Variability of core reduction strategies of the late Middle Palaeolithic of assemblages 6 and 4 of Yabroud I (Syria): An analytical and comparative study

Inaugural dissertation
to complete the doctorate from the Faculty of Arts and Humanities
of the University of Cologne
in the subject Prehistoric Archaeology

by
Amal Al Kassem

born on 29.6.1984
in Daraa (Syria)

Cologne 07.07.2021

First Supervisor: Prof. Dr. Jürgen Richter
Second Supervisor: Prof. Dr. Gerd-Christian Weniger

Table of Contents

Abstract

Acknowledgment

Abbreviation index

1. Introduction 1

1.1. Opening 1

1.2. Presentation of the Yabroud area 4

1.2.1. Geographical setting 4

1.2.2. History of research 6

1.2.3. Environmental setting 15

1.2.4. Chronology 16

1.2.5. Raw material 17

2. The Levantine Middle Palaeolithic: an overview 18

2.1. History of research 18

2.1.1. The first phase 1930-1960s 18

2.1.2. The second phase 1960s-1980s 20

2.1.3. The third phase from 1990s 21

2.2. Hominin fossils 22

2.3. Variability of lithic industries in the Levantine Middle Palaeolithic 24

3. Methodology of the lithic analysis 27

3.1. The theoretical notions of the present study 27

3.1.1. Typological approach 27

3.1.2. Technological approach 28

3.1.3. Transformation analysis 28

3.2. The Levallois production concept 30

3.2.1. Definition of the Levallois concept 31

3.2.2. Variability of Levallois methods 33

3.3. Method to investigate the technological reason for the standardization of morphological, technical characteristics of Levallois points 42

3.3.1. Cross-section angles of Levallois points 43

3.3.2. Lateral angles of Levallois point 43

3.3.3. Experimental work 44

4. Inventory of assemblages 6 and 4 of the Yabroud Shelter I 44

4.1. Archaeological assemblage 6 44

4.2. Archaeological assemblage 4 45

4.2.1. Problem of number of stone artefact in assemblage 4 45

5. The TECHNO-TYPOLOGICAL analyses and transformation analysis of the late Middle Palaeolithic assemblage 6 of Yabroud Shelter I.....48

5.1.Identifying core reduction techniques.....49

5.2.Strategy of Levallois core reduction 50

5.2.1. Levallois cores for points 51

5.2.2. Levallois cores for flakes 55

5.2.3. Levallois cores for blades.....59

5.2.4. Initial Levallois cores 60

5.2.5. Maximum benefit of the exhausted Levallois cores by exploitating the lower surface 61

5.2.6. Re-exploitation of the discarded bifaces using Levallois method.....62

5.3.Core on flake strategy 63

5.3.1. Selection of the flake and setting up the flaking surface.....65

5.3.2. Dimension 66

5.3.3. Exploitation 67

5.3.4. The similarities of reduction criteria between the strategies of Levallois methods and core on flake 68

Summary 70

5.4.The characters of cores and Levallois blanks 72

5.4.1. Dorsal scar patterns of Levallois blanks and cores 73

5.4.2. Maintenance of the striking platforms 76

5.4.3. Quantity of cortex on Levallois blanks 79

5.4.4. Size of Levallois blanks and cores 80

5.5.Strategies of blank production 84

5.5.1. Levallois point reduction strategies.....84

5.5.2. Levallois blade reduction strategies 91

5.5.3. Levallois flake reduction strategies.....93

Summary 96

5.6.By- products.....97

5.6.1. Cortical flakes 97

5.6.2. Naturally backed knives and core edge flakes *Éclats débordants* 99

5.6.3. Striking platform flakes.....101

5.6.4. Flaking surface preparation flakes 102

5.7.Typological classification: manufacturing tools 103

5.7.1. The Middle Palaeolithic group (Group II) and partially retouched pieces.....104

5.7.2. Denticulates, Notched elements and Upper Palaeolithic group (Group III) 105

5.7.3. Composite tools 106
5.7.4. Analysis of modified blanks 106
5.8. Transformation analysis 110
5.8.1. Raw material units imported as single objects or tools 110
5.8.2. Raw material units imported as dynamic objects 113
5.8.3. Raw material units imported as nodules 114
5.8.4. Raw material units imported as partially prepared cores 120
5.9. Reconstruction of recurrent occupation of the late Middle Palaeolithic base camp, assemblage 6 of Yabroud Shelter I 136
5.9.1. Clear diversity of the lithic material 137
5.9.2. Repeatedly occupation of the base camp assemblage 6 of Yabroud Shelter I 139
5.9.3. High Mobility 141
5.9.4. Strategies and circumstances of raw material procurement 142
6. The TECHNO-TYPOLOGICAL analyses and transformation analysis of the late Middle Palaeolithic assemblage 4 of Yabroud Shelter I 144
6.1. Identifying core reduction techniques 144
6.2. Levallois core reduction strategies 146
6.2.1. Levallois cores for points 148
6.2.2. Levallois cores for blades 151
6.2.3. Levallois cores for flakes 153
6.2.4. Initial Levallois cores 156
Summary 158
6.3. The characters of Levallois blanks and cores 160
6.3.1. Dorsal scar patterns of Levallois blanks and cores 160
6.3.2. Maintenance of the striking platforms 167
6.3.3. Quantity of cortex on Levallois blanks 169
6.3.4. Size of Levallois blanks and cores 170
6.4. Strategies of blank production 172
6.4.1. Levallois point reduction strategies 172
6.4.2. The close technological correlation between an obliqueness of two preceding predetermined convergent removals of Levallois point production and the classical Levallois point 177
6.4.3. Levallois flake and blade reduction strategies 184
6.5. By- products 188
6.5.1. Cortical flakes 189
6.5.2. Naturally backed knives and Core edge flakes *Éclats débordants* 190

6.5.3. Flaking surface preparation flakes 191
6.5.4. Striking platform flakes.....192
6.6.Typological classification: manufacturing tools 193
6.6.1. The Middle Palaeolithic group (Group II) and partially retouched pieces.....194
6.6.2. Denticulates, Notched elements and Upper Palaeolithic group (Group III) .196
6.6.3. Composite tools.....196
6.6.4. Analysis of the modified blanks.....197
6.7.Transformation analysis.....200
6.7.1. Raw material units imported as single objects or tools.....200
6.7.2. Raw material units imported as dynamic objects.....206
6.7.3. Raw material units imported as nodules 206
6.7.4. Raw material units imported as partially prepared cores 212
6.8.Reconstruction of recurrent occupation of the late Middle Palaeolithic task-specific site, assemblage 4 of Yabroud Shelter I.....224
6.8.1. Low diversity of the lithic material 224
6.8.2. Repeatedly occupation of the task-specific assemblage 4 of Yabroud Shelter I 228
6.8.3. High mobility 229
6.8.4. Strategies and circumstances of raw material procurement 231
6.8.5. Off versus on-site activities.....232
Summary 233
7. Comparative study of the late Middle Palaeolithic industry of assemblages 6 and 4 of Yabroud Shelter I 234
7.1.Identifying core reduction techniques.....234
7.2.Levallois core reduction strategies.....235
7.2.1. Levallois cores for points 235
7.2.2. Levallois cores for blades.....237
7.2.3. Levallois cores for flakes 238
7.3.Initial Levallois cores.....239
7.4.Core on flake strategy 240
7.5.Summary 240
7.5.1. Characteristics confined to the lithic industry of the assemblage 6 240
7.5.2. The technological aspects most common to the lithic material of in both assemblages.....241
7.5.3. The clearest technologically differences between assemblages 6 and 4.....242
7.6.Strategy of the blank production 243
7.6.1. Strategy of Levallois point production.....243

7.6.2. Strategy of Levallois flake production 247
7.6.3. Strategy of Levallois blade production 248
7.7.Tools.....250
7.8.Transformation analyses 253
7.8.1. Imported raw material units as single objects or tools 254
7.8.2. Imported raw material units as dynamic objects 254
7.8.3. Scarcity of imported raw material units as nodules 255
7.8.4. Predominance of importing raw material units as partially prepared cores ...256
7.9.Multiple palimpsests of a base camp site versus a task-specific site of late Middle Palaeolithic, assemblage 6 and 4 of Yabroud Shelter I.....257
7.9.1. Clear diversity versus low diversity 258
7.9.2. High mobility 259
7.9.3. Predominance of the embedded strategy of raw material procurement 261
8. Discussion.....263
9. Conclusion.....278
10. Summary.....283
Bibliography. 288
List of figures.....308
List of tables.....314
Table of contents.....317

Variability of core reduction strategies of the late Middle Palaeolithic of assemblages 6 and 4 of Yabroud I (Syria): An analytical and comparative study

Abstract

There is a pronounced technological diversity in the Levantine Mousterian. This diversity has been interpreted by some researchers as a result of the diffusion of different human groups, while others see it rather as an expression of technological plasticity within a single group. Between these poles, the current study focuses on an analytical and comparative study of the lithic industry of assemblages 6 and 4 of Yabroud Shelter I (Syria) to elucidate the differences and similarities in technological behaviour with reference to resource exploitation, mobility systems, and land use. Yabroud Shelter I is located 60 km north of Damascus, at an elevation of 1420 m.a.s.l, in an ecotone area between the Mediterranean coast and the arid steppe region in the inland. Dated between 70.000 and 45.000 years ago, assemblages 6 and 4 both accumulated under fairly similar environmental conditions. The analogous technological behaviour of exploitation, core management, and raw material procurement attested in assemblages 6 and 4 support the notion that the Levallois concept was the only concept applied, and the core on flakes and *Nahr Ibrahim* technique in assemblage 6 are interlinked behaviourally with the Levallois concept. Taking into consideration the previous models of Levantine Middle Palaeolithic land-use strategies, the total absence of exotic raw material in both assemblages, especially amongst the high number of personal gears, and frequent reuse of discarded lithic materials from previous periods, the emerging picture supports the interpretation that hunter-gatherers from Yaborud might have moved in rathe close vicinity of the site between the highland in warm seasons and the lowland in cold seasons. This strengthens the possibility that humans stayed in the region year-round, suggesting that the observable technological diversity is related to the technological plasticity of a single group of people.

التغيرات في استراتيجيات تقصيب النوى في أواخر العصر الحجري القديم الأوسط في الطبقتين 6 و 4 من ملجأ يبرود الأول (سورية): دراسة تحليلية ومقارنة

موجز

تتميز الصناعات الحجريّة في المشرق بتنوع تقني ملحوظ خلال العصر الحجري القديم الأوسط، وقد تم تفسير هذا التنوع من قبل بعض الباحثين بأنّه نتيجة لانتشار مجموعات بشريّة مختلفة، بينما يرى آخرون أنّها تُظهر المرونة التقنية داخل مجموعة بشريّة واحدة. و بين هذين القطبين من الآراء تركز الدراسة الحالية على دراسة تحليليّة ومقارنة للصناعات الحجريّة في الطبقتين 6 و 4 في ملجأ يبرود الأول (سورية) بغية توضيح الاختلافات والتشابهات في السلوك التقني وفيما يتعلق أيضاً باستغلال الموارد وأنظمة التنقل وأنماط الاستيطان. يقع ملجأ يبرود الأول شمال دمشق على بعد نحو 60 كليومتراً وعلى ارتفاع 1420 متراً فوق سطح البحر، بين بيئتين مختلفتين وهما ساحل البحر الأبيض المتوسط والباديّة السوريّة. تم استيطان الطبقتين 6 و 4 من الملجأ الأول والمؤرختين بناء على الصناعات الحجريّة مابين 45.000 – 70.000 ألف سنة خلت وذلك في ظل ظروف بيئة متشابهة إلى حد ما.

يدعم التشابه في السلوك التقني لتقصيب وإدراة النوى، وكذلك استراتيجيات الحصول على المواد الخام الذي تم إثباته في الطبقتين 6 و4 بأنّ اللفلوازيّة هي الصناعة الوحيدة المستخدمة، وأنَّ تقصيب الشظايا و تقنية نهر إبراهيم في الطبقة 6 مرتبطتان سلوكياً مع الصناعة اللفلوازيّة. مع الأخذ بعين الاعتبار النماذج المطروحة سابقاً لأنماط الاستيطان في أواخر العصر الحجري القديم الأوسط في المشرق، فإن الغياب التام للمواد الخام الغير محلية في كلا الطبقتين خاصة بين العدد الكبير للأدوات المستخدمة أثناء التنقل، وكذلك إعادة الاستخدام المتكرر للمواد الحجرية المهملة من الفترات الزمنية السابقة تدعم الصورة المكوّنة لدينا والقائلة بأنّ الصيادين وجامعي الثمار من ملجأ يبرود الأول ربما تنقلوا ضمن مسافات قريبة من الموقع بين المرتفعات في المواسم الدافئة والأراضي المنخفضة في المواسم الباردة، يعزز هذا احتمالية بقاء البشر في المنطقة على مدار العام، مما يشير إلى أنّ التنوع التقني الملحوظ مرتبط بالمرونة التقنية لمجموعة واحدة من البشر.

Acknowledgement

This doctoral dissertation was financed by the *Gerda Henkel Stiftung* grant and by the *Dr. Carl-Arthur Pastor* grant. I would like to express my deep thanks *to Gerda Henkel Stiftung* team for their great moral support.

In our lives, there are specific people whose noble attitudes cannot be forgotten. The presented research results could not have been achieved without many years of support, inspiration on countless occasions, and the persistent care of my supervisor Professor. Dr. Jürgen Richter. I am especially grateful to him for his noble attitudes and for embracing me since the first moment of my arrival in Germany. Additionally, I am grateful to him for offering me the possibility to access the lithic material of Yabroud Shelter I and for offering me all means, which in turn, contributed to achieving this research. Additionally, I am deeply thankful to my second supervisor Professor. Dr. Gerd-Christian Weniger for being there whenever I needed him, and for all of the profitable discussions and advice that widened my knowledge constantly.

I must also give great thanks to Professor. Dr. Maysoon Al Nahar who adopted and guided me since I joined the master's degree course. Countless times over all of these years she reminded and helped me to make a weakness into a strength, by facing up to myself and the new circumstances. Her support has made me a stronger person and I will forever be grateful to her.

I would like to express my deep gratitude to Professor. Dr. Andreas Maier. He has provided priceless academic as well as logistical support for which I am very grateful.

I would like to express my sincere gratitude to Dr. Thomas Hauck who was the first person who believed in my ability to achieve this research in Germany.

I am indebted to many individuals, who supported the research whether through practical help, pieces of advice or in other ways: Professor. Dr. Thomas M. Weber-Karyotakis, Dr. Karin Kindermann, Dr. Isabell Schmidt, Dr. Florian Sauer, Dr. Dirk Leder, Dr. Wei Chu, Dr. Ralf Vogelsang, Mirijam Zickel, Thomas Wolter, Dr. Hauke-Peter Vehrs, Joel Orrin, Osama Samawi, Johanna Dreier, Christiana Richter, Anja Duwe, Rainer Zuszek, Dr. Hannah Parrow-Souchon, Dr. Daniel Schyle, Dr. Daniela Holst, Dr. Werner Schuck.

I am very grateful to Professor. Dr. Frédéric Abbès, Dr. Michel Brenet, Jérémie Vosges and Antoni Palomo at Lyon University who supported me and discovered my talent as a flint knapper, and for their profitable discussions.

I am deeply grateful to the international office at Cologne University for many years of great support, especially to Dr. Johannes Müller.

I wish to express my thanks to all my Syrian friends for their support: Amjad Al Qadi, Mustafa Al Najar, and Manar Kerdy.

Finally, I dedicate this dissertation to members of my family who are spread all over the world and to my friend Waed Ahmad for their patience and support. I also dedicate it to souls of my father, Mousa, Khaldon and Abdulgani whose loss taught me a sense of patience.

Abbreviations

YSI	Yabroud Shelter I
MP	Middle Palaeolithic
UP	Upper Palaeolithic
IUP	Initial Upper Palaeolithic
a.s.l.	above sea level
BP	Before present
ka	Kilo annum, 1000 years
TL	Thermoluminescence
OSL	optically stimulated luminescence
ESR	electron-spin resonance
U-series	uranium-series
MIS	Marina Isotopes Stage
RMU	Raw material unit

1. Introduction

Foreword

In 2016, when I began my PhD, I was very excited to investigate the lithic material of Yabroud Shelter I, purely as it belongs to my homeland (Syria), which I was compelled to leave. Later, I started to feel attached to it and that it is a part of me since. There is a similarity between my journey from Syria to Germany by foot in order to get a PhD and that of Alfred Rust, who discovered and excavated Yabroud Shelter I, II and III, travelling from Germany to Syria by bicycle.

The first difficulties were related to the fact that Yabroud Shelter I was excavated in the 1930s and ambiguity surrounds various aspects of the excavations in respect to the stratigraphy, where the spatial relationship between the levels remains unclear. In addition, Rust might have selected the stone artefacts in order to reduce his load, which he had to transfer from the shelter alone. Consequently, the challenge was to gain the maximum amount of information from the lithic artefacts in the absence of other deposits such as fauna and flora. In addition, the Mousterian industries finds from Yabroud Shelter I have been studied by different researchers such as Bordes during the 1950s, Hours (1992), Solecki & Solecki (1995), Frank (2004), and Pagli (2013), so I had to investigate the lithic material in detail and in a different way in order to get new results.

1.1.Opening

The Levantine Mousterian is a technocomplex characterized by a homogenous body in its general features, through the application of a unique Levallois reduction concept. On the other hand, it is characterized by notable technological diversity in some situations. For decades, the definition of the Middle Palaeolithic relied on a pan-Levantine model according to the lithic industries of the Tabun sequence (layers D, C, and B) with which a chronological succession for the entire Middle Palaeolithic in the Levant was characterized (Garrod & Bate 1937; Jelinek et al. 1973; Copeland 1975, 1981; Jelinek 1975, 1982a, 1982b; Bar-Yosef 1998). However, recent consensus suggests there are several reasons that the variability in lithic technology in the Levant cannot be accommodated into a single model. The Tabun sequence was dated between circa 250 ka BP and 90–80 ka BP (Grün et al. 1991; Grün and Stringer 2000; Mercier & Valladas 2003; Rink et al. 2003; Coppa et al. 2005, 2007). This, in turn, rules out the existence of the late Middle Palaeolithic (MIS 4 and the first part of 3) from the Tabun sequence (more detail see Hovers 2009 and Leder 2014).

More importantly, the great variability in technology becomes a distinct character of the Late Levantine Mousterian, especially in those sites dated between 70 and 50 ka BP. The Nahal Mahanayeem outlet, for instance, is characterized by reduction of blade core concept with a prepared platform by abrasion attributed to the Upper Palaeolithic (Ekshtain et al. 2019). Non-Levallois flake-bearing assemblages of the Quneitra site and Levallois flake-bearing level V2 of Umm el Tlel also do not fit with the industry of Tabun B (Goren-Inbar 1990; Pagli 2013 and Al Sakhel 2004). Moreover, the discovery of Neanderthal fossils associated with the Nubian technocomplex at Shukbah Cave in Palestine increases the unviability of using a single model to define Middle Palaeolithic industries. Finally, variability has been observed in the human fossils discovered and dated within the timeframe 70–50 ka BP. *Homo sapiens* fossils found in Manot Cave were dated to 55 ka BP (Barzilai et al. 2016; Alex et al. 2017), while Neanderthal fossils discovered in Dederiyeh, Amud, Kebara and Shukbah Cave have been dated between 70 and 50 ka (Akazawa et al. 1995; Akazawa & Muhesen 2002; Valladas et al. 1999; Rink et al. 2001; Valladas et al. 1987). Furthermore, variability in technology is not only observed between sites that differ environmentally and geographically, but can even be present within the same site where the aim was to meet the varied needs of hunter-gatherers and where each knapper had their own manner and skill in dealing with cores, regardless of the targeted end product.

The current study addresses the lithic material from assemblages 6 and 4 of Yabroud Shelter I. These two occupations basically share the same life circumstances such as time frame, during which the recurrent Levallois method was the dominant method among the late Middle Palaeolithic in the Levant, in particular unidirectional convergent Levallois method. Moreover, the two occupations had the same environmental setting, associated with an arid climate, with an alternation between steppe and desert vegetation that expanded from the late Middle Pleistocene through the Holocene (Zohary 1973; Dodonov et al. 2007). In addition, pollen and spores tested from various depths at Yabroud Shelter I indicate that specific layers of were deposited during warm periods (Schrøder et al. 2012). However, it is difficult to assume that the environment impacted the variability of technology in the absence of faunal and botanical evidence. In addition, the paleontological and botanical evidence substantiated that resource diversity did not change through the Mousterian in the Levant. In fact, the assumption is that it was stable and resembled present-day vegetation and faunal resources, with differences between now and the Middle and Upper Pleistocene being more of degree than of kind (Goring-Morris et al. 2009). Moreover, the Eastern-Mediterranean-Levant climate was favourable (wetter and

warmer), based on the marine pollen record, even in the currently semi-arid/steppe regions, during the late Middle Palaeolithic-initial Upper Palaeolithic 56–44 ka. This was most likely driven by increased precipitation related to the intensification of the North Atlantic-Mediterranean climate system (Langgut et al. 2018). However, the role of the environment cannot be ruled out.

Consequently, the main objective of the ongoing study is to carry out techno-typological analysis and transformation analyses of the late Middle Palaeolithic industries of assemblages 6 and 4 of Yabroud Shelter I in order to find out the reasons for the differences in industry in the two assemblages, despite them sharing the same circumstances during their occupation. Therefore, the reasons for the difference in composition must be addressed as follows:

- Could the difference be due to the selection of lithic materials by Rust in order to decrease his load, thus impacting the observed variability in lithic technology? I believe that Rust transported most of the lithic material, as the collection includes quite ugly and indeterminate pieces. It seems unreasonably to suggest he carried out indeterminate pieces and threw away blanks and tools.
- The size of the assemblages cannot be ruled out as a reason for their different compositions. However, assemblages 6 and 4 have more or less the same number of lithic materials, 618 and 706 stone artefacts respectively. Therefore, the difference cannot be related to assemblage size.
- Furthermore, if I expect that the different seasonality of occupation of the two assemblages might have effected the composition, this is difficult to substantiate since we have no reliable data on this. However, the high elevation of the shelter at 1420 m combined with harsh winters in the region suggests that both assemblages may have been used in spring or early summer. Seasonality can thus not be considered as a reason for the variability. The duration of occupation can also be ignored as the accumulation of lithic material is not intense and the two assemblages include very similar numbers of items.
- The two occupations were by hominins who procured local raw material without any evidence of acquiring exotic raw materials. However, assemblages 6 and 4 show different compositions brought about through the variability in core reduction strategies and the different proportions of Levallois blades versus flakes, and Levallois points. Variability can therefore not be related to the raw material used.

The factors mentioned combined with common technological traits between both assemblages reflecting analogous technological human behaviour is not reliable and reasonable enough cause for the different compositions between two assemblages. The variability in Levallois blank proportions may have resulted from different site functions. Additionally, variability may have been affected by more focus on a single subsistence strategy in assemblage 4 versus different subsistence strategies in assemblage 6. However, although the same Levallois methods were used in both assemblages, the variability in skills of knappers affected standardization versus diverse morphological and technical characteristics of Levallois blanks.

The manuscript deals with five main parts. The first part (subchapters 1–4) includes a presentation of the study area in subchapter 1, including the geographical, environmental, and archaeological context as well as the history of research. Subchapter 2 presents an overview of the Middle Palaeolithic in the Levant. Subchapter 3 exhibits the analysed material and the methodology of the study and analysis of the lithic material. The second and third parts present the results of techno-typological analysis and transformation analyses in chapters and subchapters of 5 and 6. The forth part of the manuscript is represented by chapter 7, presenting the results of the comparative study between assemblages 6 and 4 expressing the similarities and differences whether in core reduction or in land use. The last part includes the discussion, which presents the place of both assemblages 6 and 4 in the regional context, conclusion and the summary. This study could be used as an additional reference for future investigations related to the late Middle Palaeolithic in Syria, especially, since lithic materials from several Middle Palaeolithic sites, such as the open-air site in El Kowm, have been lost during the Syrian war.

1.2 Presentation of the studied areas

1.2.1. Geographical setting

The Yabroud Shelters (I–IV) are located 60 kilometres north of Damascus, Syria. These shelters are about 150 km east of the Mediterranean Sea. Yabroud Shelter I (henceforth labelled ‘YSI’) is located on the eastern slopes of the Qalamoun Mountains at the top of the Skifta Valley, in a suburb west of the village, against a steep cliff of Eocene limestone (Fig. 1-2) (Rust 1950; Solecki & Solecki 1966; Schrøder et al. 2012). Narrow passages connect YSI to neighbouring villages (Rust 1950).

YSI is located at an elevation of 1420 metres a.s.l., between the coastline and Mount Lebanon, which is comprised of Jurassic to Tertiary limestone and a spread of volcanic lava in different areas (Walley 2017) to the west, and steppe and desert areas to the east. This is very

high when compared with other Levantine sites that are located just short distances up major stream valleys (Ksar 'Akil, Sefunim, Antelias, Jiita and Geula in the coastal zone, as well as Wadi-Amud sites facing the Rift Valley zone), and do not exceed the 500-metre elevation line (Ziffer 1981; 72).

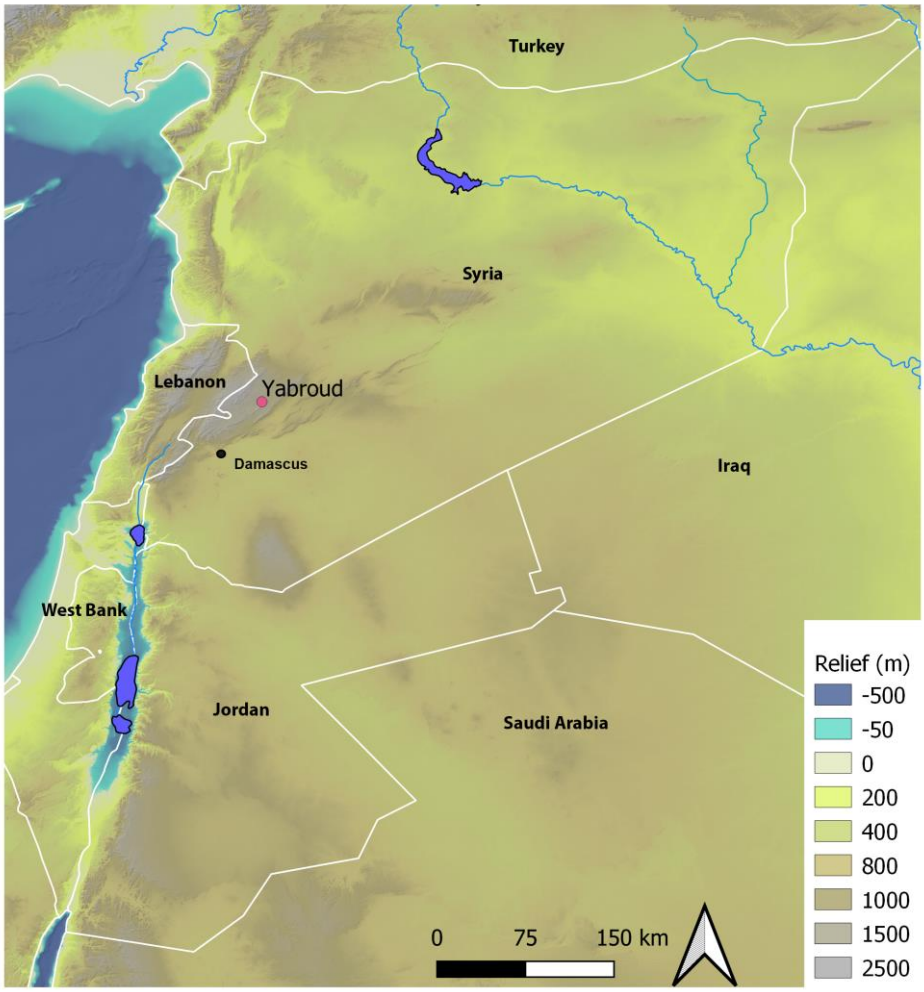


Fig. 1. Digital elevation map showing the location of Yabroud Shelter I (naturalearthdata.com). Coordinate System used: WGS 84/EPSG 4326.

Although the coastline forms suitable localities for hunter-gatherers, passage along the coast would have been difficult due to the cliffs. In contrast, passing through the Yabroud area during the summer would have been more suitable for migrants (Schrøder et al. 2012; 27).

According to Solecki & Solecki (1966; 123), the geomorphology of the Yabroud area was formed by a warping of the landscape, creating the Al-Majar depression that trended SW-NE. Frequent geological processes resulted in the uncovering of the limestone barrier around the whole of the Al-Majar depression, including in the Skifta Valley formation where the shelters are situated.

1.2.2. History of research

Before addressing the history of research in detail, we should recall that, due to many factors, the investigation of prehistoric sites in Syria was initiated very late in the day. The first reason for this is that Syria has been occupied by a succession of the military forces. Syria was part of the Ottoman Empire for 400 years (1516–1916), after which it was under British occupation from 1918 to 1919 and then the French Mandate for Syria and Lebanon from 1920 to 1946. None of the occupiers cared about research into the important history of the country as much as they did about its treasures. The first studies and excavations therefore concentrated on the Classical period, the Roman period and the Bronze Age, which are prevalent all over Syria. The second reason is the lack of local prehistoric archaeological experts. Archaeology can be considered an absolutely new science in Syria, as it began academically at the end of 1990s.

A. Rust's investigations of the Yabroud Shelters in the 1930s

The Yabroud Shelters were discovered by A. Rust in the 1930s during a trip from Germany to Egypt by bicycle. He arrived in Syria motivated by discoveries made by D. Garrod and R. Neuville on Mount Carmel in Palestine (Rust 1950; 10). He made three trips between 1930 and 1933. His investigations of the Yabroud Shelters in the 1930s are considered the basis of the first systematic excavations in Syria, and Rust is seen as one of the main reasons for the proliferation of excavations in Levant at that time (Jelinek 1992).

During his trips he excavated three rock shelters (*Schutzdach*), across two seasons from October to January of 1932/1933 and from March to July of 1933, which we now call the Yabroud Shelters I, II and III (Fig. 2). Rust excavated a trench, 23 m long, a maximum of 5 m wide and 11.5 m deep, across the rear of Shelter I (north–south), which was divided into four trenches (*Kammern 1–4*). He identified 25 so-called cultural layers (*Kulturschichten*) of Palaeolithic materials (Fig. 3). Sediment sieving was not used in this shelter, except for the micro-Mousterian layer 5 (Solecki & Solecki 1966). Furthermore, he asserted that the concentration of artefact distribution was at the rear of the shelter (Rust 1950). He also indicated that there was not occupation continuously along the surface of the shelter but were concentrated in specific areas. The material of layer 2 was situated more towards the northern part of the shelter, while that of layer 3 was localised in the southern part, and that associated with the micro-Mousterian (layer 5) was situated in the central area.

Shelter I included 25 cultural layers encompassing those of the Lower Palaeolithic (i.e. alternating layers of the Yabroudian, the Acheuleo-Yabroudian layers and so-called Pre-

Aurignacian), which are called Amudian nowadays, superimposed by Middle Palaeolithic layers (Rust 1950; Bordes 1955, 1984; Solecki & Solecki 1966, 1995; Bourguignon 1997; Al Qadi 2008, 2016; Pagli 2013, 2015).

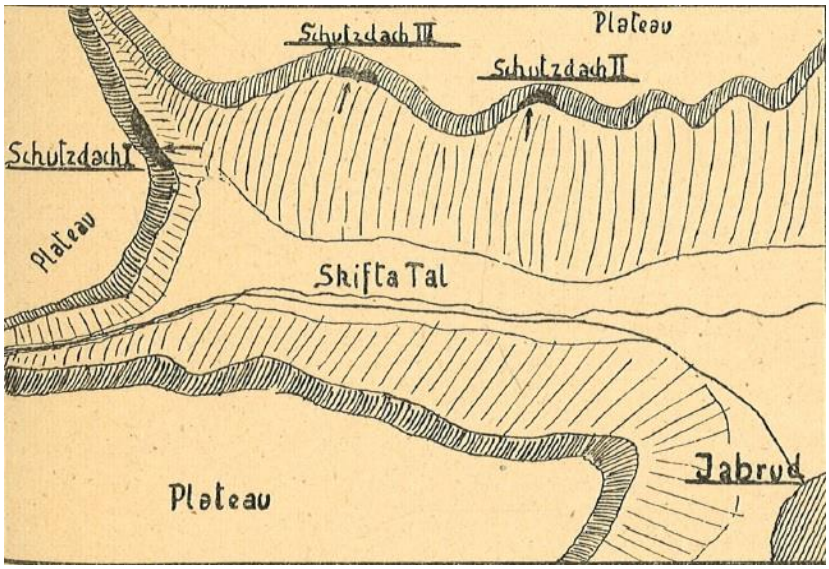


Fig. 2. Location of Yabroud Shelters I, II and III (Rust 1950).

Shelter II is located about 380 m east of Shelter I in the same valley, containing 10 layers from the end of the Middle Palaeolithic and the Upper Palaeolithic (labelled UP henceforth) (Rust 1950; Solecki & Solecki 1966; Ziffer 1981; Bakdach 1982; Pastoors et al. 2008). Shelter III contained eight UP assemblages, as well as the Epipalaeolithic layer with residues from the Natufian and Neolithic periods (Rust 1950; Bakdach 1982; Al Ahmar 2015).

Stratigraphy of YSI according to Rust (1950)

As mentioned above, Solceki's test trench did not add any substantial data to Rust's stratigraphy of YSI, and the spatial relationship between the layers of YSI are still ambiguous. Rust (1950) identified 25 cultural layers in YSI as following (Fig. 3 & Table. 1). Other researchers have since reassessed the distribution of the lithic industries (Waechter 1952; Bordes 1955; Copeland 1975; Solecki & Solecki 1995)

- Industries of the Yabroudian or Acheulo-Yabrudian were identified in the lower part of the shelter (layers 25–22), and in the middle part of the stratigraphy (layers 16, 14 and 11).
- 'Pre-Aurignacian' industry, as Rust called it (1950), was specified in layers (13 and 15). Furthermore, it is interstratified in the middle part. Specifically, in the two Yabroudian layers (16 and 14).

- Industries associating Levallois debitage with bifacial parts. This association is present in layers 23, 18, 17 and 12.
- Industries associated with Levallois debitage in the uppermost layers (10–1).
- Layers 19–21 contain very few artefacts and were therefore not assessed.

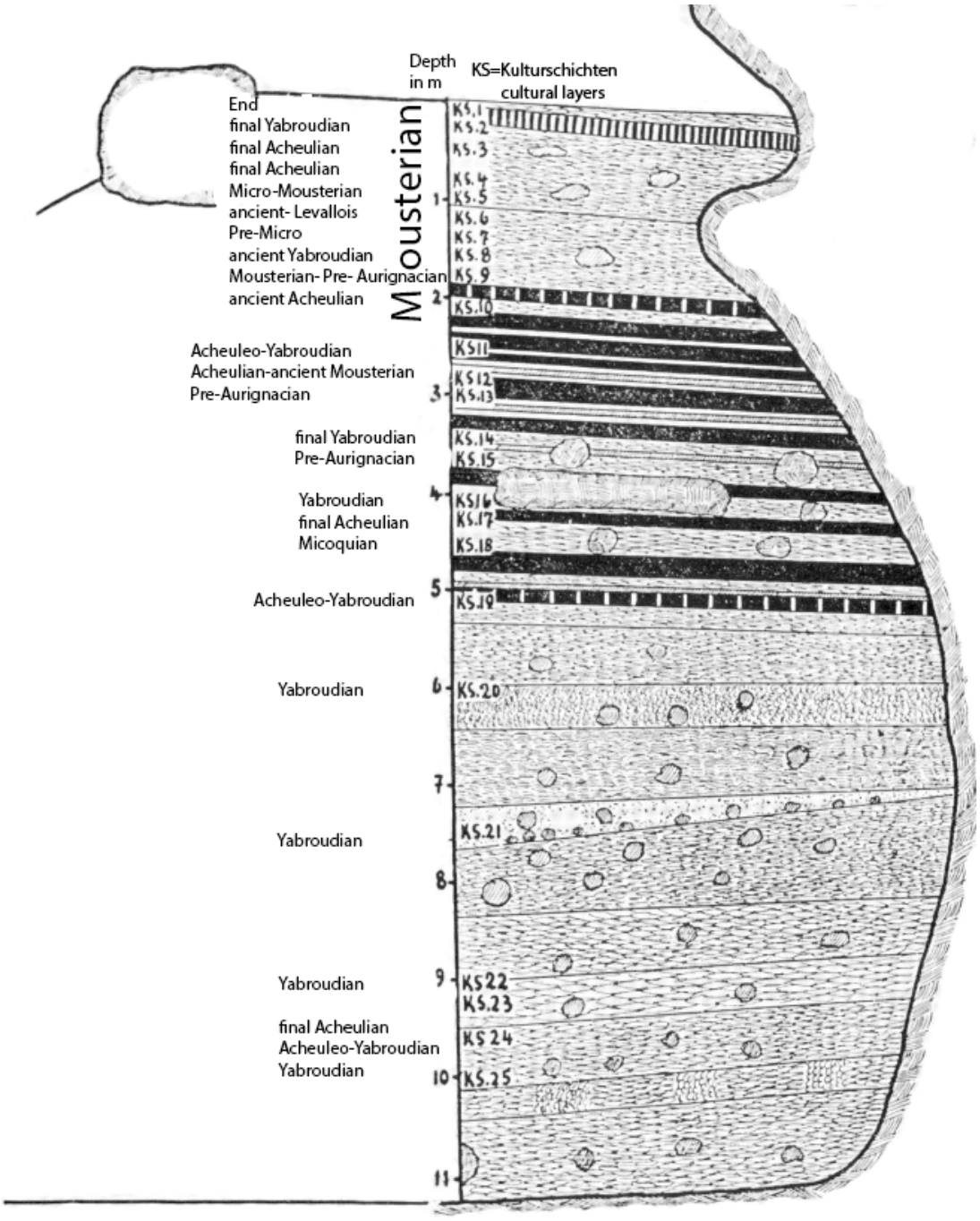


Fig. 3. The Mousterian profile of Yabroud Shelter I, KS 1-25 (after Rust 1950).

Layer	Cultural Name according to Rust 1950	Depth
1	Young Mousterian	
2	Young Yabroudian – Mousterian	0.20-0.30 m
3	Young Acheulian – Mousterian	0.40 m
4	Young Acheulian – Mousterian	0.60-0.80 m
5	Micro – Mousterian	0.80-1.00 m
6	Old Levallois/ Acheulian – Mousterian	1.00-1.20 m
7	Pre-Micro – Mousterian	1.30 m
8	Old Yabroudian – Mousterian	1.50-1.70 m
9	Mousterian Pre-Aurignacian	1.80 m
10	Old Acheulian - Mousterian	2.00-2.20 m
11	Acheulian – Yabroudian	2.50-2.70 m
12	Late Acheulian/ Pre-Aurignacian	3.00 m
13	Pre-Aurignacian	2.90-3.00 m
14	Late Yabroudian	3.40-3.70 m
15	Pre-Aurignacian	3.80-4.00 m
16	Yabroudian	4.20 m
17	Late Acheulian	4.20 m
18	Micocian	4.60-4.40 m
19	Acheulian – Yabroudian	5.20-5.00 m
20	Yabroudian	6.00 m
21	Yabroudian	7.00-7.75 m
22	Yabroudian	8.90-9.10 m
23	Late Middle Acheulian	9.20-9.40 m
24	Acheulian – Yabroudian	9.50-9.70 m
25	Yabroudian	9.90-10.10 m

Table. 1. The lithic cultures of Yabroud I according to Rust (1950).

B. Reinvestigation of YSI and discovery of YS IV, V, VI and Cave I, Solecki & Solecki 1960s and 1980s

Even though Rust's work represents the first systematic investigation of the site, ambiguity surrounds various aspects of the excavations, particular in respect to the stratigraphy of Shelter I (Solceki & Solecki 1986; 53). Consequently, YSI was reinvestigated in 1960s by a Columbia

University expedition under the direction of Solecki (Solceki & Solecki 1966; 122). The main reinvestigation was carried out in 1963 and 1965. Solceki and Solceki along with an interdisciplinary team identified three new rock Shelters IV, V, VI and Cave I (Fig. 4), but the main fieldwork focused on reinvestigating Shelter I and excavating Shelter IV. The fieldwork was otherwise confined to digging test pits at the other sites (Solecki & Solecki 1966; 123). The purpose of the expedition was to iron out problems in Rust's cultural stratigraphy of Yabroud I (Solceki & Solecki 1986; 53).

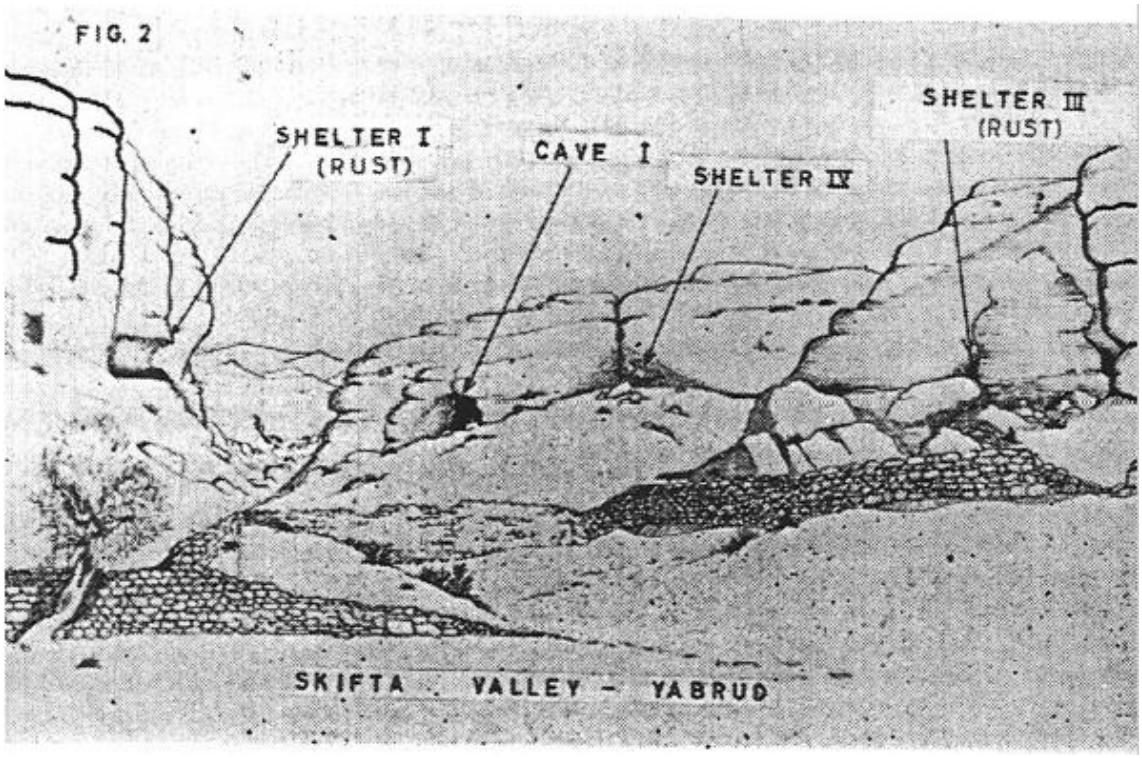


Fig. 4. Discovery of Shelter IV and Cave I (Solecki & Solecki 1966).

Solecki & Solecki dug a 24 x 3, 4 or 6 m extension eastward of '*Kammer 1*', vertical to Rust's trench, using a 2 x 2 m grid (Fig. 5-6) (Solecki & Solecki 1966). New investigations were carried out in 1987 and 1988 aimed at reassessing Rust's stratigraphy by analysing of the sections left by his excavation (Solecki & Solecki 1986, 1987-88).

Although Solecki's hope was to reveal new data on Shelter I, he did not add any substantial information. He did, however, confirm that Rust excavated the richest part of the shelter (Solecki & Solecki 1966, 1995). Moreover, Solecki & Solecki (2007) confirmed, on the basis of their survey, spread some 15 km around the shelter, and Rust's survey, that the YSI knappers used chert and flint that was available locally, at most six hours walking distance from the site, for the production of their stone tools.

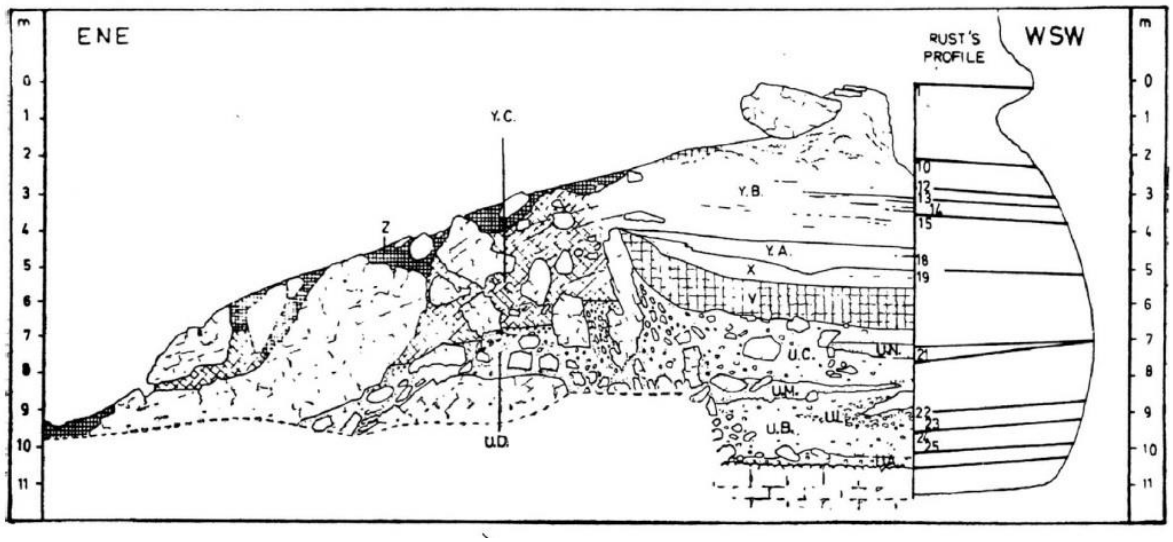


Fig 5. The profile of the Solecki & Solecki reinvestigation of Yabroud I (Solecki & Solecki 1966).

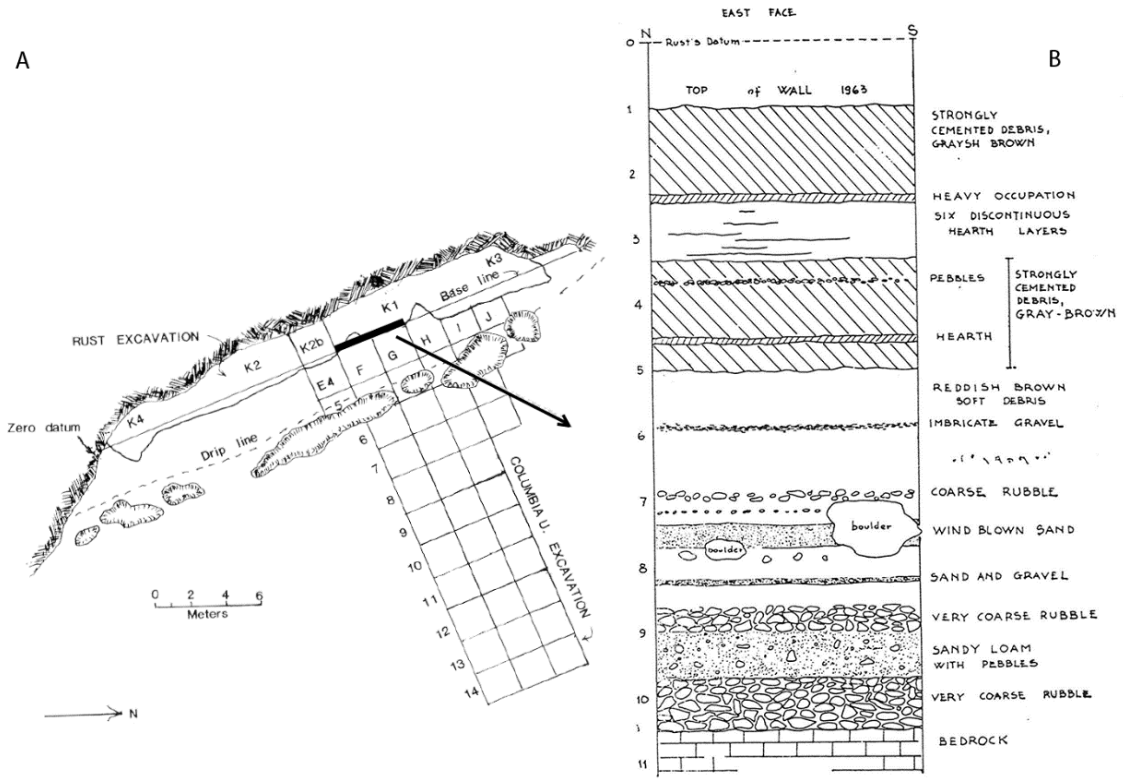


Fig. 6. A. Solecki and Solecki's reinvestigation of Yabroud Shelter I, an extension eastward of 'Kammer 1', vertical to the Rust trench (Solecki & Solecki 1966). B. East section of Kammer 1, with the analysis performed by Farrand (1965).

C. Tübingen Damascus Excavation and Survey Project (TDASP)

The last research carried out in the Yabroud area before the outbreak of the Syrian War was conducted by the German-Syrian mission 'Tübingen-Damascus Excavation and Survey Project (TDASP)' and run by Conard and Masri. The work revealed a new rock shelter in the Wadi Mashkuna (Conard et al. 2006; Conard et al. 2008a, 2008b).

A wide survey of the geology, geomorphology, and Palaeolithic archaeology of an area of roughly 500 km^2 was carried out between 1999 and 2010. This survey focused on the region north of Damascus stretching between the eastern side of the Anti-Lebanon Mountains with elevations ranging from 2350 to 800 metres a.s.l., moving from west to east, where both the elevation and the amount of precipitation drop sharply. As a result of the survey, they identified 354 Middle Palaeolithic sites, the most frequent type of site recorded (Conard et al. 2006; Conard et al. 2010; Dodonov et al. 2007).

D. Sedimentary sequence of Yabroud Shelter I

The reinvestigation of YSI by Solecki and Solecki in the 1960s clarified the sedimentary sequence of the shelter during its occupation. The sedimentological analyses were carried out by Heinzelin (1966), Farrand (1965, 1970, 1979), Brunnacker (1970), Goldberg (1971), and Solecki & Solecki (1966, 1987–88). The most important observations they agreed upon were that there was no stratigraphical break or major discontinuities in YSI, and the upper part of YSI (Yabroudian, Pre-Aurignacian, and Levalloiso-Mousterian layers) attested to the densest occupations. In addition, it was asserted that the upper part of deposit slanted downwards toward the rear of the shelter with the slight slant of the stratigraphy (Solecki & Solecki 1966).

In the light of Solecki and Solecki's excavations, Farrand, Heinzelin, and Solecki and Solecki themselves distinguished several points:

- Generally, **the upper part of the sequence** (the first 5 metres) shows homogeneous fine sediments and displays almost cemented light-coloured pebble (Heinzelin 1966; Farrand 1965, 1970, 1979; Solecki & Solecki 1987-88). However, the layers are not clear, and no precise stratigraphic layers can be distinguished.
- Solecki and Solecki (1966, 1987–88) indicated that the Mousterian layers at the depth 0 to 2 m seem to be filled by the same type of sediment and did not exhibit any distinct features. In addition, Solecki and Solecki noticed a number of widespread hearths laying in a horizontal position at a depth of 2 m (Solecki & Solecki 1966). Rust and Farrand mentioned that extensive hearths between 2 and 4.5 m, and dark, fire-burned horizons are also visible in the upper section concentrated towards the rear of the shelter (Rust 1950; Farrand 1970 In: Solecki & Solecki 1987–88). These refer to heavy occupational zones widespread over the shelter area within the drip line in Fig. 6 (Solecki & Solecki 1987–88).

- Heinzelin (1966) indicated that the upper 5 metres of YSI attest to a single sedimentary ensemble, mentioned in Fig. 5 as 'member'.
- According to Heinzelin (1966), **the lower part of YSI**, from layer 19 down, consists of sediments of a torrential nature that caused a heterogeneous sedimentary, labelled in Fig. 5 as "U member". He also suggested, based on geological observations, that all the deposits below 5 m were brought into the shelter through fluvial actions despite the absence of rolling Yabroudian artefacts (Solecki & Solecki 1987–88).
- No hearths nor living floors are present anywhere in the shelter below 5 m (Solecki & Solecki 1987–88) and it is poor in archaeological material in layers 19 to 21 (Heinzelin 1966).
- Farrand (1965, 1970, 1979) saw that the sedimentary sequence of YSI represents scree that is finer in the upper part and coarser in the lower part (Fig. 6; B). Goldberg's sedimentological analyses seem to confirm the absence of torrential deposits in this part of the sediments (Goldberg 1971).

E. The related studies of the Middle Palaeolithic lithic material in Yabroud Shelter I

- Rust (1950) argued that several variable and distinct cultures appeared along layers 1 to 25. Each culture was found in more than one assemblage and they were placed indiscriminately along the sequence. He has attributed layers 1 to 10 to the Mousterian with variable effects (Table. 1).
- Bordes (1955) described the last 10 layers typologically, indicating different industries and classifying each layer according to its tools. He attributed layer 10 to Abu Sif industry due to the large size of the retouched Levallois points.
- Hours (1992) attributed layers 7 to 1 to a Levalloiso-Mousterian industry with a tendency toward blade production (i.e Abu Sif type) classifying it Tabun D type.
- Solecki & Solecki (1995) distinguished two variants of Mousterian industries in YSI from 2.20 m up to the surface: YMI (KS 2–4, 6, 8, 10) and YMII (KS 5, 7, 9). It should be noted that their study relied on classifying the retouched tools more than identifying the flaking methods used. Based on a comparison, they indicated that the main difference between them is that YMI is characterized by a predominance of Levallois flaking method with clear dominance of Middle Palaeolithic tools Group-II. YMII, on the other hand, is characterized by the application of prismatic blade production and the

Levallois flaking method, and the predominance of Middle Palaeolithic tools Group-II as well as denticulates and notches.

- Frank (2004) highlighted the methods of Levallois point and triangular flake production in layers 4, 3 and 2, concluding they are very similar to those produced by the unidirectional convergent method in Kebara (Meignen & Bar-Yosef 1992).
- More recently, an important study was carried out by Pagli (2013), who analysed the 6 uppermost layers of YSI using her own classification system. She identified change dynamics based on the technological diversity of Mousterian industries at three different sites located in different geographic contexts, each associated with a specific environment, in order to explore the relationship between technological diversity and environment. Through a technological comparison of the Mousterian industry at the three different Middle Palaeolithic sites – Ksar Akil (Mediterranean), Umm el Tlel and YSI (steppe area) – she showed that the same system of lithic production – Levallois – was used at all of them, but different flaking methods were applied. In addition, she clarified that the technical variability throughout YSI sequences is as rich as that seen in Umm el Tlel. The technological analyses in Ksar Akil, on the other hand, exhibit large stable technical complexes, with human groups sharing the same technical knowledge. Consequently, she proposed a specific "reticular space"[1] model of mobility (Bonnemaison 2000) to describe movement in the steppe region (Umm el Tlel, layers in complex VI3, and Yabroud I, layers 4 and 3) that exhibits a succession of identical human groups and repeated occupation of a single site. In Ksar Akil, on the other hand, she proposed several occupations by a single human group or several groups that had the same knowledge base.
- Hauck (2013) conducted a detailed comparison of layers 2 and 10 at YSI and the Mousterian industry at the Hummal site. He deduced that the recurrent bidirectional flaking method was applied at YSI, producing points in layer 2 and blades in layer 10. In contrast, it was only incidentally applied in the Hummal assemblages, and only appeared in the lowest levels 5e-5f2. The layer composition is radically different from the Yabroud samples. He also showed that layer 2 reflects standardized Levallois point production aimed at elongated and short, broad-based Levallois points. In addition, he suggested that these aspects, together with the predominance of flakes and the high

[1] This type of mobility is characterized by a linear structure and the organization of places visited in a network. In this structure, the site is not the central place of a territory, but rather a point along a route (Pagli 2015).

faceting index in layer 2, warrant its tentative attribution to the group of point-dominated late Levantine Mousterian assemblages. Furthermore, he indicated that layers 2, 3 and 4 are similar in terms of reduction strategies and Levallois point morphology (Frank 2004; Solecki & Solecki 1995). This in turn resembles the uppermost Mousterian levels of Hummal (HM-A1 industry), despite a difference in the chosen flaking methods, and he attributed technological variability to the diversity of the raw material in Yabroud. In contrast, he attributed the homogeneity in flaking concepts to a single, high-quality flint type.

1.2.3. Environmental setting

A. Climate

The Great Rift Valley split the Levant into a western coastal lowland region (Mediterranean zone) and an eastern interior region. Both regions are characterized generally by seasonal climatic patterns with cold, short, and relatively rainy winters, and dry, hot, and long summers (Goring-Morris et al. 2009; 186). In the Middle Palaeolithic, the climate was generally cooler and more humid, though the period was punctuated by episodes of extreme aridity. However, the coastal lowlands of the north-central Levant were humid, whereas the southern and interior parts of the Levant were arid and semi-arid with more humid conditions during specific periods (Cheddadi & Rossignol-Strick 1995). Recently, Langgut et al. (2018) reconstructed the paleo-environmental conditions of the southeastern Mediterranean-Levant based on a marine pollen record spread over the last 90 ka. It was suggested that the rise in Mediterranean arboreal pollen values was a result of increased precipitation related to the intensification of the North Atlantic–Mediterranean climate system. The Eastern-Mediterranean–Levant climate was favourable (wetter and warmer), even in the currently semi-arid/steppe regions, during the late Middle Palaeolithic and Early Upper Palaeolithic, the early part of Marine Isotope Stage MIS 3 (ca. 56–44 ka BP).

Yabroud is located at the confluence of two water springs, which are common in the Mediterranean zone but widely dispersed throughout the arid areas (Goring-Morris et al. 2009). There are many green spots in Yabroud village (Ziffer 1981; 72). The winter in this region is cold, often with snow, with an average January nighttime minimum of 1 °C, and a daytime maximum of 8 °C. In addition, average annual rainfall is around 200 mm, while summers are dry, with an August average daytime maximum of 32 °C and nighttime minimum of 16 °C (Schrøder et al. 2012; 28). Dodonov et al. (2006) recently reconstructed the climate as arid,

with an alternation between steppe and desert vegetation that expanded from the late Middle Pleistocene through the Holocene. Furthermore, pollen and spores were tested from various depths at YSI. Accordingly, certain assemblages in the shelter were deposited during warm periods (Schrøder et al. 2012).

B. Paleoecology

Three major phytogeographic zones have been identified in the Levant based on the faunal and vegetal evidence: a Mediterranean woodland dominated by terebinth and oak, an Irano-Turanian steppe dominated by wormwood (Artemisia) and various grasses, and a Saharo-Arabian desert with thinly scattered vegetation (Goring-Morris et al. 2009; Zohary 1973).

Faunal evidence from YSI and the Yabroud region has also been published (Schrøder 2012; Conard et al. 2010; Lehmann 1970; Perkins 1968; Heinzelin 1966). Although there is scarce faunal evidence from YSI, remains of *Equidae* (horses) are the most frequent throughout the sequence. Such evidence was found especially in the uppermost layers (6, 5, 3, and 2), while remains of *Dama* (deer), *Capra* (goats) and Bos are present in some layers (Lehmann 1970). Solecki & Solecki (1966) indicated that it is difficult to imagine that the Yabroud area had been inhabited by numerous animals, such as rhinoceros and horses as well as goats, gazelles, deer, bears and turtles. These remains were found during the 1964/65 excavation and, according to Perkins (1968), point to steppe conditions, in Shelter IV. This helped in the reconstruction of an open, steppe-like environment during the Paleolithic occupations of YSI (Solecki 1970), consistent with the location of YSI on the margins of the Syrian desert (Perkins 1968).

Conard et al. (2010) confirmed that the late Middle Palaeolithic was characterized by relatively dry conditions with equids serving as a key prey species, with their prevalence throughout the Middle Palaeolithic Wadi Mashkuna sequence (layers II to XVI). He identified at least two equid species, the African wild ass (*Equus africanus*) and the onager (*Equus hemionis*), as well as remains of wild sheep (*Ovis orientalis*), gazelle (*Gazella cf. Subgutturosa*), and a small number of fox, turtle and hare bones.

1.2.4. Chronology

Rust (1950) hypothesized that the base of YSI may have been occupied at the end of the Riss glaciation, followed by the Riss-Würm interglaciation period. This was later supported by Farrand (1965). Based on typological analysis, Bordes (1961) assumed that deposits at YSI

were set down between Würm I and Würm III (Rust 1950; Bordes 1961; Heinzelin 1966; Farrand 1965; Solecki & Solecki 1966; 143).

We must recall that there is no chronological element for the Mousterian at YSI. It is, however, confined to the Yabroudian and Acheulean-Yabroudian layers.

Samples from YSI were dated by Porat & Schwarcz (1991; 206) using electron spin resonance (ESR). Burnt flint from the Yabroudian layer at a depth of 4 to 5 m gave ages between 100 and 150 ka. ESR dating was carried out on the enamel of three equine teeth found during the Solecki & Solecki campaigns (1966) in Rust's layers 18/19 (Micoquian and Acheuleo-Yabroudian layers). Farrand (1994; personal communication by N. Porat) published ages of 170 to 225 ka, but recent recalculations date them between 220 and 250 ka.

A burnt flint found in a fireplace area at a depth of 4.60 m during the 1988 Solecki & Solecki campaign (1966) was dated by Thermoluminescence (TL) at 185 ± 18 to 210 ± 20 ka with an average of 195 ±15 ka (Oxford Research Laboratory for Archaeology 1990). This was later corrected to 224 ± 17 ka using a different age model (Mercier & Valladas 1994; Porat et al. 2002).

The most recent dating was carried out by Schrøder et al. (2012) using optically-stimulated luminescence (OSL) on samples taken from the Solecki & Solecki excavation profile, between 2 and 8 m depth, giving ages ranging between 190 ± 20 at the depth 2.26 m and 175 ± 17 at the depth 7.91 m (Schrøder et al. 2012; 28).

1.2.5. Raw material

The raw material in the Yabroud area is spread in two sections. The first spread is of primary raw material situated in several locations around Yabroud in a radius of about 7 km, on the slopes of Anti-Lebanon to the northwest and on the south Palmyrides to the southeast of the shelter (El Kassem 2001). In addition, a few pieces in Yabroud II show fresh chalky cortex, pointing to the use of primary sources, which occur in the region around 7 km in Eocene marl or Upper Cretaceous limestone (Pastoors et al. 2008; 50).

The second section is of secondary raw material, which is located within a radius of 5 km of the site (Solecki & Solecki 2007; El Kassem 2001; Frank 2004; Pastoors et al. 2008; Dodonov et al. 2006, 2007). Secondary flint blocks have been found in the deposits of an ancient wadi. These may be the same supply sites reported by Solecki & Solecki (2007), who mention the deposits of old wadis in the Yabroud area delivering small and medium sized siliceous blocks (Solecki & Solecki 1966).

El Kassem (2001) identifies 23 subtypes of color in layer 25 of YSI, which are matte and gloss. The most represented types are grey-brown matte. He recognized three main types of raw materials. The vast majority are flint (more than 80%) and the others include jasper and chalcedony. Based on previous data, the acquisition of raw materials by occupants of YSI relied mainly on secondary resources.

According to a general overview of the material of the 10 uppermost layers at YSI, I found a high proportion of affinity among the raw material used, indicating the same raw material source. In addition, the artefacts bearing cortex are mostly rolled, confirming they were collected from a secondary position.

2. The Levantine Middle Palaeolithic: an overview

While the Middle Palaeolithic began around 250.000 years ago according to TL dates from Tabun and Hayonim Caves (Bar-Yosef 1998; Mercier & Valladas 2003; Mercier et al. 2007; Valladas et al. 1998), two hypotheses on the origin of Levallois technology in the Levant are widely discussed. Some archaeologists claim it developed out of local industry known as Acheulo-Yabrudian (e.g. Jelinek 1982a; Rolland 1995; Tuffreau 1995; DeBono & Goren-Inbar 2001; Adler et al. 2014), while others suggest that it was invented in Africa and spread to Eurasia by a common ancestor of both modern humans and Neanderthals (Foley & Lahr 1997). A recent study of the early Mousterian in the Misliya Cave, based on an association of *Homo sapiens* maxilla with early Middle Palaeolithic (EMP) industry, supports the hypothesis that Levallois technology was introduced to the Near East via an early dispersal of *Homo sapiens* from Africa. There was therefore a break in Tecnhology between the Lower and the Middle Palaeolithic. This can be seen at the level of core management involved in producing convergent Levallois products and in preparing laminar cores for points as well as in a major conceptual change from the preceding Acheulian and Acheulo-Yabrudian (Zaiden & Weinstein-Evron, 2020).

2.1.History of research

Archaeological research on the Middle Palaeolithic (MP) in the Levant can be described in three main periods, each attesting to paradigm shifts either in terms of the equipment and methods used or the importance of the results.

2.1.1. The first phase 1930s–1960s

This phase saw the discovery and excavation of the most important MP sites in the Levant. MP artefacts were discovered along the coast of Lebanon at the beginning of the 19th century

(Zumoffen 1900), followed by the excavation of Ksar Akil by Alfred Ely Day in 1925, Father Doherty in 1937/38 and Father Ewing in 1947/48 (Ewing 1947). Furthermore, the excavations at Zuttiyeh Cave by Turville-Petre from 1925 to 1926 are among the earliest in the Levant to discover hominin cranial fragments associated with later Acheulean assemblages (Turville-Petre 1927).

Many MP sites discovered during the 1920s and 1930s constituted references for later research such as the work by Rust (Yabroud Shelter I), Garrod (Tabun, Skhul, el-Wad), Neuville (Qafzeh, the Judean Desert sites), Turville-Petre (in the Amud drainage, Kebara), and Stekelis (Rust 1950; Garrod & Bate 1937; Neuville 1951; Stekelis 1956; Turville-Petre 1932). Garrod's work in the Mount Carmel sites (el-Wad, Skhul and Tabun) are considered the basis for later Palaeolithic research in the region, where rich series of human fossils were found (McCowm & Keith 1939), and the stratigraphic sequence layers of the Tabun cave became a reference or a tripartite model for structuring the variability of the Mousterian in the Levant.

Garrod observed a significant variation in the composition of the lithic industries that she characterized in two sets. The first is the Lower Levallois-Mousterian including the lithic industries of layers D and C. She substantiated that although the difference between the two industries is real, it is not fundamental (Garrod & Bate 1937; 76). While the industries of layer D are characterized by leaf-shaped points with a narrow base and triangular flakes, the industries of layer C are characterized by the predominance of large broad Levallois flakes that were produced by the centripetal Levallois method. The second is the Upper Levallois-Mousterian that is linked to the lithic industries of layer B, in which points, often retouched, and triangular flakes are dominant (Garrod & Bate 1937).

Rust's excavations at YSI in Syria between 1931 and 1933 revealed a deeply stratified sequence of assemblages spanning the Lower Palaeolithic and MP periods (Rust 1950). Neuville's excavations in the Galilee and Judean Deserts also recovered MP assemblages from the sites of Qafzeh, Abu Sif, Umm Qatafa, et-Tabban, Larikba, Ghrar, Sahba, and Erq el-Ahmar (Neuville 1951).

Rust (1950) named new cultures for the lithic industries of YSI, but he did not provide detailed explanations about the foundations he relied on nor the difference between these industries and others in the region (Solecki & Solecki 1986). Although Rust's work is characterized as the first systematic excavation in Syria, mystery surrounded many aspects of the stratigraphy, prompting Solecki & Solecki to reinvestigate the site in the 1960s (Solecki &

Solecki 1986). Jerf al-Ajlah Cave in Syria, found in 1955 by C. Coon, is also one of the earliest and most important MP sites discovered in the Levant during this phase (Schroeder 1966, 1969; Richter et al. 2001).

In the late 1950s and early 1960s, Garrod together with Henri-Martin and Kirkbride excavated Bezez, Abri Zumoffen and Ras El-Kelb, though the work was only published in a few articles (Garrod 1962; Garrod & Henri-Martin 1961; Garrod & Kirkbride 1961; Copeland 1978). Other sites at Adlun and Naame were re-excavated (Fleisch 1970, 1971).

2.1.2. The second phase 1960s–1980s

This stage began when Van Liere surveyed several different areas, such as Nahr el Kabir in the north of Syria, identifying different Palaeolithic periods including the MP (Van Liere 1960). Accordingly, el-Kowm was the most important area for researchers during this period. The first exploration was undertaken by Buccellati in 1966 and Suzuki & Kobory 1967/68, resulting in the discovery of the first Palaeolithic sites (Buccellati & Buccellati 1967; Akazawa 1974, 1979). Widespread surveys in the eastern Mediterranean (Lebanon, Syria and Jordan) in 1967 had a great impact on choosing the Mousterian Douara Cave in the el-Kowm area in Central Syria as a site for excavation (Akazawa 1979). YSI was also reinvestigated by Solecki & Solecki in the 1960s (Solecki 1969). However, they did not add any substantial data. In 1978, Jacques and Marie-Claire Cauvin began systematic investigations in the el-Kowm area, observing numerous Palaeolithic sites (Cauvin et al. 1979).

Rapid and partial surveys were carried out between 1974 and 1980 by the French geomorphologist Sanlaville, while Hours' work in the Nahr el Kebir region led to the formation of a team to research the issue of the environment and human life in the Levant region. Joint team R.C.p 438 (Besançon, Copeland and Muhesen) surveyed three areas, Nahr el Kebir, Orontes river and Balikh River, where different Palaeolithic cultures were identified, including the MP, such as the Khellale site on the north of Nahr el Kebir, surveyed later by Wendt (Wendt 1971; Meignen et al. 1994).

Investigations in the 1970s led to the discovery of more than 300 prehistoric sites, some of which had special significance. The importance of the el-Kowm area had been highlighted after the sondages performed by Dorneman and Van Loon in 1965 and the survey conducted by a Japanese mission led by Suzuki and Dorneman and Russian geologists (Muhesen 1992).

In the late 1960s, Nahr Ibrahim cave in Lebanon was excavated, also yielding MP evidence (Solecki & Solecki 1979, 1975). The "Tokyo University Scientific Expedition to

Western Asia" team also undertook surveys in Lebanon and Syria in this period, publishing information on some newly discovered sites and excavating the MP site of Keoue cave in 1970 (Suzuki & Kobori 1970).

Between 1981 and 1988 investigations of Palaeolithic sites focused on stratigraphy and Quaternary geology, especially at the Hummal site and Nadaouiyeh Aïn Askar. Meanwhile, Besançon & Sanlaville carried out a geomorphological survey, allowing a good understanding of the natural setting of Palaeolithic sites in the Al Kowm area (Geyer & Sanlaville 1991).

In the 1960s, Bordes' typological approach for the differentiation of industries was broadly used by researchers to distinguish variability in lithic material among assemblages in the Levant. In the 1980s and 1990s, the technological approach, relying on *chaîne opératoire* (Leroi-Gourhan 1964; Geneste 1985), was widely used and aimed to reconstruct the whole reduction sequence process from the first stage of the acquisition of raw material to the final abandonment of the desired/used end products.

Excavation was renewed in some major sites and new sites were discovered, at Tabun (Jelinek et al. 1975), Amud (Suzuki & Takai 1970), Kebara (Schick & Stekelis 1977), Shovakh (Binford & Binford 1966), Qafzeh (Vandermeersch 1981), and Zuttiyeh (Gisis & Bar-Yosef 1974), Far'ah II (Gilead 1980) Tor Faraj and Tor Sabiha (Henry 1983) Quneitra (Goren-Inbar 1988a). The big technical revolution occurred during the 1980s when researchers began to use the radiometric dating, thermoluminescence (TL), electron-spin resonance (ESR), and U-series in order to date MP assemblages (Bar-Yosef 1989).

2.1.3. The third phase from the 1990s

Research up until this point had made the distribution of prehistoric sites in Syria clearer. In the 1990s, excavations and surveys were expanded, increased and developed using new techniques that had a huge impact on discoveries and further study. Skeletons of two Neanderthal children were exposed in the Dederiyah Cave in northern Syria (Akazawa et al. 1993, 1955). As a result of previous work carried out by a number of researchers in the el Kowm area, explorative activities flourished in the region, such as at the Nadaouiyeh Aïn Askar site (Le Tensorer et al. 2003), the Hummal site in 1997 (Hauck 2011, 2013; Wojtczak 2014) and the Umm el-Tlel site, which provided more than 100 layers, most of which are rich in MP animal industries and fauna (Boëda et al. 2001; Griggo 2004). The combined stratigraphies of Hummal, Nadaouiyeh and Umm El Tlel cover the whole known Palaeolithic record (Jagher & Le Tensorer 2011). According to the importance of discoveries made by Kobori and Suzuki in

the 1960s, several sites have been surveyed in the Jabal Abdelaziz area (Diab 2005), identifying several Mousterian sites.

A wide survey of geology, geomorphology, and Palaeolithic archaeology in an area of roughly 500 km2 was carried out between 1999 and 2010, resulting in about 250 MP sites and the excavation of the Mousterian Mashkuna Cave (Conard et al. 2006, 2008 a and b, 2010).

In 2010, a national mission initiated the excavation at Aïn Jawal in the el Kowm area. The preliminary results indicated a Mousterian site (Al Qadi et al. 2015).

Due to the poverty of prehistoric research in the southern region of Syria, the University of Damascus, in cooperation with the Directorate General of Antiquities and Museum, surveyed the southwestern region of the Daraa Governorate in 2010, identifying three main Mousterian sites: Wadi Sharar, Wadi Khawaby, and Khirbt Shayah (Diab 2011, Al Kassem 2013, 2015).

2.2.Hominin fossils

Levantine hominin fossils are still quite significant for indicating the first human habitat out of Africa (Table. 2) despite the recent discovery of human fossil in Al Wusta-1 in the Arabian Peninsula dated to ca. 95-86 ka (Groucutt et al. 2018). The Levant, as the bridge to Eurasia, thus plays an important role in understanding the path of modern humans out of Africa. Furthermore, regional fossils demonstrate the coexistence of several human types (Neanderthals and *Homo sapiens*). Although such coexistence has also been attested to in Europe (Higham et al. 2006; Hublin et al. 1995; Mercier et al. 1991; Schmitz et al. 2002; Hovers 2009), there are no known instances of modern humans producing Mousterian industries in Europe to date (Hublin et al. 1996; Vandermeersch 1984).

The first human fossil, a skull, was discovered in Zuttiyeh Cave by Turville-Petre in 1925 (1927). In the 1930s, Garrod unearthed human fossils in Tabun attributed to Neanderthal (I-VI), ten human remains in burial sites (Skhul I-X) that were ascribed to *Homo sapiens* and associated with lithic artefacts resembling those in Tabun C Levallois assemblage (Garrod & Bate, 1937; McCown & Keith, 1939; Trinkaus 1984), while human burial sites were discovered by Neuville in Qafzeh cave in 1933–35 and by Vandermeersch in 1965–70 (Vandermeersch 1981).

Neanderthal remains were subsequently unearthed in Dederiyeh (Akazawa et al. 1993, 1995, 2004), Umm el Tlel (Couture 1998), Shanidar (Solecki 1971; Trinkaus 1983), Kebara (Bar-Yosef & Vandermeersch 1991), and Amud (Rak et al. 1994; Hovers et al. 1995).

The issue of Neanderthal and modern human coexistence in the Levant, based on the human fossils found in the Qafzeh, Skhul, and Tabun caves, has been debated for a long time. Several hypotheses have been formulated on the affinities of these remains to known species (McCown & Keith 1939; Howell 1958; Vandermeersch 1981).

Some researchers claim the remains at Dederiyah, Tabun C1, and Kebara do not present any traits that can clearly separate them between Neanderthals and modern humans, suggesting they are attributed to a single, highly polymorphic human population from the late Levantine Pleistocene (Arensburg & Belfer-Cohen 1998; Kramer et al. 2001; Arensburg 2002 cited in Richter et al. 2012). Others attributed the remains at Tabun C1, Kebara, and Amud to early Neanderthals and those at Skhul and Qafzeh to early modern humans (Trinkaus 1986).

Richter et al. (2012) readdressed the possibility of Neanderthal expansion into the Levant during MIS 6 and 5 based on the position of human fossils in Tabun level C (C1: female skeleton; C2: mandible; C3-C5: postcranial elements). They assumed that if the female skeleton at C1 was intrusive and should be ascribed to the overlying layer B (Bar-Yosef & Callander 1999), which was said to date from the late MIS 6/MIS 5 (Grün & Stringer 2000), this proves the oldest coexistence for Neanderthal and modern human in the Levant. In addition, if the taxonomic affiliation of the C2 mandible is attributed to Neanderthal (Stefan & Trinkaus 1998), the presence of Neanderthals would be even more prolonged. In contrast, if the C2 mandible is ascribed to modern human, the arrival of modern humans in the Levant would be much earlier than the Skhul and Qafzeh modern humans (Richter et al. 2012).

Recently, the discovery of *Homo sapiens* fossil from Manot Cave western Galilee, which dated to around 55 ka BP by the U/Th method (Barzilai et al. 2016; Alex et al. 2017), opened new inquiries about the probability of co-existence of Neanderthal and *Homo sapiens* might have been at least parts of the late Middle Palaeolithic, Transitional and IUP industries until Neanderthals disappeared (Richter et al. 2020).

The earliest evidence of *Homo sapiens* is updated constantly according to the continuous research. A *Homo sapiens* maxilla was recently found in the Upper Terrace of the Misliya cave and dated by TL at 212 ± 27 to 166 ± 23 ka (Zaiden & Weinstein-Evron 2020), thus becoming the earliest evidence of *Homo sapiens* in the Levant. By way of comparison, the earliest *Homo sapiens* fossil in Africa, from the Jebel Irhoud site in Morocco, is dated to 300.000 ka BP (Hublin et al. 2017).

Site	Hominin fossils	References
Dederiyah	Neanderthal	Akazawa et al. 1995, 2004
Umm el Tlel	Neanderthal	Couture 1998
Shanidar	Neanderthal	Solecki 1971, Trinkaus 1983
Amud B	Neanderthal	Suzuki & Takai 1970; Hovers et al. 1995
Zuttiyeh	In doubt, attributed between Acheulo-Yabrudian and Middle Palaeolithic.	Keith 1927; Zeitun 200; Freidline et al. 2012
Kebara F	Neanderthal	Bar-Yosef &Vandermeersch 1991
Ksar Akil - XXV	Neanderthal	Ewing 1947
Shukbah	Neanderthal	Keith 1931; Blinkhorn et al. 2021
Tabun B	Neanderthal (female skeleton)	McCown & Keith 1939
Tabun B/C	Neanderthal	McCown & Keith 1939; Bar-Yosef & Callendar 1999
Tabun C	Neanderthal	McCown & Keith 1939; Stefan & Trinkaus 1998
Skhul B	Homo Sapiens	McCowm & Keith 1939
Qafzeh XV-XXII, L	Homo Sapiens	Vandermeersch 1981
Misliya	Homo Sapiens	Weinstein-Evron et al. 2003 Zaidner & Weinstein-Evron 2020
Manot	Homo Sapiens	Barzilai et al. 2016 Alex et al. 2017
Al Wusta-1	Homo Sapiens	Groucutt et al. 2018
Shovakh	indeterminate	Trinkaus 1987
Ras el Kelb	indeterminate	Bourke 1998
Hayonim E	indeterminate	Arensbourg et al. 1990
Geulah A	indeterminate	Arensbourg 2002
El Wad	indeterminate	McCown & Keith 1939

Table. 2. Hominin fossils discovered at Levantine MP sites.

2.3.Variability of lithic industries in the Levantine Middle Palaeolithic

The variations in lithic industries of the Levantine Mousterian have been debated over a long period of time, leading to different types of classification, both typological and technological (Garrod 1934; Garrod & Bate 1937; Bordes 1950, 1961; Neuville 1951; Garrod 1962; Crew 1975; Skinner 1965; Perrot 1968; Jelinek 1975, 1982a, 1982b; Ronen 1979).

Garrod (1934) made a typological distinction between the Lower and Upper Levallois-Mousterian industries based on the Tabun, Skhul, and el-Wad sequences.

Garrod and Neuville elucidated the variability in the lithic industries found in the Mount Carmel sites and the Judean Desert. Firstly, Garrod showed the predominance of triangular pieces, points and scrapers in layers B and D at Tabun and that layer C is characterized by the production of broad-oval flakes. She also observed a decrease in the proportion of points to scrapers over time in the Tabun sequence. Neuville pointed out the predominance of triangular pieces in all MP sites in the Judean Desert (Abu Sif, Tabban, Umm Naqous and Sahba). Secondly, Garrod and Neuville indicated the predominance of leaf points and narrow-based points in layer D of Tabun and at the Abu sif site. However, Garrod later stated that "*an industry*

found in isolation cannot be classified as Upper or Lower Levalloiso-Mousterian on the basis of typology alone" (Garrod 1962; Copeland 1983a).

Skinner and Perrot (1965, 1968) proposed a classification based on Bordes' typology, relying on the ratio of convergent and non-convergent pieces. Skinner (1965) differentiated the variability at local and regional levels. He presented four industrial types of the Levantine Mousterian (group C) within the same geographical area (Abu Sif, Tabun, Yabroud, and Erq el-Ahmar). In addition, he differentiated the interregional variability based on the differences between Zagros and Levantine Mousterian. Perrot (1968) proposed a different type of classification that also relied on the Bordes method, in which variability was the result of the process of branch evolution (*évolution buisonnante*).

Crew (1975) carried out a technological comparison between coastal and inland Mousterian sites in the southern Levant. In addition, he made interregional comparisons between them and Mousterian sites in the Nile Valley and North Africa in order to follow the trajectory of this culture. However, he did not offer an interpretation of the differences he noted. Furthermore, he was not convinced of the criteria of Levantine Mousterian classification. He therefore identified variability based on the executed method and not according to the quality and quantity of products.

Copeland (1975) proposed a tripartite model for the industrial variability of Tabun layers D, C, and B to describe a chronological sequence of changes in Mousterian industry in the Levant (Copeland 1975; Jelinek 1975; 1982a; 1982b). Although Copeland later stated that it could not measure the variability of Levantine industries based on a single sequence, many researchers upheld this model (e.g. Bar-Yosef & Meignen 2001; Kaufman 2001; Shea 2003, 2008; Nishiaki et al. 2012; Hauck, 2013).

- Tabun layer D is characterized by a predominance of elongated blanks with parallel edges produced unidirectionally.
- Tabun layer C is identified by an absence of Levallois points and abundance of broad-oval flakes obtained by means of centripetal preparation or detached along an orthogonal axis.
- Tabun layer B is characterized by triangular blanks and short broad-based Levallois points.

Although Jelinek (1982b) accepted the Tabun as a model, he noted that not all Levantine assemblages correspond with it. He re-excavated the Tabun Cave between 1967 and

1972, and redefined the overlying stratigraphic sequence established by Garrod (Jelinek 1975, 1977, 1981, 1982a). He renamed Garrod's Layers D (Unit IX), C (Unit I, beds 18–26), and B (Unit I, beds 1–17). In fact, he added very few distinct differences from what Copeland mentioned, apart from the redefinition and renaming of the layers. However, he only recognized a bipartite division of the Tabun sequence (Tabun D type with elongated blanks and a recent phase C–B type) due to a decrease in the width/thickness ratio of the blanks over time, especially from layer D to layer B. This was also accepted by Ronen (Jelinek 1982b; Ronen 1979).

- **Tripartite model of Tabun sequence**

Although there are many current arguments against a tripartite model for the Levantine Mousterian variability, the work of Garrod, Copeland and Jelinek (Garrod 1934; Garrod & Bate 1937; Copeland 1975; Jelinek 1982a, 1982b) are fundamental cornerstone for the definition of technological variability.

Tabun D type/phase 1:

This industry was identified in many different Levantine sites such as Tabun Unit IX (Garrod 1934; Copeland 1975; Jelinek 1982a), Hayonim F/Lower E (Meignen 1998, 2000, 2007; Bar-Yosef et al. 2005), Yabroud KS 8–10 (Solecki & Solecki 1995) Douara IV, Jerf Ajla E–F (Schroeder 1966), Rosh Ein Mor (Rink et al. 2003), Abu Sif Levels B–C, Misliya cave (Zaiden and Weinstein-Evron, 2020), Hummal 6–7 (Hauck 2013; Wojtczak 2014), and is dated roughly 150.000 to 260.000 years old (MIS 7-5) by TL chronology (Mercier et al. 1995; Valladas et al. 1998). According to Copeland (1975), it is characterized by a predominance of elongated blanks and triangular parallel-sided blanks that were removed by unidirectional-parallel and bidirectional-parallel Levallois preparation methods with an abundance of retouched Levallois blanks. Other researchers compressed Copeland's Phases into a bipartite model. Tabun D type (phase 1) became 'Early Levantine Mousterian', while Tabun C and B types (phases 2 and 3) were combined into a single 'Later Levantine Mousterian' (Jelinek 1982a; Marks 1992; Ronen 1979). An increasing proportions of blades, elongated points Abu Sif (Ronen 1979), and Upper Paleolithic tools were noted. In contrast, a low frequency of Mousterian tools was observed (Marks 1992; Ronen 1979).

Tabun C type/phase 2:

Sites attributed to this type include Tabun Cave Unit I Beds 18–26 (Garrod 1934; Copeland 1975; Jelinek 1982a), Qafzeh (Hovers 2009), Skhul B (Copeland 1998), and Naamé (Fleisch

1970). They fall between 92 ka and 170 ka BP, with the majority during MIS 5. Lithic industry is characterized by the production of large oval/quadrangular flakes, obtained by centripetal Levallois method and/or bi-directional exploitation. In addition, triangular flakes and Levallois points were observed in small numbers such as in layer XV in Qafzeh (Bar-Yosef & Meignen 2001, Hovers 1997, 2009).

Tabun B type

This industry is characterized by a predominance of the production of triangular blanks and short, broad-based Levallois points, obtained by recurrent unidirectional convergent or centripetal Levallois methods (Meignen 1998; Meignen & Bar-Yosef 1988, 1991, 1992). It is dated to the end of MIS 4 and beginning of MIS 3. The most important Levantine sites attributed to this type are Kebara (Meignen & Bar-Yosef 1992; Bar-Yosef 1992; Meignen 1995), Amud (Hovers et al. 1995; Hovers 1998), Tor Faraj and Tor Sabiha (Henry 1995a and b, 1998) Hummal HM-A (Hauck 2013), and layers in complex VI3 of Umm el Tlel (Boëda et al. 1999; Al Sakhel 2004).

3. Methodology of lithic analysis

3.1.The theoretical notions of the present study

Several systematic methods have been established in order to study MP lithic variability (Bordes 1950, 1961, 1980; Jelinek 1977, 1981; Geneste 1985; Boëda 1994, 1995; Boëda et al. 1990; Meignen 1995). The current study aims to carry out a techno-typological analysis of the late MP of the material from layers 6 and 4 (henceforth assemblages 6 and 4 or Yabroud I-6 and 4) of YSI in order to understand and reconstruct the core reduction strategies executed. Consequently, it will rely on three approaches: a typological approach according to Bordes (1950, 1961), a technological approach based on *chaîne opératoire* according to Geneste (1985), and transformation analyses according to Weißmüller (1995) and Richter (1997).

3.1.1. Typological approach

According to Bordes (1950, 1961, 1980), a typological approach is the science that makes it possible to recognise, define and classify the variety of tools found in the deposits of a site that has had a long period of human occupation and can help in comparisons with assemblages in the region that have been studied previously, based on a list of 63 types that only contains modified artefacts and totally neglects other debitage.

3.1.2. Technological approach

The technological approach is based on the *chaîne opératoire* concept, equivalent to an operational sequence, introduced by Leroi-Gouhran (1964) to identify production methods. This concept has been widely used by researchers since (e.g. Geneste 1985, 1989; Inizan et al. 1999).

The *chaîne opératoire* concept draws on reading and understanding the technological organization of the lithic materials in order to reconstruct the whole reduction sequence process from the first stage of the acquisition of raw material to the final abandonment of the desired/used end products. This can provide us with the environmental and dynamic organization of human behaviour that forms the residue of material culture (e.g. Geneste 1985; Boëda et al. 1990; Inizan et al. 1995; Kuhn 1995; Bar-Yosef & Van Peer 2009). The *chaîne opératoire* or operational sequence "*encompasses all the successive processes, from the procurement of raw material until it is discarded, passing through all the stages of manufacture and use of the different components*" (Inizan et al. 1999; 8).

3.1.3. Transformation analysis

The concept of transformation analysis was developed theoretically and methodologically during work on the lithic material of the lower MP layers of the Sesselfelsgrotte in the Altmühl valley in Germany (Weißmüller 1995; Richter 1997). Stone artefacts are sorted back to raw material varieties by analysing macroscopic features, with the aim of reconstructing the import state and on-site transformation of artefacts brought to the site, on-site activities, and future off-site activities. However, it is worth noting how difficult it is to sort artefacts in the complete absence of refitting. Difficulties lie in the great similarity of raw material features. In addition, heavy patination sometimes obstructs sorting.

Stone artefacts of both assemblages 6 and 4 were sorted macroscopically and by low power microscope with up to 40 times magnification, which allowed a differentiation of the principal features of the raw material: lustre, opacity, inclusion, type of cortex, external alterations etc. From a microscopical point of view, on the other hand, we can examine the texture, fossil content, micro-inclusions, and other small micro-features that can help us understand depositional and diagenetic processes. We use the microscope in particular to examine lithic material that includes different debitage from a double strategy of core reduction.

All raw material units consisting of two or more artefacts from the same raw material are treated as equivalent to refittings. These units are called “workpieces”, while raw material units that consist of pieces without any counterparts with identical raw material attributes within the entire assemblage are called single pieces. It is worth noting that Weißmüller’s list was slightly modified in order to better suit the lithic artefacts of assemblages 6 and 4 of YSI. This editing is related to the Levallois cores that were reduced on local thick flakes and is characterised by raw material units involving the re-exploitation of flakes (transformation section Crf), raw material units including debitage from two different Levallois methods (transformation section Ct), raw material units including reduction of local bifaces as cores (transformation section Cdb), and a split volume for executing two different Levallois methods (transformation section Cs), raw material units classified as exhausted discarded core (transformation section Ci), raw material units imported as dynamic objects (transformation section Do), only by-products of nodule without end-products (Np), and raw material as core fragment (Cg) (Table. 3).

Transformation section	explanation
Tw (Tool without transformation)	a single modified blank (e.g. a formal tool) without debitage, brought onto the site and discarded after use.
Bw (blank without transformation)	a single blank without debitage, brought onto the site and discarded without formal modification.
Cw (preform without transformation)	a single core, brought onto the site, at least after decortication, probably after preparation and some reduction, but discarded without further reduction on the site.
Ei (isolated functional end of tool)	isolated tip detached or broken off from a formal tool in the course of its use. The formal tool entered the site as a modified piece and was exported after the tip was lost.
TT (Tool with corresponding tool Tip)	two or more fragments of a formal tool that was imported as a dynamic object and broke into static pieces during its use; a part of the formal tool might have been exported afterwards.
Mi (isolated Modification)	two or more isolated pieces (static objects) resulting from the modification of a blank that was brought onto the site as a dynamic object, modified and probably used, and exported afterwards.
TM (Modification with corresponding surface shaped Tool)	a formal tool with one or more detached fakes from modification and/or rejuvenation.
Cc (Correction of a surface shaped tool)	correction of a core. Two or more chunks or core trimming elements, without or very little cortex, that were detached as static objects during the re-reparation of a core. As an object with the potential of mobility the core might be discarded but might also be missing.
Cb (production of a surface shaped blank from a preform)	blank production from a core. Two or more point, flakes or blades, without or with very little cortex. The pieces result from the debitage of a core that was (at least in part) decorticated off-site. If the core is present, one more flake is sufficient for classification. If several blanks are present, they might also include core-trimming elements. Because flakes and blades without core trimming elements and cores are supposed to be dynamic objects, several pieces including the core might have left the site.
Nb (production of a surface shaped blank from a raw Nodule)	blank production from a raw nodule. Two or more cortical flakes or blades, flakes with cortex, in combination with artefacts with none to little cortex. The artefacts result from decortication, preparation, and flaking of a nodule that was brought directly from the source onto the site. If the core is present, one more cortical flake is sufficient for this classification. If several blanks are present, they might also include core-trimming elements. Because flakes and blades without core trimming elements and cortex, as well as cores, are supposed to be dynamic objects, several pieces might have left the site.
Np (by-products of nodule without end-products)	Two or more by-products that are covered by high amount of cortex in combination with core or not. These cortical elements were detached during decortication of the nodule.
Cm (Production of a surface shaped blank from a preform with subsequent modification)	blank production from a core with modification of blanks. The artefacts needed for the classification are the same as for a Cb (blank production from a core), with additional proof for the modification of blanks into formal tools. Because tools are dynamic objects, it might happen that only a tool tip proves the modification of a blank. Because this class represents the entire *chaîne opératoire*, many dynamic objects occur, and the workpieces might be to a large extent incomplete between initial and final phases. Therefore, a great diversity of possible combinations of artefacts leads to the same classification of the transformation section.
Nm (production of a surface shaped blank from a raw Nodule with subsequent modification)	blank production from a raw nodule with modification of blanks. This transformation section is similar to Cm, with additional cortical fakes, and a high frequency of cortex.
Crf (Re-exploitation of flake)	a thick discarded flake (cortical or not) was re-reduced. It has to show clear evidence of being a flake. Sometimes there is debitage of core that contains a single cortical flake re-exploited.
Ct (Two methods of the same core)	debitage of core contains different end-products that result from the application of two different methods to the same core (e.g. Levallois blade produced from the first stage of core reduction, whereas Levallois flake resulting from the second stage of core reduction).
Cdb (exploitation of biface as core)	any part of biface (e.g. the tip) in combination with debitage that includes end-product and/or core trimming elements without cortical blanks.
Cs (Split volume for exploitation)	a block was split into two or more thick flakes, and each flake was used as a core for the production of the same or different blanks.
Ci (Exhausted core)	a single exhausted core. Its size does not allow for further exploitation.
Do (Dynamic objects)	Two or more blanks or tools without core trimming elements and core.

Table. 3. List of transformation sections for raw material units according to Weißmüller 1995 (Uthmeier 2004, 2005), with modifications according to the raw material of assemblages 6 and 4 of YSI.

3.2.The Levallois production concept

Our focus is on the Levallois concept (Fig. 7), as this is the most common reduction concept for Levantine MP, elaborated on by Boëda (1990, 1994, 1995) and Boëda et al. (1990).

3.2.1. Definition of the Levallois concept

The definition of the Levallois concept remained a matter of debate for several decades among many researchers (e.g. Copeland 1983b; Perpère 1986; Boëda 1994, 1995; Bordes 1980; Van Peer 1992; Chazan 1997; Dibble & Bar-Yosef 1995; Dibble 1989; Eren & Bradley 2009; Richter 2011; Hovers 2009; Meignen 1995; Otte 1995) from the first mention of the term by the geologist Reboux in 1861. However, Genest (1985) did the archaeologist a favour when he replicated the flake characteristics according to the stage in the core reduction they belonged using the scar patterns. Boëda created a definition of Levallois in 1986 based on experimental work (Boëda 1986, 1988; Boëda et al. 1990), which basically represents an extension of Bordes' original definition (for more detail on the history of Levallois, see Wojtczak's (2014) elaboration on the term).

Boëda (1988, 1994, 1995) and Boëda et al. (1990) developed the Levallois concept further by identifying six technical criteria that differentiated Levallois methods from other flaking methods (Fig.7):

1- The core is formed by two intersecting asymmetrical convex surfaces.

2- Two surfaces are hierarchically shaped: one is designed as a flaking surface and serves for production; the second surface is designed as a surface for striking surfaces. Their roles cannot be interchanged during the same production sequence of predetermined blanks.

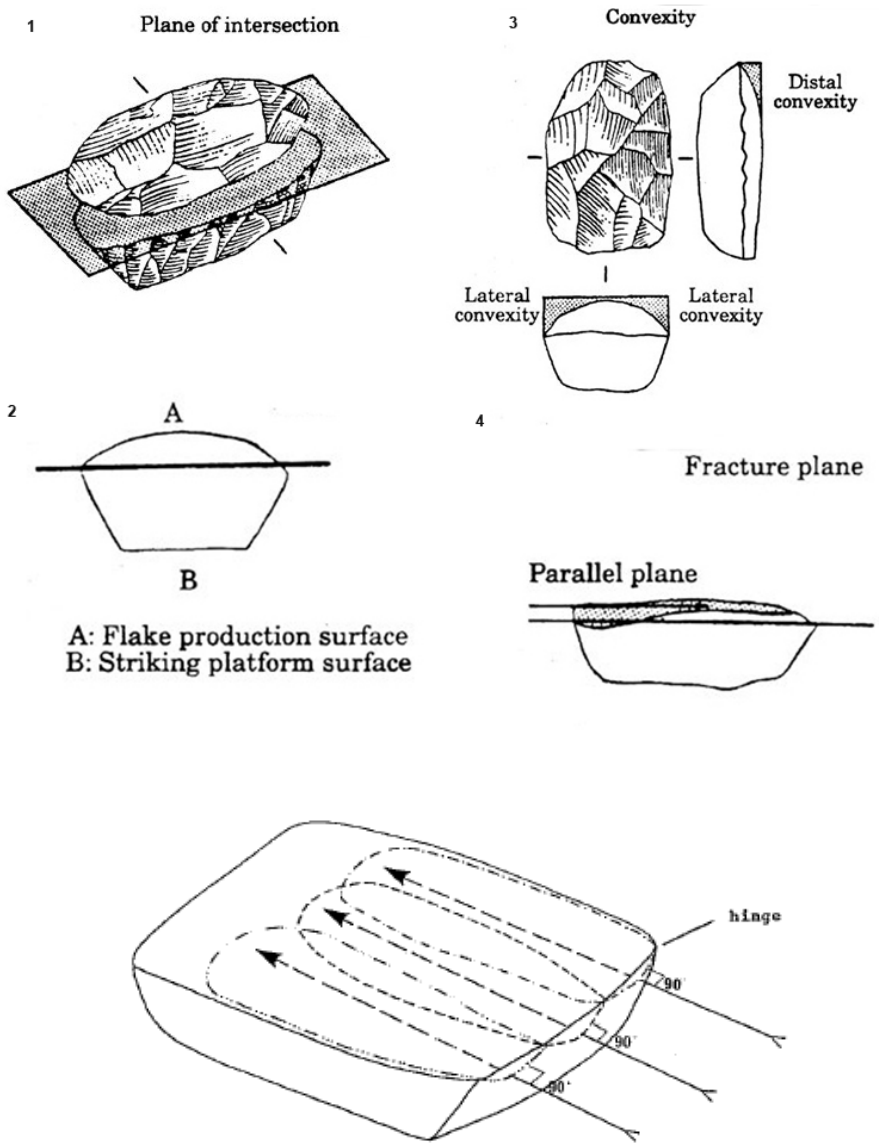
3- The flaking surface is preserved in such a way that the products obtained are going to be predetermined shape.

4- The fracture plane is parallel or sub-parallel to the plane of intersection.

5- The striking platform is carefully prepared to allow a controlled removal of blanks parallel to the intersection plane.

6- Only direct percussion with a hard hammer is used.

Boëda (1988, 1994, 1995) Boëda et al. (1990) defined the Levallois method as being concerned with the productivity of Levallois surfaces aimed at producing one predetermined object by preferential method (lineal method) or many predetermined objects by recurrent method with edges that could be transformed to a tool. Van Peer (1992) agreed with the concept of predetermined production and added that it is a method that can be used to point out a certain system of the organization of scar patterns on the Levallois surface.



5+6 Mode and movment of the percussion

Fig 7. Technical criteria of the Levallois concept (Boëda 1995).

Dibble (1989), on the other hand, rejected the definition of Levallois as a specific method that produces flakes constantly with the concept of predetermination, through an analysis of the metrical attributes of three groups of Levallois products. He considered

Levallois as a concrete method that leads to the production of many flakes from a single core and indicated that the predetermination notion should be visible through a greater standardization of Levallois flakes in terms of shape/size.

Boëda (1988) affirmed that Levallois is a unified and invariable concept, while Otte (1995) indicated that the technological strategy in a given site may include varied reduction sequence. In this case, the Levallois is a particular aspect of a general technological system used in a specific assemblage.

The Levallois concept is linked to the production of predetermined objectives. Based on this experimental work, the predetermined objectives could have been associated with their function and different skills of knappers. In the case that the predetermined detached object could not be produced, the goal might have been reached through retouch. The Levallois flake is thus a predetermined blank.

3.2.2. Variability of Levallois methods

Based on the quantitatively and qualitatively objectives Boëda identified two main Levallois methods (1990; 55, 1994, 1995) on which this study fundamentally relies.

A. The preferential Levallois method:

According to Boëda et al. (1990; 60), this is characterized by a Levallois core with preferential flake. The example chosen refers to the sites of Bagarre and Ault (Boëda 1986).

Quantitatively, the preferential method aims to produce a single predetermined flake from a single prepared flaking surface (Fig. 8; A). In case another flake is to be produced, the flaking surface has to be re-arranged with all of the technical criteria of preparation (Fig. 8; B). Qualitatively, a quadrangular triangular flake is desired in Bagarre, whereas a large oval flake is preferred in Ault.

- **Core decortication:** is carried out either by large cortical flakes and by shaping flakes, or by cortical flakes of medium size then semi-cortical or non-cortical flakes. The characteristic products are flakes, cortical flakes and knives with cortical backs.
- **Setting up the main striking platform:** is done by means of cortical flakes and striking platform preparation flakes.
- **Installation of the flaking surface convexity:** the detached removals can be varied from one core to another. Clear variability among these removals was observed at Bagarre, ranging from unidirectional parallel to bidirectional to perpendicular. At the

Ault site they are mostly centripetal. The characteristic products are pseudo-Levallois points, flakes and core edge flakes that give a favourable inclination and create lateral convexities.

- **Production phase:** the products are variable, corresponding to preferential flakes or preferential points and the discarded core shows a collar corresponding to the preparation removals around the large preferential flake scar pattern.

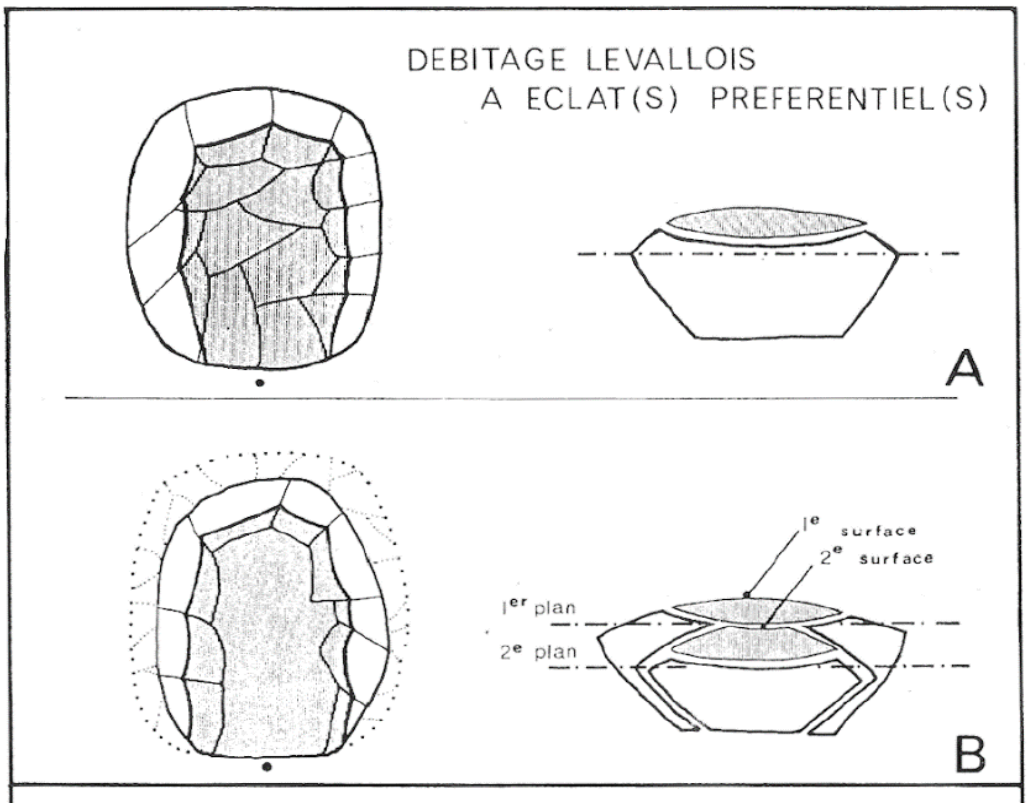


Fig. 8. Debitage Levallois methods. A. Preferential (Lineal) Levallois method, first removal. B. Preferential (Lineal) Levallois method; second removal (adjustable Boëda et al. 1990; 54).

B. The Recurrent Levallois methods:

In contrast to the former method, the recurrent method aims to produce several predetermined blanks from a single prepared flaking surface (Fig. 9; C and D). Each removal is necessary for the subsequent removal. Recurring removals will therefore be predetermined, and will predetermine given that each is a consequence and function of successive and previous removals.

On the basis of the quantitative and qualitative objectives that were removed by the recurrent Levallois method, four recurrent Levallois modes were recognized.

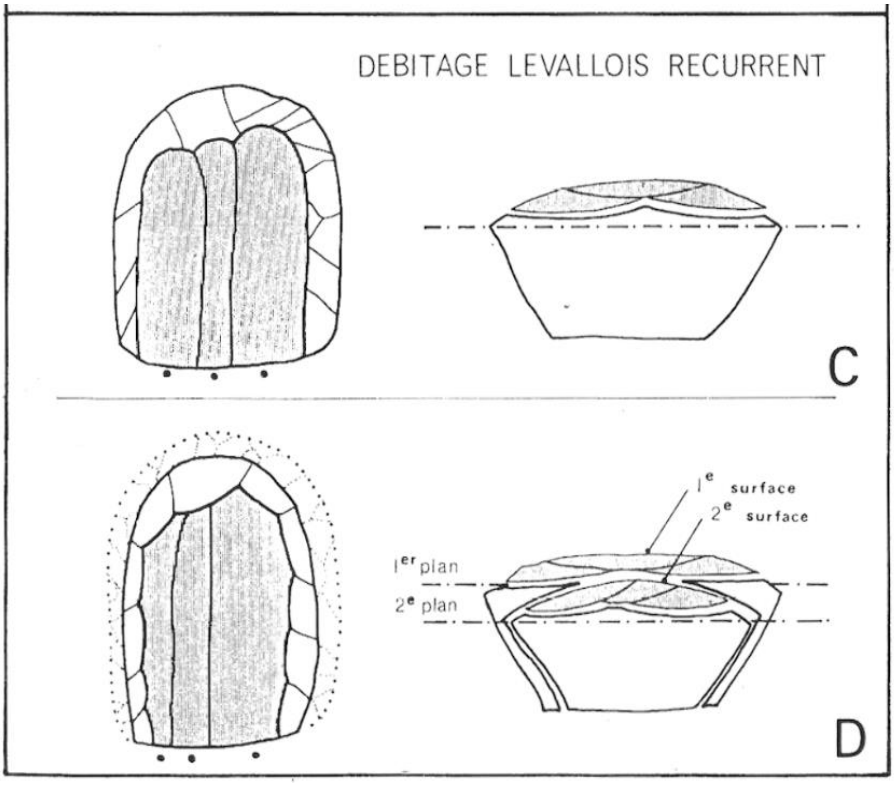


Fig. 9. Debitage Levallois methods. C. recurrent unipolar Levallois method, first series of removal. D. recurrent unipolar Levallois method, second series of removals after redevelopment of the surface of debitage (adjustable Boëda et al. 1990; 54).

B.1. Recurrent uni- and bidirectional parallel Levallois method

According to Boëda et al. (1990), this is characterized by a Levallois core with several removals and a unidirectional parallel debitage. The description of this method was based on the operatory scheme of Biache-Saint-Vaast, layer IIa (Boëda 1994) and Vaufrey Cave, layers VII and VIII (Geneste 1985).

Quantitatively, it aims to obtain several products and qualitatively they are often elongated flakes with different morphotechnical characteristics (Fig. 10-11).

- **Decortication phase:** is executed through unidirectional and centripetal removals. Accordingly, the products are cortical, semi-cortical and cortical-backed removals.
- **Setting up the main striking platform**: is carried out by an arrangement of several contiguous striking platforms unidirectionally or two striking surfaces that are opposite each other, one primary and one secondary.
- **Installation of the flaking surface convexity**: appears to be carried out by centripetal removals with semi-abrupt inclination or by unidirectional removals of pronounced obliquity. The characteristic products are often atypical, and pseudo-Levallois removals.

- **Production phase:** successive series of detachments of two, three, four removals according to a parallel arrangement, which follow one another along the guide ridge of the removal negatives precedents, whose width does not exceed half the width of the core. The detachment of the first removal will create a rib which will be used as a guide for the next, contiguous flake. It will thus replace the convexity. Accordingly, the characteristic products consist of three types of Levallois removals:
- **removal I** which displays technical characteristics depending on core initialisation, whether unidirectional, bidirectional or centripetal.
- **removal II** which shows the predetermined removal negatives on the upper surface and a previously obtained invasive scar pattern of the predetermined type I removal
- **removal III** which exhibits several invasive removal scar patterns corresponding to previously obtained scar patterns of the predetermined type I, II and III removals.

Finally, the phase of re-installation in which the flaking surface is carried out by core edge flake or cortical-backed flakes, whether uni- or bidirectional, or by centripetal removals.

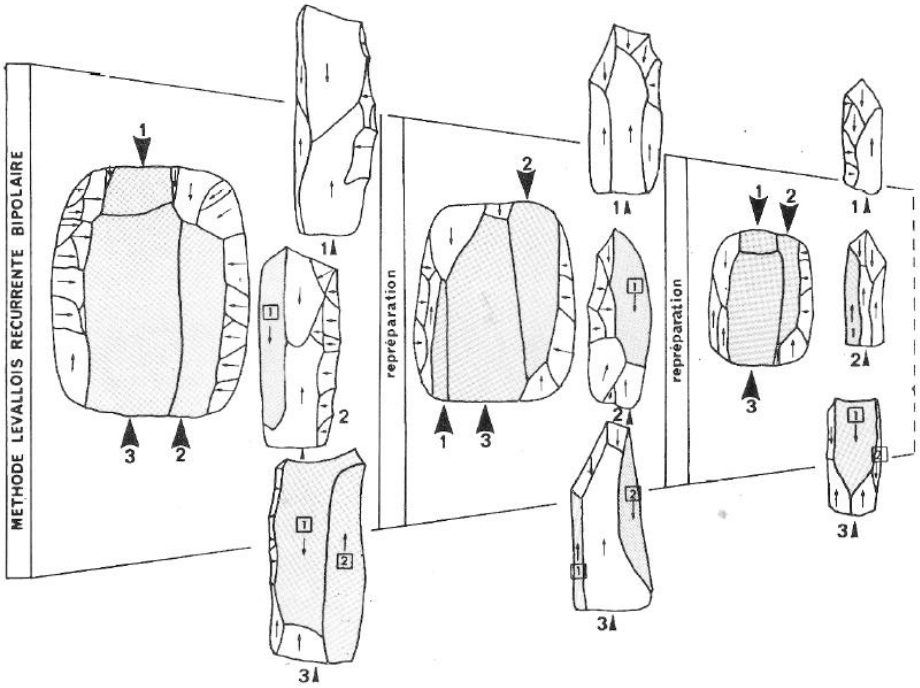


Fig. 10. Debitage of recurrent bidirectional Levallois method (Boëda et al 1990; 54)

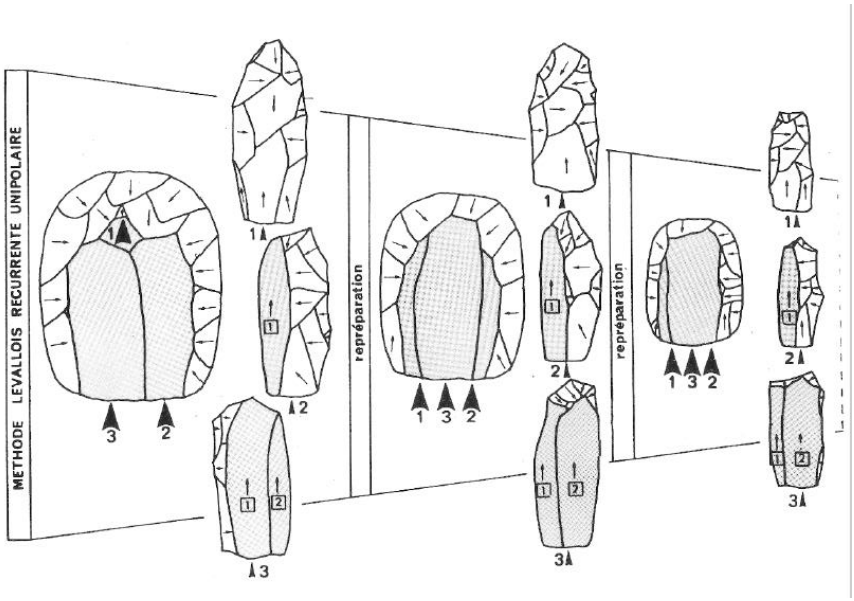


Fig. 11. Debitage of recurrent unidirectional Levallois method (Boëda et al. 1990; 54).

B.2. Recurrent centripetal Levallois method

The operatory scheme of centripetal Levallois method is described based on using the series from the open-air of Fonseigner, and Dronne valley (Boëda et al. 1990; Genest 1985) (Fig. 12).

- **Decortication phase:** is carried out by unidirectional, bidirectional or centripetal removals. The characteristic products are fully cortical, more frequent semi-cortical removals and also quite rare natural backed removal.
- **Setting up the striking platform**: a peripheral striking platform is installed gradually, around the flaking surface.
- **Installation of the flaking surface convexity:** the lateral and distal convexities are installed by detecting unidirectional and bidirectional rather oblique removals and by short centripetal removals.
- **Production phase:** detachment of a series of Levallois removals that simultaneously operate and maintain the flaking surface. They are divided into several characteristic categories which follow one another and are arranged on the flaking surfaces.
    - symmetrical products which are often the first of the series and more or less preferential splinters obtained on an occasional basis, which appear cyclically.
    - clearly lateralized removals which are atypical, centripetal but also core edge flakes. Core edge flakes and cortical-backed removals maintain lateral convexity throughout the process.

- pseudo-Levallois splinters which help to maintain the lateral and distal convexities between the various series.
- Levallois removals with converging edges can be obtained in series after lateralized removals. In addition, preferential removal can be obtained from the last round of removals.

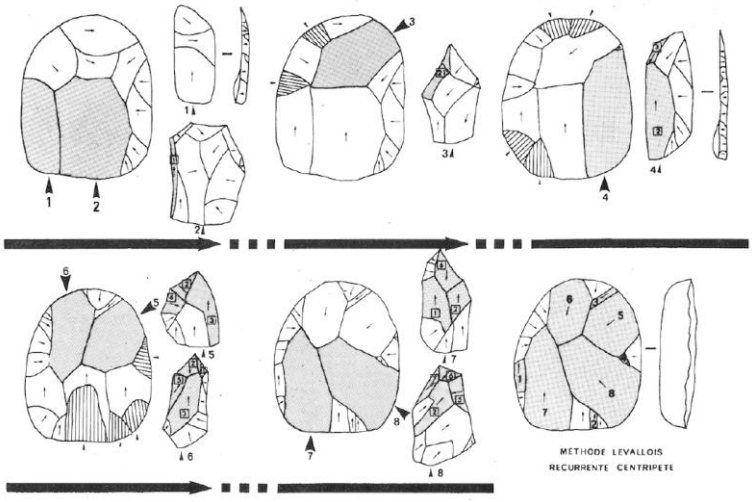


Fig. 12. Debitage of recurrent centripetal Levallois method (Boëda et al. 1990; 63).

B.3. Recurrent unidirectional convergent Levallois method

The description of the operatory scheme is based on the Kebara cave levels IX and X (Meignen & Bar-Yosef 1988; Boëda et al. 1990; Meignen 1995). Quantitatively, several products are removed, qualitatively, they are short Levallois points, often showing a wide base, as well as subtriangular and triangular flakes and blades (Fig. 13).

- **Decortication phase:** the core is decorticated by detaching large, elongated removals, sometimes blades unidirectionally, parallel or convergent. The products are completely cortical removals, naturally backed knives, semi-cortical removals distal or lateral. They are often overhanging and slightly twisted allowing the distal convexity to be developed at this stage.
- **Setting up the striking platform**: a wide strike platform, limited at the proximal part of the core.
- **Installation of the flaking surface convexity:** the first stages of preparation seem to arrange and maintain these convexities by convergent unipolar removals of pronounced obliquity. The distal convexities, on the other hand, can be arranged by detaching small, short bidirectional and perpendicular removals. The characteristic products are often

still blades, overhanging and slightly twisted which are generally unidirectional. Sometimes overhanging removals which will have cortical backs due to the lack of preparation of striking planes on the lateral parts of the core or more rarely non-cortical.

- **Production phase:** a series of subtriangular, often elongated or Levallois points are removed, and the production process sweeps the flaking surface from right to left and continues in a back and forth movement constantly and convergently. The order of the most frequently attested scar patterns is 1.2.3 or 3.2.1. As a consequence, the products obtained are lateralized with asymmetrical cross sections. Moreover, the Levallois points have a particular morphology: their profile is not only curved, which is frequent in Levallois production, but also has so-called "*Concorde*-shaped distal termination".

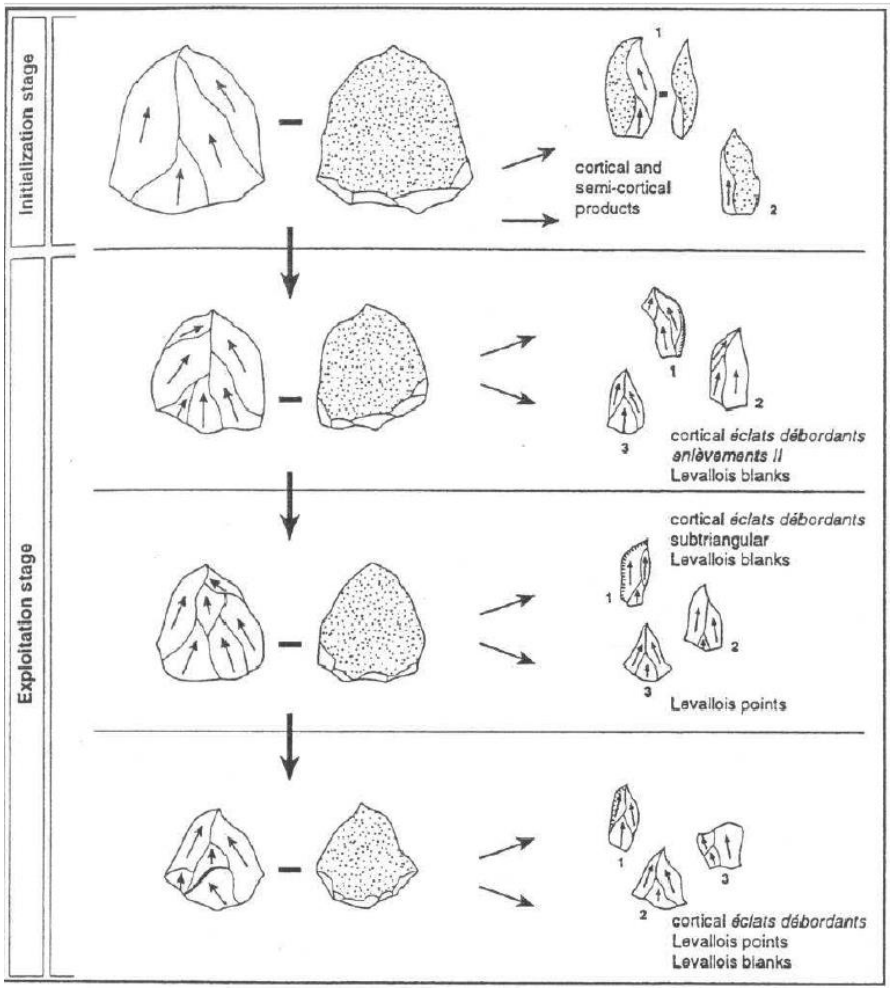


Fig. 13. *Chaîne opératoire* of the unidirectional convergent recurrent Levallois debitage of Kebara, layers IX–X (Meignen 1995; 365).

In order to emerging the most target blanks to cores used, I use Bordes' terms (1980) for Levallois cores. This classifies cores according to the morphology of the last removal on the core flaking surface. Two additional core types are also defined: core on flake (Schroeder 1969; Solecki & Solecki 1979; Goren-Inbar 1988b, 1990; Hovers 2007, 2009; Hauck 2013).

I use lists of attributes following Hauck (2013) that fit into the technological features of the industries of YSI's assemblages 6 and 4. In turn, these qualitative and quantitative attributes are used to describe the concept of Levallois core reduction (Table. 4-7).

N.	attribute	features
1	Texture	fine-grained; coarse-grained
2	Shining	mat; glossy
3	inclusion	fresh; layering; spot; layered zones; cracks; patinated
4	translucency	opaque; translucent; semi-translucent
5	dotted	yes; no; unclear/patinated
6	color	according to Munsell 1975
7	raw material unit	number
8	number of artefacts	number
9	category of raw material unit	according to Weißmüller list
10	raw material	flint; chert; other
11	state of preservation	fresh; patinated; edge damage; rolled/abraded; cortex; natural surface; weathe red; chalk; broken; indet.
12	thermic alternation	absent; change of colour; cracks; pot lids; Oxidation
13	object category	flake; blade; point
14	morphology	triangular; quadrangular; rounded / oval; polygonal; conic / tetrahedral; polyhedral; irregular
15	location and amount of cortex	examination of sectors according to Fig Nr. 14
16	butt preparation	faceted; faceted cortex; dihedral; plain; cortex; cortex & faceting; splintered; indet.
17	butt morphology	rhomboid; trapezoidal; rectangular; triangular; rounded; micro-butt; aviform; partitioned; *chapeau de gendarme*
18	butt-length	in mm
19	butt-thickness	in mm
20	flaking angle	in degrees
21	maximum Length	in mm
22	maximum width	in mm
23	maximum thickness	in mm
24	number and direction of dorsal negatives	Count of negatives in each sector according to Fig. 14
25	scar pattern	Unidirectional parallel; unidirectional convergent; perpendicular; bidirectional; semicentripetal; centripetal; indet.
26	longitudinal axis	symmetric; asymmetric; indet.
27	longitudinal section	straight; curved; *Concorde*-shaped; twisted to the left; twisted to the right
28	cross section	triangular (equal-sided); scalene; trapezoidal; lenticular; domed
29	technological definition	Levallois point; Levallois fake; Levallois blade; débordante Levallois flake/blade; Kombewa flake cortical flake; first flake; natural backed knife; core edge flake; flaking surface preparation flake; striking platform preparation flake; indet.
30	Levallois stage	first order; second order; third order; unclear
31	modification	yes / no
32	location of modification	modificationdorsal and ventral face: examination of sectors according to Fig. 14
33	depth of retouch	in mm
34	type of modification	edge retouch (substantial); partial retouch; abrupt retouch (backed); planar retouch; denticulation; notch; burin spall removal; thinning
35	intensity of retouch	single; twofold; threefold
36	recycled tool	yes / no
37	typological group	partially retouched piece; simple side scraper; double side scraper; Mousterian point; Upper Paleolithic tool type; notched piece; denticulate; multiple tool; miscellaneous
38	typological definition	according to Borde's typological list

Table. 4. Techno-typological attributes recorded for complete blanks. Attributes 1-10 recorded for cores, fragments and core on flakes.

N.	attribute	features
1	object category	core; core fragment; unworked pebble; tested pebble; chopper; chopping tool; indet .
2	morphology	discus; tablet; polyhedral; tetrahedral/conical; irregular; indet.
3	maximum length	in mm
4	maximum width	in mm
5	maximum thickness	in mm
6	n° or surfaces	1, 2, 3…etc.
7	function of surface	determination for each surface flaking surface; striking platform; both; unclear
8	n° and direction of negatives	determination for each surface
9	strategy of exploitation	determination for each surface: unidirectional parallel; unidirectional convergent; perpendicular; bidirectional; semi-centripetal; centripetal; alternating; indet.
10	n° of striking platforms	1, 2, 3,…
11	preparation of striking platform	determination for each striking platform: faceted; plain; cortex; clivage; indet.
12	circumferential striking platform	yes/no
13	exterior platform angle	measurement of angle between flaking surface and striking platform in degrees
14	flaking accident	none; hinge fracture; step fracture; inclusion; splintering; plunging removal
15	reduction stage	early; exhausted core; unclear
16	technological identification	non-Levallois flake core; non-Levallois blade core; Levallois core; core on flake; unworked; cobble; tested cobble; chopping tool; chopper; indet.
17	modification	yes/ no
18	type of modification	retouch; other
19	typological definition	According to Bordes´ typological list

Table. 5. Techno-typological attributes recorded for cores.

N.	attribute	features
1	exploitation	dorsal; ventral; both
2	location of breaking surface	none; proximal; distal; mesial left; mesial right; multiple; indet.
3	surface quality	homogeneous; rippled; stepped; inclusion; clivage
4	location of secondary	negatives determination of each surface according to Fig Nr. 14
5	n° of secondary blank removals	determination of each surface according to Fig. Nr. 14
6	n° of preparation flake removals	determination of each surface according to Fig. Nr. 14
8	exterior platform angle	measured for each exploited section according to Fig. Nr. 14
9	maximum length of secondary blank removal	in mm
10	maximum width of secondary blank removals	in mm
11	preparation of striking platform	faceted; flake scar; breaking surface; cortex
12	n° of flaking accidents	determination of each surface according to Fig. Nr. 14
13	type of flaking accident	determination of each surface according to Fig. Nr. 14: hinge fracture; step fracture; other
14	maximum length of flake blank	in mm
15	maximum width of flake blank	in mm
16	maximum thickness	measured distal, mesial and proximal
17	type of flake blank	flake; broken flake; tool; broken tool
18	technological identification	dorsal core; ventral core; multiple core

Table. 6. Techno-typological attributes recorded for core on flakes.

N.	attribute	features
1	part of fragment	determination according to Fig Nr
2	Refitting	yes/ no
3	fragmentation	modern; old
4	Siret fracture	yes/ no
5	Butt-length	in mm
6	Butt-thickness	in mm
7	Butt- preparation	faceted; faceted cortex; dihedral; plain; cortex; cortex & faceting; splintered; indet.
8	Butt morphology	rhomboid; trapezoidal; rectangular; triangular; rounded; micro-butt; aviform; partitioned
9	Modification	yes/ no
10	Moment of modification	prior to fragmentation; after fragmentation
11	type of modification	edge retouch (substantial); partial retouch; abrupt retouch (backed); planar retouch; denticulation; notch; burin spall removal; thinning

Table. 7. Techno-typological attributes recorded for fragments.

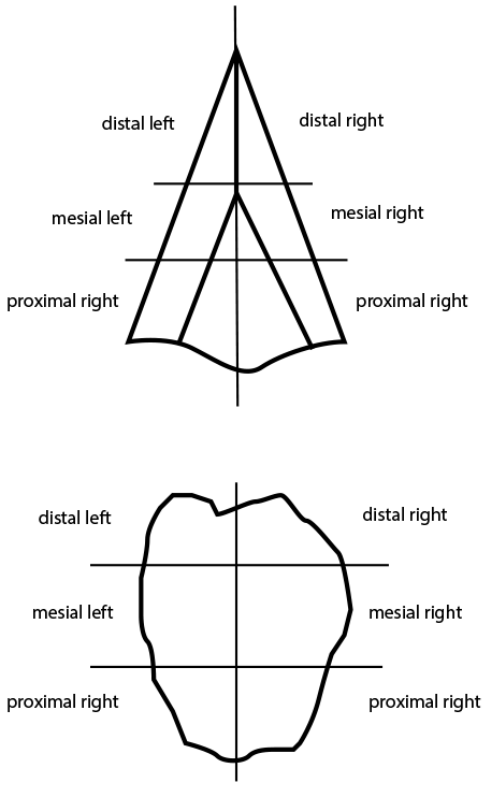


Fig. 14. The division of sectors for the count of dorsal negatives and the determination of dorsal scar patterns.

3.3. Method to investigate the technological reason for the standardization of morphological, technical characteristics of Levallois points

Levallois points can in fact be produced by both Levallois concept and non-Levallois concept. This suggests that there is a technological condition that must be applied to obtain a typical Levallois point regardless of the concept. Here I present the method I use to analyse the Levallois points from assemblage 4 in order to specify their precise technological backgrounds.

3.3.1. Cross-section angles of Levallois points

In order to determine the technological factors that causes *Concorde*-shaped distal termination and regular-shaped outline, the cross-section angles of 100 types of Levallois points of YSI assemblage 4 were measured with a goniometer in order to associate the obliqueness of the two preceding convergent removals with these two technological features (Fig. 15).

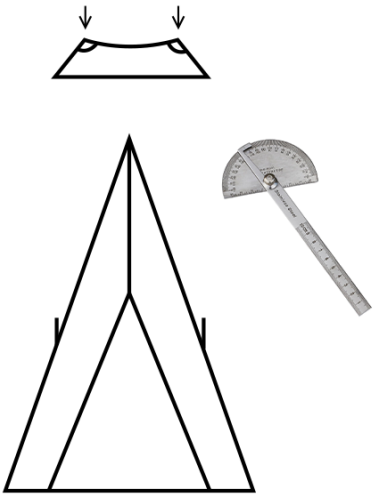


Fig. 15. Using a goniometer to measure the cross-section angle.

3.3.2. Lateral angles of Levallois points

In order to recognize the technological factors that result in short, broad-based Levallois points, I measure the angle between the lateral edges and the base of 100 elongated and broad-based Levallois points using a protractor. I followed a triangle that connects the three points of the elongated and broad-based Levallois points (Fig. 16).

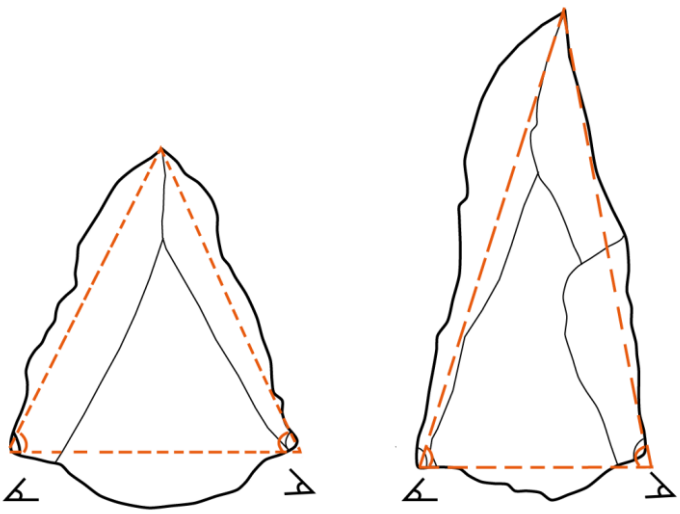


Fig. 16. Drawing triangle according to the three points in order to measure the lateral angles.

3.3.3. Experimental work

We carried out experimental work in order to verify that the cross-section angles and the angles of the lateral edges could be responsible for the five typical features of classic Levallois points. The experimental work was applied to a high quality of raw material imported from Fécamp in the Normandy region in north-western France (Fig. 17), which is very similar in quality to the raw material from Yabroud. I applied the five criteria of the Levallois concept to produce classic Levallois points by the preferential method, as well as non-classic Levallois points produced by the unidirectional convergent Levallois method.

I then measured the angles of both cross-section and the lateral edges of the Levallois points obtained. The result can be compared with their technological features and the result of analysis the Levallois points of assemblages 4 and 6 at Yabroud I.



Fig. 17. The raw material used in the experimental work.

4. Inventory of assemblages 6 and 4 of Yabroud Shelter I

4.1.Archaeological assemblage 6

This assemblage is positioned at a depth of 1–1.2 m and involves 618 artefacts. Rust (1950) labeled it Acheuleo-Mousterian or old Mousterian. He stated that assemblage 6 is completely different from the previous and subsequent assemblages in terms of the size of the artefacts, which were characteristically big and wide. He described this assemblage as showing clear Levallois diversity, underscoring the dominant triangular flakes and scrapers.

Bordes stressed the absence of biface and a strong presence of Levallois points, triangular flakes and a descent of the laminar index, as well as the presence of scrapers, burins, notches, denticulates and knives throughout Rust's descriptions (Bordes 1984). Pagli agreed with Rust and Bordes, indicating a predominance of the production of Levallois points, triangular flakes and flakes with an equal predominance of the recurrent centripetal method among others (Pagli 2013).

4.2. Archaeological assemblage 4

This assemblage is situated at a depth of 0.6–0.7 m and was labeled June Acheuleo–Mousterian by Rust (1950). It contains 706 stone artefacts. Rust (1950) indicated an evolution in assemblage 4, but it did not happen by means of a radical transformation of the industry, because the old cultural features continued. The first sign of this transformation, according to Rust, is the lack of those large artefacts that were found in the lower Mousterian assemblages. The second indication is an increasing number of Mousterian '*Handspitze'* points at the expense of other materials. Bordes (1984) accepted that the index of faceting is unusually high in this assemblage and indicated the presence of Levallois, a Mousterian point, scrapers, burins, notches and denticulates. Furthermore, Bordes noted the absence of a biface and backed knife. While Pagli (2013) pointed out that the industry of assemblage 4 is characterized by the production of Levallois points and triangular flakes.

4.2.1. Problem of the number of stone artefacts in assemblage 4

We must bear in mind that there is a clear difference between the available number of stone artefacts of assemblage 4 at the Institut für Ur- und Frühgeschichte der Universität zu Köln and the number analysed by Pagli (2013).

As we can see in (Fig. 18), Pagli (2013; 405) recorded the total number of stone artefacts as 1102 pieces – almost twice the available number in assemblage 4. If we compare her statistics with ours, the number of oval and quadrangular pieces she records is almost triple the number that exists in this assemblage. This statistic might also effect results, such as the function of the assemblage. The number of fragments is also twice that available. Furthermore, the number of *Nahr Ibrahim* pieces is high compared to the complete absence of this element among the lithic material. The number of Levallois points, triangular flakes, and Levallois blades, on the other hand, is very similar to the inventory of this assemblage. Rust (1950; 57) recorded completely different numbers that do not exceed 896 stone artefacts (Fig. 19).

Furthermore, the number of stone artefacts in assemblage 4 is documented as being 688 at the Institut für Ur- und Frühgeschichte der Universität zu Köln.

The accessible number of artefacts is consequently much closer to Rust's figure. The result of techno-typological analyses will be slightly different, and the function of this assemblage will be different.

III – YABROUD I – COUCHE 4

PRESENTATION DE L'ASSEMBLAGE

Le caractère principal de la couche 4 est une abondance exceptionnelle de produits triangulaires, en particulier, des pointes (Tab. 113).

La plupart de ces produits proviennent d'un système Levallois, mais quelques rares produits laminaires attestent de l'existence d'un système de débitage différent, de type D à éclats laminaires, que l'absence de nucléus ne permet pas d'approfondir.

Outre cette production très importante de produits triangulaires, la série se distingue par un fort développement de la phase de transformation des supports, visible notamment par la proportion importante de Nahr Ibrahim et de pièces retouchées après fracture.

Les procédés d'aménagement sont aussi remarquables. Ils s'agit généralement de retouches intenses, souvent associées à des procédés plus spécifiques, comme le coup de tranchet latéral, en continuité avec un tranchant retouché.

Beaucoup des supports transformés présentent un volume convergent, cohérent avec la tendance principale de la production Levallois de la série.

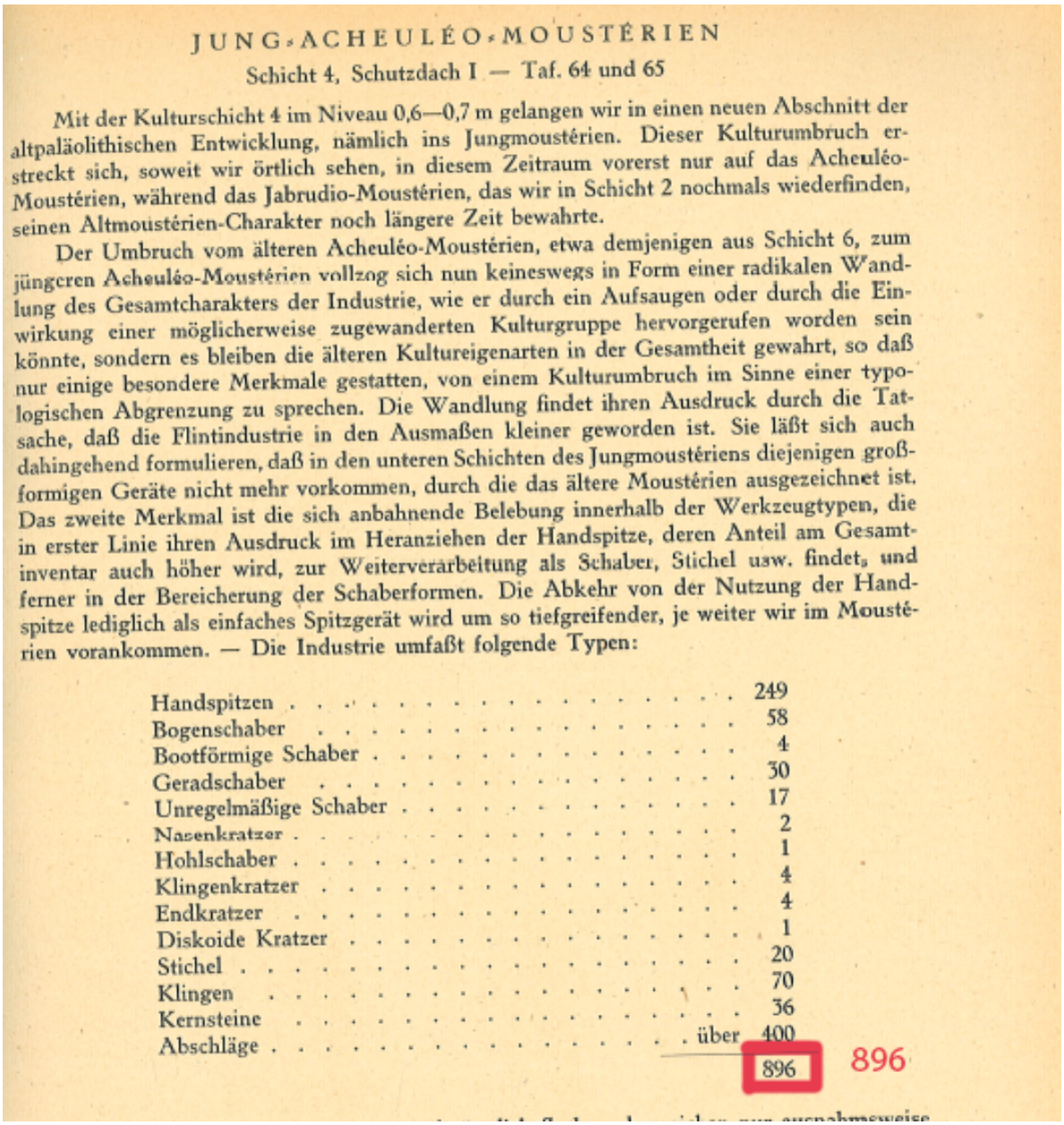
Nucléus		42	3,8%
Supports prédéterminés Levallois		563	51,1%
Fragments de supports prédéterminés Levallois		107	9,7%
Nahr Ibrahim		51	4,8%
Lames non Levallois		6	0,5%
Eclats prédéterminants 287	Eclats corticaux et semi-corticaux	167	15,2%
	Eclats non corticaux	121	11%
Fragments indéterminés		45	4,1%
Total		**1102**	**100%**

1102

Supports prédéterminés Levallois		
Pointes et éclats triangulaires	232	41,2%
Eclats à dos	127	22,6%
Eclats quadrangulaires/ovalaires	113	20,1%
Eclats laminaires	91	16,2%
Total	**563**	**100%**

Tableau 113 : Yabroud I – couche 4 : décompte de l'assemblage lithique.

Fig. 18. Total number of assemblage 4 stone artefacts, according to Pagli 2013.



JUNG-ACHEULÉO-MOUSTÉRIEN

Schicht 4, Schutzdach I — Taf. 64 und 65

Mit der Kulturschicht 4 im Niveau 0,6—0,7 m gelangen wir in einen neuen Abschnitt der altpaläolithischen Entwicklung, nämlich ins Jungmoustérien. Dieser Kulturumbruch erstreckt sich, soweit wir örtlich sehen, in diesem Zeitraum vorerst nur auf das Acheuléo-Moustérien, während das Jabrudio-Moustérien, das wir in Schicht 2 nochmals wiederfinden, seinen Altmoustérien-Charakter noch längere Zeit bewahrte.

Der Umbruch vom älteren Acheuléo-Moustérien, etwa demjenigen aus Schicht 6, zum jüngeren Acheuléo-Moustérien vollzog sich nun keineswegs in Form einer radikalen Wandlung des Gesamtcharakters der Industrie, wie er durch ein Aufsaugen oder durch die Einwirkung einer möglicherweise zugewanderten Kulturgruppe hervorgerufen worden sein könnte, sondern es bleiben die älteren Kultureigenarten in der Gesamtheit gewahrt, so daß nur einige besondere Merkmale gestatten, von einem Kulturumbruch im Sinne einer typologischen Abgrenzung zu sprechen. Die Wandlung findet ihren Ausdruck durch die Tatsache, daß die Flintindustrie in den Ausmaßen kleiner geworden ist. Sie läßt sich auch dahingehend formulieren, daß in den unteren Schichten des Jungmoustériens diejenigen großformigen Geräte nicht mehr vorkommen, durch die das ältere Moustérien ausgezeichnet ist. Das zweite Merkmal ist die sich anbahnende Belebung innerhalb der Werkzeugtypen, die in erster Linie ihren Ausdruck im Heranziehen der Handspitze, deren Anteil am Gesamtinventar auch höher wird, zur Weiterverarbeitung als Schaber, Stichel usw. findet, und ferner in der Bereicherung der Schaberformen. Die Abkehr von der Nutzung der Handspitze lediglich als einfaches Spitzgerät wird um so tiefgreifender, je weiter wir im Moustérien vorankommen. — Die Industrie umfaßt folgende Typen:

Handspitzen	249
Bogenschaber	58
Bootförmige Schaber	4
Geradschaber	30
Unregelmäßige Schaber	17
Nasenkratzer	2
Hohlschaber	1
Klingenkratzer	4
Endkratzer	4
Diskoide Kratzer	1
Stichel	20
Klingen	70
Kernsteine	36
Abschläge	über 400
	896

896

Fig. 19. Total number of assemblage 4 stone artefacts, according to Rust 1950.

5. The TECHNO-TYPOLGICAL analyses and transformation analysis of the late Middle Palaeolithic assemblage 6 at Yabroud I

This chapter will address the techno-typological variables in the lithic material in order to reconstruct the strategies of core reduction and of raw material procurement employed in assemblage 6. Fragments were excluded from techno-typological analyses but were included in the transformation analyses as they may carry inferences of on-site activities. Firstly, the cores will be analysed in order to identify core reduction strategies including the influence of the type of raw material on the reduction process. Secondly, the technological variables of the debitage combined with the results of core analyses will be approached together. As a consequence, the point, flake, and blade reduction strategies will be recognized. Thirdly, the lithic material will be addressed by typological analyses endeavouring to identify the tools used on-site. Finally, this chapter will deal with transformation analyses that aim to predict the activities carried out on-site and off-site, and inferences that can be made about land use.

We must mention that both flint and chalcedony were exploited, though flint is the dominant raw material and chalcedony was rarely exploited. In addition to the scarcity of chalcedony use, the cores were abandoned early due to the heterogenous raw material.

As can be seen in Table. 8, assemblage 6 of YSI includes 618 stone artefacts, which have been sorted into five main categories, 234 blanks (hereafter referred to as Levallois points, flakes and blades), 249 by-products, 28 Levallois cores, 34 cores on flakes, and 64 fragments.

Category	%	Number
Levallois Cores on blocks	2.1	13
Levallois Cores on flakes	2.4	15
Cores on flakes	5.5	34
Initial cores	0.4	3
Bifacial fragments	0.3	2
Core fragment	0.1	1
Levallois blanks	37.8	234
Kombewa blanks	0.4	3
By-products	40.6	249
Fragments	10.3	64
Total	**100**	**618**

Table. 8. Distribution of lithic material in assemblage 6.

5.1.Identifying core reduction techniques

Previous studies of stone artefacts from assemblage 6 exhibited variability of core reduction strategies whether Levallois or non-Levallois. Pagli (2013, 2015) analysed the lithic material of assemblage 6 according to her own classification system, presenting brief but useful results on the variability of the lithic industry. She discerned the variability through technical changes in the operatory scheme, methods, and production objectives. She stated that assemblage 6 is characterized predominantly by a Levallois production system aimed at obtaining mainly triangular flakes including Levallois points by means of the recurrent unidirectional convergent method, or the preferential method, and quadrangular/oval flakes by means of recurrent centripetal or unidirectional method, or according to a preferential flaking method. She found that the Levallois product categories are approximately equal in size, 42.7% and 40.1% respectively. Moreover, she found that Levallois blades are the least predetermined Levallois product category in assemblage 6 as a result of recurrent unidirectional, parallel or convergent method, and sometimes showing bidirectional methods. Finally, she assumed that the majority of Levallois cores were executed on blocks and the minority were applied on flakes. In addition, she found that the *Nahr Ibrahim* technique was executed mainly on different Levallois products and in several cases on cortical flakes.

She also asserted that another group of products, accounting for 6.5% of the artefacts, has volumetric characters that cannot be obtained by a Levallois system. These blades show quite a high elongation index, and their negatives correspond to removals obtained according to very oblique, almost abrupt fracture planes. She confirmed that no cores testifying to this system of production were found, which may have helped deepen an understanding of the nature and the volumetric rules governing it. However, she proposed their affiliation to non-Levallois volumetric structures, type C[1] or D. Finally, she stated that although Levallois blade production is not dominant in this assemblage, the Levallois products show a significant elongation, the length/width ratio being mostly between 1.5 and 1.9 (Pagli 2013, 2015).

While Pagli's PhD dissertation relied on a brief analysis of the lithic production system of assemblages 6, 5, 4, 3 and 2, and compared them with other Levantine late MP sites in order to design a specific model of mobility and related site function, the current study will present

[1] According to Pagli (2013:170), type C do not have any changes in volume prior to debitage, and the products were removed from the convexities naturally present in the volume of raw material. Thus, the creation of the criteria of convexities is therefore replaced here by the selection of adequate volumes for carrying out debitage. The production phase always includes short series, of various directions (uni- or bidirectional, orthogonal or centripetal) and their characters do not allow them to be distinguished from predetermined flakes from Levallois debitage.

a detailed analysis of the applied core reduction strategies in detail according to techno-typological analyses and transformation analyses that reflect the human behaviour and its inferences for land use.

Although the current study presents two strategies of core reduction, types C and D were not recognized as will be discussed in context. Accordingly, only Levallois and core on flake reduction strategies were exploited in assemblage 6. Furthermore, it is worth pointing out that the majority of core reduction was executed on flakes including Levallois methods, whereas blocks were less reduced. Accordingly, they are abbreviated under a few main points as follows:

Levallois method on blocks: although the blocks were exploited, they number less than cores on flakes in total. However, the number of exploited Levallois cores on blocks is equal to the number of exploited Levallois cores applied on flakes.

Levallois cores with further exploitation of the lower surface: the last removal before the discard of a Levallois core was detached from the lower surface. It was clearly recognized, especially, where Levallois cores were applied to blocks, given that they still exhibit a clear convexity on the lower surface.

Levallois method was applied on flakes: thick flakes were reduced by the Levallois method, which is parallel to the number of Levallois cores applied to blocks.

Initial Levallois cores: were executed only on thick flakes bearing criteria of the initial stages of the Levallois core reduction process.

Core on flakes: were clearly reduced, including *Nahar Ibrahim* technique.

Core fragment: one piece was recognized.

Levallois method applied on bifaces: both fragments are the maximum distal termination of bifaces.

5.2.Strategy of Levallois core reduction

Techno-typological analyses of Levallois cores and debitage suggest both Levallois methods, preferential and recurrent, were exploited in assemblage 6, but the recurrent method was clearly predominant (Fig. 20). As mentioned before, all of the Levallois cores were exploited by two different types of volumes, blocks and thick flakes, with a slight tendency towards flakes. Furthermore, initial Levallois cores were applied only on thick flakes. This implies that the exploitation of thick flakes and blocks were both main strategies of raw material procurement.

Levallois cores were classified in accordance with Bordes (1980) based on the last removals on the discarded Levallois cores. Consequently, it is worth pointing out that Levallois cores for flakes are the most frequent, executed by both Levallois methods, accounting for 60.7% of the total discarded Levallois cores, followed by cores for points at 32.1%. Levallois cores for blades were rarely exploited presenting only 7.1% of the total. It is worth noting that Levallois points and flakes were struck from both the recurrent and the preferential method. The following categories of Levallois cores will be analysed in order to find out which method was used to remove the Levallois end-products (Bordes 1980).

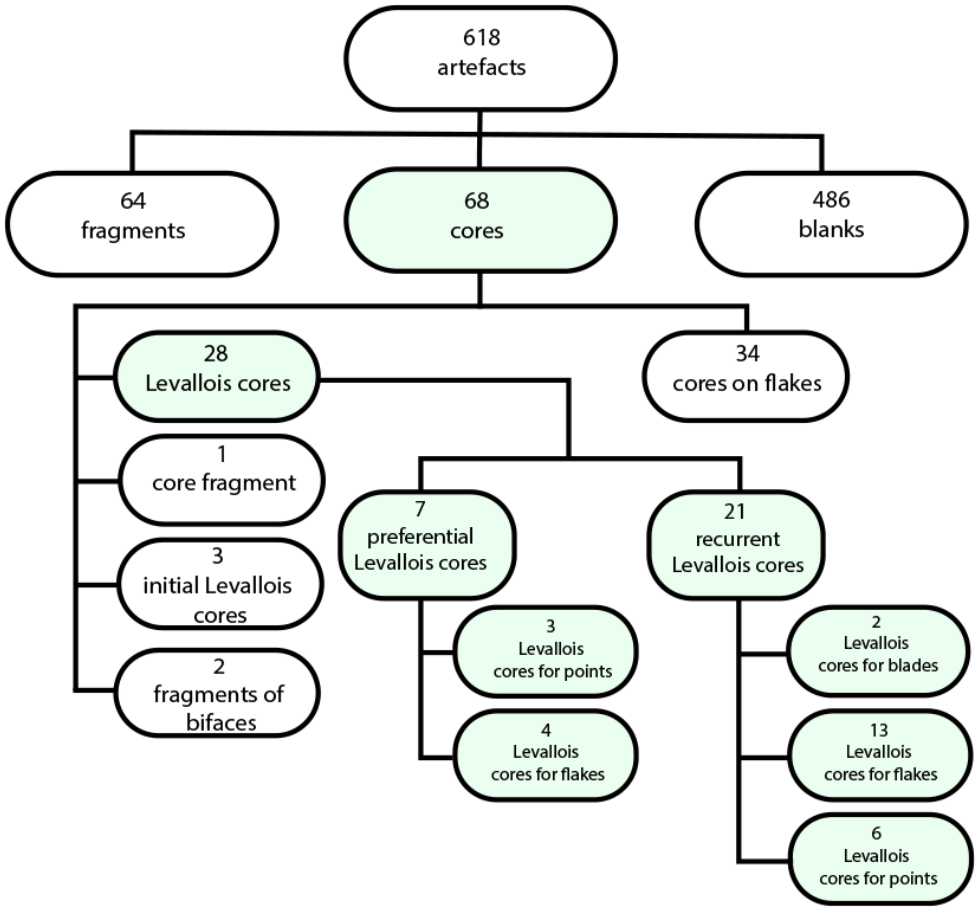


Fig. 20. Variable methods of core reduction identified in the Mousterian assemblage 6 of Yabroud I.

5.2.1. Levallois cores for points

Levallois points can in fact be produced by both Levallois and non-Levallois schemas (Boëda 1995; 51). However, Levallois points can be struck by two specific Levallois methods; the preferential method (Boëda 1995; Inizan et al. 1995) and the recurrent method (Meignen 1995; Boëda 1995). Accordingly, it is difficult to make a distinction between the technological and morphological characteristics of Levallois points obtained from each, particularly in the

absence of refitting[2]. According to discarded cores, both Levallois methods were executed in order to obtain Levallois points in this assemblage. The unidirectional convergent Levallois method is dominant, representing 21.4% (6 cores) of all Levallois cores, while the preferential method makes up 10.7% (3 cores).

The scar patterns of preferential Levallois cores exhibit the typical shape of preferential cores for points, where small centripetal preparatory scar patterns stem from the core's circumference with the intention of reinstalling flaking surface convexity. The negative of the detached Levallois point occupied two-thirds of the flaking surface. It is worth noting that a single preferential Levallois core was reduced on a flake (Fig. 21). In fact, the flaking surface of this core shows a part of the original ventral surface of the cortical flake, which is a scar pattern in the opposite direction to the other centripetal preparatory scar patterns, proving that the exploitation was executed on a flake.



Fig. 21. Preferential Levallois core for point production.

When it comes to the scar patterns of discarded unidirectional convergent Levallois cores, they display two different types of flaking surface preparation. In the first type, the two lateral edges and the distal part were prepared differently: one exhibits a prepared distal termination by detaching small bidirectional or perpendicular removals (Fig. 22), the other was prepared by detaching elongated lateral removals (Fig. 23-24). The second type of preparation is limited to elongated lateral removals. These two types of flaking surface preparation have been observed on various sizes of cores, which might indicate that the knappers did not follow a unique and systematic strategy in order to obtain Levallois points. They prepared the cores

[2] Sometimes it is possible to differentiate between Levallois points produced by the preferential or recurrent method. This may be by way of the scar patterns (Levallois points produced by the preferential method mostly bear the characteristics of classic Levallois points, especially the Y-pattern shape, whereas Levallois points obtained by the recurrent method might show a series of scar patterns that stem from a single striking platform, except for those prepared using a flaking surface preparation, called "constructed" Levallois points (Boëda 1982; Boëda et al. 1998). However, the distinction is still difficult to make.

based on the status of the flaking surface without taking the type of the preparation, which impacts the final characteristics of the Levallois point, into consideration. This is therefore clear evidence of the rapid adaptive behaviour to different types of core preparation in order to meet requirements.



Fig. 22. Unidirectional convergent Levallois core, the lateral edge displays a prepared distal termination by detaching small bidirectional or perpendicular removals.



Fig. 23. Unidirectional convergent Levallois core on flake was prepared by detaching only elongated lateral removals.

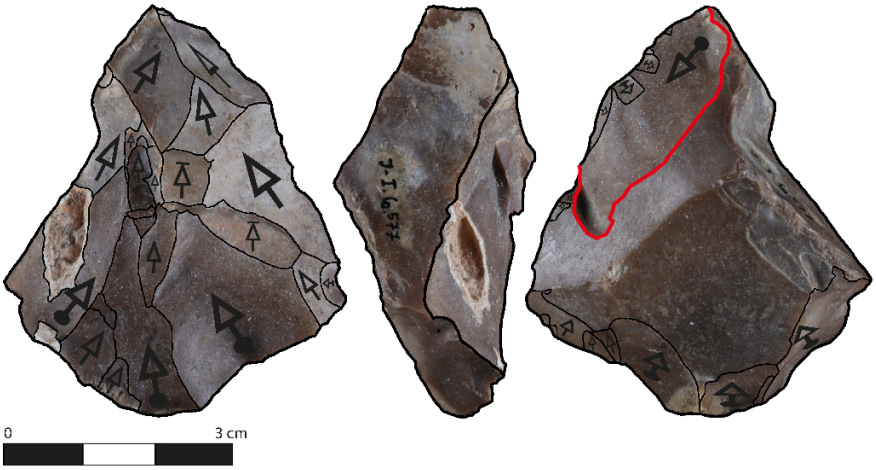


Fig. 24. Unidirectional convergent Levallois core was prepared by detaching only lateral removals that stem from proximal striking platform.

The striking platforms of both preferential and unidirectional convergent Levallois cores are limited at the proximal area. In addition, about 60.4% of the total striking platforms are faceted, while 39.6% of them display plain striking platforms. The mean degree of striking platform angles is 69.3°. It is worth noting that while all preferential Levallois cores exhibit a negative of *Chapeau de gendarme* shape of butt, associated with broad-based Levallois points, 66.6% of the unidirectional convergent Levallois cores lack a negative of *Chapeau de gendarme* shape of butt. This might explain the absence of a *Chapeau de gendarme* shape of butt on a lot of Levallois points.

While the flaking surface of all of the Levallois cores exhibits no cortex, the vast majority of the lower surface of Levallois cores for points exhibit a high amount of cortex ranging from 10% to 95%. In fact, the high proportion of cortex is relatively associated with convexity: the more convex the lower surface, the less cortical it is. In other words, during the preparation of the flaking surface, striking platform preparation flakes were removed, reaching the medial part of the lower surface, and hence, more cortex was removed. The flatter the lower surface, the more cortical it is. Therefore, the high amount of cortex can be attributed to the flat surface preventing an extension of detached preparatory (striking platform preparation flakes) reaching into the medial part of the lower surface and removing more cortex. (Fig. 21). Thus, the lower surface of cores maintained the high cortex.

Table. 9 shows Levallois cores for points with volumetric differences, probably related to the reason for discarding the core. Although 70% of recurrent convergent Levallois cores are larger in size than preferential cores, which could have allowed for further exploitation, they have been discarded, mostly due to deep hinge accidents. I.e. if the knappers had got rid of the accidents, the Levallois cores would not have allowed for further exploitation as they would have lost the required volume. 50% of them have insufficient thickness given that they were made on flakes. Accordingly, they have been discarded despite their large length and width. The other discarded unidirectional convergent Levallois cores exhibit both small values and knapping accidents that prompted discard. The preferential Levallois cores have been discarded as their exhausted size would not allow for flaking surface re-preparation. The mean size of the last removal struck using both Levallois methods shows that the desired obtained Levallois points were in the range between two to three centimetres.

Finally, it is important to point out that the recurrent convergent cores display LWR, suggesting that most broad-based Levallois points might have been produced at the last stage

of the core reduction sequence. However, cores during the first phases of production might have been completely different morphometrically.

	N.	%	core on block	opportunistic exploitation	Core on cortical flake	% of all cores (core fragments and biface fragment excluded)	mean Length (mm)	mean width (mm)	mean thickness (mm)	last removal mean Length (mm)	last removal mean width (mm)	LWR	EPA
Levallois cores for points	**9**					**29.1**	_	_		_			
Preferential method	3	10.7	1				47.6	51	18	32	35.6	0.9	70.3
Unidirectional convergent method	6	21.4	3				63.0	57	18.6	27	19.8	1.2	69.3
Levallois cores for flakes	**17**					**54.8**	**52.3**	**53.2**	**20.0**	**35.0**	**33.0**	**1.0**	**74.6**
Preferential method	4	8.6	1	2	1		54.5	56.0	22.0	39.5	40.7	0.97	75.5
Centripetal mode	11	37.9	4	2	7		51.1	52.0	18.5	_	_	0.98	73
Bidirectional mode	1	3.4					52.0	46.6	18.5	30.0	26.5	1.1	77.5
Unidirectional mode	1	3.4					44.0	44.0	21.0	21.0	20.0	1.0	68.0
Levallois cores for blades	**2**					**6.4**							
Unidirectional mode	2	9.3					48.0	52.5	18.0	34.0	18.0	0.91	72.5
Initial cores	**3**					9.6	45.3	43.2	17.1	_	_	1	_
Core fragments	**1**												
fragment of bifaces	**2**												

Table. 9. Metric measurements of Levallois cores for points. The length-width ratio (LWR) is the ratio between the maximum length and width. The exterior platform angle (EPA) is the intersection angle between the flaking surface and the striking platform.

5.2.2. Levallois cores for flakes

Levallois cores for flakes are the most available cores in assemblage 6, representing 60.7% of all discarded Levallois cores. However, this percentage does not correspond with either the most frequent type of discarded end-products nor the predominant scar patterns on Levallois blanks. Although both preferential and recurrent Levallois methods were exploited, cores of the recurrent centripetal method are the most frequent, accounting for 64.7% of the total Levallois cores for flakes. Those from the preferential method make up 23.5%, while

bidirectional and unidirectional methods together represent 11.7% of the total [3]. This implies the probability of applying different methods during the earlier stages of core reduction.

A. Preferential Levallois cores

While three preferential cores were reduced on blocks, a single core was executed on a flake. It is worth noting that the lower surface of two cores on blocks was exploited systematically before their discard.

In terms of scar patterns, while the quantitative aim is to obtain a single product from each prepared flaking surface, the qualitative aim is to produce quadrangular or rounded/oval shaped flakes according to the last removal. The flaking surfaces show an extremely high number of scar patterns, with an average of 12.7. This implies that cores have been carefully prepared by detaching small peripheral removals proportional to the small flaking surface. In addition, the flattening of the entire flaking surface, including the last preferential removal, which occupies only a third of the flaking surface, implies that convexity of the flaking surface was slightly reinstalled as a result of lacking adequate thickness (Fig. 25). This could alternatively be an organized process of the flaking surface in order to maintain the raw material as much as it could be to increase productivity.

The cortex is completely absent on flaking surfaces, whereas the amount of cortex varies on the lower surface of preferential cores according to the raw material, either blocks or flakes. While three preferential cores on blocks exhibit well prepared lower surface covering by the poor amount of cortex reaching 10%, the single preferential core on flake displays a limited preparation at the lateral circumference of the lower surface covering by cortex that ranges between 90% to 80% (Fig. 25). This difference may indicate the short life usage of preferential core on flake, which means that the knappers might have picked up a thick cortical flake and reused it. In turn, this implies this flake had a short production life due to a lack of adequate volume for a long reduction sequence.

All of the preferential cores display faceted striking platforms. While cores executed on blocks show negatives of *Chapeau de gendarme* butt shape, the core performed on flake does not. However, it exhibits a more well-prepared striking platform than the others. Given that core on flake displays 10 mm thickness, the knappers might have prepared the striking platform intensively in order to determine the impact-oriented blow precisely.

[3] In case that the core shows more than two striking platform, it would be called centripetal core.

Two main reasons caused the knappers to discard preferential Levallois cores. Firstly, Table. 9 shows the small size of the discarded cores. If knappers had re-prepared these cores for further removal, the cores would have decreased further in size, particularly thickness, and would not have been appropriate for further exploitation. Secondly, if the cores still had appropriate length and width, they lacked the adequate thickness that hampers further exploitation. A comparison between the sizes of the abandoned centripetal and preferential cores indicate that the preferential cores discarded lie within a larger size range, suggesting their use has been discontinued earlier than centripetal cores. Consequently, the discard of cores was due to either inadequate thickness to support further exploitation, or inadequate size.



Fig. 25. Preferential Levallois core for flakes showing restricted parts of preparation on the lower surface.

B. Centripetal Levallois cores

Centripetal Levallois cores exhibit two modes of exploitation. The first mode exhibit cores with a complete circumference used as a striking platform, forming 63.3% of all centripetal cores. This mode lacks hierarchical structure and some have a concave lower surface (Fig. 26). It can therefore be inferred that they have been struck on cortical flakes. These striking platforms have kept the convexity of the flaking surface (Boëda 1995) and circular shape of the cores. The second mode exhibits cores with a discontinuous striking platform accounting for 36.3% of all centripetal cores. They have been exploited on blocks (Fig. 27).

While most cores displaying a complete circumference used as striking platforms are associated with intensively exploited flaking surfaces with a mean of 16.2 scar patterns, the minority exhibit limited discontinuous striking platforms with a mean of 5.7 scar patterns. Accordingly, the density of scar patterns is related to the number of striking platforms. It was also noted that the centripetal cores with discontinuous striking platforms exhibit larger

negatives than in centripetal cores displaying continuous striking platforms. Therefore, the fewer the number of removals, the larger the size of removals.

The cortex is completely absent on all flaking surfaces of both modes. However, the amount of cortex on the lower surface of cores varies between the modes. While it covers more than 80% of the lower surface of cores that have been struck on a cortical flake, the figure is less than 50% for cores that have been exploited on blocks and it distributes only to limited parts of the lower surface, where there is no striking platform. This variation of cortex distribution resembles what was mentioned for the Levallois cores for points. The variation can in fact be extended to include the size of striking platform angles, where cores exhibiting large cortex coverage are substantially linked to higher angles with a mean of 75.2°, whereas those with less cortex are related to smaller angles with a mean of 71.8°. The similarity in distribution and amount of cortex on lower surfaces on both kinds of Levallois cores reflects the same behavioural influences on their condition.



Fig. 26. Centripetal Levallois core executed on a cortical flake.



Fig. 27. Centripetal Levallois core executed on a block.

While 72.7% of the cores exhibit faceted striking platforms, 27.7% of them bear plain striking platforms. This implies that the striking platform was mostly well prepared and sometimes did not need preparation.

Although 54.5% of these cores applied to cortical flakes could have allowed for further exploitation, they were probably discarded due to the lack of adequate thickness. In contrast, executed centripetal cores on the block were discarded due to their exhaustion, except a single core that could have been used before discarding; however, the concave flaking surface would have consumed the whole core in case the knappers had recreated its convexity. They therefore preferred to exploit the lower surface that exhibits an appropriate convexity (see below). This confirms that the exploitation of centripetal cores may have been abandoned once they reached a specific size threshold, if no technological accident had caused their discard.

A single bidirectional core and a single unidirectional core have been struck in order to obtain flakes. However, they form 3.4% of all Levallois cores respectively. Given they are single cores for each mode, it is difficult to summarize their core reduction process.

5.2.3. Levallois cores for blades

The Levallois cores for blades are only two unidirectional parallel cores forming 5.8% of all Levallois cores. Both cores were applied to flakes that do not allow for a long reduction sequence. This scant number hampers detailed analysis.

The last production process of flaking surface attests to have been prepared in the same way. While one specimen shows semi-centripetal preparation scar patterns stemming from the distal termination and a single lateral edge of the flaking surface, the removal of end-products left scar patterns that occupy 75% of the flaking surface (Fig. 28). The other specimen displays perpendicular preparation scar patterns that stem from both lateral edges. Thus, the end-products have been detached from the centre, occupying 60% of the flaking surface. Accordingly, the Levallois blades were produced from different parts of the flaking surface and were not restricted to a specific part. The mean number of scar patterns is 10 scars, very high when compared to the small size of discarded Levallois cores. This suggests the knappers had a high level of skill in order to be able to control and organise the small size.

Both unidirectional Levallois cores exhibit well-prepared striking platforms with a mean interior angle of 72.5°. Although their striking platform angles could have allowed for further exploitation, they have been abandoned. Several factors prompted the discard of the

cores. Although one core still has enough length and width, it was discarded because of the low thickness that hindered further exploitation combined with the several hinge fractures appearing on the flaking surface. The other core was abandoned as it was completely exhausted and could not have allowed for any further exploitation. Its size also resembles the mean size of other discarded Levallois cores, confirming that the knappers abandoned cores when they reached a certain size threshold.



Fig. 28. Unidirectional parallel Levallois core, showing lateral and distal preparation scar patterns.

5.2.4. Initial Levallois cores

Three initial Levallois cores were identified. They exhibit the initial stage of the flaking surface installation. These cores show that the first criteria of the Levallois method were applied to small, thick, and cortical flakes. As can be seen in (Fig. 29), although the flake's ventral surface shows a slightly concave surface, the knappers endeavoured to prepare it; however, the process of setting up the flaking surface was not completed as they realised its size was inadequate for exploitation.



Fig. 29. A core on flake bears the initial criteria of the Levallois method.

The knappers therefore got rid of it as it would have lost its whole size immediately if they had continued the process. Their mean size corresponds with the size threshold of the discarded Levallois cores (Table. 9). This implies that the endeavour of the knappers to exploit these flakes failed as they lack the adequate size for use.

Consequently, the clear endeavour of the knappers to utilize any available discarded flakes enhances the theory that the human groups occupying the area were well organized and highly skilled.

5.2.5. Maximum benefit of the exhausted Levallois cores by exploitating the lower surface

One of the six criteria that Boëda defined for the Levallois concept is that Levallois cores have unchangeable platform and debitage surfaces (Boëda 1990, 1995). Surprisingly, 25% of the Levallois cores carry intentional removals that were detached from lower surfaces. The reasons that led to knappers exploiting the lower surface are different according to the condition of the cores. It seems that the knappers shifted to the lower surface of two preferential and recurrent centripetal Levallois cores in order to obtain the last removal due to their appropriate convexity for further exploitation on the one hand, and the inefficient concave flaking surfaces on the other hand. Specifically, these further exploitations were executed on cores applied to blocks. Accordingly, it can be concluded that if they had reinstalled the flaking surface convexity, they would have consumed the whole core. Therefore, the adequate convexity of the lower surface prompted them to reduce it. In the rest of the cores, the knappers exploited the lower surface due to the exhausted size of the discarded cores or after hinge accidents on flaking surfaces. In both cases, they preferred getting a flake from the proper lower surface before discarding (Fig. 24).

Another possibility is that the core reduction process in assemblage 6 was confined to striking the Levallois blanks at the beginning. Later, the same people or maybe other people reused these discarded cores in order to meet their needs. Thus, they invested in the adequate size of Levallois cores and decided to exploit the convex lower surface once or twice at maximum. In the Hummal Mousterian site (Hauck 2011), the same concept of exhausting core investment was seen, where low core volumes were opportunistically struck by an alternative flaking method in the final stage of the core reduction in order to obtain small flakes or bladelets. Furthermore, high intensity of reduction was observed in some cases in the late MP

Tor Faraj shelter in Jordan, through the removal of Levallois points from two faces of cores (Henry et al. 1996; Demidenko & Usik 2003; Groucutt 2014).

Consequently, different reasons forced knappers to abandon the exploitation of flaking surfaces, while a single reason prompted them to obtain the last removal from the lower surface: appropriate convexity for exploitation. The transformation process was not executed systematically and mirrors the response of human behaviour to the size constraints of raw material in hand.

5.2.6. Re-exploitation of the discarded bifaces using the Levallois method

It appears that the strategy of biface reduction for blank production was applied in assemblage 6. Two biface tips were recognized showing scar patterns on both surfaces (Fig. 30). According to the transformation analysis, it turns out that these tips are part of the core debitage (see RMU 93, Fig. 76). Solecki and Solecki (2007) mentioned there was a scarcity of good-sized raw material. Based on the size of the nodules found at quarry 1, which are not very large, they also assumed that the nodules used by knappers at YSI were not much bigger.

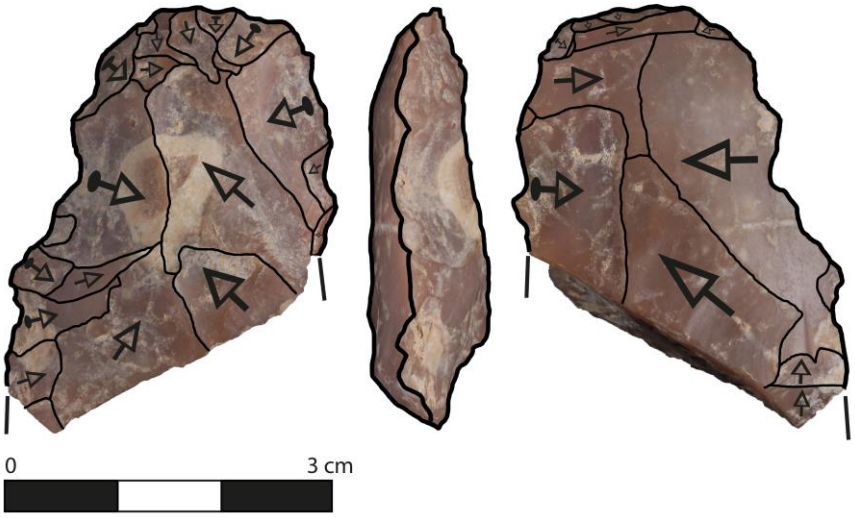


Fig. 30. Tip of a biface shows scar patterns on both surfaces.

Their survey confirmed that the raw material source of quarry 1 includes small to medium-sized nodules. Furthermore, two samples of nodules were recovered from the excavation at Yabroud I showing different sizes, one measuring 101.0 × 83.6 × 47.0 mm, which is a fracture complete nodule, the other, an initially prepared core, measures 87.0 × 60 × 53 mm. The size of these samples as well as the available small to medium-sized nodules in quarry 1 confirmed that the size of raw material used by knappers of Yabroud I was not much larger. Consequently, it can be assumed that the size of the bifaces would not be smaller than the

prepared core. In fact, on the basis of a comparison between the size of the fractured complete nodule, measuring 101.0 × 83.6 × 47.0 mm, recovered from excavations at Yabroud and the largest biface found at Yabroud, measuring 185 × 98.6 × 43.9 mm, it is logical to conclude that bifaces were reduced. Accordingly, late MP users of assemblage 6 picked up bifaces discarded at the surface site by earlier Acheulian groups and used them along with local nodules to manufacture their tool (Solecki & Solecki 2007; 127).

5.3.Cores on flakes strategy

The definition of the modified flake as a core on flake remained a controversial subject for a long time before archaeologists considered it an intentional human behaviour, and a strategy aimed at reusing the flakes as cores, rather than an incidental occurrence. Several studies have been carried out to differentiate between the truncation-faceted flakes that were described by Schroeder (1969) from Jerf Ajla cave in Syria, and the same artefacts from Nahr Ibrahim cave in Lebanon, described by Solecki & Solecki (1979) as "*Nahr Ibrahim* technique".

Newcomer and Hivernel-Guerre (1974) were the first to suggest that the so-called *Nahr Ibrahim* tools and truncated-faceted blanks are cores. After analysing the cores on flakes from the Quneitra site, Amud cave, and Qafzeh cave, it was agreed that the detailed technological characteristics of manufacture of the truncation-faceted flake and *Nahr Ibrahim* technique show a similarity in typological, technological and stylistic attributes with the cores on flakes (Goren-Inbar 1988b; 37). Based on a size comparison, it was clarified that the last removal from the nodule core and truncated-faceted flake showed the same size (Crew 1976;111; Goren-Inbar 1988b; Nishiaki 1985, Hovers 1997;70-75; Munday 1977;44).

To differentiate between the end-products obtained from cores on flakes and Levallois method in assemblage 6 and to derive the difference and similarity criteria between both reduction processes, the cores on flakes were classified into three categories based on the exploited part according to Hauck (2013; 118).

- Exploited dorsal surface; this category includes each blank exhibiting one or more secondary removals on its dorsal surface regardless of the number of striking platforms and which part of the dorsal face was exploited (Fig. 31). This category involves mostly truncated-faceted flakes and *Nahar Ibrahim* pieces (Fig. 32-33).
- Exploited ventral surface; this category includes each blank showing one or more secondary removals on its ventral surface regardless which part of the ventral face was

exploited. Their end products were reduced by Kombewa and Janus methods or could be initial Levallois method applied on flakes.

- Exploited multiple faces; this category contains all cores on flakes that show one or more secondary removals from the dorsal, ventral surface and distal termination.

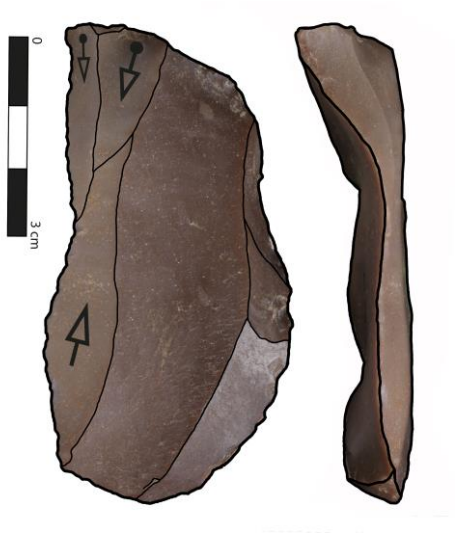


Fig. 31. Core on flake showing double patination.

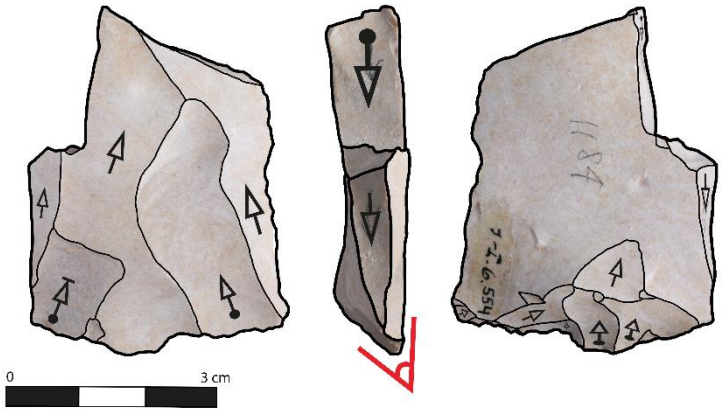


Fig. 32. *Nahr Ibrahim* technique, the profile shows that the exploited part profile is still thick even though it was exploited.



Fig. 33. *Nahr Ibrahim* technique, the profile shows a quite adequate striking platform angle for exploitation.

Theoretically, any successful core reduction process requires specific criteria, such as a convex flaking surface and a striking platform surface (whether convex or not). In the case of a cortex-free blank it is therefore quite logical to select the dorsal surface of any flake as a flaking surface since it is slightly convex, and the ventral surface can be set up as a striking platform due to its concavity, which cannot serve as a flaking surface. The dorsal surface is therefore the most exploited face among the cores on flakes, with 68.7% of the total, followed by an exploited ventral surface, especially, thick cortical blanks making up 25.1%. The group of exploited multiple faces is 6.2% of the total number. The importance of ready convexity is apparent in the natural convexity of nodules imported into the Tor Faraj shelter. This enabled knappers to produce Levallois points after only minor initial preparation (Groucutt 2014) and confirms the importance of natural/ready convexity for the facilitation of obtaining blanks without intensive preparation of the core.

By and large, exploitation of the Levallois and non-Levallois core reduction processes rely on several criteria. However, volume size of the raw material that allows for reduction can be considered the first condition. Accordingly, if the raw material has adequate volume, it can be easily reduced, regardless of its type – nodule, blank, or fragment. The volume may allow for several exploitations, permitting a long process, or exhibit a short reduction sequence lifespan. In both cases, the core reduction process is completely related to the volume size, in particular, the thickness. The fact that by-products are generally thick and allow for secondary flake production explains the clear tendency towards selecting core trimming elements in assemblage 6, which account for 65.6% of the total cores on flakes. However, Levallois blanks were also re-exploited. Another point is that secondary flakes were mostly removed from unmodified blanks at the expense of those struck from modified blanks, forming 34.2% of the total. The relation between the selected dorsal surface and the convexity of the blank can lead to very important observations.

5.3.1. Selection of the flake and setting up the flaking surface

The exploitation of the flake's dorsal surface is dominant. As mentioned before, this can be interpreted as knappers intentionally choosing the appropriate convex surface and setting it up as a flaking surface. Exploitation of the ventral surface of the cortical flake is the next most frequent, indicating intentional selection of the cortex-free surface to economize on raw material. Furthermore, while 40.6% of the total show secondary flakes were removed from the proximal part and 28.1% from the distal part of the dorsal surface, 21.8% of the core on flakes were exploited from the proximal part of the ventral surfaces. This underlines the importance

of the proximal part, whether on the dorsal surface or ventral surface for reduction, because it is often the thickest part of the blank.

5.3.2. Dimension

The selected flakes were not confined to a specific range of sizes. They exhibit various dimensions (Fig. 34). Exploitation was more specifically linked to the thickest part of the flake. This corresponds with the concept of selecting the adequate volume for exploitation – the thickest section was used intentionally as it is the most exploitable section (Fig. 35). In a specific example, sections of cores on flake manifest different thicknesses. While the exploited section is the distal termination of the blank 23 mm, the thinnest section is the proximal section 5 mm. In this instance it can be asserted that the knappers intentionally chose not only a thick flake but also the thickest section of the flake even though it is located at the distal termination. This correlates to the point of view of both Bar-Yosef and Meignen (1992; 175) "*it is understandable why the prehistoric knappers have additionally exploited flakes as cores by taking advantage of the natural convexity of their bulbar face*".

Logically, most flakes show feathered terminations, specifically the end-products. Accordingly, the proximal part of flakes where the bulb is the thickest and the most convex section can be allowed for creating a suitable striking platform angle (Fig. 32-33) from which a secondary flake can be struck.

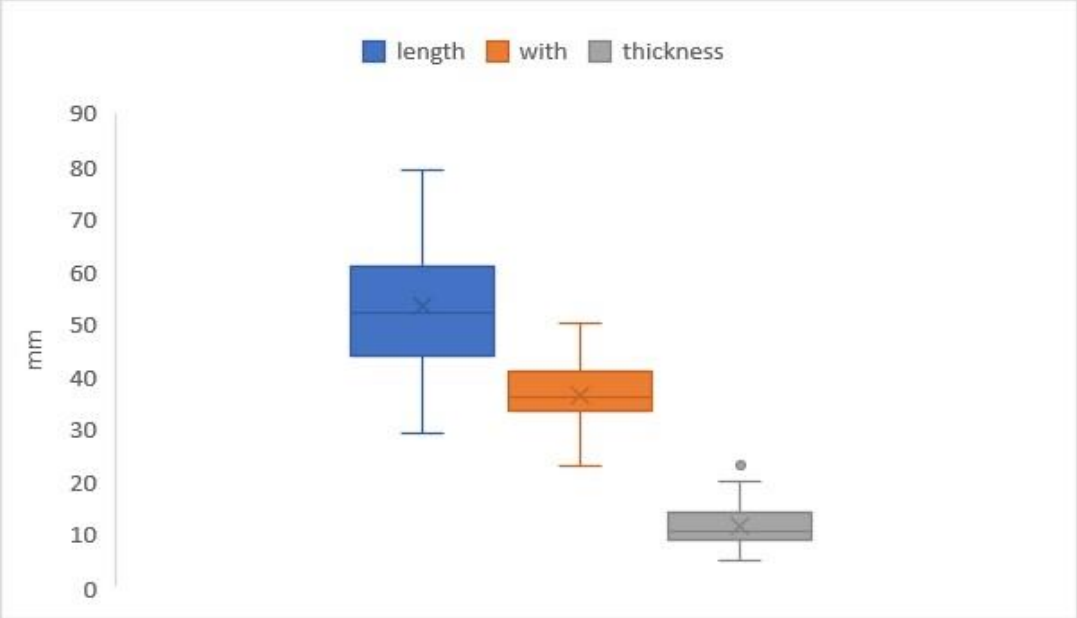


Fig. 34 shows the minimum, maximum and mean values of the cores on flakes.

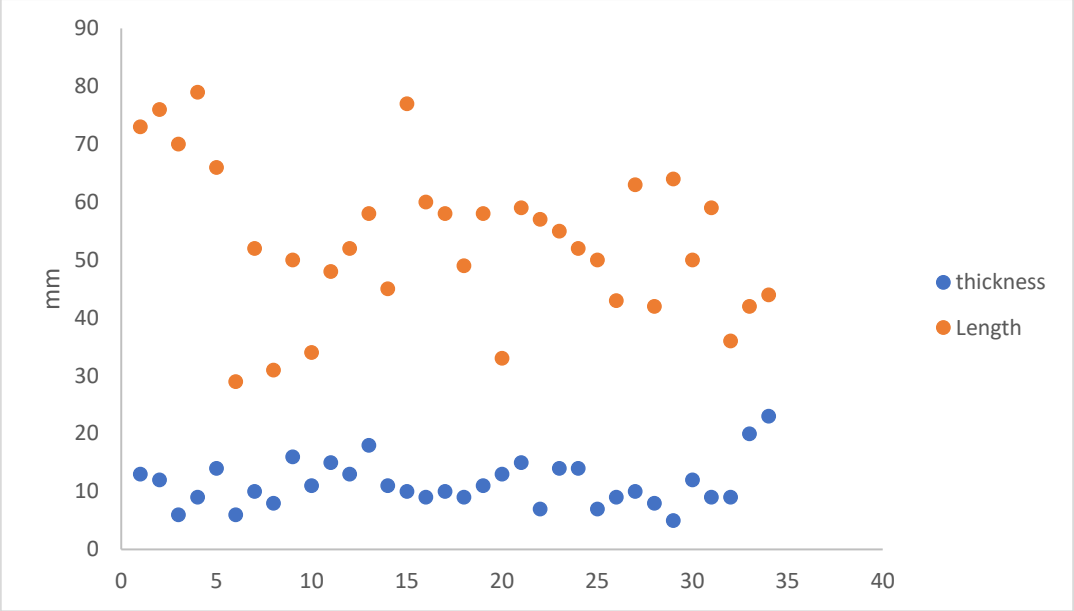


Fig. 35 shows the various lengths and the almost standard thickness of the cores on flakes.

5.3.3. Exploitation

According to the last removal on cores on flakes, the secondary flake is the most obtained, making up 82.8% of the total. Secondary bladelets were rarely obtained, constituting 17.1% of the total, mainly removed by the *Nahr Ibrahim* Technique. In contrast, points were never produced. In fact, this corresponds with the proportion of Levallois flakes produced in assemblage 6. Furthermore, it is worth noting that all of the secondary blades were struck from elongated blanks. This correlation asserts that the shape of the core plays a big role in identifying the shape of the end-product (Boëda 1995).

The predominance of dorsal surface exploitation matches ultimately with the scarcity of Kombewa or Janus flakes. Moreover, the majority of cores on flakes exhibit hinge fractures, at 74.2% of the total. Consequently, this high percentage of accidental knapping could be attributed to the low impact point. Unsurprisingly, 65.7% of the cores on flakes were designed to obtain two or three secondary removals showing a mean size of 55.1 × 35.3 × 11.6 mm, which resemble small Levallois flakes, whether as end-products or negatives on discarded cores. Furthermore, 34.2% of the cores on flakes exhibit the negative of a single secondary removal bearing a mean size of 51.0 × 37.8 × 10.0 mm. Accordingly, the productivity of the cores on flakes does not relate to the size of the flake. This can, however, be associated with the needs of knappers.

Consequently, it can be assumed that quantitative and qualitative attributes of the secondary removals, as well as the criteria of reduced cores on flakes, indicate that specific

flakes were selected in order to meet the knapper's urgent needs. Because about 60% of the cores on flakes carry a double patination (Fig. 31) and sometimes even triple patination (Fig. 146) indicating the frequent reuse of these artefacts despite the local dispersal of the raw material. In addition to intentional recycling in this assemblage, affirming economical purposes, it can be suggested many behavioural episodes, or at least many events in different periods were carried out.

Since the *Nahr Ibrahim* technique is predominant, the striking platforms of most cores on flakes were prepared by the removal of small scars from the ventral surface to create an appropriate platform angle between the two surfaces. Several specimens are paired with faceted platforms. Moreover, 62.5% of the cores on flakes, which were prepared with the *Nahr Ibrahim* technique at the proximal part, have lost the bulb as a result of preparing the striking platforms. The platform angles range between 60 and 75°, identical to the range measured for Levallois cores (Fig. 32-33).

5.3.4. The similarities of reduction criteria between the strategies of Levallois methods and core on flake

After agreeing that *Nahr Ibrahim* tools and truncated-faceted blanks are similar in terms of the reduction process, the researchers went deeper into the process of core on flake reduction in order to compare it with other core reduction strategies. Hovers (1997, 2007; 50, 2009) compared the similarities between the criteria of the Levallois method and the core on flake reduction strategy. She indicated that core on flake reduction fulfills particularly the first and third criteria of the Levallois concept given the flake has two distinct, more or less parallel, surfaces, thus complying with the volumetric configuration of Levallois cores.

In total accord with Hover (2007), I think that the exploitation of any raw material has to undergo similar criteria of exploitation but in different ways. However, specific criteria could be skipped if they are already available in the raw material. To clarify this point, we will verify the differences and similarities between the exploitation processes of core on flake and Levallois strategies. Consequently, we think both reduction processes follow the same reduction stages as following:

- Selecting the raw material: regardless of the type of raw material – nodule, blank, or fragment – it can be exploited as long as it has an adequate volume for exploitation (Abbes, personal discussion 2017).

- Installation of the flaking surface: the flaking surface of any core must be slightly convex. Therefore, knappers look for an appropriate surface as a flaking surface. The Levallois core on the nodule core can be prepared in order to establish the flaking surface and striking platform. The core on flake, on the other hand, already has a convex and prepared dorsal surface that can serve as flaking surface and the striking platform can be set based on the most convex and thickest part of the blank. The hierarchical shape in both types of cores is not a precondition to obtaining end-products, an example of that is that the majority of Levallois cores of assemblage 6 were exploited on flakes.
- Setting up the striking platform: both core types aim to create a suitable platform angle. The angle of the platform of a nodule core is established automatically throughout the flaking surface preparation process, whereas the angle of the striking platform of a core on flake has to be created at the moment of identifying the exploitable part, which can be established by small ventral removals. Thus, both core types aim to obtain an appropriate striking platform angle.

Briefly, based on a comparison between strategies of *Nahr Ibrahim* Technique and Levallois concept, it turns out that (Fig. 35.1):

1. Both cores exhibit two intersecting planes
2. Both cores display two surfaces, one is flaking surface and the second is striking platform. Although they differ morphologically, blanks can be produced from both strategies.
3. Both cores exhibit fracture plane that is sub-parallel to the intersection plane
4. striking platform in both cores is carefully prepared to allow a controlled removal of blanks that parallel to the intersection plane.
5. Finally, the faking surface of the Levallois core is prepared in such a way that blanks with a predetermined form can be obtained, whereas *Nahr Ibrahim* Technique cores show an intentional selection of the thickest flakes and thickest part of the flakes for exploitation (Fig. 35- 35.1).

Consequently, I assume, on the basis of the previous explanation, that the Levallois method and *Nahr Ibrahim* Technique show the same principal criteria.

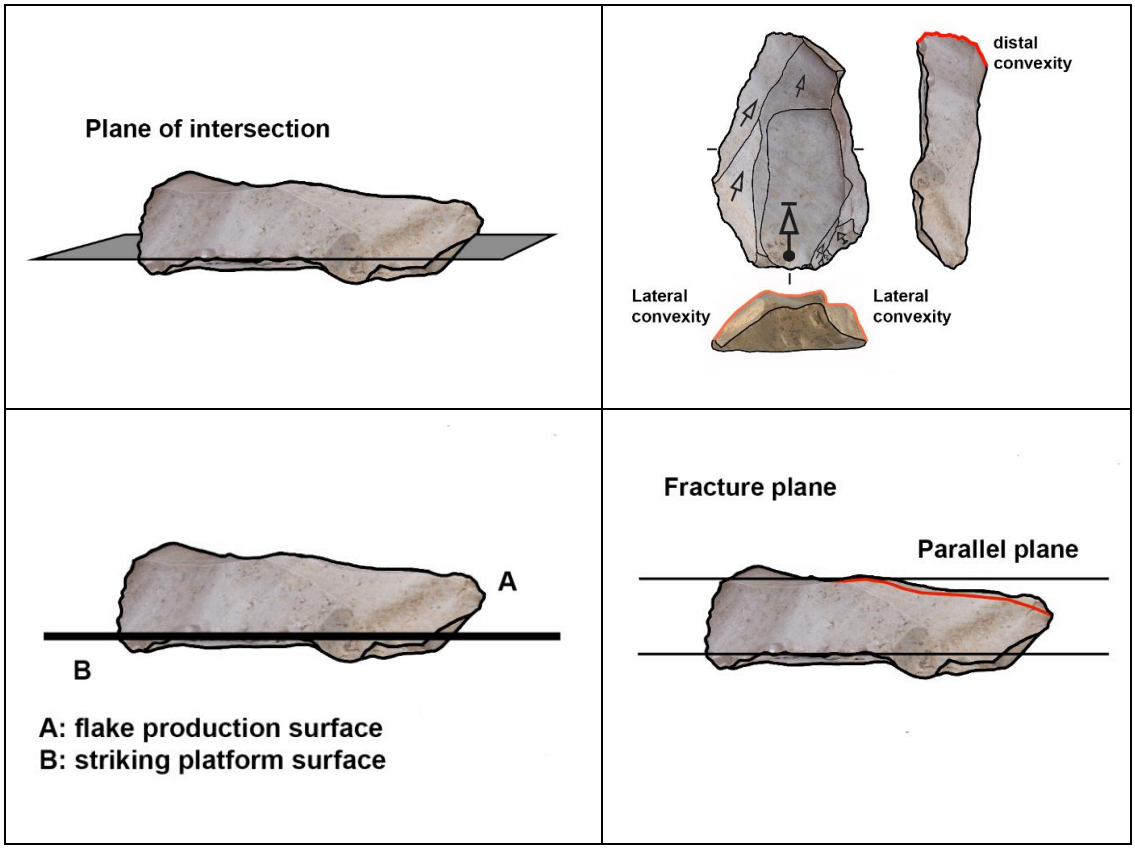


Fig. 35.1. Technical criteria of the Levallois concept elaborated by Boëda (1990, 1994, 1995; Boëda et al. 1990) applied on a flake.

Summary

To sum up, the techno-typological attributes of cores indicate that both the Levallois and the core on flake reduction strategy were applied in assemblage 6. They can be summed up under the following points.

- Human behaviour mirrors pronounced adaptation to local raw material given that blocks, discarded flakes, and bifaces were consumed in assemblage 6 of YSI. Moreover, the reduction sequence of those raw materials shows considerable organization of the volume. Especially a clear tendency towards the re-exploitation of local discarded flakes as cores on flakes, evidencing the preference to reuse local material rather than procure new nodules.

- The core reduction strategy was not confined to the Levallois concept, the strategy of cores on flakes was applied with a clear behaviour towards reducing the flakes regardless of the methods used. Furthermore, while more than half of the recurrent Levallois cores were executed on thick cortical flakes, the majority of preferential Levallois cores were applied to blocks. The reason could be that the recurrent Levallois methods are more productive, since several removals can be produced from a single

prepared flaking surface, while only a single removal can be obtained from a single prepared flaking surface using the preferential method. The discarded cores for flakes, whether Levallois or on flakes, are dominant. Both preferential and recurrent Levallois methods were used to obtain Levallois flakes with a clear predominance of the recurrent Levallois method. This strategy for the exploitation of thick cortical flakes has been seen in layer B1 of the Levantine Amud cave. The ventral faces of large, cortical hinged flakes that have first been removed from a nodule, were used as a flaking surface for Levallois removals (Hovers 1998;147).

- A clear variability in the use of preferential Levallois cores, where the last removals confirm striking Levallois points and Levallois flakes. This can be derived from the last stage of core reduction; however, the reduction of preferential Levallois cores for flakes is more common. In contrast, the recurrent convergent method was clearly reduced to obtain Levallois points. However, there was no unified type of flaking surface preparation, so a clear strategy for preparing the flaking surface cannot be identified. However, the distribution of the scar patterns asserts that the cores were addressed based on the condition of the flaking surface.
- The recurrent centripetal Levallois method is the most used method for producing Levallois flakes. Furthermore, they exhibit either a peripheral striking platform associated with a high number of small scar patterns on the flaking surface or two or three discontinuous striking platforms, which is linked to a smaller number and larger scar patterns. Accordingly, the density of flaking surface scar patterns is linked to the distribution of striking platforms and *vice versa*.
- Scarcity of the Levallois cores for blades attests to a single type of preparation relying on detaching small semi-centripetal or perpendicular removals from the core's distal termination and lateral edges.
- The fact that several factors compelled knappers to discard cores. While about 85% of all Levallois cores were discarded due to reaching the size threshold for Levallois blank production, around 59 x 57 mm (Fig. 22, 24 and 26), which resembles the size of cores on flakes, the others were abandoned due to the lack of adequate thickness combined with knapping accidents that appeared frequently. Accidents were observed on 82.1% of Levallois cores. These are principally hinge accidents and the cores would have lost their volume if they had been re-prepared (Fig. 27–28).

- In contrast to one of the six criteria of the Levallois concept defined by Boëda (1995), which states that the core has an unchangeable platform and debitage surfaces during exploitation, a quarter of Levallois cores, specifically those executed on blocks, showed evidence of deep thought and rapid response to the change of convexity criterion of the flaking surface at the last stage of core reduction and before their discard, through a shift to exploiting the lower surface that bears a ready convexity for flake production.
- The strategy of flake reduction is more prevalent than the strategy of Levallois core reduction, and the *Nahr Ibrahim* technique is the most frequent technique for obtaining secondary flakes in assemblage 6. They are mostly made on by-products. In fact, it can be assumed that specific criteria compelled the knappers to select these elements, such as suitable thickness for flaking and specifically, the thickest part and the most convex section of flakes, which is usually the proximal part where the bulb is. Consequently, it allowed the creation of platform angles that are identical to the range measured for Levallois cores. The clear occurrence of double patination and triple patination is evident for the palimpsest of multiple usages.
- Given that the *Nahr Ibrahim* and Levallois methods hold common criteria for reducing material, the *Nahr Ibrahim* technique can be considered a Levallois strategy but on flakes. However, we have to investigate whether the aim of the core on flake strategy was to produce a predetermined end-product. From my perspective, the Levallois concept is only part of a much broader continuum of similar technological concepts. Any technological concept relies on the availability of two surfaces, regardless of if they are parallel or perpendicular. Furthermore, one surface has to fulfil the conditions of adequate convexity and right angle to allow the production. The other surface can be set up as a striking platform.
- The strategy of biface reduction was observed to produce flakes, points, or blades. The fact that this strategy, combined with the overwhelming number of cores on flakes and the reducing majority of Levallois cores on thick flakes, attests to the clear behaviour of reusing discarded lithic material.

5.4.The characters of cores and Levallois blanks

Analyses of several variables (e.g. scar patterns, types of striking platforms, size, and amount of cortex) of blades, flakes, points, and cores aim to figure out the relationship between them,

and hence, to discern and reconstruct the reduction sequences through following the pathway of each product. However, it must be mentioned that the subheads included only "Levallois blanks" as the vast majority of debitage was produced by the Levallois method and it is difficult to distinguish between the debitage of the Levallois method and core on flakes since they have the same size values, except for Kombewa flakes. When the need arises to differentiate between them, it will be referred to in the context.

5.4.1. Dorsal scar patterns of Levallois blanks and cores

The final stage of core reduction could be completely different from the original strategies (Hovers 2009). However, the scar patterns together with sizes of the end-products could identify the early stage of the core reduction process (Bar-Yosef & Meignen 1992).

Although, according to the available Levallois blanks in assemblage 6, which form 37.8% of the total lithic material, the tendency was not oriented exclusively towards Levallois point production, unidirectional convergent scars are the most frequent scar patterns accounting for 56.5% of the total. Furthermore, this is not consistent with the predominance of discarded Levallois cores for flakes, especially centripetal Levallois cores. This obvious difference in variables poses logical questions. Why is this discrepancy present and what can it tell us? The only possible interpretation is that cores attested to a change in blank production along with the reduction sequences. In other words, it looks like the reduction sequence began with Levallois blade or point production and ended with flake production. This would leave the lithic material with very few discarded cores for blades, some cores for points, and a lot of cores for flakes. These expectations will be answered in context.

Table. 10 shows the frequency of unidirectional convergent scars, mostly on Levallois points, elongated points, and triangular points, followed by Levallois flakes and finally Levallois blades. 76% of all Levallois points display converging removals struck from the basal striking platform, whereas 24% exhibit small bidirectional or perpendicular removals, struck from the left or right core edge. In addition, Levallois flakes and blades bearing unidirectional convergent scar patterns exhibit the same type of scar pattern distribution. Elongated points show various scar patterns, ranging from unidirectional convergent to parallel with a predominance of convergent scar patterns. The fact that there are no cores proves that these elongated points have been produced separately. It is quite obvious that they have been struck from elongated flaking surfaces, either by Levallois cores for points (i.e. unidirectional convergent Levallois method) or Levallois cores for blades (i.e. unidirectional parallel method)

with a preponderance of the former. However, the LWR of Levallois cores for points (Table. 9) does appear to might be responsible for their production. This in turn hints to cores having different variables in the earlier stages of reduction. While 68.6% of the Levallois flakes and blades exhibit only unidirectional convergent scar patterns, 31.3% of them show convergent scar patterns with small bidirectional or perpendicular removals struck from the left or right core edge. This confirms that these Levallois blanks might have been by-products of Levallois point production.

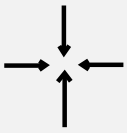
Direction of scar patterns	N.	End- products	total
	62	Levallois points	134
	27	elongated points	
	17	triangular flakes	
	21	Levallois flakes	
	7	Levallois blades	
	3	Levallois points and triangular flakes	37
	9	Elongated points	
	8	Levallois flakes	
	16	Levallois blades	
	6	Levallois points and triangular flakes	19
	8	Levallois flakes	
	5	Levallois blades	
	23 3	Levallois flakes Triangular flakes	44
	9 1	Levallois flakes Triangular flakes	
	4 4	Levallois flakes Triangular flakes	
Indet.	3		3

Table. 10. Frequency of unidirectional convergent scar patterns on Levallois end-products.

Consequently, these scar pattern types correspond with both types of flaking surface preparation of Levallois cores for points mentioned before, which shows a flexible style of preparation according to the status of the flaking surface.

Centripetal, semi-centripetal, and perpendicular scar patterns, taken together are the most frequent scar patterns on Levallois flakes, indicating that they were mostly produced by the recurrent centripetal and preferential methods. This corresponds with the dominance of discarded recurrent centripetal Levallois cores. Furthermore, the frequency of Levallois flakes bearing bidirectional scar patterns is low to moderate, indicating that they were struck from recurrent centripetal Levallois cores with two opposed striking platforms. This is consistent with the discarded centripetal cores that show two opposite striking platforms. Moreover, the frequency of the unidirectional parallel category is also low to moderate. This can be evidenced by the scarcity of discarded cores for flakes with one striking platform. Finally, preferential scar patterns are quite low, corresponding with the few appearances of preferential Levallois cores for flakes.

The predominance of centripetal, semi-centripetal and perpendicular scar patterns on Levallois flakes is consistent with the most frequent cores (i.e. Levallois cores for flakes). However, the frequency of these scar patters does not mirror the dominance of Levallois cores for flakes. This hints again to a fluctuation in blank production through the reduction sequences. Despite the scarcity of Levallois cores for blades, the frequency of unidirectional parallel scar patterns is present among other categories. Although assemblage 6 lacks bidirectional Levallois cores for blades, the frequency of the bidirectional category was also observed. This could be also evidence of change in the flaking surface method during execution of unidirectional parallel core reduction.

It is worth noting that 63.8% of all Levallois blanks bearing unidirectional-parallel scar patterns did not exhibit scar patterns of flaking surface preparation, whereas 36.1% of them show scar patterns of flaking surface preparation limited at the distal termination of the elements. This implies that Levallois cores for blades have not undergone lateral preparation in most cases, rather the flaking surfaces were prepared unidirectionally. Hereby, the by-products (i.e. natural backed knife) show unidirectional parallel scar patterns as well, which confirm that knappers have mostly preferred to prepare their cores unidirectionally. The low percentage of Levallois blades showing preparatory perpendicular and bidirectional scar patterns on the distal termination also corresponds with the last stage of core reduction. This implies that the cores for blades were prepared differently at the last stage of core reduction.

Alternatively, they might have been transformed subsequently into Levallois cores for flake/point production.

The mean number of scar patterns recorded on all Levallois blanks is high at 5.5, with variations from 5.5 (Levallois points) and 5.6 (Levallois blades), to 6.3 (Levallois flakes). Although the nuance in the mean number of scar patterns between three Levallois blanks is obvious, they have been mostly removed at the third or second stage. For instance, 36.2% of Levallois blades exhibit small lateral or opposite scar patterns as a result of the reparative process. These small scars are limited to one side of the Levallois. This implies that a clear proportion has been struck from a single side of the flaking surface, suggesting they are either second or third removal.

According to the techno-typological analyses of the Levantine MP, the unidirectional convergent method is linked to sites dated between 70 ka and 50 ka, such as Hummal HM-A1 (Hauck 2011) and Dederiyah cave in Syria (Akazawa et al. 1999), Amud (B2 and B1) and Kebara (especially units X–IX) in the Mediterranean zone (Meignen & Bar-Yosef 1992; Hovers 1998, 2009;267–273; Valladas et al., 1999), and Tor Sabiha and Tor Faraj in the south of Jordan (Henry 1995a and b; Henry & Miller 1992; Groucutt 2014).

To sum up, the distribution of scar patterns of Levallois blanks indicates that knappers mainly relied on the unidirectional convergent and parallel methods to produce Levallois points (elongated or not) and Levallois blades, even for reinstallation of the flaking surface. Furthermore, the flaking surface was mainly prepared by detaching unidirectional and elongated removals. However, it also shows non-standardized preparation types through small perpendicular or bidirectional removals, which could be limited at the last stage of core reduction. Furthermore, although the convergent scar patterns are dominant, Levallois cores for flakes are the most frequently discarded cores. This in turn hints to changes in the flaking method during reduction sequences. Another interpretation is that hunter-gatherers carried the Levallois cores for points while moving around in order to obtain more points for off-site activities. This corresponds with the common tendency of Levantine core reduction. The sizes of blanks can interpret these changes.

5.4.2. Maintenance of striking platforms

As can be seen in Fig. 36, the striking platforms of Levallois blanks are diverse. However, the majority of striking platforms are well prepared (faceted and dihedral platforms) accounting for 72.5% of the total. These butts are related to percussion with hard hammers and mirror very

intensive and intentional preparation of the core's striking platform (i.e. faceted butt). The faceted platforms are mostly related to Levallois points and triangular flakes, and Levallois flakes, 60.1% and 31.7% respectively. Only 8.0% of the total faceted platforms distribute to Levallois blades. This suggests the production of Levallois points and flakes may have required a more precise impact point, thus more faceted platforms.

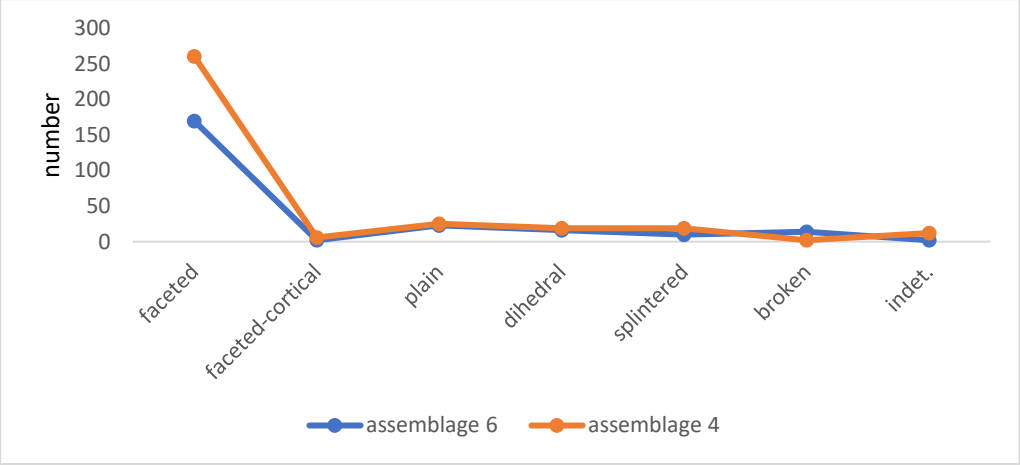


Fig. 36. Predominance of faceted striking platform of Levallois blanks.

Chapeau de gendarme is the most frequent butt type (Fig. 37). Both categories (i.e. faceted butt and *Chapeau de gendarme* type of butt) serve to control the energy of the blow during detachment, and the protrusion plays the main role in determining a specific and preferential impact point, giving better control over blank removal (Inizan et al. 1995). While the *Chapeau de gendarme* is mostly characterized on Levallois points and flakes, various types of butt characterize the Levallois blades. It is worth noting that faceted and dihedral platforms were noticed on by-products as well accounting for 41.5% of the total by-products. This implies that knappers needed to determine the impact point precisely before removing by-product, given that the more prepared the platform, the more successful the target removal.

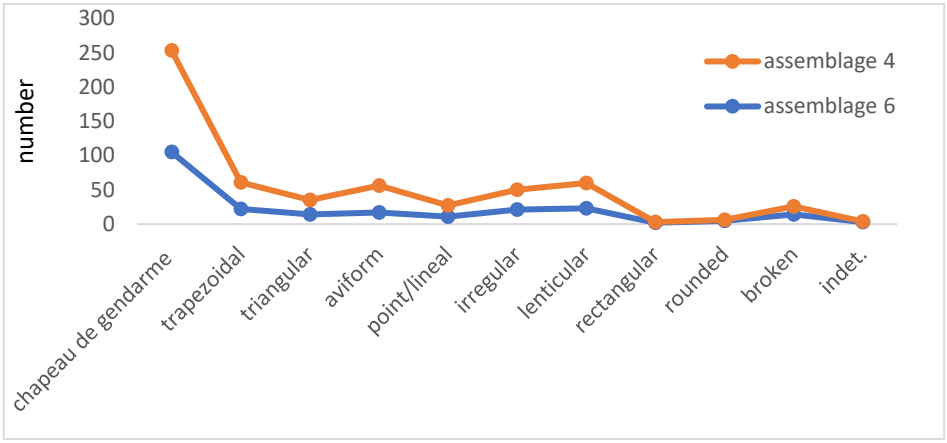


Fig. 37. Frequency distribution of types of butt of Levallois blanks with clear predominance of *Chapeau de gendarme*.

Although the faceted butt is the most applied type, it was not the only type that Levallois blanks paired with. 17.8% of Levallois blanks displayed faceted cortical, plain, and splintered butts. This indicates that they did not need to be prepared in some cases (i.e. plain butt type) and in a few cases they were removed from the core early on (i.e. faceted- cortical). However, the scarcity of these butt types hints that knappers tended towards exploiting local material that had already been discarded or importing prepared cores.

Although the frequency of the plain butt is not clear, it is basically associated with Levallois blades and flakes, except for two Levallois points. This enhances the theory that faceted butts are extremely related to Levallois point production in the assemblage. It is also another argument for the prevalence of blade production rather early in the reduction sequence, since 24.1% of Levallois blades exhibit plain platforms that are related to the initial stage of core reduction.

Unsurprisingly, as can be seen in Fig. 38, the widest butt is linked to the *Chapeau de gendarme* type, as this is a general feature of these kinds of butts due to the typical length-width-ratios of Levallois end-products. However, it is not the thickest type. The lenticular type is the thickest butt and it exhibits the widest base after *Chapeau de gendarme* and irregular butts. A single Kombewa flake exhibits a faceted butt, whereas the other two flakes display broken and cortical butts. The latter suggests that these flakes were struck from cortical flakes without the preparation process. This implies needs being met urgently or more conveniently when they were at hand.

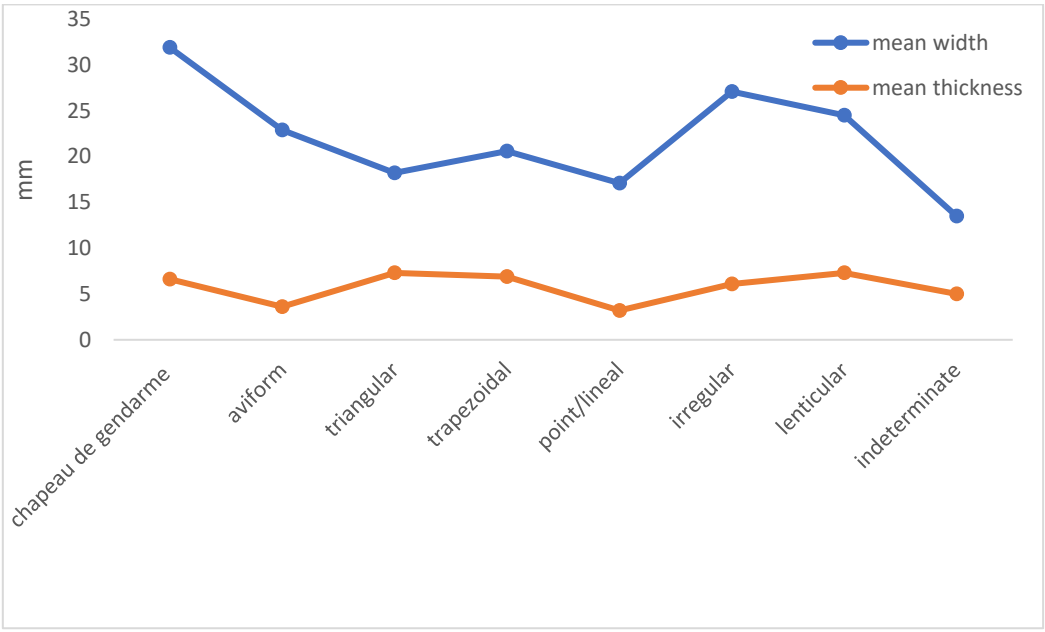


Fig. 38. The mean width and thickness of striking platform types.

The discarded Levallois cores and cores on flakes mainly show faceted striking platforms often combined with *Chapeau de gendarme* butts, while plain platforms were observed more rarely, especially the *Nahr Ibrahim* Technique. This corresponds to the high representation of the faceted butt in Levallois blanks. In addition, it is evidence of the ability of knappers to prepare the striking platform despite the tiny cores at the last stage before core discard. Furthermore, it underlines the importance of having a well-prepared platform when the core is already small, helping to determine a more accurate impact point. All of the cores present striking platform angles suitable for further exploitation, with a mean of 70°. However, the cores were usually discarded due to the size threshold. In addition, the flaking angle of Levallois blanks is quite standard, with a mean of 102° indicating high control of the impact point.

5.4.3. Quantity of cortex on Levallois blanks

Assessment of human activities, whether outside and inside the site, based on the amount of cortex on the blanks of the Yabroud material is a confusing matter. This is confounded by the fact that Rust may have selected the lithic material based on what he could carry on his bicycle to Nebek (Solecki & Solecki 1966; 126). However, an estimation of human activities can still be made based on the stone artefacts available.

While the majority of Levallois blanks show cortex-free dorsal surfaces, accounting for 83.5% of the total, the cortex covers an isolated patch of the other Levallois blanks, with only 16.4%, except for a few triangular flakes showing a cortex reaching 70–90% of the dorsal surface (Fig. 39). However, these exhibit cortex-free edges. This suggests that the cortex did not prevent the use of the artefact. It is worth pointing out that 47.3% of the cortical Levallois blanks bear partially cortical edges that have not hampered the function of the Levallois blanks. However, the partially cortical edge may have been invested to facilitate the process of holding the blanks. Consequently, the partially cortical Levallois blanks suggest that their production was sometimes initiated in a quite early stage of core reduction. This, in turn, corresponds to the appearance of Levallois blanks with faceted-cortical butts.

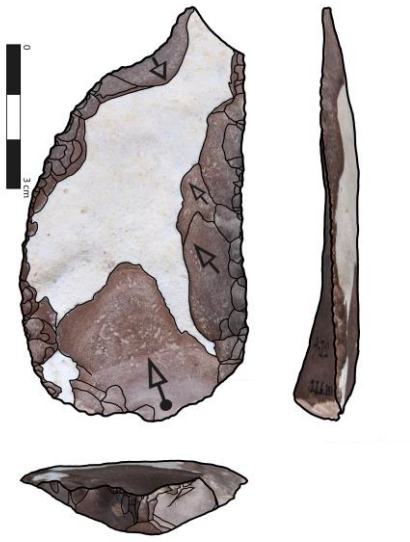


Fig. 39. The cortical part of the Levallois flake did not hamper the function of the flake and it was retouched.

5.4.4. Size of Levallois blanks and cores

The morphometrics combined with the scar patterns of the Levallois blanks and cores can enable us to reconstruct the technological variability of Levallois blade, point (elongated or not), and flaks production and the human strategies of raw material investment in the production of each. Such variability could appear throughout the reduction sequence. In other words, the older product should be larger and reflect the core's features in the early stages, and *vice versa*.

By and large, the Levallois blanks of assemblage 6 show diverse sizes between relatively large and small (Table. 11 & Fig. 40). The discarded Levallois cores exhibit a mean size of 53.8 × 53.9 × 20.4 mm, which is consistent with the size when the last end-product has been removed (Fig. 40).

	length mean mm	**width mean mm**	**thickness mean mm**	**LWR**
Elongated points	69	29.6	7.2	2.4
Levallois blades	67.2	27.2	7.7	2.5
Levallois points	60	38.1	6.6	1.6
Triangular flakes	62	39.2	7	1.6
Levallois non- triangular	50	38	9.1	1.3
Kombewa flakes	31	19.3	3	1.6

Table. 11. The mean size of Levallois blanks and Kombewa flakes.

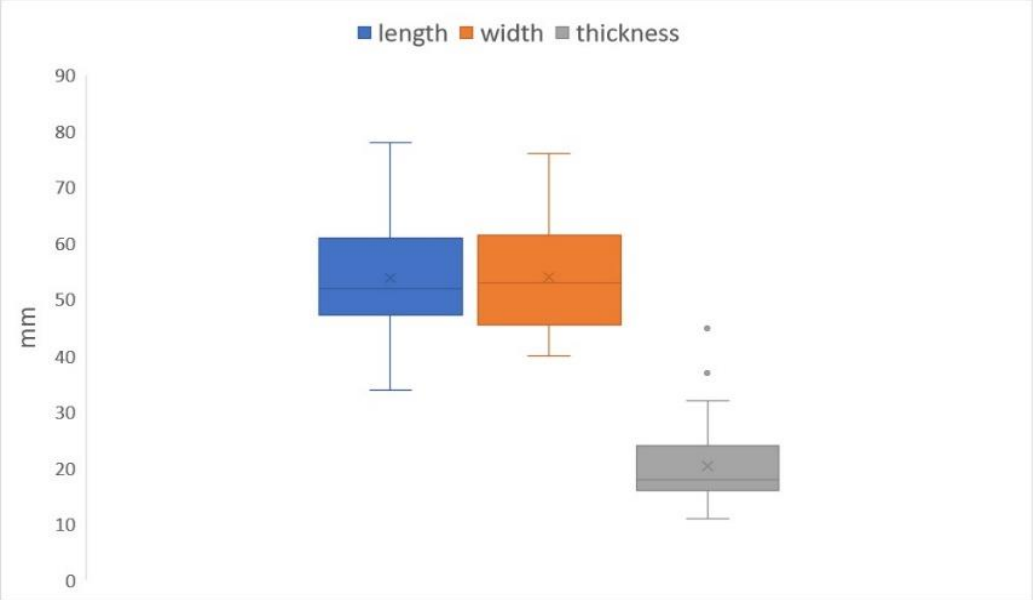


Fig. 40. The maximum, minimum and median size of Levallois cores.

The Levallois points show diverse sizes ranging from relatively large to medium to small, with an average of 58.4 x 37.8 mm. This is consistent with the diverse sizes of exhausted Levallois cores for points that show a mean size of 57.8 × 55.5 × 21 mm (Fig. 41-42).

This variety of Levallois point sizes reflects several assumptions. First, they were produced along an individual reduction sequence that started, continued, and terminated to produce Levallois points. As a consequence, they show the size of the core from the first stage of core reduction to the discard stage. Second, the sizes of the raw material used for point production might have been varied, hence the points reflect the sizes of the exploited cores.

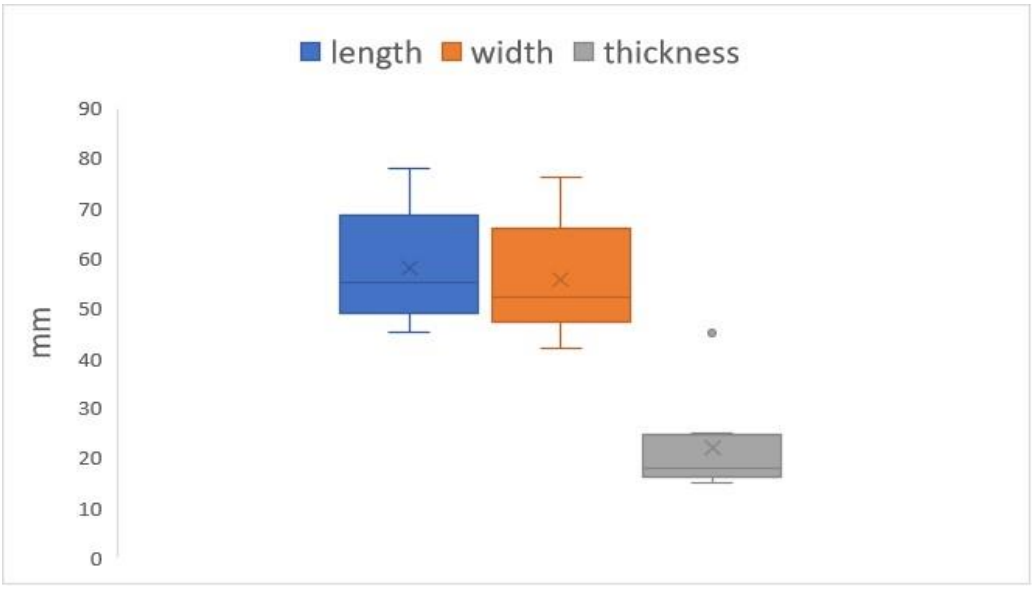


Fig. 41. Maximum, minimum and median size of the Levallois cores for points.

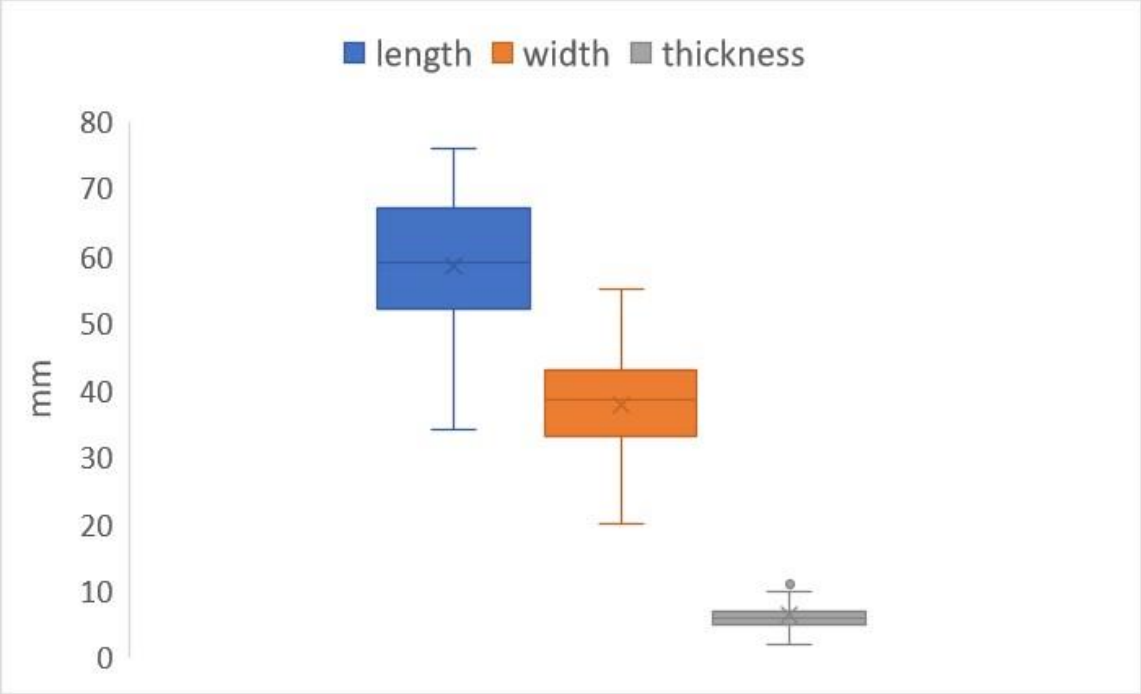


Fig. 42. Maximum, minimum and median size of the Levallois points.

Levallois blades (Table. 11) exhibit a large mean size. Furthermore, the largest Levallois blades are related to unidirectional parallel and bidirectional scar patterns, whereas the smallest Levallois blades show unidirectional convergent scar patterns with an average size of 58.5 × 26.4 × 6.8 mm (Fig. 43). Consequently, it can be expected that large Levallois blades were removed using unidirectional parallel and bidirectional methods. However, it is difficult to assume that the cores responsible for their production were exploited further along an individual reduction sequence until discard due to their large size, while small Levallois blades bearing convergent scar patterns seem to be part of Levallois point production.

Levallois points, elongated points, and Levallois blades show a high degree of similarity, both in terms of mean size and distribution of scar patterns. This could be an indication that their production was frequently executed at a certain size of core, especially, elongated points and Levallois blades from a single reduction sequence. Indeed, Levallois points (elongated or not) together with Levallois flakes were the main targets of core reduction in assemblage 6. However, the similarity in size between elongated points and Levallois blades suggests a correlated relationship between these products. Furthermore, the mean LWR values (Table. 11) of Levallois points (elongated or not) and blades demonstrates the slight tendency of the knappers towards extracting elongated products. In contrast, the LWR of the Levallois cores for points and blades present low values (Table. 9). This implies that the first stage does

not correspond with the last stage of core reduction. Thus, I suspect that the reduction sequence was changeable.

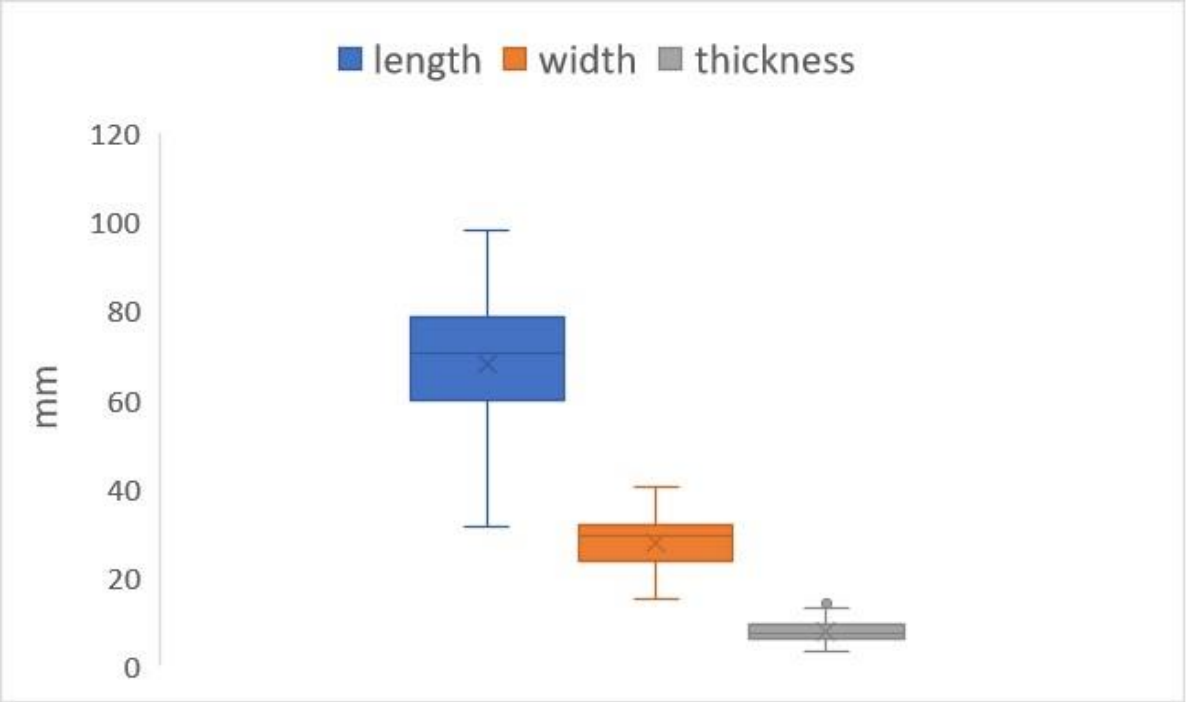


Fig. 43. Maximum, minimum and median size of the Levallois blades.

Only a few Levallois flakes are large, with the majority of them relatively small (Fig. 44). Furthermore, a comparison between the mean size of the triangular flakes and non-triangular flakes (i.e. quadrangular, rounded/oval, polygonal, and irregular) (Table. 11) shows that the triangular flakes have a larger mean size than the non-triangular flakes. This may relate to the size of cores at the moment of core reduction. In addition, the mean length and width of the last removal on the Levallois cores for flakes (Table. 9) are consistent with the smallest Levallois flake that is 30.0 × 36.0 mm.

The number of Kombewa flakes compared to their cores on flakes is relatively low, accounting for only 3 Kombewa flakes. On the other hand, 10 cores on flakes are recognized, identified by the reduction of the flake's ventral surface. Their size is relatively small, which is consistent with the size of their cores. Their mean size is not comparable with the Levallois flakes due to the threshold size of flake production. It is worth noting that their LWR shows similarity with Levallois points and triangular flakes, which is a clear tendency toward producing slightly elongated shapes and this corresponds with the policy of blank production in assemblage 6.

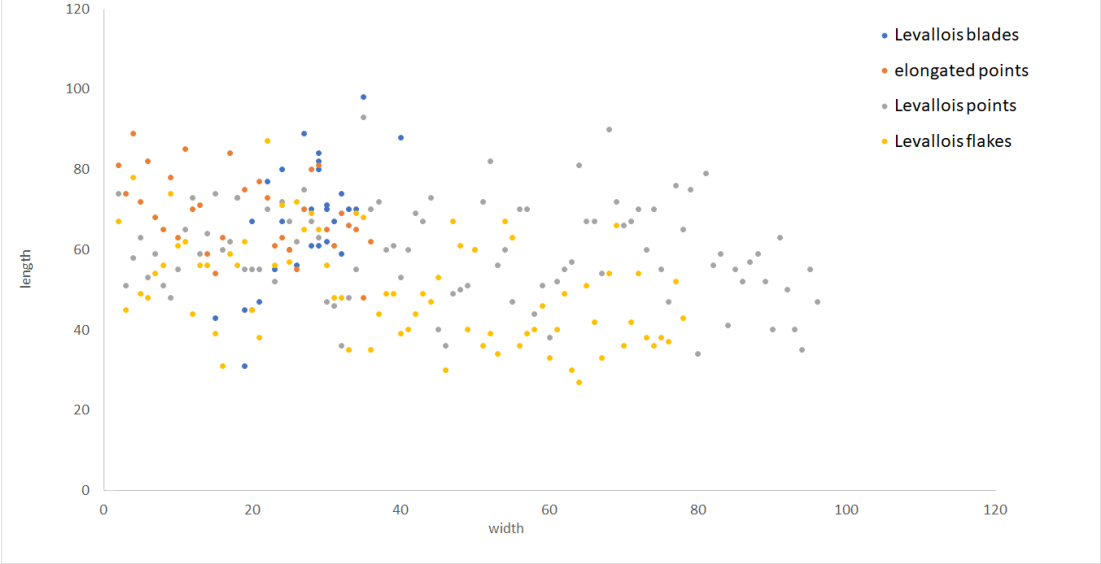


Fig. 44. The distribution of the different sizes between Levallois blanks.

To sum up, the variables of Levallois blanks and their cores are not consistent and do not imply a stable reduction sequence. In fact, in many cases they contradict. For instance, the predominance of unidirectional convergent scar patterns on Levallois blanks combined with the dominance of centripetal cores for flake production. Furthermore, the LWR ratio of the cores does not suggest they are responsible for blade and elongated point production. The combination of large Levallois blades with unidirectional parallel scar patterns on one hand, and the scarcity of small Levallois blades with unidirectional parallel on the other, proves the gap or change in the reduction sequence. The scarcity of Levallois cores for points compared to their products also asserts a change in the technology. These discrepancies are going to be filled in the strategies of blank production.

5.5.Strategies of blank production

5.5.1. Levallois point reduction strategies

Levallois points, triangular flakes, and elongated points together outnumber Levallois flakes and blades, accounting for 55.4% of all Levallois blanks (Fig. 45). Within the first category, broad-based Levallois points outnumber elongated points, at 66.0%, and 33.9% respectively. When viewed separately, broad-based Levallois points and triangular flakes outnumber Levallois flakes despite the predominance of Levallois cores for flakes.

As mentioned previously, Levallois points can be produced by both Levallois methods, recurrent unidirectional convergent and preferential, according to the technological attributes of the cores. Therefore, both constructed and classical Levallois points were observed,

representing 67.6% and 32.3% respectively. This in turn reflects the predominance of unidirectional convergent Levallois cores.

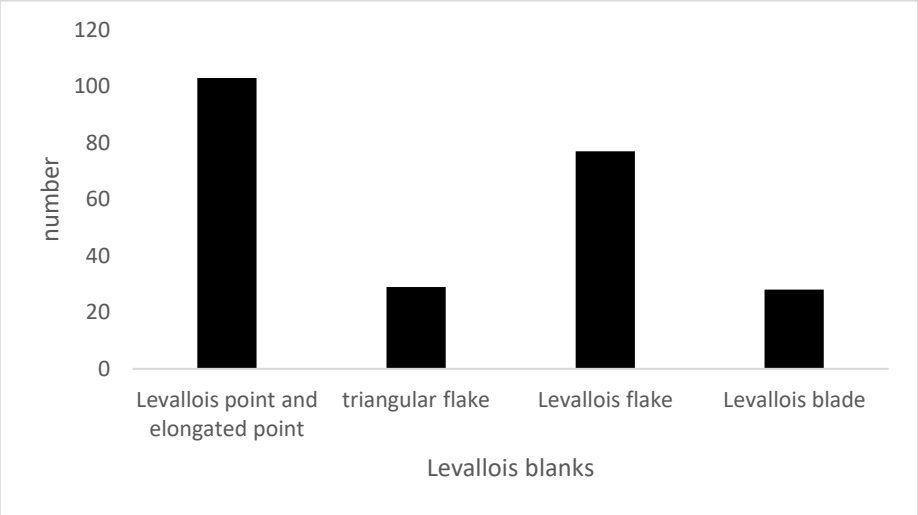


Fig. 45. The distribution of Levallois blanks.

Constructed Levallois points with more than three scar patterns exhibit relatively high numbers, with an average of 5.5. In 54.3% of the total, the scar patterns were struck from the lowest part of the convergent cores. 45.6% display small bidirectional or perpendicular scar patterns on the distal part of the Levallois point. The latter reflects the preparatory process of the flaking surface. Small bidirectional or perpendicular scar patterns on the distal parts of Levallois points are limited mainly to one side, either the left or the right section. Interestingly, discarded unidirectional convergent cores exhibit the same scar pattern distribution.

Consequently, the features of these Levallois points combined with the technological attributes of the Levallois cores for points indicate that two different types of flaking surface preparation were applied. The main type was prepared by detaching elongated lateral removals. The secondary type was executed by detaching small removals from the core's distal termination. The shift to bidirectional or perpendicular preparation was not regularly and continuously executed and the only objective was to reinstall flaking surface convexity. However, it was systematically applied in necessary cases. We can therefore interpret that these types of preparation were carried out as alternative solutions, either when the whole flaking surface lacked comprehensive convexity (laterally elongated removal) or only when it lacked partial convexity at the distal part (bidirectional and perpendicular removal). This in turn reflects how skilled knappers were in meeting their requirements.

Most of the constructed Levallois points are asymmetric, accounting for 68.8% of the total. Their longitudinal axis varies mainly between *Concorde*-shaped distal termination and a

curved longitudinal axis, representing 42.2% and 40% respectively. *Concorde* -shaped distal termination is mostly limited to a single edge. When it comes to their butts, the majority show a faceted base. These faceted butts are mostly associated with the *Chapeau de gendarme* type, constituting 76.3% of the total. 17.3% exhibit various types of butt (Table. 12). In addition, the largest butts are associated with the *Chapeau de gendarme* type. However, the greatest width is not at the base of constructed Levallois points in 67.3% of the total. This may associate with the types of flaking surface preparation that have not aimed to maintain the greatest width of cores at the base, in order to obtain the most broad-based Levallois points as possible as they could. Consequently, it can be assumed that executing unsystematic preparation types resulted in very diverse morphological, technical and metric characteristics of Levallois points (Fig. 46), for instance, majority of Levallois points show the highest width at different parts of the points and not exclusively at the base.

Only 22 Levallois points bear three overlapping unidirectional convergent scar patterns (Fig. 47). Half of these points lack at least one of the typical textbook features: (a) a regular triangular outline, (b) highest width at the base, (c) *Concorde*-shaped distal termination, (d) Y-type dorsal scar pattern formed by three overlapping negatives, and (e) a *Chapeau de gendarme* type of butt. For instance, 13 pieces lacked feature (b). In addition, 4 of the 13 pieces exhibit non-*Chapeau de gendarme* types of butt.

Butt		Assemblage 6					
		Constructed Levallois point			Elongated point		
		N	Width mean mm	thickness mean mm	N	width mean mm	Thickness mean mm
faceted	*Chapeau de gendarme*	31	35.2	6.7	12	25.5	4.9
	Other butt types	8	30.3	8	12	29.9	7
faceted-cortical		-	-	-	-	-	-
dihedral		1	29	5	4	26.3	5.6
plain		1	19	3	4	15.5	7
splintered		3	35	6.3	1	9	4
broken		2	-	-	2	-	-
cortical		-	-	-	1	13	5

Table. 12 The distribution of butt types and their sizes on Levallois points and elongated points.

As a result of the distribution of the greatest width on different parts of each Levallois point type, the knappers have not endeavoured to maintain the width of the Levallois cores during flaking surface preparation in order to constantly obtain a broad-based Levallois point. In addition, and as previously mentioned, the metric properties of Levallois points (elongated or not), blades and triangular flakes exhibit varied and high values compared to Levallois flakes (Fig. 45). This implies that Levallois point production mostly attests to the entire core reduction sequence from the first stage until the discard of the exploited core (Fig. 48).

Despite the complete absence of Levallois cores for elongated blanks, assemblage 6 shows a clear tendency to produce elongated points, constituting 34.6% of the total points that have at least a 2 to 1 length/width ratio. They present clear technological affinities with the blades and points industries. In addition, they exhibit both unidirectional convergent and parallel scar patterns forming 77.2% and 22.8 respectively. According to their scar patterns and sizes, these elongated points might have been removed from either Levallois cores for points or Levallois cores for blades. While unidirectional convergent scar patterns are prevalent among elongated points, unidirectional parallel scar patterns are dominant among backed knives. This variability may indicate fluctuations in the flaking surface preparation and reflect different skills of knappers.

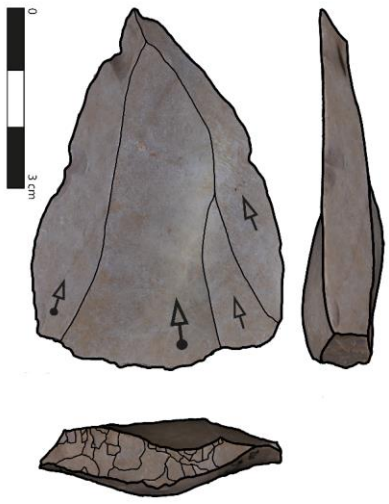


Fig. 46. Constructed Levallois point.

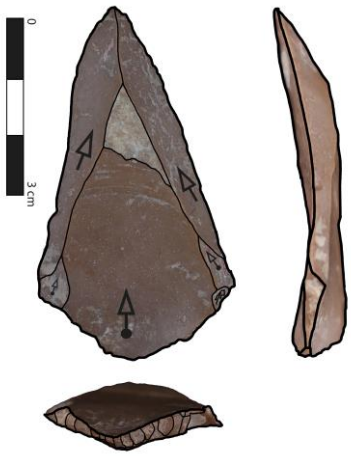


Fig. 47. Classical Levallois point.

The number of scar patterns on elongated points ranges between 3 and 12, with a mean of 5.2, which corresponds more with the number of scar patterns on Levallois blades rather than Levallois points. In addition, the metric properties of the elongated points are more related to the Levallois blades rather than the Levallois points. The majority of elongated point butts are faceted, accounting for 66.6% of the total. Furthermore, while the mean width of the butt

is 23 mm, the greatest width rarely appeared at the base, accounting for only 8.3% of all elongated points. Despite the variety of butts, the *Chapeau de gendarme* type is the most frequent (Table. 12). This suggests that elongated point production was frequently well prepared.

Although the size and elongation of the points is not related to the morphology and size of the discarded cores, Shimelmitz & Kuhn (2018) demonstrated, on the basis of their study of the material from Tabun IX, how Levallois blades, flakes, points, and elongated points could all be generated in a single reduction sequence, as well as how different areas of the Levallois surface can be utilized in order to produce a variety of products. They indicated that Tabun IX provided knappers with the ability to make a wide range of useful blanks from a single core.

Consequently, it can be assumed that Levallois blades, elongated points and Levallois points were probably occasionally produced from a single reduction sequence (Fig. 49). Specifically, elongated points and blades were removed at the early stage of core reduction for point production. Additionally, the Naturally backed knives and Levallois blades played major roles in maintaining the convexity of the flaking surface, which gave the cores more elongated shape as well. Or elongated points were produced from Levallois cores for blades that might have transformed into Levallois cores for flake production.

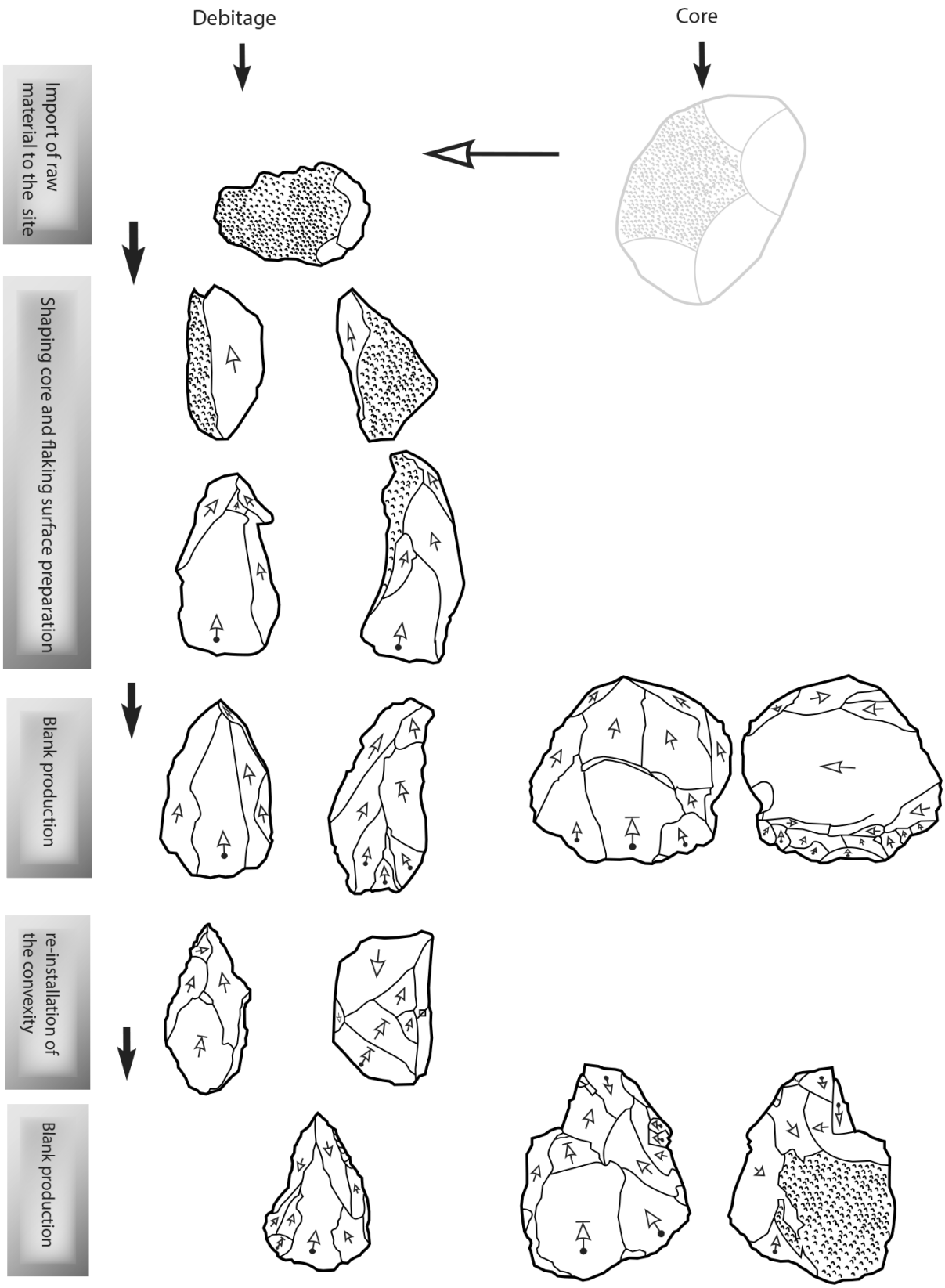


Fig. 48 *Chaîne opératoire* of the vast majority of Levallois points produced in assemblage 6.

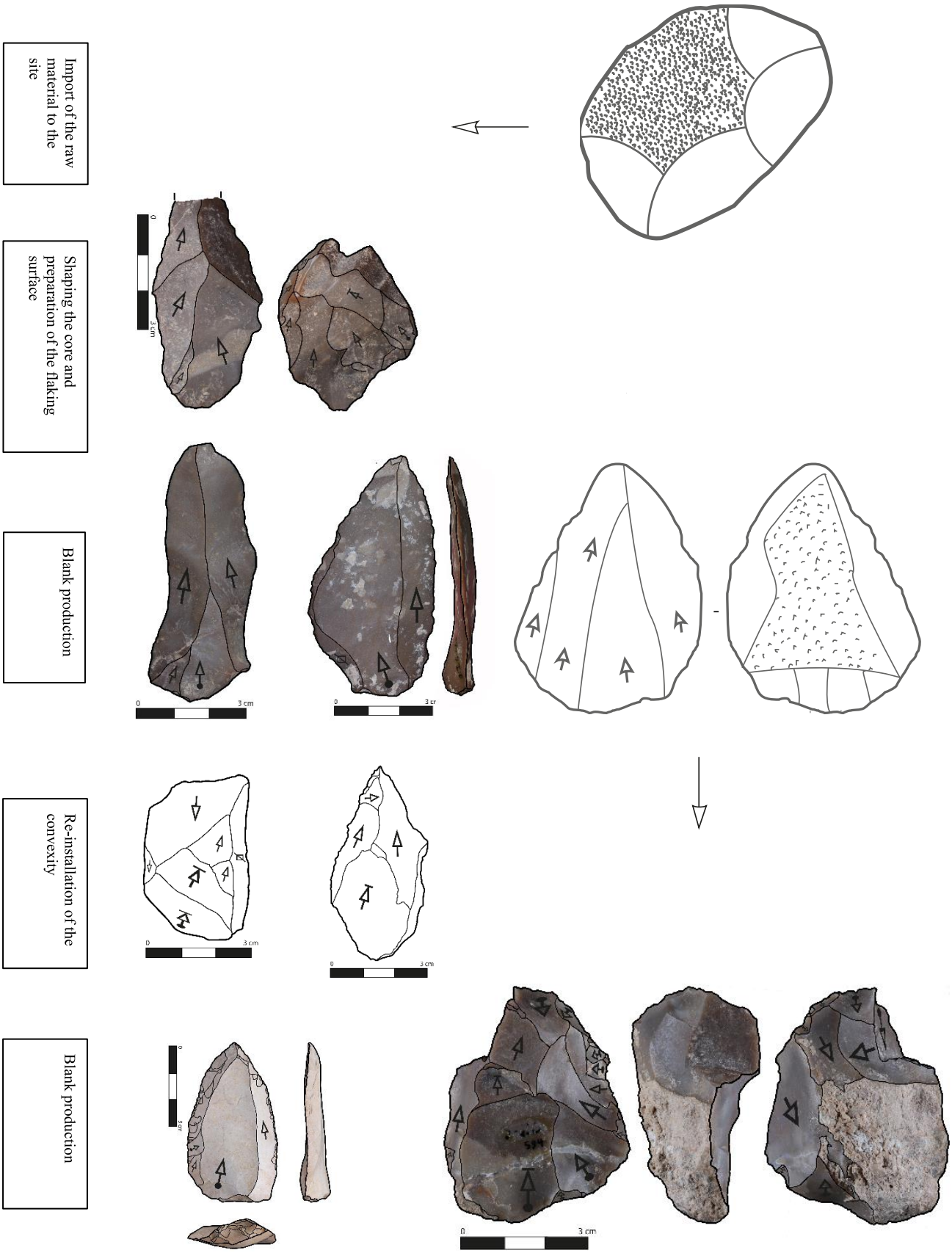


Fig. 49. Raw material unit shows *Chaîne opératoire* in which elongated points were produced at the early stage of core reduction, whereas discarded Levallois cores refer to struck broad-based Levallois points before its discard.

5.5.2. Levallois blade reduction strategies

Levallois blades are least frequent, forming 11.4% of all Levallois blanks (Fig. 45). They show a variety of scar patterns, ranging from unidirectional convergent, parallel to bidirectional, with a clear dominance of unidirectional parallel scar patterns (Table. 13). Those showing unidirectional convergent scar patterns combined with a small average size indicate they might have been a part of an individual reduction sequence serving Levallois point (elongated or not) production. The fact that other technological attributes of Levallois blades such as unidirectional parallel and bidirectional scar patterns, quadrangular shapes, and their various sizes imply that they can be the result of an individual reduction sequence for blade production using either unidirectional parallel or bidirectional Levallois methods that correspond with the discarded Levallois cores for blades.

Interestingly, as a result of the predominance of parallel ridges, most of the blades are quadrangular (Table. 14). Furthermore, the most frequent scar patterns correspond with discarded Levallois cores for blades that are only recurrent unidirectional parallel cores. In addition, 58.6% of the total blades display small preparatory removals on the dorsal surface. Half of them exhibit small lateral removals as a result of the lateral preparation of the flaking surface, whereas the other half display small preparatory removals on the distal termination of the blades. Furthermore, 41.3% of Levallois blades exhibit only unidirectional convergent or parallel or bidirectional scar patterns. This is clear evidence that the flaking surface was prepared in accordance with this slight discrepancy of the preparation type, varying between a single and different direction. Therefore, it can be assumed that the flaking surface underwent an alternate type of preparation. Moreover, the vast majority of Levallois blades exhibit one or two scar patterns from earlier blank removals, indicating they were second or third order. Accordingly, the Levallois blade of the first order is scarce. However, these few Levallois blades of the first order correspond with the scarcity of Levallois cores for blades. This confirms that an individual reduction sequence for obtaining Levallois blades was rare executed. Consequently, it can be assumed that Levallois blades were mostly as a result of reducing uni/bidirectional Levallois cores.

In some other cases, Levallois blades were a part of a single reduction sequence that served the production of Levallois blades and Levallois points (elongated or not) as was clarified previously (Fig. 49). However, the most interesting result regarding blade production is that a double strategy of core reduction was observed. This strategy served for Levallois

blade production at the early stage and afterward the same flaking surface was shifted into another task, either for Levallois flake (Fig. 50) or Levallois point (RMU 45) production. In addition, the low representation of small Levallois blade versus predominance of large sizes supports this assumption.

Shifting the flaking surface from Levallois blade production to Levallois point production only depends on changing the direction of removals from unidirectional to convergent, and hence, these removals are not only able to change the core shape but also the quality of the products. In chapter 6, the importance of the predetermined and preceding removal of the Levallois production for identifying typical textbook features, especially for obtaining broad-based Levallois points or elongated points, will be looked at in detail.

While elongated points are targeted end-products, Levallois blade production received less interest due to their low number. It may therefore be assumed that Levallois blades are by-products of elongated point production, through which the flaking surface gained the elongation. Or elongated points might have been struck from Levallois cores for points. In this case, it can be assumed that the flaking surface alternated between elongated and broad shapes.

Scar patterns of the blades	N.	Length mean mm	Width mean mm	Thickness mean mm	LWR
Unidirectional parallel	16	69	26.5	8.0	2.5
Unidirectional convergent	7	58.5	26.4	6.8	2.2
Bidirectional	5	74	31.0	8.0	2.4

Table. 13. Size of Levallois blades according to distribution of their scar patterns showing that Levallois blades with unidirectional parallel scar patterns are the largest.

Shape	Elongated point N.	Blade N.
triangular	29	2
quadrangular	-	22
rounded / oval	-	1
polygonal	-	-
irregular	-	4
Total	**29**	**29**

Table. 14. Predominance of quadrangular shape of Levallois blades.

5.5.3. Levallois flake reduction strategies

There are 106 Levallois flakes. According to the scar pattern distribution of Levallois flakes and the discarded Levallois cores for flakes, the Levallois flakes were obviously the result of two Levallois methods. The lithic material exhibits both non-triangular and triangular flakes in assemblage 6, 72.6%, and 27.3% of the total Levallois flakes respectively. Given that triangular flakes with convergent scar patterns are well known as a result of Levallois point production, we will only address the 77 non-triangular flakes, with a comparison between them when necessary. Non-triangular Levallois flakes account for 32.3% of all Levallois end-products and are mainly quadrangular and oval. Thus, they are the second most frequent targeted blanks after points (elongated or not). Several factors help us to conclude that Levallois flakes are the result of two different strategies of core reduction sequence carried out in assemblage 6. In the first, an individual reduction sequence was used to obtain only Levallois flakes. In the second, Levallois flakes were the result of applying a second strategy of core reduction on a core that was used for point or blade production in the first phase.

A. Evidence of an individual reduction sequence for Levallois flake production

The gradual variation in Levallois flake size helps to attribute them to the productivity of an individual reduction sequence for Levallois flake production. 12.9% of the Levallois flakes with centripetal scar patterns are large, with a mean size of 70.7 × 46.2 × 10.7 mm, closely reflecting the size of the prepared cores that were mentioned by Solecki & Solecki (2007). Thus, they represent the earlier stages of core reduction, if not the first stage. In addition, the majority of Levallois flakes are relatively small referring to either the late stages of core reduction or that the core was relatively small at the moment of exploitation. This supports the assumption that the production of some Levallois flakes persisted and attested to the entire core reduction.

B. Double strategy of core reduction (shifting from Levallois blade/point to flake production)

If Levallois blades and elongated points attest to the early stage of core reduction and Levallois flakes were exploited in the late stage, the large by-products should exhibit identical scar patterns to the Levallois blades or elongated points. Furthermore, their number should exceed the number of by-products for Levallois flake production and *vice versa*.

Consequently, there is a clear difference in size between the larger naturally backed knives and the smaller core edge flakes (Fig. 54). Furthermore, naturally backed knives

showing unidirectional parallel and bidirectional scar patterns together are dominant, followed by unidirectional convergent scar patterns. Moreover, the number of naturally backed knives is more than twice that of core edge flakes. Accordingly, the difference in size implies that unidirectional convergent, parallel, or bidirectional reduction was often begun at quite an early stage of core reduction. The size and number of core edge flakes on the other hand suggests that Levallois cores for flake might have often been initiated at the late stage of other reduction sequences. This is attested to by the predominance of small Levallois flakes (Fig. 50).

In turn, a few partially cortical Levallois flakes are quite small, with a mean of 51.3 × 38.9 × 7.9 mm. This suggests that the production of Levallois flakes might sometimes have been applied to relatively small cores. A few triangular flakes with 80% of cortex on the dorsal surface are large and quite similar in shape to Levallois points, leading to the theory that triangular and Levallois point production started quite early in the core reduction sequence. We must also mention that the presence of Levallois flakes exhibiting unidirectional convergent and parallel scar patterns represent anterior removals of the previous reduction sequence.

It can be assumed that Levallois flakes, alongside Levallois points and triangular flakes, were the main targets of late MP human industry in assemblage 6. However, the production of Levallois flakes was rarely initiated at the first stage of the reduction sequence or exploitation of the large raw material that effected their size. Another assumption is that knappers might have invested the large size in volume in order to produce elongated points and Levallois points and blades, given their requirements of large size. They then shifted to producing Levallois flakes at an advanced stage of the same core reduction sequence.

Furthermore, the low number of unidirectional convergent and parallel Levallois cores compared to the high and clear existence of their scar patterns on the blanks indicates that some of these cores were either exported or transformed to another reduction sequence in the late stage of core's life.

Previous data refers to a standardized tendency towards shifting the reduction strategy from Levallois blade to Levallois point or flake production, except in a single RMU that exhibits a shift from Levallois point into Levallois flake production.

The same process was seen in layer B2 of the Levantine Amud cave. This layer exhibited high frequencies of centripetal removals on cores as well as relatively high frequencies of centripetal scar patterns on both Levallois and non-Levallois debitage. However, 30% of all the debitage is pointed or triangular in shape. Furthermore, the frequency of small

debitage showing centripetal scar patterns (up to 30 mm in length) is high compared to those exhibiting other scar patterns. This suggests that convergent Levallois cores were shifted to preferential flaking in the final stages of core reduction in some cases (Hovers 1998; 151).

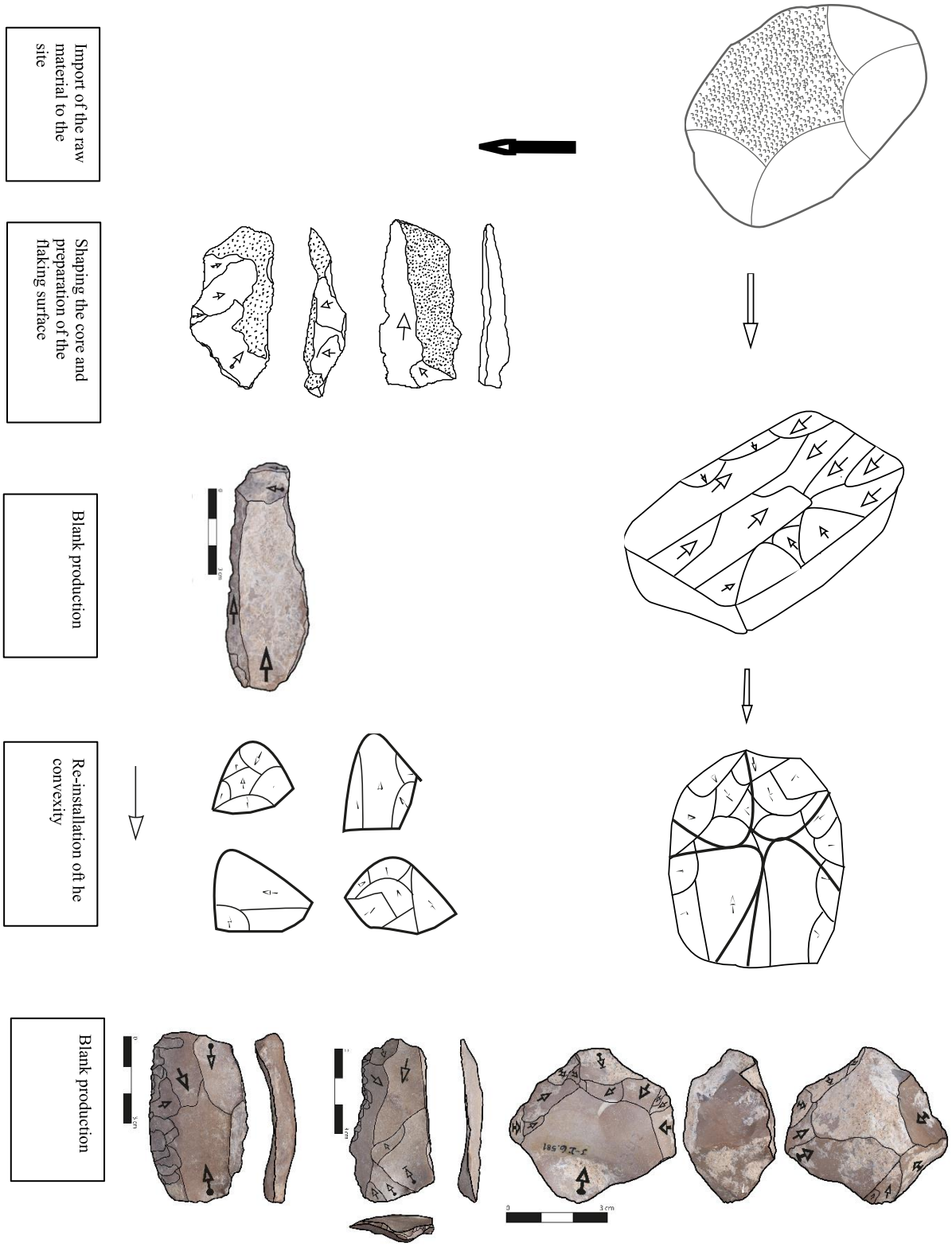


Fig. 50. Levallois blade production at the early stage of core reduction. Afterwards the smaller core was used to obtain Levallois flakes.

Summary

Although there is a clear tendency towards Levallois flake production, with a predominance of discarded Levallois cores for flakes, Levallois points (elongated or not) and triangular flakes are the most frequent blanks in assemblage 6. This can be supported by the predominance of unidirectional convergent scar patterns among both end-products and by-products. Both Levallois methods were applied, particularly the recurrent Levallois method in order to obtain Levallois points. Also, despite the clear existence of cores on flakes and *Nahr Ibrahim* technique in the assemblage 6, they were not reduced for Levallois point production. They were in fact mainly used to produce flakes and their end-products cannot be differentiated from Levallois blanks, except Kombewa flakes, due to the similarity in volumetric properties of cores and negative of the last removal.

Different strategies for producing Levallois points were employed. The main strategy was executing an individual reduction sequence in which the Levallois point was removed along with the core reduction sequence. The products therefore show various sizes that reflect the size of the core through all the stages. Alternatively, Levallois points were struck from the first phase of a double strategy of core reduction, followed by a strategy of Levallois flake production in the second phase. Or Levallois points were removed from the second phase of a double strategy of core reduction, preceded by a Levallois blade production strategy. The recurrent unidirectional convergent method is the most frequent method used to strike Levallois points. The flaking surface underwent an alternate type of preparation based on its convexity, ranging between spatial or total flaking surface preparation. Consequently, the Levallois points obtained present mostly heterogeneous morphological and technological attributes. In particularly, the greatest width appears at different places on the Levallois points and an intentional tendency to keep the greatest width at the base was not observed.

The predominance of flaking surface preparation by detaching elongated removals gave the cores their elongated shape. Thus, elongated points bearing unidirectional convergent scar patterns are part of the core reduction in Levallois point production.

Surprisingly, although cores for flakes are the most frequent cores in assemblage 6 (i.e. Levallois cores and cores on flakes), flakes are only the second most frequent blanks. On one hand, the scarcity of large Levallois flakes bearing centripetal, perpendicular and semi-centripetal scar patterns combined with more frequency of small flakes mirrors the earlier stages of core reduction if not the first stage. On the other, the low number of large flakes with

a predominance of small flakes indicates that the strategy of Levallois flake production rarely began with an individual core reduction sequence. The predominant strategy noticed was the removing of Levallois flakes in the second phase of a double strategy of core reduction whether, after a first phase of flaking surface for points or blades. This can be supported by the fact that a number of the non-triangular Levallois flakes still carry unidirectional convergent scar patterns. In addition, core edge flakes are relatively small, reflecting the small size of Levallois cores.

Finally, Levallois blades are the least discarded blanks. Most are large, a few blades are small. The low number of discarded Levallois cores for blades corresponds with the low number of small blades bearing unidirectional parallel scar patterns, indicting an individual reduction sequence aimed at producing only Levallois blades. The Levallois blades bearing unidirectional convergent scar patterns are smaller than those with parallel scar patterns, suggesting there were part of a single reduction sequence serving Levallois blade and point production.

5.6.By-products

By-products are elements that were removed in order to decorticate a core or to prepare the core's flaking surface for producing predetermined blanks. Preferential production can provide high levels of predetermination. Therefore, the distinction between end products (predetermined) and by-products used to shape the core (predetermining) is clear. However, individual removals by recurrent methods help to prepare the surface for the removals that follow, so they are both predetermined and predetermining. Consequently, the shapes of end products are less controlled and more variable (Van Peer 1992; Pelegrin 2005; Bar-Yosef & Van Peer 2009). Meanwhile, the variables of by-products mostly reveal changes along the core reduction sequence. Boëda et al. (1990; 68) hinted that specific by-products such as naturally backed knives, core edge flakes, and pseudo-Levallois flakes point to more advanced stages of Levallois removals.

5.6.1. Cortical flakes

In this study, the assessment of the cortex is a subjective matter. Accordingly, all blanks that display ≥ 10% cortex cover on their dorsal surface are defined as cortical flakes. Indeed, the lithic material of assemblage 6 was mainly made up of two types of cortex: cortex and natural surface. Therefore, it is also worth noting that this definition includes natural surface. There is no doubt that cortical flakes, generally, play a basic role in identifying the strategies of raw

material procurement. However, it should always be borne in mind that cortical flakes can be reused as cores if they can fulfil conditions of reduction such as adequate volume. In this case, it is difficult to derive all the mechanisms of raw material procurement.

First flakes were barely observed in assemblage 6 (Fig. 51). They are only 7 full cortical flakes, indicating that the strategy of nodule import was rarely carried out (Fig. 56; 1). Apart from the fact that Rust (1950) did not transport all of the material, transformation analyses verified that some of the by-products, in particular, cortical flakes, were re-exploited, and the initial Levallois cores confirm this process. This clarifies that the number of first flakes might be more than those noted. Consequently, the nodules were imported to the site even though it was not the main strategy. Furthermore, the scarcity of first flakes in assemblage 6 indicates that flint nodules were principally prepared at workshop localities outside of YSI.

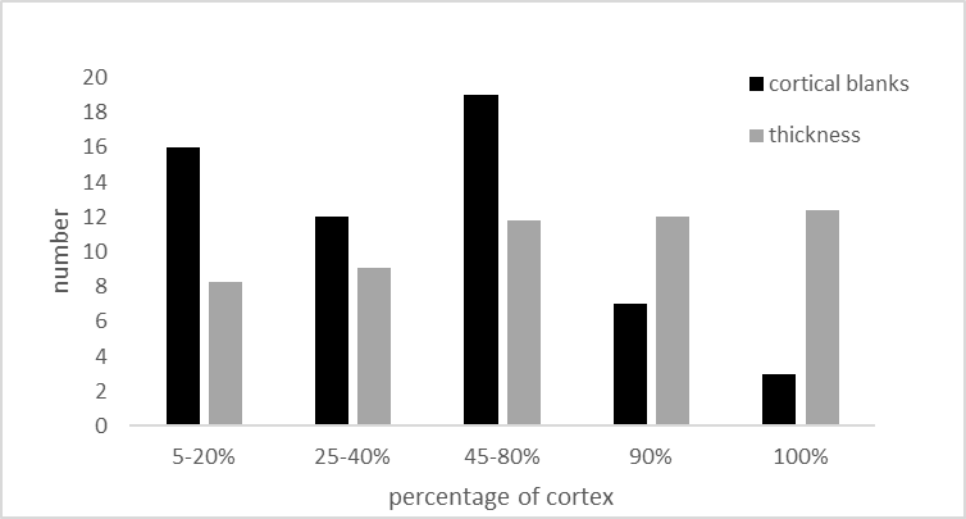


Fig. 51. The distribution of cortex on the by-products.

In terms of cortical flakes, 105 blanks (21.7% of the total) carry a partial cortex, indicating that the main strategy of raw material procurement was to import partially prepared cores (Fig. 56; 2). Interestingly, the thickness of the cortical flakes increases gradually with an increase in the amount of cortex. This implies that the cortex removal process was executed systematically. In addition, the LWR value of the cortical flakes, which is 1.8, shows a slightly higher value, which might be an indication of an orientation towards forming an elongated core at the beginning. This in turn corresponds to the previous assumption that elongated blanks were produced in the early stages of core reduction.

The first flakes and partially cortical flakes show various sizes and the largest are not the first flakes, which could reflect the size of the nodule. However, the largest cortical flakes are covered by 40–80% cortex on the dorsal surface. Also, the majority of first flakes and

partially cortical flakes show plain butts (Fig. 52), which mainly indicates the initial stage of core reduction. Returning to the Levallois blades that show plain platforms, this also confirms the correlation of producing some Levallois blades with the initial stage of core reduction. However, it is worth noting that some elements that are covered by a high amount of cortex exhibit faceted butts. This indicates that by removing some cortical flakes, the striking platform was carefully prepared to increase the precision of the impact point for removing the entire cortex from the flaking surface precisely.

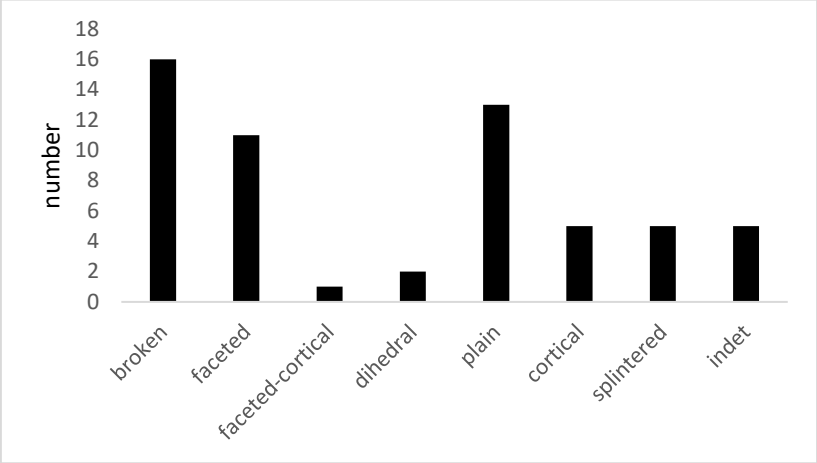


Fig. 52. Various types of by-product striking platforms.

5.6.2. Naturally backed knives and core edge flakes (*Éclats débordants*)

The importance of naturally backed knives and core edge flakes comes from their ability to reinstall the lateral and distal convexity of the flaking surface. Normally, they can appear as a result of applying both the recurrent and the preferential Levallois methods. In assemblage 6, naturally backed knives form 12.2% of all blanks and core edge flakes constitute 5.1% of all blanks (Fig. 56; 4). Each category is expected to associate with a different Levallois method. As such, these clear numbers evoke a certain question. How could naturally backed knives be the most frequent by-product, above edge flakes, despite the predominance of recurrent centripetal Levallois cores?

As can be seen Fig. 53, the majority of naturally backed knives show unidirectional parallel and convergent scar patterns, followed by bidirectional scar patterns. The predominance of naturally backed knives contradicts the prevalence of Levallois cores for flakes and the low number of Levallois cores for blades, which are recurrent unidirectional parallel cores. The large number of naturally backed knives bearing unidirectional parallel scar patterns suggests that unidirectional parallel cores for blade production should be more frequent than what is actually observed in assemblage 6.

While naturally backed knives bearing unidirectional convergent scar patterns show various metric values, the others bearing unidirectional parallel and bidirectional scar patterns, as the trendline in (Fig. 54) clarifies, are large in size, with a mean of 60.1 mm, proving they have been struck in the early stage of core reduction. Their cores were then used for manufacturing other products. Furthermore, naturally backed knives often only exhibit uni-parallel and bidirectional scar patterns without small preparatory removal in the distal terminations. This in turn confirms that Levallois cores for blades were mainly prepared uni- or bidirectionally.

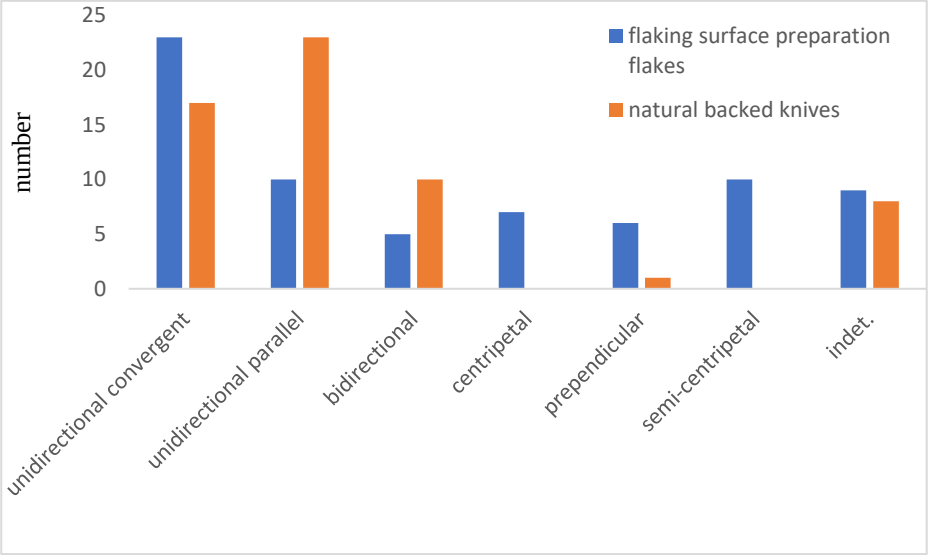


Fig. 53. Frequency of scar patterns on naturally backed knives and flaking surface preparation flakes.

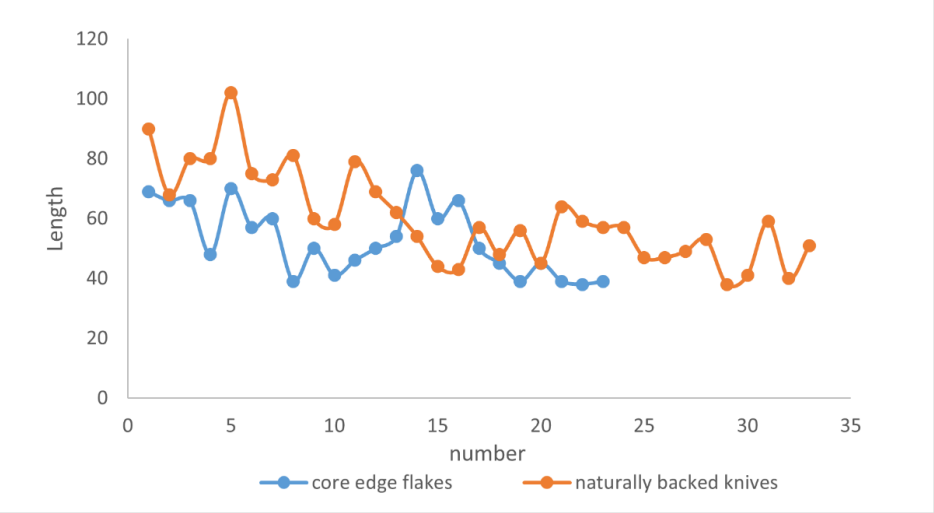


Fig. 54. The size difference between Naturally backed knives and core edge flakes.

Core edge flakes are low in number compared to the high number of Levallois cores for flakes. In addition, the majority of them are relatively small. While the largest 10 elements show a mean length of 72.6 mm, the other 15 elements are relatively small, with a mean length

of 48.1 mm. This implies that either the raw material used for producing Levallois flakes was small or the exploitation moment was begun in the late stage of the core reduction sequence.

Based on a metric and numerical comparison between the two categories (naturally backed knives and core edge flakes), the implication is that the peak stage for using the unidirectional parallel and bidirectional core, based on the preparation of the flaking surface by detaching naturally backed knives, was early in the core reduction sequence. In contrast, the reduction of Levallois cores for flakes has, in most cases, been initiated in the later stage of the core reduction sequence.

Both categories show various types of butts. Faceted and dihedral butts are the most frequent type of platform, followed by plain butts. In addition, as can be seen in Fig. 55, plunging distal termination is the most frequent fracture termination, indicating that the function of these categories worked out successfully in order to reinstall lateral and distal convexity. This is why the majority of elongated points and blades did not bear small preparative scar patterns.

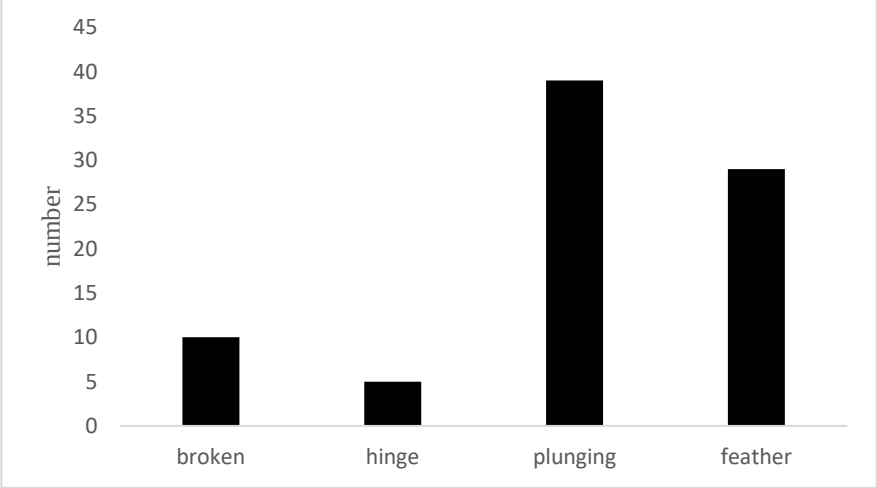


Fig. 55 Plunging distal termination is the most frequent fracture termination.

5.6.3. Striking platform flakes

This element is clear evidence of core exploitation on-site, which can be distinguished by its small size and sometimes by the cortical distal termination. In addition, these flakes represent the process of setting the striking platform up, whether in order to create a proper angle for end product removal or to set up a new striking platform for the following preparing removal from the flaking surface. In this assemblage, 18 striking platform flakes were observed. They have a mean size of 28.5 × 26.9 × 6.5 mm that reflects the thickness of the exploited cores. Cortex covers 50% of these elements and is confined to the distal part of the flakes. Their dorsal

surfaces exhibit a high number of scar patterns, with a mean of 5.7, indicating rough preceding preparatory processes.

5.6.4. Flaking surface preparation flakes

It is difficult to make a distinction between these flakes and Levallois flakes given that they may exhibit the same technological attributes. Indeed, both can be used as long as they achieve their purpose. However, several criteria can be used to differentiate the Levallois blanks such as the organisation of scar patterns on the dorsal surface and the morphology of the flake. In fact, scar patterns of the dorsal surface might indicate the way and reason of their detaching. For instance, the clear variation of negative depth leads to the deduction that this part of core had to be removed as it lacked convexity. Or exciting traces of flaking accidents that must be removed. In addition, the organization of scar pattern must be familiar and in line with the standardized morphology of the discarded cores. Furthermore, Levallois blanks are thin and exhibit a relatively homogeneous distribution of their thickness, slightly concave ventral longitudinal profile, and robust butts (Hovers 2009). Moreover, these flaking surface preparation flakes serve for either reinstallation of the flaking surface or disposing of accidents on the flaking surface. Therefore, their technical attributes mirror the reason for their removal.

69 flaking surface preparation flakes were observed in assemblage 6. Fig. 53 shows various distributions of scar patterns including unidirectional convergent, parallel, bidirectional, perpendicular, and semi-centripetal patterns. However, unidirectional convergent and parallel scar patterns are the most frequent types among these flakes that served to re-organise the convexity of the flaking surface (Fig. 56; 3). This is completely consistent with the distribution of the most common scar patterns on the blanks. These are followed by semi-centripetal scar patterns, asserting that centripetal Levallois cores might have been prepared from time to time and or might be preparatory flakes for preferential Levallois cores.

The size of preparatory flakes bearing unidirectional convergent and parallel scar patterns display slightly higher values than the other preparatory flakes (with a mean of 51.1 × 30.8 × 8.6 mm compared to 49.6 × 38.1 × 10.1 mm). This indicates that at a specific point, the cores for points and blades have been prepared not only by lateral removals (i.e. naturally backed knives), but that their flaking surfaces have also been reinstalled by removing flakes from specific parts, with the aim of maintaining as much volume as possible. In addition, they exhibit various morphologies ranging from quadrangular and rounded to triangular, with a clear predominance of quadrangular morphology, with a variety of scar patterns. The majority of

preparatory flakes show faceted striking platforms, accounting for 36.2% and plain platforms constituting 27.5% of the total. The rest are distributed among various types.

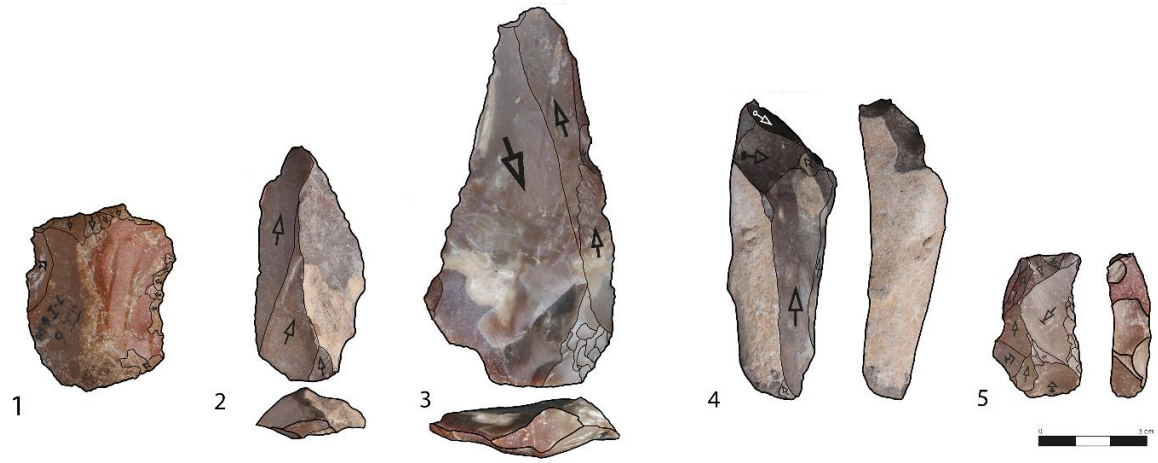


Fig. 56. Instances of the by-products in assemblage 6. 1. Full cortical flake 2. Cortical flake 3. Flaking surface preparation flake 4. Naturally backed knife 5. Core edge flake.

5.7.Typological classification: manufacturing tools

Bordes' list (1961) was slightly modified in order to suit the lithic artefacts from assemblages 6 and 4 from YSI. The editing is related to the category of the partially retouched tool, which was numbered 106. In this respect we follow the scheme of Goren-Inbar (1990) and Hauck (2013). The aim of the application of Bordes' typological method is to find intra-assemblage similarities and differences (subchapter 7.7).

Assemblage 6 shows low to moderate frequencies of modified blanks, accounting for 146 tools including modified fragments. This study agrees with Pagli (2013; 379) that the modified blanks display a clear tendency toward modification of a single edge of the blank, whereas convergent and double tools are rarely represented. Retouch is the most frequent type of modification, accounting for 69.7% of all modified blanks.

As can be seen in Table. 15, the modified blanks are much less than those unmodified. Modified Levallois blanks are predominant, with almost twice the number of modified by-products, especially on triangular blanks. This shows that Levallois blanks were preferred for retouch and reuse. This distinction does not negate the importance of modified by-products as long as the modification could fulfil the purposes of hunter-gatherers. In addition, reverse retouching is present, and it shows diverse distribution on different sections of the retouched blanks. However, it is particularly associated with triangular products with no idea about their function.

	N.	Length mean mm	Width mean mm	Thickness mean mm
modified blanks	146	60.2	35.9	8
unmodified blanks	341	54.3	32	8.5

Table. 15. The distribution of tools and their mean sizes.

5.7.1. The Middle Palaeolithic Group (Group II) and partially retouched pieces

In assemblage 6, the MP group (Group II) is predominant, accounting for 59.6% of all tools (Fig. 57). This group consists of mainly scrapers and partially retouched elements that are generally found in Levantine MP sites, followed by pseudo-Levallois points (Fig. 58).

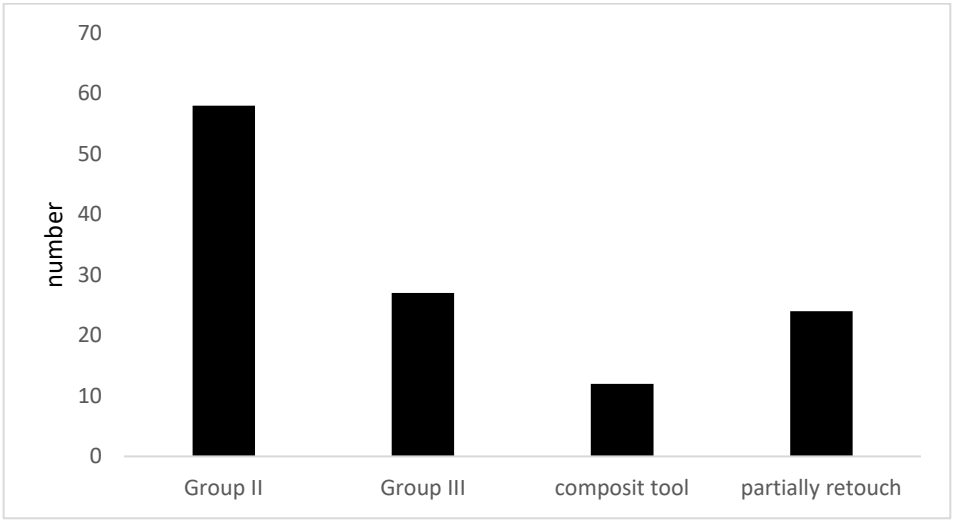


Fig. 57. The distribution of the tools to different categories.

Mousterian points (type 6): Despite all of the Levallois points (elongated or not) and triangular blanks present, elongated Mousterian points are totally absent in assemblage 6. In fact, there is only a single Mousterian point (Fig. 60; 2), which exhibits invasive retouch of up to 6 mm.

Scraper types (types 9–19): Scrapers are not only the most frequent tools in this group but also the most common tool types in assemblage 6. While they form 30.9% of all tools, they constitute 61.8% of the tools of group II. Most are simple side scrapers (types 9–11, 87.2% of all scrapers) and especially single convex scrapers (type 10) (Fig. 60; 4). Furthermore, retouch on the dorsal surface is predominant, accounting for 89.7%, whereas 4.0% display alternate retouch on the distal part of the scraper and 6.3% only on the ventral surface.

Partially retouched tools: Given the difficulty Rust had in transporting the lithic material from Syria in the 1930s, it is hard to distinguish between use wear and edge damage. In order to identify partial retouch, the criteria were that each blank has continuous small removals for at least a centimetre along the edge of the tool and extends to a dorsal or ventral tool surface for more than 2–3 mm. Each blank retouched at a length between one and two centimetres was considered a partially retouched blank (Hauck 2013). In given cases, the retouch length is less than one centimetre. These were also considered partially retouched due to the small size of the retouched blank. Accordingly, the length of the partial retouch is related to the size of the retouch blank (Fig. 60; 16).

This type of retouch was observed on both Levallois products and by-products without any predominance. While partial retouch is found mainly on the dorsal surface, accounting for 83.3% of all partially retouched tools, 16.6% of them exhibit the partial retouch on the ventral surface, resembling the distribution of the retouch on the scrapers. It is worth noting that partial retouch is mainly related to the distal section of these blanks. Three of them display double patination, asserting intentional reuse. This type of retouch could also be a correction of the blank's irregular shape (Hauck 2013). Four specimens display retouch crafted on the ventral surface.

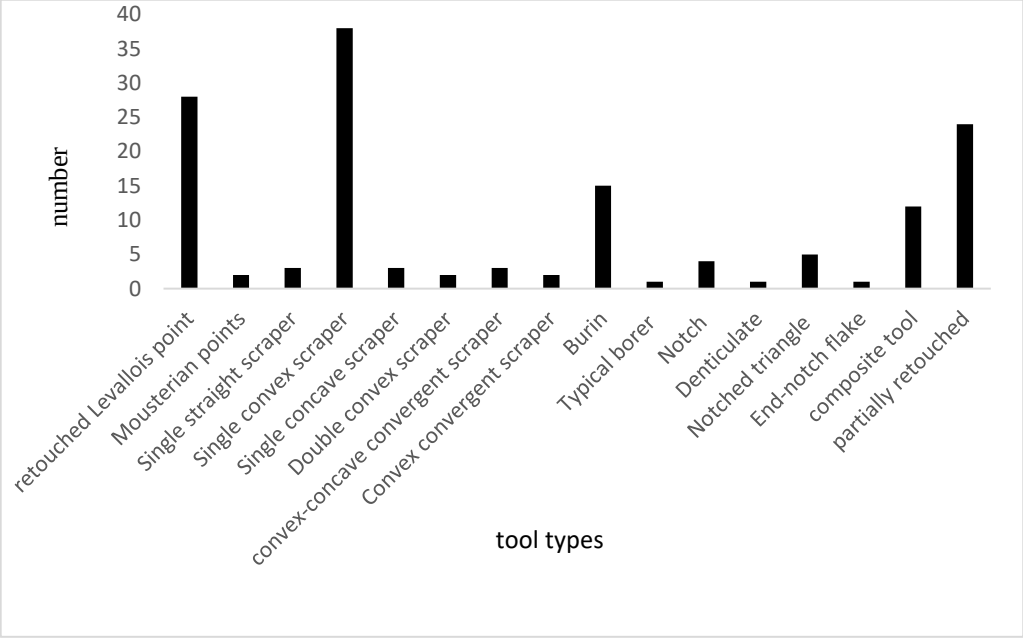


Fig. 58. The frequency of tools in assemblage 6.

5.7.2. Denticulates, notched elements and Upper Palaeolithic tool group (Group III)

The number of tools in this group are relatively low. They form 15.9% of all the tools in assemblage 6. There is a clear tendency to execute both burins and notches. Burins are the most

common tools in this group (burin: types 32 and 33), followed by notches (notch: types 42, 52 and 54). Denticulates, on the other hand, are very rare.

Burin: Constitute 55.5% of all UP tools. All of the specimens exhibit one narrow spall removed either from the distal or proximal part of the tool. In addition, they were crafted either on Levallois products or by-products (Fig. 60; 10), rarely on fragments.

Notched pieces and denticulates: While denticulates are quite rare, notched pieces form 37.0% of all UP tools in this group. As can be seen in Fig. 60, three types of notched pieces are observed (42, 52 and 54). However, the end-notched flake is quite scarce. The majority of notches were executed on the dorsal surface. In two pieces the notches were crafted on the ventral surface. 4 pieces exhibit more than one notch, which may have served different functions or could be multiple tools.

5.7.3. Composite tools

This type of tool exhibits a composite modification on a single blank (Fig. 60; 15), classified as miscellaneous (Bordes 1961). They form 7.2% of all tools. They basically display a retouched edge (planar, abrupt, substantial, or partial retouch) combined with a second type of modification, which varies mainly between notch or burin. However, notches executed on partially retouched edges is the most frequent composite tool recorded. It is worth noting that composite tools do not exhibit evidence of recycling, such as double patination, indicating that both types of modification might have been executed at the same time. Thus, they served a specific function that required this type of modification.

5.7.4. Analysis of modified blanks

A. Modification of slightly larger products

Table. 15 shows that modified blanks are slightly larger in size than unmodified blanks, especially in length and width. However, unmodified blanks are slightly thicker than modified blanks. Although this assemblage has no elongated Mousterian points, modified blanks exhibit relatively high lengths, with an average of 60.2 mm (Fig. 59). The longest modified blanks were not restricted by a specific shape. Triangular and quadrangular blanks both show the longest modified blanks with a scarcity of oval blanks. In fact, this can be interpreted as due to the paucity of large oval blanks, which are mostly the result of the second sequence of core reduction. The longest tools are diverse, such as scrapers, burins, partially retouched tools, notched pieces and composite tools. This indicates that there is no clear tendency to execute a specific tool on the long blanks. Unmodified blanks are only slightly thicker than modified

blanks, on average 8.5 and 8.0 mm respectively. This does not allow us to assume that the thinnest blanks were intentionally selected for modifying. As a result of this size comparison, the tendency was more toward selecting large blanks for modification with the aim of using them frequently. Or large products were intentionally selected to be more convenient and fit in the hand.

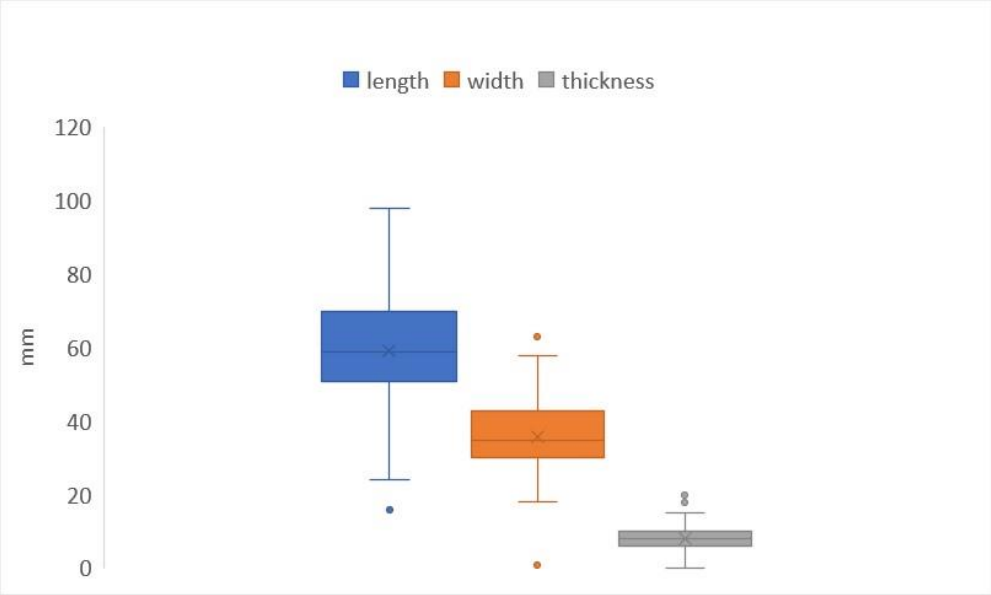


Fig. 59. Maximum, minimum and median sizes of the modified products.

B. Clear tendency to modify cortex-free products

Given that the vast majority of modified elements are Levallois blanks, it is quite normal that the tools show no cortex on the dorsal surface, accounting for 76.3% of the total. 23.7% of them exhibit various amounts of cortex, mostly less than 20% of the dorsal surface. A few tools bear a high amount of cortex, between 90% and 75% of the surface. This indicates that modification was executed on cortical blanks if the cortex does not hamper the function of the tool. In addition, these highly cortical blanks represent the decortication stage of core reduction. This confirms that large blanks were selected for modification. These tools are mainly by-products, accounting for 77.6% of all cortical blanks. The MP group of tools (group II) with partially retouched tools are the most common, forming 55.0%, followed by the UP group of tools (group III) accounting for 35% of all cortical blanks including notches and denticulates. Of all the cortical tools, 17.5% were frequently reused, as is evidenced by double patination.

C. Condition (Complete /Broken)

Most tools are complete, whereas 28.7% are broken. Breakage is confined to either the distal or the proximal part of the tool, each occurring with almost equal frequency. It is quite difficult

to differentiate whether breaks have happened due to knapping reasons, usage or other reasons. The MP group of tools (group II) with partially retouched tools are the most common of broken tools, forming 71.4% of the total, especially simple side scrapers. The UP group of tools (group III) including notches and denticulates tools account for 23.8% of broken tools.

Given that scrapers are the most frequent tools in assemblage 6, it is to be expected that they are also the most broken tools due to their frequent use.

D. Striking Platforms

The majority of tools (69.8%) show faceted and dihedral platforms, with a clear predominance of the former, related to the prevalence of executing modifications on the Levallois blanks. 57.2% of them are related to Levallois products, while 17.1% of them are by-products. The faceted and dihedral platforms are more linked to the MP group of tools (group II) with partially retouched tools given that UP tools were executed on by-products.

E. Scar patterns

Despite a clear diversity of scar patterns on the tools in assemblage 6, unidirectional convergent scars are the most common, constituting 50% of the total, followed by modified blanks bearing centripetal, bidirectional and unidirectional parallel scar patterns with only slight differences between them. This distribution of scar patterns resembles the most frequent scar patterns on unmodified blanks and given that the tools were executed on Levallois blanks. In contrast, perpendicular and semi-centripetal are the less frequent scar patterns. It must be noted that the tools bearing unidirectional convergent scar patterns are not confined to triangular shapes, despite their dominance. Other shapes are also present, such as oval and quadrangular blanks. This reflects the application of a double strategy on a single reduction sequence, where the first strategy leaves its scar patterns on the products of the early stage of the second strategy.

Scar pattern distribution is diverse among tools. However, the Mousterian and partially retouched group (group II) exhibit the most unidirectional convergent scar patterns among the tools of assemblage 6, specifically the different types of scrapers. The highest representative is amidst unidirectional convergent, centripetal, and unidirectional parallel scar patterns.

Finally, there is a low frequency of retouched tools in this assemblage (regardless of whether Rust brought out all of the lithic artefacts from this assemblage) and 19.4% of tools were recycled, indicating that these products might have been repeatedly used for the same or different tasks in different periods.

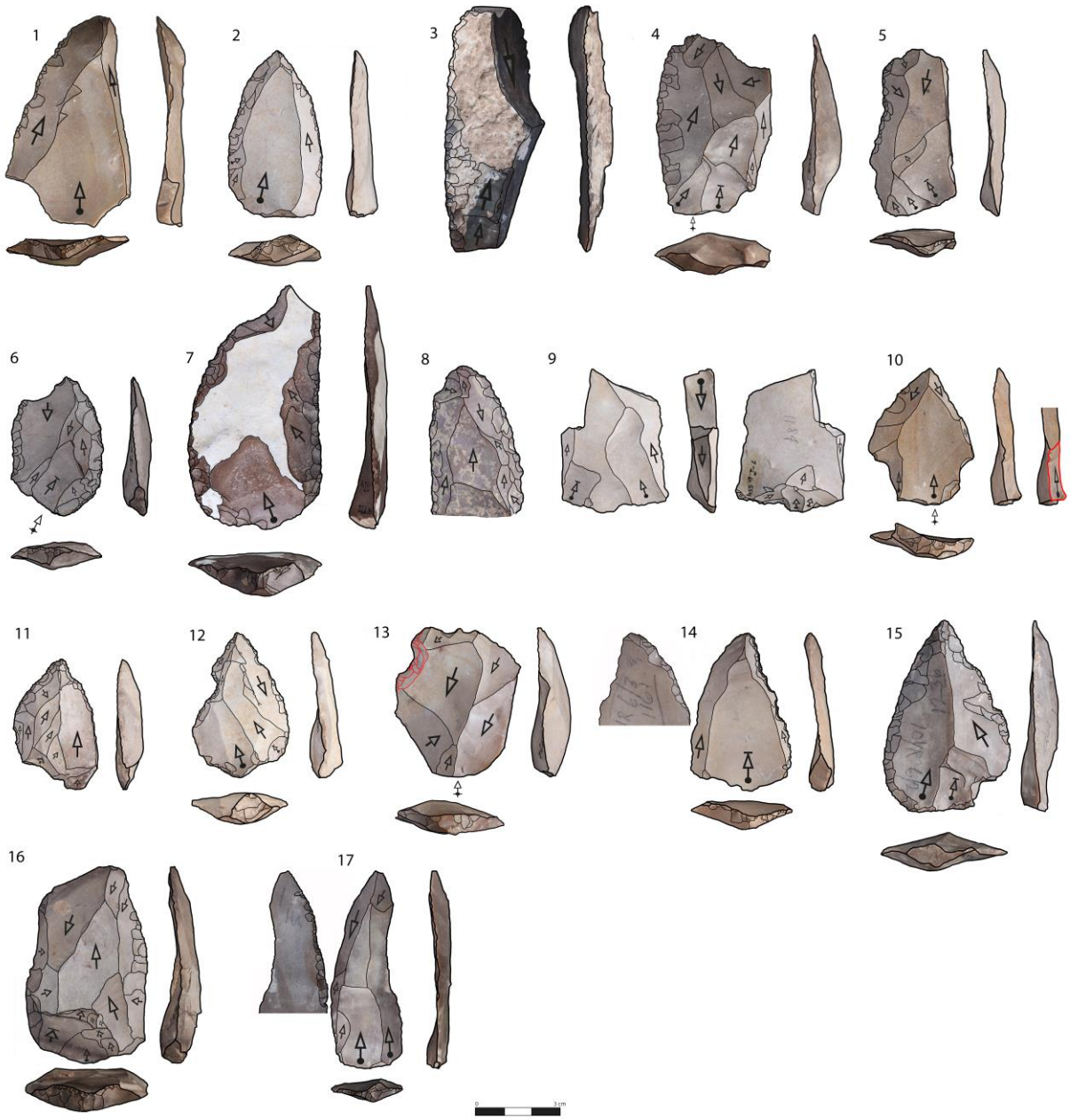


Fig. 60. The various types of tools in assemblage 6 1. Retouched Levallois point 2. Mousterian point 3. Simple straight scraper 4. Simple convex scraper 5. Simple concave scraper 6. Double convex scraper 7. Double convex-concave scraper 8. Convex convergent scraper 9–10 Burin 11. Borer 12. Notched-triangular piece 13. Notch 14. Alternative retouch 15. Composite tool 16. Partially retouched piece 17. Ventral retouch.

5.8.Transformation analysis

Weißmüller (1995) clarified that transformation analysis treats the raw material as equivalents of refits, even if there are no refits, assuming that several artefacts of the same volume were manufactured and discarded on-site. In addition, it is possible to measure the degree of incompleteness depending on the size/completeness of the excavated area by using transformation analysis. Consequently, it can be assumed that a single raw material unit (henceforth RMU) could itself represent different events at the technological level, which might be linked to various functions mirroring human behaviour. If a single RMU does not show variation at the technological level, it may relate to only a single function.

It is worth noting how difficult it is to sort stone artefacts on the basis of the raw material in the complete absence of refitting due to the high similarity of the features of the raw material. In addition, patination sometimes obstructs sorting. Furthermore, it should be noted that as the sieving process was not executed by Rust (1950), chips of modification processes are completely absent. On top of all this, Rust may have selected the lithic material based on the fact that he had to carry it on his bicycle to Nebek (Solecki & Solecki 1966; 126).

Assemblage 6 consists of 618 stone artefacts sorted into 207 raw material units, which were distributed to four main categories (Fig. 61).

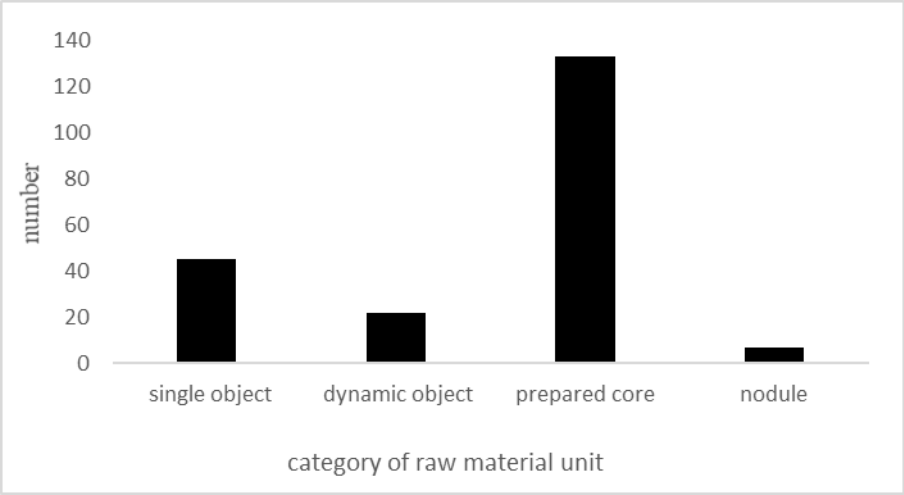


Fig. 61. Distribution of the raw material units to different categories.

5.8.1. Raw material units imported as single objects or tools

As can be seen in Fig. 59, this category and the dynamic objects are called personal gear (Binford 1979), pocket gear (Richter 2001), and provisioning individuals (Kuhn 1995). They are the second most frequent objects imported into the site, accounting for 22.9% of all RMUs.

They attribute to different transformation sections. Levallois RMUs are predominant (Fig. 62). Levallois flakes are the most frequently imported Levallois blank, followed by Levallois points (Table. 16). They contain different types of tools, accounting for 20.4% of all imported single pieces including tool fragments. It is worth pointing out that modified Levallois blanks are predominant: partially retouched Levallois flakes and points (RMUs 171, 175 and 191), two single convex side scrapers crafted on Levallois flakes (RMUs 173 and 193), a Mousterian point (RMU 178), a single straight side scraper executed on a cortical flake (RMU 199), and a retouched fragment (RMU 207). This implies that the imported single pieces might have been used for diverse functions such as butchering or scraping. Consequently, Levallois pieces are the most mobile items imported into the site, whether as modified items or with lateral sharpened edges, either in order to be used on-site or to decide if their equipment is still valuable.

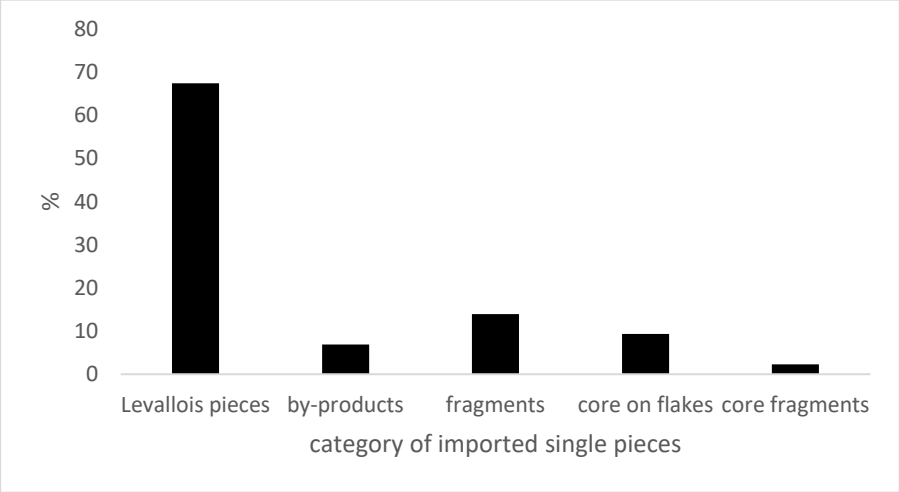


Fig. 62. Distribution of the imported single pieces.

It is unlikely that the exhausted Levallois cores (Ci) and core fragments (Cg) were imported into the site for further exploitation or to serve for other functions since they, firstly, lack the proper volume needed for exploitation, and secondly, did not exhibit sharp or retouched edge that could have been used. Furthermore, cores on flakes, particularly *Nahr Ibrahim* Technique, could be evidence of procuring flakes from an area adjacent to YSI during visits to the site or local flakes discarded on-site from previous events have been re-used. Specifically, 11.4% of the total exhibit double or triple patination, indicating the use of the objects in different time spans. It can therefore be assumed they were picked up off-site and only the last step of use was part of on-site activities. Meanwhile, double or triple patination can be clear evidence of reusing these objects as a result of frequently visiting assemblage 6 of YSI, with gaps in time between them.

The fact that these objects were discarded on-site implies that they were used on-site. But as they were imported as single objects, they may have been used both off-site and on-site. The decision to discard them was made on-site. For example, they may have been used off-site, were then transported into the site for an on-site function or for evaluating if they were still usable, and were then discarded.

Transformation section	Entire raw material units	Levallois cores	Levallois points	Levallois flakes	Levallois blades	By-products
(Bw): Import of single blank without transformation	RMUs: 169, 170, 172, 174, 176, 177, 179, 180, 181, 182, 183, 184, 185, 186, 187, 189, 190, 192, 194, 195, 196, 197, 200, 247, 257	-	RMUs: 177, 179, 180, 181, 182, 189, 190	RMUs: 169, 170, 172, 174, 176, 186, 192, 194	RMUs: 183, 184, 187	RMUs: 185, 200
number	**21**		**7**	**8**	**3**	**2**
(Tw): Import of single tool without transformation	RMUs: 20, 171, 173, 175, 178, 191, 193, 199	-	RMUs: 171, 20 178.	RMUs: 173, 175, 191, 193	-	RMUs: 199
number	**8**		**2**	**4**		**1**
(Ei): Isolated functional end of a tool	RMUs: 195, 196, 197, 198, 207, 247.	-	-	-	-	-
number	**6**	-	-	-		
(Ci): Exhausted discarded core	RMUs: 238, 240, 241, 242, 243.	RMUs: 238, 240, 241, 242, 243	-	-	-	
number	**5**					
(Crf) Core on flakes	RMUs: 208, 235, 237, 239.					
number	**4**					
(Cg): Core fragment	RMUs: 244					
number	**1**					
(Do): Dynamic objects	RMUs: 6, 7, 8, 17, 26, 27, 32, 41, 46, 50, 52, 70, 75, 77, 86, 100, 114, 116, 119, 121, 127.		RMUs: 7, 8, 17, 26, 27, 29, 50, 70, 114, 116, 119, 121, 127.	RMUs: 6, 7, 26, 27, 32, 41, 46, 52, 70, 75, 86, 100.	RMUs: 6, 26, 50, 75, 77, 114	RMUs: 8
number	**22**					

Table. 16. Distribution of the single pieces and dynamic objects in the raw material units of assemblage 6.

In addition, 6 RMUs contain fragment of tools. RMU 195 exhibit a tip of a triangular flake, which could be a convergent scraper and RMU 196 show the distal part of an elongated point. This fragment (Fig. 62.1) implies that it might have been imported to the site, either as

a fragment which was then used and discarded, or as a complete tool which broke during use on site (Richter 2005).

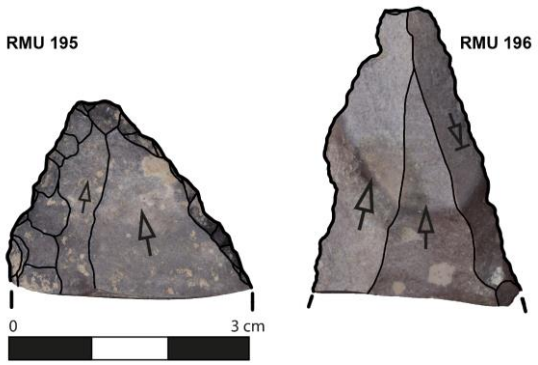


Fig. 62.1. RMUs have used either as fragments then discarded, or as a complete tool that broke during use on site.

5.8.2. Raw material units imported as dynamic objects (transformation section Do)

This category contains two or more blanks or tools produced from the same core without core and by-products. As can be seen in Fig. 61 and Table. 16, dynamic objects, according to Weißmüller (1995), are the third most frequently imported items. They are mostly Levallois blanks, except a flaking surface preparation flake that is a convex side scraper. Each RMU contains two objects, except for one that contains three. Given that the strategies of Levallois point and flake reduction are predominant, it is not surprising that Levallois points and flakes are the most frequently imported items (Fig. 62 and Table. 16).

It is worth noting that the dynamic object RMUs are not confined to a single type of product. In fact, around 38.0% of them involve different Levallois items (RMUs 6, 7, 26, 27, 50, 70, 75, and 114). However, the majority (five) include Levallois flakes or points coupled with a Levallois blade, whereas the remaining three display both Levallois points and Levallois flakes (Fig. 63). This implies that although there are only a few dynamic Levallois blades, they were a part of their planned gear during their mobility. Consequently, the variability of the dynamic objects suggests that the activity executed required different Levallois blanks. Thus, hunter-gatherers sometimes had to carry various objects in order to meet their needs. In addition, the raw material of dynamic objects corresponds with the properties of the secondary position of the raw material source that was mentioned by El Kassem (2001). Therefore, human groups of assemblage 6 not only organized the manufacture of their pre-planned gear but also relied on local raw material that supplied them with equipment during their mobility. Additionally, the mobility of various dynamic objects reflects the behaviour responding to the requirements of the pre-planned activities.

Finally, the retouched blanks suggest frequent mobility of these components and the double patination may reflect a palimpsest of different events carried out using the same tool. This combined with frequent re-reduction of the discarded stone artefacts suggests that the occupants might have been scavengers for discarded artefacts.

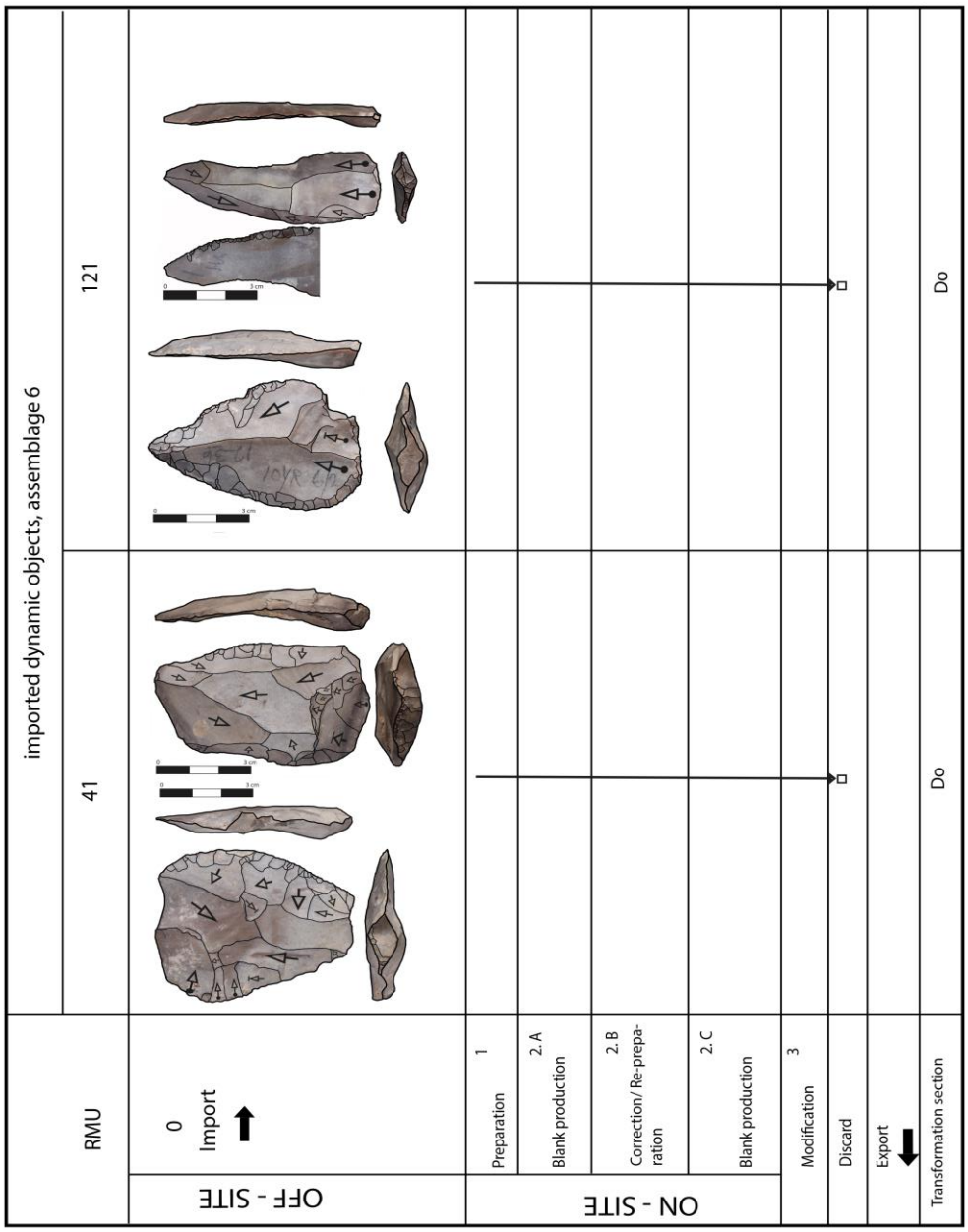


Fig. 63. Dynamic objects with heavy retouch were imported to the assemblage 6.

5.8.3. Raw material units imported as nodules (transformation section N)

These RMUs represent nodules that were transported to the site. This in turn shows blanks from all the stages of the core reduction process, from decortication of the core to on-site modification of the blanks produced. They therefore attest to the longest applied core reduction on-site. Complete nodules were rarely transported to assemblage 6 of YSI. Only three RMUs

display components of nodules, accounting for 3.3% of all the cores imported into the site (Table. 17). Accordingly, it is quite obvious that the direct strategy of raw material procurement was rarely executed.

It must be mentioned that nodules were reduced by the Levallois method, such as in RMUs 98, 122, and 149. RMU 122 (transformation section Nm) contains 6 objects that bear evidence of all stages of core reduction, including discarded centripetal Levallois cores (Fig. 64).

Two blanks carry a high proportion of cortex, indicating the early stages of core reduction (decortication stage). One is covered with 90% cortex and the other with 80%. Accordingly, the decortication stage was carried out on-site. After the decortication stage, two Levallois blanks were removed bearing centripetal and perpendicular scar patterns as a result of centripetal core reduction. Afterwards, Levallois flakes and cortical flakes were crafted by heavily retouching a single edge of a Levallois flake (single scraper) and both edges of a cortical flake (double side scraper). Cortical blanks show the maximum size, an average of 66 × 43 × 11.6 mm, while Levallois blanks show the minimum length and width, with a mean size of 47.5 × 32.5 × 8 mm. Accordingly, all Levallois core reduction was carried out on-site despite the lack of the majority of debitage. If the reduction process was carried out on a large cortical flake, then the content of this RMU would be products of an imported nodule to the site.

Transformation section	**n**	**Raw material unit <u>with</u> core**	**Raw material unit <u>without</u> core**
Nm	4	RMUs: 122	RMUs: 29, 88, 149.
Cb	50	RMUs: 36, 78, 104, 134, 135, 136, 151.	RMUs: 3, 4, 5, 9, 10, 12, 19, 21, 23, 24, 25, 28, 30, 35, 38, 39, 40, 48, 54, 55, 62, 63, 64, 66, 81, 83, 84, 85, 87, 90, 96, 97, 102, 112, 115, 123, 126, 132, 142, 152, 153, 154, 255.
Cc	13	RMUs: 58, 98, 103.	RMUs: 14, 44, 60, 71, 74, 95, 128, 130, 140, 144, 155.
Cm	60	RMUs: 16, 33, 76, 105, 107, 108, 137, 150, 254.	RMUs: 1, 2, 11, 13, 18, 22, 31, 34, 37, 42, 43, 44, 47, 49, 51, 53, 59, 65, 67, 68, 69, 72, 73, 79, 80, 91, 92, 94, 99, 101, 105, 106, 107, 108, 109, 110, 111, 113, 118, 120, 124, 125, 129, 131, 138, 141, 143, 150, 156, 256.
Ct (two methods)	8	RMUs: 15, 145, 146, 148.	RMUs: 45, 56, 82, 147.
Cdb (core on biface)	2		RMUs: 93, 139
Total	**137**	**24**	**113**

Table. 17. The distribution of the raw material units imported as partially prepared cores and as nodules.

RMU 149 contains a Levallois core, an initial Levallois core, and a cortical triangular flake. Typologically, it is worth noting that although the natural surface covers 80% of the triangular flake, its shape and the carefully prepared butt suggest its categorisation as a Levallois point. As can be seen in Fig. 65, the initial Levallois core and the convergent Levallois core have been reduced on thick flakes that were removed from the same nodule. Given that the initial Levallois core and the triangular flake exhibit a high proportion of cortex, reaching 90% of the dorsal surfaces, this implies that they were originally by-products of a core that was imported as a nodule and reduced on-site. However, due to the existence of only the by-products, it can be assumed that the end products as well as their cores were exported off-site. Afterwards, another group or the same group of people reused the discarded by-products, and again their end products also were exported.

RMU 98 includes two full cortical flakes and a preferential Levallois core (Fig. 66). The cortical elements cannot be part of this preferential core for point production, why? While the blanks are completely covered by cortex indicating the decortication stage of core reduction, the preferential core presents proof that it was reduced on a full cortical flake. Therefore, the flaking surface of this core has not undergone a decortication stage because it is already a cortical-free ventral surface. The proof is that the preferential Levallois core exhibits only centripetal scar patterns, except for a single scar pattern that shows the opposite direction, which is the original ventral surface of the cortical flake that was reduced later by the preferential method.

Consequently, the three objects (i.e. the two cortical flakes and the preferential core) are originally by-products of the decortication of the nodule and the thick flake, which still shows scar patterns of the original ventral surface, was reused by preferential method for one removal.

It is worth noting that there are no elements of correction of the flaking surface. This enhances the theory that the preferential core was prepared for one removal. Thus, the end products of both core reduction sequences (i.e. both blanks of preferential cores and the original reduced core) were exported for off-site activities.

Interestingly, the frequent re-reduction of the nodules' products combined with double patination of personal gear increase evidence that the occupants of assemblage 6 were scavengers for discarded stone artefacts.

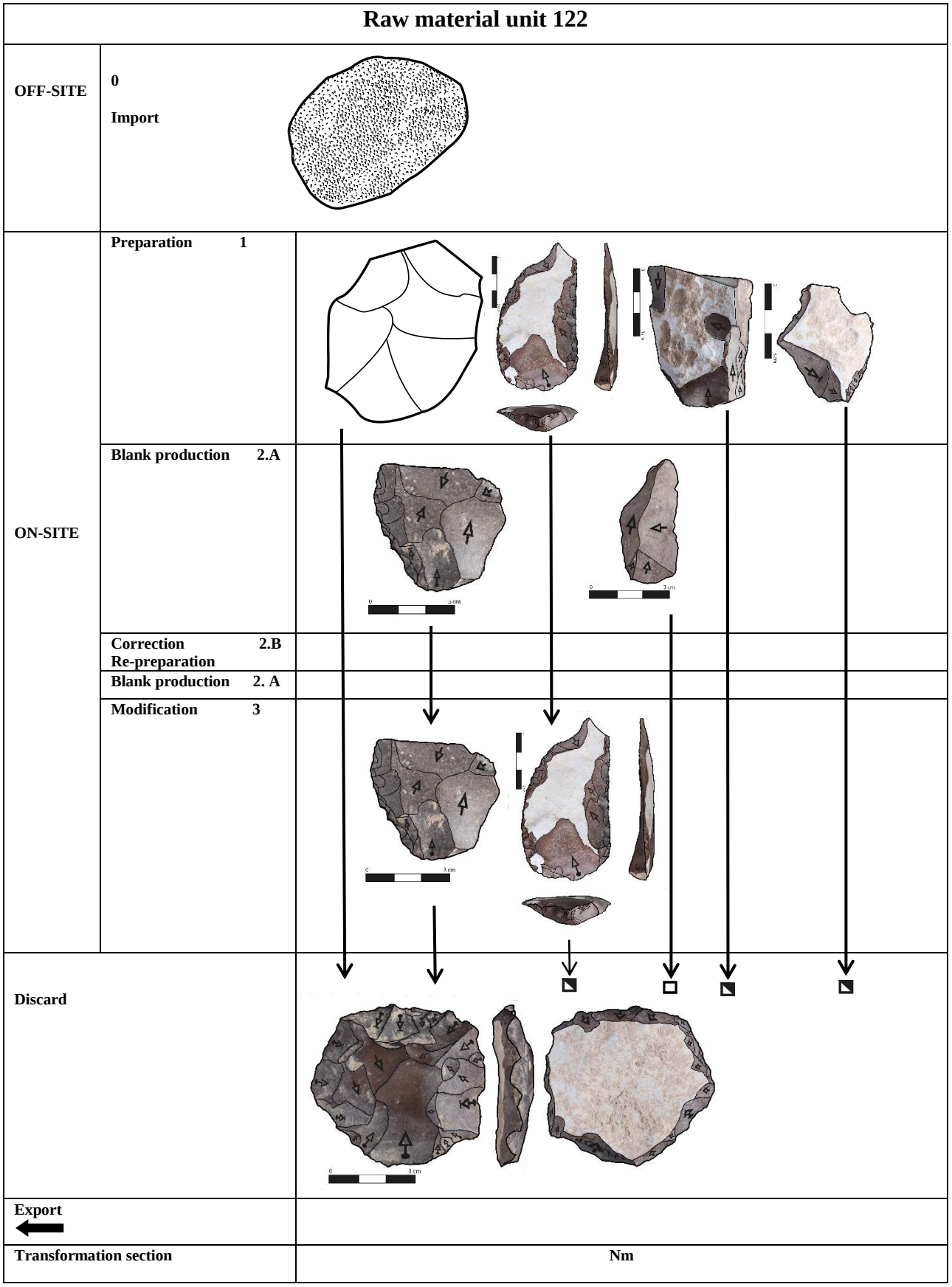


Fig. 64. Debitage of a nodule imported and exploited on-site.



Fig. 65. Debitage of a single nodule re-exploited as cores on flakes.

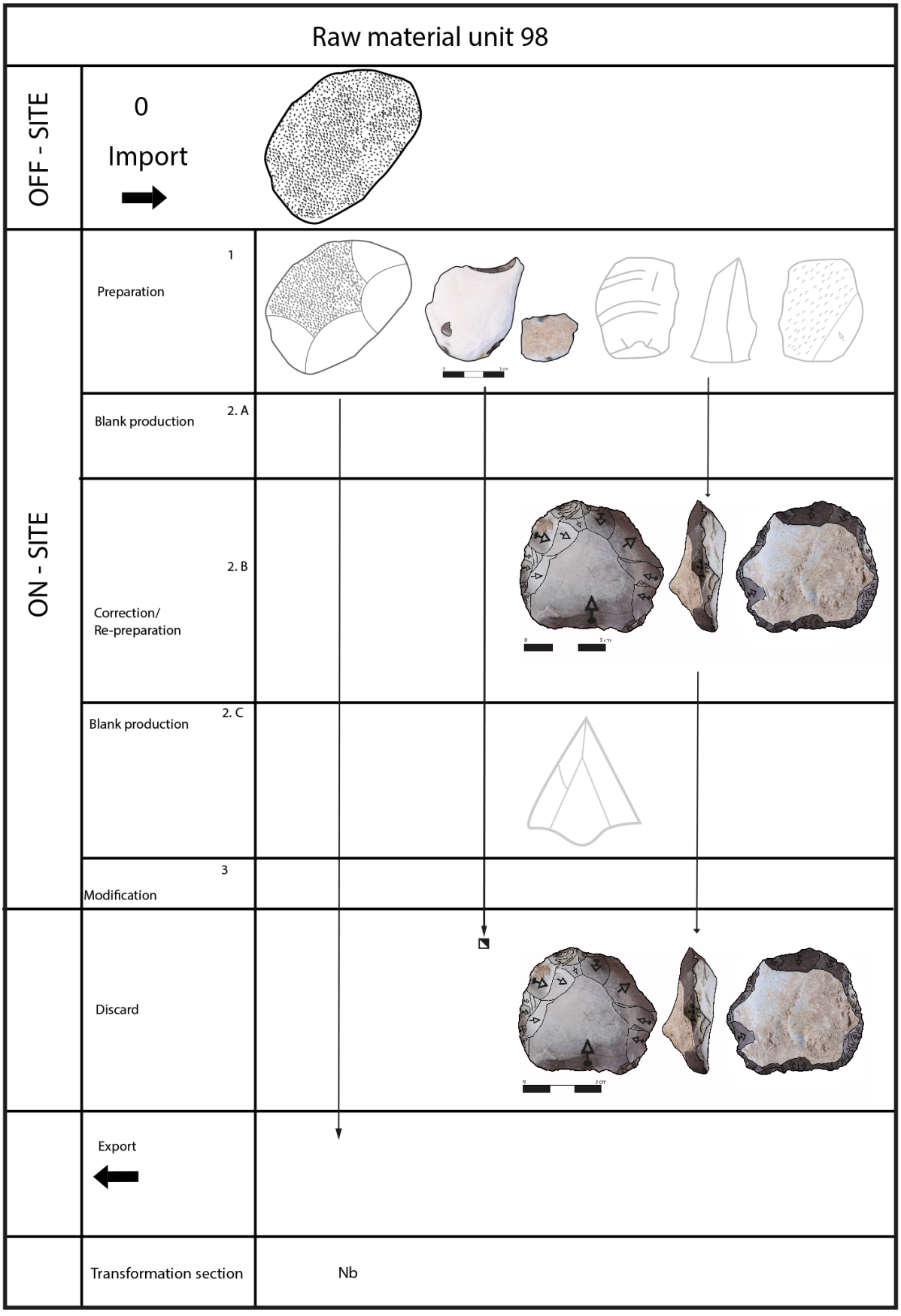


Fig. 66. Full cortical debitage and one piece that still has adequate size that was re-reduced.

5.8.4. Raw material units imported as partially prepared cores (transformation section C)

As is clarified in Table. 17 and Fig. 61, the dominant strategy of raw material procurement relied on decortication of nodules at the source of the raw material, either partially or completely. Afterwards, flint knappers transported the cores onto the site. Although 58.1% of all RMUs include cortical blanks covered by >10% on the dorsal surface, partial decortication is more prevalent than complete decortication due to the scarcity of full cortical flakes. However, the majority of RMUs lack cores.

A. Raw material unit as blank production from a core (transformation section Cb)

The transformation section Cb includes both end products and by-products with cores or without, which were obtained from partially prepared cores off-site. This category of RMUs is the second most frequent raw material unit, accounting for 42.8% of all RMUs imported as prepared cores. While the majority of these RMUs contain only a single end product, 43.2% contain two or three end products. These RMUs show low productivity of the reduction sequence, which might be due to the small size of the cores or the process of exporting end products by the hunter-gatherers who carried part of the equipment with them to other sites (Uthmeier 2005; 140). This implies that a lot of end-products were struck for off-site activities. A few RMUs (28, 97, and 153) exhibit different end products (i.e. points and flakes/blades); and given that their products display unidirectional convergent scar patterns, this suggests that Levallois flakes and blades sometimes served as by-products for Levallois point production. The Levallois point, showing unidirectional parallel scar patterns accompanied by a Levallois blade (RMU 84), indicates its production by the unidirectional parallel method.

RMU 104 includes 5 objects (Fig. 67): 4 products and their core. The products are an elongated point, a triangular flake, a cortical flake, and a striking platform preparation flake. As it contains both by-products and end products, it is quite obvious that the whole core reduction sequence was executed on-site. It is worth noting that all of the products only exhibit unidirectional convergent scar patterns, whereas the discarded unidirectional convergent Levallois core shows that the last preparation of the flaking surface was carried out by detaching small perpendicular removals from the core's distal termination. Accordingly, this indicates that flint knappers processed the core differently in the early stage of core reduction according to the desired end products. This RMU reminded us of the strategy of elongated point and blade production in the early stage of core reduction that was supported by the lateral

unidirectional preparatory removals, giving the core an appropriate elongation for elongated point and blade production. Or the flaking surface in the early stage of core reduction served for point, elongated point and blade production. However, the whole core reduction sequence served to obtain triangular blanks.

B. Raw material unit as correction of a core (transformation section Cc)

The transformation section Cc contains only by-products, both with or without cores, which were obtained from partially prepared cores off-site. They are only a few of these RMUs compared to those which contain end products, accounting for 7.9% of those imported as partially prepared cores. While 10 RMUs include only by-products, three RMUs contain by-products with cores. Therefore, this suggests that these RMUs are associated with activities off-site because of exporting the end-products.

RMU 44 exhibits three objects (Fig. 68): a cortical flake, a naturally backed knife, and a Levallois core. Given that the by-products bear convergent scar patterns, they might be the result of the convergent Levallois method. However, the discarded Levallois core for flakes reflects a shift in the exploitation method in the last stage of core reduction, from Levallois core for point to Levallois core for a flake. The end products are completely absent, which could be the result of use off-site.

While the cortical flake was removed off from the initial preparation of the partially prepared core, the naturally backed knife represents an advanced stage of core reduction. The affinity of their sizes mirrors the small size of the imported partially prepared core. Another assumption is that these three elements are by-products of a nodule for point production, and a thick cortical flake might have re-reduced for flake production.

C. Raw material units as blank production from a core with subsequent modification (transformation section Cm)

The transformation section Cm contains blank production from a core with subsequent modification with or without a core, which were obtained from cores partially prepared off-site. This is the most frequent category of RMU, forming 48.7% of all imported RMUs as partially prepared cores. RMU 16, for instance, contains 6 objects: a Levallois core and 5 by-products without end products, which are a cortical flake (natural surface covers 30% of the dorsal surface), three naturally backed knives, and a broken flake (Fig. 69). Interestingly, all of the by-products were removed from an imported partially prepared core. In contrast, the Levallois core itself was executed on a flake. Consequently, two interpretations can be

forwarded. One is that the by-products might have been removed from this convergent Levallois core when it was a flake covered by the cortex, and its cortical dorsal surface was set up as a flaking surface. The other is that the core and the by-products were derived from the same volume.

While the Levallois core only displays unidirectional scar patterns, the by-products bear small bidirectional and perpendicular scar patterns. If the by-products were removed off from this core, then the type of flaking surface preparation was processed differently throughout the core reduction sequence. If, however, they were derived from different cores but the same volume (i.e. the by-products, and the Levallois core), then the block was split and their debitage used to produce triangular blanks. A notch was executed on the end section of a naturally backed knife. In fact, the broken flake exhibits double patination and is a core on the flake. Accordingly, the reuse of the broken flake as a core supports the assumption that the core and the by-products might have been derived from the same volume and have not been not the result of a single core reduction.

D. Raw material units including debitage from two different Levallois methods (transformation section Ct)

Transformation section Ct contains different blanks (i.e. Levallois blades and points or flakes), which were removed by different Levallois methods but from the same core, with or without core. It is worth noting that these RMUs mainly show a unified technological behaviour that shifts from Levallois blade production in the earlier stages of core reduction to point or usually flake in the later stages. A single RMU exhibits a shift from Levallois point into Levallois flake production. Although they are only a few RMUs, accounting for 4.6% of all the RMUs imported as partially prepared cores, this is clear behaviour aimed at economizing the raw material and investing in the size value of the core.

D.1. Shifting from Levallois blade to Levallois flake production

RMU 147, for instance, consists of three blades and a flake without core, which bear the same raw material properties. However, their technological attributes attest to two different Levallois methods (Fig. 70), as end products and by-products of Levallois core for blades and Levallois cores for flakes. The three blades show techno-typological attributes of the bidirectional Levallois method, and their scar patterns attest to second and third order removal, exhibiting two negatives from earlier blank removals on their dorsal face or lateral removal. Furthermore, their metric properties prove that they were removed in the early stage of core reduction (Table.

18). It is difficult to identify whether the reduced core was imported partially or completely prepared. However, given that they show no cortex on their dorsal surfaces, the core might have been imported as a completely prepared core. These products attest that the flaking surface was prepared by detaching small perpendicular and bidirectional removals from the core's lateral edges and both opposite proximal and distal parts served as striking platforms.

The same groups or other groups have shifted the Levallois core for blades to Levallois core for flakes production. As can be seen in Fig. 68, a rounded Levallois flake was obtained. Its techno-typological features point to second order preferential Levallois method with an extremely prepared butt with *Chapeau de gendarme* shape. In addition, it shows plunging termination as a result of excessive impact power, which reflects the size of the core 54 × 53 × 12 mm, on the threshold for discarded Levallois cores. This suggests that the Levallois core was discarded as a Levallois core for flakes.

In fact, it is difficult to know whether both Levallois methods were reduced during the same time period or if there was a gap time between them. Likewise, we can not say whether they were produced by the same group. However, we can assume that the shift in method is related to functional purposes requiring different blanks.

D.2. Shifting from Levallois blade to Levallois point production

RMU 45 is made up of 5 blanks (a Levallois blade, a triangular flake, a Levallois point, a cortical blank, and a flaking surface preparation flake) (Fig. 71), exhibiting the same raw material features. As two blanks are partially covered in cortex, the implication is that a partially prepared core was transported to the site where the core was reduced. Their techno-typological attributes attest that they were removed using two different Levallois methods.

As can be seen in Table. 18, the metric properties of the cortical blank and the Levallois blade are evidence of the first stage of the core reduction. In addition, their scar patterns suggest they have been reduced by unidirectional parallel Levallois method. Furthermore, the flaking surface was re-prepared by detaching small semi-centripetal removals from the core's distal termination and lateral edges. Moreover, the Levallois blade shows scar patterns of the second order of removals that bear signs of earlier removals on the dorsal surface. Afterwards, the unidirectional parallel Levallois core was shifted to Levallois core for point. Given that the metric variance between the Levallois point and blade is small, it can be assumed this Levallois blade was the last removal detached from the unidirectional Levallois core. After that, lateral elongated removals were detached, serving to prepare the flaking surface, giving the core its

elongation and triangular shape, which in turn immediately allowed for Levallois point production.

D.3. Shifting from Levallois point to Levallois flake production

RMU 148 contains three objects: a centripetal Levallois core, a Levallois point and a core edge flake (Fig. 72). The Levallois point is clearly asymmetric. First impressions suggest it is a pseudo-Levallois point. However, its scar patterns suggest it was produced by unidirectional convergent Levallois method. Accordingly, this RMU indicates the application of two different Levallois methods to the same block. As can be seen in Table. 18, the size of the Levallois point refers to its production at the early stage of core reduction. The sizes of the core edge flake and the centripetal Levallois core are proof that the last stage of core reduction was carried out in order to obtain a Levallois flake.

As can be seen in Table. 18, the is no clear difference in size between the Levallois point and the discarded Levallois core, which implies that the shift took place during the last stage of the core's life. In addition, this difference in size indicates rapid and economical shifting, and the flexibility of the flint knappers. This might have been the case throughout the removal of the distal part of the unidirectional convergent Levallois core that gives it a rounded shape.

Number of RMU	Contents of RMU	Length mm	Width mm	Thickness mm
122	Naturally backed knife (*Nahr Ibrahim* Technique)	52	34	14
	Naturally backed knife (*Nahr Ibrahim* Technique)	63	28	10
	Naturally backed knife	43	13	7
45	Cortical flake	54	27	9
	Levallois blade	70	33	9
	Levallois point	65	37	6
	Triangular flake	24	28	6
	Striking platform preparation flake	54	27	9
147	Levallois blade	82	29	14
	Naturally backed knife	80	29	12
	Naturally backed knife	73	25	10
	Levallois flake	54	53	12
148	Levallois point	72	43	10
	Centripetal Levallois core	65	65	18
	Core edge flake	50	27	5

Table. 18. The metric properties of the contents of RMUs 122, 45, 147, and 148.

E. Raw material units involving re-exploitation of flakes (transformation section Crf)

These RMUs appear clearly in assemblage 6, accounting for 8.2% of the total. They contain one or more re-reduced objects whether by *Nahr Ibrahim* Technique, thick flake re-reduced as a core on flake, Levallois method, or Kombewa method. However, the *Nahr Ibrahim* Technique is the most frequent method recognized. RMU 122, for instance, contains only three by-products, all naturally backed knives (Fig. 73). They all bear a partial cortex indicating they were struck from an imported partially prepared core. All of the products bear unidirectional convergent scar patterns, referring to their production by the convergent Levallois method. In fact, this RMU contains neither cores nor end products. This implies that both were exported for off-site use. It is worth pointing that the two naturally backed knives were reused as cores to obtain a secondary flake by *Nahr Ibrahim* Technique. The proximal part of one naturally backed knife and the distal part of the other were selected to be re-reduced. As can be seen in Table. 18, the thickest elements were clearly selected for exploitation. Specifically, the thickest part was intentionally set up as a striking platform.

Furthermore, RMU 151 presents a clear instance of the intensive investment of raw material throughout the re-exploitation of thick flakes (Fig. 74). This RMU includes 6 objects: three cores on thick flakes, a core edge flake, a proximal fragment, and a Levallois blade. According to their scar patterns, it can be assumed that they were derived from a unidirectional parallel Levallois core that was prepared laterally, as the Levallois blade refers to. In addition, the three discarded cores on flake are small and also exhibit unidirectional parallel scar patterns. Accordingly, exported the Levallois core and the three cores on flakes served for blank production. The strategy of intentionally selecting the thickest part of the flake is extreme evidence of deep thought of the group in organising the process of achieving their aim from small discarded flakes. This sheds light on organized behaviours, both in selecting the raw material and the method of reduction.

Interestingly, 6 RMUs, accounting for 2.8% of the total, contain Levallois cores that were exploited on cortical thick flakes in a similar way to the re-exploitation of by-products of nodules, as mentioned in RMUs imported as nodules. There may be more, but due to the absence of cores among the majority of RMUs, it is quite impossible to differentiate them. RMU 33 contains 4 objects: a unidirectional convergent Levallois core and its debitage (a proximal fragment of Levallois point, a Levallois flake, and a triangular Levallois flake) (Fig. 75). Multiple modifications were executed on the Levallois flake (notch and intensive retouch). All of the blanks exhibit unidirectional convergent scar patterns, except for the Levallois flake,

which shows a bidirectional lateral removal matching the type appearing on the preparation on the core.

F. Raw material units including discarded bifaces reused as cores (transformation section Cdb)

Assemblage 6 exhibits several pieces of evidence that indicate the re-exploitation of scattered discarded artefacts, such as reuse of old artefacts bearing double patination (i.e. core on flake and *Nahr Ibrahim* Technique) and re-reduction of discarded Levallois cores by different methods. In addition, two RMUs (93 and 139) attest to the exploitation of the discarded bifaces. RMU 139 exhibits 6 objects: an elongated point, a Levallois point, two flaking surface preparation flakes, an indeterminate flake and a distal termination of biface (Fig. 76). Given that the reduction was executed on a biface, the expectation is that both dorsal and ventral surfaces will have no or a small amount of cortex. This was also the case: none of the products have cortex, and based on the unidirectional convergent scar patterns, it can be assumed that the triangular shape of the biface helped to organize the flaking surface easily, facilitating the process of triangular flake production.

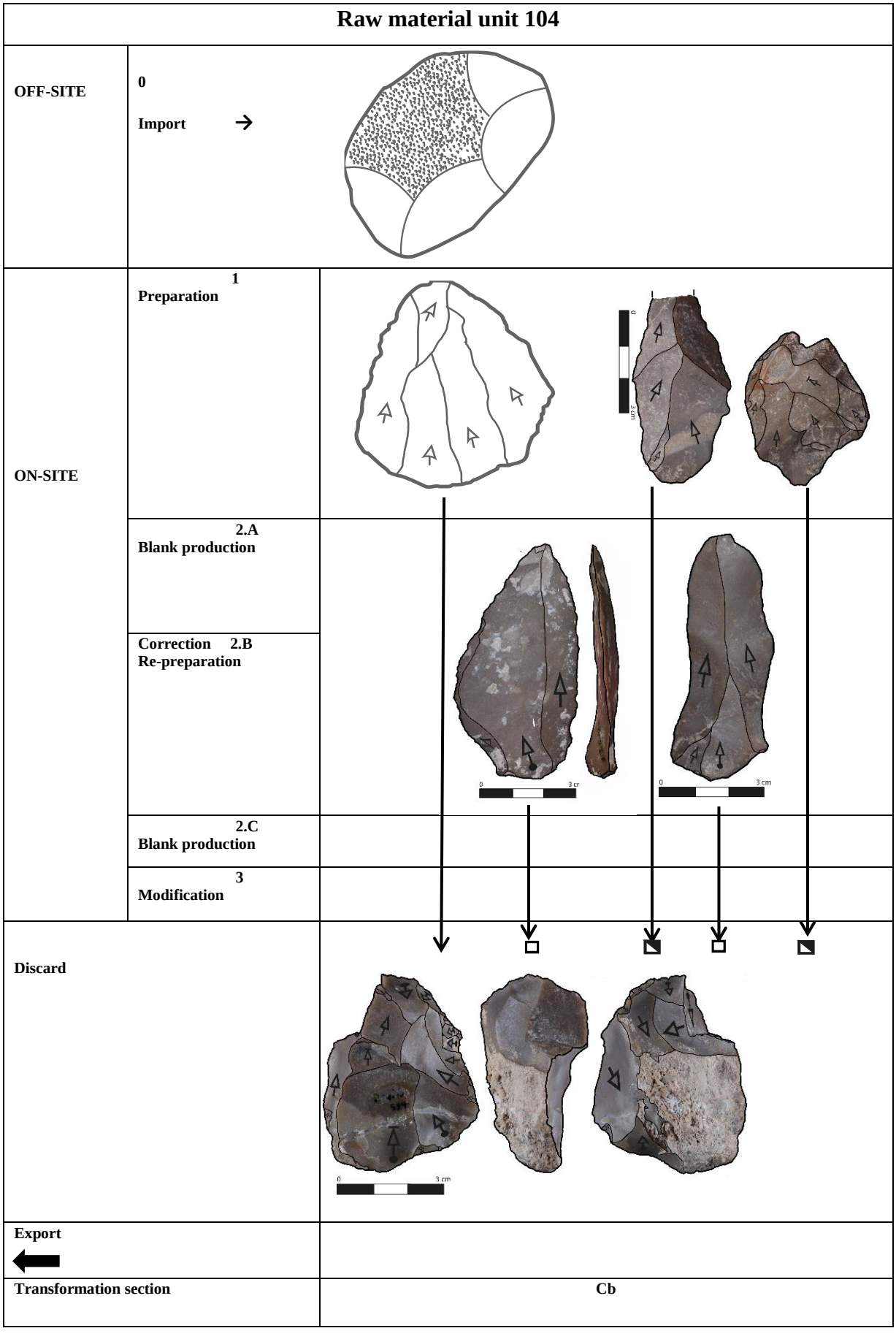


Fig. 67. Blank production from a core.

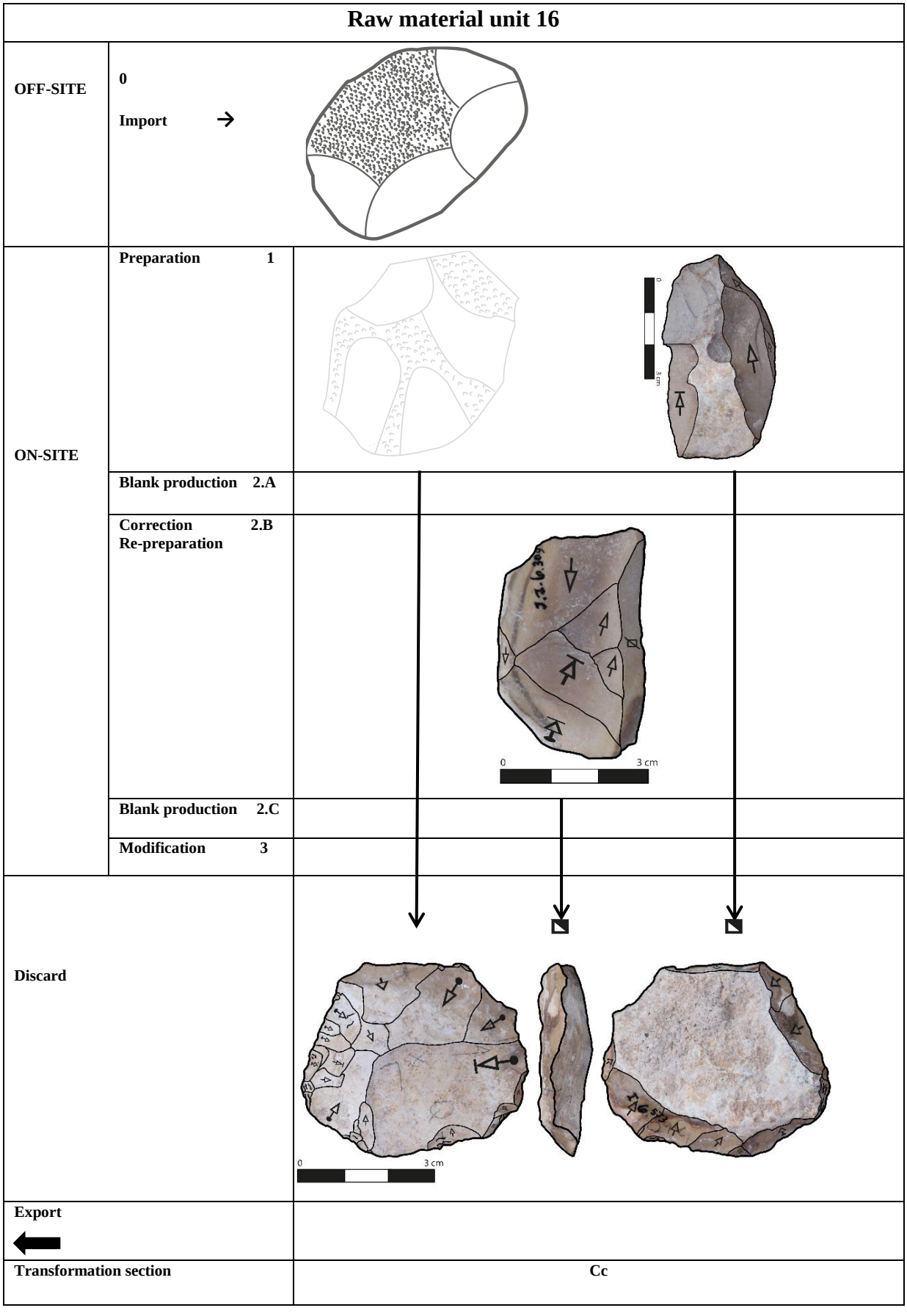


Fig. 68. Elements of the correction of a core.

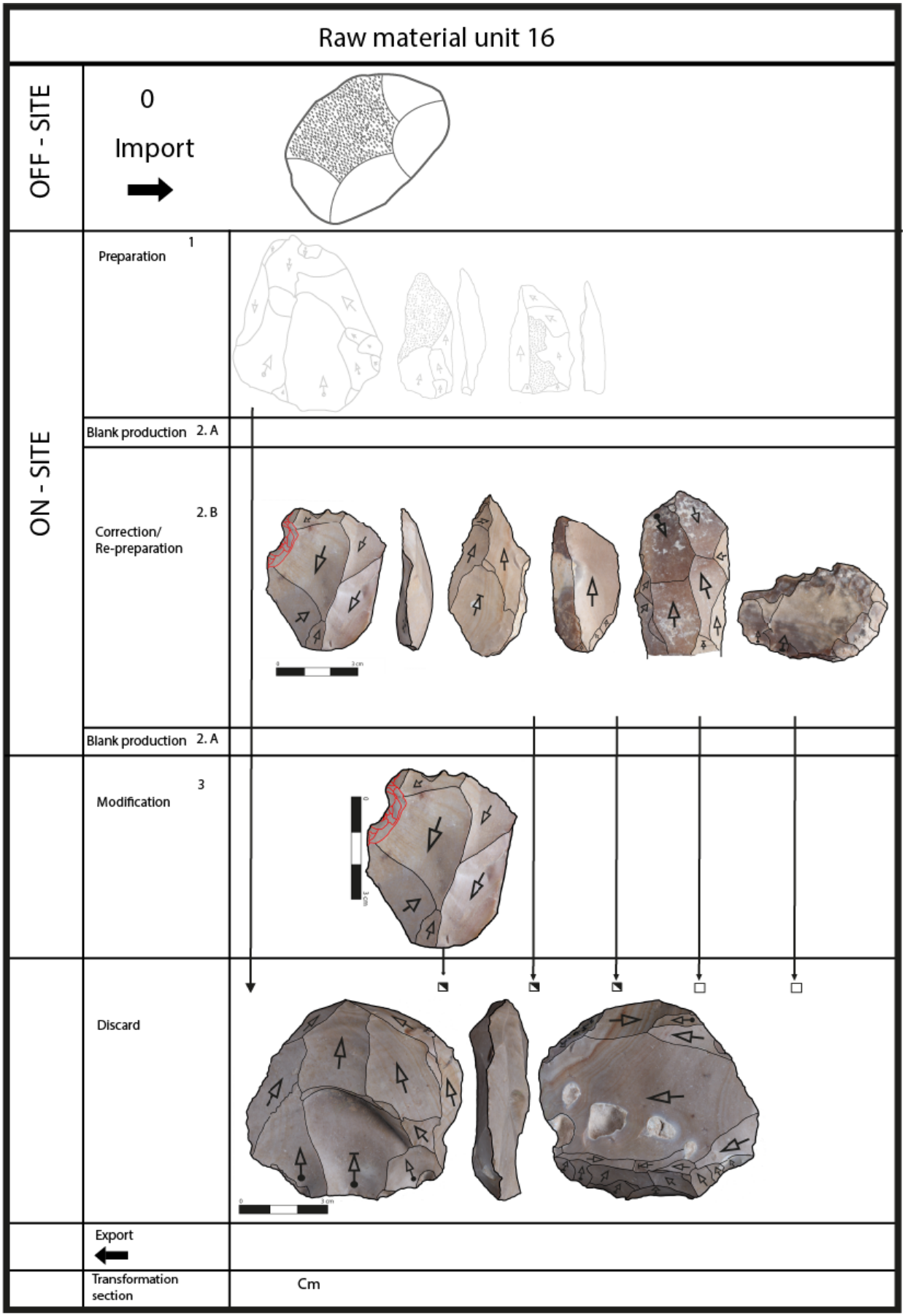


Fig. 69. Blank production from a core with subsequent modification.

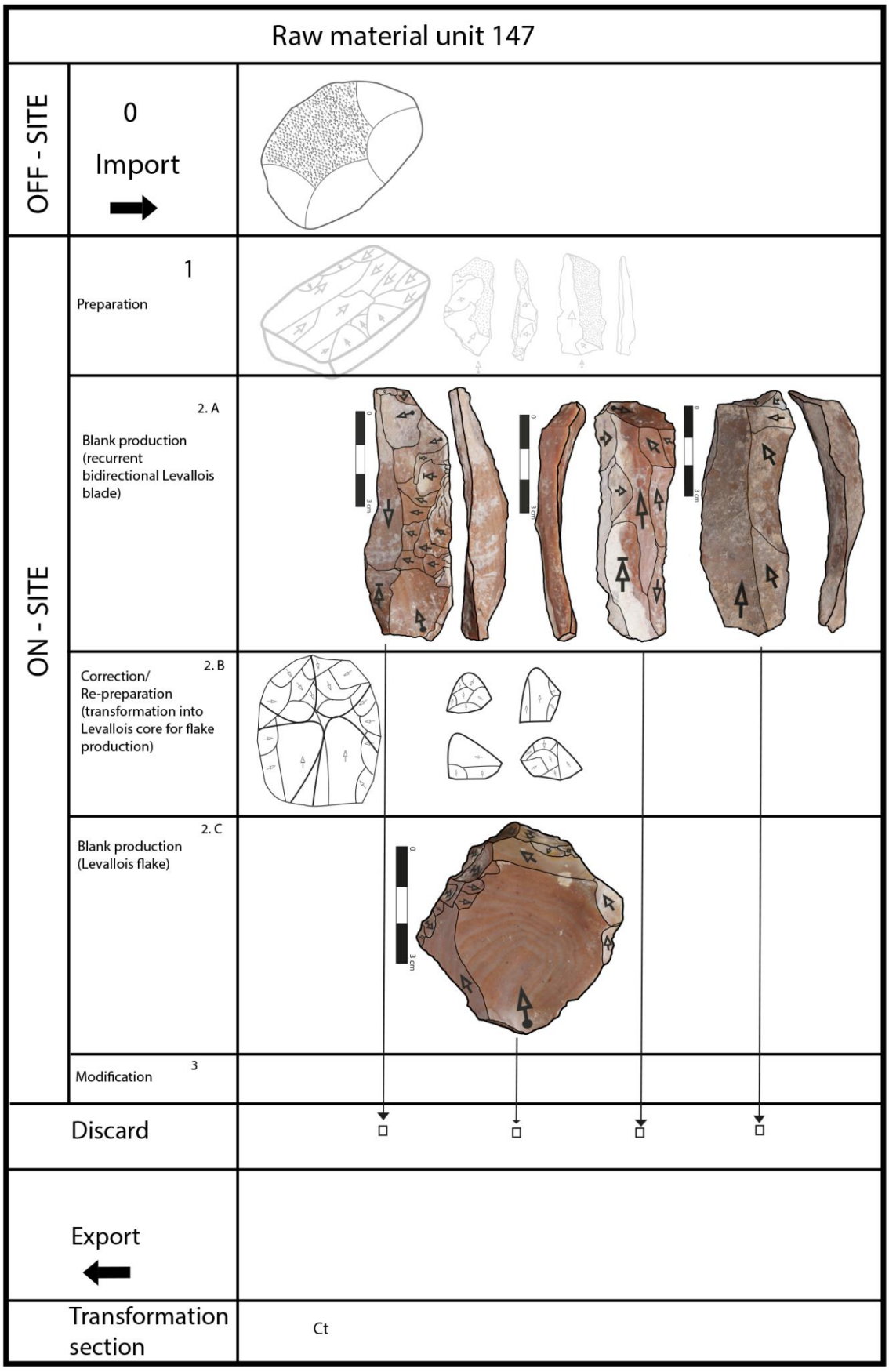


Fig. 70. A debitage of two different Levallois methods were applied to the same core, which was reduced to obtain Levallois blades at the first stages and Levallois flakes at the later stages of core reduction.

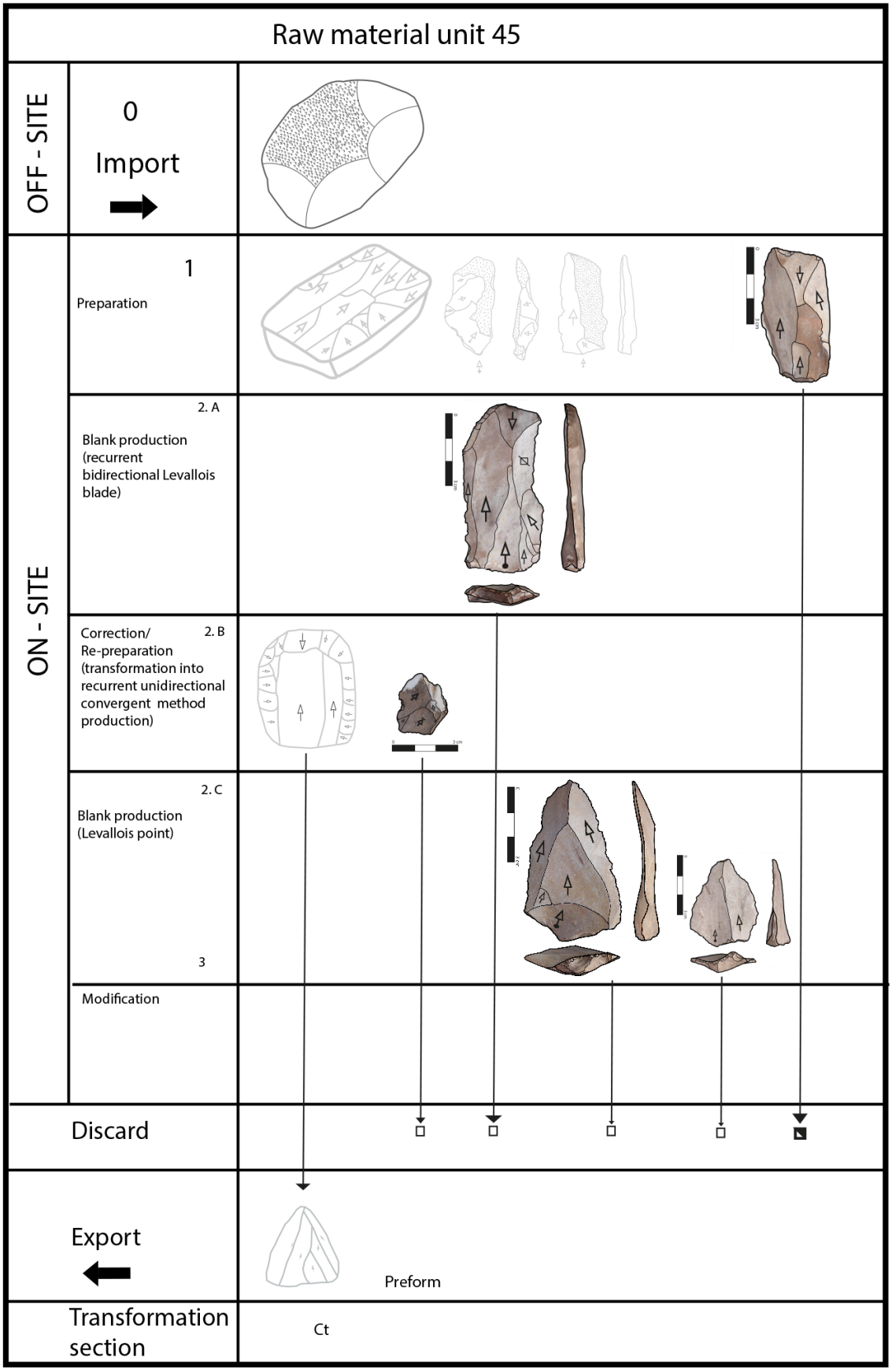


Fig. 71. A debitage of two different Levallois methods were applied to the same core that was reduced to obtain Levallois blades at the first stages and Levallois points at the later stages of core reduction.

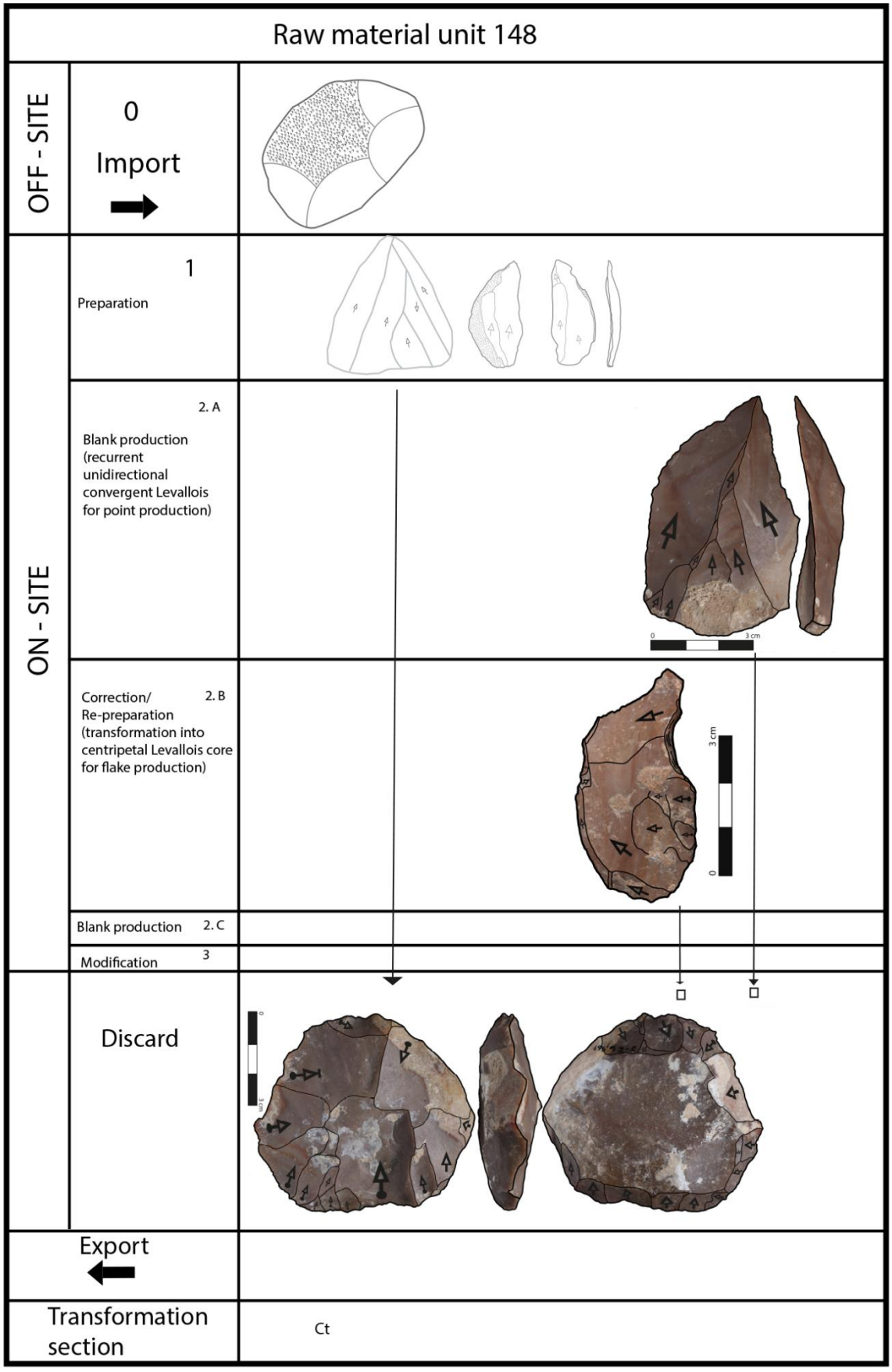


Fig. 72. A debitage of two different Levallois methods were applied to the same core that was reduced to obtain Levallois points at the first stages and Levallois flakes at the later stages of core reduction.

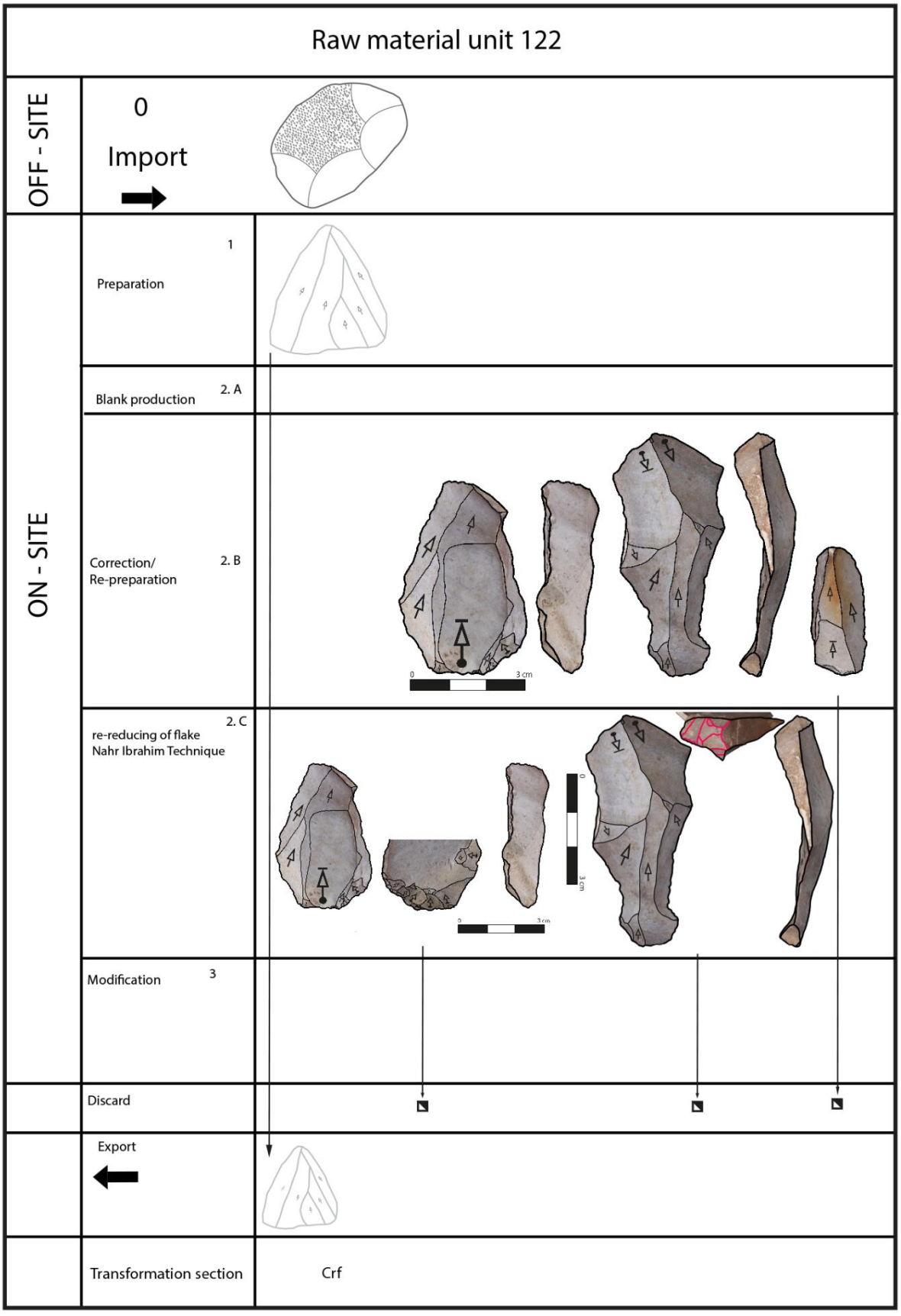


Fig. 73. Re-exploitation of flakes using the *Nahr Ibrahim* Technique.

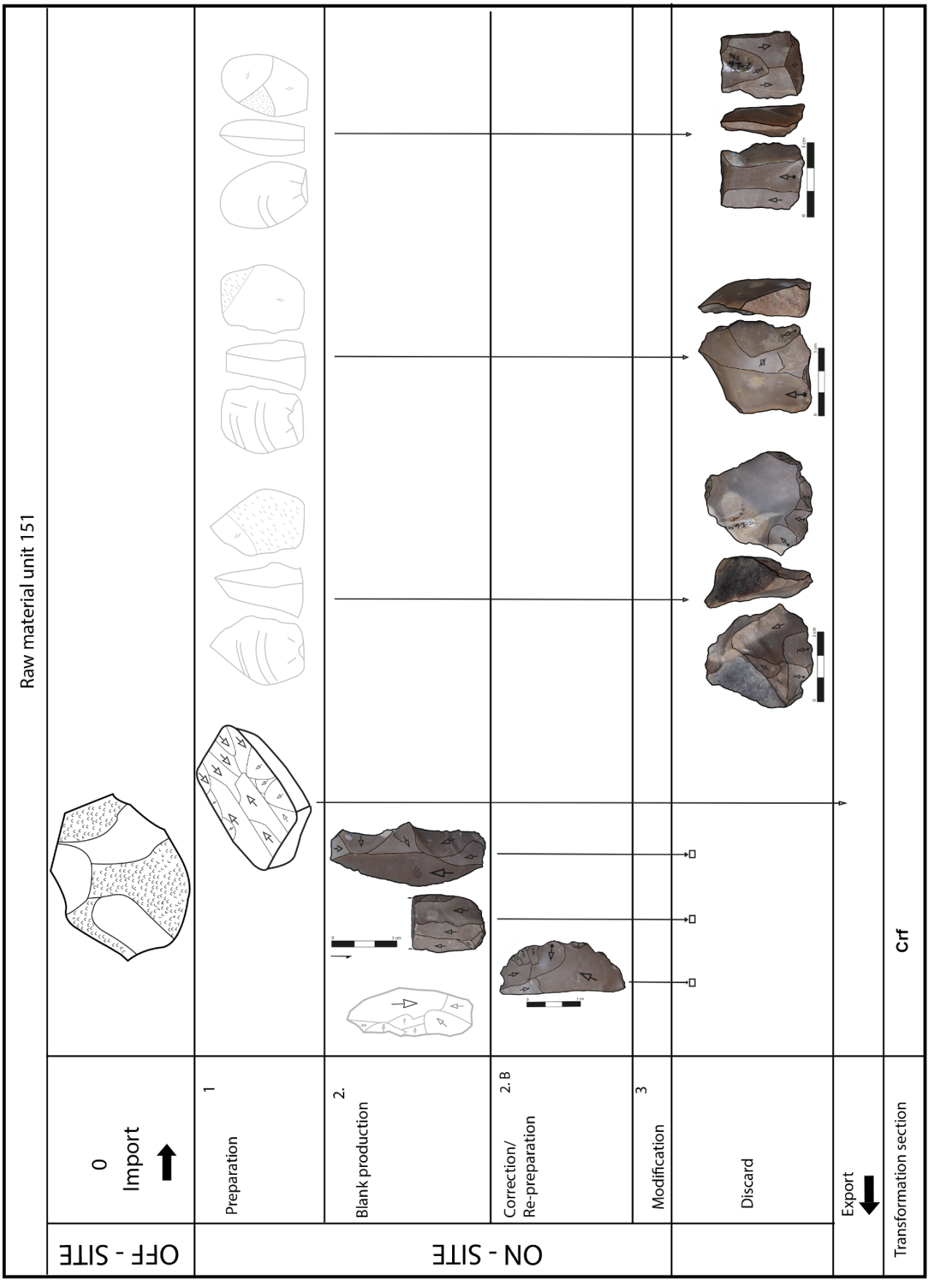


Fig. 74. Re-exploitation of the debitage.

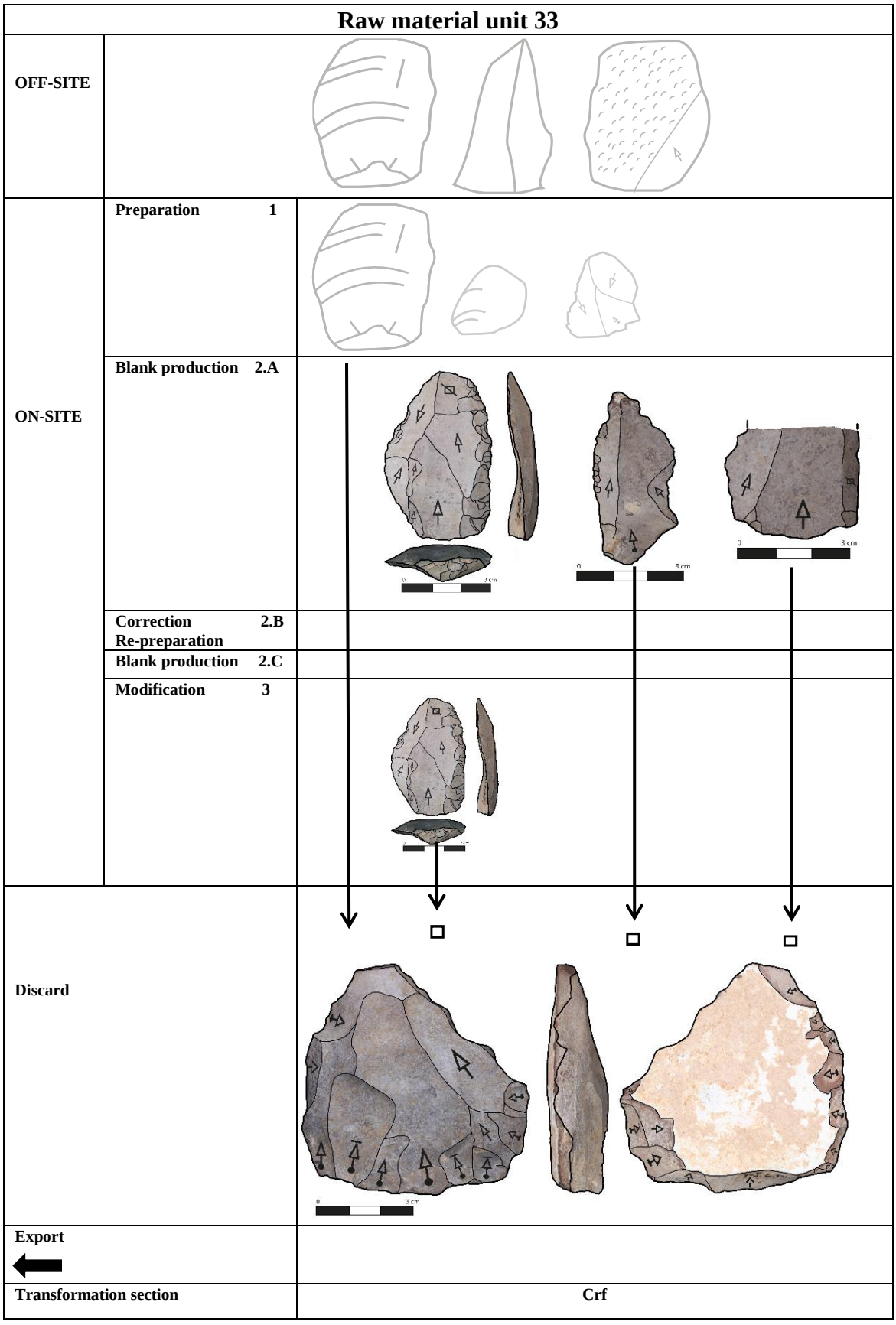


Fig. 75. Debitage of the exploitation of a local cortical flake.

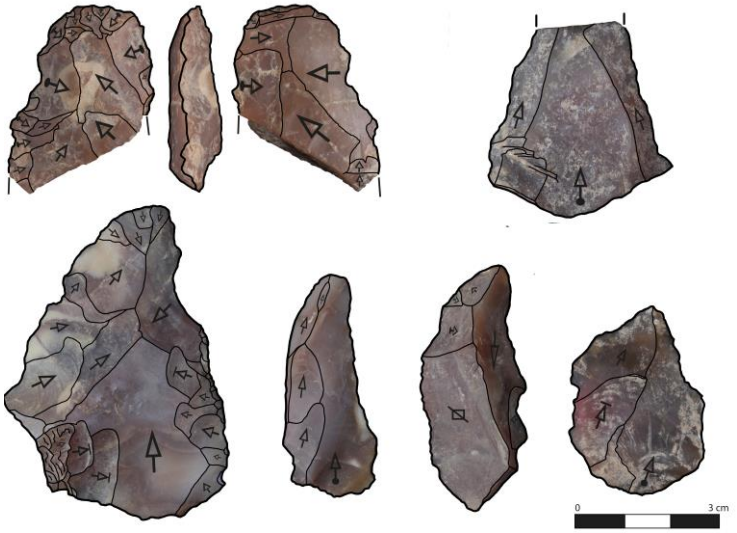


Fig. 76. Tip of a biface and a debitage of core reduction from the same raw material.

5.9.Reconstruction of recurrent occupation of the late Middle Palaeolithic base camp, assemblage 6 of Yabroud Shelter I.

It must first be mentioned that the available sedimentary data from the Mousterian occupations of YSI was found in fine uniform sediments made up of cave debris and without major breaks in the sequence (Farrand 1965; Heinzelin 1966). This boosts the chances that the processes that exported the artefacts were the result of anthropogenic activities and not due to natural dislocation.

According to the previous diverse strategies of raw material procurement and core reduction strategies, which are linked closely to the purposes of the late MP hominins of assemblage 6, the human behaviour responsible for the variability could be reconstructed. This involves dealing with the range of environments and the distribution of raw material resources they encountered. Several questions can be posed and require interpretation. What strategies have human groups applied to procure raw materials? Were the strategies of raw material procurement embedded within some other strategies, as Binford (1979) suggests, and/or intentional direct procurement? Which role did old local artefacts play in strategies of raw material procurement? Were lithics manufactured in anticipation of future activities or did they serve in parallel for on-site activities? Was the personal gear related to high or low mobility systems and a specific pattern of land use? What is the advantage of the blade-point-flake reduction sequence and double strategy of core reduction in this context? What is the specific advantage of selecting larger blanks for tool production? How widespread was the blade-point-flake sequence during the period in question?

5.9.1. Clear diversity of the lithic material

Given that the end products distribute to different categories, this may be related to diverse human behaviours towards meeting the needs of different activities and not confined to specific purposes. The techno-typological analyses of the lithic material proves: firstly, both Levallois points and flakes are the most frequent end products. However, the activities in assemblage 6 might have been more related to the functions of Levallois points and triangular flakes due to their relative predominance combined with the prevalence of unidirectional convergent scar patterns. Secondly, these blanks were mainly produced on-site. Furthermore, it suggests, as clarified above, that a few Levallois cores for blades have been shifted to Levallois cores for the production of either Levallois points or flakes. Moreover, the imported personal gear exhibits a predominance of both Levallois points. This suggests that the activities of humans in assemblage 6 might have been linked to the functions of both Levallois points and flakes. Although both Levallois blanks can be used for the same scraper function, the functional difference between them might be stated in terms of the sharp edge angle of the point relating more to hunting and the wide edge angle of the flake correlating more to scraping (Andrefsky 2005). Variability is not only seen in the Levallois blanks but also in the changing of flaking surface preparation types when the need arose.

Edward H Simpson's diversity index from 1949, in which (1) represents maximal diversity and (0) minimal diversity, was applied (Simpson 1949; 688).

$$D = 1-\left(\frac{\sum n(n-1)}{N(N-1)}\right)$$

The figure of 0.56 is a clear indicator of the diversity of the lithic industry. This variability in the end-products suggests that the activities executed were often linked to functions of Levallois points and flakes on-site. Furthermore, the majority of the personal gear are Levallois points, followed by Levallois flakes, supporting the association of human activities with both categories off-site. Interestingly, the imported Levallois flakes themselves include triangular flakes. Therefore, the predominance of Levallois points among the personal gear, combined with triangular flakes, can be interpreted in relation to off-site activities, such as for hunting functions.

However, since the density of the lithic material is clearly low and without knowing the extent of the excavated area of this assemblage, except that it is at a depth of 1–1.2 m, its diversity cannot be taken as a sign of long-term occupation of assemblage 6.

Debris of bones appears only rarely in the other assemblages. This includes remnants of *Asinus, hydruntinus* (I/25, I/22, I/19-21, I/18, I/5 and specifically I/3) (*Reste von Eseln sind ebenfalls nur spärlich. Zahnreste liegen bereits aus Horizont I/25 vor, andere aus I/22, I/19-21, I/18, I/5, vor allem aber aus I/3*) and teeth of *Equus* in assemblage 2 and 25 of Shelter I (Lehmann 1970; 186). These species favoured semi-arid, steppe conditions and showed a preference for temperate climates, although they were also found in cool or cold conditions. Accordingly, there would have been a greater availability of bones, but the taphonomic process might have affected their preservation[1].

The question here is when was assemblage 6 occupied? The Tübingen Damascus Excavation and Survey Project tested pollen from three different areas of the Ma'aloula region, where MP sites are dispersed (Fig. 77). The environmental data indicates alternating steppe and desert-steppe vegetation, which expanded from the late Middle Pleistocene through the Holocene (Dodonov et al. 2007). Furthermore, Schrøder et al. (2012) tested pollen and spores from various depths at YSI. He identified that certain assemblages in the shelter were deposited during warm periods.

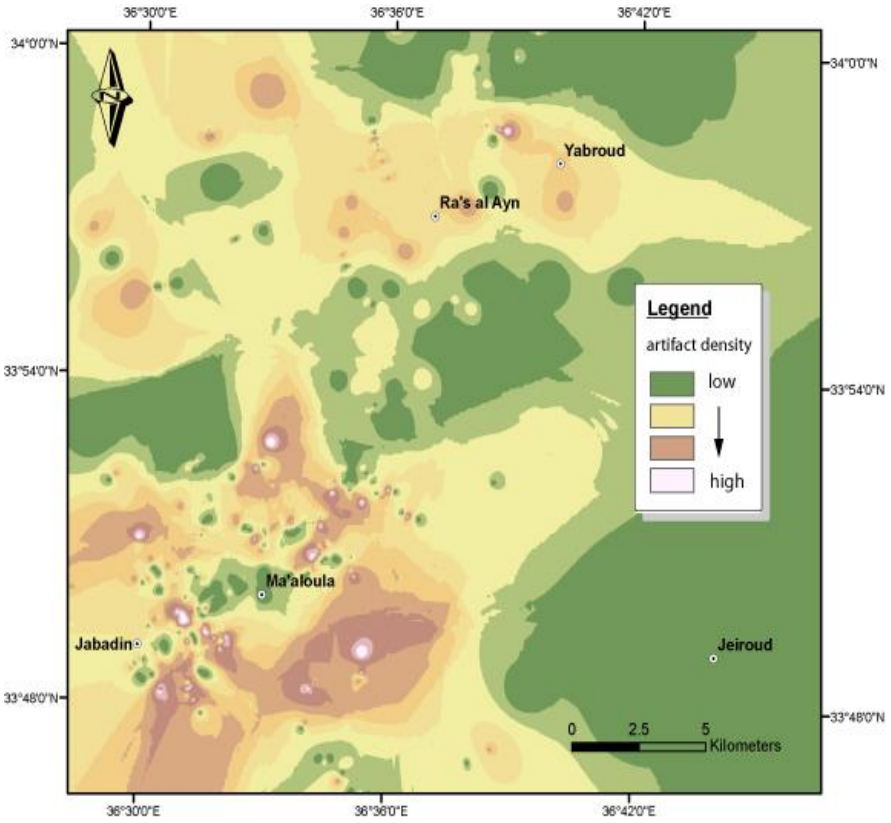


Fig. 77. Lithic density of Levallois Middle Palaeolithic in Yabroud and Ma'aloula region (Conard et al. 2010).

[1] Rust (1950. P 11) indicate that soil moisture could affect on the preservation of bones, since at depth of 5 m, the existing moisture was barely noticeable. But at a depth of 9 m, the components were a bit wet.

All indications, for instance, the faunal remnants, even though they are scarce (Lehmann 1970), or the reconstructed environmental data (Dodonov et al. 2007; Schrøder et al. 2012) with the harsh winter at the high elevation, suggest that assemblage 6 might have been occupied during summer or spring seasons. YSI is surrounded by water tables and springs, which together with the contribution of the Wadi al Majarre coming from the south allowed the development of wooded areas, forming an oasis. The availability of freshwater attracted foragers and the gregarious ungulates they preyed upon to these micro-environments.

5.9.2. Repeated occupation of the base camp assemblage 6 of Yabroud Shelter I

Pagli (2013) indicated that assemblages 6, 5 and 2 of YSI show technical changes in the operatory scheme, methods and production objectives. She assumed that these technical changes were the result of successive occupations of groups with different technical systems, characterized by different technical cultures. Furthermore, she linked these technical changes to regional macro-groups noted in the Levant, which became possible as a result of regional mobility of people or their ideas. Consequently, she proposed that the technological variability reflects the highly mobility of human groups who moved around the territory, exploiting a wide area without returning to the same site, according to the "reticular space" concept. Thus, high mobility promoted the pursuance of technological variability over time.

Contrary to Pagli (2013) and her hypothesis that assemblage 6 was a point along a route according to the "reticular space" concept, the importance of YSI to local occupants of the late MP, as was previously postulated, is evident in many points. The first indicator is that YSI presents a long and successive stratigraphy, beginning from the Lower Palaeolithic and running to the late MP. It includes 25 assemblages representing different successive cultures (i.e. alternating layers of the Yabroudian, the Acheuleo-Yabroudian and so-called Pre-Aurignacian), which are nowadays called the Amudian, superimposed by MP assemblages (Rust 1950). This cultural accumulation suggests that the frequent occupation of YSI cannot be due solely to its discovery as a result of the high mobility of humans. This stratigraphic succession suggests that spans of occupation might have been planned by local people over time, particularly in the absence of the exotic raw material of the personal gear. Secondly and more specifically, assemblage 6 exhibits various aspects of frequent reuse. Several indices point out intentional reuse of old local artefacts, for instance, a reduction of discarded bifaces as cores. Furthermore, both Rust (1950) and Solecki & Solecki (2007) interpreted the presence of biface fragments recovered from Mousterian levels as being the result of secondary use of handaxes as cores. Other indices suggest frequent reuse of the discarded artefacts, such as the

technological strategies of cores on flakes, *Nahr Ibrahim* and Kombewa. In addition, the reuse of the lithic material is clear through the application of a double strategy core reduction, indicating the systematic use of the raw material and is evidence of intentional reuse of local artefacts. Moreover, the double and sometimes triple patination that appeared on 11.4% of all artefacts suggests the reuse of local material in different time periods.

Finally, the most important argument is that there is no strong evidence of the importation of exotic raw material to suggest YSI's use as a point along a route. It was agreed that the occupants of YSI used local material and mainly from the second position (Rust 1950; Solecki & Solecki 2007; Pagli 2013). This can be supported by Hovers (2001; 125), who assumed that when human groups venture into regions that are not often frequented during individual lifetimes, the members of these groups will possess little information about the distribution of local resources. Thus, she assumed that these groups must carry their "personal gear" equipment, which had to be manufactured from exotic raw material, for any contingencies or activities that could not be anticipated. Accordingly, the frequent occupations of assemblage 6 were the result of prior knowledge of the site and its environmental circumstances.

According to Binford (1980), hunter-gatherers displayed two different kinds of settlement patterns: residential and logistical mobility. Each one has a different impact on the production, use, maintenance, and discard of artefacts. Rolland (1981), who studied the variation in Mousterian facies in southwestern French, argued that the longer people stay in one place, the more extensively they use up whatever artefacts and raw material they have previously brought to the spot and abandoned. According to the previous indices of intensive reuse of local artefacts, a successive occupation of Shelter I, and the clear diversity in the lithic industries according to Simpson Index, it can be assumed that assemblage 6 looks like a frequently used base camp. However, the density of artefacts, the great evidence of reusing artefacts, and the low to moderate percentage of retouched pieces all imply that a palimpsest of multiple occupations was for short-term periods. Therefore, it may have been a base camp of residential mobility that was successively occupied by the same or different groups with different subsistence strategies, for short-term periods during spring or summer in an area characterized by arid climate.

Furthermore, patination supports the assumption that these behavioural episodes, or at least many events, might have been executed in different time periods. Given that Levallois methods were the major concept used, we can conclude that the site was at least used by the

same kind of hominins at the same phase of late MP. They reused the shelter with prior knowledge of the richness of the area with local material, allowing them to reuse it.

If variability was rooted in the occupation of a succession of different technical cultures (Pagli 2013), the site cannot have been used as a point along their route. The human behaviour in assemblage 6 refers to a comprehensive knowledge of local resources. Thus, the occupation cannot have only been by different technical cultures without them returning to the same site. In particular, no exotic raw material was observed.

5.9.3. High Mobility

The movement of tools and raw material is clear evidence and the basis for arguments about planning or anticipatory organization (Binford 1980; Kuhn 1992, 1995; Roebroeks et al. 1988).

I am in totally agreement with Pagli (2013) that highly mobile people occupied assemblage 6. This can be seen through the high presence of personal gear, which was carried and used off-site and on-site in micro-local movements. It is worth noting that 22 RMUs include 45 personal gear (RMUs imported as single objects or tools), which are all Levallois blanks, except for a single side scraper executed on a flaking surface preparation flake. In addition, 35 RMUs exhibit personal gear that are mainly Levallois blanks (RMUs imported as dynamic objects). It is worth pointing out that 45.5% of them are retouched. Furthermore, the double patination on 10.2% of the personal gear suggests frequent use. Consequently, these objects have been heavily used during hunter-gatherer activities on which they relied for subsistence.

However, I disagree with Pagli (2013, 2015) in terms of the interpretation of the high mobility system. While she proposes that the technological changes reflect highly mobile human groups who had different technical systems and moved around territory exploiting wide areas without returning to the same site, I attribute this high mobility to gaining a comprehensive knowledge of the landscape and the distribution of raw material and as a result of frequent occupation of the assemblages. This is supported by the absence of exotic raw material, especially among the personal gear.

According to Binford (1980; 5), the number of residential moves increases as the distance of the moves decreases. This system of movement led to good coverage of the resources around the base camp. A good knowledge of the distribution of resources can explain the absence of exotic raw material. The fact that sources of subsistence, which played the main

role in determining mobility patterns (Binford 1979; Kelly 1988; Nelson 1991), were at hand, might have facilitated the mobility system within the Yabroud region.

As a result of the Tübingen survey, which shows a high distribution of MP sites in the region (Conard et al. 2006), it can be assumed that hominins occupied the region for long periods. High mobility over long periods would have enabled them to gain quite deep knowledge of the region and an understanding of its nature and properties. This led to the frequent occupation of Shelter I. Accordingly, assemblage 6 of YSI might have served as a base camp, which might have been located near large congregations of animals, attracted to nearby water during the spring or summer. However, this is difficult to back up without faunal data.

Focusing on the nature of the items transported may lead to an understanding of anticipated needs. According to Simpson's diversity index, which gives a result of more than 0.63, indicating high diversity in personal gear. This suggests that personal gear might have been linked to different activities or different subsistence practices. Kuhn (1995; 36) linked the predominance of personal gear in the assemblage to short-term occupations. In addition, the more prevalent personal gear is, the briefer the ephemeral occupations are. The personal gear in assemblage 6 represents 32.4% of the abundant end products, a high percentage indicating short-term occupation of the assemblage.

5.9.4. Strategies and circumstances of raw material procurement

Based on a general study of MP in the Levant, Shea (2004) indicated that most sites are located less than 10 km from either primary or secondary flint sources. In addition, he pointed out that most strategy of raw material procurement has been carried out in the course of daily foraging tasks.

A. Direct strategy of raw material procurement

Based on transformation analyses, it turns out that direct raw material procurement was rarely part of the hunter-gatherers' strategy of procurement during occupation of assemblage 6. This can be assumed because of the low number of imported nodules compared to imported partially prepared cores and reuse of old discarded artefacts. All the evidence leads to the same assumption that assemblage 6 has been utilized heavily and frequently.

B. Embedded strategy of raw material procurement

Many pieces of evidence suggest that the main strategy of raw material procurement was embedded within the daily foraging tasks of hunter-gatherers. Each detail observed suggests their broad understanding of the dispersal of raw material. This is evident, for example, in their behaviour in dealing with old artefacts and locally available raw material. The embedded strategy mainly involves imported partially prepared cores. The re-exploitation of discarded flakes reflects a rapid response to meet their needs, instead of a specialization in a direct strategy of procurement of the raw material. Furthermore, shifting from the exploitation of the flat flaking surface to the convex lower surface before core discard mirrors the deep thought and rapid response in investing in the convexity of the lower surface.

Also, Levallois blade-point-flake manufacture from a single reduction sequence implies an embedded strategy of raw material procurement, through which different products were obtained from a single reduction instead of importing an individual core for each product. Meanwhile, single reduction is explicit proof of the economic strategy of raw material utilisation. According to Shimelmitz and Kuhn (2018), this procedure minimizes raw material lost in initial preparation and core maintenance given that the most wasteful reduction phase occurs in the shifting the nodule to a properly shaped core. All of the previous manifestations, from reuse of discarded artefacts, application of a double strategy on the same block, to the size of the raw material exploited, suggest not only embedded procurement and an economic strategy but also indicate short productivity.

Consequently, the occupants of assemblage 6 relied mainly on embedded procurement strategies within daily foraging tasks that largely included provisioning of individuals and provisioning of place (Kuhn 1995) from local sources within and near the Yabroud region with a priority for the reuse of discarded artefacts.

6. TECHNO-TYPOLOGICAL analyses and transformation analysis of the late Middle Palaeolithic assemblage 4 of Yabroud Shelter I

The lithic material of assemblage 4 will be addressed here, following the same structure as for assemblage 6 in the previous chapter, and then a comparative study between the two assemblages will be carried out. Accordingly, all of the lithic material will be analysed in order to reconstruct the core reduction strategies in assemblage 4. While fragments will be excluded from the techno-typological analyses, they will be included in the transformation analysis.

As can be seen in Table. 19, assemblage 4 of YSI encompasses 706 stone artefacts, which have been classified into five categories: 344 Levallois blanks, 239 by-products, 32 Levallois cores, 4 initial cores, and 84 fragments. Each category will be looked at in detailed in context. According to the last removal on waste cores and the end-products, various Levallois methods were used in this assemblage, presenting diverse attributes that refer to different methods of Levallois core reduction.

Category	Number
Levallois cores	32
Initial cores	4
Core fragment	1
Indeterminate core	2
Levallois blanks	344
By- products	239
Fragments	84
Total	**706**

Table. 19. Distribution of lithic material of assemblage 4.

6.1.Identifying core reduction techniques

Many attempts have been made to identify the core reduction techniques in assemblage 4 of YSI since the 1930s. Solecki & Solecki (1995) only analysed the Mousterian lithic material typologically. The most recent study was carried out by Pagli (2013), who identified Levallois and non-Levallois concepts. She named the latter type C core reduction strategies (Fig. 90) (see the definition of the concept in subchapter 5.1). In addition, she suggested that a few blades attest to the existence of a different concept that lacks cores, which makes detailed analysis difficult (Pagli 2013; 405). Furthermore, she concludes that the technical system of this assemblage is aimed at the production of Levallois points and triangular flakes, corresponding

to 53% of the predetermined Levallois products. Moreover, she pointed out that triangular flakes are characterized by a rather important standardization in their morphometric characters. Moreover, the unidirectional convergent Levallois method is the most frequent method, associated with a parallel unidirectional method, which is however less frequent. Additionally, she suggests that this assemblage shows a rather important heterogeneity in the production methods of triangular flakes. Next to the convergent unidirectional method, the management of bidirectional and centripetal convexities are also attested to (Pagli 2013; 479).

It is worth noting how difficult it is to distinguish between the cores executed on blocks and those carried out on cortical flakes. Several factors play roles in their differentiation, such as transformation analyses, which rely on sorting artefacts based on their raw material. The whole structure of the core reduction sequence can be reconstructed in chapter (6.7). The size properties of cores and their exploited sections, where a preference for specific sections of the core over others, also contributes to distinguishing Levallois cores of flakes. In addition, the status of the prepared lower surface of the cores can help differentiate which cores were applied to local discarded flakes. The Levallois cores on flakes do not, in most cases, bear a very well-prepared lower surface. In contrast, cores on blocks exhibit mostly very well-prepared lower surface. Accordingly, two diverse types of cores have been reduced (Fig. 78). While the majority of Levallois core reductions were performed on blocks, a few were applied exclusively on thick cortical flakes. These cortical flakes have been systematically recycled and prepared following the criteria of the Levallois concept to obtain blanks.

Consequently, only the Levallois flaking methods was recognised in assemblage 4 of YSI. However, Levallois methods were executed on different raw materials, which might relate to the specific circumstances of hunter-gatherers and their mobility.

Beyond transformation analyses, it is difficult to differentiate between Levallois blanks that were derived from blocks or flakes, *per se*, especially in the absence of refitting. The difficulty comes from both cores having been abandoned at the same size. This increases the similarity of their blanks in terms of size and shape. This means that the process of flake selection and exploitation is systematic, and flakes had to fall under adequate size constraints and not chosen randomly.

Flint and chalcedony were both used for the production of stone artefacts in assemblage 4. Flint is the most frequently exploited raw material, as chalcedony was unfavourable and its use was limited to a small amount.

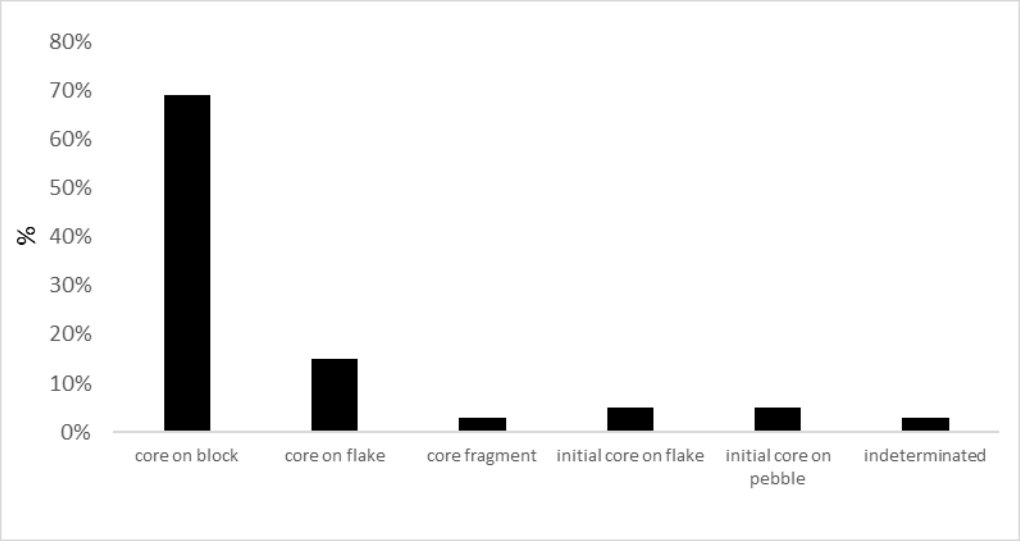


Fig. 78. Distribution of types of the raw material.

6.2.Levallois core reduction strategies

Quantitative and qualitative attributes of discarded Levallois cores and the debitage indicate that two Levallois methods were applied: the preferential Levallois method and the recurrent Levallois method (Fig. 79). The recurrent Levallois method is clearly the most frequently applied, accounting for 94% of all exploited Levallois cores. The preferential Levallois method is confined to the production of Levallois flakes, while the recurrent Levallois method was exploited to produce Levallois points, flakes and blades. Unidirectional convergent is the most common recurrent Levallois method at 60%, followed by the bidirectional Levallois method accounting for 16.6 %. The centripetal Levallois method was used on 13.3% of all Levallois cores, while the unidirectional parallel method constitutes 10% of the total (Fig. 80).

According to the morphology of the last removal on the core flaking surface (Bordes 1980), Levallois cores for points are the most prevalent discarded cores at 60%, followed by Levallois cores for flakes and finally Levallois cores for blades (Fig. 79).

It is worth pointing out that the exploited thick cortical flakes were exclusively reduced by Levallois method to obtain Levallois flakes, except in a single case that was used to produce a Levallois point (Fig. 79). This implies that the size of discarded flakes meant they could be reduced for flake production, and hence, there was no need to procure blocks specifically. Therefore, Levallois cores for flakes do not attest to a long reduction sequence, as will be seen, due to the size restrictions of the flakes. This may imply that the production of Levallois flakes was a secondary strategy. Furthermore, three small and thick cortical flakes show the criteria of the Levallois concept, which indicates the intentional exploitation of thick cortical flakes.

However, their reduction was not carried out due to their small sizes. In the absence of Levallois cores for blades on flakes, it is quite important to indicate that the knappers did not re-exploit flakes in order to produce Levallois blades. Accordingly, this implies that Levallois blade production might have required large-sized raw material and the local discarded flakes did not meet their needs, which will be seen in strategies of Levallois blank production (subchapter 6.4.3).

Finally, we must mention that the production of Levallois blanks was not confined to a specific Levallois method *per se*. In other words, Levallois flakes were removed using preferential, centripetal, and bidirectional Levallois methods. Accordingly, human behaviour adapted to technical changes in order to meet demands in different ways. The Levallois cores will be analysed in order to investigate the stages of the core reduction process for each method in detail.

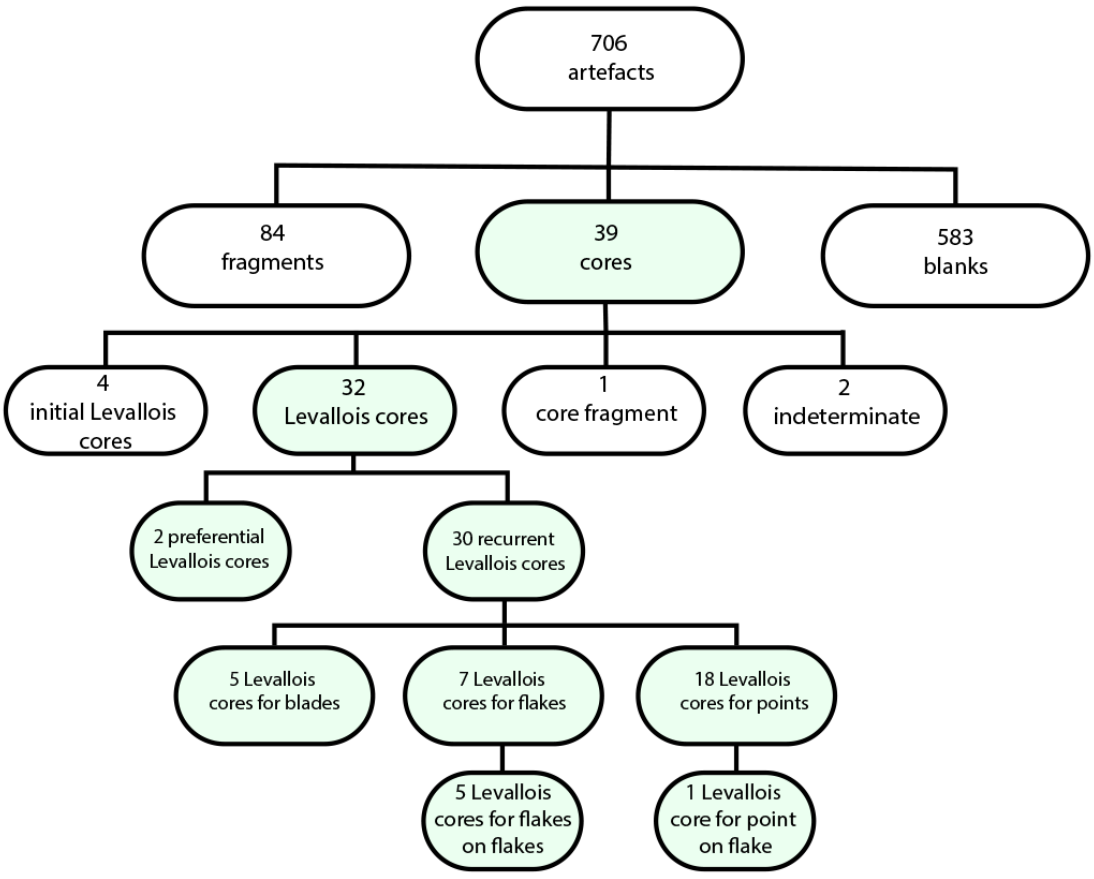


Fig. 79. Variable methods of core reduction identified in the late Mousterian assemblage 4 of Yabroud Shelter I.

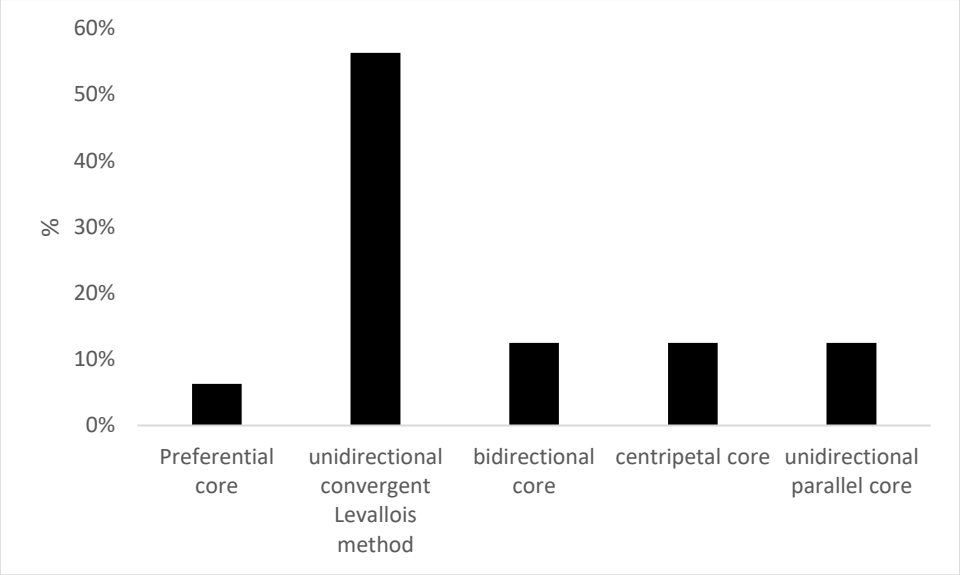


Fig. 80. Distribution of Levallois cores.

6.2.1. Levallois cores for points

The unidirectional convergent Levallois method is the only clear method used in Levallois point production, and it accounts for 56% of all Levallois cores in this assemblage (Fig. 81). Despite the availability of classical Levallois points, the preferential Levallois cores for this kind of point production is completely absent. This absence poses the question of how these points were produced. There are many possible theories. They might have been struck off-site, and when then imported into the site. Another supposition is that they might have been produced in an early stage of core reduction by means of the preferential Levallois method. The core was then shifted to a different flaking method in the last stage of core reduction. The answers will be interpreted in context (subchapters 6.4.1). In the meantime, we can assume that unidirectional convergent Levallois method was the only method used to produce Levallois points in assemblage 4.

As only unidirectional convergent Levallois cores are present, they will be in the spotlight as the unique method for Levallois point production. In terms of scar patterns, it was observed that all of the discarded unidirectional convergent Levallois cores were prepared by detaching small bidirectional, perpendicular, and/or centripetal removals from the core's distal termination and lateral edges. These preparatory small flakes occupied mostly the uppermost third of the cores. Accordingly, it is quite obvious that the knappers pretty much relied on this specific type of flaking surface preparation to reinstall distal and lateral convexities (Fig. 82-83). In addition, it is very interesting to point out that all of the Levallois cores for points exhibit flaking surfaces devoid of any kind of knapping accident. Finally, the combination of these

scar patterns with the fact that Levallois points bear only unidirectional convergent scar patterns led to further question being posed. When have these Levallois points been produced if there is no discarded Levallois cores showing only unidirectional scar patterns? This phenomenon will be interpreted in detail in the context (subchapter 6.3.1).

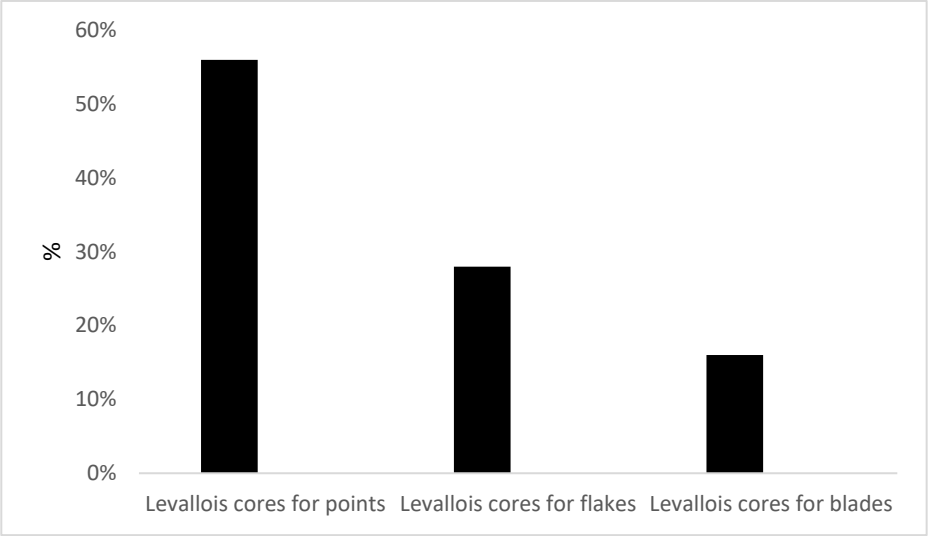


Fig. 81. Distribution of Levallois cores according to the last removal.





Fig. 82 and 83. The applied type of flaking surface preparation.

All of the unidirectional convergent Levallois cores have a single striking platform that is limited at the proximal part of the cores. They are mostly faceted and occupy around a third of the circumference. In addition, they show almost standardized angles, with a mean of 72°. Accordingly, they reflect the proper situation for further exploitation at the moment of their discard. Furthermore, 62% of all Levallois cores for points exhibit a negative of the *Chapeau de gendarme* type of butt. This high representation mirrors the high frequency of the broad-based type of Levallois points and the high focus on the production of quite morphologically standardized points given that the function of *Chapeau de gendarme* is to determine the impact point precisely.

Discarded Levallois cores for points are small (Table. 20). Furthermore, the mean LWR value suggests a relation to the predetermined plan of keeping the width of cores in order to obtain broad-based Levallois points. Moreover, the mean length and width of the last removal on their cores correspond with the mean size of the smallest discarded Levallois points, at 3.3 × 2.8 cm. Consequently, the desired Levallois points were in the range between four and three centimetres. The small size of discarded Levallois cores for points and the absence of knapping accidents attests to the reason for their discard being size limitations. Both factors indicate these were highly skilled knappers who have managed the cores despite their small size. Moreover, exploitation might not have been restricted to a specific size of raw material. On the contrary, the skill of knappers might have expanded raw material procurement options.

While the flaking surfaces of Levallois cores for points are completely devoid of cortex, lower surfaces display amounts ranging between 40% and 90%. This variation of cortex on the lower surface is associated with the re-installation of flaking surface convexity and the type of raw material (i.e. Levallois core on flake or block). 80% of Levallois cores for points bear less than 70% cortex, which is confined to the medial or proximal section of the lower surface. This can be correlated to the type of flaking surface preparation in which small bidirectional or perpendicular removals were detached from the distal termination and lateral edges. Levallois cores for points bearing a cortical lower platform ranging between 75% and 90% might have been prepared during the reduction sequence, or at least during the last two preparations, mostly by detaching lateral removals from core edges. Thus, the lower surface of the second type of flaking surface preparation displays a lower number of scar patterns compared to the first type of flaking surface preparation.

	No.	%	Striking platform angle in degree	Length Mean mm	width mean mm	thickness mean mm	LWR	Length of last removal mean mm	width of last removal mean mm
Levallois cores for points	18		72	48	46	20	1.0	33	28
Levallois cores for flakes	9		71	51	47	20	1.0		
Preferential Levallois cores for flakes	2		70	59	57	14	1.0	43	40
Centripetal Levallois cores fore flakes including continuous and discontinuous striking platform	7		69	48	44	23	1.0	24	22
Levallois cores for blades	5		78	49	42	20	1.1	42	17
Initial Levallois cores	4		-	45	49	18	0.9	-	-
Core fragment	1		-	-	-	-	-	-	-
Indet.	2		-	-	-	-	-	-	-

Table. 20. Sizes of discarded Levallois cores in assemblage 4 in mm.

6.2.2. Levallois cores for blades

Both unidirectional and bidirectional Levallois methods were employed to obtain Levallois blades. They represent the lowest percentage of Levallois cores in this assemblage, forming 16% of all discarded Levallois cores (Fig. 81).

All of these cores exhibit only unidirectional or bidirectional scar patterns (Fig. 84-85), except for a single bidirectional core showing lateral perpendicular scar patterns that represent flaking surface re-preparation. This implies that the process of flaking surface preparation carried was mostly out simultaneously to Levallois blade production and a series of blades were removed from the entire flaking surface including the lateral edges. There is a mean number of 6.2 scar patterns, which indicates that even though the cores are very small, intensive exploitation was executed in the last phase of cores.

This implies that these cores underwent a single type of flaking surface preparation through the core reduction sequence. In addition, the thickest part of unidirectional Levallois cores is limited to the distal termination of the cores reaching 24 mm, whereas the thickness of the striking platforms measures between 5 and 12 mm. This refers to a focus on frequent removal from the proximal part without any attempt to re-create the lateral or distal convexity of the flaking surface. These observations support the previous tentative assumption that the flaking surfaces have been re-prepared, at least at the last stages of the core reduction sequence, by the removal of two lateral blanks and not by small lateral perpendicular removals.

This type of convexity installation helps to maintain and economize the raw material, thus minimising the load for further use during mobility—the preparatory process consumes part of the raw material. With the predominance of this standard type of flaking surface preparation, the same question is posed. How were Levallois blades with lateral preparatory scar patterns produced? This will be addressed in context (subchapter 6.3.1).

95% of the cores show lower cortical surfaces in which non-cortical parts are confined to the striking platform. This supports the theory that the reinstallation of flaking surface convexity was mainly carried out by lateral removal, meantime, these lateral removals might also have been used as Levallois blanks.

As can be seen in Table. 20, Levallois cores for blades generally exhibit a small size. While bidirectional Levallois cores display similar thicknesses of both striking platforms, on average 18 mm, unidirectional Levallois cores display extremely exhausted striking platforms and the thickest parts distribute to the core's distal termination and lateral edges (Fig. 84-85). Consequently, the alternate bidirectional removals maintained not only the convexity of the flaking surface, but also preserved the similar distribution of thickness on both striking platforms. This minimises the raw material consumption and increases productivity.

Several factors led to Levallois cores for blades being discarded. In addition to reaching the size threshold of reduction in terms of unidirectional Levallois cores, their inadequate proximal thickness did not aid further exploitation. The bidirectional Levallois cores, on the other hand, have all been discarded due to knapping accidents or small size, except for a single specimen. Although it is still reducible in terms of size and angle of the striking platform, reaching 76.5°, it may have been discarded as the blade that could have been removed was undesirable.



Fig. 84. Unidirectional Levallois core bearing a single striking platform, which is very exhausted.

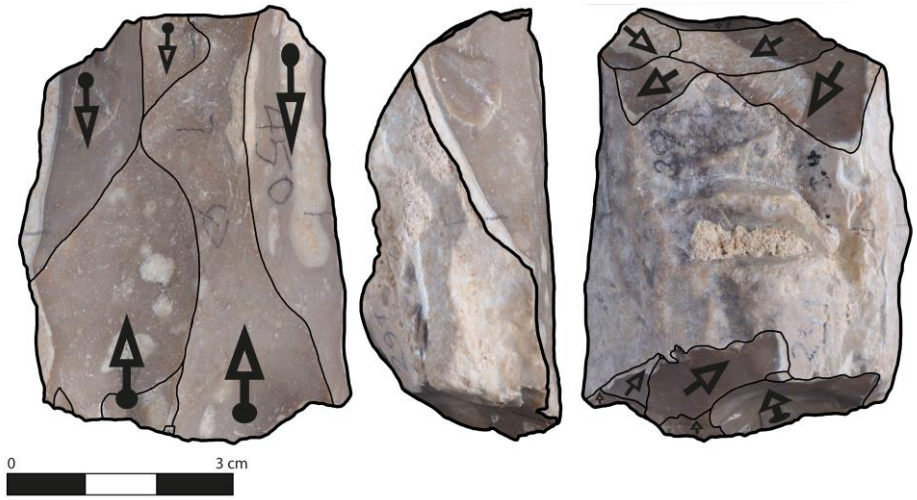


Fig. 85. Bidirectional Levallois core bearing two opposed striking platform, which have almost similar thickness.

6.2.3. Levallois cores for flakes

Both preferential and recurrent Levallois methods were applied to obtain Levallois flakes, which account for 28.1% of all Levallois cores (Fig. 81). They distribute to two preferential cores, 4 centripetal cores, and three bidirectional cores. While 55.5% of the Levallois cores for flakes have been struck on blocks, 44.5% of them have been applied to thick cortical flakes.

A. Preferential Levallois cores

Preferential cores are the least frequent Levallois core found in assemblage 4, at only 5% of the total Levallois cores. These two preferential cores were applied to flakes that can be derived from the spatial distribution of thicknesses and scar patterns. The thickest part has been chosen and devoted as a striking platform (Fig. 86). The thinnest parts of the cores distribute at the distal and lateral parts. This intentional selection allowed the preparation of a precise point for oriented blow, displaying the negative of *Chapeau de gendarme* butt, which would have not been suitable to set up at the thin part of the flake.

In addition, these preferential cores do not display scar patterns of preparation processes at the whole circumference of the lower surface (Fig. 86). They are confined to the thin distal and lateral parts of the flaking surface, which indicates that these cores were picked up even though they big enough for frequent exploitation, but were instead reduced once or twice for urgent purposes and then discarded. This behaviour reflects the reuse of discarded artefacts, thus, there was no need to specialize a specific trip for raw material procurement, but rather the available artefacts were sufficient to meet their needs. On the other hand, they may have been reduced heavily until exhausted. This, however, can be ruled out due to the relative scarcity of

preferential Levallois flakes, which would have been removed off from a long reduction sequence.

The fact is, despite the extremely small size of cores, especially the thickness (Table. 20), detached preferential flakes have left large scar patterns occupying more than 70% of the flaking surface. Furthermore, detached preferential flakes, as the last removals, are supposed to leave deeper scar patterns than preparatory removals. In addition, preparatory scar patterns are expected to be slightly oblique as a result of convexity preparation. However, both preparatory and preferential scar patterns are almost flat. Consequently, it can be assumed that these preferential Levallois cores had no proper convexity due to the lack of adequate thickness. This supports the theory they were applied to flakes and were only exploited once or twice maximum due to inadequate thickness.

Although the angle of the striking platform, 70°, still allows for further exploitation the relatively thin distal and lateral parts did not permit additional preparation for the re-creation of convexity.

The cortex is completely absent from the flaking surface, whereas is covers 95% of the striking platform due to the limited preparation process, which could not be applied due to inadequate thickness.

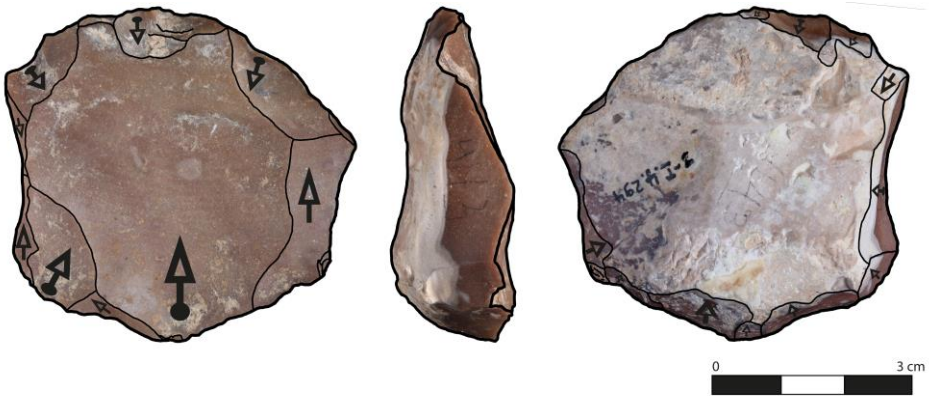


Fig. 86. Preferential Levallois core was applied to thick flake, showing very thin distal termination.

B. Centripetal Levallois cores

Centripetal Levallois cores make up 15.6% of all Levallois cores in this assemblage. They display multiple and continuous striking platforms, reaching circumference, in three cores. Four cores exhibit discontinuous platforms that have kept the convexity of the flaking surface. Of the cores with continuous platforms, two still maintaining the hierarchical structure were applied on blocks. A single core was reduced to a cortical flake that exhibits four striking

platforms, limited at the thickest parts of the core: however, the thinnest part of the core lacks traces of removal or striking platform preparation.

The mean number of scar patterns is 7. Therefore, it is obvious that the flaking surface was highly exploited compared to their small size (Fig. 87). Lower surfaces exhibit low numbers of scar patterns, especially Levallois cores made on cortical flakes, and the preparatory scar patterns, as mentioned above, were limited to the thick parts of the core. Cortex is completely absent on the flaking surface. While it covers less than 50% of the lower surface of three Levallois cores, the fourth specimen, which is made on a cortical flake, shows more than 80% cortex. The amount of cortex reflects the relationship between long reduction sequences executed on blocks and the reduction of thick flakes.

The mean size of centripetal cores is very small compared to preferential cores, except for thickness, which was measured as 1.4. The obvious difference in thickness comes about since preferential cores were made on cortical flakes, whereas centripetal cores were mostly reduced on blocks.



Fig. 87. Recurrent centripetal Levallois core showing peripheral /continuous striking platform.

Two Levallois cores for flakes show two opposing striking platforms and the other two have three striking platforms, two are contiguous. It seems that one was exploited on the block and the other still has part of the ventral face of the original flakes. The last two contiguous removals from the core bearing three striking platforms were struck from the extreme side of the flaking surface without any preparation of the striking platform, whereas the last removal from the core with two opposing striking platforms have been prepared very well and the last removal occupies almost the whole flaking surface. The condition of these discarded cores makes it difficult to read the installation of the convexity of the flaking surface because there are few traces left visible. However, it can be assumed that the convexity was re-created by

alternate Levallois removals from the opposing striking platforms and small semi-abrupt lateral removals, which can be seen only at the edge of the discarded cores.

Several reasons lead to the discarding of a core, but exhausted size is the main cause. Two cores, as mentioned above, lack the thickness to allow further exploitation. In addition, a hinge fracture that occurred on the same cores during the last removal attempt hampered additional exploitation. Finally, the dimension of the last Levallois removal, as can be seen in Table. 20, indicates that the last detached flake measures between two and three centimetres.

6.2.4. Initial Levallois cores

Two types of initial core were recognized. While two reductions have been applied to a pebble, the other two initial Levallois cores were small thick cortical flakes. They exhibit the criteria of the Levallois concept, with two hierarchically surfaces: the striking surface and the flaking surface. One sample, for instance, exhibits a partially prepared flaking surface with small removals detached, whereas about 45% of it displays the original ventral surface of the cortical flake, involving part of the bulb (Fig. 88). The lower platform exhibits obvious properties of a Levallois core striking platform, such as the initial scar patterns of the preparation process. It is worth noting that preparatory scar patterns on the lower surface are confined to certain parts, associating basically with the thickest parts of the flake and the slightly prepared part of the flaking surface. This is the same strategy that was used to reduce the preferential cores, relying on selection of the thickest part of the flake in order to reduce it.

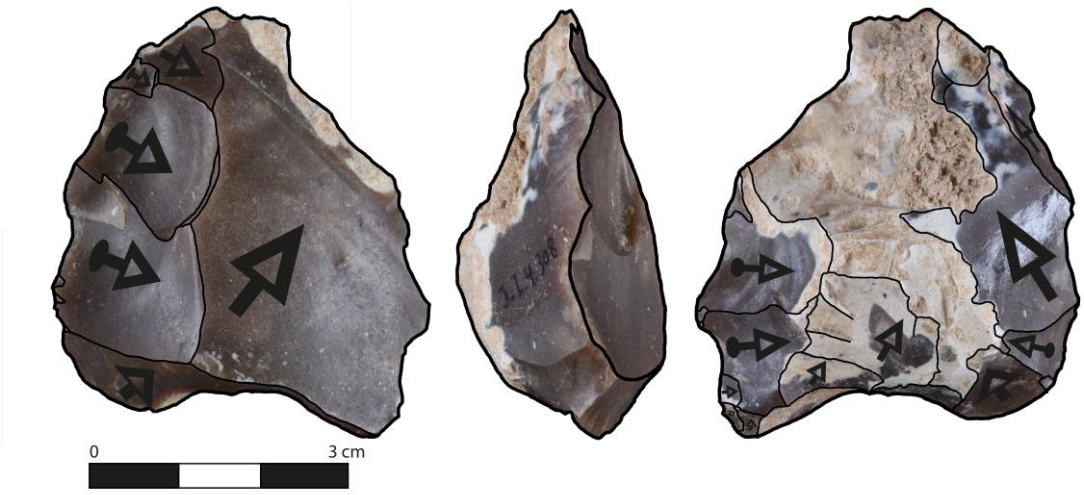


Fig. 88. Initial Levallois core bearing criteria of Levallois concept applied to thick flake.

As can be seen in Table. 20, the majority of Levallois cores were exploited intensively and the size threshold for Levallois blank production is around 59 x 57 x 14 mm. The mean size of the initial Levallois core corresponds to the exhausted discarded Levallois cores.

Therefore, after knappers picked up these thick flakes and began preparing them, they recognized that their size does not allow for exploitation—they were abandoned due to their extremely small size. Furthermore, the exhausted Levallois cores applied on flakes have a similar size after exploiting: 57 × 50 × 17 mm. This means they were bigger at the moment of the exploitation and have been reduced and not discarded at the initial stage of core reduction.

Despite the small size of these exploited cores on pebbles (Fig. 89), equal to the size threshold of abandoned Levallois cores, it was intentionally selected as it has two proper hierarchical surfaces for production. Thus, preparation of the flaking surface, which would have led to losing part of the core size, was not required to create convexity. However, it might have been used to obtain a single removal.



Fig. 89. Initial Levallois core bearing criteria of Levallois concept applied to pebbles.

As can be seen in Fig. 90, it is quite obscure to make out which surface was selected to be a striking platform and which one is the flaking surface. However, it can be assumed that due to very clear knapping accidents on the first surface, which would have collapsed the core if removed, the knappers shifted into exploiting the already convex lower surface. After three small removals from the same proper lower platform, the core was abandoned due to size constraints. As opposed to Pagli (2013; 420), who classified the core as core type C "LES NUCLEUS DE TYPE C A ECLATS", my interpretation is that this core was exploited opportunistically as long as it exhibited a proper convexity that allowed exploitation. In addition, it cannot be named a new type of core reduction sequence based on a single sample that is still in the first stage of core reduction.

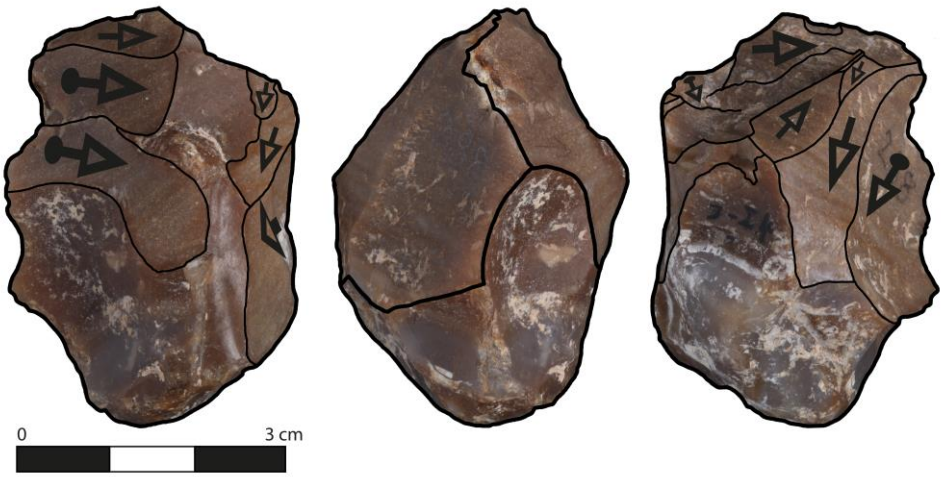


Fig. 90. Initial Levallois core bearing criteria of Levallois concept applied to pebbles, which was named a type C core by Pagli (2013).

Summary

The core reduction strategies of lithic material from assemblage 4 of YSI can be summarized as follows:

- Levallois core reduction strategies have been mainly carried out on blocks. In the meantime, knappers had enough skill to organize thick flakes in accordance with Levallois methods in order to produce their Levallois blanks when the need arose. Therefore, the strategies of core reduction including management of the flake's size are counterbalanced by a high degree of technical skill.

- Analysis of discarded cores clarified that Levallois flaking methods are the only concept used in this assemblage. Both preferential and recurrent Levallois methods were performed. However, the recurrent method is the most frequent, and was executed, in most cases, on blocks. The preferential Levallois method was only applied to cortical thick flakes.

- Recurrent unidirectional convergent Levallois method is the next most frequent. In addition, based on the discarded Levallois cores, it is the only method that has been used in order to produce Levallois points. Although Levallois points can be produced by other methods, especially preferential Levallois method, there is no evidence of such Levallois point production.

- The scar patterns of discarded recurrent unidirectional convergent Levallois cores imply that only one type of flaking surface convexity preparation was used. This type was applied by detaching small bidirectional or/and perpendicular removals from the

core's distal termination that aimed to re-create flaking surface convexity. This contradicts with the many Levallois points that display only unidirectional scar patterns.

- The combination of the mean LWR of Levallois cores for points and the frequent *Chapeau de gendarme* type of butt, supports the assumption that they were organized in a way that allowed for mainly short, broad-based Levallois point production.

- When it comes to Levallois cores for flakes and blades, both Levallois methods were applied. In Levallois flake production the recurrent Levallois method is dominant. In particular, recurrent centripetal Levallois cores whose striking platforms extend between two discontinuous and peripheral continuous platforms. Levallois cores for blades were reduced using both recurrent unidirectional parallel and bidirectional methods, with the former predominant. All of the discarded Levallois cores for blades, except for one, exhibit no scar patterns of flaking surface convexity reinstallation. However, the scar patterns do indicate that work on preparing the flaking surface was carried out simultaneously with blade production, which looks like the way of centripetal Levallois core exploitation. The availability of Levallois blades bearing lateral scar patterns resulting from perpendicular flaking surface preparation prompted the question as to when these specific Levallois blades were produced.

- Initial Levallois cores are the same size as discarded Levallois cores. This attempt to reduce small flakes can be interpreted as either economising on raw material despite its local availability, or as a rapid response to meet urgent needs as long as local flakes had the sufficient size at the place and time they were required. Actually, the predominance of recurrent Levallois method can be further evidence of the economical investment of raw material whose productivity after each re-preparation of the flaking surface is greater than the preferential Levallois method, which needs re-preparation of the flaking surface after each single removal, thus, investing a bigger amount of raw material.

- Moreover, the knappers of assemblage 4 did not restrict themselves to a specific raw material size. On the contrary, their skill expanded their options for raw material procurement. This is quite clear through the exploitation of local discarded flakes.

- By and large, the exhausted size of cores is the main cause for their discard, especially Levallois cores for points that are devoid of any kind of accidents on the flaking surface. While discard of preferential Levallois cores was due to their inadequate thickness as they were applied to cortical thick flakes, centripetal cores were, in some cases, discarded due to both accidents and exhausted size.

6.3.The characters of cores and Levallois blanks

The variables of assemblage 4 Levallois cores and their products (i.e. scar patterns, types of striking platforms, size, and amount of cortex) will be dealt with in the same structure as assemblage 6 above. In this way, the relationship between them can be shown in a comparative study. Please note that the subheaders only include Levallois debitage since only Levallois methods were exploited in this assemblage.

6.3.1. Dorsal scar patterns of Levallois blanks and cores

344 Levallois blanks, 96% of the total, exhibit cortical-free dorsal surfaces, the remaining 4% carry partial cortical surface, up to a maximum of 30%. This implies that the production process of Levallois blanks was, in some cases, extracted from the earlier stages of core reduction. While 77% of Levallois blanks display unidirectional convergent scar patterns, the other Levallois blanks exhibit unidirectional parallel, bidirectional, perpendicular, centripetal, and semi-centripetal scar patterns and 4 specimens were undefinable (Fig. 91).

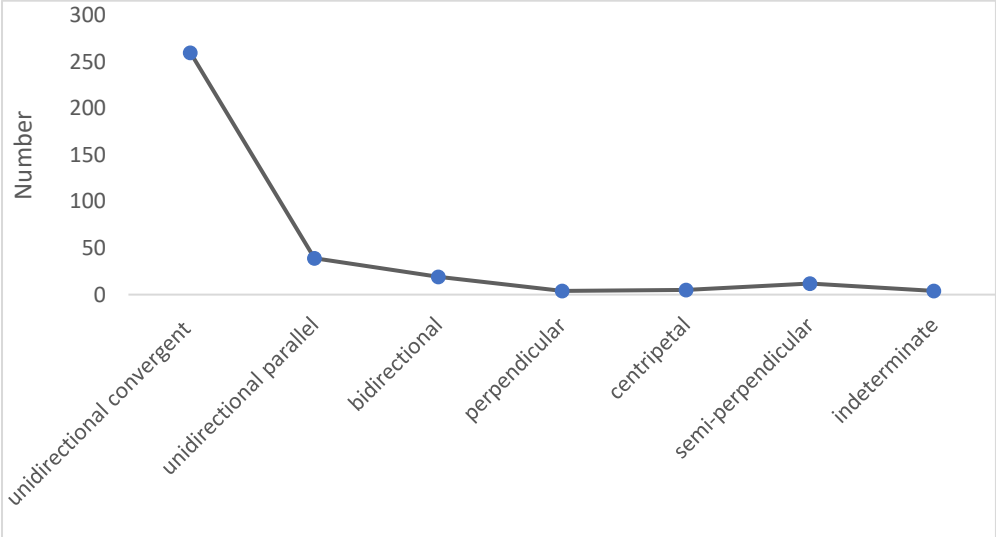


Fig. 91. Frequencies of scar pattern types on Levallois blanks.

Accordingly, the prevalence of unidirectional convergent scar patterns completely corresponds with the predominance of discarded unidirectional convergent Levallois cores. However, it is worth noting that 128 Levallois points exhibit only unidirectional scar patterns

that were struck from the basal striking platform (Fig. 92), whereas 52 Levallois points display two or three removals struck from the basal striking platform combined with one or more small perpendicular, bidirectional and/or semi-centripetal removals from the core's distal termination or lateral edges (Fig. 93).

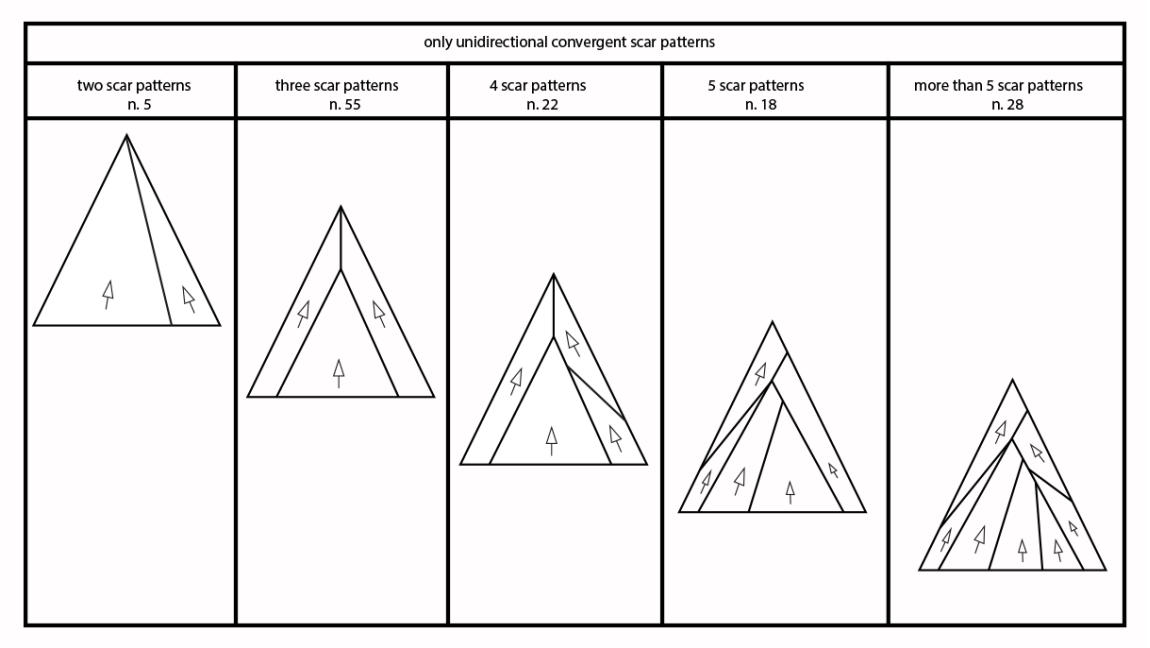


Fig. 92. Only unidirectional convergent scar patterns stem from the basal striking platform.

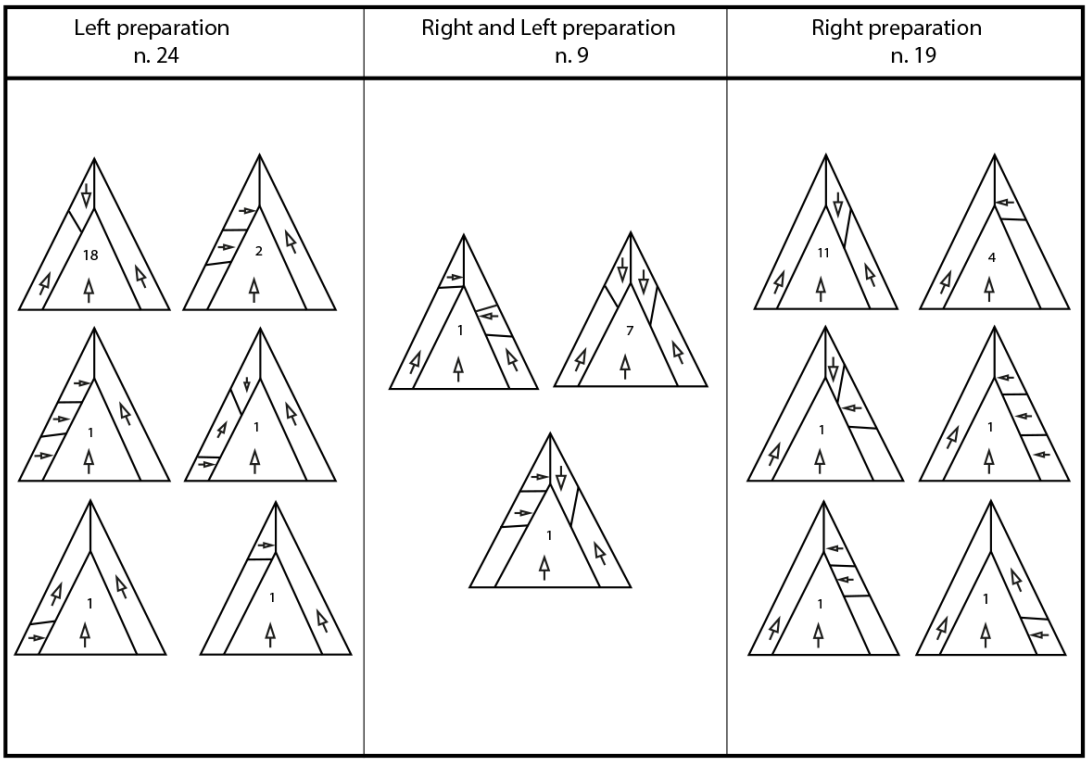


Fig. 93. Levallois points reflecting the spatial distribution of scar patterns as a result of the flaking surface preparation process.

Groucutt (2014) suggested, based on the refits and technology of Tor Faraj site (Demidenko & Usik 2003), that the cores for point production might have undergone more unidirectional convergent preparation in the earlier phase of production with at least one removal from the distal helping to shape the core. Bidirectional preparation, on the other hand, was done in the late stage of core reduction. However, this hypothesis needs to be tested as some large elements display bidirectional and multidirectional scar patterns.

If I combine this hypothesis with the technological attributes of the discarded Levallois cores for points and the discarded Levallois points themselves, which are as follows:

A. All of the discarded unidirectional convergent cores were prepared by detaching small perpendicular, bidirectional, and/or semi-centripetal removals from the core's distal termination and lateral edges.

B. The assemblage contains large Levallois points bearing only unidirectional convergent scar patterns.

Does this lead to an answer to the question of when these Levallois points were produced?

As can be seen in Table. 21, a comparison of the size of Levallois points bearing only unidirectional scar patterns and those showing perpendicular, bidirectional, and/or semi-centripetal scar patterns was carried out. It can be assumed that these cores may have undergone two alternate types of flaking surface preparation. The first type was often applied in the earlier stages of core reduction by detaching elongated lateral removals. The Levallois point obtained is large and bears only unidirectional convergent scar patterns. The second type was mostly applied in the late stage of core reduction by the detachment of small perpendicular, bidirectional, and/or semi-centripetal removals from the core's distal termination and lateral edges. The Levallois points obtained were smaller and exhibit various scar pattern directions according to the type of detached removal aimed at reinstalling flaking surface convexity (Fig. 94).

It turns out that the type of flaking surface preparation executed shifted in rotation from detaching either elongated lateral removals to small perpendicular, bidirectional, and/or semi-centripetal removals from the core's distal termination and lateral edges (Fig. 94). These different and alternate types of preparation pose another question: What is the technological cause of this shift, that might have carried out at different stages of core reduction?

The underlying assumption may be that Levallois cores for points were designed intelligently and economically for a defined purpose, to keep as much of the base width of cores as possible

to obtain broad-based Levallois points, which might be resistant to breakage at hafting. This will be investigated in the Levallois point reduction strategies (subchapter 6.4.1). However, this type of core preparation may show that adaptive behaviour is a response to technological requirements, i.e. they have been forced to maintain the eligibility of the flaking surface by using the appropriate type of preparation.

Type of Levallois point	N.	%	Length mean mm	Width mean mm	Thickness mean mm
	59	31	68	37	9
	40	21	62	38	8
	69	36	49	34	7
	22	12	42	30	6
Total	**190**	**100**	-	-	-

Table. 21. Levallois point size compared to type of scar patterns.

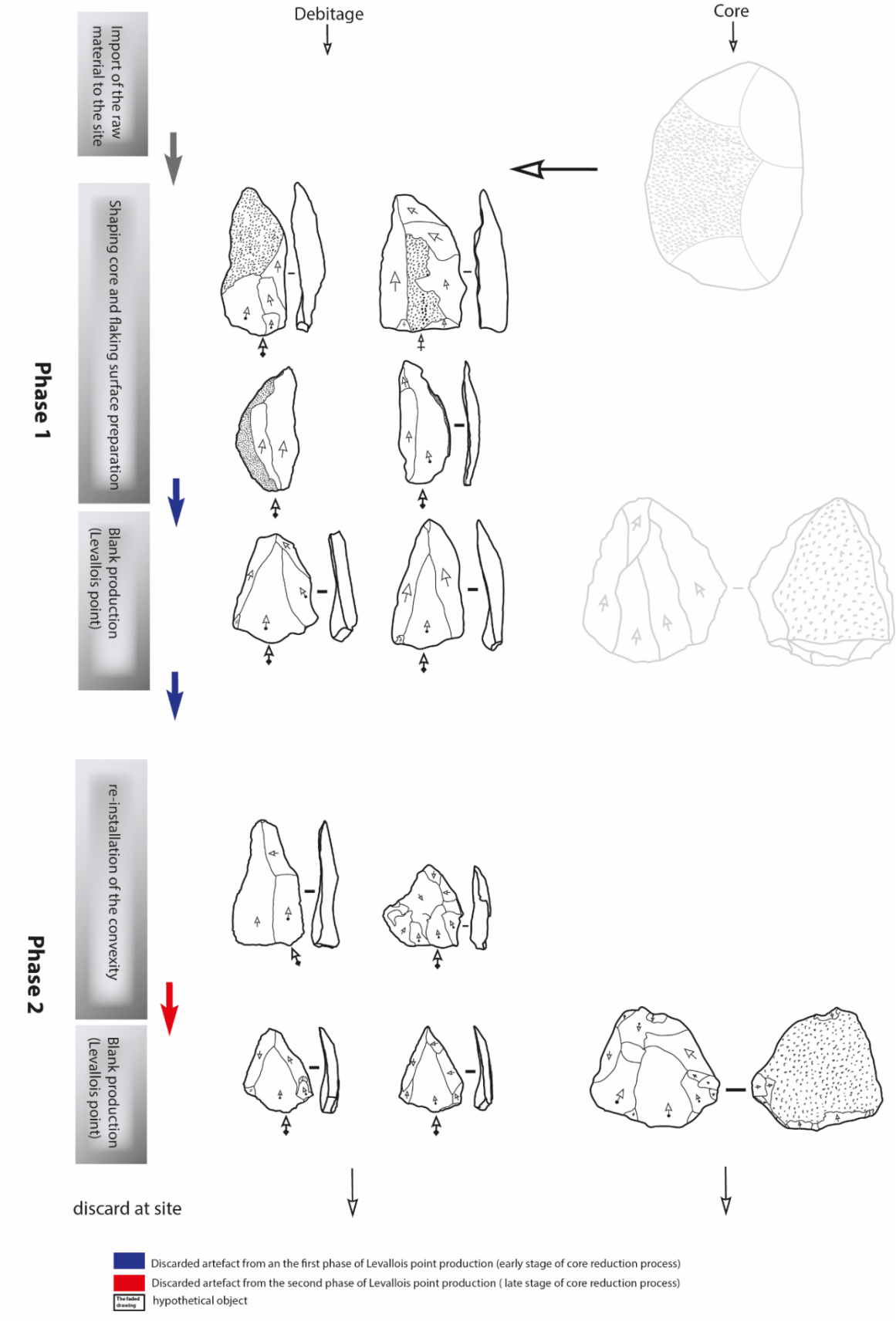


Fig. 94. Two types of flaking surface preparation on unidirectional convergent Levallois cores.

Several analysts have assumed that while the main aim of the convergent Levallois method is to produce Levallois points, other products, such as Levallois blades, are described as by-products of this process (e.g., Monigal 2002; 459- 460; Demidenko & Usik 2003; Shea 2003; 328; Hovers 2009; 99; Hauck 2011; Shimelmitz & Kuhn 2018; 82; Jelinek 1977; Meignen & Bar-Yosef 1992). As Table. 22 shows, 32.4% of Levallois blades bear unidirectional convergent scar patterns, indicating they were either by-products removed during flaking surface preparation of unidirectional convergent cores, or they were produced from a single reduction sequence that produced different Levallois blanks. Levallois blades exhibiting unidirectional parallel and bidirectional scar patterns are more frequent.

blank	Unidirectional convergent		Unidirectional-parallel	Bidirectional	Perpendicular	Semi-Centripetal	Centripetal	Indet.	**Total**
	Unidirectional-convergent	Bidirectional/perpendicular							
Levallois flake	25	18	2	10	1	7	4	1	68
Levallois blade	19	8	33	12	-	-	-	2	74
Total	**44**	**26**	**35**	**12**	**1**	**7**	**4**	**3**	**142**

Table. 22. Frequency distribution of scar patterns recorded on Levallois flakes and blades.

It is worth noting, as mentioned in the core reduction strategies, that scar patterns of Levallois cores for blades indicate that blades obtained from the core's lateral edges also served to re-prepare the flaking surface, which looks like centripetal Levallois core exploitation. This means Levallois blades are supposed to exhibit either unidirectional parallel or bidirectional scar patterns. Counter to what Levallois cores for blades referred to, 49% of the Levallois blades bear small bidirectional and perpendicular scar patterns (Fig. 95 and 96). This is clear proof that early stages of flaking surface re-installation have been executed differently.

Consequently, it can be assumed that Levallois cores for blades underwent two different types of flaking surface preparation. One was executed by detaching small perpendicular and bidirectional removals from the core's distal termination and lateral edges. The second was performed by striking Levallois blades from the core's lateral edges. Thus, they simultaneously played the roles of desired Levallois blades and by-products.

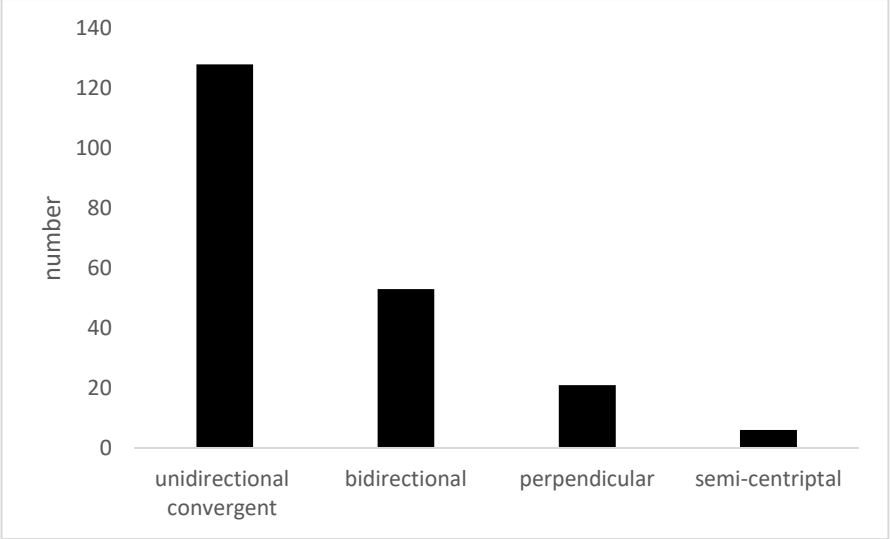


Fig. 95. Distribution of scar patterns on Levallois blades.

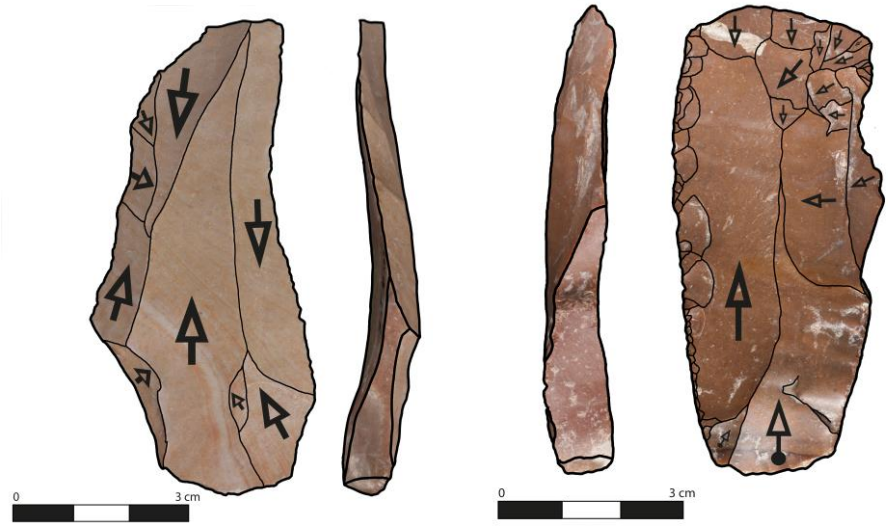


Fig. 96. Levallois blades bearing scar patterns of flaking surface re-installing process.

Given that preferential and centripetal Levallois flakes are rare and Levallois points are the dominant end product, it can be assumed that Levallois flakes and blades bearing unidirectional convergent scar patterns were by-products of Levallois point production.

The mean number of scar patterns recorded on Levallois blanks is relatively high, even in the absence of preferential flakes, at 4.8. The number of scar patterns recorded on Levallois points is high, with a mean of 5.0 (Fig. 97). In addition, Levallois points were most frequently removed in the third stage. In most cases the flaking surface attests to several preceding removals before the Levallois point was obtained. Furthermore, it can also be inferred that most Levallois points were struck from the centre of the flaking surface and Levallois points with Y- shaped scar patterns were obtained intentionally.

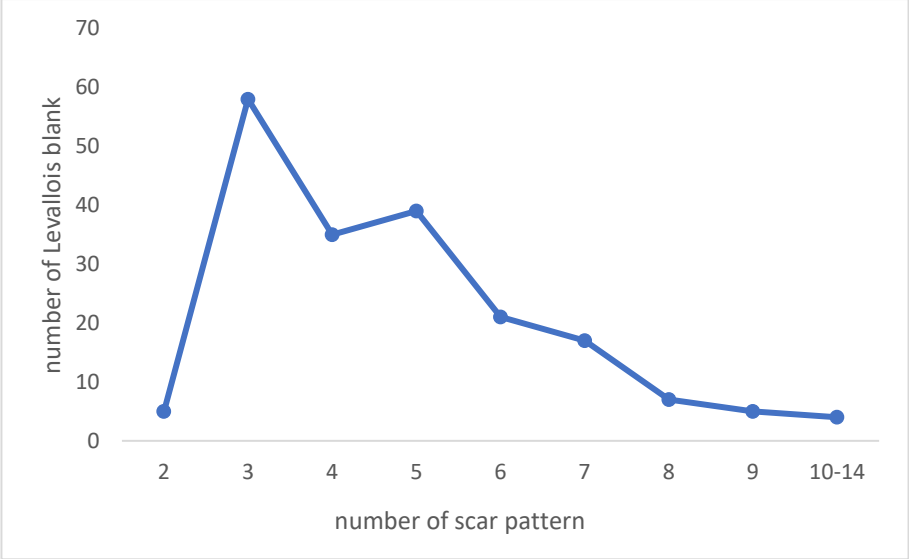


Fig. 97. Number of scar patterns recorded on Levallois points.

The variability of the unidirectional convergent core reduction process can be interpreted in different ways. While maintaining Levallois point production bearing unidirectional convergent scar patterns requires high skilled knappers, re-preparation of the core by detaching bidirectional, perpendicular, and/or semi-centripetal removals can be carried out by less skilled knappers. Accordingly, variability can be attributed to differing levels of flint knapping skills. Another interpretation can be based on the relative similarity of the average width with both types of Levallois points. Re-creating the convexity of a flaking surface by detaching small bidirectional, perpendicular, and/or semi-centripetal removals from the core's distal and lateral removals can maintain the width of the striking platform. Thus, maintaining the maximum width at the base of Levallois points reflects the raw material economy strategy and might have been related to the function of broad-based Levallois points.

6.3.2. Maintenance of the striking platforms

Fig. 98 shows the diversity of the striking platform types executed. Carefully faceted and dihedral butts are the most frequent butt types, indicating the use of a hard hammer and very well-prepared striking platforms. The majority of faceted butts are *Chapeau de gendarme* type (Fig. 100) that serve to define a precise point of the blow. 261 of the faceted butts are linked to different Levallois blanks, in particular Levallois points. However, the faceted butt is not confined to Levallois blanks. 45.1% of by-products (e.g. naturally backed knives, core edge flakes, and flaking surface preparation flakes) exhibit faceted and dihedral butts. The dihedral butt is mainly associated with these by-products. By-products bearing faceted and dihedral

butts attest to the fact that knappers sometimes carefully prepared the core's striking platform during flaking surface preparation.

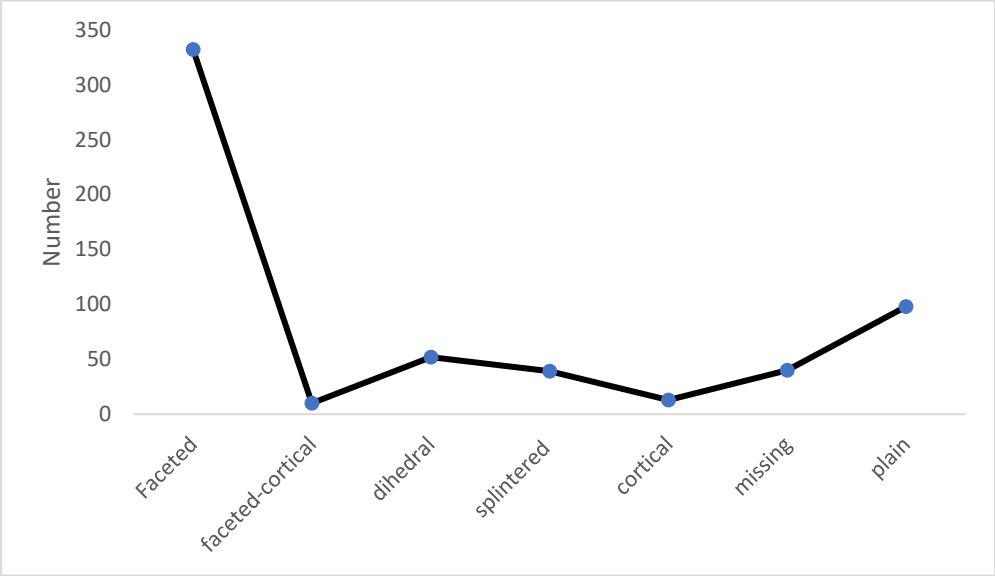


Fig. 98. Distribution of type of striking platform recorded in the entire debitage.

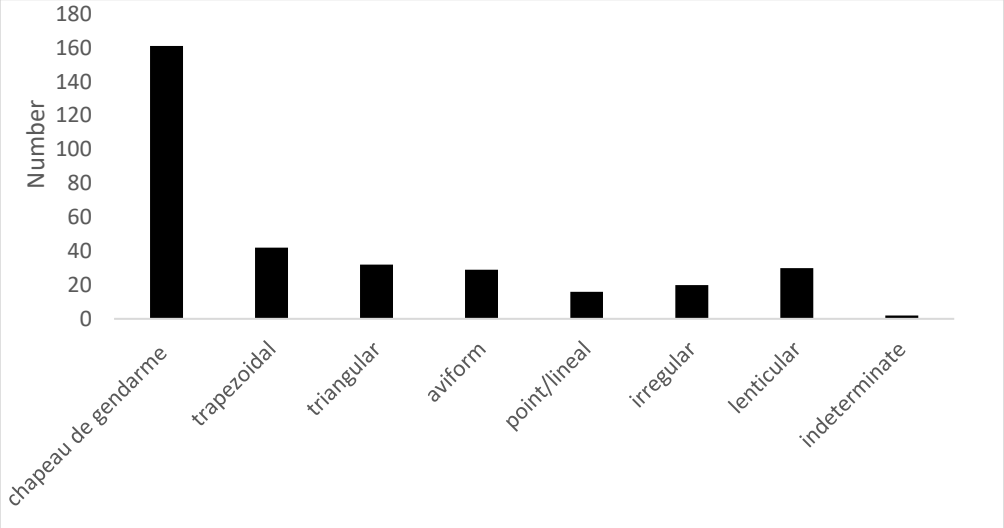


Fig. 99. Distribution of types of striking platform on Levallois blanks.

Interestingly, 53.5% of by-products with faceted butts, and 25% of by-products with dihedral butts, exhibit plunging termination. This can be an indication that these by-products were intentionally well prepared in order to gain better control over blank removal aimed at reaching the core's distal termination in order to reinstall distal convexity as well.

It is to be expected that *Chapeau de gendarme* platforms appear frequently because of the predominance of the Levallois points, as well as the fact that Levallois methods were the only kind executed. Plain butt types are mainly associated with by-products (e.g. first flakes, cortical flakes, and naturally backed knives). However, 25% of plain butts are linked to

Levallois blanks, in particular, Levallois blades. This could support the theory that some Levallois blades were by-products of Levallois point production. On the other hand, it may indicate that careful preparation of the core's striking platform may not have been a prerequisite for Levallois blank production if the point of impact combined with the appropriate striking platform's angle could achieve a successful removal. The least frequent category among Levallois blanks are cortical and faceted-cortical butts. However, 34.7% of them are Levallois items. This may be a sign of early production of Levallois blanks, as such butts represent the initial stages of core reduction when the core still bears a large amount of cortex.

The convergent standardization of the flaking angle of Levallois products, on average 104°, indicates a high degree of control over the products for knappers. In addition, I believe the frequent use of the same reduction method (i.e. convergent method) made the knappers craftier and more precise. Fig. 100 also displays a close relationship between the largest butts and the *Chapeau de gendarme* type of striking platform, whereas diverse butts reveal almost standard thickness, referring to a high degree of control over the same impact point as well.

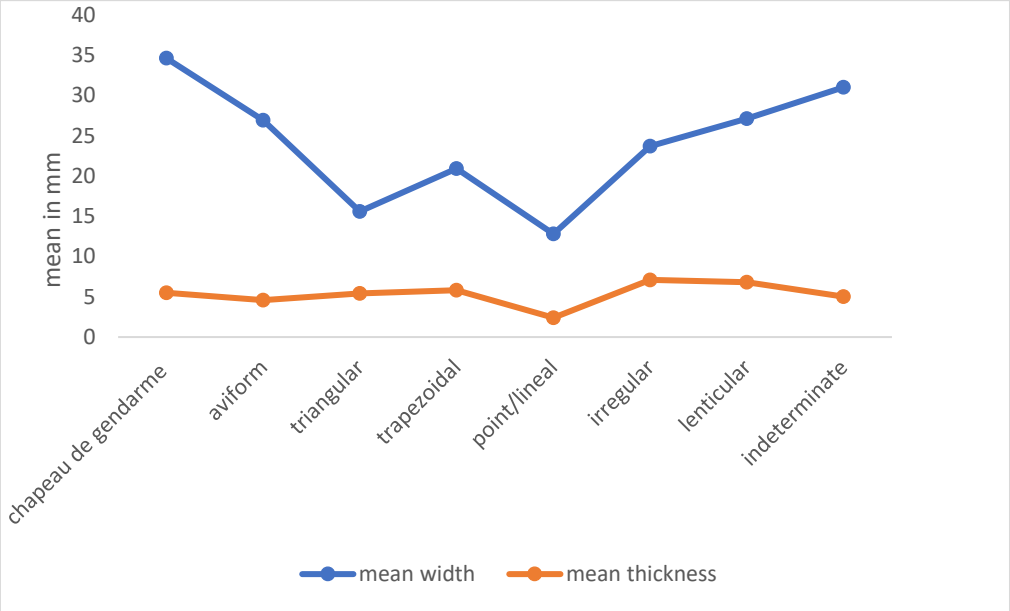


Fig. 100. Mean width and thickness of platform types clarifies the relationship between the type of platform and the size.

6.3.3. Quantity of cortex on Levallois blanks

As can be seen in Fig. 101, the majority of Levallois blanks exhibit cortical-free dorsal surfaces constituting 81.1% of the total. Only 1.7% of Levallois blanks have cortex on between 20 and 40% of the dorsal surface and a further 0.81% have between 70 and 90% coverage.

The scarcity of Levallois blanks bearing more than 20% of dorsal surface cortex indicates that cores were almost completely decorticated before blank production. Indeed, all

of these cortical Levallois blanks exhibit cortical-free edges and the cortex is limited to the medial part of the dorsal surface. This implies that the cortex does not prohibit the function of Levallois blanks. Additionally, the cortical Levallois blanks bearing the highest amount of cortex, between 40 and 90% of the dorsal surface, have a mean size of 47.4 × 30.6 × 7.6 mm. This implies they were removed from small cores and an attempt was made to obtain products from the early stages due to the size limitation of the cores.

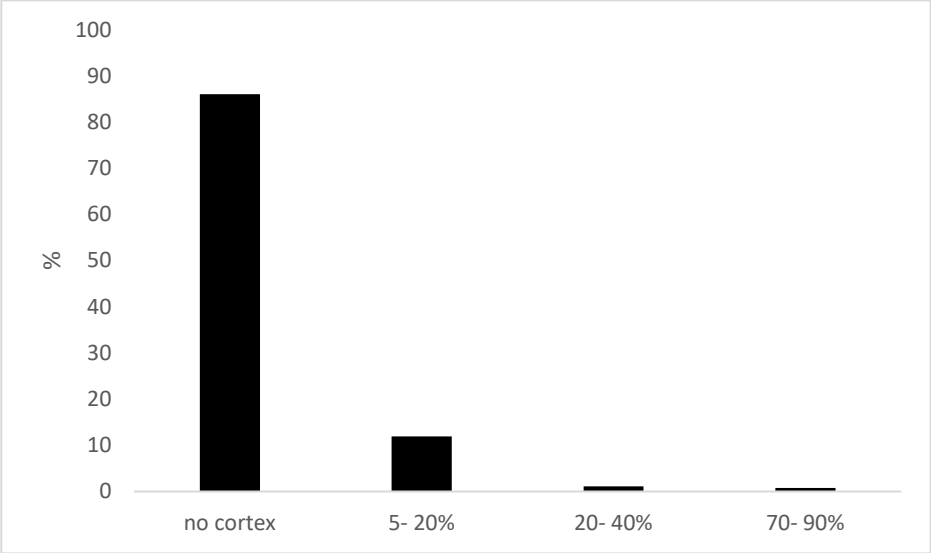


Figure. 101. Distribution of cortex on the dorsal surface of Levallois blanks.

6.3.4. Size of Levallois blanks and cores

As displayed in Table. 20, the mean size of exhausted Levallois point cores shows that the volume threshold for their production is around 48 × 46 × 20 mm. This suggests that the last removed points ranged between four and two centimetres. In addition, Levallois flake and blade cores exhibit an average dimension of 50 × 44.5 × 20 mm. This indicates that flakes and blades of smaller size are the end-products removed from these discarded cores.

The size properties of Levallois blanks (Table. 23) indicate that Levallois flakes and points exhibit relatively close mean size. However, Levallois points show more variation in size, from 102 × 45 × 11 mm to 29 × 21 × 4 mm. Although the Levallois flakes also display variation, they are smaller and more standardized in size as a result of the reduced size range. The largest is 75 × 42 × 8 mm and the smallest is 25 × 20 × 4 mm. In contrast, Levallois blades and elongated points show the highest values compared with the others. This exposes the tendency to either extract elongated blanks from large cores or the preference to obtain from the early stage of core reduction.

	No	% of Levallois blanks	Length mean mm	Width mean mm	Thickness mean mm	LWR
Levallois point and triangular flake	207	68.8	43.6	32.6	7.8	1.6
Elongated point	30	8.7	64.2	29.3	8.3	2.2
Levallois flake	33	9.5	49.7	35.3	7.5	1.4
Levallois blade	74	21.5	62.4	25.6	7.1	2.3
Total	**344**					

Table. 23. Mean size of Levallois blanks.

This size convergence and homogeneity between Levallois points can reasonably be attributed to a number of factors: Firstly, the Levallois point was the main desired end product struck from the first stage of an individual reduction sequence until the final discard of unidirectional convergent cores. The standardization of the reduction method reflects standardized technical features, as the knappers got used to handling cores. Secondly, this can be observed through the average size of naturally backed knives bearing unidirectional convergent scar patterns, 56 × 30 × 10 mm. This size convergence shows a significant consistency in frequency distributions between Levallois points and backed knives. Thus, both Levallois points and naturally backed knives represent the size of the core throughout an individual reduction sequence. Furthermore, it refers to skilful knappers given that the flaking surface did not lose much raw material during re-installation of convexity because both Levallois cores and naturally baked knives display almost accident-free surfaces.

In contrast to Levallois blades and elongated points, the size of Levallois flakes combined with the frequency of unidirectional convergent scar patterns may reflect they were removed from an individual reduction sequence, originally aimed at producing Levallois points. However, the Levallois cores for flakes are not consistent, with a low number of Levallois flakes bearing non-unidirectional convergent scar patterns and their small size. This suggests that they were produced from small cores or were products of the second stage of core reduction.

As can be seen in Table. 24, the mean width and thickness of striking platforms of Levallois points varies noticeably between types of butts, ranging from 17 to 43 mm and from 0.2 to 10 mm respectively. However, the *Chapeau de gendarme* types of butt exhibit the largest values. The mean length of Levallois blanks with a faceted or dihedral striking platform is greater than blanks with other types of the butt, and they often exhibit feather termination. This implies that the careful preparation contributes to obtaining successful removals.

Faceted and *Chapeau de gendarme* butts combined with the force of the oriented blow can influence the size of Levallois points. In addition, Levallois point length does not confine them to a certain type of butt. The longest Levallois points distribute to various types of platforms. Therefore, it is hard to link the type and/or morphology of the platform to the length of Levallois blanks. It is quite normal to notice that the Levallois points are the longest Levallois blanks given that this assemblage is a point-bearing assemblage.

Type	Morphology	No	%	Striking platform		Mean size of Levallois points		
				Width mean mm	Thickness mean mm	Length mean mm	Width mean mm	Thickness mean mm
Faceted	Semi/*chapeau de gendarme*	114	60	35.1	5.2	56.7	36.4	7.1
	Aviform	16	8.4	30.6	5.6	57	33.4	7.5
	Lenticular	15	7.8	31.5	6.8	59.2	35.7	8.1
	Trapezoidal	13	6.8	27.5	6.7	62	32	9.7
	Point/ lineal	5	2.6	23.6	2.8	43	29.8	5
	Triangular	4	2.1	23.4	5.8	62.8	32.2	8.6
	Irregular	3	1.5	38.6	9.6	70.3	39.3	10.3
Faceted cortex	Semi/*chapeau de gendarme*	2	1	31	9.5	51.5	30.5	10
Dihedral	Lenticular	2	1	20.5	8	67.5	30	8.5
	Aviform	1	0.5	34	3	35	34	5
	Irregular	1	0.5	17	6	40	25	6
Plain	Irregular	2	1	18.5	6	60	46	10.5
Cortical	Irregular	1	0.5	19	5	76	27	9
Splinted	Aviform	3	0.5	30.3	2	50.3	33.3	6
	Lenticular	2	1	25	7.5	55	38	11.5
	Irregular	2	1	33	10	61	37	10
Missing and indeterminate		4	2.1	-	-	-	-	-

Table. 24. Type of striking platform combined with the mean size of Levallois points.

6.4.Strategies of blank production

According to the combination of the techno-typological attributes of Levallois blanks and Levallois cores, the strategies of Levallois blank reduction will be reconstructed as follows:

6.4.1. Levallois point reduction strategies

Levallois points were the main blanks obtained by the knappers of this assemblage, accounting for 55.2% of all Levallois blanks (elongated or not elongated). While short, broad-based

Levallois points are dominant, forming 84.2%, elongated Levallois points constitute 15.7% of the total. In addition, constructed Levallois points account for 69% of the total, and classical Levallois points with three scar patterns represent 31%. Accordingly, the main tendency of obtaining short, broad-based Levallois points is extremely clear. The production of these Levallois points basically relied on the same method that led to the production of constructed Levallois points.

Constructed Levallois points are mainly asymmetrical (Fig. 102.1). While 54.1% exhibit a curved longitudinal axis, 43.1% show *Concorde*-shaped distal termination mainly at one edge. Almost all of the specimens bear faceted butts. However, only 66.9% of the faceted butts display *Chapeau de gendarme* type butts, whereas 25.6% exhibit various butt types. It is worth pointing out that despite the variability of butt types, faceted *Chapeau de gendarme* and other faceted types display almost similar sizes in terms of width and thickness (Table. 25). Moreover, 33.9% of constructed Levallois points exhibit distribution of the greatest width on different parts of the point body, even though 51.3% bear faceted *Chapeau de gendarme* type of butt. The greatest width of constructed Levallois points is not linked exclusively to the base and specifically to the *Chapeau de gendarme* type. However, the majority of constructed Levallois points, 63.3% show the greatest width at the base.

Butt		**Assemblage 4**							
		Constructed Levallois point				Elongated point			
		N	%	Width mean mm	Thickness mean mm	N	%	Width mean_mm	Thickness mean mm
Faceted	*Chapeau de gendarme*	73	66.9	35.0	5.1	6	20.0	25.8	4.5
	Other butt types	28	25.6	32.1	6.0	19	63.3	25.2	6.4
Faceted-cortical		1	0.9	27	7	-	-	-	-
Dihedral		2	1.8	25.5	4.5	2	6.6	20.5	8.0
Plain		1	0.9	25	9	-	-	-	-
Splintered		3	2.7	30.3	6.6	1	3.3	28	3.0
Broken		1	0.9	-	-	1	3.3	-	-
Cortical		-	-	-	-	1	3.3	19	5

Table. 25. The relationship between platforms and constructed and elongated Levallois points.

Most of the constructed Levallois points have 4 to 5 scar patterns on the dorsal surface, with an average of 5.5. However, a few points have between 8 and 11 scar patterns. The standardization of scar pattern numbers means that the flaking surface was prepared skilfully, allowing knappers to obtain Levallois points after 4 to 5 removals. Furthermore, while 53.2% of constructed Levallois points bear only unidirectional convergent scar patterns, 46.8% show

bidirectional, perpendicular, and semi-centripetal scar patterns. This emphasizes that the core's flaking surface was processed by two different alternate types of preparation, in almost equal measure, and there is no priority for a specific type of preparation. In addition, this might be interpreted that the production of constructed Levallois points did not rely on a specific part of the core. They were removed from the lateral and medial sections of cores.

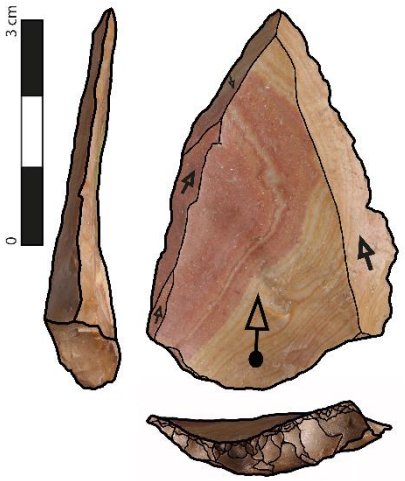
Classical Levallois points bear standardized technological features: (a) a regular triangular outline, (b) greatest width at the base, (c) *Concorde*-shaped distal termination, (d) Y-type dorsal scar pattern formed by three overlapping negatives, and (e) a *Chapeau de gendarme* type of butt. While 68.6% of Levallois points that bear three scar patterns exhibit the five typical textbook features, 31.3% of them lack one feature, specifically *Chapeau de gendarme type* of butt. It is worth pointing out that 92.1% show Y-type unidirectional convergent dorsal scar pattern formed by three overlapping negatives that stem from the striking platform. Only four specimens were prepared bidirectionally. This implies that the majority of classical Levallois points may have been removed after preparing the flaking surface by detaching elongated lateral removals. In fact, if these classical Levallois points are products of preferential Levallois method, then where have they been struck, particularly in the absence of discarded preferential Levallois cores for points. Accordingly, a few theories can be proposed. First, they may have been struck off-site, and then imported to the site. Secondly, they may have been produced in the early stages of core reduction. Thirdly, given there is no evidence of their production by preferential Levallois method, it can be assumed that constructed Levallois points and classical Levallois points were produced using the same method. However, they were placed in different categories and show slight variability in their technological attributes, though this may not have hampered their unique function. They exhibit high standardization in attributes such as size (Table. 26) and morphology (Fig. 102.2).

Assemblage 4											
Classical Levallois point mean mm				Constructed Levallois point mean mm				Elongated point mean mm			
Length	Width	Thickness	LWR	Length	Width	Thickness	LWR	Length	Width	Thickness	LWR
54.5	37.0	7.5	1.47	54.9	36.4	7.5	1.5	64.2	29.3	8.3	2.2

Table. 26. Mean size of Levallois points.

Pagli (2013) distinguished Levallois points obtained by the centripetal method based on their rounded tips, whereas others with pointed tips were produced by the unidirectional convergent method. Although we assume that Levallois points can be produced using any method, the transformation analysis disagrees with her observation, showing that no Levallois

points can be attributed to RMUs that include centripetal Levallois cores or any debitage carrying variables of centripetal cores.



102.1. Constructed Levallois point.

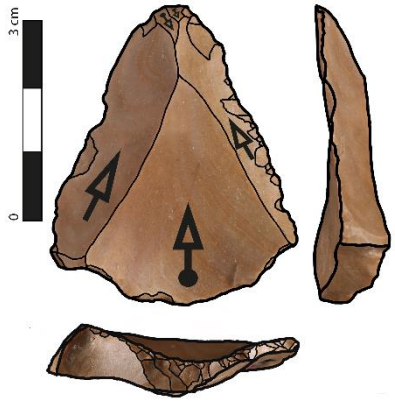


Fig. 102.2. Classical Levallois point.

As the techno-typological analyses of scar patterns of both Levallois cores for points and Levallois points implied that two alternate types of flaking surface preparation were applied, I tried to find out the causal relationship in this technological shift. I measured the mean width of the base to length ratio of Levallois points bearing only unidirectional scar patterns and their counterparts exhibiting small bidirectional and/or perpendicular scar patterns (Fig. 102.4). This resulted in very similar values of 0.62 and 0.63 respectively, indicating that shifting the preparation of the flaking surface from unidirectional to bidirectional or perpendicular might have been aimed at maintaining the most suitable base width to length ratio, given that unidirectional preparation reduces the base's width and gives a more elongated shape. This, in turn, supports the production of short, broad-based Levallois points.

The large number of Levallois points in archaeological level VI 3b'1 of the Umm el Tlel site, dated by thermoluminescence to 71–72 ka BP, are characterized by diverse morphological, technical and metric features. In contrast, the Levallois points in the other Mousterian levels of Umm el Tlel exhibit more standardized technical features. This disparity has been attributed to different functional processes (Boëda et al. 1999, 2008).

Although a slight technological difference was clearly observed, base width to length ratios implies there is no functional difference – both types have served the same function, which could be to keep base width to maintain resistance to breakage at hafting. In addition, the R-square indicates that Levallois points exhibiting perpendicular and bidirectional scar patterns are more standardized than Levallois point bearing unidirectional scar patterns (Fig.

102.3). This supports the idea that shifting from unidirectional to bidirectional and/or perpendicular preparation helped to obtain more standardized Levallois points.

Hauck (2013, 2011; 529) indicated that the industry of the uppermost part of the Hummal site HM-A1 is dominated by broad-based points that were produced by recurrent unidirectional convergent Levallois method. As a result of applying one reduction concept, the Levallois points obtained exhibit the most standardized technological features, showing a relatively limited size distribution.

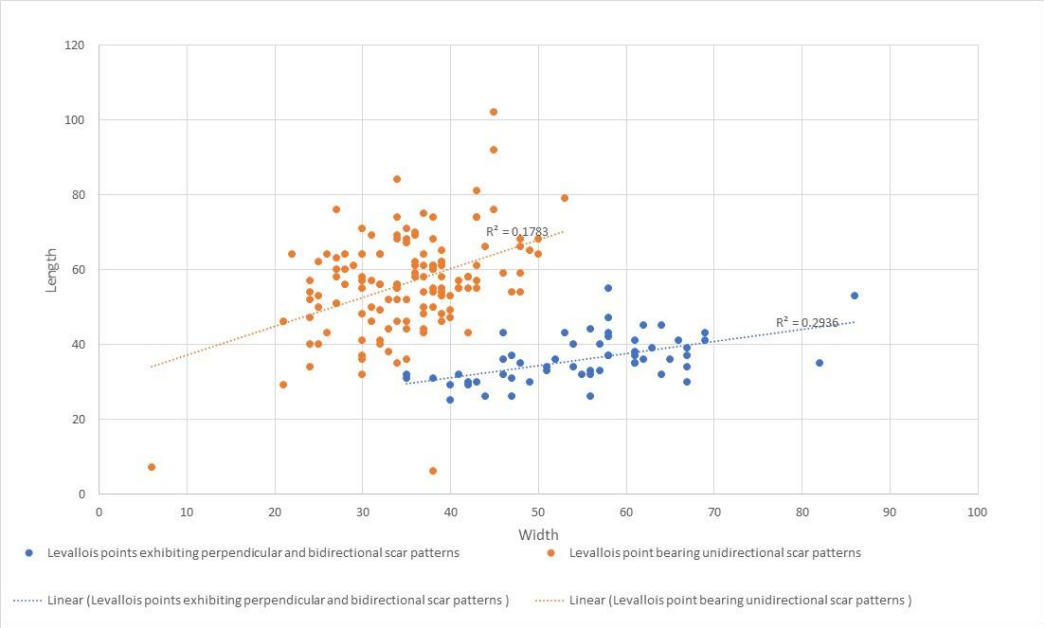


Fig. 102.3. Width to length of non-Levallois and classical Levallois points.

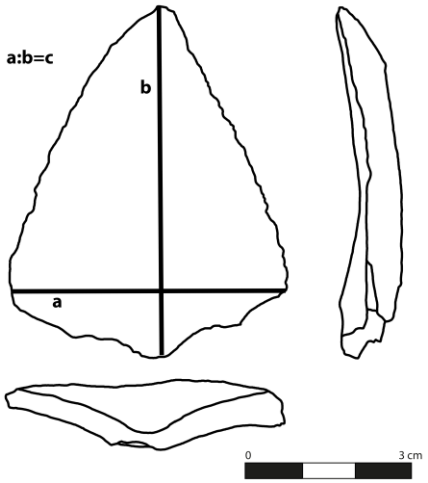


Fig. 102.4. Distribution of dimension of both types of Levallois points.

Elongated points account for 15.7% of all Levallois points, and 90% of them bear completely unidirectional convergent scar patterns. As mentioned under the subchapter

"Dorsal scar patterns of Levallois blanks and cores", recurrent unidirectional convergent cores were prepared by detaching unidirectional convergent removals. This indicates that elongated points were the targeted end-products at a specific moment, mainly produced in the early stage of core reduction. The scar patterns on the dorsal surface range between 3 and 14, with a mean of 5.2. This is close to the average number of scar patterns on Levallois points, supporting the idea that elongated points were derived from the reduction sequence of the unidirectional convergent method. As can be seen in Table. 26, different size values between both types of Levallois points and elongated points could further support the idea that the latter was struck in an early stage of core reduction.

While the butt mean width is 24 mm, 26.6% of points exhibit the greatest width at the base. This implies they may have been removed from the same unidirectional convergent flaking surface within the process of Levallois point production. Of these, 83.3% exhibit faceted butts, without the predominance of a specific type.

6.4.2. The close technological correlation between an obliqueness of two preceding predetermined convergent removals of Levallois point production and the classical Levallois point

As mentioned above, two types of Levallois points were defined (Boëda 1982; Boëda et al. 1998; 249): the so-called "three hits" point (*trois coups*), which is qualified here as "classical Levallois point" is distinguished from the "constructed" point, which is qualified here as "non-classical point" based on the number of preparatory removals. The former displays three, the latter more than three removals.

Classical Levallois points are mostly characterized by the five typical textbook features: a perfect triangular outline, highest width at the base, *Concorde*-shaped distal termination, Y-type dorsal scar pattern formed by three overlapping negatives, and a *Chapeau de gendarme* butt type. The non-classical Levallois point may display more than three scar patterns and present two or three and sometimes four textbook features.

The method of Levallois point production has been a matter of ongoing debate for decades. Some archaeologists have attributed it to preferential and recurrent unidirectional convergent Levallois methods (e.g. Boëda et al. 1990; Boëda 1995; Meignen 1995; Van Peer 1992). Others, such as Inizan et al. (1999;68), have indicated that Levallois point can also occur fortuitously during debitage or discussed how Levallois flakes, blades and points can be obtained from unidirectional, parallel, and bidirectional Levallois methods (Shimelmitz &

Kuhn 2018). It has also been suggested that Levallois point production is not limited to the Levallois concept, and can also be obtained using non-Levallois concepts, e.g. discoidal and pyramidal concepts (Boëda 1995;51). This suggests that there are technological conditions that must be applied in order to obtain a classical Levallois point regardless of the applied concept. Meignen (1995; 367) hinted that the *Concorde*-shaped distal termination of Levallois points is partially a result of the obliqueness of the lateral removals. Recently, Groucutt (2014; 220) discussed the variation in preparatory scar patterns of Levallois point production and its relationship to the morphological differences in Tor Faraj Shelter. He indicates that different variants of unidirectional convergent scar patterns generally produced morphologically similar points. The technical criteria responsible for obtaining a classical Levallois point will be addressed in detail here, based on the analysis of 100 Levallois points from assemblage 4 of YSI. The perfect triangular shape and *Concorde*-shaped distal termination of the Levallois point will be correlated with the obliqueness of the lateral negatives, by measuring the cross-section angles with a goniometer. In addition, it will associate the convergency of the lateral scar patterns with the broad-based Levallois point by measuring the angles between the lateral edges and the base with a Geodreieck, a set square combining a 90-45-45 triangle with a protractor.

A. Cross-section angles of Levallois points

To define the technological factors that caused *Concorde*-shaped distal termination and regular-shaped outline, the cross-section angles of 100 classical and non-classical Levallois points from assemblage 4 of YSI were investigated for morphometric and technological features. The measurement was performed with a goniometer in order to associate the obliqueness of the two preceding convergent removals with these two technological features. The measurement was applied to the distal third of the Levallois points as this is the least concave section of the medial scar pattern on the Levallois point (Fig. 15).

I discovered that the cross-section angles of classical Levallois points, characterized particularly by regular triangular outline and *Concorde*-shaped distal termination, range between 130° and 145° (Fig. 103). The cross-section angles of non-classical Levallois points, which display often irregular triangular outline and non- *Concorde*-shaped distal termination, are greater than 150°. Although the more regular shaped lateral edge is related to smaller cross-section angles in most instances, it is not a basic condition for it. Furthermore, observing a *Concorde*-shaped distal termination on a single edge can be reasonably expected when the Levallois point only has a single small cross-section angle. Moreover, it must be noted that all

edges with *Concorde*-shaped distal termination have an almost regular shaped outline. Consequently, *Concorde*-shaped distal termination and a regular triangular outline is, in most cases, associated with small cross-section angles, ranging between 130° and 145°, whereas regular shaped lateral edges are related to all sizes of cross-section angles, with small cross-section angles predominant.

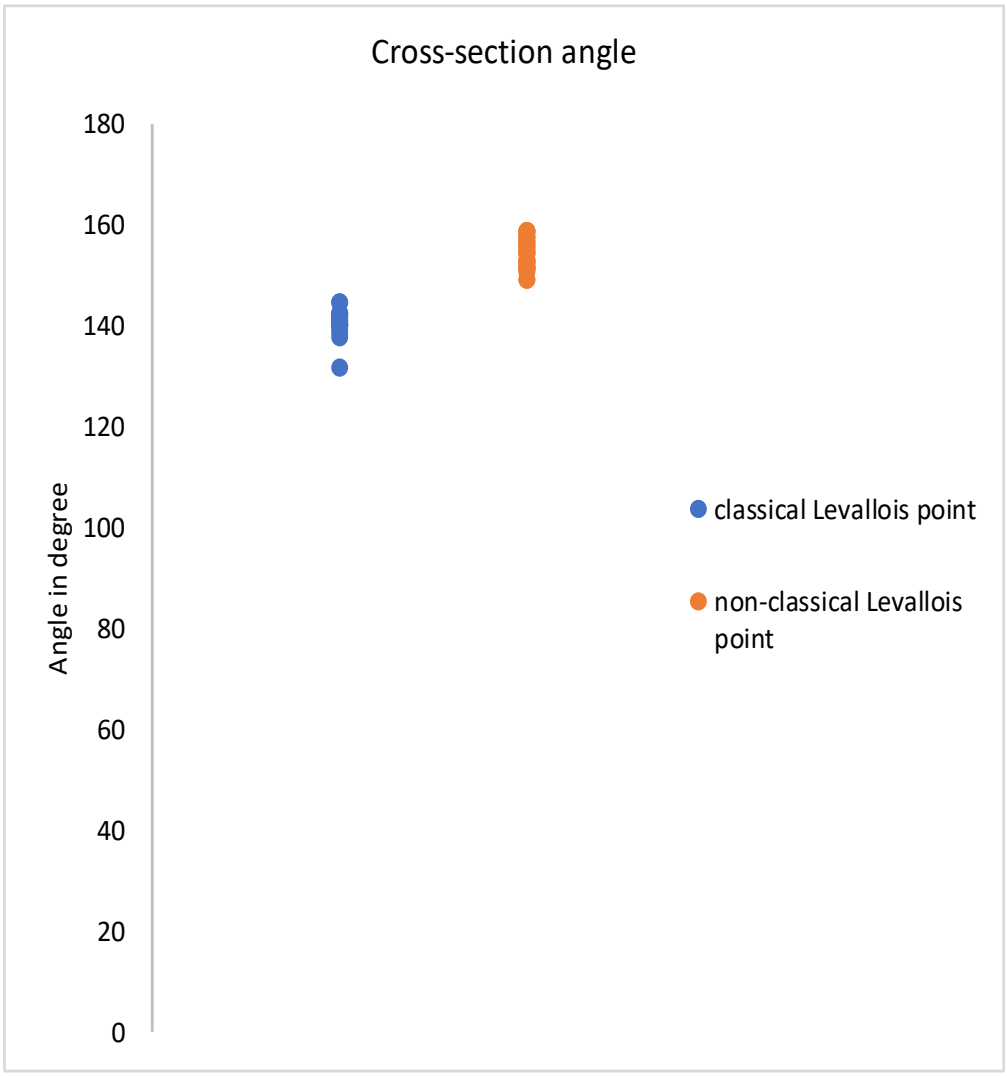


Fig. 103. Cross-section measurement of 100 classical and non-classical Levallois points.

Non-classical Levallois points that exhibit irregular shaped lateral edges and non-*Concorde*-shaped distal termination are associated with cross-section angles greater than 150°. Thus, it can be suggested that the obliqueness of the two preceding convergent removals plays a main role in the predetermination of the outline and *Concorde*- shape of Levallois points. The smaller the cross-section angle, the more regular the shape of the lateral edges and more *Concorde*-shaped the distal termination of the Levallois point can be (Fig. 104).

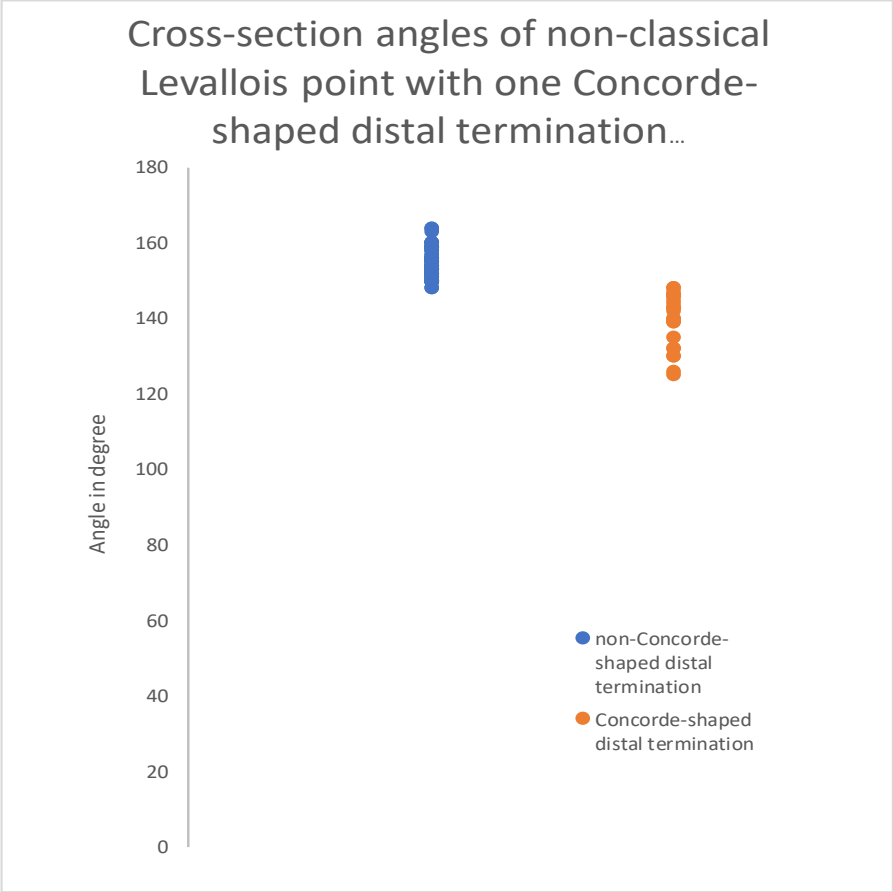


Fig. 104. Non-classical Levallois points show different technological features because of different cross-section angles.

It follows that the small cross-section angles measured on classical Levallois points resulted in *Concorde*-shaped distal termination and a more regular-shaped lateral edge, whereas the larger cross-section angles caused non- *Concorde*-shaped distal termination and irregular shaped lateral edges.

B. The lateral angles of broad-based Levallois points

In order to identify the technological factor that results in short, broad-based Levallois points, the angle between the lateral edges and the base of 80 elongated and short, broad-based Levallois points were measured with a protractor. I followed a triangle that passes three angles of the elongated and broad-based Levallois points (Fig. 16).

The lateral angles of short broad-based Levallois point bases averaged 67° (Fig. 105), whereas those of elongated Levallois points averaged 82°. Consequently, the two preceding convergent removals obviously played the main role in identifying the base type of Levallois points. The lateral angles of short, broad-based Levallois points are closer to acute angles, whereas the lateral angles of elongated Levallois points are closer to right angles, greater than

75° in all instances. The more convergent the two preceding removals are, the broader the base of the Levallois point obtained.

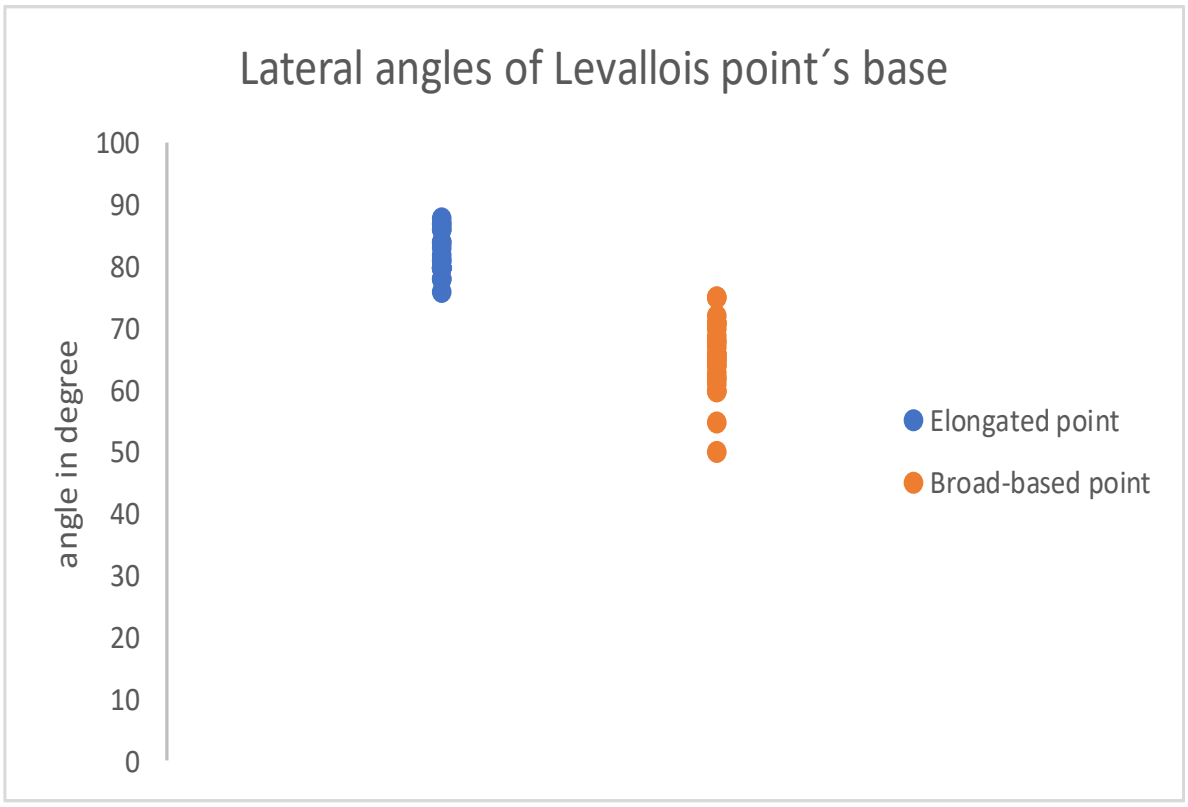


Fig. 105. Measurements of the lateral angles of elongated and broad-based Levallois points.

C. The experimental work

The following experimental work was carried out in order to verify that the obliqueness of the two preceding convergent removals is responsible for the five typical features of classical Levallois points.

- **Classical Levallois point**

Two convergent removals have been carried out once the flaking surface is prepared. The negatives of these removals showed different obliqueness, based on the location of the impact point. The farther from the edge the impact point, the deeper the negatives of preceding removals can be.

After preparing the striking platform in order to obtain a specific protrusion to receive the oriented blow, the strike invaded the flaking surface toward the distal termination and lateral edges of the block. It is important to be aware that the production process was carried out by a non-Levallois method (Fig. 106; b).

Owing to the fact that the two preceding convergent removals had different obliqueness, the classical Levallois point showed slightly different technological features in terms of the regular-shaped lateral edge and the *Concorde*-shaped profile. The cross-section angle was measured at 122° on the more regular shaped edge with *Concorde*-shaped profile, and 135° on the other edge exhibiting a *Concorde*-shaped profile and less regular shaped edge (Fig. 106; b).

The small cross-section angles of the classical Levallois points resulted in *Concorde*-shaped distal termination and a more regular shaped lateral edge, which corresponds to the result of the experimental work. Therefore, it can be confirmed that these two technological features are obviously related to the obliqueness of the two preceding convergent removals.

The explanation for this phenomenon is that the obliqueness of one preceding removal hampered extension of the lateral edge, whereas the other preceding removal that was less oblique provoked further extension of the lateral edge. Accordingly, the more oblique removal resulted in a regular lateral edge, as well as, a *Concorde*-shaped distal termination. As can be seen in Fig. 106; b, the two oblique preceding convergent removals result in short-based broad Levallois point as well.

- **Non-classical Levallois point**

In terms of the unidirectional convergent Levallois method, after the flaking surface was prepared and several recurrent preceding removals were struck from a single flaking surface and faceted striking platform, the flaking surface exhibited less convexity and the scar patterns were almost flat. Accordingly, the preceding semi-flat removals allow an extension of lateral edges when the Levallois point is struck, meaning that the point has an irregular shaped outline. In addition, it lacks the *Concorde*-shaped distal termination and *Chapeau de gendarme* shaped striking platform. The cross-section angles of both non-classical Levallois points and elongated points were greater than those of classical Levallois points, measuring between 155° and 162° (Fig. 106 a and c). In addition, as it can be seen in Fig. 106; a and c, the two preceding removals are more likely to be slightly parallel than convergent, which causes the elongated Levallois point.

Consequently, there is no variation in Levallois point production, but rather an appropriate flaking surface condition, in which the preceding oblique convergent removals permit classical Levallois point production. On the other hand, an inadequate flaking surface condition permits non-classical Levallois point production. Accordingly, both types of

Levallois point may have served the same function. The appropriate obliqueness and convergency of two preceding convergent removals can also result in the standardization of technical and morphological characteristics of Levallois points and *vice versa*.

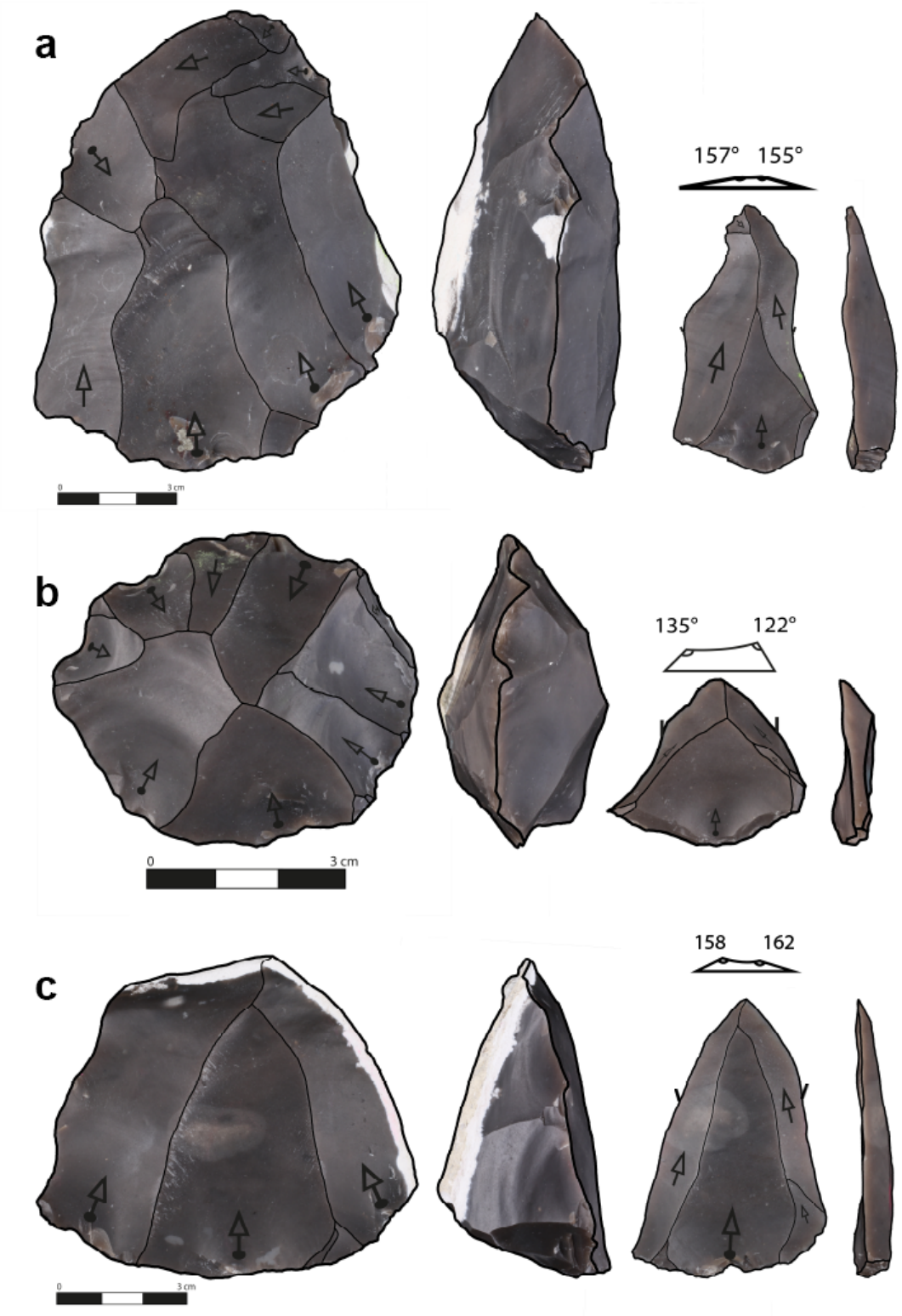


Fig. 106. Various Levallois points produced by different methods, showing different cross-section angles. The experimental work was executed by Brenet and Al Kassem.

6.4.3. Levallois flake and blade reduction strategies

Given that Levallois flakes and blades have been frequently produced in the point-bearing assemblage, it is worth deriving the techno-typological variables of these elements and associating them with the Levallois cores employed in order to obtain them. Levallois flakes and blades together account for 44.7% of all Levallois blanks, including triangular flakes. In contrast to material from Kebara IX-X where Levallois points are dominant with Levallois flakes (Meignen & Bar-Yosef 1992), Levallois blades outnumber flakes in this assemblage.

Levallois blades form 25% of the total. They show a high frequency of unidirectional convergent scar patterns, while unidirectional parallel and bidirectional scar patterns are also clearly present. Furthermore, 22 blades have an average length of 42.5 mm, whereas the majority show a mean length of 68.5 mm. Levallois blades are not consistent with the small number of Levallois cores for blades (Fig. 107). This poses many questions. Were the Levallois blades produced separately from individual cores? Or were they struck at the late or early stages of a single reduction sequence for Levallois point production?

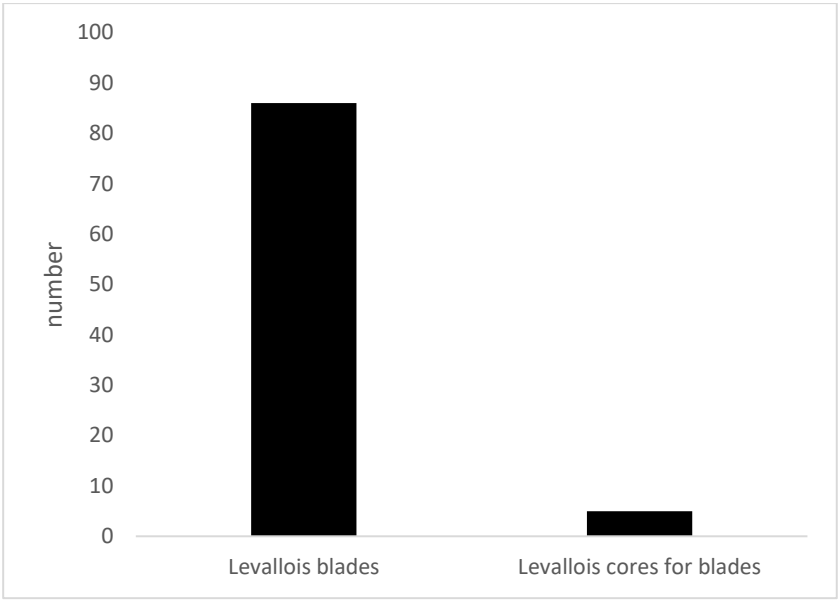


Fig. 107. The high discrepancy between the available Levallois cores for blades and their end-products.

Consequently, it can be assumed that two different strategies for Levallois blade production were executed resulting in different shapes (Fig. 108-109) with a predominance of quadrangular shaped blades. Levallois blades bearing unidirectional convergent scar patterns appear to be related to shaping Levallois cores for points, found in a relatively high proportion (ca. 25% of the debitage) in Tor Faraj Shelter (Henry et al. 1996; Demidenko & Usik 2003).

The quadrangular shaped blades might have been removed from an individual reduction sequence for blade production.

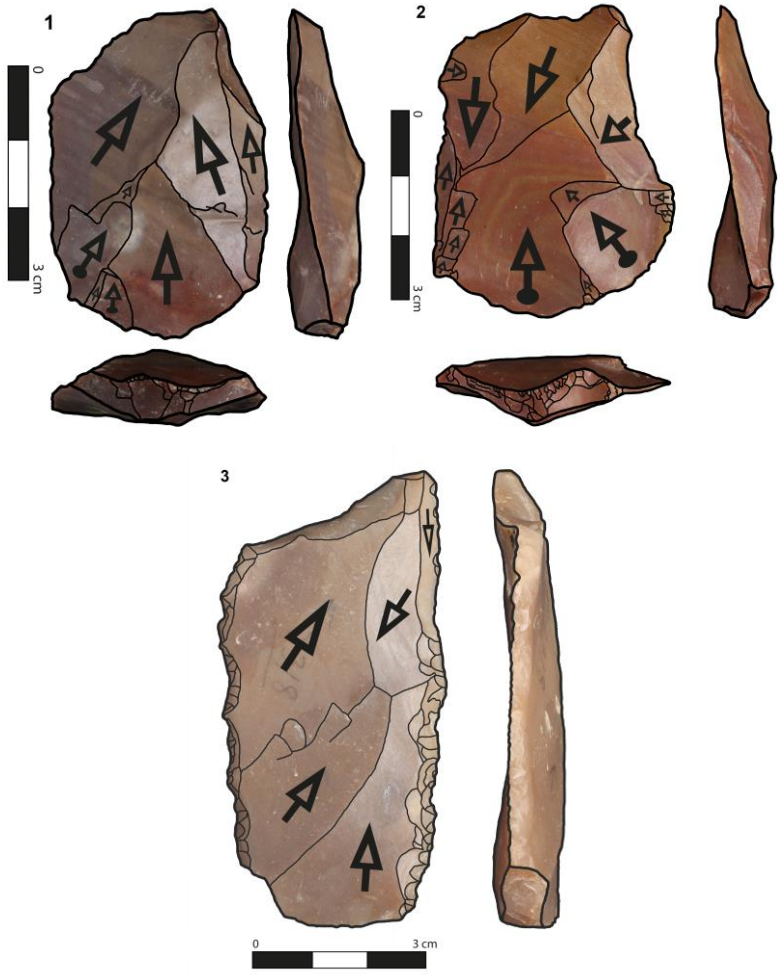


Fig. 108. 1. Levallois flake showing unidirectional convergent scar patterns, 2. Levallois flake exhibiting centripetal scar patterns, 3. Levallois blade bearing unidirectional convergent scar patterns.

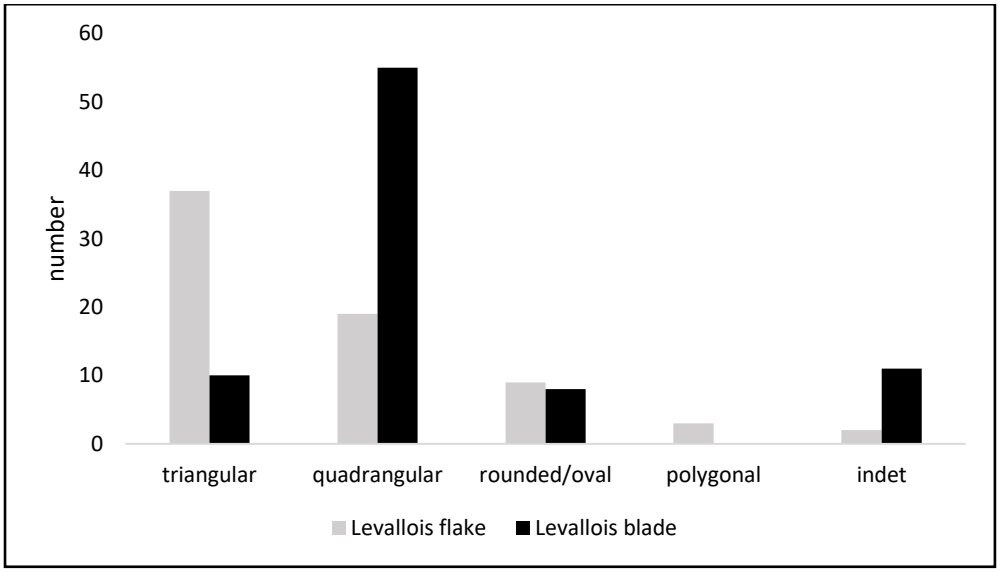


Fig. 109. Distribution of shapes of Levallois flakes and blades.

A. Strategy of Levallois blade production from an individual reduction sequence

Three reasons lead us to believe that Levallois blades were produced from an individual reduction sequence that was specialised exclusively for Levallois blade production, i.e. the flaking surface only served for blade production, from decortication to discard of the core. The first is the obvious frequency of unidirectional parallel/bidirectional scar patterns. The second is that these blades show various size values, reflecting the whole size of the core throughout the reduction sequence, on average 63.5 × 26.4 × 7.2 mm. Finally, the clearest evidence is that transformation analyses indicate Levallois cores for blades with their debitage from the first stage of core reduction to the final stage of discard (Fig. 125). Discarded Levallois cores for blades display only unidirectional parallel or bidirectional scar patterns, whereas 24.4% of Levallois blades bear unidirectional parallel or bidirectional scar patterns with small perpendicular and/or bidirectional preparatory removals. They exhibit various sizes, with a mean of 65.8 × 27.7 × 7.9 mm. This suggests that Levallois cores for blades underwent different types of flaking surface preparation throughout the core reduction sequence, not limited to unidirectional or bidirectional removals.

B. A single reduction sequence for point (elongated or not) and blade production

As can be seen in Fig. 110, blades were struck at the early stage of a single reduction sequence for Levallois point production, in which knappers invested in the large size of the nodule in order to obtain large blades. The clear evidence behind this is that 43% of Levallois blades display unidirectional convergent scar patterns. In addition, they have an average size of 60.0 × 25.3 × 6.8 mm. This strategy of obtaining different Levallois products has been observed in Tabun lithic material analysed and illustrated by Shimelmitz and Kuhn (2018). On the other hand, these Levallois blades may also have served as by-products for Levallois point production observed in the late MP Levantine sites, such as Kebara Cave level IX-X (Meignen & Bar-Yosef 1992; Jelinek 1977, 1981), the lower layers of the chimney sequence in the Dederiyeh Cave (14–9), where narrow blanks were produced in the course of earlier core preparation for point production (Nishiaki et al. 2012), and in Hummal site HM-A1 (Hauck 2011). Both interpretations support unidirectional convergent removals being the initial preparation type executed because of the predominance of large blades bearing convergent scar patterns.

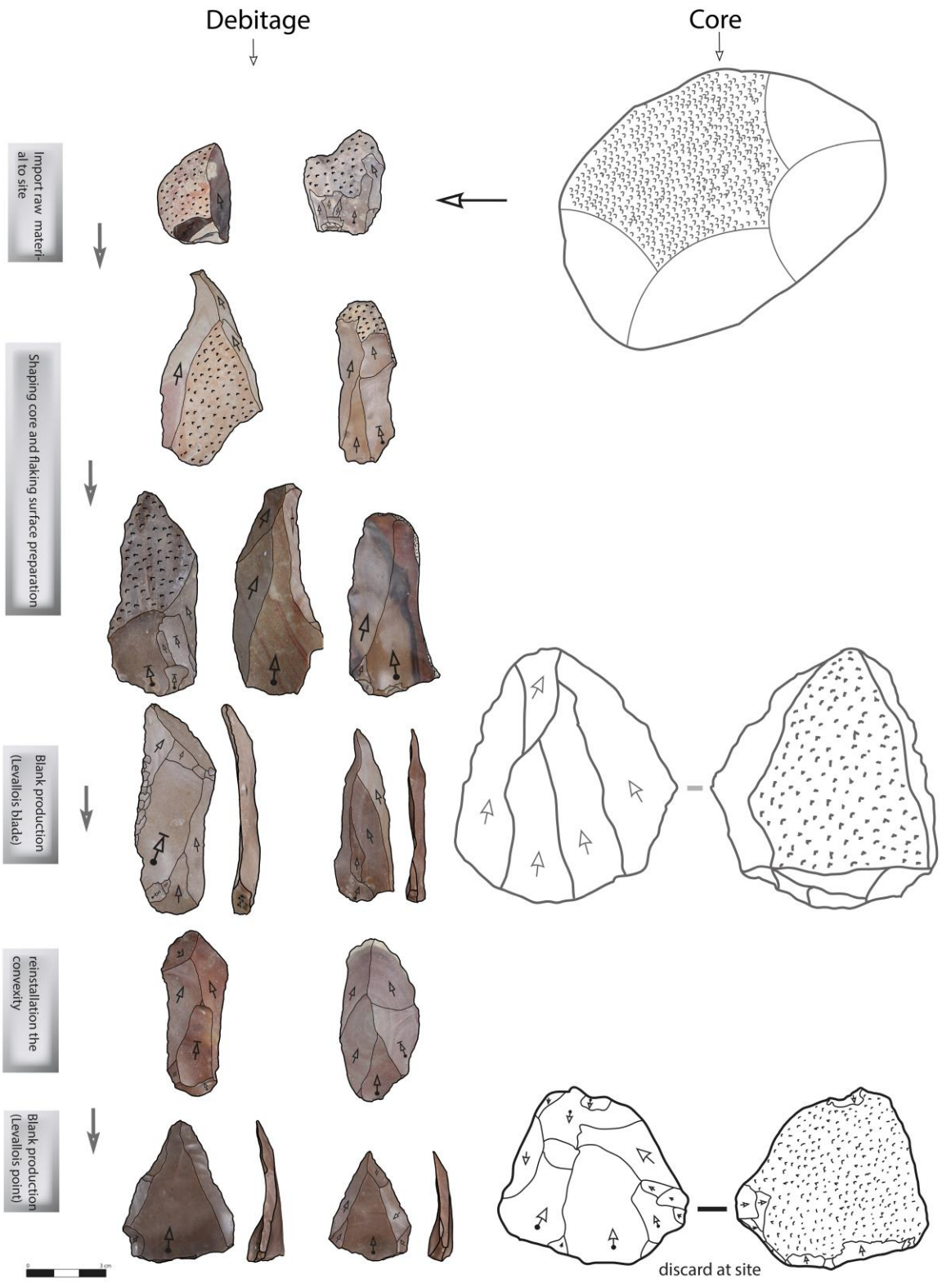


Fig. 110. Strategy of Levallois blade and elongated point production. Faded shapes are virtual cores.

C. A double strategy of core reduction for Levallois blade production

As can be seen in Fig. 132, two Levallois methods were applied to the same core. At the early stage of the reduction sequence, Levallois blades were struck using unidirectional

parallel/bidirectional Levallois methods. Thereafter, the flaking surface was shifted gradually from Levallois blade production to Levallois point or flake production by detaching elongated lateral removals (naturally backed knives/core edge flakes) or by detaching small bidirectional and perpendicular removals from the unidirectional parallel/bidirectional cores in order to obtain a convergent prepared flaking surface. In this case, the triangular Levallois flakes obtained still exhibit unidirectional parallel/bidirectional scar patterns, obvious evidence that the first method has been applied. Afterwards, Levallois points were produced.

Solecki discovered two nodules during his excavation in the 1960s. One is an almost complete nodule with only initial core preparation, measuring ca. 87 × 60 × 53 mm (Solecki & Solecki 2007). Based on a size comparison between this complete nodule and the Levallois blade, which measures 80 × 36 × 6 mm, it can be deduced that the blade was produced in the early stages of core reduction. However, it is difficult to identify whether these behavioural episodes occurred in the same period or if there was a gap between each core reduction.

Levallois flake are the least frequent end-products in this assemblage. It is quite obvious that triangular flakes with unidirectional convergent scar patterns were removed during Levallois point production. Non-triangular flakes form 7.2% of all Levallois blanks. They are mainly oval or quadrangular flakes displaying centripetal, semi-centripetal, and perpendicular scar patterns (Fig. 108; 2). Although Levallois cores for flakes constitute 18% of the total, Levallois flakes are disproportionally scarce. Due to the clear paucity of large non-triangular Levallois flakes it can be assumed that Levallois flakes were produced at the last stage of core reduction when core size no longer meet their needs for points or blades. The application of most core reduction on flakes that lacked adequate thickness may also have contributed to the low level of productivity. Triangular-shaped flakes are dominant, which is consistent with the point bearing assemblage.

6.5.By-products

The 239 by-products counted, compared to 344 end-products, is not a logical number since the frequency of by-products is supposed to be greater than that of the end-products. This indicates, as mentioned above, that Rust might have disposed of part of the lithic material to facilitate its transportation. It is therefore difficult to estimate all of the strategies of raw material procurement based on the cortical by-products. However, it can be considered as an incomplete excavated site.

6.5.1. Cortical flakes

Cortical flakes account for 23.8% of all by-products. Although it is possible that many cortical flakes were thrown out by Rust, this section of the by-products has 10 to 100% cortex coverage of the dorsal surface (Fig. 113;1). If Rust did dispose of cortical flakes, such a variability in cortex could be evidence that the initial stage of core reduction was exploited on-site in several cases. However, these are the least frequent cortical flakes in the assemblage (Fig. 111). From the predominance of partially cortical flakes, it can be assumed that most flint nodules were prepared off-site and then imported to the site as partially prepared cores.

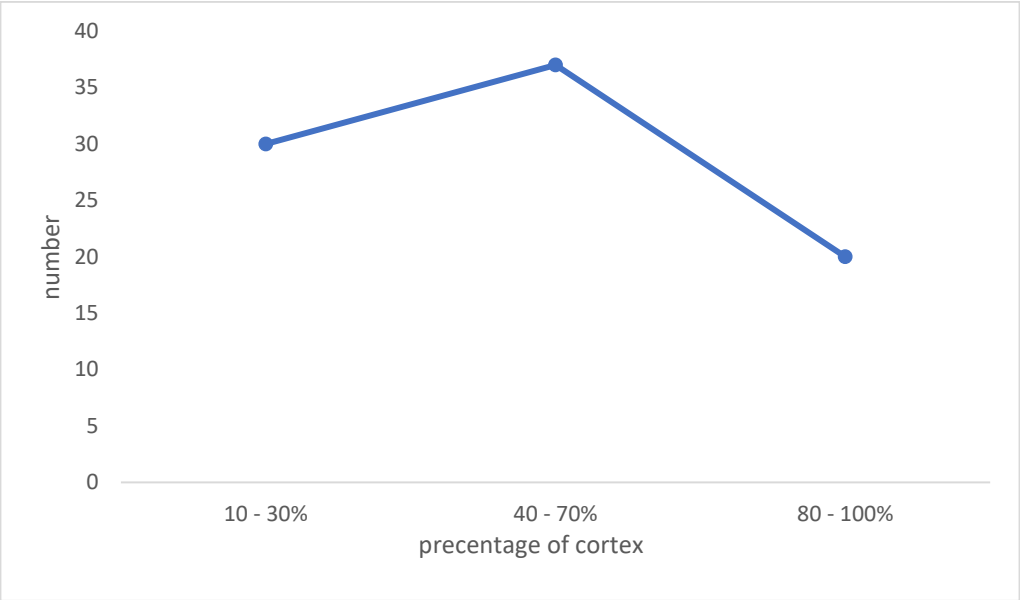


Fig. 111. Distribution of by-products with more than 10% cortex cover of the dorsal surface.

Cortical flakes have various sizes. The largest is 86 × 33 × 9 mm, whereas the smallest is 15 × 19 × 11 mm. The mean size is 53.7 × 30.9× 9.3 mm. This attests to different sizes of reduction and the use of relatively small nodules as well. This could be the reason behind the short productivity in many cases.

It is worth noting that 71.9% of cortical flakes show a mean of 3.5 unidirectional convergent scar patterns. Furthermore, the largest cortical flakes with a mean length of 72.0 mm exhibit unidirectional convergent scar patterns. This suggests that most cores were prepared at the early stage of core reduction by detaching unidirectional convergent removals, which corresponds with the dominant scar patterns in the point-bearing assemblage.

As can be seen in Fig. 112, faceted and dihedral butts together represent the highest values, followed by plain butts. However, faceted and dihedral butts are mostly associated with by-products with little cortex coverage. This implies that careful preparation of the core's

striking platform began too early. By-products with high level of cortex coverage are coupled to cortical and plain butts, which corresponds to the initial decortication of the flint nodule.

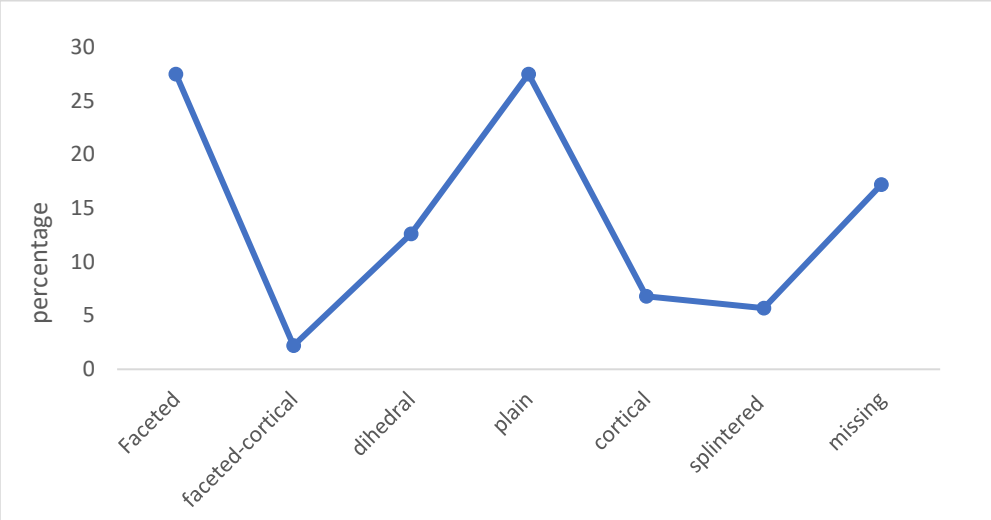


Fig. 112. Frequency of striking platforms recorded on cortical by-products.

6.5.2. **Naturally backed knives and core edge flakes** (*Éclats débordants*).

Removing either naturally backed knives or core edge flakes may be the most successful process for re-preparing the lateral and distal convexity of the flaking surface through Levallois-Mousterian sites. At the early Middle Palaeolithic site of Misliya Cave, for instance, on the western slopes of Mount Mar Elias (Mount Carmel), the unidirectional convergent Levallois method is the most used flaking exploitation. Removal of plunging twisted naturally backed knives gradually gave the unidirectional convergent Levallois cores more abrupt sections toward the distal termination, which exhibits a slightly convex section at one-fifth along the length and a much more abrupt section at four-fifths along the length (Zaidner & Weinstein-Evron 2020). Naturally backed knives (Fig. 113; 3-4) and core edge flakes (Fig. 113; 5) are clearly evident, accounting for 30.1% and 8.7% of all by-products respectively. This clear difference is extremely logical as we know that the recurrent unidirectional Levallois method was the most frequent method executed. Additionally, the low frequency of core edge flakes corresponds with the scarcity of Levallois flakes, but contradicts the clear number of discarded Levallois cores for flakes. This supports the theory that Levallois cores for flakes were either the last stage of core reduction in point or blade production or were applied to cortical small flakes whose short productivity did not allow them to be prepared frequently.

Naturally backed knives exhibit different scar patterns associated with various sizes. The largest naturally backed knives, 29% of the total, have a mean size of 72.5 × 36.0 × 12.5 mm. They show only unidirectional convergent and parallel scar patterns (Fig. 113; 3). This

suggests that flaking surface preparation was carried out by detaching elongated lateral removals in the early stages of core reduction, proportional to the large size of the cores. Meanwhile, this caused the elongation of the core shape that aided the production of elongated points. The smaller naturally backed knives, with a mean of 48.7 × 27.9 × 9.2 mm, exhibit bidirectional, perpendicular, and semi-centripetal scar patterns (Fig. 113; 4). These patterns attest to the second type of flaking surface preparation, aimed at maintaining the greatest width at the core base.

Thus, the naturally backed knives attest to two different alternate types of flaking surface preparation.

While 58% of both categories (i.e. naturally backed knives and core edge flakes) exhibit plunging termination, 32.5% of them display feathered termination. 3.7% bear hinge termination and 11% of both categories have broken distal termination. These percentages suggest that knappers frequently succeeded in reinstalling the lateral and distal convexity of cores through the detachment of naturally backed knives and core edge flakes.

In addition, pseudo-Levallois points that also served to correct the localized parts of the flaking surface of the centripetal Levallois core (Fig. 113; 6) giving a favourable inclination and creating lateral convexities were distinguished (Boëda et al. 1990; 50). However, it is not possible to determine whether they were the result of centripetal Levallois core reduction or other methods as their extremely low number hampers detailed analysis. Moreover, the transformation analyses suggest they were part of the personal gear imported to the site.

6.5.3. Flaking surface preparation flakes

This category constitutes only 13.8% of all by-products (Fig. 113; 7). This is a low percentage compared to the high frequency of naturally backed knives. This supports the idea that the re-installation of flaking surface convexity was mostly carried out by detaching lateral removals. While 33.3% of all preparation flakes exhibit plain butts, the majority of them, 42.4%, show faceted and dihedral butts, indicating that knappers usually prepared the striking platform well before their removal in order to specify the exact impact point that allowed them to achieve the purpose of preparatory flake removal, whether to get rid of an accident or to prepare a specific part of the core.

They are small in size, with mean of 45.8 × 30.0 × 8.5 mm. This implies that they were removed from different restricted parts and they did not invade large parts of the core's flaking surface as naturally backed knives and core edge flakes, and hence, and hence, they may have

served to correct spatial irregularities. Or they were removed in later stages of core reduction due to their small sizes. It is worth noting that the majority, 78.7%, display unidirectional convergent scar patterns. Furthermore, they show variability in morphology ranging from quadrangular, to rounded, to triangular. The latter forms 28% of the total. This suggests they might have mainly been preparatory flakes for recurrent unidirectional convergent Levallois method.

6.5.4. Striking platform flakes

Striking platform flakes form 7.1% of all by-products (Fig. 113; 8). They are characterised by their quite small size, with a mean of 28.5 × 26.8 × 6.2 mm. In addition, they mainly show cortex limited to the distal termination. Given that they did not invade the whole lower surface of the core because their function was only to create a proper striking platform angle, the cortex is confined to a small part of the distal termination that was taken from the medial part of the core as a result of the slight and restricted impact point. Moreover, although they are extremely small size, they bear a high number of small scar patterns (a mean of 3.7) as a result of preceding preparation processes.

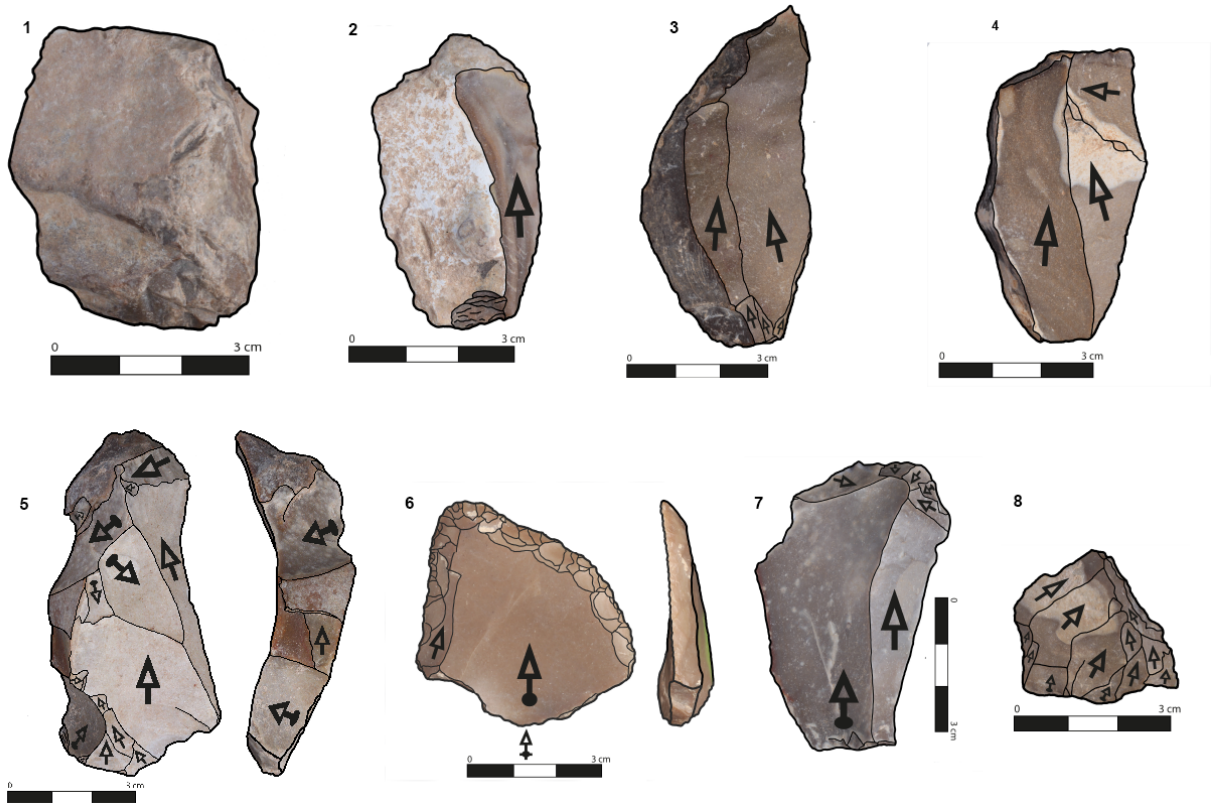


Fig. 113. 1. First removal, 2. cortical flake, 3. naturally backed knife clarifies first type of flaking surface preparation and shows feathered distal termination, 4. naturally backed knife clarifies second type of flaking surface preparation and shows plunging distal termination, 5. core edge flake shows plunging termination, 6. convergent side scraper on pseudo-Levallois point, 7. flaking surface preparation flake was removed to reinstall flaking surface's convexity of bidirectional Levallois method, 8. striking platform flake.

6.6. Typological classification: manufacturing tools

Assemblage 4 of YSI is characterized by low to moderate frequencies of modified blanks, accounting for 193 tools (28.9% of the total), including the modified fragments. This is considered a considerable amount compared to other Levantine MP sites that are poor in retouched blanks such as Hummal (Hauck 2013), Qafzeh sites (Hovers 2009) and Tor Faraj and Tor Sabiha (Henry et al. 1996). The tool group contains diverse types of modification with a predominance of the retouch that was crafted on the dorsal or inverse face of the tools, accounting for 80.3% of all modified blanks. Specifically, the retouch was mainly executed on a single edge, accounting for 66.4% of all retouch blanks. The economic strategy of using the artefacts can be seen through the retouched tools. Hunter-gatherers reused the same tools frequently through retouching them even though raw material was available within a 5 km radius.

As can be seen in Table. 27, modifications were three times more likely to be executed on Levallois blanks than on by-products. In addition, the reverse retouch is scarce. Such retouch is oriented almost exclusively to a single section, the uppermost section of modified blanks. Furthermore, it is worth noting that the distal section of the triangular is the most frequently retouched part, whether partially or substantially. This gives a hint that it is the most used part.

	Levallois end-product	**By-product**
triangular	108	14
quadrangular	21	15
Rounded/oval	9	7
polygonal	1	2
irregular	1	15
total	**140**	**53**

Table. 27. Frequency of distribution of modified tools by shape.

As can be seen in the Fig. 114, the Mousterian group (Group II) and partially retouched tools are the most frequent tool types, followed by denticulates, notched pieces, the UP group (Group III), and finally the miscellaneous group.

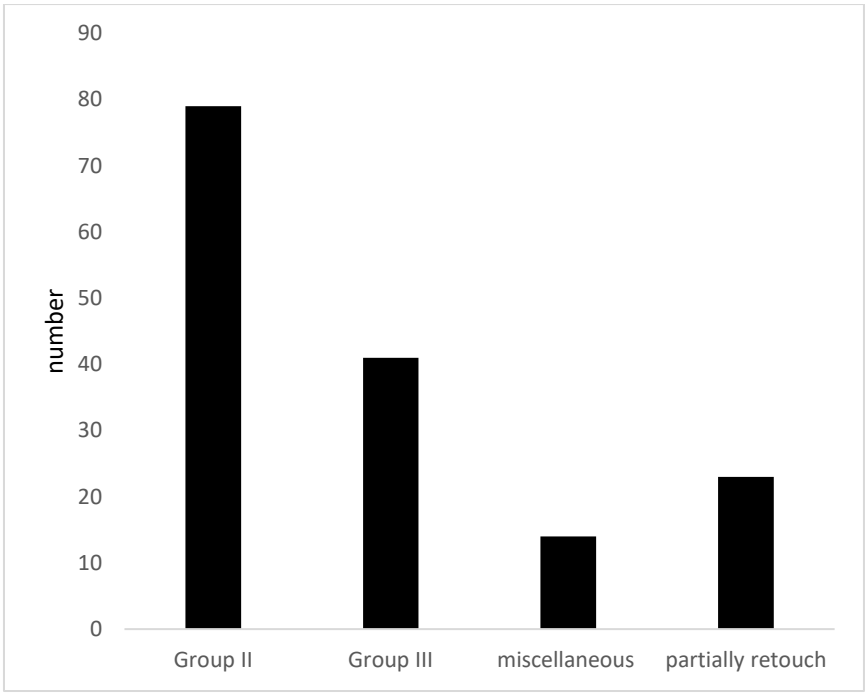


Fig. 114. Distribution of tool groups, showing dominance of the Mousterian group (Group II) and partially retouched tools.

6.6.1. The Middle Palaeolithic group (Group II) and partially retouched pieces

The MP group (Group II) is the largest category of tools in assemblage 4, accounting for 50.3% of the total (Fig. 114). This group presents different types of retouched products. Fig. 115 shows that scrapers are the most common type.

Mousterian points and elongated Mousterian points (types 6 & 7): the Mousterian of assemblage 4 can be characterized by the presence of Mousterian points and elongated Mousterian points (Fig. 117; 1-2), which together form 7.7% of all modified blanks. All of the specimens exhibit two completely retouched edges with invasive retouch. The dorsal surfaces exhibit a higher depth of retouch, some up to 10 mm. One-third display double patination, which can be representative of frequently use. In turn, frequent use itself clarifies the invasive retouch. Given that these items achieved the required conditions of use, whether triangular shape or suitable size, they were recycled frequently.

Scraper types (types 9–26): taken together, scrapers are the most frequent type of tool in group II (Fig. 114), accounting for 33.1% of all retouched blanks. Within this group, simple side scrapers (type 9–11) show obvious dominance, constituting about 65.6% of all scrapers, followed by convergent scrapers (type 19–26) reaching 14.0%. Finally, double side scraper (types 13–15) form 10.9% of the total. As such, simple convex side scrapers are dominant among group II tools.

Zaidner & Grosman (2015) demonstrated the resharpening of side scrapers by a spall removal at the open-air MP site Nesher Ramla, situated at an elevation of 85–120 m a.s.l. on the coastal plain of Palestine, and inhabited during MIS 6–5 according to OSL chronology (Zaidner et al. 2015). This is a rare case that shows side scrapers were frequently modified by the removal of longitudinal spalls from their edges (LSF). Their research suggested that LSFs were mainly removed from side scrapers, and in a few cases from un-retouched flakes, in order to reshape the edge through reducing the angle of the parent tool edge, making it sharper than the original for use in butchering. Resharpening was carried out by preparing a small truncation on the ventral surface of the side scraper that served as a striking platform for the spall removal.

Interestingly, the resharpening of un-retouched blanks was observed in assemblage 4. However, it is quite scarce (Fig. 117; 3). Only three samples seem to have undergone the same resharpening process, where LSFs were removed from the dorsal surface of blanks after the preparation of a striking platform on the ventral surface. Although the three samples exhibit clear similarities to the side scrapers and un-retouched blanks resharpened at Nesher Ramla, we cannot judge this as common technological behaviour on such limited evidence.

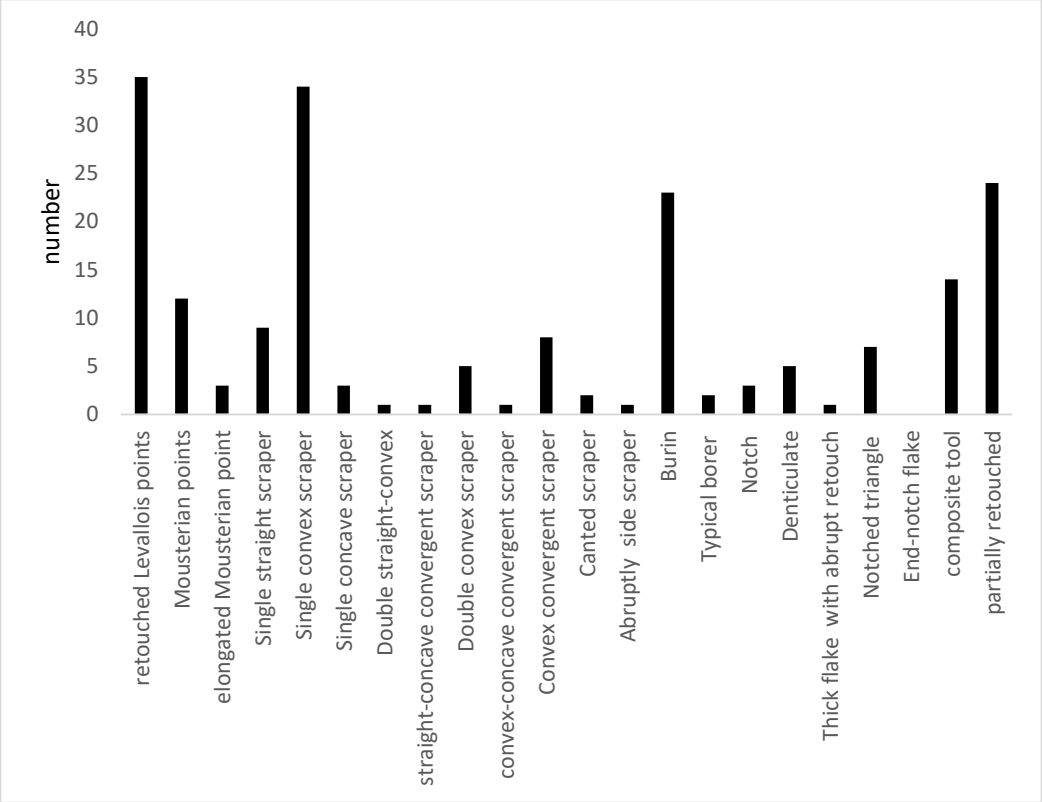


Fig. 115. Distribution of tools in assemblage 4.

Partially retouched tools (106): This type of retouch was executed on both Levallois blanks and by-products without preference for a certain category. In most cases, 79.1%, the

partial retouch was confined to the dorsal surface, especially the distal section of blanks. Only four specimens display retouch crafted on the ventral surface. This indicates that the distal section is the most used section. This could be further supported by four specimens that exhibit double patination, suggesting they may have been reused later.

6.6.2. Denticulates, notched elements and Upper Palaeolithic tool group (Group III)

Denticulates, notches, and the UP tool group (Group III) forms 26.1% of all tools, making them less common than MP group II (Fig. 114). This group reflects the occurrence of different types of tools. Burins (types 32–33) are the dominant type, followed by notched pieces (types 42 and 52), and denticulates (type 43).

Burins: exhibit one or more narrow spalls removed either from the proximal or, more frequently, the distal section. Burins were executed on both Levallois blanks and by-products, with Levallois blanks predominant at 56.5% of all burins (Fig 117; 4-5). They were rarely crafted on fragments (Fig 117; 5). Burins occur on multiple tools that show retouch on one edge and spall on the other. This kind of burin is relatively infrequent. Their low representation makes it difficult for us to classify them as faceted-truncated technique. Especially if they exhibit one lateral removal.

Denticulates and notched pieces: make up 36.5% of this group of tools. While there are few denticulates (Fig. 117; 6), accounting for 5 pieces, the 10 notched pieces represents a large number (Fig. 117; 7). Triangular blanks are still the most favoured, so notched triangles crafted by forming a large retouch scar on the distal section of the triangular blank are predominant. In all the specimens, the notch was performed on the dorsal surface of the edges, except for two tools where the notches were executed on the ventral surface. Their retouch depth is quite standardized, ranging between 3 and 4 mm. Four pieces have multiple notches.

6.6.3. Composite tools

These account for 8.9% of all tools. Composite tools all exhibit various types of retouched edges, whether planar, abrupt, substantial or partially retouch on one edge, combined with a second type of modification on the other edge, either notch, denticulate or burin and sometimes both modifications on the same edge (Fig. 117; 8). Based on modification types, burins executed on substantially retouched edges is the most frequent composite tool. The high number of composite tools combined with the actual presence of recycling tools confirms that tools were frequently used in several separate periods for different functions.

6.6.4. Analysis of modified blanks

Each type that was not represented by more than 2 tools was excluded. In this way, concrete types were chosen for detailed discussion in order to avoid the effect of individual outliers on the characteristics of the most modified blanks.

A. Modification of relatively larger products

Length: modified blanks exhibit a mean length of 59.3 mm (Fig. 116). Based on a comparison between unmodified and modified blanks, it is obvious there was a clear tendency toward selecting blanks that were longer than unmodified blanks. Retouched Levallois points and triangular blanks are the longest among tools, particularly elongated Mousterian points, followed by typical borers, a single abrupt and alternate retouch that is triangular as well as various types of scraper.

Width: modified blanks all display relatively similar width, with an average of 38 mm. They are wider than unmodified blanks. It is worth noting that the greatest width was observed on tools that were not the longest, especially notched triangles and retouched Levallois points.

Thickness: modified blanks are thicker than unmodified blanks, with mean thickness of 8.7 mm. UP tools are the thickest tools, followed by MP tools, such as double straight concave side scrapers. As previously mentioned, the thicker the blank, the more intensive the modification. This may indicate that knappers tried to thin the edge sharp by retouching.

In summary, it turns out that modified blanks are larger than unmodified blanks, indicating that they may have been intentionally selected for frequent use.

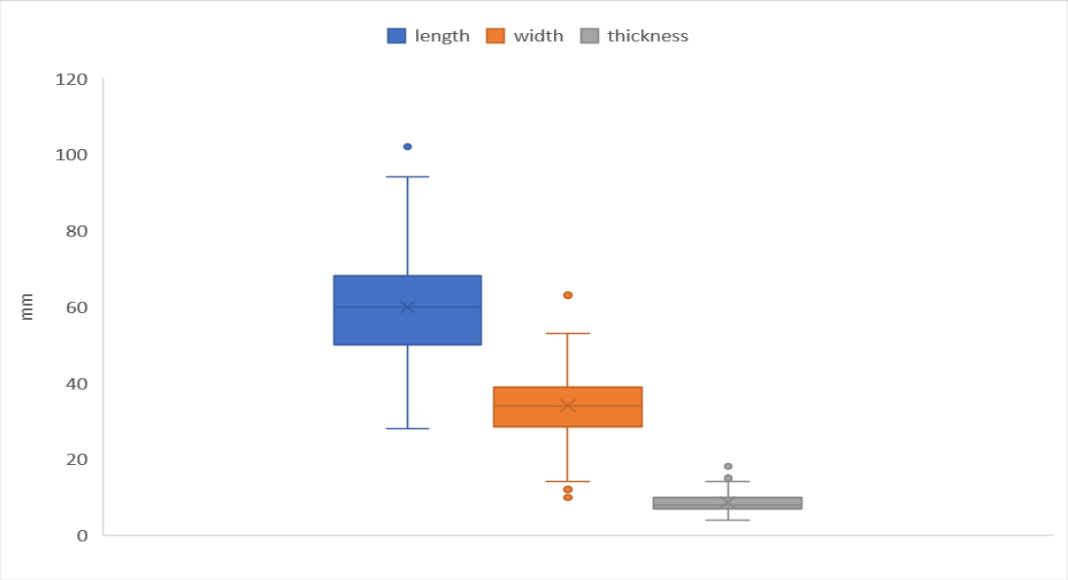


Fig. 116. Maximum, minimum and median size of modified blanks.

B. Amount of cortex on the dorsal surfaces

A significant amount, almost 61.2% of modified pieces, have no cortex at all, while on most of the rest cortex covers less than 20% of the dorsal face. Various tool types were executed on cortical blanks, mainly by-products, accounting for 67.2%. The MP tool group (Group II), with partially retouched tools, are the most frequent tool type, forming 72.1%, followed by the UP tool group (group III) with 14.7%. Notches and denticulates were rarely crafted on cortical blanks. Although cortical tools exist, the cortex has no effect on the function. 14% of the all cortical blanks were reused.

C. Condition (Complete /Broken)

Most modified blanks are complete tools, except for those exhibiting damaged edges and new breakages. Broken modified blanks account for 18.2% of the total. These elements display either broken distal or, most frequently, proximal parts. Making a distinction between the reasons for breakages is difficult. However, given that most broken tools are simple side scrapers, we might assume that breakages have happened during tool use.

D. Type and angle of striking platform

The vast majority of different tool types, 70.7% of the total, are characterized by faceted and dihedral striking platforms. Plain striking platforms make up only 12.7% of the total. The high frequency of faceted striking platforms is associated with the fact that most modified blanks were executed on Levallois blanks.

E. Scar patterns

Generally, the dorsal surfaces of modified blanks exhibit a variety of Levallois methods. Unidirectional convergent scar patterns are dominant, followed by a smaller number of modified blanks bearing unidirectional parallel and bidirectional scar patterns. Modified blanks bearing semi-centripetal, centripetal and perpendicular scar patterns are very rare. This matches well with the scar pattern frequencies of unmodified blanks.

Unidirectional convergent scar patterns are found most frequently on the most frequent tools, triangular blanks. They distribute mostly to MP group II, followed by UP group II, then denticulates and notches. Tools bearing unidirectional parallel scar patterns are Levallois blanks, mainly Levallois blades as scrapers, and rarely by-products.

Other types of flaking (semi-centripetal, and perpendicular scar patterns) distribute to various types of tools. It is difficult to identify the most executed method due to the low number

in each category. We should bear in mind that the lack of modified blanks with preferential scar patterns is due to absence of the preferential Levallois method.

Finally, the high frequency of retouched tools—regardless of whether Rust brought back all of lithic artefacts of this assemblage—and clearly recycled tools indicate that most blanks were repeatedly used for different tasks with further modification.

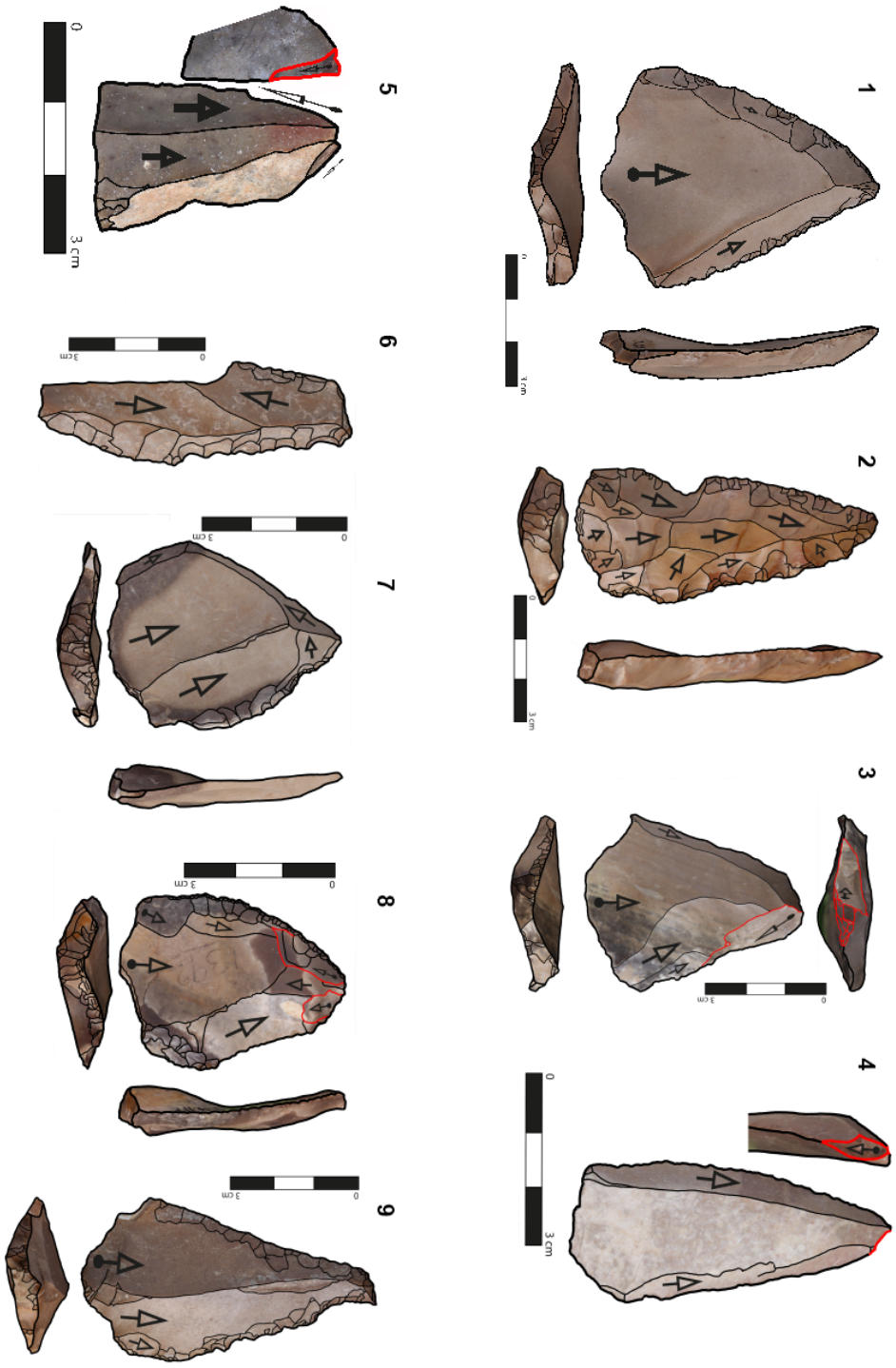


Fig.117. 1. Mousterian point. 2. Elongated Mousterian point, **3**-4 Executed burin on Levallois point, 5. Executed burin on fragment, 6. Denticulate, 7. Notched piece on retouched edge, 8. Burin executed on side scraper, 9. Borer.

6.7.Transformation analysis

The lithic material in this assemblage is comprised of 706 artefacts. These were sorted into 241 raw material units, which were distributed to four categories (Fig. 118). By and large, RMUs imported as prepared cores are the most frequent category, followed by RMUs imported as single and dynamic objects (personal gear), and finally RMUs imported as nodules.

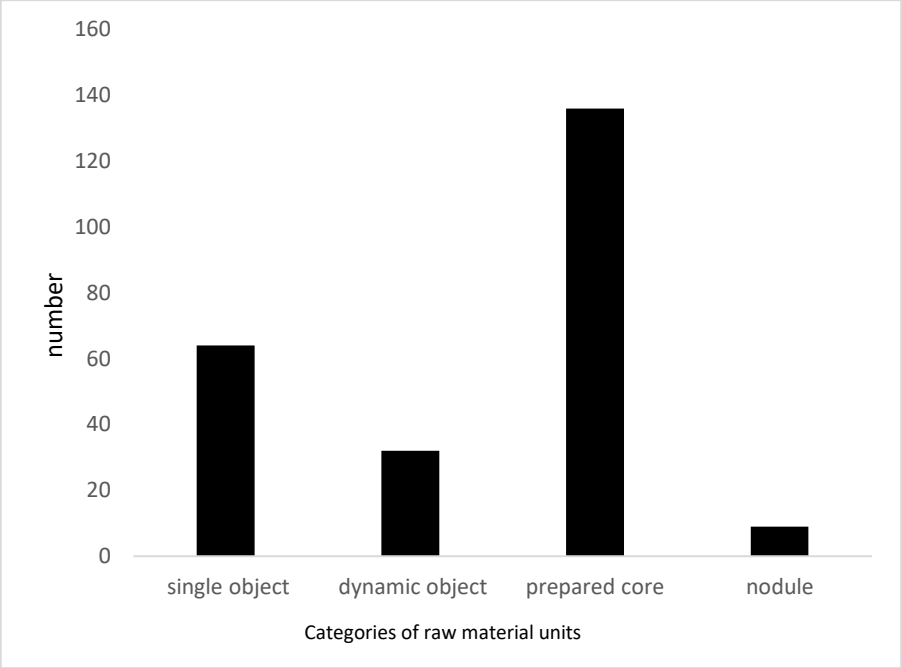


Fig. 118. Distribution of the raw material units.

6.7.1. Raw material units imported as single objects or tools

26.5% of all RMUs are single objects that have been imported to the site. They distribute to various transformation sections (Table. 28 and Fig. 119). Of them, 43.5% are modified. It is worth noting that Levallois blanks are prevalent, particularly Levallois points, followed by Levallois flakes and blades, then elongated points (Fig. 120). In addition, 12 by-products were imported, which distribute to different categories (Fig. 121). The question is, is it reasonable to assume by-products were imported? This is quite likely as long as the by-products can function like end-products. Furthermore, Levallois cores are the most frequent cores among others (Fig. 122) including an initial Levallois core. When it comes to the fragments, two distal fragments and an approximal fragment of Levallois points as well as a burin were discarded on-site.

These blanks may have been imported for different functions. Artefacts displaying cutting edges used and discarded without further modification may have been used for

butchering, while artefacts with retouched edges, which account for 43.5% of all imported single pieces, including tool fragments, may have been used for scraping activities. Modified blanks distribute to scrapers (RMUs 191, 192, 213–215 and 224), Mousterian points (RMUs 190, 207, 209, 210 and 217), retouched Levallois points (RMUs 185, 189, 193, 194, 198 and 205), burins (RMU 208, 211, 212 and 218), a composite tool, which exhibits a denticulate edge and intensive retouching on the other edge (RMU 195) a notch (RMU 223), a burin on a fragment (RMU 232).

In fact, the two distal fragments (RMU 233 and 45) and the proximal fragment of Levallois points, as well as the burin (RMUs 232) suggest that they had been used on-site and were discarded after they broke. Consequently, the MP group (Group II) represent the most frequently imported tools among imported single objects.

When it comes to the single cores (transformation section Ci), it is not thought that they were imported for on-site reduction due to their small size, which could not allow for further exploitation. However, they might have been imported, reduced and their products exported off-site or scattered somehow. The initial Levallois core (RMU 180), executing on a very small pebble, suggests that it was an old scattered artefact that they tried to exploit. Due to its very small size, it has been discarded at the preparation phase.

The two most frequently imported categories (i.e. Levallois cores and Levallois blanks) suggest that only the Levallois concept for blank production was executed, whether for on-site or off-site activities, regardless of whether they were used by the same groups or for the same functions. On the other hand, both categories exhibit double patination, accounting for 10% of personal gear, indicating that this assemblage was used repeatedly by the same or different people in different time periods. This implies that this assemblage was a known site, frequently used through time and various subsistence tasks were executed from the same place at different times. Given that Levallois blanks, particularly Levallois points and tools, are the most prevalent imported single pieces, it can be assumed they were imported in accordance with their planned uses.

The high frequency of single Levallois blanks and tools (Table. 28) can be a sign of high mobility. These single imported items were personal gear for contingencies. The Yabroud site may therefore be one of the site clusters in the region that was occupied and frequented by different groups of people or by the same group whose personal gear is Levallois blanks.

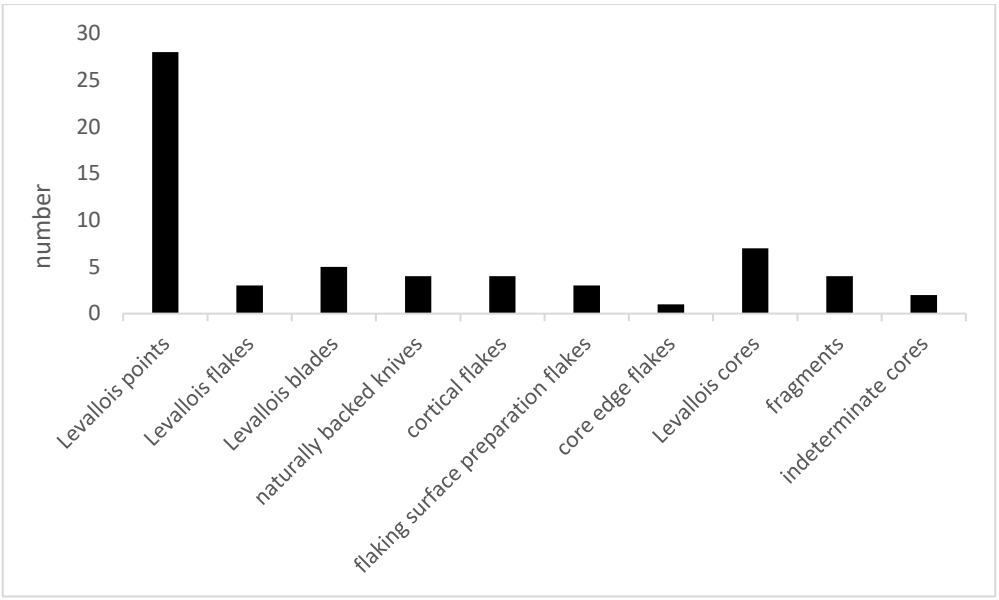


Fig. 119. Categories of imported single objects.

Transformation section	All raw material units	Levallois cores	Levallois points	Levallois flakes	Levallois blade	By-products
(Bw): Import of single blank without transformation	RMUs: 186, 187, 188, 196, 197, 199, 200, 201, 202, 203, 204, 206, 216, 219, 220, 221, 222, 225, 226, 227, 228, 229, 230, 231, 241.	-	RMUs: 186, 187 188, 196, 197, 199, 200, 201, 202, 204, 206, 227, 231	RMUs: 203, 226, 229, 230, 241.	RMUs: 221, 228.	RMUs: 216, 219, 220, 222, 225
number	**25**	**-**	**13**	**5**	**2**	**5**
(Tw): Import of single tool without transformation	RMUs: 185, 189, 190, 191, 192, 193, 194, 195, 198, 205, 207, 208, 209, 210, 211, 212, 213, 214, 215, 217, 218, 223, 224, 240.	-	RMUs: 185, 189, 190, 191, 193, 194, 195, 198, 205, 207, 208, 209, 210, 217, 240.	RMU: 192	RMU: 215	RMUs: 211, 212, 213, 214, 218, 223, 224
number	**24**	**-**	**15**	**1**	**1**	**7**
(Ei): Isolated functional end of a tool	RMUs: 45, 232, 233, 234.	-	.	.	.	-
number	4	-	.	.	.	.
(Ci): Exhausted discarded core	RMUs:177, 178, 179, 180, 182, 183, 184, 236, 237	RMUs: 177, 178, 179, 182, 183, 236, 237.	.	.	.	.
number	**9**	**7**	.	.	.	.
(Do): Import of dynamic objects	RMUs: 11, 19, 30, 31, 32, 33, 58, 68, 69, 80, 81, 82, 83, 84, 85, 86, 87, 103, 112, 117, 118, 119, 121, 127, 140, 141, 142, 143, 144, 158, 159, 160.	-	RMUs: 11, 31, 32, 33, 58, 68, 69, 80, 81, 82, 83, 84, 86, 87, 103, 112, 117, 118, 119, 121, 127, 140, 141, 142, 143, 144, 158, 159,	RMUs: 30, 19, 144, 160.	RMUs: 30, 85, 160.	.
number	**32**		**25**	**4**	**3**	

Table. 28. Distribution of raw material units imported as single objects (personal gear).

Fig. 120. Single Levallois blanks imported to assemblage 4 of Yabroud shelter I.

Fig. 121. Modified by-products and broken tools discarded/imported to assemblage 4 of Yabroud shelter I.

Fig. 122. Raw material units including Levallois core and initial Levallois cores.

6.7.2. Raw material units imported as dynamic objects (transformation section Do)

As can be seen in Table. 28, there are 70 dynamic objects in this assemblage, accounting for 32 RMUs. Levallois blanks are dominant, with only two by-products. However, they are tools (side scrapers). The majority of RMUs consist of two objects and on the rare occasion three. Binford (1979) wondered how these people made their gear. Did they manufacture them according to anticipated events in the future (Binford 1979:261)?

No variability can be observed among the dynamic objects, with a clear tendency toward gearing Levallois points. Indeed, 27 RMUs exhibit Levallois points (Fig. 123-124). This corresponds perfectly with the predominant and targeted end-products in assemblage 4, implying that the occupants manufactured mainly Levallois points, which might have served as pre-definite gear for specific activities or more specialization on a single subsistence strategy. It must also be mentioned that as long as they manufactured Levallois points to carry them during mobility and in order to meet their specific needs, they had enough time to organize their planned gear (Binford 1979). Accordingly, Levallois points were manufactured with prior knowledge of anticipated events in future conditions. Not only did the dynamic objects not show up any exotic raw material, they also present identical features with a second source of raw material. This may be interpreted as them having prior knowledge of the intensive distribution of the raw material in the region. They depended essentially on local material.

6.7.3. Raw material units imported as nodules (transformation sections N)

There are very few RMUs containing blanks derived from nodules in this assemblage. Only 9 RMUs, 3.8% of the total, contain cortical blanks representing the decortication stage of nodules (Fig. 118). 4 RMUs (transformation sections Np; 89, 90, 91, and 115) show only by-products with a high coverage of cortex without cores, and a single RMU (transformation section Npm; 92) includes by-products and a modification cortical flake. In addition, 4 RMUs (transformation sections Nbm 88, 93, 97, and 116) attest to the entire core reduction process, including modification. This implies that 5 RMUs were decorticated and reduced on-site, but their end-products were exported off-site. The other 4 RMUs were decorticated and reduced, and their end-products discarded, on-site.

As can be seen in Fig. 125, RMU 97 (transformation section Nbm) displays blanks of all the stages of core reduction, applied to a nodule that represents the decortication stage (first flake and cortical flakes) of Levallois blade production, and reinstallation of the flaking surface

in an advanced stage of core reduction (flaking surface preparation flake, naturally backed knife and striking platform preparation flake).

The cortical blanks show both high and low cortex coverage, indicating both early (first flake and cortical flakes) and advanced stages of core reduction (naturally backed knife) carried out on-site. In addition, the retouch was executed on Levallois blades. Furthermore, the Levallois blades and by-products show scar patterns of bidirectional Levallois method, both on the largest and the smallest blanks, suggesting that the nodule was only reduced by bidirectional Levallois method, from the first stage to discard. Blanks exhibit a maximum length and width of 86 × 51 mm respectively. This leads us to conclude that the original nodule size was small, suggesting a long sequence of core reduction relative to their small size.

RMU 92 (transformation section Npm) (Fig. 126) shows only the blanks of the core decortication stage. In addition, a single side scraper was retouched on a cortical blank. The cortical blanks were discarded while the core and the end-products were exported. This could imply that the nodule was imported to the site and then decorticated on-site in order to be exported. Another possibility is that it was reduced after decortication and both the core and the end-products were exported together as gear for contingencies. According to the scar patterns on the dorsal surface, they may have been removed by unidirectional parallel Levallois method. Although only few nodules were imported, they reflect the different human behaviours that may have been associated with the strategies of subsistence.

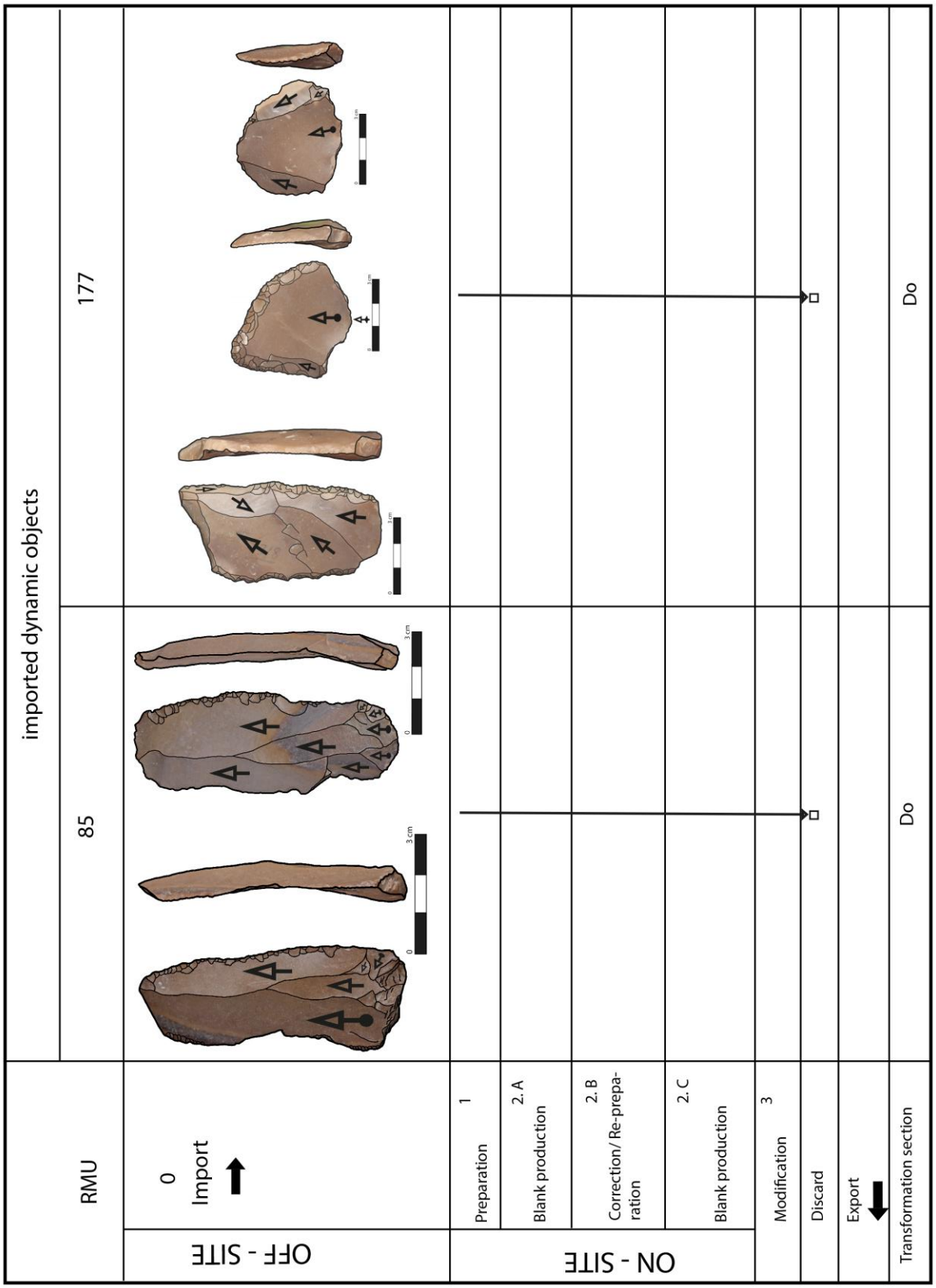


Fig. 123. Raw material units imported as dynamic objects.

Fig. 124. Raw material units imported as dynamic objects.

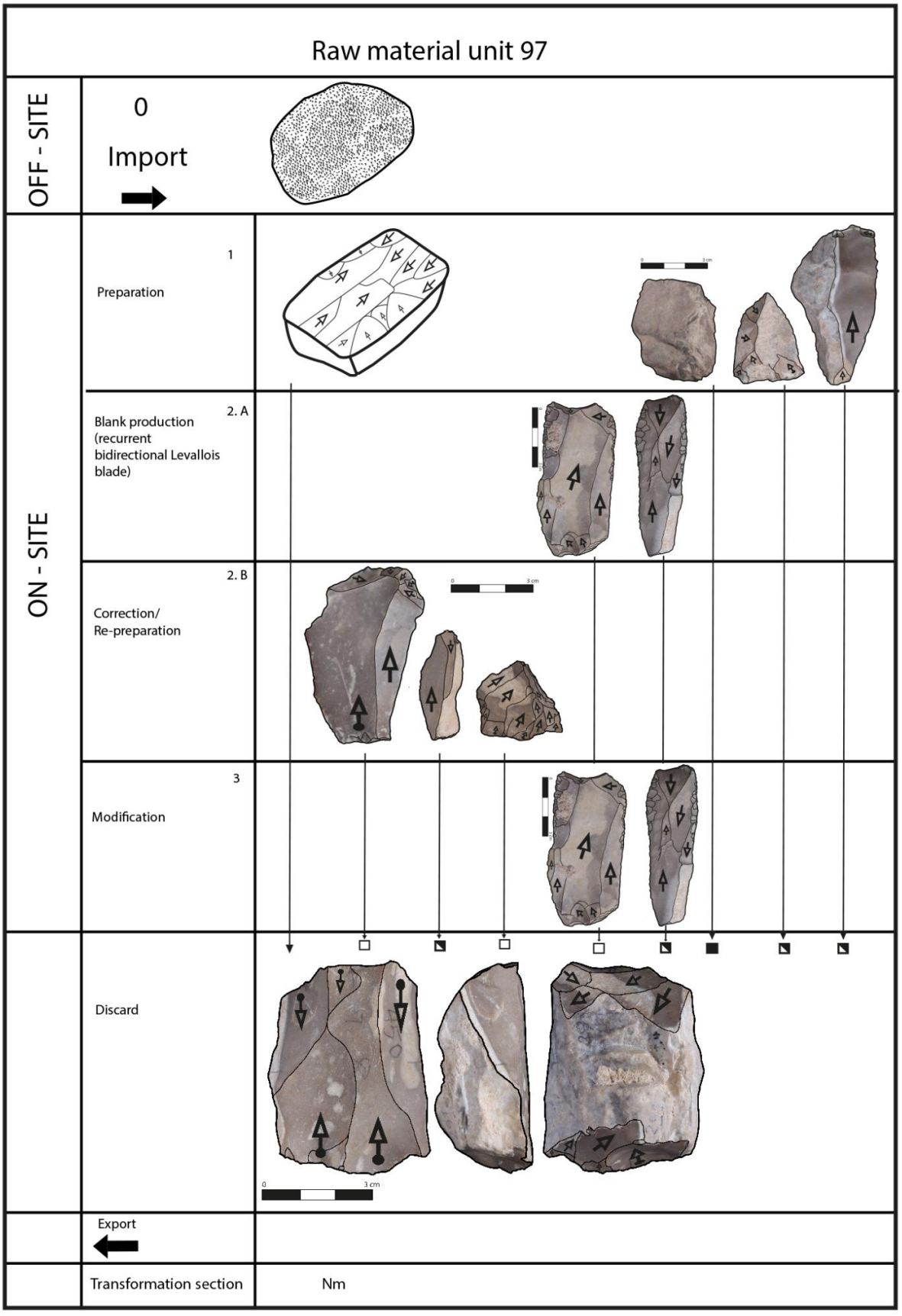


Fig. 125. Elements of imported raw material as nodule, including end-products discarded on-site.

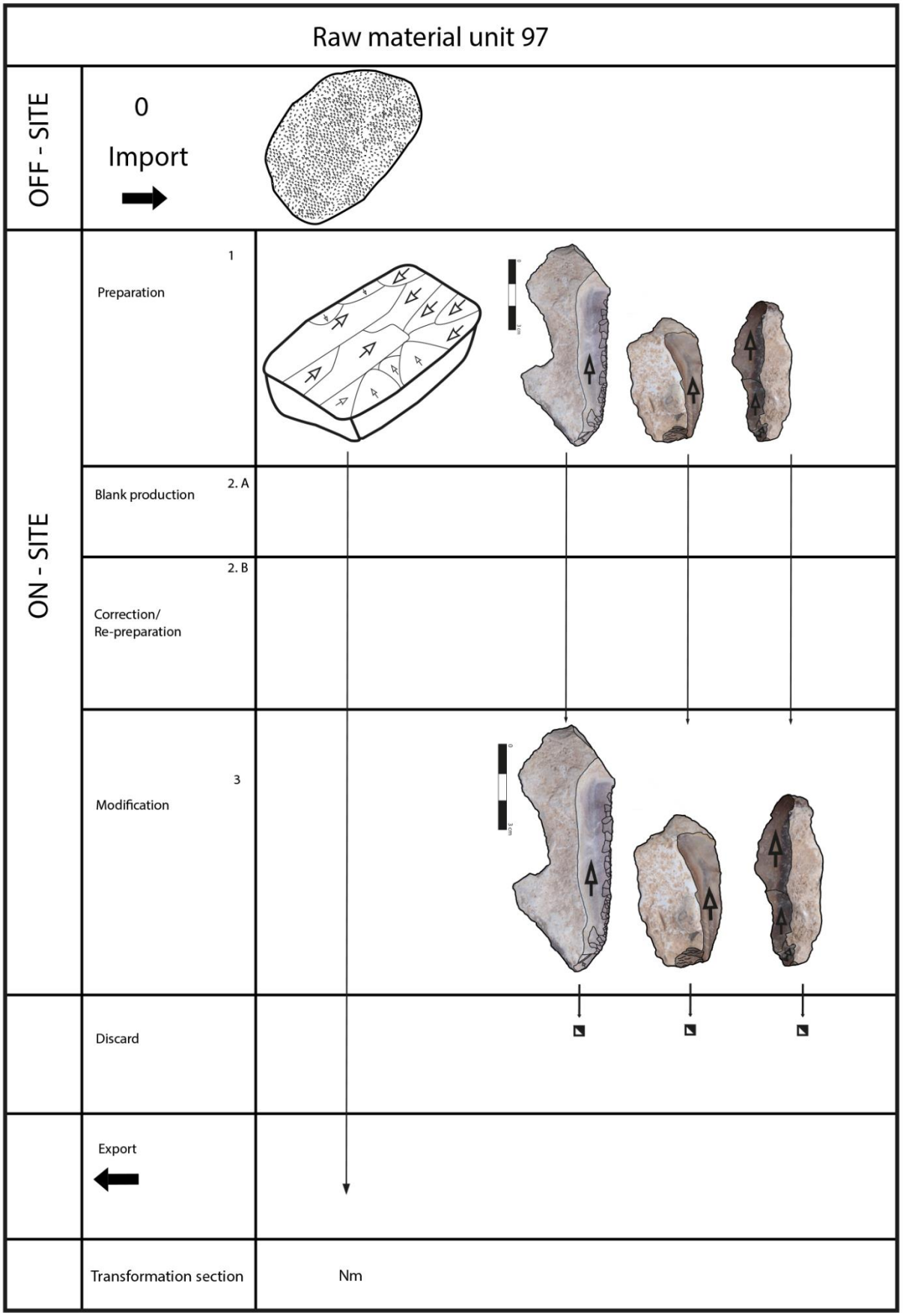


Fig. 126. Elements of imported raw material as nodule and their end-products exported with the core.

6.7.4. Raw material units imported as partially prepared cores (transformation sections C)

Table. 29 shows 138 RMUs that exhibit evidence of partially prepared cores that were imported to the site. Their contents display partial cortical blanks that are still covered by the residue of the fresh cortex (i.e. nodules processed prior to their transport to the site), reflect partial decortication of the core off-site. However, the vast majority of the RMUs lack the cores. This implies the presence of a raw material source near the site, located as a second position within 5 km. In addition, many factors refer to the reduction of these cores on-site: Firstly, the majority of these RMUs include categories of both end-products and by-products with core and without. Secondly, the morphometric diversity of both categories hint at the stages of core reduction. Thirdly, the variation in the amount of cortex, between 5 and 90% on most of the by-products, reflects variability in the degree of core decortication. Finally, the exhausted cores, in some RMUs, compared to the large debitage indicate core reduction on-site. Accordingly, it can be assumed that these cores underwent different degrees of decortication off-site and were then imported and reduced on-site.

Transformation section	**n**	**Raw material unit <u>with</u> core**	**Raw material unit <u>without</u> core**
Np	4		RMUs: 89, 90, 91, 115
Nm	4	RMUs: 97	RMUs: 88, 93, 97, 116
Npm	1		RMU: 92
Total	**9**	**1**	**8**
Cb	40	RMUs: 35, 41, 100, 135.	RMUs: 9, 14, 16, 20, 26, 28, 32, 35, 41, 49, 52, 54, 55, 61, 66, 67, 72, 73, 100, 104, 107, 110, 120, 122, 124, 126, 129, 130, 131, 132, 134, 135, 145, 148, 150, 152, 163, 171, 173, 175.
Cc	15	RMUs: 102, 168	RMUs: 3, 7, 11, 48, 57, 63, 73, 77, 102, 168, 169, 172, 174, 235, 238.
Cm	69	RMUs: 36, 37, 38, 40, 78, 98, 99, 136, 138, 147.	RMUs: 1, 4, 5, 6, 8, 10, 12, 13, 15, 17, 18, 21, 22, 23, 24, 25, 27, 29, 34, 36, 37, 38, 40, 47, 50, 51, 53, 56, 59, 60, 62, 64, 65, 70, 71, 74, 75, 76, 78, 98, 99, 105, 106, 108, 109, 111, 113, 114, 123, 125, 128, 132, 136, 138, 139, 146, 147, 149, 151, 154, 155, 156, 157, 161, 164, 165, 166, 170, 239
Ct (two methods)	7	RMUs: 46	RMUs: 42, 43, 44, 94, 95, 96
Total	**131**	**18**	**123**
Crf (Levallois core on flake)	7	RMUs: 2, 39, 79, 101, 133, 137, 167	0
Total	**7**	**7**	**0**

Table. 29. All of the raw material units imported as nodule and as partially prepared core, import of partially prepared core including raw material has objects of two different methods and raw material units include re-reducing local flakes.

A. Raw material unit as blank production from a core (transformation section Cb)

This category (transformation section Cb) is the second most frequent, accounting for 31.7% of all the RMUs imported as partially prepared cores. The frequency of Levallois blanks varies between them. Most RMUs, 53.8% of category Cb, include only a single end-product, while

43.5% contain two end-products. However, there are very few RMUs containing three end-products. It can therefore be assumed that the reduction sequence is mainly short, exhibiting low productivity, which might be related to the small size of cores.

RMUs 35 and 37 (Fig. 127) represent a strategy of importing prepared cores completely. RMU 35 contains two blanks and a core (Levallois point, a flaking surface preparation flake as well as recurrent unidirectional convergent Levallois core).

The three artefacts display unidirectional convergent scar patterns with cortical-free dorsal surfaces. Comparing the scar patterns on the blanks and the core, what was mentioned in subchapter 6.3.1 can be confirmed: the core has undergone two different types of flaking surface preparation. Based on a morphometric comparison between an almost complete nodule with only initial core preparation that was recovered from Solecki's excavations and measures 87 × 60 × 53 mm (Solecki, 2007), and the broken Levallois point and the core that measure 61 × 46 × 11 mm and 62 × 57 × 22 mm respectively, it can be presumed that the Levallois point might have been the third removal of the first flaking surface preparation. Consequently, this RMU might be clear evidence of importing full prepared cores to the site and reducing them there.

B. Raw material units as blank production from a core with subsequent modification (transformation section Cm)

This category is the most common, constituting 55.6% of all RMUs imported as partially prepared cores. They include one or more tools. RMU 4 is a clear instance of transformation sections Cm (Fig. 128). It exhibits end-products and by-products of unidirectional convergent Levallois method without core (i.e. three Levallois points, a cortical flake, and a naturally backed knife), two of the Levallois points are cortical. The sizes of both categories (i.e. end-products and by-products) and the distribution of cortex implies that the core was partially decorticated off-site, and all core reduction was executed on-site, and then the Levallois point was modified. Apparently, a partially prepared core was imported to the site at stage 0. The metrics and the diversity of cortex on the cortical blank demonstrate the preparation process—stage 1 of core reduction was carried out on-site. In addition, the sizes of blanks, an average of 67.7 × 41.5 × 7.7 mm, and amount of cortex on the Levallois blanks indicate it might have been removed immediately after the decortication stage, blank production 2.A. The naturally backed knife, measuring 58 × 33 × 8 mm, is evidence of the core correction stage due to its small size. Moreover, it bears plunging termination, which is part of distal core termination and refers to

an advanced stage of core reduction, perhaps the core correction phase 2.C. The variability of metrics and cortex of the blanks may indicate different stages of core reduction that have been carried out on-site. A single side scraper was retouched on a cortical flake and a Levallois point.

C. Raw material unit as correction of a core (transformation section Cc)

Transformation section Cc contains the lowest frequency of RMUs, only 12.1% of the total. While 4 RMUs show by-products accompanied with cores, the other 11 RMUs include only by-products without cores. This category is reflected well by RMU 7, which includes three naturally backed knives and a fragment (Fig. 129). The scar patterns of the three objects imply removal by the unidirectional convergent Levallois method. In the absence of end-products and their core, we can assume they have been exported off-site.

RMU 102 involves a core and a by-product (i.e. naturally backed knife) (Fig. 130). The backed knife bears unidirectional convergent scar patterns indicating flaking surface preparation of the unidirectional convergent Levallois method in the advanced stages.

The low number of these RMUs might indicate that the process of exporting end-products was not carried out frequently. The number of Levallois blanks seen in the majority of other RMUs support this assumption. However, if the size of the reduced cores is small, then the size of cores must have caused low productivity, and hence discarded Levallois blanks were used on-site and part of them were exported for off-site activities.

D. A split volume for executing two different Levallois methods (transformation section Cs)

RMU 46 was imported as a partially prepared core and has been struck by two different Levallois methods on-site. As can be seen in Fig. 131, different end-products were obtained from the same volume (i.e. Levallois point and blade). Since Levallois points can be obtained using different concepts (Boëda 1995), it might be assumed that both Levallois blanks were produced using the same method but at different stages of the core reduction due to the size differences or that they were removed using two different Levallois methods because of their different scar patterns (i.e. recurrent unidirectional convergent and bidirectional scar patterns methods). Since the discarded Levallois core and the blades show bidirectional scar patterns, this suggests that the Levallois point might have been produced at the first stage of core reduction by recurrent unidirectional convergent method. The Levallois blade was then obtained by applying the bidirectional Levallois method as the second strategy of core reduction. Since the Levallois point exhibits a plunging termination, this indicates that its

production invaded the whole flaking surface, reaching and removing a part of the core's distal section. Accordingly, the Levallois point should bear the same length as the core. It is, however, obviously smaller, at 46 × 32 × 9 mm, than the discarded bidirectional, measuring 55 × 47 × 17 mm. This implies that the Levallois point must have been obtained from a smaller core. Consequently, it can be assumed that the Levallois point was produced with the same raw material but from a different core. We can conclude that the volume was split up into two volumes and each Levallois method was applied to a different volume. This suggests flexibility among knappers in core reduction given that they were able to manipulate the available material with planned technological and morphological characteristics.

E. Raw material units including a debitage of two different Levallois methods (transformation section Ct)

E.1. Shifting from Levallois blade into Levallois point production

Interestingly, 5 RMUs contain debitage from two different Levallois methods. RMU 42, for instance, includes 5 stone artefacts (a Levallois blade, a naturally backed knife, two triangular Levallois flakes, including a broken one which is a composite tool, and a Levallois point) (Fig. 132). Their technological attributes can indicate two different Levallois methods. The triangular Levallois flake still exhibits bidirectional scar patterns, which is obvious evidence that the first method has been applied (for further explanation refer to subchapter 6.4.3).

F. Re-exploitation of thick and cortical discarded flakes (transformation section Crf)

6 raw material units (RMUs 2, 79, 101, 133, 137 and 167) exhibit Levallois methods applied to local thick flakes. Of them, 2 (RMUs 2 and 133) are initial Levallois cores on flakes. 6 raw materials units belong to transformation section Crfm, containing modified items (RMUs 2, 79, 101, 133, 137 and 240).

RMU 101 consists of cortical flakes and a preferential Levallois core (Fig. 133). Both flakes bear cortex that is limited to the edges. The location of the cortex demonstrates that the preferential Levallois core has been executed on a thick flake. Such by-products (i.e. a flake bears cortical plunging termination and a naturally backed knife) are not acquired as a by-product of the preferential Levallois method, but because the core is originally a thick flake, it is very common for naturally backed knives to appear.

This means that the core was not subject to frequent preceding preparation processes due to their small size. Thus, it produced a naturally backed knife and a cortical flake with plunging termination instead of core edge flakes. Regarding the discarded preferential

Levallois core, it is obvious that it was not subject to frequent preparation processes due as the cortex is still covering almost the entire lower surface, except for the striking platform, which has been intentionally selected as a striking platform given that it is the thickest part of the flake. This implies that a local flake was prepared on-site, phase 1, afterwards a Levallois flake was struck on-site, phase 2, then exported.

Otherwise, these RMUs can be a good indication that the occupants carried out various strategies of raw material acquisition. They made use of local material, even though the main source of raw material is located within 5 km. This poses the question of why they used small material even though material of good size was available within 5 km?

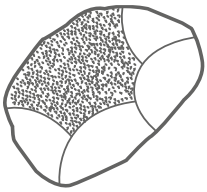
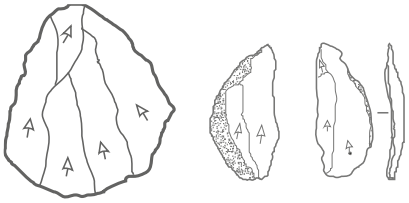
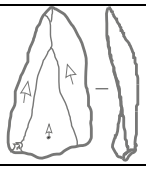
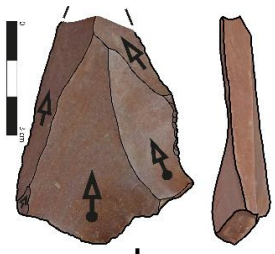
<table>
<tr><th colspan="3">Raw material unit 35</th></tr>
<tr><td>OFF-SITE</td><td colspan="2">0
Import →
</td></tr>
<tr><td rowspan="5">ON-SITE</td><td>Preparation 1</td><td></td></tr>
<tr><td>Blank production 2.A</td><td></td></tr>
<tr><td>Correction 2.B
Re-preparation</td><td></td></tr>
<tr><td>Blank production 2.C</td><td></td></tr>
<tr><td>Modification 3</td><td></td></tr>
<tr><td colspan="2">Discard</td><td></td></tr>
<tr><td colspan="2">Export ←</td><td></td></tr>
<tr><td colspan="2">Transformation section</td><td>Cb</td></tr>
</table>

Fig. 127. Raw material unit imported as partially prepared core (Cb) that was exploited by unidirectional convergent Levallois method.

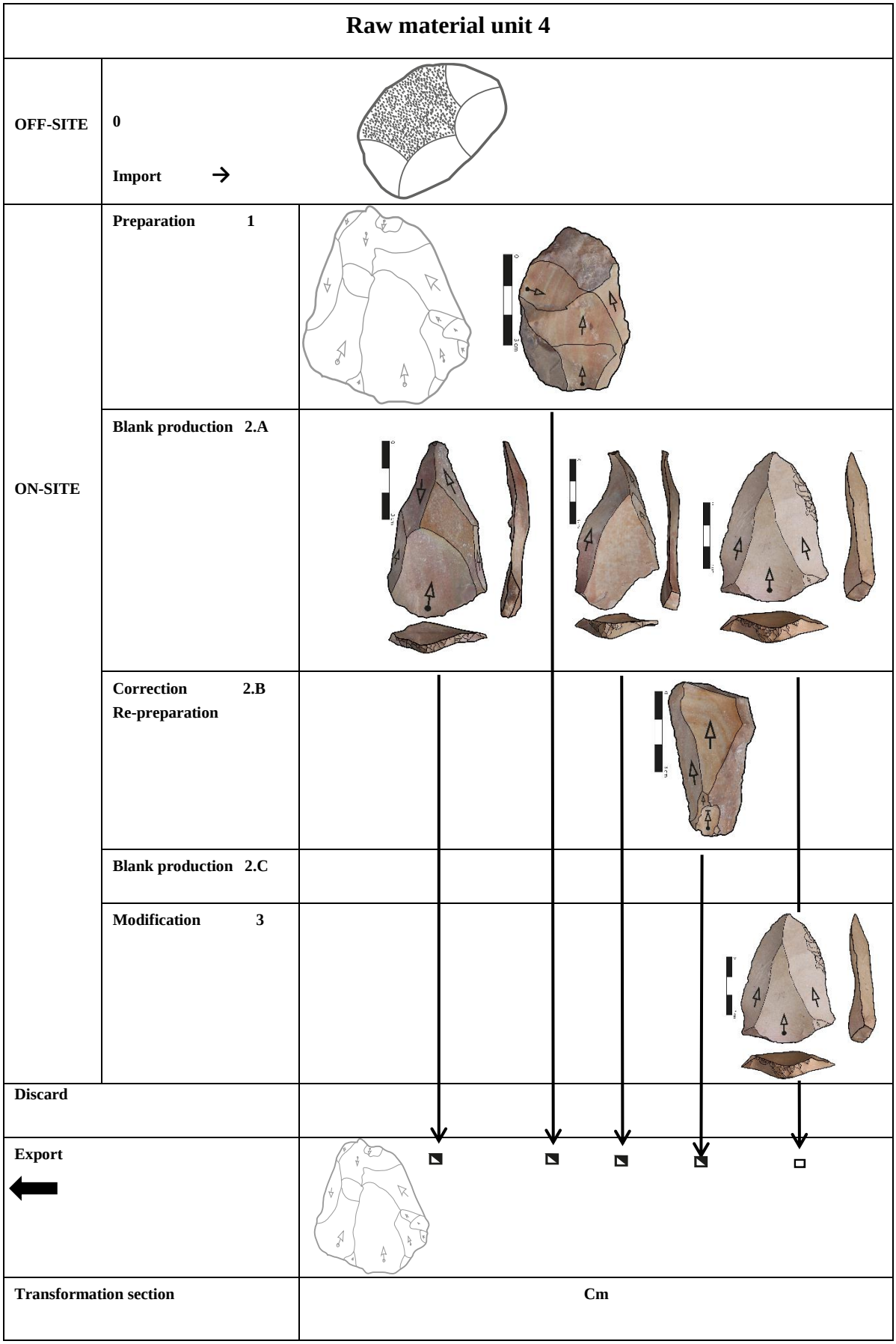


Fig. 128. Raw material unit imported as partially prepared core (Cm) and attests to all phases of the core reduction sequence.

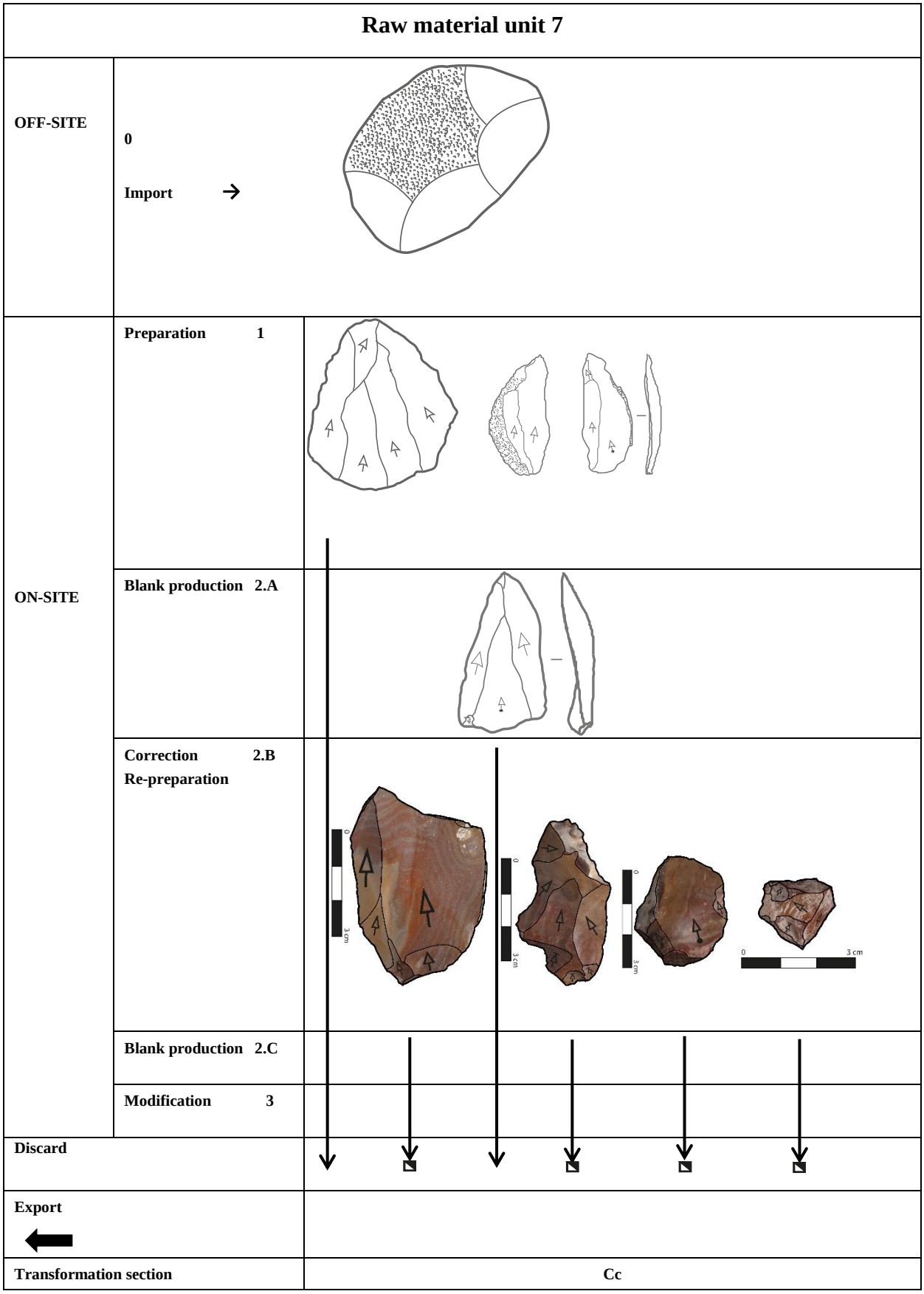


Fig. 129. Raw material unit imported as partially prepared core (Cc) showing only by-products. The core and its end-products have been exported.

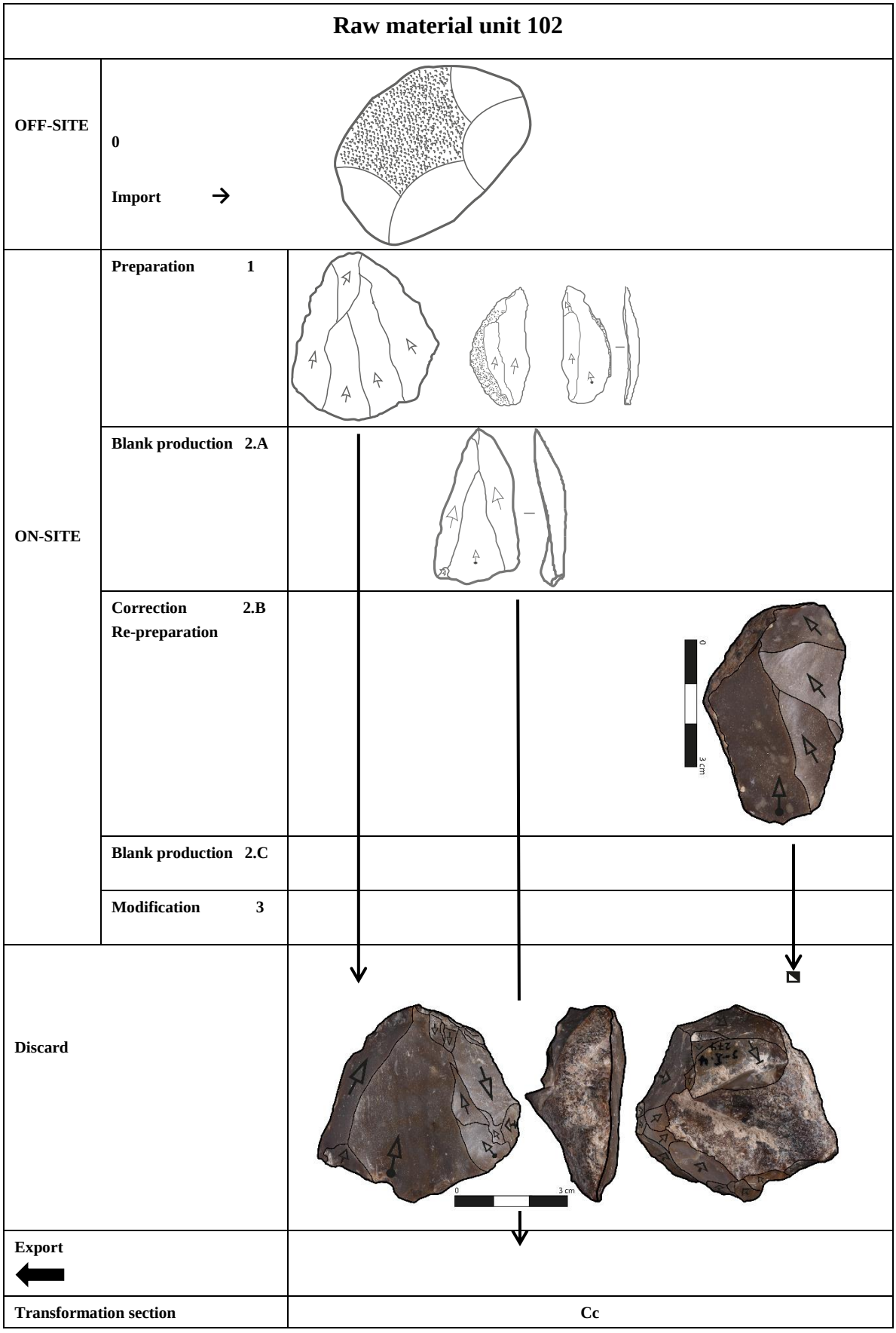


Fig. 130. Raw material unit imported as partially prepared core (Cc) showing only by-products. The core and its end-products have been exported.

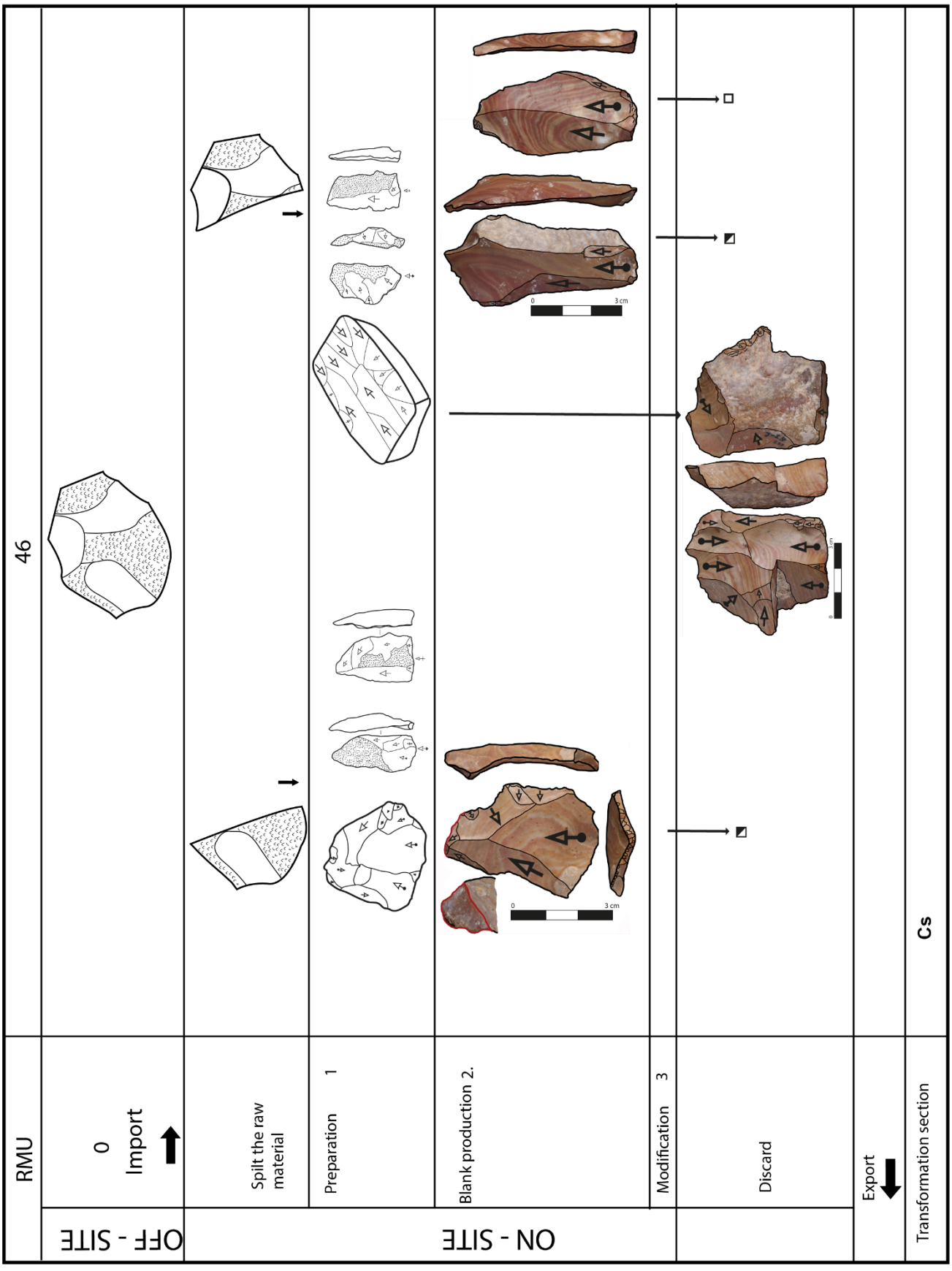


Fig. 131. Raw material unit includes imported partially prepared core (Cs) that was split into two volumes and reduced by two different Levallois methods.

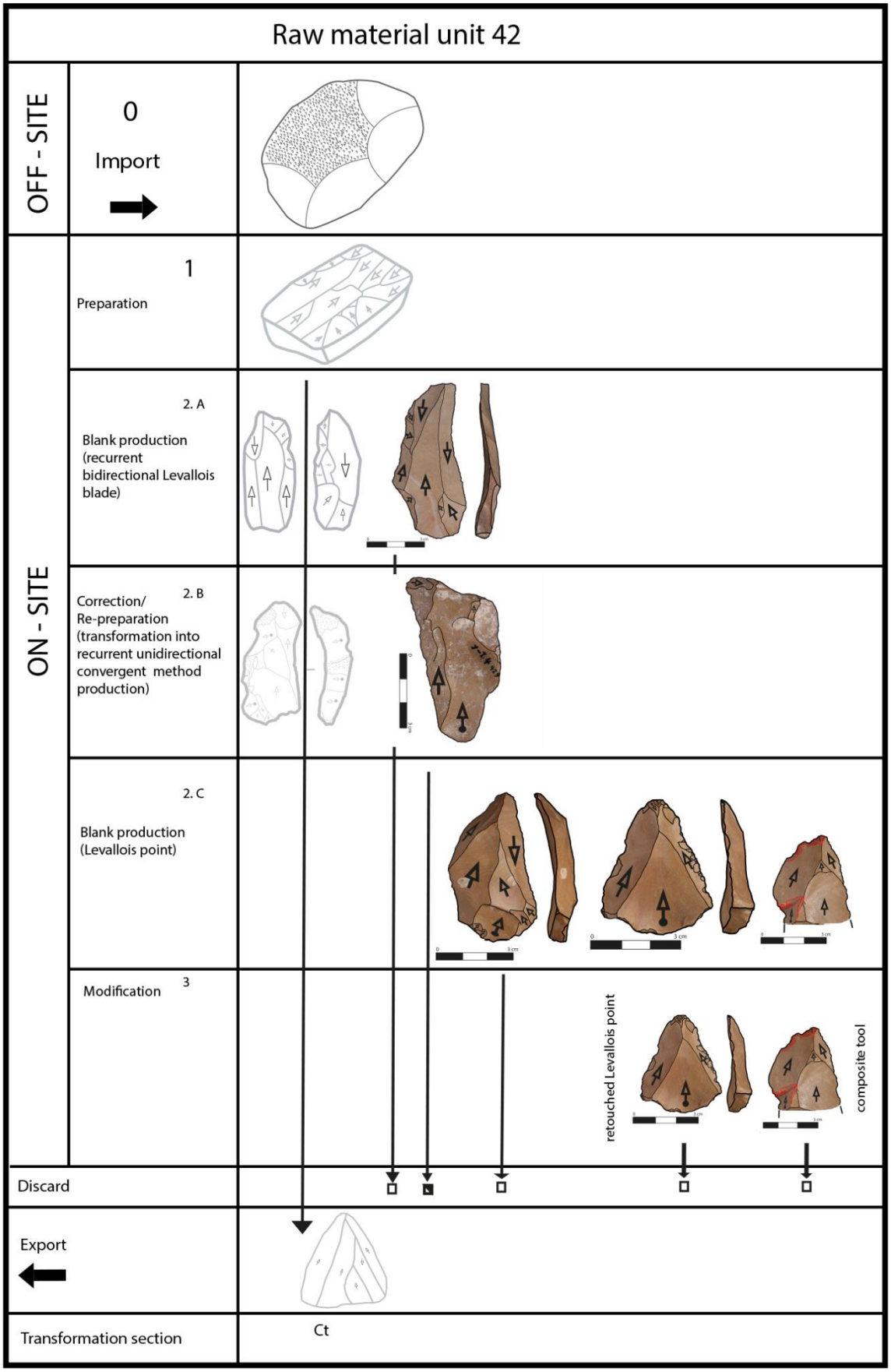

Raw material unit 42
OFF - SITE
0
Import
ON - SITE
1
Preparation
2. A
Blank production (recurrent bidirectional Levallois blade)
2. B
Correction/ Re-preparation (transformation into recurrent unidirectional convergent method production)
2. C
Blank production (Levallois point)
3
Modification
retouched Levallois point
composite tool
Discard
Export
Ct
Transformation section

Fig. 132. Application of two different Levallois methods on the same core (Ct).

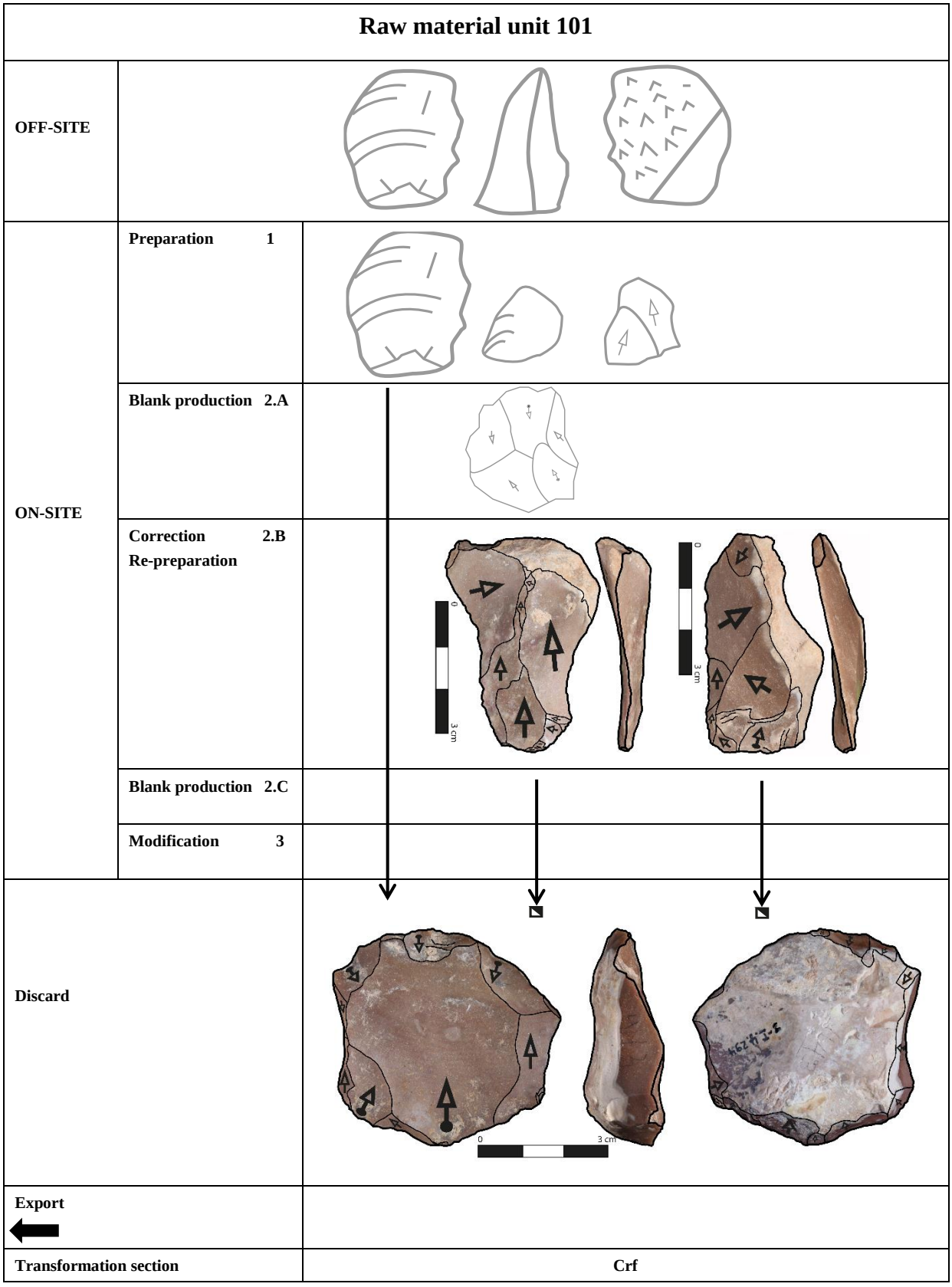


Fig. 133. Raw material unit including local thick flakes reduced and discarded on-site (Crf).

6.8. Reconstruction of recurrent occupation of the late Middle Palaeolithic task- specific site, assemblage 4 of Yabroud Shelter I

In the following, we will reconstruct the human behaviour in the late MP of assemblage 4, which reflected their mentality on strategies of raw material procurement and the noticeable adaptation to circumstance in order to fulfil their daily and future demands.

Several questions are posed. Was raw material procured by strategies embedded within some other strategies, and/or by intentional direct procurement? Did they procure old artefacts? Were lithics manufactured in anticipation of future activities or did they serve in parallel for on-site activities? Were the single and dynamic objects related to mobility and a specific pattern of land use?

All of the RMUs show a low number of artefacts, less than 10, which is an index of short reduction sequences. The reasons behind short reduction sequences may be the small size of the imported raw material, measuring 87 × 60 × 53 mm, as Solecki indicated (Solecki & Solecki 2007) or the importation of preforms that were not entirely reduced at one time in order to export and use them off-site. Another reason may be that part of the debitage was exported for off-site activities. The apparent diversity in the size of products (i.e. end-products and by-products) and cortex amount combined with the availability of core correction elements within the majority of raw material units may indicate short reduction sequences can be attributed to the small size of cores and the process of exporting Levallois blanks for off-site activities.

6.8.1. Low diversity of the lithic material

As opposed to assemblage 6, Pagli (2015; 164) indicated that assemblages 4 and 3 of YSI attested continuity in occupation by a single group of humans or several groups with the same knowledge base, given that these assemblages present technological continuity. In addition, she suggested the application of the hypothesis of settlement dynamics is in line with models of territorial behaviour proposed for late MP occupation in the southern coastal zone (Hovers 2001, 2009; Meignen et al. 2006), interpreting the absence of abrupt technological changes in sequences as a result of small territories and repeated use of the same sites. Assemblages[1] 5 and 6 of YSI exhibit completely different lithic industry (Fig. 134). In contrast, assemblage 4 shows a predominance of Levallois points and triangular flakes, representing 69% of all Levallois blanks. In addition, Levallois points and triangular flakes are dominant among the

[1] Lithic material of assemblage 5 is characterized by quadrangular and oval flake production predominantly. Levallois products are also very small, less than 6 cm (Pagli 2013, p 478). In turn, assemblage 6 exhibits that Levallois flakes and points were made in almost equal amounts at the expense of blade production.

personal gear, forming 70% of the total. The result of the Chi-squared test shows that there is not only no evidence of an association between the three assemblages, but, given the very low critical values[2], they are in fact extremely independent (Fig. 135).

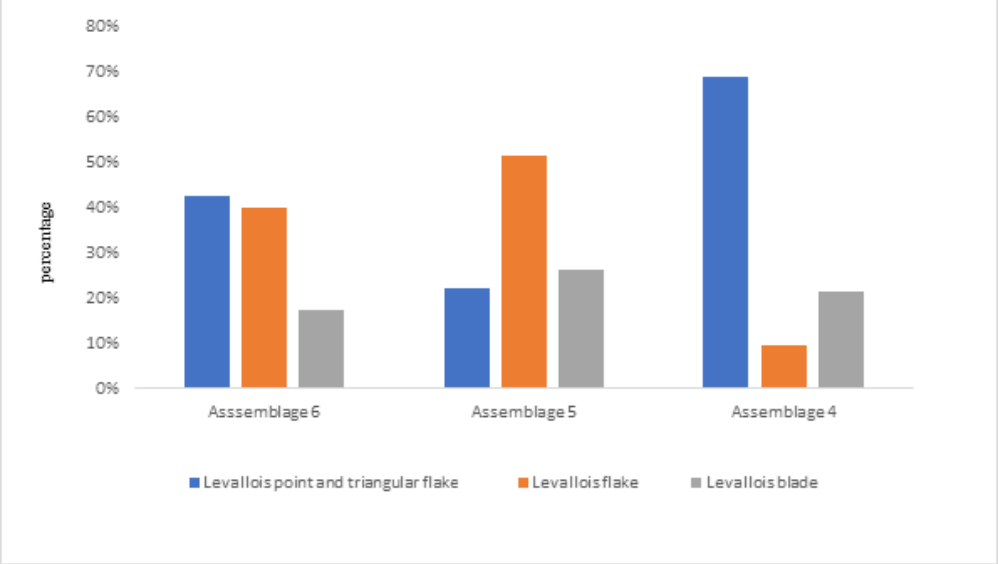


Fig. 134. Distribution of Levallois blanks from assemblages 6, 5 and 4.

Degrees of freedom (d.f.) = 2

	Assemblage 6	Assemblage 5	Assemblage 4	Assemblage 3	Assemblage 2
Assemblage 6	●	◇◇	◇◇		
Assemblage 5	◇◇	●	◇◇		
Assemblage 4	◇◇	◇◇	●	◇◇	◇◇
Assemblage 3			◇◇	●	◇◇
Assemblage 2				◇◇	●

Fig. 135. Result of Chi-square test, (◊ ◊) no evidence of an association, (◊) evidence of an association, (●) cannot be compared.

The clear shift in lithic industry towards the production of Levallois points and triangular flakes suggests that the tasks executed were mostly linked to Levallois point functions. The Simpson index of diversity gives a result of 0.47, a clear indication of the low

[2] For an association of at least 0.1%, the value should be less than 13.8.

diversity of the lithic industry, which might have produced during short-term occupations. Hauck (2013; 209) attributed the technological homogeneity that appeared to a reliance on the unidirectional-convergent flaking method to produce Levallois points in the upper HM-A1 industry and an increasing specialization on a single subsistence strategy. He concluded that the standardization of point production is related to efficiency and tool utility. Therefore, this assemblage looks like a task-specific site was occupied for specific activities or it might have resulted from more specialization on a single subsistence strategy.

Rust (1950) referred to the rear of YSI as the main occupied part of the shelter. Also, because of the spatial distribution of artefacts, he assumed that not all occupants lived in the same section. Solecki & Solecki (1966) later approved of Rust's assumption after investigating unexcavated sections, asserting that activities were limited at the rear part of the shelter. It is difficult to determine the function and time of occupation with a complete absence of faunal and botanical remains. However, this assemblage may have been occupied for short-term periods because of the low density of lithic material, and it was used for hunting equipment preparation that might have proceeded in the course of planned hunting events as weapon tips, as supported by the recovery of a point embedded in the 3rd cervical vertebra of a wild ass in the Umm el Tlel site in Syria (Boëda et al., 1999). According to the environmental data mentioned above (Dodonov et al. 2007; Schrøder et al. 2012), the assemblage might have been occupied during spring or summer seasons because of the fertile environment surrounding YSI and the harsh winter at the high elevation.

Henry (1995, 1998) identified 11 MP sites, including Tor Sabiha and Tor Faraj, at an elevation ranging from 280 to 1,400 m a.s.l in the highest (Ma'an Plateau and high piedmont) and lowest belts (Rift Valley) in the semi-arid region of southern Jordan. He demonstrated that the occupants of the area moved seasonally between lowlands and highlands. Consequently, A group of people may have occupied an area near YSI for a long-term period and visited assemblage 4 of YSI in a specific period of the year, where they made tools and planned hunting operations.

The diversity of retouch on Levallois points was measured using the Simpson index to specify whether retouch is limited to a certain part of Levallois points, which would suggest they served a specific function. The result of 0.87 is a clear indication of high diversity (Fig. 136). This may indicate that the essential purpose of Levallois point manufacture was for the creation of projectiles for hunting. Later they were retouched for various other functions. In fact, a great number of heavily modified dynamic objects (Fig. 137) are observed, forming 67%

of the total. This not only indicates high mobility, but also that the objects frequently met the different needs of hunter-gatherers.

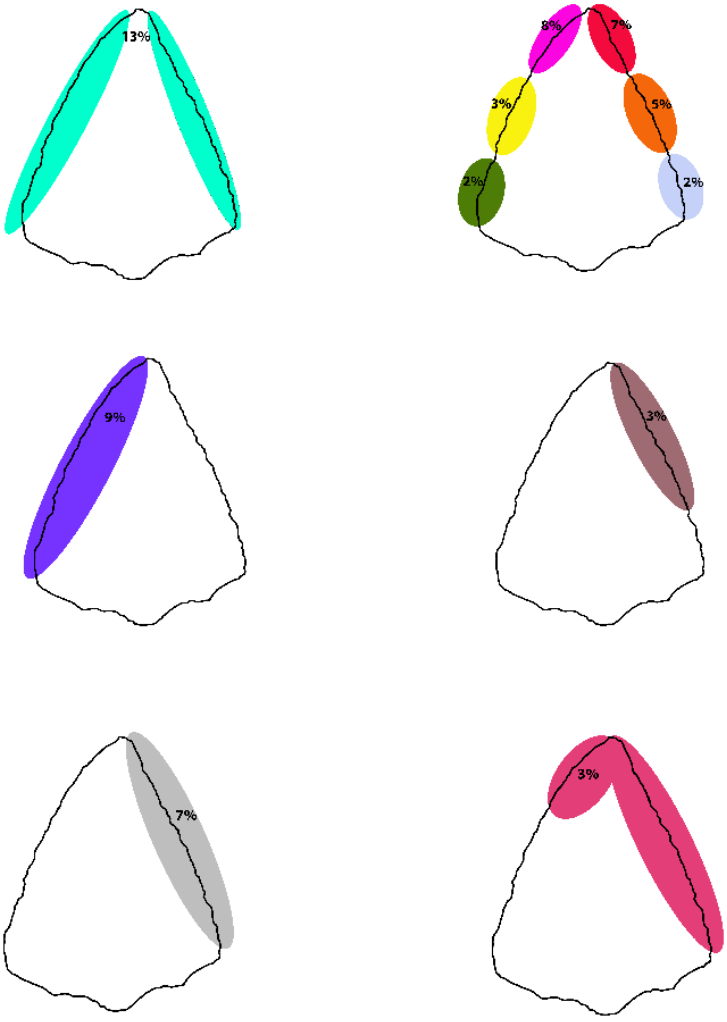


Fig. 136. Wide distribution of retouch on sections of a Levallois point.

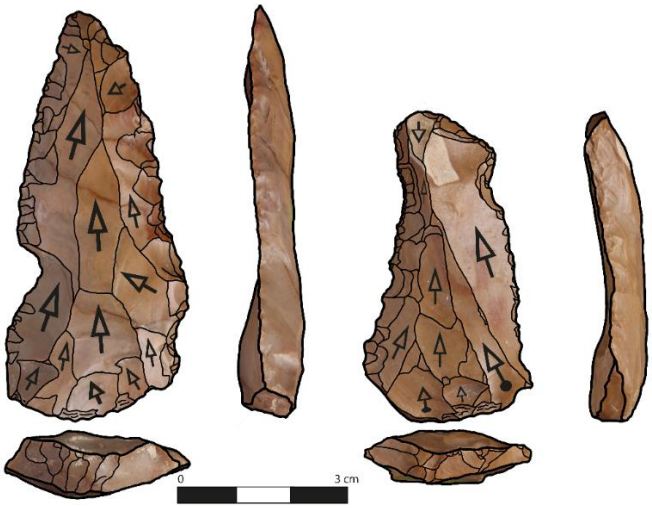


Fig. 137. Heavily retouched elongated Mousterian points.

6.8.2. Repeated occupation of the task-specific assemblage 4 of YSI

Lithic material presents several pieces of evidence of the repeated occupation of assemblage 4. However, was it occupied continuously or were there gaps between occupation episodes?

The reuse of old artefacts can be observed through the double patination, which appears on 8% of all end-products (Fig. 138). An elongated Levallois point, for example, shows a noticeably bigger size than the other artefacts, measuring 103 × 45 × 10 mm, with double patination. It is also a dynamic object. This suggests it may be related to an older event, was picked up, retouched for reuse and finally discarded. Secondly, the cognitive ability required for the reuse of old artefacts is exhibited in the systematically management of discarded Levallois cores by shifting to different Levallois method. The reduction of old cortical flakes, with intentionally setting the thickest section of the flake as a flaking surface, suggests the design of reduction strategies as tools of adaptation to the limitations of size and short-term occupation of the site. This deliberate, repetitive and very intelligent reduction of small discarded flakes to achieve specific tasks and the high ability to manipulate the available resources confirm behavioural adaptations to meet the needs of human groups. Finally, the thickness of assemblage 4 ranges between 20 and 30 cm according to Rust (1950), which cannot involve lithic material of a single event. Given the lithic material shows coarse-grained assemblage, it suggests a palimpsest of multiple and short occupations has been accumulated.

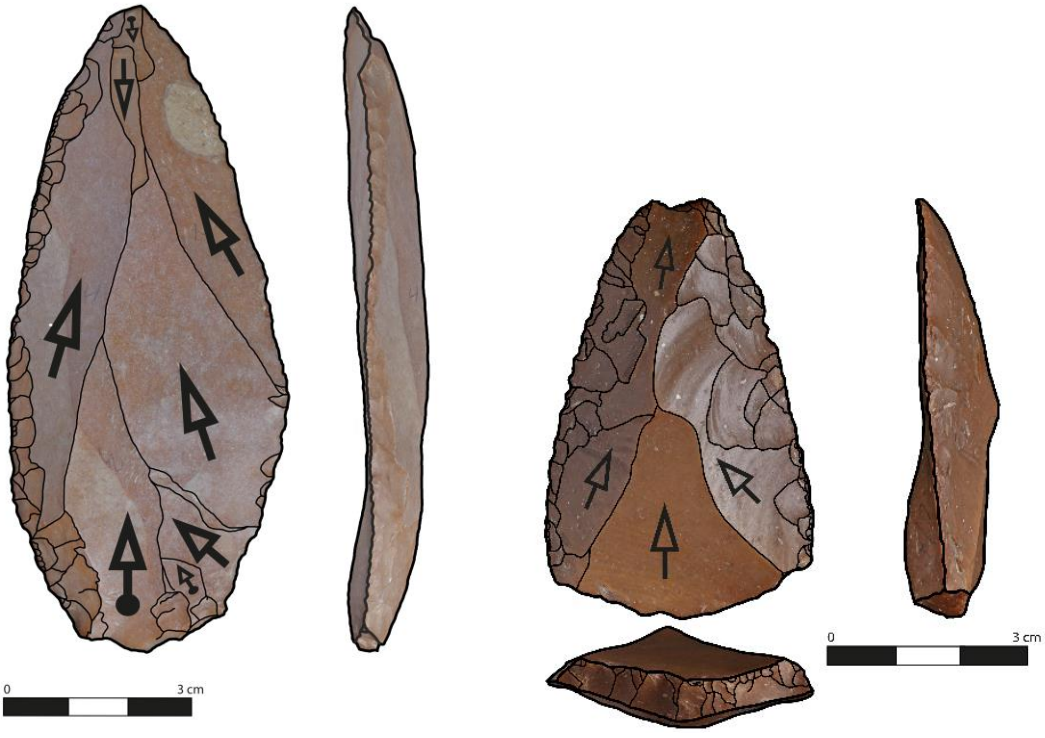


Fig. 138. Levallois points showing double patination.

It is difficult to identify whether these behavioural episodes occurred in the same period or if there were gaps between them. But given that only Levallois methods were executed, it can be concluded at least that the site was used by the same kind of human. In addition, double patination indicates there were gaps between occupation episodes.

Richter (2001; 212) made a distinction in G-Complex of Sesselfelsgrotte in southern Germany between four subsequent cycles, on the basis of the diversity of raw material in small assemblages (*Initialinventare*). He assumed that a group arrived in the region from elsewhere, having no prior knowledge of raw material resources. Larger assemblages, on the other hand, procured more specialized raw material confined to fewer resources (*Konsekutivinventare*) since they had a deeper knowledge of resources, having occupied the region for a long period. As a result of the Tübingen survey that shows a high distribution of MP sites in the Yabroud region, it can be assumed that human groups occupied location for long-term periods. This long-term occupation of the Yabroud area led to a deep knowledge of raw material distribution and the landscape, thus, the frequent occupation of assemblage 4. They organized their hunting trips in accordance with the location of YSI and what it presented in terms of potentials which helped them adapt to the surroundings. Consequently, assemblage 4 might have been a task-specific site which humans went to frequently as a result of prior knowledge of the area, located near to large congregations of animals attracted to nearby water during the spring.

6.8.3. High mobility

The lithic material of assemblage 4 of YSI suggests a total reliance on local raw material procurement without any evidence of exotic raw material. In addition, the dispersal of old local artefacts in the Yabroud area (i.e. hand axes, thick flakes, and discarded cores etc.) (Solecki & Solecki 2007; Conard et al. 2004; Dodonov et al. 2007), as well as the availability of raw material resources, represent adequate, permanent, and insured caches for frequent use of the site.

The high frequency of personal gear is evidence of high mobility. It has been carried frequently and regularly used off-site. Moreover, the quantity of personal gear that was made completely from local material also indicates that a residential base camp was situated elsewhere near YSI. The closeness of a residential base camp and the well-known location of YSI may have played an essential role to the lack of exotic raw material being carried. They used and reused local material.

According to Binford (1979), personal gear represents tools that are used regularly and distributed differentially within sites and in different patterns of association. Therefore, they are indicative of earlier planning, which always prepared for certain activities and the specific demands of tools connected to it. The high percentage of lithics derive from the "pockets" of the occupants, showing obvious planning for future demands (Richter 2005; 187; Kuhn 1995; Binford 1979). Torrence (1983) suggested that mobility imposes constraints on the quantitating artefacts by imposing carrying costs. Thus, he linked the increase in the number of artefacts, which must have met functional demands or requirements, to the increase in the ability to carry more artefacts. This assumption corresponds to cases in which hunter-gatherers carried out forays in areas devoid of or far away from raw material resources.

If we link the ability of hunter-gatherers to carry a quantity of personal gear to carrying costs, we should note that the hunter-gatherers of assemblage 4 did not go to the trouble of carrying and looking for raw material because they only used local material during their mobility. This indicates that their movements were confined to specific ranges within the region.

It is of no surprise that 67% of the personal gear is modified. As can be seen in Fig. 124 and 125, some tools exhibit a high degree of retouch, reaching the middle of the dorsal surface. This implies that some were repeatedly reshaped before going into the field. Another important point is that 14.2% of personal gear shows double patination (Fig. 125). This suggests the frequent use of the assemblage at different times and indicates the reuse of the discarded local blanks. Although micro-movements have been executed, the human groups could be highly mobile within the local area.

It has been proposed that a group of people may have occupied an area near Yabroud I for a long-term period and frequently used assemblage 4 as logistical site, having good prior knowledge of the region and thus local raw material distribution. They therefore never imported exotic raw material.

The Simpson index gives a result of around 0.38, indicating low diversity in personal gear. This suggests that personal gear was linked to specific activities or more specialization on a single subsistence. That these Levallois points are often carried might be a sign of high inter-site mobility, made for contingencies as well.

6.8.4. Strategies and circumstances of raw material procurement

Economisation in raw material procurement was a constantly applied strategy. The slight variability of RMUs and the techno-typological analysis of the lithic material of assemblage 4 allows us to derive two specific strategies of raw material procurement.

A. Direct strategy of raw material procurement

Since nodules were rarely procured, it seems that direct raw material procurement was a secondary strategy. Hunter-gatherers relied, basically, on importing partially prepared cores as well as the re-reduction of adequate local old artefacts (i.e. hand axes or thick flakes). Nodules therefore did not get as much attention in strategies of raw material procurement due to their dispersal in the vicinity within 5 km radius. The low number of nodules may be related to the purpose of carrying more load within trips to ensure subsistence, and this provisioning strategy was probably not a planned activity and it seems that displaced flint cobbles were collected whenever they were encountered.

B. Embedded strategy of raw material procurement

Several indices lead to the assumption that the main strategy of raw material procurement was embedded in basic subsistence schedules of hunter-gatherers. This can be simply read through the availability of raw material resources, which are situated in a 5 km radius, i.e. they are always within reach. In addition, the variability of RMUs and the techno-typological analysis indicate the reuse of old artefacts that were at hand. Actually, the repeated occupation of the well-known assemblage 4 and the specialized tools made for certain activities allow us to assume that raw material was procured according to technological requirements, correlated to the functions of Levallois points.

It is worth noting that the reuse of old artefacts did not appear as “cores on flakes”, which is the way they were observed in Levantine Palaeolithic sites, such as Hummal (Hauck 2013), Qafzeh cave (Hovers 2009) and Dederiyeh cave (Nishiaki et al. 2012). We can interpret this with Kuhn’s (1995; 21) theory that foragers dealt with their tools according to anticipated demands, depending on the conditions and contingencies they encountered. Therefore, the strategy of reusing old artefacts on-site occurred, when it corresponded to the technological requirements, despite the availability of raw material. This strategy appeared in various aspects and can be understood as another source of exploitable raw material. Evidence of these kinds of strategies includes the double patination observed on 8% of end-products.

As was elucidated above, the reuse of discarded Levallois products from older events indicates that blanks were procured from older event waste and remanufactured into tools. In addition, reflective and organised behaviour can be observed explicitly through 7 RMUs, which contain thick local flakes on which the Levallois method has been executed and another 7 RMUs that involve debitage of two different Levallois methods applied to the same core. This supports the idea of logical investment as opposed to more distant raw material procurement strategies.

6.8.5. Off versus on-site activities

While four nodules have been reduced and their products discarded on-site, another 5 RMUs include only cortical blanks, their core and end-products having been exported. Thus, it seems that they were reduced for off-site activities. In other words, they might have been prepared as personal equipment for contingencies/activities off-site.

Patou-Mathis (2006) analysed the faunal remains from Kabazi Level II/8. They concluded that primary butchering was undertaken on-site, while the elements of high nutritional value were exported to a residential camp nearby. Cores can be considered as the high lithic value of artefact production, so they were regularly being carried to be reduced off-site to meet urgent off-site needs. Thus, they can also be understood as elements of "high nutritional value" that were exported for off-site activities.

Among the lithic material of assemblage 4, transformation sections Cb and Cm are extremely dominant, beyond comparison with other transformation sections, particularly transformation section N. Consequently, partially prepared cores were imported to the site for blank production. Afterwards, the cores were mostly exported for off-site activities. Richter (2005; 191) called the subjects of this process of importing and exporting "migrant cores".

The interpretation that the absence of cores is due to their intentional dumping by Rust in order to reduce the weight of his load is unlikely, as Rust kept even the ugly indeterminate cores. Another theory, that their absence is a result of their deposition in other unexcavated areas, is also unlikely, since Solecki & Solecki excavated the other parts of the shelter, asserting that the rear part of the shelter is the section of occupation. Consequently, we must assume that a strategy of preform exportation has been carried out.

RMUs are related to various on- and off-site events. 41% of 'C' RMUs include end-products. This implies that activities were probably carried out on- site. Meanwhile, 51% of RMUs do not include cores, attesting to their exportation. Furthermore, while the importation

of cores together with the high representation of dynamic objects implies that other activities were carried out off-site, the high representation of discarded end-products asserts activities were also carried out on-site. Moreover, discarded broken tips (RMUs 2, 36, 99, 133, 147 and 235) support the execution of on-site activities. It can therefore be presumed that hunter-gatherers mostly used Levallois points for both on- and off-site activities.

Given that there are no traces of modification on-site (i.e. chips), the implication is that the modification processes have been executed off-site. The sediments have not been sieved, which could have proved the contrary. Imported modified tools confirm the strategy of importing these pieces as single objects.

Summary

The Yabroud region may have been a main dwelling area that hunter-gatherers occupied throughout the year. Given that the climate of the Yabroud was arid, hunter-gatherers may have moved around the region frequently. While they occupied lowland areas during cold seasons, they might have repeatedly moved to higher elevations during spring or early summer seasons. Especially, where the water tables and springs, with the contribution of the Wadi al Majarre from the south, allowed for the development of wooded areas around an oasis, with a favourable microclimate for animals and humans. As a result of the frequent occupation of YSI, experience was gained on the spatial distribution of raw material, hunting places and the best places to move through climate changes over the year. Consequently, assemblage 4 was a logistic site, frequently occupied for a specific task by a group of people occupying a base camp elsewhere in the Yabroud region for longer periods.

7. Comparative study of the late Middle Palaeolithic industry of assemblages 6 and assemblage 4, Yabroud shelter I

Based on the previous study of the techno-typological analysis of lithic material from assemblages 6 and 4, this comparative study aims to address the most similar and different techno-typological aspects observed in both assemblages. Many techno-typological aspects are similar in both assemblages, but they vary completely in other aspects. Both assemblages present lithic industry corresponding with the late MP industry in the Levant, evidenced clearly in the predominance of the recurrent Levallois method, particularly the unidirectional convergent flaking method, with a clear disparity in the targeted blanks between the assemblages.

7.1. Identifying the reduction techniques

Although assemblages 6 and 4 exhibit a clear behaviour of exploiting blocks and flakes, each presents a different tendency toward the use of each type of raw material (Fig. 139). The fact is that while the majority of the core reductions in assemblage 6 were executed on flakes, including Levallois methods, the core reductions in assemblage 4 were mainly applied on blocks. Furthermore, while Levallois methods are the only core reduction strategy applied in assemblage 4, Levallois methods and strategy of cores on flakes including *Nahr Ibrahim* Technique were applied in assemblage 6. In addition, the behaviour of knappers in assemblage 6 shows a clear strategy of utilizing the lower convex surface of Levallois cores in order to obtain the last removal before core discard. Both assemblages show direct evidence of reducing the Levallois method on flakes through the initial Levallois core.

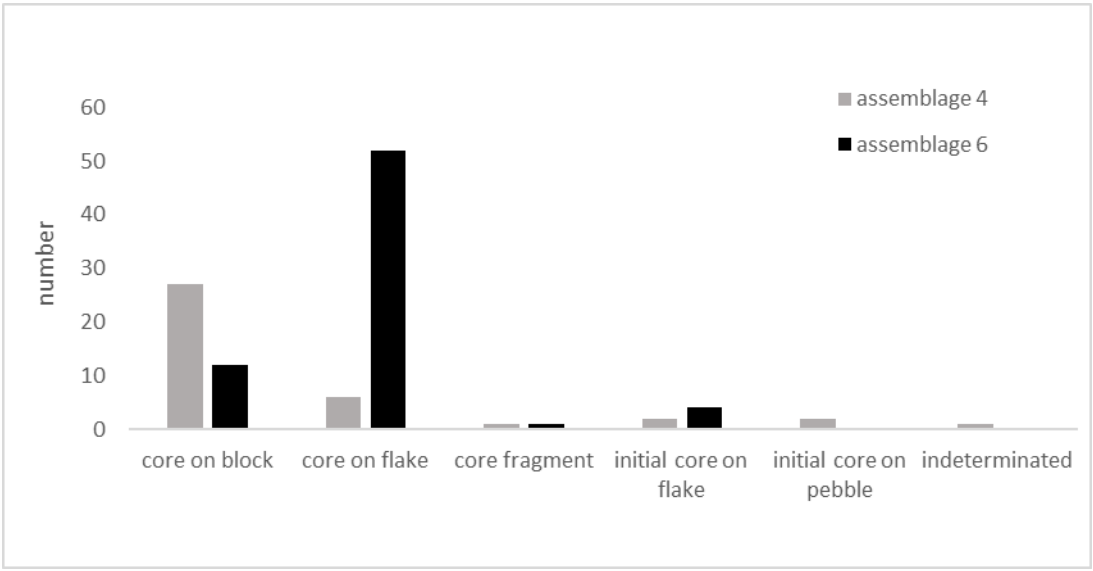


Fig. 139. Distribution of core reductions on types of raw material in assemblages 6 and 4.

Levallois methods were reduced in both assemblages, both on blocks and flakes with a priority of flake usage in assemblage 6. In addition, only assemblage 6 presents the strategy of cores on flakes, including the *Nahr Ibrahim* Technique that is not observed in assemblage 4 at all.

7.2.Levallois core reduction strategies

While assemblage 6 show clear variability in core reduction, no clear changes are observed in assemblage 4. In terms of the last stage of core reduction, the recurrent Levallois method is dominant in both assemblages, whereas the preferential method was barely exploited. Levallois cores for points are the most frequent cores in assemblage 4. The recurrent convergent Levallois method aimed at producing Levallois points and triangular flakes is most prevalent, followed by Levallois cores for flakes, with a priority of recurrent centripetal Levallois cores. Levallois cores for blades rarely exist. On the other hand, Levallois cores for flakes are the most frequent cores in assemblage 6, specifically the recurrent centripetal Levallois method, followed by Levallois cores for points, both recurrent unidirectional convergent and preferential method, with a priority of the former. Finally, Levallois cores for blades are the least discarded cores. Consequently, the similarities and differences can be seen through the following aspects:

- The predominance of the recurrent Levallois method was observed in both assemblages.
- Both assemblages show a similarity in the low number of Levallois cores reduced for blades.
- Both assemblages differ mainly in regard to the dominant discarded Levallois cores. While Levallois cores for points are predominant in the assemblage 4, Levallois cores for flakes are the most frequent core in the assemblage 6.

7.2.1. Levallois cores for points

A. Methods of producing the Levallois point

Levallois cores for points in assemblages 6 and 4 show more qualitative and quantitative differences than similarities. However, the unidirectional convergent Levallois method is the most reduced flaking method for Levallois point production in both assemblages. There are 6 unidirectional convergent cores and 3 preferential cores in assemblage 6, whereas unidirectional convergent cores are the only flaking method used in assemblage 4, accounting for 18 cores. The preponderance of the unidirectional convergent flaking method corresponds

with the predominance of Levallois points in assemblage 4, whereas the high number of Levallois points and triangular flakes do not correlate to the low number of Levallois cores for points in assemblage 6.

B. Unified versus random preparation of the flaking surface

Interestingly, the type of flaking surface preparation of convergent Levallois cores varies between both assemblages, despite the Levallois point being the targeted blank in each. In assemblage 4, discarded unidirectional convergent cores show a unified type of flaking surface preparation, relating mostly to the last stage of core reduction. Flaking surface preparation is limited to detaching small bidirectional and perpendicular removals from the core's distal termination and lateral edges to reinstall convexity. In contrast, unidirectional convergent cores have undergone random types of flaking surface preparation in assemblage 6. All of the unidirectional convergent cores exhibit preparatory bidirectional and perpendicular scar patterns on a single lateral section, either the right or left section of the flaking surface, whereas the other edge shows only elongated lateral removal. However, the scar patterns of Levallois points in assemblage 4, especially those large, do not correspond with those on discarded convergent cores. In contrast, scar patterns of Levallois point in assemblage 6 show some similarity to those seen on discarded convergent cores.

Consequently, flaking surface preparation may have been executed in order to shape the flaking surface according to specific requirements in assemblage 4, with the of retaining the greatest width at the base, allowing for the production of broad-based Levallois points. Flaking surface preparation in assemblage 6 is related to creating only spatial convexity without any systematic intentions to control the core's shape.

C. Size properties and discard of the cores

The LWR of unidirectional convergent cores displays a slightly higher value in assemblage 6 than their counterparts in assemblage 4 (Table. 30). This can be attributed to the reliance on flaking surface preparation to detach lateral removals that gave the core a slightly elongated shape, which effected the end-products. In contrast, the LWR of unidirectional convergent cores supports the production of short, broad-based Levallois points as a result of the execution of alternate types of flaking surface preparation. These types were applied alternatively by between detaching elongated lateral removals and bidirectional and/or perpendicular removals detached from the core's distal termination.

In addition, the mean size of cores in assemblage 6 is slightly higher than those in assemblage 4, because half of them lacked the thickness before they reached the size threshold for blank production that did not allow for further exploitation. As a consequence, the reasons for the core discard are slightly different between the two assemblages. While unidirectional convergent cores were discarded due to size limitations without showing any knapping accidents at all in assemblage 4, unidirectional convergent cores in assemblage 6 were abandoned because of 70% of them display deep hinge accidents and lack adequate thickness.

Assemblage	Levallois cores for points					Levallois cores for blades					Levallois cores for flakes				
	N.	Length mean mm	Width mean mm	Thickness mean mm	LWR	N.	Length mean mm	Width mean mm	Thickness mean mm	LWR	N.	Length mean mm	Width mean mm	Thickness mean mm	LWR
6	6	63.0	57.0	18.6	1.2	2	48.0	41.5	18.0	1.2	17	52.3	53.2	20.0	1.0
4	18	48.0	46.0	20.0	1.0	5	49.0	42.0	20.0	1.1	9	51.0	47.0	20.0	1.0

Table. 30. The dimension of Levallois cores and the LWR show slight elongation of the Levallois cores for points and blades.

7.2.2. Levallois cores for blades

Levallois cores for blades are the least discarded cores in both assemblages. There are only two in assemblage 6, whereas they are more frequent (5 cores) in assemblage 4. The quantity of Levallois blades does not correspond with the number of their discarded cores in either assemblage.

A. Methods of producing Levallois blades

Each assemblage presents a different amount of Levallois cores for blades, with a greater number in assemblage 4. In addition, the cores in assemblage 4 are varied including unidirectional parallel and bidirectional Levallois cores. Assemblage 6, on the other hand, shows a unified Levallois method for blade production, the unidirectional parallel flaking method. Consequently, quantity and quality vary between both assemblages.

B. Installation of flaking surface convexity

The last scar patterns on Levallois cores for blades show different types of flaking surface preparation. While flaking surfaces in assemblage 6 were reinstalled by detaching small semi-centripetal preparation removals, stemming from the distal termination and a single lateral edge, they were mostly prepared simultaneously with Levallois blade production in assemblage 4. A series of blades were removed from the entire flaking surface, including the lateral edges of the core. Consequently, the type of flaking surface preparation according to the last removal also varies between the two assemblages.

C. Size properties and discard of the cores

Levallois cores for blades show small size properties in both assemblages (Table. 30). While cores for blades were discarded for different reasons in assemblage 4, either due to reaching the size threshold for blank production or the flaking surface show knapping accidents, a single reason caused the discard of cores in assemblage 6: the fact that striking platforms lacked adequate thickness given they were applied to flakes, and hence did not allow for further exploitation.

Consequently, according to low number of the discarded Levallois core for blades, Levallois blades were not the main desired end-products in either assemblage.

7.2.3. Levallois cores for flakes

Both preferential and centripetal Levallois cores were used in both assemblages in order to obtain Levallois flakes. However, these cores are the most frequent in assemblage 6 (17 cores), whereas they are much less frequent in assemblage 4 (7 cores). However, the clear frequency of Levallois cores for flakes in assemblage 6 does not correlate with the high frequency of unidirectional convergent scar patterns and high number of Levallois points and triangular flakes.

A. Methods of producing Levallois flakes

Preferential cores were executed on flakes in assemblage 4, but were mainly reduced on blocks in assemblages 6, except for high representation of cores on flakes and the *Nahr Ibrahim* technique. In contrast, the tendency towards executing centripetal cores on flakes is much more evident in assemblage 6.

B. Installation of flaking surface convexity

Preferential cores executed on flakes exhibit common characters in both assemblages, specifically the distribution of thicknesses and scar patterns. The cores suggest that knappers intentionally selected the thickest part of flakes to be used as striking platforms since the distal termination of Levallois blanks is always quite thin and relates to a feather termination and do not need adequate thickness. Thus, the distal part of the core can not be as thick as the proximal part that is the striking platform. Given that cortex covers almost the entire lower surface of preferential cores, reaching 90% coverage, and there is a scarcity of their end-products, suggests the short life of the preferential core on flake in both assemblages.

Furthermore, the centripetal cores in both assemblages exhibit the same method of reduction, through setting either continuous or discontinuous striking platforms. The convexity of flaking surface was simultaneously re-installed with Levallois blank production. In addition, the intensity of scar patterns relates to the number of striking platforms in both assemblages. In other words, the more striking platforms, the more scar patterns the flaking surface exhibits. Consequently, the same behaviour in both assemblages is observed as following:

- The thickest part of the exploited flakes was intentionally selected to be set up as a striking platform either in assemblage 4 (i.e. Levallois core applied on flake) or in assemblage 6 (i.e. both Levallois core on flake and *Nahr Ibrahim* Technique).
- Exploitation of the centripetal Levallois cores either by continuous or discontinuous striking platform.
- The convexity of flaking surface of centripetal Levallois core was re-installed simultaneously with Levallois flake production.
- Preferential Levallois cores were exploited on flakes.

C. Size properties and discard of the cores

In both assemblages the majority of Levallois cores for flakes were discarded due to their small size, especially in terms of thickness, followed by knapping accidents on the flaking surfaces. Accordingly, Levallois cores for flakes exhibit a similar mean size, reaching the size threshold for blank production.

7.3.Initial Levallois cores

As mentioned previously, the evidence of Levallois core reduction on flakes is clear in both assemblages, but is much more frequent in assemblage 6. The appearance of the initial Levallois cores supports the clear tendency towards the exploitation of discarded flakes. Interestingly, both assemblages display cortical flakes with scar patterns on the ventral and dorsal surfaces, which aimed to install flaking surface convexity. Furthermore, the ventral surface of the cortical flakes was set up as the flaking surface in both assemblages because they are cortex-free surfaces that help to economize the raw material. Moreover, these initial Levallois cores and the exhausted and discarded Levallois cores have almost the same mean size. Once knappers initiated flake reduction, they recognized that they could not be exploited due to size limitations. They therefore discarded the flakes that still carry the initial criteria of the Levallois concept.

7.4.Cores on flakes strategy

The strategy of cores on flakes and *Nahr Ibrahim* technique were not observed in assemblage 4. Furthermore, initial Levallois cores seem upon first inspection to be cores on flakes, as they have been classified by other researchers (Pagli 2013). However, their technological characters are identical with the characters of the initial stage of the Levallois concept. Moreover, the exploitation of many Levallois cores on thick flakes supports the clear tendency of knappers toward reusing discarded cortical flakes.

In contrast, the cores on flakes and *Nahr Ibrahim* technique were clearly observed in assemblage 6, especially the *Nahr Ibrahim* technique. Their number is greater than Levallois cores in assemblage 6, and they exhibit a common aspect, in both *Nahr Ibrahim* technique and cores on flakes, of the thickest part of the flake being devoted as the striking platform in order to remove the secondary flake. Furthermore, they were used mainly to produce flakes, rarely for blade production, and never for point production.

Application of criteria of Levallois concept of *Nahr Ibrahim* Technique, theoretically, led to conclude that both strategies show the same criteria of exploitation. Or at least, they are is interlinked behaviorally with unidirectional Levallois reduction.

7.5.Summary

7.5.1. Characteristics confined to the lithic industry of assemblage 6

A. Exploitation of the lower surface of Levallois cores

Shifting from exploiting the flaking surface to the lower surface of the core represents the last removal before discard of Levallois cores. Interestingly, this phenomenon is closely linked to the proper and ready convexity of the lower surface for exploitation, instead of the flat flaking surface of the exhausted core. However, this phenomenon was only observed on Levallois cores of assemblage 6, specifically the Levallois core reduced on blocks. It mirrors rapid response to needs, whether carried out by the knapper who started the core reduction, or by another group of people that occupied the assemblage later and picked up the discarded core and removed one or two flakes from the proper lower surface.

B. Exploitation of discarded bifaces

According to Solecki & Solecki (2007), the raw material used in YSI was not large, and two samples of different sized nodules were discovered from the excavation. One sample is an initially prepared core measuring 87 × 60 × 53 mm. This resembles the largest Levallois blanks

in assemblage 6. Therefore, I think the size of the biface would not be smaller than a prepared core. The exploitation of the bifaces might have been very common, as two tips of bifaces were observed in assemblage 6 combined with Levallois debitage that belong to the same raw material as the tips. Moreover, a biface was observed among the lithic material of assemblage 3 of YSI that might have been imported for exploitation.

C. Cores on flakes and *Nahr Ibrahim* technique

As mentioned above, the strategies of core on flake and *Nahr Ibrahim* technique were frequently employed in assemblage 6. Furthermore, no tendency to the selection of a specific blank to re-reduce was observed, both Levallois blanks and by-products were used. More specifically, the thickest part of selected blanks was exploited. In contrast, core on flakes and *Nahr Ibrahim* technique were not recognized in assemblage 4 at all.

7.5.2. The technological aspects most common to the lithic material in both assemblages

A. Frequent reduction of the recurrent Levallois flaking method

Although the recurrent Levallois flaking method is the most frequent in both assemblages, assemblage 6 is characterized by the predominance of discarded recurrent centripetal method whereas assemblage 4 is distinguished by the preponderance of discarded unidirectional convergent method. However, the predominance of the recurrent Levallois method in both assemblages is a feature common to most late MP Levantine sites, particularly centripetal Levallois cores and unidirectional convergent Levallois cores.

B. Method of Levallois flake production

According to the discarded cores for flakes, although there is a disparity in the number of centripetal cores executed in each, with a greater number in assemblage 6, these cores were struck with the same method, either with continuous or discontinuous striking platforms. Furthermore, the implications can be seen in the number and size of the negatives of the removals on the flaking surface. Therefore, the greater the number of striking platforms, the smaller and the greater the number of removals and *vice versa*. Another point is that Levallois cores for blades are the least frequent core in both assemblages.

C. Maximum benefit of Levallois cores

The mean size of discarded Levallois cores suggests that knappers in both assemblages took maximum benefit from the cores. Furthermore, the discarded Levallois cores that still exhibit adequate size for exploitation show quite logical reasons for discarding them, in particular, a

lack of adequate thickness combined with hinge knapping accidents on the flaking surface. If the knapper had repaired and prepared the flaking surface of a thin Levallois core, it would no longer have sufficient size for exploitation.

D. Initial Levallois cores

Interestingly, discarded cortical flakes were exploited using recurrent or preferential Levallois methods in both assemblages. Furthermore, the initial Levallois cores mirror the same behaviour, whether by the same group of people or different groups, represented by the selection of thick blanks, the attempted installation of convexity on the ventral surface and finally the discard of the blank due to size limitations.

7.5.3. The clearest technologically differences between assemblages 6 and 4

A. The predominance of different Levallois methods

Each assemblage is characterised by the preponderance of a different Levallois flaking method. While centripetal cores are the most frequent in assemblage 6, unidirectional convergent cores prevail in assemblage 4. Interestingly, as will be mentioned below, despite the predominance of centripetal cores in assemblage 6, unidirectional convergent scar patterns are the most frequent. This can be explained as due to the exploitation of centripetal cores in the second phase of core reduction. The majority of Levallois cores for points were therefore shifted to Levallois cores for flakes in the last stage of core reduction.

B. Method of Levallois point production

Both unidirectional convergent and preferential Levallois cores were reduced to obtain Levallois points in assemblage 6. However, only unidirectional convergent Levallois cores were used to produce Levallois points in assemblage 4. Nonetheless, unidirectional convergent cores are still the most frequent method applied in assemblage 6. Furthermore, the type of flaking surface preparation of unidirectional convergent cores suggests different purposes in each assemblage. While knappers endeavoured to maintain the greatest width at the base of the convergent core in assemblage 4, preparation of the convergent cores was confined to convexity reinstallation, either by detaching small removals of specific parts of the core according to the condition of the convexity or by elongated lateral removals, in assemblage 6, giving the cores and products elongated shapes.

C. Slight disparity of the Levallois cores for blades

Taking into account that discarded Levallois cores represent the last stage of core reduction, and that they might have been changeable during the reduction sequence, Levallois cores for blades are the least frequent in both assemblages. Both unidirectional parallel and bidirectional flaking method were executed in assemblage 4, whereas it seems that only the unidirectional parallel flaking method was exploited in assemblage 6.

7.6.Strategies of blank production

The techno-typological analyses of the cores and debitage, supported by transformation analyses, led to the formation of clear knowledge about the variability of Levallois blank production strategies in both assemblages (Fig. 139.1). In other words, although the Levallois concept was applied in both assemblages, clear variability, on the one hand, can be seen in the frequency of end-products. On the other, analogous technological behaviour of exploitation is observed in technological aspects.

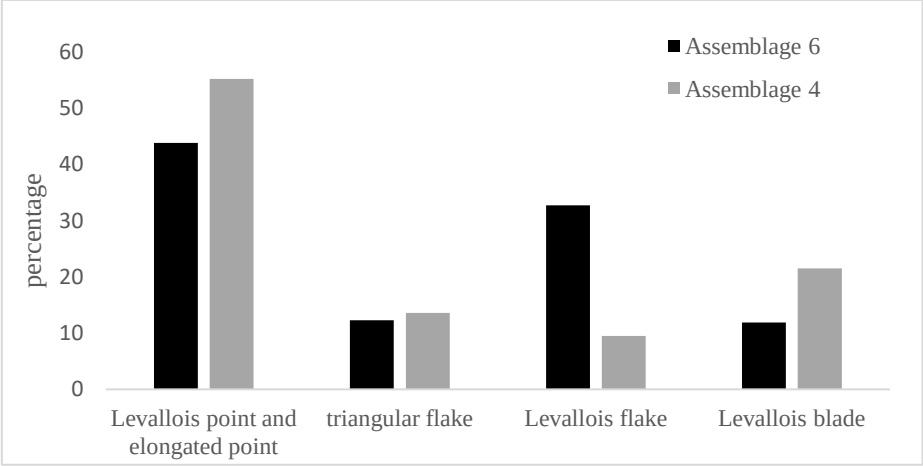


Fig. 139.1. Distribution of Levallois blanks identified in assemblages 6 and 4 of YSI.

7.6.1. Strategy of Levallois point production

Although the recurrent unidirectional convergent and preferential methods were applied to obtain Levallois points, the former flaking method is still the most frequent method in assemblage 6. On the other hand, the unidirectional convergent Levallois method was the only flaking method applied in assemblage 4. Furthermore, while Levallois points are the main target of core reduction in assemblage 4, accounting for 55.2% of all Levallois blanks (190 points, elongated or not) excluding triangular flakes, they appeared to be the main target alongside Levallois flakes in assemblage 6, accounting for 43.8% of the total Levallois blanks (103 points, elongated or not) excluding triangular flakes.

Levallois points were struck from different reduction sequences in both assemblages. The vast majority of Levallois points were basically produced from an individual reduction sequence. However, some evidence appears to indicate that many Levallois points were a result of a single reduction sequence for point, elongated point and blade production and/or a double strategy of core reduction.

A. An individual reduction sequence for Levallois point production

The individual reduction sequence for Levallois point production, in which the flaking surface was prepared and specialized to only produce Levallois points from the initial stage of core reduction to core discard, is the most frequent sequence in both assemblages. Furthermore, the flaking surface preparation for the individual reduction sequence varied in each assemblage, affecting the techno-typological features of the Levallois points produced.

Assemblage 4

Levallois point production underwent a systematic strategy by applying alternative types of flaking surface preparation. The preparation process saw an alternation between detaching elongated lateral and bidirectional/perpendicular removals (Table. 21). The aim of these preparation types was to maintain the greatest width at the base of the core and prevent core elongation in order to gain broad-based Levallois points (Fig. 94) corresponding to characteristic of the lithic industry of the late MP in the Levant. In addition, the scar patterns on the largest Levallois points (elongated or not) confirm that the flaking surface was mainly prepared by detaching elongated lateral removals in the earlier stages of core reduction, helping to obtain elongated points as well. When the flaking surface began to take on an elongated shape, the knappers shifted to detaching preparatory bidirectional and perpendicular removals from the cores' distal termination that kept a suitable width to length ratio of the core. This shifting in flaking surface preparation and the exclusive use of unidirectional convergent flaking method helped knappers to obtain short, broad-based Levallois points that are more standardised in shape and size. Therefore, it is quite logical to find the vast majority of constructed Levallois points, 74.3% of the total, have the greatest width at their base (see LWR ratio in Table 26).

Assemblage 6

As opposed to assemblage 4, flaking surface preparation for Levallois point production was unsystematic and does not exhibit a long-term goal in assemblage 6. In other words, convexity was re-installed according to the condition of the flaking surface, alternating between detaching

elongated lateral removals and spatial bidirectional/perpendicular removals from the core's distal termination, mostly confined to either the left or right section of the core. This unsystematic preparation accordingly resulted in Levallois points that show the greatest width at different places on points and not exclusively at the base, forming 67.3% of all Levallois points. In addition, the frequent preparation by detaching elongated lateral removals gave Levallois points a slightly elongated shape (see LWR ratio in Table 31). This variability cannot be attributed to different functions. Rather, it might have related to the knappers' skills.

B. A single reduction sequence for Levallois point, elongated point and Levallois blade production

Although the LWR of Levallois cores for points does not indicate that they are responsible for producing the elongated points, the predominance of unidirectional convergent scar patterns combined with the large size of elongated points and Levallois blades compared to Levallois points in both assemblages suggests that elongated points were removed from an early stage of core reduction for Levallois point production. The flaking surface was exploited by a unidirectional parallel-convergent scar patterns that helped to provide the core with the appropriate elongation for producing elongated points. Afterwards, when the size of the core started to decrease, the same unidirectional scar patterns were slightly reorganised to be more convergent in order to initiate the flaking surface for exploiting broad-based Levallois points. Or by detaching small bidirectional and perpendicular removals from core' distal termination and lateral edges that helped to balance the length to width ratio. The existence of this process can be supported by the absence of cores that can be responsible for their production.

Assemblage	Core and point	No.	Length mean mm	Width mean mm	Thickness mean mm	LWR
6	Elongated points	35	69.0	29.6	7.2	2.4
	Levallois cores for points (Unidirectional convergent)	6	63.0	53.0	18.6	1.2
4	Elongated points	30	64.2	29.3	8.3	2.2
	Levallois cores for points (Unidirectional convergent)	18	48.0	46.0	20.0	1.0

Table. 31. A slight difference in the length to width ratio of elongated points and Levallois cores for points between assemblage 6 and 4.

However, as can be seen in Table. 31 elongated points are slightly more frequent in assemblage 6 and more elongated than their counterparts in assemblage 4, evident in the slight difference

in LWR of both elongated points and Levallois cores for points. The difference resulted from the predominance of preparing the convergent cores in assemblage 6 by laterally elongated removals.

C. Double strategy of core reduction

C.1. Standardization of Levallois point production from the second phase of the double strategy of core reduction in assemblage 4

According to the transformation analyses, 7 RMUs exhibit debitage of double strategy of core reduction. Levallois points were mainly produced from the second phase of core reduction. Interestingly, this strategy was not widely executed. In addition, it was observed that the double strategy of core reduction was carried out in order to obtain Levallois blades at the first phase of core reduction by unidirectional parallel/bidirectional Levallois flaking methods, investing the large size of the core. Afterwards, the flaking surface was probably shifted into a triangular shape by detaching elongated lateral removals (naturally backed knives/core edge flakes) or by detaching small bidirectional and perpendicular removals from the core's distal termination in order to reshape the core for Levallois point production. All double strategies of core reduction were executed in order to obtain exclusively Levallois blades from the first phases, and mainly Levallois points from the second phase, except, for a single double strategy of core reduction that was carried out to obtain Levallois flakes from the second phase of core reduction.

C.2. Standardization of Levallois flake production from the second stage of double strategy of core reduction in assemblage 6

The double strategy of core reduction was observed on 8 RMUs in assemblage 6. As opposed to assemblage 4, the double strategies of core reduction were not restricted to the production of Levallois blades from the first phase and Levallois points from the second phase. While all double strategies aimed at Levallois flake production from the second phase, the first phase of core reduction was either for the production of Levallois blades or Levallois points, with predominance of Levallois blade production. The only exception was a single double strategy applied to produce Levallois blades from the first phase. Afterwards, the core reduction was shifted to Levallois point production.

Consequently, despite the different aims of the double strategy of core reduction in assemblages 6 and 4, they share a clear joint feature in the aim of producing Levallois blades as the first phase.

7.6.2. Strategy of Levallois flake production

Although Levallois flakes are qualitatively similar in both assemblages, they show a clear quantitative difference in favour of assemblage 6. Levallois flakes were the most produced end-products in the assemblage 6 beside Levallois points. Whereas they are the least frequent end-products in assemblage 4, where Levallois points are dominant, followed by Levallois blades.

A. Paucity of application of an individual reduction sequence for Levallois flake production in assemblage 4

In the point-bearing assemblage 4, Levallois flakes are the least frequently obtained blank, numbering 33. It is quite normal to recognise common triangular flakes bearing convergent scar patterns that were probably by-products of point production and were derived from unidirectional convergent cores. They form 10.1% of all Levallois blanks. Non-triangular Levallois flakes constitute 9.5% of all Levallois blanks. However, almost half of them show unidirectional convergent scar patterns, whereas the other half exhibit semi-centripetal, centripetal, and perpendicular scar patterns.

The small size of non-triangular flakes bearing non-unidirectional convergent scar patterns, with a mean of 49.7 × 35.3 × 7.5 mm, prompts three assumptions:

- It can be assumed that Levallois flakes were rarely produced from an individual reduction sequence. Core edge flakes show a smaller mean size than their counterparts in the assemblage 6. Therefore, they were rarely struck from an individual reduction sequence.
- The centripetal and preferential Levallois methods might have been mainly reduced on flakes. Thus, inadequate thickness might have contributed to the low level of productivity.
- Production of Levallois flakes might have been limited to the last stage of the core reduction before discard since Levallois points were the main targeted products.

As opposed to assemblage 4, Levallois flakes are the second most obtained blanks in assemblage 6, numbering 77. However, both assemblages show joint core reduction strategies at some points and differ in others. The differences can be seen through individual reduction sequences being applied in assemblage 6, whereas evidence of them is quite rarely observed in assemblage 4. The relatively gradual sizes of Levallois flakes in assemblage 6 also suggests application of the individual reduction sequence.

B. Predominance of Levallois flake production from a double strategy of core reduction in assemblage 6

Interestingly, Levallois flakes were mainly produced from the second phase of a double strategy of core reduction in assemblage 6. The predominance of small Levallois flakes, compared to the high number of Levallois cores for flakes, combined with the scarcity of large Levallois flakes can be a sign that the majority were produced at the last stage of core reduction, and rarely started from the first stage and continued to the core discard stage. In addition, the large mean size of naturally backed knives at the expense of the small size of core edge flakes confirms that the application of both centripetal and preferential methods started in the advanced stage of core reduction or may have been applied to small cortical flakes.

Consequently, Levallois flakes were mainly produced from the second phase of a double strategy of core reduction in assemblage 6. On the other hand, it is difficult to assume that Levallois flakes were obtained from the second phase of the double strategy of core reduction in assemblage 4 due to the low number of samples.

7.6.3. Strategy of Levallois blade production

While Levallois blades are the least frequent end-product in assemblage 6, accounting for 12.1% of the total, they are the second most abundant blanks after Levallois points in assemblage 4 constituting 21.5% of the total. Despite the clear quantitative difference between the assemblages, the strategy of their production shows similar aspects, being obtained from different phases of the core reduction sequence as following:

A. Paucity versus high frequency of the individual reduction sequence for Levallois blade production

On the basis of the volumetric properties of the Levallois blades in assemblages 6 and 4 (Fig. 140) and the transformation analysis, it turns out that the individual reduction sequence for Levallois blade production was carried out more frequently in assemblage 4 than in assemblage 6. Although Levallois blades in assemblage 4 show a small mean size, they clearly display various sizes, reflecting the different sizes of the core along the stages of core reduction. In contrast, the vast majority of Levallois blades in assemblage 6 are relatively large, implying they have been produced from the first phase of core reduction. The exceptions are a few Levallois blades that may have resulted from an individual reduction sequence, though rarely applied, and a few others that may have been removed from a flaking surface for point production because they show unidirectional convergent scar patterns.

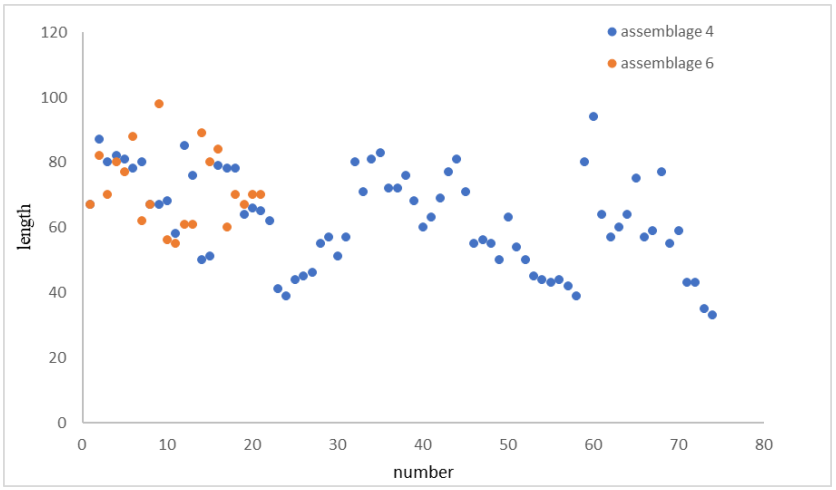


Fig. 140. Disparity in length of Levallois blades between assemblages 6 and 4.

B. A single reduction sequences for blade and point (including elongated) production

Levallois blades bearing unidirectional convergent scar patterns are present in both assemblage 6 and 4, making up 27.5% and 39.1% of all blades respectively. This may indicate that these Levallois blades were part of a flaking surface for Levallois point production. They are therefore clearly more frequent in assemblage 4 given that it is a point-bearing assemblage. In contrast, they are only a few pieces in assemblage 6. Furthermore, the mean sizes of Levallois blades bearing unidirectional convergent scar patterns (Table. 32) in both assemblage 6 and 4 are very close to the mean sizes of Levallois points, which are 58.4 × 37.8 × 6.3 mm and 56.5 × 36.8 × 7.7 mm respectively.

Moreover, the flaking surface preparation type of detaching elongated lateral removals, which gave the core its elongated shape, was carried out in both assemblages, particularly in assemblage 6. Levallois blades and elongated point were frequently obtained in this way.

	assemblage 6		**assemblage 4**		**length mean in mm**		**width mean in mm**		**thickness mean in mm**	
	N.	%	N.	%	assemblage 6	assemblage 4	assemblage 6	assemblage 4	assemblage 6	assemblage 4
uni-convergent	8	27.5	29	39.1	60.8	61.8	27.5	25.0	6.8	7.1
uni-parallel	17	58.6	33	44.5	70.1	65.3	27.2	27.2	8.0	7.4
bidirectional	4	13.7	12	16.2	70.5	58.3	28.7	23.6	7.7	6.2

Table. 32. The relationship between scar patterns and the size of Levallois blades.

C. Double strategy of core reduction for Levallois blade production

The double strategy of core reduction for Levallois blade production was carried out in both assemblages. Interestingly, Levallois blade production was confined to the first strategy of core reduction in both assemblages, with more evidence of it in assemblage 6. While Levallois points were the main target of the second phase in assemblage 4, Levallois flakes and/or points were the obtained end-products from the second phase of core reduction in assemblage 6, with the predominance of the former.

Consequently, the tendency towards producing Levallois blades at the first phase of core reduction can be attributed to investing in the large core size in order to obtain Levallois blades that bear the size of the prepared core.

According to the explicit evidence of the implementation of a double strategy of core reduction, it appears it was widely applied in the Levant. It is a common trait recognized particularly during the late Mousterian in the Levant. In Far'ah II, for instance, the execution of the last stage of reduction of both non-Levallois (blade cores and discoidal technique) and Levallois flaking (Hovers 1998; Goren-Inbar 1990) was observed, based on core morphologies and scar patterns. Although Levallois cores with unidirectional scar pattern represent over half of the discarded cores in units XI-IX of Kebara Cave, with priority to convergent scar patterns, a high frequency of cores with centripetal scar patterns were recorded. In addition, while products bearing unidirectional scar patterns attest to recurrent methods, other flakes with preferential scar patterns indicate a shift from recurrent convergent method to preferential method at the end stage of core reduction (Bar-Yosef et al. 1992).

7.7. Tools

The number of tools differs between the assemblages, with more recorded in assemblage 4 (Fig. 141). Despite all the various types of modification in both assemblages, retouch is the most frequent type of modification. Retouch executed on a single edge is predominant in both assemblages. The reverse retouch was rarely executed in either assemblage, which is a general feature of assemblages of this period. Reverse retouch distributed to different parts of tools. However, it was mostly on the uppermost part of tools, mainly Levallois points, in assemblages 4. In contrast, although executed on various parts, most retouch was oriented toward the lowermost parts of tools, mostly flakes, in assemblage 6. Consequently, diversity can even be seen in reserve retouch in assemblage 6, while showing more standardisation in assemblage 4.

Although modification was mainly executed on Levallois blanks (Fig. 141), by-products were also modified in both assemblages, as long as the targeted purpose could be achieved. Furthermore, by-products that bear an area where the hand can be placed without injury have been clearly selected in both assemblages. This can be seen in the vast majority of selected by-products being naturally backed knives, core edge flakes, and cortical flakes. This may reflect the intentional selection of pieces bearing a back to facilitate handling of the tool.

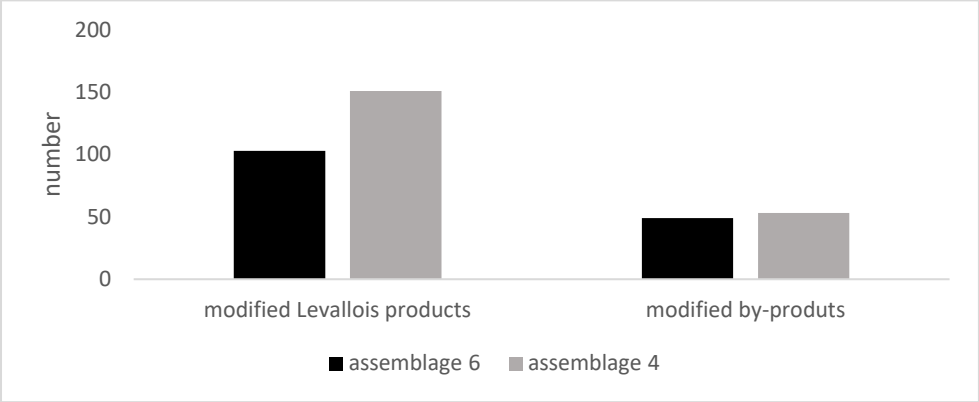


Fig. 141. Modifications executed on end-products and by-products of both assemblages.

The **Mousterian group (Group II),** including partially retouched products, is dominant in both assemblages. However, the most interesting observation is that while elongated Mousterian points and Mousterian points were clear crafted in assemblage 4, they are almost absent in assemblage 6 (Fig. 142), especially elongated Mousterian points. This may be associated with the orientation of assemblage 4 toward the exclusive use of Levallois points.

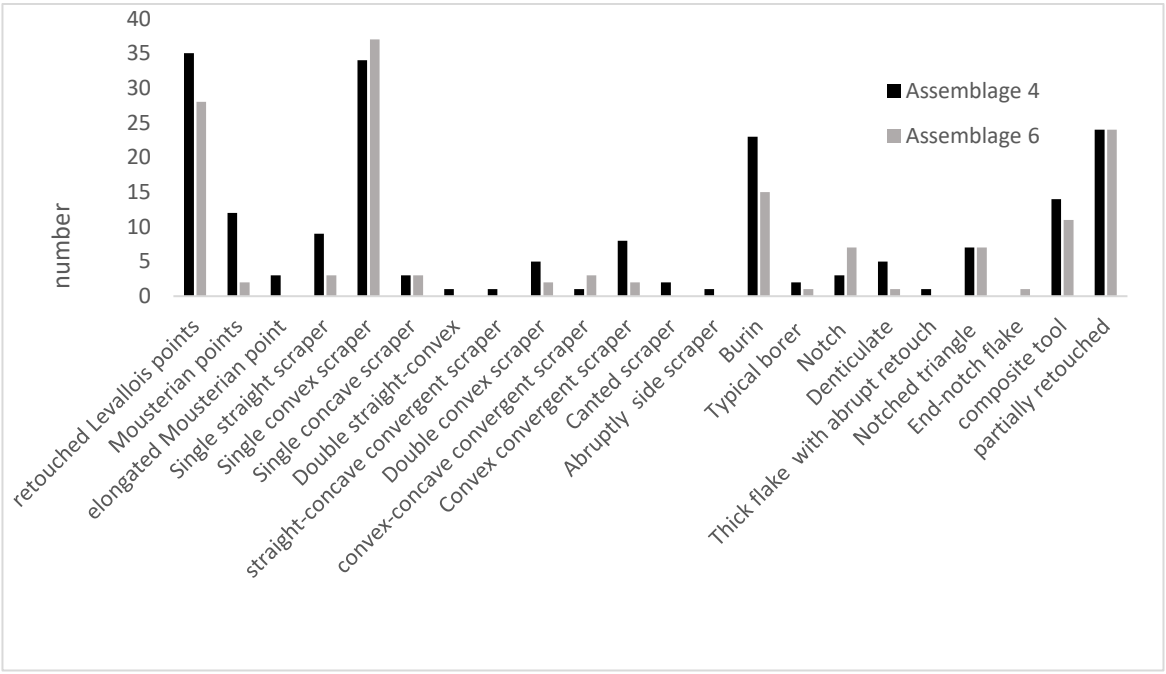


Fig. 142. Distribution of tool frequency in assemblages 6 and 4.

As can be seen in Table. 33, the tools in the two assemblages were executed on different product shapes. However, triangular products were predominant in both assemblages. Furthermore, although scraper types are the most frequent tools in both assemblages, a common feature in Levantine Mousterian sites (Hovers 2009), they were mostly executed on triangular products in assemblage 4 while being applied to a greater variety of shapes in assemblage 6, such as quadrangular, rounded/oval and triangular products alike. Consequently, modification tended to be executed on triangular blanks in assemblage 4, but crafted on more varied shapes in assemblage 6. Thus, the selection of tool shape mirrors the requirements in each assemblage, suggesting that scrapers were applied differently in each assemblage.

Interestingly, assemblages 6 and 4 both contain partially retouched tools, 23 and 24 respectively. Moreover, partial retouch was mainly limited to the distal part of blanks, either on the dorsal or ventral surface. This may suggest a unified purpose of its execution: to correct a specific part of the blank (Hauck 2013), especially the distal part, since the vast majority of partially retouched pieces are by-products and the distal part is the most frequently used part.

Shape	**Levallois blanks**		**By-products**		**Total**	
	Assemblage 6	Assemblage 4	Assemblage 6	Assemblage 4	Assemblage 6	Assemblage 4
Triangular	57	108	7	14	64	122
Quadrangular	14	21	23	15	37	36
Rounded/oval	19	9	9	7	28	16
Polygonal	5	1	2	2	7	3
Irregular	5	1	5	15	10	16
Total	100	140	46	53	146	193

Table. 33. Execution of modification on various shapes with tendency toward triangular blanks in assemblages 6 and 4.

When it comes to the **Upper Palaeolithic tool group (Group III)**, denticulates, and notched elements, the two assemblages show similar tools, but differ quantitatively. This group is less common than the Mousterian group in both assemblages. As can be seen in Fig. 142, the number of burins in assemblage 4 is greater than those in assemblages 6, 23 and 15 burins respectively. Furthermore, they were crafted equally on Levallois blanks and by-products in each assemblage. Notch types, on the other hand, are more frequent in assemblage 6 than in assemblage 4. However, notched triangles are equally frequent in both assemblages since assemblage 4 is a point-bearing assemblage.

Composite tools mostly display a retouched edge (planar, abrupt, substantial, or partial retouch) combined with a second type of modification. The two assemblages exhibit different composite tools. While notches executed on partially retouched edges are the most frequent composite tool noticed in assemblage 6, burins executed on substantially retouched edges are most frequent in assemblage 6. Furthermore, composite tools in assemblage 4 show double patination, indicating frequent use during several separate intervals, probably for different functions. In contrast, although double patination was recognized among tools, it did not appear among the composite tool in assemblage 6, suggesting that they might have been executed at the same time.

Metric properties: The mean sizes of the tools in both assemblages show slightly higher volumetric values than for unmodified blanks. Furthermore, tools in both assemblages exhibit almost the same mean sizes, 60.2 × 35.9 × 8.0 mm for assemblage 6 and 59.9 × 34.0 × 8.7 mm for assemblage 4. However, the longest modified blanks were not restricted to a specific shape in assemblage 6, where both triangular and quadrangular blanks are the longest modified blanks, with a scarcity of oval blanks since they are mostly the result of the second phase of the core reduction sequence, when the core is small. In contrast, triangular blanks are the longest among other tools in a point-bearing assemblage.

Consequently, there was no preference of a specific shape. However, the tendency toward selecting large blanks for modifying might have been with the intention of using them frequently.

Striking platform: Since the vast majority of tools are Levallois blanks, it is quite normal that faceted and dihedral are the most frequent platforms in the two assemblages.

Scar patterns: Tools bearing unidirectional convergent scar patterns are the most frequent in both assemblages despite the diversity of scar patterns in assemblage 6. Furthermore, they mostly distribute to MP group II.

All of these common features among tools between the two assemblages, despite their different functions, suggest a clear analogous human behaviour.

7.8.Transformation analyses

There were some difficulties in sorting the raw material in the two assemblages, such as patination and similar colours of the lithic material. This difficulty was compounded by patination being heavier in assemblage 6, while did not causing any problem in assemblage 4.

As can be seen in Fig. 143, the categories of the raw material units in assemblage 4 (241 RMUs) exceed their counterparts in the assemblage 6 (207 RMUs).

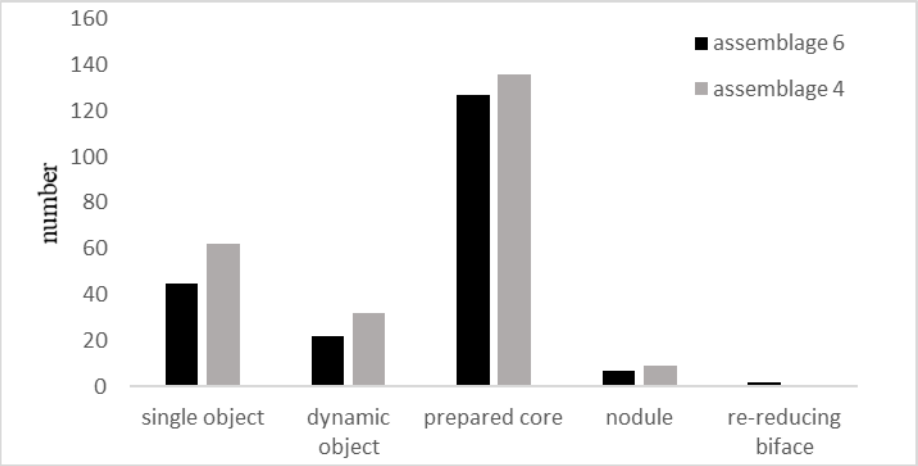


Fig. 143. The distribution of raw material units in both assemblages 6 and 4.

7.8.1. Imported raw material units as single objects or tools

The vast majority of imported single objects (personal gear) in both assemblages are Levallois blanks, 64.4% in assemblage 6 and 58.6% in assemblage 4. However, while Levallois points were the most frequently imported objects in assemblage 4, both Levallois points and flakes together were imported almost equally to assemblage 6. Furthermore, although the two assemblages show different proportions of modified imported single objects including fragments, 20.4% and 43.5% respectively, Levallois blanks are still the most modified imported blanks in both. Consequently, Levallois blanks are the most mobile pieces and were found particularly in the MP group (Group II).

Exhausted single Levallois cores were observed in both assemblages. Given their small volumes, it cannot be assumed that they were imported to be exploited on-site. However, they may either have been reduced and their products exported, or they were used and discarded from previous events. Another theory would suggest that these cores were personal gear and the decision to discard them was taken on-site: they were discarded after hunter-gatherers recognized their uselessness.

7.8.2. Imported raw material units as dynamic objects

As can be seen in Fig. 144, although Levallois points (including elongated) are the most imported Levallois blanks among dynamic objects (personal gear) in both assemblages, Levallois flakes were rarely imported to assemblage 4, but were imported in higher numbers to assemblage 6. In contrast, Levallois blades were rarely imported to either assemblage.

Consequently, dynamic objects related mainly to Levallois points in both assemblages referring to their importance for off-site hunter-gatherer activities.

Interestingly, dynamic objects are the most frequent tools in both assemblage 6 and 4, representing 60.0% and 62.3% of the total respectively. Furthermore, double patination appeared on the dynamic objects of both assemblages, accounting for 11.1% and 14.4% of all dynamic objects respectively. These dynamic objects were thus frequently transported and used.

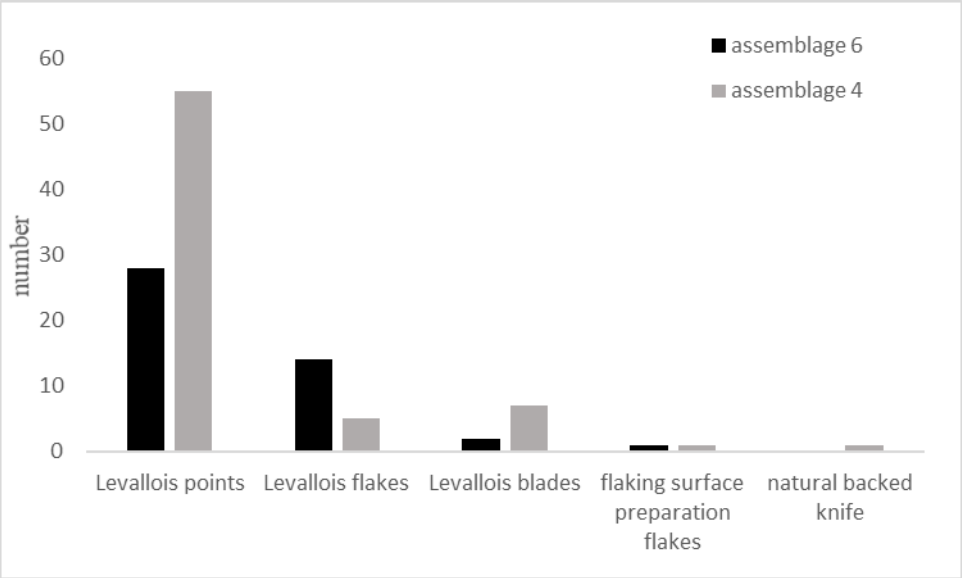


Fig. 144. Distribution of dynamic objects on Levallois products in assemblages 6 and 4.

The abundant appearance of personal gear in both assemblages is not only evidence of high mobility systems, but also reflects the same strategy of local mobility, since neither assemblage contained personal gear made from exotic raw material, all gear was struck from local raw material.

7.8.3. Scarcity of imported raw material units as nodules

The rare importation of nodules reflects logic evidence corresponding to the intentional reuse of discarded artefacts in both assemblages. Nodules were rarely imported in either assemblage: assemblage 4 shows 9 RMUs imported as nodules, assemblage 6 displays only 7 RMUs. This mirrors the rarity of the occupants in both assemblages to procure the raw material as nodules.

An interesting observation is that the *chaîne opératoire* of the nodules was confined to the production of Levallois blades in assemblage 4, whereas reduced nodules in assemblage 6 aimed to produce different Levallois blanks and were not limited to a single blank *per se*.

Consequently, hunter-gatherers may have imported nodules purely for blade production in order to invest its large size for large blade production in assemblage 4. The rarity of nodule imports combined with the reuse of old discarded artefacts in both assemblages reflects the scarce reliance on the direct strategy of raw material procurement.

7.8.4. Predominance of importing raw material units as partially prepared cores

Partially prepared cores are the most frequent raw material units in both assemblages (Fig. 145), and they exhibit almost the same number. Therefore, the importation of partially prepared cores is the dominant strategy of raw material procurement, relying on partial or complete decortication of nodules at their sources. Afterward they were imported to the site. Thus, the two assemblages share a lot of characteristics and differ in others:

1. The vast majority of RMUs lack cores, implying a strategy of exporting cores for off-site activities.
2. In both assemblages, the RMUs of the transformation section Cb mainly contain one or two end-products and rarely three. This refers to the short reduction sequence that may have been due to size limitations and the exportation of the end-products for off-site activities.
3. The transformation section Cc including only by-products with or without core constitutes the least frequent RMUs in both assemblages. They show no cores in most cases, 76.9% of the total transformation section Cc in assemblage 6 and 73.3% in assemblage 4. Accordingly, cores might have been prepared on-site then exported for off-site activities, or cores might have been exploited on-site and exported combined with the end-products.
4. The transformation section Cm exhibiting modified blanks are the most common RMUs among the transformation sections C in assemblages 6 and 4, 48.7%, and 55.6% of the total respectively. The strategy of splitting a volume in order to execute two different Levallois methods was carried out in both assemblages, but rarely.
5. The double strategy of core reduction was clearly evident in both assemblages alike. However, the blanks obtained from the shifting process varied between the two assemblages.

- The double strategy of core reduction in assemblage 4 shows a unified feature of shifting process, in which Levallois blade production was always extracted from the first phase of core reduction. However, the second phase served for Levallois point production, except for one strategy that served for Levallois flake production in the second phase.
- The double strategy of core reduction in assemblage 6 exhibits a bit more variety in the blanks obtained from the shifting process. The majority of double strategy core reductions show shifting from Levallois blade in the first phase to Levallois flake production in the second phase. However, while one double strategy displays a shift from Levallois blade to Levallois point production, another exhibits a shift from Levallois point to Levallois flake production.

6. Although both assemblages exhibit evidence of the re-exploitation of old artefacts, assemblage 6 shows more explicit evidence (i.e. core on flake and *Nahr Ibrahim* Technique) and two RMUs attest to re-exploitation of discarded bifaces.

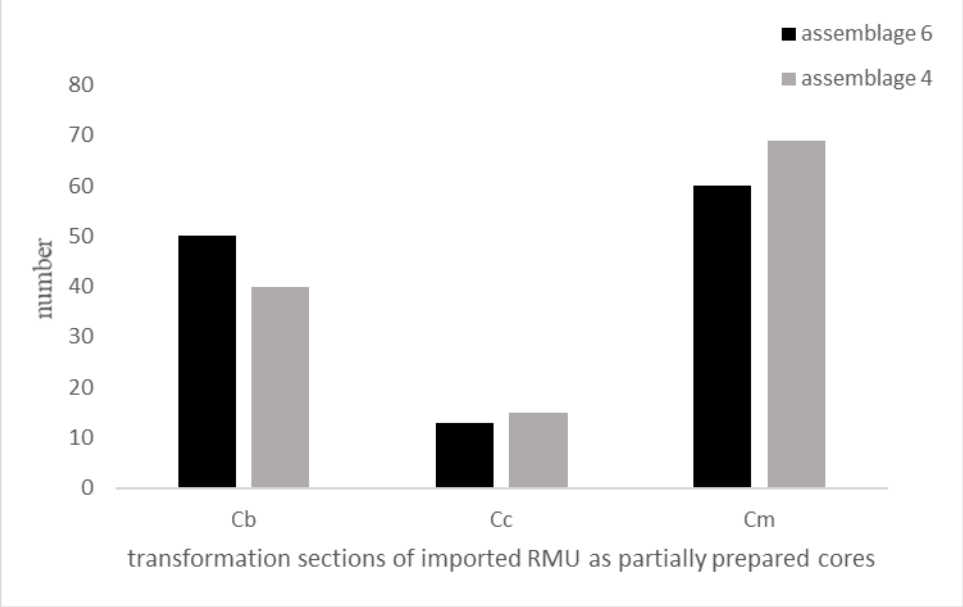


Fig. 145. The similarity in distribution of raw material units imported as partially prepared cores in assemblages 6 and 4.

7.9.Multiple palimpsests of a base camp site *versus* a task-specific site of the late Middle Palaeolithic, assemblage 6 and 4 of Yabroud Shelter I

Late MP settlement patterns in the Levant included the repeated use of caves and open landscape sites (Been et al. 2017). Therefore, although the two assemblages share essentially the same environmental circumstances, they exhibit different synthesis. This synthesis was

based on technological diversity, reflected by the variability in Levallois methods, production objectives and convexity of flaking surface preparation. However, the similarity in technological features can be observed in many manifestations, which in turn, reflect analogous human behaviour in both assemblages with different skills of knappers.

7.9.1. Clear diversity versus low diversity

The Simpson index of diversity returns different values for assemblages 6 and 4 as can be seen in Table. 34, high diversity in assemblage 6 *versus* low diversity in assemblage 4. Furthermore, the Chi-square test suggests there is no evidence of an association between the two assemblages and that they are extremely independent (Fig. 135).

Assemblage	period	No. (end-products)	Levallois points and triangular flakes	Levallois blades	Levallois flakes	Simpson index
6	Late Middle Palaeolithic	237	133	29	77	0.56
5	Late Middle Palaeolithic	350	78	92	180	0.61
4	Late Middle Palaeolithic	344	237	74	33	0.47
3	Late Middle Palaeolithic	308	149	64	95	0.62
2	Late Middle Palaeolithic	229	81	90	58	0.65

Table. 34. Simpson index measuring the diversity of assemblages 6-2. Frequencies of stone artefacts for assemblages 2, 3 and 5 based on the data published by Pagli 2015.

Furthermore, assemblage 6 shows more variety in imported single objects and dynamic objects, ranging mostly between Levallois points and Levallois flakes alike, whereas assemblage 4 exhibits mainly imported Levallois points and triangular flakes. In addition to the predominance of Levallois points and flakes in assemblages 6, the double strategy of core reduction has been specialized to obtain mainly Levallois flakes in the late stage of core reduction. Thus, this is intentional behaviour to meet their needs, which required the production of Levallois flakes. However, given that there are more Levallois points (elongated or not) and triangular than Levallois flakes and unidirectional convergent scar patterns are the most frequent recorded, the activities executed in assemblage 6 may have been more related to the functions of Levallois points and triangular flakes, possibly used for hunting purposes. In contrast, Levallois points are not only the main target of core reduction in assemblage 4, but the double strategy of core reduction aimed also at producing only Levallois points refers to the explicit link of their needs to Levallois point functions.

Therefore, it can be assumed that human behaviour in assemblage 4 was oriented to the exclusive production of Levallois points, which allows us to attribute it as a special task site that was repeatedly visited for the execution of specific purposes combined with focusing on a single subsistence strategy. In contrast, assemblage 6 shows clear diversity in lithic industries combined with clear reuse of discarded artefacts, which might allow us to assign it as a base camp that was visited frequently for different purposes combined with different subsistence strategies. Accordingly, they are palimpsests of multiple occupations accumulated over time. Moreover, although the seasonality of these occupations is not entirely certain, the reconstruction of the climate, which indicates an arid climate with an alternation between steppe and desert vegetation that expanded from the late Middle Pleistocene through the Holocene (Zohary 1973; Dodonov et al. 2007). In addition, Schrøder et al. (2012) indicate that various depths at YSI in the shelter was deposited during warm periods based on testing pollen and spores. This implies that the principal occupations would have taken place during spring seasons when the water tables and springs, together with the contribution of the Wadi al Majarre from the south, formed an oasis with a microclimate favourable and attractive to animals and humans, also during summer.

Simpson diversity Index shows that strategy of land use was applied in YSI 1-6 (Table 34). In the absence of faunal and botanical evidence, it is quite challenging to suggest the reason behind the difference in land use between these assemblages, especially between assemblages 4 and 6. If we take common aspects between both assemblages into our consideration such as the same environmental settings, the same assemblage size, the same used raw material, and finally the analogous technological behaviour of knapping combined with different skills of knappers, Then I suggest that the difference might have been caused by the different strategies of land-use. In addition, reliance on a single subsistence strategy in a task-specific site of assemblage 4, whereas different subsistence strategies in the base camp of assemblage 6 might interpret the variability in Levallois blanks.

7.9.2. High mobility

According to the survey focused on the region north of Damascus, stretching between the eastern side of the Anti-Lebanon Mountains, moving from west to east in the region, the spatial distributions of Lower, Middle and Upper Palaeolithic artefacts cover an area of roughly 500 km2. In additional to the denser coverage of MP artefacts, they also cover a much broader area than that of the Lower and Upper Palaeolithic, which are concentrated within roughly 5 km

radiuses of the major perennial springs near Ma'aloula and Jaba'deen (Conard et al. 2010). This implies the occupants of the region had high mobility systems.

The high representation of dynamic objects and imported single objects, which are mainly Levallois blanks, is significant evidence of high mobility. However, the variation in the quality of imported single and dynamic objects between the two assemblages demonstrates the different purposes of their activities. Furthermore, the Simpson index clearly suggests low diversity between the personal gear (0.38) in assemblage 4. Thus, it can be assumed the function of dynamic objects served for a specific purpose. On the other hand, the Simpson index suggests clear diversity between personal gear (0.63) in assemblage 6, an indication of the anticipation of diverse needs.

The quantity of imported dynamic objects and single objects in assemblage 4 exceeds those in assemblage 6, suggesting the possibility of greater mobility of the hunter-gatherers in assemblage 4. This is a reasonable assumption since Levallois points are the most frequent blanks manufactured and have been transported.

The appearance of double patination in both assemblages and specifically triple patination (Fig. 146) in assemblage 6 on dynamic objects and the predominance of retouched pieces in both assemblages suggests the frequent use of this equipment during their mobility. In addition, exotic raw material has never been used by the hunter-gatherers, and the lithic industries in the two assemblages relied completely on local raw material. Consequently, despite the high mobility of hunter-gatherers, micro-movements have been executed within the local area.

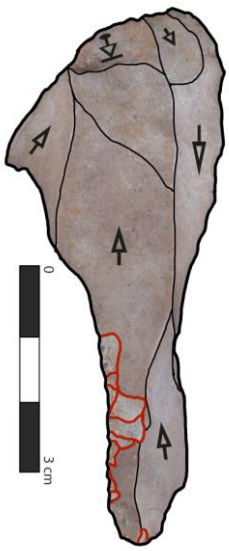


Fig. 146. Triple patination indicates frequent reuse of artefacts in different times, assemblage 6.

7.9.3. Predominance of the embedded strategy of raw material procurement

Despite frequent import of personal gear (i.e. provisioning of individuals) in both assemblages, the process of core reduction on-site (i.e. provisioning of places) is also mainly executed in both assemblages 6 and 4. Due to the scarcity of nodule procurement, it is quite obvious that the users of the two assemblages did not execute the direct acquisition of raw materials. This can be interpreted as a result of the clear dispersal of well-known and local raw material sources. Thus, they would have preferred to procure partially prepared cores that have been obtained during the performance of other activities that allowed them to carry more load.

As opposed to the direct strategy, their acquisition of raw material was embedded in the basic subsistence schedules of hunter-gatherers. This can be observed in several aspects.

1- The availability of raw material resources that situated within a 5 km radius.

2- Double patination asserts the reuse of available local artefacts that were scattered.

3- The attempt to re-reduce discarded cortical flakes by the Levallois method is evidenced by the initial Levallois cores in both assemblages.

4- The double strategy of core reduction demonstrates the intentional selection of local artefacts at times, instead of the specialty of a certain round in order to procure the raw material that appeared in both assemblages.

5- Partially prepared cores are the most frequently imported raw materials in both assemblages. Furthermore, they are the also the most exported elements. This strategy of export and import is explicit evidence of alleviation of the load during movements. Therefore, the strategy of preform export has been carried out most commonly. However, assemblage 6 presents more of a tendency towards the reuse of old discarded artefacts.

6- Triple patination: the patinated pieces may have been collected off-site and only the last step of use was part of on-site activities. Therefore, the collection and reuse of discarded artefacts fall under the embedded strategy of raw material procurement.

7- Cores on flakes and *Nahr Ibrahim* technique: picking up discarded artefacts, whether abandoned off-site or on-site and re-exploiting them by the strategy of core on flake/*Nahr Ibrahim* Technique falls under the embedded strategy of raw material, as long as a specific round was not specialized to procure them, but the

collection or selection was provisioned during the execution of their normal activities.

8- Maximum benefit of exhausted Levallois cores: the shift from the exploitation of the flat flaking surface to the convex lower surface before core discard mirrors the maximum utilization of exhausted cores instead of looking for another raw material for exploitation, despite the closeness of local raw material.

9- Re-exploitation of discarded bifaces is clear evidence of re-exploitation of scattered old artefacts in assemblage 6.

8. Discussion

The technological traits and changes in the lithic industries of assemblages 6 and 4 reflect the variability of the late MP industry in the contextual area. Each assemblage is characterized by different core reduction strategies, types of flaking surface preparation, different frequencies of blanks. In the total absence of absolute dates in either assemblage, it is very risky to use the tripartite model of the Tabun sequence (layers D, C and B), defined by Copeland (1975) to identify changes in lithic technology of the Levantine Mousterian, as an analytical framework for inter-site comparison. The scale is considered unreliable to determine the variability of lithic industry in the Levant (e.g. Grün et al. 1991; Grün & Stringer 2000; Mercier & Valladas 2003; Rink et al. 2001, 2003; Coppa et al. 2005, 2007). Culley et al. see a strong affinity between the B and C facies, using a discriminate analysis that involved 54 levels in 20 different Levantine sites that are results of different activities rather than distinct industries, and clearly differentiated from D (Culley et al. 2012) and the re-dating of Rosh Ein Mor (D15) to the late Middle Palaeolithic after it had been attributed to the D-type for a long time (Goder-Goldberg & Bar-Matthews 2019). Moreover, Neandertal fossils have recently been found in Shukbah cave in Palestine, associated with Nubian Levallois technology, dated between 70 and 50 ka (Blinkhorn et al. 2021) after this technology had been long attributed to *Homo sapiens*.

In line with the numerous criticisms and the risky comparison with the Tabun D, C and B scheme, I would rather compare the industry of assemblages 6 and 4 with the industry of Levantine sites dated to the late Middle Palaeolithic between 70 and 45 ka BP, especially those characterized by point-bearing industry and a predominance of unidirectional convergent flaking. This is despite an increase in diversity of late Middle Palaeolithic industries when open-air sites are considered, e.g. flake-dominated assemblages of Ein Qashish, Far'ah II and Nahal Mahanayeem outlet site (NMO) that are characterized by unique technology using blade core concept with a prepared platform by abrasion, seen in the Upper Palaeolithic (Ekshtain et al. 2019; Goder-Goldberger 2020; Sharon 2018; Kalbe et al. 2014, 2015; Sharon & Oron 2014).

While no radical changes in the strategies of core reduction in assemblage 4, which exhibits a clear tendency towards frequent production of short, broad-based Levallois points with *chapeau de gendarme* platforms and the predominance of the unidirectional convergent flaking method, the changes appeared clearer in the industry of assemblage 6. In the absence of fossil evidence and dating at YSI, it is impossible to say which hominins were responsible for the lithic reduction. However, the technological traits that are seen in other late Levantine MP sites, such as Tabun, Amud, Dederiyah, Kebara cave, where Neanderthal fossils have been found,

lead us to suggest that assemblages 6 and 4 might have been repeatedly used by Neanderthals during MIS4 and beginning of MIS3.

Consequently, if we place the lithic assemblages 6 and 4 in a broader regional context, they show an obvious affinity to the industry of Kebara Cave IX-XII in regard to Levallois point technology, which is dated to roughly 60–48 ka BP (Valladas et al. 1987; Rebollo et al. 2011). Specifically, the technology of point-bearing assemblage 4 shows great affinity to levels IX-X. They show the strategy of importing partially prepared cores and exploiting them on-site. Provisioning of place is observed in both sites (Meignen 2019); however, provisioning of individuals is seen in Yabroud I-4. They are characterized by the predominance of short, broad-based Levallois points and triangular flakes with *chapeau de gendarme* type of butts (Fig. 147), and exclusive use of recurrent convergent flaking Levallois method and almost the same the degree of convergence (Fig. 147.1). However, Yabroud I-4 is differentiated from Kebara IX-X by much more frequent Levallois blades and the scarcity of quadrangular flakes, which are more frequent in Kebara IX-X, especial the uppermost levels (VIII-VI) (Bar-Yosef et al. 1992; Meignen & Bar-Yosef 1992; Meignen 2019). Yabroud I-4 and Kebara IX-X also exhibit frequent production of elongated points, though more frequently in the latter, which may be due to the dominance of flaking surface preparation through large and often elongated *éclats débordants*. In addition, the short, broad-based Levallois points of Yabroud I-4 exhibit more standardized technical and morphological characteristics that resulted from applying systematic alternating types of flaking surface preparation with the aim of maintaining the greatest width at the core's base. While in Kebara IX-X some points, often the large ones, are regular and symmetric and have a slightly curved profile (Meignen 2019). This might be due to lateral and distal convexities re-installed through the removal of large and often elongated *éclats débordants*, where a few convergent cores show traces of flaking surface preparation by detaching centripetal/perpendicular removals. Finally, Yabroud I-4 is characterized by more modified blanks, 28.95% of the total, whereas in Kebara IX and X modified blanks make up 2.2% and 1.2% of the total blanks respectively. However, they conform in terms of scrapers, most often with one lateral edge, being dominant among the retouched tools. To conclude, despite the great affinity of technological traits between Yabroud I-4 and Kebara X-IX, the management of flaking surface convexity is quite idiosyncratic in the former.

The lithics of Amud do not easily fit within the tripartite model of the Levantine Mousterian (Hovers 1998: 144). However, the late Mousterian assemblages B1, B2 and B4, dated by TL between circa 50 and 70 ka BP (Rink et al. 2001; Valladas et al. 1999) show

similarities and differences with Yabroud I-6 and 4. By and large, all the layers in Amud and Yabroud I-6 and 4 show evidence that the decortication stage of core reduction was mainly carried out off-site. In addition, they are characterized mainly by Levallois method application. While convergent flaking method was preferred in B1, B4 and Yabroud I-6 and 4 (Fig. 147.1), Amud B2 is more variable showing convergent and centripetal flaking methods. However, the differences appeared during the advanced stages of the core's use in B2 and Yabroud I-6. Both show changing in the final stage of core reduction, shifting from convergent flaking to the production of centripetally prepared preferential flakes in Amud B2 and B1 (Hovers 1998) and to centripetal Levallois method in Yabroud I-6, where the majority of Levallois flakes resulted from the final stage of core reduction. In addition, although points in Amud B1 and Yabroud I-6 show a high laminar tendency, the latter presents less frequent elongated points and blades than in Amud B1 and more frequent short, broad-based Levallois points characterized by diverse technical and morphological traits, which are rare in Amud B1 but more frequent in B4 (Ohnuma & Akazawa 1988). Interestingly, Amud B1, B2 and Yabroud I-6 also show some affinities through the first stage of core reduction prepared by detaching elongated naturally-backed knives with plunging termination LWR 2.1 (B1 and B2), 1.6 (Yabroud I-6). The latter shows scarcity of large core edged flakes despite the predominance of centripetal Levallois cores. Finally, B1 and B4 and Yabroud I-6 show high frequencies of cores on flakes and/or *Nahr Ibrahim* techniques that were reduced by application of criteria of Levallois concept, especially re-reduction of cortical flakes removed from nodules during the decortication stages (Hovers 1998, 2007), which is quite common in Yabroud I-6. By and large, although some evidence suggests similarity between Yabroud I-6 and all of the Amud layers, the clear resemblance is between Yabroud I-6 and Amud B4 (Fig. 147). However, Amud B1 and B4 show high frequencies (30–40% of artefacts) of non-local raw materials (Ekshtain et al. 2017), contradicting with Yabroud I-6 and 4, where occupants relied exclusively on the exploitation of local material.

To the north, the sequence of Dederiyah cave's chimney (layers 14-1) was ascribed to the Tabun B type industry based on the predominance of convergent scar patterns throughout the sequence (Nishiaki et al. 2012). The technological comparison with the richest site bearing Neanderthal fossils in Syria shows more differences than similarities. While the density of artefacts increases from 11 onward, Yabroud I-6 and 4 show almost stable amounts of lithics, and no radical change in the size of the assemblage can be observed. Although similarity between the sites can be seen in terms of the procurement of local and small raw material, there

were conveyed directly to Dederiyeh Cave, while cores were mostly partially prepared before being imported to Yabroud I-6 and 4. Yabroud I-6 also bears more evidence of reliance on the raw material distributed outside the site through reduction of the discarded cortical flakes and bifaces. Moreover, the basic difference is seen in the variability in the technology in chimney assemblages, however, typical features of the point-dominated assemblages are seen more in earlier layers 10-14. While the Dederiyeh sequence exhibits more variable reduction concepts with a predominance of Levallois methods (e.g. Levallois, prismatic, core on flakes and globular cores with more than one crossed flaking surface), Levallois concept is the only reduction concept applied in Yabroud I-4 with both the Levallois concept and core on flakes in Yabroud I-6.

Dederiyeh and Yabroud I-6 and 4 show affinity in the predominance of unidirectional convergent scar patterns, especially the lower layers at Dederiyeh (Fig. 147.1). This corresponds with a predominance of Levallois points and triangular flakes in Yabroud I-6 and 4, but contradicts the dominance of short, broad flakes in the Dederiyeh layers, despite their production by convergent flaking, with a decrease in Levallois point production gradually from layers 8 upwards, with general rare production of blades. Additionally, the behaviour of investment in the large size of cores to produce elongated blanks (point or blade) then short, broad blanks in the late stage of core reduction is recognized in Dederiyeh and Yabroud I, especially in the lower layers of Dederiyeh and Yabroud I-6, despite the low frequency of blades in both sites. Short, broad flakes were removed mainly in Yabroud I-6 by the second stage of core reduction. As in other Levantine MP sites, retouched tools are rare in the Dederiyeh assemblages forming 1.5% of the total, with an increase in Upper Paleolithic tools (burins, end scrapers and backed pieces) in the later layers. In contrast, tools are more frequent in Yabroud I-6 and 4, 26.5% and 28.95% respectively. However, side-scrapers are the most common tools in both sites. To sum up, despite the predominance of convergent flaking method in Dederiyeh and Yabroud I-6 and 4, they show totally different tendencies towards obtaining different Levallois blanks. Nishiaki et al. (2012) attributed the frequent production of points in the steppe environment to the need for points as projectiles in hunting, which contradicts the point-bearing assemblages IX–X of Kebara Cave on the coast.

A recent study clarifies that the industry of Rosh Ein Mor (D15) in the central Negev highland is attributed to the late Middle Palaeolithic industry, dated by U-series between 70 and 35 ka, rather than the early Middle Palaeolithic (Goder-Goldberger & Bar-Matthews 2019). Although the new analysis indicates some affinities to the industries of Yabroud I-6 and 4, the

latter exhibit distinctive technological features that do not correspond fully with the Z19 industry of Rosh Ein Mor. The exclusive application of the Levallois concept and Levallois concept with cores on flakes are idiosyncratic features of Yabroud I-4 that are not seen in the other late Levantine MP sites. In fact, Rosh Ein Mor exhibits more variability of core reduction strategy through the application of Levallois and non-Levallois methods, i.e. single platform cores (including prismatic and pyramidally cores with surficial rather than volumetric), opposed platform cores, others (including single and double platform cores mainly for flake production), cores on flakes. Levallois cores are the least applied concepts (Goder-Goldberger & Bar-Matthews 2019). Furthermore, they differ in the use of Levallois methods. While Z19 of Rosh Ein Mor lacks Levallois cores for point (there are a few in D15 assemblage) and shows a predominance of the centripetal flaking method, recurrent unidirectional convergent cores are dominant in Yabroud I-4 and clearly present in Yabroud I-6 and responsible for the high frequency of triangular blanks. However, Z19 and Yabroud I-6 and 4 share the predominance of unidirectional convergent scar patterns amongst Levallois blanks (Fig. 147.1) and facetted striking platforms even among non-Levallois blanks in Z19. Apart from plain platforms, this is the most frequent type of butt among non-Levallois flakes. Moreover, while flakes produced by Levallois or non-Levallois methods (mainly by single platform cores) are dominant in Z19, Levallois points triangular flakes are the most common blanks in Yabroud I-6 and 4 (Fig. 147). However, the lithics of Z19 in particular and in D15 in general show an affinity with Yabroud I-6 in terms of the elongation of points and the investment in large size for core reduction to produce points (elongated or not) by unidirectional convergent Levallois method, then later shifting to flake production, which is rare in Yabroud I-4. Also, they show a mix of Upper Paleolithic and Middle Paleolithic types, with the predominance of the latter. To conclude, it is difficult to find a close resemblance in the industry of Rosh Ein Mor Z19 with those in Yabroud I-4, but a few points can be seen in Yabroud I-6. The Rosh Ein Mor assemblage fits well within the variability seen at the end of the Middle Paleolithic (Goder-Goldberger & Bar-Matthews 2019).

To the northwest, in the semi-arid steppe zone of the el Kowm region in central Syria, is one of the best documented late Mousterian sites in the Levant. There is great affinity between Yabroud I-4 and Hummal HM-A1 in the exclusive use of unidirectional convergent flaking method, the predominance of short, broad-based Levallois points and triangular flakes, and the prevalence of convergent scar patterns (Fig. 147.1). Furthermore, slight standardization of technical and morphological characteristics of the Levallois points in Yabroud I-4 resemble

those described by Hauck (2011, 2013) in Hummal HM-A1 (5AI- 5AVI). His interpretation is that standardization is a result of the exclusive use of the unidirectional convergent flaking method. Additionally, I assume that the systematic alternating preparation of flaking surface, between detaching elongated lateral removals and small opposed and perpendicular preparatory removals is a significant feature and factor in getting standardized points in Yabroud I-4 and maintaining the greatest width at the base of cores (see subchapter 6.4.2), whereas detaching lateral elongated preparatory removals is mainly used in Hummal HM-A1. Surprisingly, although Yabroud I-4 shows more systematic types of flaking surface preparation, both sites exhibit almost standardized Levallois points. Therefore, the preparatory lateral removals in HM-A1 might be more convergent than in Yabroud I-4. The standardization of technical and morphological characteristics of Levallois points seems to be a common feature in point-bearing assemblages. However, it cannot be asserted that their standardization results from the convergent flaking method exclusively in the Levant. The high standardization in Levallois points and flexibility in their preparation in level C of Tor Faraj Shelter in Jordan, which is dated to around 70 ka BP (Henry 2003, 1995a, 1995b), shows affinities to the point industry in Yabroud I-4. However, unlike assemblage 4, point industry in Tor Faraj exhibits a preference for the use of the lineal and high frequency of cores on flakes strategy and *Nahr Ibrahim t*echnique (Demidenko & Usik 2003).

Furthermore, they show the same duration of occupation, where both sites Yabroud I-4 and Hummal HM-A1 present indices of high mobility of hunter-gatherers during short-term occupations. However, they show differences in the strategy of provisioning. While provisioning of both individuals and place was employed in Yabroud I-4, the strategy of provisioning individuals is dominant with little on-site production in Hummal HM-A1(Hauk 2011, 2013).

Interestingly, the industry of Yabroud I-6 exhibits some affinities to Hummal HM-A2 in terms of the great variability in blank morphology. While there is no trend toward obtaining specific or a preferred type of blank in HM-A2, there is a clear endeavor towards producing short broad-based Levallois points, triangular flakes and quadrangular and oval-shaped flakes. The difference can be seen through the strategy of core reduction as well. In addition, while cores were mainly reduced by unidirectional-parallel pattern, followed by the convergent flaking concept in HM-A2, convergent flaking method, followed by centripetal Levallois methods, are dominant in Yabroud I-6. However, Levallois blanks in both sites show laminar tendency. In Yabroud I-6, only points (elongated or not), triangular flakes, and Levallois blades

exhibit LWR means above 1.5, whereas the majority of flakes combined with points in Hummal HM-A2 show the same value. Furthermore, although Hummal HM-A2 and Yabroud I-6 present base camp features, the latter shows a low density of artefacts indicating short-term occupations. Finally, Hauck (2011, 2013) hints that the industry of HM-A2 shows a relationship to Tabun D-type. But the absence of non-Levallois blades, prismatic cores and the scarcity of retouched tools, especially Upper Paleolithic types makes this impossible. This is not observed among the contents of Yabroud I-6 because of the predominance of short, broad-based Levallois points with so-called *chapeau de gendarme*-shaped butt, triangular flakes, and quadrangular/oval-shaped flakes, whereas it shows a low frequency of elongated blanks mainly produced by unidirectional convergent (Fig. 147.1) and parallel flaking methods. To conclude, great similarity in technology is seen between point-dominated assemblages Yabroud I-4 and the uppermost levels of Hummal HM-A1 (5AI- 5AVI), and although Hummal HM-A2 and Yabroud I-6 share variability in blank morphology and laminar tendency, the latter shows a few elongated points that are dominant in some levels of Hummal HM-A2.

In the same region (el Kowm), about 10 km north of the Hummal site, is the Umm el Tlel site with the well-documented and longest stratigraphy of Mousterian with Levallois reduction (Boëda & Muhesen 1993; Boëda et al. 1998, 2001). Layers VI3 c and d (complex VI3) was dated by TL to 71 ± 4 ka BP and layer V2βa (complex V) to 68 ± 6 ka BP (Boëda et al. 2008). Pagli (2015) indicates that Levallois flakes are dominant in all of the assemblages of complex V2, except assemblage v2 πb, where Levallois blades are more frequent. The Levallois blanks were produced mainly by unidirectional parallel Levallois method according to the predominance of scar patterns (Pagli 2015), except in assemblage v2 βa, which has more unidirectional convergent scar patterns and Levallois points and triangular flakes are associated with a high frequency of quadrangular and oval-shaped Levallois flakes resembling Yabroud I-6 (Fig. 147-147.1). The predominance of Levallois flakes and unidirectional parallel scar patterns in Umm el Tlel complex V2 cannot be compared to the point-dominated assemblage of Yabroud I-4 using the unidirectional convergent flaking method. A detailed techno-typological analysis of the whole of complex VI3, more specific layers VI3 b' and VI3 b1, is not yet available, except for some brief descriptions included in studies focused on the function of the site (Boëda et al. 1998, 1999, 2001, 2008). Yabroud I-6 shows similarity with VI3 b1 of Umm el Tlel (Fig. 147) in terms of the predominance of short, broad Levallois points accompanied by quadrangular flakes. The initial stage of reduction was executed bidirectionally and unidirectionally in the initial stages and later, unidirectional convergent

method became more common (Boëda et al. 2001). Furthermore, the very diverse morphological, technical and metric characteristics of Levallois points in Yabroud I-6 show affinities to those produced in level VI 3b'1 (Boëda et al. 1999). Boëda et al. (1999) attributed this diversity to the different functions of Levallois points as well as manners and contexts of function. In contrast, I believe this could be attributed to the application of the bidirectional Levallois method, given that standardized Levallois points are basically associated with exclusive exploitation of the unidirectional convergent Levallois method as can be seen in point-dominated Yabroud I-4 and Hummal HM-A1, and other technical reasons (see 6.4.2). To sum up, it is difficult to find a perfect match between the late Mousterian assemblages of Umm el Tlel and Yabroud I-6 and 4 as can be found between Yabroud I-4 and Hummal HM-A1, despite their situation in the same arid and semi-arid conditions (Griggo 2004).

The industries of Yabroud I-6 and 4 present another instance of the variability of late Mousterian in the Levant. They do not fit with the flake-dominated assemblages of Umm el Tlel, Quneitra in Golan Heights, Ein Qashish in lower Galilee, and Mount Lebanon sites (Boëda et al. 2001; Pagli 2013, Goren-Inbar 1990; Ekshtain et al. 2019; Leder 2014). Units 3a-b (areas B and F), unit 5a (areas A, C and E) and unit 5b (areas A, C and non-excavated areas of B, E and F) of the late Mousterian in the Ein Qashish open-air site, which presents a high probability of Neanderthal fossils (Been et al. 2017) and was dated by OSL to between 71 and 54 ka BP, and is probably from 70-60 ka BP (Greenbaum et al. 2014), is mainly dominated by flakes, followed by blade/let production obtained by single platform cores. It involved three main flaking technological systems, of which Levallois flaking is relatively low, whereas cores on flakes are the most common core category. Interestingly, Levallois points are quite rare (Ekshtain et al. 2019). The difference between Yabroud I-6 and Ein Qashish is clearly observed through more variable reduction core strategies in the latter, where the Levallois concept is the least applied. In contrast, the Levallois concept is the only reduction concept recognized in Yabroud I-4 and the main ones besides cores on flakes in Yabroud I-6. In addition, difference is observed in the predominant end-products. While Ein Qashish is a flake-dominated site (Hovers et al. 2008), triangular blanks characterize the industries of Yabroud I-6 and 4. However, they show some affinities as to some off-site knapping that is evidenced by low frequencies of cores, by-products and cortical elements in Ein Qashish (Ekshtain et al. 2019) and by high frequencies of personal gear imported to Yabroud I-6 and 4. Both sites correspond in terms of short and repetitive human occupations; however, they contradict as to site function, which is probably generalized occupations for Yabroud I-6 rather than palimpsests

of task-specific occupations that might have characterized Yabroud I-4. To conclude, Yabroud I-6 and 4 show basic differences rather than similarities. In a regional context, Ein Qashish presents a paradigm of variability of the late Mousterian industry that cannot fit with tripartite model of the Tabun sequence.

Finally, in the comparison with other late Mousterian sites in the Levant, Yabroud I-6 and 4 can be assigned to the timeframe between 70 ka and 45 ka BP. Hauck (2013) proposed that two types of assemblages are discernible during the late Mousterian (Fig. 147). One is characterized by high blade and/or point proportions and a moderate-to-low application of the convergent flaking method such as Hummal levels 5a2 to 5E, Yabroud I-2, and Amud B2. The other features high flake and point proportions with a clear predominance of convergent scar patterns on cores and debitage, such as Hummal level 5AII and 5AIV, Kebara levels IX to XII, Amud B4 and B1, and Tor Faraj. This hypothesis is, as Hauck suggested, applicable to Yabroud I-6 and 4 (Fig. 147). However, it is not valid for all late Mousterian sites since many are flake-dominated such as Ein Qashish, complex V2 of Umm el Tlel and Quneitra (Boëda et al. 2001; Goren-Inbar 1990; Ekshtain et al. 2019).

Interestingly, Pagli (2013, 2015) follows the concept of "reticular space" (Bonnemaison 2000) in order to describe the mobility system of Yabroud Shelter I. She proposes, based on the diversity in technology, that Yabroud I-6 was used as a point along a route without return by regional macro-groups who had different technical knowledge bases and circulated ideas across the territory. Meanwhile, she proposes that Yabroud I-4 and 3 show technological continuity applied by human groups that shared the same technical knowledge and occupied the same site repeatedly (Pagli 2013, 2015). She also adds that this continuity in technology harmonizes with the models of territorial behaviour proposed for the southern coastal region during the late Middle Palaeolithic (Hovers 2001; Meignen et al. 2006), suggesting circulation across small territories and recurrent use of the same sites resulted in technological continuity in the sequences. On the contrary, the current study suggests that despite variability in the obtained blanks in Yabroud I-6 and 4, the lithic industries show clear technological characteristics that propose an analogous human behaviour between. Additionally, the raw material used in both assemblages is confined to local resources and did not show exotic raw material, in particular, the personal gear of which there is much. This suggests that Yabroud I-6 is neither a point along a route nor the result of different cultural groups. Instead, successive occupations and micro-movements within the Yabroud region were likely executed by human groups who probably did not leave the region. Furthermore, in the absence of faunal and

botanical remains in both Yabroud I-6 and 4, it is quite impossible to determine the probable incentives that triggered or impacted the variability in the technology and site use, except the human behaviour that might have been driven by the fluctuation of subsistence strategies and the applied tasks.

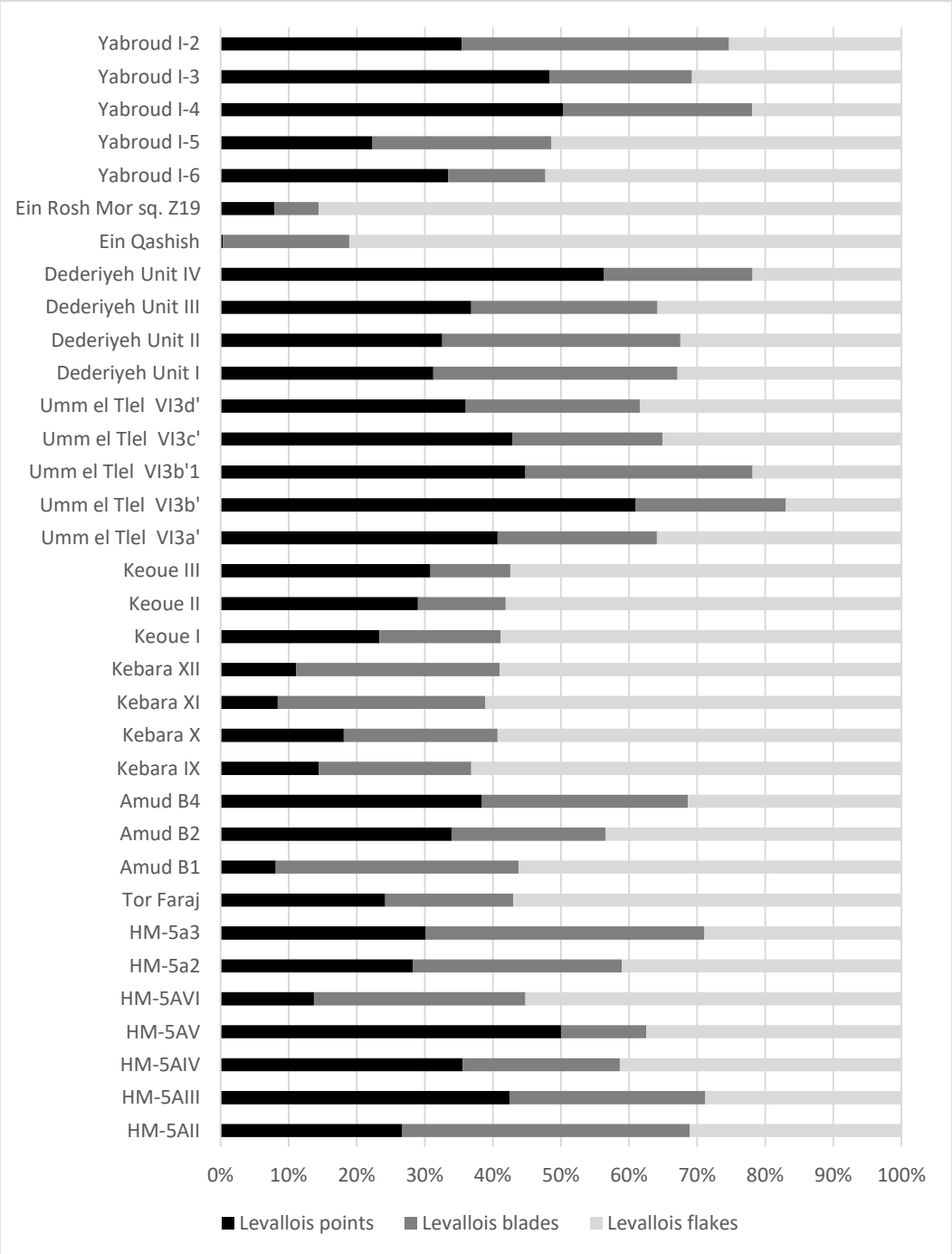


Fig. 147. Percentage of Levallois flakes, blades and points in the most known late MP site in the Levant. Note that elongated points are included within the blade category and flakes include triangular flakes in Yabroud I assemblages 6 and 4. Eni Rosh Mor sq. Z19: non-Levallois blanks are excluded (Goder-Goldberger & Matthews 2019). Umm el Tlel: triangular flakes included in point category (Pagli 2015). Dederiyeh: blades include elongated points (Nishiaki et al. 2012). Keoue (Nishiaki & Copeland 1992). Ein Qashish: the percentage is from the 2009-2011 excavation and the material includes Levallois and non-Levallois, additionally, bladelets are included in the blade category (Hovers 2008, Malinsky-Buller et al. 2014). Hummal (Hauck 2013). Amud (Hover 1998). Tor Faraj (Henry 1995a and b, 2003). Kebara (Meignen & Bar-Yosef 1991). Yabroud I-5, 3-2 (Pagli 2015).

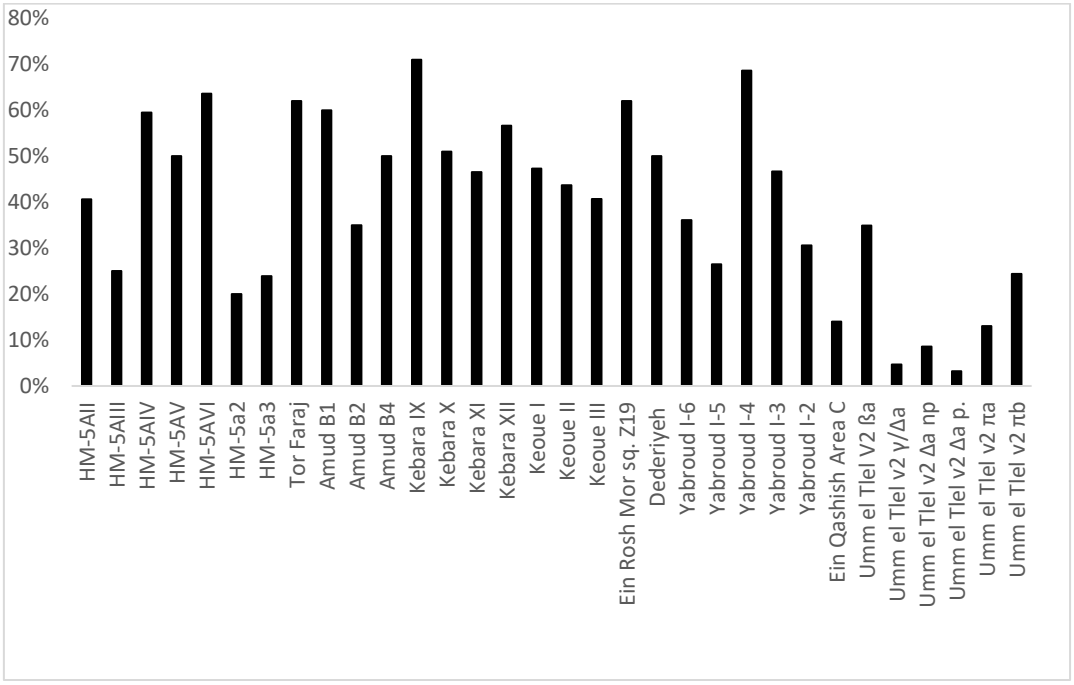


Fig. 147.1. Percentage of unidirectional convergent scar patterns in the most known late MP site in the Levant. Eni Rosh Mor sq. Z19: only scar patterns on Levallois blanks (Goder-Goldberger & Matthews 2019). Dederiyeh: convergent scar patterns are common in the lower layers 14-7 (Nishiaki et al. 2012). Keoue (Nishiaki & Copeland 1992). Ein Qashish area C (Hovers 2008). Hummal (Hauck 2013). Amud (Hover 1998). Tor Faraj (Henry 1995a and b, 2003). Kebara (Meignen 2019). Yabroud I-5, 3-2 and Umm el Tlel complex V2 (Pagli 2015).

Hovers (2001) proposes models of territorial behaviour suggesting that hominins might have moved within small territories and used the same site repeatedly in the coastal area. Furthermore, Meignen (2019) suggests that the unidirectional convergent pattern is the basic characteristic of the technical tradition in the Kebara Cave sequence because it is the preferred option used by Kebara occupants for short as well as elongated Levallois blank production, despite variability seen through the increased use of centripetal Levallois cores and more production of quadrangular oval-shaped Levallois flakes, with less abundance of triangular blanks in the upper levels of the sequence (VIII-VI). If we take this observation as a measure of site occupation by human groups that had the same technical tradition, then Yabroud I-6 and 4 was occupied by hominins sharing the same technical knowledge. Meanwhile, this variability corresponds to the fluctuation of the site's function as referred to by Speth & Tchernov (2007:197). Based on analysis of fauna from Kebara Cave, they propose that its functional position within the settlement system was not static during the late Mousterian. It fluctuated between a series of brief occupations in which hunting played the main role during the early occupations that took place in the late spring and summer. I therefore assume we cannot rule out that site functions and subsistence strategy played a role in the variability of obtained blanks in Yabroud I-6 and 4.

The same rhythm is observed in Amud Cave, the variability appeared through the predominance of short, broad-based points and triangular flakes in the lower layer B4, whereas there is a tendency towards rectangular blades and flakes in layer B1 (Fig. 147). Recently, Friesem et al. (2019) compared the land use of the contemporaneous and adjacent sites, Shovakh and Amud caves, that are dated to the same time in the late Mousterian and are located within the same geographic context of the Amud drainage. Based on the rate of sedimentation, quantity and taxonomy of phytoliths and abundance of fire residues, it was suggested that Amud Cave attested to intensive human activities (Madella et al. 2002) due to a relatively high rate of sedimentation (particularly in units B1 and B2) as a result of a large amount of ash accumulating at the site. Furthermore, the richness of phytolith assemblages and the high abundance of fire residues at Amud Cave compared to the findings in Shovakh Cave suggest that human activities in Shovakh were of lower intensity, reflecting a more sporadic occupation of the cave at the same time that Amud Cave, only 500 m down the wadi, was intensively occupied (Friesem et al. 2019). This comparison clarifies the variability of site use despite sharing the same life circumstances.

To the northeast, the variability in the Umm el Tlel sequence is visible through the fluctuation of industries between flakes, triangular blanks and Levallois blades, with the predominance of triangular blanks in the lower parts (levels VI3) using bidirectional and convergent Levallois method, with more flakes in the upper parts (levels V2) and a pronounced decrease in triangular blanks (Pagli 2013, 2015). This variability might be conformed with diversified functions mentioned by Boëda et al. (2001), ranging between diversified activities of short or long duration, level V2ßa, of the hunting site, preliminary butchery work level VIIa0, and specialized activities related to meat processing level VI3b '1, which is related more to Levallois point industry. On the contrary, the Hummal Mousterian sequence attests to the prevalence of triangular blanks in the uppermost parts HM-A1 with the predominance of convergent scar patterns, whereas HM-A2 is characterized by laminar tendency showing the variability of Levallois blanks without preference toward a single type, ranging between flakes, points, and blades (Huck 2011). Although the occupation periods of a single site may have shared the same environmental settings, its lithic composition and fauna indicate that diversified functions were executed over time. This implies the variability of site use is a distinct character of late Levantine MP sites, regardless of spatial distribution, whether inland or coastal. The reconstruction of the palaeoenvironment suggests that the MP ecosystem exhibits relative stability, with variations in degree rather than in kind (Hovers 2001). I

therefore suggest that the variability between the two assemblages may have resulted from the different site functions and subsistence strategies. While assemblage 6 appears to have been occupied as a base camp using different subsistence strategies, assemblage 4 is thought to have been used as a specific-task site, relying on a single subsistence strategy. Furthermore, although the variability in technology is clear between the two assemblages, the exclusive use of Levallois methods combined with similarities in the management of core reduction per se reflect analogous human behaviour. The different technical and morphological characteristics of Levallois blanks have resulted from the different skill levels of knappers.

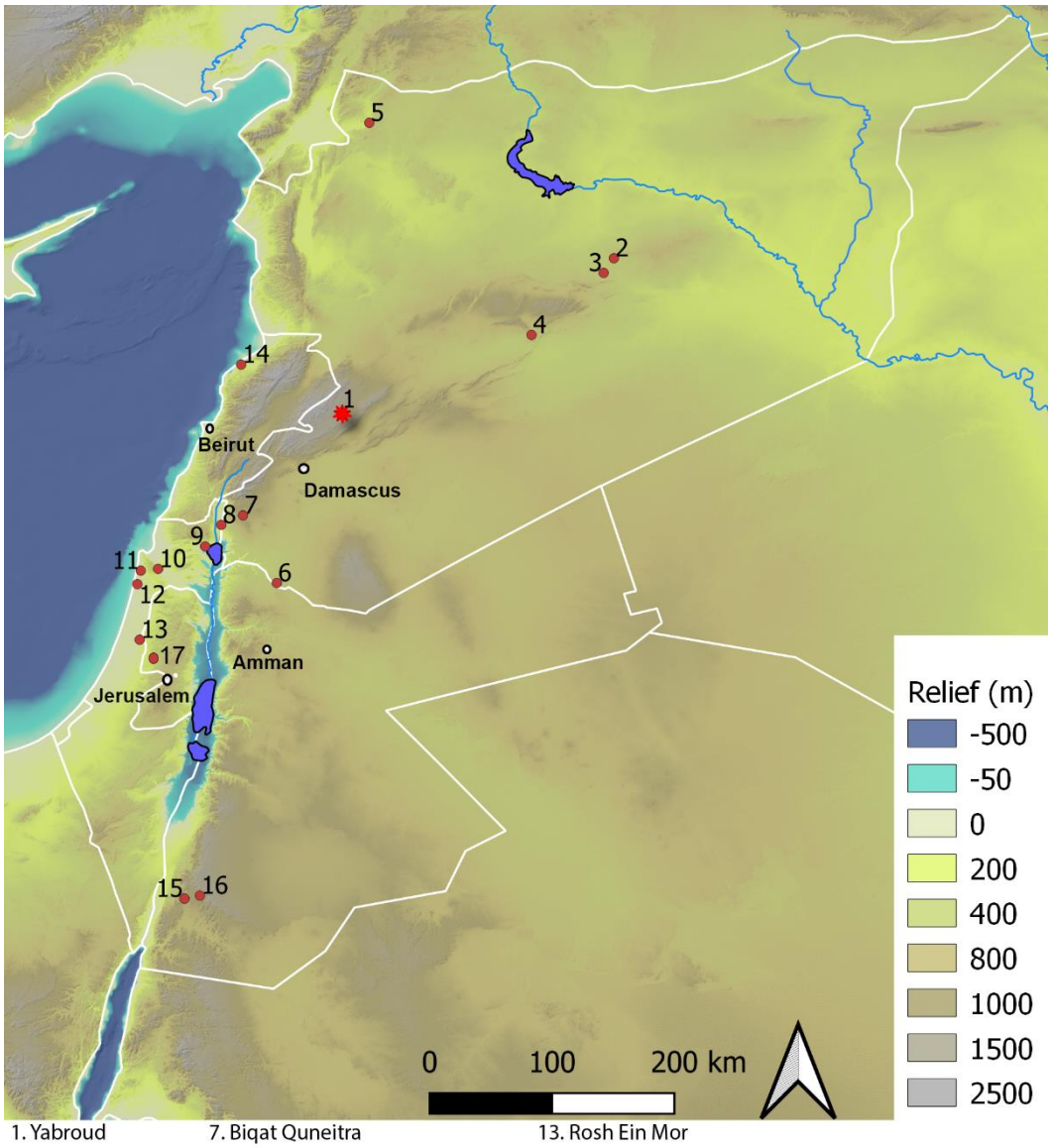


Fig. 148. Digital elevation map showing location of the important LMP sites in the Levant (naturalearthdata.com). Coordinate System used: WGS 84/EPSG 4326.

The timing and definition of the end of the MP has being debated for several decades, especially as both Neanderthals and *Homo sapiens* were responsible for exploiting the Mousterian industry in the Levant.

While many researchers align the termination of the MP to the appearance of modern humans from the south, going on to call it a human revolution (Mellars & Stringer 1989; Mellars 2006), other researchers saw that many behavioural features of modern humans evolved gradually with its first occurrence circa 200 ka BP, or already existed circa 300 ka BP (Clark & Lindly 1988; McBrearty et al. 2000; Richter et al. 2001; McBrearty 2007; Hovers & Belfer-Cohen 2006). It has also been argued that bio-cultural changes during the Upper Pleistocene, including MP to UP transition between 50 and 30 ka BP, did not coincide with each other in time and space nor followed a single, repetitive pattern when they occurred. However, they may have related to the dispersal of modern humans out of Africa some 50,000 years ago, whose cultures developed in many different ways in Europe as much as in other places on the globe (Bar-Yosef & Belfer-Cohen 2013; d'Errico et al. 1998; Hovers 1997, 2009; Hovers & Belfer-Cohen 2006; McBrearty & Brooks 2000). Accordingly, Meignen (2012) called for a more regionalised approach in order to create a better understanding of the diverse and complex transitional phase.

Leder (2014) highlighted the complexity and cultural variability that existed in the region between 50 and 35 ka BP (i.e. techno-typological industries of the Initial/Early UP in the Levant, henceforth IUP), and later shed light on industrial differences in connection with environmental and techno-economic factors (Leder 2018). He aimed to identify the predecessors and/or origin of IUP industry in Lebanon. Accordingly, he identified four distinct transitional industries in different sub-regions at different times, each with its own origin and developmental history, which were likely associated with two different human species, Neanderthal and *Homo sapiens*.

While transitional industry in central Syria was left in the dark due to a hiatus in occupation circa 6–7 ka following the MP, and despite the appearance of Jerf Ajilian industry circa 35 ka BP, the Emiran transitional industry in Lower Galilee, north and centre of Palestine circa 45 ka BP has characteristics common with Levallois and volumetric concept. Most authors would argue that assemblages assigned to the Emiran by Leder (2014) are all mixed assemblages, 70 cm thick, see for example Barzilai & Gubenko 2018 (Emireh Cave). However, Bar-Yosef & Belfer-Cohen recently published data on the Upper Paleolithic at Kebara Cave

showing the persistence of the Levallois flaking systems (Bar-Yosef & Belfer-Cohen 2019), adding new weight to Leder's argument for a transitional Emiran.

In contrast, the transition from Middle to Upper Palaeolithic is represented by a break in technology in Lebanon and did not show any affiliation with local MP entities. It is related to the industry of Boker Tachtit 1-3 in the Central Negev industry circa 47 ka BP. Another transitional industry appeared circa 40–37 ka BP, so-called Ksar Akilian, that regressed from IUP lithic traditions with its later stages related to *Homo sapiens*. This industry expanded further north and reached the Üçağizli site in southern Turkey by circa 40 ka BP (Fig. 149).

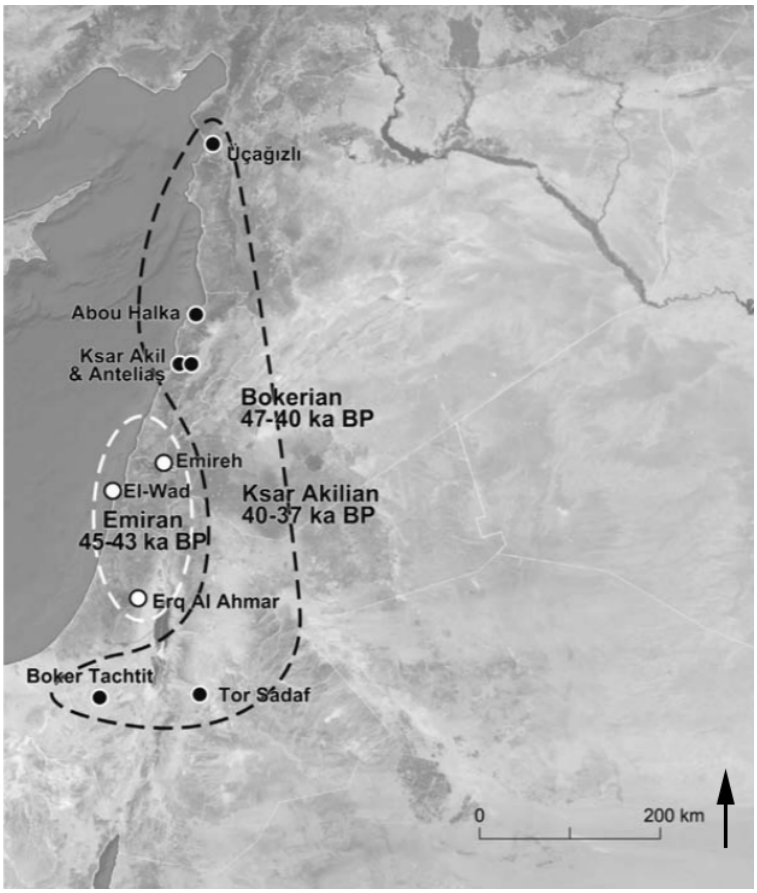


Fig. 149. Technocomplexes of the early transitional era between 47 and 37 ka BP. It shows the points of technological break and continuity between the Middle Palaeolithic and the Initial Upper Palaeolithic. The black dashed shape represents the technological break by dispersal of the Bokerian industry made by *Homo sapiens*. The white dashed shape represents the technological continuity by the Emiran industry (Leder 2014).

Therefore, Leder (2014) assumed that the late MP terminated in Lebanon with the arrival of the second migration of the Bocker Tachtit human around 50 ka BP. The recent discovery of *Homo sapiens* fossil in Manot Cave in western Galilee, dated to around 55 ka BP by the U/Th method (Barzilai et al. 2016; Alex et al. 2017), indicates that it is very likely that Neanderthal and *Homo sapiens* co-authored at least parts of the Late Middle Palaeolithic, Transitional and IUP industries until Neanderthals became extinct before the Early Upper

Palaeolithic (early Ahmarian) (Richter et al. 2020). The Eastern-Mediterranean-Levant was particularly favourable (wetter and warmer), based on marine pollen record, even in the currently semi-arid/steppe regions, from the late MP to IUP 56–44 ka, most likely driven by increased precipitation related to the intensification of the North Atlantic-Mediterranean climate system in the first part of MIS 3 (Langgut et al. 2018), causing the transgression of Lake Lisan (Abu Ghazleh 2011).

Greenbaum et al. (2019) propose that the gradual inter-population connectivity, both within and between species (Neanderthal and *Homo sapiens*), commencing in the late MP, may have resulted in variability in lithic material. Afterward, interaction increased over time, reflected in great variability in the transitional assemblages between 50 and 40 ka BP. Therefore, although the technical features of Yabroud I-6 and 4 show clear affinities to the Levantine sites that are coupled with Neanderthal fossils, it is difficult to assume who produced the composition of the late Mousterian in Yabroud I. Meanwhile, the inter-site comparisons show that the industries of Yabroud I-6 and 4 share many technical traits with Mousterian sites in the Levant, which would place them in the late Middle Palaeolithic context MIS 4 and beginning of MIS3 circa 70–45 ka. However, they are idiosyncratic in other features such as a distinct tendency towards the only application of the Levallois concept and the alternate and systematic types of flaking surface preparation that resulted in the production of standardized characteristics of Levallois points in Yabroud I-4, as well as the predominance of Levallois blanks in Yabroud I-6, despite the high number of cores on flakes and *Nahr Ibrahim* technique with a near absence of Kombewa flakes.

9. Conclusion

The variability of core reduction strategies seen in Yabroud I-6 and 4 harmonizes with the industries of sites dated to the late Mousterian in the Levant such as Kebara, Amud and Dederiyeh caves, Tor Faraj Rockshelter, Umm el Tlel, and the undated industry of Hummal HM-A1 and HM-A2 open-air sites. The predominance of short, broad-based Levallois points, convergent scar patterns, and the high number of blanks with a *chapeau de gendarme* allows us to assign both assemblages to a timeframe between 70 and 45 ka BP (Table. 35). Although the main focus was on the application of Levallois methods in both assemblages, variability is visible in the Levallois methods applied, core preparation types, sizes, morphologies, and frequencies of Levallois blanks. While no radical changes are noticed in the technology of Yabroud I-4, a clear variability appears in Yabroud I-6.

Site: layer	Method						Reference
	TL	ESR (EU)	ESR (LU)	OSL	U-series	Others	
Kebara: VI- XII	59.9 ± 3.5 48.3 ± 3.5	60.4 ± 5.9	64.3 ± 5.9				Valladas et al. 1987
Tabun: B		86 ± 11	103 ± 16				Grün et al. 1991 Grün & Stringer 2000 McDermott et al. 1993
Amud: B1	57.6 ± 3.7	38 ± 5	41 ± 6				Valladas et al. 1999 Rink et al. 2001
Amud: B2	56.5 ± 3.5	51.5 ± 5 66 ± 8 54 ± 7	65 ± 8 77 ± 11 63 ± 9				Valladas et al. 1999 Rink et al. 2001
Amud: B4	68.5 ± 3.4	68 ± 10	73 ± 12				Valladas et al. 1999 Rink et al. 2001
Umm el Tlel – VI3 (c and d) Umm el Tlel – V2βa	71.4 ± 7 68 ± 6						Boëda et al. 2008
Dederiyeh: Layer 3 and 11						48.1± 1.2-53.6± 1.8 AMS radiocarbon	Akazawa & Muhesen 2002
Quneitra		39.2	53.9 ± 1.7				Ziaei et al. 1990
Tor Faraj: layer C	43.8 ± 2.0 47.5 ± 3.0 53.8 ± 3					69 ± 6 acid racezimation of ostrich eggshells	Henry & Miller 1992 Henry 1995b, 1998
Tor Sabiha						69 ± 6	Henry & Miller 1992
Jerf Ajla: layer C	33.3 ± 2.3						Julig et al. 1999 Richter et al. 2001
Rosh Ein Mor D15					between ~70 to 34 ka		Goder-Goldberger & Bar-Matthews 2019
Nahal Mahanyeem Outlet Area D Nahal Mahanyeem Outlet Area E				65 ±5 - 56 ± 3 74 ± 3			Kalbe et al. 2014
Far'ah II – 1-2		49.1 ± 4.1	62.2 ± 7.0		76.4 ± 1.5		Schwarcz & Rink 1998

Table. 35. Data from the late Levantine Mousterian sites mentioned in the conclusion, ages expressed in ka and BP.

Only Levallois methods were applied in Yabroud I-4, in particular the convergent flaking method with a clear tendency toward Levallois point production, whereas the strategy of cores on flakes and *Nahr Ibrahim* technique was used together with Levallois methods in Yabroud I-6, particularly centripetal and convergent flaking methods. However, for Hovers (2007) as I suggest that both cores on flakes and the Nahr Ibrahim technique corroborate with some basic parameters of the Levallois concept (see subchapter 5.3). Therefore, the variability in Yabroud I-6 is difficult to be attributed to different strategies of core reduction. This, in turn, indicates an analogous technological behaviour of exploitation through reliance on only Levallois concept application, since both assemblages present evidence of high ability and flexibility to reduce Levallois methods on flakes. Furthermore, cores on flakes and/or *Nahr Ibrahim* technique in Yabroud I-6 represent analogous technological behaviour of exploitation —the intentional and delicate selection of the thickest part of flakes for exploitation—that is

also observed in the reduction of Levallois cores in Yabroud I-4. Thus, I agree with Hovers (2009) and Hauck (2011) that this kind of core on flake reduction is interlinked behaviorally with unidirectional Levallois reduction.

Interestingly, analogous technological behaviour of exploitation is also evidenced through the dominance of convergent scar patterns, despite different proportions of flakes, blades, and points, between and within each assemblage. Yabroud I-4 is characterized by a high proportion of Levallois points and triangular flakes accompanied by a moderate number of blades with a predominance of convergent Levallois cores. Yabroud I-6 has a predominance of both Levallois points, triangular flakes and quadrangular/oval-shaped flakes, with a prevalence of centripetal Levallois cores, which are mainly reduced in the second stage of core reduction, and cores on flakes and/or *Nahr Ibrahim* technique.

Technical and morphological variability in Levallois points versus more standardized characteristics, in Yabroud I-6 and 4 respectively, can be attributed to specific technical rather than functional reasons, unlike that was indicated in level VI3b'1 of Umm el Tlel (Boëda et al. 1999). In Yabroud I-4, the focus on Levallois point production resulted in the exclusive exploitation of the convergent flaking method, with systematically alternating and planned types of flaking surface preparation, aimed at maintaining the greatest width at the base of cores. This, in turn, caused more stable technology, producing standardized short, broad-based Levallois points that are seen in the point-dominated assemblages in Hummal HM-A1 (Hauck 2013). However, they exhibit slight variability, attributed to the variable obliqueness of the two preceding preparatory removals. Experimental work indicates that the more oblique the two preceding preparatory removals, the more typical the features of the Levallois point. In addition to the variability of proportions of Levallois blanks in Yabroud I-6, variability is discerned through the morphological, technical and metric characteristics of Levallois points. Non-standardized Levallois points were probably the result of unsystematic flaking surface preparation that relied on spatial preparation according to the condition of the flaking surface's convexity, without a planned purpose. They are also the result of low application of individual reduction sequences for point production, because convergent cores may have been shifted to cores for flake production. Consequently, the variability in Levallois points between both assemblages is difficult to ascribe to different functions or cultural human groups. It may be related to the skill of knappers since they used the same raw material and as a knapper I see that the systematic prepared flaking surface is eligible for producing a predetermined blank. According to the German saying "*Übung macht den Meister"*, the focus and repetition of

Levallois point production from individual reduction sequences, using the same method and the same types of flaking surface preparation, led to the production of standardized points, as was the case in point-dominated Yabroud I-4.

In addition, analogous human behaviour between both assemblages can not be seen only through adaptation to the local raw material available. But the occupants also invested the large size of cores for blade and point (elongated or not) production in the first stage of core reduction. However, each assemblage displays an idiosyncratic double strategy of core reduction. While the target of the second stage of core reduction was confined to obtaining quadrangular/oval-shaped flakes in Yabroud I-6, Levallois points were the preferred end-products of the second stage in Yabroud I-4. This variability in the exploitation of the second stage of core reduction may be the result of the occupants' differing needs. A clear difference between Levallois blanks in Yabroud I-6 and in Yabroud I-4 is that the former shows a greater laminar tendency. This is the result of mainly preparing the flaking surface of convergent cores by detaching elongated lateral removals. This gave the core more elongation and allowed for the production of Levallois points and elongated points from the same flaking surface, observed in Yabroud I-4, but more frequent in Yabroud I-6. Apart from their function, the similarity in tools in Yabroud I-6 and 4 is evident in the frequent use of retouch modification with a clear tendency towards its execution on triangular blanks.

Both assemblages more or less shared the same basic life circumstances, such as the time frame of occupation, the environmental situation, the raw materials used, the assemblage size, and finally the seasons in which they were occupied. However, Yabroud I-6 exhibits clear variability in its proportions of Levallois blanks. According to Simpson's diversity index, applied to all Levallois blanks and personal gear, variability in the archaeological records of Yabroud I-6 and 4 is evidence of the sites' different uses, residential and logistical mobility respectively. However, both provisioning of place and provisioning of individual strategies applied in both assemblages, with a predominance of provisioning of place strategy from the secondary position of raw material situated within a 5 km radius. Fluctuation in site use is a common character of late Mousterian cave sites, such as Kebara cave (Speth & Tchernov 2007) and open-air sites, Hummal and Umm el Tlel (Hauck 2013; Boëda et al. 2001). However, the low density of lithic material in both assemblages records palimpsests of multiple occupations for short-term periods. Interestingly, Yabroud I-6 displays more evidence of frequent reuse of discarded artefacts from previous events, either inside or outside, especially, it appears, through the exploitation of discarded bifaces due to the similarity of their volumetric properties with

prepared cores (Solecki & Solecki 2007). I am in total agreement with Pagli (2013, 2015) that occupants of both Yabroud I-6 and 4 were part of a high mobility system. However, I disagree that Yabroud I-6 was occupied by different cultural human groups, and that groups circulated the inland territory without returning to the same site. Groups of people who had an idea of the location of Yabroud Shelter I at an elevation of 1420 m a.s.l and the distribution of raw material, were part of high mobility systems and carried out micro-movements. This is suggested by the absence of exotic raw material, especially among the personal gear that is mainly Levallois blanks, which is more efficient as mobile elements (Geneste 1985; Henry 1995; Hovers 2009; Turq et al. 2013; Ekshtain et al. 2017) and the frequent reuse of discarded lithic material. Therefore, they may not have left the Yabroud area.

This is also supported by the successive occupation of YSI, where there was no stratigraphic break or major discontinuities is recorded. Furthermore, the Mousterian layers at a depth between 0 and 2 m seem to be filled by the same type of sediments and did not exhibit any distinct features (Rust 1950; Solecki & Solecki 1966; Heinzelin 1966). This indicates that both assemblages had the same climate. Finally, the elevation of YSI at 1420 m.a.s.l is very high compared with other late Middle Palaeolithic sites that are located just short distance upstream valleys such as Ksar Akil in the Mediterranean coast and those located in Wadi Amud and do not exceed 500 m.a.s.l. Therefore, this high elevation could not be occupied by accident as a point on the road. Rather this high elevation must have been pre-known by their occupants.

The near absence of botanical and faunal sediments in YSI makes it difficult to deduce the seasonality of occupation. However, the reconstruction of the environment indicates an arid climate, alternating between steppe and desert vegetation zones (Dodonov et al. 2006). In addition, specific layers from various depths of the shelter were deposited during warm periods (Schrøder et al. 2012), implying the difficulty of occupying the highlands during cold winters. All of the above combined with the availability of water tables and springs with the contribution of the Wadi-Al Majarre in the south imply that YSI might have formed an attractive micro climate for gregarious ungulates during spring and/or early summer.

There is total corroboration with Binford & Binford (1966) and Binford (1973, 2001) who saw the variability in lithic technology as a result of variable adaptive strategies resulting from different land use and different subsistence practices. In addition, Crew (1975) indicated that only the reconstitution of production methods can highlight the different industries: "*It is this variability in the execution of the method which must be measured, and not the qualities of the products, nor their number"* (Crew 1975, p. 6). Also, Meignen (2000) mentioned the

importance of taking not only the end-products and the tools into account, but also the strategies of core reduction for producing them. Thus, techno-typological traits of cores and blanks, types of flaking surface preparation, management and procurement of raw material in both assemblages 6 and 4 reflect analogous human behaviour in terms of core reduction, with slight differences attributed to the differing skills of knappers. Meanwhile, the variability in Levallois blanks may reflect increasing specialization on a single subsistence strategy in Yabroud I-4 versus different subsistence strategies and different land use strategy in Yabroud I-6.

Despite the similarity in environmental settings at a single site, at an interregional level Levantine Mousterian sites are mostly related to different functions. This may call for a greater focus on the human behaviour driven by different subsistence strategies and the function between inter-sites as a key to variability, instead attributing the variability of lithic technology and site use to different technological knowledge (though these effects cannot be ruled out). In addition, the skill of knappers must also be taken into account as a reason for the different technological and morphological characteristics of end-products, instead of attributing the heterogeneity of blanks to different functions. Given that the current study attests to analogous human behaviour despite the variability in technology between the two assemblages, the other late Mousterian assemblages of YSI require further investigation to deduce whether they also exhibit analogous human behaviour. In addition, light should be shed on the raw material resource used in the other Mousterian assemblages to widen our knowledge of mobility systems and whether occupants executed micro-movements or also left the region. The matter of attributing the strategy of cores on flakes or *Nahr Ibrahim* technique and Levallois methods to the same human behaviour is also an open question, requiring more investigation in order of the controversy around it to be settled in the future.

10. Summary

The archaeological record of YSI presents a long stratigraphy consisting of 25 layers, representing different lithic industries. They extend from Acheulo-Yabrudian industry, identified in the lower part of the shelter, to Mousterian industry in the uppermost 10 layers. YSI is situated in an ecotone area, at an elevation of 1420 m.a.s.l, in an arid climate alternating between steppe and desert vegetation zones. The shelter is ringed by water tables and springs with the contribution of the Wadi Al-Majarre coming from the south allowing for the development of wooded areas and forming an oasis with a microclimate that would attract gregarious ungulates, upon which foragers preyed. The current study aims to understand human behaviour in conjunction with their environment by identifying the variability in core reduction

strategies of the late Mousterian assemblages 6 and 4, land use practices and the mobility systems of hunter-gatherers. To this end, techno-typological analyses and transformation analyses were applied to 618 and 705 stone artefacts respectively. It must be noted that while fragments were including in the transformation analyses, heavy patinated pieces were excluded. The study consists of 5 main parts, each encompassing several chapters and subchapters.

The first part is made up of 4 chapters: chapter 1 presents a comprehensive overview of Yabroud Shelter I in terms of geographical and geological settings, the history of research, the paleoenvironment, and the raw material distribution according to the available data. Chapter 2 addresses an overview of the Levantine MP regarding the history of research of the most important sites and the human fossils discovered in the Levant up until 2020. Chapter 3 presents the materials and methods used to answer the questions posed by the research, concentrating on the Levallois concept as it is the most common reduction concept in the Levant. Furthermore, I propose a new method for investigating the technological reasons responsible for the typical textbook features of classical Levallois points (subchapter 3.3), i.e. the perfect triangular outline, *Concorde-shaped* distal termination, and the greatest width at the base. Finally, chapter 4 displays the inventory of assemblages 6 and 4.

The second part consists of chapters 5 and 6, with the essential content of the current study. Each addresses the techno-typological analyses and transformation analyses of the lithic material from the two assemblages.

In chapter 5, techno-typological variables of cores from assemblage 6 show clear variability in core reduction strategies through the application of both Levallois methods, cores on flakes, and *Nahr Ibrahim* technique (subchapters 5.2 and 5.3). The variables of blanks show the basic characteristics of Levallois methods, with the difficulty of differentiating between them and the end-products obtained by *Nahr Ibrahim* due to the similarity in volumetric properties and the negative of the last removal on both cores, and additionally, the rarity of Kombewa flakes. However, a comparison suggests that both strategies share the same basic criteria of the Levallois concept (subchapter 5.3.4). In contrast, variability appears in the types of Levallois blank, ranging from the predominant Levallois points (elongated or not), to triangular flakes, non-triangular flakes and less frequent blades (subchapter 5.4 and 5.5). This corresponds with the predominance of convergent scar patterns, but contradicts the predominance of cores for flake production. This indicates that core reduction sequences were shifted in advance stages. In subchapters 5.4 and 5.5, the morphometric features of Levallois blanks and by-product, specifically, core edge flakes and naturally backed knives (subchapter

5.6.2) as well as the transformation analyses (subchapter 5.8.4) show the investment of large core sizes to produce mainly blades and sometimes Levallois points in the first stage of core reduction. Levallois flakes were mainly removed in the second stage of core reduction because of their small mean size compared to other Levallois blanks. Subchapter 5.5 shows that while Levallois blanks are mainly a result of individual reduction sequences and double core reduction strategies, single reduction sequences were sometimes executed to produce Levallois blades, points, and flakes from a single flaking surface that was prepared by detaching elongated lateral removals that gave the core more elongated shape and resulted in higher length to width ratios and exhibiting slight characteristics of laminar production. This efficient strategy could meet various requirements from a single core, which in turn helps to decrease the load, facilitating mobility and the meeting of different needs. Moreover, despite the tendency towards Levallois point production, they exhibit clear variability in their technological features. This is a result of the irregular installation of flaking surface convexity by small and spatial removals according to the condition of the flaking surface, as well as the instability of core reduction strategies shifting from Levallois blade and/or point to flake production. Variability is also seen among the high numbers of personal gear (subchapter 5.8.1 and 5.8.2), which are mainly Levallois blanks. They are not only indicative of a high degree of provisioning of individual strategies, but also refer to high mobility systems due to the absence of exotic raw material. In addition, the number of by-products and the predominance of RMUs imported as partially prepared cores from secondary positions (subchapters 5.8.4) suggests a high degree of on-site core reduction as well as indicating the provisioning of place strategy. Simpson's Index of diversity gives a result of 0.56 for all Levallois blanks and 0.63 for the personal gear. This clear variability combined with the double or triple patination that appears on 11.4% of all blanks, and frequent reuse of old artefacts (e.g. re-reduction of bifaces, exploiting the lower surface of Levallois cores before their discard, cores on flakes and *Nahr Ibrahim* technique, and initial Levallois cores) refers to a palimpsest base camp with multiple occupations for short-term periods (see chapter 5.9).

In chapter 6, the techno-typological variables of cores and blanks in assemblage 4 show that only Levallois methods have been applied (subchapters 6.2 and 6.3.1). The clear stability in technology is mainly attributed to the planned tendency for on-site application of recurrent convergent method. Therefore, technological variables in cores and blanks exhibit no clear changes in strategies applied, and shows endeavour in human behaviour to manufacture short, broad-based Levallois points and triangular flakes (subchapters 6.3.1 and 6.4.1). The exclusive

application of the convergent flaking method resulted in the production of technologically and typologically standardized Levallois points. In addition, the application of two alternating preparation types to individual reduction sequences, through shifting from detaching unidirectional elongated lateral removals to bidirectional and perpendicular small removals, contributed to the continued production of short, broad-based Levallois points (subchapter 6.3.1 and 6.4.1). In subchapter 6.3.2, measurements of cross-sections and lateral angles of 100 Levallois points indicate that the obliqueness of the two predetermined, preparatory and preceding removals are related to the textbook features of classical Levallois points. The more oblique removal resulted in a regular lateral edge and *Concorde*-shaped distal termination. Also, the more convergent the two preceding removals, the broader the base of Levallois points. The combination of techno-typological analyses (subchapter 6.4.3) and transformation analyses (subchapter 6.7.4) revealed the application of two different Levallois methods on the same block. The first stage of core reduction was specialized to produce Levallois blades, then the block was shifted to obtain points. The predominance of raw material units imported as partially prepared cores (subchapters 6.7.4), reduction of cortical flake (subchapter 6.5.1), and reuse of discarded artefacts (subchapter 6.8.2) enable us to deduce that embedded strategies of raw material procurement were mainly executed. In addition, the clear presence of personal gear (subchapters 6.7.1 and 6.7.2) and the dominance of on-site core reduction (subchapter 6.7.4) suggest both strategies of place provisioning and individual provisioning. In subchapter 6.8, Simpson's Index of diversity gives a result of 0.47 for all Levallois blanks and 0.38 for the personal gear. These results together with double patination on 8% of the total indicate a palimpsestic specific-task site occupied for short-term periods. Subchapter 6.8.3 shows the high mobility system of hunter-gatherers due to the high number of personal gear made completely of local raw material with the total absence of exotic raw material.

Tools appeared in both assemblages almost equally with slightly more frequent in assemblage 4. Middle Palaeolithic group II is the most frequent tools in both assemblages 6 and 4, especially scrapers. They share the same human behaviour through executing the retouch on a single edge of Levallois blanks and scarcity of reverse retouch. However, while the modification is more concentrated on the uppermost part of the blanks in assemblage 4, it is observed more on the lowermost part of the blanks in assemblage 6.

A comparison between the compositions of assemblages 6 and 4 can be seen in Table. 36 (chapter 7). The table displays the most different and similar points observed. Finally, I place the late Mousterian industries of assemblages 6 and 4 in the Levantine context through

the discussion in chapter 8, showing the technological similarity of assemblage 4 with other Levantine sites such as Hummal HM-A1, Kebara IX-X, and Tor Faraj level C. All exhibit a clear focus on Levallois point production with a high degree of morphological standardization, and a predominance of convergent scar patterns. The technology of assemblage 6, on the other hand, shows some affinities to Hummal HM-A2 and level VI 3b'1 of Umm el Tlel in terms of the great variability in blank morphology and production of elongated points and a slight tendency of laminar production, and with Amud B4 in the predominance of convergent scar patterns despite the dominance of flakes. There is a recap of the current study's findings in the conclusion, where questions for future research are also proposed. Finally, an outline of current study is drawn up in the summary.

	Assemblage 6	**Assemblage 4**
Core reduction strategy (subchapter 7.2)	clear variability in core reduction strategies. • Levallois methods. • cores on flakes and Nahr Ibrahim Technique.	no changes in core reduction strategies. • only Levallois methods.
Dominant Levallois cores (subchapter 7.2.1 - 7.2.3)	Levallois cores for flake production	Levallois cores for point production.
Flaking surface preparation of Levallois cores for points (subchapter 7.6.1)	non-systematic types of flaking surface preparation	systematic and planned types of flaking surface preparation.
Dominant scar patterns (subchapter 7.6)	**prominence of unidirectional convergent scar patterns**	
Variability of Levallois blanks (subchapter 7.6)	variability of Levallois blank production with dominance of Levallois points, triangular flakes, and Levallois flakes.	tendency toward Levallois point and triangular flake production.
Strategy of Levallois point production (subchapter 7.6.1)	**predominance of individual reduction sequence for Levallois point production in both assemblages**	
	• double strategy of core reduction for Levallois point production. • first phase: Levallois blades or points. • second phase: Levallois flakes.	• double strategy of core reduction for Levallois point production. • first phase: Levallois blades. • second phase: Levallois points.
	Levallois blade, point and flakes produced from a single flaking surface in both assemblages	
Standardization of Levallois points (subchapter 7.6.1)	• clear variability of technical and morphological characteristics of Levallois points.	• clear standardization of technical and morphological characteristics of Levallois point.

Reason for non-standardization versus standardization	• may have been related to less skilled knappers • as result of unsystematic preparation of flaking surface.	• may have been related to highly skilled knappers. • as result of systematic preparation of flaking surface. • exclusive using convergent flaking method.
Strategy of Levallois flake production (subchapter 7.6.2)	predominance of Levallois flake production from a double strategy of core reduction.	paucity of individual reduction sequence for Levallois flake production because it is point-bearing assemblage.
Strategy of Levallois blade production (subchapter 7.6.3)	• paucity of individual reduction sequence for Levallois blade production. • less frequent as by-products of Levallois point production.	• more frequent individual reduction sequence for Levallois blade production. • more frequent as by-products of Levallois point production.
	limitation of Levallois blade production to the first stage of core reduction, investing the large size of cores	
Diversity of Levallois blanks according to Simpson's Index	high diversity 0.56	low diversity 0.47
Tools (subchapter 7.7)	• low to moderate percentage. • modification is concentrated on the lowermost part of blanks. • retouch distributes on different Levallois blank types.	• more frequent. • modification is concentrated on the uppermost part of blanks. • mainly retouched on Levallois points and triangular flakes.
	• **retouch is dominant type of modification.** • **scrapers are dominant.** • **reverse retouch is rare.** • **modification executed mainly on Levallois blanks.**	
Land use (subchapter 7.9)	• a base camp for short-term periods because of the low density of artefacts. • different subsistence strategies.	• a specific-task site for short-term periods. • more specialization on a single subsistence strategy.
Time of occupation	**possibly in spring seasons or early summer for sporadic periods**	
Reuse of old artefacts	**clear in both assemblages with more intensive reuse in assemblage 6**	
Number of personal gears (provisioning of individual)	**high number of mainly Levallois blanks**	
On-site reduction (provisioning of place)	**highly applied**	
Diversity of personal gears according to Simpson's Index	Clear diversity of Levallois blanks (points and flakes) with a result of 0.63 (Simpson's Index of diversity).	low diversity of Levallois blanks (mainly Levallois points) with a result of 0.38 (Simpson's Index of diversity).
Mobility system	**highly mobile hunter-gatherers, but in micro-movements due to the absence of exotic raw materials**	
Raw material procurement	**embedded in the subsistence schedule with predominance of import of partially prepared core and rarity of nodule import.**	

Table. 36. Summary of most important similarities and differences between the lithic industries of assemblages 6 and 4. Similarities in bold.

Biography

Abbreviation

BAR	British Archaeological Reports
CNRS	Centre National de la Recherche Scientifique
CTHS	Comite des Travaux Historiques et Scientifiques

Abu Ghazleh, S., 2011. Lake Lisan and the Dead Sea: Their Level Changes and the Geomorphology of their Terraces. Ph.D. Dissertation, Technische Universität.

Adler, D. S., Wilkinson, K. N., Blockley, S., Mark, D. F., Pinhasi, R., Schmidt-Magee, B. A., Nahapetyan, S., Mallol, C., Berna, F., Glauberman, P. J., Raczynski-Henk, Y., Wales, N., Frahm, E., Jöris, O., MacLeod, A., Smith, V. C., Cullen, V. L., Gasparian, B., 2014. Early Levallois technology and the Lower to Middle Paleolithic transition in the Southern Caucasus. *Science* (345), pp. 1609-1613.

Akazawa, T., 1974. Palaeolithic assemblages from the Douara Cave site. *Bulletin of the Museum of the University of Tokyo* 6.

Akazawa, T., 1979. Middle Paleolithic assemblages from Douara Cave. *Bulletin of the Museum of the University of Tokyo* 16, pp. 1-30.

Akazawa, T., Dodo, Y., Muhesen, S., Abdul-Salam, A., Abe, Y., Kondo, O., Mizoguchi, Y., 1993. The Neanderthal Remains from Dederiyeh Cave, Syria: Interim Report. *Anthropological Science* 101(4), pp. 361-387.

Akazawa, T., Muhesen, S., Dodo, Y., Kondo, O., Mizoguchi, Y., Abe, Y., Nishiaki, Y. A., Ohta, S., Oguchi, T., Haydal, J., 1995. Neanderthal infant burial from the Dederiyeh cave in Syria. *Paléorient* 21 (2), pp. 77-86.

Akazawa, T., Muhesen, S., 2002. Neanderthal Burials. Excavations of the Dederiyeh Cave, Afrin, Syria. Studies in honour of Hisashi Suzuki. Kyoto: International Research Center for Japanese Studies, 394 p.

Akazawa, T., Muhesen, S., Dodo, Y., Kondo, O., Yoneda, M., Griggo, C., Hakime, I., 2004. Neandertal Burials: Excavations of Dederiyeh Cave, Syria. In: Aurenche O., Le Miere M., Sanlaville P. (Eds.), From the River to the Sea. The Paleolithic and the Neolithic on the Euphrates and in the Northern Levant. Studies in Honor of Lorraine Copeland. Oxford: BAR International Series 1263, pp. 241 - 270.

AL Ahmar, H., 2015. L'Épipaléolithique dans les régions arides et semi arides en Syrie. Ph.D. Dissertation, Université Paris Ouest Nanterre la Défense.

Alex, B., Barzilai, O., Hershkovitz, I., Marder, O., Berna, F., Caracuta, V., Abulafia, T., Davis, L., Goldberger, G. M., Lavi, R., Mintz, E., Regev, L., Bar-Yosef Mayer, D., Tejero, M. J., Yeshurun, R., Ayalon, A., Bar-Matthews, M., Yasur, G., Frumkin, A., Latimer, B., Hans, G. M., Boaretto, E., 2017. Radiocarbon chronology of Manot Cave, Israel and Upper Paleolithic dispersals. *Science Advances* 3: e1701450.

Al Kassem, A., 2015. Al Khawaby Valley- A New Site Dated to Prehistory South of Syria. Jordan. *Journal for History and Archaeology* 9 (1), pp. 89-106.

Al Kassem, A., 2013. Palaeolithic sites in the south of Daraa, Syria. Unpublished Master thesis, Damascus University.

Al Qadi, A., 2008. Le Yabroudien et la transition entre le Paléolithique inférieur et moyen au Proche-Orient, l'exemple d'El Kowm (Syrie centrale). Mémoire de Master, Université de Bâle.

Al Qadi, A., 2016. Le Yabroudien: un faciès paléolithique au Proche-Orient Etude des variabilités techniques des industries lithiques au Levant. Ph.D. Dissertation, Université de Genève.

Al Qadi, A., Awad, N., Albukaai, D., A L Asaad, W., Khawam, R., Ali, H., 2015. Aïn Jawal (cuvette d'El Kowm, Syrie centrale). Un niveau d'occupation néolithique précéramique autour d'un puits artésien : résultats préliminaires. *Syria* (92), pp. 225-238.

Al Sakhel, H., 2004. Le Paléolithique moyen dans des oasis du Proche-Orient Ph.D. Dissertation, Université de Paris-X Nanterre, Paris.

Andrefsky, J. W., 2005. Lithics: Macroscopic Approaches to Analysis. Cambridge University Press, Cambridge.

Arensbourg, A., Bar-Yosef, O., Belfer-Cohen, A., Rak, Y., 1990. Mousterian and Aurignacian human remains from Hayonim Cave. *Paléorient* 16 (1), pp. 107-109.

Arensburg, B., Belfer-Cohen, A., 1998. Sapiens and Neandertals: rethinking the Levantine Middle Paleolithic hominins. In: Akazawa, T., Aoki, K., Bar-Yosef, O. (Eds.), Neandertals and Modern Humans in Western Asia. Kluwer Academic Publishers, New York, pp. 311-322.

Arensburg, B., 2002. Human remains from Geula Cave, Haifa. *Bulletins et mémoires de la Société d'Anthropologie de Paris* 14 (1-2), pp. 141-148.

Bakdach, J., 1982. Das Jungpalaolithikum von Jabrud in Syrien. Ph.D. Dissertation, Universität zu Köln.

Bar-Yosef, O., 1989. Geochronology of the Levantine Middle Paleolithic. In: Mellars, P. A., Stringer, C. B. (Eds.), The Human Revolution. Edinburgh University Press, Edinburgh, UK, pp. 589-610.

Bar-Yosef, O., 1992. Middle Paleolithic adaptation in the Mediterranean Levant. In: Akazawa, T., Aoki, K., Kimura, T. (Eds.), The Evolution and Dispersal of Modern Human in Asia. Hokusen-Sha, Tokyo, pp. 189-216.

Bar-Yosef, O., 1998. The chronology of the Middle Paleolithic of the Levant. In: Akazawa, T., Aoki, K., Bar-Yosef, O. (Eds.), Neandertals and Modern Humans in Western Asia. Plenum, New York, pp. 39-56.

Bar-Yosef, O., Belfer-Cohen, A., 2013. Following Pleistocene road signs of human dispersals across Eurasia. *Quaternary International* 285, pp. 30-43.

Bar-Yosef, O., Belfer-Cohen, A., 2019. The Upper Paleolithic Industries of Kebara Cave. In: Meignen, L., Bar-Yosef, O. (Eds.), Kebara Cave, Mt Carmel, Israel: The Middle and Upper Paleolithic Archaeology, Part II. American School of Prehistoric Research, Peabody Museum, Harvard University Press, pp. 309-401.

Bar-Yosef, O., Callander, J., 1999. The woman from Tabun: Garrod's doubts in historical perspective. *Journal of Human Evolution* 37, pp. 879-885.

Bar-Yosef, O., Meignen, L., 1992. Insights into Levantine Middle Paleolithic cultural variability. In: Dibble, H. L., Mellars, P. (Eds.), The Middle Paleolithic: adaptation, behavior, and variability. The University Museum, Philadelphia, pp. 163-182.

Bar-Yosef O., Meignen, L., 2001. The chronology of the Levantine Middle Palaeolithic period in retrospect. Analyse retrospective de la chronologie du Paleolithique moyen du Levant. *Bulletins et Memoires de la Societe d'Anthropologie de Paris* 13 (3-4), pp. 269-289.

Bar-Yosef, O., Vandermeersch, B. (Eds.), 1991. Le Squelette Mousterien de Kebara 2, Mt. Carmel, Israel, Editions du CNRS, Paris.

Bar-Yosef, O., Van Peer, P., 2009. The chaîne opératoire approach in Middle Paleolithic archaeology. *Current Anthropology* 50 (1), pp. 103-131.

Bar-Yosef, O., Belfer-Cohen, A., Goldberg, P., Kuhn, L. S., Meignen, L., Vandermeersch, B., Weiner, S., 2005. Archaeological background to Hayonim Cave and Meged Rockshelter. In: Stiner, M. C. (Ed.), The faunas of Hayonim Cave, Israel. A 200'000-year record of Paleolithic diet, demography, and society. Peabody Museum of Archaeology and Ethnology, Cambridge, pp. 17-38.

Bar-Yosef, O., Vandermeersch, B., Arensburg, B., Belfer-Cohen, A., Goldberg, P., Laville, H., Meignen, L., Rak, Y., Speth, J. D., Tchernov, E., Tillier, A. M., Weiner, S., Clark, G. A., Garrard, A., Henry, D. O., Hole, F., Roe, D., Rosenberg, K. R., Schepartz, L. A., Shea, J. J., Smith, F. H., Trinkaus, E., Whalen, N. M., Wilson, L., 1992. The excavations in Kebara Cave, Mt. Carmel. *Current Anthropology* 33(5), pp. 497-550.

Barzilai, O., Hershkovitz, I., Marder, O., 2016. The early Upper Paleolithic period at Manot Cave, Western Galilee, Israel. *Human Evolution* 31(1–2), pp. 85-100.

Barzilai, O., Gubenko, N., 2018. Rethinking Emireh Cave: The lithic technology perspectives, *Quaternary International* 464 (A), pp. 92-105.

Been, E., Hovers, E., Ekshtain, R., Malinski-Buller, A., Agha, N., Barash, A., Mayer, D. E. B., Benazzi, S., Hublin, J. J., Levin, L., Greenbaum, N., Mitki, N., Oxilia, G., Porat, N., Roskin, J., Soudack, M., Yeshurun, R., Shahack-Gross, R., Nir, N., Stahlschmidt, C. M., Rak, Y., Barzilai, O., 2017. The first Neanderthal remains from an open-air Middle Palaeolithic site in the Levan. Scientific reposts, pp. 1-8.

Binford, L. R., 1973. Interassemblage variability - the Mousterian and the "functional" argument. In: Renfrew, C. (Ed.), The explanation of culture change: Models in prehistory. Proceedings of a meeting of the Research Seminar in Archaeology and Related Subjects held at the University of Sheffield. Duckworth, London, pp. 227-254.

Binford, L. R., 1979. Organization and formation processes: Looking at curated technologies. *Journal of Anthropological Research* 35(3), pp. 255-273.

Binford, L. R., 1980. Willow smoke and dogs' tails: hunter-gatherer settlement systems and archaeological site formation. *American Antiquity* 45 (1), pp. 4-20.

Binford, L. R., 2001. Constructing frames of reference: An analytical method for archaeological theory building using hunter-gatherer and environmental data sets. University of California Press, Berkeley.

Binford, L. R., Binford, S. R., 1966. A preliminary analysis of functional variability in the Mousterian of Levallois facies. *American Anthropologist* 68(2), pp. 238-295.

Blinkhorn, J., Zanolli, C., Compton, T., Groucutt, H. S., Scerri1, E. M. L., Crété, L., Stringer, Ch., Petraglia, M. D., Blockley., 2021. Nubian Levallois technology associated with southernmost Neanderthals. *Science Report* 11, 2869, pp. 1-13.

Boëda, E., 1982. Etude éxperimentale de la technologie des pointes Levallois. *Studia Praehistorica Belgica* 2, pp. 23-56.

Boëda, E., 1986. Approche technologique du concept Levallois et évaluation de son champ d'application. Ph.D. Dissertation, Université de Paris X.

Boëda, E., 1988. Le concept laminaire: rupture et filiation avec le concept Levallois. In: Otte, M. (Ed), L'homme de Néandertal (8). ERAUL, Liège, pp. 41-59.

Boëda, E., 1990. De la surface au volume: analyse des conceptions des débitages Levallois et laminaire. In: Farizy, C. (Ed.), Paléolithique moyen récent et paléolithique supérieur ancien en Europe. Ruptures et transitions: Examen critique des documents archéologiques. CNRS, Nemours, pp. 63-68.

Boëda, E., 1994. Le concept Levallois: Variabilité des méthodes. CNRS, Paris.

Boëda, E., 1995. Levallois: A volumetric construction, methods, a technique. In: Dibble, H. L., Bar-Yosef, O. (Eds.), The definition and interpretation of Levallois technology. Prehistory Press, Madison (Wis.), pp. 41-68.

Boëda, E., Geneste, J. M., Meignen, L., 1990. Identification de chaînes opératoires lithiques du Paléolithique ancien et moyen. *Paléorient* 2, pp. 43-80.

Boëda, E., Bourguignon, L., Griggo, C., 1998. Activités de subsistance au Paléolithique moyen: couche VI3 b' du gisement d'Umm El Tlel (Syrie). In: Brugal, J.P., Meignen, L., Patou-Mathis, M. (Eds.), Économie préhistorique: les stratégies de subsistance au Paléolithique. XVIIIe Rencontres Internationales d'Archéologie et d'Histoire d'Antibes. Editions Association pour la Promotion et la Diffusion des Connaissances Archéologiques, Antibes, pp. 243-258.

Boëda, E., Geneste, J. M., Griggo, C., Mercier, N., Muhesen, S., Reyss, J. L., Taha, A., Valladas, H., 1999. A Levallois point embedded in the vertebra of a wild ass (Equus africanus): hafting, projectiles and Mousterian hunting weapons. *Antiquity* 73, pp. 394-402.

Boëda., E., Criggo. C., Noël-Soriano. S., 2001. Différents modes d'occupation du site d'Umm el Tlel au cours du Paléolithique moyen (El Kowm, Syrie centrale). *Paléorient* 27 (2), pp. 13-28.

Boëda, E., Bonilauris, S., Connan, J., Jarvie, D., Mercier, N., Tobey, M., Valladas, H., AL Sakhel, H., 2008. New evidence for significant use of bitumen in Middle Palaeolithic technical systems at Umm el Tlel (Syria) around 70.000 BP. *Paléorient* 34 (2), pp. 67-83.

Bonnemaison, J., 2000. La geographie culturelle. Paris, Editions du CTHS.

Bordes, F., 1950. Principes d'une méthode d'étude des techniques de débitage et de la typologie du Paléolithique ancien et Moyen. *L'Anthropologie* 54 (1-2), pp. 19-34.

Bordes, F., 1955. Le Paléolitique inférieur et Moyen de Yabrud (Syrie) et la Question du Pré-aurignacien. *L'Anthropologie* 59 (5-6), pp. 486-507.

Bordes, F., 1961. Typologie du Paléolithique ancien et moyen. CNRS, Paris.

Bordes, F., 1980. Le Debitage Levallois et ses variantes. *Bulletin de la Societe Prehistorique Francaise* 77, pp. 45-49.

Bordes, F., 1984. Leçons sur le Paléolithique, Tome III. Paris: Éditions du CNRS.

Bourguignon, L., 1997. Le Mousterien de type Quinaı: nouvelle definition d'une entite technique. Ph.D. Dissertation, Universite Paris X – Nanterre 2, 671 p.

Bourke, S. J. 1998. Two human teeth from Ras el-Kelb. In: Copeland L., Moloney, N. (Eds.), The Mousterian Site of Ras-El Kelb, Lebanon. Oxford: BAR International Series 706, pp. 68-72.

Brunnacker, K., 1970. Die sedimente des Schutzdaches I von Jabrud (Syria). In: Gripp, K., Schutrumpf, R., Schwabedissen, H. (Eds.), Frühe Menschheit und Umwelt, Fundamenta, Monographien zur Urgeschichte. Köln Wien : Böhlau Verlag, pp. 189-198.

Buccellati, G., Buccellati, M. K., 1967. Archaeological survey of the Palmyrene and the Jebel Bishri. *Archaeology* 20, pp. 305-306.

Cauvin, J., Cauvin. C. M., Stordeur. D., 1979. Recherches Prehistoriquses A Al kowm –Syrie. Première champagne 1978. *Cahiers de la Euphrate* 2, pp. 80-117.

Chazan, M., 1997. Redefining Levallois. *Journal of Human Evolution* 33, pp. 719-735.

Cheddadi, R., Rossignol-Strick. M., 1995. Eastern Mediterranean quaternary paleoclimates from pollen isotope records of marine cores in the Nile cone area. *Paleoceanography* 10 (2), pp. 291-300.

Clark, A. G, Lindly, J. M., 1988. The Biocultural Transition and the Origin of Modern Humans in the Levant and Western Asia. *Paléorient* 14 (2), pp. 159-167.

Conard, N. J., Kandel, A. W., Dodonov, A. E., AL Masri, M., 2004. Middle Palaeolithic settlement in the Ma'aloula region of the Damascus Province, Syria. In: Conard. N. J. (Ed.), Settlement Dynamics of the Middle Paleolithic and Middle Stone Age II. Tübingen: Kerns Verlag, pp. 65-87.

Conard, N. J., Kandel, A. W., Dodonov, A. E., Masri, M., 2006. Middle Palaeolithic settlement in the Ma'aloula Region of the Damascus Province, Syria. In: Conard. N. J. (Ed.), Tubingen-Damascus Excavation and Survey Project: 1999 - 2005. Tübingen: Kerns Verlag, pp. 239-256.

Conard, N. J., Malina M., Masri, M., 2008a. The 2007 excavations at Wadi Mushkuna RockShelter, Damascus Province, Syria. In: Abdulrahman, A. (Ed.), Chronique archéologique en Syrie. Al Bassel Centre for Archaeological Research and Training and the Directorate General of Antiquities and Museums, Syria, pp. 25-34.

Conard, N. J., Dodonov, A. E., Dodonov, M., 2008b. The 2007 TDASP survey and geological research in the Damascus Province, Syria. In: Abdulrahman, A. (Ed.), Chronique archéologique en Syrie. Al Bassel Centre for Archaeological Research and Training and the Directorate General of Antiquities and Museums, Syria, pp. 41-52.

Conard, N. J., Bretzke, K., Masri, M., Napierala, H., Kandel, A.W., 2010. Modeling Middle Palaeolithic land use in the Damascus province, Syria. In: Conard. N. J., Delagnes, A. (Eds.), Settlement Dynamics of the Middle Palaeolithic and Middle Stone Age III. Tübingen: Kerns Verlag, pp. 123-144.

Copeland, L., 1975. The Middle and Upper Paleolithic of Lebanon and Syria in the light of recent research. In: Wendorf, F., Marks, A. E. (Eds.), Problems in prehistory: North Africa and the Levant. SMU Press, Dallas, pp. 317-350.

Copeland, L., 1978. The Middle Palaeolithic of Adlun and Ras el Kelb (Lebanon): First results from a study of the flint industries. *Paléorient* 4, pp. 33-57.

Copeland, L., 1981. Chronology and distribution of the Middle Paleolithic, as known in 1980, in Lebanon and Syria. In: Préhistoire du Levant Chronologie et organisation de l'espace depuis les origines jusqu'au VIe millénaire Colloques Internationaux du CNRS No 598. Centre national de la recherche scientifique (CNRS), Lyon, Maison de l'Orient méditerranéen, pp. 239-263.

Copeland, L., 1983a. The Levalloiso-Mousterian of Bezez Cave, Level B. In: Roe, D. A. (Ed.), Adlun in the Stone Age The excavations of DAE Garrod in the Lebanon, 1958-1963. *British Archaeological Reports*, Oxford, pp. 261-329.

Copeland, L., 1983b. Levallois / Non-Levallois determinations in the early Levant Mousterian. Problems and questions for 1983. *Paléorient* 9, pp. 15-27.

Copeland, L., 1998. The Middle Palaeolithic flint industry of Ras el-Kelb. In: Copeland. L., Moloney. N. (Eds.), The Mousterian Site of Ras el-Kelb, Lebanon. Oxford: BAR International Series 706, pp. 73-175.

Coppa, A., Grun, R., Stringer, C., Eggins, S., Vargiu, R., 2005. Newly recognized Pleistocene human teeth from Tabun Cave, Israel. *Journal of Human Evolution* 49 (3), pp. 301-315.

Coppa, A., Mannif, F., Stringer, C., Vargiu, R., Vecchi, F., 2007. Evidence for new Neanderthal teeth in Tabun Cave (Israel) by the application of self-organizing maps (SOMs). *Journal of Human Evolution* 52 (6), pp. 601-613.

Couture, C., 1998. Le fragment d'occipital d'Umm el Tlel (Syrie). In: Otte, M. (Ed.), Prehistoire d'Anatolie, Genese de deux mondes. Liege, ERAUL 85, pp. 775-784.

Crew, H. L., 1975. An examination of the variability of the Levalloisian method: its implications for the internal and external relationships of the Levantine Mousterian. Ph.D. dissertation, University of California.

Crew, H. L., 1976. The Mousterian Site of Rosh Ein Mor. In: Marks, A. E. (Ed.), Prehistory and Paleoenvironments in the Central Negev, Israel, Vol. 1. Dallas: Southern Methodist University Press, pp. 75-112.

Culley, E. V., Popescu, G., Clark, G. A., 2012. An analysis of the compositional integrity of the Levantine Mousterian facies. *Quaternary International* 30, pp. 213-233.

DeBono, H., Goren-Inbar, N., 2001. Note on a link between Acheulian handaxes and the Levallois method. *Journal of the Israel Prehistoric Society* 31, pp. 9-23.

Demidenko, Y. E., Usik, V., 2003. Into the mind of the maker: refitting study and technological reconstructions. In: Henry, D. O. (Ed.), Neanderthals in the Levant. Behavioral organization and the beginnings of human modernity. Continuum, London, pp. 107-155.

d'Errico, F., Zilhao, J., Julien, M., Baffier, D., Pelegrin, J., 1998. Neanderthal Acculturation in Western Europe? A Critical Review of the Evidence and its Interpretation. *Current Anthropology* 39 (supplement): S1–S44.

Diab, A., 2005. The Palaeolithic of the East of Asia. Ph.D. Dissertation, Cairo University.

Diab, A., 2011. Study of the stone artefacts of Palaeolithic sites in southwestern Daraa in Syria. Journal of historical studies. Vol, 115-116. Damascus university, pp. 1-22.

Dibble, H. L., 1989. The implications of stone tool types for the presence of language during the Lower and Middle Paleolithic. In: Mellars, P., Chris, S. (Eds.), The human

revolution: Behavioural and biological perspectives on the origins of modern humans. Edinburgh University Press, Edinburgh, pp. 415-432.

Dibble, H. L., Bar-Yosef, O., 1995. The definition and interpretation of Levallois technology. Prehistory Press, Madison (Wis.).

Dodonov, A. E., Kandel, A. W., Simakova, A. N., AL Simakova, M., Conard. N. J., 2006. Geomorphology, site distribution and Paleolithic settlement dynamics of the Ma'aloula Region, Damascus Province, Syria. In: Conard, N. J. (Ed.), Tübingen-Damascus Excavation and Survey Project 1999 - 2005. Tübingen: Tübingen Publications in Prehistory, pp. 257-273.

Dodonov, A. E., Kandel, A. W., Simakova, A. N., AL Masri, M., Conard, N. J., 2007. Geomorphology, Site distribution, and Palaeolithic settlement dynamics of the Ma'aloula Region, Damascus Province, Syria. *Geoarchaeology* 22 (6), pp. 589-606.

Ekshtain, R., Malinsky-Buller, A., Greenbaum, N., Mitki, N., Stahlschmidt, C. M., Shahack-Gross, R., Nir, N., Porat, N., Mayer, E. D., Yeshurun, R., Been, E., Rak, Y., Agha, N., Brailovsky, L., Krakovsky, M., Spivak, P., Ullman, M., Vered, A., Barzilai, O., Hovers, E., 2019. Persistent Neanderthal occupation of the open-air site of 'Ein Qashish, Israel. *PLoS ONE* 14 (6), pp. 1-34.

Ekshtain, R., Ilani, S., Segal, I., Hovers, E., 2017. Local and Nonlocal Procurement of Raw Material in Amud Cave, Israel: The Complex Mobility of Late Middle Paleolithic Groups. *Geoarchaeology* 32: pp. 189-214.

EL Kassem, M., 2001. Das Jabrudien von Jabrud (Syrien): Felsdach I, 25. Magisterarbeit, Universität zu Köln.

Eren, M. I., Bradley, B. A., 2009. Experimental evaluation of the Levallois "Core Shape Maintenance" hypothesis. *Lithic Technology* 34 (2), pp. 119 -125.

Ewing, J. F., 1947. Preliminary note on the excavations at the Paleolithic site of Ksar' Akil, Republic of Lebanon. *Antiquity* 21, pp. 186-196.

Experimental work: Brenet, M and Al Kassem, A.

Farrand, W. R., 1965. Geology, climate and chronology of Yabrud Rock Shelter I. *Les Annales Archéologiques Arabes Syriennes* 15 (1), pp. 35-50.

Farrand, W. R., 1970. Geology, climate and chronology of Yabroud Rock-Shelter I. In: Gripp, K., Schutrumpf, R., Schwabedissen, H. (Eds.), Frühe Menschheit und Umwelt. Fundamenta, Monographien zur Urgeschichte. Köln Wien: Böhlau Verlag, pp. 212-223.

Farrand, W. R., 1979. Chronology of palaeoenvironment of Levantine prehistoric sites as seen from sediment studies. *Journal of Archaeological Science* 6, pp. 369-392.

Farrand, W., 1994. Confrontation of geological stratigraphy and radiometric dates from Upper Pleistocene sites in the Levant. In: Bar-Yosef, O., Kra, R. (Eds), Late Quaternary Chronology and Palaeoclimate of the Eastern Mediterranean. Arizona: Radiocarbon, pp. 33-53.

Fleisch, H., 1970. Les habitats du Paléolithique moyen à Naamé (Liban*). Bulletin du Musée de Beyrouth* XXIII, pp. 25-93.

Fleisch, H., 1971. Les sables de Beyrouth (Liban) et leurs industries préhistoriques. *Fundamenta Reihe* A (2), Frühe Menschheit und Umwelt, Koln, pp. 171-180.

Foley, R., Lahr, M. M., 1997. Mode 3 technologies and the evolution of modern humans. *Cambridge Archaeological Journal* 7, pp. 3-36.

Frank, T., 2004. Die Levallois-Spitzen von Jabrud, Felsdach I, Schichten 2 – 4. Magisterarbeit, Universität zu Köln.

Freidline, S. E., Gunz, P., Jancovic, I., Harvati, K., Hublin, J. J., 2012. A comprehensive morphometric analysis of the frontal and zygomatic bone of the Zuttiyeh fossil from Israel. *Journal of Human Evolution* 62 (2), pp. 225-241.

Friesem, D., Malinsky-Buller, A., Ekshtain, R., Gur-Arieh, S., Vaks, A., Mercier, N., Richard, M., 2019. New Data from Shovakh Cave and Its Implications for Reconstructing Middle Paleolithic Settlement Patterns in the Amud Drainage, Israel. *Journal of Paleolithic Archaeology* 2 (3), pp. 298-337.

Garrod, D. A. E., 1934. The Stone Age of Palestine. *Antiquity* 8 (3), pp. 133-150.

Garrod, D. A. E., 1962. The Middle Palaeolithic of the Near East and the Problem of Mount Carmel Man. *The Journal of the Royal Anthropological Institute* 92 (2), pp. 232-259.

Garrod, D. A. E., Bate, D. M. A., 1937. The Stone Age of Mount Carmel: Excavations at the Wady el- Mughara: Report of the joint expedition of the British School of Archaeology in Jerusalem and the American School of Prehistoric Research 1929 - 34. Oxford.

Garrod, D. A. E., Henri-Martin, G., 1961. Rapport preliminaire sur la fouille d'une grotte au Ras el-Kelb. *Bulletin du Musee de Beyrouth* XVI, pp. 61–67.

Garrod, D. A. E., Kirkbride, D., 1961. Excavation of the Abri Zumoffen: A Palaeolithic rockshelter near Adlun in South Lebanon. *Bulletin du Musee de Beyrouth* XVI, pp. 7-45.

Geneste, J.-M., 1985. Analyse lithique d'industries moustériennes du Périgord: Une approche technologique du comportement de groupes humains au Paléolithique moyen. Ph.D. dissertation, University of Bordeaux.

Geneste, J.-M., 1989. Economie des ressources lithiques dans le Moustérien du Sud-Ouest de la France. In: Otte, M. (Ed.), L'Homme de Neandertal: La subsistance. ERAUL, Liège, pp. 75-98.

Geyer, B., Sanlaville, P., 1991. Signification et chronologie des terrasses holocènes du bassin syrien del'Euphrate. *Physio-Géo* 22-23, pp. 101-106.

Gilead, I., 1980. A Middle Palaeolithic Open-Air Site near Tell Far'ah, Western Negev: Preliminary Report. *Israel Exploration Journal* 30, pp. 52–62.

Gisis, I., Bar-Yosef, O., 1974. New Excavation in Zuttiyeh Cave, Wadi Amud, Israel. *Paléorient* 2, pp. 175-180.

Goder-Goldberger, M., Crouvi, O., Caracuta, V., Horwitz, L., Neumann, H. F., Porat, N., Scott, L., Shavit, R., Jacoby-Glass, Y., Zilberman, T., Boaretto, E., 2020. The Middle to Upper Paleolithic transition in the southern Levant: New insights from the late Middle Paleolithic site of Far'ah II, Israel. *Quaternary Science Review* 237, pp. 1-19.

Goder-Goldberger, M., Bar-Matthews, M., 2019. Novel chrono-cultural constraints for the Middle Paleolithic site of Rosh Ein Mor (D15), Israel. *Journal of Archaeological Science* 24, pp. 102-114.

Goldberg, P., 1971. Analyses of sediments of Jerf 'Ajla and Yabrud Rockshelters Syria. In: Ters M. (Ed.), Etudes sur le Quaternaire dans le monde. Union Internationale pour l'Etude du Quaternaire, VIIIe Congres INQUA, Paris, pp. 747-754.

Goren-Inbar, N., 1988a. Notes on "Decision Making" by Lower and Middle Palaeolithic Hominins. *Paléorient* 14, pp. 99–108.

Goren-Inbar, N., 1988b. Too Small to be True? Reevaluation of Cores on Flakes in Levantine Mousterian Assemblages. *Lithic Technology* 17, pp. 37-44.

Goren-Inbar, N., 1990. The lithic assemblages. In: Goren-Inbar, N. (Ed.), Quneitra: A Mousterian site on the Golan Heights. The Hebrew University of Jerusalem, Jerusalem, pp. 61-149.

Goring-Morris, N., Hovers, E., Belfer-Cohen, A., 2009. The dynamics of Pleistocene and Early Holocene settlement patterns and human adaptations in the Levant: an overview. In: Lieberman, D. E., Shea, J. J. (Eds.), ransitions in Prehistory. Essays in Honor of Ofer Bar-Yosef. Oxford and Oakville: Oxbow, American School of Prehistoric Research Monograph Series, pp. 185 – 252.

Greenbaum, G., Friesem, D. E., Hovers, E., Feldman, M. W., Kolodny, O., 2019. Was inter-population connectivity of Neanderthals and modern humans the driver of the Upper Paleolithic transition rather than its product? *Quaternary Science Reviews* 217, pp. 316-329.

Greenbaum, N., Ekshtain, R., Porat, N., Malinsky-Buller, A., Hovers, E., 2014. The stratigraphy and paleogeography of the Middle Palaeolithic open-air site of 'Ein Qashish, Northern Israel. *Quaternary International* 331, pp. 203-215.

Griggo, C., 2004. Mousterian Fauna from Dederiyeh cave and comparisons with Fauna from umm El Tlel and Douara cave. *Paleorient* 30, pp. 149-62.

Groucutt, H. S., Grün, R., Zalmout, I. S. A., Drake, N. A., Armitage, S. J., Candy, I., Clark-Wilson, R., Louys, J., Breeze, P. S., Duval, M., Buck, L. T., Kivell, T. L., Pomeroy, E., Stephens, N. B., Stock, J. T., Stewart, M., Price, G. J., Kinsley, L., Sung, W. W., Alsharekh, A., Al-Omari, A., Zahir, M., Memesh, A. M., Abdulshakoor, A. J., Al-Masari, A, M., Ahmed A., Bahameem, A. A., Al Murayyi, K. S. M., Zahrani, B., Eleanor M. L., Scerri, E. M. L., Petraglia, M. D., 2018. Homo sapiens in Arabia by 85,000 years ago. *Nature ecology & Evolution* 2, pp. 800-808.

Groucutt, H. S., 2014. Middle Palaeolithic point technology, with a focus on the site of Tor Faraj (Jordan, MIS 3). *Quaternary International* 350, pp. 205-226.

Grün, R., Stringer, C. B., Schwarcz, H. P., 1991. ESR dating of teeth from Garrod's Tabun Cave collection. *Journal of Human Evolution* 20, pp. 231–248.

Grün, R., Stringer, C., 2000. Tabun revisited: Revised ESR chronology and new ESR and U-series analyses of dental material from Tabun C1. *Journal of Human Evolution* 39, pp. 601–612.

Hauck, T. C., 2011. Mousterian technology and settlement dynamics in the site of Hummal (Syria). *Journal of Human Evolution* 61 (5), pp. 519-537.

Hauck, T. C., 2013. The Mousterian sequence of Hummal (Syria). Kölner Studien zur Prähistorischen Archäologie 4 (Rahden/Westf. 2013).

Heinzelin, J. D. E., 1966. Revision du site de Yabroud. *Les Annales Archéologiques Arabes Syriennes* 16, pp. 157 – 163.

Henry, D. O., 1983. Adaptive Evolution within the Epi-Paleolithic of the Near East. In: Wendorf, F., Close, A. E. (Eds.), Advances in World Archaeology II, pp. 99–160. Academic Press, New York.

Henry, D. O., 1995a. Prehistoric cultural ecology and evolution: Insights from Southern Jordan. Plenum Press, New York.

Henry, D. O., 1995b. The influence of mobility levels on Levallois point production, Late Levantine Mousterian, Southern Jordan. In: Dibble, H. L., Bar-Yosef, O. (Eds), The definition and interpretation of Levallois technology. Prehistory Press, Madison (Wis.), pp. 185-200.

Henry, D. O., 1998. The Middle Paleolithic of Jordan. In: Henry, D. O. (Ed.), The Prehistoric Archaeology of Jordan. BAR International Series 705., pp. 23–38.

Henry, D. O., 2003. Neanderthals in the Levant: behavioural organization and the beginnings of human modernity. Continuum, London.

Henry, D. O., Hall, S. A., Hietala, H. J., Demidenko, Y. E., Usik, V. I., Rosen, A. M., Thomas, P. A., 1996. Middle Paleolithic Behavioral Organization: 1993 Excavations of Tor Faraj, South Jordan. *Journal of Field Archaeology* 23, pp. 31–53.

Henry, D. O., Miller, G. H., 1992. The Implications of Amino Acid Racemization Dates of Levantine Mousterian Deposits in the Southern Jordan. *Paléorient* 18, pp. 45–52.

Higham, T., Ramsey, C. B., Karavanic, I., Smith, F. H., Trinkaus, E., 2006. Revised Direct Radiocarbon Dating of the Vindija G1 Upper Paleolithic Neandertals. *Proceedings of the National Academy of Science* U.S.A. 103, pp. 553–557.

Hovers, E., 1997. Variability of Levantine Mousterian Assemblages and Settlement Patterns: Implications for the Development of Human Behavior, Ph. D. dissertation, Hebrew University, Jerusalem.

Hovers, E., 1998. The lithic assemblages of Amud Cave. Implications for understanding the end of the Mousterian in the Levant. In: Akazawa, T., Aoki, K., BarYosef, O. (Eds.), Neandertals and Modern Humans in Western Asia. Plenum Press, New York, pp. 143-163.

Hovers, E., 2001. Territorial behaviour in the Middle Paleolithic of the Levant. In: Conard, N. J. (Ed.), Settlement dynamics of the Middle Paleolithic and Middle Stone Age. Kerns Verlag, Tübingen, pp. 123-152.

Hovers. E., 2007. The many faces of cores-on-flakes: A perspective from the Levantine Mousterian. In: McPherron, S. (Ed.), Tools versus cores: Alternative approaches to stone tool analysis. Cambridge Scholars Publishing, Newcastle, pp. 42- 74.

Hovers, E., 2009. The lithic assemblages of Qafzeh Cave. Oxford University Press, Oxford.

Hovers, E., Buller, A., Ekshtain, R., Oron, M., Yeshurun, R., 2008. 'Ein Qashish—A New Middle Paleolithic Open- Air Site in Northern Israel. *Journal of The Israel Prehistoric Society* 38, pp. 7-40.

Hovers, E., Belfer-Cohen, A., 2006. "Now You See It, Now You Don't": Modern Human Behavior in the Middle Paleolithic. In: Hovers, E., Kuhn, L.S. (Eds.), Transitions before The Transition: Evolution and Stability in the Middle Paleolithic and Middle Stone Age. Springer, New York, pp. 295–304.

Hovers, E., Rak, Y., Lavi, R., Kimbel, W. H., 1995. Hominin Remains from Amud Cave in the context of the Levantine Middle Paleolithic. *Paléorient* 21 (2), pp. 47 – 62.

Howell, F. C., 1958. Upper Pleistocene Men of the Southwest Asian Mousterian. In: Koenigswald, G. H. R. (Ed.), Hundert jahre Neanderthaler, pp. 185–198. Kemik en zoom, Utrecht.

Hours, F., 1992. Le Paleolithique et l'Epipaleolithique de la Syrie et du Liban. Beyrouth: Dar el-Machreq, 154 p.

Hublin, J. J., Ben-Ncer, A., Bailey, S. E., Freidline, S. E., Neubauer, S., Skinner, M. M., Bergmann, I., Le Cabec, A., Benazzi, S., Harvati, K., Gunz, P., 2017. New fossils from Jebel Irhoud, Morocco and the pan-African origin of Homo sapiens. *Nature* 546, pp. 289-292.

Hublin, J. J., Ruiz, C. B., Lara, P. M., Fontugne, M., Reyss, J.-L., 1995. The Mousterian Site of Zafarraya (Andalucia, Spain): Dating and Implications on the Paleolithic Peopling Process of Western Europe. Comptes Rendus de l'Academie des Sciences, serie IIa 321, 931-937.

Hublin, J. J., Spoor, F., Braun, M., Zonneveld, F., Condemi, S., 1996. A Late Neanderthal Associated with Upper Palaeolithic Artefacts. *Nature* 381, pp. 224-226.

Inizan, M.-L., Reduron-Ballinger, M., Roche, H., Tixier, J., 1995. Technologie de la pierre taillée. CREP, Meudon.

Inizan, M.-L., Reduron-Ballinger, M., Roche, H., Tixier, J., 1999. Technology and Terminology of Knapped stone translated by J. Feblot Augustins.

Jagher, R., Le Tensorer, J. M., 2011. El Kowm, a key area for the Palaeolithic of the Levantine central Syria. In: Le Tensorer, J.-M., Jagher, R., Otte, M. (Eds.), The Lower and Middle Palaeolithic in the Middle East and Neighbouring Regions, Liege: ERAUL 126, pp. 197-208.

Jelinek, A. J., 1975. A preliminary report on some Lower and Middle Palaeolithic industries from Tabun Cave, Mount Carmel (Israel). In: Wendorf, F., Marks, A. E. (Eds.), Problems in prehistory: North Africa and the Levant. SMU Press, Dallas. pp. 279–316.

Jelinek, A. J., 1977. A preliminary study of flakes from the Tabun Cave, Mount Carmel. *Eretz-Israel Memorial Volume for Moshe Stekelis* 13, pp. 87 – 96.

Jelinek, A. J., 1981. The Middle Paleolithic in the Southern Levant. In: Cauvin, J., Sanlaville, P. (Eds.), Prehistoire du Levantı: chronologie et organisation de l'espace depuis les origines jusqu'au VIe millenaire. Paris: Editions du CNRS, pp. 299 – 302.

Jelinek, A.J., 1982a. The Middle Palaeolithic in the Southern Levant, with comments on the appearance of modern Homo sapiens. In: Ronen, A. (Ed.), The transition from Lower to Middle Palaeolithic and the origin of modern man. BAR International Series 151, pp. 57-104.

Jelinek, A. J., 1982b. The Tabun Cave and Palaeolithic man in the Levant. *Science* 25, pp. 1369-1375.

Jelinek, A. J., 1992. Problems in chronology in the Middle Paleolithic and the first appearance of modern humans in Western Eurasia. In: Akazawa, T., Aoki, K., Kimura, T. (Eds.), The evolution and dispersal of modern humans in Asia. Hokusen-sha Press, Tokyo, pp. 253-276.

Jelinek, A. J., Farrand, W. R., Haas, G., Horowitz, A., Goldberg, P., 1973. New excavations at the Tabun Cave, Mount Carmel, Israel, 1967 - 1972: a preliminary report. *Paléorient* 1 (2), pp. 151-183.

Julig, P. J., Long, D. G. F., Schroeder, H. B., Rink, J. W., Richter, D., Schwarcz, H. P., 1999. Geoarchaeology and new research at Jerf al-Ajla Cave, Syria. *Geoarchaeology* 14 (8), pp. 821-848.

Kalbe, J., Sharon, G., Porat, N., Zhang, C., Mischke, S., 2014. Geological setting and age of the Middle Paleolithic site of Nahal Mahanayeem outlet (upper Jordan valley, Israel). *Quaternary International* 331, pp. 139–148.

Kalbe, J., Mischke, S., Dulski, P., Sharon, G., 2015. The Middle Palaeolithic Nahal Mahanayeem Outlet site, Israel: reconstructing the environment of Late Pleistocene wetlands in the eastern Mediterranean from ostracods. *Journal of Archaeological Science* 54 (2015), pp. 385-395.

Kathy, L. R., Geoffrey, A., C., 1997. Use- Wear analysis of Levallois points from Ain Difla Rockshelter, West-Central Jordan. In: Gebel, H. G. K., Kafafi, Z., Rollefson, G. O. (Eds.), The prehistory of Jordan, II: perspectives from 1997. Berlin: ex oriente, pp. 101-109.

Kaufman, D., 2001. Comparisons and the case for interaction among Neanderthals and early modern humans in the Levant. *Oxford Journal of Archaeology* 20, pp. 219-240.

Keith, A., 1927. A report on the Galilee skull. Researches in Prehistoric Galilee, 1925-1926. Jerusalem: British School of Archaeology in Jerusalem, pp. 53-106.

Keith, A., 1931. A New Discoveries Relating to the Antiquity of Man. London: Williams and Norgate.

Kelly, R. L., 1988. The Three Sides of a Biface. *American Antiquity* 53(4), pp. 717-734.

Kramer, A., Crummett, T. L., Wolpoff, M. H., 2001. Out of Africa and into the Levant: replacement or admixture in Western Asia? *Quaternary International* 75, pp. 51-63.

Kuhn, S. L., 1992. On planning and curated technologies in the Middle Paleolithic. *Journal of Anthropological Research* 48(3), pp. 185-214.

Kuhn, S. L., 1995. Mousterian lithic technology: An ecological perspective. Princeton University Press, Princeton (N.J.).

Langgut, D., Almogi-Labin, A., Bar-Matthews, M., Pickarski, N., Weinstein-Evron, M., 2018. Evidence for a humid interval at ~56- 44 ka in the Levant and its potential link to modern humans dispersal out of Africa. *Journal of Human Evolution* 124, pp. 75-90.

Leder, D., 2014. Technological and typological Change at the Middle to Upper Palaeolithic Boundary in Lebanon. Universitätsforschungen zur prähistorischen Archäologie 255. Habelt Verlag, Bonn.

Leder, D., 2018. Lithic Variability and Techno-Economy of the Initial Upper Palaeolithic in the Levant. *International Journal of Archaeology* 6 (1), pp. 23-36.

Lehmann, U., 1970. Die Tierreste aus den Holen von Jabrud (Syrien) In: Gripp, K., Schutrumpf, R., Schwabedissen, H. (Eds.), Frühe Menschheit und Umwelt, Fundamenta, Monographien zur Urgeschichte. Köln Wien : Böhlau Verlag, pp. 181 – 188.

Leroi-Gourhan, A., 1964. Le geste et la parole: II, Technique et langage. Paris: Albin Michel.

Le Tensorer, J.-M., Hauck, T., Wojtczak, D., 2003. Le Paléolithique ancien et moyen d'Hummal (El Kowm, Syrie Centrale). *Swiatowit* 46 (5), pp. 45-52.

Madella, M., Jones, M. K., Goldberg, P., Goren, Y., Hovers, E., 2002. The Exploitation of Plant Resources by Neanderthals in Amud Cave (Israel): The Evidence from Phytolith Studies. *Journal of Archaeological Science* 29, pp. 703-719.

Malinsky-Buller, A., Ekshtain, R., Hovers, E., 2014. Organization of lithic technology at 'Ein Qashish, a late Middle Paleolithic open air site in Israel. *Quaternary International* 331, pp. 234-247.

Maps: Data used: naturalearthdata.com (https://www.naturalearthdata.com/). Coordinate System used: WGS 84/EPSG 4326.

Marks, A. E., 1992. Typological variability in the Levantine Middle Paleolithic. In: Dibble, H. L., Mellars, P. (Eds.), The Middle Paleolithic: Adaptation, behaviour, and variability. The University Museum, Philadelphia (Pa.), pp. 127-142.

McBrearty, S., 2007. Down with the revolution. In: Mellars, P., Boyle, K., Bar-Yosef, O. (Eds.), Rethinking the Human Revolution. New Behavioural and Biological Perspectives on the Origin and Dispersal of Modern Humans. Short Run Press, Exeter, pp. 133-151.

McBrearty, S., Brooks, A. S., 2000. The Revolution that Wasn't: A New Interpretation of the Origin of Modern Human Behavior. *Journal of Human Evolution* 39, pp. 453-563.

McCown, T. D., Keith, A., 1939. The Stone Age of Mount Carmel II: The fossil human remains from the Levalloiso- Mousterian. Oxford: Clarendon Press.

McDermott, F., Grun, R., Stringer, C. B., Hawkesworth, C. J., 1993. Mass-spectrometric U-Series Dates for Israeli Neanderthals/Early Modern Hominin Sites. *Nature* 363, pp. 252-255.

Meignen, L., 1995. Levallois lithic production systems in the Middle Paleolithic of the Near East: The case of the unidirectional method. In: Dibble, H. L., Bar-Yosef, O. (Eds.), The definition and interpretation of Levallois technology. Prehistory Press, Madison (Wis.), pp. 361-379.

Meignen, L., 1998. Le Paléolithique moyen au Levant Sud et Central: que nous apprennent les données récentes? In: Otte, M. (Ed.), Préhistoire d'Anatolie: Genèse de deux mondes: Actes du colloque international, Liège, 28 avril - 3 mai 1997. Université de Liège, Liège, pp. 685-708.

Meignen, L., 2000. Early Middle Paleolithic Blade Technology in Southwestern Asia. *Acta Anthropologica Sinica* 19, pp. 158-168.

Meignen. L., 2007. Middle Paleolithic blady assemblages in the Near East: a reassessment. In: Caucasus and the initial dispersals in the Old World. Russian Academy of Sciences. Institute of the History of material culture XXI, pp. 33-148.

Meignen, L., 2012. Levantine perspectives on the Middle to Upper Palaeolithic ''Transition''. Archaeology, *Ethnology and Anthropology of Eurasia* 40 (3), pp. 12–21.

Meignen, L., 2019. The Mousterian Lithic Assemblages from Kebara Cave. In: Meignen, L., Bar-Yosef, O. (Eds.), Kebara Cave, Mt Carmel, Israel: The Middle and Upper Paleolithic Archaeology, Part II. American School of Prehistoric Research, Peabody Museum, Harvard University Press, pp. 1-126.

Meignen, L., Bar-Yosef, O., 1988. Kebara et le Paléolithique moyen du Mont Carmel (Israël). *Paléorient* 14 (2), pp. 123-130.

Meignen L., Bar-Yosef O., 1991. Les outillages lithiques mousteriens de Kebara (fouilles 1982 - 1985). Premiers resultats. In: Bar-Yosef, O., Vandermeersch, B. (Eds.), Le Squelette Mousterien de Kebara 2. Paris, Editions du CNRS, pp. 49-76.

Meignen L., Bar-Yosef, O., 1992. Middle Paleolithic variability in Kebara Cave, Mount Carmel, Israel. In: Akazawa T., Aoki K., Kimura T. (Eds.), The evolution and dispersal of modern human in Asia. Tokyo: Hokushen- Sha Press, pp. 129-148.

Meignen, L., Bar-Yosef, O., Speth, J. D., Stiner, M. C., 2006. Middle Paleolithic Settlement Patterns in the Levant. In: Hovers, E., Kuhn, S. L. (Eds.), Transitions before The Transition: Evolution and Stability in the Middle Paleolithic and Middle Stone Age. Springer, New York, pp. 149–169.

Meignen, L., Sanlaville, P., Besancon, J., Copeland, L., Muhesen, S., 1994. Le Paléolithique de la vallée moyenne de l´Oronte (Syrie). *Paléorient* 20 (2), pp. 169-170.

Mellars, P., 2006. Why did modern human populations disperse from Africa ca. 60,000 years ago? A new model. *Proceedings of the National Academy of Sciences of the United States of America* 103, pp. 9381-9386.

Mellars, P., and Stringer, C., 1989. Behavioural and Biological Perspectives on the Origins of Modern Humans. Edinburgh University Press, Edinburgh.

Mercier, N., Valladas, H., 1994. Thermoluminescence dates for the Palaeolithic Levant. In: Bar-Yosef, O., Kra, R. S. (Eds.), Late Quaternary Chronology and Paleoclimates of the Eastern Mediterranean, Tucson: Radiocarbon, pp. 13-20.

Mercier N., Valladas, H., 2003. Reassessment of TL Age Estimates of Burnt Flints from the Paleolithic Site of Tabun Cave, Israel. *Journal of Human Evolution* 45 (5), pp. 401-409.

Mercier, N., Valladas, H., Froget, L., Joron, J.-L., Reyss, J.-L., Weiner, S., Goldberg, P., Meignen, L., Bar-Yosef, O., Belfer-Cohen, A., 2007. Hayonim Cave: a TL-based Chronology for This Levantine Mousterian Sequence. *Journal of Archaeological Science* 34, pp. 1064-1077.

Mercier, N., Valladas, H., Joron, J.-L., Reyss, J.-L., Leveque, F., Vandermeersch, B., 1991. Thermoluminescence Dating of the Late Neanderthal Remains from Saint- Cesaire. *Nature* 351, pp. 737–739.

Mercier, N., Valladas, H., Valladas, G., Reyss, J. L., Jelinek, A., Meignen, L., Joron, J.-L., 1995. TL dates of burnt flints from Jelinek's excavations at Tabun and their implications. *Journal of Archaeological Science* 22 (4), pp. 495-509.

Monigal, K., 2002. The Levantine Leptolithic: Blade production from the Lower Paleolithic to the dawn of the Upper Paleolithic. Ph.D. Dissertation, Southern Methodist University, Dallas. Texas, Dallas.

Muhesen, S., 1992. The Palaeolithic of the centre of Syria. *Les Annales Archéologiques Arabes Syriennes* 46, pp. 45-52.

Munday, F., 1977. Nahal Aqev (D35): a stratified, open-air Mousterian occupation in the Avdat/Aqev area. In: Marks, A. E. (Ed.), Prehistory and Paleoenvironments in the Central Negev Israel, Volume II, The Avdat/Aqev area Part 2, and the Har Harif. Southern Methodist University (SMU) Press, Dallas, pp. 35-60.

Nelson, M. C., 1991. The Study of Technological Organization. In: Schiffer, M. B. (Ed.), Archaeological Method and Theory 3, pp. 57-100.

Newcomer, M. H., Hivernel-Guerre, F., 1974. Nucléus sur éclat: Téchnologie et utilisation par différentes cultures préhistoriques. *Bulletin de la Société Préhistorique Française* 71, pp. 119-128.

Neuville, R., 1951. Le Paleolithique et le Mesolithique du desert du Judee. Archives de Musee de Paleontologie Humaine memoire n. 24. Masson et Cie, Paris.

Nishiaki, Y., 1985. Truncated-faceted flakes from Levantine Mousterian assemblages. *Bulletin of the Museum of the University of Tokyo* 4, pp. 215-226.

Nishiaki, Y., Kanjo, Y, Muhesen, S., Akazawa, T., 2012. The temporal variability of late Levantine assemblages from Dederiyeh Cave, Syria. *Eurasian Prehistory* 9 (1-2), pp. 2–27.

Ohnuma, K., Akazawa, T., 1988. Reexamination of the lithic artifacts from layer B (square 8-19) of the Amud Cave, Israel. *Paléorient* 14(2), pp. 137-144.

Otte, M., 1995. The nature of Levallois. In: Dibble, H. L., Bar-Yosef, O. (Eds.), The definition and interpretation of Levallois technology. Prehistory Press, Madison (Wis.), pp. 117-124.

Oxford Research Laboratory for Archaeology., 1990. Date list. Ancient TL, 8/3, Suppelement.

Pagli, M., 2013. Variabilité du Moustérien au Proche-Orient. Approche géographique des dynamiques de changement en milieu méditerranéen et en milieu steppique. Ph.D. Dissertation, Université Paris Ouest Nanterre La défense.

Pagli, M., 2015. Middle Paleolithic Variability in the Near East as a Reflection of Different Settlement Dynamics: A Comparative Study of Umm el Tlel, Yabrud I (Syria) and Ksar 'Akil (Lebanon). In: Conard, J. N., Delagnes, A. A. (Eds.), Settlement Dynamics of the Middle Paleolithic and Middle Stone Age IV, pp. 145-170.

Pastoors, A., Weniger, G.-C., Kegler, J. F. 2008. The Middle-Upper Palaeolithic Transition at Yabroud II (Syria). A re-evaluation of the lithic material from the Rust excavation. *Paléorient* 34 (2), pp. 47-65.

Patou-Mathis, M., 2006. Analyse archeozoologique de l' Unite II, Niveaux II / 7AB a IIA / 4B. In: Chabai, V. P., Richter, J., Uthmeier. T. (Eds.), Kabazi II: The 70 000 Years since the Last Interglacial. Simferopol – Cologne: Shlyak, pp. 37-62.

Pelegrin, J., 2005. Remarks about Archaeological Techniques and Methods of Knapping: Elements of a Cognitive Approach to Stone Knapping. In: Roux, V., Bril, B. (Eds.), Stone Knapping: The Necessary Conditions for a Uniquely Hominin Behavior, pp. 23–33. McDonald Institute for Archaeological Research, Cambridge.

Perkins, D. 1968. The Pleistocene Fauna from the Yabroud Rockshelters. *Les Annales Archéologiques Arabes Syriennes* 18, pp. 123 – 130.

Perpère, M., 1986. Apport de la typométrie à la définition des éclats Levallois: L'exemple d'Ault. *Bulletin de la Société Préhistorique Française* 83(4), pp. 115-118.

Perrot, J., 1968. La Préhistoire palestinienne. Supplément au Dictionnarie de la Bible, Tome VIII. Paris, Letouzey et Ané, p. 286 – 446.

Porat, N., Chazan, M., Schwarcz, H. P., Kolksa Horwitz, L. K., 2002. Timing of the Lower to Middle Palaeolithic boundary: new dates from the Levant. *Journal of Human Evolution* 43, pp. 107-122.

Porat, N., Schwarcz, H. P., 1991. Use of signal subtraction methods in ESR dating of burned flint. International Journal of Radiation Applications and Instrumentation, Part D. *Nuclear Tracks and Radiation Measurements* 18, pp. 203-212.

Rak, Y., Kimbel, W. H., Hovers, E., 1994. A Neandertal infant from Amud Cave, Israel. *Journal of Human Evolution* 26 (4), pp. 313 – 324.

Rebollo, N.R., Weiner, S., Brock, F., Meignen, L., Goldberg, P., Belfer-Cohen, A., Bar-Yosef, O., Boaretto, E., 2011. New radiocarbon dating of the transition from the Middle to the Upper Paleolithic in Kebara Cave, Israel. *Journal of Archaeological Science* 38(9), pp. 2424-2433.

Richter, D., Schroeder, H. B., Rink, W. J., Julig, P. J., Schwarcz, H. P., 2001. The Middle to Upper Palaeolithic Transition in the Levant and New Thermoluminescence Dates for a Late Mousterian Assemblage from Jerf Al-Ajla Cave (Syria). *Paléorient* 27, pp. 29-46.

Richter, J., 1997. Sesselfelsgrotte III: der G-Schichten-Komplex der Sesselfelsgrotte: zum Verständnis des Micoquien. Quartar-Bibliothek Bd.7. Saarbrücken: Saarbrücker Druckerei und Verlag.

Richter, J., 2001. For lack of a wise old man? Late Neanderthal land-use patterns in the Altmuhl River Valley; Bavaria. In: Conard, N. J. (Ed.) Settlement Dynamics of the Middle Paleolithic and Middle Stone Age I. Kerns, Tübingen, pp. 205-219.

Richter, J., 2005. Kabazi II, Unit V, Lower Levels: Lithics from the Pocket. In: Chabai, V. P., Richter, J., Uthmeier, T. (Eds.), Kabazi II: Last Interglacial occupation, environment and subsistence. Simferopol – Cologne: Shlyak, pp. 181-191.

Richter, J., 2011. When Did the Middle Palaeolithic Begin. In: Conard, N. J., Richter, J. (Eds.), Neanderthal Lifeways, Subsistence and Technology. Springer, pp. 7-14.

Richter, J., Hauck, Th., Vogelsang, R., Widlok, Th., Le Tensorer, J.-M., Schmid, P., 2012. "Contextual areas" of early Homo sapiens and their significance for human dispersal from Africa into Eurasia between 200 ka and 70 ka. *Quaternary International* 274, pp. 5-24.

Richter, J., Litt, T., Lehmkuhl, F., Hense, A., Hauck, C. T., Leder, F. D., Miebach, A., Parow-Souchon, H., Sauer, F., Schonenenberg, J., Al-Nahar, M., Hussain, Sh., 2020. Al-Ansab and the Dead Sea: Mid-MIS 3 archaeology and environment of the early Ahmarian population of the Levantine corridor. *PLoS ONE* 15(10): e 0239968.

Rink, J. W., Richter, D., Schwarcz, H. P., 2003. Age of the Middle Palaeolithic Site of Rosh Ein Mor, Central Negev, Israel: Implications for the Age Range of the Early Levantine Mousterian of the Levantine Corridor. *Journal of Archaeological Science* 30 (2), pp. 195-204.

Rink, J. W., Schwarcz, H.P., Lee, H. K., Rees-Jones, J., Rabinovich, R., Hovers, E., 2001. Electron spin resonance (ESR) and thermal ionization mass spectrometric (TIMS) U dating of teeth in Middle Paleolithic layers at Amud Cave, Israel. *Geoarchaeology* 16, pp. 701-717.

Roebroeks, W., Kolen, J., Rensink, E., 1988. Planning Depth, Anticipation and the Organization of Middle Paleolithic Technology: The "Archaic Natives" Meet Eve's Descendants. *Hellinium* 28, pp. 17-34.

Rolland, N., 1981. The Interpretation of Middle Palaeolithic Variability. *Man* 16, pp. 15-42.

Rolland, N., 1995. Levallois technique emergence: single or multiple? A review of the Euro-African record. In: Dibble, H. L., Bar-Yosef, O. (Eds.), The definition and interpretation of Levallois technology. Prehistory Press, Madison (Wis.), pp. 333-359.

Ronen, A., 1979. Paleolithic Industries. In: Horowitz, A. (Ed.), The Quaternary of Israel. Academic Press, New York, pp. 296-307.

Rust, A., 1950. Die Höhlenfunde von Jabrud (Syrien). Karl Wachholtz Verlag, Neumünster.

Schick, T., Stekelis, M., 1977. Mousterian Assemblages in Kebara Cave, Mount Carmel. In: Arensburg, B., Bar-Yosef, O. (Eds.), Eretz-Israel 13. Israel Exploration Society, Jerusalem, pp. 97-149.

Schmitz, R. W., Serre, D., Bonani, G., Feine, S., Hilligruber, F., Krainitzki, H., Paabo, S., Smith, F. H., 2002. The Neandertal Type Site Revisited: Interdisciplinary Investigations of Skeletal Remains from the Neander Valley, Germany. *Proceedings of the National Academy of Science* U.S.A. 99, pp. 13342-13347.

Schroeder, B., 1966. The lithic material from Jerf Ajla a preliminary report. *Les Annales Archéologiques Arabes Syriennes* 16 (2), pp. 79-82.

Schroeder, B., 1969. The lithic industries from Jerf Ajla and their bearing on the problem of a Middle to Upper Palaeolithic transition. Ph.D. Dissertation, New York, Columbia University, 550 p.

Schrøder, N., Jensen, G. M., Limbord, M., 2012. Groundwater spring deposits as proxy for interstadials in the Levant: the chronology and climate history of the Palaeolithic cultures from Yabroud (Syria). *Quaternary International* 257, pp. 27-33.

Schwarcz, H. P., Rink, W. J., 1998. Progress in ESR and U-series chronology of the Levantine Paleolithic. In: Akazawa, T., Aoki, K., Bar-Yosef, O. (Eds.), Neandertals and Modern Humans in Western Asia. Plenum Press, New York, pp. 57-67.

Sharon, G., 2018. Week in the Life of the Mousterian Hunter. In: Nishiaki, Y., Akazawa, T. (Eds), The Middle and Upper Paleolithic Archeology of the Levant and Beyond. Singapore: Springer Singapore, pp. 3547.

Sharon, G., Oron, M., 2014. The lithic tool arsenal of a Mousterian hunter. *Quaternary International* 331, pp. 167-185.

Shea, J. J., 2003. Neandertals, Competition, and the Origin of Modern Human Behavior in the Levant. *Evolutionary Anthropology* 12, pp. 173-187.

Shea, J. J., 2004. The Middle Paleolithic of the East Mediterranean Levant. *Journal of World Prehistory* 17: pp. 313-394.

Shea., J. J., 2008. Transitions or turnovers? Climatically- forced extinctions of Homo sapiens and Neanderthals in the east Mediterranean Levant. *Quaternary Science Reviews* 27 (23–24), pp. 2253-2270.

Shimelmitz, R., Kuhn, S. L., 2018. The toolkit in the core: There is more to Levallois production than Predetermination. *Quaternary International* 464, pp. 81-91.

Simpson, E. H., 1949. Measurement of diversity. *Nature* 163, p. 688.

Skinner, J., 1965. The Flake Industries of Southwest Asia: A Typological Study. Ph.D. Dissertation, Columbia University.

Solecki, R. L., 1969. Summary report of the Columbia University Prehistoric investigations in Lebanon, Season 1969. *Bulletin du Musee de Beyrouth* XXIII, pp. 95-128.

Solecki, R.S. 1970. A sketch of the Columbia University archaeological investigation at Yabroud (Syria). In: Gripp, K., Schutrumpf, R., Schwabedissen, H. (Eds.), Frühe Menschheit und Umwelt. Fundamenta, Monographien zur Urgeschichte. Köln Wien, Böhlau Verlag, pp. 199-201.

Solecki, R. S., 1971. Shanidar, the First Flower People. New York: Knopf, 290 p.

Solecki, R. L., 1975. The Middle Paleolithic site of Nahr Ibrahim (Asfourieh Cave) in Lebanon. In: Wendorf, F., Marks, A. E. (Eds.), Problems in Prehistory: North Africa and the Levant. Dallas. pp. 283-295.

Solecki, R. S., Solecki, R. L., 1966. New data from Yabroud, Syria. Preliminary report of the Columbia University archaeological investigations. *Les Annales Archéologiques Arabes Syriennes* 16 (2), pp. 121-153.

Solecki, R. L., Solecki, R. S., 1979. A new secondary flacking technique at the Nahr Ibrahim Cave site, Lebanon. *Bulletin du Musee de Beyrouth* 23, pp. 137-142.

Solecki, R. L., Solecki, R. S., 1986. A reappraisal of Rust's cultural stratigraphy of Yabroud Shelter I. *Paléorient* 12 (1), pp. 53-59.

Solecki, R. S., Solecki, R. L., 1987-1988. Archaeological researches at Yabroud, Syria, and vicinity, summer 1987. *Les Annales Archéologiques Arabes Syriennes* 37 - 38, pp. 9-49.

Solecki, R. L., Solecki, R. S., 1995. The Mousterian industries of Yabroud Shelter I: A reconsideration. In: Dibble, H. L., Bar-Yosef, O. (Eds.), The definition and interpretation of Levallois technology. Prehistory Press, Madison (Wis.), pp. 381-397.

Solecki, R. L., Solecki, R. S., 2007. Use of raw material at Yabroud Rockshelter I, Syria. BAR International Series 1615, pp. 117-129.

Speth, J. D., Tchernov, E., 2007. The Middle Palaeolithic Occupations at Kebara Cave: A Faunal Perspective. In: Bar-Yosef, O., Meignen, L. (Eds.), Kebara Cave, Mt. Carmel, Israel. The Middle and Upper Palaeolithic Archaeology Part I, pp.165–260. Cambridge, MA: Peabody Museum of Archaeology and Ethnology.

Stefan, V. H., Trinkaus, E., 1998. Discrete trait and morphometric affinities on the Tabun 2 madibule. *Journal of Human Evolution* 34 (5), pp. 443-468.

Stekelis, M., 1956. Nouvelles fouilles dans la Grotte de Kebara. Cronica del IV Congres Internacional de Ciencias Prehistoricas y Protohistoricas. Zaragoza, Madrid 1954, pp. 385-389.

Suzuki, H., Kobori, I., 1970. Report of the reconnaissance survey on Palaeolithic sites in Lebanon and Syria. *Bulletin of the Museum of the University of Tokyo* 1, pp. 1-135.

Suzuki, H., Takai, F., 1970. The Amud Man and his Cave site. Tokyo: The University of Tokyo. 439 p.

Torrence, R., 1983. Time Budgeting and Hunter-Gatherer Technology. In: Bailey, G. (Ed.), Hunter-Gatherer Economy in Prehistory: A European Perspective, Cambridge University Press, Cambridge, pp. 11-22.

Trinkaus, E., 1984. Western Asia. In: Smith, F. H., Spencer, F. (Eds.), The Origins of Modern Humans, Alan R. Liss, New York, pp. 251-293.

Trinkaus, E., 1983. The Shanidar Neanderthals. New York. Academic Press.

Trinkaus, E., 1986. The Neanderthals and Modern Human Origins. *Annual Review of Anthropology* 15, pp. 193-218.

Trinkaus, E., 1987. The Upper Pleistocene human molar from Me'arat Shovakh (Mugharet es-Shubbabiq), Israel. *Paleorient* 13 (1), pp. 95-100.

Tuffreau, A., 1995. The variability of Levallois technology in northern France and neighbouring areas. In: Dibble, H. L., Bar-Yosef, O. (Eds.), The definition and interpretation of Levallois technology. Prehistory Press, Madison (Wis.), pp. 413-427.

Turq, A., Roebroeks, W., Bourguignon, L., Faivre, J.-P. 2013. The fragmented character of Middle Palaeolithic stone tool technology. *Journal of Human Evolution* 65.

Turville-Petre, F., 1927. Researches in prehistoric Galilee, 1925-26. With sections by Dorothea M. Bate and Charlotte Baynes and a report on the Galilee skull by Sir Arthur Keith. London.

Turville-Petre, F., 1932. Excavations in the Mugharat el-Kebara. *Journal of the Royal Anthropological Institute* 62, pp. 271-276.

Uthmeier, T., 2004. Transformation analysis and the reconstruction of on-site and off-site activities: methodological remarks. In: Chabai, V. P., Monigal, K., Marks, E. A. (Eds.), The Middle Paleolithic and Early Upper Paleolithic of Eastern Crimea. ERAUL 104, Liege, 175-191.

Uthmeier, T., 2005. Saving the Stock to be Prepared for the Unexpected. Transformation of Raw Material at the Middle Paleolithic Site of Kabazi II, Level V / 1. In: Chabai, V. P., Richter, J., Uthmeier, T. (Eds.), Kabazi II: Last Interglacial occupation, environment and subsistence. Simferopol-Cologne: Shlyakh, pp. 133-153.

Vandermeersch, B., 1981. Les Hommes Fossiles de Qafzeh (Israel). Cahiers de Paleontologie. Editions du CNRS, Paris.

Vandermeersch, B., 1984. The Discovery of the Neanderthal Skeleton of Saint-Cesaire. *Bulletins et Memoires de la Societe d'Anthropologie de Paris* 11, pp. 191-196.

Valladas, H., Joron, J.-L., Valladas, G., Arensburg, B., Bar- Yosef, O., Belfer-Cohen, A., Goldberg, P., Laville, H., Meignen, L., Rak, Y., Tchernov, E., Tillier, A.-M., Vandermeersch, B., 1987. Thermoluminescence Dates for the Neanderthal Burial Site at Kebara in Israel. *Nature* 330, pp. 159-160.

Valladas G., Mercier, N., Hovers, E., Froget, L., Joron, J. L., Kimbel, W.H., Rak, Y., 1999. TL dates for the Neanderthal Site of the Amud Cave, Israel. *Journal of Archaeological Science* 26, pp. 259-268.

Valladas H., Mercier, N., Joron, J. L., Reyss, J. L., 1998. GIF Laboratory Dates for Middle Paleolithic Levant. In: Akazawa, T., Aoki, K., Bar-Yosef, O. (Eds.), Neandertals and Modern Humans in Western Asia, New York: Plenum Press, pp. 69-76.

Van liere, W. J., 1960. Observations on the Quaternary of Syria. Berichten van de Rijksdienst voor het Oudheidkundig Bodemonderzoek, pp. 7-151.

Van Peer, P., 1992. The Levallois reduction strategy. Prehistory Press, Madison, Wisc.

Waechter, J. D'A. 1952.The excavation of Yabrud and its relation to the Prehistory of Palestine and Syria. *Annual Report Institute of Archaeology, University of London* 8, pp. 10-28.

Walley, D. C., 2017. The geology of Lebanon. American University of Beirut (online). Accessed. https://almashriq.hiof.no/ddc/projects/geology/geology-of-lebanon/.

Weißmüller, W., 1995. Die Silexartefakte der Unteren Schichten der Sesselfelsgrotte. Ein Beitrag zum Problem des Mousterien. Quartar-Bibliothek 6. Saarbrucken.

Wendt. E. W., 1971. Das Paläolithikum im Tal des Nahr el Kebir bei Latakia (Nordsyrien) und seinen Beziehungen zu den quartären fluß-und Strandterrassen. Ph.D. Dissertation, Universität zu köln.

Wojtczak, D., 2014. The Early Middle Palaeolithic Blade Industry from Hummal, Central Syria. Ph.D. Dissertation, Basel University.

Zaidner, Y., Grosman, L., 2015. Middle Palaeolithic sidescrapers were resharped or recycled? A view from Nesher Ramla, Israel. *Quaternary International* 361, pp. 1-10.

Ziaei, M., Schwarcz, H. P., Hall, C. M., and Grun, R., 1990. Radiometric Dating at the Mousterian Site at Quneitra. In: Goren-Inbar, N. (Ed.), Quneitra: A Mousterian Site on the Golan Heights. Institute of Archaeology, Hebrew University, Jerusalem. pp. 232-235.

Zaidner, Y., Weinstein-Evron, M., 2020. The emergence of the Levallois technology in the Levant: A view from the Early Middle Paleolithic site of Misliya Cave, Israel. *Journal of Human Evolution* 144, pp. 1-21.

Ziffer, D., 1981. Yabrud Shelter II: a reconsideration of its cultural composition and of its relevance to the Upper Paleolithic cultural sequence in the Levant. *Quartär* 31-32, pp. 69 – 94.

Zohary, M., 1973. Geobotanical Foundations of the Middle East (Vol. Vol. 1–2). Stuttgart: Gustav Fischer Verlag, 738 p.

Zumoffen, G., 1900. La Phenicie avant les pheniciens. Beirut.

List of figures

Fig. 1. Digital elevation map showing the location of Yabroud Shelter I (naturalearthdata.com). Coordinate System used: WGS 84/EPSG 4326. (p. 5).

Fig. 2. Location of Yabroud Shelters I, II and III (Rust 1950). (p. 7).

Fig. 3. The Mousterian profile of Yabroud Shelter I, KS 1-25 (after Rust 1950). (p. 8).

Fig. 4. Discovery of Shelter IV and Cave I (Solecki 1966). (p. 10).

Fig. 5. The profile of the Solecki & Solecki reinvestigation of Yabroud I (Solecki & Solecki 1966). (p. 11).

Fig. 6. A. Solecki and Solecki's reinvestigation of Yabroud Shelter I, an extension eastward of '*Kammer* 1', vertical to the Rust trench (Solecki & Solecki 1966). B. East section of *Kammer* 1, with the analysis performed by Farrand (1965). (p. 11).

Fig. 7. Technical criteria of the Levallois concept (Boëda 1995). (p. 32).

Fig. 8. Debitage Levallois methods (adjustable Boëda et al. 1990; 54). A. Preferential (Lineal) Levallois method, first removal. B. Preferential (Lineal) Levallois method; second removal. (p. 34).

Fig. 9. Debitage Levallois methods (adjustable Boëda et al. 1990; 54). C. recurrent unipolar Levallois method, first series of removal. D. recurrent unipolar Levallois method, second series of removals after redevelopment of the surface of debitage. (p. 35).

Fig. 10. Debitage of recurrent bidirectional Levallois method (Boëda et al. 1990; 54). (p. 36).

Fig. 11. Debitage of recurrent unidirectional Levallois method (Boëda et al. 1990; 54). (p. 37).

Fig. 12. Debitage of recurrent centripetal Levallois method (Boëda et al. 1990; 63). (p. 38).

Fig. 13. *Chaîne opératoire* of the unidirectional convergent recurrent Levallois debitage of Kebara, layers IX–X (Meignen 1995; 365). (p. 39).

Fig. 14. The division of sectors for the count of dorsal negatives and the determination of dorsal scar patterns. (p. 42).

Fig. 15. Using a goniometer to measure the cross-section angle. (p. 43).

Fig. 16. Drawing triangle according to the three points in order to measure the lateral angle. (p. 43).

Fig. 17. The raw material used in the experimental work. (p. 44).

Fig. 18. Total number of assemblage 4 stone artefacts, according to Pagli 2013. (p. 46).

Fig. 19. Total number of assemblage 4 stone artefacts, according to Rust 1950. (p. 47).

Fig. 20. Variable methods of core reduction identified in the Mousterian assemblage 6 of Yabroud I. (p. 51).

Fig. 21. Preferential Levallois core for point production. (p. 52).

Fig. 22. Unidirectional convergent Levallois core, the lateral edge displays a prepared distal termination by detaching small bidirectional or perpendicular removals. (p. 53).

Fig. 23. Unidirectional convergent Levallois core on flake was prepared by detaching only elongated lateral removals. (p. 53).

Fig. 24. Unidirectional convergent Levallois core was prepared by detaching only lateral removals that stem from proximal striking platform. (p. 53).

Fig. 25. Preferential Levallois core for flakes showing restricted parts of preparation on the lower surface. (p. 57).

Fig. 26. Centripetal Levallois core executed on a cortical flake. (p. 58).

Fig. 27. Centripetal Levallois core executed on a block. (p. 58).

Fig. 28. Unidirectional parallel Levallois core, showing lateral and distal preparation scar patterns. (p. 60).

Fig. 29. A core on flake bears the initial criteria of the Levallois method. (p. 60).

Fig. 30. Tip of a biface shows scar patterns on both surfaces. (p. 62).

Fig. 31. Core on flake showing double patination. (p. 64).

Fig. 32. *Nahr Ibrahim* technique, the profile shows that the exploited part profile is still thick even though it was exploited. (p. 64).

Fig. 33. *Nahr Ibrahim* technique, the profile shows a quite adequate striking platform angle for exploitation. (p. 64).

Fig. 34 shows the minimum, maximum and mean values of the core on flakes. (p. 66).

Fig. 35 shows the various lengths and the almost standard thickness of the cores on flakes. (p. 67).

Fig. 35.1. Technical criteria of the Levallois concept criteria elaborated by Boëda (1990, 1994, 1995; Boëda et al. 1990) applied on a flake. (p. 70).

Fig. 36. Predominance of faceted striking platform of Levallois blanks. (p. 77).

Fig. 37. Frequency distribution of types of butt of Levallois blanks with clear predominance of *Chapeau de gendarme*. (p. 78).

Fig. 38. The mean width and thickness of striking platform types. (p. 79).

Fig. 39. The cortical part of the Levallois flake did not hamper the function of the flake and it was retouched. (p. 80).

Fig. 40. The maximum, minimum and median size of Levallois cores. (p. 81).

Fig. 41. Maximum, minimum and median size of the Levallois cores for points. (p. 82).

Fig. 42. Maximum, minimum and median size of the Levallois points. (p. 82).

Fig. 43. Maximum, minimum and median size of the Levallois blades. (p. 83).

Fig. 44. The distribution of the different sizes between Levallois blanks. (p. 84).

Fig. 45. The distribution of Levallois blanks. (p. 85).

Fig. 46. Constructed Levallois point. (p. 88).

Fig. 47. Classical Levallois point. (p. 88).

Fig. 48. *Chaîne opératoire* of the vast majority of Levallois points produced in assemblage 6. (p. 89).

Fig. 49. Raw material unit shows *Chaîne opératoire* in which elongated points were produced at the early stage of core reduction, whereas discarded Levallois cores refer to struck broad-based Levallois points before its discard. (p. 90).

Fig. 50. Levallois blade production at the early stage of core reduction. Afterwards the smaller core was used to obtain Levallois flakes. (p. 95).

Fig. 51. The distribution of cortex on the by-products. (p. 98).

Fig. 52. Various types of by-product striking platforms. (p. 99).

Fig. 53. Frequency of scar patterns on naturally backed knives and flaking surface preparation flakes. (p. 100).

Fig. 54. The size difference between Naturally backed knives and core edge flakes. (p. 100).

Fig. 55. Plunging distal termination is the most frequent fracture termination. (p. 101).

Fig. 56. Instances of the by-products in assemblage 6. 1. Full cortical flake 2. Cortical flake 3. Flaking surface preparation flake 4. Naturally backed knife 5. Core edge flake. (p. 103).

Fig. 57. The distribution of the tools to different categories. (p. 104).

Fig. 58. The frequency of tools in assemblage 6. (p. 105).

Fig. 59. Maximum, minimum and median sizes of the modified products. (p. 107).

Fig. 60. The various types of tools in assemblage 6 1. Retouched Levallois point 2. Mousterian point 3. Simple straight scraper 4. Simple convex scraper 5. Simple concave scraper 6. Double convex scraper 7. Double convex-concave scraper 8. Convex convergent scraper 9–10 Burin 11. Borer 12. Notched-triangular piece 13. Notch 14. Alternative retouch 15. Composite tool 16. Partially retouched piece 17. Ventral retouch. (p. 109).

Fig. 61. Distribution of the raw material units to different categories. (p. 110).

Fig. 62. Distribution of the imported single pieces. (p. 111).

Fig. 62.1. RMUs have used either as fragments then discarded, or as a complete tool that broke during use on site. (p. 113).

Fig. 63. Dynamic objects with heavy retouch were imported to the assemblage 6. (p. 114).

Fig. 64. Debitage of a nodule imported and exploited on-site. (p. 117).

Fig. 65. Debitage of a single nodule re-exploited as cores on flakes. (p. 118).

Fig. 66. Full cortical debitage and one piece that still has adequate size that was re-reduced. (p. 119).

Fig. 67. Blank production from a core. (p. 127).

Fig. 68. Elements of the correction of a core. (p. 128).

Fig. 69. Blank production from a core with subsequent modification. (p. 129).

Fig. 70. A debitage of two different Levallois methods were applied to the same core, which was reduced to obtain Levallois blades at the first stages and Levallois flakes at the later stages of core reduction. (p. 130).

Fig. 71. A debitage of two different Levallois methods were applied to the same core that was reduced to obtain Levallois blades at the first stages and Levallois points at the later stages of core reduction. (p. 131).

Fig. 72. A debitage of two different Levallois methods were applied to the same core that was reduced to obtain Levallois points at the first stages and Levallois flakes at the later stages of core reduction. (p. 132).

Fig. 73. Re-exploitation of flakes using the *Nahr Ibrahim* Technique. (p. 134).

Fig. 74. Re-exploitation of the debitage. (p. 134).

Fig. 75. Debitage of the exploitation of a local cortical flake. (p. 135).

Fig. 76. Tip of a biface and a debitage of core reduction from the same raw material. (p. 136).

Fig. 77. Lithic density of Levallois Middle Palaeolithic in Yabroud and Ma'aloula region (Conard et al. 2010). (p. 138).

Fig. 78. Distribution of types of the raw material. (p. 146).

Fig. 79. Variable methods of core reduction identified in the late Mousterian assemblage 4 of Yabroud Shelter I. (p. 147).

Fig. 80. Distribution of Levallois cores. (p. 148).

Fig. 81. Distribution of Levallois cores according to the last removal. (p. 149).

Fig. 82 and 83. The applied type of flaking surface preparation. (p. 49).

Fig. 84. Unidirectional Levallois core bearing a single striking platform, which is very exhausted. (p. 152).

Fig. 85. Bidirectional Levallois core bearing two opposed striking platform, which have almost similar thickness. (p. 153).

Fig. 86. Preferential Levallois core was applied to thick flake, showing very thin distal termination. (p. 154).

Fig. 87. Recurrent centripetal Levallois core showing peripheral/continuous striking platform. (p. 155).

Fig. 88. Initial Levallois core bearing criteria of Levallois concept applied to thick flake. (p.156).

Fig. 89. Initial Levallois core bearing criteria of Levallois concept applied to pebbles. (p. 157).

Fig. 90. Initial Levallois core bearing criteria of Levallois concept applied to pebbles, which was named a type C core by Pagli (2013). (p. 158).

Fig. 91. Frequencies of scar pattern types on Levallois blanks. (p. 160).

Fig. 92. Only unidirectional convergent scar patterns stem from the basal striking platform. (p. 161).

Fig. 93. Levallois points reflecting the spatial distribution of scar patterns as a result of the flaking surface preparation process. (p. 161).

Fig. 94. Two types of flaking surface preparation on unidirectional convergent Levallois cores. (p. 164).

Fig. 95. Distribution of scar patterns on Levallois blades. (p. 166).

Fig. 96. Levallois blades bearing scar patterns of flaking surface re-installing process. (p. 166).

Fig. 97. Number of scar patterns recorded on Levallois points. (p. 167).

Fig. 98. Distribution of type of striking platform recorded in the entire debitage. (p. 168).

Fig. 99. Distribution of types of striking platform on Levallois blanks. (p. 168).

Fig. 100. Mean width and thickness of platform types clarifies the relationship between the type of platform and the size. (p. 169).

Fig. 101. Distribution of cortex on the dorsal surface of Levallois blanks. (p. 170).

Fig. 102.1. Constructed Levallois point. (p. 175).

Fig. 102.2. Classical Levallois point. (p. 175).

Fig. 102.3. Width to length of non-Levallois and classical Levallois points. (p. 176).

Fig. 102.4. Distribution of dimension of both types of Levallois points. (p. 176).

Fig. 103. Cross-section measurement of 100 classical and non-classical Levallois points. (p. 179).

Fig. 104. Non-classical Levallois points show different technological features because of different cross section angles. (p. 180).

Fig. 105. Measurements of the lateral angles of elongated and broad-based Levallois points. (p. 181).

Fig. 106. Various Levallois points produced by different methods, showing different cross section angles. The experimental work was executed by Brenet and Al Kassem. (p. 183).

Fig. 107. The high discrepancy between the available Levallois cores for blades and their end-products. (p. 184).

Fig. 108. 1. Levallois flake showing unidirectional convergent scar patterns, 2. Levallois flake exhibiting centripetal scar patterns, 3. Levallois blade bearing unidirectional convergent scar patterns. (p. 185).

Fig. 109. Distribution of shapes of Levallois flakes and blades. (p. 185).

Fig. 110. Strategy of Levallois blade and elongated point production. Faded shapes are virtual cores. (p. 187).

Fig. 111. Distribution of by-products with more than 10% cortex cover of the dorsal surface. (p. 189).

Fig. 112. Frequency of striking platforms recorded on cortical by-products. (p. 190).

Fig. 113. 1. First removal, 2. cortical flake, 3. naturally backed knife clarifies first type of flaking surface preparation and shows feathered distal termination, 4. naturally backed knife clarifies second type of flaking surface preparation and shows plunging distal termination, 5. core edge flake shows plunging termination, 6. convergent side scraper on pseudo-Levallois point, 7. flaking surface preparation flake was removed to reinstall flaking surface's convexity of bidirectional Levallois method, 8. striking platform flake. (p. 192).

Fig. 114. Distribution of tool groups, showing dominance of the Mousterian group (Group II) and partially retouched tools. (p. 194).

Fig. 115. Distribution of tools in assemblage 4. (p. 195).

Fig. 116. Maximum, minimum and median size of modified blanks. (p. 197).

Fig. 117. 1. Mousterian point. 2. Elongated Mousterian point, 3-4 Executed burin on Levallois point, 5. Executed burin on fragment, 6. Denticulate, 7. Notched piece on retouched edge, 8. Burin executed on side scraper, 9. Borer. (p. 199).

Fig. 118. Distribution of the raw material units. (p. 200).

Fig. 119. Categories of imported single objects. (p. 202).

Fig. 120. Single Levallois blanks imported to assemblage 4 of Yabroud shelter I. (p. 203).

Fig. 121. Modified by-products and broken tools discarded/imported to assemblage 4 of Yabroud shelter I. (p. 204).

Fig. 122. Raw material units including Levallois core and initial Levallois cores. (p. 205).

Fig. 123. Raw material units imported as dynamic objects. (p. 208).

Fig. 124. Raw material units imported as dynamic objects. (p. 209).

Fig. 125. Elements of imported raw material as nodule, including end-products discarded on-site. (p. 210).

Fig. 126. Elements of imported raw material as nodule and their end-products exported with the core. (p. 211).

Fig. 127. Raw material unit imported as partially prepared core (Cb) that was exploited by unidirectional convergent Levallois method. (p. 217).

Fig. 128. Raw material unit imported as partially prepared core (Cm) and attests to all phases of the core reduction sequence. (p. 219).

Fig. 129. Raw material unit imported as partially prepared core (Cc) showing only by-products. The core and its end-products have been exported. (p. 221).

Fig. 130. Raw material unit imported as partially prepared core (Cc) showing only by-products. The core and its end-products have been exported. (p. 220).

Fig. 131. Raw material unit includes imported partially prepared core (Ct) that was split into two volumes and reduced by two different Levallois methods. (p. 221).

Fig. 132. Application of two different Levallois methods on the same core (Ct). (p. 222).

Fig. 133. Raw material unit including local thick flakes reduced and discarded on-site (Crf). (p. 223).

Fig. 134. Distribution of Levallois blanks from assemblages 6, 5 and 4. (p. 225).

Fig. 135. Result of Chi-square test, (◊ ◊) no evidence of an association, (◊) evidence of an association, (●) cannot be compared. (p. 225).

Fig. 136. Wide distribution of retouch on sections of the Levallois points. (p. 227).

Fig. 137. Heavily retouched elongated Mousterian points. (p. 227).

Fig. 138. Levallois points showing double patination. (p. 228).

Fig. 139. Distribution of core reductions on types of raw material in assemblages 6 and 4. (p. 234).

Fig. 139.1. Distribution of Levallois blanks identified in assemblages 6 and 4 of YSI. (p. 243).

Fig. 140. Disparity in length of Levallois blades between assemblages 6 and 4. (p. 248).

Fig. 141. Modifications executed on end-products and by-products of both assemblages. (p. 251).

Fig. 142. Distribution of tool frequency in assemblages 6 and 4. (p. 251).

Fig. 143. The distribution of raw material units in both assemblages 6 and 4. (p. 254).

Fig. 144. Distribution of dynamic objects on Levallois products in assemblages 6 and 4. (p. 255).

Fig. 145. The similarity in distribution of raw material units imported as partially prepared cores in assemblages 6 and 4. (p. 257).

Fig. 146. Triple patination indicates frequent reuse of artefacts in different times, assemblage 6. (p. 260).

Fig. 147. Percentage of Levallois flakes, blades and points in the most known late MP site in the Levant. Note that elongated points are included within the blade category and flakes include triangular flakes in Yabroud I assemblages 6 and 4. Eni Rosh Mor sq. Z19: non-Levallois blanks are excluded (Goder-Goldberger & Matthews 2019). Umm el Tlel: triangular flakes included in point category (Pagli 2015). Dederiyeh: blades include elongated points (Nishiaki et al. 2012). Keoue (Nishiaki & Copeland 1992). Ein Qashish: the percentage is from the 2009-2011 excavation and the material includes Levallois and non-Levallois, additionally, bladelets are included in the blade category (Hovers 2008, Malinsky-Buller et al. 2014). Hummal (Hauck 2013). Amud (Hover 1998). Tor Faraj (Henry 1995a and b, 2003). Kebara (Meignen & Bar-Yosef 1991). Yabroud I-5, 3-2 (Pagli 2015). (p. 272).

Fig. 147.1. Percentage of unidirectional convergent scar patterns in the most known late MP site in the Levant. Eni Rosh Mor sq. Z19: only scar patterns on Levallois blanks (Goder-Goldberger & Matthews 2019). Dederiyeh: convergent scar patterns are common in the lower layers 14-7 (Nishiaki et al. 2012). Keoue (Nishiaki & Copeland 1992). Ein Qashish area C (Hovers 2008). Hummal (Hauck 2013). Amud (Hover 1998). Tor Faraj (Henry 1995a and b, 2003). Kebara (Meignen 2019). Yabroud I-5, 3-2 and Umm el Tlel complex V2 (Pagli 2015). (p. 274).

Fig. 148. Digital elevation map showing location of the important LMP sites in the Levant (naturalearthdata.com). Coordinate System used: WGS 84/EPSG 4326. (p.275).

Fig. 149. Technocomplexes of the early transitional era between 47 and 37 ka BP. It shows the points of technological break and continuity between the Middle Palaeolithic and the Initial Upper Palaeolithic. The black dashed shape represents the technological break by dispersal of the Bokerian industry made by *Homo sapiens*. The white dashed shape represents the technological continuity by the Emiran industry (Leder 2014). (p. 277).

List of tables

Table. 1. The lithic cultures of Yabroud I according to Rust (1950). (p. 9).

Table. 2. Hominin fossils discovered at Levantine MP sites. (p. 24).

Table. 3. List of transformation sections for raw material units according to Weißmüller 1995 (Uthmeier 2004, 2005), with modifications according to the raw material of assemblages 6 and 4 of YSI. (p. 30).

Table. 4. Techno-typological attributes recorded for complete blanks. Attributes 1-10 recorded for cores, fragments and core on flak. (p. 40).

Table. 5. Techno-typological attributes recorded for cores. (p. 41).

Table. 6. Techno-typological attributes recorded for core on flakes. (p. 41).

Table. 7. Techno-typological attributes recorded for fragments. (p. 42).

Table. 8. Distribution of lithic material in assemblage 6. (p. 48).

Table. 9. Metric measurements of Levallois cores for points. The length-width ratio (LWR) is the ratio between the maximum length and width. The exterior platform angle (EPA) is the intersection angle between the flaking surface and the striking platform. (p. 55).

Table. 10. Frequency of unidirectional convergent scar patterns on Levallois end-products. (p. 74).

Table. 11. The mean size of Levallois blanks and Kombewa flakes. (p. 81).

Table. 12 The distribution of butt types and their sizes on Levallois points and elongated points. (p. 87).

Table. 13. Size of Levallois blades according to distribution of their scar patterns showing that Levallois blades with unidirectional parallel scar patterns are the largest. (p. 92).

Table. 14. Predominance of quadrangular shape of Levallois blades. (p. 92).

Table. 15. The distribution of tools and their mean sizes. (p. 104).

Table. 16. Distribution of the single pieces and dynamic objects in the raw material units of assemblage 6. (p. 112).

Table. 17. The distribution of the raw material units imported as partially prepared cores and as nodules. (p. 115).

Table. 18. The metric properties of the contents of RMUs 122, 45, 147, and 148. (p. 124).

Table. 19. Distribution of lithic material of assemblage 4. (p. 144).

Table. 20. Sizes of discarded Levallois cores in assemblage 4 in mm. (p. 151).

Table. 21. Levallois point size compared to type of scar patterns. (p. 163).

Table. 22. Frequency distribution of scar patterns recorded on Levallois flakes and blades. (p. 165).

Table. 23. Mean size of Levallois blanks. (p. 171).

Table. 24. Type of striking platform combined with the mean size of Levallois points. (p. 172).

Table. 25. The relationship between platforms and constructed and elongated Levallois points. (p. 173).

Table. 26. Mean size of Levallois points. (p. 174).

Table. 27. Frequency of distribution of modified tools by shape. (p. 193).

Table. 28. Distribution of raw material units imported as single objects (personal gear). (p. 202).

Table. 29. All of the raw material units imported as nodule and as partially prepared core, import of partially prepared core including raw material has objects of two different methods and raw material units include re-reducing local flakes. (p. 212).

Table. 30. The dimension of Levallois cores and the LWR show slight elongation of the Levallois cores for points and blades. (p. 237).

Table. 31. A slight difference in the length to width ratio of elongated points and Levallois cores for points between assemblage 6 and 4. (p. 245).

Table. 32. The relationship between scar patterns and the size of Levallois blades. (p. 249).

Table. 33. Execution of modification on various shapes with tendency toward triangular blanks in assemblages 6 and 4. (p. 252).

Table. 34. Simpson index measuring the diversity of assemblages 6-2. Frequencies of stone artefacts for assemblages 2, 3 and 5 based on the data published by Pagli 2015. (p. 258).

Table.35. Data from the late Levantine Mousterian sites mentioned in the conclusion, ages expressed in ka and BP. (p. 279).

Table. 36. Summary of most important similarities and differences between the lithic industries of assemblages 6 and 4. Similarities in bold. (p. 287).

Table of Contents

Abstract

Acknowledgment

Abbreviation index

1. Introduction 1

1.1.Opening 1

1.2.Presentation of the Yabroud area 4

1.2.1. Geographical setting 4

1.2.2. History of research 6

A. Rust's investigations in Yabroud Shelters I, II and III in the 1930s 6

B. Re-investigations of YSI and discovery of YS IV, V, VI and Cave I, Solecki &Solecki 1960s and 1980s. 9

C. Tübingen Damascus Excavation and Survey Project (TDASP) 11

D. Sedimentary sequence of Yabroud Shelter I 12

E. The related studies of the Middle Palaeolithic lithic material in Yabroud Shelter I 13

1.2.3. Environmental setting 15

A. Climate 15

B. Paleoecology 16

1.2.4. Chronology 16

1.2.5. Raw material 17

2. The Levantine Middle Palaeolithic: an overview 18

1.3.History of research 18

1.3.1. The first phase 1930s-1960s 18

1.3.2. The second phase 1960s-1980s 20

1.3.3. The third phase from 1990s 21

1.4.Hominin fossils 22

1.5.Variability of lithic industries in the Levantine Middle Palaeolithic 24

3. Methodology of the lithic analysis 27

3.1. The theoretical notions of the present study 27

3.1.1. Typological approach 27

3.1.2. Technological approach 28

3.1.3. Transformation analysis 28

3.2.The Levallois production concept 30
3.2.1. Definition of the Levallois concept 31
3.2.2. Variability of Levallois methods 33
A. The preferential Levallois method 33
B. The recurrent Levallois method 34
B.1. Recurrent uni- and bidirectional parallel Levallois method 35
B.2. Recurrent centripetal Levallois method 37
B.3. Recurrent unidirectional convergent Levallois method 38
3.3.Method to investigate the technological reason for the standardization of morphological, technical characteristics of Levallois points 42
3.3.1. Cross-section angles of Levallois points 43
3.3.2. Lateral angles of Levallois points 43
3.3.3. Experimental work 44
4. Inventory of assemblages 6 and 4 of the Yabroud Shelter I Introduction 44
4.1. Archaeological assemblage 6 44
4.2. Archaeological assemblage 4 45
4.2.1. Problem of number of stone artefact in assemblage 4 45
5. The TECHNO-TYPOLOGICAL analyses and transformation analysis of the late Middle Palaeolithic assemblage 6 of Yabroud Shelter I 48
5.1.Identifying core reduction techniques 49
5.2.Strategy of Levallois core reduction 50
5.2.1. Levallois cores for points 51
5.2.2. Levallois cores for flakes 55
A. Preferential Levallois cores 56
B. Centripetal Levallois cores 57
5.2.3. Levallois cores for blades 59
5.2.4. Initial Levallois cores 60
5.2.5. Maximum benefit of the exhausted Levallois cores by exploitating the lower surface The Levantine Middle Palaeolithic: an overview 61
5.2.6. Re-exploitation of the discarded bifaces using Levallois method 62
5.3.Cores on flakes strategy 63
5.3.1. Selection of the flake and setting up the flaking surface 65
5.3.2. Dimension 66
5.3.3. Exploitation 67

5.3.4. The similarities of reduction criteria between the strategies of Levallois methods and core on flake 68

Summary 70

5.4.The characters of cores and Levallois blanks 72

5.4.1. Dorsal scar patterns of Levallois blanks and cores 73

5.4.2. Maintenance of the striking platforms 76

5.4.3. Quantity of cortex on Levallois blanks 79

5.4.4. Size of Levallois blanks and cores 80

5.5.Strategies of the blank production 84

5.5.1. Levallois point reduction strategies 84

5.5.2. Levallois blade reduction strategies 91

5.5.3. Levallois flake reduction strategies 93

A. Evidence of an individual reduction sequence for Levallois flake production 93

B. Double strategy of core reduction (shifting from Levallois blades/points to flakes production) 93

Summary 96

5.6.By- products 97

5.6.1. Cortical flakes 97

5.6.2. Naturally backed knives and core edge flakes É*clats débordants* 99

5.6.3. Striking platform flakes 101

5.6.4. Flaking surface preparation flakes 102

5.7.Typological classification: manufacturing tools 103

5.7.1. The Middle Palaeolithic group (Group II) and partially retouched pieces 104

5.7.2. Denticulates, notched elements and Upper Palaeolithic group (Group III) 105

5.7.3. Composite tools 106

5.7.4. Analysis of the modified blanks 106

A. Modification of slightly larger products 106

B. Clear tendency to modify cortex-free products 107

C. Condition (Complete /Broken) 107

D. Striking Platforms 108

E. Scar patterns 108

5.8.Transformation analysis 110

5.8.1. Raw material units imported as single objects or tools 110

5.8.2. Raw material units imported as dynamic objects 113
5.8.3. Raw material units imported as nodules 114
5.8.4. Raw material units imported as partially prepared cores 120
A. Raw material unit as blank production from a core (transformation section Cb) 120
B. Raw material unit as correction of a core (transformation section Cc) 121
C. Raw material units as blank production from a core with subsequent modification (transformation section Cm) 121
D. Raw material units including debitage from two different Levallois methods (transformation section Ct) 122
D.1. Shifting from Levallois blade to Levallois flake production 122
D.2. Shifting from Levallois blade to Levallois point production 123
D.3. Shifting from Levallois point to Levallois flake production 124
E. Raw material units involving re-exploitation of flakes (transformation section Crf) 125
F. Raw material units including discarded bifaces used as cores (transformation section Cdb) 126
5.9. Reconstruction of recurrent occupation of the Late Middle Palaeolithic base camp, assemblage 6 of Yabroud Shelter I 136
5.9.1. Clear diversity of the lithic material 137
5.9.2. Repeated occupation of the base camp assemblage 6 of Yabroud Shelter I .. 139
5.9.3. High Mobility 141
5.9.4. Strategies and circumstances of raw material procurement 142
A. Direct strategy of raw material procurement 142
B. Embedded strategy of raw material procurement 143
6. The TECHNO-TYPOLOGICAL analyses and transformation analysis of the late Middle Palaeolithic assemblages 4 of Yabroud Shelter I 144
6.1. Identifying core reduction techniques 144
6.2. Levallois core reduction strategies 146
6.2.1. Levallois cores for points 148
6.2.2. Levallois cores for blades 151
6.2.3. Levallois cores for flakes 153
A. Preferential Levallois cores 153
B. Centripetal Levallois cores 154
6.2.4. Initial Levallois cores 156
Summary 158

6.3.The characters of Levallois blanks and cores 160
6.3.1. Dorsal scar patterns of Levallois blanks and cores 160
6.3.2. Maintenance of the striking platforms 167
6.3.3. Quantity of cortex on Levallois blanks 169
6.3.4. Size of Levallois blanks and cores 170
6.4.Strategies of blank production 172
6.4.1. Levallois point reduction strategies 172
6.4.2. The close technological correlation between an obliqueness of two preceding predetermined convergent removals of Levallois point production and the classical Levallois point 177
A. Cross-section angles of Levallois points 178
B. The lateral angles of broad-based Levallois points 180
C. The experimental work 181
6.4.3. Levallois flake and blade reduction strategies 184
A. Strategy of Levallois blade production from an individual reduction sequence 186
B. A single reduction sequence for point (elongated or not) and blade production 186
C. A double strategy of core reduction for Levallois blade production 187
6.5.By- products 188
6.5.1. Cortical flakes 189
6.5.2. Naturally backed knives and Core edge flakes *Éclats débordants* 190
6.5.3. Flaking surface preparation flakes 191
6.5.4. Striking platform flakes 192
6.6.Typological classification: manufacturing tools 193
6.6.1. The Middle Palaeolithic group (Group II) and partially retouched pieces 194
6.6.2. Denticulates, notched elements and Upper Palaeolithic group (Group III) 196
6.6.3. Composite tools 196
6.6.4. Analysis of modified blanks 197
A. Modification of slightly larger products 197
B. Amount of Cortex on the dorsal surfaces 198
C. Condition (Complete /Broken) 198
D. Type and angle of Striking Platform 198
E. Scar patterns 198
6.7.Transformation analysis 200

6.7.1. Raw material units imported as single objects or tools 200
6.7.2. Raw material units imported as dynamic objects 206
6.7.3. Raw material units imported as nodules 206
6.7.4. Raw material units imported as partially prepared cores 212
A. Raw material unit as blank production from a core (transformation section Cb) 212
B. Raw material units as blank production from a core with subsequent modification (transformation section Cm) 213
C. Raw material unit as correction of a core (transformation section Cc) 214
D. A split volume for executing two different Levallois methods (transformation section Cs) 214
E. Raw material units including a debitage of two different Levallois methods (transformation section Ct) 215
E.1. Shifting from Levallois blade into Levallois point production 215
F. Re-exploitation of thick and cortical discarded flakes (transformation section Crf) 215
6.8. Reconstruction of recurrent occupation of the late Middle Palaeolithic task-specific site, assemblage 4 of Yabroud Shelter I 224
6.8.1. Low diversity of the lithic material 224
6.8.2. Repeated occupation of the task-specific assemblage 4 of YSI 228
6.8.3. High mobility 229
6.8.4. Strategies and circumstances of raw material procurement 231
A. Direct strategy of raw material procurement 231
B. Embedded strategy of raw material procurement 231
6.8.5. Off versus on-site activities 232
Summary 233
7. Comparative study of the late Middle Palaeolithic industry of assemblages 6 and 4 of Yabroud Shelter I 234
7.1. Identifying core reduction techniques 234
7.2. Levallois core reduction strategies 235
7.2.1. Levallois cores for points 235
A. Methods of producing the Levallois point 235
B. Unified versus random preparation of the flaking surface 236
C. Size properties and discard of the cores 236
7.2.2. Levallois cores for blades 237
A. Methods of producing the Levallois blades 237

B. Installation of the flaking surface convexity 237
C. size properties and discard of the cores 238
7.2.3. Levallois cores for flakes 238
A. Methods of producing the Levallois flakes 238
B. Installation of the flaking surface convexity 238
C. size properties and discard of the cores 239
7.3.Initial Levallois cores 239
7.4.Core on flake strategy 240
7.5.Summary 240
7.5.1. Characteristics confined to the lithic industry of the assemblage 6 240
A. Exploitation of the lower surface of the Levallois cores 240
B. Exploitation of discarded bifaces 240
C. Cores on flakes and *Nahr Ibrahim* technique 241
7.5.2. The technological aspects most common to the lithic material of in both assemblages 241
A. Frequently reduction of the recurrent Levallois flaking method 241
B. Method of Levallois flake production 241
C. Maximum benefit of the Levallois cores 241
D. Initial Levallois cores 242
7.5.3. The clearest technologically differences between assemblages 6 and 4 242
A. The predominance of different Levallois methods 242
B. Method of Levallois point production 242
C. Slightly disparity of the Levallois cores for blades 243
7.6.Strategy of the blank production 243
7.6.1. Strategy of Levallois point production 243
A. An individual reduction sequence for Levallois point production 243
B. A single reduction sequence for Levallois point, elongated point and Levallois blade production 245
C. Double strategy of core reduction 246
C.1. Standardization of Levallois point production from the second phase of the double strategy of core reduction in assemblage 4 246
C.2. Standardization of Levallois flake production from the second stage of double strategy of core reduction in assemblage 6 246
7.6.2. Strategy of Levallois flake production 247
A. Paucity of application of an individual reduction sequence for Levallois flake production in assemblages 4 247

B. Predominance of Levallois flake production from a double strategy of core reduction in assemblage 6 248
7.6.3. Strategy of Levallois blade production 248
A. Paucity versus high frequency of the individual reduction sequence for Levallois blade production 248
B. A single reduction sequences for blade, points (including elongated) production 249
C. Double strategy of core reduction for Levallois blades production 250
7.7.Tools 250
7.8.Transformation analyses 253
7.8.1. Imported raw material units as single objects or tools 254
7.8.2. Imported raw material units as dynamic objects 254
7.8.3. Scarcity of imported raw material units as nodules 255
7.8.4. Predominance of Importing raw material units as partially prepared cores 256
7.9.Multiple palimpsests of a base camp site versus a task-specific site of Late Middle Palaeolithic, assemblage 6 and 4 of Yabroud Shelter I 257
7.9.1. Clear diversity versus low diversity 258
7.9.2. High mobility 259
7.9.3. Predominance of the embedded strategy of raw material procurement 261
8. Discussion 263
9. Conclusion 278
10. Summary 283
Bibliography. 288
List of figures 308
List of tables 314
Table of Contents 317