave (Formozov 1971; Amirkhanov 1986) was first excavated in 1961 by A.A. Formozov with a recovery excavation technique that was rather poor even for the early 1960s, hence many bladelets and microblades have definitely been lost from the site's lower layer assemblage. Nevertheless, it has the following Early/Archaic Aurignacian industrial features (see Demidenko 2000-2001). From the technological point of view, they are traced through the presence of single-platform bladelet and blade/bladelet cores with an indicative appearance of carinated pieces among bladelet cores, as well as a dominance of flat/incurvate in profile items among the bladelets. Typologically, some carinated items (15.4%) occur among 24 burins and their 26 definable burin verges (fig. 8:1-2) (although burins on

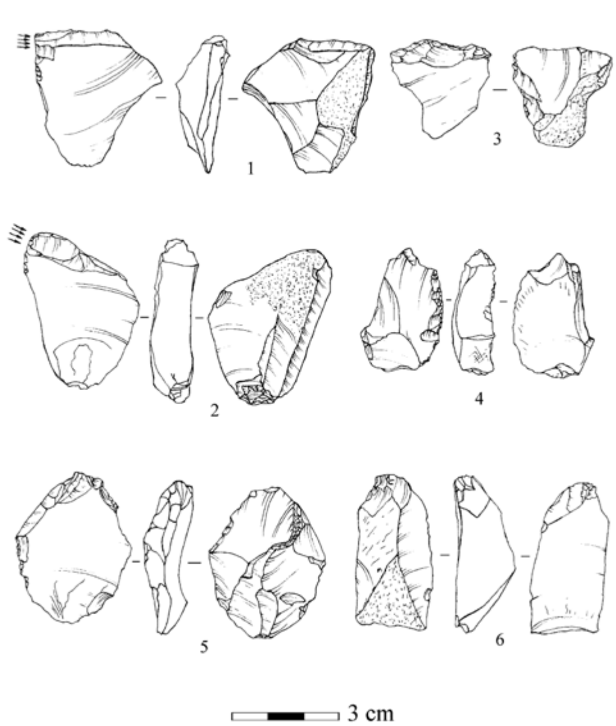

Figure 8 - Kamennomostskaya cave, lower layer (North-Western Caucasus). 1-2: carinated burins; 3-6: "inverse truncations" / lateral carinated pieces.

truncation/lateral retouch (30.8%) and angle burins (34.6%) dominate there where some dihedral items are also known – 19.2%); two carinated and two flat nosed end-scrapers among all twelve end-scrapers; three alternate, ventral Dufour bladelets of Dufour sub-type and a bilateral dorsal Krems point among all eleven "non-geometric microliths" with flat and semi-steep micro-scalar and/or micro-stepped retouch testify to the declared Aurignacian attribution for the assemblage. At the same time, the Upper Palaeolithic tool-kit with just 69 pieces is also notable for eight specific items (11.6%) (fig. 8:3-6). Initially, they were neutrally classified as "inverse truncations" (Demidenko 2000-2001:158-160). They bear a ventral semi-steep secondary treatment at either their proximal or distal end. Moreover, four of them have been recognized as initially elaborated items with a few retouch scars (fig. 8:4). Four other items are with regular inverse either a scalar (fig. 8:3) or a lamellar retouch (fig. 8:5-6). Apart from one chunk, all these tools were manufactured on different flakes and a blade, including one core tablet (fig. 8:5) with a mean length 3.4 cm ranging from 2.5 to 4.2 cm. Leaving aside the previously proposed typological comparisons for the specific pieces discussed – within either French Early Magdalenian or Moravian Epi-Aurignacian (Demidenko 2000-2001), real comparisons should be sought within the strict Aurignacian context. One definite solution for the search does really exist. By the retouch treatment characteristics and placement, the "inverse truncations" find direct analogies to the south of the Northern Caucasus – in the Levant, where the same items are called lateral carinated pieces.

The Shyrokiy Mys site, discovered in the mid-1960s by V.E. Shchelinsky and still under his investigations (Shchelinsky 1971, 2007), is represented by a huge collection of more than 30 000 mainly redeposited flints containing ca. 1200 core-like pieces and more than 2000 tools. Again, as with the kamennomostskaya cave find complex, the assemblage's basic characteristics lie within the Early/Archaic Aurignacian industry. It is distinguished by the following techno-typological features: a dominance of single-platform blade/bladelet (fig. 9:7-8) and bladelet specimens within morphologically stable cores and a serial presence of carinated items among them (fig. 9:1-6); of ca. 550 end-scrapers (mostly simple and variously retouched ones – fig. 10:1-4), about 10% are carinated and thick shouldered/nosed ones (fig. 9:9–13); dihedral burins account for just a little more than 10% among all ca. 250 burins, while notable is the angle (fig. 10:5) and truncation/lateral retouch (fig. 10:6), the high dominance of burin types and the absence of carinated burins; the presence of some Aurignacian blades, including even strangled ones among them (fig. 10:10-11), occurred also as blanks of some end-scrapers and burins (fig. 10:8); the availability of serial mainly bilateral dorsal Krems points (fig. 11:1-9) and alternate (fig. 11:34-40) and ventral Dufour bladelets of Dufour sub-type within the "non-geometric microliths" sample in ca. 700 pieces. At the same time, the "non-geometric microlith" internal typological structure is rather peculiar for analysing the Early/Archaic Aurignacian assemblage. On the one hand, alternate and a few ventral Dufour bladelets together account for no more than 15% of all microliths. Krems points attain a high value – almost 9%. On the other hand, an overwhelming majority of the microliths are pieces with either lateral or bilateral dorsal retouch (up to 75.9%). Of course, some of the bilateral dorsal microliths in reality could be fragmented Krems points, as they bear traces of projectile damage (fig. 11:10-15). But still no less than 70% of all microliths are so-called pseudo-Dufour pieces (fig. 11:16-33). Two aspects seem to be important for the Shyrokiy Mys microlith discussion. First, many of the pseudo-Dufour microliths do bear Ouchtata retouch (fig. 11:16-25), which is well pronounced at a microlith's proximal end and becomes thinner toward its distal end. The fineness of the Ouchtata retouch might be caused by an abrasion treatment when an applied power is stronger at the beginning and gets weaker through a microlith's lateral edge length. The retouch is well-known for Ahmarian and especially Late Ahmarian microliths in the Levant, although it also occurs on some Aurignacian microliths there. Second, a subordinate position of alternate Dufour bladelets and a serial presence of Krems/el-Wad points seem to be a distinct feature for Levantine Early Aurignacian *sensu lato* assemblages.

Thus, the basic assemblage data for the Early/Archaic Aurignacian in the Great North Black sea region archaeologically connect the four analysed sites with two different non-Eastern European regions. While Siuren I and Chulek I site materials are well affiliated with the European Aurignacian 0, Kamennomostskaya and Shyrokiy Mys complexes are more related to the Near Eastern Aurignacian.

The Levantine record

Having the two peculiar features for the north-western Caucasus Early/Archaic Aurignacian assemblages, it is important to recognize them within the Levantine Aurignacian data.

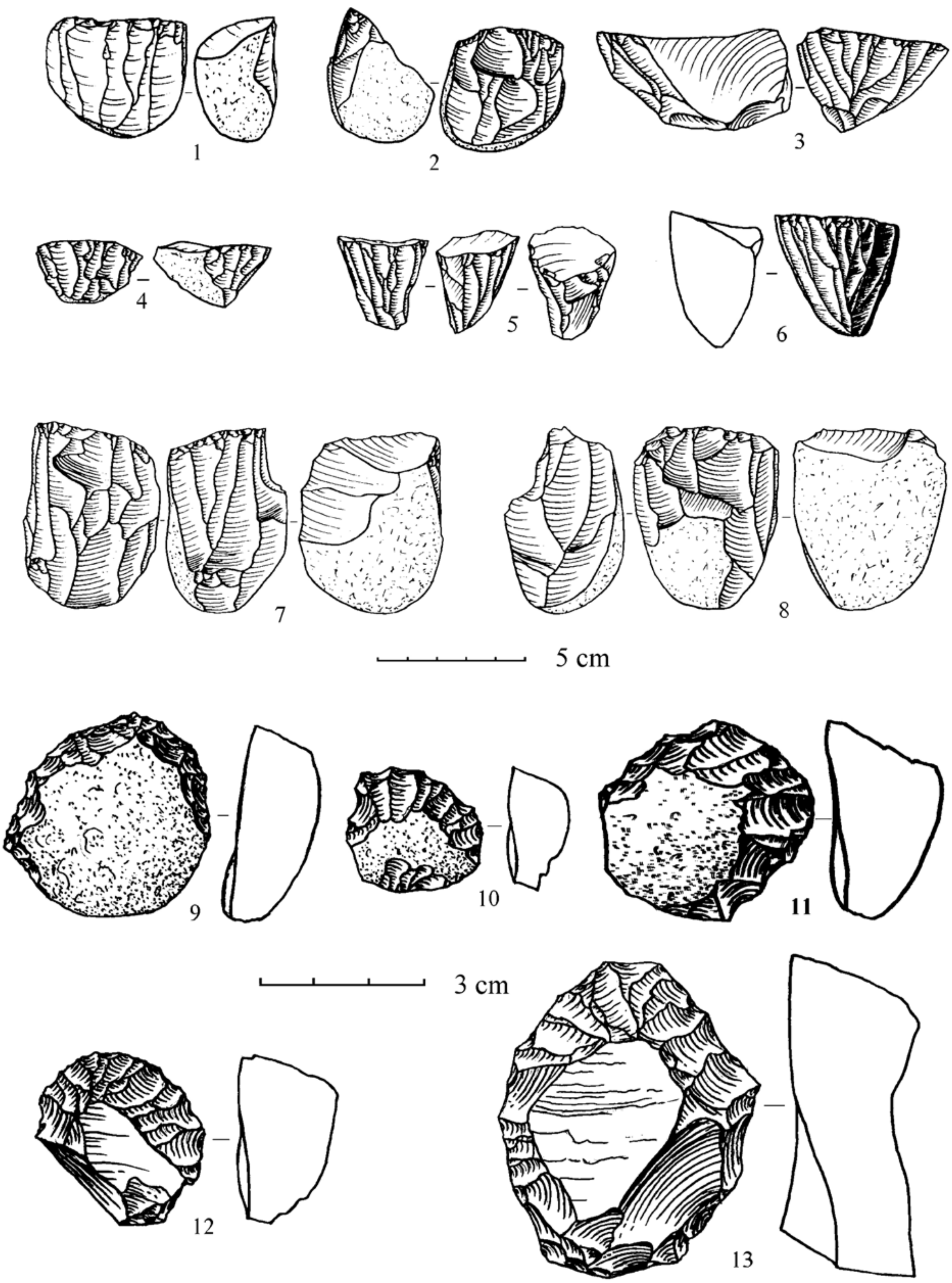

Figure 9 - Shyrokiy Mys site (North-Western Caucasus). 1-6: bladelet "carinated" cores; 7-8: blade/bladelet cores; 9-13: carinated end-scrapers (modified after originals in Shchelinsky 2007).

Lateral carinated pieces are well-known both in the Aurignacian *sensu lato* early (e.g. Ksar Akil, levels XIII–XI) and late (e.g. Ein Aqev) manifestations. Taking into consideration the basic Early Aurignacian data from kamennomostskaya cave, lower layer assemblage, a search should be directed toward Early Levantine Aurignacian find complexes, disregarding the late ones. The best comparable candidate in the Levant for now is level X from the Ksar Akil rock-shelter (Lebanon), not taking into account here the site's level IX, with its mixed upper portion (Bergman 1981, 1987, 2003). By a combination of artifact

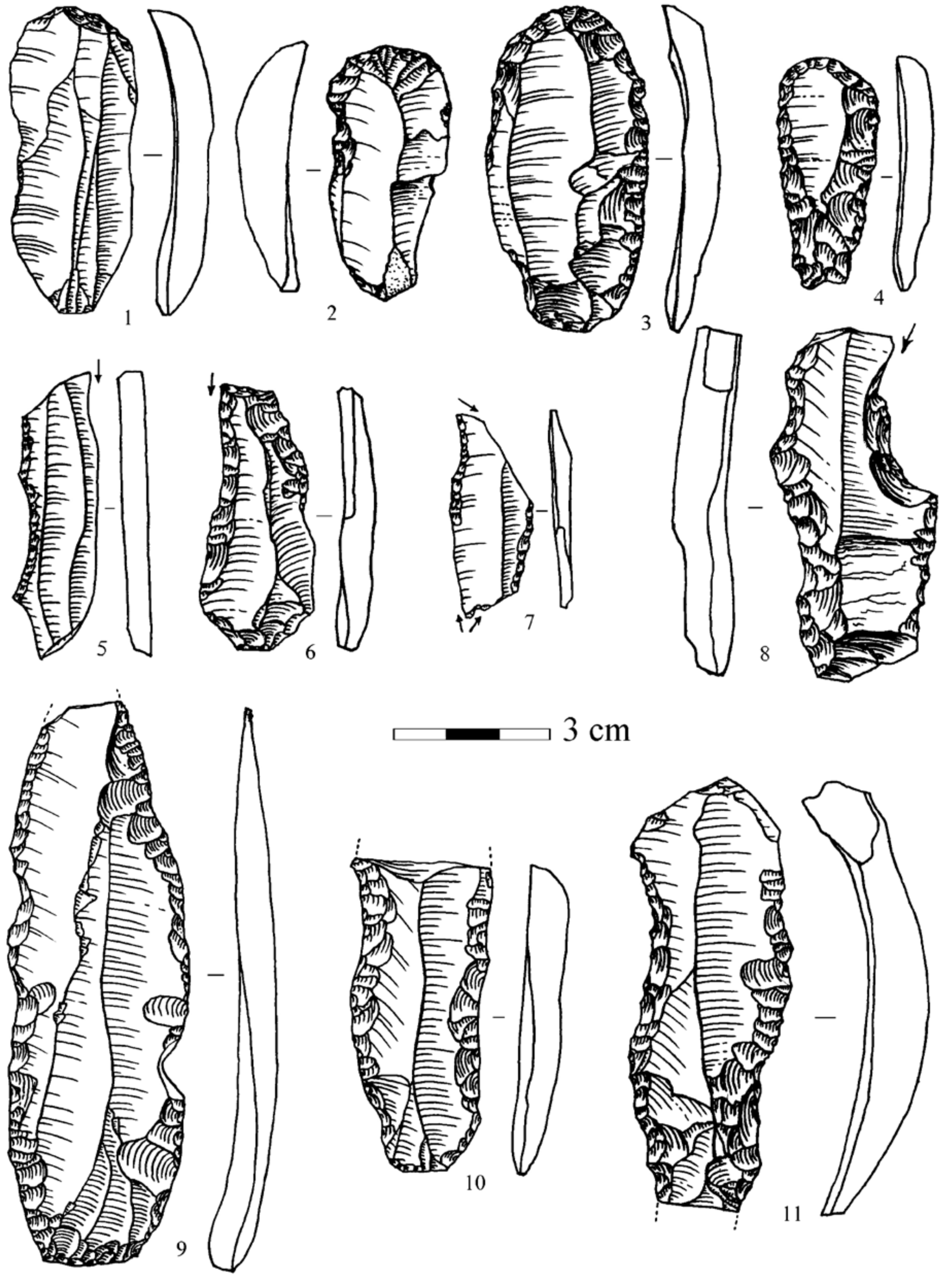

Figure 10 - Shyrokiy Mys site (North-Western Caucasus). 1: simple flat end-scraper; 2-4: end-scrapers on various retouched blades; 5: angle burin; 6: burin on truncation; 7: double mixed burin; 8: angle burin on an Aurignacian strangled blade; 9: retouched blade; 10-11: Aurignacian strangled blades (modified after originals in Shchelinsky 2007).

type presence and technological features, the kamennomostskaya and Ksar Akil assemblages have the following "points of contact": a basic single-platform blade/bladelet unidirectional primary reduction, with the production of mainly straight and incurvate bladey debitage pieces; the presence aside of carinated end-scrapers and also some flat shouldered/nosed items; an indicative but not a dominant occurrence of carinated burins among either all burins or all carinated pieces; a rather subordinate position of alternate and ventral Dufour bladelets within the whole "non-geometric microliths", including

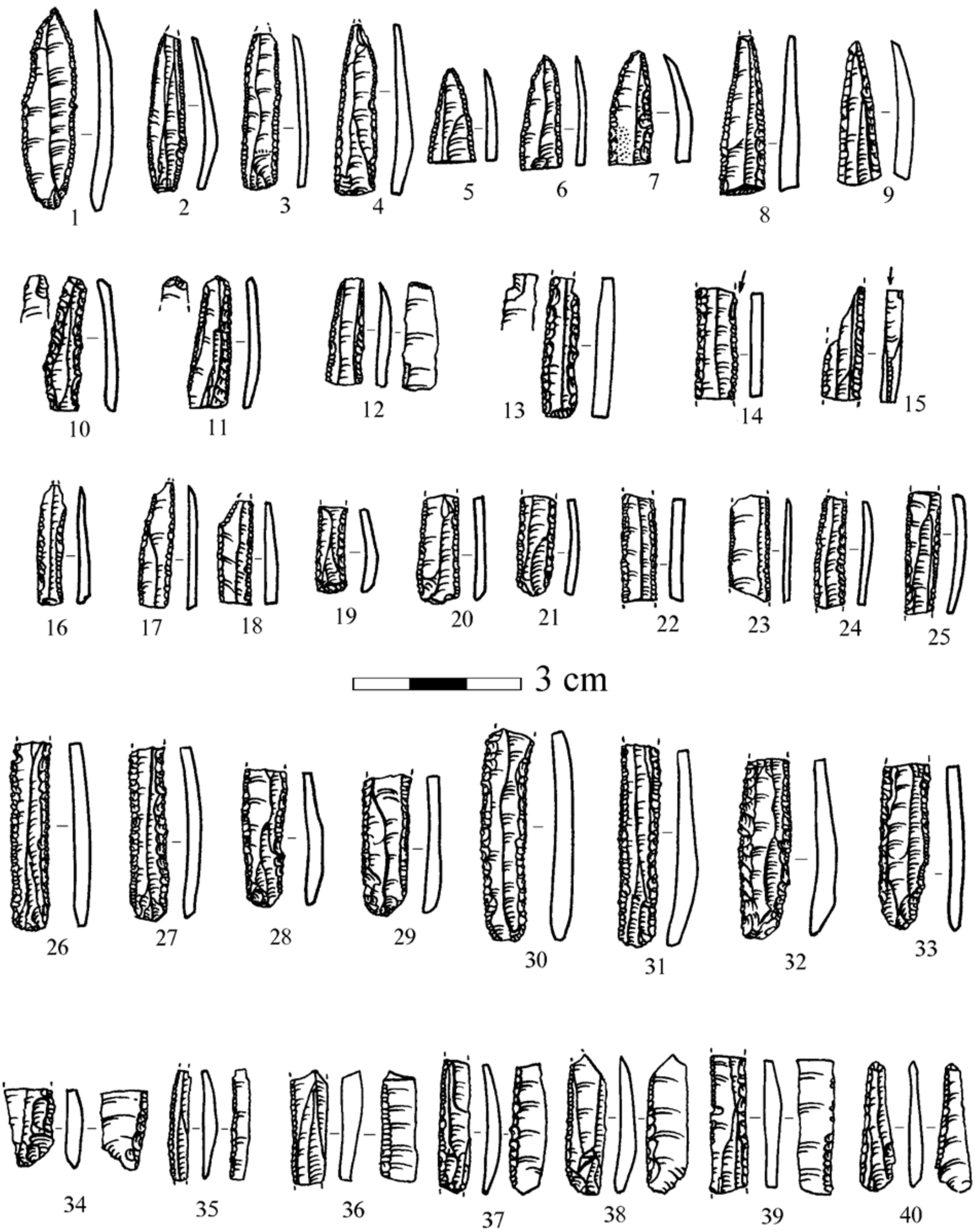

Figure 11 - Shyrokiy Mys site (North-Western Caucasus). "Non-geometric microliths", 1-9: Krems points with bilateral dorsal retouch; 10-15: pseudo-Dufour bladelets with bilateral dorsal retouch having projectile "bending" and/or "spin-off" damage; 16-25: pseudo-Dufour bladelets with bilateral dorsal retouch, having Ouchtata fine retouch on some of them; 26-33: pseudo-Dufour bladelets with bilateral dorsal retouch; 34-40: alternate Dufour bladelets (modified after originals in Shchelinsky 2007).

Krems/el-Wad points there; and, finally, an important role of our "fossiles directeur", the lateral carinated piece type, being sufficiently numerically represented. The kamennomostskaya cave data lack any natural science chronological determinations, while the 1969–1974 excavations of archaeological level 12 at Ksar Akil (the very probable stratigraphical analogue of the 1937–1938 excavations upper part of level X) is dated on a charcoal sample to 32 000 ± 1500 BP (MC-1192) that is in a good accord with a series of Oxford AMS dates and one more Monaco C14 date for overlying archaeological levels of the 1969–1974 excavations (Mellars & Tixier 1989: tab. 1; Bergman 2003:191).

The Shyrokiy Mys assemblage, with the prominent Early/Archaic Aurignacian industrial characteristics, having a peculiar "non-geometric microlith" internal typological composition and some definite Ouchtata retouch pieces, does share some features in common again with the Ksar Akil level X assemblage. They are seen through the dominance of bilateral and lateral dorsal pseudo-Dufour bladelets, some of which bear a fine Ouchtata retouch (e.g. Bergman 1981: pl. 3: h, l, n; 1987: figs. 31:6-7; 36:6, 8), and a significant number of Krems/el-Wad points. At the same time, lateral carinated pieces and carinated burins are completely missing from the Shyrokiy Mys assemblage. Therefore, it is only possible to argue on some particular but not basic similarities for the two assemblages.

The proposed comparisons between the two north-western Caucasus Early/Archaic Aurignacian assemblages and the Ksar Akil level X assemblage and possibly some similar Levantine EUP find complexes (see Bergman 1987:149-151) raise an important question on an industrial taxonomy position of the analysed Ksar Akil assemblage. Now it is widely accepted that Aurignacian *sensu stricto* in the Levant is actually represented by "Levantine Aurignacian C" cave/rock-shelter sites mainly in the north and central Mediterranean Levant (e.g. Ksar Akil, levels VIII–VII; Hayonim, layer D; Sefunim, layer 8; Raqefet, layers II (very base)–III–IV (very top); el-Wad, layer D) that is indicatively characterized by both flake and bladelet twisted primary reduction technologies with, at the same time, a number of tools on blades, and numerous carinated and thick nosed/shouldered end-scrapers, but no lateral carinated pieces, varying numbers of carinated burins, serial flat nosed/shouldered end-scrapers, tiny Dufour bladelets, some el-Wad points and Aurignacian blades, accompanied by plenty of utilitarian and non-utilitarian bone, antler and tooth artifacts (Bergman 1987; Belfer-Cohen & Bar-Yosef 1981, 1999; Bar-Yosef 2000; Belfer-Cohen & Gorring-Morris 2003; Lengyel 2005; Goring-Morris & Belfer-Cohen 2006). Accordingly, the previously defined "Levantine Aurignacian A–B" blade/bladelet-oriented assemblages and also Aurignacian flake-oriented assemblages in the southern Levant are often excluded from the Aurignacian *sensu stricto* as not having all the components of the true Aurignacian artifact package (e.g. Belfer-Cohen & Gorring-Morris 2003; but see contra Marks 2003). The discussed Ksar Akil level X assemblage, with a combination of Ahmarian-like unidirectional technology and some clear Aurignacian typological elements, falls into the former group of supposedly non-Aurignacian find complexes. The problem, however, is that adherents of the Aurignacian *sensu stricto* in the Levant base their considerations on some direct comparisons with French Aurignacian I characteristic data. The true European Aurignacian industrial-chronological composition is a much more complex one, however, being represented by three assemblage groups for an interval between ca. 38–36 and 28 ka: (1) Aurignacian 0/Proto-Aurignacian/Archaic/Primitive Aurignacian complexes with basically flat/incurvate in profile alternately retouched Dufour bladelets of Dufour sub-type and some Krems/Font-Yves points; (2) Early Aurignacian I with split-based bone/antler points and the whole classical Aurignacian package having no or very few carinated burins and also a few, at best, tiny non-twisted microliths; (3) Late/Evolved Aurignacian II–IV with a full range of carinated pieces and a significant number of carinated burins among them. Hence the main body of "non-geometric microliths", if they occur, is represented by twisted and off-set ventral and narrow Dufour bladelets of Roc de Combe sub-type and morphologically the same but dorsal pseudo-Dufour bladelets, whereas Krems/Font-Yves points and Aurignacian blades with stepped retouch do not usually occur there.

If we accept the represented tripartite European Aurignacian subdivision for a possible look at the Levantine Aurignacian, the following picture might appear. First, the Levantine Aurignacian *sensu stricto* may actually envelope assemblages similar to the European Aurignacian I and Aurignacian II–IV assemblages, e.g. Hayonim layer D for the former type and Ksar Akil levels VIII–VII for the latter type. Second, Aurignacian 0 has not yet been defined in the Levant. On the other hand, there is a new idea on a possible origin of the Mediterranean Aurignacian 0 from Early Ahmarian in the Levant, initiated by O. Bar-Yosef and supported by some European colleagues (Bar-Yosef 2003; Teyssandier 2006; Mellars 2006). The present author does not agree with the claimed significant similarity in between the Aurignacian 0 and actual Early Ahmarian complexes, taking into account many industrial features that considerably differentiate them in terms of primary reduction technologies and tool type, morphology and structure representations. At the same time, assemblages like level X of Ksar Akil with a blade/bladelet technology where most of the core flaking surfaces and bladelets are no longer than 5 cm (Bergman 1987:64-83), and some definite Aurignacian typological features, unlike the true Early Ahmarian data, might indeed be similar to the Aurignacian 0 complexes (see also Mellars 2006:171-176). In this case, the kamennomostskaya cave assemblage looks like the best comparable candidate for now having lateral carinated pieces, which, however, are totally absent from any Mediterranean Aurignacian 0 assemblages. These considerations can also give a "second wind" to the personal observation of F. Bordes of the Ksar Akil level X assemblage and his conclusion that it is "strikingly similar to the Aurignacian of Font Yves" in France (Bergman 1987:8). Thus, instead of insisting on the strong Early Ahmarian connections with the European Aurignacian 0, it may be more productive to restructure the Aurignacian *sensu lato* in the Levant through the European standards. If Aurignacian 0 is really represented there, which can be only proved by some direct comparisons of the respective European and Ksar Akil assemblages, it could greatly enlarge our detailed understanding of both the Levantine Aurignacian record and the whole Aurignacian concept in western Eurasia.

Finally, coming back to the Early/Archaic Aurignacian industrial event in the Great North Black sea region, an important chronological subject also arises. The question is that the respective Siuren I assemblage is dated no earlier than the Arcy interstadial (ca. 30 ka), which is a late geochronological position for the European Aurignacian 0, dated from ca. 38–36 to 34–32 ka. Moreover, if our typological comparisons of the kamennomostskaya cave lower layer and the Ksar Akil rock-shelter level X assemblages are correct, keeping in mind also the latter assemblage's chronology of ca. 33–30 ka, in that case, the kamennomostskaya cave Early/Archaic Aurignacian might also be of a late chronology for this kind of Aurignacian industry. Therefore, we have some direct (Siuren I rock-shelter) and indirect (kamennomostskaya cave) indications of a basic late geochronology for the whole Early/Archaic Aurignacian in the south of Eastern Europe. Moreover, it is interesting to note that the possible late (33–30 ka) chronology for the Great North Black sea region Early/Archaic Aurignacian might be valid for both the complexes archaeologically connected to the European respective materials (Siuren I and Chulek I) and the complexes having some definite parallels in the Levant (kamennomostskaya cave, Shyrokiy Mys). Accordingly, the southern territories of Eastern Europe can well represent the chronologically latest region of the Early/Archaic Aurignacian in western Eurasia.

Final Remarks

The complex picture of industrial variability for the Latest Levallois-Mousterian and Early/Archaic Aurignacian assemblages of the Levantine and the Great North Black sea regions presetned here show some level of archaeological and chronological similarity. Of course, in the present article there is just a first step for recognizing and understanding the assemblages' basic and peculiarly similar features. More studies of the noted particular LMP and EUP sites and their materials are certainly needed with their mutual similarities kept in mind. They deserve special attention and further studies as they can significantly contribute to our understanding of many problems for an important transitional period from the Middle to the Upper Palaeolithic for these parts of the Great Mediterranean. Moreover, the subject of similarity presented is interesting in that it is related to the LMP and EUP industries which have not been involved in any so-called direct transitional processes on the emergence of the first true UP industries in the regions, but it rather represents industrial "outsiders" of the transitional period. Finally, detailed studies of the assemblages from the Levant and Great North Black sea regions involved can also assist in their industrial classification and role within both the LMP and EUP regional archaeological contexts.

Acknowledgements

I am deeply grateful to Jean-Marie Le Tensorer, Thomas Hauck and Dorota Wojtczak for inviting me to the Basel conference (May 2008), all the financial support they provided and a good atmosphere of freely sharing ideas between colleagues from many different countries during the conference. My ideas and the present article would never have appeared without much help from many colleagues. Regarding my Levantine Palaeolithic knowledge, it is impossible for me not to mention the great help of the following people who showed me many artifact collections, who shared with me their ideas and with whom I even worked in the field in Jordan: Tony Marks, Don Henry, Geoffrey Clark, John Lindly, Ralph and Rose Solecki, Ofer Bar-Yosef, Gil Tostevin and John Shea (USA). Thanks are also due to the late Marianna D. Gvozdover and to Evegeniya V. Bulochnikova (Moscow, Russia), as well as to Vyacheslav E. Shchelinsky (St. Petersburg, Russia) for granting me kind permission to study artifact collections from Chulek I site, Kamennomostskaya cave and the Shyrokiy Mys site in 2001 and 2002. A special note of appreciation goes to my old friend Dmytro Ya. Vortman (Research Institute of Geodesy and Cartography, Kiev, Ukraine) for the preparation of the two site location maps.

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THE ARCHAEOLOGY OF AN ILLUSION: THE MIDDLE-UPPER PALEOLITHIC TRANSITION IN THE LEVANT

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Introduction

Transitions are popular metaphors for change in prehistory. Levantine prehistorians favor transition scenarios because they assert the relevance of the evidence from a relatively small geographic region to central narrative of human origins. The Levant's small size, geographic circumscription and limited carrying capacity make turnovers far more likely explanations for evolutionary change among Pleistocene hominin populations. This paper asserts that the MP-UP "Transition" in the Levant was not a transition. It was a turnover event in which *Homo sapiens* populations dispersing out of Africa replaced Neandertal populations whose numbers had been reduced below viable levels by abrupt onset of cold dry conditions between 45-52 ka.

The Middle-Upper Paleolithic (MP-UP) Transition is often described as a watershed event, even a "human revolution" (Bar-Yosef 2002; Mellars 2007; Gamble 2007). Throughout Europe and Western Asia between 35-45 ka, Middle Paleolithic archaeological assemblages associated with Neandertals were supplanted by Upper Paleolithic assemblages associated with *Homo sapiens*. The Upper Paleolithic is the point at which many uniquely human behavioral universals begin to appear consistently in the archaeological record. These include art, symbol, personal adornment, visual metaphor, musical instruments, specialized subsistence technologies, domestic architecture, advanced pyrotechnology, broad-spectrum subsistence, systematic division of labor and extensive exchange networks.

The MP-UP Transition in the Levant is the earliest of the various MP-UP "transitions" in Western Eurasia and North Africa. Around 45/47 ka, stratigraphically-superposed lithic assemblages from numerous Levantine sites shift from laminar Levallois core reduction to prismatic blade core reduction. This shift has been documented throughout the Levant, at Ksar Akil Rockshelter (Lebanon), Umm El Tlel (Syria), Boker Tachtit (Israel), and Tor Fawwaz and Tor Sadaf (Jordan), Üçagilzi Cave (Turkey) and other sites (Belfer-Cohen & Goring-Morris 2003). That the same distinctive artifact-types (chamfrein end-scrapers, Emireh points) continue to be made over the course of this technological shift is accepted as evidence for cultural continuity, and by implication biological continuity among toolmaking populations (Neuville 1934; Howell 1959; Garrod 1962; Binford 1968; 1970; Copeland 1975; Marks 1983; Clark & Lindly 1989; Bar-Yosef 1992, 1993, 1996, 2000; Belfer-Cohen & Goring-Morris 2003).

This paper challenges the central assumption of evolutionary continuity during the MP-UP Transition in the Levant. It argues that the MP-UP Transition was not a "transition". Rather, it was a "turnover event" in which African *Homo sapiens* populations dispersed into the region replacing Neandertal precursors. The turnover appears to have been climatically-driven, the result of sharp downturns in temperature and rainfall precipitating Neandertal extinction. Behavioral changes among *Homo sapiens* populations may also played an important role (Shea 2007a). The use of complex, stone- and bone-tipped projectile weaponry to construct a broader ecological niche may have been among the most important of these changes.

Background: Transitions and Turnovers

A transition is a behavioral change within a single evolving hominin lineage. Assemblages from the starting point of a transition differ from those at its end and both are separated by assemblages that can be arranged into a series of intermediate chronological stages. This definition of a transition does not exclude possible gene flow from other evolving hominin lineages or recursive patterns of behavioral change, but there must be evolutionary continuity between the authors of the assemblages at opposite ends of sequence for it to be a transition. Most of the major "revolutions" in the recent human past, the Neolithic, Urban, and Industrial Revolutions, were actually transitions.

The polar opposite of a transition is a "turnover event". In a turnover event, one of two contemporary species replaces the other in a broadly equivalent ecological niche. The processes of replacement and the timescale involved can vary; but, the irreducible character of a turnover event is that at its conclusion there are no survivors of the replaced population. Turnovers are a consequence of extinction. There have been few real turnover events in recent human history. Most cases of "genocide" among recent humans are not turnover events, because there

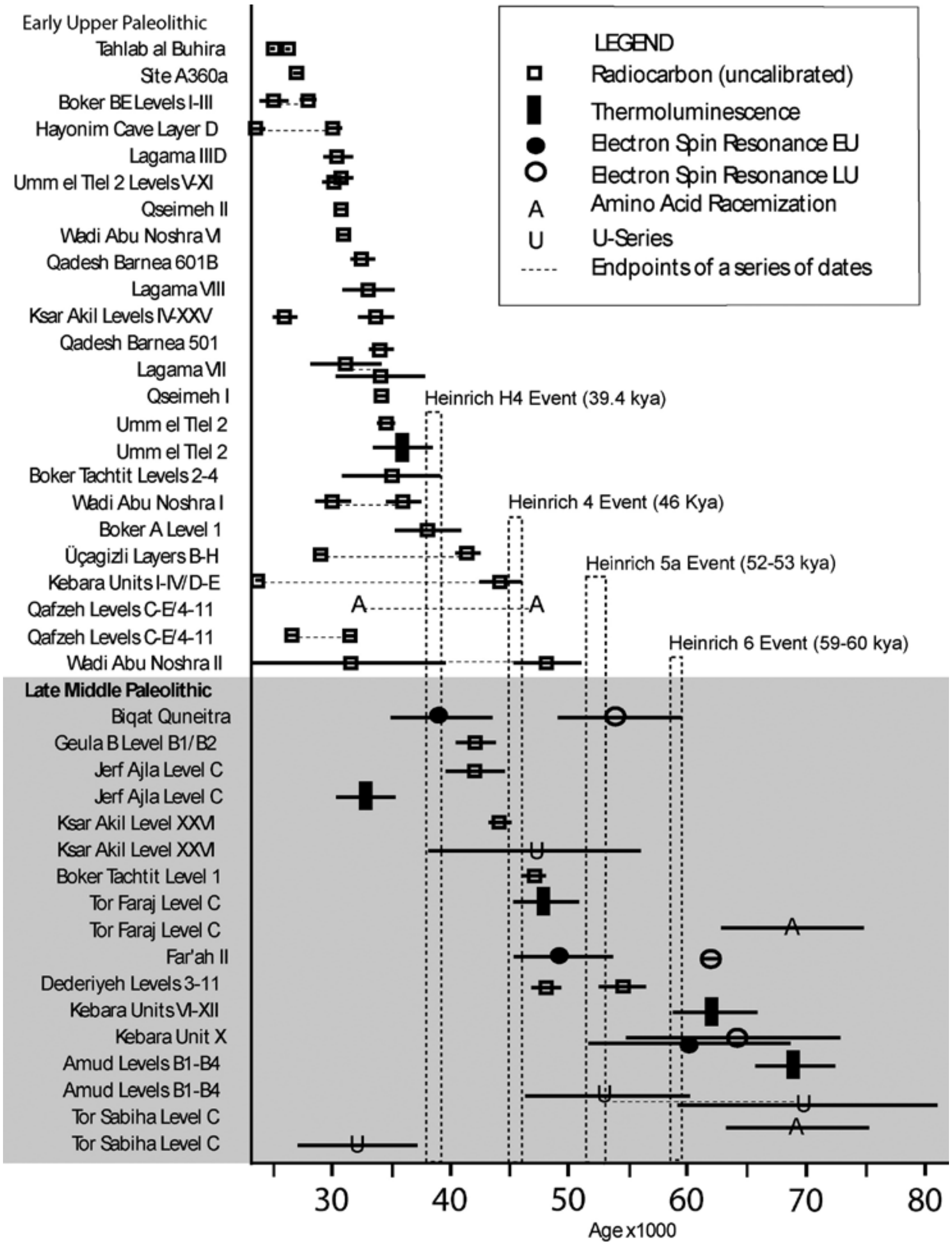

Figure 1 - Geochronology of Levantine Early Upper Paleolithic and Later Middle Paleolithic Periods. For original dates and references, see Shea (2007a, 2003) and (Goring-Morris & Belfer-Cohen 2003). Note: Radiocarbon dates are uncalibrated.

are nearly always survivors of the targeted population. More numerous examples of turnover events involving human populations involve human domesticates, commensals, and other "invader species" replacing indigenous flora and fauna (Crosby 1986).

As metaphors for change in prehistory, transitions are by far more commonly invoked than turnover events. The reasons for this popularity include (1) the perception that turnovers are unusual, and (2) subjective factors favoring transitions over alternative explanations. The lack of recent cases of turnover events in human history fosters the assumption that extinctions and turnover events were rare in the course of human evolution as well. This assumption overlooks the large population, wide local genetic diversity, global geographic distribution and other technological and social factors that insulate recent human populations from the effects of rapid climate change. Many of these insulating factors are consequences of the agro-pastoral adaptations developed over the last 12,000 years. Pleistocene humans had no such insulation from extinction. Our species insulation from climatically-forced extinction is an evolutionary novelty.

A second set of factors involve careerism. Transition implies continuity and continuity implies relevance to human evolution. Research on ancestral individuals commands far more interest than research on evolution's "dead ends". No one ever lost a job, was refused an excavation permit, or had a grant declined for arguing that the archaeological record of their chosen geographic region was vital to the central narrative of human evolution. As scientists, we know preservation does not favor ancestral individuals. We also know that fossils and archaeological assemblages created by non-ancestral individuals preserve just as well (or poorly) as those left behind by ancestral individuals. The "doublethink" this situation creates is especially problematical in Levantine prehistory *["Doublethink" is a term coined by George Orwell in his dystopian novel, 1984. It refers to the ability to simultaneously accept two contradictory ideas]*. Smaller regions and biogeographic corridors are less likely settings for long-term evolutionary continuity among large mammals than larger regions, if only for reasons of sample error alone. Thus, in a small region like the Levant one is likely to find mismatches between actual evolutionary turnover events and archaeological models casting those changes as transitions. This paper contends that this is precisely what has happened in past archaeological models of the MP-UP Transition in the Levant.

The principal archaeological periods involved in the MP-UP Transition in the Levant are the Later Middle Paleolithic (LMP) and the Early Upper Paleolithic (EUP). For recent overviews of both periods, see Shea (2003, 2007a) and Belfer-Cohen and Goring-Morris (2003). Both periods have reasonably well-dated archaeological records, although the availability of radiocarbon dating makes the chronology of the EUP somewhat more secure than that of the LMP (fig. 1).

Later Middle Paleolithic assemblages come from contexts dating to between 45-75 ka. The best documented of these contexts include Amud Cave Levels B1-4, Boker Tachtit Level 1, Biqat Quneitra, Dederiyeh Cave Levels 3-11, Far'ah II, Geulah Cave B Level B1/B2, Jerf Ajla Cave Level C, Kebara Cave Units VI-XII, Ksar Akil Rockshelter Level XXVI, Shovakh Cave "Lower Cave Earth", Shukhbah Cave Level D, Tor Faraj Rockshelter Level C and Tor Sabiha Rockshelter Level C. LMP lithic assemblages exhibit frequent use of recurrent unidirectional-convergent core preparation to detach triangular and subtriangular flakes (or "points"). These assemblages also feature variable proportions of cores and débitage from radial-centripetal core reduction. Prismatic blade production is evident, but it is rare and follows a different set of procedures and "volumetric conception" of core geometry than blade production in EUP assemblages. Most LMP assemblages feature both large and small Levallois points, as well as sidescrapers and naturally-backed knives (fig. 2). No carved bone/antler tools are known from LMP contexts.

Early Upper Paleolithic assemblages date to at least 28-47/45 ka. The best documented EUP sites include Boker A Level 1, Boker BE Levels I-III, Boker Tachtit Levels 2-4, Hayonim Cave Layer D, Kebara Cave Units I-IV/Levels D-E, Ksar Akil Rockshelter Levels IV-XXV (phase III-VII), Lagama IIID, VII, and VIII, Qadesh Barnea 501 and 601B, Qafzeh Cave Levels C-E/ 4-11, Qseimeh I and II, Site A360a, Thalab al Buhira, Üçagizli Cave Layers B-H, Umm el Tlel 2 Levels V-XI, Wadi Abu Noshra I, II, and VI. Numerous other assemblages are assigned to the EUP on the basis of their lithic typology and/or their geological context. Most EUP lithic assemblages feature prismatic blade and bladelet cores. Laminar débitage is common. EUP assemblages show less emphasis on Levallois core reduction and more prismatic blade production than LMP assemblages. Retouched tools types made on elongated flakes or blades, such endscrapers, burins, and backed knives, are common (fig. 3). Emireh points, Umm el Tlel points, and chamfrein endscrapers are thought to be index fossils for the earliest or "Initial" Upper Paleolithic. EUP assemblages are subdivided into named industries, including the "Initial Upper Paleolithic", "Ahmarian", "Levantine Aurignacian" and a fourth unnamed flake-based industry, on the basis of variation in retouched tool types and the relative frequencies of blades and bladelets. A variety of carved bone/antler implements and perforated shells and teeth assumed to be personal adornments have been recovered from EUP contexts.

The geographic range and floral/faunal associations of LMP and EUP sites are broadly similar, consisting mainly of species endemic to the Mediterranean woodland and its ecotone with the Irano-Turanian steppe. The most ubiquitous large mammal taxa in these assemblages include wild cattle (aurochs), horse, red deer, fallow deer, ibex, wild boar, and gazelle. Gazelle are somewhat more common in EUP assemblages than in LMP ones, but faunal assemblages from both periods exhibit wide variability (Rabinovich 2003). There is a trend towards increasing exploitation of smaller prey (birds, rodents, lagomorphs, and tortoises) in EUP assemblages (Stiner 2006).

LMP archaeological contexts from Amud, Dederiyeh, Geulah, Kebara, Shovakh, and Shukhbah contain hominin fossils. All of them are either Neandertals, or they are too fragmentary to allow attribution to species. Human fossils from EUP contexts include the burials from Ksar Akil (one of which has been lost), two sets of cranial remains from Qafzeh, fragmentary remains from Hayonim Level D, and ten isolated dental remains from Üçagizli. All of these fossils are attributed to *Homo sapiens*, except for one tooth from Üçagizli preliminarily described as "Neanderthaloid". Most physical anthropologists are deeply skeptical about species-level attributions of isolated teeth.

At this juncture, it is important to stress that this paper is not questioning arguments about evolutionary continuity within either the LMP or the EUP. This paper is solely concerned with the question of evolutionary continuity between the LMP and the EUP.

Problems with the MP-UP Transition as a Transition

Describing the shift from LMP to EUP as a "transition" made sense when the archaeological and hominin fossil records seemed to indicate a parallel process of biological and cultural evolution, but this is no longer the case. Since the mid-1980s, U-series, TL, and ESR dating have shown that Levantine *Homo sapiens* fossils from Skhul and Qafzeh are older than their putative Neandertal ancestors. These early dates were controversial, but they were eventually confirmed by several independent dating methods (Millard 2008). The relevant aspects of the paleontological record are briefly summarized below.

Few hominin fossils are known from contexts dating to 130-400 ka. The most complete of these, Zuttiyeh, shows no Neandertal autapomorphies. It resembles *Homo sapiens* only in terms of primitive morphologies shared by *Homo sapiens* and African *Homo heidelbergensis* (Rak 1993). As such, they are no more clearly ancestral to us than they are to Neandertals.

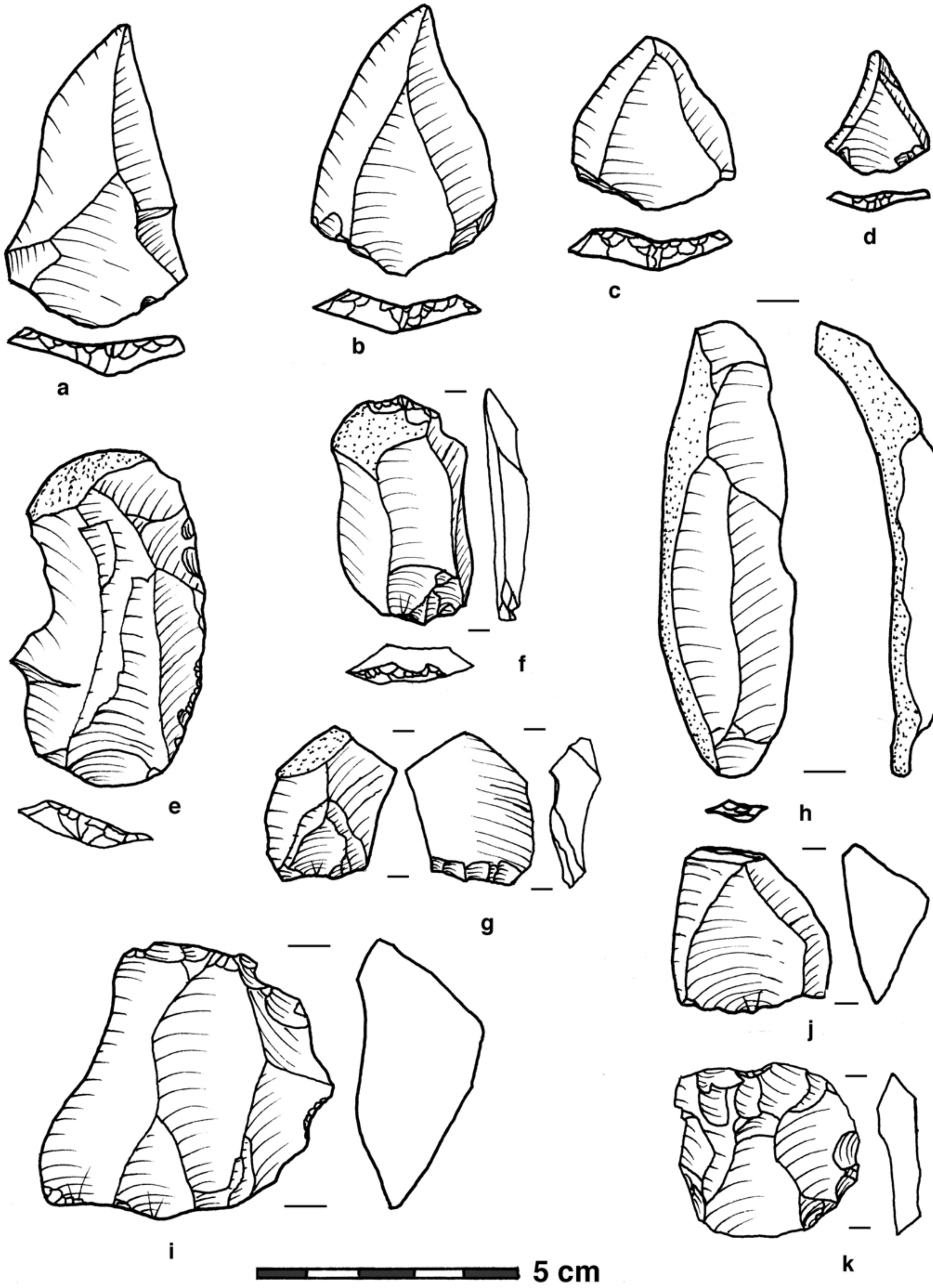

Figure 2 - Levantine Later Middle Paleolithic Artifacts. a-d. Levallois points, e. retouched Levallois flake, f-g. truncated-facetted pieces, h. naturally backed blade, i-j. unidirectional convergent Levallois core, k. discoidal core. Source: Kebara Cave Units VII-XII.

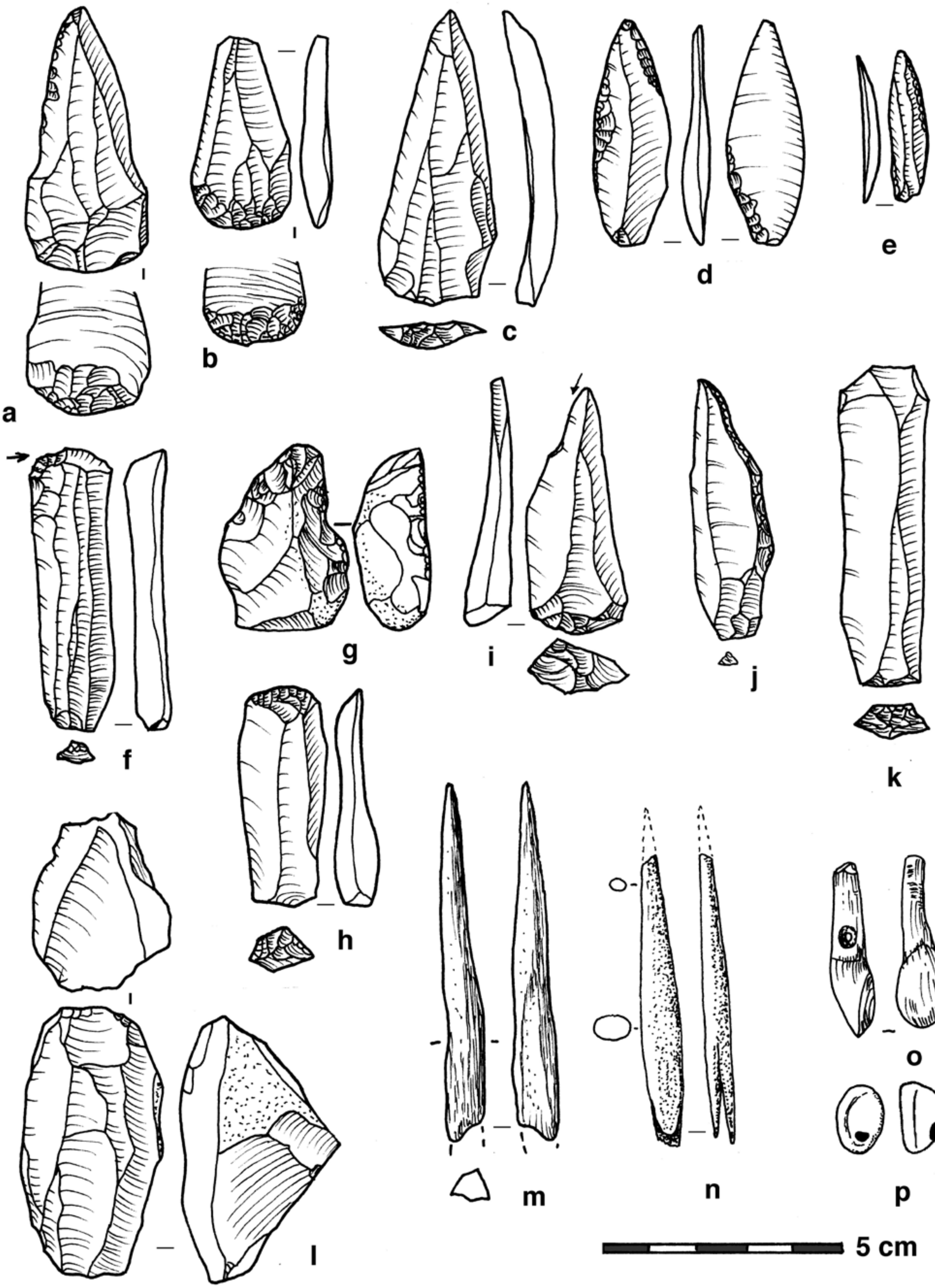

Figure 3 - Levantine Early Upper Paleolithic Artifacts. Early UP tools associated with Homo sapiens at Ksar Akil and other UP sites. Descriptions: a-b. Emireh points, c. Umm el Tlel point, d. Ksar Akil point, e. El Wad point, f. chamfrein endscraper, g. carinated endscraper/core, h. endscraper on blade, i. burin, j. backed blade, k. prismatic blade, l. prismatic blade core, m-n bone/antler points, o. perforated deer tooth, p. perforated Nassarius shell. Sources: a. Qafzeh Level E, b. Boker Tachtit Level 1, c. Umm el Tlel Unit II Base, d,f,h-l. Ksar Akil Levels XXV-XVI, e,g,m, o. Hayonim Level D, n. Kebara Unit I-II, p. Üçagizli Level H.

The early Upper Pleistocene fossil record shows early *Homo sapiens* present in "last interglacial" times (*sensu lato*, i.e., Marine Isotope Stage [MIS] 5), ca. 75-130 ka. This timing agrees well with speleothem evidence from the Negev suggesting wetter conditions ca. 100-130 ka that would have facilitated early human dispersals from Africa to the Levant (Vaks *et al.* 2007). The most recent radiometric dates for the Tabun C1 fossil suggests Neandertals were present in early in MIS 5 as well (Grün *et al.* 2005). The uncertainties surrounding the stratigraphic provenance of this fossil and others from the 1930s excavations in Tabun preclude viewing them as evidence of actual sympatry between Neandertals and *Homo sapiens* (Bar-Yosef & Callendar 1999; Shea 2003). No other Levantine site dating to early MIS 5 has yielded Neandertal fossils.

During the onset of glacial conditions during MIS 4 and early MIS 3 (45-75 ka) only Neandertal fossils are known from Levantine contexts (e.g., Tabun, Kebara, Amud, Dederiyeh, Shukhbah). No *Homo sapiens* fossils are known from Levantine sites dating to this period.

From 35-45 ka onwards to the present day only fossils of *Homo sapiens* have been recovered from Levantine archaeological contexts. That there is no gap in the fossil record for this period longer than a few thousand years suggests *Homo sapiens* occupation of the region has been more-or-less continuous since at least 35 ka.

What the MP-UP Transition in the Levant was NOT

Much has been written about what the MP-UP Transition was or what it reflected. It is now actually a lot easier to say what the MP-UP Transition in the Levant was not.

The MP-UP Transition in the Levant did not have anything to do with the origin of *Homo sapiens*. The earliest known *Homo sapiens* fossils come from Ethiopian contexts dating to 160-195 ka in the Lower Omo Valley Kibish Formation and the Bouri Formation near Herto, Middle Awash Valley (McDougall *et al.* 2005; White *et al.* 2003). These fossils' archaeological associations are broadly analogous to Eurasian Middle Paleolithic assemblages (Levallois core technology, lanceolate bifaces, neither blades nor microliths)(Clark *et al.* 2003; Shea *et al.* 2007).

The MP-UP Transition in the Levant did not have anything to do with the initial dispersal of our species out of Africa. Nearly a dozen fossils universally recognized as early forms of *Homo sapiens* are known from at least two sites in northern Israel, Skhul and Qafzeh, that date to 80-130 ka (Shea & Bar-Yosef 2005).

The MP-UP Transition in the Levant did not have anything to do with the origin of "modern" human behavior (by which most archaeologists mean the derived features of the European Upper Paleolithic). Two of the Skhul and Qafzeh hominins are buried with grave goods, and there is evidence from both sites for both the use of mineral pigments and personal adornments in the form of perforated marine shells (Shea 2007a). In fact, evidence for nearly all of the purported hallmarks of "behavioral modernity" are known from African contexts prior to 50 ka (McBrearty & Brooks 2000; McBrearty 2007; Willoughby 2007; Barham & Mitchell 2008).

The MP-UP Transition was not good news for the Neandertals. Neandertal fossils last appear 42 ka at Geulah Cave B (Arensburg 2002). This date is younger than or broadly equivalent to the oldest dates for EUP assemblages, but it is also a date obtained for a context that was profoundly disturbed by carnivore activity. To assume Neandertals were present in evolutionarily significant numbers in the Levant after 45 ka requires one to make more than the minimum number of assumptions about the hominin fossil record.

The MP-UP Transition in the Levant did not involve an evolutionary transition among Levantine hominins, either solely among *Homo sapiens* or between *Homo sapiens* and Neandertals. *Homo sapiens* fossils are absent from Later Middle Paleolithic contexts dating to between 45-75 ka. The Skhul/Qafzeh humans appear to have been an evolutionary "dead end", that the succumbed to the rapid cooling and desertification of the region ca. 75 ka (Shea & Bar-Yosef 2005; Shea 2007b). One cannot rule out the possibility that some *Homo sapiens* populations were present in the Levant at this time but in numbers too low to achieve paleontological visibility (Hovers 2006), but inasmuch as it equally well accommodates both the presence and absence of data, neither is it clear how one could falsify this "invisibility hypothesis".

McCown and Keith (1939) originally proposed that the Levant was a transition zone in which interbreeding occurred between Neandertals and *Homo sapiens* populations. This argument still retains some support today (Simmons 1999; Kramer *et al.* 2001; Eswaran 2002). Nevertheless, conclusive evidence for such interbreeding remains elusive. While it is conceivable that early Neandertals and the Skhul/Qafzeh humans interbred (Holliday 2000; Trinkaus 2007), there is no evidence that strongly compels one to accept this interpretation of the evidence to the exclusion of other hypotheses. Nor is there evidence for actual sympatry between these hominins immediately prior, during, or after the MP-UP Transition. In this respect, the Levantine evidence is exactly consistent with the overwhelming majority of genetic, morphological, and geochronometric evidence now available indicating Neandertals and *Homo sapiens* were different species who were rarely, if ever, sympatric and between whom gene flow was of negligible evolutionary consequence (Hublin & Pääbo 2006).

Was the Transition Actually a Turnover Event?

The most parsimonious reading of the Levantine hominin fossil record is that the period 35-45 ka witnessed a turnover event. Levantine Neandertals became extinct and were replaced by *Homo sapiens* populations who dispersed into the Levant from elsewhere, most likely from East Africa. This hypothesis makes no assumptions about what manner of coevolutionary relationships may have existed among these hominins in earlier times. As outlined below, the hypothesis of a turnover event is consistent with what we can plausibly infer about how rapid climate change affected hominin demography in the Levant. It is consistent with our growing understanding of the relationship between environmental change and human evolution in Africa. Lastly, it explains the available evidence better than alternative arguments about biological and cultural transitions.

Claims that some recent humans possess DNA traceable to Neandertal ancestors, as the result of interbreeding between Neandertals and early *Homo sapiens* have to be treated skeptically. The most recent such claim by Green and colleagues (2010) identifies the Levant between 60-100 Ka as the most likely time and place for such interbreeding. But, if one examines the references cited, it is clear that it does so based on interpretations of the archaeological record! The circularity of this reasoning is obvious. Alternative explanations for the seeming introgression of "Neandertal DNA" into *Homo sapiens* must be falsified before such hypotheses are accepted.

Any hypothesis relating the MP-UP Transition to an evolutionary turnover event has to explain (1) the mechanism by which the replaced population became extinct, (2) the cause of their extinction, (3) the geographic source of the successor population, and (4) why the successor population dispersed into the former range of the replaced population.

The Mechanism of Extinction

The ultimate cause of extinction is the reduction of a population below the minimum number necessary to reproduce itself (Gilpin & Soulé 1986). Demographers and ecologists use the term "population sink" for regions in which populations of a given species persistently drop below sustainable levels. There are compelling reasons to believe that the Levant became a hominin population sink many times during the Pleistocene.

Estimating the preagricultural human population of the Levant involves making some necessarily simplifying assumptions about habitat preferences, and population densities (see Shea 2007b). Most faunal remains from LMP and EUP sites are those of species endemic to Mediterranean habitats (i.e., woodland, batha, garigue, and the woodland-steppe ecotone). The Mediterranean woodland offers far greater density and diversity of food resources to preagricultural humans than any other SW Asian habitat (Blondel & Aronson 1999). Consequently, it makes sense to model Paleolithic hominin demography in terms of change in this Mediterranean woodland phytozone. Mediterranean habitats currently comprise 80,000 km² in Lebanon, Syria, Israel, Jordan, and the Palestinian territories. Pollen spectra from the Jordan Valley and foraminifera from the East Mediterranean sea floor indicate that today's warm, humid conditions are exceptional, and that Mediterranean ecozones were less extensive under cooler, drier Upper Pleistocene conditions (Cheddadi & Rossignol-Strick 1995; Almogi-Labin *et al.* 2004). One can base a preagricultural human population estimate on the current extent of Mediterranean habitats, but the results will likely err on the high side. Such estimates, for example, would not take into account topography, watershed, and other terrain effects on primary productivity and carrying capacity.

The best models for preagricultural human population size in the Levant are ethnographic hunter-gatherers living in temperate woodlands. There are two major published sources for temperate woodland hunter-gatherer population density figures (Binford 2001; Kelly 1995), and both yield concordant results. Among mostly Western North American and Aboriginal Australian groups surveyed by Kelly, the median population density is 7.2 people per 100 km². The minimum is 1.3 people per 100 km². It is probably safest to frame estimates of population size as a range of values between the median and minimum figures. Even so, estimates derived from ethnographic population density figures will also likely be overestimates. Recent human hunter-gatherers deploy specialized extractive technologies that leave detectable traces in the Holocene archaeological record (Kuhn & Stiner 2001). None of these technologies are reliably and consistently documented for Levantine contexts prior to 50 ka.

Population density per 100 km²	25% Present (20,000 km²)	50% Present (40,000 km²)	75% Present (60,000 km²)	Present (80,000 km²)
1	200	400	600	800
2	400	800	1200	1600
3	600	1200	1800	2400
4	800	1600	2400	3200
5	1000	2000	3000	4000
6	1200	2400	3600	4800
7	1400	2800	4200	5600
8	1600	3200	4800	6400

Table 1 - Estimates of Levantine hominin populations obtained by multiplying various population densities against differing extensions of contemporary Mediterranean woodland habitats.

Multiplying population density figures ranging from 1 to 8 persons per 100 km² against a geographic range from 25-100% of the present Mediterranean woodland yields values for the total Levantine population ranging from an unrealistically low of 200 to a maximum of 6400 (tab. 1). The most generally accepted estimate for a human minimum viable population (MVP) is 500 reproducing individuals (Wobst 1974). Yet, a MVP of 500 is unrealistically low for a region like the Levant, one that is elongated North-South and divided topographically East-West by the Lebanon Mountains and the Jordan Rift Valley. A more realistic MVP would probably be around 2000 individuals, with at least 500 people living in four topographically-distinct subregions (Lebanon and northern Israel, southern Israel and the Sinai, Syria, and Jordan).

The results of this simulation suggest that it would not have taken much to drive Levantine hominin populations to extinction. A reduction in the Mediterranean woodlands to 25% of its present extent would have turned the Levant into a population sink. The effects of such a reduction would not have been evenly distributed geographically within the region. In the event of a sudden downturn in rainfall and temperature, the southern Levant would have been impacted first and most severely (Enzel *et al.* 2008). Surviving hominin populations would have persisted longest in areas with the highest rainfall, at lower elevations along the Mediterranean Coast in the northern Levant and in the foothills of the Taurus-Zagros Mountain Range.

The Cause of Extinction

Is there evidence for reductions in humidity and temperature in the East Mediterranean sufficient to cause drastic reductions in human population around 45 ka? Isotopic analysis of speleothems from Soreq and Peqiin caves in Israel show rapid short-term shifts in temperature and rainfall over the last 100,000 years (Almogi-Labin *et al.* 2004; Bar-Matthews *et al.* 2000; McGarry *et al.* 2004). The timing of these events is closely correlated with global patterns of climate change (Burroughs 2005). Change in rainfall in the Upper Pleistocene Levant was driven by shifts in oceanic circulation patterns in the North Atlantic. During "Heinrich Events", when this circulation slowed, Europe froze and the Levant grew colder and drier (Bond & Lotti 1995; Bartov *et al.* 2003). The period 44-50 ka witnessed rapid and substantial shifts in global and local climate. Sharp decreases in temperature and humidity were followed by wide short-term variability. These are exactly the conditions one would expect to reduce Levantine hominin populations heavily dependent on resources in Mediterranean woodlands. The absence of *Homo sapiens* fossils from contexts dating 45-75 ka probably reflects a regional extinction event associated with a previous sharp temperature and humidity decrease ca. 75 ka. Contrasting signals of wetter conditions detected at many coastal caves are likely local phenomnena, reflecting hydrostatic spring activity during times of lowered sea level.

Neandertals seem to have been doing well in the Levant up to 45 ka. There is no clear evidence that they were in any trouble, ecologically or evolutionarily. Yet, the interval between 45-50 ka would have posed new challenges. This period encapsulates the H5 and H5a North Atlantic Heinrich Events, rapid shifts to colder conditions (Bond & Lotti 1995; Rashid *et al.* 2003). The H5a event was unusual in both its magnitude and its long duration (Andrews 1998). Speleothems from Soreq and Peqiin caves register sharp increases in 13C and 18O around 45-50 ka, indicating rapid and significant reductions in temperature and rainfall. These carbon and oxygen isotopic increases are paralleled by oxygen-isotope values for foraminifera in East Mediterranean sediment cores (Bar-Matthews & Ayalon 2003). Speleothem and foraminifera isotopic data suggest rainfall in the coastal lowlands of the Levant plummeted to less than 200 mm (vs. 500 mm today) and average temperatures declined to 12-13°C (vs. 20°C today) (McGarry *et al.* 2004). A rapid decrease in the level of the Lisan paleo-lake during this period shows colder temperatures and increased aridity in the interior southern Levant (Bartov *et al.* 2003; Haase-Schramm *et al.* 2004). A correlated decline in regional terrestrial productivity is evident in increased pollen from steppe-desert taxa in marine sediment cores from the eastern Mediterranean (Cheddadi & Rossignol-Strick 1995; Almogi-Labin *et al.* 2004). In the microfaunal record for this period, cold-tolerant mice, voles, and hamsters, replace thermophilous species, such as gerbils and African grass rats (Tchernov 1998). All this evidence points to an abrupt and sustained drop in terrestrial productivity ca. 45-50 ka.

H5's cold, dry conditions probably retracted Neandertal settlement to woodland refugia along the Mediterranean coast. Evidence for over-hunting deer and gazelle at Kebara Cave (Speth & Clark 2006) is evidence for precisely the kind of resource stress one would expect to see among hominins beginning to run up against the limited subsistence options such refugia presented to them. Levantine Neandertals probably dwindled to extinction shortly after 45 ka.

Geographic Source of the Successor Population

Africa, and particularly East Africa, is currently the leading candidate for the ultimate source of the Levant's EUP human populations. East Africa's fossil record preserves strong support for an inferred morphological transition between *Homo heidelbergensis* (a.k.a. *H. rhodesiensis*) and *Homo sapiens* around 160-195 ka (Trinkaus 2005, Rightmire 2008). The Hofmeyr fossil, coming southernmost Africa, dating to 36 ka, and nearly indistinguishable from European Upper Paleolithic humans clearly points north, to East Africa, as the likely source of western Eurasia's *Homo sapiens* populations (Grine *et al.* 2007).

Studies of living human genetic variation consistently show greater variation among African populations, evidence for our species greater antiquity on that continent (Pearson 2004; Weaver & Roseman 2008). Among living humans, distance from East Africa strongly and accurately predicts local genetic diversity (Prugnolle *et al.* 2005), further narrowing the geographic locus of human origins on the African Continent. The estimated date at which African and Eurasian *Homo sapiens* genetic lineages diverged from one another ca. 65 ka (Kivisild 2007) immediately precedes the appearance of EUP assemblages in the Levant. Analysis of human linguistic variability also points towards our species recent origin in East Africa (Ehret *et al.* 2004).

The Levant is connected to East Africa by a major biogeographic corridor, the Nile River and the Afro-Arabian Rift Valley. Tracing human dispersal from the Levant back to East Africa involves the least number of untestable assumptions about human origins and the biogeographic factors that influenced their dispersal (Lahr & Foley 1998). It is possible that humans dispersed to the Levant from the Mediterranean Coast of North Africa, or from the Arabian Peninsula, but the ultimate source of those populations was almost certainly East Africa.

Why the Successor Population Dispersed

Dispersal is usually driven by population increase. Recent studies of equatorial African paleoclimate suggest an ecological basis for inferring a rapid growth among East African human populations immediately prior to the MP-UP Transition in the Levant. Analysis of sediment cores from Lake Malawi reveal pollen and isotopic evidence for overall drier conditions and a series of acute and long-lasting megadroughts in Subsaharan Africa between 75-130 ka (Cohen *et al.* 2007). These megadroughts likely concentrated human populations into those parts of Africa with persistently high rainfall and vegetation cover. The most likely such regions close to the Levant include the Ethiopian Highlands, the headwaters of the Nile and the flanks of the East African Rift Valley (Cowling *et al.* 2008). After 75 ka, when humid conditions returned, the Continent's carrying capacity increased, and human populations undoubtedly increased as well. The period 45-75 ka probably saw Africa steadily "filling up" with humans, increased intra-specific competition, and greater incentives for geographic dispersal, both within the Continent and beyond it. The Levant would have been an attractive destination for such dispersal, because *Homo sapiens* populations migrating in that direction would not have been competing against dense populations of conspecifics. Evidence that by 50 ka the Northeast African *Homo sapiens* populations were persisting in desert habitats (Wendorf & Schild 1996) suggests they possessed the skills necessary to disperse into Levant across its desertic southern periphery. The distances involved are not all that great. In fact, the entirety of the Sinai Peninsula would easily fit within the annual range of recent African arid-zone hunter-gatherers, like the !Kung San (Lee 1979).

Dispersal Out of Africa: Assumptions vs. Evidence

Is there archaeological evidence for the inferred dispersal of African *Homo sapiens* into the Levant around 45 ka? The simple answer to this question is "yes", but it is a different kind of evidence from what archaeologists are accustomed to seeking.

None of the diagnostic artifact-types of the Levantine EUP are present in large numbers and at earlier dates in either North or East African contexts. For this reason, most archaeologists who have considered the "Out of Africa" dispersal hypothesis with respect to the MP-UP Transition in the Levant have reached a negative verdict (Marks 1992; Bar-Yosef 2000; Vermeersch 2001). The problem with this approach to the lithic evidence is that it places great emphasis on interpreting variability among a category of evidence, stone tools, whose formation processes we do not fully understand. Stone tools from separate contexts may resemble one another because of a cultural connection between their authors or because of convergent selective pressures on stone tool design. Stone tools made by the same person may differ in response to raw material availability, to particular needs for tools, to transport decisions, and any number of other factors. Without adequate, much less robust, middle-range theory to sort out these possible sources of lithic variability the lithic record can easily send a "false negative" signal about human dispersal (Tostevin 2007).

Such false negative findings are demonstrable in two other well-documented cases of Late Pleistocene continental-scale dispersal, those to New Guinea and Australia after 45 ka and to the New World after 13 ka. In both cases, the dispersing *Homo sapiens* populations littered their new habitats with lithic assemblages that differ from those in those parts of Asia from which these dispersals are thought to have originated (Meltzer 1993; Mulvaney & Kamminga 1999). Expecting humans dispersing from Africa to retain that continent's traditions of stone tool production thousands of years later in the Levant contradicts nearly everything that is known about the flexible relationship between social identity and ethnographic material culture (Hodder 1982). There is no reason to assume Pleistocene human cultural identities were more rigidly linked to tool production strategies than among recent humans.

A more productive approach for testing the African dispersal hypothesis would be to trace the distribution of archaeological evidence for behavioral strategies uniquely associated with recent *Homo sapiens*. This is not an easy task. Our species exhibits an extraordinary capacity for behavioral variability, one that is almost certainly the result of strong and sustained selective pressure from very early stages in our evolution (Potts 1998). The particular archaeological "signatures" of many uniquely human activities likely vary widely through space and time. Nevertheless, it is sometimes possible to cut through the clutter of typological variability to track change and variability in the underlying technology.

The use of complex projectile weaponry is a behavioral strategy that is universal among historic and ethnographic human populations (Knecht 1997), and it appears to be associated solely with *Homo sapiens* in the paleoanthropological record (Shea 2006). As used here, the term "complex projectile weaponry" refers to weapon-systems such as the bow and arrow and spear-thrower and dart that combine low-mass penetrating weapons with high-speed delivery systems. Heavy, slow moving weapons like hand-cast spears and thrusting spears are excluded by this definition. Unlike hand-cast spears and non-piercing weapons (boomerangs, throwing sticks, etc.) projectile weapons are light, allowing a single hunter to carry many of them at the same time. They fly quickly, allowing them to be used on small, fast-moving targets as well as larger stationary ones. They retain energy longer in flight, allowing them to be used against larger dangerous prey, or other humans, with less risk of injury (Churchill 1993; Yu 2006). In a word, projectile weaponry is niche-broadening technology. Its underwrites one of the most distinctive derived features of Eurasian (indeed all) human adaptations after 50 Kya, our broad and flexible ecological niche. Like no other subsistence adaptation, complex projectile technology makes *Homo sapiens* the quintessential ecological generalist, and in evolutionary competition, generalists always beat specialists.

The mechanical constraints under which projectile weapons perform offer a route to identifying the durable components of projectile weapon systems in spite of the wide local and regional morphological variability. The most durable remains of projectile weapons are stone weapon tips. (Bone was used in many parts of the world as well, but its preservation is subject to taphonomic bias.) Studies of ethnohistoric North American stone arrowheads and dart tips suggest that such weapon armatures can be discriminated from other pointed stone tool types by wear patterns, mass, and tip cross-sectional area (TCSA)(Shea 2006). Of these, TCSA data can be recovered from the broadest range of archaeological points. A study of stone points from a wide range of African contexts dating to more than 50 ka revealed small numbers of artifacts in nearly every sample whose TCSA values overlapped with those of the ethnohistoric projectile points (Shea 2009). These data suggest that even though projectile technology was not the sole factor driving the production of these points, stone tipped projectile weapons were being produced in North, East, and South Africa before 50 ka. Subsequent studies of wear patterns and residues on these points and on backed pieces from additional African contexts have since affirmed the widespread use of projectile technology by African *Homo sapiens* between 50-100 ka (Shea & Sisk 2010). This finding suggests African humans developed complex projectile weapons as a strategy for diversifying their

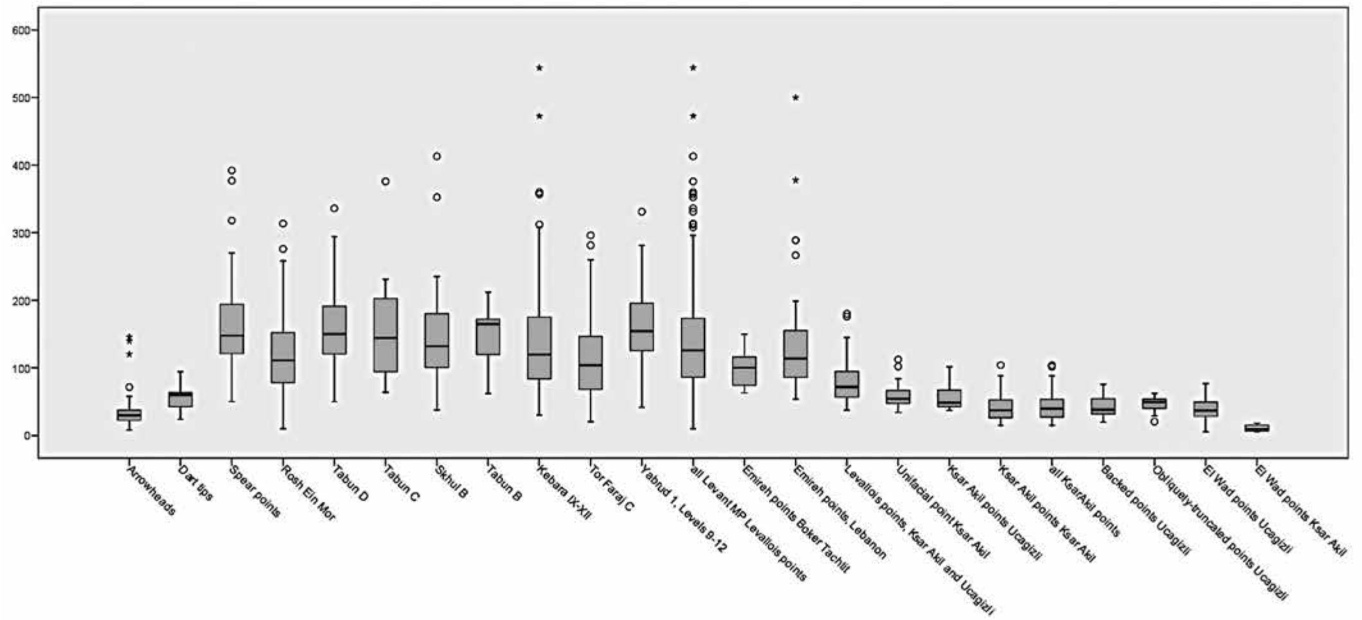

Figure 4 - Tip Cross-Sectional Area (TCSA) Values in mm² for hafted ethnohistoric North American arrowheads and dart tips, experimental thrusting spear points compared to Levantine Middle and Upper Paleolithic points. For original data, see Shea (2006).

ecological niches, possibly intensifying their use during the period of Late Pleistocene megadroughts. It is only reasonable to assume that this technology spread geographically as African populations increased along with wetter conditions after 75 ka.

If this hypothesis is correct, then durable evidence for projectile weaponry should appear in the Levant after 45 ka in contexts directly or indirectly associated with *Homo sapiens*. This is exactly the pattern one sees in the Levantine archaeological record. Samples of retouched and unretouched Levallois points from Levantine Middle Paleolithic contexts (n = 749 artifacts) show TCSA values consistently higher than those of ethnohistoric projectile points (fig. 4). There is no chronological trend in these data towards lower TCSA values, nor are the TCSA values from contexts associated with *Homo sapiens* fossils from Qafzeh significantly different ($p < .01$) from those associated with Neandertals. Pointed stone artifacts from Levantine EUP contexts (mostly Ksar Akil points, El Wad points) exhibit mean TCSA values that do not differ significantly from ethnohistoric projectile points. This evidence supports the inferred dispersal of African humans equipped with projectile technology into the Levant after 45 ka. The exact nature of this projectile technology remains unknown. Inasmuch as the spearthrower is virtually unknown from African ethnographic contexts, we cannot reject the hypothesis that the first *Homo sapiens* who entered the Levant after 45 ka did so carrying bows and arrows. (Emireh points, a point type that has been cited most often as evidence for continuity between LMP and EUP assemblages, exhibit high TCSA values, suggesting they were probably used in a manner more similar to the Middle Paleolithic Levallois points than to EUP projectile points.)

Stone points with TCSA values equivalent to known projectile points occur in European Early Upper Paleolithic assemblages, but not in Middle Paleolithic ones (Shea 2006). This and the Levant evidence are consistent with increasing evidence that what most distinguished *Homo sapiens'* adaptations in Europe and Western Asia was a wide ecological niche and an unprecedented degree of social networking among the populations (O'Connell 2006; Marean 2007; Stiner & Kuhn 2006). Projectile weaponry demonstrably plays a key role in recent human niche construction and social relations. Accepting the hypothesis that projectile weaponry enabled human survival in Africa and dispersal from that continent involves no greater leap of faith than any other inference about the past derived from uniformitarian principles.

The weak evidence for the use of complex projectile weaponry by Neandertals and by the Levant's Middle Paleolithic *Homo sapiens* population is puzzling. It is possible that our habit of referring to the Skhul/Qafzeh fossils as early "modern" humans underestimates significant biological differences between them and Upper Paleolithic *Homo sapiens* populations.

Conclusion

There is a long tradition in Levantine prehistory of describing change in terms of the metaphor of transition (see papers in Levy 1995; Bar-Yosef 1998). This is neither surprising nor unique to the Levant. Transitions imply continuity and continuity implies centrality and relevance to human origins and evolution. Regionalism, nationalism, careerism, and many other factors furnish strong incentives to describe change in prehistory in terms of transition. Yet, there are also compelling reasons to be skeptical about claims regarding prehistoric transitions. The most obvious one is that such claims are neither biogeographically nor evolutionarily realistic. Not all regions are equally likely places for long term continuity in hominin evolution. The smaller the region, the less likely it is to have been a locus for such continuity among large mammals (MacArthur & Wilson 1967). Continuity is even less likely among small populations of large mammals during periods of rapid climate change (Cardillo *et al.* 2005). When climates change, big mammals move, unless their movements are constrained by geography, competition, or predation. The dwindling populations of rhinos, elephants, gorillas, and other endangered species today living in game preserve refugia are sad proof of truth of this principle. Bounded by mountains, oceans and deserts, the Pleistocene Levant posed similar challenges to hominin survival to those currently faced by many of the world's large nonhuman mammal species. If this interpretation of the evidence is correct, then the events of 45-50 ka may have been but the most recent of many turnover events in the Levant Paleolithic prehistory. While there appears to be a consensus that the Levantine Upper Paleolithic period was not marked by turnover events, the lithic evidence for this assumption rests on the same shaky ground as that cited in support of the MP/UP Transition.

Contemporary archaeology draws on both humanistic and scientific epistemologies. Predictably, current debate about the MP-UP Transition contains a mixture of arguments and hypotheses. Most archaeological models invoking transitions and continuity in the Paleolithic record are arguments in the humanistic tradition. They are not hypotheses. They do not specify the mechanisms of continuity in terms of interpretive models derived from middle-range research. We can only explain past human behavior to the extent that we understand present-day sources of behavioral variability and use that understanding to generate hypotheses about the formation processes of the archaeological record. Continuity inferred from similarities among stone tools might reflect ancestor-descendant relationships, gene flow, culture contact, diffusion, convergent behavioral evolution, some other mechanism, or a combination of mechanisms. Unless the precise mechanism underlying the inferred continuity is specified and test criteria for rejecting that mechanism are made explicit, it is impossible to prove arguments about prehistoric transitions wrong. This does not make these continuity/transition arguments more likely to be correct; it just removes them from the arena of serious scientific debate. Science advances by the refutation of hypotheses, not by the mere repetition of arguments.

In presenting this "Out of Africa" explanation for the MP-UP Transition in the Levant, this paper is intended to be provocative. In current debate about this event, turnovers in hominin populations and dispersal from Africa are all too often dismissed because a robust, testable model incorporating these evolutionary mechanisms has not been proposed. Consequently, the "Out of Africa" hypothesis that is rejected in much recent debate about Levantine prehistory is a weakened, watered-down, "straw man" version of an hypothesis that actually explains the MP-UP record much better than competing arguments about transitions and continuity. There are at least four ways to prove the turnover hypothesis proposed here wrong:

- Finding shared derived morphological features (synapomorphies) between LMP and EUP hominins would show evolutionary continuity across the proposed turnover event.
- Showing abrupt climate change (specifically, temperature and humidity reduction comparable to that associated with Heinrich 5 and 5a) had no detectable effect on Middle Paleolithic hominin settlement, subsistence and demography would challenge the proposed role for climate change in the extinction of the Levantine Neandertals.
- Tracing EUP behavioral innovations or hominin populations to elsewhere in Eurasia would contradict their proposed African origin.
- Discovering evidence for widespread complex projectile weapon use in Eurasian Lower or Middle Paleolithic contexts would contradict the proposed role for projectile technology in *Homo sapiens'* dispersal into Eurasia after 45 ka.

Acknowledgements

I thank Jean-Marie Le Tensorer, Dorota Wojtczak, Thomas Hauck and Daniel Schuhmann for inviting me to this conference. The final draft of this paper profited immeasurably from discussions at the Basel Symposium. I also thank Gil Tostevin and two anonymous reviewers for comments on earlier drafts of this paper. I thank Reto Jagher for editorial guidance. All opinions expressed and any errors of fact are my sole responsibility.

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LA TRANSITION DU MOUSTÉRIEN À L'AURIGNACIEN AU ZAGROS

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Introduction

Par différents aspects, l'aire géographique centrée sur le Zagros semble correspondre à la fois aux origines de l'Aurignacien et de l'Homme moderne en Europe.

Des aspects anatomiques au cœur de la problématique

Diverses datations directement réalisées sur les restes humains de Mladeč, en Moravie, permettent de les attribuer à l'Aurignacien (32 000 BP, Teschler-Nicola 2006). Dans ce cas, le matériel lithique, l'outillage osseux et le contexte sépulcral évident (vu la disposition des restes, les pendeloques et l'ocre rouge) renforcent cette attribution. Les anthropologues avaient souligné les traits archaïsants des crânes de Mladeč en les expliquant par un métissage entre hommes modernes récemment arrivés en Europe et les néandertaliens locaux (fig. 1). Une autre hypothèse, à laquelle nous tendons, pourrait tout aussi bien y voir des traces d'archaïsme précisément contenues dans les populations originelles asiatiques, telles qu'elles sont aujourd'hui admises (Krause 2007). Des examens récents des isotopes de strontium dans les fossiles de Mladeč ont permis de constater une variation de Sr qui montre une mobilité importante de cette population (Galler 2008)

Puisque aucune théorie ne convient aux origines des Cro Magnon d'Europe, on peut alors retenir l'idée d'une filiation orientale, là où la variabilité génétique devrait être beaucoup plus forte qu'en Europe, alors cloisonnée par la mer ou les glaciers sur presque tous ses fronts, excepté l'oriental. Les recherches récentes menées sur l'ADN confirment cette tendance migratoire, de l'Asie centrale, vers l'Europe du Sud-Est (Chaix 2008). Les résultats récents des observations paléogéographiques, en

Figure 1 - Crânes de Techik-Tass (Moustérien, Ouzbékistan), à gauche, et de Mladeč (Aurignacien, Tchéquie), à droite.

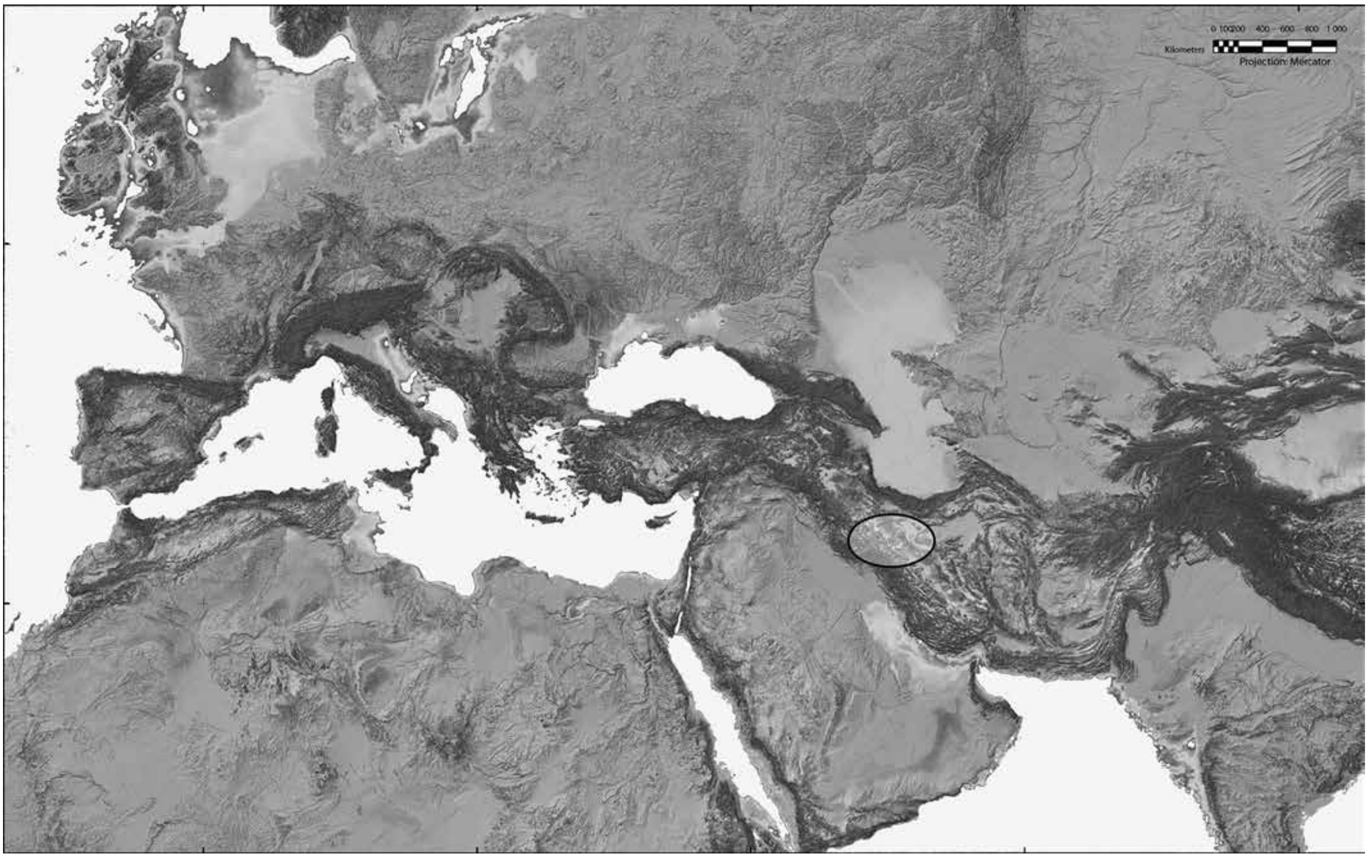

Figure 2 - Localisation de la région de Khorammabad (Iran) (carte J.-N. Anslijn).

particulier le travail de P. Dolukhanov (2008), permettent d'envisager une route Balkans-littoral nord de la mer Noire, vers le Caucase et le bassin de la Volga au nord de la mer Caspienne. Dolukhanov envisage cette route d'ouest en est; dans les conditions des datations anciennes en Asie centrale, on pourrait, sur un même principe paleogéographique, envisager une direction opposée.

Le Luristan aux marges de l'Asie centrale

Pour cerner cette question, de nombreuses missions archéologiques furent organisées en Iran, dans le Caucase, en Irak, Afghanistan et Ouzbékistan (Garrod 1930; Solecki 1955; Smith 1986; Piperno 1973; Mc Burney 1971; Nioradze 2000; Belfer-Cohen 1981; Bar-Yosef 2006; cf. Otte & Kozlowski 2007). Après diverses campagnes de prospection et la reconnaissance de nombreux sites, notre équipe s'est concentrée sur la région du Luristan, près de Koram Abad, afin d'y poursuivre des fouilles en collaboration avec Fereidoun Biglari et Sonia Shirdane de Téhéran.

Cette région, où diverses missions fructueuses furent effectuées dans les années 1960 (Hole 1967; Speth 1971), est non seulement centrale dans la chaîne du Zagros, mais surtout elle borde les plaines centrales asiatiques et les relie au Proche-Orient par une série innombrable de cavités naturelles, grottes ou abris, habités à toutes périodes. Au niveau culturel, son intérêt réside dans le fait que le Paléolithique supérieur n'y est représenté par aucune autre tradition que celle apparentée à l'Aurignacien, et cela malgré l'intensité des recherches qui y furent menées. En effet, les études préalables que nous avons menées dans l'ensemble des collections disponibles, en Iran comme aux Etats-Unis, ne nous ont livré que les restes de cette tradition, ou du Moustérien sous-jacent. Déjà, cette constatation possède un poids immense, étant donné l'étendue de l'espace considéré, son immense profondeur diachronique et l'analogie entre néandertaliens orientaux et Cro Magnon archaïque d'Europe centrale. Ce premier bilan ne peut être que l'effet marginal d'un phénomène beaucoup plus dense développé dans l'espace central, du Zagros au pied de l'Himalaya (fig. 2).

Un environnement attrayant

La ville de Koram Abad est située au débouché des vallées et des chemins, digités à l'est du Zagros vers les déserts centraux. A proximité, dans l'arrière-pays, s'ouvrent une série d'abris et de grottes, dont le site éponyme d'Arjanesh, où la lamelle appointée fut définie, et l'immense grotte de Kunji connue pour l'intensité de ses occupations moustériennes. Plus loin, la grotte de Yafteh est implantée au pied d'un magnifique cirque rocheux formé d'une immense falaise. L'endroit est parfaitement illuminé, possède une large vue sur la plaine environnante et se trouve en contact direct avec les rochers où sautillent, aujourd'hui encore, les troupeaux de chèvres. Les plaines alluviales proches regorgent de galets en radiolarite et la rivière qui y coule continue à offrir aux villageois les mêmes ressources complémentaires en poissons qu'au Paléolithique. Dans les années 1960, Fr. Hole y mena des fouilles à droite de la salle d'entrée, où il atteignit le rocher à quelque 2,50 m de profondeur, sans y rencontrer de Paléolithique moyen, mais en y traversant de nombreuses couches aurignaciennes (dénommées alors "baradostiennes"). Nos propres fouilles s'amorcèrent du côté opposé, proche de la terrasse, mais toujours sous l'auvent rocher. Sous d'abondants dépôts historiques faits de déchets blanchâtres, nous avons retrouvés intacts les nombreux niveaux aurignaciens, répartis en couches serrées très denses, d'une épaisseur d'environ 1,50 m (fig. 3), parfaitement en place, avec foyers, surfaces ocrées, brulées et aires de rejets cendreux. Ces fouilles préliminaires firent l'objet d'un rapport séparé (Otte 2007). Les dates au C14 sont étalées de 32 à 35 000 ans BP, mais le fond rocheux n'est pas atteint. Les fouilles de Franck Hole, beaucoup plus profondes, avaient livré des dates C14 allant jusqu'à 41 000 ans BP.

Les procédés techniques

Les industries de Yafteh, tous niveaux confondus, possèdent une très forte homogénéité, et sont assez analogues à celles qu'on appellerait proto-aurignaciennes à l'Ouest (le détail sera présenté dans des publications ultérieures). L'outillage est fait sur lames épaisses, directement extraites des galets de rivière que l'on trouve à proximité du site. Il comprend des grattoirs sur lames, des burins carénés et des lames retouchées de style aurignacien. Certaines de ces lames, au profil très régulier et à épaisseur constante, furent faites dans un matériau homogène, un silex à grain fin, d'origine extérieure. Un débitage Levallois, à talon facetté, est également présent mais en faible quantité. La fraîcheur de ces objets et l'existence simultanée de produits latéraux (issu de la mise en forme) et axiaux (les supports eux-mêmes) démontrent la mise en œuvre de ces techniques sur place, à l'emplacement même de l'habitat. Sur le plan numérique, les ensembles sont surtout dominés par des produits lamellaires : rectilignes pour les pointes d'armatures (type Arjeneh) ou courbes et légères (type Dufour). Indifféremment, la fine retouche marginale ou la retouche semi-abrupte ont été employées. Clairement, ces armatures légères et, souvent, pointues indiquent l'emploi d'armes à propulsion mécanique, telles que l'arc. Ces outillages manifestent donc à la fois la persistance de méthodes moustériennes, les caractères avancés nettement aurignaciens et la forte tendance à l'outillage léger fait sur lamelles. Il semble qu'ici le Paléolithique supérieur se manifeste davantage par l'orientation vers les armes propulsées à l'arc, justifiant l'abondance des lamelles, que vers la production de lames massives comme en Europe. Le fonds local moustérien semble avoir joué aussi un rôle significatif (fig. 4).

Un matériel riche et varié

Les différents niveaux aurignaciens possédaient de nombreuses traces de foyers : surfaces plates brulées, rougies ou amas cendreux noirs ou blancs. Certaines surfaces furent en outre colorées en rouge par des épandages de poudre ocrée. De nombreuses traces, très ténues, y marquaient aussi la dispersion d'hématite noire, brillante et dont certains objets furent façonnés. Des modelages en argile cuite furent aussi retrouvés, mais sans forme reconnaissable. L'outillage osseux y est représenté par diverses formes de baguettes, lissoirs, poinçons, alènes et autres produits manufacturés dont, surtout, la partie médiane d'une sagaie à section elliptique. La cassure de sa base empêche d'en connaître le type précis, mais ce qu'il en reste suggère une pointe à base massive de type Madleč. Les pendeloques y sont nombreuses par rapport à l'exiguïté des sondages. Elles furent essentiellement réalisées à partir de canines atrophiées ("croches") de cerfs rouges, percées dans le plat de la racine. D'autres sont faites par la perforation de coquilles marines (originaires du golfe Persique) colorées en rouge, ou façonnées en hématite, dont une imite la silhouette d'une croche de cerf, polie, brillante et agrémentée d'une série d'encoches périphériques. Tous ces témoins d'activités esthétiques convergent et renforcent l'idée

Figure 3 - Localisation et plan de la grotte de Yafteh, avec notre sondage au centre (fouilles 2005).

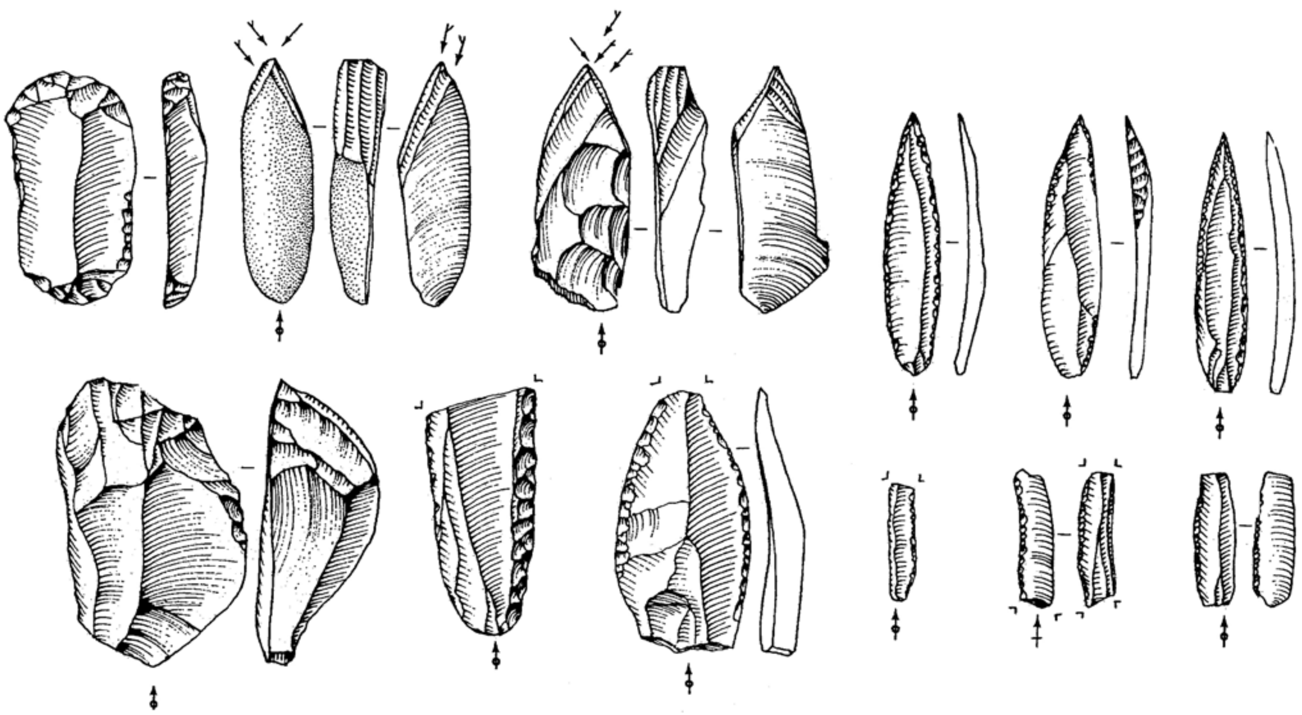

Figure 4 - Matériel lithique de Yafteh, 35 000 B.P., burins et grattoirs carénés, lame retouchée, pointes d'Arjeneh et lamelles Dufour.

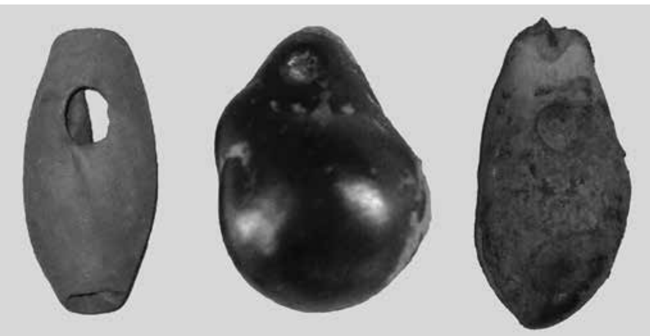

Figure 5 - Pendeloques de Yafteh : coquille, hématite, croche de cerf.

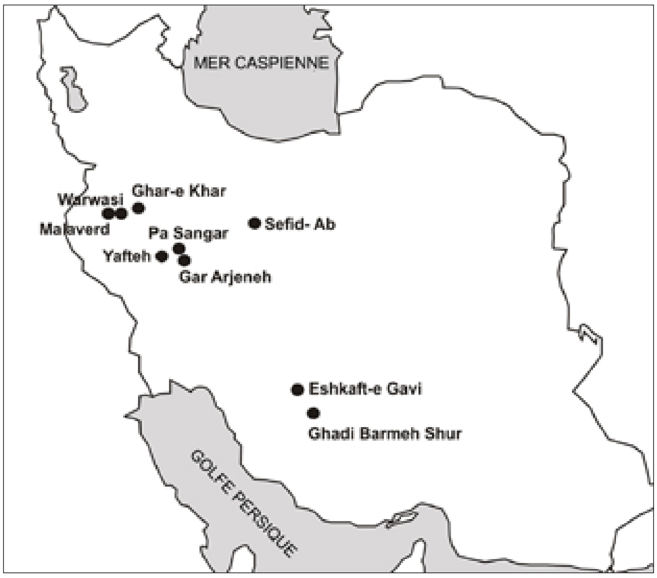

Figure 6 - Répartition des sites aurignaciens en Iran (carte F. Biglari).

d'une "révolution" spirituelle accompagnant celle des techniques, exactement comme en Europe, mais sans cassure brusque : tout se passe ici dans une sorte de continuité, au moins pour ce qui nous est désormais connu (fig. 5).

L'Aurignacien au-delà de Yafteh

La carte de répartition des sites aurignaciens iraniens fut réalisée par Fereidoun Biglari, à la suite des campagnes de prospection (fig. 6). Elle montre leur extension, presque jusqu'à Ormuz. Lorsqu'on considère l'existence de cet aurignacien plus à l'est en Afghanistan (site de Kara Kamar) et au Nord en Ouzbékistan (site de Kul Beulak), on perçoit l'extrême étendue de ce territoire culturel et ethnique, véritable réservoir ouvert sur l'Europe balkanique toute proche, d'autant qu'alors, la mer Caspienne était exondée et la mer Noire réduite à un lac dans sa partie méridionale actuelle. Il aurait suffi d'un excédent démographique, dû par exemple à une meilleure efficacité des armes propulsées, pour que ces populations s'étendent vers l'ouest, en Europe (et, apparemment, aussi vers le sud, au Levant).

De part et d'autre du Zagros

L'extension vers l'ouest du Zagros ne fait aucun doute. Les fouilles de Shanidar (Solecki 1955, 1963) ont livré d'abondants restes aurignaciens identiques à ceux de Yafteh (fig. 7) : burins carénés, lamelles, lames retouchées, lamelles appointées entrent clairement dans la définition du Baradostien, faciès local de l'Aurignacien. On y trouve aussi des éléments de débitage Levallois ou centripète, rappelant ledit Moustérien du Zagros, en réalité connu jusqu'en Anatolie occidentale, à Karaïn (Otte *et al.* 1998). Toutefois, à Shanidar, les séquences sont interrompues entre le Moustérien et l'Aurignacien avec environ 10 000 ans d'hiatus, apparemment dus aux effondrements abondants qui

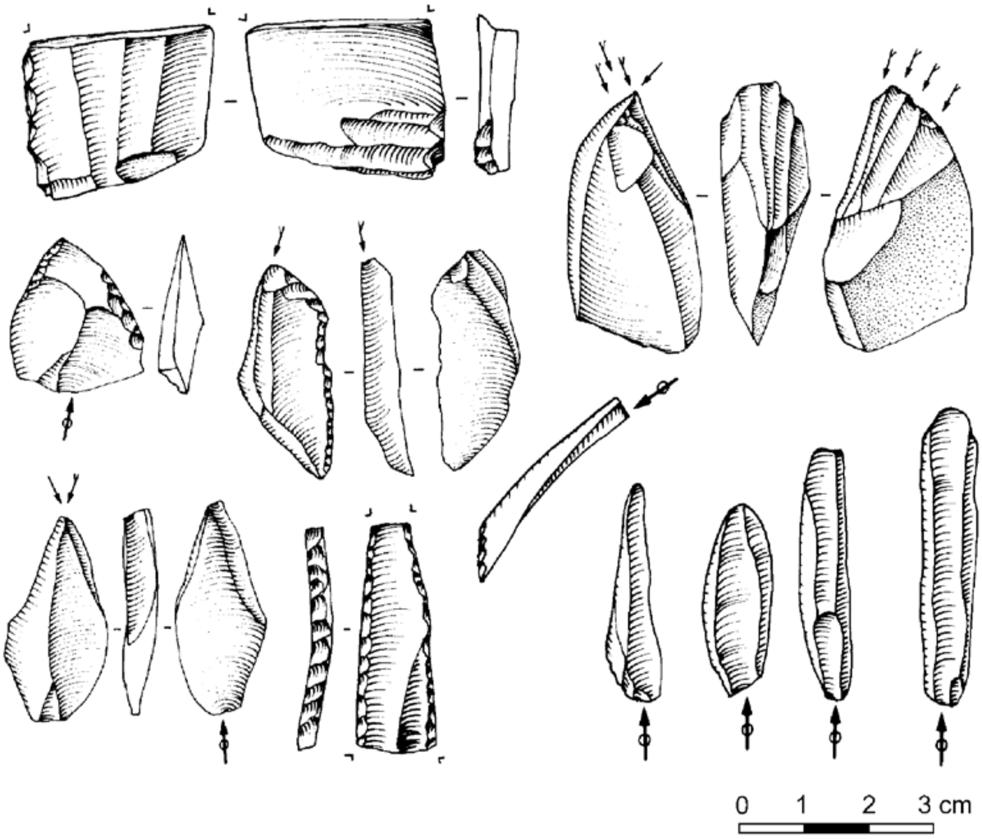

Figure 7 - Matériel lithique de Shanidar, sommet du niveau C (fouilles R.S. Solecki, dessins M. Otte).

marquèrent la fin de la séquence moustérienne. On trouve en outre, à la base de sa séquence aurignacienne, des pièces dites "à chanfrein", c'est-à-dire amincies à une extrémité par des enlèvements transversaux lamellaires. Cette méthode, très répandue dans le Moustérien local, semble liée à la carence en matériaux de bonne qualité. Dans ces sites de grottes, éloignées et élevées, l'outillage final se présente souvent sous forme de petites pièces intensément retouchées et ré-exploitées, grâce peut-être à un système d'emmanchement qui amincit une extrémité. Cette méthode aboutit à la production de lamelles à l'origine de technologies nouvelles orientées vers cette forme de supports, légers et favorables aux armes propulsées, bien davantage que les pointes de bois utilisées jusque-là selon toute apparence. Parallèlement, se constituait la panoplie d'armes en matières osseuses dans le prolongement mécanique des sagaies en bois, mais cette fois-ci dans un matériau résistant, compatible avec la propulsion lancée par levier tournant (propulseur). De tels impacts n'auraient pas convenus aux pointes en bois végétal, qui se seraient écrasées bien plus rapidement que l'os.

Les aires aurignaciennes orientales

La répartition des diverses aires aurignaciennes (fig. 8) montre un étirement de ces régions du sud-ouest asiatique (vers le Penjab) au sud-est européen (la Bulgarie), exactement selon l'axe défini par les données de l'ADN (Chaix *et al.* 2008). Les aires analogues, liées à cette répartition, se retrouvent à Kara Kamar (Afghanistan), dans le Caucase (russe et géorgien), en Crimée et en Anatolie, pour se disperser ensuite vers l'Ouest comme en Vénétie (Fumane), en Provence (Echipo Grapara) ou en Catalogne (Arlueda). Un mouvement longitudinal se dessine, étiré selon des latitudes constantes le long de ce qui fut alors le continent eurasiatique, beaucoup plus homogène qu'aujourd'hui, comme la restitution proposée à la carte au Pléistocène le montre bien (fig. 8). Un noyau de cet Aurignacien lamellaire entourent les déserts centraux, encore largement méconnus (Kazakhstan, Caspienne), dont l'Europe, considérée à cette échelle, ne semble constituer qu'une aile latérale, justifiant le retard qui y fut pris par la colonisation moderne et par la culture aurignacienne. Une seconde aire d'extension se situe vers le nord, jusqu'en Altaï (Anouï, Ust-Karakal) et vers le sud jusqu'au Levant (Umm el Tlel, Ksar Aqil, Hayonim).

Le Caucase, l'Anatolie et la Crimée

Depuis les premières recherches de Nioradze et Tcheriteli, l'Aurignacien était attesté des deux côtés de la chaîne caucasienne. Cette présence est aujourd'hui largement confirmée, bien datée et documentée par les fouilles récentes, menées par Dan Adler, Anna Belfer-Cohen, Ofer Bar-Yosef (2006) et Lubov Golovanova (2006). Comme à Yafteh ou à Shanidar, l'outillage comprend des grattoirs et des burins carénés (fig. 9) et une abondante composante d'armatures sur lamelles, faite de pointes Dufour (fig. 10). Les dates C14 y oscillent entre 32 et 36 000 ans BP, plus jeune donc qu'en Iran ou en Afghanistan, où elles atteignent 40 000 ans. Par ailleurs, les supports laminaires, lamellaires et centripètes rappellent les mêmes composantes techniques qu'au Zagros.

Ces éléments se poursuivent vers l'ouest, avec les niveaux médians de Karain B en Turquie et l'ensemble de la stratigraphie

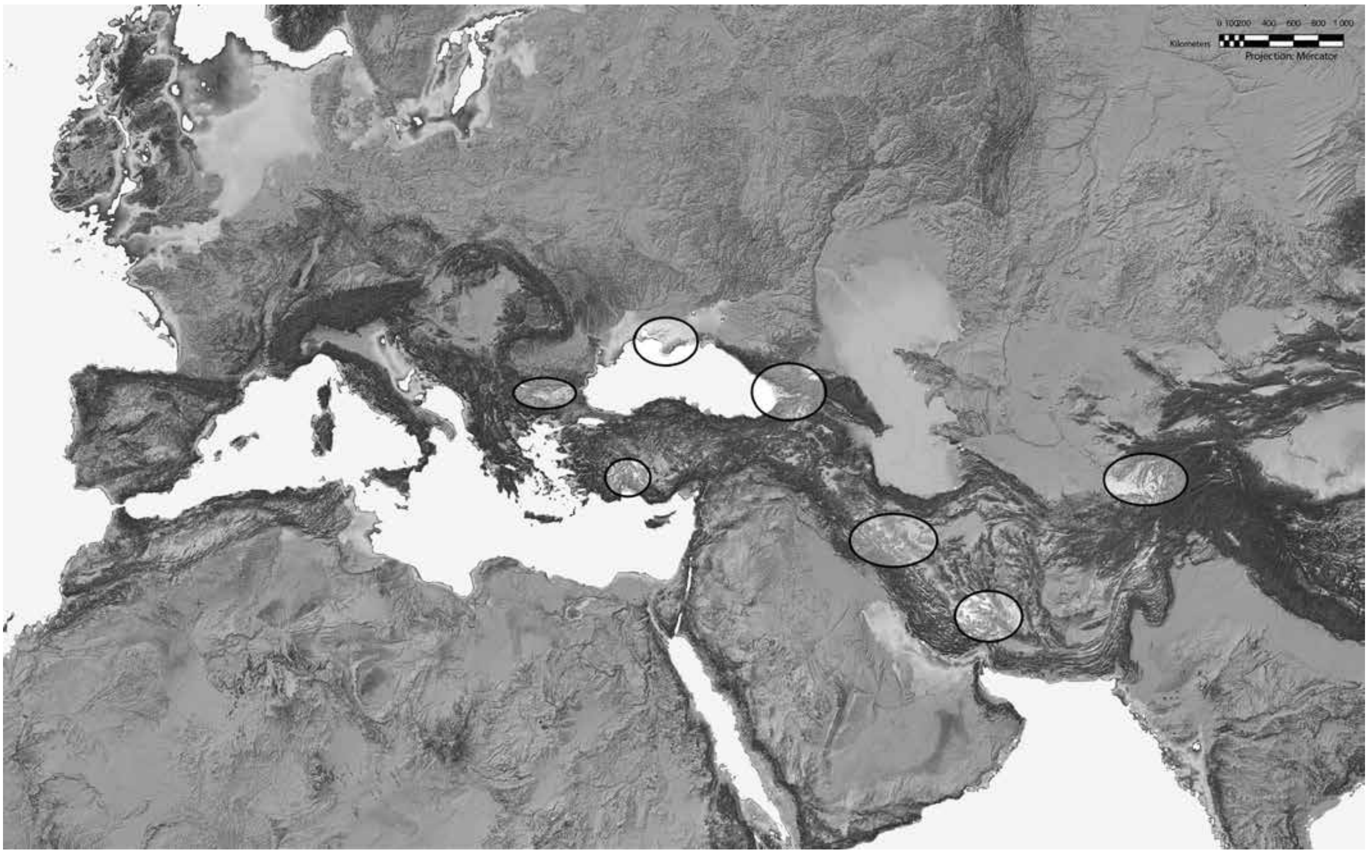

Figure 8 - Localisation des aires aurignaciennes orientales : Bulgarie, Anatolie, Crimée, Caucase, Zagros, Afghanistan (carte J.-N. Anslijn).

sous le grand abri de Siuren, en Crimée où les lamelles appointées rectilignes dominent (fig. 11; Otte 1996)

Aurignaciens et néandertaliens orientaux

La comparaison entre la répartition des néandertaliens orientaux, dont ceux récemment soumis aux analyses ADN, et les aires nucléaires orientales indique une assez nette convergence (fig. 12). Tout se passe alors comme si la population européenne, dans son relatif isolement, s'était sur-spécialisée à l'époque néandertalienne, telle une caricature de ses caractères généraux sur le seul plan morphologique et non dans son génome. Symétriquement, les populations asiatiques, installées en espaces immenses, à forts échanges géniques et à variabilité beaucoup plus forte, n'auraient gardé ces traits que sous une forme diffuse, plus évolutive qu'en Europe, comme les restes de Madleč, associés à une culture asiatique nouvelle, le démontrent clairement.

La séquence de Warwasi à l'appui

L'un des arguments de cette démonstration est contenu dans la longue séquence de Warwasi – un des rares sites où le terme de passage fut conservé -, montrant nettement la progression de l'outillage du Moustérien du Zagros vers le Baradostien. Les stades intermédiaires (fig. 13) attestent par exemple du maintien des lames retouchées, de la transformation des pièces à chanfrein en nucléus à lamelles ("grattoirs carénés") et du développement des armatures légères sur lamelles. Ce type de Moustérien, très réductif, serait ainsi logiquement orienté vers la production de lamelles légères, dont les supports conviendraient précisément bien aux pointes propulsées à l'arc employées dans des milieux montagneux où séjournent des animaux fugaces, tels la chèvre ou le bouquetin. Dans ces régions, les aspects mécaniques se superposent à un stade d'évolution anatomique mais ils apparaîtront liés dès que ces populations quitteront cette aire nucléaire.

Mécanisme évolutif de l'anatomie

A. Leroi-Gourhan et Fr. Weideinreich l'ont toujours montré : l'évolution de l'anatomie humaine se résume en un long processus purement mécanique et fondé ultimement sur la réaction lointaine à la bipédie, enclenchant une forme de tendance, présente en toute humanité et toujours active aujourd'hui. La "modernité" de l'humanité n'est donc qu'une phase transitionnelle mais, en aucune façon, un aboutissement. Rétrospectivement, cette considération implique à la fois la séparation de la notion d'espèce d'avec celle de stades évolutifs et la flexibilité morphologique extrême inscrite à l'intérieur de l'espèce humaine, toutes périodes confondues, comme en témoignent, sous nos yeux, toutes les populations terrestres et les innombrables formes de métissage. Aucune raison logique (ne parlons pas des autres) ne nous autorise à placer le Rubicon de l'humanité à tel ou tel autre moment de son aventure biologique. Cependant, partout les tendances sont restées, et resteront, identiques à celles qui ont enclenché ce processus il y a des millions d'années : le retrait de la face, l'équilibrage du crâne, l'augmentation de sa capacité par le déblocage des "verrous" musculaires greffés sur la face et sur l'occipital. C'est ainsi que les néandertaliens orientaux possèdent moins de caractères particuliers que ceux de la pénin-

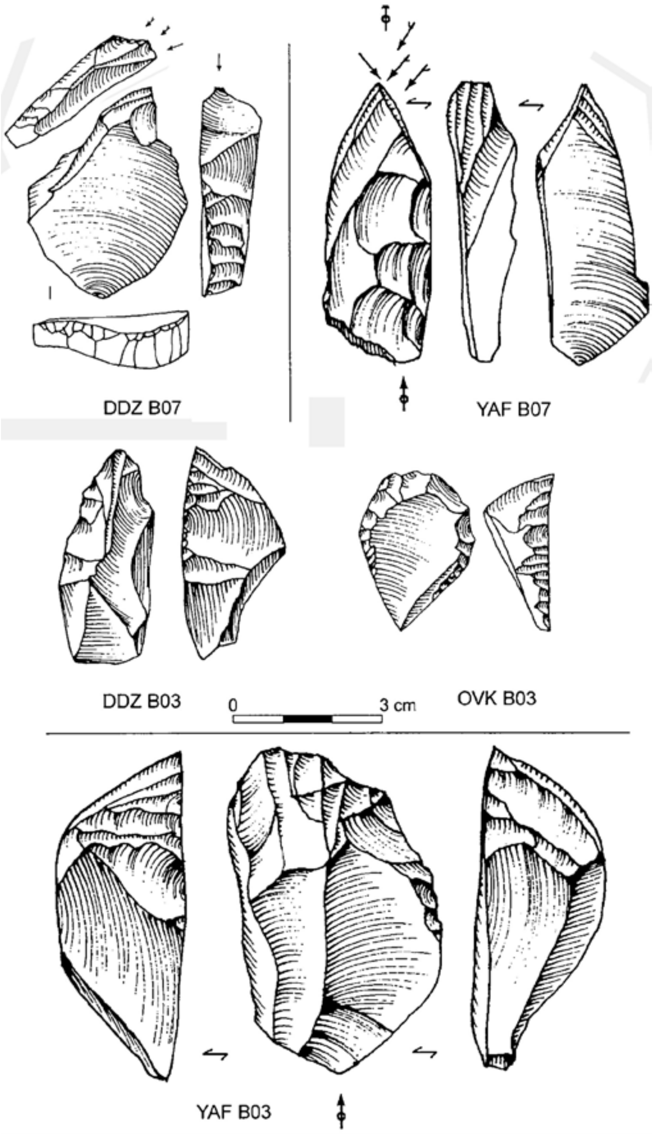

Figure 9 - Echantillon représentatif de l'Aurignacien du Caucase (Dzudzuana, Ortvala Klde).

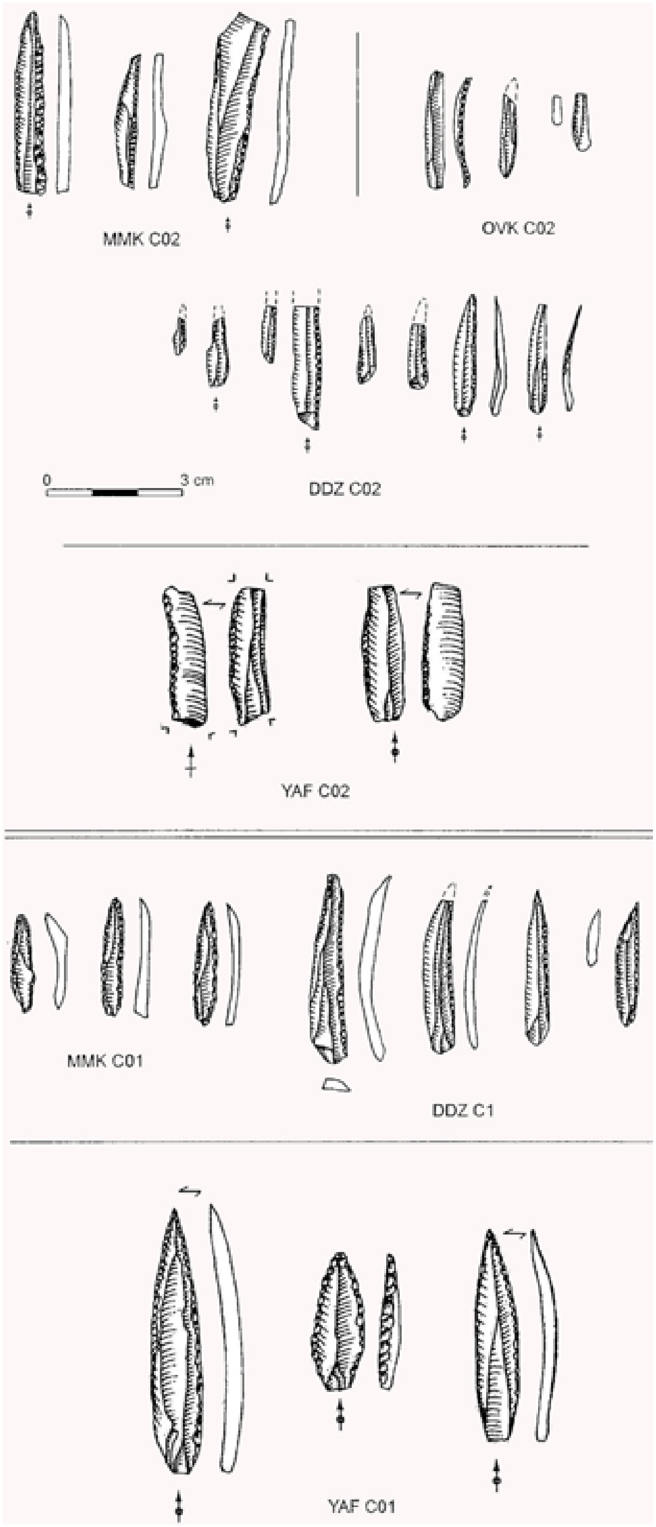

Figure 10 - Echantillon représentatif de l'Aurignacien du Caucase (Mesmanskaia).

sule européenne; c'est ainsi aussi que les premiers Européens "modernes" (Mladeč) portent ces traces d'archaïsmes d'origine externe (fig. 15).

L'autre modernité asiatique

Outre l'Extrême-Orient, où les populations évoluent en totale autonomie, le nord de l'Asie centrale possède un processus évolutif très particulier et original. La longue séquence de Obi-Rahmat, en Ouzbékistan, contient une évolution technologique continue, étalée de 90 à 40 000 ans (Derevianko 2004). Le débitage Levallois représenté y est de plus en plus laminaire, mais sans jamais passer par les nucléus volumétriques de l'Aurignacien. De plus, des lames brisées donnent souvent lieu à l'extraction de lamelles latérales, débitées à partir du plan de fracture (fig. 14). Au milieu de cette séquence, un fragment de pariétal humain possède toutes les apparences d'un crâne moderne. En Sibérie méridionale, dans la région de l'Altaï, des ensembles identiques furent retrouvés en phases récentes : entre 42 et 38 000 ans. Le débitage laminaire Levallois y est abondant ("lames appointées") ainsi que l'extraction de lamelles sur bords de lames cassées (fig. 14). Il semble dés lors qu'il existe, dans cette immense région, plus septentrionale que la précédente, des tendances évolutives, fondées sur le Levallois et orientées vers la production de lames et de lamelles, en totale indépendance avec l'Aurignacien et, apparemment, également associée à une forme d'humanité moderne.

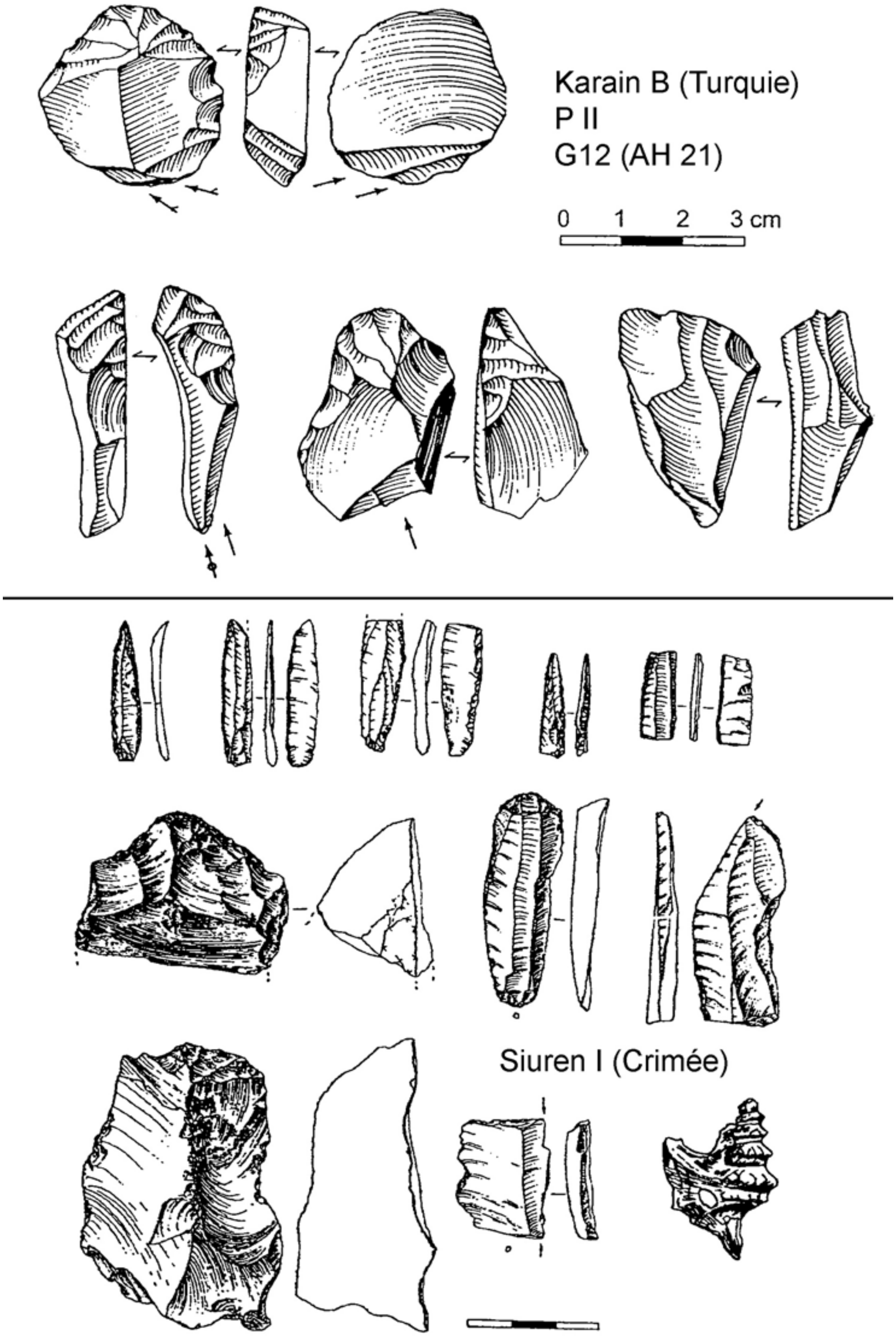

Figure 11 - Echantillon représen-tatif de l'Aurignacien de Turquie et de Crimée (Karain et Siuren).

Entre archaïsmes et modernité

Lorsque l'on considère les crânes européens les plus caractéristiques des périodes moustérienne et aurignacienne, on constate une opposition flagrante entre les deux morphologies, directement opposées dans la même région de l'Extrême-Ouest. Mais, dès que l'on quitte ces franges marginales, où cultures et ethnies se superposent comme les tuiles d'un toit, ces distinctions s'atténuent, leurs critères s'y superposent, s'y interpénètrent, à la fois au fil du retrait spatial, vers l'est et au fil de l'écoulement du temps, vers le Gravettien. S'il fallait encore une preuve à l'interfécondité paléolithique, elle se trouve apportée par chaque crâne du Gravettien morave où traits archaïques locaux et traits modernes se trouvent inextricablement mêlés, alors que les fondements techniques y sont radicalement neufs.

Acculturation spirituelle

Si les restes osseux suggèrent le métissage aux origines des populations gravettiennes, si profondément différentes dans leurs comportements, des traces de cette mixité apparaissent également dans les sphères métaphysiques, exprimées par les arts et les mythes. Clairement, le corpus d'images aurignaciennes est cohérent, il s'impose d'emblée par ses constantes de formes, de

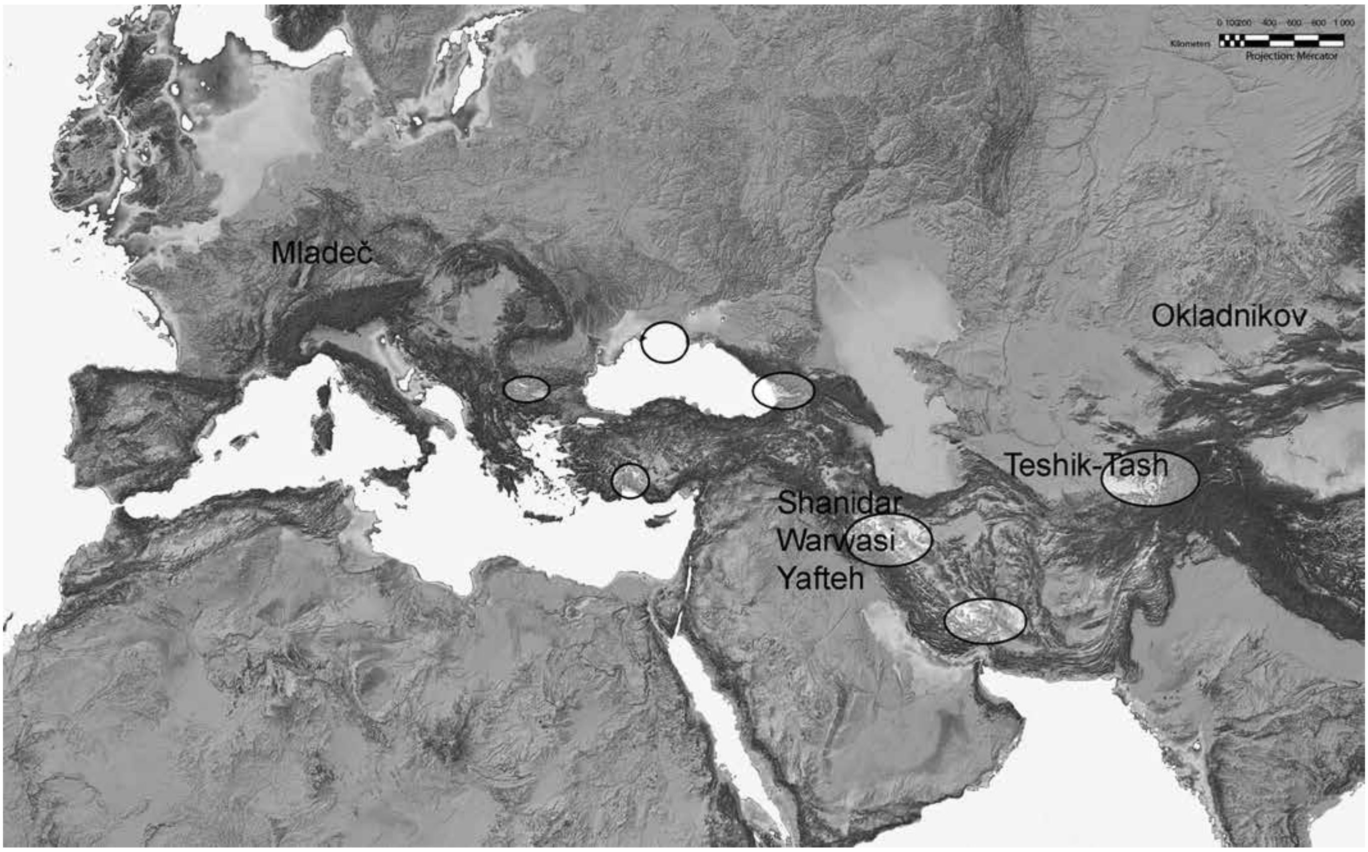

Figure 12 - Répartition des Aurignaciens et des Néandertaliens orientaux (carte J.-N. Anslijn).

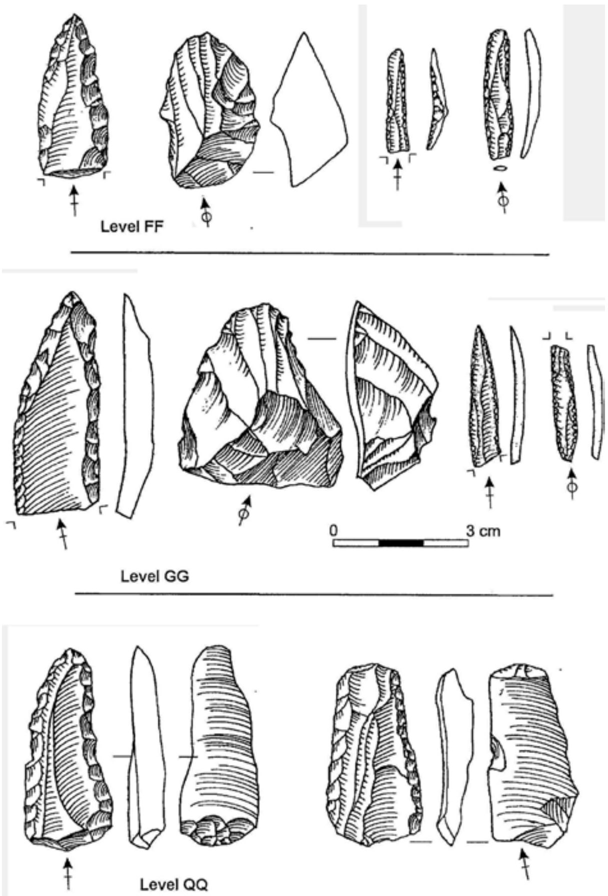

Figure 13 - Matériel lithique de Warwasi, Moustérien lamellaire (mode aurignacien).

styles, de thèmes et, surtout, par la création désormais définitive de représentations, utilisées à la place de l'animal lui-même ou de son évocation orale dans les récits (fig. 16). Cette cohérence s'étend des statuettes du Vogelherd (Jura Souabe) aux peintures de Chauvet (Ardèche), tout en changeant de supports et de moyens d'expression : styles et figures traversent toutes les contraintes mécaniques imposées par les matières. Lorsque le Gravettien apparaît, il suit d'abord exactement les mêmes tendances et en reste inféodés longtemps (fig. 17, 18, 19). Les thèmes des félidés, mammouths, chevaux, anthropomorphes dominent et se tournent vers une représentation réaliste, volumétrique, dense et expressive. Comme les Aurignaciens, les Gravettiens empruntent à la nature ses lois et tendent vers l'analogie dans les représentations. Si le Gravettien se distingue nettement, il absorbe aussitôt la pratique de l'image dès ses premiers contacts avec l'Aurignacien. Cependant, dès que cet échange paraît assumé, le Gravettien poursuit son évolution picturale dans des voies toutes neuves : vers les figures conquises dans les deux dimensions de la silhouette, poursuivant ainsi la trajectoire picturale d'un art de plus en plus éloigné de son référent naturel et devenant ainsi beaucoup plus autonome, chargé toujours davantage de spiritualité.

Conclusion

L'aventure humaine n'est sûrement pas simple car il s'y combine des tendances mécaniques, des lois biologiques et les puissants processus historiques. La "modernisation" de l'Europe forme l'un de ces cas complexes où les événements s'accélèrent, les contacts ethniques se diversifient, l'image apparaît avec son

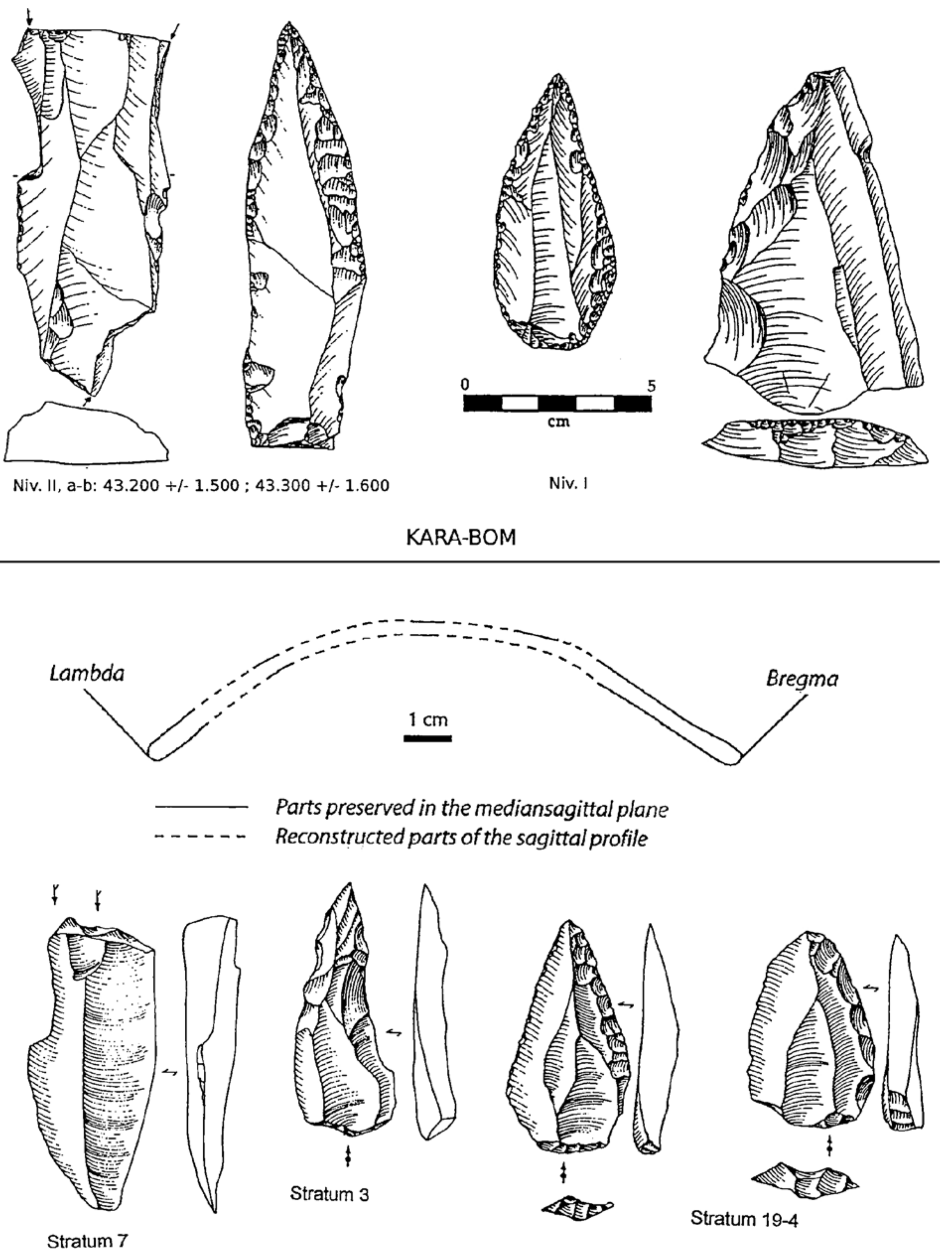

Figure 14 - Moustérien laminaire Levallois (mode gravettien).

procédé de "délégation" mythique : de la pensée vers la forme. Aucune solution simple et radicale ne peut convenir pour expliquer des situations aussi complexes et, par ailleurs, si universelles. L'art et l'homme moderne apparaissent partout, toujours, inexorablement, de l'Australie au Khalari, de la Chine au Brésil. Réduire cette immense complexité à une ou à l'autre théorie dogmatique revient à commettre une absurdité et, au passage, une injure à la dignité humaine.

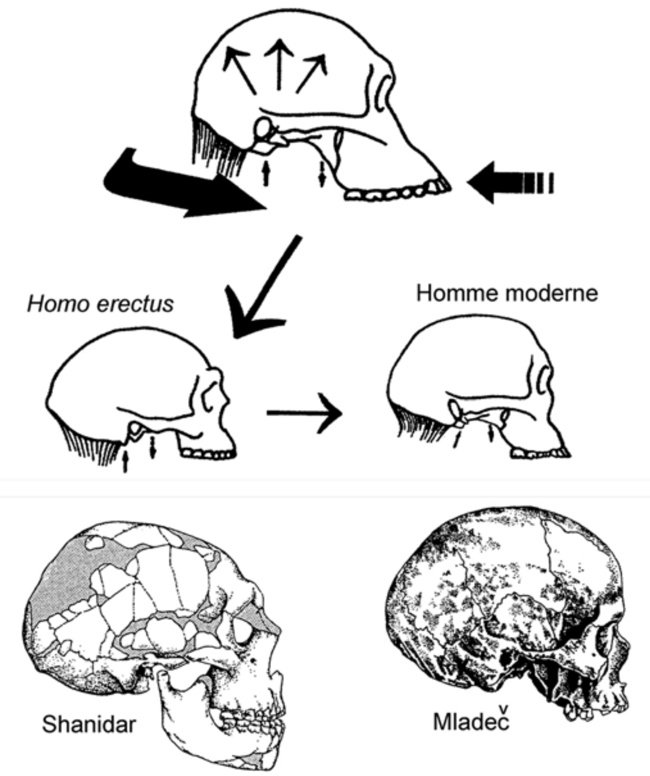

Figure 15 - En haut: mécanismes d'hominisation; en bas: comparaison des crânes de Shanidar (Moustérien) et de Mladeč (Aurignacien).

Figure 16 - Premières images; au-dessus : Chauvet; en bas à droite: Vogelherd.

Figure 17 - Acculturation gravettienne; au-dessus : Chauvet; en bas, à droite: Vogelherd, à gauche : Dolni Vestonice.

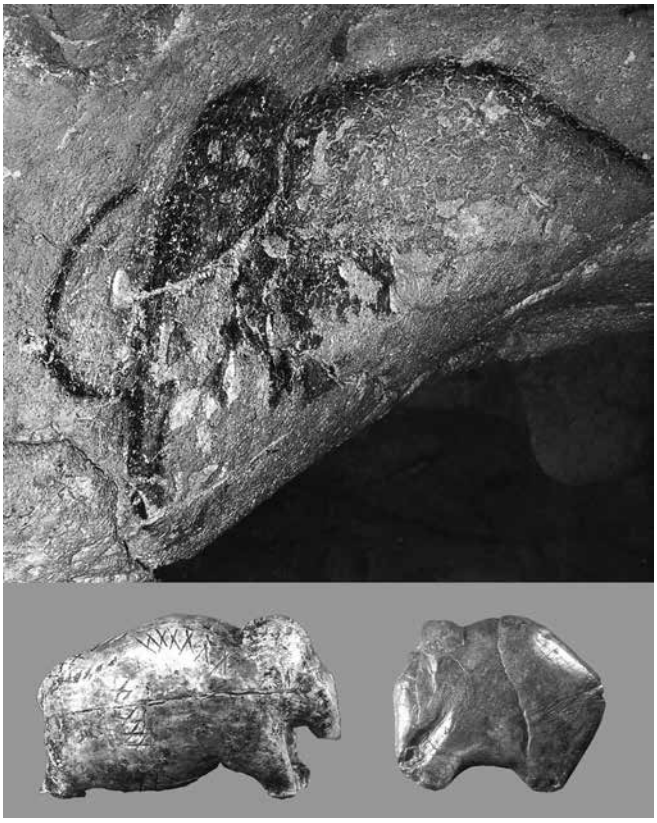

Figure 18 - Acculturation gravettienne; au-dessus: Chauvet; en bas, à gauche: Vogelherd, à droite: Predmost.

Figure 19 - Comparaison entre les figures anthropomorphes de l'Aurignacien et du Gravettien; à gauche: Stadel, à droite: Brno.

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EL KOWM, A KEY AREA FOR THE PALAEOLITHIC OF THE LEVANT IN CENTRAL SYRIA

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Introduction

The El Kowm oasis is located about 90 km north-east of Palmyra in the very centre of modern Syria, within the heartlands of the Fertile Crescent (fig. 1). The small area of about 25 by 25 km is characterised by an important cluster of perennial natural springs, within a greater area where natural springs are scarce and fickle. This precious natural resource attracted game in great numbers from afar. Since the Lower Pleistocene, humans have left their traces continuously in this region for over one million years (Le Tensorer 2009; Le Tensorer *et al.* 2011). The exceptional density of sites and their extraordinary preservation make this inconspicuous area one of the most prominent regions for understanding the human presence in the Levant throughout the whole Palaeolithic era. In fact nowhere else in the Fertile Crescent can human cultural evolution and behaviour be followed in such detail in such a small geographical area, and over a comparably long time span.

The region owes its name to the prominent tell of al Kowm, an impressive hill dominating the surrounding plains by about 20 metres. The tell, just 120 by 180 metres at its base, has an eye-catching cone-like structure and with its distinctive steep flanks it is a prominent landmark contrasting with the open, poorly structured landscape.

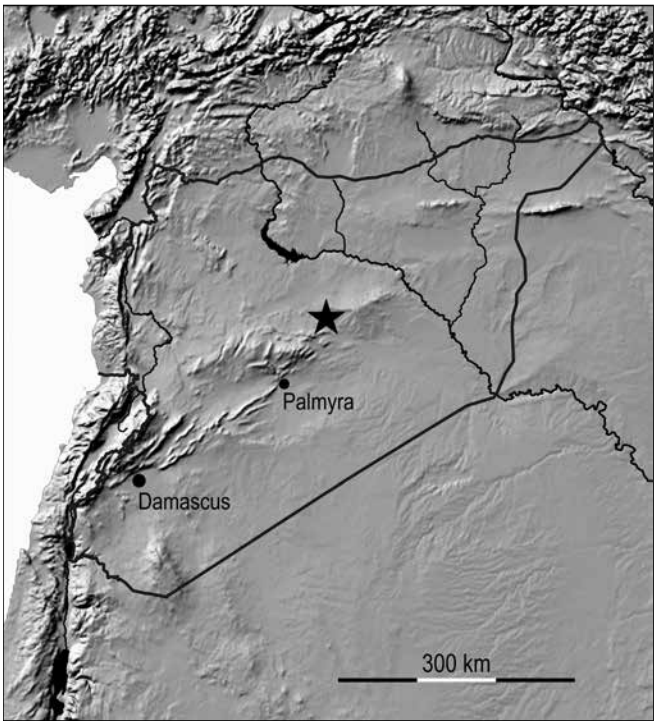

Figure 1 - Location of El Kowm area.

History of research

The area of El Kowm was completely unknown as a prehistoric location until the late 1960s. The first explorations undertaken by G. and M. K. Buccellati in the summer of 1966, and independently by I. Suzuki and I. Kobory during the winter of 1967/68, resulted in the discovery of the first Palaeolithic sites (Buccellati 1967; Akazawa *et al.* 1970). The results of Buccellati's survey led R. Dornemann to carry out the first excavations in the "tell" of El Kowm, revealing a substantial settlement of the aceramic Neolithic (Dornemann 1969, 1986).

In spite of these encouraging explorations, research almost completely ceased for a decade until 1978 (Bader & Tchoumakov 1977), when Jacques and Marie-Claire Cauvin began systematic investigations in this area, discerned for its excellent conditions of preservation for early agricultural cultures (Cauvin *et al.* 1979, Stordeur ed. 2000). Even during their initial field work, numerous Palaeolithic sites were again recognised. Subsequently in 1980 a systematic survey for Palaeolithic sites was launched under the auspices of Lorraine Copeland and Francis Hours, assisted by Sultan Muhesen. Within the core area of about 150 km² 72 Palaeolithic sites were recorded. Many of them had an incredible wealth of lithic artefacts and to a lesser extent associated Pleistocene fauna. At that stage, observations were limited to qualitative confirmation of the archaeological periods observed. Later field work until 2004 extended the area of interest, eventually producing 152 locations with pre-Neolithic discoveries. Interim syntheses of these observations outlined the importance of the region for the Palaeolithic of the Levant (e.g. Le Tensorer & Hours 1989; Le Tensorer *et al.* 2001, 2007).

From 1981 to 1988 investigations on Palaeolithic sites focused less on surveys, but concentrated on the stratigraphy and Quaternary geology of selected sites, especially the large well of Hummal (Copeland 1985) and the unassuming site of Nadaouiyeh Aïn Askar (Hours *et al.* 1983). At the same time an extensive geomorphological survey permitted a basic understanding of the natural setting of Palaeolithic sites in Al Kowm area (Besançon & Sanlaville 1991). During this first period, preliminary studies were carried out on the newly discovered Hummalian industry (e.g. Hours 1982; Bergman & Ohnuma 1983; Copeland 1985) and focused on the Yabrudian (Copeland & Hours 1983; Le Tensorer 2004). In the same period additional field work was carried out on the late Palaeolithic site (Geometric Kebaran) of Nadaouyeh-2 (Cauvin & Coqueuniot 1989).

With the beginning of systematic excavations at Nadaouiyeh Aïn Askar from 1989 until 2003 (Jagher 2000; Jagher 2011; Reynaud 2011) as a joint venture of the Universities of Basel and Damascus, the Palaeolithic period again became a focus of archaeological research in the El Kowm area. Since 1991 comprehensive excavations have been conducted at Umm El Tlel by Eric Boëda and Sultan Muhesen in a Syrian-French joint venture concerning Middle and Upper Palaeolithic settlements (e.g. Boëda *et al.* 2001, 2008). In 1997 the still ongoing archaeological investigations were resumed in Hummal as a Syrian-Swiss cooperation (Hauck 2011; Le Tensorer *et al.* 2011; Richter *et al.* 2011, Schumann 2011; Wegmüller 2011; Wojtczak 2011).

The combined stratigraphies of Hummal, Nadaouiyeh and Umm El Tlel cover the complete Palaeolithic record known in the El Kowm area, from Oldowan-like core and flakes industries to the latest Palaeolithic. Additionally to these main excavations, smaller explorations were carried out at three Acheulean sites; in 1989 at Juwal Aïn Zarqa and 1991 in Qdeïr Aïn Ojbeh, both by the Syrian-Swiss team, and from 1996 to 1998 in El Meïrah under the responsibility of E. Boëda and S. Muhesen (Boëda *et al.* 2004). In the late 1990s a number of soundings were carried out on several Aurignacian surface sites by M. Taha (Ploux & Soriano 2003) within the scope of the Mission Archéologique Umm El Tlel-El Meirah directed by Eric Boëda, Sultan Muhesen and Heba Al Sakhel.

Topography

The immediate surroundings of El Kowm are shaped by low hills about 450–500 m above sea level that hardly rise from the landscape. Along its southern margins, the El Kowm lowlands are dominated by the eastern foothills of the Palmyrides, dominating the plains by 400 to 600 m. To the northeast of the region rises the broad dome of the Djebel Al Bishri. The area of El Kowm is best described as a broad gap about 20 km wide, cut into the Central Syrian range, that stretches from the Anti-Lebanon Mountains in the west to the Euphrates river in the east, dividing northern Syria from the plains of the Arabian Desert in the south. The El Kowm area occupies the centre of several morphologically different landscapes, offering a variety of ecologically diverse hinterlands within a short distance.

In the arid environment of central Syria, the several dozens of perennial springs played a pivotal role for the survival of animals and humans. The next safe waterholes are located either about 75–100 km to the north along the oasis of the Euphrates or 90 km to the southwest at the oasis of Palmyra. The strategic setting of the El Kowm springs within a natural passage certainly had an effect on wandering animals. Less than a century ago, this opening in the mountain range offered a preferential route for passing herds, as is still indicated by well preserved remains of many desert kites, the extensive traps used for hunting gazelles since antiquity.

The centre of the El Kowm area is composed of several distinct topographic structures, which are faintly visible in the terrain to the untrained eye. Even a few metres of difference in elevation has a considerable influence on the drainage pattern. One of these features is the El Kowm platform, a low, more or less flat rise of roughly 5 by 5 km, overlooking the surrounding wadis by about 15–20 m. This structure is the main divider in the drainage for the Sabkha Al Kowm, a temporary shallow salt lake that today spreads over 4 km². About two-thirds of the waterholes of the area are located within the confines of the El Kowm platform. The most prominent feature in the area is the Al Qdeïr plateau, a rectangular tabular rise of approximatively 5 by 13 km rising 35–40 m above the adjacent wadis draining the area on its western slopes to the Sabkha Al Kowm and its southern and eastern margins to the southeast in the direction of Qasr Al Hair Ash Sharqi. Within the wider surroundings of the actual village of El Kowm, a number of distinct round hills rise a few tens of metres over the landscape among them the most prominent, the eponymous tell of El Kowm.

Geology

The geological setting of the region is basically visible from the surface structures which determine the topography. Available geological maps are unsatisfactorily straitened having just a limited resolution. The Palmyrides limiting the area to the south are a range of strongly faulted formations of Lower and Middle Cretaceous rocks, while the Al Bishri anticline is a huge dome of Tertiary sediments. The lowlands between the mountains are made up of soft chalk and marl from the Late Cretaceous and Early Tertiary.

The Lower Eocene deposits are of particular interest for prehistory, as they contain first-rate flint nodules of substantial dimensions and unlimited quantity (Medvedev 1966; Oufland 1966). Extensive outcrops of these deposits are easily accessible within 10–20 km from the Palaeolithic sites in the north, east and south of El Kowm (fig. 2). The quality and productivity of these deposits is poorest in the north and richest in the east, located somewhat farther away. However, blocs of fine grained flint of several tens of centimetres across are readily available at most outcrops. The Lower Eocene flint deposits are exposed within the Palmyrides for more than 200 km, with El Kowm at its eastern end. Over the entire area of distribution, the Lower Eocene flint material is virtually the same and its precise place of origin cannot be determined (Diethelm 1996; Julig & Long 2001). This character of the Lower Eocene flint impedes the identification of raw material circulation in Palaeolithic sites in the El Kowm area, where almost exclusively Lower Eocene flint has been processed.

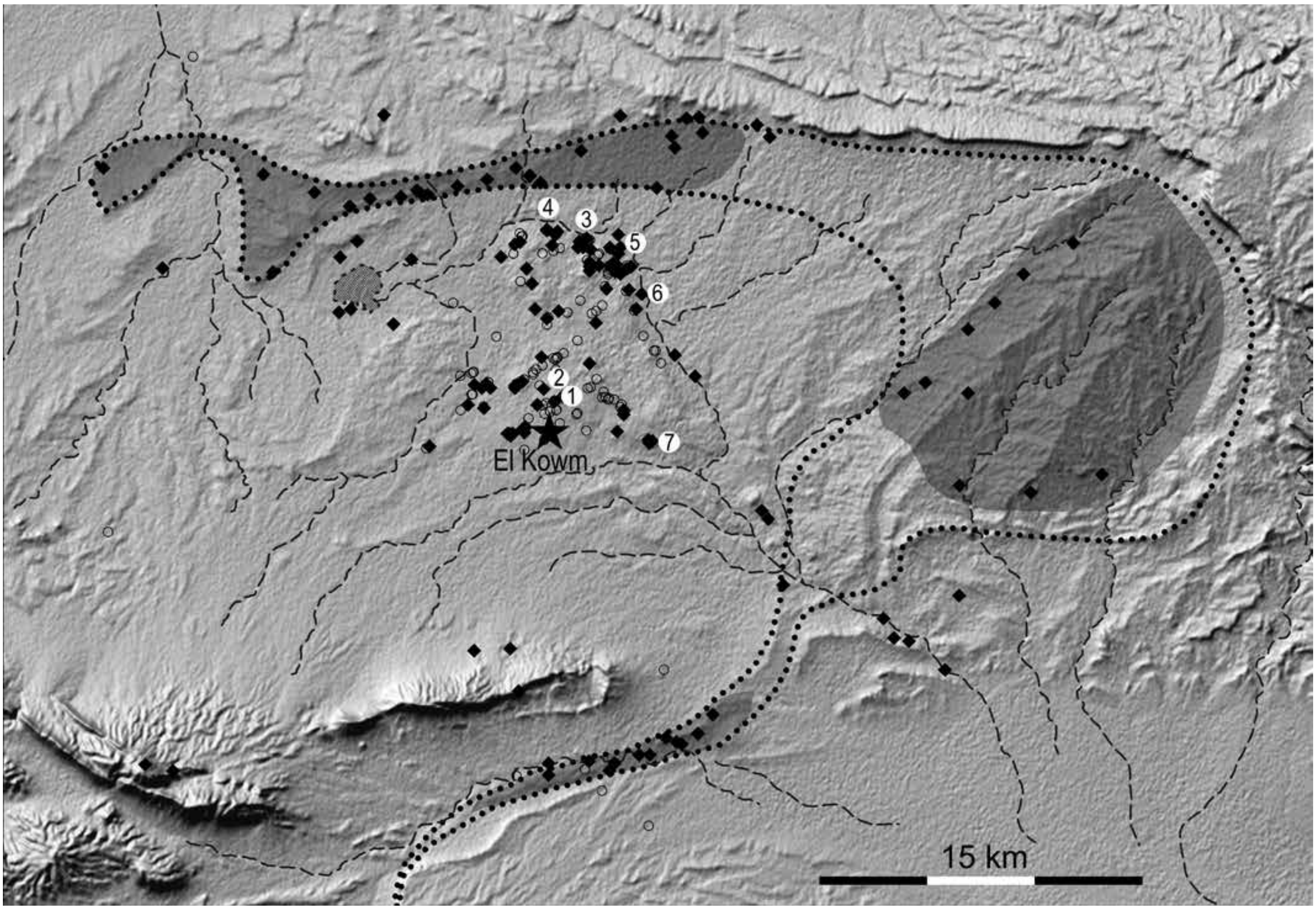

Figure 2 - Topographic map of El Kowm region. Black diamonds show Palaeolithic sites, circles natrual or drilled wells. Grey shaded areas indicate major outcrops of raw material (the dashed line indicates the potential extent of the flint bearing strata). Sites mentionend in the text: 1 Hummal, 2 Aïn Al Fil, 3 Nadaouiyeh Aïn Askar, 4 Qdeïr Aïn Ojbeh, 5 Umm El Tlel, 6 Juwal Aïn Zarqa, 7 Meirah.

Tectonically the El Kowm Gap occupies the interface of two major structural units, the Bilas block to the west and the Bishri block to the east (Brew *et al.* 2001). The complex engagement of orogenic activity and continental collision has produced an intricate tectonic situation. Along the Al Bishri fault, stress was released, resulting in a flower structure within the core of the Al Bishri anticline (Pümpin 2003). This structure is clearly visible on the surface as the Al Qdeïr plateau. The drainage along its eastern and southern rim (e.g. Wadi Fatayah) shows the typical asymmetrical cross-section of a tectonic rise. The exposed bedrocks are soft calcareous marls that are prone to rapid erosion. As the margins of the structure show few signs of degradation, the age of that rise must be quite young and uplifting is probably still going on.

Hydrology

The local hydrological system today is characterised by a mere 120 mm of annual precipitation on average. Considering the geographical situation of the region, annual rainfall patterns over inland parts in the Middle East basically did not change throughout the Pleistocene (Wirth 1971; Enzel *et al.* 2008). The climate is and was dominated by intermittent rains in winter and long dry summers. Cooler temperatures during the Pleistocene, however, slowed evaporation, leaving more water available to vegetation permitting a substantial extension of a rich steppe flora in nowadays desertified areas (Haude 1969). The poorly developed desert soils have no capacity to store water and most of the scarce water coming through precipitation is quickly drained off through the wadis into local saltpans (sabkhas) or disappears into the plains. Infiltration into the local aquifer is also limited by the nature of the bedrock. Drinkable surface water is only available at the bottom of the wadis for short time after heavy rains. Perennial sources of potable water are only found in the springs around El Kowm which thus permit a continuous survival in the desert steppe for man and animals.

The local hydrology depends on a number of particularities demonstrating the complexity of the system. The natural springs of the region are epithermal artesian wells, saturated with mineral salts, flowing out at temperatures of 26–31°C. The uniformly composed mineral load, of 1.75–2.75 g/l in the mean, consists in the essential of sulphates (~60%) and carbonates (~30%) (Margueron 1998). The consistent properties of the groundwater throughout the whole area point to a common aquifer. A precise mapping of all active or decommissioned wells, together with the unsuccessful attempts to hit the water table, revealed a surprising pattern: Positive wells are aligned like pearls on a string along an orthogonal system running northeast–southwest and southeast–northwest. Dozens of drillings sunk in the 1990 set only slightly off these axes for a few of tens metres, remained dry. Obviously the local aquifer is not present as an extensive groundwater lake, but wells up along a system of faults running along the main tectonical structures within the Djebel Bishri anticline (Pümpin & Jagher 2005). Such faulting is positively confirmed at the site of Nadaouiyeh Aïn Askar by geophysical prospection (Turberg 1999), its orientation fitting perfectly with the regional scheme. The thermal gradient of the groundwater and the imposed trajectory along the faults, point to a fast ascent from considerable depth. Hence, a purely regional recharge of the aquifer through precipitation absorbed by the surrounding mountains can be ruled out (Besançon & Sanlaville 1991; Margueron 1998). Furthermore the nature of the bedrocks and their tectonic structure excludes simple gravity to build up artesian pressure. Obviously the aquifer of El Kowm depends on a much wider system, comprising a huge catchment, that is still poorly understood.

Another particularity of the El Kowm wells are the spring-mounds of different sizes from a few dozen metres up to several hundred metres across, where windblown detritus was consolidated by vegetation and cemented by mineral precipitations from the groundwater. Unlike previous investigations (Besançon & Sanlaville 1991), spring mounds are only present on the El Kowm platform (i.e., in the southern part of the area), concentrated within a sector of a few square kilometres (Pümpin & Jagher 2005). The most prominent of these features is the Tell El Kowm, mistaken by earlier archaeologists for an artificial structure. However, its suspicious shape of a perfect cone about 125–150 m across, rising more than 20 m above the landscape, conspicuously resembles a mud volcano by its typical shape. Archaeological evidence at the base and on the top shows that this structure came into being during a short spell between the geometric Kebaran and the PPNB at the very end of the Pleistocene or the beginning of the Holocene (e.g. Cauvin & Coqueugniot 1988). Such mud volcanoes occur on artesian wells with a particularly high pressure, usually depending on natural gas seeps. Today, less than 15 km to the north of Tell El Kowm, natural gas fields are developed from shallow wells. Such intermittent activity could have occurred also for the much more massive structures of Tell Arida or the hill of Aïn Hummal.

El Kowm today

Despite its abundance of water, the El Kowm area has only been permanently settled since the beginning of the twentieth century, when the Osmanian army established regular control of the steppe areas to contain the Bedouin tribes. Armed transgressions of the nomads on the farmers only ended with the establishment of a permanent police station by the French Mandate authorities in the 1930s (pers. comm. A. Taha, Palymra). From that time onwards, the oasis of El Kowm continuously prospered.

The settlements in the proximity of El Kowm all depend on irrigated farming with motor-pumps operating the water wells. Due to increasing access to improved technologies, the extent of the irrigated areas considerably increased during the second half of the past century. This led to a dispersion of settlements and dissolution of traditional agglomerations, with numerous small hamlets and farms growing over the countryside (fig. 3).

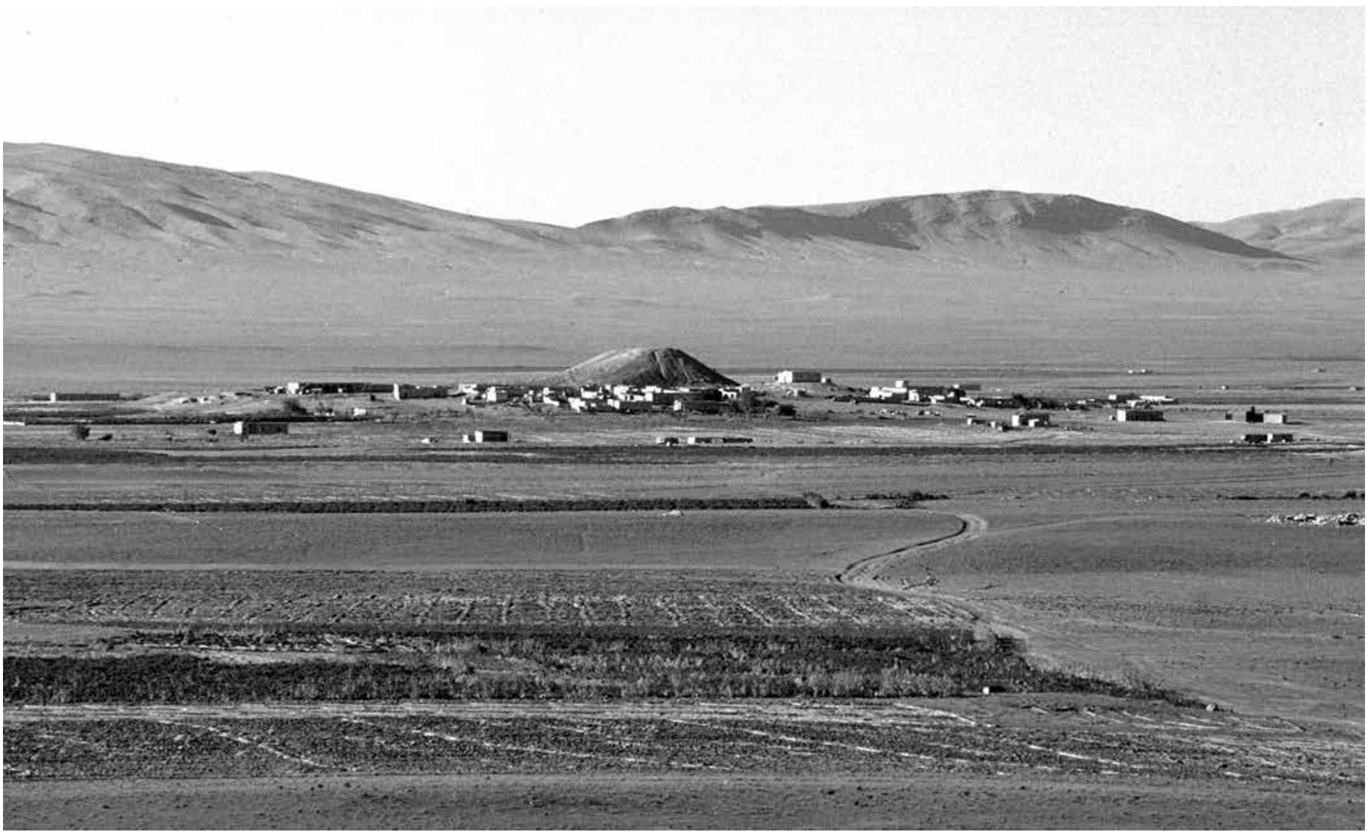

Figure 3 - The landscape of El Kowm the low topographical features are dominated by the impressive tell. Natural vegetation nearly completely disappered through overexploitation by livestock and intensive landuse through agriculture.

Today settlements are clustered on the El Kowm platform comprising most of the actual farming homesteads. The village of Al Qdeïr, a main Bedouin winter camp with permanent houses, is located at the northern end of the Al Qdeïr Plateau. Additional humble settlements are concentrated around the north-eastern corner of this plateau.

The accelerated expansion of cultivated areas during the last decades of the twentieth century resulted in a massive depletion of the water resources. At the height of farming, about one hundred pumps were working around the clock from April to October. On average, water has to be lifted from a depth of between 40 and 75 m from wells, where 15 to 20 years before, water was found at less than 10 to 15 m. To mitigate the effects of excessive irrigation, the Syrian government established an acreage restriction in 2000 and in 2001 imposed an almost complete moratorium on agriculture, allowing only the cultivation of limited areas for self supply or the practice of more sophisticated irrigation techniques curbing the waste of water.

Vegetation

The vegetation cover within the El Kowm area today, as for the majority of the Syrian Badia, is severely impoverished due to overgrazing by mixed flocks of sheep and goats. The present monotonous vegetation of the Syrian steppe is the result of a widespread overexploitation by sheep and goat herders (Wirth 1971). In contrast to the traditional land use, moving the animals from waterhole to waterhole, today water is brought to the animals by cisterns for a longer grazing of the pastures. The once opulent and rich plant communities, which formed a relatively high plant cover, nowadays have almost completely disappeared, with the exception of a limited number of locations (Pabot 1956; Assad 1982). The stunning potential of the Badia in this part of Syria is dramatically demonstrated in the Talila reserve near Palmyra, where the long-term impact of land use and restoration are well documented (Batello n.d.).

Fauna

The current state of the local fauna is even more critical than the condition of the local vegetation (Harrison & Bates 1991). Almost all larger indigenous mammals have been wiped out, persecuted for their assumed competition with sheep and goats. Thus, gazelles have been eradicated almost completely. Larger grazers like antelopes and wild asses totally disappeared from the Syrian Badia a long time. Only a few individuals of the larger predators, such as wolf and hyena, could more or less evade the extensive hunting and still survive in small numbers. However, their future is bleak too. Wild birds face the same fate as wild mammals. Falcons, two decades ago omnipresent in the El Kowm area, were heavily poached almost to extinction to be sold to falconers.

For these reasons, knowledge of larger animal species that might have been important for Palaeolithic man must be sought from historical sources. However, the accuracy of such information is often meagre and it is not clear, for instance, how big reported herds of gazelles, "counting several thousand heads", were in fact (pers. comm. A. Taha, Palmyra).

In conclusion, the actual landscape with its depleted botanical and zoological resources gives no clues about the natural potential of the Syrian Badia under the actual climatic conditions. Thus it is all the more difficult to reconstruct the past. Nevertheless it can be stated that the natural potential of these landscapes is much higher than we might suspect today, and the resources for hunters and gatherers were plentiful even under severe climatic conditions (fig. 4).

Palaeoecology

The reconstruction of the palaeoecology within the El Kowm area rests essentially on the sites of Hummal, Nadaouiyeh and Umm El Tlel whose combined stratigraphies cover the periods from the Lower Pleistocene to Holocene, i.e., more than one million years. Available results from geoarchaeological investigations (e.g. Le Tensorer *et al.* 2007 (and literature therein); Boëda *et al.* 2004), palaeontological analysis of animal bones (e.g. Morel 1996; Reynaud & Morel 2005; Griggo 2000,) and pollen (Renault Miskovsky 1998; Emery-Barbier 1998) indicate for all periods the prevalence of an arid to semi-arid environment. Short-lived periods of better climatic conditions never produced a higher vegetation cover such as extensive woodlands.

The steppe environment is also reflected by the faunal assemblages attesting some fluctuation within semi-arid conditions and only a few short-lived periods with increased precipitation. The presence of large predators, like lions and hyenas, indicates a substantial stock of grazing animals. Human subsistence depended basically on the hunting of steppe animals such as gazelles, antelopes, equids of different kinds and especially camelids (Morel 1996; Le Tensorer *et al.* 1997; Griggo 2000; Reynaud 2011). Gathering activities are demonstrated through ostrich eggs and carapaces of tortoises. Big game like camels was regularly hunted from the earliest periods. In most of the Palaeolithic levels in the El Kowm area studied so far, hunting activities covered a wide array of different species, demonstrating the versatility of ancient humans and their excellent know-

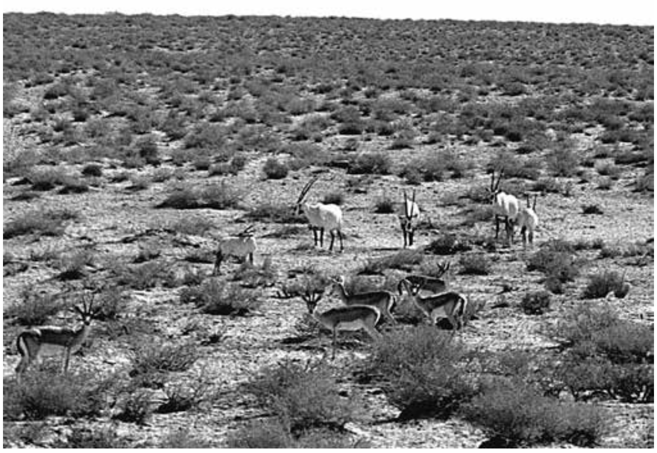

Figure 4 - Arabian oryx and gazelles in Talila natural reserve near Palmyra. This picture gives a good impression of the natural potential of El Kowm area when overgrazing and competition by domesticated aminals is excluded.

ledge of animal behaviour, essential for successfully slaying wild animals. Even in cases where there appears to be a preference for a particular kind if prey (e.g. camelids, equids or gazelles), an important variety in hunting is visible.

Absolute chronology

Since the beginnings of Palaeolithic investigations in the El Kowm area, efforts have been made to date the archaeological sites. Early attempts made (Hennig & Hours 1982; Oxford Laboratory 1988) on different sites produced no reliable dates as the different parameters (e.g. background radiation) were difficult to get under control. Of all the Middle Palaeolithic and older sites in the El Kowm area, only the upper part of the Umm El Tlel stratigraphy is well dated (Boëda *et al.* 1996, 2008). Ongoing studies on the Hummal stratigraphy revealed promising results, but need further confirmation (Richter *et al.* 2011).

For all age estimations beyond the end of the Middle Palaeolithic in the region of El Kowm we depend on analogies from other sites in the Levant. In this respect, the stratigraphy of Tabun is one of the pivotal cornerstones. The chronological framework is established on an extensive base of TL datings (Mercier *et al.* 1993, 2000; Mercier & Valladas 2003) and forms the background for the chronology actually adopted in our research of the Palaeolithic in El Kowm (fig. 5).

In this age model, the beginning of the classical Levantine Middle Palaeolithic (Levalloiso-Mousterian s.l.) can be placed around 170 ka. For the preceding Hummalian, analoguous to the Tabun-D complex, an age between 170 and roughly 250 ka is adopted. Similar ages, with a somewhat younger onset, have been proposed for layers of Hayonim cave (Mercier *et al.* 2007) showing a strong affinity to the Hummalian.

For the Yabrudian and the transition from the Acheulean, the situation is less clear. For this study, an age between ±250 and ±350 ka is proposed. Older claims for the Yabrudian (Barkai *et al.* 2003; Rink *et al.* 2004) need further confirmation before being taken into account. When correlating these ages with the marine oxygen isotope stages, the resolution of the underlying TL dates has to be respected.

For the Upper Acheulean there are, for the time being, no absolute age determinations available. However geological observations on the Nadaouiyeh Aïn Askar stratigraphy permit us to pinpoint the maximum cooling of MIS 12, dated to about 435 ka. Above this level a substantial stratigraphy of 8 m is present, comprising 15 distinct Acheulean levels. Palaeoecological data for the oldest levels of this site indicate a moderate climate associated with MIS 13, beginning at 533 ka (Lisiecki & Raymo 2005). An age of 525 ka for these levels is also consistent with geological considerations (Jagher 2011). The complete Acheulean stratigraphy of Nadaouiyeh belongs to the Upper Acheulean.

For the Middle Acheulean chronological data are scarce and its transition to the Upper Acheulean can only be estimated. The Middle Acheulean is certainly present at the Brunhes Matuyama boundary (e.g. Gesher Benot Ya'akov: Goren-Inbar *et al.* 2000; Meirah: Boëda *et al.* 2004) but there are barely any clues about its beginning or end.

Pleistocene Geology

Investigations concerning the Quaternary geology of the El Kowm area date back to the very beginnings of systematic Palaeolithic research. They were organised along two complementary approaches, i.e., the local study of stratigraphies at selected Palaeolithic sites and a regional survey. In 1980 Jacques Besançon and Paul Sanlaville (1991) conducted systematic geomorphological investigations covering the central area of the El Kowm gap.

This fundamental research permitted the essential understanding the Quaternary history in the El Kowm area. In the subsequent decades, Quaternary geology focussed mainly on understanding the formation processes of Palaeolithic sites under excavation. Growing experience challenged more and more the basic concepts of landscape history during the Pleistocene. The original concept of a fluvial evolution leaving distinct terrace systems can be ruled out. With new topographic data at hand today, it can be said that the local wadis did not have the capacity and necessary catchment to build up a classical fluvial system. The only references to competent rivers are some few scattered observations of more or less well rounded pebbles of micritic limestone and flint directly overlying the local bedrock. The age of these formations remains unknown. The accessibility to this formation today is limited to two outcrops, but the archaeological evidence from different sites clearly shows that such deposits have again and again been exploited as a source for raw materials (e.g. Wegmüller 2011), suggesting that these formations are more widespread than one might suppose today.

The basic processes shaping the landscape of El Kowm during the Pleistocene are erosion, hydrology and aeolian processes. Besides the draining of surface waters, fluvial activity was intermittent and left no systematic record. Erosion and deflation steadily shaped the surfaces. This is clearly shown by the preservation of surface sites, where settlements prior to the Levantine Aurignacian are badly affected by erosion. The farther back into the past the stronger this impact becomes (Jagher 2011).

Aeolian deposits are found at many places throughout the area in different settings. Most of the aeolian deposits consist of extended sheets, covering considerable tracts of the landscape and they may reach a thickness of several metres (Pümpin & Jagher 2005). In a topographical setting with low elevations, as is the case of El Kowm, such insignificant deposits may alter the landscape considerably. Aeolian sediments occur in distinct facies corresponding to different depositional episodes. The low degree of consolidation indicates a quite young age, which is also supported by archaeological observations. In the long term, aeolian sediments had only a limited impact on the landscape history. True dunes are rare. The most prominent is the fossil one at Umn el Tlel (Boëda *et al.* 1994; Muhesen *et al.* 1996) that developed during the terminal millennia of the Pleistocene. Active (diminutive) dunes are restricted to a small area just north of Hummal. In all the Palaeolithic sites excavated so far, there are clear traces of aeolian deposits, but they always

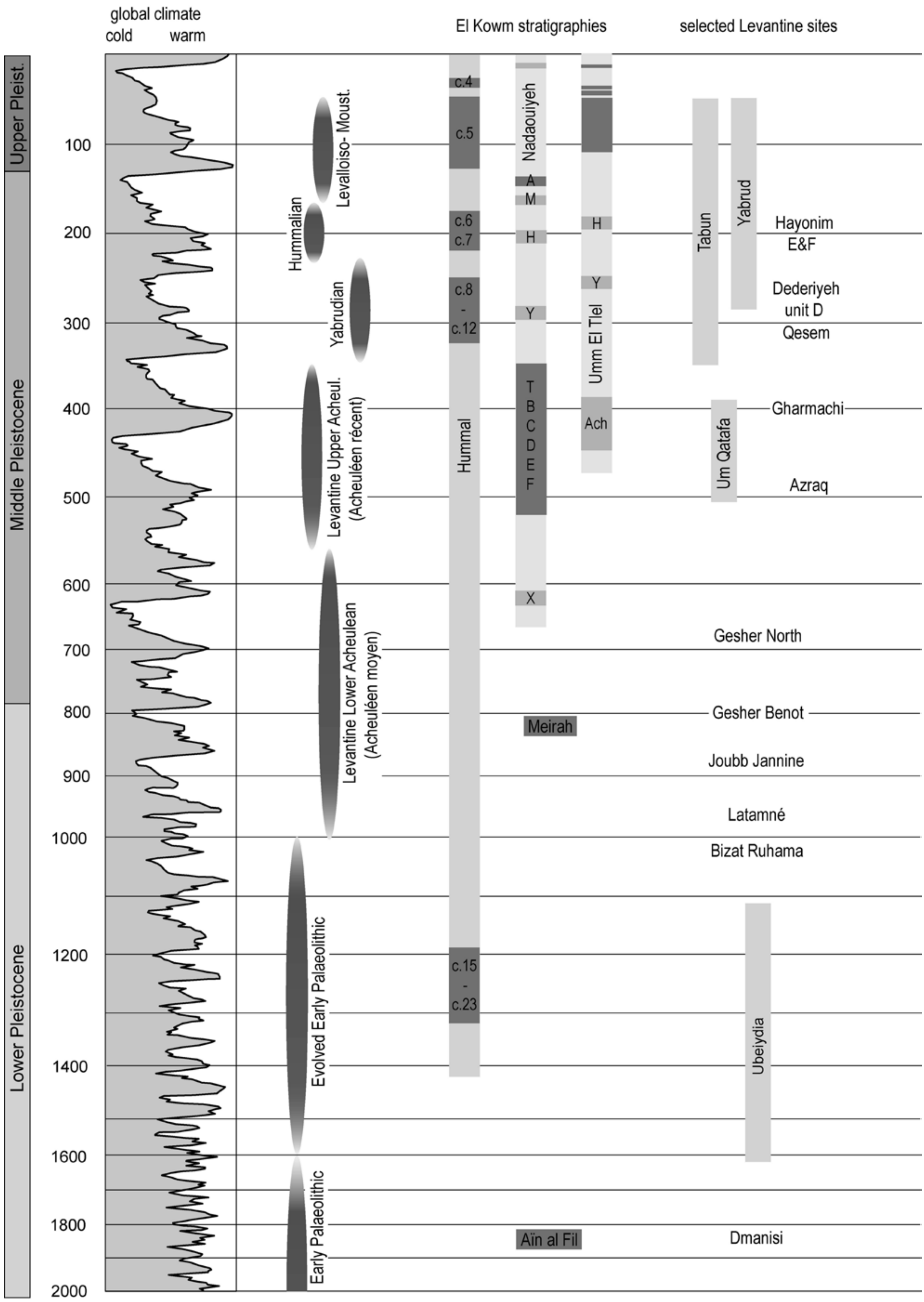

Figure 5 - Tentative chronological framework of the Levant; global palaeoclimate changes after Lisiecki & Raymo (2005); dating of archaeological entities based on TL dates for the last 350 ka, earlier age estimations are made with different methods. Light shaded sections in the Nadaouiyeh and Umm El Tlel stratigraphies identify archaeological periods only observed in secondary geological context. "Selected Levantine sites" are those mentioned in the text.

had just a limited impact on the overall sedimentation. This and surface observations clearly indicate that aeolian deposits, almost as easily as they accumulated, were remobilised. They succumbed to erosion leaving little evidence of their presence and no memory about their original impact on the topography.

Hydrological deposits are limited to the closer precincts around still active or fossil springs. The most characteristic type of these sediments are travertines, which resist exposure and erosion well. Mineralisations like these permitted the preservation of Palaeolithic sites at many places. Travertines stretch out at such points just for a few tens of metres. Extended formations of travertine covering huge tracts occur just once in the El Kowm area, at the north-western rim of the Al Qdeir plateau, where they extend over several hectares. Limnic sediments are limited to the immediate precincts of the springs that could sustain substantial water bodies such as the pond at Umm El Tlel measuring more than 60 m across (E. Boëda pers. comm.). Most of the runoff washed into the actual saltpan of the Sabkah El Kowm is deflated by aeolian erosion. In fact there are no notable lacustrine deposits in the whole area that originate from extended water bodies fed by surface drainage. However, the presence of a perennial water body at the Sabkha El Kowm in the not too distant past is reflected by a few waterfowl regularly visiting the dry sabkha during annual migrations from Central Asia to the south.

Cultural History – from Oldowan to Kebaran

Human presence in El Kowm is reaching back to the very beginnings of human history in the Levant. Recent discoveries at Aïn al Fil revealed a considerable settlement dating back to the very early Pleistocene (Le Tensorer 2009). Preliminary palaeontological investigations, confirm the presence of an archaic equid clearly older than the Ubeidiya fauna (pers. comm. Vera Eisenmann). The associated lithic artefacts can be identified as an archaic pebble-tool dominated core and flake industry. Comparable Oldowan-like industries also are under excavation in the site of Hummal (Wegmüller 2011). Chronometric observations indicate however a clearly younger age than the Aïn al Fil discoveries. Sparse, still to be confirmed observations hint at further sites of the archaic Palaeolithic within the El Kowm area. Within regional prehistory, the El Kowm findings belong to the first wave of human settlers in the Middle East. Their geographic position clearly in the interior of the continent adds a new aspect to the meaning of the "Levantine-corridor" and potential routes for the human dispersal out of Africa.

For the subsequent periods, information from el Kowm is sparse. However there is a clear presence during the Lower Levantine Acheulean (i.e. Acheuléen moyen). Best known from the Meirah site (Boëda *et al.* 2004), traces of this period are known from Nadaouiyeh Aïn Askar (Jagher 2011). The discovery of isolated hand axes fashioned in an archaic technology hint at a wider distribution of this period in the region. After about 550 ka ago more and more informations are available. Key site, understanding the Upper Levantine Acheulean (i.e. Acheuléen récent) is the site of Nadaouiyeh that permitted for the first time in the Middle East to trace a history of that period. The results of the Nadaouiyeh excavations shed a completely new light on that period. In fact, a number of long standing archaeological concepts became obsolete (Muhesen & Jagher 2011). Instead of a linear evolution, a much more differentiated picture emerged of a surprisingly versatile cultural entity, with individual groups marked by distinguished tool-sets clearly showing strong individual traits and profound conceptual changes throughout the Upper Acheulean. In El Kowm this period is furthermore present in a considerable number of sites. However our knowledge about them is limited, as most of them succumbed to natural phenomena or still await further investigation.

About half of the known Yabrudian sites in the Levant are located within the El Kowm area. All of these were open air sites contrary to the situation in the coastal regions, where all such discoveries are associated with caves and rock shelters. Unfortunately most of the eleven Yabrudian sites around el Kowm produced little more information than the presence of that period, as at most places the discoveries were made in the backdirt of artificial wells. Excavated sites contributed little more information. At Nadaouiyeh Aïn Askar and Umm El Tlel the geologic situation prevents any further diagnostics. The excavations at Hummal revealed a high stratigraphic resolution but a low number of artefacts (Schuhmann 2011), however the excellent preservation of bones permits a good understanding of the subsistence of the Yabrudians.

The beginnings of the Middle Palaeolithic are marked by a substantial shift in lithic technology. The Hummalian tradition is characterised by the use of multiple technological approaches for producing blanks (Wojtczak 2011). Additionally to the classical elongates blades of all kind, a clearly Levallois component is present. The hallmark of the Hummalian, the pointed tools and big blades are much less common than suggested in earlier research (Bergman & Ohnuma 1983; Copeland 1988). Aside from the eponymous site, the Hummalian has been recognised at 4 more places around El Kowm. The excavations at Nadaouiyeh Aïn Askar and Umm El Tlel produced this blade industry only in secondary positions. Despite the low numbers of Hummalian sites in El Kowm, this cultural entity shows a respectable geographic distribution from the Levantine coast (Abu Sif and Hayonim: Neuville 1951; Meignen 1998) to the Zagros Mountains (Hazar Merd: Garrod 1930) and until the foothills of the Caucasus (Djruchula cave: Meignen & Tushabramishvili 2006)

Compared to the preceding periods the number of sites of the Levantine Mousterian rises considerably. A total of 58 locations are actually known in the area. This increase is probably due to taphonomic phenomena. For the first time sites exposed to the sky since ever, contribute to more than half of the discoveries. About half of the find spots can be considered as factory sites located at outcrops of a first grade flint raw-material. It is the first time in the El Kowm area that a clear division between factory sites and settlements can be drawn. Similar comportments for earlier periods can be suggested, but lack direct evidence. Main sites, actually under excavation are Umm El Tlel and Hummal. Both sites feature very rich stratigraphies with many dozens of archaeological levels each. The former covers particularly the later phase of the Levantine Mousterian and its transition to the early Upper Palaeolithic (Bourguignon 1998). The Hummal Mousterian sequence for its part reaches further into the past, showing clearly an inherent evolution (Hauck 2011). The El Kowm Mousterian falls well into the mainstream of the Levantine Levalloiso-Mousterian, preferring in an earlier phase rather broad Levallois flakes and in the subsequent phase favouring triangular Levallois points.

The transition to the Upper Palaeolithic is especially well documented at Umm El Tlel (Soriano & Ploux 2003). Despite quite an impressive number in comparison of the area (i.e. 13 sites), the Upper Palaeolithic in El Kowm is far from understood. Generally labelled as "Aurignacian" these discoveries need further investigation. However it looks like the distinctive more progressive Aurignacian tools are absent in the region. Strikingly this ostensible hiatus is emphasised by the prevalent Geometric Kebaran sites. What triggered these apparent shifts in peopling the area remains open. Either climatic or simply cultural constraints are possible. At the threshold to a more sedentary livelihood, the El Kowm area was less appealing to humans as only four Natoufian sites are known and during the PPNA the area seemed to be completely abandoned. However, in the late pre-pottery Neolithic natural resources around El Kowm were again inviting for settlement as is evinced by far more than a dozen PPNB sites.

Land use during the Palaeolithic

Within the El Kowm area only open-air sites are known as the local geology impedes the development of substantial caves and rockshelters. Among the Palaeolithic sites, two basic types can be distinguished. On the one hand there are stratified sites embedded in Pleistocene deposits that are usually associated with former or still active wells. These stratigraphies (with just a few exceptions in natural outcrops) are basically revealed in the open shafts of historic wells dug by the local farmers decades ago. These impressive operations reached depths of 10 to 15 m or more, and with a similar diameter they permit a good observation of the uncovered sediments (fig. 6). Out of 58 potential artificial outcrops in wells, only 32 produced Palaeolithic finds. One-third of them are stratigraphies comprising three or more distinct periods, usually with a multitude of archaeological levels. In the few natural cuts along wadis only on exceptional occasions are Palaeolithic finds exposed.

On the other hand, there are the classic open-air sites with artefact scatters visible on the surface. Surprisingly only a small minority of these sites shows a palimpsest of different periods. Except for taphonomic problems concerning the Acheulean and early Middle Palaeolithic (Jagher 2011), the open-air sites around El Kowm are dated to the Upper Pleistocene. Unprotected sites older than MIS 5 with rare exceptions succumbed to erosional processes completely remodelling the surfaces of the entire area. Therefore our knowledge about land use is limited to buried sites coincidentally exposed in modern wells. This constricted database hampers detailed reflection on how Lower and Early Middle Palaeolithic people organised their lives within this landscape.

The seeming preference for spring-related settlements for the early periods is rather a taphonomic problem than a real human choice. If we take into account the well established Acheulean

Figure 6 - The well at Atham Hautman is one of the last existing huge shafts typical for El Kowm. Such impressive installations permitted the discovery of burried Palaeolithic stratigraphies.

sites only (excluding isolated discoveries of hand axes), from the Lower Palaeolithic to the Early Middle Palaeolithic (i.e., Yabrudian and Hummalian), all of the 28 sites are stratified (i.e., covered and hence protected by sediments). With just four exceptions, all are associated with a spring. The fact that none of these discoveries is an open-air site in the classic sense, clearly suggest the presence of taphonomic processes responsible for the conservation for Middle and Lower Pleistocene settlements.

Among the open-air sites two categories can be distinguished; settlements per se and factory or workshop sites. The latter are directly located at or next to the outcrops of flint on the immediate periphery of the El Kowm area. Where raw material is plentiful and well exposed, such factories can stretch out over several hundred metres. Despite the susceptibility to palimpsests, essentially three- quarters of these work shops comprise just one single archaeological period.

Considering the land use during the younger Pleistocene, surprising shifts in occupation patterns become apparent. For the Levalloiso-Mousterian there was a clear preference for settlements associated with springs (22 sites). Open-air camps with no reference to a well were chosen on much rarer occasions (n=11). In contrast to this, the presence of the Levalloiso-

Mousterian connected to outcrops of flint is considerable. At least 25 places can be designated as workshops where Levallois production was carried out, in many cases to a substantial extent. The Levalloiso-Mousterian accounts for more than half of all workshop sites located during surveys. For the Upper Palaeolithic (Levantine Aurignacian), there is just an opposite trend with a clearly lesser importance of sites related to springs. Out of 13 locations, nine are plain open-air sites. For the Kebaran the situation is more or less the same with just 12 sites out 37 located directly at a spring. Kebaran workshops at the outcrops of flint were only noticed twice. The conspicuous difference between Neanderthals and modern humans is difficult to explain, as no reasonable palaeoecological data for the younger periods are currently available from the El Kowm area. The observed difference could simply be cultural without any direct environmental constraint.

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NADAOUIYEH AÏN ASKAR – ACHEULEAN VARIABILITY IN THE CENTRAL SYRIAN DESERT

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Introduction

The original well at the ancient spring of Nadaouiyeh Aïn Askar (hereafter Nadaouiyeh), located in the very heartlands of Syria (Jagher & Le Tensorer 2011), was probably dug for an outpost of the meharists, the mounted desert police during the French mandate. The well consisted of an open shaft, about 10 metres across, reaching the water table approximately 3 metres below the surface. The well ran dry more than 40 years ago. During the excavations, reaching about 10 metres below the surface, no indication of the water table was observed. The archaeological site of Nadaouiyeh was discovered in 1978 during the first surveys of the French team in the El Kowm area conducted by Jacques Cauvin (Cauvin *et al.* 1979). In 1980 meticulous investigation of the artefacts exposed on the rubble dumps of the old well revealed its interest as a lower Palaeolithic site, which was confirmed by a small sounding in 1982 (Besançon *et al.* 1981; Hours *et al.* 1983). From 1989 to 2003 Nadaouiyeh was investigated by the Institute of Prehistory and Archaeological Science of the University of Basel, in close collaboration with the University of Damascus and the Directorate General of Antiquities and Museums of Syria under the direction of Jean-Marie Le Tensorer and Sultan Muhesen (fig. 1). These excavations revealed a comprehensive, more than 32 m thick, stratigraphy covering particularly the Acheulean period. Actually, the Nadaouiyeh sequence is the most extensive site of the Upper Acheulean in the Levant.

The origin of the site is due to a number of faults dissecting the bedrock, permitting the development of a karstic system. Artesian ground water found its way to the surface at the intersection of two main faults beneath the site that have been detected by geophysical prospection (Turberg 1999). The conjuncture of the two faults enabled the groundwater to erode an extended cave system in the marly limestones of the Upper Cretaceous (Cenoman/Turonian). As the roof of this system weakened, a number of cave-ins occurred successively over time (Jagher 2000). The open sinkholes extended about 40 to 50 metres across, being more than 10 metres deep. Altogether at least seven such events were observed within the excavated area. The hollow structures of the dolinas were perfect sediment traps in an environment generally subject to slow erosion. At the same time as cave-ins created space for sedimentation, older parts of the site were destroyed in the process. The inter-

Figure 1 - The site of Nadaouiyeh Aïn Askar at the begining of the excavations (left) and fifteen years later (right).

laced stratigraphy can be cumulated to a section at least 32 metres high, divided into twelve main stratigraphic stages. Within this column, more than 12 metres of erosions are identifiable. Sedimentation either consists of limnic deposits during periods of a high water table, or comprises detrital run-off from the margins of the sinkholes during drier periods (Rentzel 1998; Pümpin 2003). These often violent erosions substantially enlarged the space of sedimentation. The existence of extended water bodies is confirmed by the nature of the deposits and typical fossils of these environments (Le Tensorer *et al.* 2007). Wind blown deposits and travertines are only of minor importance in the makeup of the deposits.

Within the stratigraphy, 32 distinct Acheulean levels were recognised. Most of them were exposed only on a limited surface. Half of these levels were excavated for less than 5 m² and only nine levels could be investigated for more than 10 m², the largest being 19.5 m², leaving important parts of the site still to explore. The preservation of most of the levels in Nadaouiyeh is surprisingly good. Dislocation of flint artefacts is easily recognised due to the brittleness of the local flint material, being extremely sensitive to mechanical stress. The older levels, particularly, present a perfect preservation of the flakes, with just a little damage occurring during the time of the settlement. Younger levels were more subject to post-depositional weathering. Taphonomic observations on the animal bones associated with the lithics permit a further appraisal of the preservation of the archaeological levels. The perfect conservation of the palaeontological material in many levels, indicates a rapid covering with sediments within a very short time (i.e. almost simultaneously) after the occupants left. In a good number of levels, bones show barely any traces of weathering, an unexpected observation at an open-air site, where bones are subject to rapid decomposition. Such arguments, but also the in situ observations, make it possible to identify at least nine levels truly as living floors.

By means of their stratigraphic position and the general composition of the lithic assemblages, they can be grouped into seven distinct archaeological entities, labelled units Nad-A to F and Nad-T. They all are characterised by an abundance of core tools of all kinds, making it possible for the first time in the Levant to follow in detail the evolution of handaxe traditions. In addition to the Acheulean sequence, evidence of younger occupations is present in the stratigraphy of Nadaouiyeh with traces of Yabrudian, Hummalian and Middle Palaeolithic occupations, as well as faint indications of human presence from the Kebaran, Neolithic and historic periods.

Aside from the presence of water from the springs at Nadaouiyeh, the natural shelter in the depressions of the sinkholes against the constant winds in an open landscape must have been a major attraction for prehistoric peoples. Preliminary palynological studies demonstrated the preponderance of a treeless steppe during the whole period of the Acheulean (Renault-Miskovsky 1998). This reconstruction of a rather dry environment is also supported by palaeontological evidence, with a clear dominance of animals adapted to semi arid ecosystems. Ongoing taphonomic studies clearly identified humans as mostly responsible for the assemblage of animal bones at the site (Reynaud & Morel 2005; Reynaud 2011). In the upper levels, hunting focused on camelids and equids. In the lower levels, gazelles were central in a rather diversified meat procurement comprising also antelopes, wild asses, camelids and exceptionally bovids and even rhinoceros. In some of the lower levels, there is a strong presence of turtle carapaces. Besides the nutritive value also a utilitarian aspects can be considered.

Several attempts of absolute datings at Nadaouiyeh failed, due difficult dosimetry and suitable materials. In order to establish a chronological model only indirect observations are at hand. The key site for the chronology of the lower and middle Palaeolithic in the Levant is the cave of Tabun, where the transition from the Acheulean to the subsequent Yabrudian is approximately dated to 350 000 years BP (Mercier *et al.* 1995; Mercier & Valladas 2003). A further chronological marker can be deduced from the Nadaouiyeh stratigraphy with layer c.7, a clear solifluction flow deposited under periglacial conditions. The phenomenon observed in layer c.7, like similar discoveries in the El Kowm area in Juwal Aïn Zarqa or Qdeïr Aïn Ojbeh, both related to the Acheulean, indicate an important drop of temperatures at these latitudes (35° North) and elevation (465 masl.). For the present model a correlation can be made with MIS 12, one of the most important cold periods during the Pleistocene, culminating at about 435 000 years BP. Palaeontological observations and climatic considerations allow us to assess an age of slightly more than 500 000 years for the presently exposed base of the Nadaouiyeh sequence.

Archaeological Units

The archaeological units in Nadaouiyeh are defined by their position within the stratigraphy, and particularly by their archaeological material (Jagher 2000). At the beginning of the study of the handaxes, about 800 specimens were laid out on a big workbench for a direct comparison, permitting a clear allocation of every archaeological level to a specific unit on formal as well as stylistic arguments. From that point of origin, the corpus of 32 Acheulean levels was divided into seven units.

The approach adopted for the Nadaouiyeh collection refrains from specific typologies using "guide fossils" as chronological or cultural indicators. All the classical methods (e.g. Bordes 1961; Roe 1969) were devised for different requirements and approaches than those adapted for the Middle East. In a more holistic conception, the material of each unit was considered as an entity in its integrity. The intention was not a static and qualitative census of specific types but a general understanding of the inherent variability. Phases, i.e. the different units, are described by their characteristic formal spectra, defined from a statistically sound database.

In the comfortable situation having of a large number of handaxes at hand, it was possible to determine the size of statistically significant samples. Using the example of the extremely rich unit Nad-D (more than 1000 bifacial tools) a modelling of the minimal sample size for the adopted classification was carried out. Randomly selected aliquots were extracted in ten to twelve runs and their results were compared with the expected value of the complete dataset. Samples smaller than 50 objects presented little stability and showed highly variable formal spectra. Between 50 and 75 pieces, the results become more stable and plausible statements are possible. With above 75 individuals, variability among the samples is strongly reduced and the results are reliable within an acceptable tolerance (Jagher 2005). As was expected, small samples have to be interpreted with caution. Aside from general statements, little can be said about their affinities to other inventories (this is to be kept in mind in particular for not stratified collections). For well-founded evidence permitting reasonable comparisons, the minimal size of samples is significant, and has rarely been considered in the context of the Acheulean.

Classification of Handaxes

Traditional systems for the classification of handaxes, despite their widespread application, are poorly suited to seize the original intentions of the makers of these tools. Most of these classifications are constructed upon more or less theoretical specifications, albeit they are derived from a direct observation of handaxes. Besides, the classical structuring for handaxes is based upon a long-standing tradition, with a number of forms already defined in the nineteenth century. Many of these "types" were considered guide fossils for chronological periods or cultural entities.

One of the basic problems in the description of handaxes depends on the proper way they were produced. Each handaxe is an individual product made from a singular and not standardised blank. Under such prerequisites, an accurate reproduction of a specific form in exactly the same size is hardly possible. Moreover, the constraints the flint knappers came across in the process called for solutions challenging strict formal concepts. Therefore a substantial morphological variability is inherent, defying typological concepts.

In an attempt to escape these pitfalls as far as possible, a plain classification scheme was adopted that respects morphological variability better than traditional typologies (Jagher 2000). By direct comparison of the handaxes from all levels combined, a basic grouping has been devised based upon shapes apparent among the present handaxes themselves. The quality of execution, which can be quite different, was only a secondary argument for classification. Finally, seven classes were defined for the classical handaxes and additionally two classes for atypical handaxes (fig. 2):
① elongated handaxes with clearly stretched proportions presenting a well pointed tip,
② the classical drop-shaped forms, comprising the cordiformes and amygdaloïdes outlines,
③ ovate shapes with a well developed tip, i.e., having a clear distinction between base and top,
④ ovate handaxes with a bipolar contour without a clear bottom or top,
⑤ irregular handaxes, i.e., tools with a clearly inferior style in execution than the mainstream of the unit concerned. This relative aspect is more important than the absolute quality. It is obvious that this group presents a rather wide morphological variability,
⑥ triangular handaxes, i.e., tools with a clearly transverse base being manifestly offset from the sides converging into a clear tip,
⑦ miscellaneous shapes of all kinds (among the 1010 true handaxes from a well defined archaeological context, just 5% fall into this class). Originally cleavers were respected for methodical reasons, however the two sole cleavers that were observed among 1010 hand axes s.s., it was decided to abandon this type and to reclassify the respective tools within group 7 (miscellaneous shapes).

In addition to the true handaxes, there are large numbers of bifacial tools among the Nadaouiyeh material that were clearly distinguishable by their morphology. The quality of the workmanship is definitely inferior from that of the handaxes, and in many cases they evoke an impression of being just spontaneously manufactured for some domestic need. In any case, these tools cannot be considered the final state of repeatedly reworked handaxes. The construction of the volume and the façonnage adopted clearly shows that these tools have been conceived as such from the beginning. This is expressed in many cases by a strong influence of the original raw stone on the completed shape. The management of the volume is poor and flaking accidents are frequent. In short, they are implements quickly produced without seeking a precise form beyond a general shape. On the functional side they are complementary to the heavy-duty tools represented by the true handaxes – they can be considered as light-duty tools conceived in a basic manufacturing process with a minimum of effort. These tools are divided by their basic form in two categories:
a: atypical bifaces being clearly elongated artefacts with a more or less clear base and tip, reminiscent of crude handaxes with awkwardly shaped edges and
b: pièces bifaciales rather small tools with a discoidal shape about 5 to 8 cm across, presenting little morphological standardisation. Normally the retouch completely covers their two faces. In many cases, analogous artefacts would be classified as cores. Against this option speaks the general management of the volume, with two equivalent sides, that meet with an angle between 46° and 60° which is not appropriate for a purposeful core (Boëda 1993). In addition, along the equatorial plane there is never any clear preparation of a striking platform. The circumferential rim of these artefacts is clearly designed as a cutting edge and is not subject to the prerequisites of a core preparation.

A further approach to producing small tools, particularly in the younger periods (i.e. Nad-B & T), are small core-like pebble-tool implements clearly smaller than the size of a fist. On small, usually alluvial blocks of flint, a striking platform was created with a single blow, wherefrom some few polymorphous, more or less cortical flakes were struck along one face, in order to create an edge of about 60–70°. Conspicuously the production of flakes is abandoned at the stage when better-structured flakes could be produced. Obviously, the goal was not the flakes but to obtain a cutting edge, completing the respective tool set.

The analysis of the bifacial tools from Nadaouiyeh revealed two complementary strategies of production. On the one hand, there were the handaxes with a proper volume management from a carefully selected raw stone; and on the other hand, un-

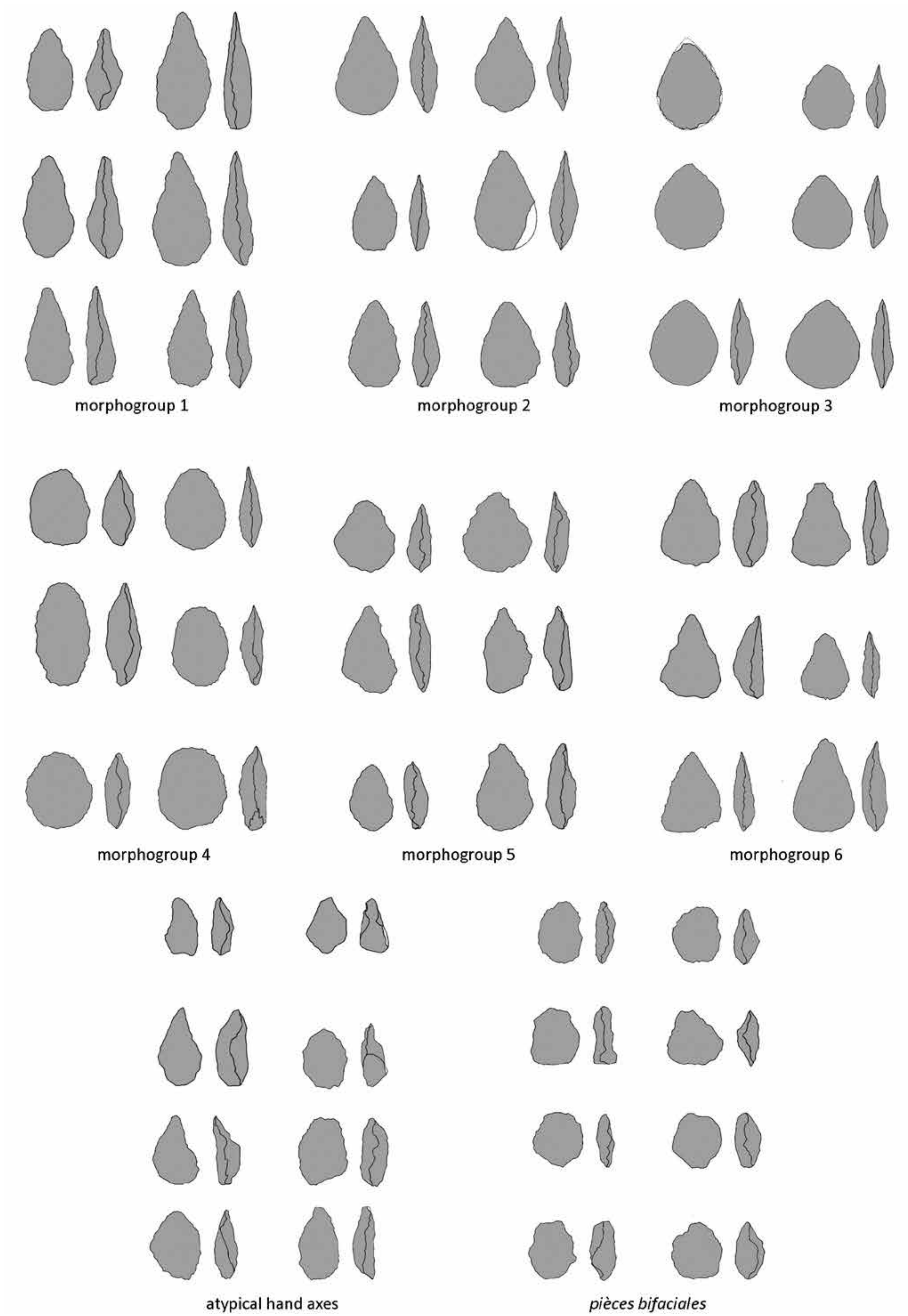

Figure 2 - Shapes of handaxes in the different morphogroups (for definitions see text).

archaeo-logical unit	hand axes										bifacials		total bifaces	retouched flakes	"pebbele" tools	cores
	elongated	cordiform	ovate w. point	ovated	ov. round	ov. paralel edges	ov. convegent	irregular	triangular	miscellaneous	atypical	pièces bifaciales				
Nad-A	0	12	0	4	---	---	---	7	2	0	9	12	**46**	10	4	4
Nad-T	9	10	15	14	---	---	---	2	4	3	4	9	**70**	x	12	13
Nad-B	11	22	1	11	---	---	---	19	15	4	16	29	**128**	17	49	107
B2	*3*	*10*	*0*	*5*	---	---	---	*12*	*9*	*1*	*6*	*13*	***59***	*6*	*22*	*67*
B1	*8*	*12*	*1*	*6*	---	---	---	*7*	*6*	*3*	*10*	*16*	***69***	*11*	*27*	*40*
Nad-C	35	26	3	7	---	---	---	9	2	5	11	49	**147**	17	12	12
Nad-D	20	119	18	(354)	74	152	128	46	10	27	111	305	**1010**	63	4	39
Da	*0*	*31*	*0*	*(44)*	*9*	*26*	*9*	*6*	*1*	*2*	*37*	*96*	***217***	*16*	*0*	*25*
Db	*2*	*14*	*1*	*(32)*	*6*	*19*	*7*	*4*	*0*	*3*	*13*	*36*	***105***	*9*	*1*	*4*
Dc	*3*	*16*	*6*	*(98)*	*21*	*44*	*33*	*11*	*3*	*7*	*22*	*67*	***233***	*19*	*2*	*6*
Dd	*10*	*15*	*5*	*(96)*	*20*	*29*	*47*	*7*	*0*	*9*	*9*	*40*	***191***	*13*	*1*	*3*
Nad-E	46	66	11	11	---	---	---	31	11	12	17	22	**227**	24	4	11
Nad-F	2	28	21	7	---	---	---	4	1	7	2	1	**73**	2	0	2

Figure 3 - Inventory of the hand-axes and retouched tools from Nadaouiyeh Aïn Askar.

pretentious procedures without much preparation on randomly chosen initial blocks, directed to obtain a functional tool with the least effort, i.e., for the production of small tools such as atypical bifaces and pièces bifaciales. Moreover, an even more basic production scheme was applied to produce small, pebble-tool like cutting instruments. The presence in good numbers of such small tools, compared with the handaxes, clearly compensates the rare retouched flakes as light duty tools. In fact, a clearly structured and purposeful production of flakes is almost completely missing in every level of Nadaouiyeh. The comparatively few cores that can actually be designated as such contributed a tiny number of the bulk of flakes.

The Acheulean of Nadaouiyeh Aïn Askar

One of the striking characteristics of the Nadaouiyeh site is the tremendous number of handaxes discovered. Fourteen field seasons eventually produced 12 415 bifacial tools, of which 9941 were handaxes strictly speaking. 10 331 bifacials have been discovered in layers where the archaeological context was completely modified by geological phenomena (e.g. erosions and cave-ins). The overwhelming majority of these artefacts (8060 pieces) come from one single layer, the already mentioned solifluction flow c.7. This layer, a perfect marker within the Nadaouiyeh stratigraphy, extends all over the investigated sectors of the site. The excavation of that layer, covering 53 m², permits us to estimate the numbers of bifacials contained in c.7 at about 75 000 to 80 000 pieces, of which at least 60 000 are true handaxes, making Nadaouiyeh one of the richest of all Acheulean sites. From this wealth, however, only 2084 bifacial tools were discovered within a clear archaeological context that can be declared in situ in the proper sense.

In all the archaeological units at Nadaouiyeh, bifacially worked tools dominate by far over retouched flakes (fig. 3). The latter are proportionally so rare that they can be considered just a secondary phenomenon. The rareness of flake tools is confirmed by the perfect state of preservation of the flakes in most levels, making easy the proper identification of retouched edges. In levels where edge damage is high, particular attention was given to potentially retouched flakes. In case of doubt, edge modification like that was not classified as manmade. The strong dominance of core tools is a particular trait of all Acheulean units in Nadaouiyeh. To a lesser extent, this is also the case for the Acheulean everywhere in the Middle East.

This is also demonstrated by the comparatively small numbers of cores within the Nadaouiyeh material, where a systematic and well-standardised production of flakes never occurred. Clearly structured target flakes cannot be discerned in any of the archaeological units. As far as the negative on the cores show, their products are virtually the same as those originating from the manufacture of atypical bifaces, pièces bifacials, and the chopping-tool like implements. A structured débitage in the sense of the Levallois technique or its antecessors is completely absent from all Acheulean levels in Nadaouiyeh. However, there is a somewhat more important production of irregular flakes in the younger levels, produced from poorly structured cores using a rather opportunistic strategy.

The flake material from all archaeological units in Nadaouiyeh clearly demonstrates that most of the preparation of handaxes and other bifacial tools occurred outside the site. Preparation flakes from the initial shaping are extremely rare and are in no proportion with the tools present. Obviously handaxes and

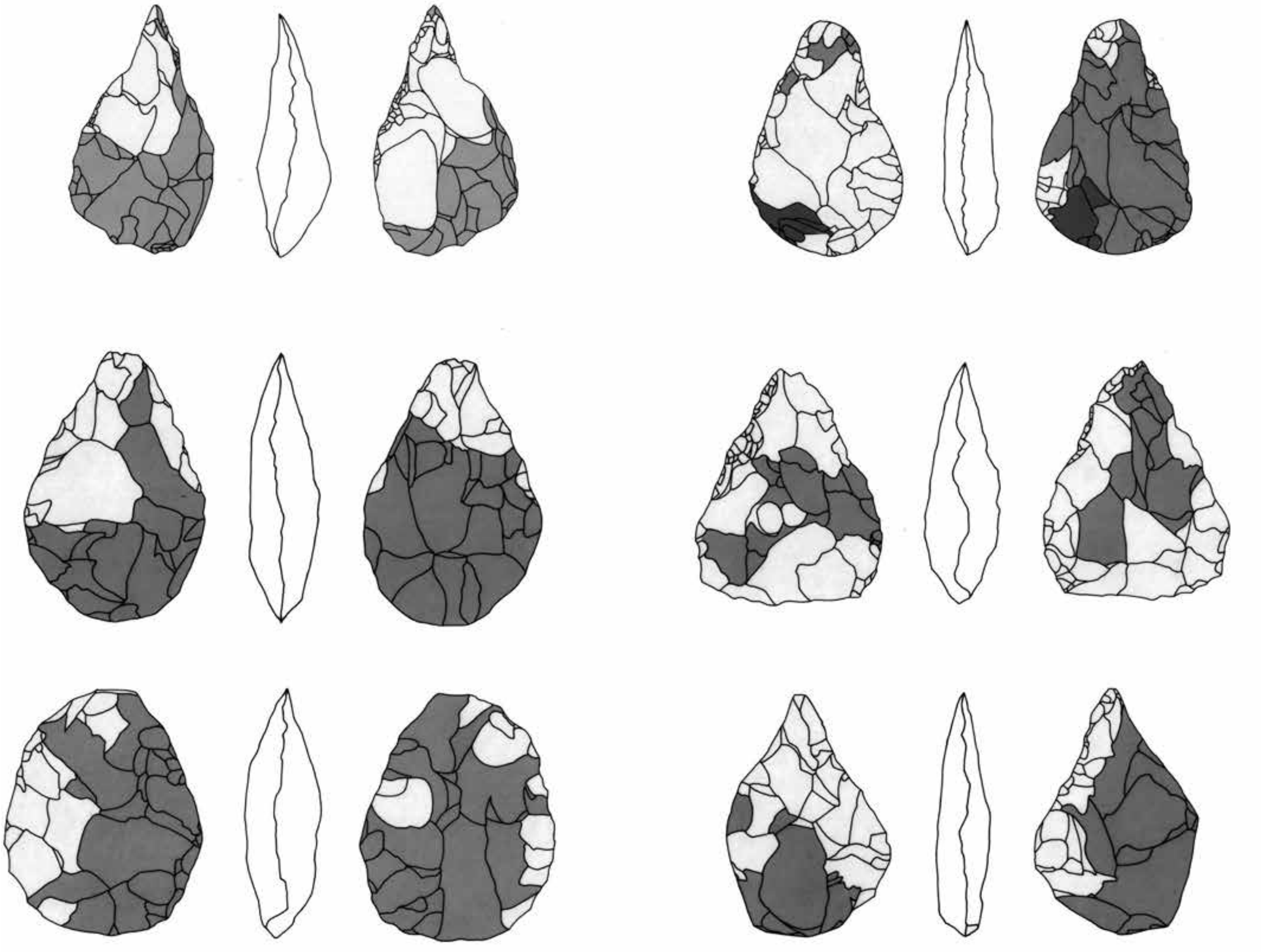

Figure 4 - Handaxes with double patina (scale 1:3).

many of the associated bifacial tools were at least prepared, if not completely elaborated, elsewhere, probably next to the outcrops of the raw material. In any case, the overwhelming majority of the handaxes arrived already as functional tools on the site. The large numbers of flakes clearly assignable to handaxes are evidence of transformation and reshaping rather than the waste of primary production. Suitable raw material is available in first-grade quality, in blocs of up 20–30 cm, from the late Palaeocene deposits within 6 kilometres from Nadaouiyeh. However, circulation patterns are impossible to reconstruct, as apart from just handful of bifacials, all are made from the same Palaeocene flint that is available along the Southern Palmyride range over a distance of more than 200 km. Over this huge area, the material is virtually all the same and macroscopically it is impossible to recognize its precise provenance. Hence, "local" and "exogenous" materials cannot be distinguished in the archaeological record.

Another striking aspect of the Nadaouiyeh handaxes, but also those from other late Acheulean sites in the El Kowm area, is their rather small size. Compared with other areas in the Middle East, the El Kowm handaxes are rather small: 75% of all the handaxes found in a controlled archaeological context in Nadaouiyeh are shorter than 10 cm and just 6% are longer than 12 cm. The restricted size is a deliberate choice of the manufacturers as the raw material available in the El Kowm area is not the constricting factor.

A secondary reshaping of handaxes can be identified directly on tools with double patina (fig. 4): 6% of the handaxes as well as other bifacial tools show traces of a more or less extended secondary reworking. These secondary modifications may involve just an overhaul of the cutting edges, but in many cases the initial shape has been completely transformed. Mostly, the quality of the secondary retouch is equivalent to that of the primary state. In exceptional circumstances, even a third generation of negatives can be discerned. The question of a regular reshaping and recycling of handaxes is difficult to assess from the bifacial tools alone, as most of them present a uniform patina and the morphology of possible secondary retouch is not decisive. Reworking of handaxes can also be perceptible by its direct waste. Particularly in the older levels (i.e. unit Nad-D-F), where the handaxes present an outstanding quality of refinement, flakes from these tools are easily recognised from ordinary débitage. Handaxes in these levels underwent a substantial transformation, as is demonstrated by a large number of equivalent flakes. These are not the primary waste of initial manufacturing, but issued from finished and clearly functional tools. They clearly show that handaxes were regularly recycled. To what extent the original shape was transformed on the individual tool, and to what extent it happened to the whole of handaxes is difficult to evaluate. In the younger stages of the Acheulean (i.e. Nad-C, B & T) this differentiation is hardly possible, as the quality of refinement of the handaxes diminishes and flakes from a potential reshaping are barely distinguishable from ordinary flaking débitage.

However, it is important to keep this recycling in mind when considering classification of bifaces. Observations on the Nadaouiyeh material point to a basic relationship: the thicker the section, the lesser the potential for reshaping. There is no reason to assume the actually present shapes had been discarded as exhausted to their makers. The presence of double patinated bifaces alludes to other possible processes, as the local Palaeocene flint of brown and black colour is prone to a fast patination. Within just one year, a notable weathering is visible on freshly flaked flint, as could be observed on knapping experiments carried out during fieldwork. From these observations it can be concluded that there was a rather short time between the "abandonment" and reshaping of double patinated handaxes. In this light it can be imagined that these tools were deliberately left in place, to be ready for use another time.

Secondary transformations on the distal edge of handaxes are limited to just one archaeological unit (Nad-D), where broad oval shapes dominate. Out of 221 handaxes with tranchet blows, 216 were discovered in the six levels of unit Nad-D. About one-third of the handaxes of this unit feature on one or both sides the scars of single or repeated tranchet blows (fig. 5). The associated "backed" flakes are present in according numbers. The resulting cutting edges are rather polymorphous, being more or less convex and with a quite different extension along the distal end of the tool. In about half of the cases tranchet blows appear on one and both sides of the handaxe. Repeated resharpening is observed only in 15% of the cases. However, negatives left by the tranchet blow, tend to be rather invasive, often removing all information about the previous condition. The cutting edges produced by this technique are extremely acute. It is surprising that none of them shows macroscopically clear traces of use wear. They are all in an almost pristine state with just occasional damage from trampling or corresponding mechanisms. There is a strong correlation of tranchet blow and shape of the affected handaxes: more than 80% of the tranchet blows appear on handaxes with broad proportions, i.e., an ovate outline, that make about 60% of the handaxes from this cultural unit. Homologous artefacts are regularly observed in the Acheulean of the Levant and beyond. They always occur as isolated phenomena and are rather infrequent. From the Azraq oasis in Jordan however, such artefacts are reported in substantial numbers (Copeland 1989 a-d; Rollefson *et al.* 2006), where they were labelled "Azraq-cleavers". However, the Azraq and Nadaouiyeh artefacts do not fall within the classical definition of the cleaver or hachereau (Tixier 1956), but are better designated as hachereau biface (Bordes 1961). At Azraq as well as Nadaouiyeh, these "cleavers" are clearly derived by a secondary transformation from a particular shape of ordinary handaxes. It is surprising how methodically this scheme has been followed in both sites, sharing strong common traits beyond this aspect.

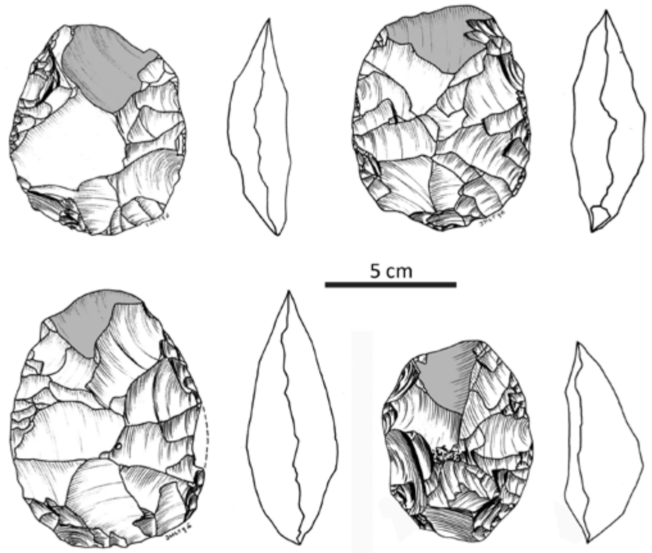

Figure 5 - Handaxes from unit Nad-D with tranchet blows (shaded negatives), drawing J.-M. Le Tensorer.

One of the amazing observations in the Nadaouiyeh material is the presence of the most refined and perfectly executed handaxes in the oldest levels, belying classical schemes based on traditional evolutionary ideas. It has to be acknowledged that for previous chronological models no direct stratigraphic control was at hand. As a general trend, a gradual disintegration of workmanship and standardisation can be observed throughout the Nadaouiyeh stratigraphy. It is not a simple matter of "decadence" but rather a question of liberty and effectiveness in the implementation of a given problem, inventing new solutions beyond the exact reproduction of cultural templates in a slavish way.

Acheulean Evolution in Nadaouiyeh Aïn Askar

The fragmentary and incomplete state of the geological and archaeological sequences preserved in the stratigraphy in Nadaouiyeh has to be kept in mind when considering the evolution of the Acheulean. In the stratigraphy, many hiatuses and gaps are clearly visible. In fact, over the periods, time is only intermittently recorded in the sediments. Hence, the history of the Acheulean, despite the rich information, is incompletely chronicled. Periods with a high resolution over short periods alternate with phases with no or just sporadic sedimentation. Overlooking the nearly 200 000 or so years spanning from the lowest Acheulean levels to the beginnings of the Yabrudian, most of that time went by unrecorded in the Nadaouiyeh stratigraphy. Such observations, that are present throughout the sequence, have to be kept in mind while drawing conclusions.

The evolution of the Acheulean in Nadaouiyeh is marked by a number of abrupt and profound changes that are unevenly spaced in time. What happened in between these breaks remains a puzzle and is difficult to reconstruct. Nevertheless, even the fragmentary information available offers, for the first time in the Levant, an idea of what really happened in the course of the late Acheulean of this area, even as the full history is yet to be revealed. The changes visible in the stratigraphy of Nadaouiyeh from one cultural unit to the next are not a regular progression, but present radical changes from one stage to the next. These alterations have to be seen in respect of long chronological intervals and a changing environment in the course of the middle Pleistocene. The relationship between these different human groups resides rather on a general common base and mutually shared concepts than on a cultural continuity in the proper sense.

Without the possibility to compare the cultural evolution model of Nadaouiyeh with other sites, it would be premature to declare it as the standard for the upper Acheulean in the Levant. Nevertheless, Nadaouiyeh is a unique reference for a better understanding of the upper Acheulean in the Middle East and its complex history. In the following, a short recapitulation from the oldest to the youngest archaeological units is presented (fig. 6).

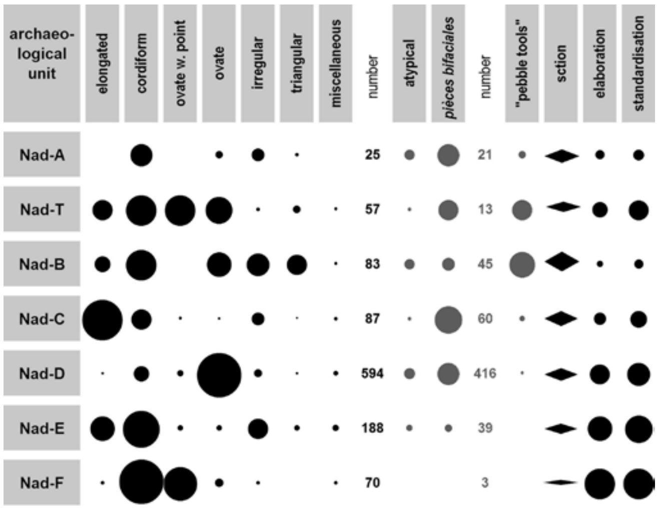

Figure 6 - Formal spectra of core-tools from the different units of Nadaouiyeh (size of dots according to the respective percentage).

Unit Nad-X

The oldest archaeological unit present at Nadaouiyeh consists of some handaxes, distinguished by their particular shapes and appearance from the amalgamated material in layer c.7 (the solifluction level described above). They are rather large handaxes (by Nadaouiyeh standards), with elongated contours and massive sections. They are manufactured in a quite uniform mode with surprisingly few and coarse retouches. This singular style in Nadaouiyeh evokes strongly the style typical of the Middle Acheulean of the Levant. Although stratigraphical confirmation is still pending, these particular handaxes clearly belong to the oldest period known from Nadaouiyeh. It can clearly be associated with the middle Acheulean of the Levant.

Unit Nad-F

The earliest period excavated in situ is characterised by an exceptionally high standard in the elaboration of the handaxes. All these tools present an astonishing evenness and perfection in shape and symmetry, exceeding by far pure functionality (Le Tensorer 2006). The standardisation of the handicraft is also expressed by an extremely low morphological variability, presenting a remarkable monotony of shapes. The highly aesthetical aspect of the handaxes and their outstanding workmanship is never again achieved in the following younger units. The identification of such an "evolved" production of handaxes in a definitely early period (just over half a million years old) is one of the big surprises of the excavations at Nadaouiyeh.

Unit Nad-E

Compared with the preceding period, the quality of elaboration of the handaxes diminishes, as well as the general sense of harmony of shapes. For the first time in Nadaouiyeh, a well-developed formal diversity is observed. There are two basic shapes with a strong formal standardisation and with a uniform and high standard of elaboration. In contrast to this, a good proportion among the handaxes are conceived and realised in a much more liberal way. This is particularly well expressed by a high percentage of irregular handaxes. Compared with its precursor, unit Nad-E presents several important changes: the monotony of the fabrication style decreases whereas formal variability clearly increases in favour of a more versatile system. The formal spectrum shows several clearly defined classes (fig. 7) that were produced each on in its appropriate way.

Unit Nad-D

Between unit Nad-E and its successor, Nad-D, a profound shift occurred in the spectrum of handaxes, which completely changed. Instead of elongated and pointed shapes, handaxes with ovate contours and blunt tips dominate by nearly two-thirds of the inventory. These broad handaxes have in common a frequent application of tranchet blows at their distal end. The preference for discoid and oval shapes among bifacial tools is also expressed by a surprisingly high number of pièces bifaciales. These clearly differ by their rather flimsy way of production from corresponding shapes of handaxes. Over all, drop shaped handaxes are rather rare, as are all other forms defined for Nadaouiyeh. Due to the general care given to the manufacture of handaxes, atypical bifaces are comparatively rare.

The geological layers containing archaeological unit Nad-D represent a stratigraphy of just 80–90 cm, which is interrupted repeatedly by discontinuities and erosions. Geoarchaeological investigations demonstrate a rather rapid sedimentation (Rentzel 1998; Pümpin 2003) within a few millennia. The hypothesis tending to a much longer period is against the geological and taphonomic observations. Of the six archaeological levels located within this section of the stratigraphy, four produced statistically sufficient inventories permitting a close study of cultural change within a short spell in terms of lower Palaeolithic archaeology. The four sub-units, labelled Da from the top to Dd at the base, display close affinities. The quality of the façonnage is surprisingly homogenous throughout all sub-units. However, distinctions comprise conceptual aspects in the making of bifacial tools, disclosing a clearly structured dynamism rarely seen in the lower Palaeolithic.

Following the evolution of bifacial tools within archaeological unit Nad-D, deep changes become apparent: in a linear evolution along regular steps, different shapes were replaced little by

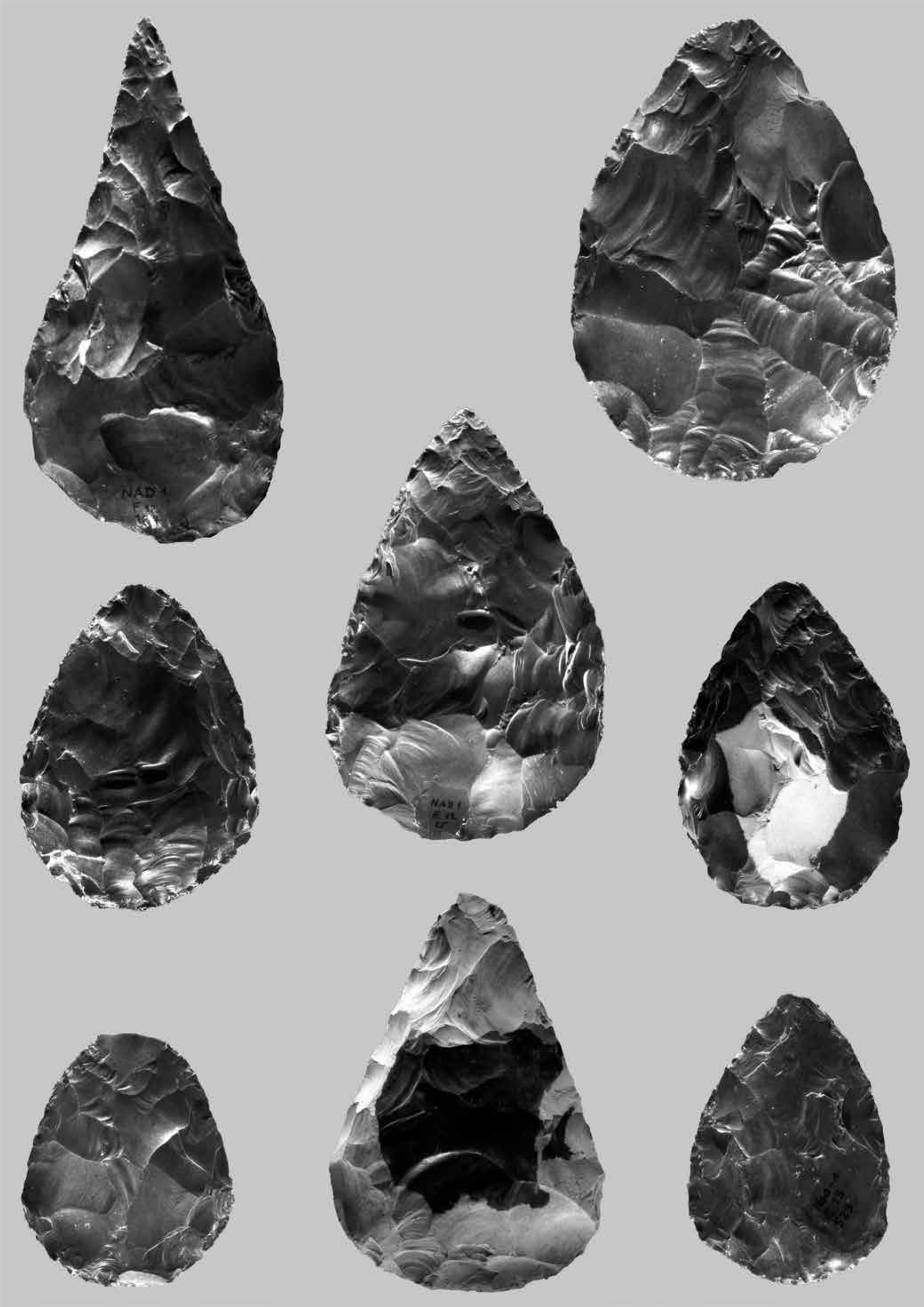

Figure 7 - Selection of handaxes from Nadaouiyeh Aïn Askar; scale half actual size (photo E. Jagher).

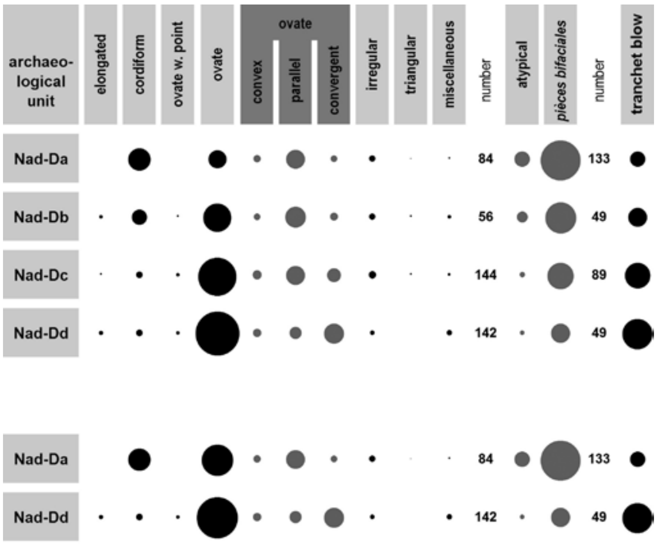

Figure 8 - Formal variation within Unit Nad-D (size of dots according to the respective percentage).

little (fig. 8). This concerns particularly ovate handaxes, which were replaced by drop shaped types. However, the accumulated proportion of both remains stable in the course of time (Dd 89%, Dc 82%, Db 79%, and Da 78%). Within the group of ovate handaxes, there is a replacement of convergent outlines in favour of parallel edges and rectangular shapes. At the same time, there is a sharp drop of tranchet blows on handaxes (Dd 50%, Dc 42%, Db 31% and Da 28%). From the early to the late period of Nad-D, pièces bifaciales make a steady appearance, rising from 26% in sub-unit Dd up to 61% in Da. All other forms of handaxes play just a minor part.

These changes proceed in a consistent way with a gradual exchange of specific elements. An evolution occurs comprising not only morphological aspects but also concepts concerning the tool set in its integrity. The difference between the initial and final state is so pronounced that without the intermediate stages it would be difficult to establish a clear, linear link. These changes are even more surprising as they occur within quite a short period. Palaeontological data show no significant change in the environment throughout unit Nad-D nor is there a shift in subsistence. Therefore, other mechanisms are responsible for the changes observed within Nad-D, but they elude a sound interpretation.

Unit Nad-C

At first glance unit Nad-C recalls to some extent unit Nad-E, an impression supported by the dominance of elongated handaxes, an affinity becoming easily apparent. However, the way handaxes were manufactured in unit Nad-C is completely different, with more massive and many plano-convex sections completely alien to its older counterpart. The dominant elongated shapes are achieved with more or less straight edges against clearly convex ones in Nad-E. The strong standardisation of proportions in top view among amygdaloids present in Nad-E is lacking in Nad-C. In contrast, the exceptionally well calibrated pièces bifaciales are numerous and represent one-third of the tools.

The differences between the two units Nad-E and C are too important to admit an inherent relationship. The strongly defined shapes of unit Nad-E are no longer present. The number of dominant shapes in Nad-C is much more restricted with a clear preference for elongated outlines, which are rare among all other units except to some extent in Nad-E.

Unit Nad-B

Between units Nad-C and Nad-B there is an important hiatus, when extensive erosion (i.e. the solifluction flow of layer c.7) completely modified the topography of the site. The subsequent period of intermittent deposition preserved the materials of the archaeological unit Nad-B in at least 15 separate levels. The bulk of the artefacts presented in this paper are limited to four main levels.

In unit Nad-B a nearly complete abandonment of any standardisation can be observed. Compared with the older units, the "archaic" appearance of the handaxes is stunning. Nevertheless, there are clear groupings and central themes in this material. Retouch, with some rare exceptions, is crude and rather schematically executed. As a result, their sections are the most massive of all units.

Within unit Nad-B there is a considerable proliferation of small tools which make up about half of the inventory. As in other units, there is a substantial proportion of atypical handaxes and pièces bifaciales and as a new "invention" the small core-like pebble-tools. These simple implements represent one quarter of all tools.

The apparently primitive trait expressed by poor standardisation and simple manufacture, however, simplifies the making of handaxes as the requirements of quality of the raw stones and their preparation diminishes considerably. A good number of the raw blocks, particularly for smaller tools, were collected from alluvial deposits, a resource only exceptionally exploited in older units. The ease with which the tools were manufactured in unit Nad-B displays a resourceful reduction to the essential with the least effort. A few rare exceptions from that basic scheme demonstrate conclusively that the people of unit Nad-B had the ability to produce exquisitely elaborated handaxes.

Unit Nad-T

Unit Nad-T, discovered at the very end of the excavations in one single level, completes the lower Palaeolithic sequence of Nadaouiyeh. Contrary to unit Nad-B, there is again a clear homogeneity among the handaxes concerning execution and shapes. There is a definite archetype clearly dominating. With these handaxes the maximum width is located well above the base, resulting in rather an oval shape. Consistently they feature a clear base and tip. Other shapes are rather rare. Overall, standardisation is poorly developed and morphological variation is considerable. Pièces bifaciales are still present in good numbers, whereas atypical bifaces occur rarely. Small tools made on little blocks such as true and core-like chopping-tools occur in a substantial proportion.

Due to taphonomic processes, the flint material of unit Nad-T is rather poorly preserved, and a reasonable appreciation of the flakes is strongly handicapped. However, the few cores do not show any trace of a well-structured débitage. Façonnage is still the predominant scheme, and unit Nad-T fits well into the Acheulean concepts observed in Nadaouiyeh.

Unit Nad-A

The most recent Acheulean unit discovered in Nadaouiyeh is definitely located above the Yabrudian and Hummalian occupations by its stratigraphic position. It is undeniably contemporaneous to the early Levalloiso-Mousterian. Its analysis is hampered by a rather limited number of handaxes, permitting us to draw general outlines only. Handaxes are of rather small dimensions with clearly thinner sections than the older units Nad-T and B. Small tools are limited to atypical bifaces and pièces bifaciales whereas the nucleus-like chopping-tools completely disappear. Retouched flakes are still as rare as in all the older Acheulean units. Despite a substantial number of cores, a deliberate production of flakes is absent. All cores are exploited in a simplistic and opportunistic way.

The existence of a typical Acheulean tradition with a clear predominance of a façonnage concept, with no or very few retouched flakes, contemporaneous with the Levalloiso-Mousterian was one of astonishing discoveries in Nadaouiyeh. Until now, this unique observation all over the Middle East is difficult to explain. Is it an isolated manifestation of something rare or was it part of a much more widespread but underestimated phenomenon? The late Acheulean facies described in the coastal regions of Syria could reflect such a phenomenon (Copeland & Hours 1979; Muhesen 1985). As all these sites are open-air discoveries, the stratigraphic context is lost.

The Acheulean in the El Kowm Area

Today a total of 31 "Acheulean" sites of greatly varying nature and significance are known in the El Kowm area (Le Tensorer & Hours 1989; Le Tensorer *et al.* 2001). In fact this perfectly mirrors the general situation of the Acheulean in the Middle East. Handaxes, considered a guide fossil for this era, by their robustness withstand strong taphonomic processes well. Even in a heavily battered state handaxes remain recognisable as such, and apparent sites are easily identified (Villa 1983). Hence, so-called "Acheulean sites" are reduced to the sole presence of handaxes. In fact more than three-quarters of the eligible "sites" produced just two or three handaxes (fig. 9), evoking the question of how many (diagnostic) artefacts make a site? If one looks at the numbers of handaxes discovered in excavated, truly Acheulean sites, handaxes always occur in substantial numbers. For a true site of that period, they can be expected by the dozens. In this light, isolated handaxes become as undiagnostic as a single swallow making a summer. In fact, the question has to be asked, how many of these sites are really what they are presumed to be?

In fact, handaxes are not the exclusive privilege of the Acheulean. Such tools were also produced to some extent during the Yabrudian, and there is no clear morphological differentiation between Acheulean and Yabrudian handaxes. Actually, isolated discoveries, besides rare exceptions perhaps, cannot be attributed for sure to a specific cultural background. As in controlled conditions Acheulean handaxes always appear in good numbers, stray finds of such artefacts conspicuously contrast to that principle.

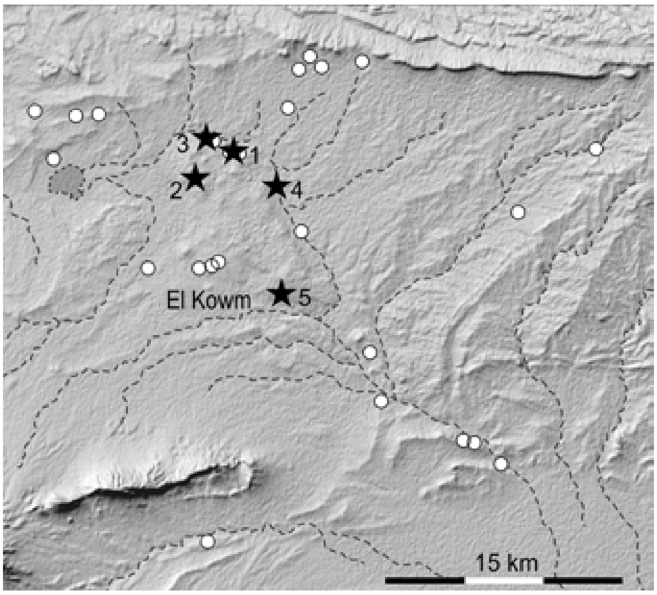

Figure 9 - Distribution of "Acheulean" sites in the El Kowm area. White dots locate discoveries with isolated handaxes (n<6); asteriks indicate true Acheulean sites where more than 30 hand axes were found. Sites mentionend in the text: 1 Nadaouiyeh, 2 Qdeïr South, 3 Qdeïr Aïn Ojbeh, 4 Juwal Aïn Zarqa, 5 Meirah. Multiple levels from Nadaouiyeh are not mapped.

Throughout the El Kowm area, rich Acheulean sites, having produced handaxes in substantial numbers, exist at five locations. Four of them have been subject to excavations. Besides the site of Nadaouiyeh, with more than 12 000 handaxes, there are in decreasing order: Qdeïr Aïn Ojbeh (597 bifaces), Juwal Aïn Zarqa (101 bifaces) – both investigated by the Institute of Prehistory and Science in Archaeology (IPSA) of the University of Basel – and El Meïrah with 78 bifacial tools (Boëda *et al.* 2004). From the fifth site (Qdeïr-South) 35 handaxes are known from a preliminary surface survey by the IPSA team.

With the exception of El Meïrah, dating to the Middle Acheulean, all the other discoveries correlate with an Upper Acheulean sensu Nadaouiyeh. The two excavated sites of Juwal Aïn Zarqa and Qdeïr Aïn Ojbeh were obviously affected by the same geochronological event corresponding to the solifluction flow observed in Nadaouiyeh. In fact, this observation is consistent with the archaeological evidence from both sites, showing strong affinities with units D and E from Nadaouiyeh, both clearly older than the mentioned solifluction flow. This event, happening most probably during MIS 12, must seriously have affected the whole region, obliterating most of the ancient surfaces. All earlier settlements not protected by a substantial sedimentation have been affected and largely disappeared from the archaeological record.

The Handaxe Phenomenon in the Levant

In the Levant and worldwide, the handaxe is one of the most fascinating artefacts of prehistory (López Junquera 1982). In Europe, "handaxes" played a major role in the authentication of prehistoric humans. The first discoveries date back to 1679 when John Conyers unearthed the first known handaxe together with elephant bones in Britain (Capitan 1901). Even before the recognition of "antediluvian man", handaxes were identified as manmade tools of great age. In 1797, John Frere declared for the famous Hoxne handaxe belonging to "a very remote period indeed". In the nineteenth century, handaxes were the keystones for the acceptance of the antiquity of the human race (Boucher de Perthes 1846; de Mortillet 1883). Since this time, handaxes have become an icon of the Palaeolithic, particularly for its beginnings. It was deeply imprinted in the minds of scientists well into the twentieth century, attributing a deep but one-sided interest to these tools declaring them of particular importance. However, the perception of handaxes by prehistoric people assuredly was different from that of prehistorians.

Considering the lower Palaeolithic of the Middle East, there is a wealth of publications reflecting a long-standing research tradition. There are several hundred Acheulean sites reported from that area, suggesting an extremely rich legacy of that period. Many local and regional syntheses have tried more or less successfully to structure this phase. Although there is an impressive number of papers dealing with the lower Palaeolithic in the Levant, clear information about that period is modest. Well excavated and documented sites producing substantial numbers of artefacts are rare, and stratified sites with multiple occupations from different periods of the lower Palaeolithic are scarce. Available data from the few excavated Acheulean sites does not make it possible to establish an unambiguous chronological and cultural framework valid for the whole Levant. Besides the Nadaouiyeh stratigraphy, only in the cave of Umm Qatafa has an analogous succession of varied Acheulean levels been excavated (Neuville 1931, 1951). For all other sites information is limited. A further pending issue is chronology, as for all late lower Palaeolithic sites there are no precise datings.

Despite the rich heritage attributed to the lower Palaeolithic in the Levant, the question of the Acheulean is difficult to apprehend (Muhesen & Jagher 2011). First of all there is a widespread confusion in terminology. The expression "Acheulean" may express a chronological term or be a cultural attribution in a strict or a wide sense, or even allude to technological and typological approaches. In many cases, just the presence of the archetype of the handaxe was sufficient for an attribution to the Acheulean. Hence, numerous isolated discoveries labelled "Acheulean" contribute to a severe overestimation of that period, comprising prehistoric manifestations of diverse nature. Indeed the term "Acheulean" comprises an inconsistent entity suggesting a shared identity.

Handaxes as Cultural Traits

In a basic attempt to differentiate the Acheulean from its successors, the fundamental composition of 64 statistically sufficient inventories (i.e., at least 100 retouched artefacts) of the Acheulean and post-Acheulean from the Levant have been tested for their basic differences, i.e., the relation of handaxes versus retouched flakes. Chronologically this corpus has been divided into Acheulean and "Yabrudian" and associated occupations or roughly the periods of MIS 13–11 (528-364 ka) and MIS 10-8 (363-242 ka) (in the following, the term "Yabrudian" is used as a chronological entity). In a clear trend, the percentage of handaxes definitely separates the two periods (fig. 10). In a surprising observation already made for the Nadaouiyeh units, handaxes clearly dominate the Acheulean inventories, whereas the Yabrudian and contemporaneous collections exhibit a contrary trend, with a clear dominance of retouched flakes and a sharp drop of handaxes. Moreover, these results clearly confirm that the Nadaouiyeh materials, with their extremely low proportion of retouched flakes, contrary to the original apprehension, fall well within the mainstream of the Upper Acheulean.

For a better understanding, these observations were compared with the contemporaneous periods in Western Europe. The area of Western Europe, in this case comprising mainly southern Britain and France and bordering countries, was chosen as a reference, as most concepts and approaches concerning the prehistory in the Levant are based to a large extent on research done in these areas. During the same periods as defined for the Levant, in Western Europe a completely different history emerges. At the same time when handaxes flourish in the Levant, in Europe they occur in surprisingly low numbers and never dominate the spectrum of retouched tools, with some rare exceptions (fig. 10). In the subsequent period, contempo-

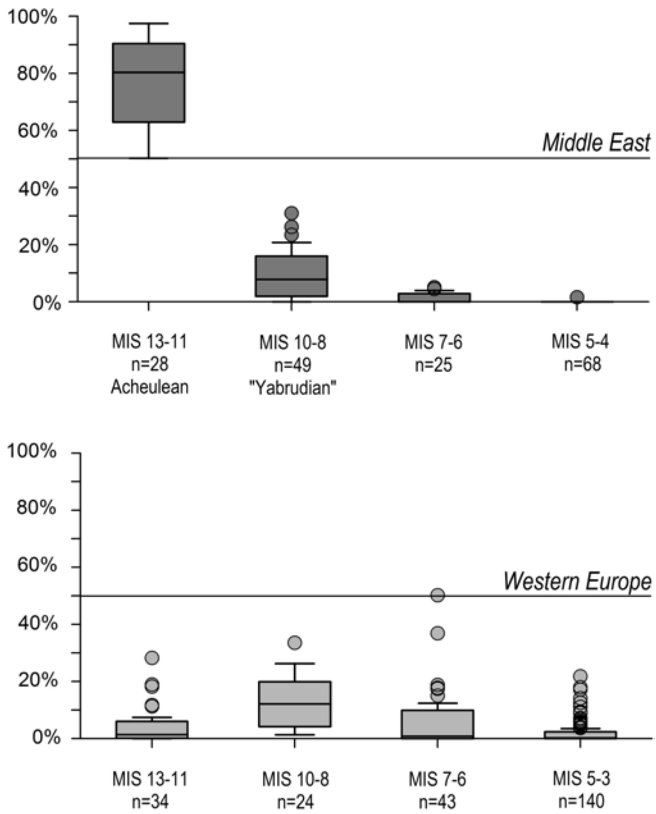

Figure 10 - Evolution of the handaxe-index (handaxes in percent of all retouched artefacts) in the Levant (top) and Western Europe (bottom).

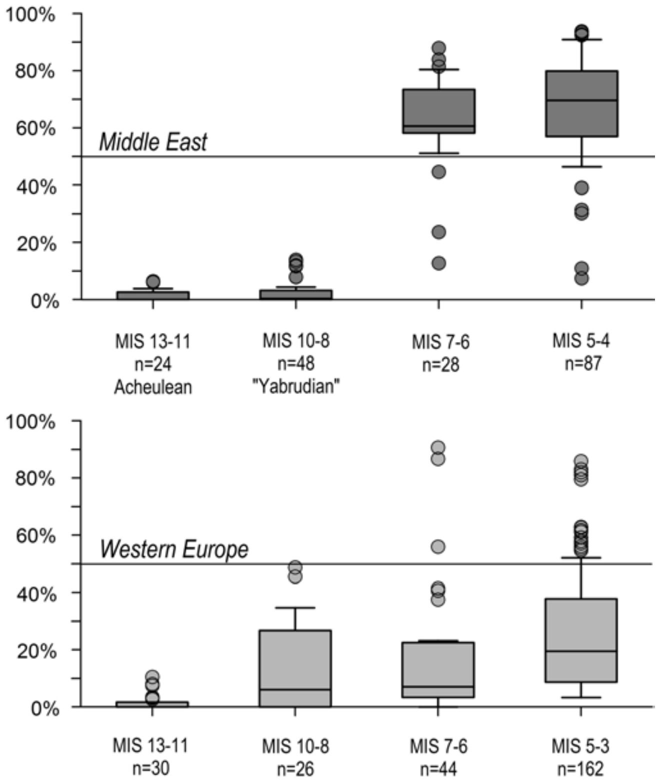

Figure 11 - Development of the Levallois technique (i.e. Levallois flakes vs. retouched artefacts) in the Levant (top) and Western Europe according to published data (bottom).

raneous to the Yabrudian in the Levant, the percentage of handaxes is identical with just somewhat smaller values in Europe. If this evolution is followed throughout the middle Palaeolithic, in the Levant handaxes virtually disappear from the archaeological record, whereas in Europe they persist in a low but steady numbers.

The unexpectedly low values for handaxes in Europe do not fall within the prevalent conception of the Acheulean, originally defined in northern France and southern Britain, and for long called the "age of handaxes". If considering this apparent antagonism, it rapidly becomes evident that the cherished old cliché is wrong. In fact, when the first Prehistoric periods were defined in the nineteenth century, scholars relied on materials produced by antiquarians rather than scientific excavations. Hence, the Acheulean in its traditional essence does not exist, a misapprehension that biased scientific perception well into the twentieth century and continues to some extent until today. Under this aspect, the new results from the Levant stand out, partially confirming traditional reasoning in an unexpected way. A further appreciation and the discussion of the consequences would go beyond the scope of this paper.

The Question of the Levallois

Another hotly debated issue is the relation of the Acheulean and the Levallois technique. In Syria, the presence of a "late Acheulean" associated with a clearly Levallois production is not demonstrated. A personal reappraisal of the Defaïan discoveries from Tulul Defai (Copeland & Hours 1993), a key site for this issue in Syria, showed the presence of a series of handaxes as well of incontestable Levallois cores, both in good numbers, but in each with a clearly different patina. Alleged Levallois cores from Acheulean sites are labelled atypical in many cases. Corresponding artefacts fall rather into the category of the pièces bifaciales that can easily be confounded with well-structured cores. "Levallois-like" flakes in an Acheulean context are not a proof for that specific technique. Particularly in sites where handaxes with a high refinement were regularly reshaped, trimming flakes may look deceptively like the presumed original (Copeland 1995). This observation is fully confirmed by the older Nadaouiyeh materials.

Even when taking published data about Levallois production in the Acheulean as such, an interesting scheme emerges. For a general comparison, the basic relation of Levallois flakes versus retouched tools was computed, again with a limit of at least 100 artefacts in the respective material (fig. 11). As in Europe, the Levallois component in the Levant during the MIS 13-11 is low, with somewhat higher values, most probably due to reshaping activities of handaxes. In the subsequent Yabrudian period, in the Levant a low Levallois percentage prevails.

In short, cultural evolution in the Levant and Western Europe shows strong inherent discrepancies. Whereas in Europe the general evolution from the upper Middle Pleistocene to the Upper Pleistocene seemed to have progressed at a regular pace, in the Middle East several distinct ruptures become evident. The first is a strong ebbing of handaxes in favour of retouched flakes from the Acheulean to the Yabrudian-complex and their complete disappearance later on. The second is the massive appearance of the Levallois technique and its dominant prevalence since the beginning of middle Palaeolithic i.e. after the Yabrudian period. In contrast, in Western Europe comparable changes do not occur, but a steady progression within a relatively broad mainstream can be observed. The reasons for the cultural ruptures in the Levant are difficult to explain. The chronological resolution of archaeological sites is still too poor to be linked directly with climatic events. However, the question arises why such ruptures are not present in Europe, much more exposed to the effects of climatic fluctuations during the Pleistocene?

Conclusions

The excavations in Nadaouiyeh Aïn Askar permit to recognise a surprisingly dynamic history of the Upper Acheulean between about 525 and 350 ka ago. Seven distinct stages succeeding each other show profound and complex changes within a definite theme, concentrated on core tools and the façonnage method of production. For the first time in the Levant it was possible to discern distinct multiple cultural stages within the Upper Acheulean in a clear stratigraphic setting. At present, seven distinct Upper Acheulean archaeological units are known from the Nadaouiyeh site, whose base is not yet explored.

Each unit stands out as a clear and individual cultural entity with little in common with its ancestors or successors, except for the mentioned mainstream of core tools. In the course of time, there is no "logical" evolution perceptible in the sense of a steady and linear change from a starting base to a final stage.

The observed changes concern technological, morphological, stylistic, as well as conceptual aspects. They occur individually or in combinations that are not in chronological order. Expected evolutions, for example, such as a steady flattening of sections, are discontinued by opposed tends (fig. 12). Cherished archaeological concepts for instance such as an evolution from primitive beginnings to an elaborate termination, have been belied, as the most refined handaxes were discovered at the base of the stratigraphy with the "crude" ones in the upper part of it.

In the past, Acheulean variability has been understood as a chronological phenomenon. The traditional concepts of understanding the Acheulean were hampered by the lack of stratigraphic control. Nevertheless, the Acheulean was already perceived as a dynamic period with several distinct groups (Muhesen 1985).

The example of unit Nad-D, with a particularly high chronological resolution, showed that profound changes are possible within the same cultural unit in a surprisingly short period, without any apparent interference such as environmental changes or a fundamental shift in subsistence. This surprising variability throughout the Upper Acheulean in Nadaouiyeh is striking evidence of a remarkable vitality of the handaxe traditions in the Levant. This conclusion is in stong opposition to conventional concepts considering the Acheulean as a more or less inert cultural period, with little progress in the course of time. The Nadaouiyeh example demonstrates the Levantine Acheulean to be as dynamic and versatile as much younger periods of the region.

A fundamental discovery within the Nadaouiyeh sequence is the observation that during the whole period of the handaxe traditions, no conceptual change at all of basic technological approach is discernible. During all that time, handaxes and their derivatives (i.e. all the variants of the core tool family) are produced in the façonnage concept. During the whole term of the Acheulean in Nadaouiyeh, intentional production of flakes in whatever method took place on an extremely low level. Consequently retouched flakes are rare and only accessory in the tool set. Despite this technological inertia, the bifacial concept is widely diversified, resulting in surprising solutions.

The study of the Nadaouiyeh handaxes demonstrated that morphological and metric analysis are possible on a general level only. Each handaxe is an individual product made from a singular and unstandardised blank. An accurate reproduction of a specific shape in exactly the same size is hardly possible. Consequently, a considerable variability is inherent, a fact rarely considered in studies of handaxes. In order to characterize such collections clearly, basic statistical requirements have to be met. The extremely rich levels in Nadaouiyeh permitted us to establish a minimal base for a statistical approach, in order to distinguish Acheulean units beyond qualitative statements, something rarely respected in sites of that period. Even in units with an evident standardisation, variability remains significant, due to the basic constraints of how handaxes were produced.

The Nadaouiyeh stratigraphy and its unique succession of handaxe traditions is an important showcase for the Upper Acheu-

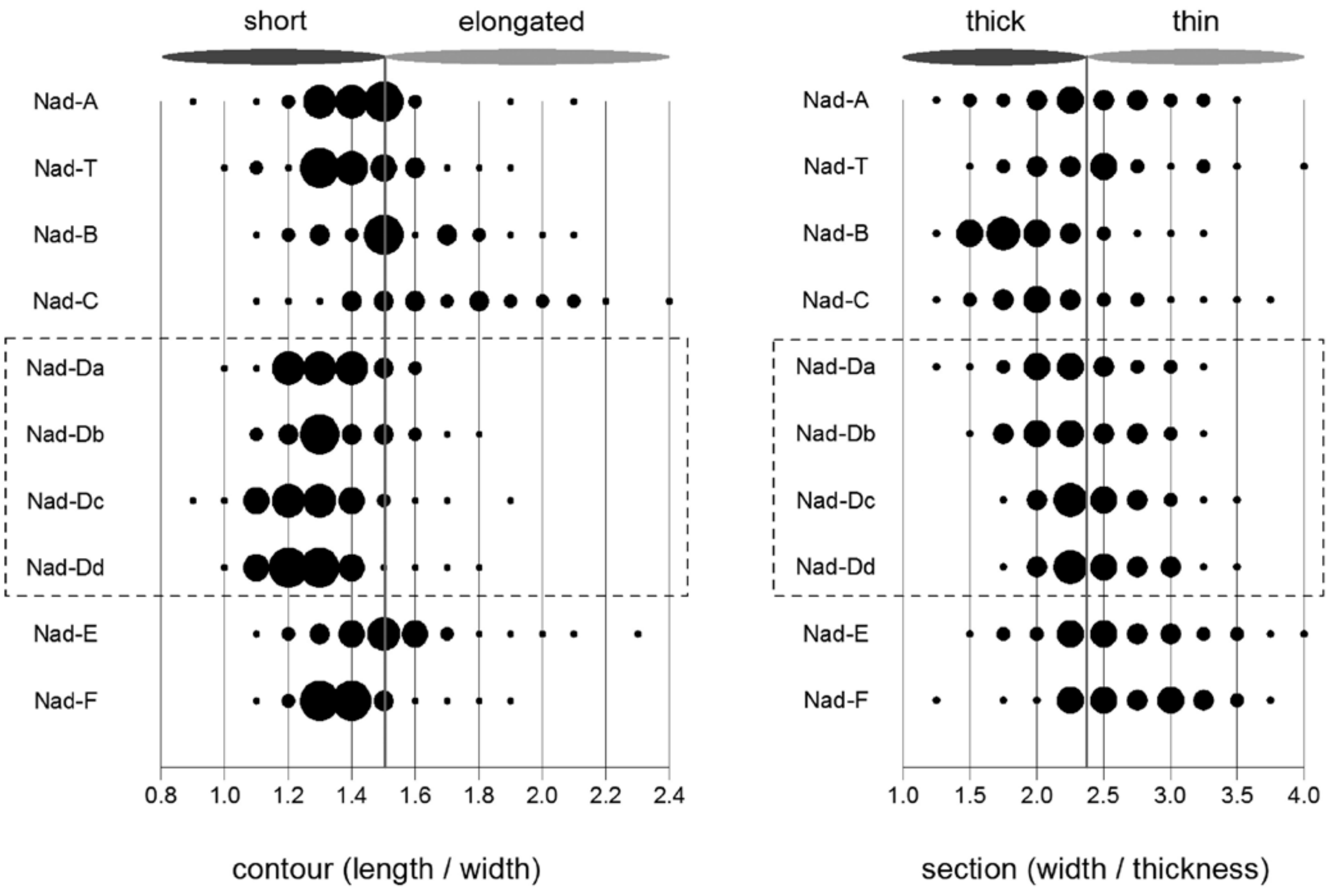

Figure 12 - Comparision of change in the proportions of the contour and section throughout the Nadayouiyeh Aïn Askar sequence.

lean of the Levant. However, the Nadaouiyeh sequence is far from being complete, and Acheulean variability could have been even wider than one might imagine. As there is just one single example of that history, it would be treacherous to declare it the sole reference to tell the story. Other sites, confirming and extending the Nadaouiyeh results, are essential in order to complete the picture of the Upper Acheulean.

When comparing the well-documented periods of the Acheulean (in the cultural sense) between the Levant and Europe, approximately in the time of MIS 13–10 (about 525–350 ka), drastic differences become apparent. In the Middle East, handaxes and core tools always prevail in a strong majority with flake tools being a sort of minor accessory. In Europe, the situation is inversed, with a strong predominance of flake tools and surprisingly few handaxes. The Levantine Acheulean is consistent with the classical cliché of a tradition rich in handaxes, to which the situation in Western Europe is strangely opposed (at least concerning conventional concepts). Due to the scarcity of information about the handaxe phenomenon during the middle Pleistocene in Eastern Europe, it is difficult to trace a limit between the European and Levantine realm. In subsequent periods, affinities between the two regions become more visible. About 350 ka ago, handaxes lose their popularity in the Levant ceding their dominance to different concepts, favouring smaller and more versatile tools. In this phase Europe and the Middle East converge in a surprising way. Whether it is a congruent phenomenon or if a cultural exchange really took place and, if so, in which direction, remains to be decided. With the onset of MIS 7 (roughly 250 ka ago), another break occurred in the Levant. With the arrival of the Levallois production scheme, handaxes disappear almost completely from the archaeological record of the Middle East. Again, a profound discrepancy during the whole period of the Middle Palaeolithic separates the Levant from its contemporaneous cousins in Europe. The strong and steady prevalence of the Levallois production concepts in the Levant is the clear hallmark of that period along the eastern shores of the Mediterranean. In such an environment the comeback of a strongly "Acheulean influenced" technological tradition, such as the Epi-Acheulean from unit Nad-A from Nadaouiyeh, was rather a surprise. Obviously, somewhere within the precincts of the Levant, archaic concepts survived with people who were not attached to the prevailing Levantine mainstream.

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THE FAUNAL REMAINS FROM NADAOUIYEH AÏN ASKAR (SYRIA). PRELIMINARY INDICATIONS OF ANIMAL ACQUISITION IN AN ACHEULEAN SITE

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Introduction

The open-air site of Nadaouiyeh Aïn Askar (Nadaouiyeh hereafter) is located in Central Syria, in the El Kowm area. Here a gap in the mountains separates the northern Badia from its southern part (Le Tensorer *et al.* 1997) (fig. 1). This particular region is characterised by the presence of numerous natural springs in an otherwise dry landscape (Jagher & Le Tensorer 2011). Water and oases have attracted humans and animals in all eras. Up to now, 186 Palaeolithic and Epipalaeolithic sites - flint-knapping workshops located in the hills and open-air settlements along the valleys and especially at the springs - are known from the El Kowm area.

Humans have regularly camped again and again at or next to the spring of Nadaouiyeh, from the Lower Palaeolithic to historical periods. The older part of this very long sequence, from about 525,000 to 350,000 years BP, is especially well represented. In total, 32 Acheulean levels, extremely rich in lithic artefacts, including more than 12,000 hand axes (Jagher 2000, 2011), and well over 14,000 faunal remains (Le Tensorer *et al.* 1997; Reynaud Savioz & Morel, 2005), have been recorded.

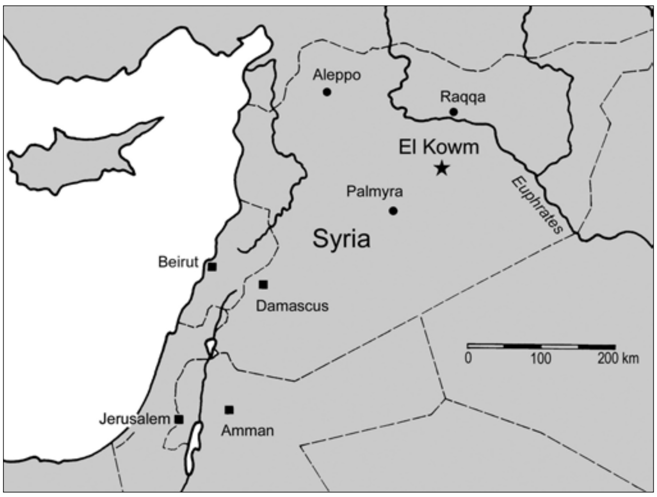

Figure 1 - Location of the El Kowm area (map R. Jagher).

The excavated surfaces cover less than 5 m² for half of the 32 Acheulean levels, and exceed more than 10 m² for just nine of the levels.

The particular setting of the site on top of a karstic system explains the occasional drying out of the spring at Nadaouiyeh (Turberg 1999). The action of groundwater is responsible for the formation of an extensive karstic vent and the periodic collapse of the underground cave system. These cave-ins created depressions on the surface of 30 to 50 m in diameter and from 5 m to well over 10 m in depth. During periods of low water table - when the Acheulean people resided near/at the spring - the majority of the sediments were deposited under limnic conditions (Pümpin 2003; Le Tensorer *et al.* 2007). Aeolian processes played a lesser role in the sedimentation process, accumulating ultimately a stratigraphy of over 30 m (for a more detailed description of the sequence and the geology, see Jagher 2011).

Faunal remains

A detailed quantitative analysis of the faunal assemblage is still in progress, therefore the results have to be considered as preliminary. At the moment, individual data are available for 13.324 bones (fig. 2). Approximately 1500 pieces, mainly from the lowest levels excavated during the last years of field work, have still to be treated. 2205 faunal remains were determined specifically and anatomically during excavation before being eliminated, because of too poor preservation, impeding a reasonable recovery of the bones.

Taphonomy and origin of bone accumulation

Fossilisation in most cases is poor, requiring a systematic *in situ* treatment with a monomer resin while unearthing, in order to stabilise the fragile animal remains. Unlike most open-air settlements, where bones rapidly deteriorate, the marshy depression offered excellent conditions for the preservation of faunal remains. Usually bones were rapidly buried in fine-grained sediments; in most levels, bone preservation indicates a fast sedimentation, which permitted the conservation of fragile bones,

units	levels	Gazelle	Antelope	Aurochs	Camelids	Equids	Rhinoceros	Carnivores	*Sus scrofa*	Bird	Tortoise	Microfauna	gazelle-size	antelope-size	antelope/camel size	camel-size	indet	total
A	c.1	2	1		1	4				1	1		1			21	1	**33**
	c.2		1										1	9				**11**
B	c.5av		1		9	7						4	8	12	16	91	3	**151**
	c.6.1				1	3								2	8	26		**40**
	c.6.2				1	19								1	9	8	1	**39**
	c.5-90	1	1		35	6							4	8	34	182	25	**296**
	c.5b	2			70	3								18	32	69	3	**197**
	c.6a				42									11	21	98		**172**
	c.6.4	1			12	159							5	72	76	151	3	**479**
	c.6b					1								17		6		**24**
	c.7 supra															2		**2**
	Ach III					3												**3**
C	c.8.1	130	25	1	18	19		1		2	11	1	126	92	72	255	61	**814**
	c.8.1a	94	62		1	9					2		10	45	19	27	32	**301**
	c.8.1b	340	42	24	13	13		1		6	92		119	46	20	95	262	**1073**
	c.94-1	6											11	4		12	7	**40**
D	c.8a/d	247	44	2	49	86			1	1	57		101	92	644	379	92	**1795**
	c.8a	1120	149	7	82	67	2	3		6	159		392	222	68	663	353	**3293**
	c.8b	529	63	5	39	36		3		5	121		205	127	39	170	195	**1537**
	c.8b infra	28	1			2					7		1	1		3	25	**68**
	c.8c	357	14	1	19	22				5	263	1	66	25	14	58	145	**990**
	c. 8c infra	9			3	1					1					2	2	**18**
	c.8d supra	5									2		1				16	**24**
	c.8d	236	49	2	22	37	1	3		3	225	2	48	34	19	104	87	**872**
E	c.9	8	10		18	69							11	22	6	226	75	**445**
F	travertin	56	1	2	19	5		1		1	3		79	53	14	156	21	**411**
	Dolina 3	5	5		9	12					10		10	11	25	104	5	**196**
	total	**3176**	**469**	**44**	**463**	**583**	**3**	**12**	**1**	**30**	**954**	**8**	**1199**	**924**	**1136**	**2908**	**1414**	**13324**

Figure 2 - General table of the faunal remains.

such as *scapulae*, and, in several instances, the preservation of complete braincases and even intact skulls of gazelles, camels and wild ass or intact carapaces of tortoise. Traces of heavy weathering were only occasionally observed, which is quite surprising in an open-air site. However, in some archaeological levels bones were poorly preserved, limiting identification. Post-diagenetic effects affected the animal remains: geochemical actions affecting not only bones but also stone artefacts (Pümpin 2003), and micro-tectonical movements during the various cave-ins of the karstic spring have often crushed, distorted and fragmented the bones (e.g. c.6.4 and c.9). Especially the long bones of large mammals and teeth were broken into several fragments, which were counted individually, raising their representation artificially. This effect of selective recognition is exemplarily shown by the numerous recorded remains of tortoise, which is almost only known by fragments of carapace, which is easily recognised by its characteristic structure even in tiny fragments.

Gnawed bones are extremely rare in all units (preliminary projections indicate less than 3%), no digested bones have been found despite the special attention they were given, and only two coproliths of hyena have been discovered (both in unit Nad-F). The hypothesis of fragmentation due to carnivores can therefore be rejected. Furthermore, the site of Nadaouiyeh is characterised by a high density of flint artefacts (Jagher 2000, 2011). Repeated observations demonstrate that the faunal remains and the lithic tools are associated, without doubt. Several living floors, preserved by a rapid sedimentation, were identified, and some particular horizontal distributions indicate specific activity areas. For example, the archaeological level c.5b (Nad-B) shows what was very likely a butchery zone (fig. 7). In lower archaeological levels (e.g. units C and D) most of the long bones were broken in a fresh state (in many cases with clear traces of impact of a heavy tool), obviously for extracting the marrow. Even the massive long bones of big animals, such as Equids and especially Camelids, have been reduced to small fragments of less than 10 cm. Cut marks indicating defleshing are occasionally observed (fig. 3). Besides filleting and marrow-processing, indicative of butchery and consumption activities, no evidence for fire places is present in any of the archaeological units. The distribution pattern of skeletal elements shows that gazelle, antelope, Equids and Camelids were brought as complete carcasses to the spring site (figs. 4, 8).

Taking all these observations into account, it appears reasonable to assume that humans were by far (if not exclusively) the major agent responsible for these bone accumulations. It can be stated positively that the faunal remains originate from human exploitation of the local fauna during repeated occupations.

Figure 3 - Nadaouiyeh Aïn Askar, level 5b (Nad-B), cut marks on the distal articulation of a camelid phalange, 1.5 actual size (photo E. Jagher).

Units	head	axial skeleton	scapular & pelvic girdles	limb bones	feet	total
C 1	32	34	47	66	45	**224**
C 2	51	126	15	45	102	**339**
D a	266	119	35	239	454	**1113**
D b	110	105	25	100	188	**528**
D c	57	79	17	75	128	**356**
D d	28	39	13	62	93	**235**

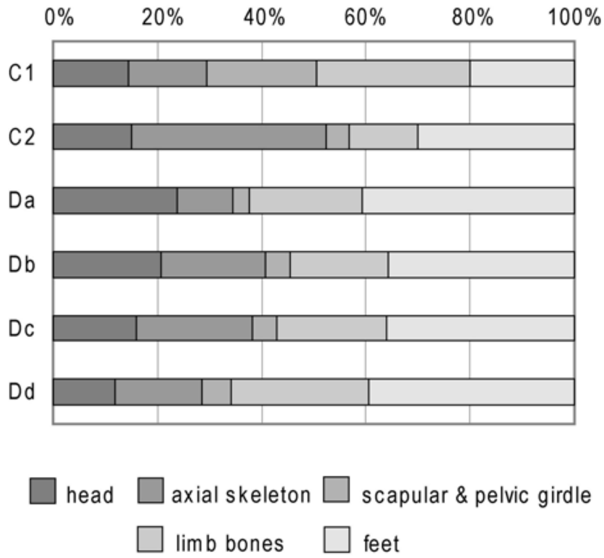

Figure 4 - Skeletal parts frequencies of the gazelle in the units Nad-C and Nad-D (diagram and table).

Taxonomy

As a whole in the Nadaouiyeh fauna, three species of Bovids are recorded; aurochs (*Bos primigenius*) (n=44), antelope (genus *Oryx*, very likely *Oryx leucoryx*) (n=469) and a gazelle (n=3176). The goitred gazelle (*Gazella subgutturosa*) has been identified with certainty in levels c.8a-d on the basis of horn cores (fig. 5). Among other herbivores are represented; rhinoceros (*Dicerorhinus mercki/hemitoechus*) (n=3), Camelids (n=463) and Equids (half-ass/ass and horse) (n=583). By the size of their teeth, the Equids can be divided into three groups: a very small one with affinities to *Equus africanus* (African wild ass) despite its inferior size; a clearly bigger species, probably *Equus hemionus* (Asian wild ass) and the third one, represented by just three teeth, is even bigger, and can be attributed to the *Equus ferus* group (Morel 1996). A pig (*Sus cf. scrofa*) is represented by a single fragment of a mandible. Carnivores are very rare and are represented by hyena (a fragment of mandible and some coproliths), lion (an isolated canine) and a fox-sized species (in all n=12). Some small birds (n=30) and a few remains of microfauna (n=8) complete the list of species, to which about 1000 remains of tortoise (n=954) have to be added. An unidentified elephant is represented by an isolated lamella of a molar, unfortunately discovered in a geological context with mixed archaeological material. Hence it remains undecided if it indicates the presence of such a pachyderm, or if the object was brought to the site as a curio by prehistoric man. Unspecified faunal remains were grouped into four size groups: the small-size class includes essentially gazelle-size bones; the medium-size group corresponding to antelope and Equid-size and the big-size group matching Camelids, aurochs and rhinoceros. The fourth group is an intermediate, between the medium- and big-size classes, for bone fragments too small to be attributed to either of them for sure.

Corresponding to its geographic setting, the Nadaouiyeh fauna comprises only animals associated with a more or less open

Figure 5 - Horn cores of goitred gazelle (*Gazella subgutturosa*) level c.8a. female (left) and male (right) (photo N. Reynaud Savioz).

steppe. Animals characteristic of woodlands such as Cervids are completely absent, as are the animals of the surrounding mountain ranges (e.g. Caprids). Ecologically, the Nadaouiyeh fauna is indicative of the same environment as is demonstrated by the palynological observations of J. Renault-Miskovsky (1998). As this steppe was predominantly treeless, remains of rhinoceros could be attributed to *Dicerorhinus hemitoechus*. Finds of fauna that are relatively older and younger than the Nadaouiyeh assemblage, from Hummal and Umm El Tlel in the El Kowm area, show the predominance of a fauna typical of a dry steppe throughout the Pleistocene (e.g. Griggo 1999; Frosdick 2010).

The archaeological context

The 32 Acheulean levels at Nadaouiyeh have been grouped into seven archaeological units, labelled Nad-A to Nad-E (Jagher 2011). The abundance of faunal remains varies from one unit to another, partly depending on the excavated surfaces. Variations in taxonomic frequencies have thus to be taken with some caution (extensive statistical tests are still pending). In the following, the number of individual specimens (NISP) refers to bones identified to the genus level at least (fig. 6).

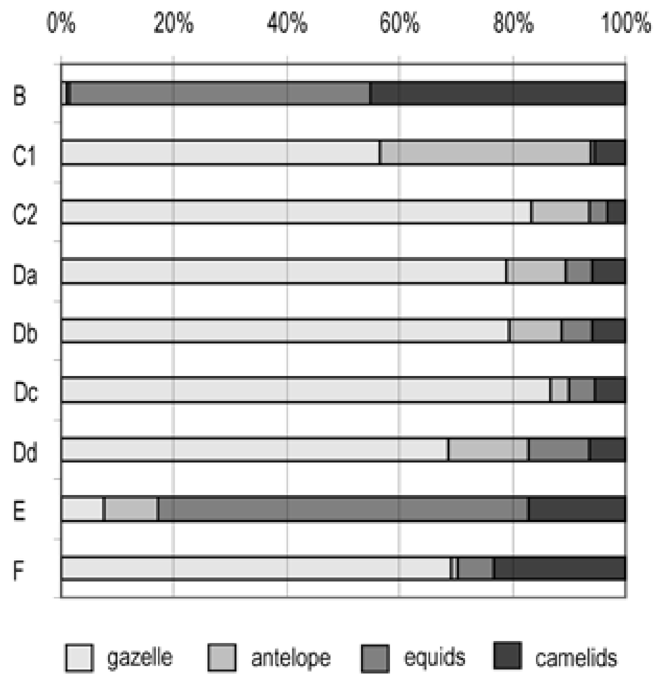

Figure 6 - Taxonomic abundance for archaeological units; bottom table with n, top graph for units with n >100.

Unit Nad-F

(>500,000 BP) NISP = 88
Among the small number of faunal remains specifically determined, gazelle is well represented, followed by Camelids, and Equids. From the 323 unspecified faunal remains, the dominant group (48%) is of big size, followed by small (24%) and medium-sized animals (16%).

In summary Camelid-size and gazelle-size animals occur in roughly the same proportion, together making up three-quarters of the material. The antelope-size group is insignificant and the Equid group is small. It is the only case in Nadaouiyeh where small- and big-size classes occur together as main components of the fauna.

Unit Nad-E

(approx. 500,000 BP) NISP = 105
The preservation of the bones is poor due to a very strong secondary fragmentation by post- sedimentary geological and geochemical processes (Pümpin 2003). Equids, essentially represented by fragments of teeth, dominate with 66% of the NISP, followed by Camelids with 17%. If we take into account the unidentified bones attributed to the big-size group (66%), however, it appears that Camelids are clearly underestimated. Gazelle and antelope-size classes reach respectively 8% and 10%. Because of poor general preservation, the initial proportion of gazelle could be higher. However, among the unidentified bones, the presence of the medium- and big-size classes clearly show a strong preference for bigger animals in this unit. In synthesis it can be said that the Camelid-size animals clearly dominate the spectrum with more than half of the bones. The second class is the Equid group with nearly one-fifth of the material. Smaller mammals, i.e., of gazelle size, clearly play an inferior role.

Unit Nad-D

(between 500,000 and 475,000 BP) NISP = 4204
Several actual living floors within this unit (e.g. c.8b and c.8d) yielded abundant and exceptionally well preserved faunal material. The bones and stone artefacts were covered rapidly by limnic and fine- grained alluvial sediments (Pümpin 2003). The faunal spectrum of all levels is clearly dominated by gazelle (60%) and followed by tortoise (20%). Much rarer are antelope (8%), Equids (6%) and Camelids (5%). Other taxa such as rhinoceros, carnivores, Suidae and small mammals, represent less than 1%. The proportion of the tortoise may be overestimated, as even tiny fragments of the carapace are easily recognised by their unique structure. Preliminary spatial analysis shows conspicuous concentrations of turtle remains, suggesting a much lower number of individuals.

Unit Nad-C

(between 475,000 and 450,000 BP) NISP = 913
As in the underlying unit, the general preservation of bones is good. The gazelle still clearly dominates with 62% of the identified remains, and is followed by antelope (14%) and tortoise (12%). Other mammals represent less than 10%: Equids (4%), aurochs (5%) and Camelids (3%). As in unit Nad-D, the remains of big animals – 30% of the undetermined bones – are heavily fragmented, in general due to human activity.

Despite a strong archaeological discrepancy between units Nad-D and Nad-C (Jagher 2011), the palaeontological material shows a very close similarity of composition. Gazelle-sized animals make up two-thirds in each of the two units, while in both close to one-fifth are Camelid-sized animals, n antelope-size and Equid-size make up around 10% each.

Unit Nad-B

(between 430,000 and 350,000 BP) NISP = 381
This archaeological unit, comprising 10 archaeological levels with palaeontological remains, is characterised by a good preservation of bones, although some levels show a strong secondary fragmentation (e.g. c.6.4). Equids dominate with 53% of the NISP, closely followed by Camelids (45%). Gazelle represent just 1% and no fragment of tortoise has been found. This spectrum is conspicuously different from the older units. If one considers that 86% of the Equid remains are small fragments of teeth, whereas only 39% of the Camelid remains are teeth, and that 63% of the unidentified bones belong to the size-class big, the strong preference for Camels in this unit becomes evident. The infrequence of small animals of gazell size, is confirmed by the fact that just 2% of the unidentified bones can be attributed to this size class.

Unit Nad-A

(approx. 200,000 BP) NISP = 11
The two levels of this most recent Acheulean unit yielded very few animal bones. In all, only 44 faunal remains were retrieved from these levels, both of which were excavated on a surface of nearly 20 m². The bones are heavily weathered and splintered. Obviously most of the faunal remains of this unit were already lost before they became buried for good. Among the 11 bones determined, Equids dominate, followed by gazelle and antelope. Only one bone was attributed to a Camelid, as is also the case for the tortoise and birds

Even if it is still difficult to estimate the impact of taphonomic biases and human selection on the variations of taxonomic abundances, faunal assemblages nevertheless testify to a more or less temperate steppe environment during the Middle Pleistocene.

Active or passive acquisition

The mode by which animals were acquired either by scavenging (confrontational or not) or through active hunting during the Lower Palaeolithic is still debated (e.g. Dominguez-Rodrigo 2002). Archaeozoological studies usually use taxonomic abundance, frequency of skeletal elements and mortality patterns to estimate the way prehistoric people procured meat. Quantitative analyses are still in the early stages for Nadaouiyeh. However, preliminary results reveal several interesting observations in this debate.

A diverse range of animal body sizes is present in the archaeological levels of Nadaouiyeh. Exploited mammals vary in size from gazelle to Camelids and aurochs. Small game comprises tortoise and perhaps small birds. The presence of the slow-moving reptile indicates collection as a way to procure animal proteins (Speth & Tchernov 2002; Blasco 2008).

Gazelle

The skeletal-element frequency and mortality pattern of the gazelle indicate that the small ungulate was actively hunted. Relative abundance of the anatomical elements, calculated for units having furnished more than 100 remains, indicates that complete animals were brought to the site (fig. 4). The meat-bearing elements are in general well represented.

A preliminary mortality pattern has been calculated for Nad-D. Work on ageing gazelle remains essentially concerns the mountain gazelle (*Gazella gazella*) (Davis 1980, 1983; Munro *et al.* 2009). In the present study, Davis' methods of age determination have been applied to the Pleistocene goitred gazelle (*Gazella subguttorosa*) from Nadaouiyeh. Even if the presented results have to be taken with caution, they still are indicative. Of the 30 mandibles studied, 20% belong to individuals aged less than 16–20 months (i.e. juveniles) and 80% to adults of more than 16–20 months. Observations on epiphysis (n=95), show 70% of bones reaching 18 months and more (i.e., adulthood). Although there is bias through differential conservation, prime adults are certainly present. According to M.C. Stiner (1990, 2002), only humans kill essentially prime adult prey, while carnivores hunt principally young and very mature prey, i.e., the weakest ones. Moreover, the large MNI of 23 gazelles for level c.8a (unit Nad-D, excavated surface of just 13.75 m²) strongly suggests that these animals were actively hunted and not scavenged.

Their presence possibly indicates seasonal hunting. During the Holocene the goitred gazelle passed through the El Kowm area in the course of their seasonal migrations in herds of 50 to 100 individuals, as shown by historical evidence, such as stone enclosures (desert kites), and archaeozoological studies of Holocene settlements in neighbouring areas (e.g. Tell Abu Hureyra, near Lake Assad) (Harrison & Bates 1991; Legge & Rowley-Conwey 1987). It is conceivable that Acheulean hunters directed their efforts towards this kind of animal congregation during their migrations.

Antelope, Equids and Camelids

Mortality patterns for these three families are not yet available as the respective data are too restricted. For an estimation of the representation of anatomical parts, only inventories with at least 100 fragments were respected. For antelope, Equids and Camelids respectively, only one archaeological unit produced a sufficient number of identified bones per family (fig. 8).

Because of the extreme fragmentation of Equid and Camelid teeth, which are recognisable even as small fragments, the cephalic skeleton is overestimated. In contrast the extensive, mainly secondary, fragmentation of limb bones, limits a clear taxonomic attribution. As all anatomical parts are present in the samples, it is possible that the animals were brought to the site as a whole. Carcass parts of high nutritive value (mandibles, shoulder blade and limb bones) as well as those of low value (axial skeleton and foot) are well represented. For the antelope, limb bones bearing a lot of meat are well represented. Vertebrae, scapulae and pelvis, particularly for Equids and Camelids, represent a smaller percentage than the head (overestimated) and limb bones (underestimated), reflecting a possible differential transport.

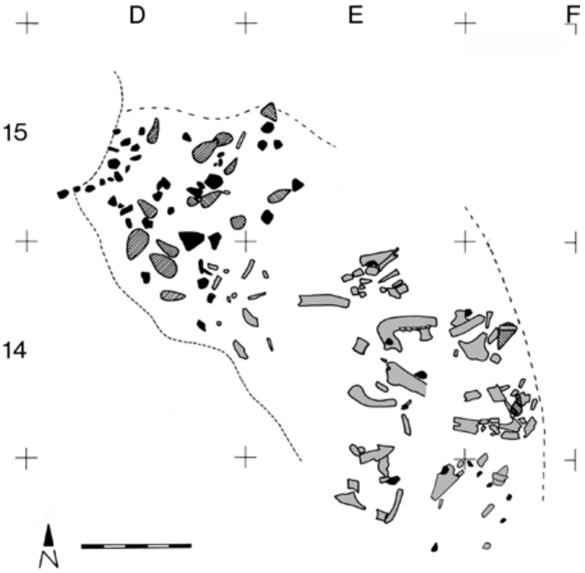

Figure 7 - Planigraphic view of level c.5b, interpreted as a butchery zone. black: flint artefacts, hatched: hand axes, grey: bones (map R. Jagher).

Units	head	axial skeleton	scapular & pelvic girdles	limb bones	feet	n
Antelope						
D a	11%	6%	8%	27%	47%	**148**
Camelids						
B 2	45%	12%	0%	1%	42%	**130**
Equids						
B 2	93%	1%	1%	3%	2%	**163**

Figure 8 - Skeletal parts frequencies of the antelope (Nad-Da), the Equids and the Camelids (Nad-B2).

All these medium- and big-sized ungulates are present with all body parts, suggesting they were brought as a whole to the camp site (fig. 8). Very likely they were dismembered for better transportation. This indicates that humans had primary access to complete and fresh carcasses. However, it is too early for further reflections at this stage.

Rhinoceros and aurochs

Both taxa are represented by a small number of remains. Potentially some of the very fragmented limb bones, not attributed specifically, could also belong to these two big mammals. Mainly fragments of head (n=14) and elements of foot (n=20), followed by limb bones (n=5), axial skeleton (n=4) and scapular/pelvic girdles (n=1), testified to the presence of the aurochs, mainly in units Nad-D & C. This anatomical pattern, based as it is on a restricted database, is ambivalent. If the aurochs was actually hunted, this would imply that the spring was the kill-site, or the hunting place was not too far away, for the transportation of this massive animal is a challenge. Even dismembered quarters would be difficult to haul over a long distance. Another possible scenario could be that aurochs were scavenged, also at or near the spring.

The remains of rhinoceros comprise a nearly complete humerus (in fact the largest bone discovered in Nadaouiyeh), a fragment of a second one, fragments of a coxal and a mandible of a very young individual (milk teeth in eruption), discovered in Nad-D. Five more or less complete molars of adult rhinoceros, found in a geological context, document a wider distribution of this family in the site. Hunting this impressive herbivore with Palaeolithic technology was undoubtedly dangerous (e.g. Guérin & Faure 1983). European Middle Palaeolithic open-air sites, where active acquisition of rhinoceros is demonstrated, are characterised by a particular topography – a marshy depression and/or at the foot of a precipitous mounds – and by the presence of a large amount of bones belonging to young and very mature individuals (Auguste *et al.* 1998). At Nadaouiyeh, the marshy depression possibly played a role in the acquisition of the very young rhinoceros, trapped in the mire and then slaughtered.

Nevertheless, the exploitation of very big mammals was occasional and unsystematic, as is shown by the weak numbers of remains and individuals. In sub-unit Nad-C2, however, the aurochs accounts for 5% of the NISP and is even better represented than Camelids and Equids.

For the time being, the discrimination between hunting or scavenging or natural causes remains difficult. Animal proteins were provided by smaller herbivores, as shown by a much more important number of bones and individuals. Hunting strategy was probably a kind of ambush predation. Maybe the depression itself played a role, offering some vegetation for ambushing. The presence of water would certainly be attractive for animals. Nevertheless the skills displayed in the acquisition of meat were considerable throughout the Acheulean, as every hunted species required a specific strategy, with the assistance of several individuals, as a single hunter would barely be successful.

Comparisons

El Kowm

The El Kowm area is a real laboratory for studying the subsistence strategies of early hominids from the lower Pleistocene to the Holocene. The importance of this region is not only its extremely long history, which is exceptionally well documented, but also the fact that it all happened in the same landscape, within a territory less than 20 km across. Aïn al Fil, the oldest site so far known, dating back to more than one million years (J.-M. Le Tensorer pers. com.) is characterised by a rich and well preserved fauna with archaic elements; but no data are yet available as preliminary investigations of that site only started in 2008.

The fauna of the Oldowan levels from Hummal seems to be dominated by large animals. Two-thirds of identified species are Camelids, followed by cattle and Equids both in about the same proportion (Frosdick 2010). In contrast to Nadaouiyeh, the Hummal fauna throughout the stratigraphy seems to be dominated by large animals. Small animals, like the gazelle at Nadaouiyeh, are conspicuously rare. Without further investigation about the taphonomic processes in Hummal, a more detailed interpretation of this observation is difficult.

Figure 9 - Close up of level c.8b (Nad-D) showing the heavy *in situ* fragmentation of bones. 1 distal articulation of gazelle's metapodium, 2 mandibular teeth of gazelle in connection, 3 & 4 unindentified fragments.

For the Acheulean period, besides Nadaouiyeh, there is only scant palaeontological information from Al Meirah, tentatively dated to around 800,000 ka (Boëda *et al.* 2004). Only 17 bone fragments were retrieved, among them remains of hippopotamus. The presence of this large herbivore does not imperatively indicate the presence of important waterbodies, but certainly the existence of lush grazing indicating a much wetter climate than today.

From the Yabrudian and Hummalian periods, only data from Hummal are available to some extent. Again taphonomy blurs the picture, but probably there was a strong preference for big game like Camelids (Frosdick 2010). Equids are represented to a much lesser extent as are gazelles.

Concerning the Middle Palaeolithic, data are available from Hummal and to a much larger extent from Umm El Tlel. The Hummal assemblage again is dominated by large animals. Camelids are by far the most common family, among them a very massive form much larger than the common variant. Human behaviour is much better observed in the Umm el Tlel material, where active hunting is documented by a nice proof, with a Levallois point embedded in a vertebra of wild ass (*Equus africanus*) (Boëda *et al.* 1999). Animal exploitation varies heavily between the different levels, always focusing on one preferred species such as Camelids, Equids or gazelle, followed by one or at most two accessory prey adding up to about 90% of the faunal material of the respective levels (Boëda *et al.* 1998, 2001).

Near East

Stringent palaeontological data and evidence of human activity for the Acheulean period in the Levant are rare due to the poor preservation of bones and small samples, impeding a clear picture of subsistence practices (e.g. Latamne (van Liere 1966), Um Qatafa (Vaufrey 1951), Azraq (Clutton-Brook 1970; Turnbull 1989). Hunting and butchering activities are demonstrated for the lower Pleistocene site of Ubeidiya, dated to about 1.6–1.2 ma, where Cervids and Equids were actively hunted and where cut marks and the absence of marrow-processing seem to indicate that the earliest Levantine hominids exploited these animals for meat only (Gaudzinski 2004). In a later period, at Gesher Benot Ya'aqov (around 800,000–750,000 BP), there is evidence for selective hunting and methodological butchering practices on fallow deer and for hunting even on elephant (Goren-Inbar *et al.* 1994; Rabinovich *et al.*, 2008). Other Levantine "Acheulean" sites clearly post-date Nadaouiyeh and occupy different ecological surroundings than the steppe of the Levantine interior. Unsurprisingly, subsistence strategies there show different approaches in a more progressive way (e.g. Qesem Cave (Stiner *et al.* 2009), Hayonim (Stiner 2005) and Misliya Cave (Yeshurun *et al.* 2007).

Conclusion

At Nadaouiyeh, rhinoceros and aurochs were possibly scavenged, as active hunting is difficult to demonstrate. In any case, scavenging must not be considered an easy strategy for procuring meat. On the contrary, it requires an excellent knowledge of animal behaviour. Furthermore, as scavenging is occasionally practised by modern humans (for instance, among present day hunter-gatherers of Eastern Africa), evidence for this practice has no chronological and cultural value.

Archaeozoological studies of Lower Palaeolithic sites, as cited above, prove the ability of large game hunting among pre-Neanderthal people. *Homo erectus* was already an efficient hunter, able to prey on a diverse range of animals of different size. The preliminary studies of the Nadaouiyeh faunal remains also sustain such conclusions. All the ecologically expected local mammals were regularly exploited, attesting a perfect knowledge of each animal's behaviour and of the terrain. *Homo erectus* was able to adapt killing strategies to each species. To be successful, as they were, they had to coordinate and cooperate. This involves an efficient communication between group members. The cognitive development of *Homo erectus* is also visible in their lithic industry. At Nadaouiyeh, innovations occurred in a very short period of time (Jagher 2011) and the perfection of the hand axes discovered in the oldest occupation levels clearly exceeds pure functionality (Le Tensorer 2001).

Acknowledgements

I am grateful to M. C. Stiner for her helpful comments on a first manuscript. Sincere thanks are also due to R. Jagher; his help was most valuable for editing this paper.

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HUMMAL: A VERY LONG PALEOLITHIC SEQUENCE IN THE STEPPE OF CENTRAL SYRIA – CONSIDERATIONS ON LOWER PALEOLITHIC AND THE BEGINNING OF MIDDLE PALEOLITHIC

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Introduction

The region of El Kowm (fig. 1) is an exceptional place, a key locale for understanding the Paleolithic of the Middle East (Jagher & Le Tensorer 2011). The research carried out over nearly 30 years by the department of Prehistory of the University of Basel, in close partnership with scientists from the University of Damascus, has greatly improved our understanding and knowledge of the evolution of human cultures in their chronological context. Within this region, the site of Hummal, a prominent mound at an artesian spring, has yielded the most complete sequence known to date, from Lower through Upper Paleolithic. The site lies at 2 km N-NE of the village of El Kowm (fig. 2). Discovered by G & M. Buccellati in 1966, the well was also identified in the literature as Bir 'Onusi, after the name of the owner of the site.

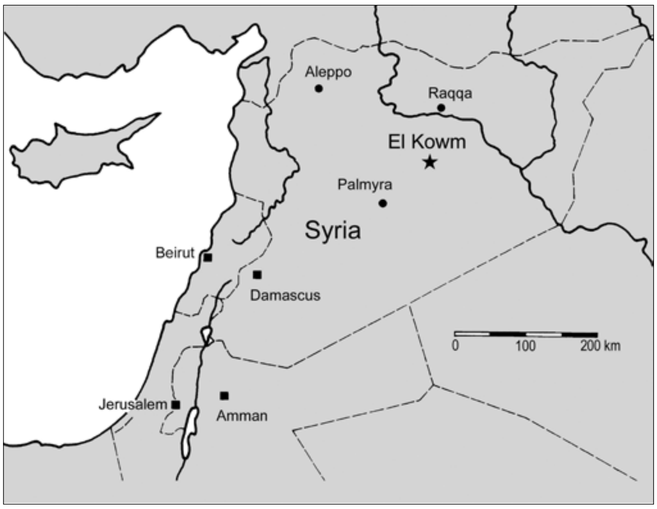

Figure 1 - General map of Syria.

In 1980, during a first field campaign devoted to geomorphology and Paleolithic research in the El Kowm region, the site was rather rapidly inspected and described (Besançon *et al.* 1981). In the lower part of the well, a new early Middle Paleolithic blade industry was recognized, and named the Hummalian (Copeland 1981; Hours 1982). At the invitation of the late F. Hours, who was directing the Paleolithic research group in the El Kowm area, the first author undertook a series of stratigraphic and sedimentological studies of the site in 1982, 1983 and 1985. Among other things, he was able to place the Hummalian stratigraphically above the Yabrudian, contrarily to what the first observations from a disturbed area had led the team to believe. During the winter of 1987, a massive collapse due to erosion of earth from the digging of the modern well and piled around its mouth filled up the lower part of the stratigraphy, which is still inaccessible nowadays. In 1997, with the support of Sultan Muhesen, then Director General of Antiquities and Museums of Syria, we decided to resume our study of Hummal. The first fieldwork consisted only in cleaning the existing profiles and collecting samples for further analyses. The excavations proper (figs. 3, 4) began in 1999 within the Syrian-Swiss Research Program on the Paleolithic in the El Kowm area under the joint direction of Sultan Muhesen and Jean-Marie Le Tensorer, with the collaboration of Hélène Le Tensorer, in charge of the lower part of the stratigraphy, Vera

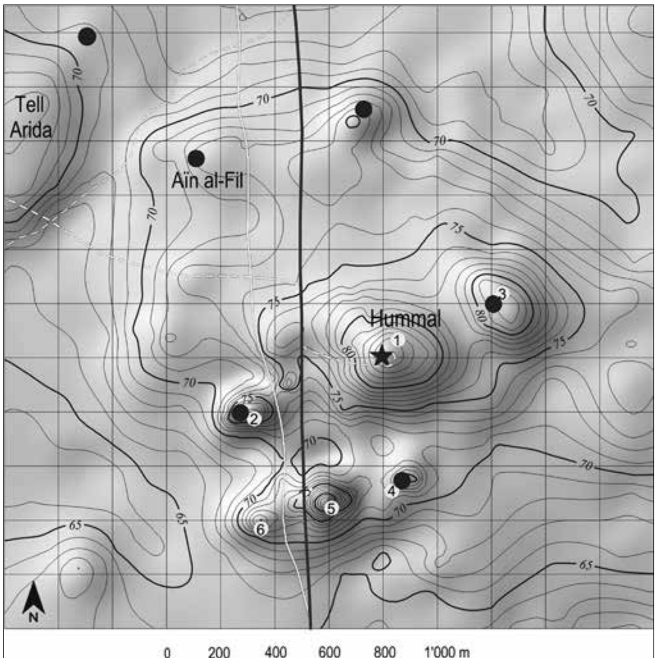

Figure 2 - Localisation of Hummal in the region of El Kowm: 1 Hummal, 2 Aïn Beni Ali, 3 Athman Hautman, 4 Bir Fransiin, 5 Tell Abu Saleh, 6 Tell Schnou, 7 Aïn Al Fil. (illustration R. Jagher).

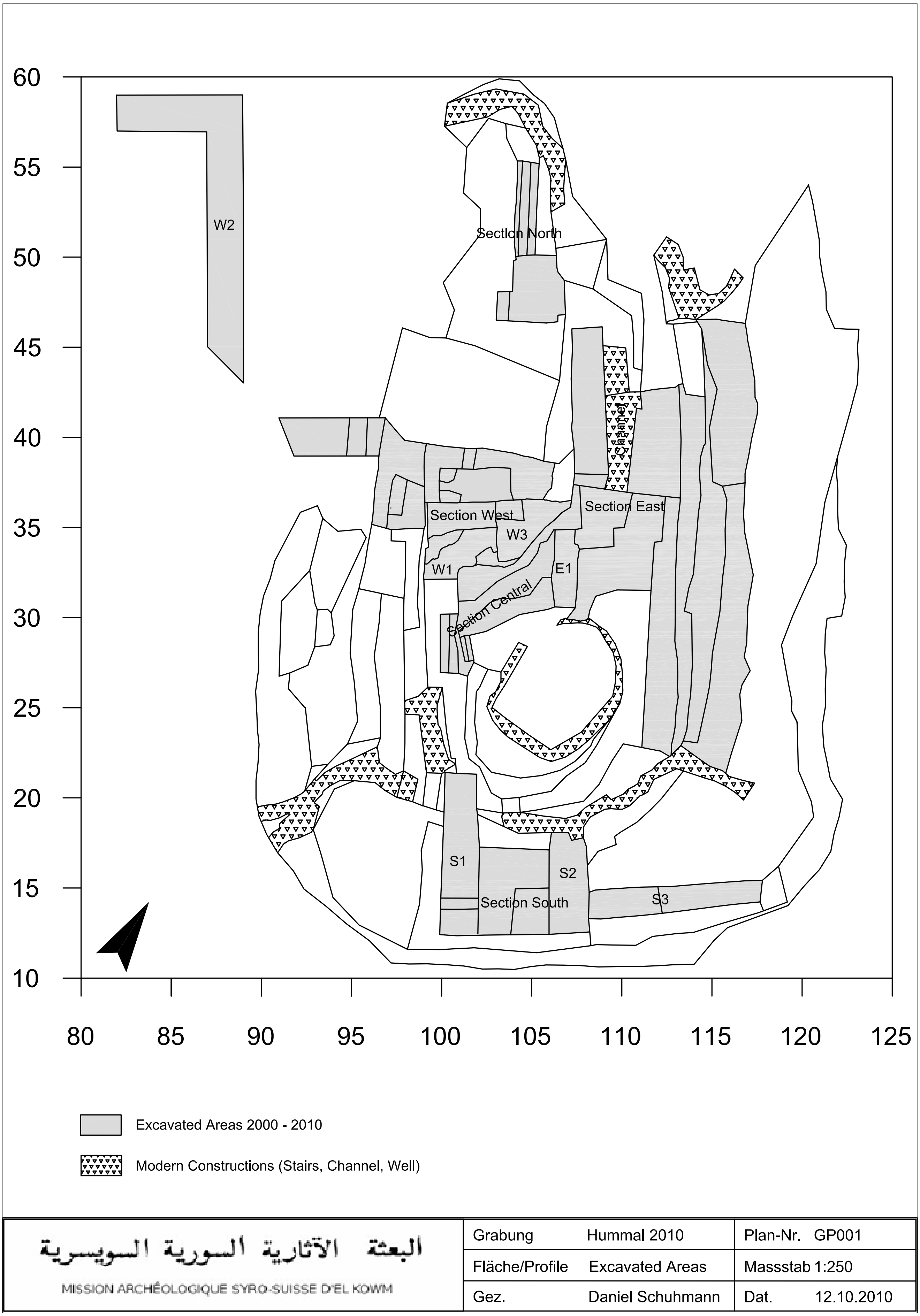

Figure 3 - General plan of the excavation (map D. Schuhmann).

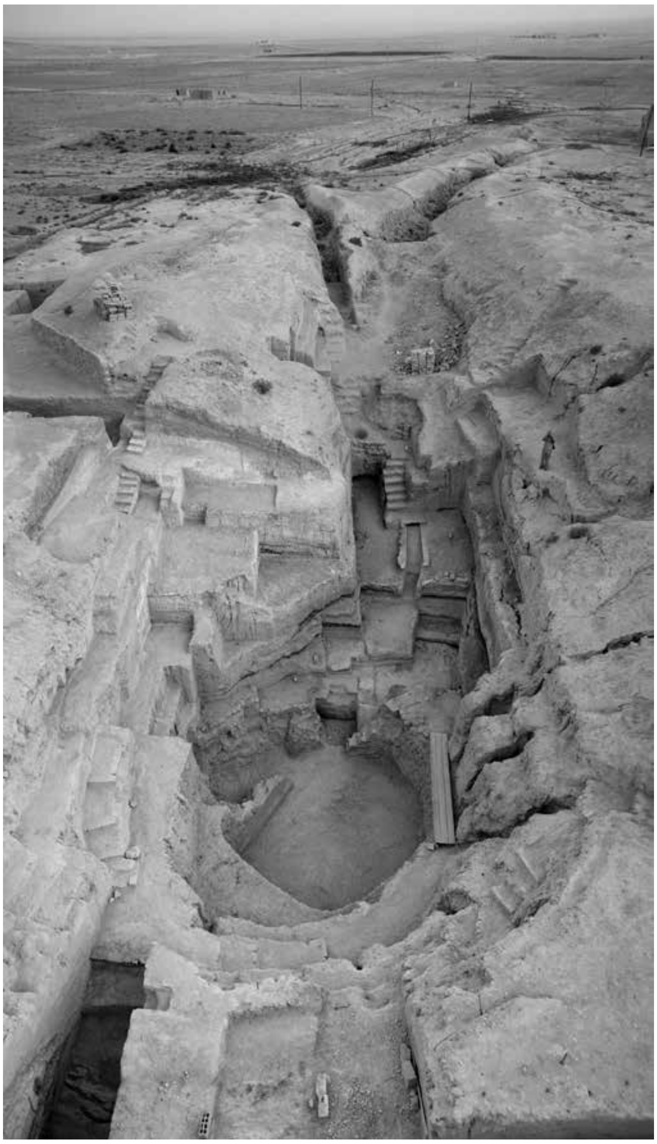

Figure 4 - General view of the site of Hummal looking north (photo A. Sanson).

von Falkenstein responsible for the middle part, and Dorota Wojtczak for the Hummalian sector. At this time it was deemed necessary to enlarge the excavation surface around the spring area in order to extend the excavations deeper.

Presentation of the site and general stratigraphy

The deposits in Hummal actually derive from two quite different, sedimentary processes (fig. 5). An in-situ consistent sedimentary series of lacustrine carbonates, clayey deposits and soil formation processes extends over 15 meters, preserving tens of archaeological levels ranging from Holocene to Lower Pleistocene, and providing evidence for hominid presence in the area over one million years at least around the spring-pond of Hummal. These levels have been integrated into large cultural complexes or units, identified by capital letters.

A central sink hole which contains detritic sand deposits accumulated along with disordered, non-stratified scree derived from massive deposits, colluvia and collapsed strata from the eroded margins of the spring well. We note the presence of at least, six detritic sequences containing a great number of Hummalian and Mousterian artifacts. The phases of erosion responsible for the massive deposits took place mainly during Middle Paleolithic times.

A simplified stratigraphy of in-situ units

Unit A. Layer 1: historical Holocene sediments beginning in Roman Times and extending to the present; layer 2: pre- and proto-historical sediments; layer 3: colluvial sediments from the beginning of the Holocene period, cutting Upper Paleolithic and Late Middle Paleolithic deposits in the Western and Northern sections.

Unit B. Layer 4: Late Upper Pleistocene sediments from an Early Upper Paleolithic (Levantine Aurignacian or Ahmarian) in the Southern section.

Unit C. Layers 5a to 5h: Upper Pleistocene sediments from a Late Middle Paleolithic (The Mousterian sequence, which is roughly four meters thick, is described by Hauck (2011).

Unit D. Layers 6 and 7: Late Middle Pleistocene sediments from an Early Middle Paleolithic (Hummalian) sequence discussed by Wojtczak (2011).

Unit E. Layers 8 to 12: Upper Middle Pleistocene sediments with the Yabrudian sequence.

Unit F. Layers 13 and 14: Lower Middle Pleistocene sediments encompassing a Lower Core and Flake Paleolithic culture with extremely scarce handaxes. We provisionally termed this industry Tayacian or Acheuleo-Tayacian, owing to analogies with the non-standardized Tabun G flake industry identified by Dorothy Garrod.

Unit G. Layers 15 to 23: Lower Pleistocene sediments comprising an Archaic Paleolithic with pebble-tools relating to an Oldowan-like Core and Flake facies. To date, excavations have not reached the bedrock.

Stratigraphy in the sector of the sink hole or doline

Series 1 & 2: αh lower sands, which include both sterile deposits (series 1) and deposits containing a large number of typical Hummalian artifacts (series 2). The deposits are obliquely stratified and result from the collapse of sand accumulations of which we can find substantial traces at the base of black clay layers 7 and 10. We are thus dealing with two successive sandy deposits. The sands below layer 10, belonging to the Yabrudian sequence, are still poorly known, while those from the Hummalian layer 7 have been found in the eastern sector where they appear in a small, typical dune-like formation.

Series 3: scree of blocks, 15 to 30 cm large, of limestone or water-polished and eroded travertine fragments divides the Hummalian sediments.

Series 4: accumulation of rust-coloured conglomerate, with small pebbles and limestone gravels, containing a combination

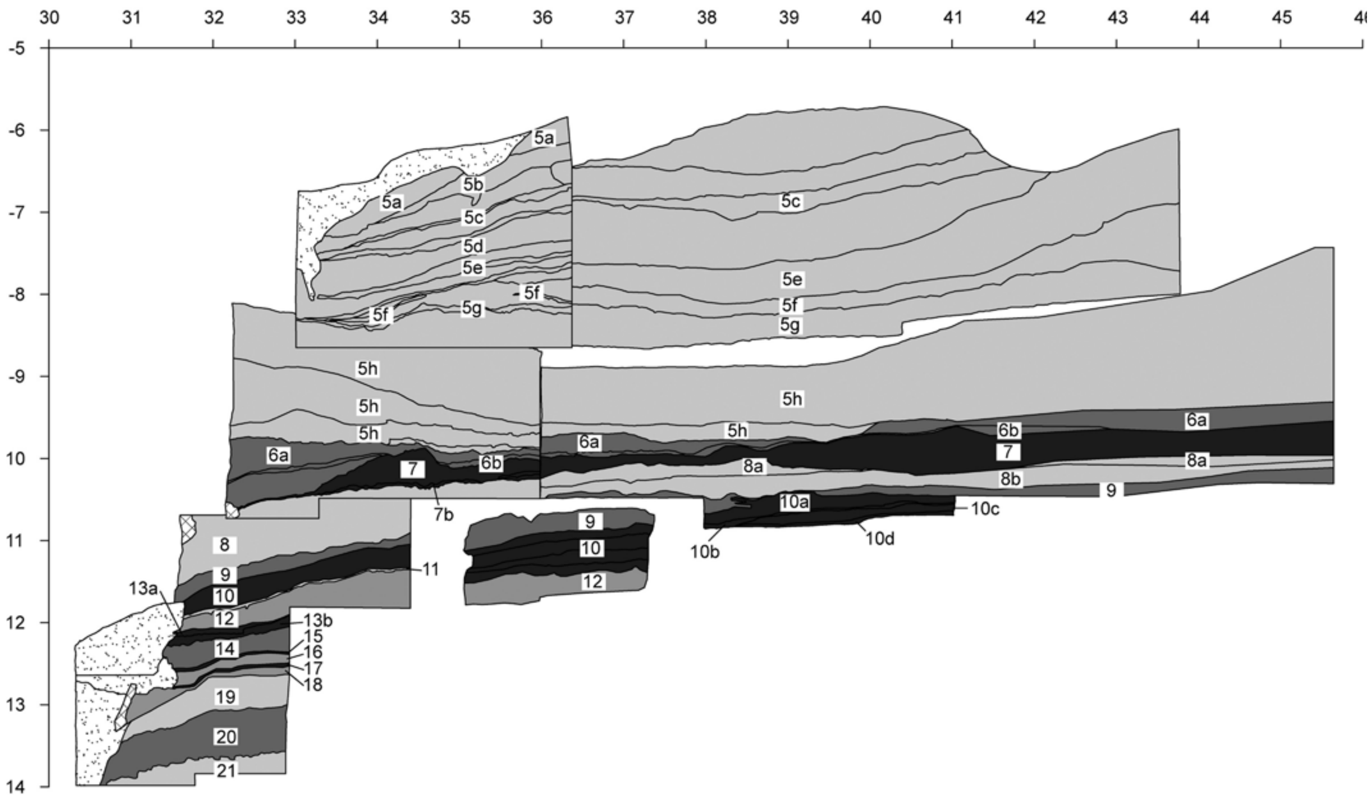

Figure 5 - General stratigraphy of Hummal (illustration D. Schuhmann).

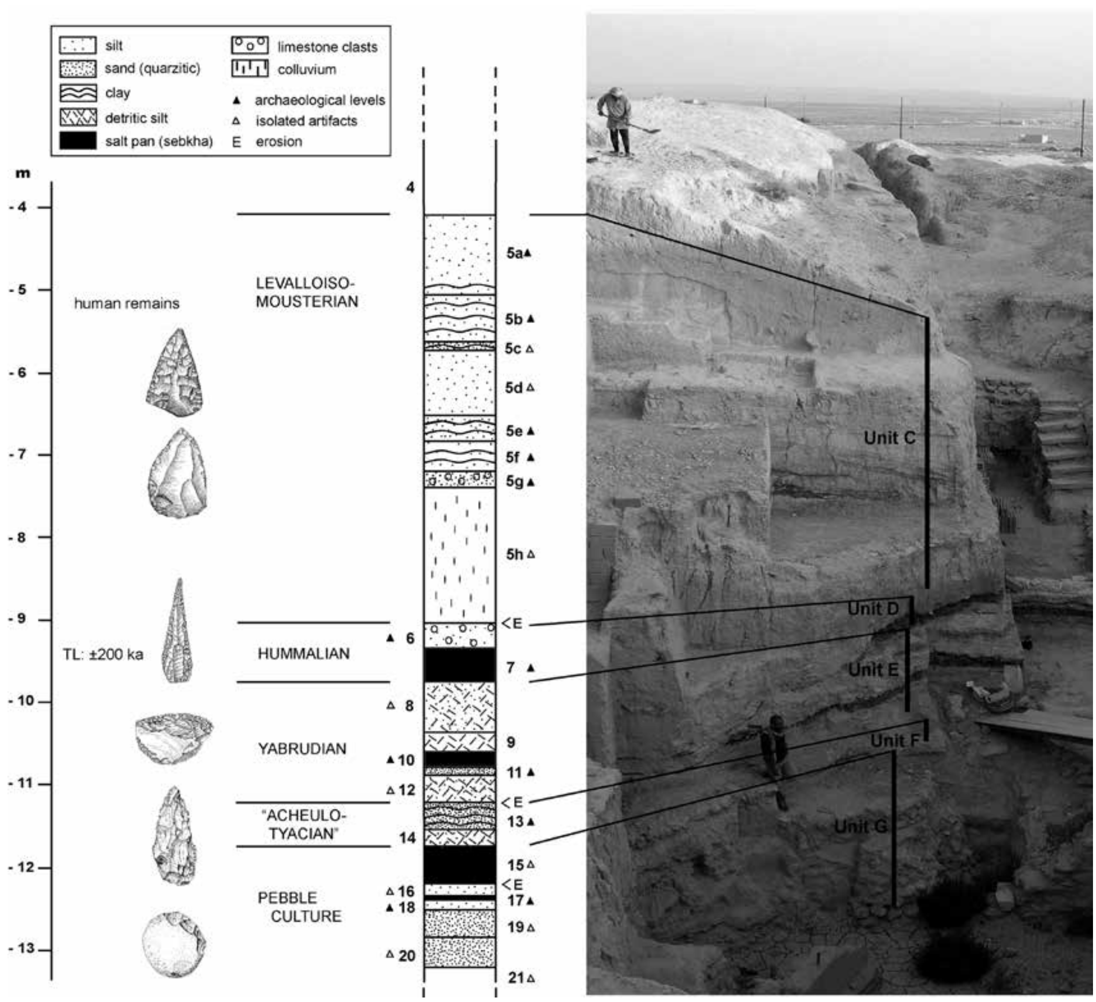

Figure 6 - Archaeological record (photo J.-M. Le Tensorer, drawing modified after Th. Hauck).

of Hummalian and Yabrudian industries which shows that erosion affected older levels still preserved at that time.

Series 5: massive collapse of big travertine blocks as large as one metre. Hummalian elements of the latest phase of layer 6 are found within this deposit. It corresponds to the breakdown of layer 6bT.

Series 6: αm upper or Mousterian sands; sub-horizontally stratified deposits yielding an industry with Levallois débitage. They might come from several sandy deposits of which we find traces at the bottom of layer 5g in particular.

These sandy detritic series gully and truncate all the layers lying below the Hummalian level 6. We may surmise that, at the beginning of the Mousterian period, a major collapse of the central doline took place, causing sand and scree to fill in the newly-formed depression.

Observations on the genesis of the deposits

In Hummal, the geological formations result from a significant accumulation of limnic, aeolian and travertine deposits around the vents of the artesian well where the sediments were trapped. The water hole, like others around it, must have been an important ecological feature in the steppe environment, attracting animals and, following on their trail, humans. Hominids visited and settled in this area over long periods, probably more than one million years, leaving evidence of their successive occupations in an extraordinary long archaeological record (fig. 6).

The site formation processes at Hummal stem from its geological structure: an artesian spring with numerous small pools of emergent groundwater (Ismail-Meyer 2009). A ring of vegetation grew on the banks of the pond and a spring mound developed by the accumulation of sediments and carbonate precipitates. Most of the deposits consist of micritic loam, directly precipitated in water. Sedimentological and micromorphological analyses indicate that the sediments accumulated both during phases of high water levels and also during dry periods. As the water level decreased, the margins of the pond were subject to erosion. Less plant cover meant more sand blown away in a region where wind is a constant erosional agent. The scanty vegetation left around the spring and the depression of the dried pond could still act as a trap for sediments, however. Large deposits of aeolian sediments are present, but, due to development of the sinkhole during the Upper Pleistocene, there were displaced, so that many cubic meters of well-sorted sand accumulated in the centre of the doline.

Some parts of the deposits show also strong post-depositional alteration. Early diagenesis is affected by processes such as dissolution and precipitation of minerals. Due to carbonic processes, pH values above 9 led to the dissolution of silica and, consequently to the formation of new quartz minerals in some parts of the stratigraphy. On a macroscopic scale flint artifacts from certain parts of the sequence at Hummal are covered with a highly glossy coating, a result of SiO2 precipitation (Masson 1982). Artifacts with this coating show an extremely shiny and smooth surfaces. The same applies to grains of quartz sand whenever they are patina-coated. This phenomenon is mainly found in layers rich in quartz sands, in a humid environment with substantial sediment cover.

Holocene (Unit A)

During the Holocene (Layers 1 to 3), the spring was not really active. Due to deflation, fine aeolian quartzitic silts and gypsum sands covered the former Pleistocene topography of the site. These sediments show strong bioturbation, including root traces or dessication cracks coated of iron and manganese oxides. Lightly developed soils occur in layer 2. In stratigraphic terms, several levels are easily identified, but their archaeological content is very poor, limited to a few ceramic shards pointing to a period from Bronze Age to Roman times. A few Neolithic or even Epipaleolithic stone artifacts were also found, but not in stratigraphic context.

Late Upper Pleistocene (Unit B)

An erosive discontinuity clearly divides the Holocene and Pleistocene levels. An Upper Paleolithic occupation (Levantine Aurignacian or Ahmarian?) is embedded in a colluvial formation (layer 4) which truncates the Mousterian levels.

Upper Pleistocene (Unit C)

The Mousterian complex represents one of the richest sets of archaeological occupations in Hummal (Hauck 2011). It is found at least in 8 successive sediment complexes (5a to 5h), comprising 39 archaeological levels forming a sequence approximately 4 m deep. In the Mousterian sequence, limnic carbonatic silts (deposited below water) alternate with detritic carbonates, sand or pedo-sediments representing dry periods. The lithic and faunal remains are exceptionally well preserved except for post-depositional weathering on the margins of the spring area.

Late Middle Pleistocene (Unit D)

The Hummalian sequence is embedded in the loamy complex of the layers 6a-6c and the clayey layer 7. Due to erosional processes, the thickness of these levels is extremely variable (from about 0.40 to 1.3 m). In the middle of Unit D, layer 6b contains a remarkably large quantity of flint artifacts (Wojtczak 2011). Nowhere thicker than 14 cm, this level eroded the underlying layer 6c and, at some places, reached the black clayey deposit 7. These blackish brownish or greenish laminated clay layers presumably relate to an environmental change to marshy conditions (Le Tensorer *et al.* 2007; Ismail-Meyer 2009). Rich in organic components, they contain a few lithic artifacts, bones and carnivore coprolites.

Upper Middle Pleistocene (Unit E)

The Yabrudian sequence occurs within in a deposit roughly 1.50 m thick. It comprises 5 layers which ultimately divide into different archaeological levels and correspond to several climatic cycles with evidence of successive alternation of arid and desertic phases with humid and cooler periods (Meyer 2000; Le Tensorer 2005):

Layer 8 is a thick deposit (up to 80 cm) of light-coloured, detritic, carbonate silts preserving, in the upper part, a Yabrudian level (8a) roughly 10 cm thick. In this layer, evidences of the first signs of a slight pedogenesis appear. This level is poor enough as regards lithic material but rich in faunal remains, especially camelids and equids. The remaining sediments in this Layer 8 are sterile and were deposited during dry, warm and stable climatic conditions in a confined swamp environment. Humans seem to have left the area during this long arid period.

Layer 9, 30 cm thick and similar to the previous one, relates to four lacustrine phases of carbonate formation in a cool and humid environment, interrupted by phases of ground-water level decrease resulting in several episodes of pedogenesis (Meyer 2000). This layer provides evidence of successive alternations of arid and humid climatic conditions. The layer, subject to a severe climatic discontinuity, yielded a few Yabrudian artifacts, mainly at its base.

Layer 10, a black clay level similar to layer 7 was probably deposited during a period of confined swamp environment under intermittent sebkha-like conditions. It is finely stratified and shows alternating greenish or blackish bands containing charcoal fragments and organic fragments of plant remains accumulated during a humid period. The thickness of the layer is variable and fluctuates from 30 to a few centimetres in the Western section where it is deeply eroded by layer 9. Bones of equids and camelids are present in the upper third of the layer. The base of the black layer shows a clear discontinuity with the underlying stratum 11 into which it cuts. Layer 10 encompasses two Yabrudian levels at least.

Layer 11 consists of an orange sandy loam level, subdivided into an aeolian sand level (11aS), a level with detritic granules (11a) and at the base, a light clay deposit (11b). It relates to a typical desertification cycle, starting with an evaporite clay deposit, followed by an erosive event and ending in a drastic arid phase with no plant cover remaining. Level 11b corresponds to a humid phase, comprising large bones and some typical Yabrudian side-scrapers. The whole sequence underwent a light soil development.

Layer 12 is a yellow plastic clay level, silty in places, travertinized in others. It is 20 to 30 cm thick, almost sterile, except at the base where a thin level yielded a few artifacts, not very characteristic but possibly Yabrudian. It relates to at least two cycles of lacustrine deposits in a humid and cool environment.

Middle Pleistocene ? (Unit F)

The Acheuleo-Tayacian Industry occurs only in Layer 13 which comprises 3 detritic levels. The upper one, 13a, is a thin, bleached layer of small granules. Its thickness varies from 1 to 6 cm. The middle one, 13b, is a thin, sterile, dislocated, pale clayey loam eroding the underlying layer 13c. This last level, about 15 to 40 cm thick, is made of gravel and small pebbles embedded in a loam with blackish traces of manganese and iron oxides. The lower level is rich in flint artifacts, which are extensively abraded.

Layer 14 About 10 – 30 cm thick, consists of fine grained carbonate silts with a minor detritic component. So far no archaeological material has been discovered in this layer.

Lower Pleistocene (Unit G)

Layer 15 consists of blackish clay and is 10 to 15 cm thick. Only few stone artefacts were found in this layer, the faunal remains are more numerous but heavily crushed and broken.

The underlying Layer 16, about 30 cm thick, is a hard, carbonated silt. The density of finds is not very high and a proper archaeological level is not recognizable.

Layer 17 is about 10 to 15 cm thick and again consists of black clay. It is very similar to Layer 15 but abounds in finds. Numerous bones are preserved but crushed and fragmented. This layer is very well-provided with microfaunal remains.

Layer 18 includes the richest levels of the Early Palaeolithic sequence. It consists of a thick (25 cm) sandy carbonated silt. Two archaeological levels are present; one is situated on the top of the layer, the other is embedded in the middle of the layer. Archaeological finds are very abundant, markedly in the upper level, including parts of animal skeletons that are sometimes anatomically connected.

The deepest archaeological level lies in Layer 19 under 1m of sterile and compact carbonated loam. This level was discovered in 2008. Several lithic artefacts and well-preserved bones, especially of a new species of a small camelid, were unearthed.

Underneath, Layers 20 and 23 are compact sandy and fine detritic series with very rare flints.

Observations on the archaeological assemblages

Upper Paleolithic (Unit B)

In the Southern section, the Upper Paleolithic assemblage represents only 319 artifacts (fig. 7). The knapping strategy focuses mainly on the production of blades and bladelets; flakes amount to 13% of the artifacts while very small flakes and debris make up a third of the débitage. Retouched pieces (fig. 9) make up 10% of the assemblage. They are mostly end-scrapers (almost half of the tools with retouch), a few dihedral or on-break burins (about 20% of the retouched pieces); the remaining tools include retouched blades (among which one of them is a typical Aurignac blade), notched pieces, and denticulates.

Late Middle Paleolithic: Mousterian sequence (Unit C)

Technological observations support a Mousterian sequence divided into three parts: the upper, middle and lower industries. This partition reflects the association of several assemblages into major techno-typological traditions (Hauck 2011). The outstanding discovery in this Mousterian period consists of the remains of a giant camel which coexisted with Camelus dromedarius. The animal measured over 3 m at shoulder-height. Roughly speaking, it was 1.5 to 1.75 times bigger than the mo-

Blades	71	22%
Bladelets	52	16%
Burin spalls	8	3%
Flakes	43	13%
Debris	112	35%
Retouched tools	33	10%
Total	**319**	**100%**

Figure 7 - Layer 4, Upper Paleolithic, inventory of artifacts.

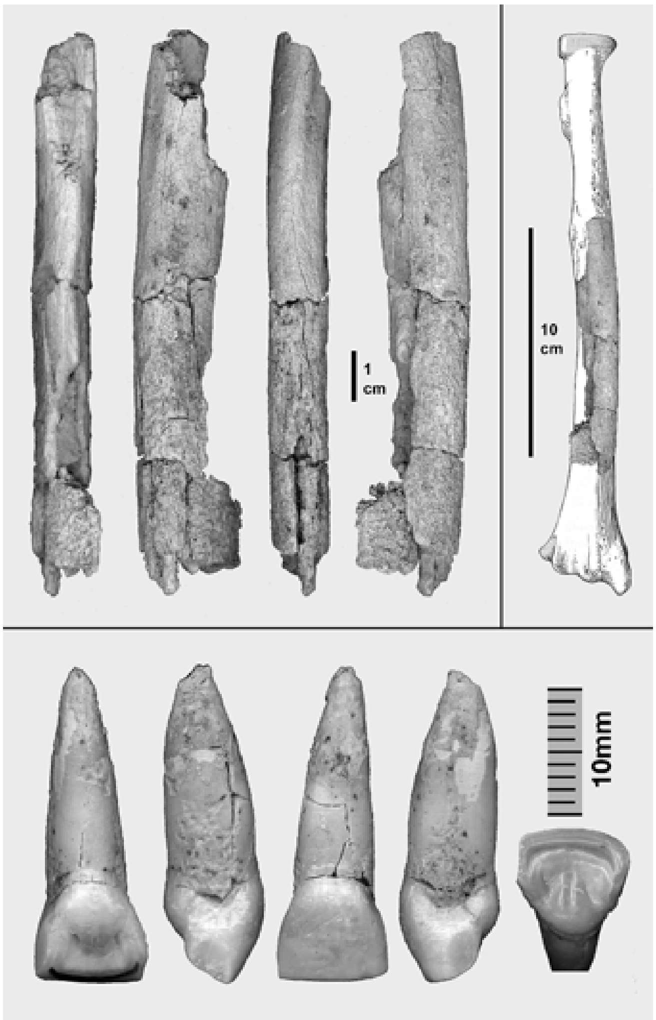

Figure 8 - Human remains from the Mousterian levels, mesial fragment of a radius (top) and an medial upper incisor (bottom), photo P. Schmid.

dern camel. We tentatively called it "*Camelus moreli*" after our late paleontologist team-member, Philippe Morel.

In the same layer, in addition to the large assemblages of flint artifacts, we unearthed two fragmentary human bones. A medial left upper incisor, designated W1374 (fig. 8), was found in level 5a4. The combination of traits favors a determination of the tooth as belonging to the Neandertal group (Schmid & Le Tensorer 2009). However, the root length (15.3 mm) is below the range observed in Neandertals. Other measurements, such as the labio-lingual diameter, seem to cluster the tooth with the latter but compared to the specimens from Qafzeh, we cannot exclude a certain resemblance to the oldest anatomically modern man. At the moment, the scanty evidence does not allow a clear determination of the species, Neandertal or Anatomically Modern Human. The second element is a fragmentary but robust rather straight radial diaphysis discovered in 2003. The total length of the specimen, designated ZZ33C, is 109 mm. Despite variation in radial diaphyseal proportions in the context of the available human remains from the later Pleistocene of western Eurasia, the Hummal radius has proportions that align it predominantly, by no means exclusively, with early modern human remains.

We have very few dates at our disposal so far (more dating is in progress) so we cannot present a complete chronological framework for the Mousterian sequence yet. Preliminary TL-dates (Richter *et al.* 2011) for sediments of layer 5g in the lower part gave an age around 100 ka. Even though better chronological control is clearly needed, the deep Mousterian sequence at Humml is of great importance, making Hummal a key site for reconstructing human presence in and exploitation of arid environments during Middle Paleolithic times.

Early Middle Paleolithic: Hummalian sequence (Unit D)

When we mention "Early Middle Paleolithic" in this paper we refer to the assemblages found between the Acheulian and Mousterian complexes, i.e. Yabrudian and Hummalian industries. The former is part of a group that also includes the Acheuleo-Yabrudian and Amudian industries (Barkai & Gopher 2011), which Jelinek (1990) grouped into the so-called Mugharan tradition. Although Yabrudian assemblages may still include a small number of bifaces, in our view they are nevertheless to be completely separated from the Acheulian. They reflect a fundamental shift toward systematic production of flakes as blanks for retouched tools, something uncharacteristic of the preceding Acheulian (Muhesen & Jagher 2011; Jagher 2011).

The second phase of the Early Middle Paleolithic at Hummal is characterized by another major technological change: the production of elongated blanks using a distinctive and specialized core reduction method. The Hummalian industry (fig. 10) is subdivided into stratified geological layers which are intercalated clearly between the Yabrudian and Mousterian sequences (Le Tensorer 2004). In the heart of the doline, the massive sand deposit includes a large number of Hummalian artifacts. Archaeologically speaking, these artifacts are not in situ but correspond to a homogeneous assemblage, while stratigraphic observations show that these Hummalian sands are in place, geologically speaking.

A thorough and detailed study of 10 000 lithic artifacts, including round 7000 items found in the stratified layers 6 and 7, was carried out by Dorota Wojtczak (2011). The technological studies demonstrate the existence of a special typical laminar system of débitage, very different from a Levallois knapping technique, and yet Levallois products occur in the same assemblages. Wojtczak argues that there are two concomitant reduction strategies. The dating the Hummalian gave an age around 200 ka (Richter *et al.* 2011). This makes it roughly contempora-

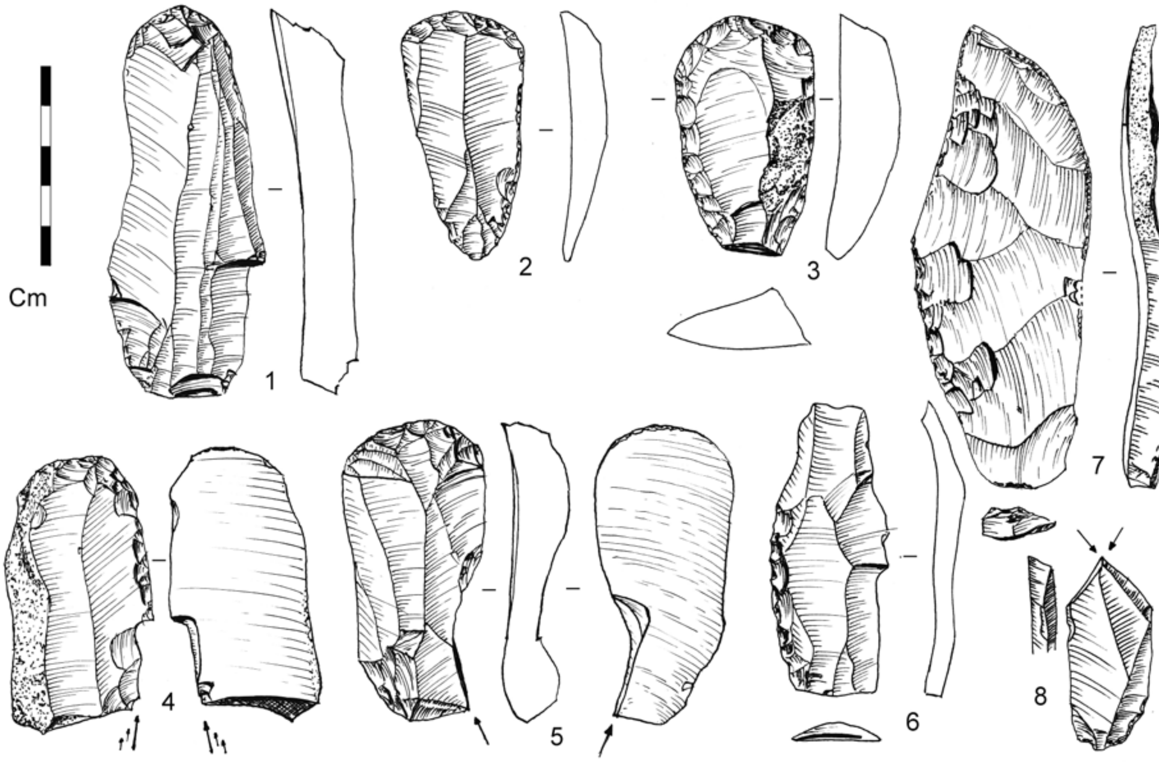

Figure 9 - Upper Paleolithic industry, selected artifacts. 1-3: end scrapers; 4-5: end scraper-burin; 6-7: retouched pieces; 8: dihedral burin (drawing J.-M. Le Tensorer).

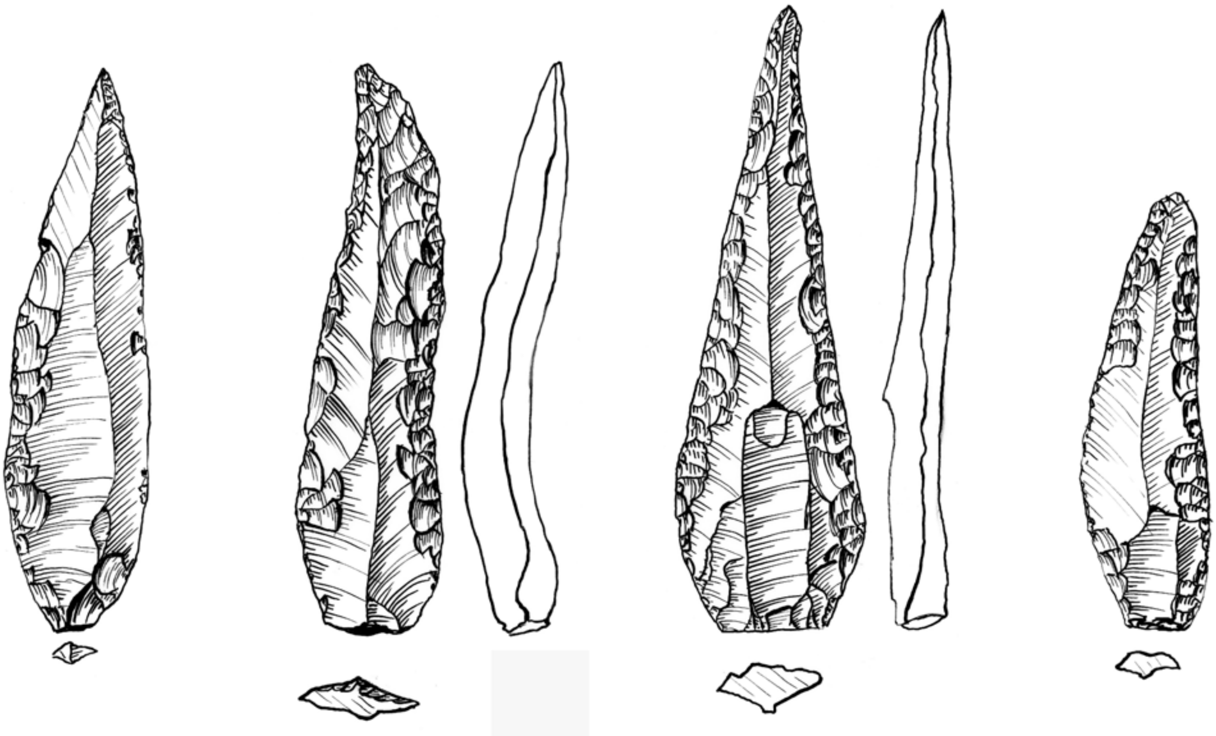

Figure 10 - Hummalian industry (drawing J.-M. Le Tensorer).

neous with so-called Tabun-D type Mousterian in other parts of the Near East.

The Yabrudian sequence (Unit E)

In Hummal, the Yabrudian sequence develops over a very long span of time, under changing climatic conditions which brought about the formation of diverse sedimentary facies. Most of the Yabrudian occupations correspond with humid, cool (even cold) times. During arid warm periods, humans seem to have abandoned the region. Layer 8 is poor enough as regards lithic material but rich in faunal remains. An entire lion mandible was discovered in this layer, which is especially rich in camelids and equids. Several typical Yabrudian side-scrapers and limaces were found in this layer Layer 10 contains two archaeological levels: an upper level of typical Yabrudian with characteristic heavily retouched side-scrapers and a lower one, in which we found in 2001 a distal fragment of biface, nicely retouched and Acheulian-like in the shaping, together with two biface trimming flakes. However, we cannot offer a final interpretation until a larger area has been excavated: as noted other Yabrudian assemblages do contain handaxes. However, at Hummal, this single Acheulian-like fragment from the base of layer 10 is the only bifacial artefact associated with typical Yabrudian scrapers.

As mentioned above, a rich Yabrudian industry was found among travertine blocks in a secondary position at the bottom of the well as it appeared in 1980. Lorraine Copeland and Francis Hours studied a first series comprising 703 artifacts, among which there were 245 retouched tools (Copeland & Hours 1983). Absolutely non-Levallois (IL 0.74) and non-laminar (Ilam 3.53), this assemblage is characterized by a great number of side-scrapers (IR 68.93). Single side-scrapers prevail (38.02%) but déjeté scrapers (10.2%) and transverse scrapers (10.6%) (fig. 11) are plentiful and quite characteristic of this culture. Generally, the side scrapers bear a Quina-like retouch. Completing this inventory were miscellaneous tools, some rare scraper forms, notches and denticulates and a few pointed flakes. Bifacially shaped pieces are also found in these levels (4%). They tend towards strong asymmetry, as in general only one single edge is finely retouched and used. These artifacts may be characterized as either genuine bifaces or large side scrapers with bifacial retouch.

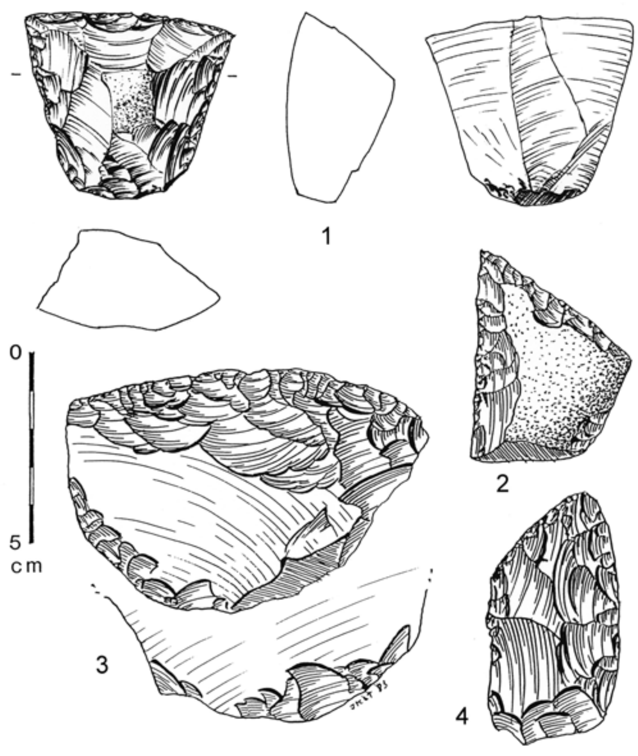

Figure 11 - Yabrudian industry, selected scrapers (drawing J.-M. Le Tensorer).

However, the validity of this series may be question as the artifacts were collected in levels, archaeologically speaking, not in situ; they might have been mixed with other industries. Since 1999 the five in situ Yabrudian layers produced too little lithic material to put forward a study of significant statistical value (Schuhmann 2011).

Nonetheless, we can safely state that, in Hummal, the Yabrudian is an industry characterized by a predominant production of very thick flakes, quite often transverse or déjetés, which were used as blanks for nearly exclusively scaled and Quina-retouched side scrapers. The artifacts are always deeply retouched and resharpened; sequential resharpening of the edges again and again on double side scrapers led to characteristic pointed limace forms (fig. 12).

The Yabrudian industry is quite in keeping with the Lower Quina culture as it is defined in Europe in term of core reduction and typical retouch (Bourguignon 1997; Al Qadi 2008). Over the past decades the question has been raised as to whether the Yabrudian, as a cultural chronological stage, should be placed within the Lower or within the Middle Paleolithic. A. Jelinek (1982, 1990) and others (Goren-Inbar 1995) consider it to belong to Lower Paleolithic. R. Barkai and A. Gopher, based on new findings from Qesem Cave, emphasize the originality of the Yabrudian and Amudian stages and suggest that we should distinguish this "cultural complex between Acheulian and Mousterian as an independent, long, creative and innovative cultural entity reflecting dynamic human behaviour and flexible local adaptations" (Barkai & Gopher 2011). Expressing another point of view, A. Ronen, as he reconsiders the sequence of Tabun, proposes to limit and redefine Jelinek's Mugharan Tradition concept. This notion applies "the proposed 'Mugharan Tradition' is only valid within Garrod's Yabrudian. Contrary to Jelinek's interpretation the terms 'Mugharan' and 'Yabrudian' are synonymous" (Ronen *et al.* 2011). What sustains the use of the term "transitional" for the Yabrudian culture? Is it a Late Lower Paleolithic or an Early Middle Paleolithic?

From our point of view, this amounts to a purely theoretical debate, as we know in Europe how difficult it is to substantiate a conventional distinction between Lower and Middle Paleolithic (Monnier 2006).

Nonetheless, we note the important changes in the Yabrudian lithic industry compared to that of the Acheulian:
- Use of a new core reduction strategy, similar to the European

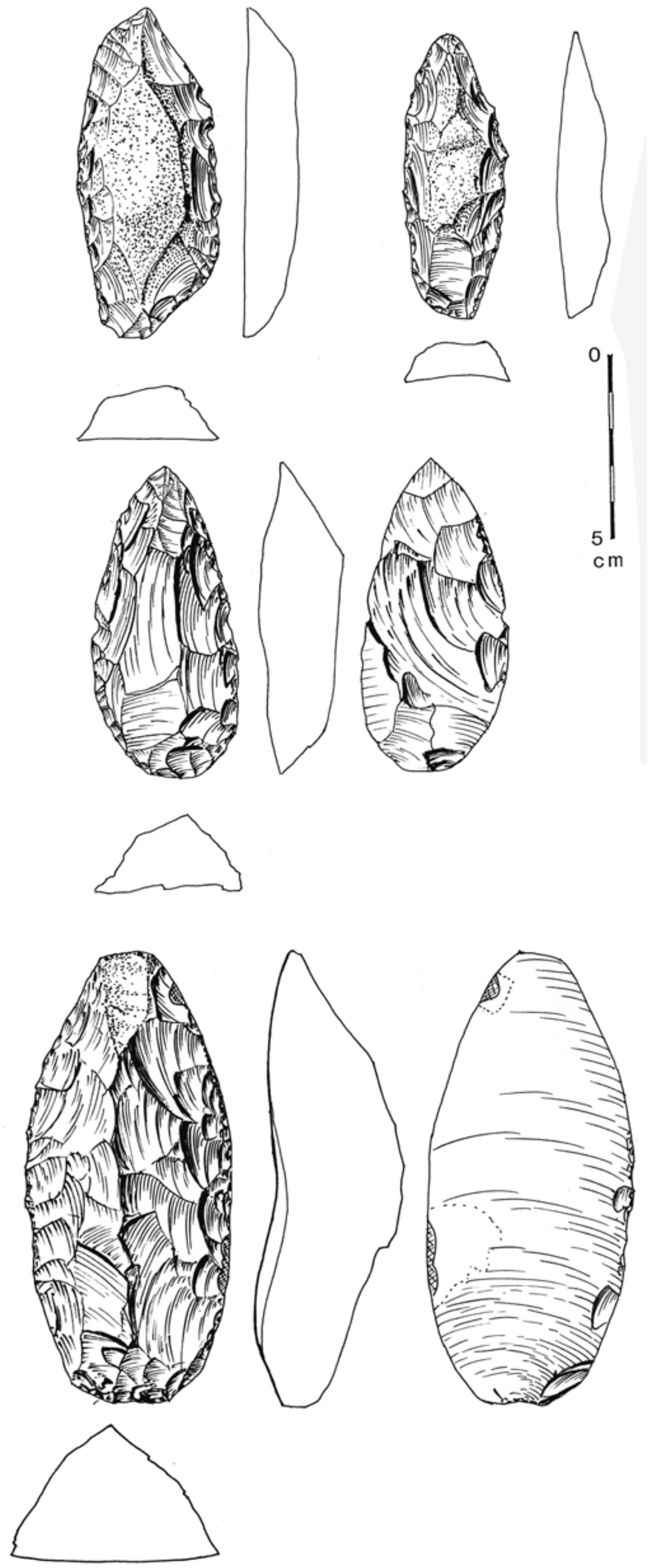

Figure 12 - Yabrudian industry, limaces (drawing J.-M. Le Tensorer).

Quina débitage, in order to produce very thick flakes, including numerous transversal and déjetés blanks.
- Systematic production of side scrapers that subsequently underwent intensive stepped-retouch and repreated resharpening.
- Presence of typical limaces as the result of repeated use and resharpening of scrapers.
- Very little true bifacial shapening. The rare "bifaces" are thick, asymmetric and perhaps used as bifacial scrapers. They also bear the typical Yabrudian (or Quina) stepped retouch.
- On the whole, the Yabrudian shows more diversity in technological procedures and products than the Acheulean.

Pebble-tools	4	0.5%
Polyhedrons	1	0.1%
Cores	13	1.6%
Handaxes	2	0.2%
Cortical flakes	118	14.3%
Flakes	180	21.9%
Debris	131	15.9%
Small debris < 2 cm	324	39.4%
Retouched tools	50	6.1%
Total	**823**	100.0%

Figure 13 - Layer 13, inventory of artifacts.

When we sum up all the distinctive traits which characterize this culture, they clearly separate the Yabrudian and the Acheulian; we would also discard the term Acheuleo-Yabrudian for the Yabrudian in Hummal. In this site, these layers are unquestionably located between Lower Paleolithic context and a typical Middle Paleolithic with blade and Levallois débitages. Levallois technology is non-existent in the Yabrudian assemblages of Hummal. Thus we are led to think that Yabrudian is quite distinctive from Hummalian and Mousterian too. In a previous paper (Le Tensorer *et al.* 2001), we suggested placing the Yabrudian in an Early Middle Paleolithic I phase, the Hummalian in Early Middle Paleolithic II and the Levallois Mousterian in a Late Middle Paleolithic. The dating of the Yabrudian units of Hummal is in progress. The base of the overlying Hummalian complex is tentatively dated around 250 ka.

Lower Paleolithic: "Acheulo-Tayacian"? Sequence (Unit F)

Below the typical Yabrudian levels, a succession of layers yields a distinctive set of assemblages with rather simple débitage and opportunistic cores. The blanks are irregular, thick flakes. Out of 823 lithic artifacts (fig. 13), 78 show use-wear or slight retouch which most of the time forms notches or denticulates. There are also a few side scrapers and pebble-tools. In these levels we discovered two typical handaxes (fig. 14). They are thick and elongated, with traces of knapping using a hard hammerstone . Before the discovery of these bifaces, the industry had been named "Tayacian" with reference to the Tabun G (Garrod & Bate 1937), Umm Qatafa (Neuville 1951) and Yabrud (Solecki 1968) assemblages which show similar features with the industry of layer 13 at Hummal (Copeland 2003; Le Tensorer 2004). Clark Howell even named the Tabun G industry "Tabunian" because he wanted to emphasize the differences with Acheulian. It has to be underlined that, usually, the cultures labelled "Tayacian" in the different sites of the Levant are located at the base of the stratigraphic sequences preceding an "Upper Acheulian" stage. In other words, this suggests that these "Tayacian sequences" are by and large contemporaneous with a Middle Acheulian stage.

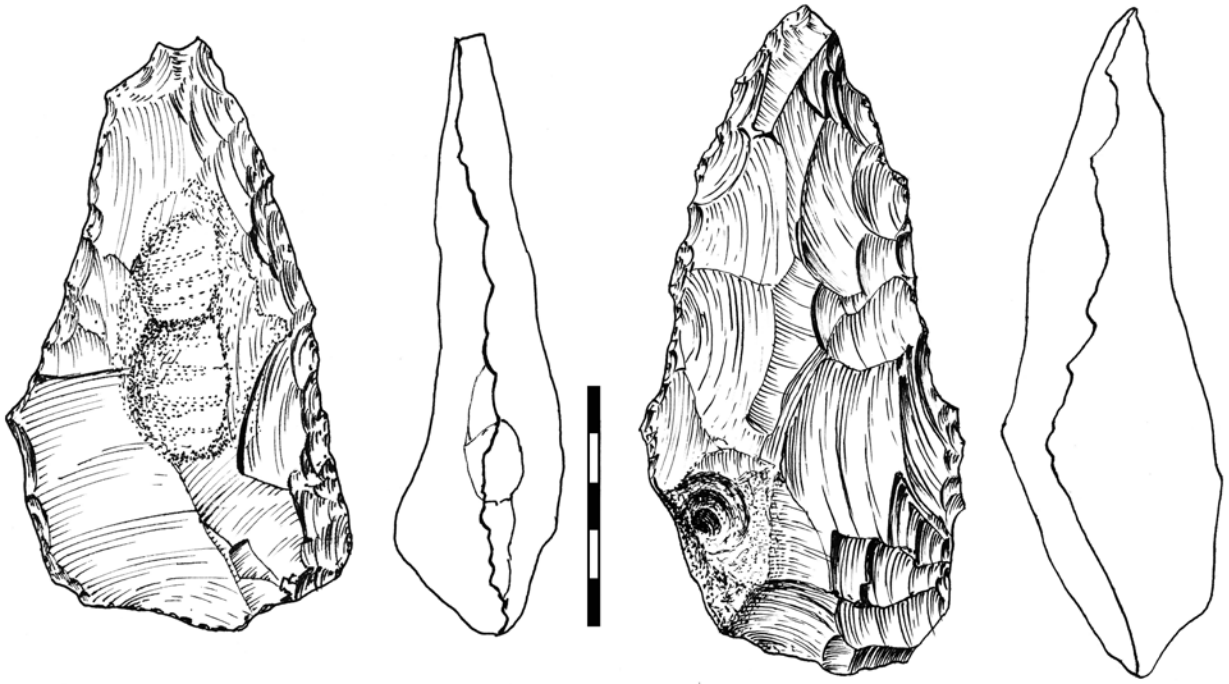

Figure 14 - Handaxes, layer 13 (drawing J.-M. Le Tensorer).

In view of the ambiguities that accumulated through the use of this term, the definition of Tayacian (Copeland 2003) is no longer useful for characterizing an archaeological culture. Nonetheless, the question remains: should we link these assemblages to a non-Acheulian "Core and Flake" culture, or, should they be considered a kind Acheulian assemblage without (or with very few) handaxes? As is typical in the Levant, Acheulian sites in the el Kowm region often yield extraordinary numbers of handaxes: The Middle Acheulean site of Al Meihra, and the Upper Acheulian assemblages of Nadaouiyeh, Juwal B or Qdeir 23 are perfect illustrations (Jagher 2011). In the archaeological layers within unit F at Hummal, bifaces are extremely rare. We could consider these levels with very few handaxes from Hummal as belonging to a different sort of "Acheulian" than those found in Nadaouiyeh or Al Meihra, perhaps a Middle Acheulian facies largely deprived of handaxes. Alternatively, the assemblage of layer 13 in Hummal might represent an independent culture from that of the biface-rich Acheulian. It should be emphasized that, so far in these levels we have never recovered biface trimming flakes, which suggests that the handaxes were not made or maintained in place.

Oldest Paleolithic: Oldowan-like Core and Flake industries (unit G)

The base of the sequence of Hummal, layers 15 to 21, contains Oldowan-like assemblages (Wegmüller 2008, 2011). The lithic industry can be characterized by non-modified flakes with occasional traces of use but seldom if ever intentional retouch. These flakes occur with pebble-tools: choppers, chopping-tools, polyhedrons, spheroids and other core-like artifacts (fig. 15). In a broad sense, this assemblage is typical of an archaic Paleolithic, the débitage of which corresponds to "Mode I Core and Flake Industries". From a techno-typological point of view, this industry fits quite well in the so-called Oldowan facies. It shows also remarkable similarities with the oldest assemblages at Ubeidiya, considered as an Ancient Acheulian (Bar-Yosef & Goren-Inbar 1993). This similarity again raises questions about cultural definitions of techno-typological assemblages and their relationship to human biological groups. We usually separate two complexes: Acheulian and "Core and Flake Industries", but are they really two different "tool traditions"? An Oldowan-like industry immediately becomes "Acheulian" as soon as a bifacial artifact or two is found (Muhesen & Jagher 2011).

As we have no absolute dating for the oldest levels at Hummal so far, we will remain cautious in assigning a chronological time span for these layers. From a chronologic point of view, the Oldowan-like levels of Hummal occur before the Matuyama-Brunhes paleomagnetic reversal, according to the preliminary findings from analyses being carried out by J.J. Villalain in Burgos. The accurate dating of the lowest sequence of Hummal is in progress. If we take into account stratigraphic and techno-typological observations, we assume that the Oldowan-like levels of the site should be older than one million years at least. These levels would be the oldest traces of human presence ever found in Syria.

Concluding Observations

Thanks to an exceptional archaeological sequence--preserving 60 or more archaeological levels from Archaic to Upper Paleolithic--Hummal has become a key sequence for the Paleolithic of the Middle East. It is among the longest Pleistocene stratigraphies of the Levant, comparable only with Tabun with which we can draw a temporary parallel. Eventually, the oncoming excavation program should help fill a few gaps and explain or interpret existing features. Correlations between the different sectors in the stratigraphy still remain to be clarified. The abso-

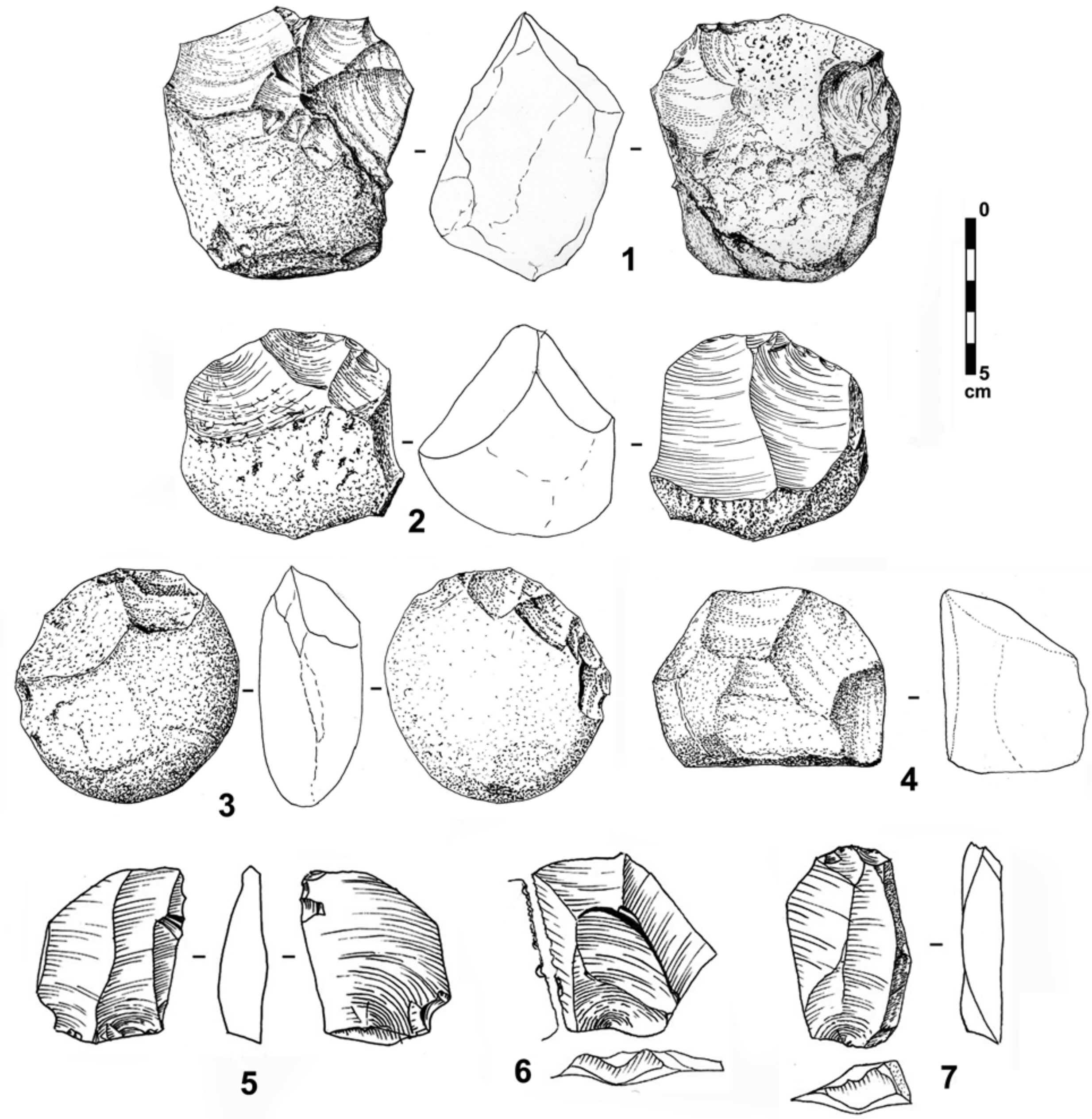

Figure 15 - Hummal Core and Flake industry, layer 18 (drawing J.-M. Le Tensorer).

lute chronology has to be completed, and although the natural radioactivity in the sediments makes it difficult to date some layers, efforts to apply a range of methods are ongoing.

From a cultural perspective, the sequence of Hummal should allow a better understanding of some major questions about the relationships between Acheulian and Core and Flake Industries and the transition from Lower to Middle Paleolithic. The enlargement of the excavation area should also provide new data on site function and help answer questions about the behavioural patterns of Pleistocene hominids.

Finally, the site of Hummal shows that a very deep cultural sequences may be encountered in open-air sites and that the steppe regions between the Mediterranean coast and the Euphrates river were also favourable territories for long-lasting human settlements, facts that should be taken into account in the currents debate about the alternate routes of human dispersal a different times during the Pleistocene.

Acknowledgements

The Research Project of Hummal is a Syro-Swiss excavation supported by her Excellency Mrs. Dr. Najah Al Attar, vice-president of the Syrian Arab Republic, the Directorate General of Antiquities and Museums of Syria, the Swiss Department of Foreign Affairs and the University of Basel. Thanks to the grants from the Swiss National Science Foundation, the Tell Arida Foundation, the Freiwillige Akademische Gesellschaft Basel and private sponsors we have been able to carry out our research in the region of El Kowm. We are deeply grateful for their help.

This research is a truly collaborative work, and could not have been carried out without the efforts of our team. A special thank to our collaborators: since 1997, Dorota Wojtczak has been digging the Hummalian sector, while Kristin Ismail-Meyer was in charge of micromorphological analyses and Josette Renault-Miskovsky of palynological studies. Since 2003, Thomas Hauck has been directing the diggings in the Mousterian section and since 2007 Fabio Wegmüller joined in to devote himself to the specific study of the oldest levels of the so-called Oldowan-like layers, while Daniel Schuhmann was entrusted with the virtual spatial reconstruction of the site in order to help establish sound and reliable stratigraphic correlations. Hominid and faunistic studies are under Peter Schmid's direction with the help of Hani El Suede; geological, sedimentological and micromorphological studies are conducted by Marie-Agnès Courty and Anne-Sophie Martineau; Daniela Hager in 2006 started analyses on traces of fire in Hummal. Daniel Richter and Juan José Villalain are in charge of the dating of the site. We are extremely grateful for the useful comments and discussions we had with Steven L. Kuhn, and thank him for his efficient help as a reviewer of our work.

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CHRONOMETRIC AGE ESTIMATES FOR THE SITE OF HUMMAL (EL KOWM, SYRIA)

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Introduction

Thermoluminescence (TL) and Optically Stimulated (OSL) ages for the sequence of Hummal (El Kowm, Syria) are presented. Because of disequilibria in the U-decay chain the external γ-dose rates cannot be assumed as constant over burial time and have to be modelled. The resulting model ages are significantly different for the Mousterian layer '5g' and the Hummalian layer '6b East'. While the age estimates for layer '6b East' are rejected as unreliable, a provisional age for the Mousterian occupation of 100 ka is given. The TL age estimates on heated flint from another Hummalian layer (α-h base) do not suffer from significantly different model ages and compare favourably with an age of 200 ka with other chronometric ages for similar blade-rich assemblages in the Levant. The OSL age for sediment sample layer '15b', located lower in the middle of the sequence at Hummal, is apparently underestimating the age, when the other results as well as the chronostratigraphical sequence is taken into consideration. The post-depositional formation of authigenic quartz crystals as well as secondary silica coatings are suggested as a likely source for the underestimation, and the OSL age result is therefore rejected for layer '15b'.

Presentation of the Hummal site

The spring site of Hummal is located in Central Syria, near the village of El Kowm between the Euphrates basin and the desert steppe. The site of Hummal is a prominent mound at an artesian spring which was responsible for piling up of sediments during the Quaternary. The impressive 20 m stratigraphy comprises more than 25 geological units preserving a large number of archaeological levels. It covers a long period of time ranging from the Lower Palaeolithic (Oldowan) to the Upper Palaeolithic over more than one million years. The mound is the eponymous site for the technocomplex of the Hummalian.

As of yet, the stratigraphy is the longest and most important cultural sequence known in an arid landscape in the Middle East. It is therefore especially important to provide a chronostratigraphy not only based on comparisons and dating results gathered elsewhere, but rather on chronometric age estimates obtained directly for the sequence. The general chronostratigraphical sequence of the Near East is heavily based on the long stratigraphy of Tabun (Bar-Yosef & Meignen 2001; Mercier & Valladas, 2003; Mercier *et al.* 1995b, 2000; Porat *et al.* 2002), but the sequence at El Kowm provides in principle the unique opportunity for verification.

The stratigraphy and an extensive description of the geological and archaeological sequence of Hummal (Hauck *et al.* 2010; Le Tensorer *et al.* 2003, 2007; LeTensorer 2004) are given in this volume (Le Tensorer *et al.* 2011).

The Lower Palaeolithic sequence at the base of Hummal (Units G and F) comprises Oldowan-like assemblages (Layers 21-15; Wegmüller 2011) which are followed by two "Acheuleo-Tayacian" assemblages (layers 14-13) consisting of unspecific flakes, few flake tools and two handaxes (Le Tensorer *et al.* 2011).

The Early Middle Palaeolithic (Units E and D) is represented by Yabrudian artefacts in layers 12 to 8, followed by a drastic change in lithic production towards blades and elongated points as characteristic hallmarks. Such a particular assemblage was defined as Hummalian by Francis Hours (1982), based on his initial study of unstratified finds (layer Ia) from the site. This technocomplex is represented in the new excavations in primary (layers 6a, 6b, 6c, 7a, 7c) and in secondary context (α-h). The latter assemblage has been recovered from the sandy filling of a dolina. All the materials attributed to the Hummalian show a strong technological relationship (Wojtzcak 2011). Based on geological observations (Le Tensorer 2004), it is assumed that the material of layer 'α-h' from the dolina filling corresponds to a stratigraphic position between layer 8 (Yabrudian) and layer 7 (Hummalian). While the lithics from the sands have fresh edges, despite a secondary silica cover (Masson 1982; Shackley 1988), the lithics from layer 6b are uniformly patinated and often broken which suggests surface exposure and trampling (Wojtczak 2011). While the dolina filling represents a catastrophic depositional event, the depositional history of the sediment covering the artefacts in layer 6b is not clear and it might have accumulated over an extended period of time. All these Hummalian assemblages fit well into the generally observed development of blade-industries in the Middle East at the beginning of the

Middle Palaeolithic, e.g. at Tabun D or at Hayonim, Abou Sif in Palestine (Meignen 2007; Neuville 1951).

The following 4 m deep Mousterian sequence (Unit C) with more than 30 archaeological levels is mainly composed of detrital carbonate deposits in alternation with poorly developed soil formations and evaporitic sediments, such as gypsum-clay accumulations. Based on the archaeological material, the sequence can be grouped into three industry types (Hauck 2010, 2011). A Middle Levantine Mousterian of Tabun C type is found at its base. The upper two Mousterian industries show a clear focus on Levallois point production with variable reduction strategies, and hence, can be assigned to a Late Levantine Mousterian of Tabun B type. Two human remains of unspecified species (Neanderthal or archaïc *Homo sapiens*) were discovered in layers 5a4 and 5b1 (Hauck 2010).

A hiatus in the sedimentation is capping the Mousterian horizons from a period of colluvial formation, which contains an Upper Palaeolithic (probably Levantine Aurignacian), underlying an impressive Holocene deposit with traces of proto-historic and historic occupations.

sample ID	layer	age (ka)	±	archaeology
235 1b (i)	Ib	180	25	Yabrudian
235 1b (ii)	Ib	145	20	Yabrudian
235 1b (ii) *	Ib	160*	23	Yabrudian
(Ox85TLfg)	**Ib**	**160**	**22**	**context age Yabrudian$**
235 6b (i)	VIb	97	8	Late Mousterian (now Hummalian)&
235 6b (iii)	VIb	105	9	Late Mousterian (now Hummalian)&
235 6b (v)	VIb	112	10	Late Mousterian (now Hummalian)&
235 6b	**VIb**	**104**	**9**	**context age Hummalian&**

Table 1 - Previous TL dating results of heated flint (data from Ancient TL date list, 1988). * The actual age of this sample is 165±23 ka according to the data given in the technical part of the same report, which results in a non-significant increase of the calculated context age; $ not in situ; & in situ and corresponding to layer '6b' of the present stratigraphy, now attributed to a Hummalian industry; designation of layers according to the 1983 stratigraphy.

Previous chronometric age estimates for Hummal

Earlier attempts to provide chronometric age estimates for the site of Hummal are limited to thermoluminescence dating of heated flint (Ancient TL date list 1988), with three dates each from a Yabrudian layer Ib (as defined in the 1983 stratigraphy) and a late Middle Palaeolithic layer VIb (tab. 1). While the position of the former layer to the present stratigraphy remains unclear, layer VIb (profile P3 East) corresponds to layer '6b East' (now attributed to Hummalian), from which TL data on burned flints is presented in this paper.

The results for layer Ib (Yabrudian) with a context age of 160 ± 22 ka were critiqued by Mercier and Valladas (1994) for probably not being based on reliable external dosimetry. They noted a discrepancy of the dosimeter results with data from Hennig and Hours (1982), and their analysis of a sediment sample from layer '6b' with γ-ray spectrometry found the U-decay chain not being in secular equilibrium. This indicates an overestimation of the dosimetry and the ages therefore have to be regarded as minimum ages (Mercier & Valladas 1994). Furthermore, the results for layer 6b were additionally challenged because of a low correction of sediment moisture, despite the occurrence of deposits indicating the presence of water at the site. This lead to an additional overestimation of the external γ-dose rate for these samples (Mercier & Valladas 1994). Additionally, the techniques used to generate these dates appear not to take into consideration the supralinearity, and the palaeodoses therefore are underestimated, which results in a further underestimation of the age. The context age of the three heated flint samples from the layer VIb of 104 ± 9 ka (Ancient TL date list, 1988) was subsequently wrongly attributed to Mercier *et al.* (1995a) by Herz & Garrison (1998).

Further attempts were made by dating the formation of secondary carbonates from a conglomerate of not well consolidated travertines of a Yabroudian context (layer Ib, 1983 stratigraphy) at Hummal (Hennig & Hours 1982), which gave an age estimate of 138-179 ka (1-σ). This result is based on the assumption of equal initial activities of ^{230}Th and ^{232}Th (Hennig & Hours 1982). However, as the sediment is described as a conglomerate, the formation of these secondary carbonates has to be suspected of not being related to the archaeological event of the deposition of the Yabroudian. Furthermore, not well consolidated secondary carbonates are prone to contamination and, with respect to the archaeology, can therefore be considered as minimum ages at best. Tentative ESR dating of this travertine provided an age considerably smaller than the U–series result and was considered as unreliable (Hennig & Hours 1982).

Thermoluminescence (TL) Dating of heated flint artefacts

TL dating of heated flint artefacts determines the timing of the last heating of rock material, and thus the time elapsed since lighting a fire. It is one of the few instances where chronometric dating can provide an age estimate of a prehistoric activity directly (Richter 2007). Natural fires are frequent (see discussion in Alperson-Afil *et al.* 2007), but heat penetration of natural fire into sediment is low (Bellomo 1993). Therefore any rock material which is covered by a few centimetres of sediment only is not heated to an extent that would allow TL dating (Richter 2007). Given the suspected antiquity of the site, a delayed lighting of a fire by a subsequent occupation having been responsible for heating the artefacts, is considered as being not significant with respect to the resolution of the TL-dating method. Natural fires can be considered as unlikely being the responsible agent for the heating, because of the geomorphological position and that only a fraction of the lithics from Hummal show traces of heating. The fire therefore can be attributed to human activities, which provides the association of the sample and the event dated.

The method of TL dating of heated flint artefacts is based on the accumulation of metastable charges (palaeodose) in the crystal lattice by ionizing radiation since the last heating of the rock (Aitken 1985). Such charges in the crystal lattice of minerals are caused by the ionizing radiation due to the decay of radioactive elements from the surrounding sediment (external dose) and the sample itself (internal dose), as well as secondary cosmic rays (external dose). This omnipresent ionization causes a radiation dose (palaeodose or P) to accumulate in the crystal in the form of electrons in excited states. For dating application only electrons in metastable states are targeted, which are resident over periods of time much longer than the anticipated age (approximately 50 Ma after Wintle & Aitken 1977). Detailed descriptions of the principles of luminescence dating methods can be found elsewhere (Aitken 1985, 1998; Bøtter-Jensen *et al.* 2003; Wagner 1998) and a general account of TL dating of lithics is given in Richter (2007).

Samples for thermoluminescence dating

Artefacts showing macroscopic traces of heating, like potlids, craquelation, crenation, reddening (Richter 2007), were submitted for TL-analysis. The majority is not suited for TL dating because temperatures achieved were too low to allow TL dating. From this ongoing study we here report on 2 samples from layer '5g' belonging to the lower Mousterian sequence, and 12 samples from layers '6b-East' (the eastern section of layer 6b) and 'α-h base', both attributed to the Hummalian technocomplex.

Layer '5g' at the base of the western Mousterian sequence consists of detritic sands and carbonate clasts, in which numerous lithic artefacts were discovered. Variable degrees of patination and trampling are observed on some of the artefacts, which lead to the conclusion of layer '5g' being a palimpsest, representing a mixture of more than one occupation (Hauck 2010). However, micromorphological data indicate a rather rapid burial of layer '5g', and hence, the time slot of its formation does not seem to be extensive (Meyer 2001).

The artefacts from layer '6b-East' are heavily and homogenously patinated and, probably as the result of trampling, often broken and/or edge-damaged. Geoarchaeological investigations indicate an intermittent sedimentation over an erosive base, but the level is clearly not a reduction horizon (Meyer 2008). Archaeologically the material is a homogenous Hummlian industry with no natural intermixture of older materials and most likely the result of successive human occupations (Wojtczak 2011).

Layer 'α-h base' was found within a dolina filling, which consists of pure, mostly unstructured sands and represents a catastrophic depositional event. However, the edges of the artefacts are fresh, despite a post-depositional coating with silica (Masson 1982; Shackley 1988). Based on stratigraphic reasons, it is believed that the time between original sedimentation and re-deposition of the 'α-h base' material is marginal (Le Tensorer 2004). Stratigraphic observations indicate a deposition of layer '6b East' after layer 'α-h base'. Therefore the difference in the dose rates as measured today, and the actual average dose rate (i.e. the sum of the doses delivered in the first and secondary deposition, see below) are assumed to be negligible. Therefore TL dating should provide a reasonable approximation of the age of the heating event. However, it has to be stressed that any results under such circumstances have to be considered carefully.

Method of thermoluminescence dating

The palaeodose (P) is a function of the dose rate ($\dot{D}$ the ionizing radiation per time unit), which provides the clock for the dating application, i.e. the time scale the crystal was exposed to the omnipresent radiation. Exposure to light or elevated temperatures causes the electrons to relax to a ground state, sometimes by emitting a photon, which is the luminescence. If the temperature is high enough (> ~400 °C) the drainage is sufficient to relax all electrons relevant to the luminescence method used, i.e. the clock is set to zero by this event. After cooling the radiation dose starts to accumulate again and as a consequence the intensity of the luminescence signal (number of photons) increases with the total absorbed dose (P) in a crystal and is therefore a function of exposure time to radiation.

The age is obtained by the ratio of the palaeodose to the sum of a series of dose-rates under the assumption of the constancy of the ionizing radiation (dose-rate) over the entire burial time (Aitken 1985) (fig. 1). The denominator $\dot{D}$ of the age formula consists of two sets of parameters, the internal ($\dot{D}_{internal}$) and the external dose rates $\dot{D}_{external}$). Any variability of any of the parameters of $\dot{D}$ through time makes it difficult to estimate the age of a heated flint (e.g. Richter 2007). All parts of the samples which are considered to be potentially geochemical unstable, like cortex or patinated portions, are carefully removed with a water-cooled diamond saw from the flint samples prior to TL-dating. The internal dose-rate ($\dot{D}_{internal}$), which is measured with Neutron Activation Analysis (NAA) on a subset of the crushed sample, is thus considered as being constant over the time-span of interest. This is an advantage of heated flint TL-dating over most other dosimetric dating methods, and increases the accuracy for any age estimate. However, the major uncertainty in TL-dating of heated flint usually derives from the estimates of uncertainties associated with the ionizing radiation from the surrounding sediment ($\dot{D}_{external}$) which is measured by either gamma ray spectrometry or insertion of dosemeters in the sediments for a specified period of time. In order to simplify the estimation of $\dot{D}_{external}$, and thus increase the precision of an age estimate, each sample is carefully stripped of its outer 2 mm surface area (approximately the range of b-radiation from isotopes contained in the surrounding sediment).

Of major concern in dosimetric dating is the assumption of the stability of the dose rates over burial time. While this is certainly valid for the internal dose rate of the heated flints because only unaltered parts are used (i.e. not patinated) it has to be verified for the external dose rates, (i.e. external γ only in the case of flints) by HPGe γ-spectrometry. However, only the present state can be determined and past changes (i.e. disequilibrium in the decay chains of Th and U) are difficult to detect and to model, especially as they could have occurred repeatedly. Because of size limitations only the smaller sediment particles can be analysed in the laboratory by HPGe γ-ray spectrometry (i.e. rocks and larger artefacts are not included). The results are therefore not necessarily representative if the

$$\text{age}_{(ka)} = \frac{P_{(Gy)}}{\dot{D}_{(Gy \cdot a^{-1})}} = \frac{P}{\dot{D}_{(internal)} + \dot{D}_{(external)}} = \frac{P}{(\eta \dot{D}_{\alpha} + \dot{D}_{\beta} + \dot{D}_{\gamma}) + (\dot{D}_{\gamma} + \dot{D}_{cosmic})}$$

Figure 1 - Age formula after Aitken (1985), palaeodose (P) is expressed in Gy, dose rates ($\dot{D}$) in Gy per time unit (usually in a or ka).

sediment contains abundant rocks and artefacts ("lumpy" after Schwarcz 1994).

TL measurement parameters and sample preparation

Because the luminescence signal of some samples from Hummal is at the onset of saturation, the palaeodose on the 90-160 µm fractions of the crushed flint material (after the removal of the outer 2 mm) was obtained by a multi-aliquot-additive-regeneration (MAAR) slide protocol (fig. 6). A comparison of data sets which could be analysed using a standard linear approximation approach revealed no significant differences in palaeodose results at the confidence level of 68%. Therefore a single analytical procedure which is appropriate for all samples was used.

In this slide approach the (linear) alpha contribution to the natural and additive TL-signals is subtracted and the TL data is described by quadratic functions and shifted along the dose axis (Mercier 1991; Valladas & Gillot 1978) with scaling of the regeneration curve (after Sanzelle *et al.* 1996). This procedure is similar to the Australian Slide Method (Prescott *et al.* 1993) and almost identical to the one employed for TL-dating of heated flints of approximately the same age at Hayonim by Mercier *et al.* (2007). An iteration procedure then corrects for the underestimation of the alpha contribution for samples at the onset of saturation, which is based on a linear approximation (after

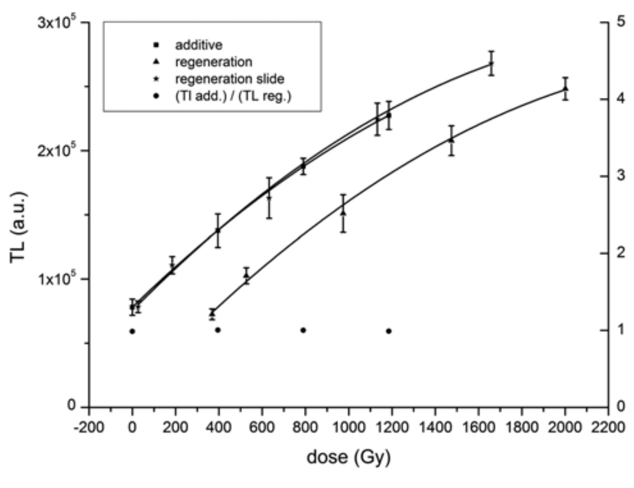

Figure 2 - TL growth curves of sample EVA-LUM-07/29 showing polynomial fits for the additive growth curve (TL add; squares), the regenerated growth curve (TL reg.; triangles) and the shifted regeneration growth curve (TL regeneration slide; stars). The ratio of the two growth curves (TL add. / TL reg.) after shifting is given for the additive doses as grey dots in order to show their similarities in shape ("homothetie" after Mercier (1992).

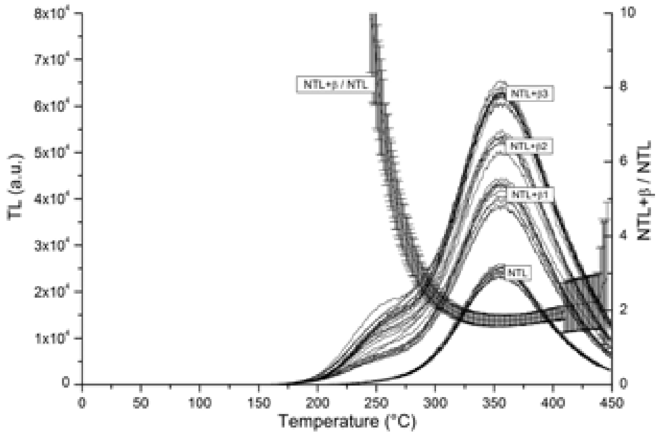

Figure 3 - TL glow curves and heating plateau of sample EVA-LUM-07/32. The natural TL-signals (NTL), the additive TL-signals (NTL+β) and the ratio of NTL+β to NTL over temperature (heating plateau defined as the temperature range of constant ratio) are shown.

Mercier 1991). Between 6 and 12 aliquots were used for each of the 4-5 dose points for each of the two growth curves, where the grains for the regeneration growth curve were heated to 360°C for 90 min in air before irradiation. This procedure is assumed to induce the least sensitivity changes. Carbonates were removed with acetic acid after crushing and/or heating. Thermoluminescence was detected with an 'EMI 9236QA' photomultiplier with detection restricted to the UV-blue wavelength band by Schott BG25 and WG5 filters at a heating rate of 5°C min^{-1} to 450°C on Risø DA-20 or DA-15 systems. Irradiations were performed with external calibrated sources (β with $^{90}Y/^{90}Sr$ at ~0.26 Gy s-1 and a with 241Am at 0.178 µm min^{-1}). The alpha sensitivity (β-value after Bowman & Huntley 1984) was determined by a regeneration approach. The luminescence response of single doses from alpha and beta irradiation to six discs each of 4-11 µm fine grain material (heated prior irradiation in air to 500°C for 30 min) was compared in order to obtain the b-value for each sample. The integration range of all luminescence signals analysed was defined by the range of overlap of the temperature ranges of the heating plateau (fig. 3) with the equivalent dose plateau in order to achieve the most accurate and precise results.

Heated flint sample selection, testing and rejection

A small portion from the outer edge of each heated flint submitted for dating was analysed in order to determine the correct attribution as being heat altered. The physical evidence for the past heating is achieved by analysing the TL response from the natural sample in relation to the TL signal from a portion which has received an additional dose from a calibrated radioactive β-source (natural + dose). The flat ratio (plateau) of the 2 signals over temperature indicates the presence of the prehistoric zeroing of the TL-signal for a given temperature. In cases of the absence of a prehistoric heating or where the heating was less to ~ 400 °C the ratio of the 2 signals is not uniform or might be flat for a short temperature range only. In such cases the lack of a plateau in the range of the peak temperature indicates the insufficiency of the prehistoric heating for TL dating analysis. An additional criterion of prehistoric heating is the presence of a single peak with a Gaussian like shape (fig. 3), lacking shoulders at either side and the peak occurring in the temperature range between 350 and 380 °C. Only such samples were considered for dating. If the flat ratio extends over the TL peak temperature, a "heating plateau" (after Aitken 1985) is defined and the sample is confirmed to have been sufficiently heated for TL analysis (fig. 3). Such samples were then prepared for full TL analysis (outer 2 mm removed and crushed) and the test was repeated with this extracted material in order to verify that the temperatures achieved in the interior of the sample were sufficient to fully erase the TL-signal and thus full fill a fundamental assumption in TL-dating of heated flint artefacts. Only such samples were subsequently used for dating analysis (tab. 2).

Dosimetry

The internal dose rates ($\dot{D}_{external}$) were calculated after (Adamiec & Aitken 1998) based on Neutron Activation Analysis results for U, Th and K on 200 mg of sample material less than 160 µm from the extracted cores, which were obtained prior to the chemical treatment.

EVA-LUM-No	square	Inv.-No.	x	y	z	layer
05/16	P.4	55	x	x	-8.20	5g
05/17	P.4	56	x	x	-8.20	5g
07/29	N34	430	112.70	33.35	-9.82	6b East
06/29	N35	6	112.76	35.33	-9.69	6b East
05/18	F35	453	105.50	35.50	-10.09	6b East
07/30	H36	33	107.74	36.88	-10.01	6b East
07/31	F35	136	105.50	35.50	-10.09	6b East
07/32	N39	95	112.58	39.41	-10.06	6b East
09/02	N39	57	112.30	39.50	-10.04	6b East
09/03	H 36	31	107.73	36.94	-10.01	6b East
07/33	D29	154	103.00	29.00	-13.65	α-h base
07/34	E30	68	104.00	30.00	-13.65	α-h base
05/19	E30	195	103.00	30.00	-13.65	α-h base
07/35	A28	139	100.00	28.00	-13.65	α-h base

Table 2 - Locations of samples for TL dating (samples lacking precise coordinates were given square coordinates only or just collected).

Dosimetric dating methods are based on the assumption of the stability of the dose rates over the burial time and the homogeneous distribution of radioactive elements in the sample. However, either can be modelled as well (Guibert *et al.* 2009; Tribolo *et al.* 2006). The flint samples from Hummal do not exhibit a large variability of grain sizes on the macroscopic scale and inhomogeneities are therefore unlikely. The stability of the internal dose rates can not be contested over the time range of interest because only those parts were used for analysis which did not show any macroscopical traces of geochemical alterations, like patination.

Most sediments at Hummal consist of fine grained particles and only the archaeological material (lithics and bones), while large clastic input (e.g large pebbles/gravel to cobble) is usually not present. Such sediment layers are not considered as especially "lumpy" and external dosimetry is therefore based on the analysis of the fine parts of the sediments with HpGe-γ-spectrometry (SiO_2 matrix) in the laboratory (tab. 3).

These analyses reveal identical patterns of disequilibria of the ^{238}U decay chain, where concentrations of ^{238}U are always lower than ^{226}Ra, which was found to be the case for all of the sediments at Hummal investigated so far (fig. 4), and which was already detected by Mercier & Valladas (1994) for a sample from a different part of the site as well. The daughter products at the end of the decay chain (e.g. ^{210}Pb) show variable ratios to their mother isotopes. These disequilibria are likely related to the rise and fall of the water table. Fluctuations may be due to natural spring activities or to the lowering of the water table through intensive pumping up of water from the well in the past decades. While HpGe-γ-spectrometry reveals only the present day state, it has to be suspected that disequilibria occurred repeatedly. However, it can not be established how often and when this did happen.

The most plausible interpretation of the occurrence of comparable larger activities measured for some of the ^{238}U daughter products (fig. 4) is uranium leaching (oral communication D. Degering, 2009). Because ^{230}Th is not easily leached, it would represent a good estimate for the dose rate for a recent single leaching of U. Additionally, a recent ^{222}Rn loss could have occurred, as indicated by the lower activity of the daughter product ^{210}Pb. However, ^{226}Ra could have been leached in, and a multiple leaching out of uranium could have occurred, as another scenario amongst others. Modelling the dose-rate for such a scenario would require the knowledge of the age of the sequence and the number of leaching cycles, as well as measurements of all sedimentological units of the stratigraphy in order to place the observed disequilibria in relation to each other. The general assumption of the constancy of dose rates for TL-dating is therefore not valid and age estimates can only be provided for dose rate models based on HpGe-γ-spectrometry. Given this problematic, only borderline model ages can be calculated and they will be restricted to the most likely minimum and maximum age.

layer	^{238}U serie				^{232}Th serie		K
	^{238}U (A/m /Bq/kg)	^{230}Th (A/m /Bq/kg)	^{226}Ra (A/m /Bq/kg)	^{210}Pb (A/m /Bq/kg)	^{228}Ra (A/m /Bq/kg)	^{228}Th (A/m /Bq/kg)	^{40}K (A/m /Bq/kg)
5g	34 ± 3	100 ± 26	78 ± 2	6 ± 3	12 ± 1	12 ± 1	100 ± 3
6b East	29 ± 3	96 ± 21	177 ± 2	131 ± 3	11 ± 1	11 ± 1	124 ± 3
α-h-base	97 ± 4	204 ± 26	324 ± 3	233 ± 5	112 ± 4	115 ± 3	37 ± 2
15b	30 ± 3	81 ± 20	87 ± 2	143 ± 5	7 ± 1	7 ± 1	121 ± 3

Table 3 - Results from HpGe γ-ray spectrometry on dry sediment samples.

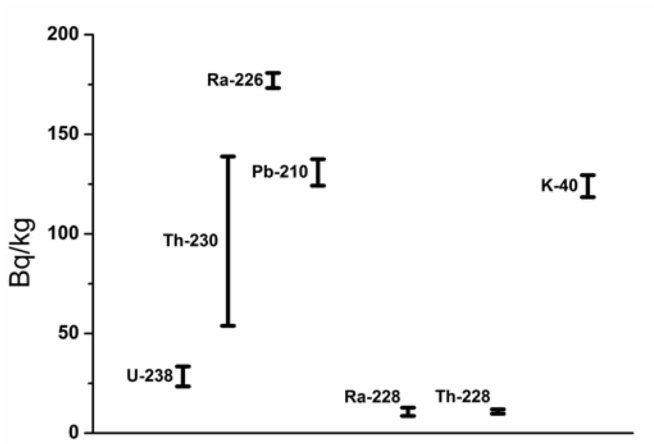

Figure 4 - Results of activity measurements (2s) of the products of the ^{238}U-decay chain with HpGe-g-ray spectrometry (^{234}Th for ^{238}U; ^{214}Pb and ^{214}Bi for ^{226}Ra; ^{230}Th; ^{210}Pb), for ^{40}K and of the ^{232}Th-decay chain (^{212}Pb, ^{212}Bi, ^{208}Tl for ^{228}Th; ^{228}Ra) of the fine grained (<5 cm) component of layer '6b-East'. Note that the sediments from the other layers display a similar general pattern.

A simple scenario would be the single leaching of U, probably related to the recent digging of the well shaft, comparable to a model used by Zander *et al.* (2007). For this scenario the dose-rate would be best represented by ^{238}U as a minimum dose (tab. 4) and calculations based on ^{238}U therefore can be considered as maximum age estimates. The disequilibria between ^{230}Th and ^{226}Ra is often related to recent events (oral communication D. Degering, 2009), and could be linked to the very recent lowering of the water table. ^{230}Th therefore is considered as best representing the maximum dose, thus providing the model for a minimum age estimate (tab. 4). Obviously other and more complex scenarios are possible. However, no data is available to further constrain such models and resulting ages would be within the limits given by the two proposed models. These model ages are based on the values measured for ^{230}Th and ^{238}U, which allow the calculation of total external γ-dose rates, assuming constant dose rates from the U-series.

The assemblage of layer 'α-h-base' was located laying directly on a solid consolidated sediment. Therefore half of the γ-dose-rate derives from this rock material, which was analysed by Neutron Activation Analysis (NAA), presented in table 5. The sum of half the dose rates provided by NAA and HpGe-γ-spectrometry give the γ-dose-rate for the samples from this layer, where minor variations in the basal surface geometry are neglected.

While ^{230}Th is considered as most likely being the best available representative of the past dose-rate, even though providing minimum age estimates only, the results based on ^{234}U have to be considered as absolute minimum rates, and thus maximum possible ages. In laboratory γ-ray spectrometry the dry sediment is analysed. The results therefore have to be corrected for the water (moisture) contained in the sediments. Because of the location in an arid zone, sediment moisture is difficult to be determined in the field. We here assume 10% moisture for the sediments from layers '5g', '6b-East' and '15b', while for layer 'α-h-base' a moisture of 15% is assumed because of the loca-

layer	min.total γ-dose rate (µGy a^{-1})	max. total γ-dose rate (µGy a^{-1})
5g	482	757
6b East	440	1006
α-h-base	3078	3499
15b	405	832

Table 4 - g-dose-rates (µGy a^{-1}) for dry sediments based on HpGe-γ-ray spectrometry. The minimum γ-dose rate is based on the activity of ^{238}U and the maximum γ-dose-rate on the activity of ^{230}Th. Note that for layer 'α-h-base' only half of the values were used for age calculation because the other 2π relates to the underlying consolidated sediment (table 5). All data is corrected for 10% moisture content of the sediment (15% for 'α-h-base').

tion of the flint samples in the depth of a dolina and lying on a dense and less permeable `rock, which probably acted as a water barrier. An increased water flow in this sediment is evidenced by the presence of SiO_2 deposits on sediment quartz grains and artefacts which require at least episodical water flow for its formation (Shackley 1988). Because the dose rates were not constant and have to be modelled, representativeness of any measurements of the present state is questionable for the past. However, the γ-dose-rate obtained by HpGe-γ-spectrometry for layer '6b-East' (1214 µGy a^{-1}) is comparable to measurements by two *in situ* Al_2O_3:C dosemeters (1197 and 1048 µGy a^{-1}). The small difference can be attributed to differences in moisture content, which would provide a 8 % natural moisture for the averaged dosemeters. This is well comparable with the value of 10% used in age calculation, which was employed in order to compensate for the reduced moisture of the sediments under study here. Uncertainties of a few percent related to the unknown moisture content of the sediments are negligible in the light of the uncertainties related to the spread in ages caused by the modelling of the external γ-dose rate. For the age calculation an uncertainty of 10% was used for the external γ-dose rate. The cosmic dose was estimated by taking into account the geographic position, altitude and thickness of sediments (Prescott & Hutton 1994; Prescott & Stephan 1982), employing a 5% uncertainty (after Barbouti & Rastin 1983).

It is generally assumed that the heating event of lithics from a given archaeological layer was more or less contemporaneous. If this is the case, then the palaeodose-internal dose-rate ratios should fall on a straight line, which is representing the age, whereas the external dose rate is the intercept with the x-axis, because the palaeodose is a function of external and internal dose-rates. Such an approache can sometimes be used to check the external dose rate employed (e.g. Aitken & Valladas 1992).

Optically Stimulated Luminescence Dating of sediment

Layer '15b' is one of several small sand lenses (maximum thickness 15 cm) of aeolian origin, which is embedded in a 10-20 cm package of clay-rich sediments (layer 15). This layer is one of several dark clay layers, which presumably formed in a marshy environment of varying size in depressions of the mound of Hummal. In general, the density of archaeological finds within the dark clays is very low. The green and black clay deposits are characterised by a high content of organic material and aeolian components (Le Tensorer *et al.* 2007), and therefore the sand lenses in Layer 15 should be well suited for Optically Stimulated Luminescence (OSL) dating.

Method of Optically Stimulated Luminescence Dating

Optically Stimulated Luminescence (OSL) dating is a dosimetric method as well, and the fundamental principles comparable to the ones described above apply. However, the zeroing of the luminescence signal is by light, and therefore the last exposure to light is the event dated. An OSL age therefore can only represent *terminii post quem* or *ante quem* ages for archaeological remains embedded inside, or, as is the case here, below and above the OSL dated layer, for which the timing of its deposition is dated (fig. 5).

$$age_{(ka)} = \frac{P_{(Gy)}}{\dot{D}_{(Gy \cdot a^{-1})}} = \frac{P}{\dot{D}_{(external)}} = \frac{P}{\dot{D}_{\beta(U)} + \dot{D}_{\beta(Th)} + \dot{D}_{\beta(K)} + \dot{D}_{\gamma(U)} + \dot{D}_{\gamma(Th)} + \dot{D}_{\gamma(K)} + \dot{D}_{cosmic}}$$

Figure 5 - Age formula for OSL dating, the palaeodose (P) is expressed in Gy, dose rates ($\dot{D}$) in Gy per time unit (usually in a or ka).

OSL measurement parameters and sample preparation

The sample was taken from the sediment profile (square L31, x=110.76, y=31.51, z=-13.03) with a steel tube and the light exposed ends were discarded, but used for HPGe γ-spectrometry. Organic and carbonate materials were removed with H_2O_2 and HCl, respectively, before quartz was separated with heavy liquids. The α-rim was removed by etching in 45% HF, before final sieving (90-160 µm). Feldspar contamination was checked with infrared stimulated luminescence (IRSL) measurements.

The same equipment as for TL was used for measuring the OSL. A single aliquot regeneration (SAR) protocol (Murray & Wintle 2000) was employed to determine the palaeodose. A preheat of 220°C was chosen and the OSL was stimulated for 40 s at 90% power with blue LEDs and the first 0.8 s of the signal was used, while the last 8 s served as a background measurement. The data was analysed with "Analyst 3.24", including the recycling measurement in dose-curve construction, 50 Monte Carlo repeats (Duller 2007), 2% measurement error, while using the previous background (Murray & Wintle 2000). Many data could be only fitted with an exponential+linear function, which was therefore used for all data, because otherwise too few data points would have been available. Failure to regenerate the level of the natural luminescence, as well as recycling ratios deviating by more than 10% from unity; test dose and palaeodose error greater than 15% and 15% max palaeodose error were employed as rejection criteria. A dose recovery test gave 224 ± 4 Gy for 5 natural aliquots which were bleached with blue LEDs for 240 s at 280°C before the dose of 230 Gy was given, thus suggesting that the chosen protocol is capable of determining a given dose very well.

Dosimetry

The problem of disequilibria in the ^{238}U-decay chain was also detected for the sediment from layer '15b (tab. 1) and therefore the discussion above (section 4.5) on the external γ-dose rate applies to OSL samples as well. However, as the quartz grains used for analysis are assumed to be free of any significant radioactive isotopes (following e.g. Henshilwood *et al.* (2002) the external γ-dose rate is of much more importance because no stable internal dose-rate is present. Therefore any change on the external γ-dose rate has a large effect on the calculated age. The dose rate for the OSL sample therefore consist of the external β- and γ-radiation, as well as the cosmic dose rate (91 µGy^{-1}), which was calculated as described above. No a-radiation has to be considered because the sample was etched with HF for 45 min.

The sediment lense was thin, and just thick enough to allow the sampling for one OSL sample. The γ-dose rate of 1450 µGy a^{-1} measured in the field with a portable NaI-γ-spectrometer (Target NanoSpec) can not be considered as representative, because the sands did not reach much further than the 10 cm sampling depth. Therefore the probe was exposed at 4π (30 cm) depth mainly to the higher radiation from the clayey lacustrine sediments, and not the sands. Therefore the actual γ-dose rate should be between the *in situ* measurement result and the HPGe-γ-ray spectrometry of the sediment which was discarded from either end of the sampling tube. However, given the problem of disequilibria as described above, model ages will be presented based only on HPGe-γ-spectrometry measurements, which were corrected for 10 % moisture. Because the largest HPGe-γ-contribution is from the immediate vicinity of the sample, the laboratory measurement of the sand is assumed to be the best representative data available (tab. 4).

Thermoluminescence (TL) dating results

A total of 60 flints showing signs of having been exposed to fire were tested for the sufficiency of the prehistoric heating with the heating plateau test. We here present the TL dating results on a total of 14 samples which passed this test. Two originate from the Mousterian layer '5g', eight were recovered from the Hummalian layer '6b East', as were four from the Dolina filling (layer 'α-h base').

Table 6 shows the results of the TL measurements as well as Neutron Activation Analysis results. The palaeodoses for the two samples from layer '5g' are in the same order of magnitude, but their internal dose rates are vastly different (tab. 6). A similar picture is observed for the samples from layer '6b East', where two samples (EVA-LUM-07/29 and -09/03) have rather different internal dose rates. For layer 'α-h base' the palaeodoses are not very different, while the internal dose rates exhibit some variation (tab. 6). Samples having been heated at the same time and always located in the same sediment layer are expected to show the same trend of large palaeodoses with high internal dose rates and vice versa. Having been exposed to similar external γ-dose rates, all samples of the same age are expected to cluster along a line (representing the age) for internal dose rate versus palaeodose. Figure 6 shows that for layer '6b East' two samples (EVA-LUM-05/18 and 07/32) have higher and lower internal dose rates, respectively, compared to the majority

	U (ppm)	Th (ppm)	K (%)	γ-dose rate (μGy a^{-1})
consolidated sediment	42.80 ± 1.24	0.60 ± 0.01	0.0755 ± 0. 0037	4883

Table 5 - Results of Neutron Activation Analysis (NAA) of the consolidated sediment on which the artefacts from layer 'a-h-base' were laying and conversion to infinite matrix γ-dose rate (Adamiec & Aitken 1998), of which half the value was used for age calculation.

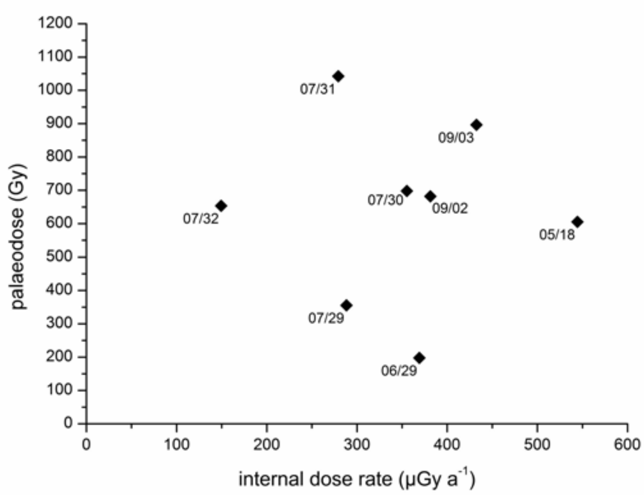

Figure 6 - Internal dose rates versus palaeodoses for samples from layer '6b East'.

of samples. It therefore has to be suspected that, at least for sample EVA-LUM-07/32 the heating events, and thus the ages, were not the same, or that the external γ-dose rates were vastly different (fig. 6).

The distribution of internal/palaeodose ratios of the samples from layer 'α-h base' forms two groups (fig. 7), with sample EVA-LUM-07/34 not being consistent with the other samples. Its palaeodose is not compatible with the external γ-dose rates the other samples must have received, because no positive relationship (positive slope) can be established. Therefore it can be suspected that sample EVA-LUM-07/34 is not being associated with the same heating event. However, it can not be ruled out that an inhomogeneous distribution of radioactive elements, which cannot be traced with NAA, is responsible for over or under estimation of the internal dose rates. In contrast, it has to be kept in mind that the external γ-dose rates can be rather different in Palaeolithic sites, because of the heterogeneity of the sediments, and therefore clear relationships between parameters are not necessarily expected.

The dependencies of the calculated ages for either model (tab. 7 and 8) on the external γ-dose rates is large, because the internal dose rates, which can be regarded as having been stable over the entire burial time, range between 5 and 50% of the total dose rate only.

The ranges of TL model age estimates for minimum ages (tab. 7) and maximum ages (tab. 8) obtained for the layers of Hummal are very large. While for layer '6b East' the model ages for the individual samples are significantly different (2σ), there are no significant difference for the samples from the other two layers. Therefore modelling has a large effect on the samples from layer '6b East' only.

The age results for layers '6b East' and 'α-h base' pass the Shapiro-Wilk test at p=0.05 (software package Origin 8.1) for both models and therefore are considered to have been drawn each from normal populations. Tests to determine outliers (Dixons test after Rorabacher 1991; Grubb's test; Chauvenet criterion) failed to detect any abnormal results, but all data fails X^2-tests. Therefore we prefer to calculate simple average ages for the samples from one layer, assuming that the heating event was contemporaneous.

EVA-LUM-No	layer	heating plateau (°C)	D_E-plateau (°C)	Palaeodose (Gy)	b-value (Gy μm^2)	U (ppm)	Th (ppm)	K (ppm)	D_{cosmic} (μGy a^{-1})	eff. $D_{internal}$ (μGy a^{-1})
05/16	5g	340-390	330-390	181±6	2.43±0.02	1.28±0.04	0.20±0.01	573±11	120	292±5
05/17	5g	330-410	340-380	132±9	1.82±0.01	2.67±0.05	0.31±0.01	1162±23	120	573±7
07/29	6b East	340-380	350-370	355±19	2.44±0.03	1.10±0.07	0.29±0.03	914±55	147	288±11
06/29	6b East	335-425	340-370	196±6	1.80±0.03	1.67±0.04	0.21±0.01	863±19	147	369±6
05/18	6b East	350-390	340-370	605±33	2.05±0.02	2.71±0.05	0.12±0.01	656±17	147	545±7
07/30	6b East	350-380	340-370	698±26	3.24±0.02	1.40±0.08	0.18±0.02	860±34	147	355±14
07/31	6b East	340-390	350-380	1037±59	2.16±0.01	1.10±0.07	0.29±0.03	869±61	147	279±11
07/32	6b East	340-390	340-365	653±23	1.95±0.02	0.53±0.05	0.21±0.03	602±48	147	149±9
09/02	6b East	340-400	345-375	682±29	2.22±0.02	1.78±0.09	0.22±0.03	598±42	147	381±14
09/03	6b East	340-430	360-400	897±31	2.87±0.03	1.90±0.10	0.22±0.02	699±42	147	433±15
07/33	α-h base	335-425	340-370	694±31	2.53±0.02	2.16±0.05	0.18±0.01	730±15	57	471±8
07/34	α-h base	350-390	340-370	839±46	1.74±0.02	0.67±0.05	0.06±0.01	687±55	57	173±9
05/19	α-h base	330-400	340-370	751±53	1.13±0.01	2.42±0.04	0.27±0.01	755±18	57	467±7
07/35	α-h base	350-380	340-370	543±18	2.32±0.06	0.89±0.06	0.22±0.03	642±51	57	223±10

Table 6 - Results of TL measurements, Neutron Activation Analysis and dosimetry. Uncertainties for $\dot{D}_{g\text{-ext.eff.}}$ is 5%.

EVA-LUM-No	layer	^{230}Th based eff. D$_{external}$ γ (μGy a^{-1})	eff. D$_{internal}$ (% total D)	eff. D$_{external}$ γ (% total D)	min. age (ka) based on ^{230}Th
05/16	5g	723	26	64	159±13
05/17	5g	448	41	50	97±7
07/29	6b East	956	21	69	255±22
06/29	6b East	951	25	65	135±11
05/18	6b East	969	33	58	365±29
07/30	6b East	915	25	65	492±40
07/31	6b East	423	33	50	1221±88
07/32	6b East	966	12	77	518±46
09/02	6b East	951	26	64	461±38
09/03	6b East	946	28	62	588±47
07/33	α-h base	3324	12	86	180±18
07/34	α-h base	3359	5	94	234±25
05/19	α-h base	3359	12	87	193±20
07/35	α-h base	3307	6	92	151±15

Table 7 - Minimum age TL dating results for heated flints based on a ^{230}Th derived external γ-dose rate. Uncertainty in age calculation for $\dot{D}_{g\text{-}ext.eff.}$ is 10 % (see text).

EVA-LUM-No	layer	^{234}U based eff. D$_{external}$ γ (μGy a^{-1})	eff. D$_{internal}$ (% total D)	eff. D$_{external}$ γ (% total D)	min. age (ka) based on ^{234}U
05/16	5g	723	33	53	206±15
05/17	5g	448	50	39	116±8
07/29	6b East	418	34	49	410±29
06/29	6b East	460	38	47	201±14
05/18	6b East	469	47	40	507±34
07/30	6b East	401	39	44	773±52
07/31	6b East	423	33	50	1221±88
07/32	6b East	423	21	59	916±69
09/02	6b East	416	40	44	715±49
09/03	6b East	414	44	42	901±60
07/33	α-h base	2924	14	85	199±19
07/34	α-h base	2955	5	93	263±13
05/19	α-h base	2955	13	85	216±22
07/35	α-h base	2909	7	91	170±17

Table 8 - Maximum age TL dating results for heated flints based on a ^{234}U derived external γ-dose rate. Uncertainty in age calculation for $\dot{D}_{g\text{-}ext.eff.}$ is 10% (see text).

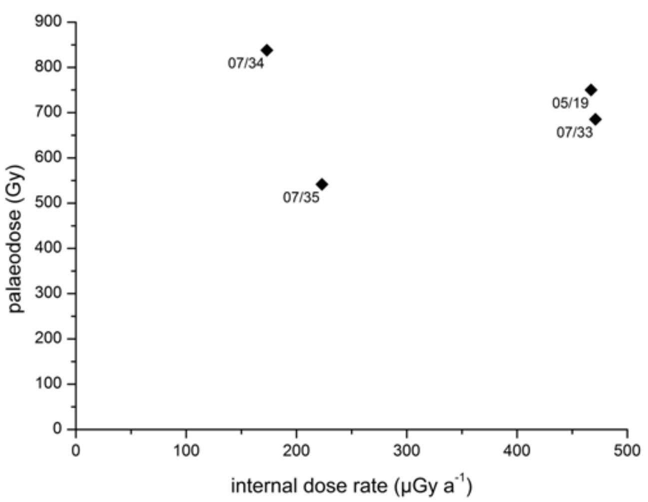

Figure 7 - Internal dose rates versus palaeodoses for samples from layer 'α-h base'.

For layer '5g' only two samples were datable, with rather opposing relationships between dose rates. Results for sample EVA-LUM-05/17 can be considered as more reliable because it is less dependent on the model for the external γ-dose rate. Six flints produced age results for layer '6b East'. The spread in ages is enormous and significant differences are observed between the two models employed. The minimum age model provides a mean age of 445 ± 192 ka (1σ standard deviation), whereas for the maximum age it is 706 ± 324 ka for all samples. The two samples (EVA-LUM-05/18 and -07/32) which were suspected of not belonging to the same population actually provide ages rather close to this mean and therefore the argument is not supported by the apparent ages. The mean results on the four heated flints from layer 'α-h base' provide 190 ± 35 ka as minimum context age estimate, and 210 ± 40 ka (1σ standard deviation) for maximum age. Here again the calculated age for the suspected sample (EVA-LUM-07/34) is relatively close to the mean, suggesting that it belongs to the majority of sampled artefacts, despite having apparently experienced a different dosimetry.

Optically Stimulated Luminescence (OSL) Dating results

A total of 48 aliquots were measured for sample EVA-LUM-08/16, of which 12 were rejected according to the criteria stated above. The data does not show any distinct pattern, but a rather wide dose distribution (fig. 8), which is difficult to interpret for aeolian sediments, which should be represented by a rather defined distribution. The resulting palaeodose based on the weighted mean of 228 Gy is not distinctively different from the radial plot result where 69% of the data are encompassed within 2σ, giving 246 Gy. Subsequently, the weighted mean palaeodose of 228 ± 36 Gy was used for the age calculation of sample EVA-LUM-08/16.

Based on the dosimetry discussion above, a maximum age of the deposition of the sand lens '15b' can be calculated by employing a γ-dose rate derived from the HpGe γ-spectrometry measurement of ^{238}U (tab. 3) and by assuming this value to represent an average minimum dose the sample has received. Vice versa a minimum age can be calculated based on ^{238}Th and the resulting ages for sample EVA-LUM-08/16 are 203 ± 36 ka and 111 ± 27 ka, respectively.

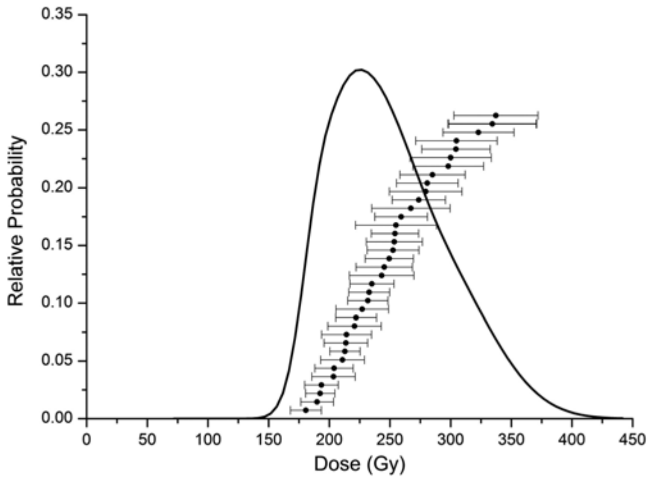

Figure 8 - Probability distribution of equivalent doses (DE) obtained for sample EVA-LUM-08/16.

Discussion of TL ages

The two models for the external γ-dose rate do not produce significantly different results for the samples from layer '5g'. However, the ages of the two samples are significantly different, which might indicate that two occupations were sampled, which are significantly different in time. Sample EVA-LUM-05/17 is less dependent on the γ-dose rate and therefore appears to be more reliable. Furthermore, with an age of approximately 100 ka it is in accordance with age estimates for similar Mousterian assemblages. However, given the large spread in TL ages of heated flint (see discussion above and e.g. Richter *et al.* 2010) such a single age estimate can not be taken as a good estimate for the age of an entire assemblage and is rather providing a general idea on the age of the layer only.

Significantly different results are obtained for the two external γ-dose rate models for the samples from layer '6b East'. While the maximum age model can be clearly rejected as being too old on archaeological arguments, the minimum age model does not fit the chronostratigraphical models (Bar-Yosef & Meignen 2001; Porat *et al.* 2002) of the Levant either. The data appears to represent different heating events or vastly different dose rates because of the enormous spread in TL-ages, which is not reflected in the proportional relationship of palaeodoses to internal dose rates. Considering that the assemblage shows clear signs of diagenetic modifications (surface exposure and trampling), but is a rather uniform assemblage in technological and typological terms (Le Tensorer *et al.* 2003), it is more likely that different dose rates are the responsible agents. In fact, the artefact assemblage is very similar to the assemblage from layer 'α-h base'. However, because none of the samples dated is typo-technological significant, it can not be ruled out that some samples originate from different assemblages. This TL data suggests that either different assemblages are mixed, or the assemblage has experienced a different dosimetric history than the one assumed. The latter would be the most parsimonious explanation because of the evidence of surface exposure in the form of patiniation and the apparent homogeneity of the assemblage. However, this can neither be quantified nor qualified.

All but one of the samples from layer '6b East' have internal dose rates and palaeodoses rather similar to the samples from layer 'α-h base' (tab. 6). Assuming an external γ-dose rate based on the measurement of solely the sediment from layer 'α-h base', the minimum age model would provide a mean of about 190 ka and the maximum age would be approximately 250 ka. These ages are very similar to the ones obtained for layer 'α-h base' and provide further evidence, that the external γ-dose rate models are likely not appropriate for the samples from layer '6b East'. A significant difference in ages is observed to the previous TL study whatever scenario is applied to the data presented here, despite the correlation of the location of layer VIb to the present day stratigraphy with layer '6b-East'. However, as outlined above, these previous age estimates (Ancient TL date list 1988) are considered as underestimations.

The models for the external γ-dose rate do not produce significantly different results for the samples from layer 'α-h base' and the spread in ages is comparable to TL-dating of other middle Palaeolithic sites. Because of the lack of age differences for the two models and under the assumption that the artefacts were re-deposited into the dolina quickly after their original deposition, it can be concluded that the age of this assemblage is ca. 200 ka (minimum model 190 ± 35 ka and maximum model 210 ± 40 ka), which fits very well the chronostratigraphical interpretation of the Levant (Mercier & Valladas 2003; Mercier *et al.* 1995b, 2000, 2007; Rink *et al.* 2003).

Discussion of the OSL age

The large influence of the γ-dose rate in OSL dating is evidenced by the two model ages for sample EVA-LUM-08/16 of 203 ± 36 ka and 111 ± 27 ka. However, these results are statistically identical at 98% probability (2σ). Furthermore, the stratigraphic location of the layer with respect to the TL dating results of selected archaeological layers above, as well as the overall chronostratigraphic interpretation of the site (layer 15 being older than ~ 350 ka, Le Tensorer *et al.* 2011), indicates a potential underestimation of the age by the presented OSL data. Despite its large palaeodose, the luminescence signal was well below saturation for the accepted aliquots. It is known that OSL ages on quartz might underestimate the age in comparison to e.g. IRSL dating (e.g. Steffen *et al.* 2009). A different explanation might be provided by the detection of authigenic quartz, which formed in a similar environment in the site of Nadaouiyeh Aïn Askar (Pümpin 2003), and which was observed in some limited analysis at Hummal as well. The *in situ* formation of authigenic quartz in deposited sediments requires time (Pümpin 2003), especially as crystals up to 1 mm in size were found. It can occur repeatedly and it is not possible to determine a time frame of formation. The, more or less, continuous palaeodose distribution of the sediment from Hummal could be explained by an intermittent but frequent formation of authigenic quartz for some time after deposition of the sediment. This process could have started rather soon after deposition or occurred later, or even repeatedly. It is not possible to distinguish the palaeodose data from quartz which was bleached and quartz which was formed after deposition. Multigrain aliquots could contain grains from different populations and therefore a continuous palaeodose distribution could be generated as a result of this mixing, which can not be distinguished from continuous formation over a certain period. Single grain luminescence analysis is required to investigate this hypothesis, by measuring palaeodoses from isolated single authigenic quartz and aeolian grains. If formation happened at different times or significantly after deposition, it might be possible to distinguish different palaeodose populations. However, it would be difficult to separate aeolian grains with attached (or coated) secondary quartz formation from single isolated authigenic quartz for grain numbers required for single grain OSL dating. Attempts to investigate differences in dissolution rates of aeolian versus authigenic quartz are under way, which might allow the separation of these quartz populations.

Based on this hypothesis, it might be assumed that the largest palaeodoses of around 330 Gy reflect the depositional age better, because the aeolian grains should have received the largest doses. However, this would be a minimum estimate again because multiple grain aliquots were measured. Hypothetical calculations for the two γ-dose rate models give ages of 160 ± 35 ka and 294 ± 39 ka for sample EVA-LUM-08/16, which are not significantly older than the ages based on weighted average palaeodoses.

Conclusions

The occurrence of disequilibria in the U-decay chain enforces the modelling of the external γ-dose-rates for dosimetric dating of the site of Hummal. The resulting TL-ages are significantly different for layers '5g' and '6b East', but not for layer 'α-h base'. Layer 'α-h base' is archaeologically not *in situ* and though layer '5g' and '6b' are documented within the stratigraphical sequence, both were exposed on the surface over certain time. Therefore the association of all samples to single archaeological events can be questioned. However, this appears to be less of a problem for the catastrophic displacement of the artefacts into layer 'α-h base', because consistent age results were obtained. This is in contrast to the two other layers, where for layer '5g' an age of approximately 100 ka is concluded from one result only, because of its increased reliability based on a larger internal dose-rate (considered as stable over burial time) in contrast to the other result. Furthermore, this age is also more in accordance with age estimates obtained for similar Tabun C type assemblages like Tabun unit I (Grün & Stringer 2000; Mercier & Valladas 2003), Skhul B (Mercier *et al.* 1993) and the Qafzeh material (Schwarcz *et al.* 1988; Valladas *et al.* 1988). The large discrepancies in model ages obtained for the two artefacts from layer '5g' indicate that the dose rate models are not appropriate for all samples from this layer, or that different events were dated.

These problems are becoming even more evident for the TL-age results for layer '6b East' which are too inconsistent to be associated with heating events close in time. While the archaeology is not consistent with an accumulation over an extended period of time, it has to be suspected that external dose rates apply, which are different to the one assumed here for establishing ages. Changes in the sediment surrounding the samples, in addition to the surface exposure, can be suspected as the cause. The resulting ages are likely overestimated, especially in the light of the dating results obtained for the other Hummalian assemblage and similar industries (see below). However, comparable results would be obtained if the external γ-dose-rate model from the sediment of layer 'α-h base' would be employed, which is also attributed to the Hummalian. It can be suspected that the changes in sediments and a potential small scale re-depositioning of the artefacts from layer '6b East' took place much later compared to 'α-h base'. However, the TL-dating results for layer '6b East' are considered as unreliable and therefore rejected.

The context age estimate of approximately 200 ka (minimum model 190 ± 35 ka and maximum model 210 ± 40 ka), as an average estimate for the heated flints from layer 'α-h base' compares well with age estimates for similar blade-rich Middle Palaeolithic industries, like Hayonim layer 'F top' and 'F base' with mean TL-dates on heated flint of 210 ± 28 ka and 221 ± 21 ka, respectively (Mercier *et al.* 2007), or at Tabun for unit IX (Tabun D-type) of 256 ± 26 ka with the same method (Mercier & Valladas 2003) with compatible Early Uptake ESR-dates on animal teeth (Grün & Stringer 2000). The agreement of the TL-ages for 'α-h base' at Hummal with these age estimates can be taken as indirect evidence that the model of a short time interval between original and re-deposition of the artefacts from 'α-h base' appears to be correct. However, the results for layer '6b East' do not agree with the previous attempts to date artefacts from this layer (see above). The results presented here appear to confirm the criticism raised above and by Mercier and Valladas (1994), stating that these previous age estimates are likely age underestimations.

The apparent age underestimation by OSL is likely caused by the post-depositional *in situ* formation of authigenic quartz. To our knowledge the formation of authigenic quartz in deposits has so far not been suggested as an explanation for age underestimation and observed palaeodose distribution in quartz OSL dating. The young OSL age, independent of the dose rate model, is neither compatible with the chronostratigraphy nor with the TL ages. This leads to the rejection of this OSL age because of suspicion that the underestimation is caused by the inclusion of authigenic quartz in the multi grain analysis.

Despite the problems in establishing the appropriate dose-rates for dosimetric dating at the site of Hummal, the modelled results for layer 'α-h base' indicate, that these problems can have little influence on the results, because the differences for the two models are not significant. This is promising in the light of the ongoing dating attempts for the Mousterian layers, which are mostly *in situ*. The interpretation of the sedimentological sequence and the state of the archaeological content of layer 'α-h base' appear to be correct, as shown by its TL age of approximately 200 ka which is in accordance with chronometric dating results on similar assemblages from the Near East.

Acknowledgements

S. Albert (MPI-EVA) is thanked for preparing and TL measuring the flint samples, D. Degering (VKTA) for γ-ray spectrometry and T.Schiffer (CEZ) for Neutron Activation Analysis. This research was made possible with the financial aid of: the Swiss

National Foundation, the Freiwillige Akademische Gesellschaft Basel and the Tell Arida Foundation, as well as a travel grant by the Leakey Foundation to Daniel Richter. We are grateful to the General Directorate of Antiquities and Museums of Syria for permission and assistance in carrying out our work, this gratitude is also extended to the Palmyra Museum for its help in our research. We also thank all members of the excavation team in Hummal, and the local community for their support.

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A YABROUDIAN EQUID SKULL AND UPPER CHEEK TEETH FROM THE SITE OF HUMMAL (EL KOWM, SYRIA)

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Introduction

This paper deals with Equid remains from an archaeological site in Syria, in particular from Yabroudian layers relatively dating between 350 000 and 250 000 years BP. The site of Hummal (El Kowm, Central Syria) yielded very rich archaeological and paleontological assemblages, indicating human activities at the site during the Middle Pleistocene (Le Tensorer *et al.* 2011). The fauna, coming from different levels, comprises Camelids, Equids and Bovids (especially Gazelle, and the absence of Aurochs and Antelopes). An Equid skull with upper cheek teeth are described. Particular attention is paid to dental enamel fold morphology and criteria are established for identifying to which species these remains belong.

The fauna of this site is dominated by steppe and desert species which are part of a faunal type called Saharo-sindian, studied for some years by Dr. P. Schmid (Schmid 2006, 2007, 2008). We find remains of Bovids; principally Gazelles (the absence of Aurochs and Antelopes should be noted), Camelids and Equids. Those Camelids are represented principally by two species, the dromedary (*Camelus dromadarius*) and a huge species (*Camelus nv. sp.*) unknown in the region. (Schmid 2007). The Equids could be distinguished by a small size (*E. hemionus*) (Schmid 2006). During the excavation of 2006, an almost complete skull of a very small size of Equid (inventory number E-6276) (figs. 1 and 2), a mandible and a metapodium of Hemione have been found in the Yabroudian layer 12. The main purpose of this paper is to study the skull and the upper cheek teeth (premolars and molars), to determine this specie of Equids which seem to have appeared for the first time in the region of El Kowm during the Yabroudian epoch. The conservation of this skull was undertaken in the laboratory of Tell Arida (El Kowm), by Dr. Peter Schmid (University of Zürich-Irchel, Switzerland), who conducts the anthropological and paleontological study of the site of Hummal. A cast of the skull had been manufacutred by Ms. Margrit Peltier, (Institute of Anthropology - University of Zürich-Irchel, Switzerland), to facilitate transportation.

The study of this skull has dual interests, first, it is situated in an important and palaeontologically little known period of the middle Pleistocene (the transition from the lower to the middle Paleolithic; relatively dated to 350 000 BP), second, it is the only discovered intact skull from this region. The detailed description of this skull will, therefore, serve as reference for the Near East and a contribution to the knowledge of the Pleistocene Equids of the Near East, whose Phylogeny is still unclear.

Material

The skull and the dental series of the fossil and recent Equids that we have personally examined to perform the paleontological study of the skull of Hummal came from the Naturhistorisches Museum Basel (Switzerland) and the Muséum National d'Histoire Naturelle (Paris, France), i.e. *Equus asinus* Linnaeus, 1758, No. C.III.50; *Equus asinus* Linnaeus, 1758, No. C.3271; *Equus asinus somaliensis* Noach, No. C.4597; *Equus asinus* Linnaeus, 1758 No. C.2061 from Naturhistorisches Museum Basel and *Equus hemionus hemippus*, No. A-65 from Muséum National d'Histoire Naturelle. In addition, the published descriptions and measurements of the different studies by V. Eisenmann (Eisenmann 1980, 1986, 1999, 2000).

Taphonomy

The layer 12 where the skull was found had two phases of formation. At the bottom, there is a layer of aeolian carbonate-silt, formed by precipitation of carbonate by algae and microorganisms in the water of the spring. This silt was covered by a layer of freshwater carbonate, which contains many shells of molluscs, ostracods and remains of algae (oogonia and stems of Characeae). This layer formed during a wet phase with a high water table in the local spring. On top of these limnic carbonates there is a travertine that was been partly eroded after its deposition, laying down detritic sediments in a palustrine environment in this part of the excavation. At the end of this cycle, drier conditions prevailed and aeolian sands were blown in (layer 11). In the sequence of layer 12 many calcified roots of plants that grew on the surface of the layer 11 have been found (Ismail-Meyer 2001 and personal communication).

We can say that the skull, after the death of the animal, was deposited at the bottom of a shallow pond. With time, the

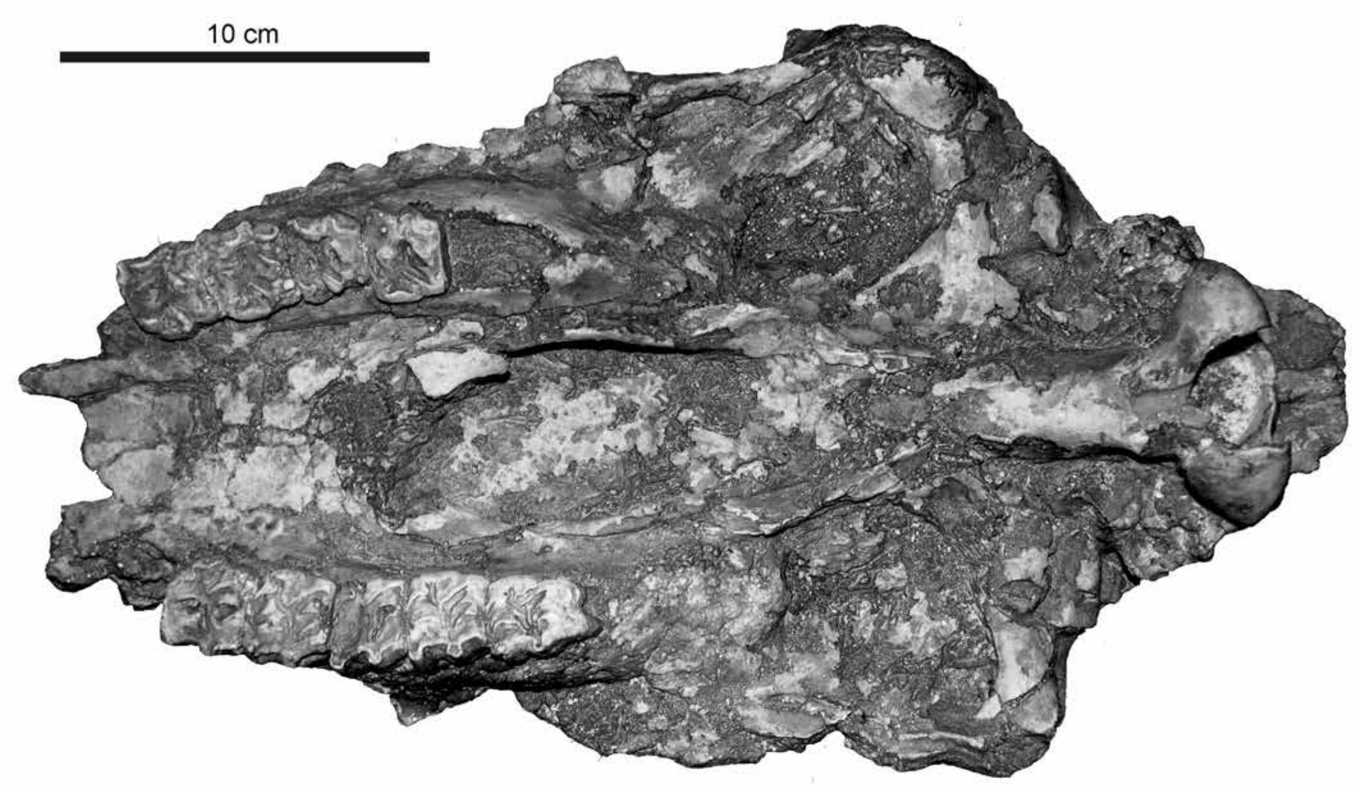

Figure 1 - View of the palate and underside of the Hummal Equid after full restoration.

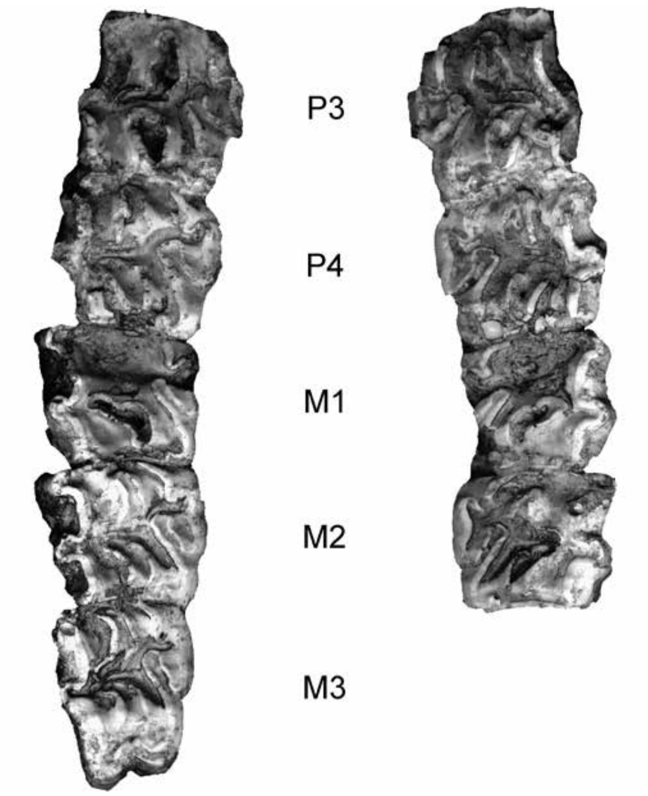

Figure 2 - Teeth rows of the Hummal Equid shown in actual size.

carbonates have covered it in a quiet environment permitting perfect preservation. The weight of the sediments affected the skull and flatted the fossil to a thickness of a few centimetres.

Methods

The measurement systems used in this paper are those of A. Von Den Driesch (Driesch 1976) and of V. Eisemann (Eisenmann 1986). Further measurements of the enamel folds of each tooth have been taken according to the method of P. Turnbull (Turnbull 1986) (fig. 3) The protocone index (the length of the protocone* 100/ the occlusal length of the tooth) was calculated according to V. Eisenmann (Eisenmann 1986) (tab.1). Similar measurements have been made on the comparative materials.

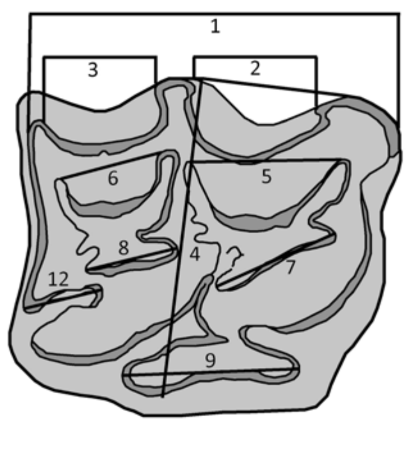

Figure 3 - Schematic drawing of upper cheek tooth of Hemionus locating the measurements taken for this study (after Turnbull).

measures	P3		P4		M1		M2		M3	
	dext	sin	dext	sin	dext	sin	dext	sin	dext	sin
Lo	22.73	23.55	20.51	21.78	17.78	17.55	19.20	18.31	23.60	--
lo	22.94	22.63	22.88	23.40	21.76	21.30	22.06	22.23	19.56	--
1	23.43	--	20.00	--	16.93	--	17.64	--	22.15	--
2	4.99	--	--	--	6.24	--	5.54	--	7.05	--
3	6.46	--	6.46	--	--	--	4.32	--	8.38	--
4	22.61	22.27	27.18	22.89	21.78	--	20.46	21.29	18.61	--
5	9.77	--	9.28	--	--	--	6.46	--	7.27	--
6	--	--	7.23	--	8.69	--	6.14	--	4.97	--
7	--	--	4.86	--	--	--	--	--	6.96	--
8	--	--	6.37	--	4.50	--	6.16	--	5.22	--
9	7.87	7.48	8.69	8.57	7.86	--	9.06	9.27	8.78	--
12	3.01	3.05	2.33	--	1.99	--	2.46	2.34	--	--
LOM	4.72	--	--	4.39	3.78	3.80	4.08	4.27	3.32	--
IP	34.62	31.76	42.36	39.34	44.20	--	47.18	50.62	37.20	--

23	60.88
48	107.8
29	64.9
30	29.9

Table 1 - Different dental and cranial neasurements in mm of the skull Hummal E 6276. L: occusial length, lo: occusal width, LOM: mesostyle length, IP: protocone index, 23: molar length, 29: width of the occipital condyle, 30: breath of the foramen magnum, 48: greatest palatal width.

Descriptive study of the skull and the upper cheek teeth

Skull

The skull of this Equid belongs to a rather aged individual, having quite worn molars. The incisors, canines and the left P^2 and P^3 are not preserved. Due to the sediment pressure the skull is highly compressed, so many characteristics are very difficult to observe. The measurements taken on each of the two upper cheek teeth, right and left, show small differences. Is this due to individual variation (Equids have a strong inter- and intraspecific variation) or to the deformation of the skull due to the weight of the sediments? S. Payne (1991) mentions that "*the pattern of enamel folding at the occlusal surface changes considerably as the tooth is worn. It is important, therefore, to consider occlusal enamel measurements and morphology in relation to the varying extent to which different teeth are worn. It has also long been recognized that the pattern of enamel folding differs in different teeth in the same tooth raw (especially between premolars and molars)*". The Equid skull found at the site of Hummal is currently a unique specimen, so its paleontological importance is considerable.

Determination of Sex and Age

Determination of the sex

In many species of mammals, some parts of the skeleton differ morphologically between the two sexes. In Equids, the jaws of males in general present big permanent canines, while they are missing or very small in the females (Klein & Cruz-Urbid 1984).

V. Eisenmann (Eisenmann 1980) mentions that in *Equus caballus*, the canines exist, in principle, only in the males. The females sometimes have two canines on the both upper and lower jaws but these teeth are in general rudimentary, in the other cases, there are females having well-developed canines in only one of the two jaws, most often on the lower jaws (Eisenmann 1980). On the skull of the Equid of Hummal, the part with the canine is destroyed, so we can not know if the canine existed or not. Indeed, it is impossible to determine the sex of the specimen of Hummal.

Determination of the age

There are several methods for determining the age of an animal from its teeth (cementochronology, the wear- teeth). There are some drawbacks of the first method. Theoretically, the main difficulty is that the causes of annual formation are not fully understood. The seasonal differences in alimentation are generally considered as responsible (Klein & Cruz-Urbid 1984). It also requires thin sections for the microscopic study of the lines of arresting growth, which are often difficult to read and requires a good practice (Chaix & Méniel 1996). Furthermore, depending on the conditions of fossilization, the cement can be poorly preserved, preventing a good observation. On the Hum-

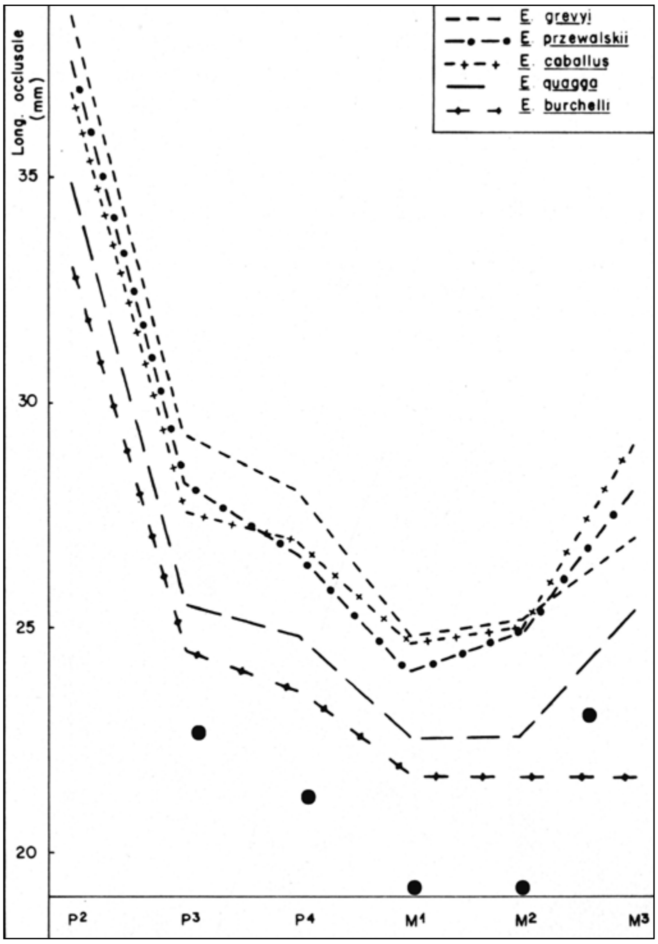

Figure 4 - Mean occlusal lengths in mm of the upper cheek teeth of current Equids. The black dots indicate the measurements of the Hummal Equid (modified after Eisenmann 1980).

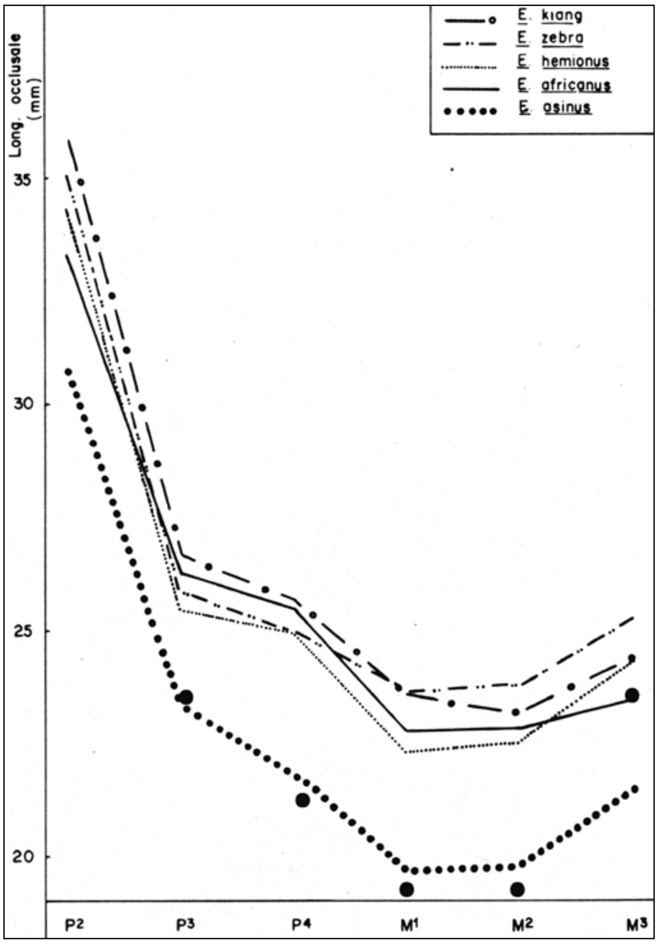

Figure 5 - Mean occlusal lengths in mm of the upper cheek teeth of asses, half-asses and zebras. The black dots indicate the measurements of the Hummal Equid (modified after Eisenmann 1980).

mal fossil this method cannot be performed, as it is destructive. Morover this method can not be applied to the specimen of Hummal, as access to the original material is restricted and work has to be done basically on a cast.

The second method has however an important drawback. The abrasion depends very strongly on the type of alimentation and the environment of the animal (Klein & Cruz-Urbid 1984; Davis 1987; Chaix & Méniel 1987, 1996). Nevertheless, this method is suitable for an approximate age estimation of Equids. It was developed by C. A. Spinage, and Klein who applied it to collections of Zebra and other animals in many sites of South Africa (Davis 1987 and literature therein). With this method, the height of the crown of a tooth is measured

The obtained data of the Hummal fossil can be compared to the curves of reference material of known age (Spinage 1972; Davis 1987). By comparing the obtained data on the specimen of Hummal with those shown in the work of Spinage (Spinage 1972), we can estimate the age of this specimen between 12-18 years. We have to note that this is not a definitive age because the study was made on a cast, and the different type of alimentation between the region of El Kowm and that in South Africa should be considered. In future, we should return to work on original material, to have a better estimate of the age of the Equid of Hummal.

Upper cheek teeth morphology

The third premolar P^3

The parastyle is well marked and has more or less external oblique flattening on its extern edge. The mesostyle is prominent, its contour is generally rounded. The metastyle is well marked. The hypocone reaches the metastyle level on the posterior surface of the tooth. The external walls of the paracone and metacone are slightly convex. The protocone is short, the general shape is almost globular, the mesial lobe is very short. The fold Caballine is not very visible or almost absent. The postprotoconic valley is wide, while the preprotoconic valley is small.

The fourth premolar P4

The parastyle is well marked and has more or less external oblique flattening on its extern edge. The mesostyle is prominent, it has a rectangular shape. The metastyle is not very visible. The hypocone reaches the metastyle level of the posterior surface of the tooth. The external walls of the paracone and metacone are flat or slightly concave. The protocone is short but longer than that of P^3 and more elongated, slightly developed in front, the lower wall is convex. The fold Caballine is not very visible or almost absent. The postprotoconic valley is wide, while the preprotoconic valley is small.

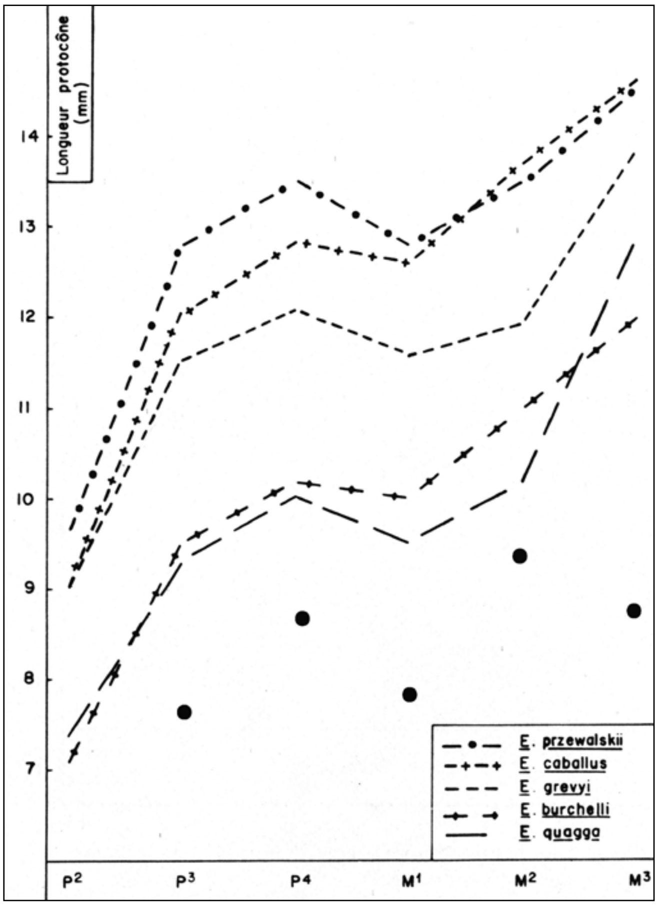

Figure 6 - Mean protocone lengths in mm of the upper cheek teeth of current Equids. The black dots indicate the measurements of the Hummal Equid (modified after Eisenmann 1980).

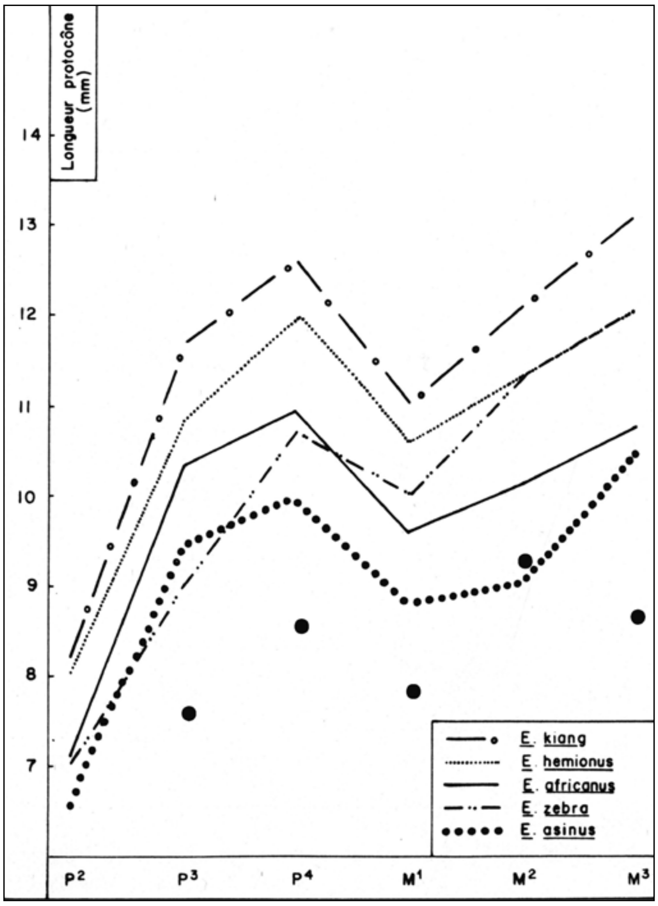

Figure 7 - Mean protocone lengths in mm of the upper cheek teeth of asses, half-asses and zebras. Black dots indicate the measurements of the Hummal Equid (modified after Eisenmann 1980).

The first molar M^1

The parastyle is stronger than on P^3 and P4, it has a semicircular shape. The mesostyle is rounded and smaller than on P^3 and P4. The metastyle is a bit visible. The hypocone reaches the metastyle level of the posterior surface of the tooth. The external walls of the metacone and paracone are flat or slightly concave as on all other teeth. The paracone is destroyed on both series. The metacone is deep and elongated upward. The protocone is slightly smaller than that on P4 and less elongated. The fold Caballine is absent. The postprotoconic valley is narrower than that on P4, while the preprotoconic valley is smaller than on P4.

The second molar M^2

The characteristics of the M^2 are very close to those of the M^1. The parastyle is not clearly visible. The hypocone reaches the metastyle level of the posterior surface of the tooth. The protocone is more elongated and larger than on M^1, more developed in front. The fold Caballine is absent. The postprotoconic valley is wider than on M^1 and the preprotoconic valley is larger as that on M^1.

The third molar M^3

The characters of the M^3 are very close to those of M^2. The styles in general are weaker than the M^2. The parastyle is not clearly visible. The metastyle is more advanced than the hypocone on the posterior surface of the tooth. The protocone is elongated as on the M^2, particularly, on the distal face, the lower wall is more flattened than on the M^2. The fold Caballine is absent. The postprotoconic valley is wider than on M^1, and the preprotoconic valley is large as on M^2.

Upper cheek teeth metrics

The fossettes in general are rarely folded. On the M^2, a contact between the two fossettes is marked. The length of P^3 is greater than P4, while their widths are almost equal. The length and width of the M^1 are smaller than those of the P4 and M^2. The M^1 is particularly very small (tab. 1, figs. 4 and 5), it has an almost trapezoid shape, its protocone is very small. The length of the M^3 is greater than the M^2, but its width is smaller. In fact, the M^3 (tab. 1, figs. 4 and 5) is the longest and narrowest of all the teeth of the skull of Hummal, it forms a trapezoid, its protocone is too elongated.

The lengths of the protocone of the skull of Hummal (tab. 1, figs. 6 and 7) increase gradually from P^3 to P4, then decrease on the M^1. The length of the M^1 is smaller than on the P4 as in *E. asinus* (Bonifay, 1991). The length of the protocone increases on M^2 where it is the longest, then decreases again on the M^3. The protocone index (tab. 1, fig. 8 and 9) of the M^1 in comparison with the P4 is increased on the skull of Hummal as in *E. grevyi*,

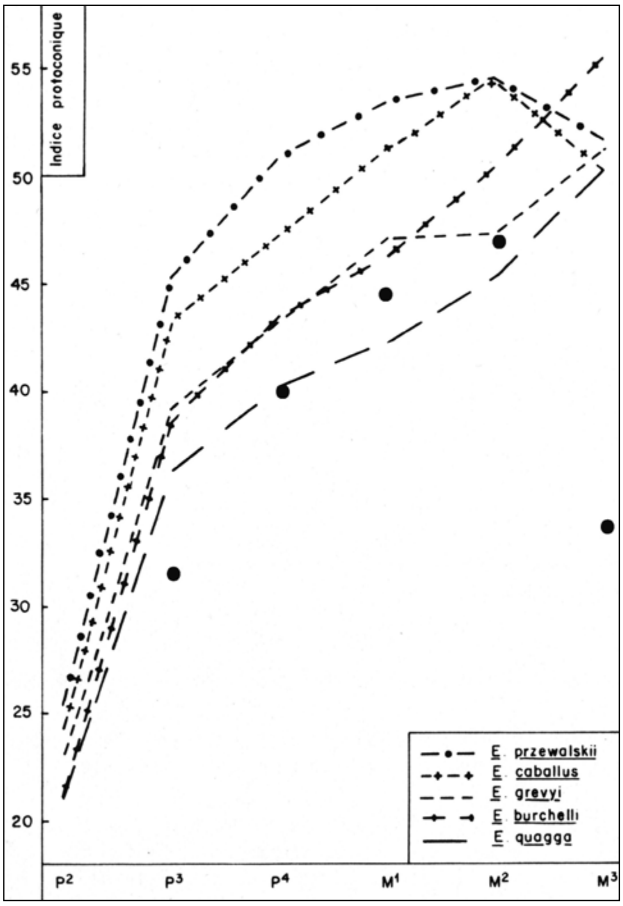

Figure 8 - Mean protocone lengths in mm of the upper cheek teeth of current Equids. The black dots indicate the measurements of the Hummal Equid (modified after Eisenmann 1980).

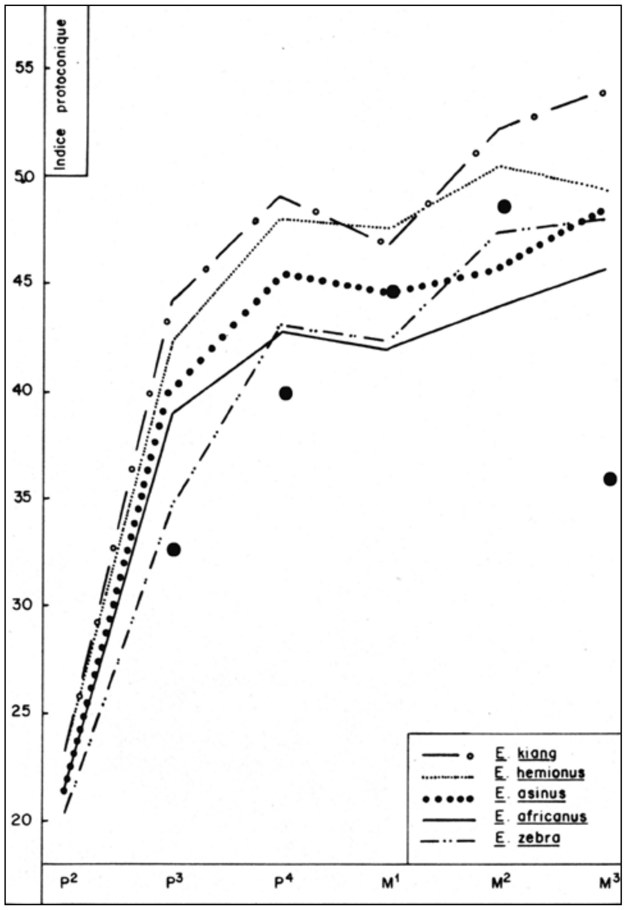

Figure 9 - Mean protocone lengths in mm of the upper cheek teeth of asses, half-asses and zebras. Black dots indicate the measurements of the Hummal Equid (modified after Eisenmann 1980).

E. burchelli, *E. quagga*, the *E. caballus*, and in the fossil Equids of Lunel Viel (France), while it is smaller in Hemiones, Asses, and Zebras (Bonifay 1991).

Comparative study

The comparative study of the skull from Hummal and other Equids covers several cranial and dental characters. The premolars and molars are much more reliable for the identification of species. Specifically, the fold caballine, the buccal region, and the protocone are distinctive characters. We can add the hypocone and the metastyle for the upper molars. Therefore, we can accept the presence or absence of a well developed fold caballine as a good feature to distinguish the upper cheek teeth of Horses from those of Hemiones and Asses. All these indexes permit the creation of graphs that show the evolution of the protocone index on the dental series for each species and the respective position of the Hummal fossil.

These results will be principally compared to those established by V. Eisenmann (1980) for the different actual Equids (figs 4-9). Thus, it will be possible to specify to which species the skull of Hummal belongs. According to V. Eisenmann (Eisenmann 1980), it is possible to establish a protocone formula to describe the form. Class 1 corresponds to protocone index between 15 and 20, class 2 corresponds to protocone index between 20 and 25, Class 3 corresponds to protocone index between 25 and 30, Class 4 corresponds to protocone index between 30 and 35, Class 5 corresponds to protocone index between 35 and 40 etc. (Eisenmann 1980).

According to V. Eisenmann (Eisenmann 1980) the protocone formula for the different Equids is:
234,456 in *E. burchelli*
234,345 in *E. quagga*
234,334 in *E. africanus*
245,344 in *E. asinus*
356,555 in *E. przewalskii*
245,555 in *E. caballus*
245,454 in *E. hemionus*

The protocone formula of *E. hemionus hemippus* is 667.787 and that of Hummal is - 46,675 as the P^2 is missing.

Overall, it seems that there are two groups of Equids that differ by the values of their protocone index. The protocone indexes are rather low in Zebrines, Asiniens and the forms of Plio-Pleistocene of Europe and Africa, the protocone indexes are high in Caballines, Hemiones and the forms of Pliocene and Plio-pleistocenes of Asia and North America (Eisenmann 1980).

Based on the morphology of the upper cheek teeth and the protocone indexes, the Equid of Hummal has clearly Hemionian affinities, and it is to this group it should belong. The small

Equid of Hummal is comparable to the Hemiones described by V. Eisenmann and others cited above. Its teeth are very small in size and can be attributed to the Hemippe of Syria (*E. hemionus hemippus*), described in 1855 by Isidore Geoffroy St. Hilaire (Ducos 1970, 1986). In the region of El Kowm (Central Syria), and more particularly at the site of Umm el Tlel, next to Hummal, C. Griggo (Griggo 1998, 2000) had already reported the presence of this subspecies in the Mousterian levels of the Middle Paleolithic, under the name of *E. hemionus syriacus*.

Relationship between the protocone index of M^1M^2 and P^3P4

Among the actual species, the protocone indexes of M^1M^2/P^3P4 permit a good distinction between the Asinids and Hemiones (105 to 108) on one hand, and on the other hand, the Zebrina and Caballins (112 to 118) (Eisenmann 1980). This observation could indicate a gradual increase of the index. Assuming this hypothesis, we note that the Equid of Hummal (112) may have given birth to *E.hemionus syriacus* of the site of Umm el Tlel (117) and to the *E. hemionus hemippus* (119). Based on the relationship between the protocone index of the M^1/M^2 and $P^3/P4$, the *Equus hemionus hemippus* of Hummal is more archaic than the *Equus hemionus syriacus* of Umm el Tlel and the *Equus hemionus hemippus* from the Muséum d'Histoire Naturelle, Paris.

Discussion

Based on the dental and cranial morphology and measurements, it seems that the Hummal Equid closely resembles *E. hemionus hemippus* described in 1855 by Isidore Geoffroy St. Hilaire. It will be helpful for the future to study more Equid remains (cranial and postcranial), to have a better idea about the different species of Equids in the Hummal and in the region of El Kowm, particularly about *E. hemionus hemmipus* whose systematic position is still unclear. While some scholars think that it belongs to the Asses, M. George and H. Milne-Edwards believe that this is not a new species but a variety from *E. hemionus*, and H. Milne-Edwards goes that far to suggest that the Hemippe of Syria is a result of hybridization of horses and Hemiones, which seem themselves an intermediate between horses and asses, but closer to asses than to horses (Eisenmann and Mashkour, 2000 and literature therein). It seems reasonable to agree with George's view and consider the Hemippe of Syria as a subspecies of *Equus hemionus* (Eisenmann & Tranier 1985).

Gromova (1955) mentions that the South-West of Asia was the meeting place of three lines of Equids: Northern (current Horses), South European (Otranto Asses) and East Asian (Half-asses). Further studies will provide a clear idea about the evolution of the Equids in this region, to which the site of Hummal and the region of El Kowm belong.

Acknowledgments

I wish to thank Prof. Dr. Jean-Marie Le Tensorer, Nicole Reynaud and Reto Jagher for their help, availability and advice. I also wish to thank the staff of the Naturhistorisches Museum, Basel (Switzerland) and of the Muséum National d'Histoire Naturelle at the Anatomie comparée (Paris); in particular Ms. Annik Abourachid and Mr. Luc Vives for their help and kindness during my study of their collections.

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THE LOWER PALAEOLITHIC ASSEMBLAGE OF HUMMAL

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Introduction

Since 1999 several layers comprising a rich assemblage of faunal and lithic artefacts have been excavated at the bottom of the Hummal well site. The lithic assemblage mainly consists of unretouched flakes, some cores and different pebble tools such as Choppers, Hammerstones and Spheroids. In this article a brief introduction to the lithic assemblage is provided and some details of each artefact category are discussed. It is based on the results of a detailed examination and description of the artefact record, which was accomplished during the excavation in the summer of 2007. The excavation work at the Hummal well site will continue in the future and further data will be accumulated. Additionally, a detailed analysis of the excavated material is planned. Therefore, this article has a preliminary character and intends to provide an initial insight into the Lower Palaeolithic material from Hummal. The Hummal excavation is a joint project of the University of Basel and the Syrian Directorate of Museums and Antiquities, which began in 1997. Two years later, in 1999, a lithic assemblage was discovered in the layers at the bottom of the well, which consists of abundant unmodified flakes and different pebble tools. The lithic inventory is accompanied by a wealth of faunal remains (see tab. 1). The artefact rich layers are located about 14 m below the present day surface. In the stratigraphy of Hummal they are placed below the Yabrudian sequence and the layer with the so-called Acheuleo-Tayacien (Le Tensorer *et al.* 2011). This Lower Palaeolithic sequence includes six geological layers, four of which (Layers 15–18) are being excavated over a large area (figs. 1 and 2).

	Faunal remains	Lithic artefacts	Total	%
Layer 15	114	8	122	5%
Layer 16	310	36	346	15%
Layers 17 and 18	1583	182	1765	79%
Total	2007	226	2233	100%

Table 1 - Composition of the finds in the different archaeological levels (status 2007).

Layers 19 and 23 are only known from a small sounding excavation completed in 2010. Subsequently, a brief description of each layer is provided.

Layer 15 is a dark, nearly black clay and has a thickness of 10 to 15 cm. Only few stone artefacts were found in this layer, the faunal remains are more numerous but heavily crushed and fractured by the weight of the sediments.

The underlying Layer 16 is a package of hard carbonated silt, about 30 cm thick. The density of finds is not very high and a genuine archaeological level is not recognisable.

Layer 17 is about 10 to 15 cm thick and again consists of black clay. It is very similar to Layer 15 but shows a higher density of

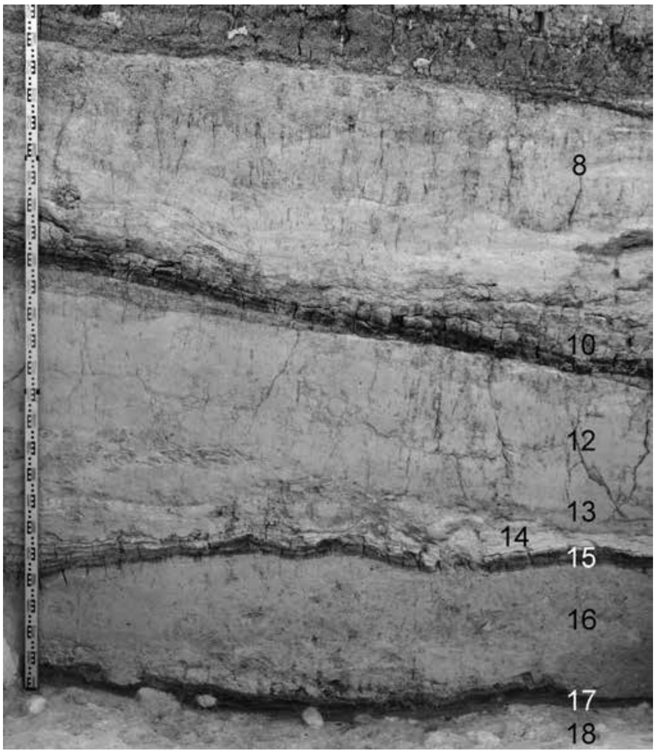

Figure 1 - Stratigraphy of Lower Palaeolithic and Yabrudian deposits in profile 57, layers 9 and 11 are not visible in this section.

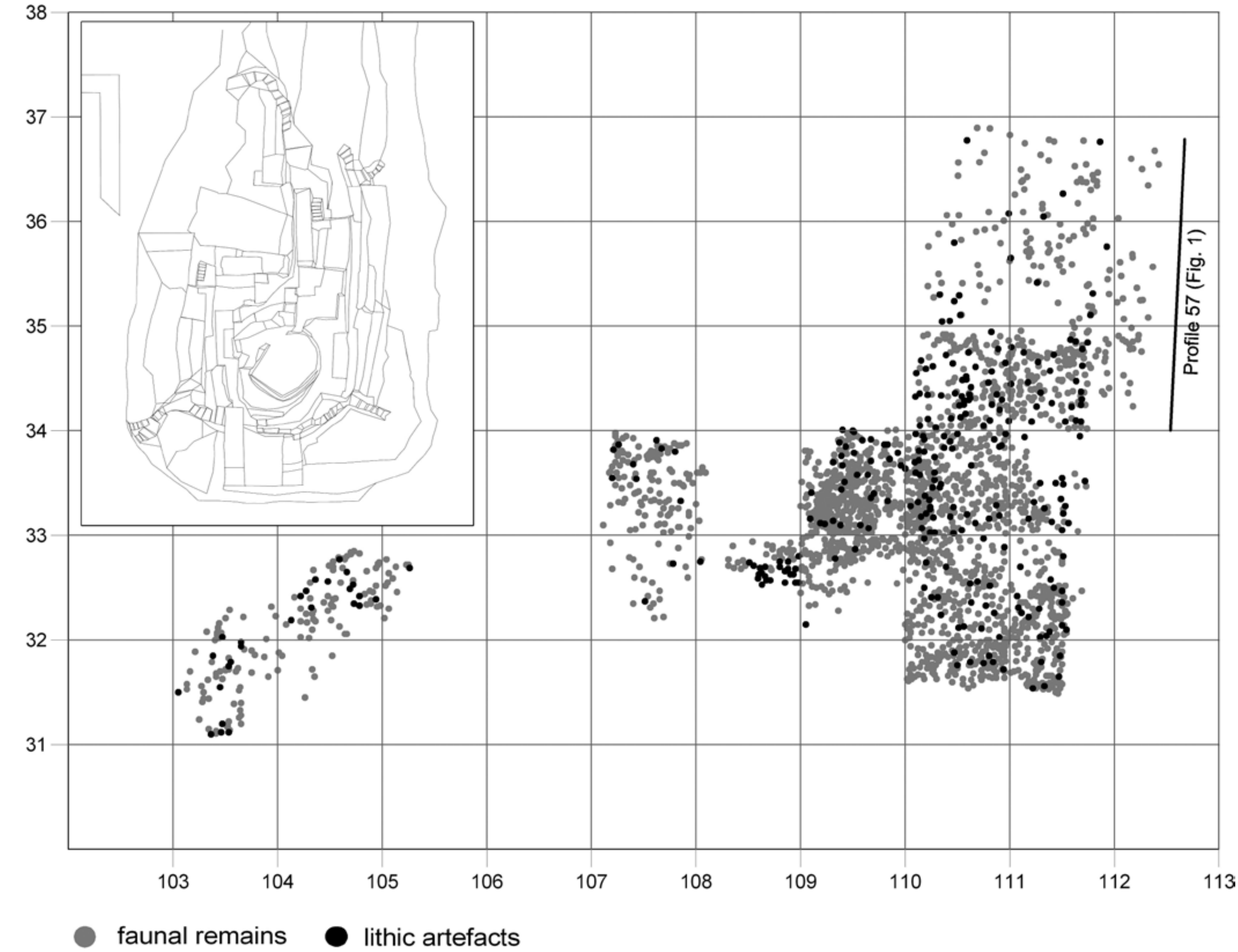

Figure 2 - Horizontal distribution of archaeological finds in the excavated area (layers 15-18).

finds. Numerous crushed and fragmented bones are preserved. Especially notable is the high number of microfaunal remains recorded from this layer.

Layer 18 bears the richest levels of the Lower Palaeolithic sequence (fig. 3). It consists of sandy carbonated silt and its thickness amounts to 25 cm. Two archaeological levels are descernible; one is located on the top of the layer, while the second level is embedded in the middle of the layer. The density of archaeological finds is highest for the whole Lower Palaeolithic sequence. Especially in the upper level where partial animal skeletons, sometimes in anatomical connection, are present together with a rich assemblage of stone tools.

The Lithic Assemblage

A total of 226 lithic artefacts was analysed (tab. 2). More than 80% of these are remains of a flake production. The rest consist of different pebble tools. All lithic artefacts are in good condition; neither physical nor chemical weathering is apparent. This implies, that the artefacts were embedded shortly after their deposition and were not exposed at the surface for any extensive period of time. The artefacts were also not significantly transported after deposition.

Flakes

The lithic assemblage includes 126 unbroken flakes, constituting about half of the total material. In addition, 39 fragmented flakes were excavated. The majority of the flakes are made from Eocene flint, only a few pieces are made from Cretaceous flint. The flakes are generally short and broad. The length-width ratio averages 1.35 (fig. 4). The thickness of the flakes is in the range of 0.2 cm to 4.5 cm. The majority of the striking platforms show no secondary preparation, 60% are plain, further 15% are cortical. Only four pieces have a kind of facetted striking platform. The few facetted objects do not indicate that the modification of the striking platforms was intentional but are rather interpreted as accidental products. The remaining striking platforms are splintered. Cortex remains are found on the dorsal faces of 65% of the flakes (fig. 5). The values for the angle between the striking platform and the ventral face of the flakes are in the range of 90° to 135°, with an average of 114°.

Tools

There are no unequivocally retouched artefacts in the assemblage. The only evidences for a secondary modification of the

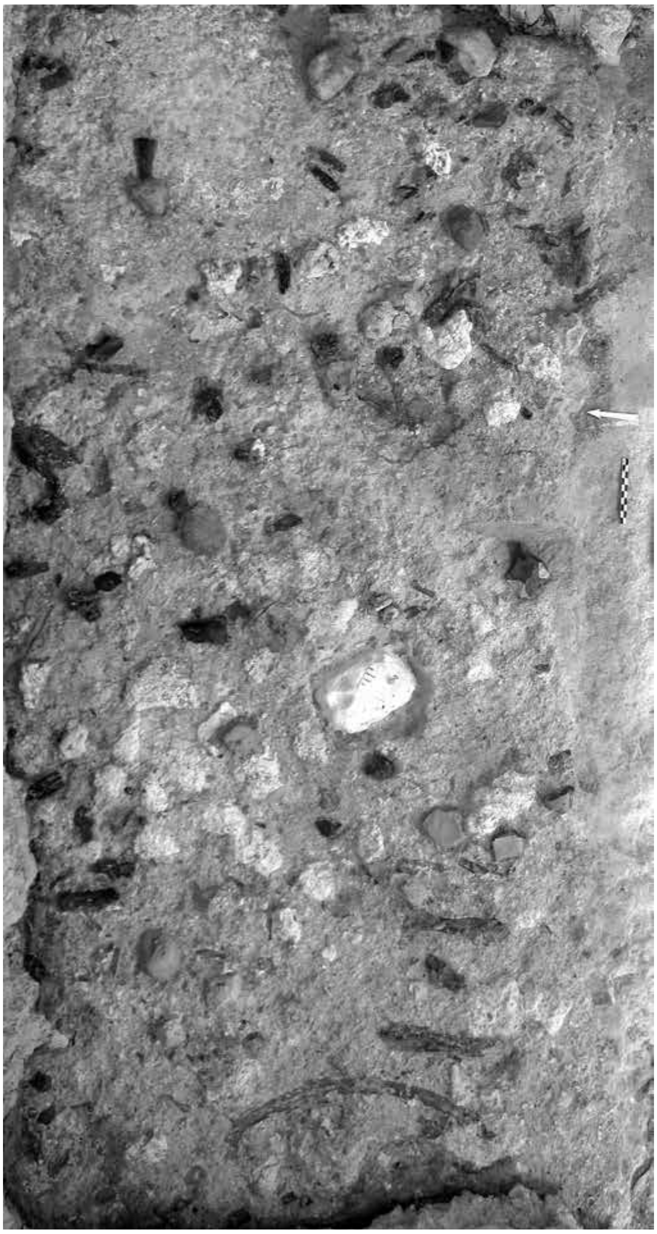

Figure 3 - Archaeological level in layer 18.

	N	%
Flakes	126	56%
Debris and fragments	52	23%
Cores	9	4%
Cores on flake	16	7%
Choppers	8	4%
Sphaeroids	2	1%
Hammerstones	7	3%
Modified cobbles	6	3%
Total	226	100%

Table 2 - The lithic assemblage (status 2007).

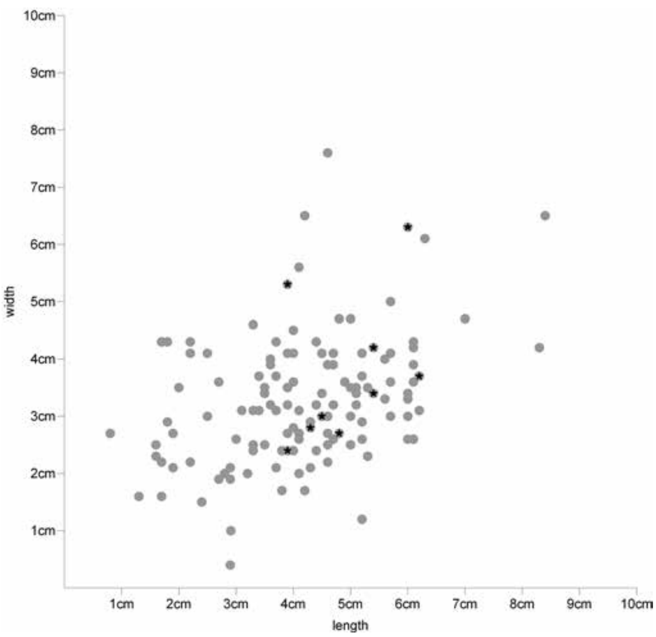

Figure 4 - Length-width-ratio of flakes, the pieces with notches or traces of use are highlighted with black stars.

flake-edges are some isolated notches. The inventory comprises a total of six specimens with one or multiple notches.

Additionally, some samples bear irregular micro-retouch on their edges, which probably resulted from their intensive use. Similar items have been described from different Early Palaeolithic sites in Africa and Europe (de Lumley 2006; de Lumley *et al.*, 2005). Only 13 pieces show such distinctive traces on their edges, a few more have possible traces. The location of the micro-retouch varies from one specimen to another. Some flakes bear traces on one or both sides, giving them a scraper-like appearance. On others they are limited to certain areas such as in the notches or on the edges. The flakes with notches or traces of use show variable dimensions (fig. 4). A specific choice of selected pieces is not evident. A microscopic use-wear analysis of the assemblage of Hummal has so far not been conducted. Therefore, these interpretations are preliminary in nature and have yet to be confirmed by a detailed analysis of the assemblage.

Cores

Of the ten cores recovered from the lithic assemblage, nine are made from Eocene flint and one is made from cretaceous flint. The cores are rather small; a standardised reduction strategy is not recognisable. The cores have two or more faces, which were used as striking platform and as flaking surface. There is no evidence for a preparation of the striking platform and the reduction sequence is simple. After detaching a flake, the remaining scar was reused as striking platform. This reduction strategy is identical to that described for the Clactonian assemblages in Europe (Forestier 1993). The small sizes and the rather high number of scars on the cores suggest that the raw material was reduced in an exhaustive manner. Another kind of core, which is abundant in the assemblage, results from the secondary use of flakes, fragments and debris, as cores. These cores are small and show just a few small scars. Altogether, 15 such specimens were found, which amounts to 6% of the lithic assemblage and constitutes 2/3 of the total number of cores. The flakes produced from these cores were small, as the maximum scar-length

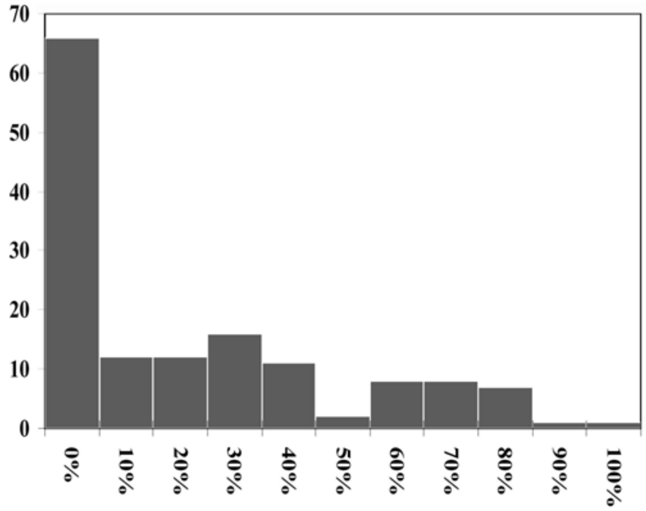

Figure 5 - Percentages of cortex on flakes.

on the cores is 1.5 cm. Several small flakes obtained from the use of flakes as cores are present in the assemblage. They are recognised on account of showing two ventral faces. The reasons for the production of such small flakes are not well understood. However, as the double ventral faced flakes are very sharp, they may be tentatively interpreted as utensils used for cutting purposes.

Pebble Tools

The description of the pebble tools follows Marie Leaky's typology established for the material from the Olduvai Gorge (Leakey 1971). This typology is a helpful tool for describing the different pebble tools and facilitates the comparison of the artefact record to that of other assemblages. The function of certain types is unclear. In many cases it is disputed whether the pebble tools were real tools or just by-products of the flake production (Toth 1985; Sahnouni *et al.* 1997, see also: Hayden 2008)

Choppers

The group of choppers includes all tools that have an artificial straight edge. The edge was formed by chipping either one or a series of flakes from either one or both sides of the pebble. On account of the small number of specimens in the assemblage, they are not grouped in more detail i.e. into choppers and chopping tools. Although some of the Choppers could also be simple cores, they are all grouped together in order to facilitate comparison. Furthermore, the choice of mainly limestone and cretaceous flint for the production of these artefacts indicates that the choppers in Hummal are a discrete tool-type rather than part of the flake production. Some of the Choppers bear different crushing marks on the edges. These are interpreted as a consequence of the use of the edges.

Modified Cobbles

The group of modified cobbles contains all artificially modified pieces that do not fit into another group. Often they are similar to Choppers, but the scars are isolated and do not form a contiguous edge. A purposive treatment of the stone is not recognisable. Probably these objects were primarily cores that were discarded at an early stage of the reduction.

Spheroids

Only two typical spheroids were recovered from the Lower Palaeolithic assemblage at Hummal. Both are made from limestone. One is a facetted object; the other has a smooth and rounded surface, which is covered in percussion marks. Spheroids are typical Lower Palaeolithic tools, which occur frequently but in small numbers. The function of these pieces is unclear, different interpretations e.g. as bola stones, club heads, hammerstones, bone breaking tools or vegetable processors have been suggested (Sahnouni *et al.* 1997 and references therein). Experimental analysis shows that the facetted objects most likely represent remaining cores of an exhaustive flake production in limestone (Sahnouni *et al.* 1997). It must be kept in mind, however, that so far no limestone flakes have been recovered from the Hummal assemblage. The rounded and battered spheroid probably represents an intensively used hammerstone (Schick & Toth 1994).

Hammerstones

Hammerstones comprise the last artefact group. These objects show clear evidence of usage although they are not the result of a purposive production. Mainly limestone was used for hammering, although one flint object and one quartzite cobble also show percussion marks. The hammerstones show areas with concentrated percussion marks, often located on the edges of the cobbles some hammerstones have additional isolated concave scars, which presumably occurred accidentally during their application.

The nature of the material, which was processed with these utensils, remains unclear; a primary employment for flint detaching is probable, however, other uses such as bone or plant processing cannot be excluded. It is conspicuous, that the size and weight of the hammerstones is decidedly higher than that of the cores. This can be considered as evidence against the utilisation of the hammerstones for flint knapping.

Raw Material

As mentioned the most important lithic raw material in the Lower Palaeolithic assemblage in Hummal is the Eocene flint. Limestone and Cretaceous flint are also present and one quartzite pebble was used as a hammerstone. When considering the use of raw material for the production of distinct artefact groups, it is conspicuous, that flakes were produced almost exclusively using Eocene flint. Only four percent of the flakes were made of Cretaceous flint, the other stones were not used for flake production. The raw material is very different from the pebble tools, which are mainly limestone or to a lesser extent Cretaceous flint. The high quality flint from the Eocene deposits was seldom used for making pebble tools.

Information on the provenance of the raw material can be gained from an analysis of the cortex. Nearly half of the ana-

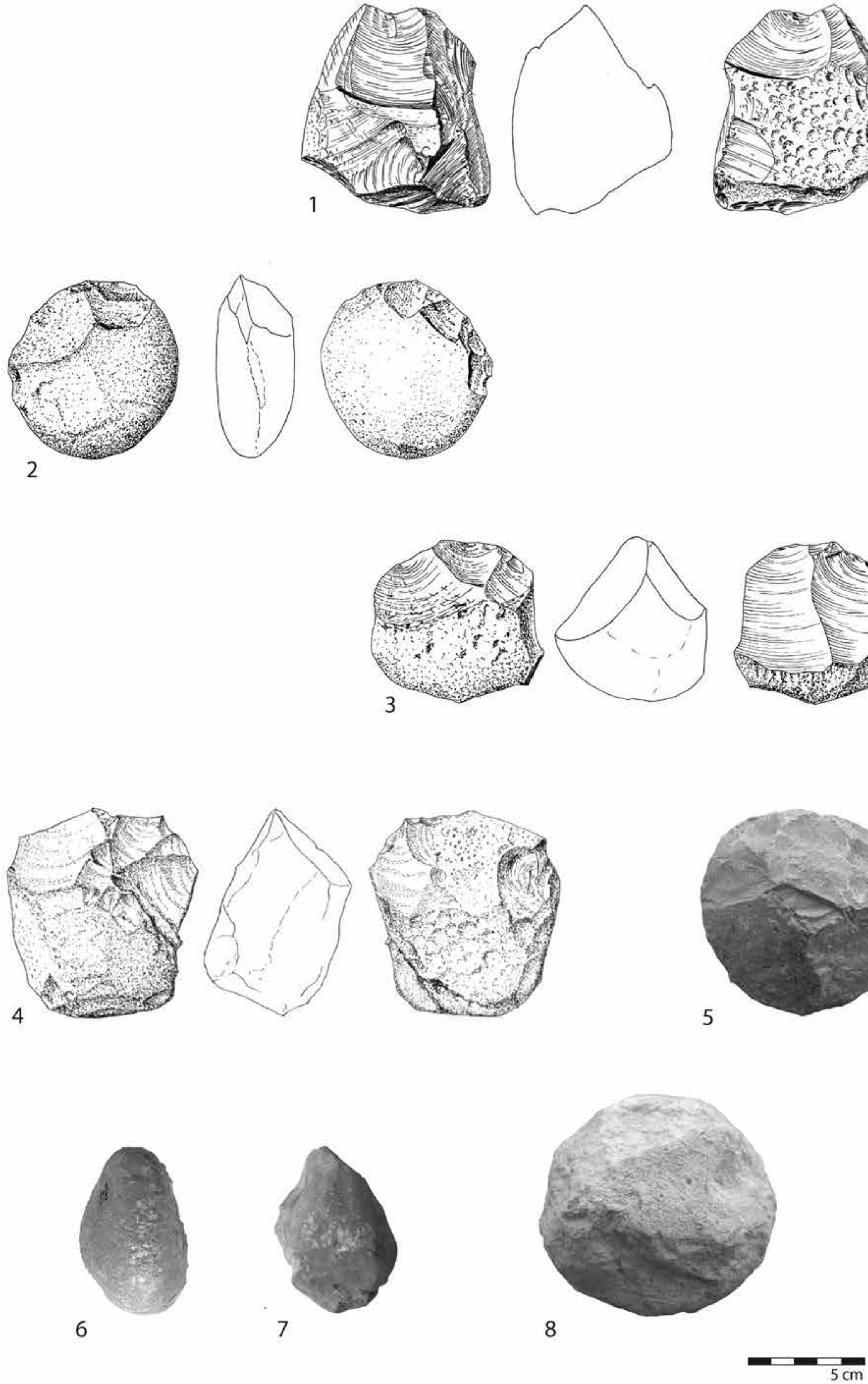

Figure 6 - Pebble tools. 1-4: choppers; 5: facetted sphaeroid: 6-7: hammerstones; 8: sphaeroid (drawings: Jean-Marie le Tensorer, photos Fabio Wegmüller).

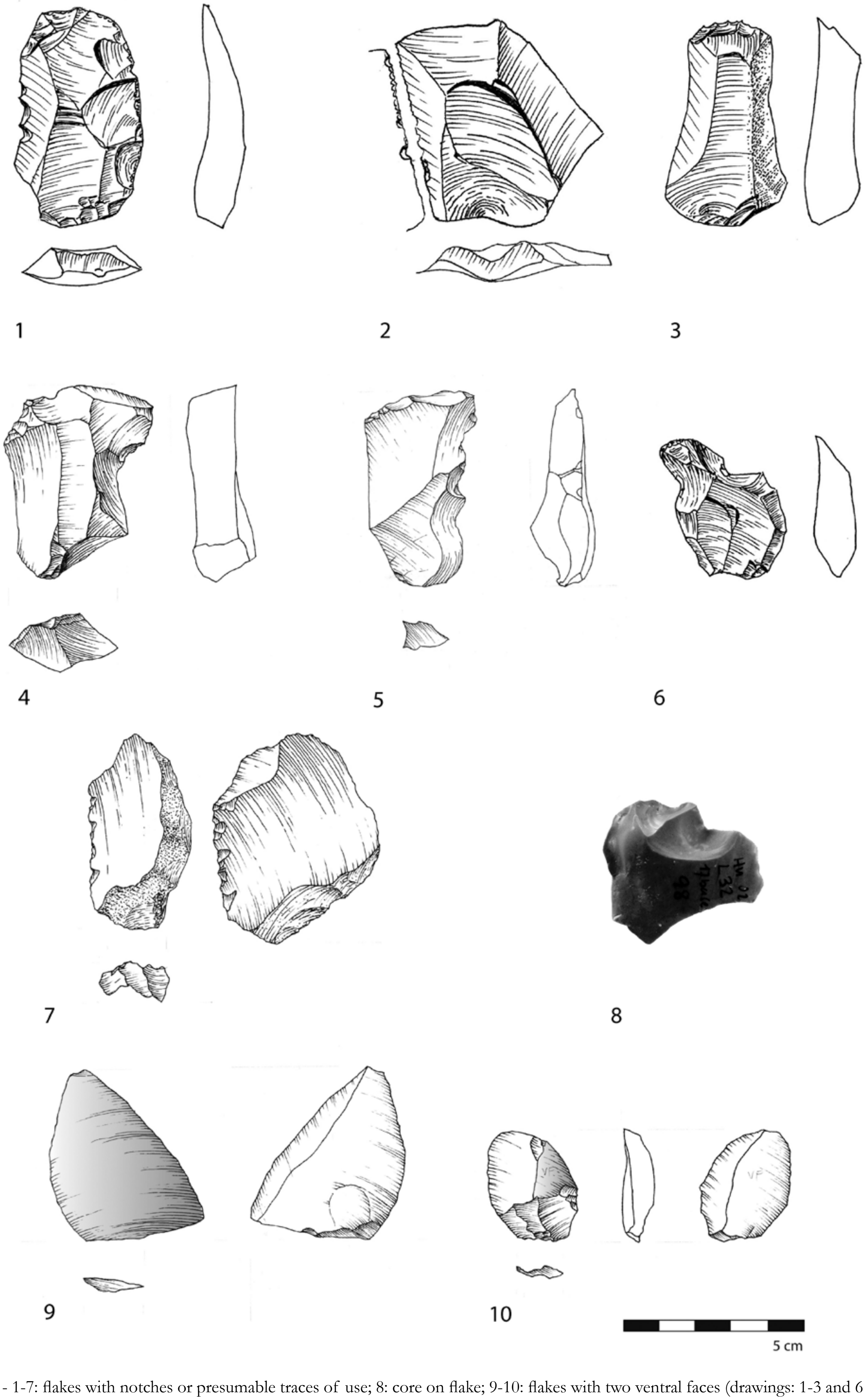

Figure 7 - 1-7: flakes with notches or presumable traces of use; 8: core on flake; 9-10: flakes with two ventral faces (drawings: 1-3 and 6 Jean-Marie Le Tensorer; 4-5, 9-10 Thomas Hauck, photo Fabio Wegmüller).

lysed pieces bear cortex remains on the surface. Independent of the raw material the majority of the cortex is totally abraded and only a neocortex is present. Further pieces have some remaining cortex, which is weathered and abraded.

Especially the flint artefacts are often made of cobbles with a neocortex, which indicates longer transport distances of the raw cobbles preceding their collection by the humans. If we compare this with the percentages of objects with neocortex and weathered cortex from the upper layers in Hummal it is conspicuous, that in all the younger assemblages the number of these pieces is significant lower, e.g. for the Mousterian layers only 20% of the cortex is not fresh. In the Hummalian these numbers are even lower. The high percentage of weathered cortex shows that the humans did not collected their raw material from the outcrops of the flint, but preferentially in secondary deposits. In the region of El Kowm artefacts made of similar raw material were found in the site of El Meirah, where a lithic inventory from the Middle Acheulian was excavated. This site dates to about 700 Ka (Böeda *et al.* 2004) The use of lithic raw material from secondary deposits, in particular from fluvial deposits, close to the site of processing, is a typical feature of the Lower Palaeolithic assemblages of Africa, Europe and the Middle East (Feblot-Augustins 1997; Garcia-Anton Trassierra *et al.* 2002). The reason why the extremely rich flint sources, which are situated less than 15 km away from the site, are only scarcely used, is unclear. One possible explanation is that, at the time of the formation of the Lower Palaeolithic assemblage, the primary outcrops of the flint were largely covered and not accessible. In contrast, it is possible, that the flint sources in secondary position were covered after this period and were no longer exploitable for the humans. Today outcrops of flint in secondary position are almost inexistent and only one outcrop in the Wadi Fataya about 10 km from Hummal is known (Böeda *et al.* 2004). Evidence for a massive change of the landscape due to the deposition of eolian sediments is found at different locations around El Kowm (Pümpin & Jagher 2004)

Conclusions

The lithic assemblage of layers 15 to 18 at Hummal consists predominantly of flakes and several distinctive pebble tools. The absence of bifaces and retouched flakes are distinctive features of the inventory. Based on its stratigraphic position below the Yabrudian and the so-called "Acheuleo-Tayacien" and its archaic appearance this inventory can be classified as Lower Palaeolithic. The studied assemblage compares well to the so-called Oldowan assemblages known from different sites in Africa and Eurasia. The Oldowan was first described in the sites of the Olduvai Gorge in Tanzania where it was divided into three stages (Leakey 1971). In general it describes lithic inventories composed of different Pebble Tools, such as Choppers, Spheroids, Polyhedrons and Hammerstones as well as small flakes obtained from a simple knapping technique.

The lithic inventory of the oldest layers in Hummal shows significant differences when compared to other Lower Palaeolithic sites in the Middle East. Most of these sites belong to the Acheulean, which is characterized by a considerable proportion of bifaces. Sites with no or rare bifaces and a high percentage of pebble tools are rare (Bar-Yosef 1998).

The Hummal site compares well to the important site 'Ubeidyia in southern Israel. There, a similar – although much richer – lithic inventory has been found, dated to a period ranging from 1.1 to 1.4 Ma. In 'Ubeidiya, several thousand stone artefacts, mainly flakes and pebble tools have been unearthed. In addition to the typical tools of the Oldowan assemblage some crude, trihedral bifaces were found, which relate this assemblage to an Early Acheulean stage. It is important to note, that the bifaces are very rare in 'Ubeidiya and are mainly found in layers excavated over large areas (Bar-Yosef & Goren-Inbar 1993).

Another non–Acheulean lithic assemblage is known from Bizaht Ruhama in southern Israel. This site was dated at about 1 Ma. The lithic assemblage is characterised by small tools, flakes and cores. Pebble tools are absent and the percentage of retouched flakes is high. (Zaidner *et al.* 2003) Therefore this assemblage shows clear differences to the Hummal site.

The attribution of the Lower Palaeolithic assemblage of Hummal to a time range similar to that of 'Ubeidiya seems reasonable. However, absolute dates for the oldest layers in Hummal are not yet available. Nevertheless, for the understanding of the Lower Palaeolithic in the Middle East the Hummal inventory is of significant importance. As a stratified site comprising numerous, partially in situ faunal remains and lithic artefacts at different levels, Hummal offers a great potential to contribute crucial results to the research of the oldest human presence in the Levantine Region.

Acknowledgements

Fieldwork in Hummal is funded by the Swiss National Science Foundation, the Tell Arida Foundation and the Freiwillige Akademische Gesellschaft Basel. I'm very grateful to Richard Waite for proof reading the manuscript and I also thank the two reviewers for their helpful remarks.

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A THREE-DIMENSIONAL MODEL OF THE PALAEOLITHIC SITE OF HUMMAL (CENTRAL SYRIA)

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Introduction

The Palaeolithic site of Hummal (Central Syria) with its huge stratigraphy, covering the whole Palaeolithic era, is predestined for a digital reconstruction. Therefore an important project, parallel to the regular excavations in the Palaeolithic site of Hummal, is the development of a three-dimensional model of the site itself and the reconstruction of related site-formation processes. This work is based on data collected during the last ten field seasons. The surface modelling includes three-dimensional survey points located in the adjacent area. Points of reference related to profiles and surfaces as well as the position of finds are also included.

Hardware and software

Since systematic excavation work began at Hummal in 1997, a cartesian coordinate system has been used for the measurements. The y-axis of this system marks the north axis and deviates about 30 degrees from geographic north. Measurements in the beginning were taken by two optical theodolites. Since 2005 two electronic distance meters (hereafter: EDM) have been in use: one Leica TPS 400 and the second a Leica Builder R200M. These two EDMs are connected directly to two Asus EeePC 900 office-notebook computers.

To save and organise the data on the computer, the software AutoCAD is utilised. The AutoCAD application TachyCAD provides the tools and drivers for the communication between the EDM and the computer. For the calculation of the grids for the surface, the software Surfer 8 is used. In order to calculate the slope and aspects of the layers of the Yabrudian complex, the author prefers to work with the Open Source GIS solution GRASS GIS.

Datasets

For the reconstruction of the excavation, several datasets were available (fig. 1). First of all there was an existing database, covering the surroundings of the well. These data were collected during the 2004 season by Tobias Tonner with conventional methods and optical instruments. The maximal distance between the points is about one metre. During the subsequent campaigns a second dataset was compiled covering the areas inside the well. These data were recorded with a high accuracy with two EDMs. The third dataset contains interpolated points representing the surfaces of the excavation. The use of these points allows us to increase "artificially" the density of points in order to refine the 3D model. The whole surveyed area extends over about 5000 square metres. Within this perimeter over 5000 points are available, with a density of one point per square metre on average.

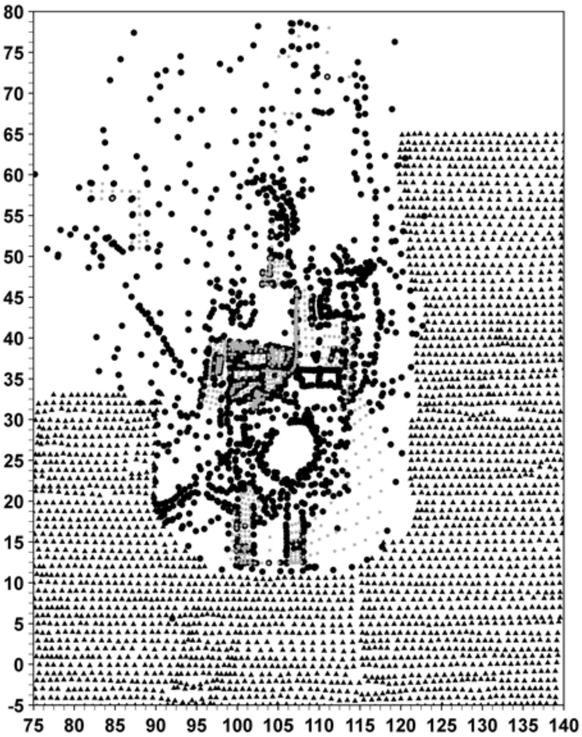

Figure 1 - Distribution of data points in Hummal (triangle: sourroundings, black points: inside well, grey points: interpolated).

The reconstruction of the topography of the layers was carried out using the information from the excavation profiles. Therefore most of the original profile drawings had to be digitised.

For the digitising our team tested two different methods: a digitising tablet, where the analogue drawings and photos can be traced directly; and scanning the analogue data and importing it into AutoCAD to redraw the documents.

We found that it is possible to create accurate digital versions with both approaches, so the user was allowed to choose in which way to digitise the data. Finally the cross-sections were aligned to their original position in the 3D plan of Hummal.

As the limits between the layers in AutoCAD are represented by lines, the author developed a macro (fig. 2) which extracts the start, middle and end point of each line. This step is necessary due to the specifications of the modelling software. The software allows the user only to work with point data for the calculation of surfaces. Furthermore, the macro permits the creation of separate files for each layer in order to reconstruct each and every layer separately.

```
For Each elem In ThisDrawing.ActiveSelectionSet
    If elem.ObjectName = "AcDbLine" Then

        'Set up Filenames
        str1 = "C:/Syria/" & elem.Layer & ".txt"
        str2 = "C:/Syria/Total.txt"

        'Open files
        Open str1 For Append As #1
        Open str2 For Append As #2
        Set line = elem

        'Get first point of line
        spt(0) = line.StartPoint(0)
        spt(1) = line.StartPoint(1)
        spt(2) = line.StartPoint(2)

        'Get last point of line
        ept(0) = line.EndPoint(0)
        ept(1) = line.EndPoint(1)
        ept(2) = line.EndPoint(2)

        'Calculate point in the middle
        pt(0) = ( spt(0) + ept(0) ) / 2
        pt(1) = ( spt(1) + ept(1) ) / 2
        pt(2) = ( spt(2) + ept(2) ) / 2
```

Figure 2 - Snapshot of the Macro to extract the line data.

Modelling techniques

For the reconstruction of the site and the spatial organisation of layers, the software Surfer 8 was used to calculate and illustrate the surfaces of the excavation and the layers. Surfer 8 enables the use of several algorithms to generate surfaces from point data. In the present work, two different algorithms have been applied to calculate the according grids for digital models.

Kriging algorithm

With this method an individual value is estimated for every point, which has to be interpolated. The estimation of this algorithm refers back to the points located around the point which has to be interpolated. Specific parameters and values used for reconstructing the site:
Density (maximal distance between estimated points): 0.05 m
Number of sectors (search of points): 6
Search radius: 25 drawing units

Minimum curvature algorithm

This algorithm makes it possible to fit a plane to the existing points with the presetting that the plane has the lowest bend possible. This method incorporates all recorded points as a whole. In Surfer 8 the principle of tensions (Smith & Wessel 1990) is used. Parameters and their particular values applied for reconstructing the site:
Tension of the interior (bending of the plane at the record): 0
Tension of the boundaries bending at the corners/borders): 1
Density: 0.05 m

A considerable advantage of the minimum curvature algorithm is the possibility of including predefined fault lines representing breaks in the surface of the model. After several tests (see Results), the author decided to apply the minimum curvature method with faults for the reconstruction of the site and the minimum curvature algorithm without faults for the surface reconstruction of the different geological layers. Due to the amount of files (n=72) for the reconstruction of the layers, it was necessary to write an automation script for Surfer 8. The script calculates two different grids for each layer. First it generates a grid which covers the maximum extensions of the profiles. The second grid is calculated by using the maximum extent of the excavation.

Each grid is calculated with a size of 100 rows and 100 columns, so the maximum distance between points is on average 0.1 m for the maximum extension grids and about 0.5 m for the whole area. In order to create synthetic cross-sections at user-defined coordinates, another script was written by the author. It creates a single text file with the coordinates of the layers along a line.

Results and interpretation of the modelling process

Site reconstruction

The two different methods of modelling produced three different models (fig. 3) in different qualities. First of all there is the result of evaluating the Kriging algorithm (fig. 3:top): in principle it is not at all satisfactory as the resulting picture is not sharp enough and angles of profiles too low. Furthermore weird structures emerged in areas with too little data. As a second test there is the first outcome of the minimum curvature method without faults: again the resolution of the picture is not sharp enough, angles of profiles are too low or too high (steep) and wavy instead of flat profile planes. The third approach shows the result of the minimum curvature with faults, producing a satisfactory outcome, profiles are straightened, their angle is nearly perfect and artificial structures in areas of low data density do not appear.

In conclusion, it became clear that the minimum curvature algorithm with faults provides the best results. With this method it

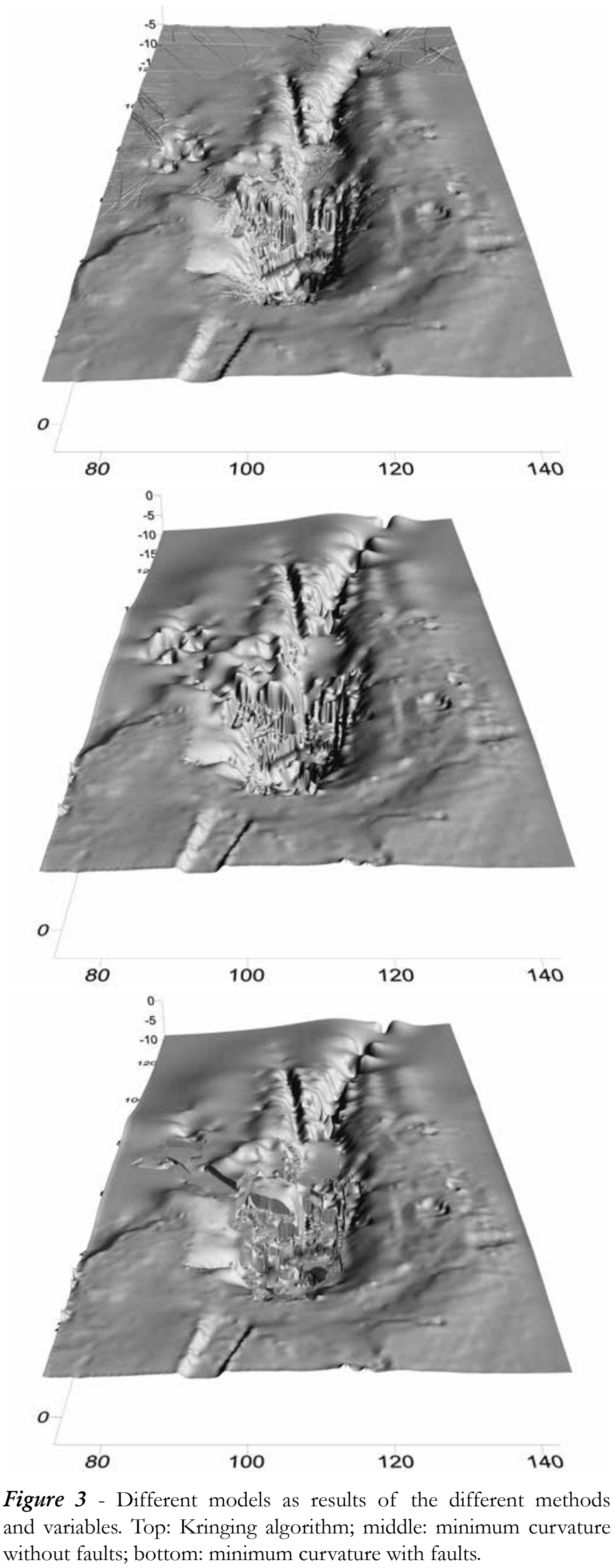

Figure 3 - Different models as results of the different methods and variables. Top: Kringing algorithm; middle: minimum curvature without faults; bottom: minimum curvature with faults.

is possible to create a real model of the excavations in Hummal which can be adjusted for several purposes. One possible use is the creation of a virtual reality model in order to permit an internet user to visit Hummal in three dimensions. Another application is the possibility for the excavation team to visualise or check certain aspects in their three-dimensional situation. This helps to understand old observations in their proper context and to check already excavated parts of the site with the latest models and interpretations. To bring this tool to perfection, texturing with real photographs from the site is under construction at the time of writing.

Reconstruction of the layers

More interesting at present might be the results of the layer reconstruction. The primary objective of the reconstruction of the layers was the correlation of the two Mousterian sectors in the west and south of the site. For this purpose a synthetic section along a north–south axis (fig. 4) had to be created. As is visible in the cross-section, the layers in the middle of the site are disturbed by the modern well. Due to this it is not possible to connect the two Mousterian sections of Hummal by a virtual reconstruction of the several geological layers and archaeological levels.

The cross-section shows clear slopes in all layers on both sides of the well. The directions of the slopes are consistently plunging towards the actual well. Hitherto this phenomenon was explained as the result of a sinkhole beneath the site. Further investigations of this bending, however, have shown that it is probably a result of the draw-down of the water table in the well. During the draw-down in a well, the water level depends on the amount of water which flows out and its recharge. figure 4 shows the situation in such a well. If no water is pumped out, the water level stays nearly level, if the level of the ground water is horizontal. With pumping or increased outflow, the water level begins to create a funnel, represented by the dashed line in figure 5. This funnel grows bigger with continued outflow. With continued drainage, the buoyancy of the sediments decreases, and they subside under their own weight, causing a bending of the layers in the direction of the draining funnel.

The draw-down is not necessarily due to human activities. A natural drop of the water table can also induce such subsidence. The result of such a drying out would be the same as a human-caused draw-down. The funnel of the natural draw-down looks the same and causes similar deformations in the ambient stratigraphy. As it is impossible to differentiate between these two

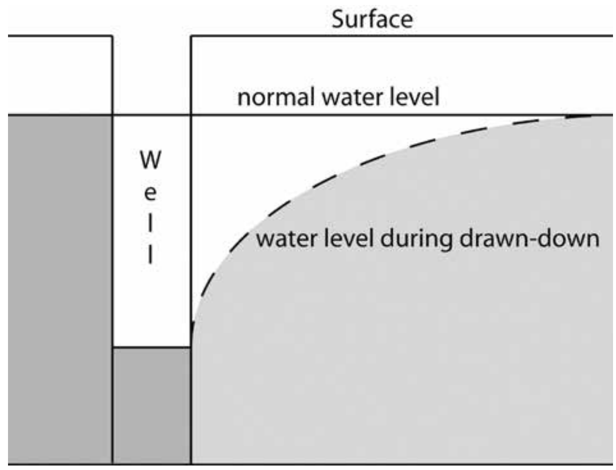

Figure 4 - Drawn down of the water level during the use of a well.

phenomena, it is to be expected that both mechanisms were involved in the deformation of the strata. At the moment it is also impossible to determine when those events took place.

Calculations of a possible drawn-down and the resulting bend showed that the bend of the funnel is similar to the bend of the layers, only smaller. This result leads to the conclusion that the draw-down during the use of the well cannot be the only reason for the bending of the layers. Geological analysis of the sediments in Hummal has shown that some layers have the characteristics of peat (Ismail-Meyer 2009). Peat has the ability to shrink from 1 metre thickness to 10 centimetres due to the loss of saturation with water. Reconsidering the fact that the draw-down leads to a relative drying out, inducing bending and loss of thickness in peat layers, we can assume that such events caused the bending of many layers in Hummal. As the peat layers are present in the lower parts of the stratigraphy, the effects of bending in the upper layers are greater than the deformation of the deeper layers. More investigations in the site itself have to be done in order to retrieve more information about the hydro-geological aspects of Hummal. For the moment, however, it can be assumed that these two phenomena are mainly responsible for the bending of several layers in Hummal.

Relation between orientation of layers and finds

Along with the reconstruction of the layers in Hummal the author pursued the objective of comparing the orientation of finds with the orientation of the layers in the Yabroudian complex (fig. 5). The idea of the comparison was to determine if it is possible to see the bending of the layers in the orientation of the archaeological objects. If this were the case, the orientation of artefacts could be a possible approach to describe the properties of the orientation and surface of a layer.

Characteristics of the Yabroudian complex

The first artefacts with Yabroudian characteristics in the El Kowm region were discovered in the early 1980s by several researchers; Cauvin (Cauvin & Cauvin 1979), Copeland, Hours and Muhesen (Besançon *et al.* 1981). The Yabroudian can be characterised as a cultural entity with no Levallois technique and a high proportion of side scrapers. Offset and transversal side scrapers are especially typical for this entity. The retouch is always very steep and is classified as Quina or demi-Quina (Le Tensorer 1996). Copeland & Hours (1983) gave the first description of the Yabroudian tools of Hummal Ib. A good example of the definition of the Yabroudian was that given by François Bordes in 1955: "*Du point de vue typologique, ce qui caractérise cette couche (couche 25 de l'Abri I [de Yabroud]), c'est la dominance des racloirs de tous types, l'importance des racloirs transversaux et déjetées étant particulièrement sensible*" (Bordes 1955:487-488).

Within a total number of flints of 703 pieces in the Hummal Ib collection, a total of 216 retouched tools were reported (Copeland & Hours 1983). More than the half of the tools (n=142) are scrapers. Among the scrapers more than one-third are offset (n=25) or transversal (n=26) scrapers. The material in the Hummal Ib collection was originally assumed to be in situ. After a re-examination of what is still preserved of this collection, it is clear that the material available today cannot be described as in situ at all, as there is a mixture of Yabroudian and Hummalian artefacts. Furthermore, the area within the well, where the original material was collected, can no longer be identified for certain.

Preliminary investigations Hummal took place until 1983 and were then interrupted for several years. In 1997 the work in Hummal was resumed, when more Yabroudian artefacts were found. Since 1999 excavations have been regularly undertaken at Hummal, including the Yabroudian layers. Systematic measurements of finds started in 2000 with the help of a cartesian coordinate system. Since 2005 the objects have been measured digitally by EDM and computer (see section 2 above).

Figure 5 shows the sectors of the Hummal site where the Yabroudian complex has been identified since the 2000 field season. Most of the finds were present in the central and eastern sectors. In the western side, excavations have not yet reached the Yabroudian levels. The Yabroudian layers in the southern part, which were only discovered during the 2010 season, have so far delivered just a few pieces.

The Yabroudian in Hummal comprises a distinct complex of five layers where locally several sublevels can be recognised. The geological aspects of the sediments are only summarised briefly here as they are presented elsewhere in this volume (Le Tensorer *et al.* 2011).

Layer 8 consists of light-coloured, detritic carbonate silts. Within the top 10 cm, the sublevel 8a is embedded. This level contained 94 lithic artefacts and a large number of animal remains (n=716). During the 2006 season it turned out that the distinction of Level 8a in the eastern section is much more difficult than in the central section, where it was possible to separate layer 8a from the deeper sediments of layer 8. In the eastern section only the separation between the layers 7, 8 and 9 was possible. Level 8a was not distinguishable. Due to this fact, the material was recorded as Layer 8.

Layer 9 is similar in composition to Layer 8 and shows evidence of four lacustrine periods of carbonate formations in a presumably cool and humid environment (Meyer 2000). Within the whole layer (about 30 cm thick) only two bones were found during the excavations.

Layer 10 consists of a dark clay, a perfect stratigraphic marker. This dark clay could be essentially the inorganic remains of a former peat layer, as described above. Remarkable about layer 10 is the fact that its thickness varies from east to west, from about 30-40 cm to only a few centimetres. This striking change in thickness can be traced back to two different events. First there is an erosional event after the sedimentation of layer 10 (Meyer 2000; Le Tensorer *et al.* 2011) and secondly the compression of the peat. From the archaeological point of view, layer 10 can be separated into at least two sublevels (Le Tensorer 2005).

Layer 11 can be described as a typical desertification cycle, which is shown by three different sublevels. First an aeolian sand level

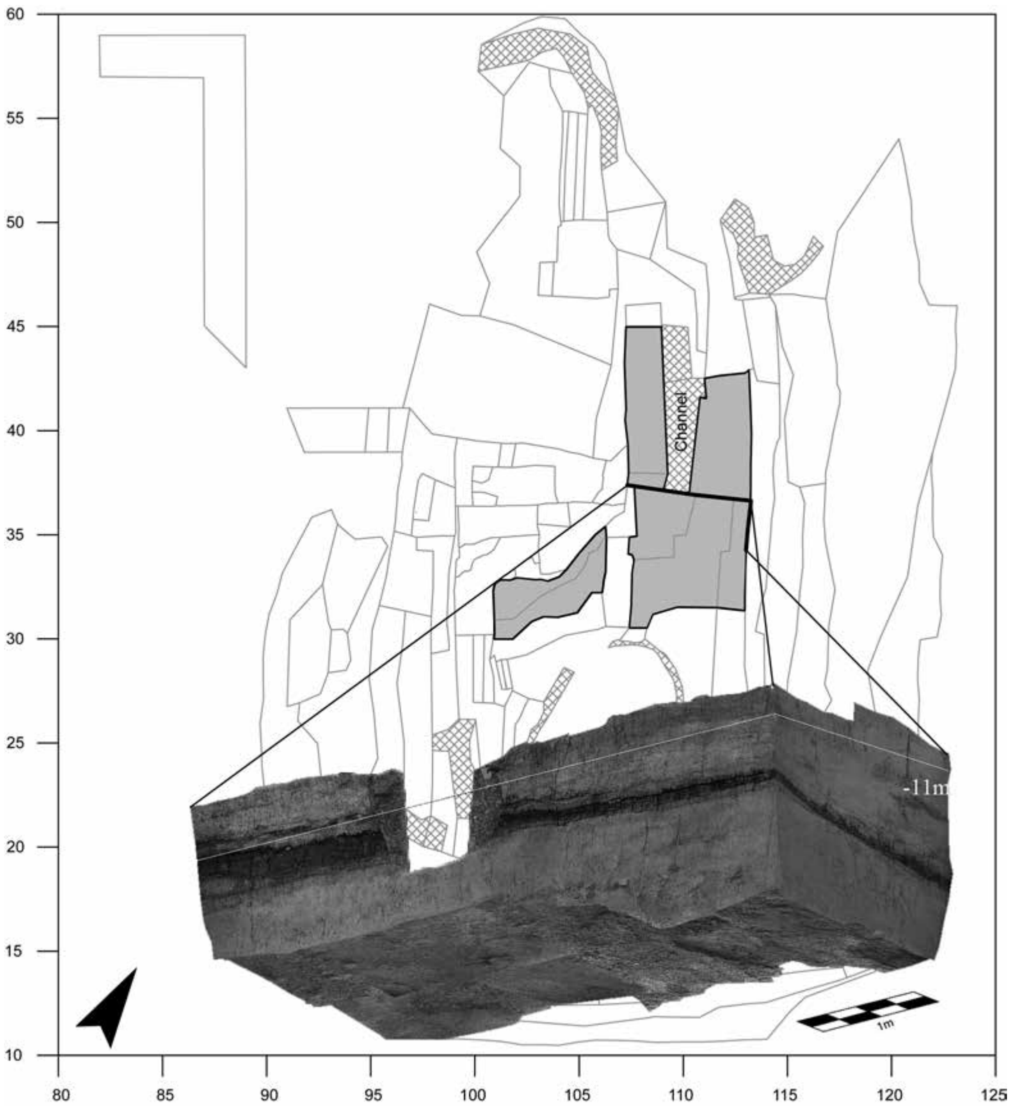

Figure 5 - Situation of Hummal and Yabroudian complex.

(11aS), preceded by a level with detritic granules (11a) and a light clay deposit (11b). As in layer 8, a differentiation between the east and centre sections can be seen. In the central section, the sand level 11aS was clearly visible during the excavations. In the eastern section, the layer seems to have disappeared. Also the separation of levels 11a and b was not possible in the eastern section. As for layer 8, all the objects were recorded as layer 11.

Layer 12 consists of a yellowish clay level. Its texture varies between silty and travertinated. As in the layers described above, it is almost sterile and produced only a few flints (n=20) and again a comparatively high number of bones (n=67).

Layer	8	9	10	11	12	Total	1b
Flakes	1794	6	106	48	113	**2067**	401
Blades	8	0	1	0	0	**9**	19
Retouched tools	16	0	8	3	4	**31**	245
Cores	3	0	3	1	0	**7**	24
Bifaces	0	0	0	0	0	**0**	10
Choppers	0	0	0	0	0	**0**	3
Percuteur	0	0	0	0	0	**0**	1
Total lithics	1821	6	118	52	117	**2114**	703

Figure 6 - Numbers of objects within the yabroudian complex of Hummal.

The Lithic material

As the overall number of lithic artefacts in the lower levels of the Yabroudian complex is still relatively small (fig. 6), it was decided, for the following study, to sum up the material from the different sub-levels, in order to obtain statistically relevant samples. Among the 2114 lithic pieces from Yabroudian contexts, all the retouched tools are scrapers (n=31). The main part of the lithic materiel are flakes smaller than 2 cm (n=1764), which are not determinable any further.

The remaining artefacts are different classes of flakes, including six Kombewa flakes, and one Kombewa core and two cores on flakes. Figure 7 shows the distribution of the types within the five layers. It is remarkable that almost half of the objects come from layer 8. The same phenomenon is visible when looking at

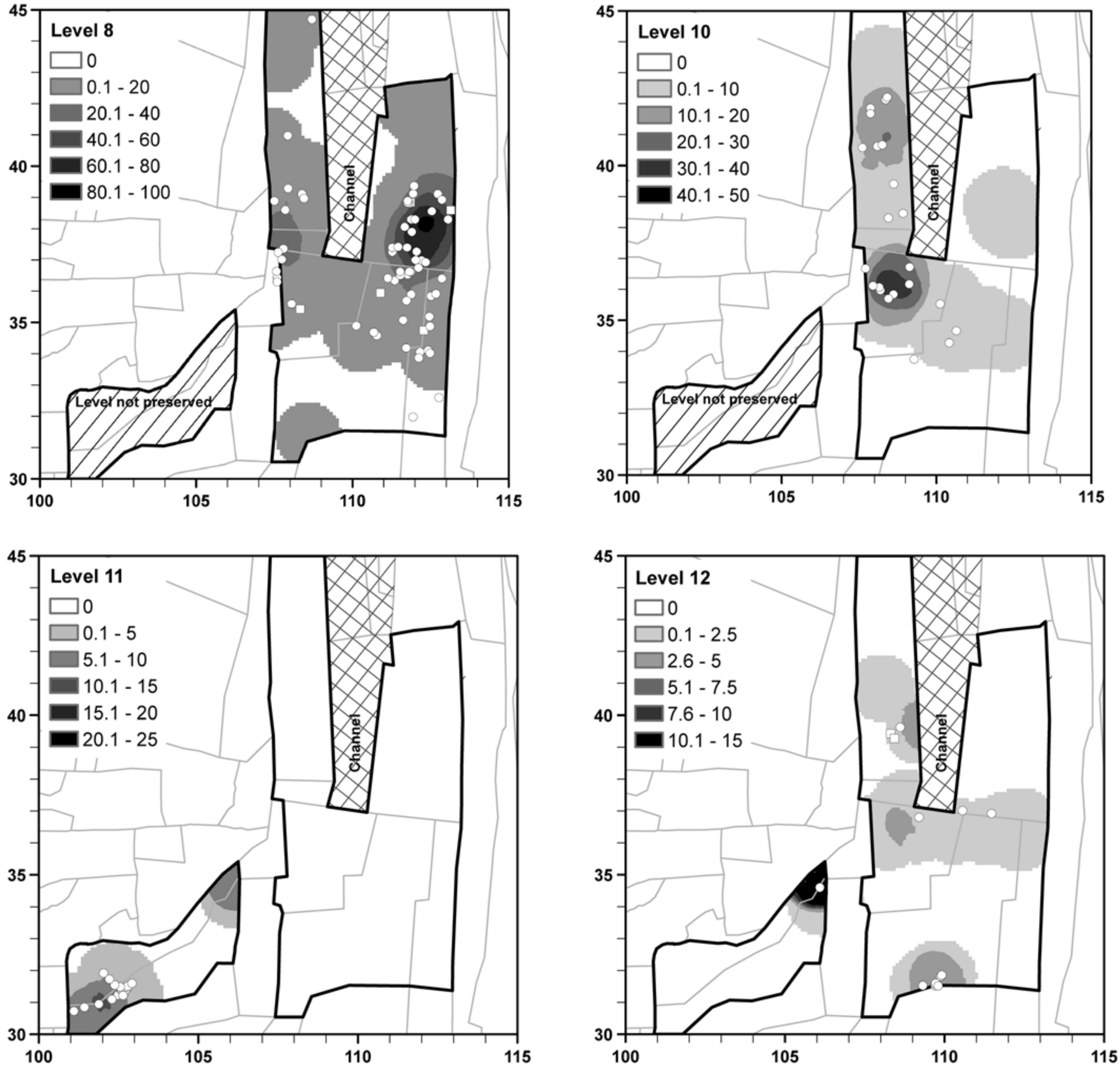

Figure 7 - Distributions of finds (shaded: Density map of bones, o: lithic material, squares: manuports).

the bones of the Yabroudian layers. As in the old collection of Hummal Ib, the offset and transversal scrapers make up one-third of the tools. In the layers 8 to 12 they only appear as a small percentage (~20%, n=6). As the overall number of pieces is very low, the materiel is not sufficiently representative.

The differences in the distribution of the finds over the several layers can be explained easily. The western part of layers 8, 9 and 10 was disturbed by several influences. Hence only a few objects were collected in 1999, without being measured as they were not in situ. As excavations went on in 2000 the objects of layers 11 and 12 appeared in situ and accordingly were measured individually. In the eastern part of the Yabroudian complex, the material from all layers was found in situ. It was only in two strips along the channel (fig. 7) that no objects were found. These areas result from the construction of the channel in the 1950s, which was used for the irrigation of extended cultivation.

The most interesting feature in the distribution of finds occurs in layer 11. Whereas in the western part of the excavations many objects (n=137) were found, in contrast, in the eastern section of layer 11 no objects were discovered at all. There are two plausible reasons for this. On the one hand, it is possible that only the western part was used in Paleolithic times. On the other hand, it is conceivable that the material was dislocated from its original position and moved to another position. The second option is supported by the fact that in layer 11 a pedogenesis took place, but no former surface is conserved (Meyer 2000).

Orientation of the finds

The orientation of the finds was measured by way of trial according to the system proposed by McPherron (2005). In this method two points are taken per each artefact; one at the distal and one at the proximal end of the find. The orientation of the objects can then be calculated with a simple calculation in a Microsoft Excel spreadsheet. The idea of recording the orientation was that it is a simple approach to describe the circumstances of discovery of the finds in an easy and accurate way. These results were then compared with the values of slope and aspect of the relevant layers. The goal of this comparison was to determine, if there is, in the Yabroudian layers, a correlation between a possible movement (erosion, draw-down, sliding, etc.) reflected by the orientation of artefacts and bones.

The definition of the orientation of finds (fig. 8) and of the layers is as follows:
- bearing: horizontal orientation of the object going from 0 degrees (due north) to 180 degrees (due south);
- plunge: vertical orientation of the object going from 0 degrees (horizontal) to 90 degrees (vertical);
- slope: horizontal orientation of the layer:
 000°: orientation towards north
 090°: orientation towards east
 180°: orientation towards south
 270°: orientation towards west
- aspect: vertical angel of the layer
 00°: layer is horizontal
 90°: layer is vertical

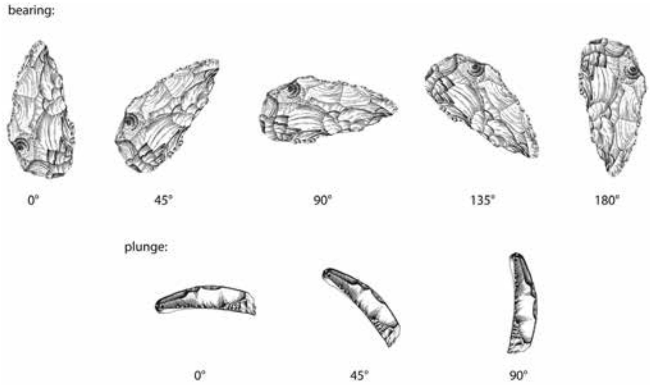

Figure 8 - Explanation of orientation of finds (drawings: J.-M. LeTensorer).

Layer	8		10		12	
n	144		137		14	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Bearing (objects)	92.73	53.22	79.55	54.99	78.32	53.51
Plunge (objects)	8.26	8.66	10.82	10.78	19.89	21.98
Aspect (layer)	147.1		150.3		173.9	
Slope (layer)	9.5		11.3		19.4	

Figure 9 - Table showing the orientation of layers and objects.

With these definitions and the data from Hummal, it is now possible to compare the orientation of objects with the orientation of the layers (fig. 9). The mean value of the horizontal orientation of the objects (fig. 9, bearing) shows that most of the objects are oriented towards the east (layer 8) or northeast. In contrast to this, the aspects of the layers show an orientation towards the southeast. The second observation is the relatively high variability in the orientation of artefacts in all layers. As there is no alignment visible in the layers, a normal distribution of the artefacts can be assumed.

On the other hand the finds from all layers plunge down. Most remarkable is that all objects are orientated more steeply than the slope of layers. For this phenomenon, only one explanation can be proposed so far: The objects were originally deposited with a certain tilt and later moved by erosion or the action of flowing of water. In layer 12 particularly the influence of water is not that absurd. In this layer geological and micromorphological analysis demonstrated the presence of a shoreline in that area (Meyer 2000).

For a more detailed interpretation of the described phenomenon, it is necessary to have a look at the distribution of the bearings and plunges of the finds (figs. 10 and 11). The majority of finds in layer 10 have an orientation between 0 and 75 degrees, while in Layer 8 no preferential direction of the objects is visible. In Layer 12 there are only 10 objects, which do not allow an interpretation of orientations. The rise in the middle shows clearly that the objects of layer 10 are orientated towards northeast by trend, but the distribution of finds (fig. 7) shows that all finds come from the same area. If we take layer 8 as a reference, we can guess that the objects from layer 10 will show the same variability in their horizontal orientation. It is necessary therefore to excavate the area east of the channel to obtain more materiel for a better database.

The next step is the comparison of the plunges in the different Yabroudian layers (fig. 11). The rises show that most of the objects have a vertical tilt of between 0 and 15 degrees. This means that almost all artefacts were lying nearly horizontal or parallel to the layer itself, so the theory of a major influence of water in layer 12 has to be rejected.

Conclusions

The construction of a topographical model of Hummal (Central Syria) is an important project complementary to the excavation. The data used for the present paper are basically topographical points recorded during the field work. First of all, several datasets recorded for different purposes during several field seasons had to be merged into a comprehensive database.

The first result in the modelling process with the Kringing algorithm was not satisfactory because of low angled profile planes and computational artefacts resulting in aberrant structures in the northern part of the excavation, where data points are mis-

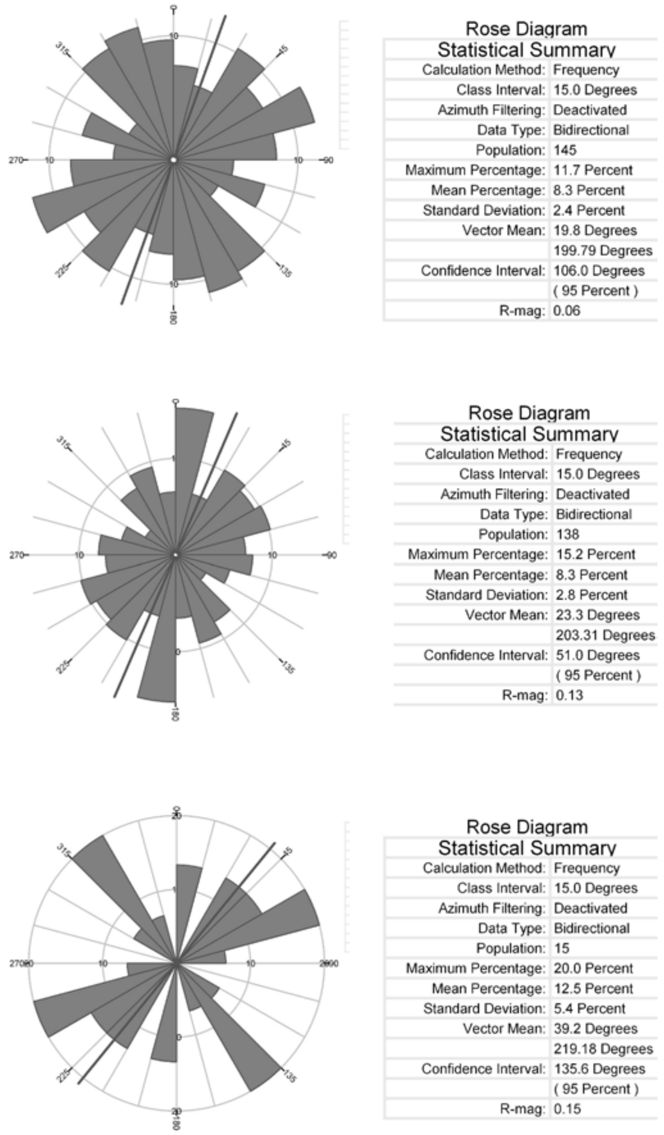

Figure 10 - Distribution of bearings within the yabroudian material.

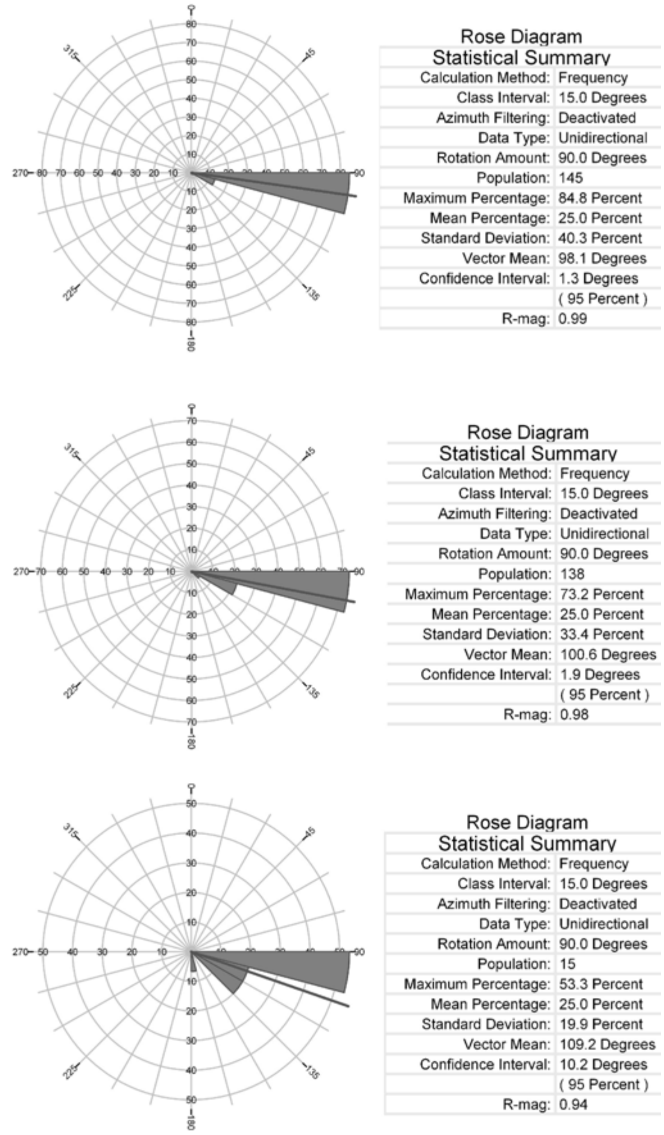

Figure 11 - Plunges of the yabroudian finds within the several layers.

sing to some extent. Furthermore this first model produced an insufficient visualisation.

For the second model a minimum curvature algorithm was used. With this algorithm it was possible to use fault lines defining breaks in the surface for the planes of profiles. With the help of this tool it was possible to rectify the aspect of the profiles. The quadratic structures in the northern part were removed by using the highest possible tension of the boundaries. Evaluating the second reconstruction, some cuts into or some conical structures in front of the profiles were recognised. This happened if a point at the foot of a profile was not directly located beneath the upper line of the same profile (i.e. when the profile was slightly caning). In this case the lower points were arbitrarily moved up to about 20 cm. For the modelling process of a whole excavation area like Hummal, such a minimal adjustment induced no deformations in the model.

The second important issue was the reconstruction of the layers. The foundations of this process are the geological profiles. For the reconstruction of the geometry of the layers, as well as the archaeological levels, again the minimum curvature algorithm was applied. On this base, a synthetic section along a north-south axis was constructed, with the aim of comparig the two Mousterian complexes in the western and southern sectors of the site. A direct correlation is hampered by a huge intrusion of an ancient well shaft. The interpretation of this cross-sectioncut showed that it is not possible to compare the two sections with this approach alone. However, the cross-section cut revealed an interesting phenomenon: all the layers in the Mousterian sections of Hummal are bending towards a centre located in between the two sections. This unnatural bending can be seen in hydrological changes of the water table, rising or falling naturally or artificially, particularly through excessive water extraction by pumping in the past few decades.

Another issue was the analysis of the orientation of the archaeological finds in the Yabroudian layers. Therefore a method of measuring this was applied, recording two points per object (McPherron 2005). With these data it is possible to calculate the horizontal and vertical orientation of the objects. As the number of artefacts and the extent of the excavated surfaces are limited, it is difficult to demonstrate precise taphonomic processes. However, the small samples are a very good example for testing new approaches describing the archaeological surfaces.

With the actually existing data it is possible to elaborate a good 3D model with a limited effort in a rather short time. The software applied (AutoCAD and TachyCAD) and procedures adopted to record the data in the field and for the modelling process (Surfer 9) are highly efficient. For the reconstruction of the topography of layers, it is necessary to collect more data during forthcoming field seasons in order to create more precise models, and thus to describe the geometry of the layers with better accuracy.

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HUMMAL (CENTRAL SYRIA) AND ITS EPONYMOUS INDUSTRY

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Introduction

Recent research reveals that the production of elongated blanks is an important part of the Early Middle Palaeolithic industries in Near Eastern sites dated between 270 and 160 ka ago (Mercier *et al.*2007; Mercier & Valladas 2003; Grün & Stringer 2000; Clark *et al.* 1997; Rink *et al.* 2003). The excavation at Hummal located in the arid steppe of Central Syria showed the similarities to the laminar assemblages found on this site and the others Early Middle Palaeolithic blade assemblages from Levant.

Hummal is one of several sites in the El-Kowm area (including Nadaouyieh Ain Askar (Jagher 1993), Ain Juwal, Arida A and Umm el Tlel) where the laminar assemblages were discovered and the only one with the stratified deposits under systematic excavation since 1999, on the other sites the position of laminar assemblages cannot be specified, these have all been recorded in secondary positions. In all cases the assemblages with the laminar characteristics were related to the artesian spring occupied by the people of the Palaeolithic (Le Tensorer & Hours 1989). Blade industries were located in the stratigraphy at Hummal only between the Yabroudian and Levantine Mousterian.

In 1980, L. Copeland and F. Hours conducted a first study campaign, at the invitation of J. Cauvin who at the time was the Director of the French Permanent Mission in El-Kowm. The project was devoted to the geomorphology and the Palaeolithic of El Kowm. A new culture was identified which was labelled "Hummalian" (Besançon *et al.* 1981, 1982).

Since then, the Hummalian industry has been the subject of several publications (Bergman & Ohnuma 1983, Copeland 1985; Hours 1982), although these were based on material from the old stratigraphy established in the Eighties. A new series of stratigraphic and sedimentological studies of the Hummalian infill revised the observations from 1980-1983. This paper introduces the new Hummalian sequence established from the results of the excavations carried out during the 1999-2005 seasons. Additionally, the studies on the Hummalian industry uncovered from the new stratified layers will be presented here with a proposed aim of defining the Hummalian industry based on these results.

The New Hummalian Stratigraphical Sequence

The earliest work on the stratigraphical and sedimentological sequences of the Hummal site at El-Kowm (Le Tensorer 2004) shows that the previous studies of the lithic material from the Ia layer were carried out on assemblages that were not in situ. A new series of studies carried out during the 1999-2005 seasons on the sequence of Hummal shows that the materials from these new excavations are, unlike the previous work, considered to in situ. This means that a far greater understanding of the lithic industries is now possible. This is of course an ongoing situation and with future field work the stratigraphy presented here will perhaps be further elucidated. In fact, the Hummalian levels that are recognised between the Yabroudian and Mousterian in the sequence presented here also appear in a similar position on the new South Profile, constructed from the 2009 fieldwork.

The sequence also contains a massive sand deposit of several meters in the heart of the doline. These sands αh contain a vast quantity of Hummalian artefacts (more than 3000 artefacts). Archaeologically these artefacts are not in situ, however the geological observations made on the ground show that it intercalates between the Yabroudian and Hummalian layers (Le Tensorer 2004). The TL dating gives an average age of 200 ka for the αh assemblage (Richter *et al.* 2011) which has comparable technological and typological features to those in layer 6b.

The stratigraphy of Hummal is composed of micritic loam precipitated directly in water, supplied by the well. The water level on the surface fluctuated appropriately with climatic changes and tectonic processes. Soil formation took place during times of reduced water levels. Through the phase of low water level the soil formation-taking place (Le Tensorer *et al.* 2007).

There was repetitive occupation at the site but the density of the artefacts in the layers remains variable (tab. 1). This could be due to the restricted excavated area but differing occupation strategies must also be considered a factor. However, the assemblages from an individual layer indicate a temporal sample, the duration of which is very difficult if not impossible to calculate. The time interval between the deposition of first and last item

layer	6a	6b	6c	7a	7c
excavated surface (m2)	10	14	2	14	18
density (item per m3)	247	2170	161	22	66
fauna (artefacts ≥ 2cm)	6	51	6	13	29
lithics (artefacts ≥ 3cm)	392	2946	190	33	326

Table 1 - Artefact density in Hummalian layers.

in the lithic assemblages are seldom precise and rarely defines a single phases of occupation. While the results from preliminary micromorphological and geological studies, the on-site field-work observations, and the artefact's category and technological features can help to construct a initial and incomplete picture of on-site versus off-site production strategies, the pending results of the more detailed micromorphological and geological studies will allow a fuller and hopefully clearer picture of the differing site strategies in the future. The high density of artefacts in layer 6b and 6a could be due to a long term occupation or several single but successive occupation episodes or due to palimpset. The density of artefacts in layers 7 and 6c is lower and can correspond to the short-term occupation where blanks were produced and maintained on-site. The stratigraphy from bottom to top is subdivided as follows (fig. 1):

Layer 7: This is a complex series of clay mineral deposits and erosions of variable thickness which reaches a maximum of 40 cm. This layer was established in swampy environment of a hot climate and is intersected throughout with red sand (layer 7b), which sometimes forms accumulations up to 20 cm thick. layer 7 is divided into three sub-levels (a,b,c).

Layer 7c is black clay containing organic levels and developed due to a change in the deposition conditions. The occurrence of a calcified horizon composed of calcified and silicified roots, the fragments of carnivore coprolites, a lot of bones, some of which are burnt and lithic artefacts indicate soil formation without water coverage but the presence of algae spores and gastropod shells testify the existence of water in close proximity. A change to Sebkha conditions interrupts the soil formation and the green-black clay started to accumulated and formed level 7a.

For the most part artefacts from layer 7a were gathered in the western area of the excavation, contrary to layer 7c where the lithic artefacts were concentrated in the eastern part. The majority of faunal material from these layers come from western part and is unfortunately highly fragmented and as a result the numbers of identified fragments are low. Among the identified fauna are Camelids which predominate, equids and a few large bovids. The surface preservation and edge sharpness of bones advocate that the burial probably took place relatively rapidly and that post depositional forces were responsible for destruction of the bones. It could be possible that this organic layer over time has become highly compressed owing to sediment over load and hence caused the high degree of bone fragmentation and also the fragmentation of several blades. Sandy layer 7b was sterile.

Layer 6c: A change to damper conditions led to the precipitation of layer 6c. Its compact, carbonate silt, of approximately 30cm thickness, which is partially eroded by the deposition of the layer 6b, is currently limited to one surface on the Eastern profile. The partial erosion of layer 6c happened before the formation of the following layer 6b. The minute remains of layer 6c were perceptible throughout the East profile, but were not identified on the West profile or on any other worked profile comprising Hummalian layers on the Western part of the excavation.

The soil formation is indicated by the presence of mud cracks and calcified root remains. It is subdivided into two sub-levels:

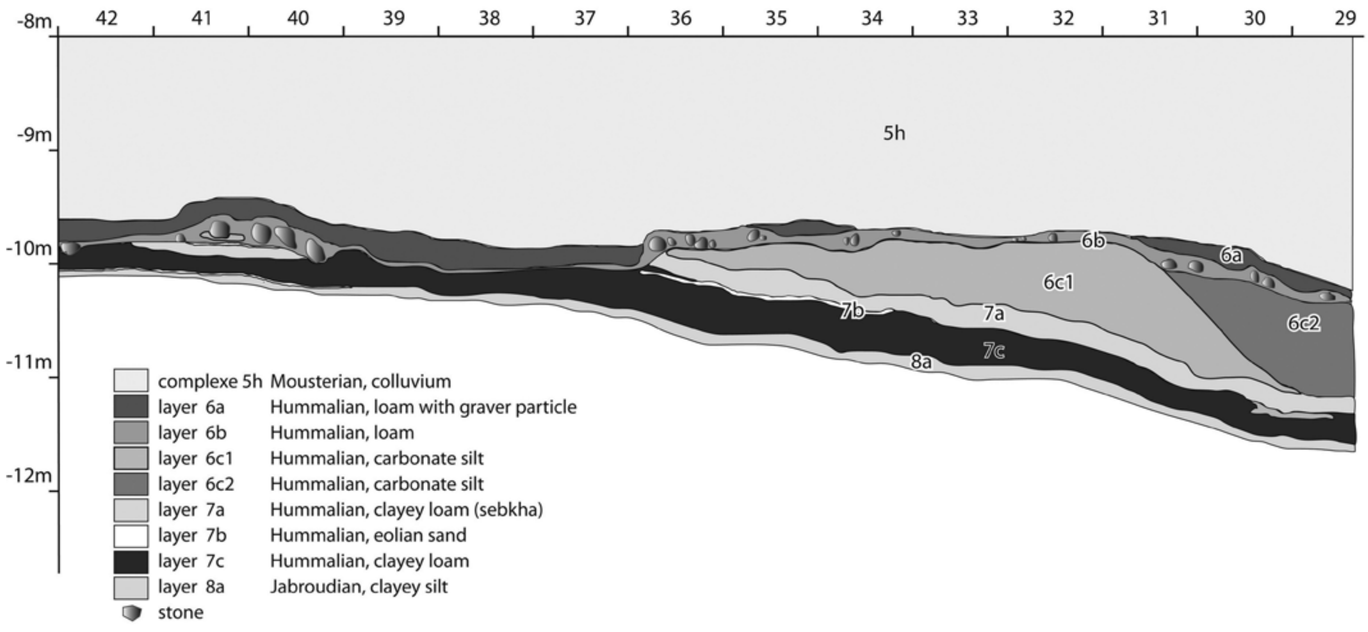

Figure 1 - Profile East, Hummalian sector.

6c-1 which is compact, sterile, white carbonate silt. Layer 6c-2, a brown yellow carbonate silt where the lithic material and small bones including a felid bone, three fragments of ostrich shell and also Equid teeth were collected from two square meters. Nearly all the artefacts were found in a sub-horizontal position which is concordant with the inclination of layer.

Layer 6b: A thin loam deposit with a maximum thickness of 14 cm. The layer seems to have formed during a period of varying water level, so from time to time a relatively dry surface appeared. It emerges to have been formed over long period and the soil formation took place during the dry phases. The surface of the layer during the deposition of the artefacts was relatively dry and seems to be well conserved as confirmed by the presence of small bones fragments and a carnivore coprolite observed in the micromorphological analysis (Rentzel & Ismail-Meyer, no date). It seems that the artefacts in this layer were laid on the surface uncovered for a long time and formed a thick layer of flints without the clear intermediate sub-levels. One small zone approximately 4 m² represents the physical deformation and erosion of layer 7c.

It is difficult to elucidate whether the assemblage from layer 6b is a result of a single or successive human occupations. Although, it does confirm that the lithic material represents a single technological tradition.

6b appears identical in all the sectors excavated and is easy to locate due to the regular presence of pebbles and blocks of limestone and travertine. These blocks although eroded were certainly brought into the site by Hominids as the type (limestone) and size of rock are not found naturally in this location, and forms something of an imitation manuport living floor (fig. 2).

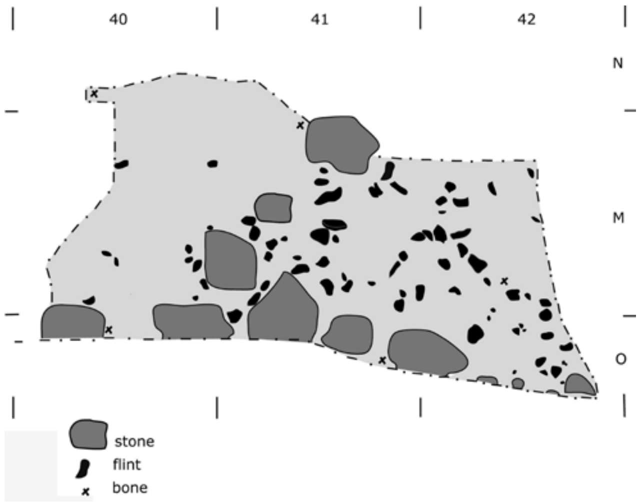

Figure 2 - Layer 6b, Manuport living floor.

Figure 3 - Layer 6b, crushing visible on blade.

Layer 6a: A detritus loam sediment with an average thickness of 15 cm. It eroded part of layer 6b. It is not always easily distinguishable from the layer 5h. The depositional context of this layer is so far not determined. It could be possible that the archaeological remnants were redeposited within repeated debris flow, but it is just as likely that humans arrived on the site after the accumulation of debris and settled on colluviated material. The concentration of objects larger than 3 cm on three square meters and the presence of small debris on almost all excavated surface could suggest that a sorting of objects according to size occurred.

At the same time nearly all objects were found in a sub-horizintal position in accordance with the layer inclination and the white-grey patination of lithic objects is homogenous. Some animal bones and two fragments of ostrich shell are also found.

Lithic Analyses

The Archaeological Samples and the Lithic Preservation

The excavation surface is located in the Northeast part of site and in 2005 reached an area of 26 m² and produced more than 6000 lithic artefacts (tab. 2) and 105 bone fragments. Unfortunately the excavated area was bisected by the cutting of a drainage channel and thus split the excavated areas into two distinct parts. Two profiles of the east and west faces of the excavated area were recorded.

The whole lithic assemblage of layer 6b is characterized by the same state of alteration. Its patina is rather strong, homogeneous and of white-grey colour. 65% of blades and 3% of flakes have undergone mechanical breakage. 25% of all artefacts show crushing or a series of pseudo-retouch removal (fig. 3). These three phenomena, erosion, mechanical breakage and crushing, are related to the post-depositional conditions of preservation within the assemblage. The bad preservation of the artefacts could be due to the effect of long-term exposure on surface (erosion and digenesis) whilst also being trampled.

		6a	% out of complete assembalge	% out of debitage and shaped items	ENIT*	% out of complete assembalge	% out of debitage and shaped items	6b	% out of complete assembalge	% out of debitage and shaped items	ENIT*	% out of complete assembalge	% out of debitage and shaped items	6c2	% out of complete assembalge	% out of debitage and shaped items	7a	% out of complete assembalge	% out of debitage and shaped items	7c	% out of complete assembalge	% out of debitage and shaped items
Artefact Categories	blank flakes	50	4%	17%	50	4%	21%	448	9%	13%	448	11%	17%	8	3%	7%	4	2%	15%	35	6%	26%
	blank blades intact	4	0%	1%	103	9%	43%	204	4%	6%	838	20%	32%	30	10%	25%	3	2%	11%	16	3%	12%
	blade fragments≥3cm	133	11%	44%				1415	28%	40%				12	4%	10%	10	5%		24	4%	18%
	bladelets intact	1	0%	0%	9	1%	4%	9	0%	0%	97	2%	4%	2	1%	2%	1	1%	4%	1	0%	1%
	bladelet fragment	21	2%	7%				134	3%	4%				9	3%	8%				9	2%	7%
	shaped tools on blades intact	2	0%	1%	7	1%	3%	112	2%	3%	232	6%	9%	21	7%	18%	1	1%	4%	7	1%	5%
	shaped tools on blade fragment ≥3cm	9	1%	3%				171	3%	5%				1	0%	1%				2	0%	1%
	shaped tools on flakes							68	1%	2%	68	2%	3%	3	1%	3%	1	1%	4%	4	1%	3%
	shaped tools on débris							14	0%	0%	14	0%	1%					0%	0%			
	cortcal elements blades(CEB) intact 50-100%	4			9	1%	4%	7	0%	0%	49	1%	2%				1	1%	4%	2	0%	1%
	CEB fragment≥3cm	10						66	1%	2%												
	cortcal elements flakes 50-100%	44	4%	15%	44	4%	18%	293	6%	8%	293	7%	11%	11	4%	9%	1	1%	4%	13	2%	10%
	core trimming blades (CTB) intact	4	0%	1%	9	1%	4%	103	2%	3%	210	5%	8%	8	3%	7%	1	1%	4%	6	1%	4%
	CTB fragment≥3cm	9	1%	3%				130	3%	4%							2					
	Core trimming flakes	7	1%	2%	7	1%	3%	155	3%	4%	155	4%	6%	9	3%	8%				8	1%	6%
	cores	4	0%	1%	4	0%	2%	176	3%	5%	176	4%	7%	5	2%	4%	2	1%	7%	7	1%	5%
	Total debitage and shaped items	**302**	24%	100%	**242**	20%	100%	**3505**	69%	100%	**2580**	62%	100%	**119**	40%	100%	**27**	15%	100%	**134**	23%	100%
	débris ≥3cm	106	9%		106	9%		342	7%		342	8%		4	1%					84	14%	
	chips≥3cm	17	1%		17	1%		55	1%		55	1%		64	21%		6	3%		108	18%	
	débris<3 cm	816	66%		816	69%		1165	23%		1165	28%		114	38%		149	82%		263	45%	
	Total	**1241**	100%		**1181**	100%		**5067**	100%		**4142**	100%		**301**	100%		**182**	100%		**589**	100%	
	medial fragments<3cm	168						1104						7						76		
dorsal scar pattern %	unidirectional	85%						82%						66%			71%			78%		
	bidirectional	11%						11%						33%			13%			16%		
	centripetal	0%						2%						1%			4%			2%		
	indeterminable	4%						5%									13%			3%		
		No.*	%					No.*	%					No.	%		No.	%		No.	%	
	laminar items	137	57%					1440	56%					83	70%		6	43%		67	50%	
	flake items	101	42%					964	37%					31	26%		6	43%		60	45%	
	cores	4	2%					176	7%					5	4%		2	14%		7	5%	
	total	242	100%					2580	100%					119	100%		14	100%		134	100%	

Table 2 - Inventory of Hummalian assemblages. ENIT; total length of intact tools added to the total length of fragments that are greater than or equal to 3 cm divided by the median length of intact specimens (ENIT). This value should approximate to the number of discarded tools.

Several experiments (Behrensmayer *et al.* 1986; Mcbrearty *et al.* 1998; Thiébaut 2007; Villa & Courtin 1983) showed that trampling can cause severe damage to the artefacts. It can cause breakage, crushing, and pseudo-retouch and vertical and horizontal displacement of artefacts. In the case of the artefacts from layer 6b; breakage, crushing and the pseudo-retouch are evident. Cryoturbation could cause a similar crushing and breakage, but there is no evidence of this phenomenon in any layer. The occurrence of a high degree of fragmentation in the faunal remains also lends weight to the trampling hypothesis (Frosdick 2010).

The presence of the broken blanks observed at the time of the excavation and whose fragments were easily joined also suggests interference by mechanical disturbances to the artefacts. In the same way some connections between the broken elements made on 4 m² of the excavation testify to a displacement of less than 1 m, and thus an in situ breakage probably mechanical in nature. However, lack of time did not allow a systematic refitting of all broken artefacts.

In the case of layer 6a ninety percent of blades are broken and several artefacts show signs of edge damage. It seems that the archaeological material from layer 6a have been subjected to the same taphonomic forces as those of layer 6b. The state of preservation of the artefacts from layers 6a and 6b indicates that the taphonomic modification of these layers was important, and also explains the small number of preserved bones, the majority of which are teeth.

The high fragmentation of artefacts due mainly to the post depositional taphonomy of the collections from layers 6a and 6b make them difficult to quantify. In both cases, blades were the worst affected by fracturing, which seem to break consistently in to two or three parts. Those items which retain the flake platforms, their original dimension can be estimated after Dibble & Pelcin (1995), but for those without their original length remain unknown at the time of fracture.

Here quantification of the different blade groups, whilst bearing in mind that this problem needs to be assessed at a later date, using a formula of estimating the number of intact tools: total length of intact tools added to the total length of fragments that are greater than or equal to 3 cm divided by the median length of intact specimens (ENIT). This value should approximate to the number of discarded tools.

Although all lithic assemblages frequently exhibit a variable rate of fragmentation, the problem of accounting for these fragments seems to be unresolved. This due to the fact that different researchers produce fragment counts, their size and their nature differently. Often, comparison between assemblages is extremely difficult and the use of a standardised methodology would allow for better understanding of differences between sites. As Shott (2000 and the references therein) showed there exists some possibilities to evaluate this quantification problem, "otherwise, differences may owe as much to how we counts as to what…" (Shott 2000:737). The lithic artefacts from layer 7a and 7c are well preserved, nearly all were found in sub-horizontal position with accordance to the inclination of layer. These do not exhibit any edge damage but at the same time a number of blades are fragmented. Several pieces demonstrate an orange patination probably originating from the iron oxide deposits. All artefacts from layer 6c are well preserved with still sharp edges and were probably covered by sediment soon after deposition. In layers 7a, 7c and 6c all intact and each fragmented item bigger than 3 cm were counted as an individual specimen, whilst refitting was continually undertaken in these assemblages

The Hummalian layers contained about 200 potentially burnt flints. The majority of these were found in layer 6b, where the overheated flints were found in three main concentrations around which the other burnt flints were distributed. Some archaeological and experimental evidence (Sergent *et al.* 2006) shows that severely overheated flints are the best marker of non-structured surface hearths. In addition, the micromorphological analysis shows the presence of charcoal in layers 6a and 6b (Rentzel & Ismail-Meyer n.d.). This could suggest the potential existence of hearths, which could also have been easily destroyed by intensive trampling.

The Procurement of the Raw Material

The raw material used in Hummalian layers is approximately 99% local Lower Eocene flint from the El Kowm area (Diethelm 1996). This is a very fine grained flint of excellent quality for knapping. Its colour varies from black to dark brown with a white cortex. The nodule size fluctuates from a few centimetres up to tens of centimetres, and are very heterogeneous, forming both nodules and plates. This flint is very abundant and easily accessible in a radius of about fifteen kilometres around the site. The rest of the raw material is made out of cretaceous flint and travertine, of which the former is probably obtained from the formations at Jabal Mqabra and Jabel Minshar a distance of about fifteen km from the site, the latter is possibly of local origin. The occurrence of lithic items which bear a weathered cortex or neocortex give evidence of using the flint gathered in secondary context. However, the small numbers of such specimens in all Hummlian assemblages demonstrates that the use of such a strategy seems to be rarely practiced.

An additional source of raw material was the flint found on the site, which is visible by the reuse of exhausted Levallois cores, the broken blanks and debris for bladelet production. The tendency to recycle the raw material is visible by, among other things, the large occurrence of cores on flake. The substantial flakes were struck on their dorsal, or occasionally on ventral surface following the different reduction strategies, Laminar, Levallois or Nahr Ibrahim technique. Their final stage of reduction shows that the aim was to obtain as many blades or bladelets as possible.

The recycling of blanks for shaping new tools, which is perceptible by double patinated items, occurred sporadically in layer 6a and 6c, but is not noteworthy in assemblages from layer 7. In layer 6b recycle material makes up 4% of retouched tools. Occasionally the exhausted cores were retouched for tool use. Two examples of cores made on Yabrudian scrapers coming from layer 7c and 6c show that the procuring of lithic material from older occupations took place as well.

Layer	Ilam	Ratio blank to CTE and cortical elements
6a	57.6	2.4
6b	59.9	1.8
6c	72.8	3.1
7a	75.0	4.0
7c	52.8	3.4

Table 3 - Ratio blank to Core Trimmig Element and cortical elements; ILam in Hummalian layers.

Blank Production

The influence of the raw material on debitage is inevitable, but it is difficult to appreciate its importance without the refitting. A high-quality raw material can increase the tool efficiency by the ease of flaking, facility for maintaining and recycling (Edmonds 1987). Experiments carried out in El-Kowm on Eocene flint show that even an inexperienced flintknapper starting with an elongated and convex nodule, is able to strike some blades but will not succeed in producing a regular series and will even make the same knapping errors as those observed from the Hummalian material. Conversely, because the flint is so easily knapped the smallest error such as an imprecise, badly controlled, too forceful or too weak blows will cause a mistake. Generally an overshot or fracturing of the proximal part is produced, which often requires repair to continue the flaking. The systematic debitage of a great number of elongated supports required experience, but it is also facilitated by the quality of flint. Laminar debitage noted here can appear in fact rather opportunistic due to the use of the natural shape of the block, the lack of or summary core shaping, but is also effective.

There were no blocks of raw material found on the site. In layer 6b the marked presence of flakes bearing from 50 to 100% of cortex on their surface, several of which are entames which present the initial stage of the raw material aquitisation (Tixier 1963:33), core trimming elements and cores shows that the debitage was at least partly carried out on site. This assumption can be reinforced by the fact that the cortical butts and single scars are observed on a large majority of cortical blades. The ratio of core trimming elements (CTE) and cortical elements to blanks is high (tab. 3), whilst the length and volume of CTE and blanks are equivalent.

In other layers the first, cortical removals from a natural platform (entames) were not recorded and the cortical elements are under represented in layer 7c, 7a and 6c. Nevertheless CTE that belong to the stage of reshaping the core, when the convexities have been lost or the core surface does not allow further flaking which required a mend, were existent alongside those with cores in variable quantities .The size of CTE is related to blank size.

It can be supposed that in case of layer 6c and 7c already prepared decocorticated nodules were transported to the site where they were shaped and blanks produced. Additionally in the level 7c a small debitage workshop was also discovered. A partial refitting shows that the debitage is produced from a small convex nodule of a few centimetres in length, which displays traces of cortex removal. A few items were removed from nodule and two of them which were elongated and broken left with the waste.

The high degree of the small debris in layer 6a is probably related to the post-depositional disturbances. In the case of layer 6c the small debris may possibly come mainly from tools production as the percentage of retouched items is high and a minority from core shaping. In the case of layer 7 it is just as likely that the small fragments were present due to post-depositional disturbances as to tool resharpening. Besides this in all levels the relatively frequent use of removal of overhang from blanks could also be liable for small debris production.

The lithic assemblages show no major differences between layers. The aim of production was the elongated, converging or parallel blanks (tab. 3). At the same time achieving the particular blades size was not an aim as the blades are extremely variable in their length, width and thickness within assemblage (tab. 4) as well as between the assemblages coming from different layers. The common flaking technique is direct percussion with a hard hammer as attested by a circular and well testified impact point, bowed bulb and numerous radial defaults (Pelegrin 2000). All assemblages fall under a particularly coherent technical unit. The technological studies confirm the existence of a Laminar system of debitage (Meignen 1998), and a particular core volume management. This process is very different from

		length (L)			width (W)			thickness (T)			WT platform			median		
Blades category	n	min	median	max	min	median	max	min	median	max	min	median	max	LW	WT	LT
Cortical (cx 50-100%)	**10**	6.2	7.9	10.6	1.4	3.0	5.0	0.8	1.4	2.4	2.0	2.1	2.3	2.6	2.1	5.6
CTB	**103**	3.1	6.8	14.0	1.2	2.5	6.6	0.3	1.2	2.5	0.9	2.0	4.5	2.7	2.1	5.7
Bladelets	**10**	2.0	3.8	4.6	0.7	1.4	1.4	0.3	0.7	1.2	2.3	2.4	2.5	2.7	2.0	5.4
Blank Levallois	**20**	5.7	6.8	8.5	1.9	2.8	3.8	0.5	0.7	1.1	2.2	4.1	12.0	2.4	4.0	9.7
Blank Laminair	**186**	4.0	7.3	16.0	1.3	2.9	6.5	0.4	1.0	2.6	0.8	2.3	4.7	2.5	2.9	7.3
Shaped	**112**	4.2	7.7	14.0	1.2	2.8	5.5	0.3	1.0	2.6	0.8	2.5	6.3	2.8	2.8	7.7

Table 4 - Layer 6b, metrical data of blades.

Levallois system of debitage which shows working on successive surfaces. However, the practice of Levallois debitage is also observed at the same time, with the presence of cores, and typical Lavallois products, lames débordantes, and predetermined flakes. It seems that there are two coexistent reduction strategies. Indeed, it could also be possible that a system of Levallois and Laminar debitage were carried out successively on the same block giving the opportunity for a more efficient use of the entire block by passing from one reduction strategy to another and might be related to the decreasing size of the core. The close connection between the two flaking system can be seen by the existence of laminar cores made on big edge flakes or on the large fragments stem from Levallois cores. This suggests that Laminar and Levallois production could take place within the same reduction sequence. A comparable situation has been identified in a Middle Palaeolithic blade industry from Etoutteville (France), where the Levallois production started on large, flint nodules. These frequently split at the beginning of the reduction process, these large broken fragments from this early stage of debitage were regularly recycled for blade cores manufacturing using the particular core volume management similar to Laminar system, whilst the original block was flaked following the Levallois scheme (Delagne & Kuntzmann 1996).

Alongside these two main core reduction strategies the Nahr Ibrahim (Schroeder 1969; Solecki & Solecki 1979) technique and the regular debitage of bladelets on thick flakes or nucleiforme debris were also documented at the site (tab. 5).

All presented flaking systems were involved in blade manufacture, but the laminar strategy is more universal. The majority of cores are exhausted and few broken at the end of the debitage (generally marked by hinges), the dorsal scar pattern shows the choice of laminar debitage; however, some cores also show the flake negative whilst others demonstrate both at the same time.

The existence of these different reduction strategies could indicate the different use of the products especially if they treated differently. This appears to be the case of the Hummalian industry, where the thick, laminar blades are often retouched and the majority of the elongated Levallois products were not modified, as their broad and thin nature was naturally appropriate for the intended use.

The technological analysis presented here will focus on layer 6b which is the richest assemblage and gives the opportunity to define the Hummalian industry. The metrical analyses were carried out on complete pieces. Although, information could be taken from the majority of broken or crushed artefacts that could be used for other technological studies.

cores types	7c	7a	6c	6b	6a
Semi-rotating	2			74	
Facial	1		2	17	1
Frontal				5	
Levallois	3		1	37	
Nucleiforme burin		2	2	28	1
Nahr Ibrahim	1			14	2
Irregular				1	
Total	7	2	5	176	4

Table 5 - Core categories in Hummalian layers.

The assemblages from layers 6a, 6c2 and 7 are less productive but present all technological features observed in layer 6b and therefore confirm that they are of the same technological tradition.

The Levallois Method

The use of Levallois method was visible in all layers either by the presence of cores or typical Levallois products. The majority of Levallois cores were made on block and a few on flake. They are rectangular or triangular to round in shape, the majority are elongated and flat, few are convex in cross section. The debitage method is mainly recurrent unidirectional (fig. 4:1), bidirectional or centripetal, and in marginal lineal (fig. 4:2). Only a few cores show the negatives of convergent unidirectional debitage but in the same time the scar pattern visible on Levallois blanks shows that this method was frequently employed.

The Levallois cores, as defined by E. Boëda (1986), are composed of two opposed surfaces, of which one is conceived as the preparation of the Levallois surface and the other, often cortical, as a surface of the striking platform. In the case of layer 6b, cortex occurs on 27 cores (68% of Levallois cores), on the ventral face in 20 (49%) and in eight (20%) on dorsal face (on proximal, medial and distal parts). In the first group the cortex coverage is important, and accounts for 25 to 50% and in the latter groups for less than 25%. The cores with non cortical coverage are the smallest with a median volume of 29.5 cm^3. The cores with cortex less than 25% are bigger with median volume of 36.7 cm^3. The cores with cortex coverage from 25 to 75% are the biggest in the series with a median volume of 49.8 cm^3. Such a cortex distribution indicates that the scarcity of cortex on the core is a function of the core size which suggests that the systematic cortex removal took place on site following the volume reduction.

The convexity of the distal and lateral portions of the cores exhibiting the recurrent method of debitage is guaranteed by the regular removal of edge flake. This removal recreates the hinges or guides and follows the exploitation of the Lavallois surface (Boëda 1988). The éclats débordants will aid the continued flaking by systematically reducing the plane of intersection and will allow a better use of the block volume (Boëda 1995). The distal convexity is also assured by small removals from the latero-distal part of the core. The large platform is established on the proximal or proximal and distal (bidirectional) part of the core. They are in the main faceted, and occasionally plain. The blanks were struck from one or two parallel platforms.

The lateral and distal convexities are achieved in the centripetal Levallois method by the removal of éclats débordants, which are often overshot (fig. 4:3) and maintains the rest of Levallois preparation. Alternatively the extraction of the small flakes around the periphery of the exploitation surface could be used to the same affect. The striking platform is organized around

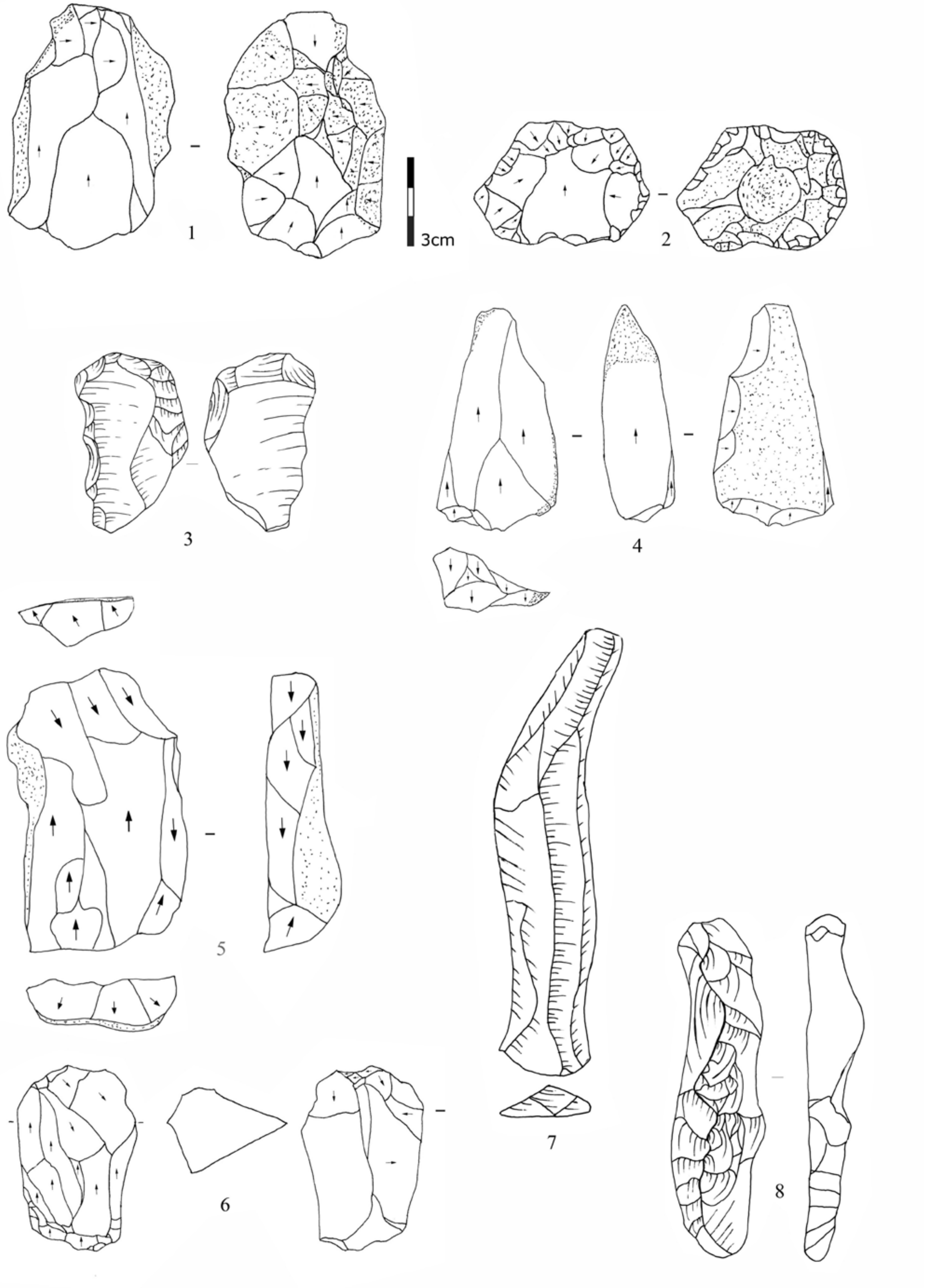

Figure 4 - Layer 6b. 1: Levallois core showing recurrent debitage; 2: Levallois core showing centripetal debitage; 3: éclat débordant; 4: re-used Levallois core exploited on the lateral edge; 5-6: bidirectional cores with shifted platform; 7: blade presenting bidirectional, shifted debitage; 8: crested blade.

the whole core periphery. Four cores show the negative of preferential flake, covering the main part of the exploitation surface. The presence of only a few blanks from this flaking method and the small volume of these cores (median volume = 21.3 cm³ compared to a median of Levallois cores = 41.8 cm³) and size (median length =3.6 cm, median length of Levallois cores=5.2 cm) suggests that the preferential flake method was not used regularly, maybe only at the end of the core reduction. This can be further evidenced by the fact that the median length of blanks (median length of all blanks = 6.2 cm, median length of blanks-flakes = 5 cm) surpass the length of these type of core.

The Levallois cores resulted in mainly large blades, and thin and flakes of varying sizes. The dorsal scar patterning on 69% of the cores shows evidence of laminar debitage and in 31% of flakes. Five cores were reused for blade/bladelet production. These were exploited on the sides (fig. 4:4). Nevertheless, the flint knapper succeeded in obtaining just two or three blades or bladelets on this narrow side because the new striking platform was not re-orientated with the new knapping surface. Occasionally, the nucleus was split in two pieces, which were then struck again if the partition created an apt angle. This cannot of course be regarded as the force behind the changing from Levallois to Laminar debitage but at the same time shows the flexibility of the "Hummalian" flint knappers whose main goal was to strike the elongated blanks regardless of their size and the reduction strategy.

The Laminar Method

The presence of the thick, elongated blanks with triangular or trapezoidal cross section and laminar cores confirm use of the Laminar method in all Hummalian layers. The majority of laminar cores were made on block but many were also made on flake (tab. 6). A consistent morphology is visible in many of the laminar cores in spite of a large variation in size; from three to twelve centimetres. Blank production was usually carried out until exhaustion of the core which produces a narrow or large, often thick blank, of differing size including small blades.

The blades were struck out from either one platform or two opposite, offset platforms. The laminar concept is characterised by frequent use of the natural shape of the block, often with minimal cortex removal and no or summary core shaping. The management of the laminar flaking surface was usually performed by the removal of a naturally backed flake, along a natural ridge without any preparation, using the natural form of block or flake. An alternative to this was to produce the flakes with cortical, often vertically backed, or by secondary crested blades retaining on one side the negatives perpendicular to the vertical axis of the core. Only six blades in layer 6b and two in layer 6c testify to the initialization of flaking using crested blades (fig. 4:8) and it seems that in most cases the first blade was struck directly from a single striking platform with respect to the natural shape of block.

layers	on block n	on plaquet n	on flake n	on debris n	total
7c	5		2		7
7a			1	1	2
6c	2		5		7
6b	83	16	64	13	176
6a			3	1	4
	90	16	75	15	196

Table 6 - Cores in Hummalian layers.

If the flaking surface showed too many hinge marks, lost its convexity or became too bowed, the flint knapper often removed a flake. Most of the struck "cleaning flakes" to maintain the flaking surface corrects the middle part, whilst a few occur at the distal part, occasionally these are also plunging. The majority are non cortical, few show 1 to 25% cortex of their dorsal face. These are rather weighty with median thickness of 1.3 cm and four to ten centimetres in length. This indicates that this practice was used throughout the core reduction.

It is entirely possible that the laminar system is related to a rotating system of debitage. This means that the tool-maker began with a frontal debitage along the narrowest face of the core and subsequently repositioned to the one of the adjacent faces, as a consequence of this changed to semi-rotating debitage. The core volume management is organised into three main categories (fig. 5 top).

Semi-Rotating Debitage

This is well represented and perceptible on 42% of cores in layer 6b. The majority are complete on block and there are several on flakes. The flaking surface covers part of the nucleus and its sides and opposes a plane or cortical surface (posterior). However, if produced on flake it opposes the ventral face. More than half of the semi-rotating cores have a single striking platform. The remainder exhibit two opposing striking platforms, the greater proportions of which are offset (fig.4:5-6) with a few parallel platforms. These can be classified according to their cross-section and demonstrate a development of the flaking surface which can be expanded on to the side during flaking (fig. 5 bottom).

The debitage is generally organized according to the vertical axis (length) of the block. Certain cores had initially, two converses and offset striking platforms, one of which was lost at the end of the debitage, by a plunging flake. The cores are rectangular to triangular in shape, elongated and as a rule convex in cross-section. The platforms of the majority of cores are minimally prepared by two or three weighty blows on the smooth lateral sides, although these occasionally occur on cortical sides. These removals from the core sides have a role of refreshing the intersection between the platform and the flaking surface and allow the exploitation of the lateral sides of the core. It seems to be frequently utilised. No more than six pieces exhibit the removal of the rejuvenation core flake. The cores with two opposed faintly offset platforms demonstrate that the flaking

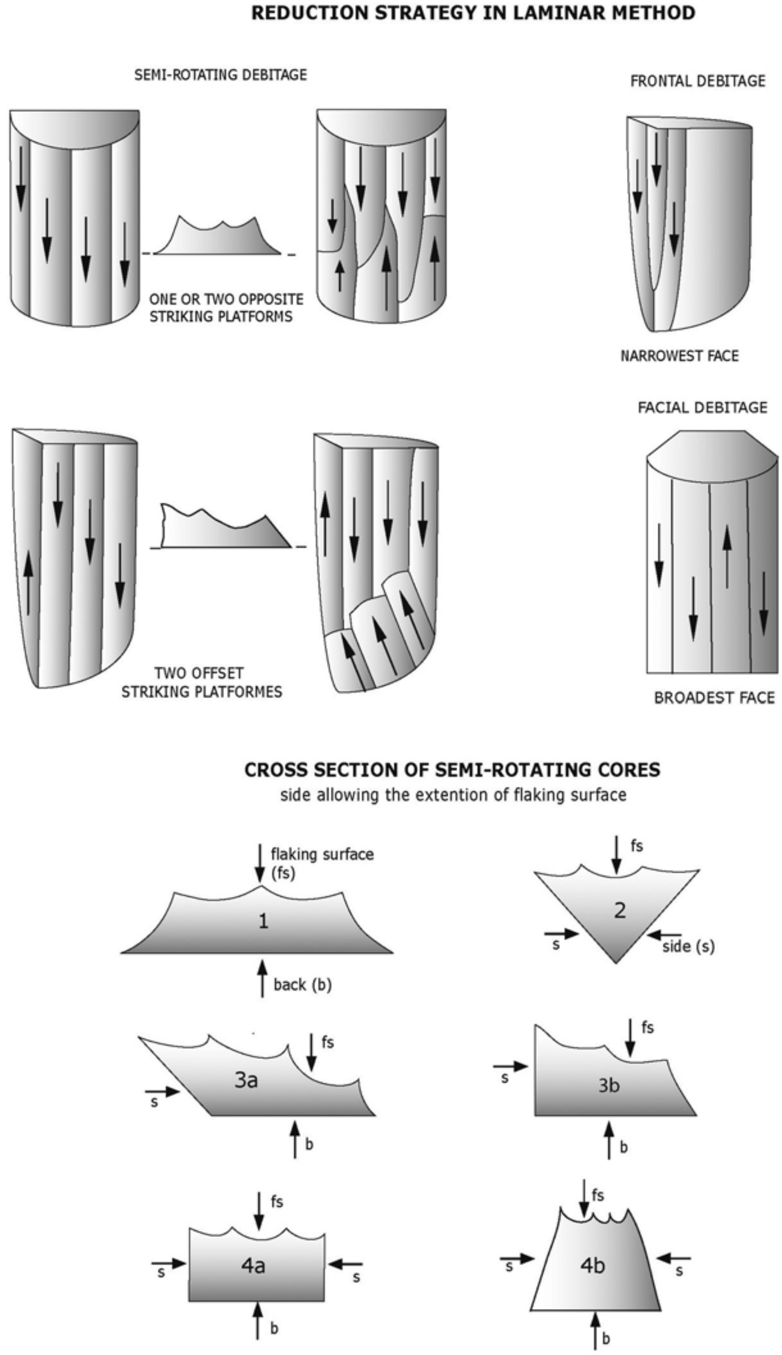

Figure 5 - Top: reduction strategy in Laminar method; bottom: cross section of semi-rotating cores.

was occurring independently on both the narrow and broadest face of the core. The intersection between these two surfaces created the required convexity of flaking surface for continuation of the debitage.

Three semi-rotating cores were made on the big éclats débordants, still having the traces of Levallois preparation, evidently from Levallois cores. All cores provided blades and several bladelets.

Facial Débitage

This is recognized in 10% of cores, half made on block and half on flake. The debitage is carried out on the broadest surface of the core from its convex or flat dorsal face. They can be either bidirectional (two opposite parallel platforms) or unidirectional. The majority of platforms are prepared as with the semi-rotating cores, by two or three blows from the lateral sides or plane. They are rectangular or triangular to round in shape and not elongated. At the end of exploitation they produce mostly blades (41%), flakes (35%) or both (24%). In three cases when the ventral face was exhausted, the core was rotated and exploited on its ventral face. The flint knapper normally managed to remove one or two more flakes before discarding the core. Despite the fact that several cores at the end of exploitation give the notion of being similar to Levallois, the management and the maintenance of the surface convexities separate them from the latter completely.

Frontal Debitage

This is recognisable on 3% of cores, four complete on block (fig. 6:1) and one on flake. They have one striking platform and the flaking concerns the narrowest face of the core. The platform is prepared by one or two blows and debitage starts on the natural edge of the block, in the case of core on flake the edge of flake serves as a guide-ridge. The cores are rectangular or triangular in shape, elongated and convex in cross-section. They provide three or four blades at the end of their exploitation.

The Nahr IbrahimTtechnique (NI)

This was recognized in 8% of cores in layer 6b. These are normally made on large non cortical flakes or those showing only small patches of cortex covering less than 25% of their distal face (fig. 6:2). They are rectangular to triangular in shape and mainly convex in cross section. The dorsal surface shows between two and five elongated negatives. Four are complete on Levallois flake while still retaining the rest of Levallois preparation. They can be bidirectional or unidirectional. The flake was truncated on either its proximal or distal ends, with some exhibiting truncation at both ends, in all cases these were also facetted, subsequently the detachment of rather thin blanks occurred. In the lithic assemblage, the blanks struck from NI cores are not abundant but are observed.

The Bladelet Production

The bladelet production was perceptible in all Hummalian layers, in the case of layer 6b it represents 16% of all cores. The small blades were systematically struck from nucleiforme burin-like pieces made on broken, thick blade, flake or on nucleiform debris (fig. 6:3-5). Similar to the frontal debitage the flint knapper used the natural shape of block and started to detach the blanks from natural edge of the core. The platform is mostly unprepared/plain or corrected by truncation, periodically they are prepared by one or two blows. The unidirectional flaking started on the narrowest face of the core and frequently expanded on to the broad face. They result in two to five bladelets, of two to four centimetres in length. Additionally, small blades were also produced from different volumetric cores at the end of their reduction or on the side of exhausted Levallois cores.

categories of CTE	blades	%	flakes	%	blades +flakes
crested	4	2%	1	1%	5
semi-crested	10	4%			10
with prepared back	20	9%	15	10%	35
with natural back	81	35%	28	18%	109
with cortical back	46	20%	28	18%	74
éclat débordant	6	3%	15	10%	21
cleaning	37	16%	26	17%	63
plunging	20	9%	11	7%	31
hinged	9	4%	28	18%	37
resharpening			4	3%	4
Total	233	100%	156	100%	389

Table 7 - Layer 6b, Core Trimming Element categories.

It was decided that the specimens which present just one coup de burin negative will be categorize as burin not as core for bladelets production. Nevertheless the question how they should be classified remains open. The microwear analyses could help to shed more light on this problem. Unfortunately such studies on the lithic material from Hummal have not so far been undertaken.

The Blades

The blades represent more than half of the debitage, excluding small debris, in almost all layers (the exception being layer 7a assemblage) and which consists of blanks, and core trimming, primary blades, bladelets, shaped tools.

The Cortical Blades

The cortical blades bearing more than 50% of cortex on their dorsal surface seem to correspond to the initial core shaping stage and differ significantly from the blanks. The cortex is perceptible on the proximal and medial parts in 64% and remainder on the medial-distal part. In most cases the striking platform is broken, cortical, and sometimes plain. The majority of these present a unidirectional scar pattern and the rest bidirectional. It indicates that the decortication of the nodule was carried out on a single, usually cortical or non-prepared platform. They are generally parallel or convergent and occasionally divergent. Single scars are observed on a large majority of cortical blades. Their median index length to thickness is the smallest in the blades group. This means that the cortical blades are thicker and smaller and relatively more substantial than other groups. This is also observed in the median volume and the median index of width/thickness (tab. 4).

The Core Trimming Blades (tab. 7)

The core trimming blades are composed of 60% backed blades with natural, cortical, or prepared back. Typical "lames débordantes", the cleaning blades, the crested and semi-crested blades, the plunging and hinged blades are considered representative of this group. The naturally backed blades are the most frequent, followed by the cortical backs and those with a prepared back. The majority are unidirectional, with the remainder being bidirectional. Alongside which most are convergent or parallel although several are divergent. Their scar pattern is significantly more variable than in the cortical blades and quite similar to those from blanks. A single scar is visible on 21% of pieces, but the greater part has two or more converging or parallel scars. 37% show from 1 to 50% of cortex on the dorsal surface which appear either on the distal or medial part although less frequently on the proximal part. The majority of striking platforms, excluding the broken pieces, are lightly facetted, punctiform, plain or cortical, some are damaged by crushing and there are rare cases of dihedral platforms. 50% have a curved profile, with just a few being twisted. They are usually quite thick, either triangular or trapezoidal in cross section, very few are flat. Similarly to the laminar blanks the maximal width occurs in the medial portion in 54%, 26% in distal and 20% in proximal.

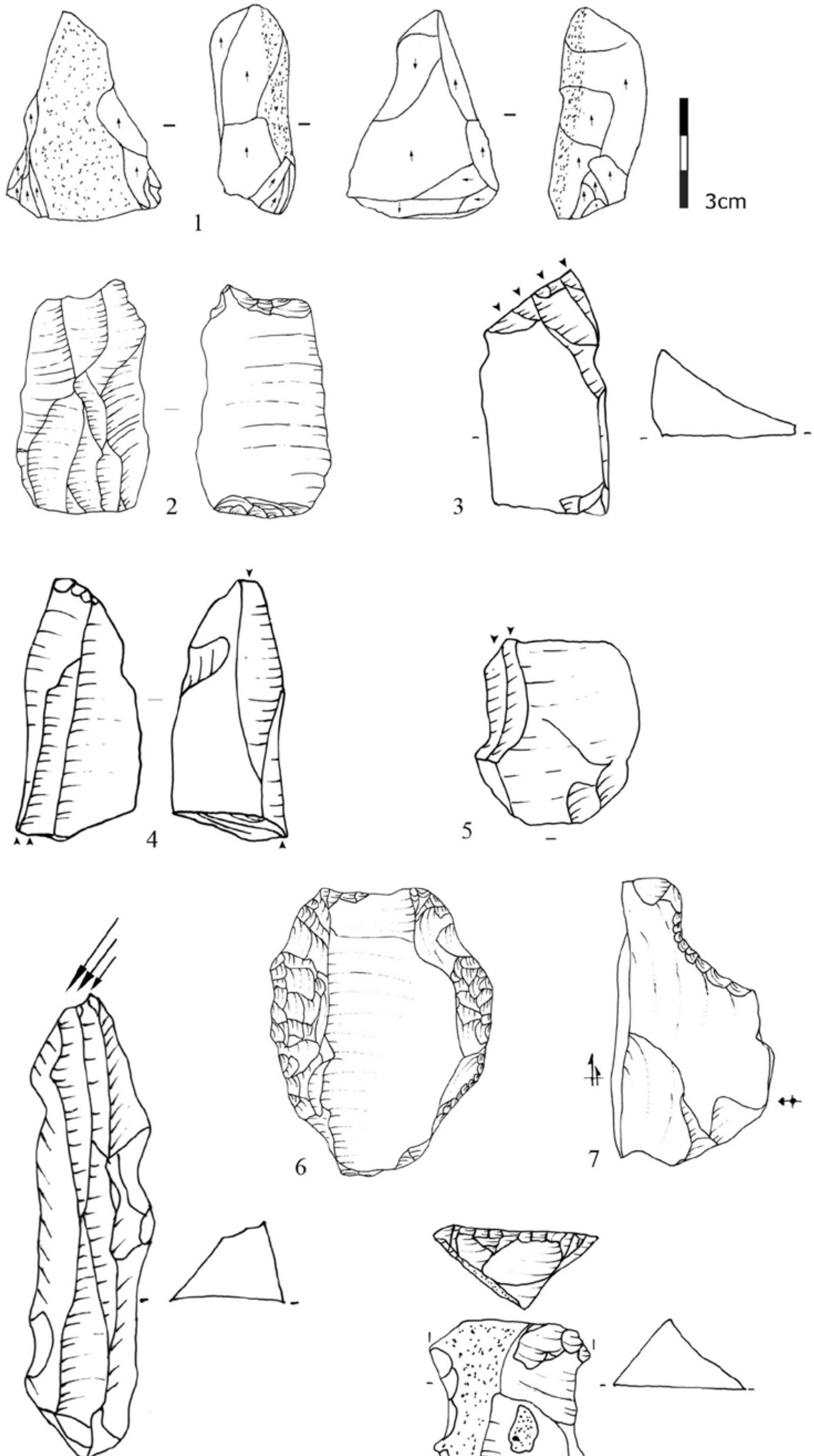

Figure 6 - Layer 6b. 1: unidirectional cores with frontal debitage on lateral edges; 2: Nahr Ibrahim core; 3-4: nucleiforme burin on debris; 5: blade fragment used for bladelet production; 6: double scraper made on Levallois flake; 7: notch made on broken flake; 8: double burin made on blade extremities; 9: end-scraper.

The blanks-blades

The volumetric cores produce the narrow and large thick blades, with triangular or trapezoidal cross sections with plain or lightly prepared butts. The Levallois recurrent method results in a series of rather wide blanks with faceted or plain platform, although occasionally narrow, and thin elongated blanks are recorded.

In the Hummalian assemblage from layer 6b the blanks showing either of these characteristics were easily separated, but between both these groups exists a number of blanks which are somewhat problematic due to their ambiguous morphology with respect to their metrical attributes. The state of preservation also adds to the difficulties in deciding about their inclusion. Most have lost their proximal part either through breakage or at the moment of failure. They are short and thin and could possibly be struck from either Levallois cores or from Laminar cores as their volume reduces and as they become flatter. Certainly this could be the case of the facial cores. For this reason it was decided to separate them from clearly Levallois and prismatic blades.

The metrical analyses made on the Levallois and Laminar sets demonstrate that the thickness and length seem to be the most distinctive attribute between these blanks. The t-test of ratio length/thickness ($t=-9.742$; $p=0.00$) and the width/thickness ($t=19.835$; $p=0.00$) confirm the total dissimilarity opposite between these two groups. Quantifying, this shows that 76% are laminar blades, 9% Levallois blades and 15% are those blades of indeterminate morphology.

The laminar blades are longer and thicker than Levallois, but there is a similarity in width measurements. The laminar blades are often curved in profile. They tend to be trapezoidal or triangular with a thick or slightly flattened section. 15% bear cortex, in most cases on the distal part, however cortex is found on the proximal and medial parts. This can indicate the partial preparation of the nucleus and that the end opposed to the striking platform did not matter. Only 6% of Levallois blades show a small amount of cortex on the dorsal surface, which occurs equally on the distal, proximal and the medial sections of the artefact. They are in the main straight in profile with a flattened or sometimes concave trapezoidal cross-section. The butts of laminar blades, excluding those which are broken, are mostly plain prepared. In the case of Levallois, they are faceted or plain. Interestingly, in the latter group fewer butts are broken. Both groups occasionally show cortical, dihedral and punctiform striking platforms. The slightly faceted platform visible on Laminar blanks appears to be applied to reduce overhang and amend the flaking angle. They are more or less rectangular in shape; the point of percussion is placed well back. Those produced by the Levallois method are rather thin in relation to the blank thickness. The contrast between the platform sizes in Levallois and Laminar blades is also confirmed using the t-test ($t=-3.170$; $p=0.02$).

The removal of overhang was used relatively often in both groups. Only the primary blades are derived of this kind of edge preparation. The dorsal scar pattern shows that unidirectional debitage dominates in both groups, but bipolar flaking is more often used in Levallois than in Laminar debitage. The flint knappers often used the ridges left by anterior removals as a guide to steer the force through the piece. This occurred either behind or to the side of a central ridge or between two central ridges. The majority of the blades are convergent with parallel blades following and the remainder being divergent. The scar patterning visible on Laminar blanks shows that two or more convergent negatives are best represented, followed by a single negative, and two or more parallel negatives. The scar organisation visible on Levallois blanks is slightly different. Two or more parallel scars; followed by two or more converging scars are the most frequent and the single scar seldom appears. The Levallois blanks with converging dorsal scar pattern are most likely related to the Levallois point production, though the typical Levallois points are seldom in all collections. It seems that in both cases the goal from the outset was to produce the converging or parallel blanks using the unidirectional and less frequently bidirectional flaking method.

As the blank production was regularly carried out until exhaustion of the core the assemblage includes blades with a size scale ranging from lengthened blades to minute blades (tab. 4). The non-Levallois blades exhibit a wide dimensional variability while the Levallois blades give an impression of being more uniform. 55% of the prismatic blades attain their maximal breadth in the middle part, 28% in proximal and 18% in distal part. The Levallois blanks are the widest at their proximal (44%) or medial (42%) part, the rest on their distal part.

The production of small blades/bladelets (length < 5cm, width ≤ 1.4cm) accounts for 4% of the debitage excluding debris. It confirms that the point of interest was manufacturing the elongated blanks throughout the whole reduction strategy regardless of their dimension, although the Levallois blades are more standardised in their size.

It emerges that the presence of blanks which length and width noticeably surpass the size of all cores and trimming elements is most likely related to the extended exploitation of cores rather than the indication of off site production (Binford 1979).

The Flakes (tab. 8)

The flakes account for approximately 40% of the debitage, excluding debris, in almost all layers excepting layer 6c where the percentage is the lowest, and consists of primary flakes, modified flakes, the core trimming elements, and flake blanks.

The cortical flakes

The flakes bearing more than 50% of cortex are most likely produced from the initial phase of core shaping as the cortex appears mostly on the proximal-medial or medial-distal part. 80% measure from 3 to 4cm in length; they are thin, convex in profile and irregular in shape. 43% of cortical flakes show from 76 to 100% cortex on their dorsal surface. The flakes measuring more than 4cm in breadth or length are substantial with the biggest volume, thick and usually broader than they are long. They are mainly unidirectional although occasionally bidirectional.

Flakes category	n	length (L) min	median	max	width (W) min	median	max	thickness (T) min	median	max	WT platform min	median	max	median LW	WT	LT
Cortical (cx 50-100%)	**268**	1.3	4.0	8.5	2.3	4.7	8.9	0.6	1.3	2.2	2.4	2.8	6.3	0.9	3.6	3.1
Core Trimming	**123**	2.6	5.0	9.3	1.7	3.5	6.5	0.4	1.0	3.2	1.1	2.6	8.0	1.4	3.5	5.0
Shaped	**73**	2.8	4.8	9.3	2.1	3.8	7.3	0.5	1.1	3.0	1.0	3.0	6.3	1.3	3.5	4.4
Blanks Levallois	**93**	2.6	5.0	9.4	1.8	3.8	7.2	0.5	0.7	1.7	1.9	4.3	14.3	1.3	5.4	7.1
Blanks non-Levallois	**95**	2.1	4.9	11.4	1.1	3.5	9.9	0.4	1.0	2.3	1.0	2.4	5.0	1.4	3.5	4.9

Table 8 - Layer 6b, metrical data of flakes.

Their striking platforms are often fractured or cortical with a few examples of plain and lightly prepared.

The core trimming flakes

The assemblage of core trimming flakes comprises of backed flakes, cleaning flakes, plunging flakes, hinged flakes, and re-sharpening elements (tab. 7). 48% show from 1 to 50% cortex on their dorsal face, distal, medial and proximal parts. The butts are facetted or plain, sometimes punctiforme, cortical and infrequently dihedral and often fractured at the moment of failure. 80% are unidirectional, 18% bidirectional, 1% centripetal and rest are indeterminate. The core trimming flakes are not very abundant, but are longer and slightly thicker than blanks, their platforms are also relatively more massive than those from latter group.

The flake blanks

The blanks are not elongated and nearly half present the Levallois morphology which is thin, rather wide and not very long. They also display variability in size from 2 to 9 cm in length. Their butts are thin, mostly faceted but can be plain or cortical. They are mainly unidirectional; although artefacts with bidirectional dorsal scar pattern are also well represented (20% of Levallois flake-blanks) and a small number are centripedal. 35% bear a small amount of cortex on their dorsal face, in most cases, on the distal part though occasionally also on the proximal and medial parts. This indicates that the flaking surface and proximal end usually lacked cortex.

The rest of the flakes are larger and thicker than Levallois examples. The platforms are rather broad, and are either plain or faceted. The dorsal scar shows unidirectional flaking in most of cases, with the presence of a small proportion of bidirectional flaking. The majority (65%) are covered by small quantities of cortex on their dorsal or proximal parts, and to a lesser extent also on the medial portion. It suggests that the cortex was not removed from the flaking surface, especially on the proximal and distal ends.

The Retouched Tools (tab. 9)

The percentage of retouched artefacts varies between the assemblages, from a high of 20% of debitage, excluding small debris, in case of layer 6c to 3%, lowest of in layer 6a. They were shaped mostly on the thick blades struck for the most part from Laminar cores, and less often on flakes or debris. The retouched blades are longer and broader than the unmodified blades (tab. 10). This indicates a choice of longer and broader supports for shaping these tools especially if it is to be believed that the original size of many of them has been reduced throughout repeated use and retouching. The retouched tool assortment consists of a high percentage of elongated end-point products fashioned by intense retouching, these are typologically considered points and convergent scrapers and parallel blades retouched continuously on one or both sides, typologically classified as single or double scrapers on blade (fig. 7:1-6). The retouched pointed blades are symmetrical or asymmetrical ("pointes incurvées" after Neuville 1951), with the semi-abrupt retouch mostly covering both sides and abrupt retouch concerning the distal parts ("Hummalian point" after Copeland 1985). The retouch applied on the blank is continuous, usually invading, and occasionally

type of tool	**7c**	**7a**	**6c**	**6b**	**6a**
retouched point			8	94	2
pointed blade	2		6	29	6
blade retouched on one bord	5	1	5	80	2
blade retouched on two bords	3			38	
partially retouched blade				20	
transversal scraper				1	
face plane				2	
notch/denticulate	1			31	
perçoir			1	5	
truncation				7	
end-scraper				14	
atypical end-scraper				6	
burin			1	16	
with Nahr Ibrahim preparation			1	7	
diverse	2	1	3	15	1
total	**13**	**2**	**25**	**365**	**11**

Table 9 - Category of retouched tools in Hummalian layers.

Layer	n	length (L) median blank	shaped	width (W) median blank	shaped	thickness (T) median blank	shaped	LW blank	shaped
7c	10	6.3	9.0	2.6	3.1	0.7	1.1	2.4	2.9
6c	20	7.6	8.5	2.3	2.9	0.7	0.8	3.3	2.9
6b	112	7.1	7.7	2.9	2.8	0.9	1.0	2.4	2.8
6a	2								

Table 10 - Metrical data of blank-blades, retouched blades in Hummalian layers.

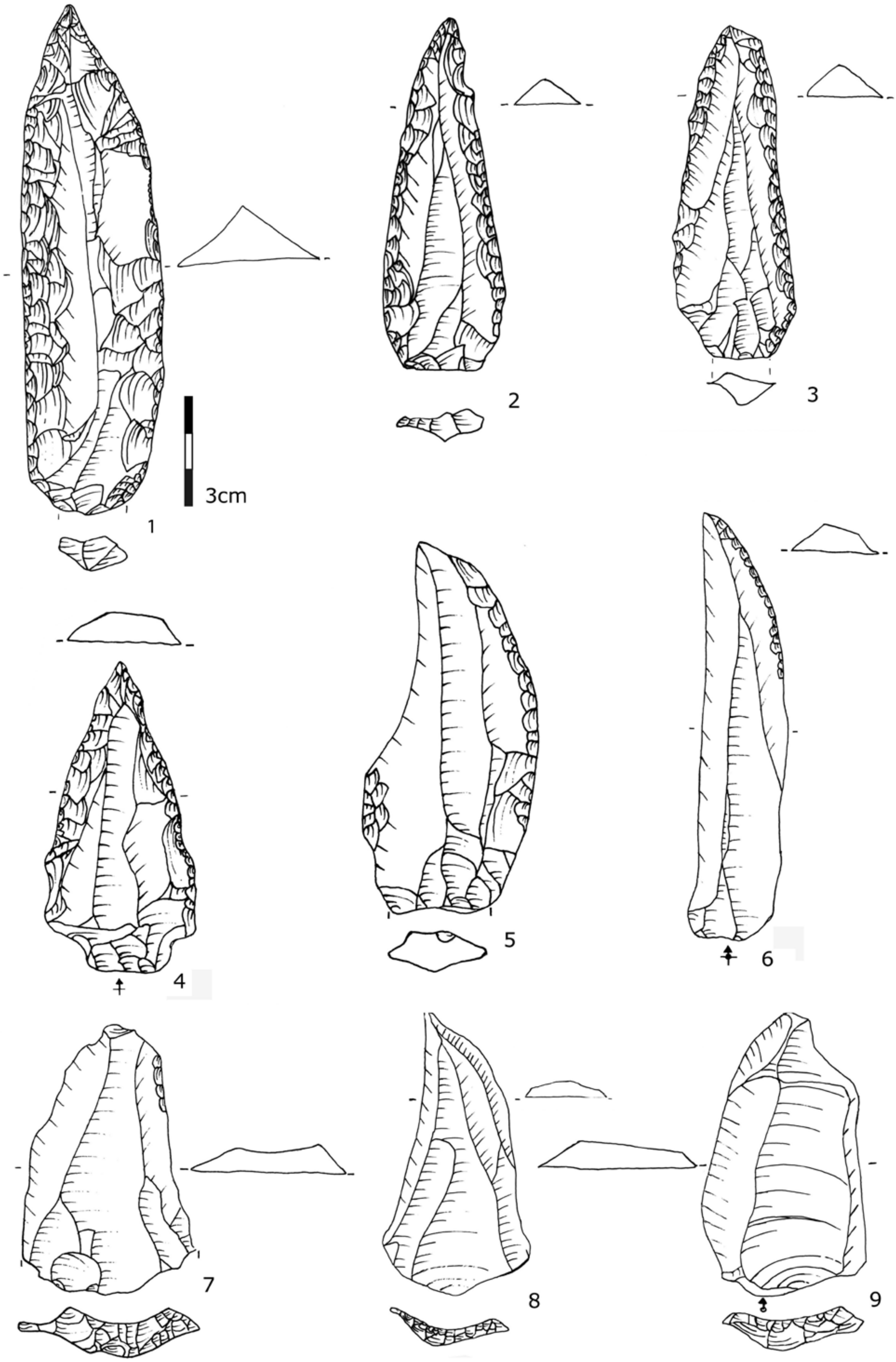

Figure 7 - Layer 6b, blades. 1-6: Laminar, retouched blades; 7-9: Levallois blanks.

invasive, covering almost the whole of the dorsal surface. The majority of blades are covered by invading semi-abrupt retouch from their proximal to distal part. Abrupt retouching is also well represented and involves essentially the distal part of blank.

Following the idea of "Frison effect" (Jelinek 1976) and the suggestion of scraper transformation through resharpening and reduction concluded by Dibble (1987), the simple lateral scrapers exhibit the least reduction whereas the converging scrapers, the most. The heavily retouched specimens could be considering in the maintained tool category indicating numerous resharpening events and thus a longer use-life.

The collections from the layer 7c, 6c and 6b present quite a large amount of retouched tools especially the assemblage from level 6c. The assemblages presenting great variability in their composition and the high rate of heavily retouched specimens relative to the total number of artefacts may possibly indicate restrained use of the lithic resources, perhaps a more intense occupation and thus less mobility (Shott 1989).

The majority of the elongated Levallois products were not retouched (fig. 7:9). Nevertheless the Mousterian tool types such as scrapers fashioned on flake, denticulate/notches, the Upper Palaeolithic tool style-like burin and end-scrapers are very significant traits of the Hummalian industry, as well (fig. 6:6-9).

Conclusions

After presenting the Hummalian blade assemblages particularly the one from layer 6b it is important reinforce the most significant features of the Hummalian industry:

• Hummalian is clearly intercalated between the Yabrudian and Mousterian levels.

• Laminar and Levallois reduction strategies are used, with the former concept dominating. Most probably both take place through the same reduction sequence.

• The unidirectional flaking system dominates, but bidirectional is also represented.

• The existence of bidirectional cores with two opposite platforms slightly offset seems to be an important and characteristic trait.

• The Laminar cores were usually not decorticated and shaped. The flinknapper use the natural shape of the block for beginning debitage. Crested blades were rarely used to initialise the flaking. The management of the laminar flaking surface was achieved either by the removal of a flake edge along a natural ridge or by flakes with cortical and often a vertical back (again due to natural form of the block) or by secondary crested blades. The maintenance of flaking surface was assured by the regular removal of "cleaning flake" throughout the reduction.

• The Levallois recurrent method is the most prevalent, but the linear method is also observed. The maintenance of flaking surface was accomplished by systematic use of éclat débordant.

• The aim of production was the converging or parallel elongated blanks of different sizes, struck mostly from Laminar cores, but also from Levallois cores which are associated with short blanks as well.

• As blank production was carried out until exhaustion of the core, the assemblage includes blanks with a size scale ranging from elongated blades to small bladelets but there is also a separate production of bladelets manufactured on debris or thick flakes recorded.

• Importance of recycling: numerous cores on flake, the reuse of patinated blanks for shaping new tools, production of the bladelets on broken blanks and debris, recycling the Yabrudian scrapers as a core and shaping exhausted core for tool use.

• The tool kit comprises of elongated points and heavily retouched blades, the Mousterian tool type scrapers and notches/ denticulate also Upper Palaeolithic type burins and end scrapers. Maintenance of tools.

• Technique of percussion: hard hammer.

The laminar phenomenon is very distinct within the Near East, it appears in the late Lower Palaeolithic (Rust 1950; Garrod 1956, 1970; Jelinek 1975; Barkai *et al.* 2003, 2005), immediately preceding Acheulo-Yabroudian contexts (Préaurignacian and Amoudian) and then is seen systematically in the early Middle Palaeolithic (Hayonim Layer F and E, Abou Sif, Tabun D, Tabun unit IX, Rosh Ein Mor, Ain Difla) and later in a heart of the Middle Palaeolithic (Nahal Aqev, Douara IV (Akazawa 1979), Jerf Ajla Unit E (Schroeder 1969)).The former group shows non-Levallois debitage. The second consists of assemblages showing the use of the Laminar and Levallois reduction strategy simultaneously and containing a high percentage of blades. All these industries differ in the use of both reduction strategies, by the production of various tools, site type and site use and also in chronology (between 260 to 160 ka). The assemblages from Tabun D (Jelinek 1981; Mercier & Valladas 1994; Mercier *et al.* 1995), Rosh Ein Mor (Marks & Crew 1972; Crew 1976; Marks & Monigal 1995) and Ain Difla (Lindly & Clark 1987) appear to be dominated by the Levallois method, including a significant percentage of Upper Palaeolithic tools and a small number of elongated usually lightly retouched points. These are clearly distinguished from the lithic industries from Hayonim Layer F and E (Meignen 1998, 2000) and Abou Sif Layer C and B (Neuville 1951, and personal studies on the part of collection at IPH, Paris) which at the moment seem to show greater similarities with the Hummalian industry. Unfortunately a detailed evaluation between the assemblages is at the moment not possible as the lithic assemblages from Hayonim are still under study and the statistical data are not available. The Abou Sif assemblages from the old excavation are described only typologically (Neuville 1951; Skinner 1965; Perrot 1968), although are considered as Mousterian with elongated retouched points. These assemblages concurrent with the Hummalian appear to present both Laminar and Levallois reduction strategies, with the former dominating. The goal was to produce the elongated blanks. The tool-kit is not only characterised by presence of the important heavily retouched points and blades, but also by the Mousterian and Upper Palaeolithic tools types. Previous TL age estimation places the Hummalian industry from layer 6b at 170-250 ka (Richter 2006). However, new results throw these dates into doubt as the variation in dating is too broad (Richter *et al.* 2011). A potential age for the Hummalian industry from sand αh of 200 ka is proposed, which places the Hummalian industry alongside the assemblages from Hayonim Layer lower E and F (160-230 ka in Mercier *et al.* 2007).

Acknowledgements

Firstly I would like to gratefully acknowledge the contributions of the Swiss National Science Foundation, the Freiwillige Akademische Gesellschaft and the Tell Arida Foundation for financial support which made this on going doctoral work possible. I am also indebted to Prof. Jean-Marie Le Tensorer for giving me the opportunity to work in such an important and stimulating field I'm grateful to the Directorate General of Antiquities and Museums of Syria for their various permissions. I would also like to thank Yuri Dimidenko and Steve Kuhn for reading and providing useful comments on the first draft of this paper. My thanks should also go to Liliane Meignen for both allowing me to study a part of the collection from Hayonim Cave in Valbone, and for her kindness in sharing opinions and offering various manuscripts and papers. I'm also indebted to Eric Boëda for interesting comments on the lithic technology and also for showing me a part of the collection of laminar industry from Umm el Tlel. Thanks go to the Institut de Paléontologie Humaine in Paris for allowing me to study the collection from Abou Sif. I am additionally grateful to Reto Jagher for making available the laminar assemblages from Nadaouyieh Ain Askar and sharing his knowledge of the El-Kowm area. Thanks should also go to Richard Frosdick for help in correcting my English and also the archaeozoological analysis, Daniel Schuhmann for providing invaluable computer support, and Phillipe Rentzel and Kristin Ismail-Meyer for the geomorphological analysis and interesting discussions on the related results. I would like to show my appreciation the whole prehistory department at the Institute for Prehistory and Archaeological Science for providing a stimulating atmosphere in which to work and providing comments and support throughout this doctoral thesis. Finally, I would like to make note of my appreciation of all the colleagues, students and co-workers that assisted me in the field work without whose cooperation this work would have been impossible.

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THE MOUSTERIAN SEQUENCE OF HUMMAL AND ITS TENTATIVE PLACEMENT IN THE LEVANTINE MIDDLE PALEOLITHIC

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Introduction

Next to well-known sites, such as Tabun Cave, Qafzeh Cave or Kebara Cave, recent excavations in the open-air site of Hummal show that this locality offers one of the rare possibilities to examine a long sequence of deposits which were left behind by successive occupations over a considerable time span (Hauck 2010; Le Tensorer *et al.* 2011). Initial investigations of the Mousterian sequence were made on collapsed sediments at the lower part of the well (Besançon *et al.* 1981, 1982; Copeland 1983). The undisturbed Mousterian deposits are nowadays found in the section between 5 to 10m below datum and comprise the major part of the Hummal sequence. Systematic excavations since 2002 were carried out in the western and southern part of the well and revealed an exceptional succession of more than 30 archaeological levels (Hauck 2010). Today, more than 10´000 lithic artifacts and faunal remains were unearthed. In addition, human remains were discovered in levels 5a4 and 5b1. Find densities vary considerably between levels, which is the result of differential degrees of preservation and/or site function (tab. 1).

levels	excavated surface	find density	fauna	lithics	lithics >2cm
	m^2	per m^3	N	N	N
5AII	53	24.8	1	315	138
5AIII	53	4.7	-	114	58
5AIV	53	264.7	8	916	384
5AV	18	57.9	3	301	41
5AVI	10	24.7	10	71	69
5a2	11	2965.5	-	1631	584
5a3	36.5	173.8	268	1436	518
5a4	8	2319.7	75	1044	269
5b1	10	173.5	45	363	107
5b2	20	564.2	78	599	149
5BII	17.5	151.9	77	89	89
5b3	20	660.9	325	1916	679
5b5	20	289.2	53	714	345
5b7	3	803.3	34	448	107
5DV	6	411.1	19	55	51
5E	6	265	75	242	211
5e	6	73.4	1	140	62
5f1	6	408.3	1	195	45
5f2	6	162.5	2	193	43
5g	6	100	4	62	48

Table 1 - Selected Mousterian levels of Hummal: size of excavated surface per level, find densities and respective counts of faunal and lithic items. N.B. find density includes faunal remains.

Hummal is not the only deeply stratified Mousterian site in the El Kowm region and several surveys revealed an abundance of stratified as well as surface sites within a relatively restricted area of 120 km² (e.g. Cauvin *et al.* 1979; Cauvin 1983; Le Tensorer *et al.* 2001). The wealth of Paleolithic sites in the El Kowm region lead to a revision of former assumptions about the presence of Middle Paleolithic humans and their migrations within the Near East. It is now clear that these people not only settled within the Mediterranean coastland with its high diversity of resources, but also penetrated into the ostensibly unfavorable arid interior. As Hummal is situated in the northern steppe region, its comparison with sites within different environmental settings delivers valuable information about the adaptive strategies of Mousterian hominids and, apart from functional considerations, the spread of their technological traditions. Although a relative chronological positioning of the Hummal Mousterian is possible on the basis of lithic data, their absolute dating is still far from definitive. However, the detailed analysis of all lithic remains and their comparison with data from other sites in the El Kowm region and beyond already enables a tentative but convincing placement of the Hummal Mousterian in the context of the Levant. In the following, the Mousterian sequence of Hummal will be briefly described and compared with artifact assemblages of other Levantine key sites. For this purpose, we chose only a handful from the pool of known Middle Paleolithic find spots on the demise of others. This is due to the limited scope of this paper and the fact that a preliminary comparison of the Hummal assemblages is reasonably done with

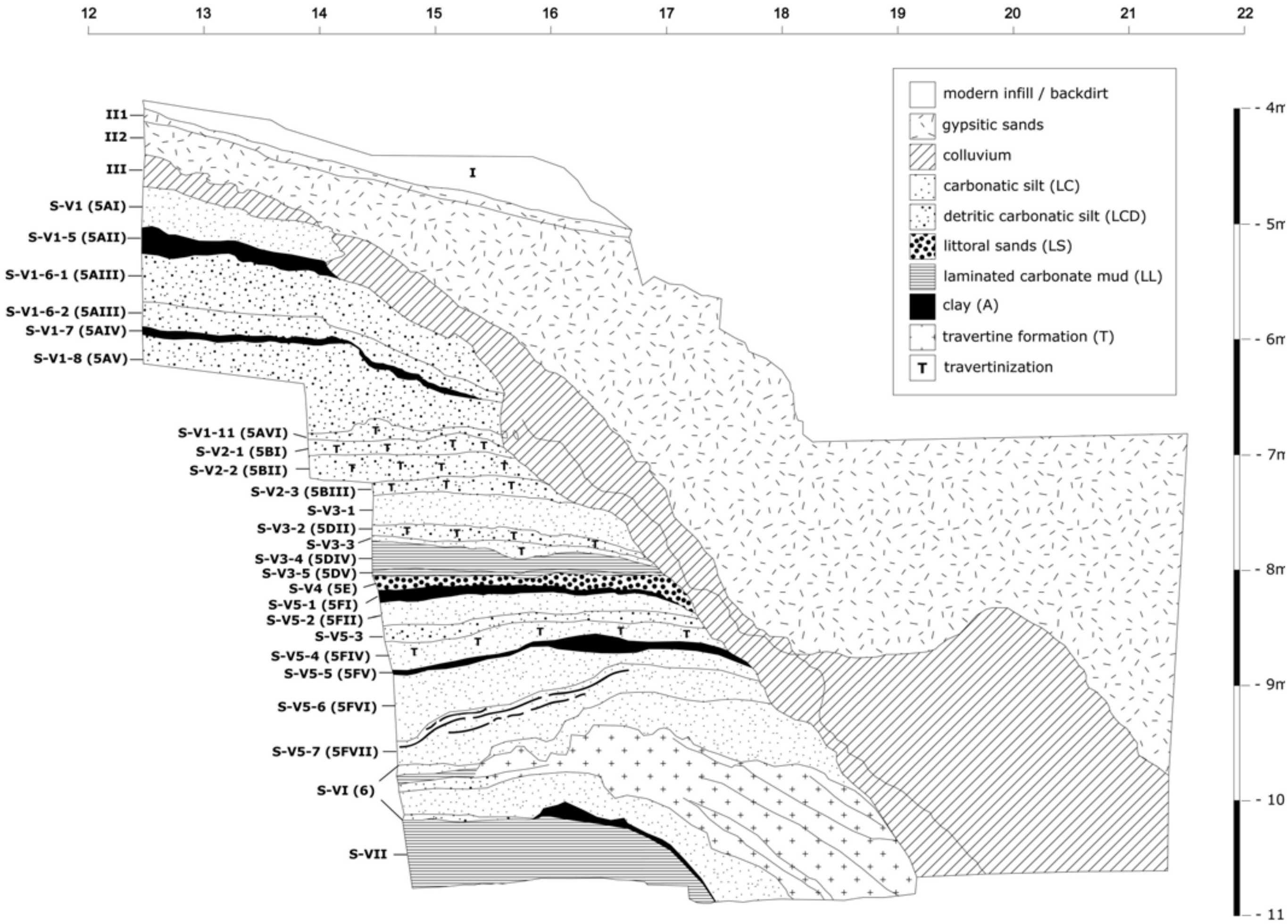

Figure 1 - Profile 59 showing the southern Mousterian Sequence and the contact between the *in situ* Pleistocene deposits, colluviated deposits and the modern infill (complex II2).

sites being geographically and/or chronologically close or from which first hand data is available.

The Mousterian Sequence of Hummal

The Mousterian levels are found in the context of typical spring deposits, such as freshwater carbonates, evaporitic clay-gypsum accumulations and travertines (Hauck 2010; Le Tensorer *et al.* 2007). Pure carbonates are rare and the dominating sediment type is a detrital carbonate often of palustrine type. The alternation between limnic and terrestrial deposits mirrors a steady shift between water transgressions and regressions, which caused the development of a broad ecological spectrum ranging from extended, oxygen-rich lake systems to marshy ponds or water-depleted depressions filled with aeolian sands (fig. 1). Colluviated deposits show evidence of recurring sediment collapses and erosion processes that were caused by instabilities in the karstic bedrock, water flows and weathering.

Regarding these taphonomic factors, the archaeological material was exposed to different degrees of weathering or destruction. Nevertheless, micromorphological analysis, preliminary refittings and the exceptional preservation of lithics indicate that the majority of archaeological levels were rapidly buried by fine-grained sediments. Minor post-depositional movements were principally caused by water flows, desiccation and subsidence effects due to a considerable and rapid lowering of the groundwater table in modern times (Schuhmann 2011).

The techno-typological characteristics of the Hummal sample

Depending on the range and duration of activities which were carried out at Hummal, and hence occupation length, the supply with raw material and the temporal as well as spatial organization of core reduction were differently organized (Hauck 2010; Hauck *et al.*, 2010). Rich flint outcrops are located along the Jebel Bishri and Jebel Mqebra mountain ranges in about 10 to 15 km distance of Hummal (Le Tensorer *et al.* 2011). The range of organizational patterns goes from a nearly exclusive production of blanks at the site to a strong reliance on imported implements (see for example variation of debitage to nodule core ratio in table 2). Off-site as well as on-site core reduction saw a systematic application of the Levallois method to obtain standardized blanks. Corresponding features are high Levallois and facetting indices in each level (tab. 3). Apart from the preponderance of Levallois blanks, some other common features can be found across the whole sequence, irrespective of flaking strategy. To mention first is the marked elongation of Levallois blanks, which is expressed by relatively high mean

	levels	analyzed sample N	retouched tools %	blanks N	cores N	Levallois cores %	cores on flakes %	debitage to nodule core ratio
HM-A1	5AII	115	13	53	3	33	67	44.0
	5AIII	22	6	8	4	0	25	12.5
	5AIV	288	9	146	14	14	64	25.4
	5AV	31	11	8	6	33	33	4.8
	5AVI	58	21	29	6	0	50	8.0
HM-A2	5a2	385	7	86	18	17	56	28.7
	5a3	349	9	89	21	19	67	19.7
	5a4	152	10	36	9	11	33	27.7
	5b1	69	16	20	5	0	80	18.8
	5b2	95	15	28	5	0	80	27.0
	5BII	83	9	38	4	50	50	20.3
	5b3	518	9	37	28	14	29	22.3
	5b5	201	5	64	22	9	50	13.7
	5b7	58	4	23	4	25	50	19.4
	5DV	35	4	10	4	0	100	0.0
	5E	143	8	54	11	9	82	15.7
HM-B	5e	34	14	10	4	50	50	10.6
	5f1	32	18	15	1	0	100	0.0
	5f2	29	30	19	3	0	100	0.0
	5g	25	10	11	0	0	0	0.0

Table 2 - Selected Mousterian levels of Hummal: assemblage composition; a) excluding fragments and chips (<2 cm).

length width ratios (LWR) for each assemblage (tab. 3). Another feature to be found in all assemblages is the scarcity of Levallois types within the group of cores (tab. 2). This is probably due to several reasons, such as the possible export of Levallois cores to other sites for further reduction, the opportunistic exploitation of Levallois cores during the final stage of blank production and sample size error. In some levels, Levallois core exportation is indirectly evidenced by a low frequency or even absence of small Levallois flakes with a size below 4 cm. The arrangement of scars on the few Levallois cores reflect either a serial production of points, flakes and blades or the removal of one final preferential flake just before their discard. Having reached a certain size threshold between 4 and 5cm, a significant number of Levallois cores were completely reworked by applying an opportunistic reduction method with the aim to obtain very small flakes and bladelets. Table 2 shows that the number of nodule cores is equal to or even outweighed by the number of cores on flakes in the majority of levels. The core on flake phenomenon in Hummal has been studied in detail to better understand its technological nature and the behavioral significance of this recycling strategy (Hauck 2010). Depending on which blank surface was exploited, three core types can be defined: dorsal cores (including Nahr Ibrahim types), ventral cores (including Levallois cores on flake, Kombewa and Janus types) and multiple cores.

The high frequency of Levallois points and blanks with a convergent scar pattern in the majority of analyzed assemblages shows that the upper two thirds of the Hummal sequence can be characterized as a point-dominated Mousterian (tab. 3). Contrastingly, the lowermost assemblages 5e to 5g present a radically different picture with a marked under-representation of Levallois points and a significant variability of core reduction patterns. This difference lead to a division of the Hummal Mousterian into an upper and lower industry, called HM-A and HM-B respectively.

Two basic variants of Levallois point technology are identified which call for a split of the upper industry HM-A into two successive sub-types. Regarding the uppermost industrial subtype, HM-A1, the Levallois points of Mousterian levels 5AI to 5AVI show a bundle of technological features which reflect one of the two varieties of recurrent Levallois point production in Hummal. These points exhibit a broad base, large-sized butts with a *chapeau de gendarme*, and frequently more than three strongly converging negatives on their dorsal face (plate 1). The angles of these overlapping scars demonstrate that during reduction, striking platforms were often expanded to the lateral sides of the core to allow converging or even perpendicular removals, which often occur in combination with strongly bent dorsal planes forming a prominent central ridge. Together with the pronounced longitudinal curvature of many flakes, it can be inferred that cores had a slightly domed flaking surface. Within one reduction sequence, preferential and recurrent Levallois points were produced on the same core, whereby larger preferential pieces were frequently struck at the end of a recurrent series. The impression we have for the moment is that of a strong standardization in blank manufacture focussing on the described Levallois point types.

A higher degree of variability is visible in the second industrial sub-type HM-A2 in respect to core reduction patterns, relative proportions of Levallois blades, flakes and points, and metrical blank attributes. No linear trend towards one preferred blank type is discernible across the sequence 3. Between the lowest level, 5E, and uppermost level, 5a2, blade percentages range between 30% and 50%. The disparity between Levallois blade and flake proportions is minimal, and may in many cases be due to sample size error. Levallois points generally comprise 20% to 30% of all blanks, except for levels 5b1 and 5b5 where they are rare or even absent. Even when all blanks with a convergent scar pattern are considered, the frequency of these point-related blanks is lower on average compared to HM-A1. Given the fact that many assemblages in the middle part of the Hummal sequence contain a significant number of blades which are not related to Levallois point production and that the mean length width ratios of all blanks are found in the range between 2.0 and 2.5, the HM-A2 industry can be characterized by a laminar tendency; some blade-rich assemblages, such as 5b7, 5DV and 5E, at the bottom of the middle sequence show extremely elongated Levallois points with mean length width ratios of 2.5 to 2.8 (tab. 3). Levallois blades and

	N	IL	IF	Ilam	L/W mean Levallois blanks	L/W mean Levallois points	Levallois blanks (%)			Unidirectional convergent scar pattern (%)
							Levallois flakes (%)	Levallois blades (%)	Levallois points (%)	
Hummal 5AII (HM-A1)	315	43.7	84.6	54.7	2.2	2.3	31.1	42.2	26.7	56.0
Hummal 5AIV (HM-A1)	916	57.7	78.6	33.6	1.9	1.9	41.3	23.2	35.5	70.0
Hummal 5a2 (HM-A2)	1631	24.4	89.5	34.9	1.8	1.7	41.3	30.7	28.0	40.0
Hummal 5a3 (HM-A2)	1436	27.8	83.9	53.9	2.0	1.9	31.1	36.5	32.4	47.0
Hummal 5a4 (HM-A2)	1044	27.9	86.1	61.1	2.2	2.3	38.2	35.3	26.5	35.0
Hummal 5b3 (HM-A2)	1916	32.4	86.1	47.7	2.0	1.9	39.0	37.5	23.5	43.0
Hummal 5b5 (HM-A2)	714	40.6	81.3	40.6	2.1	2.1	50.0	37.5	12.5	34.0
Hummal 5E (HM-A2)	242	44.2	88.9	63.0	2.3	2.6	32.0	44.0	24.0	40.0
Yabrud level 2	277[a]	30.0[b]	71.4	48.1	2.1	2.1	40.1	37.0	22.9	27.2
Tabun unit I, Beds 1-17[c]	107[a]	36.0	60.0	64.0		2.3	53.0	18.7[d]	28.0	
Kebara IX[e]	2440	11.8	79.3	9.6	1.8		63.2	22.4	14.4	67.8
Kebara X[e]	2295	20.0	75.4	13.3	1.7		59.3	22.6	18.1	48.5
Kebara XI[e]	3427	22.6	70.2	20.2	2.0		61.1	30.5	8.4	43.6
Kebara XII[e]	393	30.5	87.5	22.9	2.2		59.0	29.9	11.1	51.4
Amud B1[f]	1344	31.3	49.3	27.1		2.0[g]	56.3	35.8	8.2	50.0
Amud B2[f]	2318	40.8	37.1	25.4			43.4	22.7	34.0	10.0
Amud B4[f]	457	34.7	52.0	16.2		2.5[g]	31.3	30.2	38.4	40.0
Tor Faraj level C[h]	13286	15.5	49.7	28.2	1.7	1.4	57.0	18.8	24.2	around 50% of flakes and blades
Tor Sabiha[h]	6663	4.0	38.0	37.0	1.7	1.9	11.8	51.6	36.6	

Table 3 - Comparison of selected Mousterian assemblages of Hummal with other Late Levantine Mousterian sites (IL = Levallois index; IF = faceting index; Ilam = blade index; L/W = length with ratio). a: blank counts only; b: data taken from Solecki & Solecki 1995: c; Jelinek 1982a: d; "prismatic blades" only, Jelinek 1982a; e: Meignen 1991. Meignen & Bar Yosef 1982, note that for subtriangular flakes and atypical points were subsumed in the flake group; f: Hovers 1998, Ohnuma & Akazawa 1988; g: mean length width ratio of elongates points only; h: Henry 1992, 2003.

flakes are mainly polygonal or rectangular in shape, with parallel or diverging edges (plate. 1). A considerable variability in point morphology characterizes the HM-A2 industry. In some levels, narrow, "leaf-shaped" specimens predominate, whereas others are characterized by many broad-based types. This is probably a reflection of a changing frequency in the application of the lineal vs. recurrent method, and of core volume. Many small Levallois points and flakes in the range between 2 and 3cm evidence an intensive core exploitation which reflects the strategy of obtaining fresh edges by producing new flakes instead of retouching existing ones.

Technological analysis of the lowest Mousterian levels is limited by small sample sizes (tab. 1). Many artifacts found in backdirt deposits around the well can be tentatively allocated to the HM-B industry on the basis of specific technological attributes (plate 3). Their frequency indicates the potential for a better definition of the HI-B facies with ongoing excavation in *in situ* levels. Scar pattern analysis reveals that a bidirectional flaking method working with two opposed striking platforms and the unidirectional method were frequently applied to obtain large sized Levallois blades and elongated flakes (plate 2). To produce broad and long Levallois flakes, the Mousterian knappers prepared huge cores in a centripetal fashion, and detached one single end-product before re-preparing the surface. Thus, investment in core trimming was often intense. Corresponding waste cores show that the lineal method was applied throughout the reduction sequence until exhaustion of the cores, and was confined to Levallois flake production. This aspect clearly distinguishes HM-B from above-lying variants, where recurrent blank production dominates. Most end-products are Levallois blades and flakes, whereas the points did not play a significant role in the tool kits' repertoire, as they did during later Mousterian occupations.

In all levels, the frequency of retouched tools is low, whereby it seems that at least in some of the lowest layers slightly more blanks underwent edge modification than in the upper industries (tab. 2). On average 20% of Levallois blanks exhibit edge modification, whereas only around 5% of core trimming elements were chosen for that purpose. Due to small sample sizes, differences in tool counts between levels are not to be

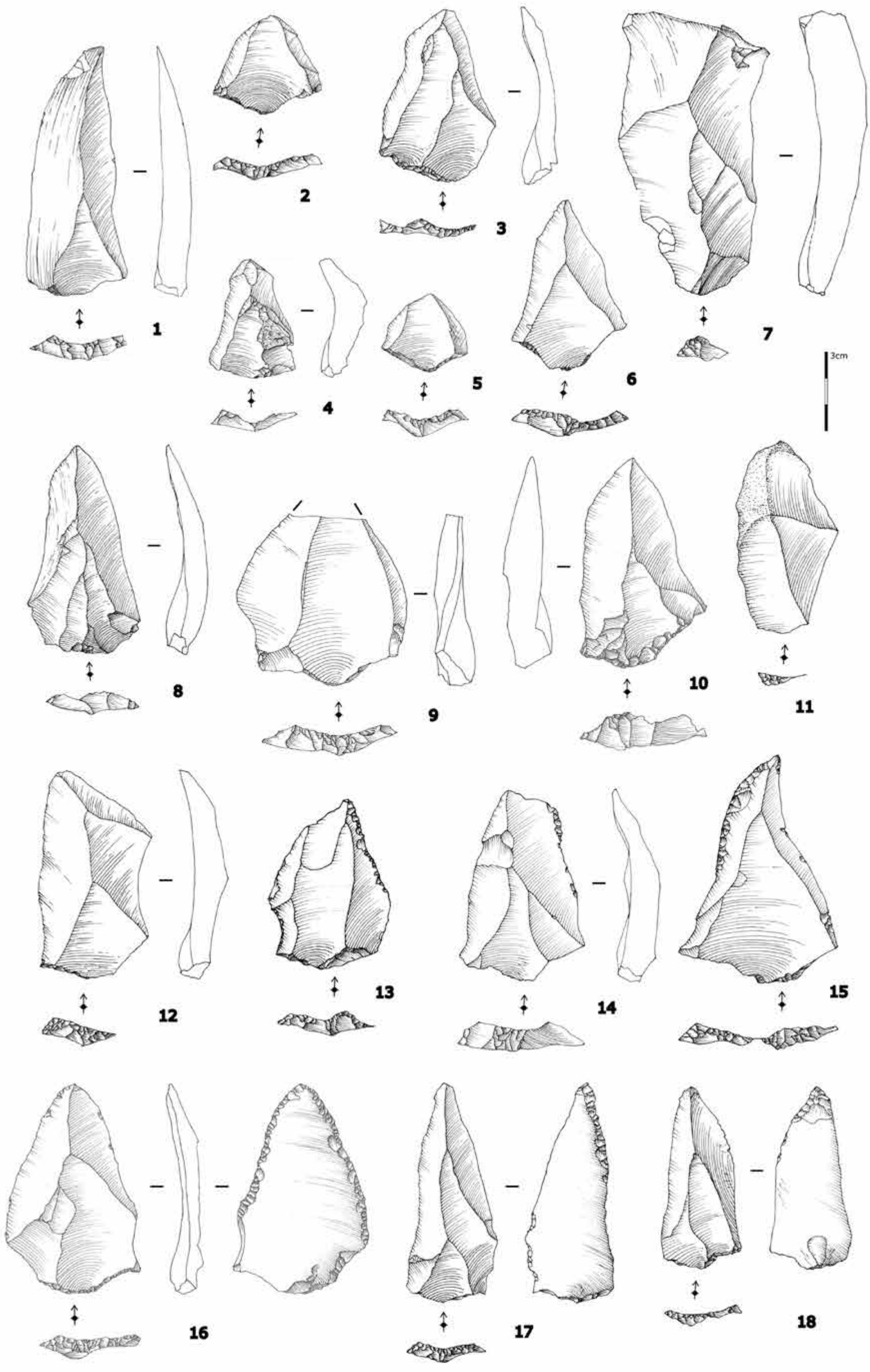

Plate 1 - Selected artifacts from the upper Mousterian industry HM-A1. Nr.1: "Janus-type" Levallois point; Nr.2-6: Levallois points; Nr. 7: plunging blade; Nr. 8: Levallois point; Nr. 9: broken Levallois blank; Nr. 10: Levallois point; Nr. 11: naturally backed knife; Nr. 12: Levallois flake; Nr. 13-14: partially retouched Levallois blanks; Nr. 15: retouched Levallois point; Nr. 16: scraper with ventral retouch; Nr. 17-18: Levallois points with partial retouch on ventral face.

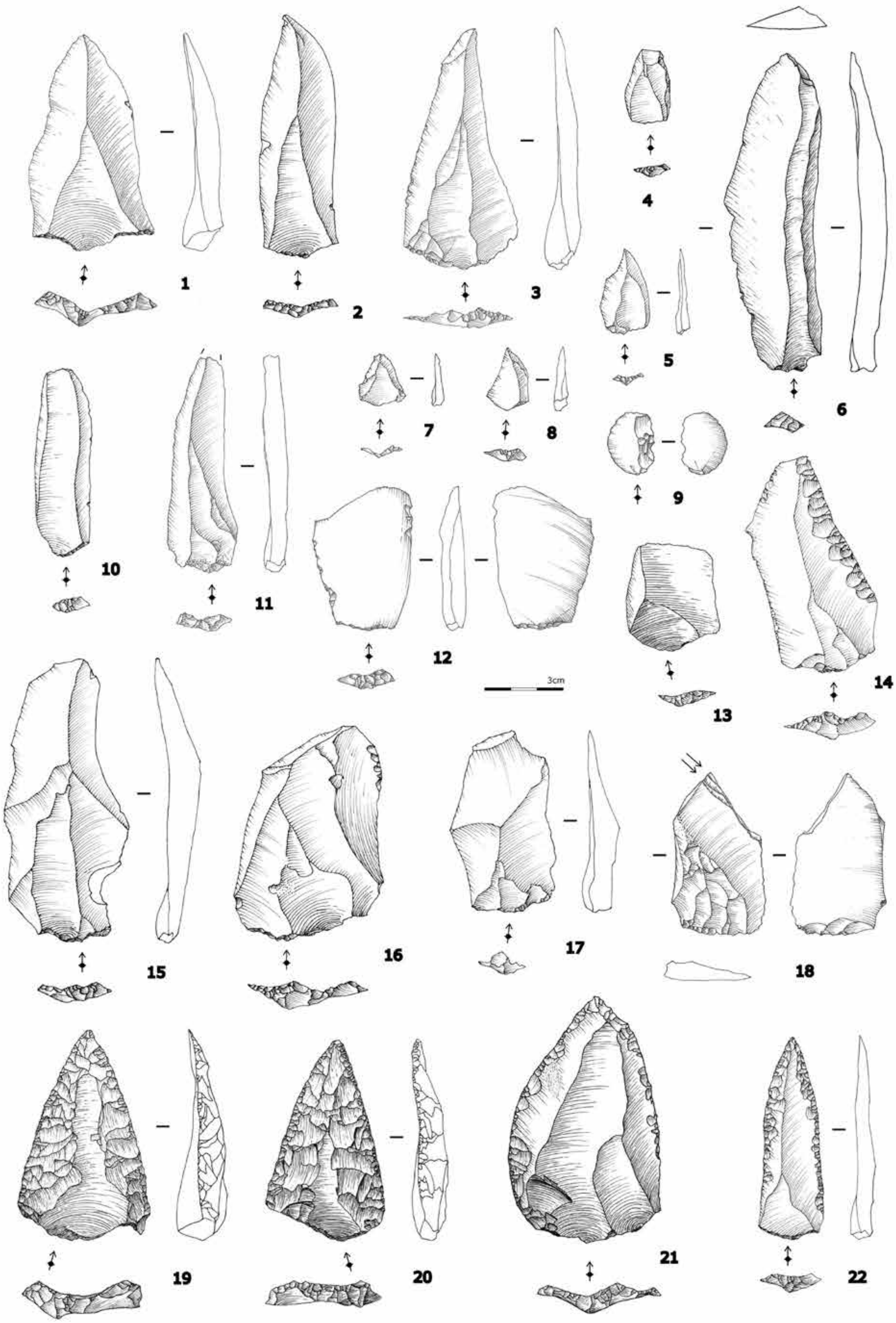

Plate 2 - Selected artifacts from the upper industry HM-A2. Nr. 1-3: elongated Levallois points; Nr. 4: Levallois flake; Nr. 5: Levallois point; Nr. 6: Levallois blade; Nr. 7-8: Levallois points; Nr. 9: retouched Kombewa flake; Nr. 10-11: Levallois blades; Nr. 12: Kombewa flake; Nr. 13: Levallois flake; Nr. 14: single convex side scraper; Nr. 15: Levallois blade; Nr. 16-17: Levallois flakes; Nr. 18: multiple burin with thinning on proximal part; Nr. 19-20: Mousterian points; Nr. 21: convergent side scraper; Nr. 22: elongated Mousterian point.

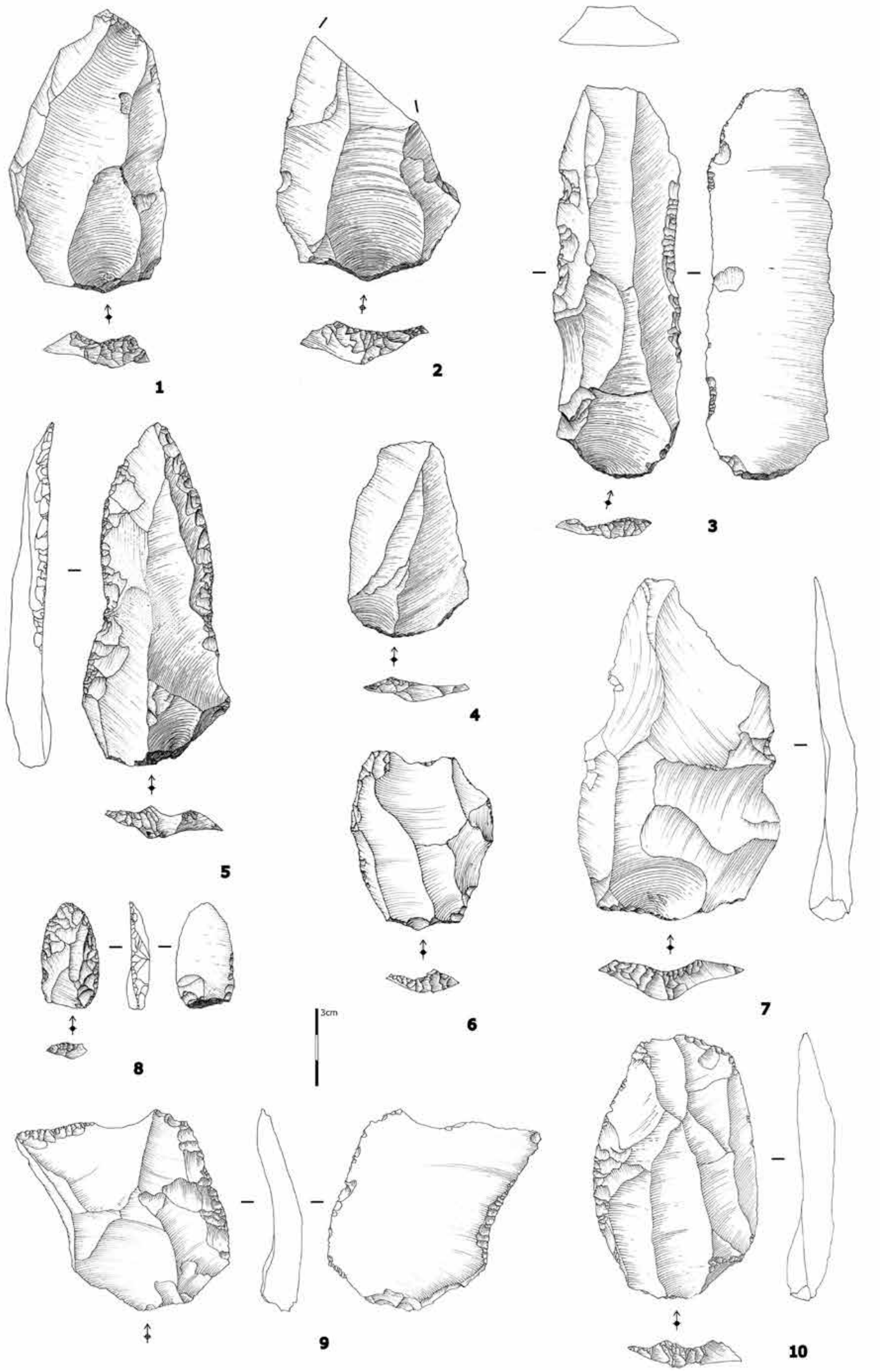

Plate 3 - Selected artifacts from the lower industry HM-B. Nr. 1: Levallois flake; Nr. 2: broken Levallois blank; Nr. 3: Levallois blade with alternate retouch; Nr. 4: Levallois flake; Nr. 5: double scraper made on Levallois blade; Nr. 6-7: preferential Levallois flakes; Nr. 8: convergent double scraper; Nr. 9: preferential Levallois flake with alternate retouch (backdirt); Nr. 10: single convex side scraper made on preferential Levallois flake (backdirt).

Figure 2 - Map showing the position of Levantine Mousterian sites mentioned in the text.

regarded as significant; in fact no major discrepancies exist. The most common retouched tools are partially retouched pieces, simple side-scrapers, and double side-scraper types, including convergent types and Mousterian points, some of which can be interpreted as curated items (plate 2:19&20). Noteworthy is the frequency of ventrally retouched pieces in HM-A1, setting it apart from the underlying industries. Ventral retouch may occur along one or both edges or may be confined to the distal end (plate 1:18). Other tool types are rare and in many cases appear in an atypical form.

The comparison of Hummal with other Levantine Mousterian sites

It is not our aim to present a new and comprehensive synthesis of Levantine Mousterian variability in this paper. The aim of the following section is to compare the Hummal Mousterian assemblages with other published sites that were chosen for similar techno-typological traits or with sites from which raw data is to hand, to enable a check for similarities as well as differences (fig. 2). Although future work with a larger sample size to hand will certainly lead to a refinement of the techno-typological aspects, the Mousterian sequence of Hummal already offers further data for the still fragmentary picture we possess of the Levantine Mousterian.

On a smaller scale, many gaps also remain in the regional database for the Middle Paleolithic in El Kowm. This is all the more regrettable as many of stratified well sites and surface scatters contain Mousterian artifacts (Le Tensorer *et al.* 2001), and this density underscores the enormous potential for future investigations. Preliminary observations made at different sites point at a considerable intra-regional variability in terms of core reduction methods and technological organization during the Mousterian (Hauck 2010).

Current models of Levantine Mousterian variability

Typically, the identification of major shifts in Levantine Mousterian technology in the Tabun sequence leads to a tripartite division of this period into succeeding phases D, C, and B. Since its definition by Lorraine Copeland (1975), this 3-stage model serves as an analytical framework for inter-site comparisons (e.g. Bar-Yosef 1998; Bar-Yosef & Meignen 1992; Copeland 1981; Jelinek 1981; Shea 2003). However, the accuracy of the phase model is tenuous. Reliable results for radiometric dating of Middle Eastern sites are still sparse, and the age of the Tabun sequence itself is still debated. In addition, discovery of new assemblages and re-analysis of older collections disclose a significant variability within the proposed stages (Bar-Yosef *et al.* 2005; Henry 1995a, 2003; Lindly & Clark 2000; Meignen 1998a, 1998b; Monigal 2002; Munday 1979).

A significant techno-typological variability is observed among Early Mousterian assemblages from sites which have been dated between 260 and 180ka BP (Bar-Yosef 1998; Bar-Yosef & Meignen 2001; Meignen 2007; Munday 1979). Dated key sites are Tabun unit IX, Rosh Ein Mor and Hayonim F / Lower E (Grün & Stringer 2000; Mercier *et al.* 1995, 2007; Mercier & Valladas 2003; Rink *et al.* 2003, 2004); sites with chronological uncertainties but technological affinities are Hummal layers 6-7, Nahal Aqev 3, Douara IV, Jerf Ajla E-F, Yabroud KS 8-10 and Ksar Akil XXVIII (Marks & Volkman 1986; Munday 1979; Nishiaki 1989; Schroeder 1969; Solecki & Solecki 1995; Wojtczak 2011). Several core reduction systems coexisted and inter-assemblage variability is mainly characterized by a shift between non-Levallois vs. Levallois methods (Monigal 2002). Given this variability, a precise definition of the Early Levantine Mousterian is problematic if not impossible. In the present state of research, it seems that in some sites the exploitation of prismatic cores was the principal means for blade production (e.g. Hummal, Hayonim), whereas in other sites this aim was preferentially achieved with the Levallois method (e.g. Yabrud, Tabun IX). However, there are no clear-cut differences in the technology, and the interrelationship between these reduction methods needs to be clarified. Layers 6 and 7 of Hummal bear evidence for an equal importance of prismatic blade and Levallois flake production. Analysis of cores and core trimming elements shows that a technological convergence between both methods is possible (Wojtczak 2011). A common aspect of all Early Mousterian assemblages is the abundance of blades, elongated points and Upper Paleolithic tool types. The problem is that high blade proportions and elongated points are equally found in much younger sites, which stimulates discussion as to their chronological position and the meaning of Levantine Mousterian variability in general; one such example is the site of Ain Difla, which revealed extremely elongated points and evidence for non-Levallois blade production (Clark *et al.* 1997; Lindly & Clark 1987). Moreover, some point-dominated Late Mousterian assemblages show a considerable overlap with Early Mousterian sites in respect to certain techno-typological features, as will be shown with reference to the Hummal Mousterian.

The younger phase or phases of the Levantine Mousterian are equally problematic in terms of defining clear-cut stage successions or a linear technological trend (Goren-Inbar & Belfer-Cohen 1998; Hovers 1998). Based on Tabun level C, Copeland (1975, 1981) proposed a second Mousterian phase characterized by relatively broad, oval-shaped Levallois flakes, which were removed from centripetally prepared cores, and a replacement of Upper Paleolithic tools by side scrapers. Although Copeland did not postulate a chronological ordering of her stages, she subsumed assemblages containing broad-based Levallois points within a third phase in analogy to level B at Tabun. Jelinek saw the Tabun C and B type Mousterian as different facies responding to specific environmental settings, and not as a succession of separate cultural entities (Jelinek 1992). Contemporary thought about the phylogenetic position of both Mousterian variants is inconclusive, with several researchers favoring a temporal succession of the two complexes (e.g. Bar-Yosef 1998; Bar-Yosef & Meignen 2001) and others pertaining to Jelinek's facies idea (e.g. Lindly & Clark 2000). As is the case for the earlier Mousterian phase, some Tabun C-like sites, such as Tabun unit I, Skhul B and Qafzeh, seem to cluster in a delimitable time frame of 170 to 80ka BP (Grün & Stringer 2000; Mercier & Valladas 2003; Mercier *et al.* 1993; Schwarcz *et al.* 1988; Valladas *et al.* 1988), whereas others, such as Quneitra, are much younger despite similar technological traits (Goren-Inbar 1990).

It is not our intention to cut the Gordian knot surrounding the question of which assemblage belongs to which Mousterian complex and whether it is reasonable to expect a coherence of technological patterns and chronometric results in the sense that different traditions follow each other in time. The confusion concerning Levantine Mousterian variability is largely a result of conflicting dating results, varying theoretical approaches and inconsistency of analytical systems. It is fairly reasonable to assume that a complex and region-specific interplay of technological traditions, subsistence strategies, mobility and land-use patterns is responsible for the apparent lack of a distinct techno-typological trajectory over time (see also Hovers 2001, 2009; Marks 1992; Munday 1976). Nevertheless, some general tendencies can be defined. The final Mousterian period is placed in the time-range of around 80 to 50 ka BP and saw an increase in point-dominated assemblages; this seems to be the case in the coastal region as well as in the arid steppe of the interior and the desert areas of the southern Levant (Hovers 2009). A characteristic feature of the Late Levantine Mousterian is the nearly exclusive use of the Levallois method and a marked standardization of the convergent flaking concept for Levallois point production. However, morphological variability among the point assemblages is stronger than is often claimed.

Preliminary age determinations of the Hummal Mousterian

Exacerbating uncertainties about the chronological position of the Hummal Mousterian is the fact that only preliminary dating results are available at present (Richter *et al.* 2011). Thermoluminescence (TL) dating of heated flint from levels 5b3 and 5g gives only a rough idea of the possible age of these levels. Dating of level 5b3 delivered a minimum age of 36 ka ± 5 ka years BP, whereas the age of lowest level 5g is placed between 98 ka ± 16 ka and 128 ka ± 18 ka years BP. These dates are far from definitive, and techno-typological features are a better means for comparing Hummal with other sites in the region and beyond.

Hummal within the Late Levantine Mousterian

The observed focus on Levallois point production in the upper two thirds of the Hummal sequence warrants a tentative placement of the HM-A industries into the pool of other Late Mousterian assemblages which equally exhibit a high frequency of Levallois points and similar standardized core reduction strategies to produce this blank type. For this purpose, the point-dominated levels of Hummal can be compared to complexes V and VI of the neighboring site of Umm El Tlel (Al Sakhel 2004; Boëda & Muhesen 1993; Boëda *et al.* 1998, 2001, 2007, 2008), the upper layers of Yabrud I rock-shelter (Rust 1950; Solecki & Solecki 1995 and own observations), layers IX to XII of Kebara Cave (Meignen & Bar-Yosef 1991, 1992; Meignen 1995), layer B of Garrod's excavation in Tabun (Garrod & Bate 1937), the Amud B assemblages (Hovers 1998; Ohnuma & Akazawa 1988), and the Southern Negev samples of Tor Faraj and Tor Sabiha (Henry 1995a, 1995b, 2003). Although the Yabrud deposits are not dated yet, we regard the level 2 assemblage as of a Late Mousterian based on techno-typological characteristics (Hauck 2010). In this respect, we disagree with Solecki & Solecki (1995), who attributed it to an Early Levantine Mousterian of Tabun D type (see also Copeland 1975).

A strikingly good accordance between Hummal and the sites mentioned above is given for the uppermost HM-A1 industry, despite certain differences in the frequency of core reduction methods, blank types and tool forms as well as blank metrics. Of crucial importance in this respect are the clear focus on triangular shaped blanks and the presence of classic Levallois points. These pieces exhibit an Y-*arrête* scar pattern, *Concorde* shaped cross section, platform faceting and *chapeau de gendarme* shaped butts. A significant number of the points are broad and rather short exhibiting the highest width at their base. The reoccurrence of these attributes points at a standardized blank production. In fact, the Levallois point samples of Hummal HM-A1, Kebara IX-XII, Amud B4, Tabun B and Tor Faraj C are nearly identical regarding technology and artifact morphology. Furthermore, blanks produced from one single striking platform are dominating in all these assemblages. This strong technological similarity is insufficiently reflected by the technological data in table 3 which can be due to sample size error but more probably because of the inconsistency between observers as regards the definition of blank categories. This aspect is especially pertinent to the differentiation between Levallois and non-Levallois blanks, as well as true Levallois points and triangular shaped flakes and IL calculation (Copeland 1983; Hauck 2010; Meignen 1995). For example, the frequency of Levallois points given for the Kebara samples is strikingly low compared to other sites because of a strict definition of this blank form. A better measurement of the importance of Levallois point production is the frequency of the unidirectional convergent scar pattern on the dorsal face of all blanks, which falls in between 40% and 60% for levels IX to XII of Kebara, and is therefore closely comparable to the frequencies observed for Hummal HM-A1, Amud levels B1 and B4 and Tor Faraj. The convergent method of core exploitation also seems to have been systematically applied in many levels of complex V and VI of Umm El Tlel and Jabrud level 2, however, the significant number of points which exhibit bidirectional removals constitutes a difference to the Hummal material. It is interesting to note that Umm El Tlel is situated closer to the El Kowm flint outcrops than Hummal, and that the bidirectional Levallois method was mainly executed during the initial phase of core reduction. Therefore, it is possible that the scarcity of corresponding blanks in Hummal is due to a distance-decay relationship. In other words, if the bidirectional production of Levallois blanks required large cores, their frequency would decrease as soon as transport costs increased. Other factors, such as raw material size and functional requirements, can explain the variability of flake / blade proportions and the chosen methods to produce them. While the centripetal method of core reduction seems to have been frequently applied for Levallois flake manufacture in some point-dominated assemblages of Umm El Tlel and Amud, evidence for it is scarce in Hummal, Kebara and Yabrud, where the unidirectional method was the preferred flaking strategy.

Aside from the presence of some classic Levallois points in levels 5a2 to 5E, the Hummal HM-A2 industry does not show a comparable similarity to the mentioned sites as do the uppermost levels of Hummal, except for Amud levels B1 and B2. This is due to the marked inter-level variability in terms of blank type frequency, intensity of core exploitation and the strong laminar aspect of many assemblages, which is also reflected by the presence of "leaf-shaped" points in the middle part of the Hummal Mousterian sequence. While many blades in point-dominated assemblages can be seen as by-products of Levallois point production (Demidenko & Usik 2003), a significant part in HM-A2 are to be seen as distinct end-products (Hauck 2010), resulting in very high laminar indices for some assemblages (tab. 3). As in Hummal HM-A2, a characteristic element of Amud levels B1 and B2 is the abundance of atypical, mostly elongated Levallois points and rectangular blades and flakes with unidirectional parallel scar patterns. In both sites the first stages of core preparation occurred off-site. The typical by-products of initial recurrent point production are elongated, semi-cortical removals with unidirectional scar patterns. The elongated asymmetrical points with only slightly converging scar patterns in levels B1 and B2 in Amud, are reminiscent of the "leaf shaped" points in the HM-A2 complex in Hummal. Moreover, the significance of elongated flakes and blades with unidirectional scar patterns in Amud B1 and in Hummal levels 5a2 to 5E reinforces this technological resemblance, although blades are much more common in the Hummal samples (tab. 3). Evidence for the production of centripetally prepared preferential flakes in the final stage of core reduction is found in both sites.

A phenomenon which is shared by all Levallois point assemblages from Hummal and other Late Mousterian sites is the scarcity of retouched implements and the dominance of retouched points and side scrapers in the tool sample. It is interesting to note that ventrally retouched pieces are a characteristic typological element in Hummal HM-A1 and complex VI3 of Umm El Tlel. The same holds true for Tor Faraj and Tor Sabiha, the samples of which exhibit a concentration of retouch on mesial and proximal point edge sections. It is conclusive to assume that this pattern reflects hafting facilities (Henry 1995a). Interestingly, we observed a reverse pattern in the Hummal assemblages in which the majority of points show retouch at the distal tip. This could be due to a differential use of points in both sites or differences in hafting technology; in this respect, it is possible that the access to natural bitumen usable as mastic in the El Kowm region reduced the need for proximal edge regulation. (Boëda *et al.* 2008).

Concerning Levallois points, little effort in core preparation is needed for a serial production, and the cores' flaking surface was repeatedly reshaped with elongated and often plunging core edge flakes. Whether it is possible to differentiate between a recurrent and lineal method of point production is a controversial issue (see discussion in Bar-Yosef *et al.* 1992). Nevertheless, the intrinsic relationship between the two reduction modes which is postulated for the Hummal HM-A1 industry seems to be equivalent in Kebara levels IX and X and certain levels of Umm El Tlel. In Tor Faraj, the core reduction strategy was probably more rigid, which is mirrored by the preference for the lineal method (Demidenko & Usik 2003). The technological rigidity seen in Tor Faraj probably explains the higher proportion of Levallois flakes and the lower length-width ratio of points in comparison with Hummal, where the unidirectional recurrent method was frequently chosen to obtain elongated blanks; however, it has to be stressed that in both sites, a significant quantity of blades are by-products of Levallois point core reduction. Moreover, preliminary refittings in some Hummal levels indicate a rather strong affinity with the technical gestures applied for Levallois point production in Tor Faraj (Demidenko, personal communication). Some of the mentioned Late Mousterian assemblages reflect an intensive core reduction for Levallois point production. (e.g. Henry 2003; Hovers 1998; Meignen & Bar-Yosef 1992). The extensive production of Levallois points until a very low size threshold of the cores is also visible in most of the Hummal assemblages. The majority of waste cores, the size of which clusters around 5cm, are extremely reduced and their totally reworked state with multidirectional removals closely resembles the core sample of Tor Faraj (Demidenko & Usik 2003). Indirect evidence for extensive Levallois point production in Hummal is given by the presence of small points in the range between two and three centimeters. A further element which corresponds with the aim of obtaining small points is the frequent recycling of broken blanks or tools. In many cases, subtriangular flakes were struck from the cores on flakes, the number of which is outstandingly high in most of the Hummal assemblages (tab. 2). A high frequency of secondary cores, to which most so called "truncated faceted pieces" can be added (Hauck 2010), is also reported for Amud levels B1 and B4 (Hovers 2007), Kebara (Bar-Yosef *et al.* 1992), Tor Faraj (Henry 2003) and Umm El Tlel level VI3a' (Bourg 2007). Recent analysis of Hummal levels 5a2, 5a3 and 5b3 revealed a striking resemblance to the secondary point production methods observed in the Tor Faraj material, including the removal of points from the ventral surface of flakes and the exploitation of extant Y-arrête scar patterns on points with burin-like spalls.

Searching for the factors which explain the importance of this recycling strategy, one has to examine the technological organization at a given site. In this respect, it is interesting to note that the technological organization reflected in the two Jordanian rock-shelter sites Tor Faraj and Tor Sabiha corroborates observations that were made for the Hummal Mousterian. The fact that Tor Faraj, which is located far away from raw material, was provisioned with complete nodules and prepared cores, whereas the Tor Sabiha site saw an import of blanks and low on-site core reduction, despite its proximity to raw material sources, affirms our observation that provisioning strategies do not necessarily follow a distance-decay relationship (Hauck 2010; Henry 1995a, 1995b). Tor Sabiha probably served as a transitory camp; raw material procurement was rather embedded in other subsistence activities, and provisioning the site with stock was unnecessary. Contrastingly, Tor Faraj was a regularly visited, long-term encampment, and hence, a wider range of activities required a considerable amount of raw material. Although the rock shelter is 17 to 22 km away from suitable raw material sources, a targeted procurement and a provisioning of place strategy was applied, which necessitated the transportation of considerable loads. To economize on raw material use, core reduction was pushed to the extreme and many flakes were secondarily used as cores. The same behavioral pattern is observable in Hummal, and it is certainly no coincidence that the humans at Tor Faraj and Hummal had to cope with equal distances to raw material outcrops. Combining the evidence of both sites, the importance of the secondary flaking method can be seen as positively correlated to transport distance; a similar observation was made for Mousterian sites in the Central Negev (Munday 1976).

A Tabun C type Mousterian facies in Hummal

The scarcity of Levallois points and the distinct features of Levallois flake and blade production in the lowest Mousterian levels of Hummal represent a totally different technological tradition compared to the overlaying HM-A industries. Important in this respect is the presence of large flakes and blades which were principally produced with the unidirectional, bidirectional and centripetal method of core reduction (plate 1 and tab. 4). This technological profile warrants a correlation of the Hummal HM-B industry with so called Phase 2 / Tabun C type Mousterian assemblages, such as Qafzeh levels V-XXI (Hovers 2009), Tabun unit I Beds 18-26 (Jelinek 1981, 1982a, 1982b and own observation), Douara layer III (Akazawa 1974, 1979) and Ksar Akil levels XXVI-XXVII (Marks & Volkman 1986), Naamé and Ras El Kelb (Copeland & Moloney 1998).

Although the Hummal samples are tool small to be conclusive, the combined percentage of centripetal and bidirectional scar patterns in Hummal levels 5e to 5g falls into the same 60% to 80% range, which is also observed across the Qafzeh sequence (Hovers 2009). In Tabun Beds 18-26, Douara level III and in Hummal HM-B, the Mousterian knappers followed a twofold strategy by removing quadrangular or oval shaped flakes from centripetally prepared cores and elongated flakes and blades from cores with one or two opposing platforms. Despite these similarities, the Hummal samples seem to exhibit idiosyncractic

level	analyzed sample[a] N	Levallois blanks N	Levallois flakes %	Levallois blades %	Levallois points %	bidirectional and centripetal scar pattern %	LWR	Ilam
5e	54	9	4	3	2	85.7	2.0	50.0
5f1	43	12	6	5	1	60.0	2.0	40.0
5f2/3	38	17	7	9	1	73.3	2.2	68.4
5g	47	11	5	5	1	77.8	1.9	36.4

Table 4 - Composition of the lowest Mousterian assemblages of Hummal (HM-B industry), a) roral debitage sample excluding debris <2cm, fragments and cores.

features which set them apart from the mentioned Phase 2 assemblages. First, there is no indication for a recurrent centripetal flake production in Hummal, such as off-set axis flakes and *débordant* elements. In the present state of analysis it seems that all Levallois flakes were obtained by the lineal method. Second, while the mentioned Tabun C type assemblages are clearly dominated by rather squat flakes, the frequency of elongated blanks is very high in Hummal and respective blade indices are found clearly outside the range of other Tabun C type assemblages (tab. 4). Concerning Hummal, a larger sample is required to test the significance and meaning of these differences.

Conclusions

Levallois point dominated assemblages are found in the upper two third of the Hummal Mousterian sequence. Two industry types, namely HM-A1 and HM-A2, can be distinguished based on differences in Levallois point technology and on the technological attributes which are exhibited by accompanying flakes and blades. Both industries show strong similarities with other point-dominated Late Levantine Mousterian sites, such as Umm El Tlel, Yabrud, Kebara, Amud, Tabun or Tor Faraj. Due to the persisting dating problem of the Hummal deposits, a chronological positioning can only be done based on techno-typological grounds. Given the similarity between Hummal levels 5AI to 5E and the mentioned Late Levantine Mousterian sites, it is reasonable to allocate the major part of the Hummal Mousterian sequence somewhere in the timeframe between 80ka and 50ka BP. The inter-site comparisons make clear that Hummal levels 5AI to 5E reveal idiosyncratic features, such as the marked laminar tendency in many levels, which can be partly explained by the access to large, high-quality flint nodules. However, the presence of broad Levallois points with an Y-*arrête* scar pattern and faceted and *chapeau de gendarme* shaped platforms and the removals' strong convergence on the core surface in Hummal HM-A1 are in good accordance with the technological profile of Kebara levels IX-XII, Amud level B4, Tabun B, Jabrud level 2 and Tor Faraj level C. Regarding assemblage composition, the Hummal HM-A2 industry is more variable showing a high amount of elongated flakes and blades in many levels and a systematic unidirectional parallel removal of blank together with the convergent method. The only Late Mousterian which shows comparable assemblages is Amud, notably levels B1 and B2.

The techno-typological variability, inherent in the Late Mousterian industries of Hummal, clearly echoes the complexity which characterizes this period in the Levant. Moreover, the bundle of techno-typological differences between the El Kowm Mousterian sites of Hummal and Umm El Tlel indicates that a considerable variability in core reduction strategies and tool manufacture exists even within a relatively restricted area. Besides the complexity of technological organization patterns, variability in the Late Levantine Mousterian can be expressed by inter-assemblage and inter-site differences in core preparation and reduction methods, blade vs. flake proportions, and point morphologies. Admittedly, the techno-typological variability of the Late Levantine Mousterian cannot be comprehensively described with these parameters alone. In our view, future research has to focus on parameters of technological organization, such as raw material provisioning and site function, to better understand the meaning of the observed variability.

The allocation of the lowermost Hummal levels 5e to 5g to the Levantine Mousterian of Tabun C type is tentative. Based on the mentioned technological aspects, Douara levels IIIA and IIIB and Tabun unit I were placed into the Middle Middle Paleolithic or Phase 2 / Tabun-C phase of Copeland's tripartite division of the Mousterian (Copeland 1975; Akazawa 1987; Shea 2003). Despite the sample size and dating problem in these sites, this general correlation would allow it to tentatively place the lowest Mousterian levels of Hummal into the middle part of the Levantine Mousterian. This period shows the same degree in variability of technological gestures as the Late Levantine Mousterian. Although broad similarities in terms of centripetal core reduction methods and scarcity of Levallois points are detectable in Hummal, Douara and Tabun unit I, many differences exist in terms of assemblage composition and alternative flaking technologies. Reinforcing this picture is the variability which is recorded between the levels of the Qafzeh sequence (Hovers 2009). Hence, we can no longer describe the Middle Levantine Mousterian as a facies which is dominated by "broad oval" flakes. Provided that the allocation of Hummal levels 5e to 5g to the Middle Levantine Mousterian proves to be correct, a chronological placement of these levels into MIS 5 would be in agreement with the preliminary TL dating results for level 5g (Richter *et al.* 2011). Current theory states that the geographical extension of the Tabun C facies is restricted to woodland areas along the eastern Mediterranean coast (Copeland 1981; Henry 1995a; Lindly & Clark 2000). The discoveries in the lowest Mousterian levels of Hummal contradict this assumption. It is possible that the Tabun C assemblages reflect the exploitation of different resource types compared to the following point-dominated Mousterian. Their evidence in the interior arid part of the Levant shows that these activities were not restricted to a specific environment. Whether the significant variability visible in the Early, Middle and Late Levantine Mousterian was triggered by ecological or merely cultural factors is an urging question, from which we are far from providing an answer. However, ongoing research in the Mousterian sequence of Hummal and neighboring sites will certainly provide further information for a better understanding of Levantine Mousterian variability.

Acknowledgements

Excavation and research in Hummal is funded by the Swiss National Foundation, the Tell Arida Foundation and the Freiwillige Akademische Gesellschaft in Basel. Presented research results could not have been obtained without the permission and help of the General Directorate of Syrian Antiquities and the Museum of Palmyra. TL-results were kindly provided by D. Richter (Max Planck Institute, Leipzig, Germany). Thanks go to Jürgen Richter, Thorsten Uthmeier and Daniel Schüle from the Intitut für Vor- und Frühgeschichte in Cologne for the opportunity to study the flint collection from Yabrud. Permission to see the Tabun collection at the University of Arizona in Tucson was kindly granted by Steven Kuhn and Arthur Jelinek. I am also grateful to James Krakker for providing me access to the Tabun material of the Smithsonian Collection in Washington. Thanks go to Eric Boëda for letting me examine assemblages from Umm El Tlel.

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