UNIVERSITY OF SOUTHAMPTON

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From Keilmesser to Bout Coupé Handaxes: Macro-Regional Variability among Western European Late Middle Palaeolithic Bifacial Tools

by

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ABSTRACT

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FROM KEILMESSER TO BOUT COUPÉ HANDAXES: MACRO-REGIONAL VARIABILITY IN WESTERN EUROPEAN LATE MIDDLE PALAEOLITHIC BIFACIAL TOOLS

by Karen Ruebens

Neanderthals in Western Europe are associated with a plethora of stone tool assemblages and their internal variation has been linked to different causal factors and behavioural interpretations. This thesis presents a new contribution to the study of Middle Palaeolithic variability by focusing specifically on the Late Middle Palaeolithic period (MIS 5d-3) and the typo-technological, spatial and temporal differences amongst bifacially worked tools.

Currently, in Western Europe distinct types of Late Middle Palaeolithic bifacial tools are associated with two macro-regional entities, the Mousterian of Acheulean Tradition (MTA) and the *Keilmessergruppe* (KMG). These two entities, centred in Southwestern France and Germany, also link to two different research traditions which use a variety of competing terms, typologies and definitions. This study uses a new classificatory approach to overcome these epistemological issues and facilitates for the first time wider-scale comparisons, incorporating the regions located in between the MTA and KMG core areas.

Bifacial tools from 14 key assemblages were analysed through an extensive attribute analysis, creating a database with primary data for 1,303 bifacial tools. This data was then incorporated with other published site information allowing for a detailed assessment of both the typo-technological characteristics of the bifacial tools and their variability.

Firstly, the results indicate that genuine differences exist among Late Middle Palaeolithic bifacial tool assemblages regardless of the classificatory framework. Secondly, exploration of the data using three different scales of analysis allowed for the recognition of different variation patterns and interpretations. At a micro-scale, it is clear that a large amount of typo-technological variability exists among Late Middle Palaeolithic bifacial tools, which can mainly be attributed to differences in local conditions, such as raw material and function.

At a macro-scale the MTA/KMG dichotomy was confirmed by a distinct divide between classic handaxes and backed bifacial tools west and east of the Rhine. Additionally, a third entity, the Mousterian with bifacial tools (MBT), is located in between the MTA and KMG core areas and contains a wide variety of bifacial tools, including MTA and KMG types. At a meso-scale, several previously identified regional entities were merged into the MTA and MBT, but specific spatio-temporal units do exist, e.g. *bout coupé* handaxes in MIS3 Britain.

At both this meso- and macro-scale the observed patterns cannot be explained merely by referring to differences in local settings, but require an additional sphere of interpretation, argued here to be culture. The MTA and KMG can be seen as two distinct cultural traditions, reflecting different lines of learned behavior, as expressed by different ways of making bifacial tools. The sporadic spread of KMG elements across Western Europe is indicative of Neanderthal population dynamics and the MBT is interpreted as the results of MTA-KMG interactions in an overlap zone where foreign influences were more easily absorbed. Finally, the distinct presence and absence of certain bifacial tool types in specific regions allow to argue for the presence of a collective cultural capacity among Neanderthals.

Résumé

Les Néandertaliens d'Europe occidentale sont associés à une pléthore d'ensembles lithiques avec une variation interne qui peut être liée à des causes différentes et des interprétations variables. Cette thèse présente une nouvelle contribution à l'étude de la variabilité du Paléolithique moyen en se concentrant spécifiquement sur sa période tardive (SIM 5d-3) et les différences typo-technologiques et régionales parmi les outils travaillés bifacialement.

Actuellement, en Europe des types distincts d'outils bifaciaux du Paléolithique moyen sont associés à deux entités macro-régionales, le Moustérien de Tradition Acheuléenne (MTA) et le *Keilmessergruppe* (KMG). Ces deux entités, centrées au sud-ouest de la France et l'Allemagne, représentent aussi deux traditions de recherche qui de plus utilisent des terminologies et typologies variables. Ici, une approche classificatoire nouvelle a été utilisée pour surmonter ces problèmes épistémologiques et a facilité pour la première fois des comparaisons larges, intégrant les régions situées entre les zones MTA et KMG.

Les attributs d'outils bifaciaux de 14 ensembles ont été analysés et une base de données a été créée avec des données primaires pour 1.303 outils bifaciaux. Ces données ont ensuite été incorporées avec des données publiées, ce qui permet une évaluation détaillée des caractéristiques typo-technologiques des outils bifaces et leur différenciation régionale.

Les résultats indiquent que des différences existent entre des ensembles du Paléolithique moyen riche en outils bifaciaux quel que soit le cadre de classification utilisé. En outre, l'analyse des données des trois échelles d'analyse a permis de reconnaitre des tendances et des interprétations différentielles. Lors d'une micro-échelle, une grande variabilité typo-technologique existe entre les outils bifaciaux du Paléolithique moyen tardive. Ceci s'explique principalement par la référence à des facteurs circonstanciels différents.

Lors d'une macro-échelle la dichotomie MTA/KMG a été confirmée par une séparation est et ouest du Rhin entre des bifaces classiques et des outils bifaciaux à dos. En outre, une troisième entité, le Moustérien avec des Outils Bifaciaux (MBT), est situé entre le MTA le KMG et contient une grande variété d'outils bifaciaux, y compris des types classiques du MTA et du KMG. Lors d'une méso-échelle, plusieurs entités régionales ont été fusionnées dans le MTA et le MBT. Mais des unités spatio-temporelles existent aussi, par exemple, les bifaces bout coupés en Grande-Bretagne pendant SIM-3.

Au méso-et macro-échelle, les tendances ne s'expliquent pas seulement par référence à des différents contextes locaux mais nécessitent une autre sphère d'interprétation, la culture. Les MTA et KMG sont considérés comme deux traditions culturelles distinctes reflétant différentes lignes de comportement appris représentant des manières différentes de production des outils bifaciaux. La propagation sporadique d'éléments KMG en Europe occidentale est révélatrice de la dynamique des populations néandertaliennes. Le MBT quant à lui peut être interprété comme le résultat des contacts MTA-KMG dans une zone de chevauchement où les influences étrangères ont été plus facilement absorbées. En outre, l'absence et la présence distincte de certains types d'outils bifaciaux dans des régions limitées permettent d'apercevoir une capacité culturelle collective pour les Néandertaliens.

Zusammenfassung

Die Neandertaler in Westeuropa werden mit einer Vielzahl von Steininventaren in Verbindung gebracht. Die interne Vielfalt wurde mit verschiedenen kausalen Faktoren und verhaltenstechnischen Interpretationen begründet. Diese Arbeit liefert einen neuen Beitrag zum Studium dieser Variabilität durch den Fokus auf das Spätmittelpaläolithikum (MIS 5d-3) und die techno-typologischen und regionalen Unterschiede zwischen den bifazialen Werkzeugen.

In Westeuropa lassen sich bifaziale Werkzeuge des späten Mittelpaläolithikums eindeutig zwei überregionalen Einheiten zuordnen, dem Moustérien de tradition acheuléenne (MTA) und den Keilmessergruppen (KMG). Diese beiden Entitäten, deren Zentren im Südwesten von Frankreich und Deutschland liegen, sind an zwei verschiedene Forschungstraditionen geknüpft, die eine Vielzahl von konkurrierenden Begriffen, Typologien und Definitionen verwenden. Diese Studie verwendet ein neues Klassifikationssystem um diese epistemologischen Probleme zu überwinden und ermöglicht zum ersten Mal breit angelegte Vergleiche der Bereiche zwischen den Zentren von MTA und KMG.

1303 bifaziale Werkzeuge aus 14 Inventaren wurden durch eine umfangreiche Aufnahme der Attribute analysiert. Die Datenbasis wurde durch bereits publizierte Inventare erweitert und die gewonnen Informationen verglichen, was eine detaillierte Bewertung der techno-typologischen Charakteristika der bifazialen Werkzeuge und deren regionaler Differenzierung möglich macht.

Erstens zeigen die Ergebnisse, dass Unterschiede zwischen spät-mittelpaläolithischen bifazialen Werkzeug-Inventaren existieren, unabhängig vom klassifikatorischen Rahmen. Zweitens zeigen sie, dass es die Analyse in drei verschiedenen Maßstäben ermöglicht Variationen in Form und Interpretation zu erkennen. Aus der Mikro-Perspektive zeigt sich eine große techno-typologische Variabilität der spät-mittelpaläolithischen bifazialen Werkzeuge, was hauptsächlich auf Unterschiede in den lokalen Gegebenheiten zurückzuführen ist.

Aus der Makro-Perspektive wird die MTA/KMG-Zweiteilung durch eine Kluft zwischen klassischen Faustkeilen westlich, und bifazialen Werkzeugen, mit einem natürlichen oder allenfalls grob zugerichtetem Rücken, östlich des Rheins deutlich. Zusätzlich erscheint eine dritte Entität, das Mousterian with bifacial tools (MBT), zwischen den Zentren von MTA und KMG deren Inventare eine große Vielfalt von bifazialen Werkzeugen, MTA- und KMG-Typen eingeschlossen, beinhalten. Aus der Meso-Perspektive verschmelzen verschiedene Aspekte/Inventare des MTA und MBT miteinander, während spezifische Raum-Zeit-Einheiten, wie die Bout coupé-Faustkeile des MIS-3 in Großbritannien, feststellbar sind.

Aus der Meso- und Makroperspektive lassen sich die beobachteten Muster nicht auf lokale Gegebenheiten zurückführen, ohne dass das Konzept von Kultur als Grundlage der Unterschiede herangezogen wird. Das MTA und die KMG können als zwei kulturelle Traditionen verstanden werden, deren unterschiedlich gelernte Verhaltensmuster sich in andersgearteten Herstellungswegen von bifazialen Werkzeugen widerspiegeln. Die sporadische Verbreitung von Elementen der KMG in ganz Westeuropa ist bezeichnend für die Populationsdynamik des Neandertalers und das MBT wird als das Ergebnis des MTA-KMG-Kontaktes in deren Überlappungsbereich interpretiert, in dem fremde Einflüsse leichter absorbiert wurden. Darüberhinaus spricht die eindeutige Abwesenheit und Anwesenheit von bestimmten bifazialen Werkzeugen in spezifischen Regionen für die Präsenz einer kollektiven kulturellen Kapazität der Neandertaler.

Samenvatting

Neanderthalers in West-Europa zijn geassocieerd met een overvloed aan lithische ensembles en hun interne variatie is gelinkt aan verschillende oorzakelijke factoren en gedragsinterpretaties. Dit doctoraat vormt een nieuwe bijdrage aan de studie van deze Midden-Paleolithische variabiliteit door te focussen op het Laat Midden Paleolithikum (MIS 5d-3) en de regionale en typo-technologische verschillen tussen de bifaciale werktuigen.

In West-Europa worden twee macro-regionale entiteiten gekenmerkt door Laat Midden-Paleolithische bifaciale werktuigen, het Mousterian van Acheuleaan Traditie (MTA) en de Keilmessergruppe (KMG). Deze twee tradities, respectievelijk gelokaliseerd in Zuidwest-Frankrijk en Duitsland, zijn gelinkt aan twee onderzoekstradities die een verscheidenheid aan concurrerende termen, typologieën en definities gebruiken. Dit onderzoek gebruikt daarom een nieuw classificatiesysteem om deze epistemologische problemen te overwinnen en een wijdere, pan-Europese vergelijking mogelijk te maken.

1,303 bifaciale werktuigen van 14 ensembles werden bestudeerd via een gedetailleerde attributenanalyse. Vervolgens werden deze nieuwe gegevens geïntegreerd met informatie beschikbaar in publicaties. Dit maakte een gedetailleerde beoordeling van zowel de typo-technologische kenmerken van de bifaciale tools als de regionale differentiatie mogelijk.

De resultaten duiden vooreerst het bestaan van specifieke verschillen tussen de Laat Midden-Paleolithische bifaciale werktuigen ongeacht het gebruikte classificatiekader. Ten tweede tonen analyses vanuit drie verschillende analyseschalen differentiële trends en interpretaties. Vanuit een microperspectief werd de grote hoeveelheid typo-technologische variabiliteit tussen de Laat Midden-Paleolithische bifaciale werktuigen duidelijk en dit kan grotendeels verklaard worden door verschillen in de lokale omstandigheden.

Op de macroschaal werd de MTA/KMG tweedeling bevestigd met een duidelijke verdeling west en oost van de Rijn tussen klassieke vuistbijlen en bifaciale werktuigen met een rug. Bovendien werd een derde entiteit gedefinieerd, het Mousteriaan met bifaciale werktuigen (MBT) gesitueerd tussen de MTA en KMG kerngebieden en gekenmerkt door een breed scala aan bifaciale artefacten, waaronder zowel MTA en KMG types. Op een mesoschaal, werden verschillende regionale entiteiten ondergebracht in het MTA en MBT, maar specifieke regionale eenheden bestaan, zoals de bout coupé vuistbijlen in MIS-3 Groot-Brittannië.

Lokale verschillen voldoen niet om de meso- en macro-trends te verklaren en daarom werd ook het potentiële effect van cultuur bestudeerd. De MTA en KMG kunnen geïnterpreteerd worden als twee culturele tradities die verschillende lijnen van aangeleerd gedrag weerspiegelen, uitgedrukt in de uiteenlopende manieren om bifaciale werktuigen te produceren. De sporadische aanwezigheid van KMG elementen over heel West-Europa is een indicatie van de dynamiek van de Neanderthaler populaties en de MBT kan best worden geïnterpreteerd als het resultaat van MTA-KMG contact in een overlappingszone waar vreemde invloeden gemakkelijker werden geabsorbeerd. De duidelijke aan- en afwezigheid van specifieke types van bifaciale werktuigen pleit bovendien voor het bestaan van een collectieve culturele capaciteit bij Neanderthalers.

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Academic Thesis: Declaration Of Authorship

I, Karen Ruebens, declare that the thesis entitled: **From Keilmesser to Bout Coupé Handaxes: Macro-regional Variability among Western European Late Middle Palaeolithic Bifacial Tools**, and the work presented in it are my own and has been generated by me as the result of my own original research.

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
2. Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated;
3. Where I have consulted the published work of others, this is always clearly attributed;
4. Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work;
5. I have acknowledged all main sources of help;
6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
7. None of this work has been published before submission.

Signed:

Date:

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Chapter 1:

Introduction

1.1 Introduction

The Middle Palaeolithic in Western Europe (ca. 300,000-35,000 BP) is associated with Neanderthal remains and a rich archaeological record, for which stone tools are the most common, durable and informative component (Text box 1.1). Since the onset of Palaeolithic research in the mid 19th century, and especially since the 1960's, this record has been widely researched from a variety of perspectives, incorporating palaeoanthropological, environmental, zooarchaeological and lithic analyses. These studies have provided a wealth of information concerning Middle Palaeolithic behaviour (for an overview see Mellars 1996; Gamble 1999; Conard and Richter 2011; Condemi and Weniger 2011). Nevertheless, several aspects are still poorly understood, including the mechanisms behind the occurrence of stone tool variability and the behavioural significance of any observed patterning.

This PhD forms a new contribution to this study of Neanderthal behavioural variability through detailed analyses of Late Middle Palaeolithic stone tool assemblages rich in bifacial tools. It integrates a new methodological approach set within a pan-European framework, incorporating lesser studied regions of Western Europe.

This research was initially triggered by the publication of new studies that focus on Middle Palaeolithic assemblages rich in bifacial tools (Richter 1997, 2004; Soressi 2002; Jöris 2004, 2006), but mainly by my study of the Oosthoven lithic assemblage (Belgium) (Ruebens 2005, 2006; Ruebens and Van Peer 2011). Both suggested the co-existence of two Late Middle Palaeolithic taxonomic entities rich in bifacial tools which occur in distinct geographical ranges; hence creating a **macro-regional dichotomy** (Text box 1.1) between:

- **The Mousterian of Acheulean Tradition (MTA)** with core area in Southwestern France, characterised by thin, roughly symmetric handaxes, often cordiform and triangular in shape.

- **The 'recent Micoquian' or *Keilmessergruppe* (KMG)** with core area in Germany, typified by a wide array of leafshaped and backed bifacial tools, including the eponym backed bifacial knives (*Keilmesser*).

A detailed analysis of the Oosthoven assemblage (Ruebens 2005), which is geographically located between the MTA and KMG range, suggested that this and other European Neanderthal assemblages do not fit the current framework of Middle Palaeolithic entities (*ibid.*). Specifically, **some assemblages contain both MTA and KMG type-fossils in a contemporary context**, challenging the current existence of a dichotomy.

The above, in conjunction with further reading (Richter 1997; Soressi 2002; Jöris 2004) led me to formulate a research question relating to this apparent dichotomy in the record:

Is the MTA/KMG dichotomy the result of genuine differences in Neanderthal behaviour or an artificial creation caused by the existence of different academic traditions which analyse and interpret archaeological data in different ways?

This thesis argues that, currently, the study of Late Middle Palaeolithic bifacial tools has been hampered by the extensive variety of competing terms, typologies and definitions used by different academic traditions, which are obscuring the underlying and genuine archaeological and behavioural patterns. By devising a new classificatory approach (Chapter 4) and applying this to a wide selection of Late Middle Palaeolithic bifacial tools and assemblages (Chapter 5, 6 and 7) a new understanding and behavioural interpretation of the Late Middle Palaeolithic can be formulated (Chapter 8).

This research demonstrates that genuine behavioural differences occur among Late Middle Palaeolithic groups as expressed through variation in bifacial tools; such variation occurs both at a regional and macro-regional scale, and it is further argued that this large-scale patterning cannot be explained without referring to a degree of cultural differentiation.

1.2 Research Problem

1.2.1 Introduction to the research problem

Debates on the Middle Palaeolithic have long been dominated by competing explanations for the variability present amongst the recovered and classified stone tool assemblages. The aim was to explain why, for example, some assemblages contained a high proportion of side scrapers, while in other assemblages this tool type was underrepresented and other tool types (such as notches and denticulates) dominated the tool kit. Different scholars (Bordes 1961, 1973; Binford 1973; Dibble and Rolland 1992; Kuhn 1995) proposed new perspectives and insights related to this concept of Mousterian inter-assemblage variability, successfully increasing the knowledge of Mousterian lithic technology in general. However, the focus of these studies has too often been restricted to Southwestern France and the varying proportions of different types of unifacial tools. Although this type of focused regional study of Middle Palaeolithic assemblages can be very informative (e.g. Geneste 1985; Mellars 1996 and Szmidt 2003), it is also critical to integrate them in a wider *pan-European perspective*, focusing on larger-scale patterns of regional variability. It is essential to incorporate the *bifacially worked tools* and assess the validity of the currently used typological frameworks and purported regional differences for this tool type.

MACRO-REGIONAL VARIABILITY

In addition to the well-studied Southwestern French Mousterian variability (micro-variability), the concept of macro-regional variability has recently emerged (Conard and Fischer 2000). This is based on the recognition that during the Late Middle Palaeolithic (MIS 5d-MIS 3, ca. 115-30 ka BP) two larger taxonomic units were present in Western Europe (Richter 2002); the Mousterian of Acheulean Tradition (MTA) and the *Keilmessergruppe* (KMG). Each occurred in a distinct but rather large geographic area (Fig. 1.1). The research concerning the characteristics, relationship and reality of these two entities is still in an early stage of development. In the past, studies about the MTA-KMG connection have mainly focused on French (MTA) and German (KMG) data (e.g. Soressi 2002; Jöris 2004). In my opinion, to formulate a better understanding of both units, and all other, biface-rich entities it is necessary to transcend this regionally-restricted approach and take a broader perspective that observes the occurrence of bifacial tools across Late Middle Palaeolithic Western Europe. Therefore, **this PhD will focus on the whole of Western Europe, incorporating the geographical areas now covered by Germany, France, The Netherlands, Belgium and Britain.**

This pan-European approach will allow for an assessment of broader-scale, regional and macro-regional, patterning within the data. Moreover, the research will incorporate data from the geographic zone between the MTA and KMG core areas (Netherlands, Belgium, Northern, Western and Eastern France), something that has not, until now, been attempted. Recent work (e.g. Rensink 2005; Bourdin 2006; Ruebens 2007; Cliquet *et al.* 2009; Ruebens and Di Modica 2012; Lamotte *et al.* in press) has highlighted that many assemblages from this region do not fit into the current framework of Middle Palaeolithic techno-complexes by containing bifacial tools which are diagnostic of both the MTA and KMG, therefore directly challenging current opinions and the KMG/MTA regional distinction.

LATE MIDDLE PALAEOLITHIC BIFACIAL TOOLS

Bifacially worked tools form a substantial part of the Neanderthal toolkit throughout the Late Middle Palaeolithic (Text Box 1.1). One of the most important asserted differences between MTA and KMG assemblages is the appearance of different types of bifacial tools. The typological characteristics of these tools have been defined in detail by Bordes for the MTA (Bordes 1961) and by Bosinski for the KMG (Bosinski 1967). These bifacial tools and the variability within them were almost always neglected in previous studies about Middle Palaeolithic variability (e.g. Mellars 1996) and therefore much still remains unknown about them. Therefore**, this PhD will focus on Late Middle Palaeolithic assemblages that are dominated by bifacially flaked tools** so the variability amongst these bifacial tools can be mapped for the first time for the whole of Western Europe.

My previous research indicates that the use of different methodologies and stone artefact typologies by different academic traditions obscures patterns and prevents bridging knowledge between the MTA and KMG core regions (Ruebens 2006, 2007). Therefore, an important aspect of this PhD research is to unravel these different methodologies and create a new simplified methodology that will facilitate comparisons between the different areas. To assist this re-examination, a coherent attribute analysis was developed and applied to several crucial Late Middle Palaeolithic assemblages rich in bifacial tools from the different regions in Europe. This new methodology can then overcome these old epistemological issues and allow for an assessment of similarities and differences within and between different geographic regions (Fig. 1.1).

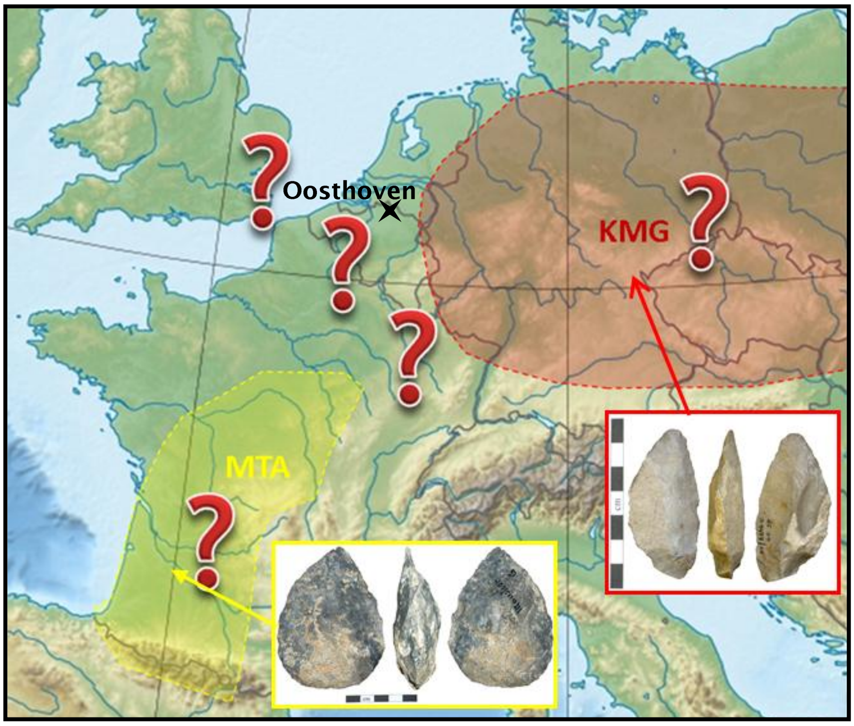


Fig. 1.1: *Overview of the MTA and KMG core areas, examples of their characterizing bifacial tools, and the location of Oosthoven (Belgium)*

Overall, this PhD will form a new contribution to current knowledge on Neanderthal behaviour by (Fig. 1.1):

- **Unravelling and reassessing current classificatory frameworks of Late Middle Palaeolithic bifacial tools**
- **Creating a new methodological framework to facilitate uniform comparisons**
- **Applying a macro-regional, pan-European approach**
- **Integrating data from the area located in between the traditionally interpreted MTA and KMG core areas**
- **Validating and characterising the current acclaimed typo-technological, spatial and temporal differentiation patterns among these bifacial tools**
- **Incorporating assemblages that do not fit the current MTA/KMG dichotomy**

1.2.2 Research questions

The primary aim of this study is to assess the validity, character and significance of patterns of variation among Late Middle Palaeolithic bifacial tools in Western Europe. Subsequent discussion will focus on the exact nature of these patterns and how these can be explained and interpreted in terms of Neanderthal behaviour. To provide a focus for this thesis several research questions have been formulated. The main research question, as introduced above, relates to establishing the genuine nature of the MTA/KMG patterning:

RESEARCH QUESTION 1:

Is the MTA/KMG dichotomy the result of genuine differences in Neanderthal behaviour or an artificial creation caused by the existence of different academic traditions which analyse and interpret archaeological data in different ways?

The next three research questions aim not only to provide the necessary data to answer Research Question 1 but also to further explore and contextualise the MTA/KMG patterning:

RESEARCH QUESTION 2:

What are the distinctive typo-technological characteristics of the bifacially worked tools present during the Late Middle Palaeolithic (MIS 5d-3; ca. 115-35 ka BP) in Western Europe (Germany, France, the Netherlands, Belgium and Britain)?

RESEARCH QUESTION 3:

What patterns of spatial and temporal differentiation are identifiable amongst the Late Middle Palaeolithic Western European bifacial tools beyond the MTA/KMG dichotomy?

Within research question 3 is one *SUB QUESTION:*

Are the so-called 'mixed' assemblages, which contain both KMG and MTA bifacial tools, a real phenomenon?

RESEARCH QUESTION 4:

How can the presence or absence of macro-regional variability patterns in the Late Middle Palaeolithic record of Western Europe be interpreted in relation to wider Neanderthal behaviour?

Within research question 4 are two *SUB QUESTIONS:*

What causal factors can help explain the observed regional differentiation?

If a 'mixed' entity exists, how does it fit with different ideas on the dynamics within and between the MTA and KMG?

To answer these questions a two-fold methodological framework is applied to 14 key assemblages from five countries. The newly collected data was then integrated with existing data from published site reports allowing for the first time an assessment of the regional and macro-regional variability patterns within the Late Middle Palaeolithic bifacial tools from an overarching Western European perspective with a single methodology.

1.2.3 Research limitations

This PhD research had to confront a number of limitations mainly due to the coarse-grained nature of the Middle Palaeolithic record and the poor recording associated with these early discoveries during the 19th and 20th century. This presented three problems for this study. Firstly, due to the excavation techniques employed many sites lack contextual information. Therefore, the integrity of these lithic assemblages can be questioned, due to a lack of stratigraphic information and the possibility that these assemblages could represent conflated samples due to the lumping of lithic artefacts. Several assemblages therefore had to be excluded from detailed analysis and preference was given to assemblages originating from a well-defined context.

Secondly, further limitations encountered relate to a significant lack of absolute dates for this period and region. Many sites have been placed within the MIS-5d to MIS-3 time period based on contextual arguments (including geology and fauna) but have no radiometric dates. This does not allow a fine chronological framework to be applied to these late Middle Palaeolithic assemblages. Currently, most newly discovered sites are radiometrically dated (e.g. Lynford and Saint-Amand-Les-Eaux) and for some old collections (e.g. Abri Peyrony and Pech de l'Azé I) new dates are on their way, slowly improving the available chronological framework.

Thirdly, it needs to be acknowledged that the current Middle Palaeolithic record is only a sample of the more complicated and regionally varied pattern of cultural and technological change once left behind by Neanderthals. Many sites are still waiting to be discovered, others have been lost forever and some areas have been more intensely researched than others. Despite these limitations, at present some general larger-scale trends and taxonomic units can be identified, interpreted and compared, contributing to our knowledge about Neanderthal behaviour.

1.3 Thesis Outline

To present the background, methodology, results and conclusions of this research this thesis is divided into 9 chapters:

Chapter 1 introduces the research project and gives a compact overview of the research problem. The four research questions and its three sub-questions are presented, together with the general limitations of the study.

Chapter 2 contextualises the Western European Late Middle Palaeolithic. This chapter includes both an overview of the chronology of the Late Middle Palaeolithic in relation with changes in climate, palaeoenvironment, Neanderthal demography and archaeology; and a more in-depth look at the occurrence of bifacial tools and entities during this time period.

Chapter 3 gives a wider theoretical contextualisation to the study of bifacial tool variability. After an overview of past research in relation to Late Middle Palaeolithic bifacial tools, the frameworks that are currently used to interpret variability amongst this tool type are described. Next, the behavioural inferences that potentially can be based on these bifacial tools are presented. Finally, a new theoretical framework is developed, stressing the importance of the use of different scales when interpreting archaeological variability.

Chapter 4 presents the two-fold methodological framework of this PhD research.Firstly, this includes the comparison of past terminologies and typologies and the development of a new simplified typological scheme applied in this thesis. Secondly, the procedures for the collection of new date, including site selection and attribute analysis criteria, are detailed.

Chapter 5 gives an overview, by country, of the bifacial entities present in each region of the study area (Germany, the Netherlands, Belgium, Britain, Northern and Southern France). This includes a comprehensive contextualisation of the 14 key assemblages that were selected for detailed study and the initial results of the reanalysis of their bifacial tools. The initial large-scale comparisons in this chapter will allow formulating an answer to Research Question 1.

Chapter 6 focuses on the techno-typological characteristics of the sample of 1,303 Late Middle Palaeolithic bifacial tools. In relation to the micro-scale of analysis, differences and similarities are explored within and between tool types and assemblages. This is achieved by applying an attribute based comparative study to the bifacial tools, and allows a detailed assessment of their manufacture processes and results in light of Research Question 2.

Chapter 7 examines Late Middle Palaeolithic bifacial tools through an inter-regional comparative study, focusing on recognising and characterising spatial and temporal differentiation patterns as brought forward in Research Question 3. This includes the incorporation of existing published bifacial tool data and the reassessment of the existing bifacial entities. Patterns are assessed at both a macro- and meso-scale of analysis and allow the proposition of a new three-fold macro-regional differentiation model.

Chapter 8 links these new studies of Late Middle Palaeolithic bifacial tools to Neanderthal behaviour (Research Question 4) using the theoretical concepts and multi-scalar framework outlined in Chapter 3. The different factors which influence bifacial tool variability are unravelled and it is assessed which behavioural inferences can be deduced. Moreover, it is detailed how depending on the used scale of analysis, different variability patterns can be observed and different behavioural interpretations brought forward.

Chapter 9 provides a conclusion to this thesis and summarises the answers to the four main research questions and their sub questions. Subsequently, to conclude, this thesis briefly discusses the different potential pathways to take this intial work further.

1.4 Summary

This thesis forms a new contribution to the study of Middle Palaeolithic variability by focusing on Late Middle Palaeolithic bifacial tools and this from a pan-European perspective. 1,303 bifacial tools from 14 key assemblages from different areas of Western Europe are reanalysed by a new uniform methodology, allowing a reassessment and new characterisation of patterns of typo-technological, spatial and temporal variation and their significance in terms of Neanderthal behaviour.

Chronological data – radiocarbon

The radiocarbon dates mentioned throughout this PhD thesis have been calibrated using the software from the Radiocarbon Accelerator Unit from the University of Oxford (OxCal http://c14.arch.ox.ac.uk/) using its most recent calibration curve (IntCal09, Reimer *et al.* 2009). Therefore all dates are in calibrated BP.

MIDDLE PALAEOLITHIC – In Western Europe defined as the period starting around 300,000 BP with the spread of Levallois technology and ending around 35-30,000 BP with the demise of Neanderthals.

LATE MIDDLE PALAEOLITHIC (LMP) – A subdivision of the Middle Palaeolithic, starting with the end of the Last Interglacial, so with the onset of MIS 5d (around 115,000 BP), and lasting until the demise of Neanderthals during the second half of MIS-3 (35-30,000 BP).

MOUSTERIAN – Taxonomic entity constructed by de Mortillet (1869, 1883) to group assemblages rich in flake tools such as scrapers and points. Later flaking technologies, such as Levallois, were added as a defining feature. Term now ambiguously equated with all Middle Palaeolithic European flake-based assemblages.

MOUSTERIAN OF ACHEULEAN TRADITION (MTA) – Term created by Peyrony (1920) to group Mousterian assemblages which are characterised by handaxes and backed knives.

MICOQUIAN – Taxonomic entity defined by Hauser (1916) to group assemblages rich in asymmetric knives and thick handaxes; later incorporated in the Acheulean but especially in Central Europe still used in relation to the Middle Palaeolithic. Overall, nowadays a confusing term linked to a controversial group of dissimilar assemblages.

RECENT MICOQUIAN OR *KEILMESSERGRUPPE* – Term introduced by Bosinski (e.g. Wetzel and Bosinski 1969) to indicate Late Middle Palaeolithic assemblages which are characterised by a variety of bifacial tools including backed bifacial knives (***KEILMESSER***).

MACRO-REGION – The term macro-region is commonly used in economic and political studies and can be defined as '*an area including territory from a number of different countries or regions associated with one or more common features or challenges*'. Within archaeology the study of a material record from a macro-regional scale seeks to identify patterns of similarity across modern geo-political boundaries.

HANDAXE – BIFACE – BIFACIAL TOOL – Many handaxe definitions contain references to its mode of manufacture, function and even their symbolic potential (for an overview see Emery 2009). In its simplest form a ***handaxe*** can be defined as an object of stone which has been deliberately shaped by the removal of large flakes from each of its two main faces. Furthermore it is agreed that this retouch must cover most or all of these two opposing surfaces (Bordes 1961; Débenath and Dibble 1994; Roe 2003).

John Frere's account of the discovery of several handaxes at the British site of Hoxne represents the first recorded discovery of these implements (Frere 1800; Fig. 1.2). It took another 50 years for these handaxes to be more generally accepted as evidence of the antiquity of man (see Evans 1872 for Britain, and Boucher de Perthes 1847 for France). From the mid-19th century onwards several studies were then undertaken to define and classify these handaxes. de Mortillet (1883) was the first to use the term '*coups de poing'* which is the French equivalent of the English 'handaxe' or German '*Faustkeil'*. In 1920 Vayson de Pradenne then introduced the term ***'biface'*** to exclude any functional connotation (biface in French but no German equivalent exists).

Throughout this thesis the words biface and handaxe will be used interchangeably. A distinction will be made between the general term ***'bifacial tool'*** which comprises any implement which has been retouched on both faces, and the much more specific term 'handaxe', which is an explicit form of bifacial tool. The definition of what can be considered as a 'classic' handaxe (Fig. 1.2) and the definitions of other bifacial tools types will be presented in Chapter 4.

Fig. 1.2: *Classic handaxe from the Lower Palaeolithic site of Hoxne (Suffolk, UK) (Frere 1800)*

Text box 1.1: *Overview of definitions of the basic concepts used throughout this thesis*

Chapter 2:

Research Background:

Contextualising the Western European Late Middle Palaeolithic

2.1 Introduction

Previous studies of the Middle Palaeolithic mainly focused on behavioural differences with the Upper Palaeolithic (e.g. White 1982; Kozlowski 1990). However, over the last two decades there has been a renewed focus on the Middle Palaeolithic itself (Mellars 1996; Conard and Richter 2011; Scott 2011). While Breuil had already introduced the terms Lower Palaeolithic and Upper Palaeolithic in 1912 (Breuil 1912), the term 'Middle Palaeolithic' only became widely used in the 1950's (Text box 1.1; Richter 2011). Although the precise distinction with the Lower Palaeolithic is in some aspects still rather blurred (see Monnier 2006 and references therein), the Middle Palaeolithic period is defined by the use of standardised flaking techniques, including Levallois technology, and the dominant presence of a range of flake tools (such as scrapers, notches and denticulates; Mellars 1996; Gamble and Roebroeks 1999; Villa 2009; Richter 2011). Furthermore the Middle Palaeolithic stands out because it is manufactured exclusively by early and classic forms of *Homo neanderthalensis* (Hublin 1998, 2009; Stringer 2006, 2011).

The European Middle Palaeolithic is seen as commencing around 300,000 BP with the spread of Levallois technology (Delagnes *et al.* 2007; Scott 2011), lasting for around 270,000 years, and ending with the demise of Neanderthals around 35-30,000 BP (Finlayson *et al.* 2006; Martinez-Moreno *et al.* 2010; Sørensen 2011). This Middle Palaeolithic time period is now commonly divided into an early and late phase based on differences in the archaeological record. The research extent of this thesis is restricted to the Late Middle Palaeolithic and more specifically the bifacially worked tools that occur throughout this time period. The Late Middle Palaeolithic is defined here as starting at the end of the Last Interglacial (aka MIS-5e, Eemian) with the onset of MIS-5d (115,000 BP), and continues until the extinction of Neanderthals in the second half of MIS-3 (around 35,000 BP) (Text box 1.1). This chapter contextualises the research problem (Chapter 1) and provides background information to the Late Middle Palaeolithic period in general and its bifacial tools and entities in specifics.

The first part of this chapter provides the chronological, environmental and archaeological setting of the Late Middle Palaeolithic. Firstly, it is described which climatic events can be distinguished. Secondly the current state of knowledge on the environment, Neanderthal demography and archaeology throughout these different climate phases is discussed.

The second part of this chapter provides a more in-depth discussion on the occurrence of bifacial tools in the Middle Palaeolithic. An overview is given of the different Western European entities that comprise bifacial tools, their techno-typological characteristics, together with their spatial and temporal ranges.

2.2 Chronological, Palaeoenvironmental and Archaeological background to the Late Middle Palaeolithic

2.2.1 Introduction

While the Early Middle Palaeolithic is associated with early forms of Neanderthals and the development of a range of behavioural adaptations, the Late Middle Palaeolithic is linked with classic Neanderthals (Hublin 1998; Tattersall and Schwartz 2008). These classic Neanderthals occupied a vast geographical area, including Europe and Western Asia, and as far east as Southern Siberia and as far south as the Middle East (Green *et al.* 2011). Neanderthal populations were hence confronted with a very different suite of geographical, climatic and ecological circumstances. Furthermore, Late Middle Palaeolithic Neanderthals in Western Europe exhibited a complex set of behaviours: they were top level carnivores, capable and selective hunters, and utilised a flexible, versatile toolkit in a well-understood, well-exploited landscape (Gaudzinski 1995 and 1996; Bocherens *et al.* 1999 and 2001; Gaudzinski and Roebroeks 2000; Roebroeks 2001; Bocherens and Drucker 2003; Soressi and Hays 2003; Rendu 2007; Claud 2008; Bocherens 2009, see also Chapter 8).

Throughout the Late Middle Palaeolithic fluctuations in climate and environment caused changes in the demography and archaeology of these Neanderthal populations on a regular basis and these are discussed below.

2.2.2 Climate, chronology and palaeoenvironment

Our understanding of the climatic and palaeoenvironmental conditions of the European Middle Palaeolithic has increased significantly over the last two decades. This mainly through data recovered from lacustrine, terrestrial and marine sediments, along with ice core data (Grootes *et al.* 1993; Dansgaard *et al. 1993*; Noller *et al.* 2000; Guiter *et al.* 2003). Currently, the Marine Isotope Stages (MIS) framework developed by Emiliani in the 1950's, is the most widely used chronological scheme throughout Palaeolithic archaeology (Lisiecki and Raymo 2005; Sharapova *et al.* 2008) and is also adhered to in this PhD.

The Middle Palaeolithic spans three major glacial (MIS-8, 6 and 4) and three intersecting interglacial periods (MIS-7, 5 and 3) (Table 2.1). The Late Middle Palaeolithic furthermore contains two interglacial (MIS-5e and 3) and one glacial phase (MIS-4). These phases are further subdivided based on local terrestrial sequences and varying terms are in use in different parts of Europe (Table 2.1). Within these glacial and interglacial phases a lot of fluctuations still occurred. This is expressed by the presence of several warmer interstadials and colder stadials, and over 15 Dansgaard/Oeschger climatic oscillations (Dansgaard *et al.* 1993; Grootes *et al.* 1993).

Chronological framework for the Middle Palaeolithic								
Period	MIS	From (kBP)	To (kBP)	Terminology and subdivisions				
				Britain	Germany		France	
Early Middle Palaeo-lithic	8	290	230	Early Saalian glacial *sensu lato*	Fuhne		Saalien	
	7	230	180	Aveley Interglacial	Drenthe-Warthe			
	6	180	125	Saalian glacial *sensu stricto*	Schöningen-Wacken-Dömnitz			
	5e	125	115	Ipswichian or Last Interglacial	Eemian		Eémien	
Late Middle Palaeo-lithic	5d	115	104	Early Glacial	Weichsel – Frühglazial	*Herning*	Weichsélien ancien or Würm I	*Melisey I*
	5c	104	92			*Brørup-Amersfoort*		*St Germain I*
	5b	92	84			*Rederstall*		*Melisey II*
	5a	84	74			*Odderade*		*St Germain II*
	4	74	60	Early Devensian or (Lower) Pleniglacial	Weichsel – Pleniglazial	Schalkholz-Stadial	Pléniglaciaire weichsélien inférieur	
	3	60	25	Middle Devensian or Interpleniglacial		*Oerel (58-54)*	Pléniglaciaire weichsélien moyen or Würm II	
						Glinde (51-48)		
						Moershoofd (46-44)		
						Hengelo (39-36)		
						Denekamp (32-28)		

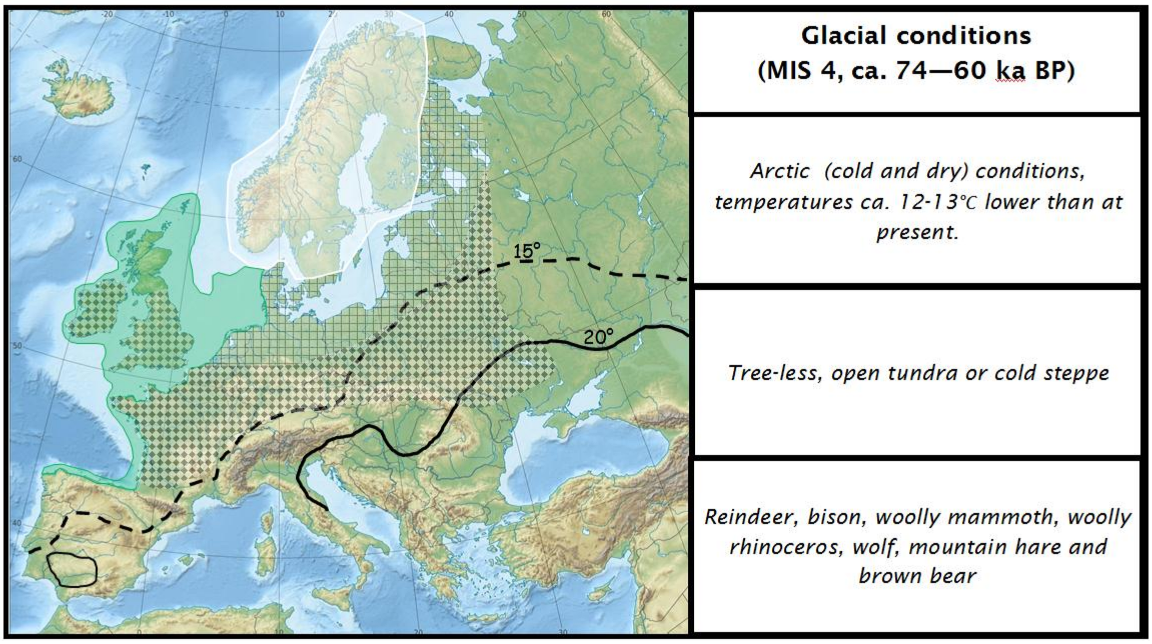
Table 2.1: *Chronological framework for the Middle Palaeolithic based on the different Marine Isotope Stages, incorporating the terminologies most commonly used across Western Europe*

Providing a detailed overview of all these climatic fluctuations is beyond the scope of this thesis. Instead a more generalised, condensed view of Western Europe during these different climatic phases is presented below and used as a guide to assess the environment and its effect on Neanderthal demography and archaeology.

1. GLACIAL CONDITIONS (MIS-4)

Separating the warmer phases of MIS 5d-a and 3 is a major cooling event that took place across Europe between ca. 74 and 60 ka BP. This (Lower) Pleniglacial or Early Devensian (MIS-4) episode is marked by a major expansion of the continental ice sheets, especially towards the end of this climatic stage. The exact geographic limits of the Fennoscandian ice-sheet are controversial (Mangerud 1999), but it is assumed that it did not reach further south than northern Denmark. The UK was always completely ice-free during this time period (Fig. 2.1; van Andel and Tzedakis 1996). In general, MIS-4 Europe was characterised by a continental dry climate with large differences in temperature between day and night, and between summer and winter (Barron *et al.* 2003).

Terrestrial sequences from Northwestern Europe indicate that the vegetation at this time is characterised by a fall in arboreal pollen and consisted of an open tundra or cold steppe, with permafrost in many places (Watts *et al.* 1996). At the end of MIS-4 the high-arctic conditions created a tree-less landscape with semi-desert vegetation (Fig. 2.1; van Andel and Tzedakis 1996; van Andel 2003). For Western Europe mean July temperatures are estimated between 5-10°C and during January as low as -20°C (Guiter *et al.* 2003). These arid steppe environments were rich in grasses and created feeding grounds for a large variety of grazers (Guthrie 1984).

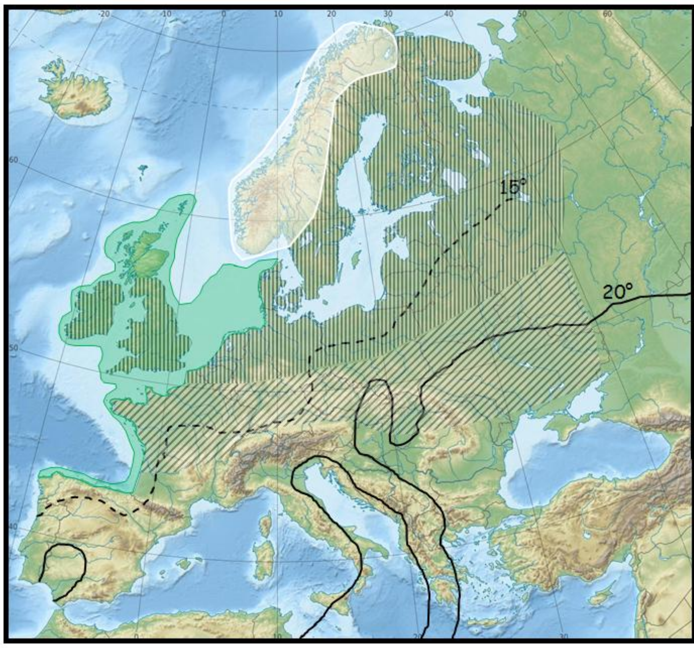


<u>Fig. 2.1:</u> *Sketch map of Europe at the end of MIS-4*
Green contour indicates the coasts at -75m; White contour the most likely expansion of the Fennoscandian ice sheet; Black lines: the mean Summer 15°C (dashed) and 20°C (solid isotherms); Large grid area: polar desert; Solid diamant area: tundra and cold steppe mosaic (based on data from van Andel and Tzedakis 1996 and van Andel 2003)

A 'mammoth fauna' evolved over the last 3-4 glacial cycles (Kahlke 1994). Steppe tundra or 'mammoth steppe' (Guthrie 1982) cold-adapted faunal species are characteristic for all Pleistocene glacial periods. For Northwestern Europe this includes taxa such as reindeer (*Rangifer tarandus*), bison (*Bison priscus*), woolly mammoth (*Mammuthus primigenius*), woolly rhinoceros (*Coelodonta antiquitatis*), wolf (*Canis lupus*), mountain hare (*Lepus timidus*) and brown bear (*Ursus arctos*) (Alvarez-Lao and Garcia 2011; Currant and Jacobi 2002).

2. INTERGLACIAL CONDITIONS (MIS 5 and 3)

The interglacials of MIS-5 and 3 both represent long slow cooling trends but comprise successions of alternately short cold and longer warm temperate periods (van Andel 2003). MIS-5 was divided into three warmer and two colder phases (Shackleton 1969). With regards to the Late Middle Palaeolithic, stages d and b reflect stadial phases of glacial advance and sea-level drop, while interstadial stages c and a correlate with major deglaciation and sea-level rise events. The onset of these stadials was not catastrophic (de Beaulieu and Reille 1984), the cooling was never as marked as during MIS-4 and the Fennoscandian ice-sheet was not very extensive (Fig. 2.2; van Andel and Tzedakis 1996). A tundra or steppe environment dominated but some more hardy trees such as pine, birch and willow were able to survive. Stages a and c on the other hand were quite warm and are characterised by an increase in pine, birch and oak resulting in temperate deciduous forests that covered Europe north of the Pyrenean and Alpine ranges (de Beaulieu and Reille 1984; Guiter *et al.* 2003).



Interglacial conditions (MIS 3, ca. 60-25 ka BP)

Temperate (mild and humid) conditions, temperatures ca. 4°C lower than at present

Mix of open forests with pine and birch and shrub tundra

bison, red deer, horse, reindeer, wild boar, woolly mammoth, woolly rhinoceros, spotted hyena, wolf and fox

Fig. 2.2: *Sketch map of Europe during MIS 5d-a or MIS 3 interglacial conditions*
Green contour indicates the coasts at -50m; White contour the most likely expansion of the Fennoscandian ice sheet; Black lines: the mean Summer 15°C (dashed) and 20°C (solid isotherms); Vertical lined area: shrub tundra; Oblique lined area: open conifer woodland
(based on data from van Andel and Tzedakis 1996 and van Andel 2003)

Furthermore, within MIS-3 six Heinrich events are distinguished (Bond *et al.* 1992, 1993). These are cool phases following a rapid warming whereby large amounts of ice discharge into the North Atlantic Ocran, affecting the circulation of the North Atlantic Deep Water (Ganopolski and Rahmstorf 2001). For example two major abrupt cooling events (Heinrich events 5 and 4) took place around 50 and 35 kaBP. It is clear that MIS-3 has a very fluctuating climate, but in general MIS-3 is characterised by mild and humid conditions and a retreat of the Fennoscandian ice-sheet (van Andel and Tzedakis 1996; van Andel 2003; Huntley and Allen 2003). Throughout MIS-3, Europe was not as densely forested as during MIS-5 although arboreal pollen percentages of 30-50% are common and mainly consist of birch and pine (Guiter *et al.* 2003).

During these interstadial ameliorations Continental Europe would have contained a species-rich mosaic of patchy biotopes (open, grass-rich and lightly forested) with highly diverse plant associations (Huntley and Allen 2003). Temperatures are envisaged as being similar to those of today (Guiot *et al.* 1989). For example during MIS-3 temperatures are envisaged as being on average 4°C below modern-day average temperatures (Fig. 2.2). For example at La Gran Pile in France the average temperature during the warmest month was 8°C and during the coldest -5°C (van Andel and Tzedakis 1996).

The Stage Three Project mammalian database (Stewart 2004) indicates that the MIS-3 fauna is dominated by bison (*Bison priscus*), red deer (*Cervus elaphus*), horse (*Equus* sp.) and rein deer (*Rangifer tarandus*), while wild boar (*Sus scrofa*), mammoth (*Mammuthus primigenius)* and woolly rhinoceros (*Coelodonta antiquitatis)* are also commonly present. Moreover, at several MIS-3 sites a variety of carnivores occur such as spotted hyena *(Crocuta crocuta)*, wolf (*Canis lupus)* and fox (*Vulpes vulpes*) (Stewart 2004). A similar fauna was present during MIS-5 with the dominance of taxa varying depending on the warmer (more forested) or colder (more mammoth-steppe like) climatic conditions.

1.2.3 Demography and archaeology

Throughout the Middle Palaeolithic Neanderthals occupied all of modern-day Europe and expanded into the Near East and Asia as far as Siberia (Mellars 1996; Gamble 1999; Krause *et al.* 2007; Green *et al.* 2011). This expansion range is characterised by a mosaic of geographical locations, each with their own set of environmental conditions, and it can easily be envisaged that exact occupation ranges fluctuate in accordance with the climatic changes described and discussed above (Roebroeks *et al.* 2011). This variation in environmental conditions, necessitated changes in Neanderthal habitations and shifts in Neanderthal dispersal during the Late Middle Palaeolithic can be presumed. Throughout this time period Germany, the Netherlands, Belgium, Britain and France, were repeatedly, but not always continuously, occupied by Neanderthals and some general trends in demography have been recognised.

1. THE EARLY GLACIAL, MIS 5d-5a, 115-74 ka BP

The current distribution of Neanderthal sites shows that throughout the majority of Middle Palaeolithic, including MIS-5, they occupied an area spanning 10 million km^2 (Roebroeks *et al.* 2011). The presence of these Neanderthal populations does show considerable variation by region. The British Isles for example are marked by an occupational hiatus between MIS-6 and the onset of MIS-3 (Ashton and Lewis 2002), although recently sporadic occupation during MIS 5d-a has been claimed (Wenban-Smith *et al.* 2010). It is important to note that the British Isles were disconnected from continental Europe for a period of several thousand years (Ashton 2002). Conversely, continental Europe was more continuously occupied during MIS-5 although it is often impossible to assign assemblages to a specific MIS-5 sub-stage. A notable exception is Northern France where stadial stages 5c and a are well-understood and represented in the stratigraphic sequences by specific forest soil formations related to the occurrence of pine and birch forests (Antoine *et al.* 1999).

Early Glacial lithic assemblages are in generally characterised by a variety of flake tools, the use of the Levallois technology (including the manufacture of Levallois points) and the low occurrence of bifacial tools. In Northern France MIS-5a assemblages are furthermore characterised by a developed blade technology (Locht *et al.* 2010).

2. THE LOWER PLENIGLACIAL, MIS-4, 74-60 ka BP

The Lower Pleniglacial, marked by cold arid conditions and an open steppe environment, is represented in stratigraphic sequences by hiatuses, caused by discontinuous eolian or fluvial dynamics. This hiatus can partly explain the relatively low number of MIS-4 archaeological sites, but conversely the high loess deposition at this time provides good conditions for the preservation of archaeological material and it is therefore generally accepted that there was a population decrease at this time (Hublin and Roebroeks 2009). Some areas, such as Southwestern France, were continuously occupied throughout the Middle Palaeolithic (ca. 300-30ka BP), even during the harsh climatic conditions of MIS-4; as is for example illustrated at the sites of Combe Grenal, Roc de Marsal and Pech de l'Azé IV (Turq 1999; Guibert *et al.* 2008; Guérin *et al.* 2012; Richter *et al.* in press). More northerly located areas such as Britain, Belgium and northern France seem to have been deserted during MIS-4 (Bringmans et al. 2000; Tuffreau 2001; Van Peer 2001, Locht 2005; Sørensen 2011 and Roebroeks *et al.* 2011), although caution needs to prevail when interpreting this absence of evidence pattern. In general, the advancing ice masses and the presence of large ice-dammed proglacial lakes, made large areas of Northern Europe unfavourable for habitation resulting both in regional extinctions and migrations into southern refuges (for a discussion see Hublin and Roebroeks 2009).

Because of the short duration of MIS-4 and the assumed population decrease at this time, lithic assemblages that can be assigned to MIS-4 are sparse compared to both MIS-5 and 3 (Bocquet-Appel and Tuffreau 2009). In most part of Western Europe there seems to be no remarkable technological and typological differences with assemblages from MIS-5 (e.g. Riencourt-les-Bapaume, Tönchesberg and Garzweiler) (Bocquet-Appel and Tuffreau 2009; Uthmeier *et al.* 2011). Conversely, in Southwestern France a link between the Quina Mousterian (rich in large scrapers with steep retouch) and cold conditions has been proposed based on their common occurrence with reindeer fauna; such as at the sites of Combe Grenal; Jonzac; Roc de Marsal and Pech de l'Azé IV (Debénath 2003; Dibble *et al.* 2009; Guérin *et al.* 2012; Niven *et al.* 2012; Richter *et al.* 2013, Richter *et al.* in press). Generally MIS-4 assemblages are characterised by generic Middle Palaeolithic traits such as the presence of scrapers, notches and denticulates and the use of Levallois and discoidal reduction methods.

3. THE INTERPLENIGLACIAL MIS-3, 60-25 ka BP

Whilst MIS-4 is characterised by a depopulation of the northern areas of Europe, the warmer conditions of MIS-3 triggered a repopulation of these areas (van Andel *et al.* 2003). This is most markedly the case in Britain, where after an occupational hiatus of ca. 120,000 years, Neanderthals prominently occupy this area again (Ashton and Lewis 2002; White and Pettitt 2011). From MIS-3 onwards the archaeological record is across Western Europe characterised by an increase in the number of sites. For example, a recent extensive review of Middle Palaeolithic sites resulted in a database of 190 assemblages, of which 69 can be assigned to MIS-3, 17 to MIS-4 and 57 to MIS-5 (Bocquet-Appel and Tuffreau 2009); in general confirming the demographic trends outlined above

Some caution is needed when interpreting this increase in sites. Many assemblages, especially those excavated before the use of systematic excavation techniques, lack contextual data and can only be assigned to a warmer Late Middle Palaeolithic phase, which can be either MIS-5c, 5a or 3. A large part of the MIS-3 time range now falls within the limits of radiocarbon dating (Bronk Ramsey *et al.* 2004; Hughen *et al.* 2004; Reimer *et al.* 2009; Higham 2011; Talamo *et al.* 2012) and therefore assemblages can be more easily assigned to this time frame (van Andel *et al.* 2003). However, a recent overview of all the dated sites in Southwestern France, dated with a combination of methods, still indicates an increase of sites throughout MIS-3 (Guibert *et al.* 2008).

The MIS-3 Mousterian assemblages feature general Middle Palaeolithic characteristics such as the use of Levallois and discoidal flaking methods and the presence of a range of flake tools. Blade-dominated assemblages disappear from Northern France (Locht *et al.* 2010) and a new feature is the occurrence of biface-dominated assemblages. All over Northwestern Europe a reappearance of bifacial tools seem to have taken place. Although bifacial technologies never completely disappeared during the Middle Palaeolithic and were already dominant during MIS-5, a real explosion of these assemblages now seems to occur and is discussed further on.

2.2.4 Summary

European Late Middle Palaeolithic Neanderthals were confronted with a mosaic of shifting climatic and environmental circumstances. The cold, dry and tree-less conditions of MIS-4 stand opposite the milder, more humid and forested conditions of MIS-5 and especially MIS-3. These shifts in climatic and palaeoenvironmental conditions also influenced and changed the occupational range of Neanderthals and a general dichotomy seems to exist between Southern Europe which shows continuous occupation, and Northwestern Europe were phases of complete abandonment seem to occur. In terms of stone tool assemblages two main changes seem to occur during the Late Middle Palaeolithic: the presence of blade assemblages and a reoccurrence of biface-dominated assemblages. This latter is described in more detail in the second part of this chapter.

2.3 Late Middle Palaeolithic Bifacial Tools and Entities

2.3.1 Introduction

In the past the Middle Palaeolithic has often been regarded as a period of stasis, a geographically and temporally homogenous entity, with few developments in hominin behaviour and capacities occurring for more than 250,000 years (Mithen 1996; Kuhn and Stiner 1998; Gamble 1999 and Klein 1999). More recently this idea has been challenged (Hovers and Kuhn 2006 and papers therein) and certain distinctive trends can be recognised in the Middle Palaeolithic record. An illustrative example is the fact that several anomalies (e.g. blade and bifacial technologies) repeatedly occur and disappear again throughout the Middle Palaeolithic. Moreover, in Late Middle Palaeolithic Western Europe some entities which are confined to a specific chronological and geographical range, so-called spatio-temporal units, can be identified; such as the occurrence of blade technology in Northern France during MIS-5 (Goval 2008) and *bout coupé* handaxes in Britain during MIS-3 (White and Jacobi 2002).

One of the main changes throughout the Middle Palaeolithic is the strong reappearance of bifacial tools during MIS-5 and 3. This is a phenomenon which often is only touched upon briefly in studies of Middle Palaeolithic variability (Bordes 1961; Binford 1973; Dibble and Roland 1992; Mellars 1996). Moreover, these bifacial tools are mainly studied from a regional perspective (Cliquet *et al.* 2001; Soressi 2002; Jöris 2004, 2006; Bourdin 2006; Wragg Sykes 2009) or in comparison with the Lower Palaeolithic (Iovita and McPherron 2011).

In this section the occurrences of bifacial tools in the Western European Middle Palaeolithic is discussed. Besides an overview of the presence of this tool type throughout the Middle Palaeolithic, the different biface-rich entities which can be distinguished throughout the Late Middle Palaeolithic are described, including their characteristics, temporal and spatial ranges.

2.3.2 Bifacial tools in the Middle Palaeolithic

In general handaxes and bifacial technologies are seen as the defining characteristic of the Lower Palaeolithic Acheulean industry where they occur from ca. 1.7mya BP to 200 kya BP Clark 1994; Gamble 1999; Santonja and Villa 2006). These bifacial technologies seem to disappear in Western Europe with the arrival of the Levallois technique (Monnier 1995; Monnier 2006; Scott 2011). For the Early Middle Palaeolithic it is generally accepted that bifacial technologies become a very marginal phenomenon, although their use does not cease completely (Monnier 2006; Villa 2009; Emery 2010). This indicates that early Middle Palaeolithic hominins were fully capable of making bifaces but their manufacture was not a significant part of the technological practice at this time, especially in Western Europe (Scott 2011). All over the study area Early Middle Palaeolithic sites (MIS-9 to 5e) occur which contain bifacial tools; often alongside Levallois technologies (Table 2.2). All of these sites have a very low number of bifacial tools, indicating the sporadic existence of these technologies but also emphasising the amplitude of their increase once again during the Late Middle Palaeolithic. Conversely, in Central Europe, bifacial tools become a more regular component of the tool kits from MIS-8 onwards (Conard and Fischer 2000).

Site	Date	Façonnage	Débitage	Reference
Petit-Bost (F)	MIS-9	handaxes	Levallois	*Bourguinon et al. 2008*
Orgnac 3 (F)	MIS-9	handaxes	Levallois	*Moncel 1995*
Barbas I C4 base (F)	MIS-8	handaxes	Levallois	*Boëda and Kevazo 1991*
Le Pucheuil C/A	MIS-8	handaxes	Levallois	*Delagnes and Ropars 1996*
Mesvin IV (B)	MIS-8	handaxes	Levallois	*Cahen et al. 1984*
Markkleeberg (G)	MIS-8/6	handaxes	Levallois	*Mania and Baumann 1990*
Cantalouette I	MIS-7	handaxes	Levallois	*Brenet et al. 2008*
Montieres c.8/7 sup (F)	MIS 7/6	handaxes	Levallois	*Tuffreau 1983*
Saint-Valéry-sur-Somme (F)	MIS 7/6	handaxes	Levallois	*de Heinzelin and Haesaerts 1983*
La Cotte de St Brelade 5 (J)	MIS 7/6	handaxes	Levallois	*Callow and Cornford 1986*
Bapaume-les-Osiers 8 (F)	MIS 7/6	handaxes	Levallois	*Tuffreau 1976*
Combe Brune 3 (F)	MIS 6	handaxes	non-Levallois	*Brenet et al. 2008*
Rheindahlen B1 (G)	MIS-5e	Keilmesser	Levallois	*Schmitz and Thissen 1998*

Table 2.2: *Examples of Early Middle Palaeolithic sites within the study area that contain bifacial tools*

At the other end of the spectrum, the use of bifacial technologies seems to decrease again from mid MIS-3 onwards and more specifically around 35,000 BP. In France MTA handaxes occur sporadically within Châtelperronian contexts (Grotte XVI (Lucas *et al.* 2003); Quinçay (Lévêque and Miskovsky 1983) and Saint-Césaire (Lévêque 1993) but this could relate to stratigraphic mixing rather than genuine occurrences (Bordes 1961; Claud 2008).

In general handaxes and *Keilmesser* seem to vanish from the archaeological record around 40,000 BP. Bifacial technologies do carry on being used and bifacially worked leaf points become the hallmark of several so-called transitional technocomplexes, such as the Szeletian and Lincombian-Ranisian-Jerzmaniwichian (LRJ; Flas 2008, 2011). By the onset of the Upper Palaeolithic, within for example the Aurignacian, these bifacially worked tools disappear completely.

The chronological trends among bifacial technologies in Western Europe can be summarised as:

1. A dominant occurrence on a majority of sites all throughout the Lower Palaeolithic (ca. MIS 16-9)
2. A strong decrease during MIS-9 and a very sporadic, low number, occurrence at sites throughout MIS-9 to MIS-5e (Table 2.3).
3. A sharp increase during MIS-5d and high frequency throughout MIS-5d until the second half of MIS-3.
4. A decrease after 40,000 BP, first a specific occurrence as bifacially worked leaf points followed by a complete disappearance from the archaeological record.

Throughout the Late Middle Palaeolithic these bifacially shaped tools occur in a wide variety of types (e.g. handaxes and *Keilmesser*, for detailed definitions see Text Box 1.1 and Chapter 4). An apparent explosion in the appearance of bifacial tools seems to occur all over Western Europe (Richter 1997; Soressi 2002; Jöris 2003). The reasons behind this reappearance or 'reinvention' (Iovita and McPherron 2011) are still poorly understood but it is clear that bifacial tools once again form a prominent feature of the toolkit. Moreover, several spatial and temporal differentiation trends have been suggested (Soressi 2002; Jöris 2004). This variability amongst Late Middle Palaeolithic bifacial tools has led to the creation of several taxonomic entities and these are described below.

2.3.3 Biface-rich entities in the Late Middle Palaeolithic

In general two main entities rich in bifacial tools have been distinguished for the more recent phase of the Middle Palaeolithic (MIS-5d to MIS-3): the Mousterian of Acheulean Tradition (MTA) and the Recent Micoquian or *Keilmessergruppe* (KMG) (Bordes 1961; Bosinski 1967; Richter 1997; Soressi 2002). These are both characterised by different bifacial tools types and supposedly occur in different geographical core areas. Additionally, a variety of other biface-rich entities have been created by different researchers to make the appearance of bifacial tools stand out in assemblages, mostly within a restricted regional context. In the current Western European literature this includes:

- *Quina Mousterian*
- *Vasconian*
- *Leaf point industries*
- *Mousterian with small bifacial tools*

- *Mousterian with bifacial tools (including the Bois-du-Rocher group)*
- *Mousterian with bifacial retouch*
- *Industries with a 'Micoquian' or 'Eastern' influence*
- *Entities with a mixed Mousterian-Micoquian nature*

Some of these entities are well-defined, such as the Quina Mousterian, while others are more convoluted and regionally restricted (e.g. Vasconian and leaf point industries). The defining characteristics, spatio-temporal ranges and internal variability of the MTA and KMG are presented below. Moreover, a brief overview of the other eight regional entities is given to unravel their meaning, and provide arguments for their inclusion or exclusion from the rest of this study (see also Chapter 7).

1. MOUSTERIAN OF ACHEULEAN TRADITION (MTA)

- Definition

The Mousterian (Text Box 1.1) encompasses a varied record of assemblages which causes and behavioural inferences are discussed in Chapter 3. Currently, over 20 Mousterian variants are distinguished in Europe and the Levant, illustrating the ever-increasing complexity of the Mousterian phenomenon (Bordes 1961; Bosinski 1967; Howell 1999; Clark and Riel-Salvatore 2006). Many of these Mousterian variants are restricted to certain regions and characterised by specific tool types, such as bifacial tools.

The main Mousterian entity comprising bifacial tools is the 'Mousterian of Acheulean Tradition' (MTA). This entity was defined by Peyrony based on the recurrent recognition of assemblages in Southwestern France that are dominated by cordiform handaxes and backed knives (Peyrony 1920). The term MTA was chosen because the presence of handaxes in these Mousterian contexts was seen as an evolutionary link with the Lower Palaeolithic Acheulean. Since this original definition the connection with the Acheulean has been revised based on the relatively recent position of these assemblages in the Mousterian sequence, but the term MTA remained in use (Soressi 2002).

- Typo-technological characteristics

MTA handaxes are roughly symmetric, contain a convergent tip opposite a base, and are predominantly cordiform and triangular in shape (Fig. 2.3 and 2.4). In general, they are considered as being smaller and thinner than the preceding Acheulean types (Bordes 1961; Monnier 2006; for a reassessment see Chapter 7, section 7.3.1). The MTA is a well-researched entity and recent studies have indicated that these handaxes are the main defining characteristic (Soressi 2002; Claud 2008; Iovita 2008; Iovita and McPherron 2011). All other technological and typological features of MTA assemblages are very variable (Claud 2008). For example the dominant flake tools and flaking techniques differ site by site and most common are Levallois and discoidal methods (for a more detailed overview see Chapter 5). In contrast with this heterogeneous nature of the MTA debitage methods and flake tools, stands the homogenous typo-technological character of the MTA handaxes themselves. They are often manufactured in a similar fashion; on large flakes and with a plano-convex section (Soressi 2002) and occur in a limited spectrum of shapes with a strong tendency towards cordiform and triangular forms (Fig. 2.4).

The other hallmark of the MTA, the backed knife, refers to a flake or large blade that has a curved edge with abrupt retouch opposite a naturally sharp cutting edge (Bordes 1961; Debénath and Dibble 1994). They occur commonly in cave and rock shelter sites in the Dordogne but are very rare or even absent on open-air sites (Turq 2000), making this a less robust defining characteristic for the MTA (for a further discussion see Chapter 7).

- Chronology

Previously, it has been argued that the MTA always occurs at the top of the Mousterian sequence in Southwestern France (Mellars 1965, 1969, 1970, 1973, 1996), making this one of the more recent Mousterian variants. This late position has been confirmed by radiometric dates (for an overview see Table 2.4; Guibert *et al.* 2008; Richter *et al.* in press). However, this does not equate the MTA to be the final expression of Neanderthals. At several localities the MTA is overlain by other Mousterian variants and most recent studies argue for a general contemporaneity of the Mousterian facies. Latest dating evidence points towards an MTA presence in Southwestern France throughout late MIS-4 and the first half of MIS-3 (Guibert *et al.* 2008 and Richter *et al.* in press).

- Internal variability

For the MTA both chronological and regional differentiation has been described. In terms of internal chronological evolution, Bordes and Bourgon distinguished an MTA type A, characterised by a dominant presence of small symmetric handaxes and scrapers, and an MTA type B with fewer/no bifaces but more backed knives and Upper Palaeolithic tool types (Bordes and Bourgon 1951). MTA-B assemblages always seem to occur above MTA-A ones and therefore MTA-B was seen as a further evolvement of MTA-A (Bordes 1961). Furthermore, the occurrence of backed knives in the MTA (type Abri Audi (Bordes 1961)) and especially their increase in MTA-B has been seen as evidence for a unilinear evolution from MTA type A to MTA type B to Châtelperronian. This is mainly based on similarities between Châtelperron points and MTA backed knives and the similar geographical distribution between these two entities. (Breuil, 1911 ; Peyrony, 1933, 1948; Bordes, 1958b, 1959, 1968b, 1972; Delporte, 1963; Mellars 1965, 1969, 1970, 1973; Soressi 2002; for a reassessment see Chapter 7).

Based on the exact outline shape of the handaxes several regional MTA variants have been proposed (Fig. 2.3; Soressi 2002; Duran and Abelanet 2004). The core area, of what is described here as the 'classic MTA', is located in Southwestern France where a concentration of assemblages with cordiform handaxes can be found (Fig. 2.4a). In the South this entity is limited by the Pyrenees and in the Northwest by the Armorican Massif. Its Eastern boundary is defined by the Rhone Valley, an area with general absence of Late Middle Palaeolithic bifacial elements (Moncel 1995; Szmidt 2003; Moncel and Daujeard 2010).

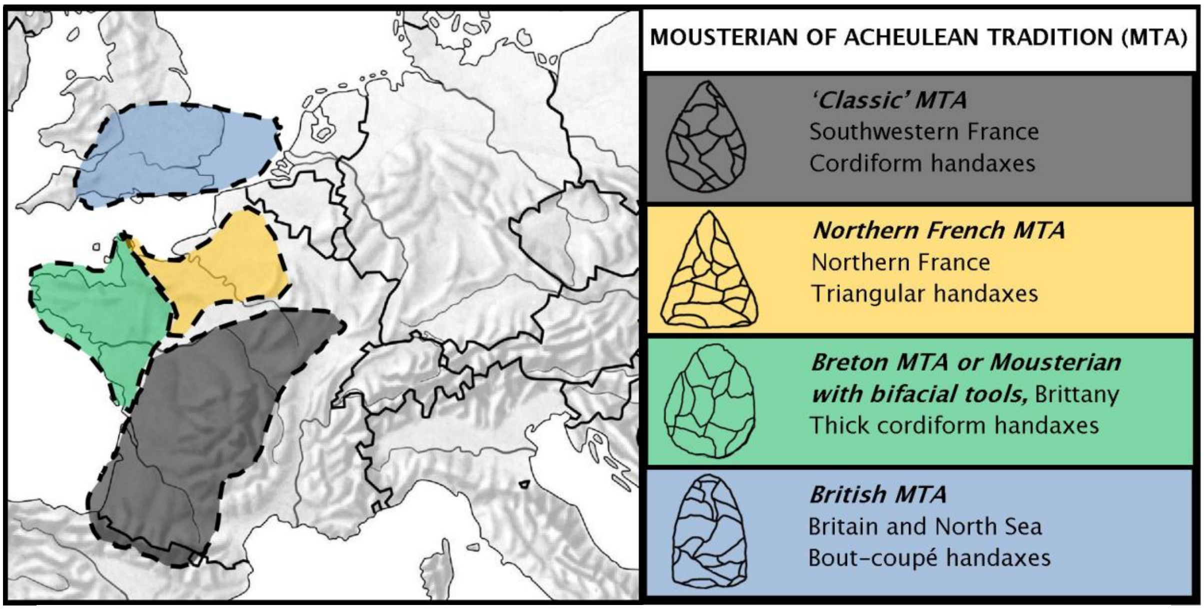


Fig. 2.3: *Regional variants of the Mousterian of Acheulean Tradition and their main handaxe type (Geographic expansions adapted from Soressi 2002)*

Its exact limitation to the North is debated, especially since it mainly concerns old, badly understood collections (Claud 2008). In this area MTA assemblages occur in large numbers at open-air localities and many of the sites are known thanks to surface finds of the distinctive handaxes (Jaubert 2001; Turq 2000). The vast majority of the classic MTA assemblages date to MIS-3 (Soressi 2002) although some sites can be placed in MIS-4 (e.g. Grotte Marcel Clouet (Natilla and Debénath 2003) or even in MIS-6 (Moulin du Milieu (Turq 2000), Barbas I C3 (Boëda *et al.* 2004) and Petit-Bost niveau 1 (Bourguignon *et al.* 2005)).

The Northern French MTA variant is characterised by the dominance of large, thin triangular handaxes (Soressi 2002; Fig. 2.4b). These seem to occur in the Paris and Somme Basins and in the northern part of Normandy (Fig. 2.3). For many of these sites chronostratigraphic information is sparse but it is generally accepted that the Northern French MTA occurs both in MIS-5 (especially in 5a and 5c) and MIS-3 (Bordes 1961; Cliquet 2001; Soressi 2002). Besides large triangular types, also sub-triangular and cordiform shapes occur regularly. Similar to their counterparts in Southwestern France they are mainly made on flakes and have plano-convex sections. While cordiform types do occur in Northern France, triangular shapes are very rare in Southwestern France.

Another spatio-temporal unit which has been linked to the MTA can be found in Britain and is related to the presence of specific flat-based cordiform types, the so-called *bout coupé* handaxes (Fig. 2.4c; Tyldesley 1987; White and Jacobi 2002; Wragg Sykes 2009; White and Pettitt 2011). These flat-butted cordiform handaxes are linked with the MIS-3 reoccupation of Britain and are found in the river valleys of eastern England and in the caves of the West Country and South Wales (Fig. 2.3; White and Jacobi 2002; Wragg Sykes 2009, 2010; White and Pettitt 2011). Few *bout coupé* handaxes have also been found in the North Sea (Wessex Archaeology 2008; Hublin *et al.* 2009) and Northern France (Tyldesley 1987) but they seem to be largely absent elsewhere.

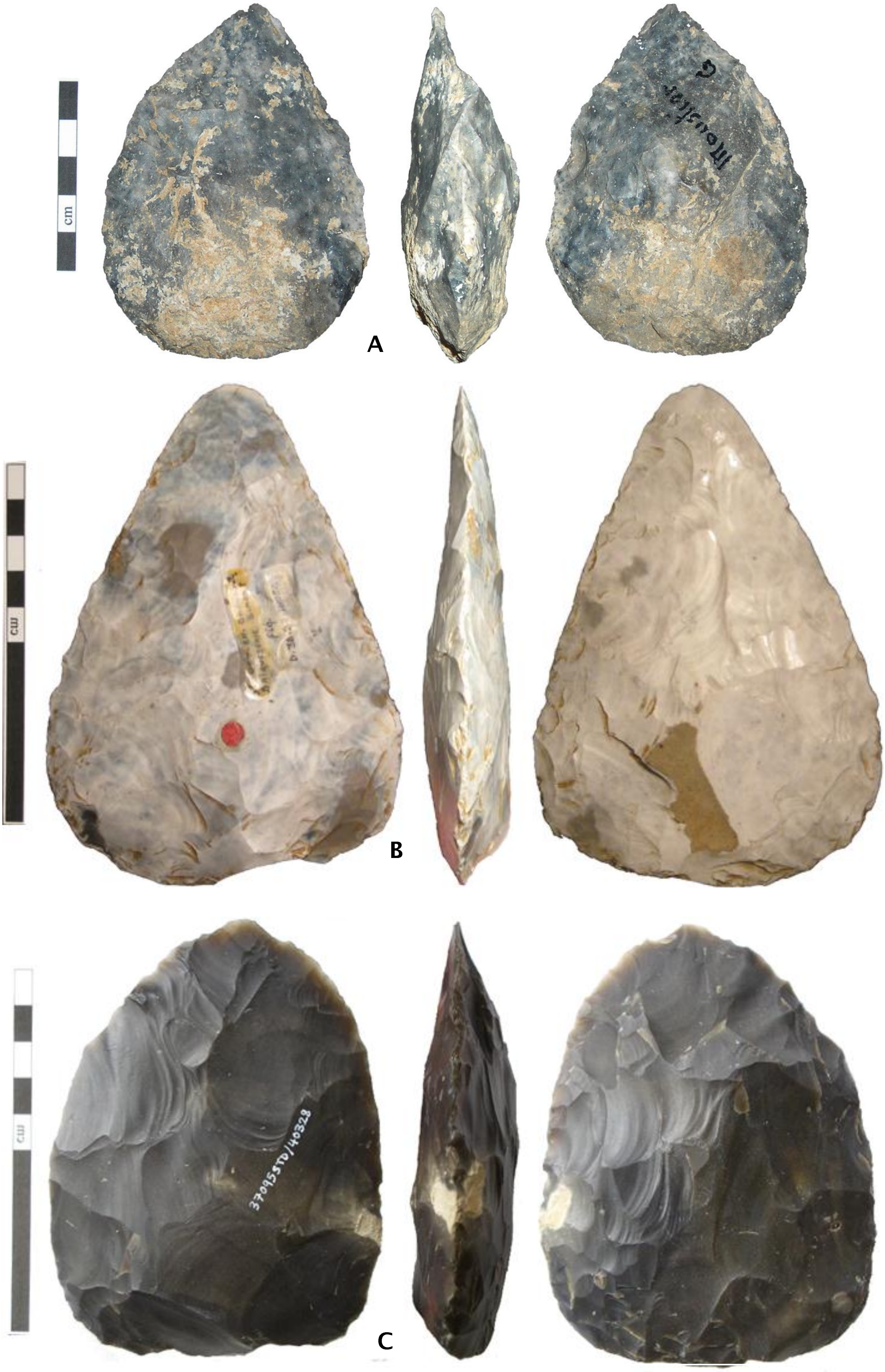
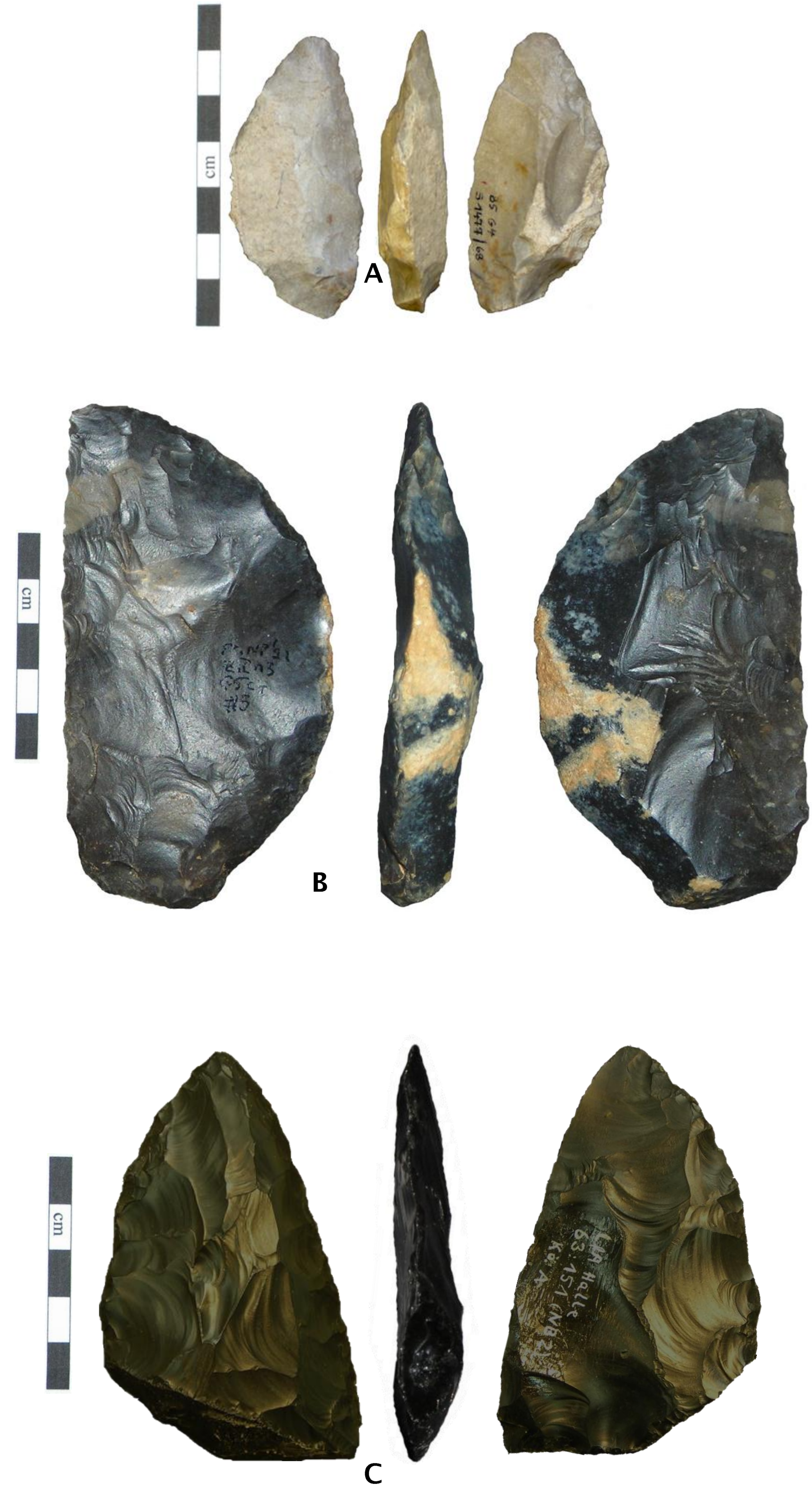


Fig. 2.4: *Late Middle Palaeolithic handaxes; A: Cordiform handaxe from Le Moustier (SW France); B: Triangular handaxe from St Just en Chaussée (N France); C: bout coupé handaxe from Lynford (UK)*



<u>Fig. 2.5:</u> *Late Middle Palaeolithic bifacial tools; A: Keilmesser from Sesselfesgrotte (Germany); B: Keilmesser from Abri du Musée (SW France); Faustkeilblatt from Königsaue (Germany)*

In Brittany, assemblages with a variety of Late Middle Palaeolithic bifacial tools are present (Fig. 2.3; Cliquet 2001; Molines *et al.* 2001; Bourdin 2006). Thick cordiform handaxes are the most common bifacial tool type (Fig. 2.8a) but also *prodniks* (a specific type of backed bifacial knives, see chapter 3) and bifacial scrapers occur. These Breton assemblages have therefore been described both as an MTA variant with cleavers (Monnier 1986, 1987; Molines *et al.* 2001) and as a having links with the recent Micoquian or *Keilmessergruppe* (Molines *et al.* 2001; Launay and Molines 2005). Most recently, they are grouped under the term 'Mousterian with bifacial tools' (Bourdin 2006) and a more detailed description is given under this heading.

The main hallmarks of the MTA are codiform and triangular handaxes. All other facets of MTA assemblages can vary, including the presence of backed knives and the use of Levallois and discoidal flaking techniques. In relation to the MTA both specific spatial and temporal trends have been claimed. Because of the defining presence of handaxes, the MTA is one of the key entities reassessed throughout this thesis, including a more detailed assessment of typo-technological, regional and chronological trends (Chapters 6 and 7).

2. RECENT MICOQUIAN OR KEILMESSERGRUPPE (KMG)

- Definition

The Micoquian was initially defined by Otto Hauser (1916), based on his research at the site of La Micoque (Southwestern France), to group assemblages rich in asymmetrical knives and thick handaxes. Later on the La Micoque material, and layer 6 specifically, was linked to the Acheulean (Breuil 1932), and hence the Micoquian was regarded as a variant of the Lower Palaeolithic. Bosinski (1967) was the first to widen up the meaning of the term Micoquian and systematically use the term for Middle Palaeolithic assemblages with asymmetric bifacial knives in Central Europe. At the same time in Poland the term "*Micoquo-Prondnikian*" was introduced for similar assemblages (Chmielewski 1969). Conversely, in France the term Micoquian remained linked to the Lower Palaeolithic (Bordes 1984). Consequently, the term Micoquian is now confusingly linked to a controversial group of dissimilar assemblages, mixing different time periods and tool types, and the meaning of the term varies strongly across authors and research traditions (Rosendahl 2011).

A first step in untangling the loaded term 'Micoquian' was to make a division between an Early and Recent Micoquian (Conard and Fischer 2000). The Early Micoquian hereby refers to Lower Palaeolithic assemblages rich in thick handaxes with concave edges (aka ficrons), and the Recent Micoquian to the Central European, Late Middle Palaeolithic assemblages with are characterised by a variety of bifacial tools, including backed bifacial knives (the so-called *Keilmesser*, Fig. 2.5a). Moreover because of the dominance at many site of these *Keilmesser*, the term *Keilmessergruppe* (KMG) was proposed and is now generally preferred (Mania 1990; Veil *et al.* 1994; Conard and Fischer 2000, Jöris 2004). Another advantage of this term is that it eliminates the necessity to correlate the Central European material with the problematic stratigraphy of the site of La Micoque. The chronology of La Micoque is uncertain and its supposedly undisturbed nature questionable (Rosendahl 2004 and 2006; Texier 2006). Therefore throughout this PhD the term *Keilmessergruppe* (KMG) will be favoured.

- Typo-technological characteristics

KMG assemblages are characterised by the occurrence of different types of bifacial tools such as *Keilmesser* (backed bifacial knives; Fig. 2.5a and b), *Faustkeilblätter* (thin leaf-shaped bifaces; Fig. 2.5c), *Fäustel* (handaxes smaller than 6cm) and *Halbkeile* (covering retouch on one face only) (for more detailed descriptions of these bifacial tool types see Chapter 4). These bifacial elements are most often asymmetric in planform (point not in the middle) as well as in their transverse section (wedge-shaped) and cross-section (plano-convex) (Jöris 2004, 2006, 2012). Furthermore handaxes, leaf points, bifacial and leaf-shaped scrapers also occur (Bosinksi 1967; Richter 2002).

Besides the clear dominance of bifacial tools, KMG assemblages are often also characterised by the use of the *pradnik* technique. This technique relates to the removal of a lateral tranchet that originates from the distal end, resulting in the resharpening of the cutting edge (see chapter 4, Fig. 4.11). This technique can also be applied to unifacial elements, including scrapers (so-called *Pradnik-Schaber*, e.g. at Buhlen IIIB and Rheindahlen B1 (Germany; Jöris 1992, 1993, 1994, 2001; Schmitz and Thissen 1998).

In the past, the term *pradnik* (also known as *prodnik* or *prondnik*) was misunderstood in Europe, creating a lot of terminological and typological confusion since people used it for all *Keilmesser* types mainly because in the Polish literature *pradnik* is the equivalent for the German *Keilmesser*. But other researchers only use the term *pradnik* for *Keilmesser* with a tranchet blow (Burdiekiewicz 2000). Furthermore at present the term *pradnik* is often used for any tool (not only *Keilmesser*) that has been sharpened using the para-burin technique (Conard and Fischer 2000). In this PhD the term *pradnik* is only used for those *Keilmesser* with a lateral tranchet blow and will be referred to as the para-burin technique.

- Spatio-temporal range

Although some of the KMG repertoire already occurs during MIS-7 (e.g. para-burin technique, Callow and Cornford 1986; Soriano 2001; Jöris 2006) the vast majority of the KMG assemblages are correlated with the Late Middle Palaeolithic (Jöris 2006; Rosendahl 2011) and the focus in this thesis will be restricted to these Late Middle Palaeolithic KMG assemblages. It is generally envisaged that KMG sites occur commonly in the interglacial conditions of MIS 5d and 3, with a significant frequency drop during the glacial conditions of MIS 4 (Jöris 2004). This is confirmed by recent radiometric dates (Table 2.4) which have securely placed KMG assemblages both in MIS-5 (e.g. Neumark Nord 2/0 (Brühl and Laurat 2010) and MIS-3 (e.g. Schulerloch (Richter *et al.* 2000), Lichtenberg (Veil *et al.* 1994) and Sesselfesgrotte (Richter 1997, Gamsenberg (Schäfer and Zoller 1996)).

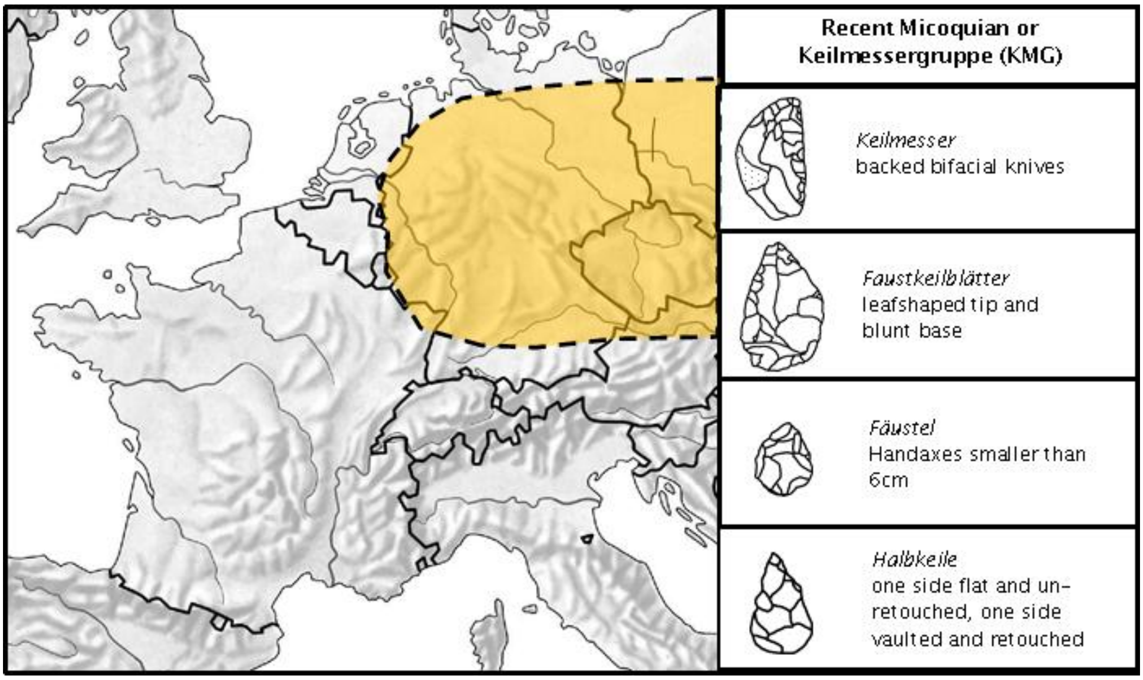


Fig. 2.6: *Geographic expansion of the Keilmessergruppe entity in Western and Central Europe and the most characteristic KMG bifacial tool types*

In Western Europe the *Keilmessergruppe* entity is centred in Germany although KMG assemblages have been described from a much wider area stretching from east-central France to the Volga. The KMG therefore covers a considerable environmental variability, and links assemblages throughout Germany, Poland, the Czech and Slovakian Republics and western Russia, including the Crimea and Caucasus (Fig. 2.6). Especially in Poland a series of rich KMG assemblages is known (e.g. Ciemna, Wylotne and Zwolen (Chmielewski 1969; Schild *et al.* 2000). Conversely, the KMG is absent in Great Britain, Iberia and Italy and rare in France (Richter 2002; Jöris 2004, 2006; for a more detailed discussion see Chapter 7).

- Internal variability

The KMG is an internally variable entity. In a detailed synopsis of the Central European Middle Palaeolithic record Bosinski (1967) distinguished four Micoquian variants based on varying bifacial tool compositions; the Bockstein, Klausennische, Schambach and Rörshain groups. These sub-groups were seen as successive in time with for example the Bockstein Micoquin being older than the Klausennische variant. The discovery of new Late Middle Palaeolithic assemblages combined with detailed studies of existing collections, including new radiometric dates, questioned this fourfold division since the succession of the bifacial tools does not appear as straightforward. Several assemblages could not be easily incorporated into Bosinski's succession (Richter 1997; Conard and Fischer 2000; Jöris 2001, 2004) and therefore this scheme is now generally abandoned.

Subsequently, several new chronological frameworks were proposed to structure the variability within the KMG (Richter 1997; Jöris 2004 and 2006). These new schemes integrate both typological and technological characteristics. For example, the use of the para-burin technique is, according to some researchers, restricted in time and seen as a chronological marker (for an assessment see Chapter 7; Bosinski 1967; Jöris 1992). Jöris has furthermore proposed to divide the KMG into three main chronological phases, linked to the different MIS stages, based on techno-typological differences amongst the *Keilmesser* (Table 2.3; Jöris 2003, 2004 and 2006):

KMG-A	**'Königsaue-Lebenstedt' type**	**MIS 5d-a**
	Keilmesser with a convex cutting edge	
KMG-B1	**'Pradnik-Horizont'**	**late MIS 5**
	Keilmesser with a rectilinear cutting edge and use of the Pradnik technique	
KMG-B2	*Difficult to identify and not yet defined*	*MIS 4*
KMG-C1	**'Bockstein' type**	**MIS 3**
	Keilmesser with a rectilinear cutting edge and without the use of the Pradnik technique	
KMG-C2	**'Klaussennische' type**	**MIS 3**
	Keilmesser with a rectilinear cutting edge and without the use of the Pradnik technique	

Table 2.3: *Overview of the subdivisions of the Keilmessergruppe (KMG) entity as proposed by Jöris (Jöris 2004 and 2006)*

Because of the presence of both unifacial and bifacially worked tools in these assemblages, and the possibility to assign them to either a Mousterian or KMG variant based on the tool type that is focused on, Richter proposed to group them under the label *'Mousterian of Micoquian Option'* (Richter 1997). Furthermore he divides this entity into two main chronological phases based on the dominant flaking method:

MMO-A – with use of the Quina technology
MMO-B – with use of the Levallois method

On top of these chronological trends, the KMG is often described as containing regional differentiation. This variation is linked to differences in *Keilmesser*, for which now over seven different types have been defined (for an overview see Chapter 4; Jöris 2006, 2012). An up-to-date comparative overview of the different KMG sites and what proportions of different *Keilmesser* types are present at each locality is currently lacking. The need to define new types, sub-entities and trends is indicative of the large amount of variability present among the KMG entity and the need for more detailed studies.

- Discussion

This thesis follows the recent tendency to use the term *Keilmessergruppe* instead of Micoquian for Late Middle Palaeolithic assemblages rich in backed bifacial knives. In terms of typo-technological characteristics the KMG is defined by the presence of a range of bifacial tools; *Keilmesser*, *Faustkeilblätter*, *Halbkeile* and *Fäustel* (for definitions see Chapter 4) and the use of the para-burin resharpening technique. Flaking methods vary and it is clear that KMG assemblages occur both during MIS-5 and 3. The KMG is a well-researched entity (Jöris 2004, 2006, 2012) but research into its chronological and regional differentiation is still in an early stage of development. Therefore, in this thesis the proposed subdivisions are not used and the KMG is studied as one single entity; moreover with a focus on its occurrence in Germany. Because of the dominance of bifacial tools, and the specific nature of these tools, the KMG will take a prominent place in further assessments of Late Middle Palaeolithic bifacial tools throughout this thesis.

3. QUINA MOUSTERIAN

- Definition

One of the Mousterian facies Bordes defined in the 1950's was named after the site of La Quina in Southwestern France. The Quina Mousterian is characterised by a low use of Levallois and blade technologies and a high occurrence of scrapers, mainly single and transverse types (Bordes 1953). A vast proportion of these scrapers were retouched with a scalariform steep 'Quina or demi-Quina' type of retouch (Bordes 1954, 1961). More recently a more technological definition is given to the Quina Mousterian entity, stressing the standardised production of thick asymmetric blanks with a triangular cross-section (Turq 1985; Bourguignon 1997). These blanks which exhibit an opposition between a thick back and a finer cutting edge can then be retouched into so-called Quina scrapers with a steep retouch. These Quina blanks are often intensely resharpened and reused (Bourguignon *et al.* 2004). In some of the Quina Mousterian assemblages the blanks were bifacially prepared; e.g. at Jonzac (Lenoir 2004; Soressi 2004) and La Quina (Park 2007).

A concentration of Quina Mousterian sites can be found in Southwestern and Eastern France but they sporadically occur further north (e.g. Veldwezelt-Hezerwater (Belgium) (Vanmontfort *et al.* 1998). They seem to be more common in caves and rock shelters e.g. La Quina (Débenath *et al.* 1992) and Jonzac (Airvaux 2004; Jaubert *et al.* 2008; Niven *et al.* 2012) than in open-air locations. In terms of chronology they occur mostly during the cold phases of MIS-6 and predominantly MIS-4 (Turq 2000; Guibert *et al.* 2008; Guérin *et al.* 2012; Richter *et al.* in press) although some potentially occur in MIS-3 (Claud 2008). The cold environment of the Quina Mousterian is furthermore confirmed by a predominant presence of reindeer at these sites (Delagnes and Rendu 2011; Niven *et al.* 2012).

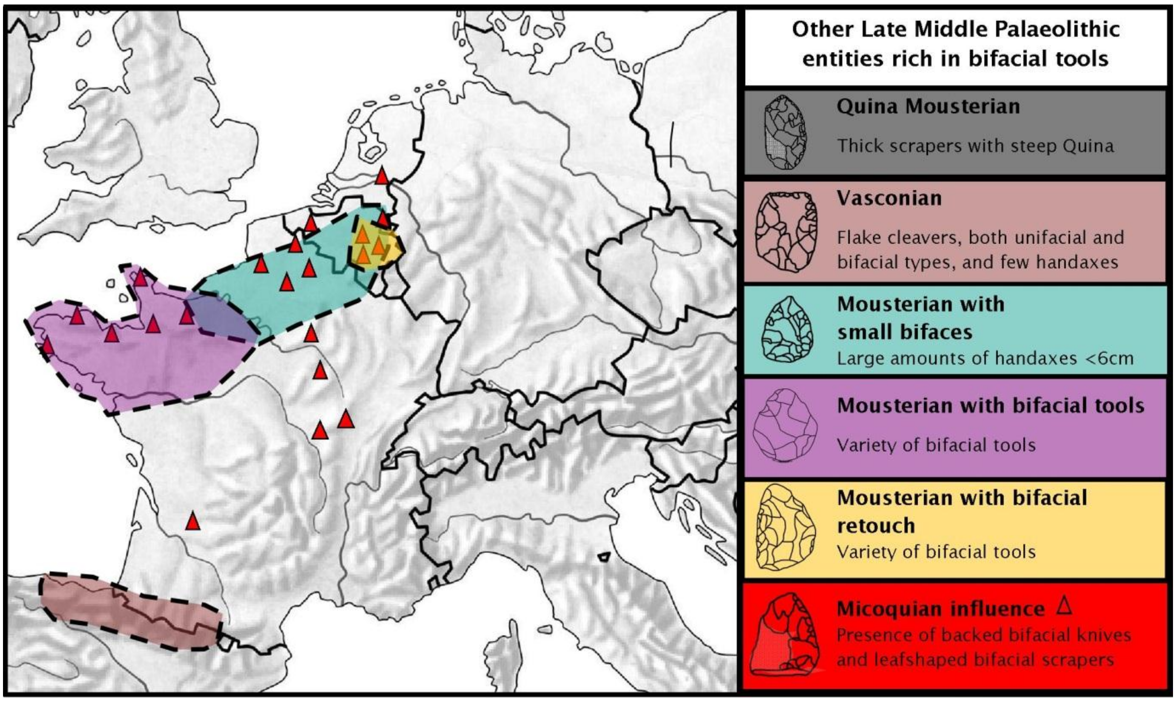
- Discussion

The relevance of the Quina Mousterian to this thesis is that it predominantly occurs during the Late Middle Palaeolithic and that some of the blanks are bifacially retouched. Even though (atypical) handaxes occur sporadically, bifacial tools are not a common, and not a defining, feature of this entity. Therefore because of the general low number of bifacially worked tools the Quina Mousterian is not further studied in this thesis.

4. VASCONIAN

- Definition

The Vasconian industry was defined by Bordes (1953) based on observations on Middle Palaeolithic assemblages from the Basque country (Vasconia is the Latin name for the Basque country). The hallmark of this Mousterian variant is the presence of cleavers which are often made on flakes. Cleavers, which are very common in Northern Africa, are tools with a thin unworked transverse cutting edge (Débenath and Dibble 1994).



<u>Fig. 2.7:</u> *Geographic expansions of the other Late Middle Palaeolithic entities rich in bifacial tools in Western Europe (Quina Mousterian assemblages are concentrated in Southwestern France but also appear sporadically all over Europe)*

Vasconian assemblages are restricted to the Western Pyrenees and Cantabria (Fig. 2.7) and seem to occur in caves and rock shelters rather than on open-air locations (e.g. Olha I and II (Deschamps 2010)). They occur both during MIS-5 and MIS-3 and are associates with a temperate fauna (deer, bovid and horse). Its validity as an entity has often been disputed (Deschamps 2010 and references therein). Although Bordes mentioned the presence of Quina scrapers and the Levallois method as other defining features, it is now clear that the presence of cleavers is the only feature connecting these assemblages. The other characteristics of these assemblages vary site by site (Deschamps and Mourre 2012) and classic handaxes are not systematically associated with Vasconian assemblages.

One of the puzzling characteristics of the Vasconian is the regionally restricted occurrence of this cleaver production. Several functional and environmental explanations have been put forward. Overall the production of these cleavers seems to be a deliberate choice and on-going work indicates the overall validity of this entity (Deschamps 2010; Deschamps and Mourre 2012; Thiébaut *et al.* 2012).

- Discussion

The Vasconian is a complicated, disputed and badly understood Mousterian facies. It concerns only a handful of assemblages and includes several surface collections lacking contextual information. Although some authors classify these cleaver-rich assemblages as a local variant of the MTA (Turq 2000; Jaubert 2000), the majority of the Vasconian cleavers are not bifacially worked. Real bifacial cleavers are rare in the Vasconian (Claud 2008) and therefore, combined with the problems related to the unity of this entity, the Vasconian will not be further included in this study.

5. LEAF POINT INDUSTRIES

- Definition

Bifacially worked leaf points, which are characterised by their thinness, flat, covering retouch and symmetrical outline shape (for a more detailed definition see Chapter 4) appear as early as 280-220,000 BP in Eastern Europe; e.g. Korolevo in Ukraine (Kozlowski 2003). Their occurrence increases throughout the Middle Palaeolithic and especially in Central and Eastern Europe they are a distinctive hallmark of some late Mousterian industries (Kozlowski 2003; Hopkinson 2004 and 2007). For example in Germany Bosinski distinguished the *Althmühlgroup*, which is rich in leaf points, occurs around 40 ka BP and can be found both on open-air (e.g. Rörshain) and cave sites (e.g. Mauern) (Bosinski 1967). They occur sporadically in *Keilmessergruppe assemblages* (e.g. Sesselfesgrotte; Chapter 5)

Conversely, further west the occurrence of leaf points is more restricted. They appear in low numbers in France (e.g. Pont-des-Planches (Lamotte *et al.* in press) and are considered absent in MTA contexts. They are a common feature in so-called transitional industries, located at the very end of the Middle Palaeolithic, such as the Szeletian and Lincombian-Ranisian-Jerzmanowician (LRJ). The latter is characterised by bifacial leaf points and blade points and occurs in Britain, Belgium, Germany and Poland between ca. 38-35 ka BP (Flas 2008, 2011). Overall, these Western European leaf point assemblages are a well-defined restricted phenomenon occurring at the very end of the Middle Palaeolithic.

- Discussion

Industries containing leaf points occur all over Europe. The core area of these assemblages in located in Central and Eastern Europe and their presence is more restricted elsewhere. In Western Europe they are mainly associated with the very end of the Middle Palaeolithic, after 40 kaBP. Because of this restricted occurrence, the general low occurrence of leaf points in the study area, and the fact that many do not exhibit bifacial retouch, this entity is regarded as beyond the scope of this PhD and not further examined.

6. MOUSTERIAN WITH BIFACIAL TOOLS

- Definition

The term Mousterian with Bifacial Tools ("*Moustérien à outils bifaciaux*") refers to Mousterian flake-based assemblage that contain a large variety of bifacial tools. The term has mainly been used to describe the biface-rich assemblages from Western France; e.g. Bois-du Rocher, Kervouster, Clos Rouge, Troua-an-Arcouest, and Montbert (Monnier 1990; Molines *et al.* 2001; Launay and Molines 2005; Bourdin 2006). Especially in the Armorican Massif (Brittany) several of these assemblages were originally gathered in the 'Bois-du-Rocher' group. This term is now mainly abandoned in favour of the more generic 'Mousterian with Bifacial Tools' (Bourdin 2006, see Chapter 5, section 5.6.2).

This entity is characterised by the generalised application of bifacial retouch on the majority of the blanks, resulting in a wide variety of bifacial tools; including cordiform handaxes (Fig. 2.8a) as well as backed bifacial tools (Molines *et al.* 2001; Bourdin 2006).

Because of the morphology of the bifacial tools, the presence of pieces that resemble leaf points, the presence of round raclettes and the abundance of notches and denticulates, this group has previously been interpreted as being a Western equivalent of the Micoquian (Cliquet *et al.* 2001; see further on). Recently an in-depth study of this entity pointed out its techno-cultural homogenous nature and occurrence in both Brittany and Normandy (Bourdin 2006). Few Mousterian with Bifacial Tools sites are associated with chronological and/or palaeoenvironmental information. Many assemblages have been recovered from the surface and were collected in the 19th century, although recent discoveries in Normandy include material in stratified position (Cliquet *pers. comm.*). The stratigraphic position of Clos Rouge and Kervouster seem to suggest a date in MIS-5 (Monnier 1980), while radiometric dates from Saint-Brice-sous-Rânes place this site in MIS-3 (Table 2.4; Cliquet *et al.* 2004).

- Discussion

The Mousterian with bifacial tools has been described as a homogenous entity occurring in Brittany and Normandy during both MIS-5 and 3. Its main characteristic is the occurrence of a substantial and varied record of bifacial tools. Despite the lack of secure contexts, because of these bifacial tools, its location in Western Europe and several recent studies, this entity is further included throughout the analyses in this PhD.

7. MOUSTERIAN WITH BIFACIAL RETOUCH

- Definition

Ulrix-Closset introduced the term Mousterian with Bifacial Retouch, '*Moustérien a retouche bifaciale*', based on her work in the Belgian Meuse Valley (Ulrix-Closset 1975). She created this term because of the lack of a suitable French term to describe Mousterian assemblages that are characterised by the presence of handaxes, backed and leaf-shaped bifacial tools (Fig. 2.8d). This term is currently only used in relation to the Belgian Middle Palaeolithic and does not occur in the French literature. The defining characteristics for this entity are both technological, wide us of bifacial retouch; and typological, presence of different types of bifacial tools (Ulrix-Closset 1975).

Assemblages that have been assigned to this entity include Grotte du Docteur and Ramioul (Ulrix-Closset 1975). Chronological and palaeoenvironmental information is sparse, and it is generally assumed that these assemblages occur throughout the Late Middle Palaeolithic, MIS-5 to 3 (Ulrix-Closset 1973, 1975, 1990).

- Discussion

Although the 'Mousterian with Bifacial Retouch' is an entity which is defined based on a limited number of assemblages from the Belgian Meuse valley, it is indicative of the wide presence of bifacial tools in Belgium (Chapter 5; Ruebens and Van Peer 2012; Ruebens and Di Modica 2012). The variety of the bifacial tools in these assemblages is very relevant to this study and therefore the Mousterian with Bifacial Retouch, and Belgian Late Middle Palaeolithic sites rich in bifacial tools in general, are included in further analyses.

8. MOUSTERIAN WITH SMALL BIFACES

- Definition

In Northern France another Mousterian variant has been defined based on the presence of a large number of small handaxes; small meaning less than 6cm (Fig. 2.8b; Tuffreau 1971; Cliquet and Lautridou 1988; Cliquet 2001). This Mousterian variant, '*Moustérien à petits bifaces dominants'*, was originally defined by Dominique Cliquet based on observations made at Saint-Julien de la Liègue (Northern France), where hundreds of small handaxes were recovered (Chapter 5; Cliquet and Lautridou 1988; Cliquet 1995).

Chronological information for this entity is sparse but a position in the Late Middle Palaeolithic (MIS 5-3) is assumed (Cliquet and Lautridou 1988). Moreover, for Saint-Julien de la Liègue a link with Central European assemblages was proposed because of the variable nature of the handaxes and the combined presence with leaf-shaped artefacts. The reduced dimensions of the bifacial tools in this entity are seen as its main defining element, the actual typological and technological features of the handaxes or the rest of the assemblage seems of secondary importance. The small handaxes take a variety of forms, often form a continuum with bifacial scraper types and many can be classified as irregular or even asymmetric in nature. The exact reasons for the small dimensions of these handaxes are still disputed and further discussed in Chapter 7.

- Discussion

This Mousterian entity with small handaxes has been defined based on material coming from Northern France and only includes a restricted number of assemblages. This entity, and the variability within its bifacial tool types, are rather badly understood and has mainly been studied form a restricted Northern French perspective (Cliquet 2001). To come to a better understanding of this entity, its validity and links with other Western European bifacial entities, its assemblages are included in further analyses throughout this thesis.

9. INDUSTRIES WITH A 'MICOQUIAN' OR 'EASTERN' INFLUENCE

- Definition

Bifacial tool types which are generally seen as hallmarks of the recent Micoquian or *Keilmessergruppe*, such as backed and leaf-shaped bifacial tools, occur sporadically outside of their Central European core area (Fig. 2.8; Ruebens 2006, 2007). Assemblages which contain several of these tool types have been grouped into entities which are labelled as having a Micoquian' or 'Eastern' influence. A good example is the '*Charentian with Micoquian influence'* (Farizy 1995; Van Peer 2001). The Charentian is a term introduced by Bordes to group assemblages which contain a high proportion of scrapers, and encompasses the Quina and Ferrassie Mousterian facies (Bordes 1961). A 'Micoquian' or 'Eastern' influence is assigned to several scraper-rich Charentian assemblages based on the presence of one or more KMG characteristics.

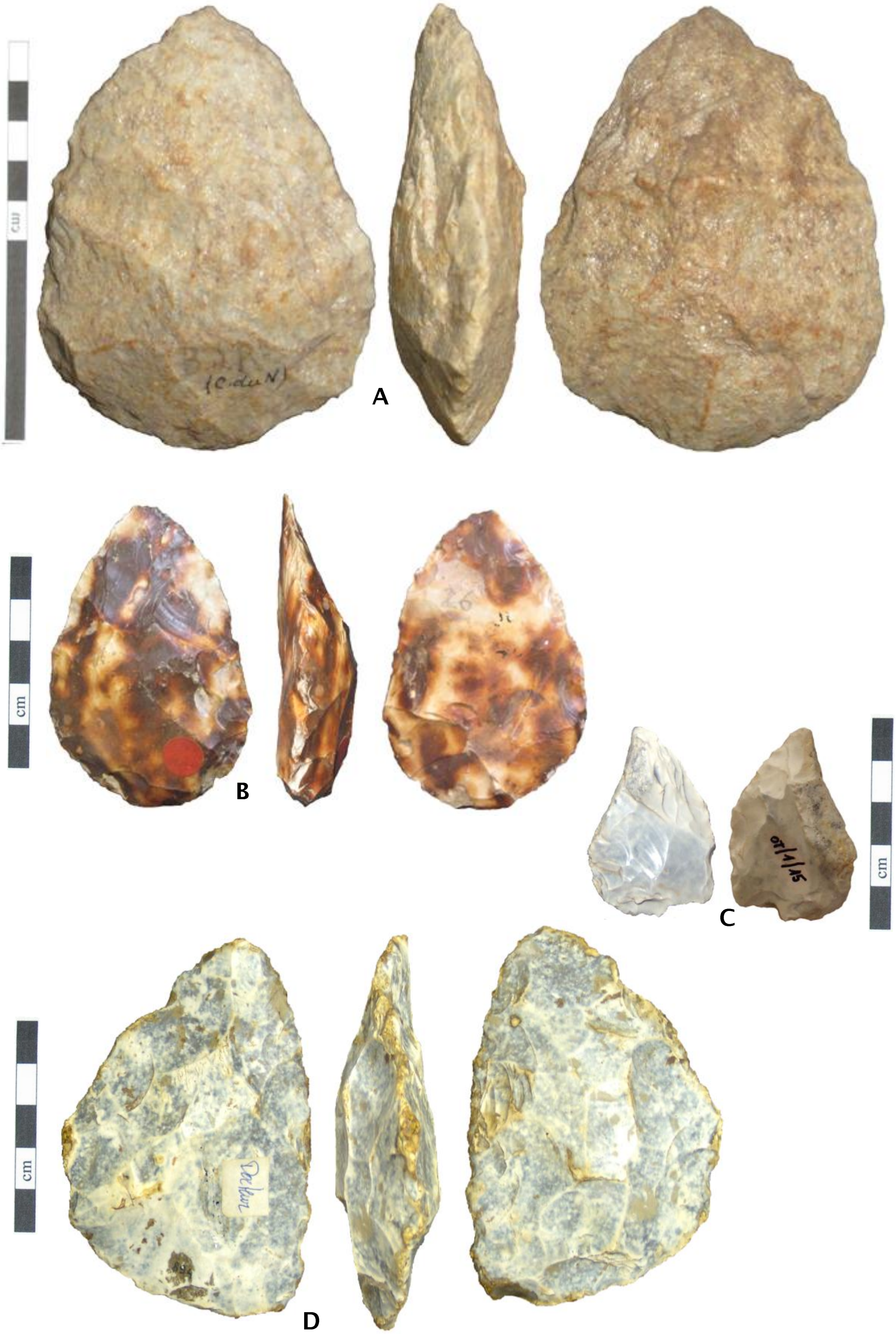


Fig. 2.8: *Late Middle Palaeolithic bifacial tools;* ***A:*** *thick cordiform handaxe from Bois-du-Rocher (W France);* ***B:*** *Small handaxe from Saint-Julien de la Liègue (N France);* ***C:*** *Small backed bifacial tool from Oosthoven (Belgium);* ***D:*** *bifacial tool from Grotte du Docteur (Belgium)*

This 'Micoquian' influence is often rather poorly defined, can refer to the presence of either backed bifacial tools, leaf points or lateral tranchet blows (para-burin technique), and can therefore incorporate rather different assemblages. Examples can be found in Western, Northern and Eastern France (e.g. Mont de Beuvry (Marcy 1991); Champlost (Gouédo 1999); Pont-des-Planches (Lamotte *et al.* in press). Furthermore, several assemblages in Belgium have also been assigned to this Charentian with Micoquian influence (Van Peer 2001, see Chapter 5). Chronostratigraphic information for these assemblages is sparse but recent radiometric dates place both Champlost and Pont-des-Planches in MIS-3 (Farizy 1995; Lamotte *et al.* in press).

- Discussion

Throughout Western Europe, Late Middle Palaeolithic assemblages occur which have been described as having a Micoquian or Eastern influence; this because of the presence of a number of backed bifacial knives, bifacial scrapers and/or leaf-shaped bifacial tools, which are a more common occurrence in the Central European *Keilmessergruppe* assemblages. Overall, these features never dominate the toolkit as they do in the German KMG core area; the main exception being the site of Abri du Musée in Southwestern France (Fig. 2.5b; Chapter 5; Detrain *et al.* 1991; Bourguignon *et al.* 1992) where the assemblage is dominated by backed bifacial knives and the wide application of the para-burin technique. These assemblages with a Micoquian influence are further included in analyses throughout this PhD to assess their occurrence, typo-technological characteristics and links with other Late Middle Palaeolithic entities rich in bifacial tools.

10. ENTITIES WITH A 'MIXED' MOUSTERIAN – MICOQUIAN NATURE

- Definition

In Germany in addition to the KMG entity, several assemblages rich in bifacial tools have been assigned to entities which stress the presence of both Mousterian and Micoquian/KMG elements (Kind 1992; Richter 1997; Conard and Fischer 2000). Firstly, Kind conducted statistical cluster analyses on a range of assemblages from Southern Germany and based on his results proposed the existence of a 'mixed' entity. This entity is characterised by a vast proportion of side scrapers (Mousterian elements) and a moderate occurrence of a few, but clear, KMG forms such as *Keilmesser* (Kind 1992). A similar 'mixed' entity, although with a stronge focus on the presence of both MTA handaxes and KMG backed bifacial tools has also been claimed in Belgium based on observations on the assemblage of Oosthoven (Fig. 2.8c; Chapter 5; Ruebens 2006, 2007; Ruebens and Van Peer 2012).

Secondly, German assemblages with a bifacial component characterised by various forms of handaxes and few *Keilmesser* (e.g. Salzgitter-Lebenstedt and Grosse Grotte IX) have been grouped under the label 'Late Middle Palaeolithic with Handaxes' (LMPH; Conard and Fischer 2000). Thirdly, Richter (1997) proposed the term 'Mousterian of Micoquian option (MMO)' based on his study of the material from Sesselfelsgrotte. He hereby sees the

Mousterian and Micoquian as expressions of the same group of Neanderthals but under different circumstances, making the Micoquian a further reduced version of the Mousterian. The Micoquian assemblages reflect the higher use duration of the site and therefore the further reduction of the lithic tools (Richter 1997).

- Discussion

The Late Middle Palaeolithic with Handaxes, the Mousterian with Micoquian Option and the 'mixed' entity are all taxonomic constructs which are not widely used in the European literature. These terms were introduced based on specific characteristics of only one or two assemblages and therefore their relevance on a wider scale can be questioned. Their distinct nature and validity has not yet been studied in detail from an overarching perspective and these assemblages will therefore be included throughout this thesis. Their existence points out the need to create various entities that do not fit with a simple KMG/MTA dichotomy, which in itself is indicative of the badly understood nature of Late Middle Palaeolithic bifacial tool record.

2.3.4 Summary

After a decline in the Early Middle Palaeolithic a proliferation of bifacial tools is observed for the Late Middle Palaeolithic. These bifacial tools take a variety of forms and over 20 bifacial tool types can be distinguished (see Chapter 4). The main taxonomic distinction among the Late Middle Palaeolithic biface-rich entities is between the MTA in Southwestern France and the KMG in Germany. Both these entities are well-researched and their differing bifacial tool types will form an important source for the study of Late Middle Palaeolithic bifacial tool variability throughout this thesis.

Additionally, a large number of other entities rich in bifacial tools have been defined based on specific typo-technological characteristics. Some were found to be outside of the scope of this PhD, because of the low number of bifacially worked tools (e.g. Quina Mousterian and Vasconian) or their more eastwards orientated geographical range (e.g. leaf point industries). Conversely, assemblages from the five other entities will be included in further analyses since they fit with the research focus by being dominant during the Late Middle Palaeolithic and characterised by a large number of bifacially worked tools.

Overall, this section demonstrated that a dense cloud of terms and entities is currently in use, indicating the variability present among Late Middle Palaeolithic bifacial tools but also the need to reassess the validity of these terms, types and territorial trends.

2.4 Discussion – Chronology and Variability

Background information presented in this chapter demonstrated that throughout the Late Middle Palaeolithic (MIS 5d-3) Neanderthals in Western Europe were confronted with a wide variety of geological, environmental and climatic settings. In terms of material culture, the Late Middle Palaeolithic is characterised by a revival of bifacially worked tools. All over Western Europe bifacial tools, such as handaxes and backed bifacial tools, dominate assemblages. In addition to the distinction between the MTA and KMG, a plethora of other biface-rich entities exists in the literature. This chapter provided a new overview of these entities from a wider European perspective and allows for two further implications to be discussed in more detail: their chronology and contemporaneous nature, and the existence of a large amount of typo-technological variability and terminological confusion.

- Chronology and contemporaneity

An extensive literature review resulted in the compilation of a list of 31 assemblages in Western Europe which are rich in bifacial tools and have been radiometrically dated (Fig. 2.9 and Table 2.4). This includes sites in England, Belgium, France and Germany and assemblages that have been assigned to the MTA, KMG and other biface-rich entities. The vast majority of these assemblages fall within MIS-3 and more specifically within the 60,000-40,000 CalBP time range (Fig. 2.9).

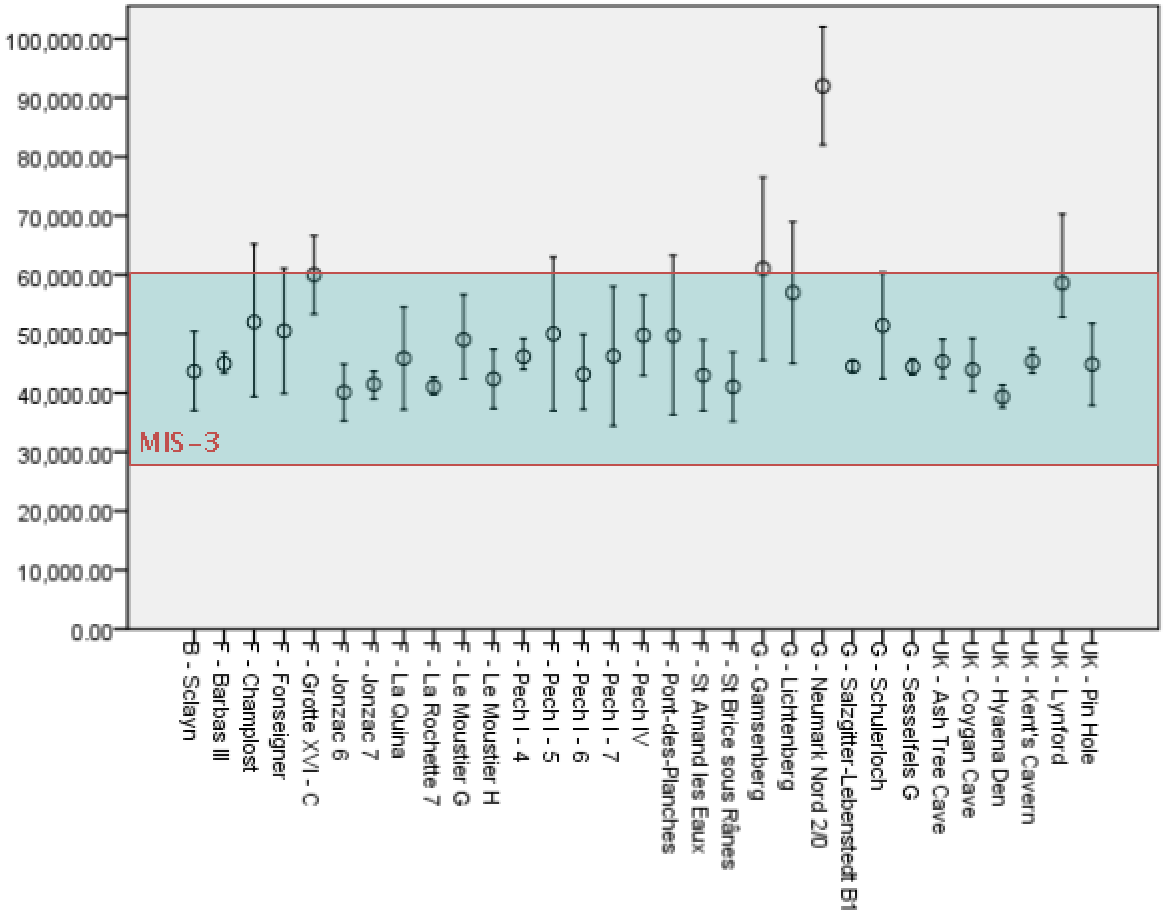


Fig. 2.9: *Dataplot with the averaged radiometric dates available for assemblages rich in bifacial tools in Western Europe; dates with two standard deviations (95%) and in CalBP.*

Site	Layer	Entity	Cat. No.	Technique	C14 age BP	CalBP	Reference
Lichtenberg (G)		KMG		TL	-	57,000 ± 6,000	Veil *et al.* 1994
Salzgitter-Lebenstedt (G)	B1	KMG	GrN-9372	C14	36,000 ± 550	41,098 ± 528	Pastoors 2001
			GrN-9894	C14	39,300 ± 800	44,778 ± 613	
			GrN-9254	C14	48,780 ± 260	49,318 ± 261	
			GrN-10702	C14	52,700 ± 600	out of range	
Königsaue (G)	A	KMG	OxA-7124	AMS C14	43,800 ± 2,100	out of range	Hedges *et al.* 1998
	B	KMG	OxA-7125	AMS C14	48,400 ± 3,700	out of range	
	Ib	KMG	GrN-5698	C14	>55,800	-	Mania 1973
	Ib	KMG	B626	C14	>45,000	-	
Sesselfels (G)	G2	KMG	GrN-6180	C14	36,600 ± 875	41,574 ± 747	Richter 2001
	G2	KMG	GrN-6848	C14	41,840 +1,170 -1,020	out of range	
	G3	KMG	*5052	C14	35,200 ± 260	40,363 ± 471	
	G4	KMG	*5065	C14	34,800 ± 300	39,857 ± 471	
	G4	KMG	*5114/5024/5026	C14	46,600 + 980 - 880	out of range	
	G	KMG		OSL	-	56,000 ± 1,900	Richter *et al.* 2000
Schulerloch (G)	-	KMG		TL	-	51,400 ± 4,500	Richter *et al.* 2000
Neumark-Nord (G)	2/0	KMG		OSL	-	92,000 ± 5,000	Brühl and Laurat 2010
Gamsenberg (G)	-	KMG		OSL	-	56,800 ± 8,000 65,300 ± 7,500	Schäfer and Zoller 1996
Sclayn (B)	Ia	MTA (?)	Lv-1377b	C14	38,560 ± 1,500	43,332 ± 1,266	Gilot 1992
			Lv-1377	C14	>36,200	-	
			OxTL230a1	TL	-	44,000 ± 5,500	
Coygan Cave (UK)		British MTA	BM-499	C14	38,684 +2,713 -2,024	43,937 ± 2,200	Aldhouse-Green *et al.* 1995
				U-series	-	64,000 ± 2000 *(terminus post quem)*	
Ash Tree Cave		British MTA	OxA-4103	C14	40,900 ± 1,800	45,288 ± 1,679	Hedges *et al.* 1994
Pin Hole (UK)		British MTA		ESR	-	39,000 ± 2,000 51,000 ± 8,000	Jacobi *et al.* 1998, 2006
				Ultrafilt. C14	40,650 ± 500 55,900 ± 4,000	44,500 ± 408 out of range	

Site	Layer	Entity	Cat. No.	Technique	C14 age BP	CalBP	Reference
Hyaena Den (UK)		British MTA	OxA-4782	AMS C14	40,400 ± 1,600	44,752 ± 1,488	Tratman *et al.* 1971
			OxA-3277	AMS C14	33,660 ± 680	38,514 ± 929	
			OxA-4111	AMS C14	28,000 ± 500	32,391 ± 633	
			OxA-4112	AMS C14	27,850 ± 460	32,225 ± 561	
			OxA-4113	AMS C14	34,900 ± 1,450	39,963 ± 1,514	
			OxA-13914	AMS ultrafiltr.	52,700 ± 2,000	out of range	Jacobi *et al.* 2006
			OxA-13915	AMS ultrafiltr.	45,100 ± 1,000	48,208 ± 988	
			OxA-13916	AMS ultrafiltr.	47,000 ± 1,700	out of range	
			OxA-13917	AMS ultrafiltr.	48,600 ± 1,000	out of range	
				U-series	-	64,000 ± 2000 *(terminus post quem)*	
Kents Cavern (UK)		British MTA	OxA-3450		34,620 ± 820	39,712 ± 947 *(terminus ante quem)*	Jacobi *et al.* 2006
			OxA-14285	AMS ultrafiltr.	43,600 ± 3,600	46,851 ± 1,855	
			OxA-14761	AMS ultrafiltr.	45,000 ± 2,200	47,808 ± 1,306	
			OxA-13589	AMS ultrafiltr.	37,900 ± 1,000	42,649 ± 768	
			OxA-13888	AMS ultrafiltr.	40,000 ± 700	44,005 ± 552	
			OxA-14714	AMS ultrafiltr.	49,600 ± 2,200	out of range *(terminus post quem)*	
				U-series/ESR	-	74,000 *(terminus post quem)*	
Lynford (UK)		British MTA	OxL-1338	OSL	-	64,000 ± 5,000	Schwenninger and Rhodes 2005
			OxL-1340	OSL	-	67,000 ± 5,000	
			OxA-11571	AMS C14	53,700 ± 3,100	out of range	Schreve and Stuart 2012
			OxA-11572	AMS C14	>49,700	-	
St-Amand-les-Eaux (F)		NF MTA		TL	-	ca. 43.000 BP	in press (as cited in Claud 2008)
Pont-des-Planches		KMG		OSL		47,300 + 7,500 -6,200	Lamotte *et al.* in press
Champlost		KMG		OSL		52,100 + 8,800 - 7,100	
		small bifaces		ESR		48,100 ± 4,400 (EU) / 56,700 ± 4,200 (LU)	Farizy 1995

Site	Layer	Entity	Cat. No.	Technique	C14 age BP	CalBP	Reference
Le Moustier (sw F)	G1	MTA	Gif-	TL	-	55,800 ± 5,000	Valladas *et al.* 1986 ; Mellars and Grun 1991
	G1-4	MTA		ESR: EU	-	43,000 ± 2,300	
	G1-4	MTA		ESR: LU	-	47,000 ± 2,500	
	G4	MTA	Gif-TL-570	TL	-	50,300 ± 5,500	
	H1	MTA-B	Gif-	TL	-	46,300 ± 3,000	
	H2-H9	MTA-B	Gif-	TL	-	42,500 ± 2,000	
	H2a-7c	MTA-B		ESR: EU	-	39,700 ± 2,400	
	H2a-7c	MTA-B		ESR: LU	-	41,000 ± 2,600	
Grotte XVI (sw F)	C	MTA	TL-CRIAA	TL	-	57,500 ± 3,600	Guibert *et al.* 1999
			TL-CRIAA	TL	-	59,500 ± 3,400	
			TL-CRIAA	TL	-	60,600 ± 3,100	
			TL-CRIAA	TL	-	62,400 ± 3,200	
			GrN-4345	C14	30,700 ± 400	34,665 ± 490	
La Rochette (sw F)	7	MTA-B	GifA-101267	AMS C14	52,500 ± 3,400	out of range	Soressi 2002
			GifA-101268	AMS C14	42,600 ± 1,600	46,557 ± 1,471	
			GrN-4362	C14	36,000 ± 500	41,118 ± 477	Vogel and Waterbolk 1967
			GrN-4345	C14	30,700 ± 400	35,414 ± 490	
Fonseigner (sw F)	D sup	MTA	Gif-	TL	-	50,500 ± 5,300 (average age)	Valladas *et al.* 1987
Barbas III (sw F)	C4	MTA-B	Gif/LSM-9591	AMS C14	38,300 ± 500	42,762 ± 398	Boeda *et al.* 1996
			GifA-93050	AMS C14	43,500 ± 2,200	47,127 ± 1,544	

Site	Layer	Entity	Cat. No.	Technique	C14 age BP	CalBP	Reference
St-Brice sous Ranes (F)	2	small bifaces		TL	-	41,800 ± 3,700	Cliquet *et al.* 2009
				TL	-	42,600 ± 3,600	
				TL	-	41,800 ± 3,600	
				TL	-	41,000 ± 3,500	
				TL	-	38,100 ± 3,000	
Pech I (sw F)	7	MTA-B		ESR	-	42,000 ± 8,000 (EU) / 49,000 ± 7,000 (LU)	Soressi *et al.* 2007
	7	MTA-B		ESR/U-series	-	51,000 +7,000 -9,000	
	6	MTA-B		ESR	-	39,000 ± 2,000 (EU) / 47,000 ± 4,000 (LU)	
	6	MTA-B	GrA 25633	AMS	37,060 +4,900 -4,200	42,817 ± 3,661	
	6	MTA-B	GrA 25632	AMS	38,430 +5,600 -4,700	43,661 ± 3,489	
	6	MTA-B		ESR/U-series	-	43,000 +8,000 -6,000	
	5	MTA A/B		ESR	-	49,000 ± 6,000 (EU) / 51,000 ± 7,000 (LU)	
	4	MTA A	GrN 6784	C14	42,230 ± 1,340	46,137 ± 1,332	
Pech IV (sw F)	3A	MTA	OxA-V-2344-11/12/13/25	AMS	43,850 ± 575 (average age)	47,065 ± 784 (average age)	McPherron *et al.* in press
	3B	MTA	-	TL	-	43,350 ± 3,900 (average age)	Bowman 1982
	3B	MTA	-	ESR	-	51,000 ± 5,000	Turq *et al.* 2011
	3B	MTA	-	TL	-	50,150 ± 4,450 (average age)	Richter *et al.* 2012
	3B	MTA	OxA-V-2344-14/15/16/17/18	AMS	44,872 ± 560 (average age)	47,008 ± 1,276 (average age)	McPherron *et al.* 2012
La Quina (sw F)	6a	above MTA		TL	-	40,400 ± 3,600 45,500 ± 4,600	Mercier and Valladas 1998
	8	below MTA		TL	-	44,500 ± 4,200 53,00 ± 5,000	
Jonzac (F)	UoS 6	MTA	KIA-29227	AMS C14	36,120 +1,980 -1,590	41,239 ± 1,823	Jaubert *et al.* 2008
	UoS 6	MTA	CPN-15	TL	-	39,000 ± 3,000	
	UoS 7	MTA	KIA-29227	AMS C14	36,490 +1,360 -1,170	41,461 ± 1,166	

Table 2.4: *Overview of the radiometric dates currently available for Late Middle Palaeolithic assemblages rich in bifacial tools in Western Europe*

These absolute dates, obtained with a range of techniques, by a variety of labs and at different points in time, are not without problems and should not be taken at face value (Pettitt and Pike 2001; Pettitt *et al.* 2003; Jöris and Adler 2008; Jöris and Street 2008; Higham 2011; Richter *et al.* in press). Even when taking into account two standard deviations, it is still difficult to assess the contemporaneity of individual sites. Furthermore, the predominance of MIS-3 sites, as opposed to MIS-5, is partly related to the finer chronological time resolution of the former (e.g. the limit of radiocarbon dating is situated around 50,000 BP (Reimer *et al.* 2009; Talamo *et al.* 2012). Neumark-Nord 2/0 is the only assemblage that can be radiometrically placed in MIS-5 but several other assemblages can be assigned to this time frame based on secure stratigraphic sequences; e.g. Buhlen and Balve (Chapter 7; Jöris 1992, 2001).

This overview does indicate that the general contemporaneous nature of the various biface-rich entities, especially during MIS-3 but also during MIS-5, appears a cognizant and is an important conclusion in relation to the interpretive aspect of this PhD thesis (Chapter 8) and further temporal trends will be assessed in Chapter 7.

- Variability and terminological confusion

Besides their rough contemporaneity, the Late Middle Palaeolithic bifacial tools are also characterised by a large amount of typo-technological and spatial variability. This became apparent throughout this background study with the identification of the use of various, terms, types and entities in the literature. Different terminologies and typologies are in use by different academic traditions in different regions of Western Europe, both in relation to bifacial tool types and regionally-restricted taxonomic entities.

Firstly, in the current literature over 20 types of bifacial tools are distinguished (see further descriptions in Chapter 4). These types are often defined in various ways by different academic traditions and can therefore relate to rather different artefacts depending on the context. Types and terms are also used in different ways in various languages; e.g. the confusion surrounding the term *prondnik/pradnik*. A uniform framework in which the Late Middle Palaeolithic bifacial tools from different areas of Western Europe can be compared is currently lacking.

Secondly, this background study demonstrated that currently 10 different taxonomic entities rich in Late Middle Palaeolithic bifacial tools are in use. Besides the well-defined and extensively studied MTA and KMG entities this also entails a plethora of lesser researched entities. Assemblages are often grouped together on a regional basis using poorly defined labels making it thus difficult to assess the exact differences and similarities between assemblages on a pan-European scale. It is clear that this plethora is a representation of the large amount of variability amongst these bifacial tools and moreover indicates that some regions are still poorly understood and require further investigation.

This mosaic of terms, types and regional entities has resulted in a large amount of epistemological confusion in relation to Late Middle Palaeolithic bifacial tools. So far, this ambiguity has severely hampered wider comparisons and explains why few wider-scale studies have been undertaken so far. Moreover, this current, rather disjointed, view on the Late Middle Palaeolithic bifacial tool phenomenon is at risk of obscuring general behavioural trends, both in relation to typo-technological characteristics and spatial and temporal patterning.

This background study illustrates the need for a larger-scale comparative study into the trends identifiable among the Late Middle Palaeolithic bifacial tools. Firstly, this will require an unravelling of different terminologies and typologies (Chapter 4 and 6), and secondly a wider study into the validity and relevance of the different taxonomic entities and the underlying patterns of spatial and temporal differentiation (Chapters 5 and 7). In order to study these Late Middle Palaeolithic bifacial tools in more detail, validating, assessing and interpreting the initial patterns described in this chapter, it is firstly necessary to analyse the theoretical concepts underlying the study of biface variability.

Chapter 3:

Theoretical Background:

Contextualising studies of biface variability

3.1 Introduction

As outlined in Chapter 2, the focus of this PhD is on the bifacial tools from the Western European Late Middle Palaeolithic and more specifically their typo-technological variability and spatio-temporal patterning. This chapter outlines the main theoretical concepts that underlie this research, starting with a synopsis of past research, followed by an overview of current interpretive frameworks and potential behavioural inferences.

This chapter is structured in four main parts. Firstly, a brief overview is presented of how theoretical ideas concerning archaeological variability in general and bifacial tools in specifics have evolved over the last 200 years. It is examined how different units of analysis have been defined and how the focus of Palaeolithic studies has shifted over the decades. Secondly, the current interpretive frameworks used to discuss Middle Palaeolithic variability are described. It is highlighted how this variability debate is still on-going and how there is a need to incorporate more studies of bifacial tools. Thirdly, it is discussed how variability in Late Middle Palaeolithic bifacial technology can, and has, been used by archaeologists to discuss Neanderthal behavioural patterns; how can the characteristics of bifacial tools and the observed variability amongst them be interpreted in terms of Neanderthal behaviour? Finally, a new approach is presented that stresses the importance of studying Late Middle Palaeolithic bifacial tools at different analytical scales; this to come to a more complete understanding of the record, its patterning and behavioural implications.

Throughout this chapter the Late Middle Palaeolithic archaeological record is used to illustrate the relevant theoretical issues. The discussion of the theoretical concepts in this chapter will also provide a framework, which can then be used throughout this thesis to establish well-founded links between data and interpretation (Chapters 6, 7 and 8).

3.2 Past Research

3.2.1 Introduction

Since the systemisation of archaeological studies, recognising and interpreting patterns of variability in the material record has formed a crucial focus. This section gives a historical overview of the different ways in which archaeological patterns in general, and variability amongst bifacial tools more specifically, have been approached. The aim hereby is to contextualise the current plethora of nomenclature, classificatory and interpretive frameworks and the theoretical concepts and thought processes behind them. It is explored how different academic traditions have shaped our understanding of Palaeolithic Europe and how understanding this past research is vital for current-day interpretations and can also act as quality control for new studies.

3.2.2 Past classifications and interpretations of archaeological and bifacial tool variability

In every aspect of the archaeological record, throughout all time periods, and within all material object types, ranging from pots, building constructions to stone tools, rarely will any two artefacts be exactly the same. There is a large amount of variability amongst all archaeological objects, comprising morphological, typological, as well as inter-assemblage variation (Barton 1991). To study such wide variety of material objects in a systematic way, they must be sorted into recurring types on the basis of shared characteristics (attributes), such as size, shape, colour, etcetera (Adams 2001). Artefact classifications usually draw arbitrary lines, often between continuums of variation, and partition the entire field of variation into a comprehensive set of mutually exclusive categories. This structuring is necessary in order to compare variability throughout the archaeological record and most importantly understand how, and if, this was related to past human behaviour.

For the Middle Palaeolithic, stone tools are the most direct, most durable and most readily quantified source of behavioural evidence that has been preserved. Variability within these stone tool assemblages is abundant and was recognised by some of the earliest researchers (de Mortillet 1872; Breuil 1912; Peyrony 1920; Bordes 1961). To facilitate comparisons, it was, and still is, necessary that these stone tools are divided up into taxonomic categories – tool types – and then grouped into industrial variants. It is important now, after over 100 years of lithic analyses, to recognise the effect that stone tool classification has on the study and interpretation of Palaeolithic variability (Bisson 2000; Odell 2001 and references therein). In the 19th century the first attempts were made to divide the Palaeolithic into different archaeological periods based on lithic characteristics (de Mortillet 1869, 1872, 1873 and 1883). These classifications were always heavily influenced by each specific researcher's personal outlook, as well as by the conventions of their time epoch (Clark 2005). Subsequently, these biases or paradigms also had an effect on how lithic variability in general and Middle Palaeolithic variability more specifically, were interpreted. An overview of the main trends in archaeological thought is presented below.

CULTURAL EVOLUTION

In the second half of the 19th century, when Darwin's ideas around evolution were more generally accepted, the ever-increasing number of archaeological assemblages was arranged into archaeological periods. This was initially done based on faunal sequences (Lartet and Christy 1865-75), but quickly artefact based classifications were favoured (de Mortillet 1872). These classifications reflect the dominant idea in social sciences at that time, more specifically the notion that cultures evolve gradually and continuously in a unilinear fashion (Monnier 2006; Vander Linden and Roberts 2011). For the Palaeolithic this is best expressed in the work of Gabriel de Mortillet (1867, 1869, 1872, 1873, and 1883). He defined archaeological periods based on lead types or index fossils, the so-called *fossils directeurs*, whereby a particular tool type is considered as a marker for a certain industrial variant. These industrial variants were then incorporated into a strictly successive evolutionary scheme with no space for geographical or chronological overlaps; evolving through in-situ development from Chellean over Acheulean to Mousterian (de Mortillet 1883).

From the onset of these classificatory schemes, the presence or absence of bifacial tools played a crucial role. Although de Mortillet (1872) recognised the presence of handaxes in both the earlier and later phases of the Palaeolithic, he defined them as the index fossil of the former. Moreover he assigned them a chronological progressive tendency manifested by increasing sophistication and described how over time handaxe become *'lighter and more finely and elegantly worked'* (De Mortillet 1883). Although de Mortillet's linear evolutionary model received criticism already soon after publication (Dupont 1874) his ideas and classificatory schemes were further developed throughout the first half of the 20th century (e.g. Commont 1913). The presence of handaxes in the Late Middle Palaeolithic was always conceived as problematic in these early evolutionary schemes. Subsequently, the realisation of the contemporaneity between handaxe and non-handaxe entities, both during the Lower and Middle Palaeolithic became the main trigger of the abandonment of this unilinear evolutionary perspective.

CULTURE-HISTORY

Throughout the late 19th century the concept of 'archaeological cultures' arose and by the 1920's a culture-historical perspective to the study of prehistory had largely replaced the cultural-evolutionary approach (Monnier 2006). Archaeological cultures were hereby seen as "*certain types of remains – pots, implements, ornaments, burial sites, house forms - constantly recurring together*" (Childe 1925) and interpreted as "*Sharply defined culture areas correspond unquestionable with the areas of particular peoples or tribes*" (Kossinna 1911). This approach criticised the cultural evolution model in two main ways:

a) Some facies do overlap in time and are contemporary.
b) Divisions should not be solely based on *fossils directeurs* but consider the entire lithic assemblage.

Although statistical analyses of lithic assemblages were proposed (Vayson 1921), initially they were not very influential and the index fossil approach still held strong. Conversely, the notion of distinct but contemporaneous facies, as proposed already by Dupont in 1874, did become more popular. These ideas of contemporaneous cultures representing distinct groups of people were developed by Samuel Hazzledine Warren (1922), Gordon Childe (1925) and Grahame Clark (1933) in the Anglophone world, by Gustaf Kossinna (1911) for the German-speaking world and initially by Denis Peyrony (1920) and Henri Breuil (1913, 1932) for the French Palaeolithic.

Peyrony initially adhered to the notion of unilinear evolution but subsequently switched to the idea of synchronic variation (Peyrony 1920, 1930). The presence or absence of bifaces was hereby still a crucial factor and he distinguished between a Typical Mousterian (without bifaces) and a Mousterian of Acheulean Tradition (MTA, with bifaces (see also

Chapter 2). He still emphasised continuity by using the term MTA, indicating that this industry had cultural affinities with the Acheulean.

The onset of the Second World War resulted in a gap in archaeological publications and theoretical constructs. It is important to note that especially in Central Europe this phase had an enduring influence on Palaeolithic archaeology. Ideas about cultures, race and people were misused and the data was made to fit preconceived (nationalist) ideas; e.g. Oswald Menghin (Kohl and Perez-Gollan 2002; Smolla 2010). After 1945, and as a reaction to this earlier work, the focus of research went back to detailed typological and chronological studies. This situation continued and explains why static ideas about archaeological cultures continue to dominate the interpretive framework for Central Europe (Rebay-Salisbury 2011).

Once the presence of contemporary facies was more widely accepted, in the 1950s and 60s the emphasis shifted to more elaborate quantitative analyses of lithic assemblages. The discovery and systematic excavation of more and more Palaeolithic sites illustrated that the tool - industry equations were unbalanced and inconsistent. Moreover, with the emergence of radiocarbon dating in the 1950's several index fossil-based chronological frameworks were dismantled through absolute radiometric dates (Vander Linden and Roberts 2011). During this phase of theoretical and interpretive framework construction, François Bordes was the most influential person in relation to Palaeolithic archaeology. He created comprehensive type-lists and introduced statistical, quantitative methods to assess assemblage variation overriding the previous qualitative index fossil approach (Bordes 1961). He further defined five Mousterian variants which he saw as reflecting five different population groups (Bordes 1950, 1973; Bordes and Bourgon 1951; for more detail see section 3.3.1). Bordes regarded the Mousterian as a period characterised by stasis and broad geographic uniformity, and therefore he applied his methodology to sites all over the Neanderthal world (Straus 2005).

Throughout these quantitative analyses the presence or absence of handaxes was still seen as an important defining factor and the term Mousterian of Acheulean Tradition remained (Bordes 1961). In general, from the 1960's onwards a more systematic approach was utilised to classify bifacial tools and several more elaborate classificatory frameworks arose (Bordes 1961; Bosinski 1967; Roe 1968, Wymer 1968). Bordes devised a set of measurements and ratios, which are still widely used today, to divide the bifacial tools from the French Mousterian into different types. Equally, Bosinski created a classificatory framework for Central Europe (Bosinski 1967), and defined over 20 types of bifacial tools (for a more detailed overview of these two typological schemes see Chapter 4). Contemporaneously, in Britain, Derek Roe and John Wymer, distinguished two distinct handaxe traditions in the British Lower Palaeolithic (ovate and pointed) and also interpreted them as the result of two distinct cultural groups (Roe 1968; Wymer 1968). Like Bordes and Bosinski, their work can be seen as part of the broader attempt to classify material culture in a more objective way.

PROCESSUAL ARCHAEOLOGY

Whilst Bordes' interpretation was cultural historical, his quantitative and statistical approach can be linked with the emergence of processual archaeology. Within this stream of archaeological thought the idea of different cultural/ethnic groups was abandoned. Moreover by the middle of the 20th century the strong influence of functionalist interpretations of material culture, which originated in anthropology, became more and more apparent and the theoretical basis of the structuring of archaeological variability was questioned. There was a general shift away from questions of culture history and diachronic patterning in favour of studies of synchronic variability and behavioural explanations (Binford 1965, 1972; Monnier 2006; Vander Linden and Roberts 2011). The variability in the archaeological record was now divided by what the objects were used for, or what they meant to their makers and users, rather than simply by what was useful to the archaeologist for the purposes of dating (Adams 2001). On this basis, Binford challenged Bordes' ethnic interpretation and suggested that Middle Palaeolithic assemblage variability related to functional and adaptive factors (Binford and Binford 1966; see section 3.3.1).

In general, the processual school of thought, i.e. the New Archaeologists, pursued a scientific approach to archaeology and demonstrated that to be certain of the recognised variability researchers have to ensure they are observing a representative sample of sites and artefacts. It was therefore argued that it was necessary to take a critical look at the sampling theory and techniques used before making interpretations (Johnson 1999). Moreover, these scholars questioned the emphasis on similarity rather than variability when dividing the past and its division into cultures, phases and types (Johnson 2006). David Clarke (1968), for example, explored the constitution of archaeological cultures in a systematic way, creating a hierarchy of concepts and nomenclature, and envisaged archaeological cultures as dynamic polythetic sets.

New technological approaches to lithic assemblages were developed, building upon the pioneering technological studies of André Leroi-Gourhan (1964), who introduced the concept of *chaîne opératoire* or operational sequence. Studies focussing on technological rather than typological aspects of lithic assemblages became more popular throughout the 1980's and dominant throughout the 1990's (Boëda *et al.* 1990; Boëda 1997). Furthermore, Graham Clark (1971) reorganised lithic assemblages into five modes of production; mode 2 incorporating bifacial technology. But despite these new approaches to the study of lithic assemblages, Bordes' quantitative approach was still adhered to and applied to many assemblages, especially in Western Europe (e.g. Cliquet and Lautridou 1988).

POST-PROCESSUAL ARCHAEOLOGY

While processual archaeology claimed that scientific methods could lead to objective interpretations of the past, the post-processuals stressed the subjective nature of any interpretation and emphasised social constructs (Johnson 2006). One of the main proponents of the post-processual school was Ian Hodder (1982, 1995). Based on ethnoarchaeological fieldwork he illustrated the interconnectedness and active role of material culture in the formation of non-random association groups in the archaeological record (Hodder 1982). Artefacts were no longer passive objects, and artefact analysis was aimed at unlocking the decision-making processes behind them (Mithen 1990, 1994).

There was a shift away from larger-scale analyses to studies that focused on the site, locale or even individual. This led to the abandonment of the concept of archaeological cultures and a more focused consideration of the artefact itself (Vander Linden and Roberts 2011). Within Palaeolithic research these concepts of social theory were extensively applied. New studies of handaxes aimed to shed light on the individual that made them and their social identity (Gamble 1998, 2004; Ashton and White 2001, 2003; Gamble and Porr 2005; Porr 2005; Machin 2009; Foulds 2010; Spikins 2012). Handaxe variation is hereby seen as heavily influenced by individual choice and skill. This school of thought stresses that handaxes were manufactured and used by individual knappers who were constrained and motivated by a variety of changing social and environmental factors (Machin 2009).

One area of debate between the processual and post-processual approaches relates to whether our classifications represent that of the original manufacturers. In different areas of the social sciences a similar distinction is made between outside and inside views. This distinction has been described by anthropologist Marvin Harris in terms of emic (inside) and etic (outside) (Johnson 1999). Emic classifications aim to order the variability in the archaeological record according to criteria believed to have been important to the makers. In my opinion, typological frameworks and artefact classifications are an essential process necessary to create some form of order in the infinite world of archaeological variability. These classifications are the prehistorian's ways of structuring the prehistoric world and in most instances do not represent emic categories.

Overall, since the 1970's there has been a diversification in archaeological thought and material culture, so much so that variability amongst bifacial tools is no longer seen as a passive replication of social behaviour but as an active component in its constitution.

3.2.3 Discussion

This historical synopsis of past archaeological thought and Palaeolithic research contextualised this new study of variability amongst bifacial tools. The overview has documented that from the onset of Palaeolithic archaeology the presence and absence of handaxes played a crucial role in developing classificatory schemes. Such schemes were constructed to understand the observed stone tool variability. A summary of the role of bifacial tools throughout the history of Palaeolithic research is presented on Table 3.1.

The cultural evolutionism model is now generally rejected and index fossils are no longer explicitly and exclusively used to date assemblages. It is generally accepted that they overlap widely in time; such is for example the case for handaxes (Monnier 2006) and blade technology (Bar-Yosef and Kuhn 1999). Conversely and perhaps curiously, de Mortillet's index fossil based classification is still the main basis for the overall Palaeolithic classificatory scheme used today.

Time Period	Intellectual stand	Main scholars	Role of bifacial tools
1850-1900	**Cultural Evolutionism**	Gabriel de Mortillet, Victor Commont	handaxes are seen as the type fossil of the Lower Palaeolithic Chellean; handaxes gradually evolve through time to be 'more elegant' in the Mousterian
1900-1950	**Culture History**	Gustaf Kossinna, Denis Peyrony, Henri Breuil, Gordon Childe	handaxe and non-handaxe industries can be contemporaneous, distinction between Typical Mousterian and MTA
1960s	**Culture History**	Francois Bordes, Gerhard Bosinski, John Wymer, Derek Roe	quantitative studies of handaxes emerge, distinction MTA-A and B in SW France, definition of KMG based on German bifacial tool record
1960-1980	**Processual Archaeology**	Lewis Binford, André Leroi-Gourhan, Grahame Clarke	focus on technological and functional studies of handaxes
1980s onwards	**Post-processual Archaeology**	Ian Hodder, Steven Mithen, Clive Gamble, Martin Porr	handaxe forms heavily influenced by individual choice, skill and social context

Table 3.1: *Overview of the role of bifacial tools in Palaeolithic studies and classificatory schemes in relation to the main stands of archaeological theoretical thought over the last 150 years*

The culture-history approach has been heavily critiqued, both in terms of the construction of archaeological cultures and its direct linkage to ethnic groups (Vander Linden and Roberts 2011). In part these critiques are justified, particularly the equation between taxonomy and ethnicity, but, in my opinion, the concept of archaeological cultures should not be wholly abandoned. In its most basic form, identifying archaeological cultures enables patterns of similarities and differences in the archaeological record to be identified and discussed. The identification of such entities can highlight certain interconnections in material culture through time and across space, of which the implications are often not well understood and require further work. Overall, culture history, despite its flaws, remains more influential and more widely used as a paradigm nowadays than either processualism or post-processualism (Roberts and Vander Linden 2011).

The strength of processual archaeology lies in the fact that it brought new approaches to the study of bifacial tools. More detailed metric and technological studies ensured that the manufacture processes of handaxes and their functional uses are now taken into account when discussing variability. The post-processual school furthermore added a well-needed social and individual dimension to the study of handaxes.

Overall, despite these critiques and theoretical developments, a wide debate about the exact meaning of the striking similarities and differences in bifacial tool morphology is still on-going (McPherron 2000, 2006; Wenban-Smith 2004; Emery 2009; Machin 2009; Iovita and McPherron 2011). In this PhD biface variability is therefore studied integrating several theoretical approaches:

1. The aim to identify large-scale patterns and non-random association groups has its roots in the culture-history approach.
2. The detailed attribute-based lithic analyses link with the processual school.
3. The overall aim to add to questions of Neanderthal behaviour, including social dimensions, is based on ideas developed by the post-processual movement.

Currently, notwithstanding the considerable number of bifacial tool studies, many questions still remain unanswered in relation to Late Middle Palaeolithic biface-rich entities. Therefore, using such an integrative approach, overcoming a reliance on one dogmatic stand, seems the best way to analyse, validate and interpret bifacial tools, biface-rich assemblages and entities in all their aspects.

This historical overview is now complemented with a synopsis of the current frameworks used to interpret archaeological and biface variability, providing a conceptual background in which new patterns of variability within bifacial tools can be interpreted.

3.3 Current Interpretive Frameworks

3.3.1 Introduction

Since the 1960s a classificatory framework for Palaeolithic handaxes and other bifacial tool types has been in place (Bordes 1961; Bosinski 1967; Roe 1968; Wymer 1968). The imposition of this framework for the study of bifacial tools opened up possibilities for more detailed comparisons, at various spatial and temporal scales. To contextualise the variability encountered in these comparisons several interpretive structures have been proposed, which were often influenced by the prevailing world view held at the time.

The best illustrative example hereby is the 'Mousterian debate', which focused on explaining variation between Mousterian lithic assemblages. Firstly, François Bordes interpreted the five different Mousterian groups he had defined quantitatively as a 'branching' complex of five different traditions (Quina, Typical, Ferrassie, Denticulate and MTA) that inter-stratify at random (Bordes 1950; Bordes and Bourgon 1951; Sackett 1981). He saw these facies or cultures as diversifying over time, each adapting to the unique constraints imposed by climate, fauna and environment, and reflecting different cultural or ethnic Neanderthal groups or tribes (Bordes 1961, 1973). Bordes' cultural interpretation was quickly and heavily criticised by other scholars and is now, in general, rejected. His cultural/ethnic interpretation initiated a long and on-going debate about how the inter-assemblage variability or industrial variation present in the Middle Palaeolithic could be explained.

Over the years several scholars brought forward new insights into this discussion. Firstly, Binford posited that the variability in the Middle Palaeolithic record was not related to cultural differences but the result of the different types of activities performed on a site

(Binford and Binford 1966; Binford 1973). Secondly, Harold Dibble successfully questioned the basis of Bordes' interpretation by showing that the resharpening of tools is an important determining factor for the final shape of the tool and therefore not all tool types can be regarded as desired end products. According to Dibble tool shapes only reflect the amount of reduction of an artefact, through resharpening, to the point of uselessness (Dibble and Rolland 1992; Dibble 1995). Thirdly, Paul Mellars illustrated a chronological succession amongst some of Bordes' group also refuting his idea of contemporary tribes (Mellars 1965, 1969, 1986, 1996).

Finally, during the 1990s the influence of ecological (Rolland 1990) and technological (Kuhn 1995) adaptations on inter-assemblage variability were emphasised and the debate is on-going. Recent papers, focusing on obtaining a better chronological control for the Southwestern French record (Guibert *et al.* 2008; Richter *et al.* in press) point out the contemporaneity of most Mousterian facies, *contra* Mellars. Moreover, the validity of our unit of analysis, the Mousterian variants themselves, is questioned. It is suggested that this classificatory construct may cover up genuine behavioural patterns (Richter *et al.* in press).

This 'Mousterian debate' illustrates how different interpretive frameworks are, and have been, used to interpret variability patterns. Currently, these interpretations can be divided into two main stands (Clark and Riel-Salvatore 2006):

1. *Social Transmission* – Artefact typology and change reflect technological and/or typological traditions held in common by identity-conscious groups of people and transmitted over generations by a process of social learning. This is often linked to a concept of 'culture' held in common by these groups.

2. *Adaptations* – Changes in artefact types result from responses to new or modified surroundings. Tools and technologies change to become suitable to new conditions and environments. Ethnographic data is often used to generate and test models which incorporate core evolutionary principles such as adaptation and selection.

Both approaches in this two-fold scheme assign different meanings to the similarities and differences identified amongst artefact assemblages. The potential factors behind artefact variability in each of these approaches are further explored below and specifically in relation to the Middle Palaeolithic and bifacial tools.

3.3.2 Interpreting biface variability – Adaptations

The variability amongst bifacial tools can be interpreted in relation to four main adaptive factors: raw material availabilities and constraints; site function; tool function; and reduction and use-life. These four interpretive frameworks are briefly presented below and will then be further assessed based on the new data collected throughout this PhD in Chapter 8.

1. RAW MATERIAL

Both Lower and Middle Palaeolithic bifacial tools are made on a variety of raw material types (e.g. flint, quartz, quartzite and sandstone) and a wide range of blank types (e.g. large nodules, small pebbles, tabular flint, large flakes, and frost fragments). It has been argued that these differences in raw material types and blanks could be responsible for the variability observed in the bifacial tool record. For example for the British Lower Palaeolithic it has been argued that pointed and ovate handaxe forms represent different responses to different types of raw material (White 1995, 1998; Ashton and McNabb 1994; Ashton and White 2001, 2003). In a more general extrapolation Dibble and Rolland (1992) argue that the strategy of stone tool manufacture in general depends on the raw material used (see also Dibble 1991). For the Middle Palaeolithic, studies of MTA handaxes seem to indicate a trend towards maintenance of shape regardless of raw material type (White and Jacobi 2002; Iovita 2008, 2009). Conversely, in Central Europe studies of KMG assemblages have indicated constraining effects of raw material (Richter 1997) and a more fluid continuation of shapes (Jöris 2006).

2. SITE FUNCTION

Binford (1973) was the first to suggest that the types of activities undertaken at each site played a role in the sorts of artefacts produced and used at these locations. In general, throughout the Palaeolithic four types of sites were distinguished (Isaac 1971):

a) transitory camps – low density of artefacts
b) kill/butchery sites – abundance of bones but relatively few stone artefacts.
c) extraction/workshop sites – dominance of stone tools
d) camp or occupation sites – abundance of both bones and stone tools

This framework can also be applied to the Middle Palaeolithic (Garefalakis 2009) and in relation to the presence of Late Middle Palaeolithic bifacial tools Turq (2007) distinguishes three specific types of sites:

1. transition sites – only the debitage of the manufacture of bifacial tools is left behind
2. processing sites – only bifacial tools are present, no signs of their manufacture
3. manufacture and/or residential sites – located near raw material sources and both the bifacial tools and their manufacture debitage are present

Besides this presence of different types of archaeological remains, the physical location of the site itself can also give an indication about the function of the locality. Assemblages rich in bifacial tools occur at both cave and open-air localities and are most commonly associated with water and raw material sources, a trend generally reoccurring throughout the Middle Palaeolithic. A further overview of these functional indicators in relation to the Late Middle Palaeolithic bifacial tools can be found in Chapter 5 and their role in explaining variability patterns in Chapter 8.

3. TOOL FUNCTION

Since their initial discovery bifacial tools, and especially handaxes, were assumed to have been utilised for a variety of tasks (for an overview see Claud 2008). Because of their morphological characteristics – two cutting edges, creating a refined point, opposite a blunt base – the prevailing idea is that handaxes are hand-held all-purpose tools. This conforms to the more general idea that Middle (and Lower) Palaeolithic tools should be regarded as non-specialised (Jaubert 1999; Odell 2001). Furthermore no direct links between the shape of a tool and its function have been established so far (Anderson-Gerfaud 1981; Beyries 1987; Rots 2009, 2011, 2013).

Conversely, it has been attempted to assign different handaxe shapes to differing immediate functions or particular activities (e.g. Shick and Toth 1993). Moreover it has been suggested that the allometric relationship between handaxe shape and size seems to indicate a preferred shape which might be linked to a specific functional need (Crompton and Gowlett 1993 and 1994). The common association, especially on Lower Palaeolithic sites, of handaxes with large faunal remains (e.g. Aridos and Torralba (Spain), Boxgrove (UK)), with or without cut marks, has always been related to their use in butchery practices. Most experimental studies furthermore agree on the superior efficiency of handaxes for heavy duty butchery tasks (Jones 1980; Schick and Toth 1993). Remarkably, these studies always focus on the larger, heavier Lower Palaeolithic biface types and so far no experiments with Middle Palaeolithic bifacial tools have been conducted. Use-wear analyses also confirm the use of these tool types for butchery. Currently, around 500 handaxes from ca. 40 Lower and Middle Palaeolithic sites have had use-wear traces recognised on them (for a summary see Claud 2008). Butchery marks are hereby most commonly identified, both on Lower and Middle Palaeolithic specimens. A more detailed discussion on their presumed multi-functionality is presented in section 3.3.2 and the implications for interpreting spatial and temporal patterning among Late Middle Palaeolithic bifacial tools in Chapter 8.

4. REDUCTION AND USE-LIFE

When studying biface variability it is important to recognise that not all tool forms represent intentionally designed end-products, the so called 'finished artefact fallacy' (Frison 1968; Davidson 1993, 2002; Davidson and Noble 1993). The idea that tools can have lengthy histories of curation, reuse and resharpening, changing their morphological characteristics on the way, has been brought forward both for scrapers (Dibble 1987, 1988 and 1995) and handaxes (McPherron 1994, 1995; Iovita 2008, 2009). McPherron conducted a metrical assessment of a wide range of Lower Palaeolithic handaxes and proposed that handaxe shapes are influenced both by the size of the raw material and the intensity of bifacial reduction. Particular handaxe shapes (e.g. pointed vs. ovate) hereby represent different stages in a continuous reduction process. This approach was also more recently applied to Middle Palaeolithic handaxes (Iovita 2008, 2009, 2010). Contrary to the allometry pattern generally recognised in Acheulean types, within MTA handaxes there seems a more isometric pattern with the maintenance of shape throughout the reduction continuum (Iovita 2009; Iovita and McPherron 2011), leaving the interpretation of different shapes open to other factors. The long use-lives of Late Middle Palaeolithic bifacial tools is further explored in section 3.4.2 and interpreted in Chapter 8.

5. CONVERGENCE VERSUS MENTAL TEMPLATE

At present it is generally accepted that handaxes are the result of intentional, deliberate flaking strategies (Gowlett 1984, 1995; Ashton and White 2003; Pope *et al.* 2006). Conversely, the different outcomes of this flaking and the resulting variety in shapes, can, as described above, be interpreted in several ways. One extreme is to see handaxe shapes as merely reflecting the limited number of form outcomes that can possibly emerge from bifacial flaking (‘*convergence*’). In other words, there is only a certain number of ways you can bifacially shape a piece of rock, and specific bifacial tool shapes are just the by-product of the application of these bifacial technologies (Davidson and Noble 1993; Otte 2003; Wynn 2004; Clark and Riel-Salvatore 2006).

The other extreme is to suggest that groups of bifacial tool makers had fixed mental templates (Gowlett 1986; White and Dibble 1986; Wynn and Tierson 1990; Ashton and White 2003; Monnier 2006) which reflect shared cultural norms and were transmitted according to strong patterns of social learning (Mithen 1996). In this context the mental template is defined as a preconceived idea in the mind of the knapper (Nowell *et al.* 2003). Gowlett more recently proposed the more flexible idea of an ‘*instruction set’*, to overcome the too rigid notion of a mental template (Gowlett 2005).

While the large amount of poorly standardised or non-classic handaxes questions the mental template hypothesis (McNabb *et al.* 2004; Ashton and McNabb 1994), the presence of ‘extreme’ or over-engineered handaxes such as twisted ovates (White 1998), giant handaxes (Wenban-Smith 2004) or *bout coupé*’s (White and Jacobi 2002) questions the convergence theory. In my opinion, the reality therefore should be sought somewhere between these two extreme viewpoints. Bifacial tools should be seen as flexible concepts, constructed intentionally but adapted to a variety of constraints during the manufacture process. Besides form, process should also be taken into account (Gamble 1999) and the mental template is only one part of a more complex suit of factors (White and Dibble 1986; Pope *et al.* 2006) which besides adaptive elements also might contain an element of social transmission or culture.

3.3.3 Interpreting biface variability – Social Transmission and Culture

In addition to the adaptive factors described above, social transmission, patterns of learned behaviour and/or culture have been invoked to explain lithic variability. Currently, the concept of culture is regarded as highly problematic by many anthropologists and the term can be defined in many ways (for an overview see Gamble 2008). This can partly be related to the differential development of culture history and archaeological cultures in different regions and periods (Roberts and Vander Linden 2011). In addition, the notion of culture is often not securely defined when used in Palaeolithic contexts (Dibble *et al.* 2006). Moreover the prehistorian's ability to recognise 'cultural' units in the Palaeolithic record in general and especially to what extent these units reflect purposeful behaviour of anthropological significance, has rightly been questioned (see above), mainly because of the coarse resolution of the record (Clark 2005; Clark and Riel-Salvatore 2006; Dibble *et al.* 2006; Iovita 2008; Richter *et al.* 2012).

Recently, within Late Middle Palaeolithic contexts the notion of different cultural traditions and social transmission has gained more and more credence (Mellars 1996; Richter 2002; Depaepe 2007; Koehler 2009; O'Brien 2010). Since this concept is quite crucial to the interpretation of the material under study here (Chapter 8) it is explored in more detail than the other factors. The concept of culture is defined, applied to the archaeological record and three meanings of culture are explored: culture in an ethological sense, culture as an anthropological phenomenon and the distinction between cultural performances and cultural capacities.

CULTURE, AN ETHOLOGICAL DEFINITION

The definition of culture varies according to different disciplines, and is often so broad that ambiguity seems inevitable (Gamble 2008; Haidle and Conard 2011). Within studies of animals (ethology) culture is defined as the behavioural patterns which are linked to the social transmission of information rather than to genetic inheritance (Boesch 2003). This ethological definition of culture can also be applied to the archaeological record and culture is then defined (Boyd and Richerson 1985; Premo and Hublin 2009) as:

'Culture is information acquired from other group members through learning or imitation that can lead to variation in behaviour'

The two concepts central to this definition are the opportunity to lead to behavioural variation and the transmission of the information through learning. These two concepts are not unique to humans and have been observed both amongst wild and captive non-human primates (Boesch 2003; Whiten *et al.* 2009; Kamilar and Marshack 2012). Chimpanzees have a rich cultural repertoire and over 39 cultural variants, with specific tool functionality identified (Kamilar and Marshack 2012). Moreover these cultural variants have patchy distributions which cannot solely be explained by genetic or environmental factors. These cultural variants seem to represent local traditions transmitted culturally from generation to generation (Boesch 2003; Whiten *et al.* 2009). Amongst these chimpanzee communities a link was also established between geographic proximity and number of shared cultural traits (Whiten *et al.* 2009; Kamilar and Marshack 2012).

Although the limitations in projecting this behaviour onto Early Pleistocene hominins have to be acknowledged, the fact that these concepts are present amongst non-human primates does indicate that their presence amongst the earliest hominin stone tool makers is not unlikely. It needs to be emphasised that it is possible that certain cultural traits are not archaeological visible, a factor also noted in the chimpanzee communities (Whiten *et al.* 2009), and idiosyncratic tool types do not yet occur in the Early Pleistocene.

The importance of culture in Middle Pleistocene contexts has recently been illustrated by agent-based simulations of genetic diversity in structured populations (Premo and Hublin 2009). This study was triggered by the finding of low genetic diversity amongst modern humans, Neanderthals and their common ancestor (Krings *et al.* 2000; Serre et al. 2004; Green *et al.* 2008), by comparison with other higher primates. In relation to modern humans this low genetic diversity has been explained by referring to a relatively recent demographic expansion from a small population that moreover probably incorporated a geographically organised structure (Harpending *et al.* 2000). To explain this low genetic diversity in relation to Middle Pleistocene populations Premo and Hublin (2009) introduce the concept of Culturally Mediated Migration (CMM). They define CMM as "*a general mechanism whereby individuals can only migrate to groups that surpass a given level of cultural familiarity*" (Premo and Hublin 2009). A low within-group and high between-group variance in this context would lead to the observed reduction in the total average gene diversity. In other words CMM implies that culture already played an influential role in structuring hominin populations throughout the Middle Pleistocene, and that the presence of cultural differentiation across regional subpopulations is very likely (Premo and Hublin 2009).

CULTURE, AN ANTHROPOLOGICAL MEANING

Even though in an anthropological sense culture is unique to humans, anthropological culture can still be defined in different ways (Dibble *et al.* 2006). Anthropological definitions of culture which incorporate concepts which are as good as invisible within the Palaeolithic archaeological record, such as belief systems and morals, are avoided here. A more simple anthropological definition of culture seems more appropriate in this Middle Palaeolithic context:

'Culture is a system of knowledge present within a group that rests on the presence of shared conventions or norms'

Crucial to this definition is the presence of shared group norms. Lycett (2010) for example emphasised that changes and variation in lithic artefacts are partly the result of a process of '*descent with modification*'. Throughout artefact manufacture people employ a set of socially inherited ideas, skills and knowledge that influences the final form of the artefact (Lycett 2010). With regards to stone tools, this definition implies that the manufacture of lithics does not rely solely on learned procedures but also reflect norms shared by the group. This is a hard concept to identify in a Palaeolithic archaeological record for which stone tools are the main information source. It not only assumes that the final forms in which stone tools were discarded reflect such group norms, it also implies that such norms were initially imposed on flint knapping methods. The archaeologist's ability to recognise such cultural units in the Palaeolithic record and especially to what extent these units reflect behaviour of anthropological significance, has rightly been questioned (Clark 2005; Clark and Riel-Salvatore 2006; Dibble *et al.* 2006; Iovita 2008). Especially for the earlier parts of the Palaeolithic it is generally accepted that we cannot distinguish such community-defined standards of artefact manufacture (Dibble *et al.* 2006). Its relevance towards the patterning among Late Middle Palaeolithic bifacial tools is explored in Chapter 8.

CULTURAL PERFORMANCES VERSUS CULTURAL CAPACITIES

A symposium held in 2011 at Tübingen provided an interdisciplinary dialogue on the nature of culture (Haidle and Conard 2011). The preliminary results of the symposium were published and led to the proposal of a distinction between cultural performance and capacity and the recognition of six steps in the expansion of cultural capacity (Haidle and Conard 2011). The strength of this symposium is that it focused on the archaeological record rather than ethologically derived features. The different cultural concepts they propose helps to define culture in relation to the Palaeolithic archaeological record.

Cultural performance is defined as "*the actual set of cultural attributes expressed by an individual, group or population*" (Haidle and Conard 2011). This relates to what is actually found in the archaeological record. Three dimensions furthermore influence this performance. The biological dimension comprises genes, anatomy and physiology. The historical-social dimension relates to the historical acquirement and social access to knowledge and skills and the extent of storage and transmission. The individual setting indicates the personal social setting and individual life setting. These three dimensions all influence the way culture is performed and expressed.

Cultural capacity is the "*potential range of cultural performances in a species at a given time*" (Haidle and Conard 2011). This capacity is not always directly reflected in the archaeological record and relates to potential rather than actual performance. The expansion of cultural capacity has furthermore been described as incorporating six steps (Haidle and Conard 2011):

1. **Socially transmitted information** relates to the transmission of simple instant data which do not have a long-term impact on behaviour.
2. **Traditions** are permanent characteristics of a group that were attained through repeated social learning.
3. **Basic culture** comprises a number of traditions that differ among geographical groups. Moreover these behavioural differences do not solely relate to varying environmental conditions.

These first three steps are all present in the animal world. Basic culture is restricted to primates and has been observed amongst at least chimpanzees and orang-utans (Whiten *et al.* 2009). Moreover the presence of basic culture has been assumed for early *Homo* species and is also not unlikely amongst Australopithecines (Whiten *et al.* 2009; Pradhan *et al.* 2012). The next three expansion steps are exclusive to Homo (Haidle and Conard 2011):

1. **Modular culture** is expressed by the ability to produce tools with other tools. Tool use becomes more flexible with tools not fixed to a specific aim but applied to a variety of different problems. The presence of this modular cultural capacity has been proposed for early Homo and *Homo erectus* (Haidle and Conard 2011).
2. **Composite or cumulative culture** is defined by the use of a combination of different objects into single units. This relates to an accumulation of knowledge and skill without reinvention. A good example is the fabrication of compound adhesives and hafted tools, combining existing ideas into a new concept. This concept has been claimed to be present in the Late Acheulean, at sites such as Gesher Benot Ya'aqov and in Mousterian context as early as MIS-6 (Mazza *et al.* 2006).
3. **Collective or communal culture** represents the emergence of the perception of the group as an acting entity, overruling individual factors. In the archaeological record this is expressed by the presence of complementary tool sets (e.g. bone and arrow (Lombard and Haidle 2012) and in communication tools (e.g. ornaments, art and musical instruments). It implies the presence of group consciousness and has so far been restricted to *Homo sapiens*.

Neanderthals are generally regarded as having a composite or cumulative culture and the potential presence of a collective or communal culture is still debated (see Chapter 8). In relation to bifacial tool variability, although the culture-history approach is now generally rejected, the reflection of cultural or social norms in the manufacture of handaxes has always remained plausible (e.g. Mellars 1996; Wenban-Smith 2004). It is argued that there is a certain amount of patterning in handaxes which seems difficult to explain solely by any, or even a combination, of the above mentioned adaptive factors. Especially in relation to extreme forms and regional signatures (e.g. *bout coupés*), a social/cultural influence has been proposed (White and Jacobi 2002). These culture models will therefore be central in further interpretations of the Late Middle Palaeolithic bifacial tool data (see Chapter 8).

3.3.4 Discussion

Patterns of variability within the archaeological record can, and have been, interpreted in several ways. A main opposition exists between explanatory frameworks relating to adaptations and ones relating to social transmission and culture. Both these schemes can be applied to this study of Late Middle Palaeolithic bifacial tool variability (see Chapter 8). In general, the differing patterns of change and continuity within the Palaeolithic record are still difficult to explain in a coherent way. Overall, it is agreed that explanations relating to one sole factor do not hold up (Gamble 1999) rather a combination of several factors are at play. Therefore these interpretive concepts and their validity in relation to Late Middle Palaeolithic bifacial tools are explored further on based on the new data gathered throughout this PhD study (see chapter 6, 7 and 8).

3.4 Potential Behavioural Inferences

3.4.1 Introduction

In addition to the interpretive frameworks presented above, the distinct nature of bifacially worked tools and the potential behavioural inferences that can be made through their detailed study are presented. In general, the recurrent focus on handaxes in the study of Palaeolithic stone tool assemblages is related to the idea that the effort and care required to shape these bifaces will also allow greater amounts of behavioural information to be deduced (Roe 2003). More than any other Lower or Middle Palaeolithic tool type, handaxes can contribute to a dynamic reconstruction of Palaeolithic life ways. Besides purely functional considerations, more behavioural aspects such as mobility, longevity and symbolism are discussed, providing a contextualising framework.

3.4.2 Bifacial tools and behavioural inferences

In a Late Middle Palaeolithic context bifacial tools are often described as multifunctional, mobile artefacts which are curated and have long use-lives (Soressi 2002; Soressi and Hays 2003; Rots 2009; Wragg Sykes 2009). Often they are regarded as potential carriers of social and symbolic information (Gamble 2004). Moreover, they have been associated with the emergence of regionalism and can reflect concepts of mixing or hybridisation. All these inferences have implications in terms of Neanderthal behaviour and therefore their potential in a Late Middle Palaeolithic context are introduced below.

1. MULTIFUNCTIONALITY

As described in section 3.3.1 bifacial tools are seen as multipurpose handheld tools. Conversely, recent use wear studies on Late Middle Palaeolithic specimens seem to indicate a more specialised use. Like with all use-wear studies it needs to be taken into account that some uses might not leave traces, on some pieces the traces might have been erased by post-depositional processes and some activities may leave similar traces, even if they are very different (Odell 2001). But together with the other lines of evidence use-wear analyses strongly point to the use of bifacial tools for a variety of task but with a clear dominance of butchery/meat cutting activities (Table 3.2). KMG backed bifacial knives seem almost exclusively to have been used for cutting meat, while on MTA pieces also wood-working is commonly identified (Claud 2008). Furthermore hide working traces are common in the MTA while they are very rare on Acheulean bifaces (Claud 2008).

Most relevant for this thesis are studies of late Middle Palaeolithic specimens. Claud (2008, 2012) has recently analysed handaxes from five MTA sites in Southwestern France. She concludes that the use of a biface is a function of its morphology and state of reduction. More specifically she distinguishes between primary and secondary functions. The most commonly recognised use-wear trace, butchery, seems to be related to handaxes with two convergent cutting edges. The other primary function, wood-working, on the other hand seems to be related to handaxes with a transverse cutting edge. Furthermore a range of secondary uses, such as scraping of hard minerals and use as a hammer stone, have been identified on handaxes which are made mainly on local raw materials and which have been repeatedly resharpened (Table 3.2). Claud therefore concludes that MTA handaxes should not be seen as multifunctional but rather were designed for a specialised function.

Site	Entity	Location	Date	Sample	Butchery	Woodworking	Hideworking	Percussion	Hafting	Reference
Corbiac (F)	MTA	open-air	MIS-3	3	–	√	√	–	–	Anderson-Gerfaud 1990
Pech de l'Azé I (F)	MTA	rock shelter	MIS-3	–	–	√	√	–	√	Anderson-Gerfaud 1990
Pech de l'Azé IV (F)	MTA	rock shelter	MIS-3	–	–	√	√	–	√	Anderson-Gerfaud 1990
Grotte XVI (F)	MTA	cave	MIS-4/3	19	√	√	√	–	–	Soressi and Hays 2003
La Graulet (F)	MTA	open-air	unknown	5	–	√	–	–	–	Claud 2008
La Conne de Bergerac (F)	MTA	open-air	unknown	5	√	–	–	–	–	Claud 2008
Combe Brune 2 (F)	MTA	open-air	unknown	5	√	–	–	√	–	Claud 2008
Fonseigner (F)	MTA	rock shelter	MIS-3	3	√	–	–	–	–	Claud 2008
Jonzac (F)	MTA	rock shelter	MIS-3	29	√	√	–	√	–	Claud 2008
St Brice sous Rânes (F)	other	open-air	MIS-3	15	–	√	–	–	–	Cliquet 2001
Lynford (UK)	MTA	open-air	MIS-4/3	1	–	–	√	–	–	Donahue and Evans 2012
Lichtenberg (G)	KMG	open-air	MIS-4/3	1	√	–	√	–	–	Veil *et al.* 1994
Sesselfelsgrotte (G)	KMG	cave	MIS-3	94	√	√	√	√	√	Rots 2009
Abri du Musée (F)	KMG	rock shelter	unknown	6	√	–	–	–	–	Coudenneau 2005
				186						

Table 3.2: *Overview of Late Middle Palaeolithic bifacial tools which have been subjected to use-wear studies and their inferred uses*

The best researched KMG site in terms of use-wear traces is Sesselfelsgrotte (Bavaria, Germany; Chapter 5). Rots (2009) recently studied around 690 pieces from the G-layers at this site (MIS-3) for use-wear traces. Amongst the bifacial tools projectiles, axes/adzes, hafted scrapers and knives were identified. An important aspect of her study is the identification that a significant proportion of bifacial tools from this site were hafted. In general, conclusive information about the mode of prehension of bifacial tools is rather sparse. It is generally assumed that many pieces were handheld and this would not leave behind any visible traces. The identification of the common practice of hafting of Late Middle Palaeolithic bifacial tools is therefore rather unique (Table 3.2) and more studies are needed to assess the extent of this phenomenon. The fact that some bifacial tools were hafted stands without doubt and there are indications that this was done with an adhesive (as indicated by the presence of pieces of birch bark pitch with imprints of a bifacial tool at the KMG site of Königsaue (Grünberg *et al.* 1999; Koller *et al.* 2001; Mania 2002).

2. MOBILITY

Another aspect of bifaces emphasised by many studies is their mobile nature – they seem to have been transported more between sites than any other tool type. This is inferred by the fact that on many sites, and especially in the late Middle Palaeolithic, the bifacial production chain was fractured both in time and in space. For example the presence of a handaxe on an exotic raw material of which no waste flakes are present, or the occurrence of sites with only biface thinning flakes and no actual handaxes, indicates that these handaxes were transported throughout the landscape (e.g. see Wragg Sykes 2009 for Late Middle Palaeolithic Britain). For the MTA transport of handaxes for over 60km has been reported (e.g. Abri Brouillaud and Pech de l'Azé I (Soressi and Hays 2003). The mobile nature of Neanderthal behaviour during the Late Middle Palaeolithic is further explored in Chapter 8 (section 8.4.2).

3. LONGEVITY

Although handaxes often seem to occur in very large numbers both in Lower (e.g. Boxgrove (ca. 400) and Middle Palaeolithic (e.g. Le Moustier (ca.250) contexts, the longevity of their use lives is generally accepted. Studies of reduction trajectories (e.g. McPherron 1995; Iovita and McPherron 2011) and use-wear traces (Claud 2008) have indicated the presence of several cycles of retouch and resharpening. Moreover it is clear that at the end of their use-lives handaxes could be re-used as different tools (as attested by the presence of scraper retouch or notches on their edges) or even as cores. The exact reasons behind the final abandonment of a handaxe are still poorly understood and it has been proposed that MTA handaxes from open-air sites are less reduced than their counterparts from caves and rock shelters, hinting at a link with site function (Turq 2000). For the KMG the different forms of *Keilmesser* have also been related to different stages in reduction and therefore extended use-lives (Richter 1997; Pastoors 2001; Jöris 2001 and 2006). The high mobility of bifacial tools, combined with this long use-life, has led to the interpretation of bifacial tools as curated objects.

4. CURATION

Binford introduced the concept of curation to Palaeolithic archaeology in the 1970's (Binford 1979). He used the term both in relation to the transport of artefacts and the efficiency of tool use. Overall the term is ill-defined and curation is now seen as a process rather than a fixed concept. The term curation will be used here as the process reflecting a tool's actual use relative to its maximum potential use (for a discussion see Andrefsky 2009). Tools can therefore have a high to low curation value. Indicators of curation are (Bamforth 1986):

- Production in advance of use
- Implementation of designs for multiple uses
- Transport to multiple locations
- Maintenance and recycling

At the other end of the spectrum is the notion of expedient tool technology. This implies the manufacture, use and abandonment of tools in the immediate context of their use. Hereby tools are manufactured and used at the same location, in a quick fashion to satisfy immediate need and without any consistent morphotechnical features.

In relation to late Middle Palaeolithic bifacial tools it is clear that they often exhibit a high curation value, as is illustrated by their high mobility and longevity as described above. A well-developed case study indicating the curated nature of MTA bifaces is the site of Grotte XVI (Soressi and Hays 2003). The bifaces from this site were studied in terms of raw material type and origin, technology and use-wear. The study showed that the bifaces were not manufactured from raw material originating at the site and that moreover the bifaces had been made elsewhere. It was also clear that they were not discarded immediately after use but rather had undergone successive stages of resharpening and use (Soressi and Hays 2003).The high curation potential of bifacial tools has furthermore led to the assignment of more subjective, symbolic, meanings to these tool types.

5. SYMBOLISM

It is generally accepted that the overall shape of a handaxe was intentionally created. The questions that remain are whether this intended shape can be related to social and/or symbolic behaviour. According to Wynn (1995) even if symmetry was sought after, handaxes cannot provide information about social behaviour. One of his arguments is the large chronological and geographical distribution of handaxe forms. Furthermore it has been suggested that even if handaxes contained behavioural information this is now obscured by modern day classifications (Clark and Riel-Salvatore 2006; Iovita 2009).

Other authors assign non-utilitarian factors to handaxes. This is triggered by the so-called Lower Palaeolithic '*biface enigma'* - the stylised form of a handaxe appears to be over-engineered to play merely a subsistence role (Wymer 1982). For example Byers (1999) sees handaxes as having a social function, namely as icons facilitating communication. Kohn and Mithen (1999) take this even further and suggest handaxes were sexual indicators, displaying the qualities of its maker. Although their theory is not supported by enough evidence from the archaeological record, the more general role of handaxes in visual display practices does have more supporters (Machin 2009; McNabb 2012b).

Furthermore the presence of extreme handaxes, such as giant specimens or *bout coupé*'s, has been used to imply that handaxes played more than just a utilitarian role (Wenban-Smith 2004). This idea was also developed by Mithen who sees handaxes as playing an important role in sexual selection (Kohn and Mithen 1999). For example the handaxe found at the Middle Pleistocene site of Sima de los Huesos (Atapuerca), named '*excalibur'*, has often been quoted as an example of symbolic meaning attached to a biface (Carbonell and Mosquera 2006). This handaxe was the sole artefact found in a pit with over 4,000 human remains, thus suggesting, but not at all proving, ritual deposition.

In contrast to the wide body of literature discussing the symbolic potential of Acheulean handaxes, literature discussing this in relation to Middle Palaeolithic bifacial tools is very sparse. Richter has stressed the presence of social memory units in which different traditions of handaxes making where passed on (e.g. MTA – KMG – Quina) (Richter 2000). In general, non-utilitarian roles of handaxes are difficult to prove and this is one aspect of which, especially in relation to the late Middle Palaeolithic more work is required. Overall it is important to realise that even if there is a form of social or symbolic meaning attached to a biface, in the first place it was intended to be an object to be used in subsistence/more utilitarian practices.

6. REGIONALISM

Several scholars have described the presence of regional differences among the characteristics of the Late Middle Palaeolithic bifacial tools. These regional trends have been linked to the first appearance in the archaeological record of regionalism or even a complex cultural geography (Richter 2000; Jöris 2004). *Regionalism* is defined here as the concept of being able to define a specific geographic region as one entity based on an unambiguous set of shared features, in this context stone tools, which make this region stand out from others.

The Western European **Lower Palaeolithic** (MIS-16 to MIS-9) is characterised by uniformity over a large geographical area (Santonja and Villa 2006 and references therein). Although differences exist between handaxe (Acheulean) and non-handaxe (Clactonian and microlithic) assemblages (White 2000; McNabb 2007; Fluck 2011a, 2011b) no regional patterning is present. Different handaxe forms can be distinguished (e.g. pointed versus ovate; Roe 1981) but overall no region-specific differences are identified.

Also for the **Early Middle Palaeolithic** (MIS-9 to MIS-5e), defined by the emergence of Levallois and decrease of bifacial technology (Scott 2011), no regional trends are identified within Western Europe. The record is characterised by a larger degree of lithic variability. For example assemblages can occur with or without Levallois, with or without handaxes and sometimes with specific technological features such as lateral tranchet blows (La Cotte de St Brelade, Callow and Cornford 1986). Another example of the lack of regionalism at this time period is how the British Early Middle Palaeolithic is largely undistinguishable from the contemporaneous continental record (Scott 2011).

It is not until MIS-5 that well-defined spatio-temporal entities occur in the record. The clearest example is the occurrence of blade technologies on sites in Northern France which can be linked to MIS-5a and are grouped in the ‘Northwestern technocomplex’. This phenomenon is both restricted to this time period and to this limited geographical area (Depaepe 2007; Goval 2008). Within the **Late Middle Palaeolithic** several of these entities can be identified (e.g. Vasconian, Quina Mousterian, MTA and KMG (Chapter 2)). This indicates that regionalism is a phenomenon that occurs for the first time in the western

European Palaeolithic record during the Late Middle Palaeolithic from MIS-5 onwards (and not from 60kya onwards as has been previously suggested (Mellars 1992, 1996).

This regionalism is further expressed throughout the final phase of the Middle Palaeolithic with the occurrence of several regionally defined 'transitional' industries such as the Châtelperronian (Southern and Central France; Pelegrin 1995; Bordes and Teyssandier 2011), Szeletian (Hungary, Svoboda 2001), Uluzian (Italy; Peresani 2008), Lincombian-Ransian-Jerzmanowician (LRJ) (Flas 2008) and Bohunician (Tostevin and Skrdla 2006). Regional differences and groups furthermore become the norm throughout the later phases of the **Upper Palaeolithic** with the emergence of a detailed cultural geography (Vanhaeren and d'Errico 2006; Otte and Keeley 1990; Gamble 1999 and references therein). This claimed emergence of regionalism in the Late Middle Palaeolithic record and the corresponding plethora of entities rich in bifacial tools are now reassessed based on the newly collected data and data available from the published literature.

While in general studies of Middle Palaeolithic variability have mainly focused on Southwestern France and the different proportions of unifacial tools, the concept of 'regionalism' within the Middle Palaeolithic is not completely new. Regionalism among lithic Middle Palaeolithic industries was already described and interpreted by Charles McBurney in the 1950s. He made a distinction between a western Mousterian concentrated in Southwestern Europe and an eastern Mousterian characterised by flat bifacial retouch (McBurney 1950). His ideas were further developed by The Cambridge School of Palaeoeconomy and nowadays several studies have hinted at a geographical zonation within Middle Palaeolithic bifacial tools (Rolland 1990; White and Jacobi 2002).

Regional studies focusing on the characteristics of the Middle Palaeolithic record within one geographically defined region, e.g. Mediterranean France (Szmidt 2003; Southwestern France (Turq 2000) have been widely applied. Although regional studies have proved to be a rich source of new data, few attempts have yet been made to create supra-regional syntheses of the Palaeolithic record. Regional studies are often inward-looking. Therefore similar dynamics are often evaluated from different perspective and consequently explained in rather different terms. This moreover precludes the analysis of patterns and dynamics in a supra-regional framework. Therefore looking at a known Palaeolithic record from a new perspective creates possibilities to come to a new understanding of the behavioural dynamics at the time period.

7. MIXING/HYBBRIDISATION

When tackling the concept of variability and discussing the occurrence of different stone tool industries on a macro-regional scale, the concept of the possible mixing of these industries needs to be discussed. Hybridity was originally a biological term but has become more and more common in the social sciences, including in archaeology. When classifying archaeological artefacts into groups or cultures, objects of ambiguous style are often put into a mixed category, sometimes called 'transitional' or 'hybrid'. *Hybridity* can be defined as the process in which discrete social practices or structures, which existed as separate entities, combine to generate new structures, object and practices in which the preceding elements mix. *Hybridisation* on the other hand is a more flexible term that includes processes of intercultural confluence (Garcia-Canclini 2001).

Despite the fact that other disciplines have actively explored, engaged, and critiqued the idea of hybridity, theoretical models in archaeology seldom address the issue of hybridity in material culture or what it means in terms of the cultural interaction that lead to production of the object (Chatfield 2008). Hybridity refers in its most basic sense to admixture (Garcia-Canclini 2001) and will also be used here in that sense. Therefore the terms hybridity and mixture will be used as synonyms throughout this PhD research.

The creation of hybrid material culture can be the result of a variety of processes, most often including the transmission of either ideas (acculturation) or people (demic diffusion) (Davies 2012). Moreover, hybrid zones can be formed where the ranges of two different groups meet/overlap. The hybridisation or mixing of Palaeolithic cultures or stone tool traditions has been an issue mainly discussed in regards to the potential contact between Neanderthal and AMH groups and the so-called Chatelperronian industry. Therefore the concept of hybridity has become a common part of the dialogue surrounding Neanderthal archaeology. In relation to Late Middle Palaeolithic bifacial tools, a Micoquian or *Keilmessergruppe* influence has been claimed for assemblages in Belgium and France and the 'mixed' nature of these assemblages is explored (Chapter 6/7) and interpreted (Chapter 8) further on.

3.4.3 Discussion

Ever since the onset of Palaeolithic archaeology many specialised studies have tried to unlock the behavioural information from bifacial tools. The so-called 'biface enigma' in which handaxes seem to be over-designed for their intended utilitarian task is still not solved. Moreover, it is clear that these bifacial tools were dynamic, curated objects with long use-lives and used for a variety of tasks though butchery and wood working appear to be the primary functions. These different functions and uses further influenced biface morphologies and help explain why a large variability of shapes and sizes of bifacial tools are present in the Palaeolithic archaeological record. The different potential glimpses bifacial tools provide into Neanderthal behaviour are further explored in Chapter 8 based on the newly collected data on the bifacial technology of the Late Middle Palaeolithic period.

3.5 A New Multi-scalar Framework

3.5.1 Introduction

An understanding of scale is central to recording and interpreting archaeological patterns. Researchers invariably sample, aggregate, and then generalise across the archaeological record in order to understand the past. Within archaeological studies there is a growing awareness of the role of analytical scale and its influence on archaeological interpretations (Stein 1993; Gamble 1999; Mathieu and Scott 2004a; Lock and Molyneaux 2006a; Koehler 2009, 2011). Analytical scale is hereby defined as the "*scales of analysis used by a research project in terms of its spatial, temporal and formal dimension*" (Spaulding 1960). It is envisaged that by applying different scales of analysis within a research project it is possible to come to a better understanding of the limitations of traditional interpretations, complement these with new interpretations and better appreciate the role of these analytical scales (Mathieu and Scott 2004b).

In this section the definitions and possibilities of different scales of analysis are presented. Further a three-fold model is designed to allow for a more comprehensive and integrative understanding of Neanderthal behavioural variability based on the Late Middle Palaeolithic bifacial tool data that is collected throughout this PhD study.

3.5.2 Exploring scales of analysis

Geographers have been actively engaged with researching scales of analysis for a long time and their theoretical concerns are equally relevant to archaeology (Harris 2006). Moreover the explicit discussion or theorisation of scale is not recent in archaeology (Spaulding 1960). Issues related to the definition and application of different scales of analysis are continually under discussion both in relation to general archaeology (Mathieu and Scott 2004a; Lock and Molyneaux 2006a) and more specifically to the Palaeolithic (Gamble 1999; Koehler 2009).

In this study, the analytical scale refers to the size of the unit selected by a researcher to gain the necessary information to analyse a certain research problem. This includes the size of the units in which phenomena are *measured* and the size of the units in which measurements are *aggregated* for data analysis (Montello 2001). For this PhD the former is always the bifacial tool, but the latter can vary. Moreover scales of analysis can differ both horizontally (through space) and vertically (through time) (Mathieu and Scott 2004b; Gosden and Kirsanow 2006).

In geography small-scale relates to large geographical areas and large-scale to small geographical areas (Montello 2001; Lock and Molyneaux 2006b); in archaeology, and also in this thesis, the terminologies are reversed, with small-scale relating to small things (Lock and Molyneaux 2006b); stone artefacts in specifics in case of Palaeolithic studies. In general, the concept of analytical scale comprises two important complementary components: extent and resolution. *Extent* relates to the overall scope of the study and its maximum limits in terms of the size of the spatial area or time span (Mathieu and Scott 2004b; Lock and Molyneaux 2006b). Conversely, *resolution* indicates the smallest, consistently discernible unit available for study (Stein 1993; Mathieu and Scott 2004b; Lock and Molyneaux 2006b). So resolution relates to the fine or coarse-grained nature of the data. The application of different scales of analysis to the archaeological record comes with several analytical issues which must be taken into account:

- **Standardisation**: the need to merge and integrate various types of data captured at a variety of scales into a coherent form in order to obtain the necessary data for the analysis (Harris 2006). Moreover Palaeolithic artefacts and assemblages are often grouped in different ways based on different criteria (Koehler 2009) further obscuring comparisons (see also Chapter 7).

- **Linkage**: the need to link results obtained at one scale of analysis to those obtained at another (Harris 2006). How can the analysis of sets of small-scale data lead to the understanding of larger units of analysis, and especially relate to the long, thin archaeological record from which so much has been lost?

- **Generalisation**: the need to compress detailed information to obtain a more generalised view of the archaeological record. The movement from archaeological material information to processed data to knowledge always requires an enormous scalar compression in time and space. Researchers should be aware that generalisations about archaeological patterns at one scale of analysis might not hold true at different ones (Haggett 1994). Although generalisations are often paired with loss of detail they should not simply be equated to loss of information. Creating a generalised view of the archaeological record can also add information by creating the ability to display the features from a larger analytical unit.

An awareness of these interpretive issues is needed when choosing the right scale of analysis to answer a specific research question. The selected analytical scale has the potential to determine and channel the interpretations made (Mathieu and Scott 2004b). This observation that different interpretations of the same archaeological material can be made according to the scale of analysis applied has also been highlighted in relation to Middle Palaeolithic assemblages. Richter for example concluded that the assemblages from the Sesselfesgrotte could be assigned to different industrial Middle Palaeolithic variants based on different categorical scales, either the unifacial or bifacial tool component (Richter 1997; Chapter 2). The problems inherent to analysing, comparing and interpreting this cluster of different scales of analysis and different units of analyses has been labelled by Koehler as the '*Mousterian cultural impasse*' (Koehler 2009); Why are the mechanics that underlie Mousterian variability in general and the occurrence of different groups or trends more specifically still not clearly understood? This is an observation and query that also stands central in this thesis.

To overcome the risk of biasing the archaeological interpretation by using just one scale of analysis, for this PhD study a three-fold multi-scalar framework was created which allows the Late Middle Palaeolithic bifacial tool data to be analysed in various ways, matching up the different research questions (Chapter 1).

3.5.3. A multi-scalar framework for the study of Late Middle Palaeolithic bifacial tools

The overview in this chapter of past research, current interpretive frameworks and potential behavioural inferences in relation to Late Middle Palaeolithic bifacial tools has led to the realisation that looking at this archaeological record from various analytical scales, including various resolutions and extents, is the best way to enhance our current understanding of the research problem.

The scalar extent of this PhD study comprises a rather extensive temporal and spatial dimension. The temporal range relates to assemblages that can be chronologically positioned between MIS 5d and 3; covering approximately an 85,000 year time span. The spatial scope includes the whole geographic area of Western Europe. The scalar resolution relates to the study of bifacial tools, an internally very variable tool type, as highlighted already throughout Chapter 2. Because of the large geographical and chronological extent of this study and the variable nature of the artefact type, the scale from which this data is examined will influence the interpretations made. The data analysed throughout this PhD is therefore approached from three aggregative scales and accordingly different results, patterns and interpretations are deduced (Table 3.3). The characteristics, potential, advantages and disadvantages of each of these scales of analysis are briefly discussed:

- *Micro-scale (individual and local)*

The micro-scale of analysis comprises both a very fine and fine-grained component. From the very fine scale of analysis the focus is on the individual bifacial tools, their individual attributes and the differences amongst them. The fine scale looks at the differences between aggregates or assemblages of bifacial tools. It allows defining and comparing the characteristics of individual assemblages, portraying the archaeological record from a detailed and local perspective.

- *Meso-scale (regional)*

When looking at the bifacial tools from a medium or meso-scale of analysis comparisons between aggregates or groups of assemblages are made. Assemblages are grouped into regions and differences and similarities between regions are explored. Fine-grained differences between individual tools and assemblages are lost but wider trends across and between assemblage groups and regions can be identified.

– *Macro-scale (macro-regional and global)*

The macro-scale entails looking at both the macro-regional and global perspective. It looks at differences between large-scale regions, macro-regions (Text box 1.1), as well as world-wide trends. For example, at this coarse-grained level the Mousterian can be seen as a rather homogenous entity, characterised by generic knapping techniques (such as discoidal and Levallois) and flake tools (such as scrapers, notches and denticulates). This macro-view is indispensable because it can identify larger-scale behavioural trends but also obscures a large amount of finer grained detail.

Scale	Unit	Resolution		Extent	
micro	LMP bifacial tools	very fine	the individual bifacial tool	MIS 5d-3	local
		fine	the assemblage		
meso	LMP bifacial tools	coarse	groups of assemblages	MIS 5d-3	regional
macro	LMP bifacial tools	very coarse	larger over-arching entities	MIS 5d-3	macro-regional and global

Table 3.3: *Overview of characteristics of the three different scales of analysis used in this PhD study, the unit studied, the scalar resolution and the scalar extent (both temporal and spatial)*

These three different scales of analysis (Table 3.3) are consistently applied to the primary Late Middle Palaeolithic bifacial tool data throughout this PhD (Chapter 6 and 7). Their relation and relevance to the research questions set out in Chapter 1 are presented in detail in Chapter 8. Overall, analysing and interpreting the Late Middle Palaeolithic bifacial tool record from these three different scales of analysis will allow to come to a more in-depth understanding, characterisation and interpretation of the variability patterns observed throughout this PhD study.

3.5.4 Discussion

Recently within archaeology there is a growing realisation that the interpretation of artefact variability is affected by the scale at which the data is analysed. Despite a long history of Palaeolithic research, there is still no satisfactory, comprehensive explanation available for all the patterns of lithic variation observed in the Middle Palaeolithic record. In my opinion, looking at the archaeological record from different resolutions or scales can enhance our understanding of this Middle Palaeolithic variability. By evaluating the data collected through this PhD from three different analytical scales it is aimed to overcome this interpretive constrain. This will achieve a more wide-ranging understanding of the causal factors at play in regards to Late Middle Palaeolithic bifacial tool variability and their potential implications for Neanderthal behaviour.

Finally, it is vital to acknowledge that every attempt to apply structure to patterns of variability recognised in the archaeological record requires a degree of simplification or condensation of the original data. This together with the coarse-grained nature of the Palaeolithic record, results in a level of generalisation regarding variability and it should be at the forefront of researchers' minds that new discoveries and new analyses and techniques could potentially alter current interpretations.

3.6 Summary

Throughout this chapter studies of stone tool variability and bifacial tools were contextualised. Firstly, the 'Past Research' section illustrated how bifacial tool research has its roots in studies of archaeological variability. To study, compare and interpret the Palaeolithic record, it is necessary to structure it in a systematic way. Our current units of analysis, the different tool types and taxonomic entities, have been defined in the beginning of the 20th century. Because of their enigmatic nature, bifacial tools, and especially handaxes, have played a crucial role in these classificatory schemes. Although both the classification into tool types and industrial variants can be critiqued (Bisson 2000, Richter *et al.* in press) for comparative purposes their use cannot be avoided. Therefore, the historically defined typological and industrial subdivisions will also be used throughout this PhD. Moreover, this PhD research has roots in the culture history approach, adopts methods of the processual school and aims to make behavioural interpretations in line with post-processualism.

Secondly, the 'Current interpretive frameworks' section showed how ideas and interpretations of Middle Palaeolithic variability have evolved and how the debate is still on-going. It was illustrated how studies focusing on bifacial tools and larger-scale, pan-European comparative analyses are needed to add new perspectives to this debate. In general, a distinction can be made between explanations referring to adaptive factors and ones discussing social transmission and culture. Both these concepts will be applied to the Late Middle Palaeolithic bifacial tool data in Chapter 8.

Thirdly, it was discussed how the enigmatic nature of bifacial tools led to a plethora of potential behavioural inferences. Previous use-wear, experimental, technological and typological studies have indicated that bifacial tools were highly mobile, curated tools with long use-lives, used for a variety of activities and their exact characteristics can vary regionally. Not all these inferences have been profoundly tested in relation to the Late Middle Palaeolithic and this achieved throughout Chapters 6 and 7.

The final section of this chapter was dedicated to the notion that variability patterns can be approached from a variety of analytical scales and that the selected scale has consequences for the archaeological interpretations. It was discussed how this PhD will add to the debate of Middle Palaeolithic variability by looking at bifacial tools through a three-fold multi-scalar approach. Variability patterns are assessed and analysed at a micro, meso and macro-scale of analysis to comprehensively understand causal factor and behavioural implications (Chapter 8).

Chapter 4:

Methodological Framework

4.1 Introduction

This research aims to assess the variability among Late Middle Palaeolithic bifacial tools in Western Europe. To achieve this, a novel two-fold methodological framework was created providing links between the theoretical concepts (Chapter 3), the research questions (Chapter 1) and the archaeological record (Chapter 2 and 5). The objective of this methodology is to assess the genuine nature of the MTA/KMG dichotomy (Research Question 1), the typo-technological characteristics underlying the MTA/KMG patterning (Research Question 2) and the spatial and temporal differences amongst the Late Middle Palaeolithic bifacial tools (Research Question 3). Furthermore, the data gathered using this methodological framework will add new information to our knowledge of Neanderthal behaviour in general (Research Question 4). This novel methodological approach is presented in detail in this chapter and comprises two main facets:

1. A new classificatory scheme for Late Middle Palaeolithic bifacial tools
Firstly, to facilitate an over-arching, pan-European study of Late Middle Palaeolithic bifacial tools it was necessary to unravel the abundance of existing terminologies and typologies (see also Chapter 2). A new simplified classificatory scheme was developed through a detailed literature review of the terms and types used in the five countries of the study area and in its four main languages. The new framework consists of five principal typological categories (classic handaxes, bifacial scrapers, partial bifaces, backed and leaf-shaped bifacial tools), which incorporate all the existing bifacial terms and types. The advantage of this framework is the facilitation of larger-scale comparisons through the removal of past epistemological confusion. Furthermore it provides the opportunity to reclassify assemblages based on information from published site reports (Chapter 7).

2. Primary data collection using a detailed attribute analysis
Secondly, to assess the presence of genuine differences and similarities among Late Middle Palaeolithic bifacial tools new primary data was collected to enable comparisons in a systematic, uniform way. Based on an extensive review of the Late Middle Palaeolithic archaeological record (see Chapter 5) 14 assemblages were selected to form a sample representative of the bifacial tool variability across the study area. 1,303 bifacial tools from these 14 key sites were analysed by recording 22 typo-technological attributes. These attributes were selected to provide comparative information about the condition, technology (including raw material), measurements and typology of each bifacial tool (Chapter 6).

Combined, these two methodological approaches will provide a large set of typo-technological data which can then be further analysed and compared. This new two-fold methodological approach is detailed in this chapter and will provide the first systematic assessment of variability among Late Middle Palaeolithic bifacial tools from a pan-European perspective.

4.2 Late Middle Palaeolithic Bifacial Tools: Terminologies and Typologies

4.2.1 Unravelling previous classificatory schemes

Bifacial tool classification is based on a mix of standardised measurements, calculated ratios, and morphological characteristics such as outline and edge shape (Bordes 1961; Debénath and Dibble 1991). This research will bridge knowledge from diverse geographic areas and is complicated by the fact that differing research traditions have been at play. In many instances, this has resulted in the use of different terms, in different languages, and of varying typological frameworks to describe, classify and group bifacial tools (see Chapter 2).

In the 1960's two comprehensive studies of Middle Palaeolithic assemblages led to the creation of two typological frameworks which are still widely used today. Firstly, François Bordes created a list with 63 Middle Palaeolithic tool types based on the type and location of the retouch and the overall outline shape of the tool (Bordes 1961). Furthermore he subdivided handaxes into several distinct morphological categories (e.g. triangular, cordiform, ovate and amygdaloid) based on their morphometric characteristics. Although some aspects of Bordes' methodology have been criticised (Bisson 2000), his method has been, and still is, widely applied to Middle Palaeolithic assemblages in France and its surrounding areas. Secondly, and in contrast to the Bordean typology that focused on Southwestern France, Gerhard Bosinski analysed the Middle Palaeolithic assemblages from Central Europe and created his own type list (Bosinski 1967). He defined over 14 bifacial tool types which commonly occur in Central Europe and include different forms of handaxes, *Faustkeilblätter* and *Keilmesser*. His typological framework is most commonly used throughout Central and Eastern Europe.

In addition to these two main Middle Palaeolithic typological frameworks, several local terms and types were defined, often in local languages, to stress the occurrence of distinct bifacial tool forms in the local Middle Palaeolithic record. Over the last five decades this has created a dense cloud of different terms and types and currently over 25 different types of Late Middle Palaeolithic bifacial tools are frequently used in the Western and Central European literature (Bordes 1960; Bosinski 1967; Debénath and Dibble 1991; Jöris 2005, 2012; Richter 1997; Koulakovskaya *et al.* 1993).

A comparison of data from published site reports quickly highlighted the epistemological confusion that surrounds these Late Middle Palaeolithic bifacial tool types. Firstly, similar tool types have different names in different languages and it is often difficult to identify which terms should, or should not, be seen as synonyms. Secondly, a single term can be defined in different ways and is therefore used in relation to various tool types in different research traditions. For example the term '*prodnik*' has been used in several conflicting ways in Eastern, Central and Western Europe (see Chapter 2). Thirdly, the quality of the site reports varies and authors often put bifacial tools into categories without clearly defining them. Some scholars also use generic categories such as ‘other bifacial tools’ or ‘bifacial scrapers’ without specifying what their classification criteria are. Overall, a disjointed view currently exists in relation to the differences between Late Middle Palaeolithic bifacial tools.

4.2.2 A new classificatory framework

To be able to conduct a macro-regional comparative study of Late Middle Palaeolithic bifacial tools it was necessary to unravel these different terminologies and typologies. In my opinion, a point has now been reached where these local terms and types are preventing larger-scale comparisons and are risking masking genuine archaeological patterns. Therefore, it was decided to group together several bifacial tool terms and types through a detailed study of the characteristics of the plethora of existing types. Based on data from both the available literature and new primary analyses of collections, five main bifacial tool categories were defined which have distinct diagnostic features such as outline shape, extent of retouch, cross section and presence of a back. These five categories are:

1. ‘Classic’ handaxes
2. Backed bifacial tools
3. Leaf-shaped bifacial tools
4. Bifacial scrapers
5. Partial bifaces

Each of these categories is defined by a combination of technological and typological attributes, including the location and extent of the retouch, the number of cutting and backed edges, the cross section of the piece and its overall outline shape (Table 4.1). All five categories can be seen as distinct tool concepts. Within each concept there is a lot of morphological variation, hence so many terms and sub-types have been created.

	Retouch extent	**Retouch location**	**Cross Section**	**Outline shape**	**Cutting Edge**	**Back**
Classic Handaxes	covering	bifacial	biconvex or planoconvex	variable, convergent point	2	no
Backed Bifacial Tools	variable	bifacial	wedge-shaped	variable, asymmetric back	1 or 2	yes
Leaf-shaped Bifacial Tools	covering	bifacial	at least partly biplano	at least partly leaf-shaped	2	variable
Bifacial Scrapers	short or long	bifacial	variable	variable	1 or 2	variable
Partial Bifaces	covering	variable	biconvex or planoconvex	variable, convergent point	2	variable

Table 4.1: *Overview of the five bifacial tool categories and their main typo-technological characteristics*

These five tool concepts incorporate all 25 commonly used bifacial tool types and their regional variants (Table 4.2). These categories were specifically chosen to provide broad definitions; therefore, it is not impossible that in the wide range of bifacial variability transitional forms exist and their classification in the scheme would be rather subjective. These transitional forms were rare in the assemblages analysed here, can be seen as exceptional, and would not fundamentally alter the overall typological composition of an assemblage. In general, each of the five bifacial tool concepts does have several distinct features that make their identification rather straightforward. Importantly, the broader and simplified definition of these categories allows for larger scale comparisons between both assemblages and geographic region. Moreover, with this simplified scheme, assemblages that have previously been recorded using the major Bordean, Bosinski or local typologies can easily be reclassified, facilitating further assessments of similarities and differences.

	Incorporated tool types
Classic Handaxes	(sub)triangular, (sub)cordiform, dicoidal, ovate, lanceolate, amygdaloid and bout-coupe handaxe, limande, ficron and fäustel
Backed Bifacial Tools	Klausennische, Bockstein, Königsaue, Pradnik or Ciemna, Balve, Lichtenberg and Buhlener Keilmesser
Leaf-shaped Bifacial Tools	leaf-shaped scrapers, Faustkeilblätter, leaf points
Bifacial Scrapers	all types of bifacially worked scrapers, including Quina scrapers
Partial Bifaces	Uniface and Halbkeile

Table 4.2: *Overview of the existing bifacial tool types and their incorporation into the new five-fold scheme for Late Middle Palaeolithic bifacial tools created for this PhD*

These five main bifacial tool categories, and the different tool types they comprise, are presented and defined in detail below, including their common name in respectively English (in bold), French, German and Dutch.

1. CLASSIC HANDAXES

Handaxes are one of the formative tool types of Palaeolithic archaeology (see Chapter 3) and have been described and discussed since the 1800's (Text box 1.1). Consequently, several definitions have been proposed. For this study a 'classic' handaxe is defined as:

a bifacially worked tool with two converging lateral cutting edges and a variable symmetric outline shape

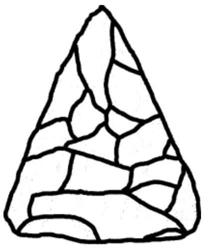
They can be made both by formshaping (façonnage) or on struck flakes (debitage) and therefore their cross section can vary, although biconvex and planoconvex types are most common. A lot of variability exists with regards to size and shape, and based on metrical criteria several subtypes have been defined (Bordes 1960; Roe 1981; Wymer 1985; Ashton and McNabb 1994; McNabb and Rivett 2007).

Below is an overview of eight subtypes of classic handaxes which occur in the Late Middle Palaeolithic record (definitions are summarised from Bordes 1960; Bosinski 1967; Debénath and Dibble 1991 and White and Jacobi 2002).

Triangular and subtriangular handaxes

(biface (sub)triangulaire; (sub)dreieckige Faustkeil; (sub)driehoekige vuistbijl)

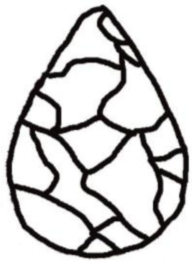
<u>Triangular</u>: straight base, straight or slightly convex lateral edges.
<u>Subtriangular</u>: more rounded base, lateral edges slightly convex, concave or straight.



Cordiform and subcordiform handaxes

Aka cordate of heart-shaped handaxe (biface (sub)cordiform; (sub)herzförmige Faustkeil, (sub)hartvormige vuistbijl)

<u>Cordiform</u>: rounded base, lateral edges very convex, distal end pointed or slightly rounded.
<u>Subcordiform:</u> thicker and more cortex



Discoidal handaxes

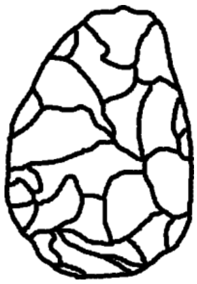
(biface discoïde; discoid Faustkeil, discusvormige vuistbijl)

Covering retouch on both faces and a more or less circular outline.

Ovate handaxes

(biface ovalaire, oval Faustkeil, ovale vuistbijl)

Elongated, rounded tip and base, clearly convex edges.



Lanceolate handaxes

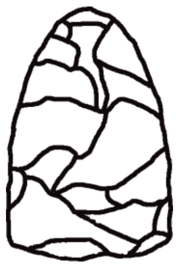
(biface lancéolé, lanzen- or lanzettförmige Faustkeil, lansvormige vuistbijl)

Thick base, often with a cortex remnant, and an elongated slender point. If the lateral edges are both concave it is a 'Micoquian' biface.

Bout coupé handaxes

(flat-butted cordiform; *bout coupé* is used in all languages)

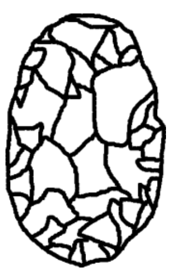
Symmetrical cordiform handaxes with a straight or slightly convex base and two clear angles formed at the intersection of the butt and lateral margins.



Limande

(the term limande is used in all languages)

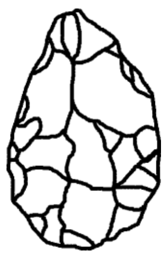
Thin, two rounded extremities and straight lateral edges.

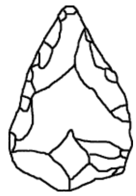


Amygdaloid (almond-shaped) handaxe

(biface amygdaloïde, mandelförmige Fautkeile, amandelvormige vuistbijl)

Thick cordiform handaxe



Ficrons (ficron is used in all languages)  *Lanceolate biface but the edges are less carefully worked*	**Faüstel** (this is only a separate tool category in the German-speaking wold)  *Small handaxes (<6cm) that occur in a variety of shapes*

2. BACKED BIFACIAL TOOLS

The term 'back' refers to a thick, blunt part on a stone tool (Fig. 4.1). Backed bifacial tools are known under a variety of terms, including: handaxe side-scrapers, scraper bifaces, *bifaces-racloir*, *Faustkeilschaber*, backed bifaces, *bifaces à dos*, *Keilmesser* and *prondnik*. Backed bifacial tools are defined here as:

> *a tool of which some of the edges are worked and some of the edges have a natural or truncated back, creating the opposition between a worked cutting edge and a thick, blunt edge*

With regards to the Late Middle Palaeolithic backed bifacial knives (*Keilmesser*) are the main representative of this category. A back is inherent to the concept of a *Keilmesser*. The main characteristic of these artefacts is the presence of a back opposite a sharp cutting edge which has been bifacially retouched (Jöris 2012; Fig. 4.1). Another characteristic is their common resharpening with lateral tranchet blows, the so-called para-burin or *pradnik* technique (Jöris 1992, 1994, 2012).

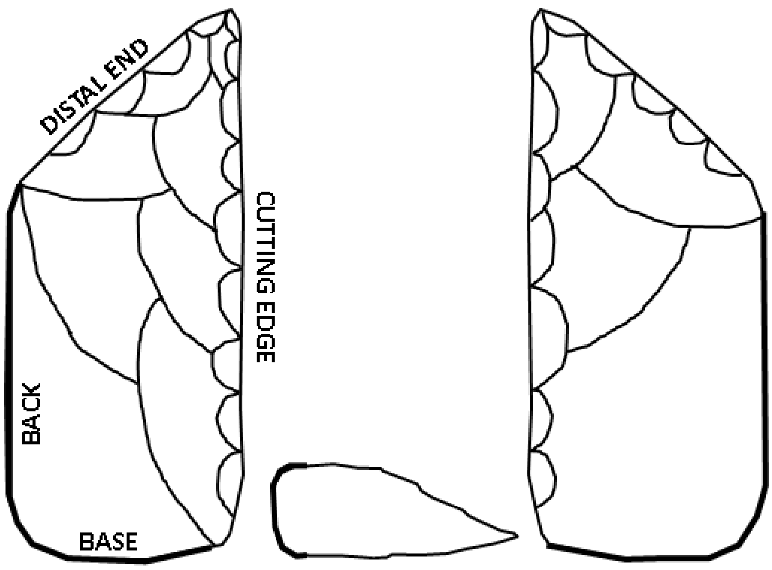
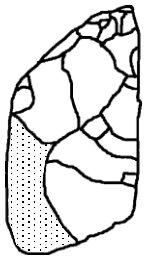
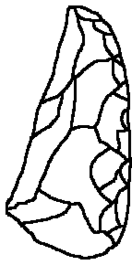
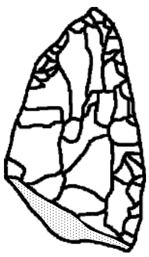
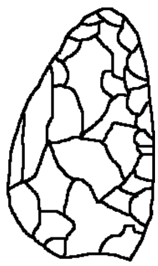
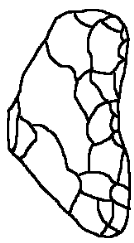


Fig. 4.1: *Schematic outline of a backed bifacial knife or Keilmesser with identification of its different areas*

Sometimes the distal end of the back of the *Keilmesser* is retouched into a second sharp edge which converges with the lateral cutting edge. The cross-section of these bifacial tools is triangular or wedge-shaped ("*Keil*" in German; Fig. 4.1). These backed bifacial knives vary in size but are generally less than 15cm long (Jöris 2012). Based on the position of the back and the configuration of the distal end, several sub types have been defined. They are named after German sites and therefore do not have synonyms in other languages. Only the term bifacial knife is translated as '*couteaux bifaciaux*', '*couteaux-racloirs bifaciaux'* or '*bifaciaal geretoucheerd mes*' and then the type site is added (e.g. *couteaux bifaciaux de type Bockstein*). The seven main subdivisions are presented below and definitions are based on Bosinski 1967, Koulakovskaya *et al.* 1993, Veil *et al.* 1994, Richter 1997 and Jöris 2002, 2006, 2012).

Klausennische messer *Backed edge parallel to the retouched edge and distal end is oblique to the axis of the piece.* 	**Bocksteinmesser** *Straight backing that extends to the distal extremity where it converges with one single cutting edge* 
Königsaue Keilmesser (or Wolgograd type) *Small backing in the proximal one-third of the piece, while the distal end resembles a leaf point* 	**Lichtenberger Keilmesser** *Convex back in lower half of the piece, elsewhere covering retouch and cutting edges form rounded distal end.* 
Balver Keilmesser (Tata type) *Trapezoidal shape, back is transverse, truncated, partly natural and partly thinned by retouch, base can be retouched or natural.* 	**Pradnik or Ciemna messer** *One straight cutting edge opposite a thicker blunt edge, a slightly convex tip of which lateral tranchets are removed.* 
Buhlener Keilmesser *Angular shape, back taking up complete lateral edge and thinned by the removal of one single large flake.* 	

3. LEAF-SHAPED BIFACIAL TOOLS

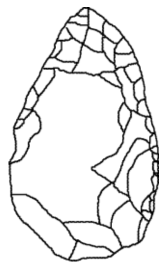
In the category 'leaf-shaped bifacial tools' a variety of artefacts are present, including *Faustkeilblätter*, leaf-shaped scrapers and leaf points. Defining tool traits include:

> *"flat, covering bifacial retouch on at least part of the tool and an outline shape that completely or partially resembles a leaf"*

Three main subtypes can be further distinguished, definitions are based on Bordes 1960, Bosinski 1967; Debénath and Dibble 1991; Bolus 2012).

Faustkeilblätter

(biface feuille, leaf-shaped handaxes, bladvormige vuistbijl)



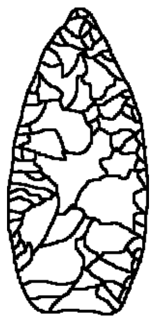
Thin, well-made point opposite a blunt often unworked base, distal point resembles a leaf point and often has one face only partially retouched. Includes several subtypes: large (breite), narrow (schmale) and small asymmetric (kleine asymmetrische) Faustkeilblätter

Leaf-shaped scrapers

(Faustkeilschaber, bladvormige schrabber)

Flat bifacial retouch, ovate outline with two rounded extremities (no point) and two convex cutting edges opposite a more blunt side. Very strict definition.

Leaf points (bifacial foliates, pointes foliacées, Blattspitzen, bladspitsen)



Elongated, thin, symmetrical, often bifacially worked, leaf-shaped, with at least one end pointed, biconvex or biplane section. Very wide definition.

4. BIFACIAL SCRAPERS

Bifacial scrapers are also known as '*racloirs à retouche bifaciaux*', '*bifaciaal geretoucheerde schrabbers'* and '*bifazielle schabers'* and are defined as:

> *"artefacts with regular, continuous, bifacial retouch along one or more edges"*

The outline shape of the tool can be irregular and the shape, extent and location of the retouch varies (Debénath and Dibble 1991). The bifacial retouch can be short or long but does not cover the whole surface of the tool. This category includes bifacially retouched Quina scrapers, characterised by steep scalar retouch (Fig. 4.2; for a description of the Quina Mousterian see Chapter 2).

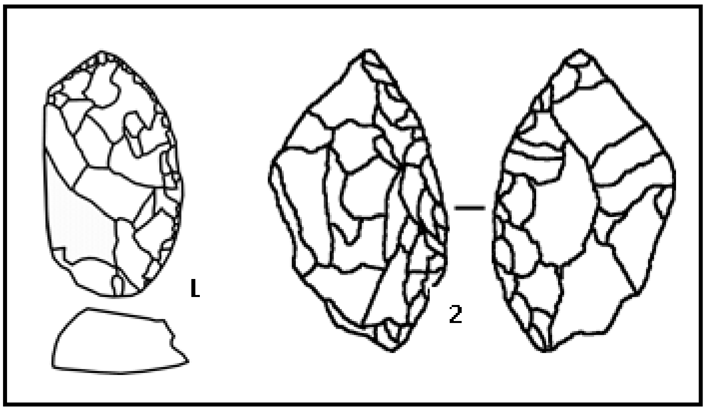


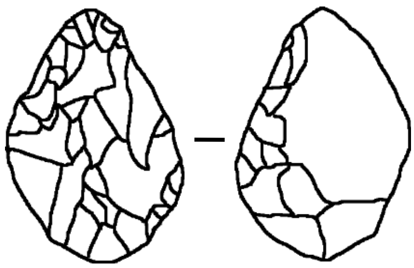
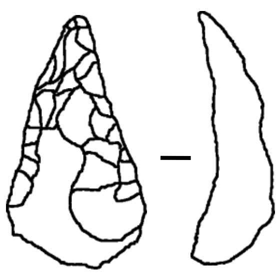
Fig. 4.2: *Examples of bifacial scrapers; **1.** Quina scraper with steep bifacial retouch; **2.** Bifacial scraper with convex cutting edge*

5. PARTIAL BIFACES

Partial bifaces, which are also known as '*biface partiel*' and '*deels bewerkte vuistbijl*', are described by Debénath and Dibble (1991) as:

> *"artefacts which exhibit covering retouch but have significant unretouched areas on one or both their surfaces"*

They differ from bifacial scrapers by the invasiveness of the retouch and moreover they often have regular shapes which can be related to classic handaxe forms (see above). In this research the category partial bifaces includes two main categories, unifaces and Halbkeile (definitions based on Bordes 1960 and Bosinski 1967).

Uniface	**Halbkeile**
One surface almost entirely retouched and shape is modified into a classifiable form (e.g. cordiform)	*One face is flat, often concave, and only roughly worked. The other face is vaulted and more intensely retouched.*
	

With this new five-fold classificatory framework assemblages which are described by different academic traditions can be more easily compared, especially on a wider macro-scale. It is acknowledged that further internal variability exists within each of these bifacial tool categories. Therefore, more detailed typo-technological studies will also be applied to the Late Middle Palaeolithic bifacial tools record, using detailed attribute analyses (section 4.3.2), especially in relation to analyses at the meso or micro-scale (Chapters 6 and 7).

4.3 Data Collection Procedures

Late Middle Palaeolithic bifacial tools have been described and published in various ways, mainly in relation to differing typological frameworks used by different research traditions (see section 4.1). Comparing assemblages across research traditions, linguistic and geographic boundaries is therefore hindered by various epistemological problems, relating to the way these tools were defined and classified. Based on the new classificatory scheme (see section 4.2) bifacial tools can be reclassified based on information gained from detailed site reports. However, because of the differing quality of these publications, and the potential loss of a certain amount of detail when applying this simplified scheme, new data was also collected. This primary data collection will allow a more in-depth comparison of bifacial tools. Firstly, this section describes the aims and structure of the comprehensive bifacial tool sample and the selection criteria for the individual sites. Secondly, it outlines in detail the attributes which have been recorded for each individual Late Middle Palaeolithic bifacial tool and how the recorded information relates back to the research questions.

4.3.1 Site selection criteria

Within the broad chronological (Late Middle Palaeolithic) and geographic (Western Europe) range of this PhD, a vast number of assemblages contain bifacial tools (see Chapter 5). A representative sample of these sites was constructed, aimed at incorporating all the variability present in Western Europe. Moreover, a strong focus on the lesser understood aspects of the record, both in terms of geographical distribution and techno-typological composition, was applied. Therefore, the sample:

- Includes assemblages from all areas of the study area (Britain, Germany, The Netherlands, Belgium, Northern and Southern France).
- Focusses specifically on the region between the MTA and KMG core areas (Britain, Netherlands, Belgium and Northern France).
- Comprises examples of all the main Late Middle Palaeolithic entities rich in bifacial tools (MTA, KMG, Mousterian with bifacial tools, Mousterian with bifacial retouch, Mousterian with small bifaces and the entities with a mixed or KMG influence).
- Focusses on assemblages that have been problematic in past classification schemes because they contain an unusual mix of bifacial tool types or fall outside the accepted distribution range of the entity.

In terms of individual collections, preference was given to assemblages that were:

- recovered using modern excavation techniques;
- originate from a secure stratigraphic context;
- contain a relative large number of bifacially worked tools;
- are chronologically secure;
- are well-published.

Despite the abundance of Late Middle Palaeolithic sites, there are still considerable problems with the record, especially in relation to contextual chronostratigraphic data. This is related to both the coarse-grained nature of the Middle Palaeolithic record and the fact that many assemblages were not recovered during modern, systematic excavations. Therefore, several assemblages that fit the majority of the sample prerequisites had to be excluded on closer examination. This was due to concerns about their origin, recovery method, chronological and/or stratigraphic context. This brought into question the homogeneity of key material from the sites of for example Sainte Walburge, Spy, La Micoque and Mont de Beuvry. Moreover, it was decided that the selected assemblages needed to be of big enough size so the collected data is statistical significant and allows for meaningful comparisons between collections. It was decided that the minimum of bifacial tools available for analysis has to be 20. This excluded several smaller assemblages, especially in Belgium and the Netherlands; e.g. Kesselt, Vollezele, Mesch-Mescherheide and Etten-Leur.

In total 14 individual sites were included in the Late Middle Palaeolithic bifacial tool sample (Fig. 4.3 and Table 4.3). For each geographic area the assemblage(s) that provide the best representation of the local variation in bifacial tools, in combination with the securest stratigraphic and chronological context, were selected. A brief description of each site is presented below and full detailed description can be found in Chapter 5.

1. GERMANY

Germany is rich in Late Middle Palaeolithic bifacial tools, especially in relation to the *Keilmessergruppe* entity, and this is represented through the study of two sites:

Königsaue: this assemblage was included as an example of a classic KMG site. Although not very large, this open-air locality has the advantage of being excavated using modern techniques and coming from a secure stratigraphic position.

Sesselfelsgrotte: additionally, to comprehensively understand the variability present within the German Late Middle Palaeolithic the large sample of diverse bifacial tools from the well-understood G-layers of the cave of Sesselfels was selected.

2. BRITAIN

The British Middle Palaeolithic record mainly consist of stray finds and small assemblages, one main site rich in bifacial tools is known and included for detailed study:

Lynford: the open-air site of Lynford was discovered in 2002 and provides the largest and best contextualised Late Middle Palaeolithic site in Britain. It has been assigned to the MTA because of the presence of a numerous classic handaxes, including *bout coupé* types.

3. THE NETHERLANDS

The Dutch Middle Palaeolithic record is complex with a scarcity of large well-contextualised assemblages (see chapter 5); because of the crucial location of this area, on the crossroads between the MTA and KMG core areas, it was decided to include the largest Middle Palaeolithic surface collection:

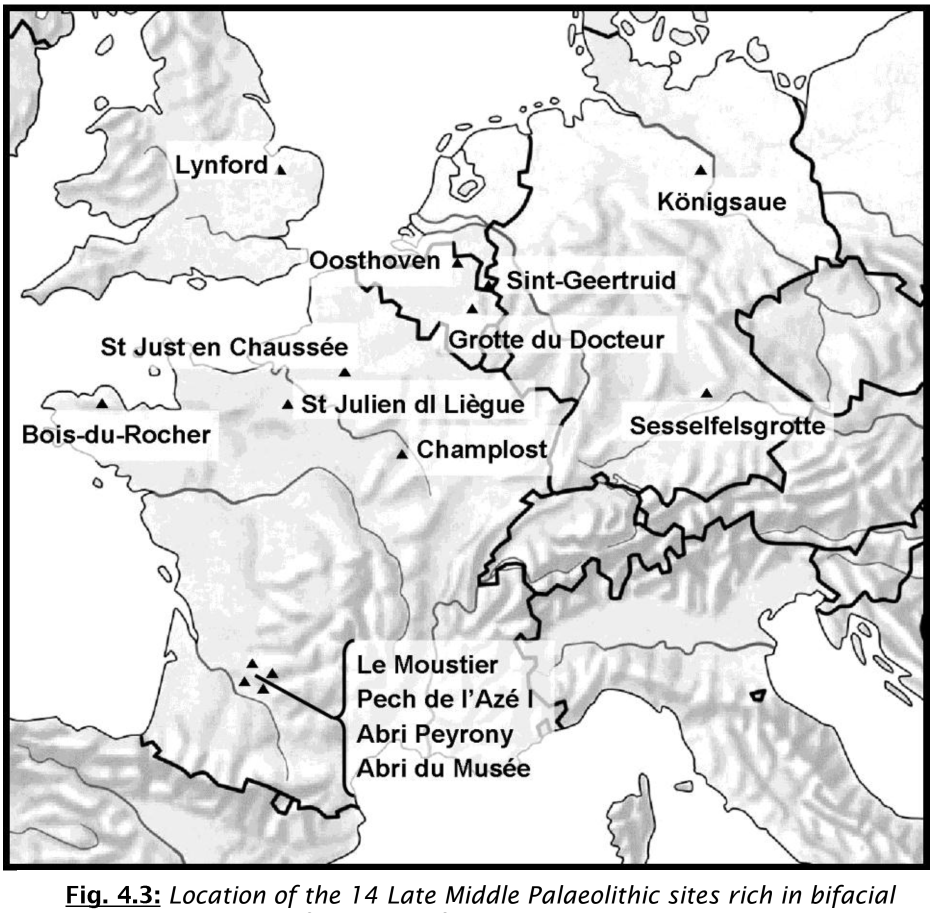
<u>*Sint-Geertruid*</u>*:* this assemblage contains several bifacial tools and interestingly has been claimed to contain a mix of both MTA and KMG elements. The context of the assemblage is not without problems, but because of its large size, previous publication and on-going fieldwork it was the best Ducth sample available for this study.

4. BELGIUM

The Belgian Middle Palaeolithic suffers similar interpretive problems as the Netherlands and several assemblages are either too small or lack a secure context. Two assemblages were chosen to represent the bifacial tools present in this area:

<u>*Oosthoven*</u>*:* this open-air site in Northern Belgium was selected because of its exceptional record of small bifacial tools recovered by a small, modern excavation in the 1990's. It has been claimed to have a mixed MTA-KMG nature.

<u>*Grotte du Docteur*</u>*:* this cave site was included to represent the 'Mousterian with bifacial retouch' which is identified in Meuse Valley in Southern Belgium. It contains a large and varied sample of bifacial tools. Although the context of the site is problematic recent fieldwork has attempted to create a better context for the material.



<u>Fig. 4.3:</u> *Location of the 14 Late Middle Palaeolithic sites rich in bifacial tools which form part of the detailed attribute analysis*

5. NORTHERN FRANCE

In Northern France several entities rich in bifacial tools have been defined and four sites were selected to represent this variability:

Saint-Just-en-Chaussée: this open-air site, excavated in the 2nd half of the 20th century, provides a representation of the Northern French variant of the MTA, containing large triangular handaxes, within a secure stratigraphic context.

Bois-du-Rocher: in Brittany a group of assemblages which are rich in bifacial tools have been grouped together in the 'Bois-du-Rocher' group. The eponymous site of this group, although containing of surface material, was studied because of the homogenous nature, extensive recent work and relative large size of the collection.

Saint-Julien de la Liègue: in Normandy several Mousterian assemblages contain small bifacial tools and the site of Saint-Julien de la Liègue represents this entity. Although the majority of these artefacts have been collected from the surface, they are homogenous in nature and contain a very large number of bifacial tools.

Champlost: a KMG influence has also been claimed for Northern France and to study and understand this phenomenon the assemblage of Champlost was added to the sample. This site is a mix of surface and stratified material but has been radiometrically dated and formed the subject of several in-depth studies in the 1990's.

6. SOUTHERN FRANCE

The Southern part of France is the core area of the MTA industry, so three key assemblages of this entity were studied. Additionally, to study the presence of backed bifacial knives in this area, one site (Abri du Musée), described as having affinities with the KMG, is analysed in detail as well.

Pech de l'Azé I: this rock shelter site contains a large, well-contextualised classic MTA assemblage and moreover new research was conducted at the site in 2004-2005, making this one of the best understood, multi-layer MTA localities.

Le Moustier: the eponymous site of Le Moustier contains a large collection of MTA handaxes which have been extensively dated.

Haut de Combe Capelle (also known as Abri Peyrony): this MTA rock shelter site provides another large MTA sample. Although originally excavated in 1925, new excavations at the site were started in 2009, making it one of the best understood MTA sites south of the Dordogne river.

Abri du Musée: this site, although not yet published in detail, contains diagnostic backed bifacial knives, a phenomenon which is unique in this area. This exceptional site has the potential to cast new light on the on-going debate surrounding the territorial trends that can be identified amongst these Late Middle Palaeolithic bifacial tools.

DATA COLLECTION SITES	Region	Location	Recovery	Position	Dating method	Date	Industry	Sample Size
Königsaue	Northern Germany	open-air	excavated 1963-64	stratified	Stratigraphy and AMS	MIS 5a or 3	KMG	22
Sesselfelsgrotte	Southern Germany	cave	excavated 1964-81	stratified	C14	MIS 3	KMG	157
Pech de l'Azé I	SW France	rock shelter	excavated 1930, 1950, 1970 and 2004-2005	stratified	AMS C14 and ESR	MIS 3	Classic MTA	101
Le Moustier	SW France	rock shelter	excavated 1910-1973	stratified	TL and ESR	MIS 3	Classic MTA	323
Haut de Combe Capelle	SW France	rock shelter	excavated in 1925, 1990, 2009 and 2010	stratified	not yet published	MIS 3	Classic MTA	191
Lynford	Southern Britain	open-air	excavated 2002	stratified	OSL and AMS C14	MIS 3	British MTA	57
Bois-du-Rocher	Brittany	open-air	collected since 1870s	surface	stratigraphy and typology	MIS 5-3	Brittany MTA	58
Saint-Just-en-Chaussée	Northern France	open-air	excavated in 1940s, 1950s and 1976	stratified	stratigraphy	MIS 5-3	Northern French MTA	27
Saint-Julien de la Liègue	Normandy	open-air	collected since end of 19th century	surface	stratigraphy and typology	MIS 5-3	Mousterian with small bifaces	215
Oosthoven	Northern Belgium	open-air	excavated 1993	stratified	stratigraphy and typology	MIS 5-3	Mousterian with small bifaces	21
Grotte du Docteur	Southern Belgium	cave	excavated 1886, 1970s and 1998	stratified	stratigraphy and typology	MIS 5-3	Other	45
Sint-Geertruid	The Netherlands	open-air	collected since 1930's, new excavation in 2011	surface	typology	MIS 5-3	Other	24
Champlost	NE France	open-air	collected since 20th C, excavated 1982-1992	stratified	ESR	MIS 3	Other	32
Abri du Musée	SW France	rock shelter	excavated 1991	stratified	stratigraphy	MIS 5-3	Other	30
							TOTAL	**1,303**

Table 4.3: *The characteristics of the 14 sites rich in Late Middle Palaeolithic bifacial tools selected for the detailed attribute analysis*

4.3.2 Attribute analysis

For each bifacial tool a set of 22 individual attributes were documented. The recording centred on obtaining information related to the condition of the artefacts, their metric, technological and typological characteristics. Subsequently, the analysis of these attributes was focused towards directly addressing the research questions and will include:

1. A detailed analysis of the distinctive typo-technological characteristics of each bifacial tool type, each assemblage and each entity (Research Question 2).
2. A comprehensive assessment of the real similarities and differences between these assemblages and entities (Research Question 3).
3. An evaluation of which attributes could potentially have played a formative role in relation to morphological variability and spatial and temporal patterning (Research Question 4).

The next section describes each attribute, providing specifics on how the attributes were recorded and how they contribute to answering questions about Late Middle Palaeolithic variability throughout further analyses (Chapters 5, 6, 7 and 8).

1. ARTEFACT CONDITION

To come to a full understanding of the taphonomic history of an assemblage, including its formation and post-depositional reworking, the condition of the artefacts need to be examined (Inizan *et al.* 1992). Assessing the taphonomic processes an assemblage has undergone, provides an evaluation of assemblage mixing, the contemporary nature of certain artefacts and the homogeneity of the assemblage in general. Such a taphonomic approach is important, especially in relation to material that was collected as surface finds or formed part of a palimpsest cave environment. Therefore, to fully understand Late Middle Palaeolithic bifacial tool variability it is vital to evaluate whether the studied assemblages suffered significant taphonomic disturbance. Two different aspects of the condition of an artefact were assessed: physical damage and chemical alterations.

- **Physical damage**

This attribute is recorded by assessing whether the edges of the artefact are damaged. The *wear of the edge* is evaluated by looking for smoother, blunted edges (rolling) and the removal of larger and/or very small chips (these are often recognisable by differences in colour and represent damage caused by friction (e.g. rolling or use-wear)) (Tringham *et al.* 1974). The piece is then placed into one of three broad categories of wear: none, slightly worn or heavily worn. It is acknowledged that these categories can be subjective it seems appropriate in regards of the overall aim of getting an overview of the variability present within an assemblage and the overall assemblage integrity. Furthermore each piece is assessed for *breakage patterns*. If the piece is broken and therefore not complete, several of the other attributes cannot be recorded in a straightforward way.

- **Chemical alteration**

These modifications were assessed by looking for patterns of decolourisation on each artefact. Besides the presence or absence of *staining* (unstained, slighty stained, heavily stained), the amount of *patina* (none, slightly patinated, heavily patinated, desilicified) is recorded. Patina is a chemical modification of the raw material often expressed by a change in colour and/or granularity. The causes can be numerous and various and often difficult to interpret (Röttlander 1975; Inizan *et al.* 1992; Burroni *et al.* 2002). The patination process generally starts with a milky-blue staining and ends with a total desilicification of the flint resulting in a white appearance and porous nature.

Fig. 4.4: *The four categories of patination as used throughout this thesis. 1: no patination; 2: slightly patinated; 3: heavily patinated; 4: desilicified*

Although the categories for each of these observations are rather broad, when combined they provide a good indication of the taphonomic history of an assemblage and the variability in artefact condition present within and between assemblages. Moreover, recording these attributes allows for an assessment of the homogeneity of an assemblage, and more specifically its bifacial tools, and whether the (broad) contemporaneity of the artefacts needs to be questioned or not (see Chapter 6, section 6.2).

2. TECHNOLOGY

Several observations are recorded to assess how the bifacial tools were manufactured, including the raw material, blank type, cortex remnant, cross-section and presence of a back. Additionally, several attributes related to the retouch are analysed, including retouch morphology, retouch extent, angle of the retouched edge, direction of the retouch removals and presence of tranchet blows. Combined, these attributes provide a comprehensive picture of the manufacture methods used to create a specific tool.

This study does not aim to make a detailed reconstruction of each knapping sequence, as is done within the *chaîne opératoire* approach (e.g. Boëda *et al.* 1990). This because the Middle Palaeolithic is characterised by a rather opportunistic way of knapping, making the used *chaîne opératoires* often difficult to reconstruct or generalise (Bar-Yosef and Van Peer 2009; Davidson 2009). The objective of recording these technological attributes is to help assess the presence of differential ways of making bifacial tools and to facilitate comparisons both within and between assemblages (Chapter 6, section 6.3). Furthermore, on a macro-regional scale it will be possible to determine if there are differences in bifacial tool manufacture between the different entities (Chapter 7, section 7.2).

- **Raw Material**

Over the past decades, several scholars have brought forward theories that link the availability, quality and size of raw material nodules as explanatory factors to the variability present amongst Middle Palaeolithic assemblages (Rolland 1981; Dibble 1991; see Chapter 3, section 3.3.2). To assess the possible influence of the raw material on the characteristics of the bifacial tools, their raw material was described and classified into broad categories (flint, chert, quartz, quartzite, other) based on visual inspection. More general information about the availability of raw materials in the area and the use of different raw materials in the assemblage will be extracted from the site publications. This raw material data can then be used to characterise bifacial tool manufacture processes (Chapter 6, section 6.3.1), and evaluate behavioural patterns (Chapter 8, section 8.3.1).

- **Blank**

The term 'blank' relates to the type of artefact that was initially chosen to be shaped and retouched into a tool. In general tools can be made either by a form shaping process (façonnage), whereby a nodule is shaped and retouched into a tool; or by retouching a detached piece derived from a nodule (debitage). Within the façonnage process a distinction can further be made between a nodule (large piece of raw material) and a pebble (smaller and often naturally rounded). Amongst the debitage process natural pieces (e.g. frost fragments) and struck flakes are separated.

In this study, the blank of an artefact is only classified if it can be recognised with a degree of certainty (e.g. clear presence of a bulb of percussion (debitage) or clear cortex remnant on both faces (façonnage)). Reconstructing the original blank of a bifacial tool is often difficult and therefore there is also an 'unknown' category. This attribute provides information about the technological sequences present in an assemblage and is assessed in detail in Chapter 6 (section 6.3.2).

- Cortex remnant

Cortex is the natural weathered crust found around the outside of a flint nodule. Assessing the amount of cortex present on Palaeolithic artefacts helps to establish its place in the knapping sequence (Dibble *et al.* 2005; Lin *et al.* 2010). The absence or presence of cortex on a bifacial tool holds potential clues about the type of raw material used, the type of blank selected and the method and amount of shaping that the bifacial piece underwent.

For this study the amount of cortex remaining on the complete surface (including the two main faces) of the bifacial tool is recorded in broad categories by visual assessment (absent, 1-25%, 25-50%, 50-75%, >75%). This number summarises the total amount of cortex present on the artefact. This cortex data is then used to assess if there are differential bifacial tool manufacture methods in the various assemblages (Chapter 6, section 6.3.3).

- Back

Within lithic analyses a back is defined as a blunt thick edge which can be either natural (unworked, including cortical) or created by truncation (blunted by steep retouch) (see definition of *Keilmesser* in section 4.2.2). In this study the presence or absence of a back is assessed for each bifacial tool, by categorisation into three groups: none, natural or truncated. The length and position of the back can be variable (Fig. 4.5).

Fig. 4.5: *Three examples of bifacial pieces with a natural back, the extent of their backing is indicated by the red line*

The presence or absence of a back influences the overall concept and outline shape of the bifacial tool under creation. Assessing the occurrence and types of backed bifacially worked pieces in an assemblage is aimed at gaining further information about the chosen blank (Chapter 6, Section 6.3.4) and the overall techno-typological concept of the bifacial tool (Chapter 7, section 7.2.2). Previously, the presence/absence of backed bifacial tools has also been used to identify several regional entities (Chapter 2) which can be reassessed on this new data (Chapter 7).

- **Cross section**

Another technological feature that is recorded for each bifacial tool is the shape of the cross section, which is classified as (biconvex, plano-convex, biplano, plano-convex/plano-convex or other (Fig. 4.6). This relates to the cross section shape which dominates over the complete length of the tool. Tools where the cross section varies a lot or is very irregular are classified in the category 'other'. For broken pieces it was often not possible to record this attribute.

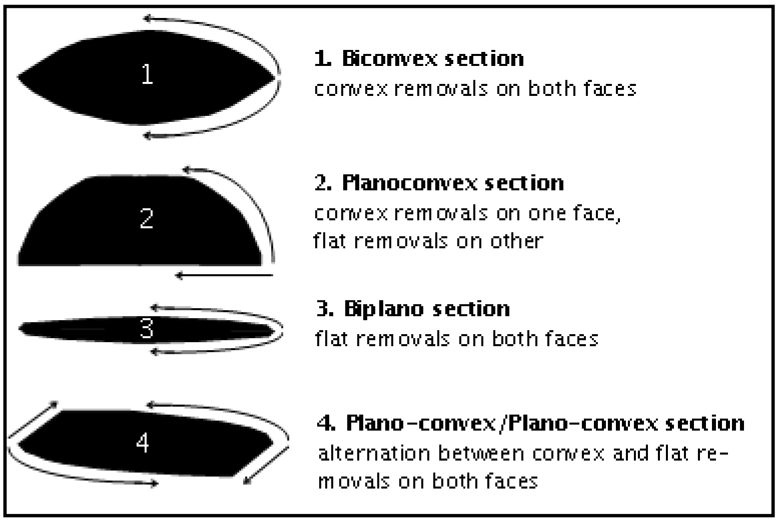


Fig. 4.6: *Overview and definition of the different cross sections recorded for the bifacial tools*

Recording the cross sections of this set of Late Middle Palaeolithic bifacial tools will provide information on the initial blank and/or shaping method used, and the presence of differential manufacture processes both within and between bifacial tool types and assemblages (Chapter 6, section 6.4.2).

- **Retouch morphology and extent**

The retouch on the bifacial tools is recorded here both by assessing the morphology of the flake scars and the extent by which the retouch penetrates the surface of the tool. Firstly, the *shape of the retouch* scars or removals are subdivided into the following types (Fig. 4.7; Bordes 1961, Inizan *et al.* 1999):

scalar; stepped; subparallel; parallel

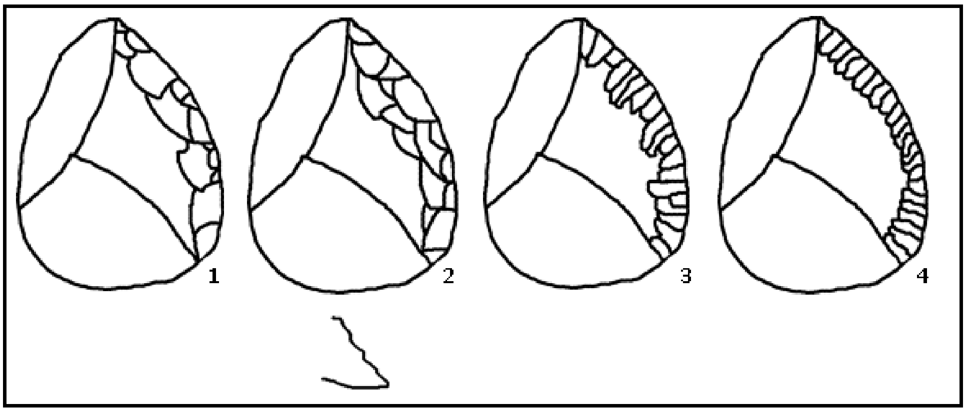


Fig. 4.7: *The four categories of retouch morphology (after Bordes 1961): 1: Scalar; 2: Steep; 3: Subparallel; 4: Parallel*

Secondly, the *length of the retouch* removals form the edge of the tool inwards is recorded as being (Fig. 4.8; as defined by Bordes 1961):

short; long; invasive; or covering

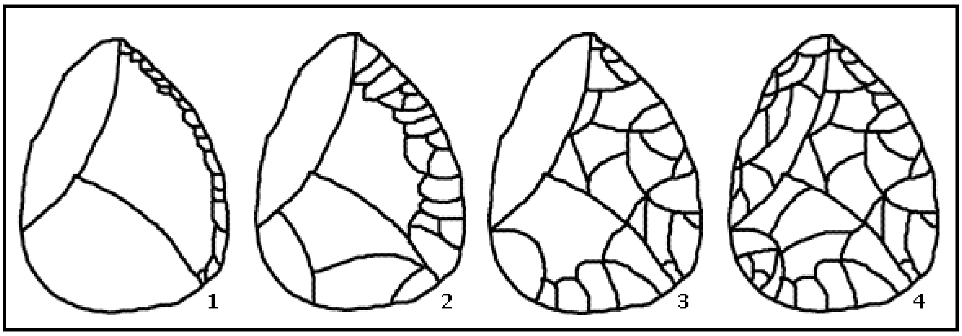


Fig. 4.8: *The four categories of retouch extent 1: short; 2: long; 3: invasive; 4: covering (after Bordes 1961)*

Recording these attributes provides information about the exact methods by which the bifacial tools were shaped and retouched. A comparative analysis of the retouch will allow to assess the presence of variability among the bifacial retouch characteristics (Chapter 6, section 6.4.1).

- Edge angles

The angle of an edge is often studied in relation to the potential uses of that edge (Keeley 1980; Veil *et al.* 1994; Soressi 2002; Soressi and Hays 2003). It is generally envisaged that tools with active edges of less than 35 degrees only allow intrusive (penetrating) cutting movements (piercing, slicing and stabbing). Conversely, edges of more than 65 degrees seem to result exclusively in non-penetrating superficial cuts (scraping, whittling, smoothing) (Soressi 2002; Soressi and Hays 2003). Edges between 35 and 65 degrees are then envisaged to allow for a wider variety of cutting movements including both intrusive and non-intrusive activities (Fig. 4.9).

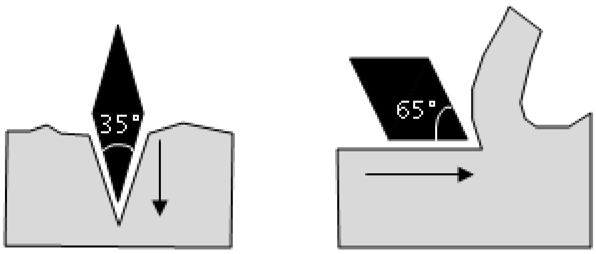


Fig. 4.9: *The dichotomy between a penetrating cutting movement made by a 35° angle, and the superficial action made by a 65° angle (after Soressi 2002)*

The angles of the edges of an artefact are difficult to measure and several complicated and exact ways of edge angle measurement exist (for a comparison see Dibble and Bernard 1980). Conversely, several studies apply a simplified approach to measure edge angles and place then within one of three potential categories: '<35°'; 'between 35-65°' and '>65°' based on a visual assessment of the retouched edges. The distinction between these three categories is based on micro-wear studies and recent analyses of palaeo-indian (Wilmsen 1968; Siegel 1985; Hayden 1979; Gould *et al.* 1971) and Acheulean tools (e.g. Hoxne) (Keeley 1980; Soriano 2000).

In this study, edge angles are recorded to obtain a general idea of the different types of angles present within the Late Middle Palaeolithic bifacial tool sample. Therefore, the latter method was preferred and the dominant angles of the worked edges are summarised in one of the three above generic categories. The edge angle data can then not only be used to conduct comparisons between tool types and assemblages (Chapter 6, section 6.4.3), but can provide glimpses into differential functional aspects (Chapter 8, section 8.3.3.)

- Direction of the retouch removals

Another feature recorded for each complete bifacial tool is the direction from which the retouch removals are originating. The removals can either come from the lateral sides, from the tip, from the base or be multi-directional (Fig. 4.10). This attribute is recorded because previous studies have stressed differences between MTA removals, generally struck from the lateral sides, and KMG removals, frequently struck from the point (Soressi 2002). Based on this new data set it will be possible to reassess this statement (Chapter 6, section 6.4.1).

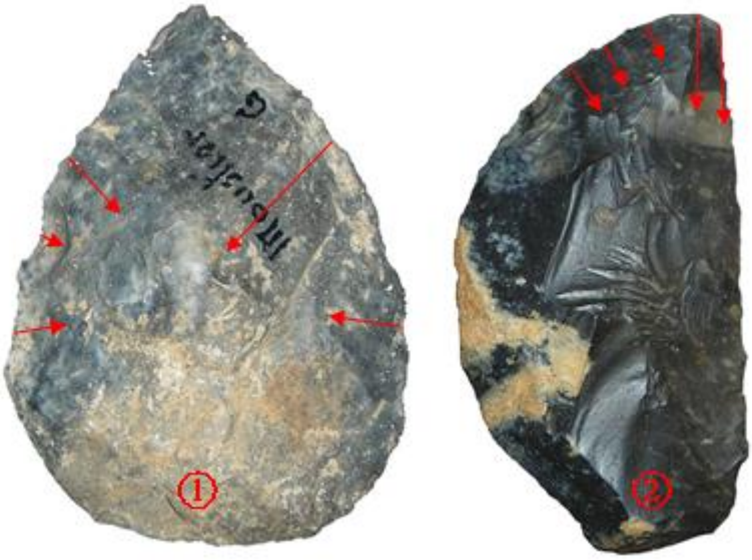


Fig. 4.10: *Schematic overview of the claimed differences in retouch removals between MTA (1) lateral; and KMG (2) from tip.*

- Lateral tranchet removals

The presence of tranchet blows, lateral removals struck from the tip, were recorded to assess the use of the para-burin technique in different assemblages (Fig. 4.11; for a definition see Chapter 2, section 2.3.3). This attribute was recorded in five categories, taking into account the number and position of the blow(s): none; 1 on 1 face; multiple on 1 face; 1 on both faces; multiple on both faces. This attributes provides information on the resharpening method of the bifacial tools and is examined in more detail in Chapter 6, section 6.4.1 and Chapter 7, section 7.2.2).

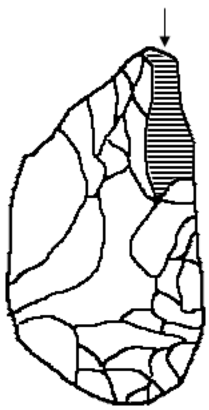


Fig. 4.11: *Example of a tool with a lateral tranchet removal (indicated by the arrow and hatched zone)*

3. MEASUREMENTS

Studies of the metric aspects of bifacial tools were devised early on in attempts to structure biface variability (see Chapter 3; Bordes 1961; Wymer 1968; Roe 1968). In this study a combination of measurements is recorded for each complete bifacial tool to allow an assessment of its overall size and shape (Fig. 4.12 and Table 4.4). Firstly, this includes *three basic measurements* (Fig. 4.12):

- Maximum Length
- Maximum Width *(measured perpendicular to maximum length)*
- Maximum Thickness

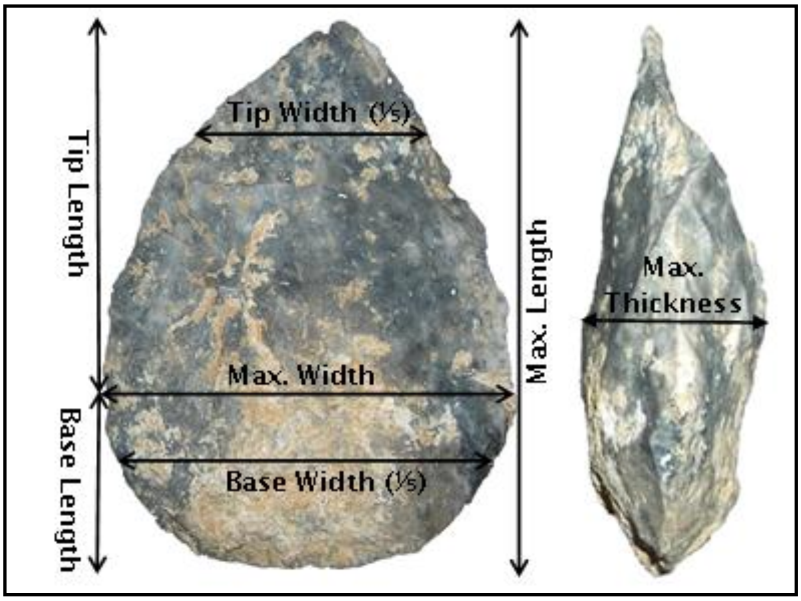


Fig. 4.12: *Overview of the measurements recorded on the bifacial tools*

Secondly, on pieces which are intensely shaped, as indicated by covering retouch (so not on bifacial scrapers), *four additional measurements* were taken as indicators of their outline shape (Fig. 4.12):

- Tip Width *(width at 1/5 from the tip)*
- Tip Length *(length between maximum width and tip)*
- Base Width *(width at 1/5 from the base)*
- Base Length *(length between maximum width and base)*

These seven linear measurements are then used to calculate *three ratios* which give an indication of the overall proportions of the tools:

- Refinement *(Maximum Thickness divided by Maximum Width)*
- Elongation *(Maximum Length divided by Maximum Width)*
- Flatness *(Maximum Width divided by Maximum Thickness)*

These ratios are commonly applied to bifacial tools and are seen as indicating the tool's overall shape (Bordes 1961; Roe 1968; Wragg Sykes 2009; Iovita and McPherron 2011). Firstly, elongation (length divided by width) is calculated; higher values indicate that the artefact is narrower for its length hence more elongated. Secondly, refinement as defined by Roe (1968) is the thickness to width ratio; lower values indicate that the tool was thinner relative to its width, hence more refined. Thirdly, Bordes (1961) defined a flatness ratio which is calculated by dividing width by thickness; higher values indicate a flatter piece. In the literature both these W/T and T/W calculations are used under the label 'refinement'. In the English speaking world there seems to be a preference for Roe's T/W ratio while in the francophone world Bordes W/T calculations are applied. Although both these calculations are expressions of the same phenomenon, for comparative reasons this thesis will mention the values of both ratios.

This detailed metric recording of the bifacial tools allows assessing metric differences between both bifacial tool types and assemblages (Chapter 6, section 6.4.4). Furthermore, previous studies have employed metric criteria to characterise different entities rich in bifacial tools, and the metric data obtained here for a large number of bifacial tools provides the opportunity to reassess these criteria in specifics, and metric variability among Late Middle Palaeolithic bifacial tools in general (Chapter 7, section 7.2.2).

4. TYPOLOGY

In addition to conditional, technological and metric characteristics the typological features of the bifacial tools are assessed. Typology relates to a classification according to general type; type being defined by a combination of attributes (e.g. outline shape, presence of a back, retouch morphology and retouch extent). As part of the attribute analysis each bifacial tool, except for the very fragmentary pieces, is integrated in the simplified classificatory scheme defined under section 4.2.

Each artefact is assigned to one of five categories: 'classic' handaxe, backed bifacial tool, leaf-shaped bifacial tool, bifacial scraper or partial bifaces (definitions are summarised on Table 4.4). The assignment to these categories is done by visual inspection of the outline shape and by integrating the previously recorded technological attributes (e.g. back, cross section, retouch morphology and extent).This typological data is then used to characterise and compare assemblages (Chapter 6, section 6.4.5) and to assess the presence of spatial trends (Chapter 7, section 7.2.2) and temporal patterns (Chapter 7, section 7.3.2).

4.4 Summary

This chapter described the twofold methodology of this PhD research. Firstly, to validate, assess and compare different biface-rich entities, a new typological framework for Late Middle Palaeolithic bifacial tools was developed. This scheme consists of five broad categories ('classic' handaxes, backed bifacial tools, leaf-shaped bifacial tools, bifacial scrapers and partial bifaces) which are defined on diagnostic features such as outline shape, retouch extent and presence of a back. It incorporates and simplifies the existing dense cloud of terms and types and facilitates typo-technological comparisons in a uniform way (Chapter 6) and can easily be applied to existing detailed site reports.

However, many of sites in the study area are not published in this detailed way. Therefore, the second part of the methodology consists of a detailed attribute analysis (Table 4.4). 14 key assemblages were selected, forming a representative sample of the Late Middle Palaeolithic bifacial tool variability in Western Europe. 22 attributes were recorded to assess the condition, raw material, morphometrics, technological and typological features of the artefacts, providing a new set of data in relation to research questions 2, 3 and 4.

Combined, the data from the application of the new classificatory framework and the new primary data gained using the attribute analyses will provide the first large uniform pan-European Late Middle Palaeolithic bifacial tool dataset. Further analyses of this dataset will form a new contribution to better understanding the genuine typo-technological, spatial and temporal trends among Late Middle Palaeolithic bifacial tools (Chapters 5-8).

DATA COLLECTION – RECORDED ATTRIBUTES	
Artefact Condition	
Edge Wear	none; slightly worn; heavily worn
Breakage	yes; no
Patina	none; slightly patinated; heavily patinated; desilicified
Staining	unstained; slighty stained; heavily stained
Technology	
Raw Material	flint; chert; quartz; quartzite; other
Blank	pebble; nodule; natural piece; struck flake (Levallois or non-Levallois); unknown
Cortex	absent; 1-25%; 25-50%; 50-75%; >75%
Back	none; natural; truncated
Cross section	biconvex; plano-convex; biplano; plano-convex/plano-convex; other
Retouch Morphology	scalar; stepped; subparallel; parallel
Retouch Extent	short; long; invasive; covering
Retouch Direction	from lateral sides; from tip; from base; mix
Edge Angle	<35°; 35-65°; >65°
Tranchet Blows	none; 1 on 1 face; multiple on 1 face; 1 on both faces; multiple on both faces
Measurements	
Max. Length	maximum length of the artefact
Max. Width	maximum width of the artefact
Max. Thickness	Maximum thickness of the artefact
Tip Length	length between maximum width and tip
Base Length	length between maximum width and base
Tip Width	width at 1/5 from the tip
Base Width	width at 1/5 from the base
Typology	
'Classic' handaxe	two converging cutting edges, overall symmetrical outline
Backed bifacial tool	bifacially retouched cutting edge opposite blunt back
Leaf-shaped bifacial tool	part of tool covering retouched and resembling leaf point
Bifacial scraper	non-covering bifacial retouch along one or more edges
Partial biface	only partly covering retouched

Table 4.4: *Overview of the 22 attributes recorded for the bifacial tool sample*

Chapter 5:

Data Presentation:

Regional Overviews and Key Assemblages

5.1 Introduction

The Middle Palaeolithic in Western Europe is represented by an extensive archaeological record with numerous sites dispersed across its geographic expansion. The focus of this PhD is on the Late Middle Palaeolithic (MIS5d-3; 115,000-35,000 BP), which is characterised by a general reappearance of bifacial tools (see Chapter 2; Bordes 1961; Richter 1997; Jöris 2004; Soressi 2002; Iovita and McPherron 2011). Previously, several patterns of variations have been claimed to occur among the existing plethora of bifacial tool types and entities (Richter 1997, 2000; Cliquet 2001; Soressi 2002; Jöris 2004, 2006). Currently, assessments of their genuine nature are obscured by the application of incoherent methodologies and classifications (Chapter 4). This chapter provides an initial reassessment of these bifacial tool differences by incorporating uniformised evidence from Germany, the Netherlands, Belgium, Britain, Northern and Southern France in relation to Research Question 1:

Is the MTA/KMG dichotomy the result of genuine differences in Neanderthal behaviour or an artificial creation caused by the existence of different academic traditions which analyse and interpret archaeological data in different ways?

Throughout this chapter, a synopsis is provided of the Late Middle Palaeolithic bifacial tools in the study area. The data is presented by country since previous research was often restricted by national/linguistic borders and within each country several different entities have been defined. The data from these countries will then be bridged throughout further analyses in this PhD. For each country, the nature of the Middle Palaeolithic record is described together with an overview of its bifacial tools. This regionalised overview will allow an assessment of the chronology, differing environments and lithic variability within each country. Furthermore, a more detailed description of the 14 key sites that were selected for detailed analysis is provided (for selection criteria see Chapter 4, section 4.3.1). Both essential background information and a new assessment of the bifacial tool characteristics are presented.

New data of 1,303 Late Middle Palaeolithic bifacial tools is presented and the bifacial tools from a further 66 sites are reclassified based on published site reports. Often publications are not fine-grained enough to allow a detailed reclassification of each individual bifacial tool. Therefore, comparisons are focused on the absence or presence of specific tool types rather than their exact proportions. The aim of this data presentation chapter is threefold:

- providing essential background information to the studied regions, sites and assemblages, including their chronological and environmental setting
- conducting an initial comparison of lithic variability among the assemblages rich in bifacial tools
- assessing if genuine differences occur in the bifacial component of the Western European late Middle Palaeolithic record regardless of the classificatory framework

5.2 Germany

5.2.1 Introduction

Germany has a rich, well-studied Middle Palaeolithic record comprising both numerous open-air and cave sites. Many find spots are situated along the main river valleys (e.g. Danube, Rhine, Elbe and Altmühl), both in the plains of northern Germany and the mountainous region of southern Germany (Fig. 5.1; Bosinski 1967, 2008; Conard and Fischer 2000). The first Palaeolithic excavations in Germany were conducted in the 1860's and used the French Middle Palaeolithic record as a guide to interpret the German material (Conard and Fischer 2000). Both in terms of geographic expansion and chronological succession the German territory seems to be continuously occupied throughout the Middle Palaeolithic (see also Chapter 2). Furthermore, numerous sites contain a significant amount of bifacially flaked tools and Germany therefore played an important role in defining the characteristics of several bifacial entities (Bosinski 1967; Richter 1997; Jöris 2005, 2006).

Fig. 5.1: *Location of the main German Middle Palaeolithic sites rich in bifacial tools*

5.2.2 The bifacial entities

Middle Palaeolithic bifacial tools occur regularly across Germany, and with a variety of forms (for the location of the main sites see Fig. 5.1). Bosinski was the first to look at the entirety of lithic material coming from this area and partly used these bifacial tools to define different typo-technological Middle Palaeolithic groups (Bosinski 1967). Nowadays his subdivisions are increasingly rejected (see Chapter 2; Fiedler *et al.* 1979/1980; Veil *et al.* 1994; Richter 1997; Conard and Fischer 2000; Pastoors 2001; Jöris 2004, 2005, 2006). Modern subdivisions generally recognise the presence of five different entities rich in bifacial tools in Germany (Table 5.1):

Firstly, the **recent Micoquian or *Keilmessergruppe* (KMG)** contains a variety of bifacial tools, including backed bifacial knives (*Keilmesser*), leaf-shaped bifacial tools (e.g. *Faustkeilblätter*), unifaces and bifacial scrapers (for a more detailed definition see Chapter 2). In Germany rich KMG sites are known from cave and open-air locations and do not appear to be associated with a specific set of topographic or environmental conditions (Conard and Fischer 2000). They appear both in MIS-5 (e.g. Königsaue (Mania 2000), Buhlen (Jöris 2001; Thissen 2006) and Balve (Jöris 1992)) and MIS-3 (e.g. Lichtenberg (Veil *et al.* 1994) and Sesselfelsgrotte (Richter 1997)). Furthermore several larger collections can currently not be placed in time (e.g. Bockstein (Wetzel and Bosinski 1969) and Klausennische (Bosinski 1967)).

Secondly, through the sporadic presence in Germany of small cordiform or triangular handaxes the presence of an **MTA entity** has been claimed (Bosinski 1967). Conversely, my extensive literature review highlighted that these handaxes very rarely occur east of the Rhine river. On a few locations in Western Germany small, triangular or cordiform handaxes have been found, but always either as isolated finds (e.g. Haltern, Senden and Bocholt (Herring and Rëschoff-Thale 1997)) or on sites lacking detailed chrono-stratigraphic information (e.g. Lenderscheid (Fiedler 1994), Rheindahlen A3 (Schmitz and Thissen 1998) and Achenheim IV (Bosinski 1967). In both scenarios it is often unclear if these handaxes should be assigned to the Lower or Middle Palaeolithic. More substantial MTA collections are absent and therefore, in my opinion, it can be concluded that a clear well-defined MTA entity is not present in Germany.

Thirdly, a **leaf point group** (*Blattspitzengruppe* or *Althmühlgruppe*) appears, mainly around 40,000BP, and is known from both open-air (e.g. Rörshain (Fiedler 1994)) and cave sites (e.g. Mauern (Bosinski 1967)). A further distinction can be made between assemblages where leaf points are rare or absent and constitute part of a continuum of biface forms, and assemblages in which leaf points occur as a discrete form (Hopkinson 2004). Overall, these leaf point asseblages are not included in this study (for reasons see Chapter 2).

Furthermore, several German sites do not fit into the MTA/KMG dichotomy since they contain Mousterian flake tools, few handaxes and also some asymmetrical KMG bifacial tools (e.g. Lenderscheid (Fiedler 1994), Salzgitter-Lebenstedt (Pastoors 2001), Wahlen

(Fiedler 1994), Grosse Grotte IX (Wagner 1983) and Kogelstein (Kind 2000)). It is interesting to see that at sites such as Rörshain and Wahlen a large variety and number of bifacial tools is present, from symmetrical triangular and ovate bifaces, to clear symmetrical leaf points, indicating the large complexity of the (German) Middle Palaeolithic archaeological record. These assemblages have previously been labeled as **Late Middle Palaeolithic with Handaxes (LMPH)** (Conard and Fischer 2000) or **'mixed' entity** (Kind 1992; see also Chapter 2). In my opinion the necessity to create these two industrial variants illustrates the difficulties related to the classification of biface-rich assemblages in Germany (and elsewhere) that do not fit the definitions of either the MTA or KMG.

Entity	Occurrence	Characteristics	Main sites
Keilmessergruppe (KMG)	both open-air and cave sites	Keilmesser, Faustkeilblätter, Faüstel, Halbkeile	Königsaue, Buhlen, Balve, Lichtenberg, Sesselfelsgrotte
Mousterian of Acheulean Tradition (MTA)	only isolated handaxe finds	small, symmetric handaxes	Haltern, Senden, Bocholt, Lenderscheid, Rheindahlen A3, Achenheim IV
Leaf point group	both open-air and cave sites	Leaf points	Rörshain, Mauern
Late Middle Palaeolithic with handaxes (LMPH)	both open-air and cave sites	classic handaxes and asymmetric bifacial tools	Wahlen, Salzgitter-Lebenstedt, Grosse Grotte IX
mixed' entity	both open-air and cave sites	classic handaxes and asymmetric bifacial tools	Kogelstein

Table 5.1: *Overview of the German Middle Palaeolithic entities rich in bifacial tools*

5.2.3 The studied assemblages

Within the study area of this PhD, Germany is the only area where a clear *Keilmessergruppe* entity is present. Therefore, two German assemblages characterised by a strong presence of *Keilmesser*, Königsaue (open-air, Central Germany) and Sesselfelsgrotte (cave, Southern Germany), have been selected out to be analysed in more detail.

KÖNIGSAUE

- ***Location***

The open-air site of Königsaue (Ldkr. Salzlandkreis, Sachsen-Anhalt) is located on the northern border of a 12 kilometre long ancient lake, the '*Ascherslebener See*', in Central Germany (Fig. 5.2). The site is located at the bottom of a hill, the *Grosse Bruchsberg*, and comprises a stratigraphic sequence of over 25 metres and includes several artefact-rich Palaeolithic horizons (Mania and Toepfer 1973; Mania 2002a).

- ***History of research***

The Palaeolithic artefacts from Königsaue were discovered during the large-scale exploitation of lignite (*Braunkohle*). After the initial discovery of artefacts in the mine in July 1963, the site was subsequently excavated under the direction of Mania and Toepfer between September 1963 and July 1964 (Mania and Toepfer 1973). In total more than 6,000 lithic and 3,000 faunal remains were recovered.

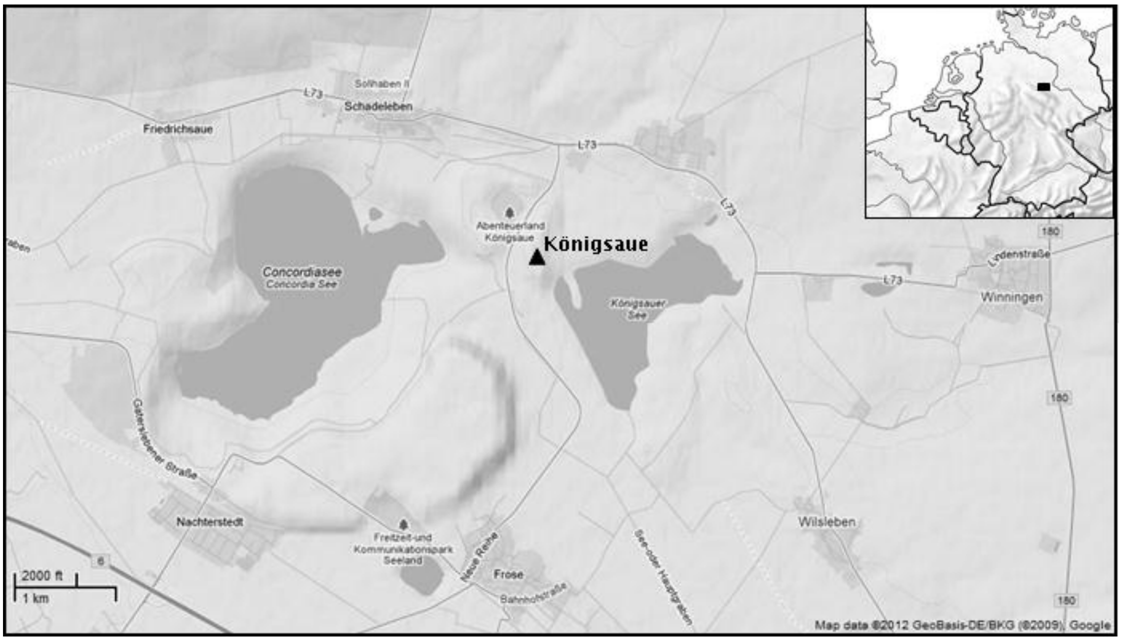


Fig. 5.2: *Location of the Middle Palaeolithic site of Königsaue (Central Germany)*

- ***Site formation and stratigraphy***

The deep stratigraphic sequence at Königsaue covers at least 125,000 years, starting with MIS-5e. Thirteen cycles can be distinguished and within unit IB three Middle Palaeolithic find horizons (A, B and C) are present (Mania and Toepfer 1973; Mania 2002a). Each of these horizons consists out of several distinct artefact concentrations. In general the artefacts are in fresh condition with sharp edges and no or minimal abrasion, indicating that they did not undergo severe post-depositional processes (see Chapter 6).

- ***Chronological position***

The original excavators place the site around 80,000 BP (Odderade Interstadial, MIS-5a) based on stratigraphic and contextual information (Mania 2000). The C14 dates conducted in the 1960’s on pieces of charcoal from unit Ib resulted in dates of >55,800 BP and >45,000 BP (Mania and Toepfer 1973). More recently, C14 AMS dates were obtained by Oxford (Hedges *et al.* 1998) on two pieces of birch bark pitch. For layer A this resulted in a date of 48,400 ± 3,700 BP and for layer B 43,800 ± 2,100 BP. These dates would place the assemblages in MIS-3 and when considering the standard deviations these results are not inconsistent with the two previously obtained dates. Acknowledging the problems related to radiocarbon dating (Higham 2011) and taking into account the established stratigraphic sequence these dates need to be seen as a *terminus ante quem* and the Königsaue lithics could have been deposited both during MIS-5a and the first half of MIS-3.

- ***Palaeoecological context***

The site of Königsaue is rich in environmental data such as fauna, pollen, charcoal and molluscs (Mania and Toepfer 1973). The fauna in the three horizons (A, B and C) is very similar and dominated by mammoth (*Mammuthus primigenius*), reindeer (*Rangifer tarandus*), wild horse (*Equus mosbachensis*) and bison (*Bison priscus*) (Mania and Toepfer

1973). Because of the rather acid nature of the sediments bone preservation is poor and so far no cut marks have been identified. The environment was dominated by birch, pine and grass indicating a steppe environment around the lake (Mania 2004).

Königsaue is also known for the discovery of two pieces of birch bark pitch, one with an imprint of a bifacial tool. These are interpreted as a type of glue to haft stone tools (Grünberg *et al.* 1999; Koller *et al.* 2001; Mania 2002b), providing insights into the ways in which these bifacial tools were used (for a discussion on tool use see Chapters 3 and 8).

- ***The lithic assemblage***

The lithic assemblages are made on locally available raw materials, mainly high quality flint and quartzite (Table 5.2). Layer B yielded the largest collection (n: 3,990) and contains a significant proportion of blades (7.32%) and cores (4.09%), of which several are prepared. The tools only represent 2.91% of this collection and only two pieces are bifacially retouched. Layer A contains a smaller percentage of cores (2.55%) and blades (1.94%) but a higher proportion of tools (6.03%) of which around 25% is bifacially retouched (n: 24, Table 5.2). Königsaue C provided a rather small collection (n: 297) and only three bifacially retouched tools. Layer A, which has been assigned to the *Keilmessergruppe* industry (Mania 2000) will be the one further analysed throughout this study.

KÖNIGSAUE	A	%	B	%	C	%
Cores	38	2.55%	163	4.09%	9	3.03%
Unretouched flakes	1328	89.01%	3401	85.24%	220	74.07%
Unretouched blades	29	1.94%	292	7.32%	44	14.81%
Unifacial tools	66	4.42%	114	2.86%	20	6.73%
Bifacial tools	24	1.61%	2	0.05%	3	1.01%
Hammerstones	7	0.47%	18	0.45%	1	0.34%
TOTAL	1492	100.00%	3990	100.00%	297	100.00%

Table 5.2: *Composition of the lithic assemblages from horizons A, B and C from Königsaue*

- ***New analysis: the bifacial tools***

The complete Königsaue collection is currently held at the Landesmuseum für Vorgeschichte in Halle (Central Germany). The collection has not yet been sorted by the original excavators and therefore the exact provenience (layer A, B or C) of an important part of the pieces still remains unclear. 21 bifacially retouched pieces from layer A were available for study. 7 of these are broken and therefore not all attributes could be recorded. On average these bifacial tools are 85.40mm long, with length measurements ranging between 58 and 159mm. A large standard deviation is also the case for the maximum width and thickness measurements (Table 5.3).

KÖNIGSAUE	Min.	Max.	Mean	Average	St. Dev
Max. Length (mm)	58.00	159.00	88.79	85.40	28.34
Max. Width (mm)	34.00	63.00	44.79	45.40	7.83
Max. Thickness (mm)	9.00	22.00	13.00	12.80	3.41

Table 5.3: *Linear measurements of the bifacial tools from Königsaue*

For most pieces it was difficult to determine if they were made on flakes or by formshaping (façonnage), but 6 pieces it were clearly made on flakes (Table 5.4). Most pieces are intensely retouched and do not have a cortex remnant (64,29%) or only a small one (28,57%) covering less than 25% of the surface of the tool. The dominant edge angle on the tools is between 35 and 65 degrees although on 5 pieces (35,71%) edges of less than 35 degrees predominate. None of the pieces have a biconvex section. The cross-sections are either plano-convex (50,00%), bi-plano (14,29%) or irregular (35,71%) (Table 5.4).

KÖNIGSAUE	Technological Attributes									
Cortex	**none**		**1-25%**		**25-50%**		**50-75%**		**75-100%**	
	9	60.0%	5	33.3%	1	6.7%	0	0.0%	0	0.0%
Cross section	**Plano-convex**		**Bi-convex**		**Bi-plano**		**Plano-convex/ plano-convex**		**Irregular**	
	7	53.8%	0	0.0%	2	15.4%	0	0.0%	5	30.8%
Blank	**Flake**		**Nodule**		**Unknown**					
	8	36.4%	0	0.0%	14	63.6%				
Edge angles	**<35°**		**35-65°**		**>65°**					
	4	36.4%	7	63.6%	0	0.0%				

Table 5.4: *Technological attributes of the bifacial tools from Königsaue*

When classifying these bifacial tools typologically there is a clear dominance of leaf-shaped (53.33%) and backed (33.33%) bifacial tools. Classic handaxes are totally absent from the Königsaue assemblage (Table 5.5). This reanalysis of the bifacial tools from Königsaue confirms the previous interpretations of the site as a *Keilmessergruppe* assemblage (Mania and Toepfer 1973, Mania 2000).

KÖNIGSAUE (n:15)	BIFACIAL TYPOLOGY	
Classic handaxes	0	0.0%
Backed bifacial tools	5	33.3%
Leaf-shaped bifacial tools	8	53.3%
Partial bifaces	0	0.0%
Bifacial scrapers	2	13.3%
TOTAL	15	100.0%

Table 5.5: *New simplified classification of the bifacial tools from Königsaue*

- ***Site Interpretation***

Neanderthals repeatedly visited the shore of the Ascherslebner Lake near the village of Königsaue and left behind an impressive archaeological record which can be divided into three main find horizons (A, B and C). The faunal remains indicate that this waterfront attracted many animals from the surrounding steppe environment, including mammoths, reindeer and horse.

The oldest of these Neanderthals visits, Königsaue A, yielded 1,492 artefacts of which the vast majority (around 90%) are unretouched flakes and debitage. The presence of a large amount of small chips, some hammerstones and several refitting sequences indicate that the knapping took place at the location itself. Several flaking methods were in use at

Königsaue A, including discoidal, laminar and Levallois methods. A low number of the obtained blanks (ca. 5%) were retouched and the dominant tools are side scrapers but also chopping tools, denticulates, burins and end scrapers appear.

The most diagnostic feature of the assemblage is the presence of around 20 bifacial tools, including *Keilmesser*, leaf-shaped bifacial tools and bifacial scrapers (Table 5.5). On average these bifacial tools are 85.40mm long and their variability in shape is indicated by the rather large standard deviations both in terms of maximum width and length. Half the tools have a plano-convex section and for around half the pieces it is clear they were made on flake blanks. They are all made on locally available flint and intensely shaped, as indicated by the lack of cortex remnant.

These results of the typo-technological reanalysis of the Königsaue bifacial tools confirm its identification as a classic example of the KMG industry.

SESSELFELSGROTTE

- **Location**

The cave of Sesselfels (Neuessing, Ldkr. Kelheim, Bavaria, Southern Germany) is located in a rock-face overlooking the Altmühl River, a tributary of the Danube (Fig. 5.3) (Weißmüller 1995; Richter 1997; Freund 1998). Several caves in this valley were visited by Neanderthals (Fig. 5.1), with Sesselfels providing the longest Middle Palaeolithic sequence of the last glacial in western Central Europe. In total the Sesselfels cave yielded more than 100,000 artefacts of the Middle and Upper Palaeolithic (Freund 1998).

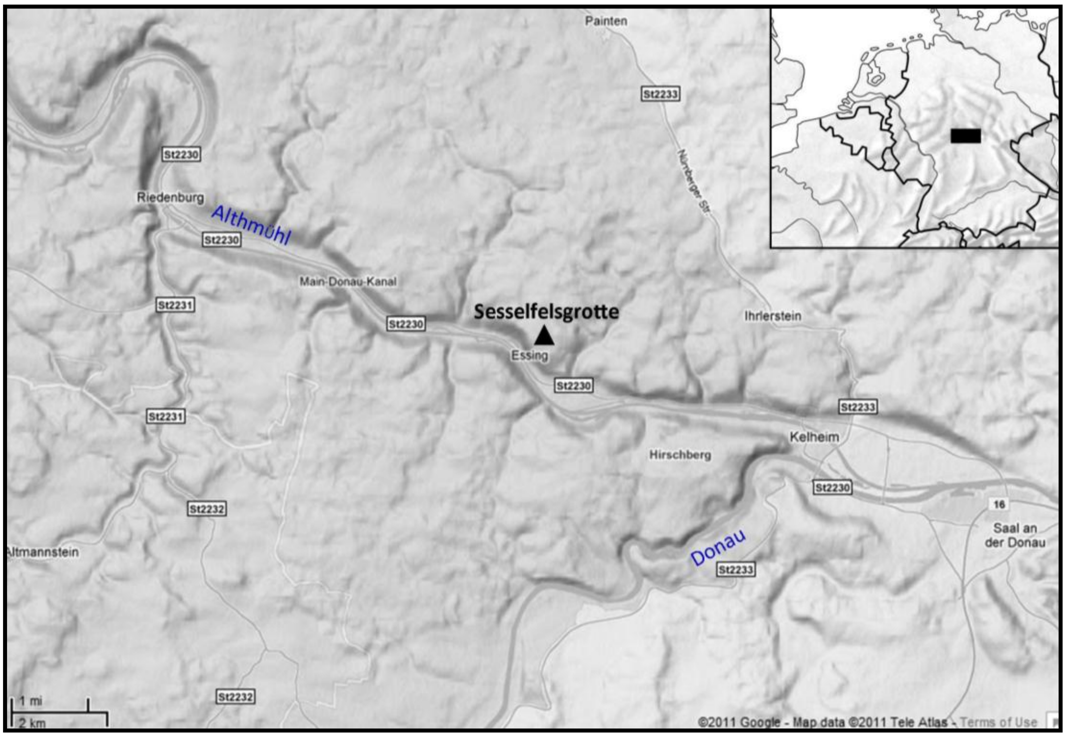


Fig. 5.3: *Location of the cave of Sesselfels (Bavaria, Southern Germany)*

- History of research

The Sesselfels cave was excavated from 1964 until 1977, and again in 1981, by the Institut für Ur- und Frühgeschichte (Universität Nürnberg-Erlangen) under the direction of Professor G. Freund and collaborators (Richter 1997). Overall, 50m² within the cave, as well as in front of the cave, were excavated.

- Site formation and stratigraphy

A total of seven metres of sedimentary deposit is present, consisting mainly of limestone debris from the roof and the slope above the cave. The stratigraphy can be divided into four main units (Fig. 5.4). Firstly, the lower part of the sequence ("*Untere Schichten*"), dating to the early Weichselian (MIS-5c and 5a), contains eight Mousterian occupation units. Secondly, the layers, L, K and I, belonging to MIS-4, contain no archaeological material, but abundant rodent remains. Thirdly, the overlying "G-Komplex" yielded 13 Mousterian and Micoquian assemblages (MIS-3), some of these were recovered from virtual living floors with several fireplaces, and this G-complex forms the focus of this study of Sesselfels. Finally, separated by an archaeological sterile layer (layer F), there occurs another Late Middle Palaeolithic horizon (layer E3) dated to 41,819 ± 668 CalBP (MIS-3; Fig. 5.4).

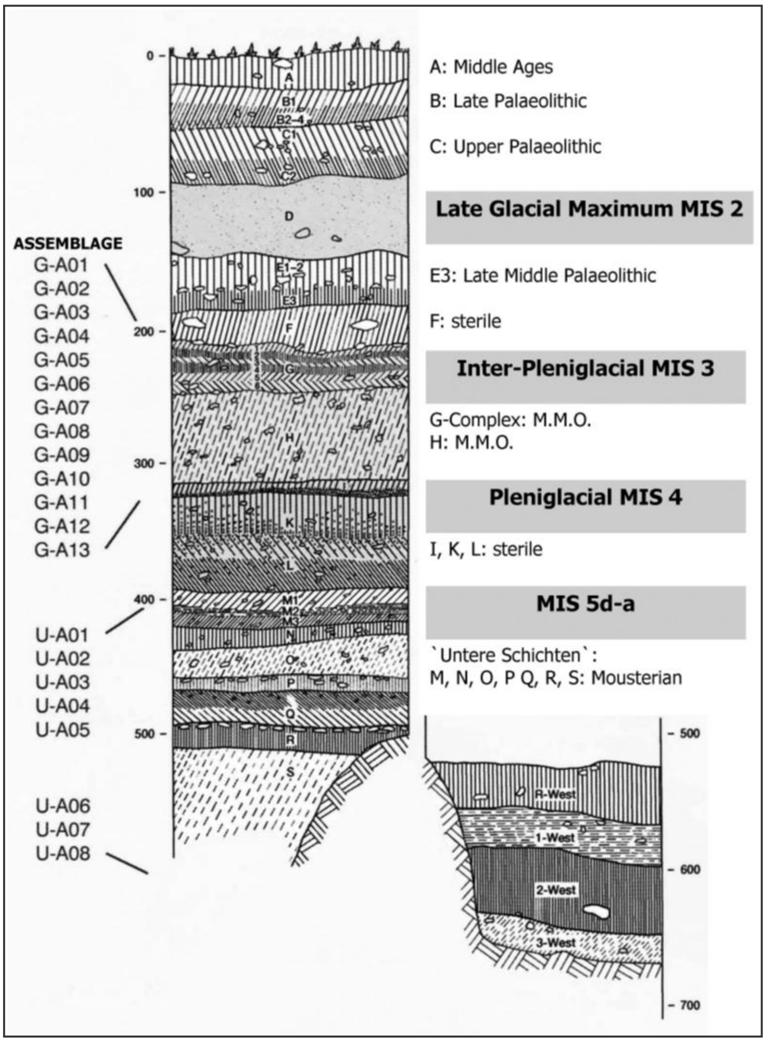


Fig 5.4: *Stratigraphic sequence from the Sesselfelsgrotte (modified after Richter 1997)*

- Chronological position

The entire Sesselfels sequence has been radiocarbon dated and all layers can be securely placed in time (Fig. 5.4). From the G-complex layers several bone and charcoal fragments were dated, all clustering around 45,000 BP and therefore the entire complex can be placed within MIS-3 (Richter 2002; for a detailed overview of the C14 dates see Chapter 2, Table 2.4).

- Palaeoecological context

The fauna from the G layers is dominated by mammoth (*Mammuthus primigenius*), reindeer (*Rangifer tarandus*) and horse (*Equus* sp.), indicating a steppe milieu with some arctic elements (Richter 1997). Within the G-complex also several Neanderthal remains were discovered, including a deciduous tooth and several foetus bones (Rathgeber 2006).

- Lithic assemblage

Over 85,000 stone artefacts were recovered from Sesselfelsgrotte. In the G-layers the dominant raw material is local chert (ca. 70%) but also a wide range of other, more exotic, raw materials were used (e.g. radiolarite, lydite, quartz and sandstone). Both discoidal and Levallois techniques were applied to obtain flake blanks. Around 10% of the blanks were retouched into tools, including all generic Middle Palaeolithic tools types (e.g. scrapers, denticulates and notches). Moreover microliths (tools smaller than 2cm) and bifacial tools occur regularly (Richter 1997).

- New analysis - the bifacial tools

The Sesselfels collections are currently held at the University of Erlangen and all the bifacial elements present from the G-complex were studied, totalling 157 bifacial tools. 41% of these were broken and therefore not all attributes could be recorded. The bifacial tools from Sesselfels are rather small with an average length of 49.84mm and overall ranging between 15 and 86mm (Table 5.6).

Sesselfelsgrotte (n:94)	Min.	Max.	Mean	Average	St. Dev
Max. Length (mm)	15.00	86.00	48.50	49.84	14.75
Max. Width (mm)	7.00	64.00	33.50	34.62	10.70
Max. Thickness (mm)	6.00	25.00	11.00	12.00	4.16

Table 5.6: *Linear measurements of the bifacial tools from Sesselfelsgrotte*

For half of the bifacial tools it was impossible to reconstruct the original blank. For a quarter it was possible to determine they were made on flake blanks and the other quarter on pebbels/nodules (Table 5.7). Furthermore a wide range of cortex remnants are present on the pieces. One third has a cortex remnant covering more than 25% of the tools surface, one third between 1 and 25% and one third is cortex-free (Table 5.7).

The vast majority (58.20%) of the edge angles on the Sesselfels bifacial fall between 35 and 65 degrees. Edge angles of less than 35° are common as well (36.07%) but angles of larger than 65° are rather rare (5.74%) (Table 5.7).

SESSELFELS	Technological Attributes (n:157)									
Cortex	**none**		**1-25%**		**25-50%**		**50-75%**		**75-100%**	
	31	31.3%	36	36.4%	20	20.2%	8	8.1%	4	4.0%
Cross section	**Plano-convex**		**Bi-convex**		**Bi-plano**		**Plano-convex/ plano-convex**		**Irregular**	
	27	27.6%	7	7.1%	1	1.0%	1	1.0%	65	63.3%
Blank	**Flake**		**Nodule**		**Unknown**					
	43	27.39%	41	26.11%	73	46.50%				
Edge angles	**<35°**		**35-65°**		**>65°**					
	44	36.1%	71	58.2%	7	5.7%				

Table 5.7: *Technological attributes of the bifacial tools from Sesselfelsgrotte*

The cross sections of the artefacts are very varied with 63.27% of them being irregular, 27.55% plano-convex and 7.14% bi-convex. Furthermore also single examples with a bi-plano and a plano-convex/plano-convex section are present (Table 5.7) indicating the bifacial tool variability present in this assemblage.

This variability is indicated by the typological classification of the Sesselfels bifacially flaked tools (Table 5.8) shows a clear dominance of backed bifacial tools, bifacial scrapers and leaf-shaped types, all clustering around 30%. Furthermore also few partial bifaces (4%) and classic handaxes (2%) are present in the assemblage.

SESSELFELS - G (n:114)	BIFACIAL TYPOLOGY	
Classic handaxes	2	1.8%
Backed bifacial tools	34	29.8%
Leaf-shaped bifacial tools	35	30.0%
Partial bifaces	5	4.4%
Bifacial scrapers	38	33.3%
TOTAL	114	100.0%

Table 5.8: *New simplified classification of the bifacial tools from Sesselfelsgrotte*

In general a large and very variable group of bifacial tools is present at Sesselfelsgrotte. A lot of variability has been documented in all the metrical, technological and typological attributes recorded. In the past the assemblages from the G layers from Sesselfelsgrotte have been assigned to a new taxonomic entity, the *Mousterian with Micoquian Option* (MMO) (Chapter 2; Richter 1997 and 2000). This new entity was created because the Sesselfels material can be attributed equally well to the KMG (based on the bifacial tool types) as well as to specific Mousterian variants (based on unifacial tool counts). Based on my reanalysis of the entirety of bifacial tools from the Sesselfels G layers, this assemblage will be treated as a representative of the KMG industry because of the defining dominant presence of backed bifacial knives, leaf-shaped bifacial tools and bifacial scrapers.

- ***Site Interpretation***

Groups of Neanderthals regularly occupied the Sesselfels cave during MIS-3. They brought back animal carcasses (dominated by mammoth, reindeer and horse) to the site and manufactured the necessary tools to process these from the locally available chert, although some tools are made from more exotic raw materials.

The study of the lithics indicates that all phases of the *chaîne opératoire* were executed locally. This is indicated by the presence of cores, debitage chips, flakes from all stages of the knapping process (as indicated by the amount of cortex), retouch debitage and rejuvenation debitage (e.g. tranchet blow spalls). The Neanderthals at Sesselfels used Levallois, discoidal and irregular flaking techniques to process the raw material nodules. Around 10% of the produced blanks were retouched in to tools and all the typical Middle Palaeolithic tool types are present, with a large representation of retouched notches, denticulates and side scrapers. Also some retouched points occur. End scrapers and piercers, which become more common in the Upper Palaeolithic, complement the toolkit of these Neanderthals.

The G-complex assemblages comprise an important proportion of bifacial tools. Larger classic handaxes, which are characteristic of the MTA, are not present in the Sesselfels G-layers. Backed bifaces, leaf-shaped elements and bifacial scrapers elements indicate that the bifacial retouch method was widely used at Sesselfels. This wide application resulted furthermore in a very varied record of bifacial tools, with intra-assemblage variability in all the recorded attributes, including measurements, cortex remnant, edge angles, blank type, cross-section and tool types. Most of the Sesselfels bifacial elements can be classified as KMG because of their asymmetry, presence of a back and/or plano-convex sections.

5.2.4 Discussion

In addition to the detailed study of the assemblages of Königsaue and Sesselfelsgrotte, ten other well-published German assemblages were studied to draw up a detailed picture of the German Late Middle Palaeolithic bifacial tools (Table 5.9a and 5.9b).

- *Chronology and environment*

Late Middle Palaeolithic (MIS 5d-3) assemblages have containing a significant proportion of different types of bifacial elements have been recovered across Germany (Fig. 5.1; Table 5.9a). These assemblages are found in open-air, rock shelter and cave environments. Where faunal remains are preserved, these are dominated by mammoth, bovids, horse and cervids and are indicative of an open steppe environment (Table 5.9a)

Radiometric dates have been published for five of these German biface-rich sites (Table 2.4; Lichtenberg, Gamsenberg; Abri I am Schulerloch, Salzgitter-Lebenstedt and Sesselfelsgrotte) and all fall within MIS-3 (Veil *et al.* 1994; Richter *et al.* 2000; Richter 2002; Jöris 2006). Furthermore several sites are dated based on information gained from their stratigraphic sequences. This method has led to the interpretation of the *Keilmesser* of Buhlen, Neumark-Nord and Balve as belonging to the end of MIS-5 (Brühl and Laurat 2010; Jöris *pers comm.*). Not all sites can be placed in time securely. For example a discrepancy exists between radiometric dates and the stratigraphic interpretation for the assemblages of Königsaue (Mania and Toepfer 1973; Grunberg *et al.* 1999). In general, the German record indicates that assemblages rich in bifacial tools occurred regularly both during MIS-5 and 3 (Table 5.9a).

SITE	LOCATION	LAYER	DATE	FAUNA	ENVIRONMENT	MAIN REFERENCE
Balve	cave	II-Iva	MIS 3	mammoth, woolly rhinoceros, bovid, deer, horse, cave bear, cave hyena	steppe	Jöris 1992 and 1993
Buhlen	open-air	IIIB	MIS 5a	mammoth, woolly rhinoceros, reindeer	boreal forest with grass steppe	Fiedler 1994 and Jöris 2001
Kogelstein	rockshelter	–	MIS 3	hyena, mammoth, horse, cervids, bovids	steppe	Kind 1988
Königsaue	open-air	A	MIS 5-3	mammoth, reindeer, horse, bison	steppe	Mania and Toepfer 1973
Lenderscheid	open-air	–	unknown	–	–	Luttropp 1975
Lichtenberg	open-air	–	MIS 3	–	–	Veil *et al*. 1994
Neumark-Nord	open-air	2/0	MIS 5c	bovid, horse, deer	–	Brühl and Laurat 2010
Rheindahlen	open-air	A3	MIS 4/3	–	–	Thissen 2006
Rörshain	open-air	–	MIS 5-3	–	–	Fiedler 1994
Salzgitter-Lebenstedt	open-air	–	MIS 3	mammoth, reindeer, horse, bison	steppe	Pastoors 2001
Sesselfelsgrotte	cave	G	MIS 3	mammoth, reindeer, horse	steppe	Richter 1997
Wahlen	open-air	–	unknown	–	–	Fiedler 1994

Table 5.9a: *Characteristics of the main German Middle Palaeolithic assemblages rich in bifacial tools, and an overview of their location, date, fauna and environment*

- *Lithic variability*

The German Late Middle Palaeolithic bifacial tools are predominantly made on flint, chert and quartzite. It mainly concerns large assemblages, containing several thousands of lithic artefacts, including tens of bifacially worked tools (Table 5.9b). The Levallois technique is used on most sites, although in varying proportions (e.g. low use at Lichtenberg and Buhlen). Both discoidal and laminar reduction techniques are also common. In terms of flake tools, different types of scrapers dominate the vast majority of biface-rich assemblages.

My analysis of the entirety of bifacial tools from Königsaue A and Sesselfelsgrotte G illustrates that *Keilmesser* dominate in both assemblages and occur together with other bifacial elements, such as leaf-shaped bifacial tools, partial bifaces and bifacial scrapers (see also Chapter 6). Besides the detailed study of these two assemblages the bifacial tools from 10 German assemblages were reclassified based on published data (Table 5.9b). These reassessments highlight that backed bifacial tools occur on all sites and are the defining element of the German Late Middle Palaeolithic.

SITE	DOMINANT RAW MATERIAL	ASSEMBLAGE SIZE	FLAKING METHODS	FLAKE TOOLS	BIFACIAL TOOLS	Classic	Backed	Leafshaped	Partial	Bif. Scraper
Balve	chert	53,000	Levallois, discoidal, laminar	scrapers	?	–	√	√	√	√
Buhlen	chert	–	Levallois	scrapers	182	–	√	√	√	√
Kogelstein	variable	400	Levallois, laminar	scrapers, points	?	–	√	–	–	√
Königsaue	flint, quartzite	1,492	Levallois, discoidal, laminar		24	–	√	√	–	√
Lenderscheid	quartzite	>1,000	Levallois, discoidal		–	√	√	–	–	√
Lichtenberg	flint	405	Levallois		45	√	√	√	–	√
Neumark-Nord	flint	8,103	Levallois, irregular	scrapers	?	–	√	√	–	√
Rheindahlen	flint	–	laminar		–	√	√	–	–	–
Rörshain	quartzite	50,000	discoidal	scrapers	–	√	√	√	–	√
Salzgitter-Lebenstedt	flint	4,200	Levallois		–	√	√	√	–	–
Sesselfelsgrotte	chert	85,000	Levallois, discoidal, laminar	scrapers, notches, denticulates	157	√	√	√	√	√
Wahlen	quartzite	–	Levallois, discoidal	scrapers	–	√	√	√	√	√

Table 5.9b: *Characteristics of the main German Middle Palaeolithic assemblages rich in bifacial tools, and an overview of the characteristics of their lithic assemblages*

Leaf-shaped and bifacial scrapers occur frequently in the German record, while partial bifaces are less common (Table 5.9b). Some assemblages contain classic handaxes but as shown by the Sesselfels case study, they only occur in very low numbers, indicating that no classic MTA assemblages occur east of the Rhine. In my opinion, the German Late Middle Palaeolithic bifacial tool record is dominated by KMG assemblages, rich in *Keilmesser,* but also a few other bifacial assemblages are present, characterised by a more varied record of bifacial tools, not dominated by *Keilmesser*.

Previous attempts to further divide these varied assemblages has led to the definition of various entities (see Chapter 2; e.g. Late Middle Palaeolithic with Handaxes, Mousterian with Micoquian Option and 'mixed' entity) which lack in clear archaeological meaning. Thereofre, it is argued here that these terms should be abandoned but a new study in to their underlying phenomenon is needed (see further analyses in Chapter 7).

5.3 The Netherlands

5.3.1 Introduction

Compared to its neighbouring countries, the Netherlands is characterised by a rather limited Palaeolithic record. This scarcity of Palaeolithic sites can mainly be explained by the geological history of the area (Vos and Kiden 2005). Firstly, during the Quaternary the Netherlands were repeatedly covered by the sea, destroying some of the occupational history. Secondly, during the Saalian glaciation (MIS 8-6) the country was partly covered by an ice sheet, making the northern part uninhabitable and also affecting the preservation of pre-Saalian remains. Despite this, lithic evidence does indicate that between 300,000 and 40,000 BP Neanderthals regularly occupied parts of the Dutch territory (Groenendijk and de Warrimont 1995; Deeben *et al.* 2005).

Research about the Middle Palaeolithic occupation of the Netherlands took a rather late start, especially in the northern part of the country. It was only in the 1980's that students systematically surveyed a field near Mander and discovered the first Middle Palaeolithic collection of more than 20 artefacts in the Netherlands (Stapert 1982). In addition many thousands of artefacts have now been found in the sand and gravel pits in the central and southern areas. Also artefacts have been discovered from dredging in the North Sea artefacts (Mol *et al.* 2006), and recently the first Dutch Neanderthal fossil (a skull fragment) has been identified (Hublin *et al.* 2009).

The discovery and interpretation of the Dutch Middle Palaeolithic record has been heavily influenced by the controversy caused by Dutch amateur-archaeologist Tjerk Vermaning. He collected Middle Palaeolithic artefacts in the northern part of the Netherlands and has been accused of forgery. Nowadays amongst academics there is consensus that the artefacts themselves are faked (Waterbolk 2003), while the role of Vermaning himself in the forgery remains unclear (Wouters 1999). The Vermaning affair had a double effect on the Dutch archaeological community. On the one hand, it seriously strained the relationships between Dutch amateur and academic archaeologists, and created a negative, sceptical atmosphere around all Dutch Middle Palaeolithic finds. On the other hand, it raised awareness about the presence of Middle Palaeolithic artefacts in the northern part of the Netherlands and since the Vermaning affair many genuine Middle Palaeolithic artefacts have been found, including bifacially retouched pieces.

5.3.2 The bifacial entities

The Late Middle Palaeolithic (MIS 5d-3) in the Netherlands is documented by hundreds of surfaces finds and dredged artefacts and these come from all over the country (Fig. 5.5). The most common and most diagnostic Middle Palaeolithic surface finds are Levallois flakes and handaxes. In the northern part of the Netherlands, the occupational history from before 150 kya BP has been destroyed by the Saalian ice sheet and *in situ* Middle

Palaeolithic finds are consequently rare. 17 isolated handaxe finds from this area have been published so far (e.g. Wijnjeterp, Elahuizen, Oldeholtwolde, Hemelum, Anderen, Exloo, Drouwen, Anreep, Eexterveld, Langelo, Peest, Tynaarlo, Anloo and Rolde) (Niekus and Stapert 2005 and references therein). Furthermore more recently systematic field surveys are being undertaken, resulting in the discoveries of larger artefact concentrations (e.g. Mander and Assen; Niekus and Stapert 2005; Beuker *et al.* 2009). These finds include both small symmetric (cordiform and triangular) handaxes and more asymmetric, backed biface types. Especially noteworthy is the on-going work at the site of Assen (Niekus *et al.* 2011). This is the only location in the northern part of the Netherlands were Middle Palaeolithic artefacts have been recovered from an *in situ* position. Moreover over 30 handaxes are present in the lithic assemblage (Niekus *pers. comm.*), making this a unique site for which further investigations and publications are awaited.

Fig. 5.5: *Location map of the main Late Middle Palaeolithic Dutch sites (□ = isolated finds; □ = concentrations; ◇ = leaf point)*

In the southern part, which was not affected by the Saalian ice sheet, both *in situ* concentrations (e.g. Maastricht-Belvédère (Roebroeks *et al.* 1997)) and numerous surface finds are known. In total thousands of artefacts were collected, mostly in Southern Limburg, an area where flint can be easily collected from the terraces of the rivers Maas and Rhine (Rensink 2005).

These finds include a variety of bifacial tools, including bifacial scrapers (e.g. in the 'Rhenen Industry' (Stapert 1987, Stapert et al. 2005, Nieukus and Stapert 2005)), asymmetric bifacial tools such as *Keilmesser* and *Faustkeilblätter* (e.g. Sint-Geertruid, Mesch-Mescherheide and Boekel (Rensink 2005)), classic handaxes (e.g. Etten-Leur and Leersum (Rensink 2005)) and leaf points (e.g. Aardjesberg and Leusderheide (De Vries *et al.* 2008)). Chrono-stratigraphic information related to these finds is very sparse. A more detailed attribution than the MIS5-3 time bracket is not possible for any of the sites. Moreover for the isolated handaxe finds it is often even difficult to assess if these belong to the Lower, Early Middle or Late Middle Palaeolithic. Reconstructing the Late Middle Palaeolithic occupation of the Netherlands in detail is therefore impossible until more well-dated and/or well-excavated sites are known. Studying this bifacial component in more detail does allow further comparisons throughout this PhD with other regions.

5.3.3 The studied assemblages

For this PhD the collection of Kim Groenendijk, which was bought in 1992 by the National Museum for Antiquities (Rijksmuseum voor Oudheden (RMO) Leiden), was studied. This collection comprises Middle Palaeolithic material coming from various find spots in the biface-rich area of Southern Limburg. It was originally intended to study the material from Mesch-Mescherheide (Kolen *et al.* 1999; Groenendijk and de Warrimont 2002), located on the northern valley slope of the river Voer (a tributary of the Meuse), but the collection present in the museum at the time of the data collection visit did not comprise enough bifacial elements from this location to make its study relevant for this PhD research. Therefore the focus was on the material collected from Sint-Geertruid.

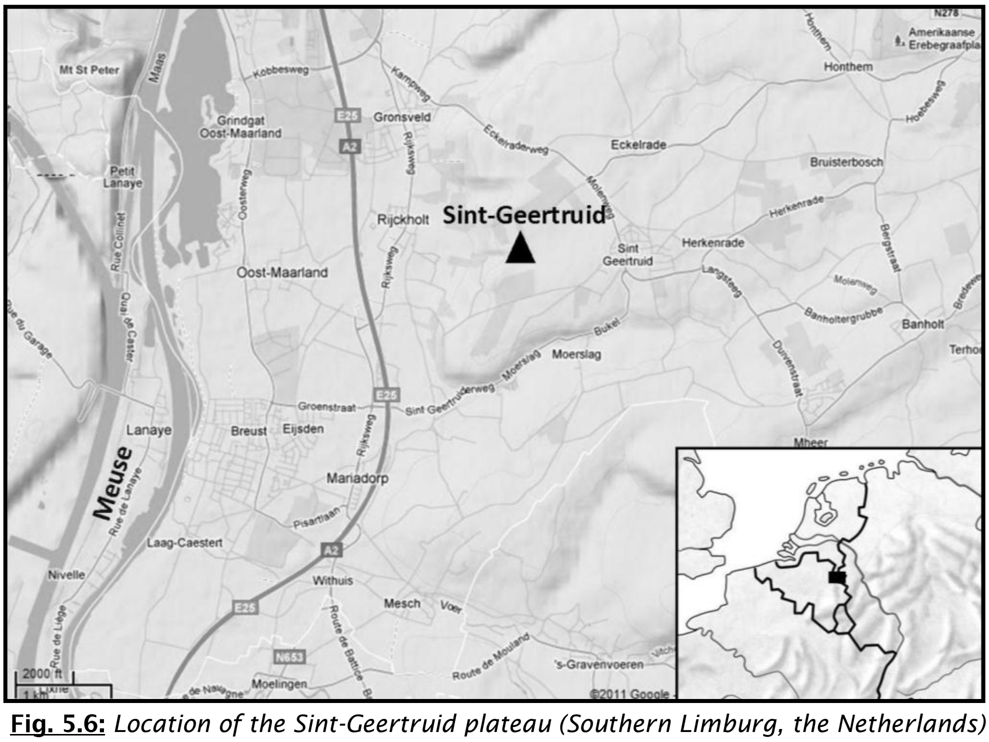
Since it relates to surface material, a variety of time periods was represented in the collection, and only material which was deemed Middle Palaeolithic and was bifacially flaked was studied. Several methodological problems arose whilst studying this surface material. Firstly, it was impossible to assess the coherence of the material, both in terms of geography and chronology. The collection contains a mix of non-time-specific, non-diagnostic unretouched flakes as well as polished (Neolithic) axes, and Levallois flakes. Secondly, the material was collected over a widespread area further questioning the coherence and contemporaneity of the studied assemblage. Finally, much of the material collected at Sint-Geertruid is widely spread over different private collections and museums, and therefore it is possible that the studied material is not completely representative of the actual collection.

Despite concerns over assemblage integrity, I decided to include Sint-Geertruid because in its Dutch context it is the richest and best studied collection of Middle Palaeolithic bifacial tools. In addition, the study of these bifacial tools still allows to assess which types of bifacial tools were present in this area, which is crucially located in between the KMG and MTA core areas. So even though the study of this assemblage is not adding to our chronological understanding of these biface-rich entities, the inter-regional variability of them can be assessed by looking at the bifacial tools from this site on an absence/presence basis.

SINT-GEERTRUID

- ***Location***

The Sint-Geertruid plateau is located in Southern Limburg (Fig. 5.6), an area rich in archaeological finds ranging from the Early Middle Palaeolithic (e.g. Maastricht-Belvédère, Veldwezelt-Hezerwater and Kesselt) to the Neolithic (e.g. flint mines at Rijckholt Sint-Geertruid) (de Warrimont 2000; Deeben *et al.* 2011). Along the edge of the Sint-Geertruid plateau, which is located ca. three kilometres east of the Meuse river, over 2,000 Palaeolithic artefacts have been collected in different surface concentrations, making this currently the richest open-air site in the Netherlands.



<u>Fig. 5.6:</u> *Location of the Sint-Geertruid plateau (Southern Limburg, the Netherlands)*

- ***History of research***

The area around Sint-Geertruid has been a popular destination for amateur-archaeologists since the 1930's, although a first Palaeolithic artefact was already recorded in 1881 (de Warrimont 2007). A large part of the material was collected in the 1970's by Jean-Pierre de Warrimont and Kim Groenendijk, who systematically surveyed parts of Southern Limburg. Since 2008 new investigations have been undertaken at the Sint-

Geertruid plateau, mainly focusing on the Neolithic flint mines (Deeben *et al.* 2011). In 2011 investigations into the loess sequence of Sint-Geertruid were added to this project to contextualise the Middle Palaeolithic surface finds (RCE press release 2011). Hereby for the first time several Middle Palaeolithic artefacts were discovered *in situ*. Based on the stratigraphic sequence a date within MIS 5d-a is suggested but needs to be confirmed by the results of the sampling and dating programme (Raczynski-Henk *pers. comm.*).

- ***Site formation and stratigraphy***

The geological composition of Southern Limburg consists of a limestone plateau covered with loess with several intersecting rivers creating valleys and exposing outcrops of good quality flint (de Warrimont 2000). All the material of Sint-Geertruid was found lying on the surface and therefore any information about the stratigraphic position of the material or formation of the site is currently lacking.

- ***Chronological position***

Because of the lack of stratigraphic information it is impossible to determine whether it concerns one or multiple occupations and to place the assemblage in time. A Late Middle Palaeolithic age is assumed (MIS 5d-3; de Warrimont 2002) but needs to be confirmed.

- ***Palaeoecological context***

No palaeoecological information is known for the Sint-Geertuid find spots since only flint artefacts were collected from the site.

- ***The lithic assemblage***

The Groenendijk collection comprises over 500 lithic artefacts from the Neolithic until the Palaeolithic and it is often difficult to identify which artefacts are related to which time period. Both heavily patinated and unpatinated, fresh and worn artefacts are present, questioning the coherence of the assemblage further. Generic Middle Palaeolithic tool types, such as Quina scrapers, limaces, piercers and denticulates, are present next to bifacially retouched tools. Furthermore several flakes and cores show that the Levallois method was in use (Roebroeks 1980).

- ***New analysis: bifacial tools***

During a data collection trip to the RMO in Leiden 21 bifacial tools from the Sint-Geertuid were accessible to be studied. Two of these were broken and therefore not all attributes could be recorded. These bifacial tools vary in length from 49 to 152mm and a lot of metric variability is present (indicated by the large standard deviations, Table 5.10).

SINT-GEERTRUID (n:19)	Min.	Max.	Mean	Average	St. Dev
Max. Length (mm)	49.00	152.00	97.00	98.64	25.11
Max. Width (mm)	24.00	102.00	62.00	61.91	20.56
Max. Thickness (mm)	7.00	41.00	26.50	27.33	11.46

Table 5.10: *Linear measurements of the bifacial tools from Sint-Geertruid*

Most bifacial tools are intensely and covering retouched, as indicated by the small cortex remnants and the difficulties to identify the blank type (Table 5.11). The cross sections are most often biconvex (66.67%) although plano-convex sections are also present (23.81%). The edge angles mainly fall in the 35-65 degrees category although angles from less than 35 degrees and more than 65 degrees have also been recorded (Table 5.11).

SINT-GEERTRUID	Technological Attributes									
Cortex	**none**		**1-25%**		**25-50%**		**50-75%**		**75-100%**	
	10	54.5%	10	45.5%	0	0.00%	0	0.00%	0	0.00%
Cross section	**Plano-convex**		**Bi-convex**		**Bi-plano**		**Plano-convex/ plano-convex**		**Irregular**	
	5	21.7%	15	65.2%	0	0.00%	0	0.00%	3	13.0%
Blank	**Flake**		**Nodule**		**Unknown**					
	4	16.7%	1	4.2%	19	79.2%				
Edge angles	**<35**		**35-65**		**>65**					
	1	4.7%	21	87.5%	2	8.3%				

Table 5.11: *Technological attributes of the bifacial tools from Sint-Geertruid*

The typological attributions make it clear that a variety of bifacial tools is present, including classic handaxes, backed bifaces (including *Keilmesser*), bifacial scrapers and leaf-shaped bifacial tools (Table 5.12). This is in accordance with the material of the site that has been published (15 classic bifaces, 6 biface fragments, 5 asymmetric (backed) bifaces and several leaf-shaped artefacts and bifacial scrapers (Roebroeks 1980, Wouters 1980 and de Warrimont 2002)). Therefore making this a representative sample of what was recovered at Sint-Geertruid.

SINT-GEERTRUID (n:18)	BIFACIAL TYPOLOGY	
Classic handaxes	12	63.2%
Backed bifacial tools	4	21.1%
Leaf-shaped bifacial tools	1	5.3%
Partial bifaces	0	0.0%
Bifacial scrapers	1	10.5%
TOTAL	18	100.0%

Table 5.12: *New simplified classification of the bifacial tools from Sint-Geertruid*

Because of the surface nature of the Sint-Geertruid assemblage no further inferences related to the contemporaneity of these different bifacial tool types can be made. Therefore the material from Sint-Geertruid will not be assigned to a specific bifacial industry as in my opinion its value lies purely in an absence/presence indicator of the different bifacial tool types in this region, indicating the presence of both classic handaxes and backed bifacial tools at one location.

- ***Site interpretation***

At Sint-Geertruid Middle Palaeolithic artefacts have been found exposed on the surface along the edge of a limestone plateau just east of the Meuse river. All the artefacts are made on flint, which was locally available as well in outcrops on the plateau as in nearby river gravels. The presence of several Levallois flakes and cores show that the Levallois method was used at Sint-Geertruid. Furthermore discoidal cores and prismatic blade cores are present.

A series of generic Middle Palaeolithic unifacial tool types are present, including Quina scrapers and denticulates. Furthermore, a rather large number of bifacially worked tools have been collected. The overrepresentation of these bifacial tools is probably the result of collector's bias, whilst small flakes and cortical artefacts are underrepresented. It is interesting to note that both backed bifacial tools and classic handaxes are present in the assemblage, making it not fit in clearly with both the MTA and KMG industry definitions. Although the lack of contextual information related to the Sint-Geertruid assemblage is sparse its value lies in the indication that both classic handaxes and backed bifacial tools were present in this area during the Late Middle Palaeolithic.

5.3.4 Discussion

The relatively large assemblage of Sint-Geertruid stands out in a Dutch Middle Palaeolithic record which is mainly characterised by isolated finds; the exception being the recent discovered assemblage of Assen (Niekus *et al.* 2011). Although loose finds of bifacial tools, and especially handaxes, are a common occurrence all over the country, larger assemblages containing bifacial tools are rare. Data from five other biface-rich assemblages (Assen, Mander, Etten-Leur, Mesch-Mescherheide and Maastricht-Belvédère) are therefore incorporated with data from 25 isolated find spots (Table 5.13a and 5.13b).

- Chronology and environment

Middle Palaeolithic bifacial tools are a common discovery in The Netherlands. Caves and rock shelters are rare so all artefacts are found in open-air settings (Table 5.13a). Since it mainly concerns surface finds both palaeoenvironmental and chronological information are absent. Based on techno-typological studies and the general occupational history of the Netherlands the majority of these finds are in general associated with the Late Middle Palaeolithic (MIS 5d-3). Recent *in situ* discoveries at Assen (Niekus *et al.* 2011) and new investigations at Sint-Geertruid (RCE press release 2011) are on-going and samples are currently being dated. Until the results of this new work are published, none of the bifacial tools discovered from the Netherlands can be assigned to a more specific phase within MIS 5-3 time bracket.

-Lithic variability

The Dutch Middle Palaeolithic exists of mainly isolated finds and larger surface collections. All artefacts are made on flint and in general bifacial tools occur in low numbers with exception of the sites of Sint-Geertruid and Assen which contain over 30 bifacially worked tools (Table 5.13b).

SITE	LOCATION	LAYER	DATE	FAUNA	ENVIRON-MENT	MAIN REFERENCE
Wijnjeterp, Elahuizen, Oldeholtwolde, Hemelum, Anderen, Exloo, Drouwen, Anreep, Eexterveld, Langelo, Peest, Tynaarlo, Anloo, Rolde	open-air	surface	MIS 5-3	–	–	Niekus and Stapert 2005
Assen	open-air	surface, stratified	MIS 5-3	–	–	Niekus *et al*. 2011
Mander	open-air	surface	MIS 5-3	–	–	Beuker *et al.* 2009
Hengelo, Kessel, Venray, Overloon, Boekel, Groot Agelo, Lonneker	open-air	surface	MIS 5-3	–	–	Stapert *et al.* 2004
Leusderheide, Aardjesberg, Eindhoven	open-air	surface	MIS 5-3	–	–	De Vries *et al.* 2008
Etten-Leur	open-air	surface	MIS 5-3	–	–	Rensink 2005
Mesch-Mescherheide	open-air	surface	MIS 5-3	–	–	Kolen *et al.* 1999
Sint-Geertruid	open-air	surface	MIS 5-3	–	–	Roebroeks 1980
Maastricht-Belvédère	open-air	**E**	MIS 5-3	–	–	Roebroeks *et al.* 1997

Table 5.13a: *Characteristics of the main Dutch Middle Palaeolithic assemblages rich in bifacial tools, and an overview of their location, date, fauna and environment*

Only at Sint-Geertruid, Assen, Mander, Etten-Leur, Mesch-Mescherheide and Maastricht-Belvédère bifacial tools have been found in association with other lithic artefacts, providing information about the assemblage composition. In these assemblages the Levallois method is attested and flake tools are generally dominated by scraper types.

The reanalysis of the Groenendijk material presented here indicated that a variety of bifacial tool types is present in the Netherlands, including classic handaxes, backed and leaf-shaped bifacial tools. The other Dutch bifacial tools that have been published indicate the dominance of classic handaxes, including both cordiform and triangular types, in this area (Table 5.13b). This has led to the inference that an MTA industry was present in the Netherlands (Niekus and Stapert 2005; Rensink 2005; Niekus *et al.* 2011).

Furthermore in several assemblages also partial bifaces, leaf-shaped and/or backed bifacial tools are present (Table 5.13b), but this always in low numbers. These bifacial tool types have been interpreted as a KMG influence.

SITE	DOMINANT RAW MATERIAL	ASSEMBLAGE SIZE	FLAKING METHODS	FLAKE TOOLS	BIFACIAL TOOLS	Classic	Backed	Leafshaped	Partial	Bif. Scraper
Wijnjeterp, Elahuizen, Oldeholtwolde, Hemelum, Anderen, Exloo, Drouwen, Anreep, Eexterveld, Langelo, Peest, Tynaarlo, Anloo, Rolde	flint	isolated finds	–	–	17	√	–	–	–	–
Assen	flint	>200			>30	√	–	–	√	–
Mander	flint	>20			1	√	–	–	–	–
Hengelo, Kessel, Venray, Overloon, Boekel, Groot Agelo, Lonneker	flint	isolated finds			7	√	–	–	√	–
Leusderheide, Aardjesberg, Eindhoven	flint	isolated finds			3	–	–	√	–	–
Etten-Leur	flint	?			1	√	–	–	–	–
Mesch-Mescherheide	flint	?			?	√	√	–	–	–
Sint-Geertruid	flint	>2,000	Levallois, discoidal	Quina and end scrapers	ca. 30	√	√	√	–	√
Maastricht-Belvédère	flint	95			1	√	–	–	–	–

Table 5.13b: *Characteristics of the main Dutch Middle Palaeolithic assemblages rich in bifacial tools, and an overview of their lithic assemblages*

Overall the Dutch Middle Palaeolithic record is difficult to interpret because of the lack of chrono-stratigraphic information, the questionable coherence of some of the assemblages, the small size of the assemblages, and general overrepresentation of bifacial tools which moreover occur in different form. The strength of the above reanalysis and literature study is that it shows that both classic handaxes and backed bifacial tools form a genuine part of the Dutch record. Moreover it demonstrates the occurrence this far east for the MTA handaxes, and this far west for the KMG tool types, providing information about the geographical extension of the late Middle Palaeolithic bifacial entities studied in this PhD.

Linking these small, badly understood assemblages to larger entities such as the MTA or KMG seem preliminary in my opinion. Larger assemblages coming from more secure contexts are needed before a more detailed interpretation of the Dutch Middle Palaeolithic bifacial tools can be made, an illustrative example hereby is the larger collection of handaxes recently discovered at Assen for which links with the MTA seems justifiable (Niekus *et al.* 2011).

5.4 Belgium

5.4.1 Introduction

The Belgian Middle Palaeolithic record formed the focus of intensive studies early on, with research concentrating on the caves in the Meuse valley from the beginning of 19th century onwards (e.g. Engis; Schmerling 1833). Since this pioneering work, over four hundred Belgian Middle Palaeolithic sites have been discovered, ranging from open-air and cave sites to surface finds and isolated objects (Di Modica 2010, 2011a). Despite the early focus on the Meuse Valley (Ulrix-Closset 1975) more recent, research has highlighted that these Middle Palaeolithic find spots are distributed across the country, indicating that Neanderthals occupied the whole region from the Flemish Valley, over the Central Belgian loess region into the Meuse Valley (Fig. 5.7; Van Peer 2001; Toussaint *et al.* 2011).

<u>Fig. 5.7:</u> *Location of the main Middle Palaeolithic sites rich in bifacial tools in Belgium*

Despite the richness of the record, the Belgian Middle Palaeolithic is also characterised by some severe interpretative problems. Many sites were excavated by old techniques, making chronostratigraphic information sparse and hindering an unambiguous interpretation of many lithic assemblages. This holds especially true for the cave environments which are most likely palimpsests. Moreover most Belgian sites have not been radiometrically dated, although often a placement within a coarse-grained timeframe proves possible (Di Modica 2011a; Pirson and Di Modica 2011; Pirson *et al.* 2012). Based on the available information it is at the moment generally accepted that Belgium was occupied during the onset of MIS-5, abandoned during MIS-4 and reoccupied during MIS-3 (Van Peer 2001; Di Modica *et al.* 2011).

The 441 currently-known Belgian Middle Palaeolithic sites are characterised by generic Middle Palaeolithic traits such as the presence of various types of scrapers, notches and denticulates; and the use of Levallois and discoidal reduction techniques (Di Modica 2010, 2011a, 2011b). 184 of these sites also contain bifacial tools (Ruebens and Di Modica 2011) and hence Belgium is contributing a significant sample to this PhD study.

5.4.2 The bifacial entities

Bifacial tools form an important component of the Belgian Middle Palaeolithic record. This was first pointed out by Ulrix-Closset (1975) when she researched the rich record coming from the sites in the Meuse valley. A recent study provided the first full synthesis of bifacial tools present in Belgium, indicating that these tools occur all over the country, both on open-air and cave sites (Fig. 5.7) and with a concentration in the Meuse valley (Ruebens and Di Modica 2011).

Assigning these biface-rich assemblages to an industrial variant is often not very straightforward. Firstly, there are cave assemblages that represent palimpsests in which numerous individual occupation phases are condensed and can no longer be distinguished (e.g. Goyet, Spy and Trou Magrite). Secondly, many of the Belgian assemblages are too small to apply any quantitative methods (e.g. Vollezele and Kesselt) or lack sufficient contextual information (e.g. Rotselaar). Consequently, the Belgian bifacial entities are distinguished rather on an absence/presence basis of certain bifacial tool types. Overall, five different bifacial entities are currently being distinguished (Table 5.14).

Firstly, to stress the presence of a distinct bifacial component in the Late Middle Palaeolithic in the Meuse Valley, Ulrix-Closset defined a **Mousterian with bifacial retouch** (see Chapter 2; Ulrix-Closset 1975, 1990). This entity is characterised by a high frequency of bifacial retouch, resulting in an important percentage of handaxes, *racloirs-bifaces* (or backed bifaces) and leaf points. Besides small and undated collections, it also contains a few larger assemblages (e.g. Grotte du Docteur and Ramioul) (Ulrix-Closset 1973, 1975).

Secondly, Van Peer (2001) emphasised the recurring presence of bifacial elements in the Belgian Middle Palaeolithic by assigning some assemblages to a **Charentian with Micoquian influences**, analogous to some sites in northern France (Chapter 2; Farizy 1995). In addition to scrapers, these collections are characterised by a variety of bifacial tools and leaf points. Examples are Vollezele (Vynckier *et al.* 1986), Sclayn (Otte *et al.* 1998), Remicourt (Bosquet *et al.* 1998) and Kesselt (Lauwers and Meijs 1985).

Entity	Occurrence	Characteristics	Main sites
Mousterian with bifacial retouch	both open-air and cave sites	high frequency of bifacial retouch	Grotte du Docteur, Ramioul
Charentian with Micoquian influence	both open-air and cave sites	variety of bifacial tools, including leaf points	Vollezele, Sclayn, Remicourt, Kesselt
Mousterian of Acheulean Tradition (MTA) influence	both open-air and cave sites	small, symmetric handaxes	Kemmelberg, Trou Magrite, Spy, Ottenburg, Sainte-Walburge, Franquenies, Rotselaar
Leaf point group	cave sites	Leaf points	Couvin - Trou de l'Abîme
mixed' entity	both open-air and cave sites	classic handaxes and asymmetric bifacial tools	Aalter Hageland/Nieuwendam, Goyet, Snauwenberg, Oosthoven

Table 5.14: *Overview of the different types of biface-rich entities present in Belgium and the main assemblages that have been assigned to them*

Thirdly, well-contextualised classic **Mousterian of Acheulean Tradition** sites, dominated by classic handaxes, do not occur in Belgium. Assemblages with an MTA affinity, in terms of the presence of cordiform or triangular handaxes, do occur all over the country. Besides some single finds (e.g. Kemmelberg (Crombé and Van der Haegen 1994), also several stratified and larger surface collections can be classified as having a strong MTA affinity (e.g. Trou Magrite and Spy (Ulrix-Closset 1975); Ottenburg (Van Peer 1986); Sainte-Walburge (Roebroeks 1981); Franquenies (Michel and Haesaerts 1975) and Rotselaar (Van Peer 1982)) but these lack in contextual and chronostratigraphic information.

Fourthly, assemblages in which ***Keilmessergruppe* elements** (*Keilmesser* and leaf-shaped bifacial tools) occur in dominating proportions as in Central Europe are absent in Belgium. Therefore it can be stated that a clear KMG is missing in Belgium. The surface collections of Aalter (Crombé and Van Der Haegen 1994; Van der Haegen *et al.* 1999) for example do contain handaxes, bifacial scrapers and leaf-shaped artefacts, but cannot be classified as KMG because of the lack of *Keilmesser*.

A KMG influence is evidently present in assemblages from all areas of the country and several sites seem to contain a real **mix of Mousterian and KMG bifacial elements**. These sites are characterised by a high use of the bifacial retouch technique resulting in a high occurrence of bifacial scrapers, handaxes, backed bifaces (*Keilmesser*) and leaf-shaped artefacts. A distinction can further be made between assemblages where these bifacial elements occur in low numbers (e.g. Kesselt (Lauwers and Meijs 1985), Vollezele (Vynckier *et al.* 1986), Veldwezelt (Bringmans 2006), Ottenburg (Van Peer 1986), Kemmelberg (Crombé and Van der Haegen 1994), Aalter Hageland/Nieuwenland (Van der Haegen *et al.* 1999), Goyet (Toussaint *et al.* 1998) and Snauwenberg (Kolen *et al.* 1999) and where they dominate the toolkit (Oosthoven (Ruebens and Van Peer 2011, Grotte du Docteur and Ramioul (Ulrix-Closset 1975)).

Finally, there are assemblages that contain delicate **bifacial foliates**. Currently, the site of Couvin-*Trou de l'Abîme* (Cattelain *et al.* 1986, 2011) is the only clear example of this Late Middle Palaeolithic leaf point industry in Belgium (Pirson 2011), an entity which is otherwise beyond the scope of this thesis (Chapter 2).

5.4.3 The studied assemblages

To represent the variable nature of the Belgian bifacial record, two assemblages which contain a high proportion and different types of bifacial tools were analysed in detail; the open-air site of Oosthoven, characterised by an abundance of small bifaces of different types; and the cave site of Grotte du Docteur, where the bifacial retouch technique is more widely applied.

OOSTHOVEN-*HEIEINDE*

- ***Location***

The open-air site of Oosthoven-*Heieinde* is situated two kilometres north of the village centre of Oosthoven (Fig. 5.8), northwest of the nature reserve '*De Liereman*' where other Palaeolithic artefacts have more recently been discovered (Meirsman *et al.* 2008). The terrain slopes gently, culminating at 31 meters above sea level, adjacent to a small stream known as '*Oosthovense Loop*'. Several lithic artefacts were found exposed on the southern slope surface between 25 and 26 meters asl, suggesting the outcrop of Pleistocene sediments at this location due to slope evolution.

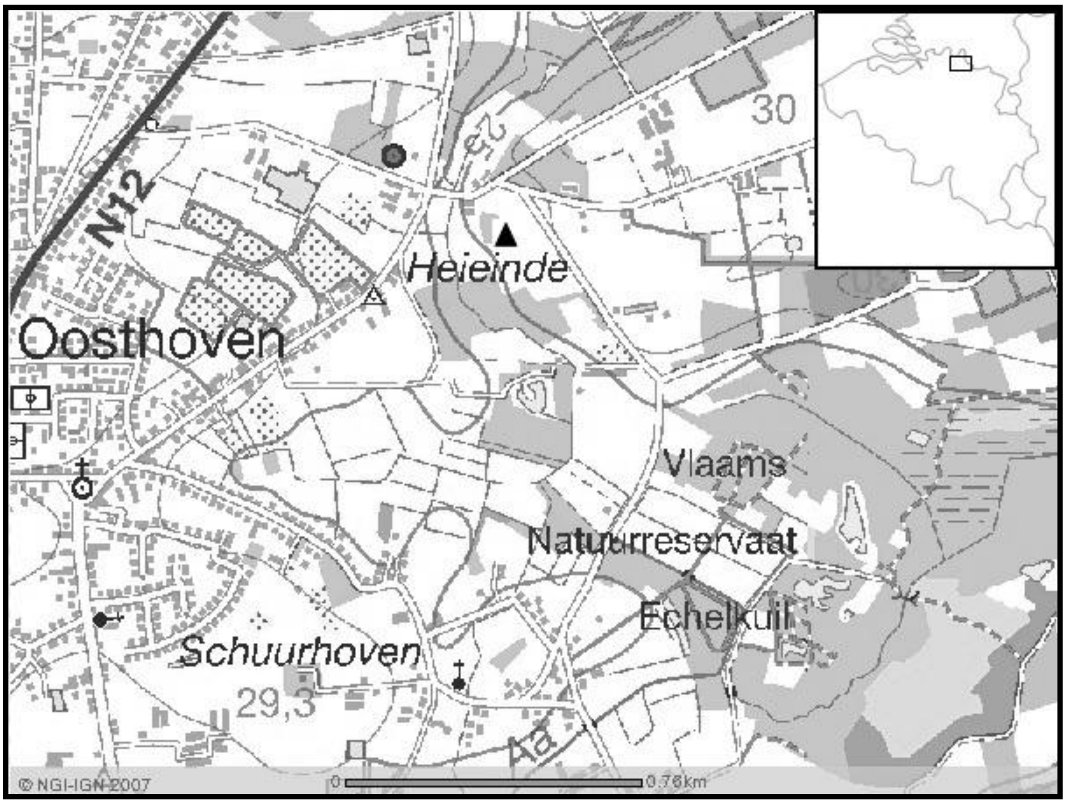


Fig. 5.8: *Location of the site of Oosthoven - Heieinde (▲, Oud-Turnhout, Northern Campine, Belgium)*

- ***History of research***

During field walking around Oosthoven several Palaeolithic artefacts were discovered and identified by amateur-archaeologists (Van Peer and Verbeek 1994). The artefacts were reported to the Katholieke Universiteit Leuven and in the spring of 1993 several test pits were opened to understand the stratigraphic origin of the artefacts. Subsequently, a season of excavation took place under the direction of Professor Van Peer covering 200m² (Van Peer and Verbeek 1994).

- ***Site formation and stratigrahy***

The test pits indicated that some of the flint artefacts were still in buried position (Fig. 5.9), and associated with a thin erosion layer on top of a unit of sands (Ruebens 2005).

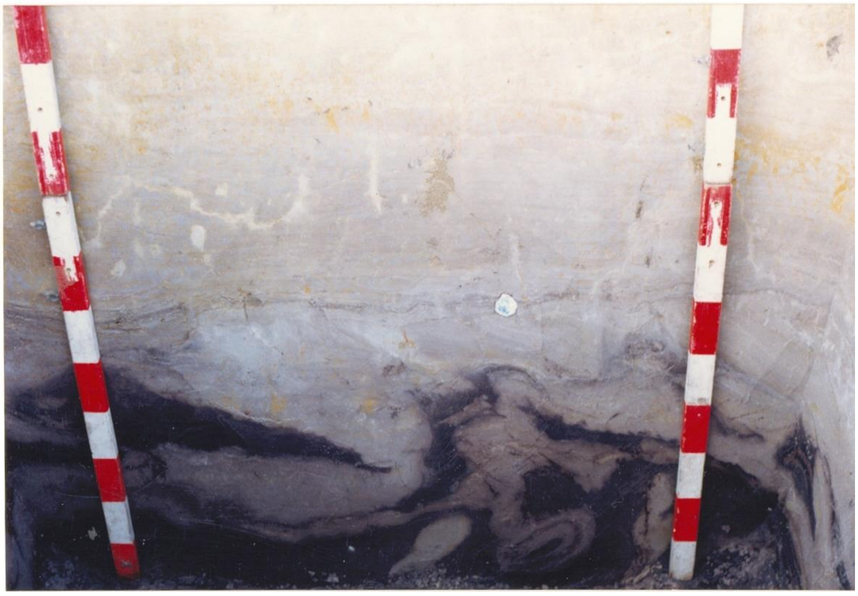


__Fig. 5.9:__ *Stratigraphic section of one of the test puts at the site at Oosthoven (Ruebens 2005)*

Within the larger excavation trench six main stratigraphic units could be distinguished (Fig. 5.10; Van Peer and Verbeek 1994). The layering in unit D is linked with a system of gullies flowing in a southwestern direction. These gullies have been filled with redeposited sediments from unit E, interpolated with grey loam layers. In the southern part of the excavation trench the sequence is slightly different with unit D being absent and the erosional layer truncating the tops of units E and F.

In the northern part of the trench the lithics are found predominantly at the base of the layered sands (unit D) while in the southern part the lithic artefacts are associated with this erosional gravel layer. This erosional level is lying on top of an undisturbed peat layer and it can be assumed that originally the artefacts were associated with this peat layer. The topography of this peat unit indicates the presence of a slight depression. Furthermore the artefacts found in clear association with the peat layer are unpatinated and very fresh, suggesting an *in situ* position while the other artefacts have been more reworked by taphonomic processes (Van Peer and Verbeek 1994).

A: plough zone

C: orange-yellow consolidated sands, with thin layers of grey loam and numerous frost cracks

D: grey sands with horizontal layering, truncated by an erosional level represented by dispersed gravels (only present in northern part of trench)

E: grey homogenous coarse sands, heavily cryoturbated

F: cryoturbated peat

G: homogenous green sands

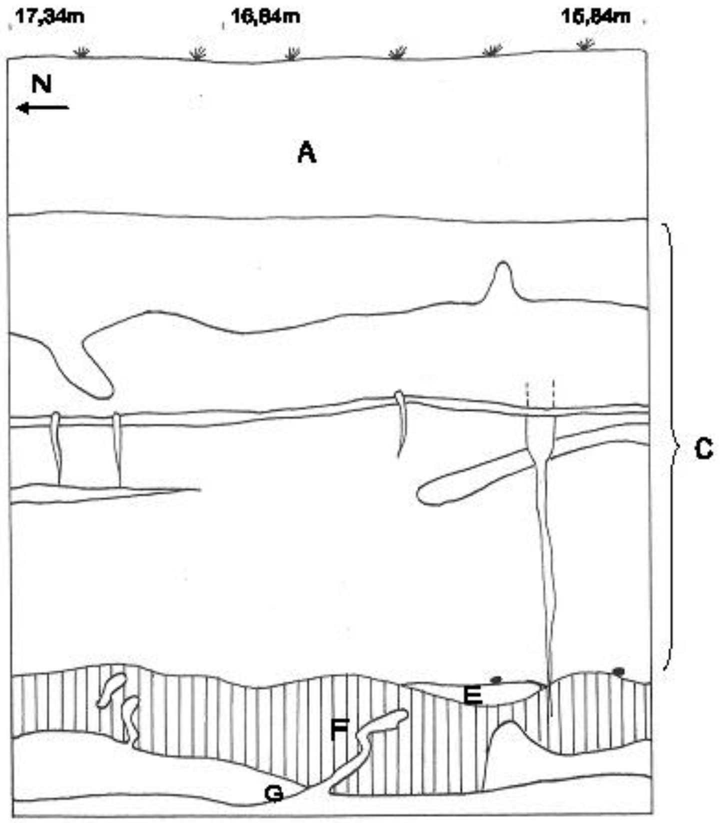


Fig. 5.10: *Stratigraphic section of the southern part of the excavation trench at Oosthoven*

- ***Chronological position***

Two samples, a piece of charcoal from the erosional layer (UtC-3315) and a fragment of wood from the peat layer (UtC-3316), were radiocarbon dated but delivered indecisive results (Van Peer and Verbeek 1994). The exact chronological position of Oosthoven remains unknown but based on the correlation with the peat layer a position within an interstadial during the Late Middle Palaeolithic has been suggested (Ruebens 2005, 2006).

- ***Palaeoecological context***

Besides one undetermined tooth fragment, no faunal remains are preserved at Oosthoven. Charcoal was found in association with the lithics, suggesting the presence of a combustion feature (Ruebens and Van Peer 2011), but no further palaeoecological studies have were conducted.

- ***The lithic assemblage***

The majority of the artefacts were found in the southern part of the trench, in association with the peat layer. In total 107 lithic artefacts were recovered, most are heavily patinated but the edges are generally fresh. Most of the artefacts are made on locally available flint (98,1%), although one sandstone and one quartzite artefact are present as well. The flint is generally of high quality although some artefacts are made on frost fragments indicating a secondary context origin (e.g. from nearby river gravels) (Ruebens and Van Peer 2011).

Different reduction methods were used to obtain flakes from the flint nodules, including laminar, discoidal and Levallois techniques (Ruebens 2005). The presence of several retouch and biface thinning flakes further indicates that the knapping took place on the site itself. The assemblage contains 22 flake tools, including 11 side scrapers of which three have been bifacially retouched. One Mousterian point, made on a Levallois flake, one backed knife, one atypical burin, one denticulate and several pieces with abrupt retouch complete the toolkit. The most characteristic feature of the Oosthoven assemblage is the presence of 18 bifacial tools of various types (Fig. 5.11).

- ***New analysis - bifacial tools***

The Oosthoven material is currently held at the Katholieke Universiteit Leuven and the complete collection was studied. In total 21 tools have been bifacially worked, representing 19.6% of the Oosthoven toolkit. Besides three bifacial scrapers, which are only bifacially retouched along one edge, eighteen tools are more covering bifacially retouched and have been analysed in more detail.

The Oosthoven bifacial tools are first of all characterised by their small dimensions. Their maximum average length is 42.13mm and all length measurements fall within 30 and 50mm (Table 5.15).

OOSTHOVEN (n:16)	Min.	Max.	Mean	Average	St. Dev
Max. Length (mm)	32.00	52.00	43.00	42.13	6.35
Max. Width (mm)	29.00	45.00	32.50	33.50	4.49
Max. Thickness (mm)	9.00	19.00	14.00	14.44	3.20

Table 5.15: *Linear measurements of the bifacial tools from Oosthoven*

The technological attributes of the Oosthoven bifaces indicate that they were made both on flake blanks and by form shaping (façonnage) (Table 5.16). Most pieces still contain a small cortex remnant, often in the form of a cortical base. The dominant edge angles on the bifacial tools fall within 35 and 65 degrees and few pieces have angles less than 35 degrees. The cross sections are most often of plano-convex type although some bi-convex pieces are also present (Table 5.16).

OOSTHOVEN	Technological Attributes									
Cortex	**none**		**1-25%**		**25-50%**		**50-75%**		**75-100%**	
	10	47.6%	10	47.6%	1	4.8%	0	0.0%	0	0.0%
Cross section	**Plano-convex**		**Bi-convex**		**Bi-plano**		**Plano-convex/ plano-convex**		**Irregular**	
	8	38.1%	4	19.0%	0	0.00%	0	0.00%	5	27.78%
Blank	**Flake**		**Nodule**		**Unknown**					
	7	33.3%	5	23.8%	9	42.9%				
Edge angles	**<35**		**35-65**		**>65**					
	4	30.8%	9	69.2%	0	0.00%				

Table 5.16: *Technological attributes of the bifacial tools from Oosthoven*

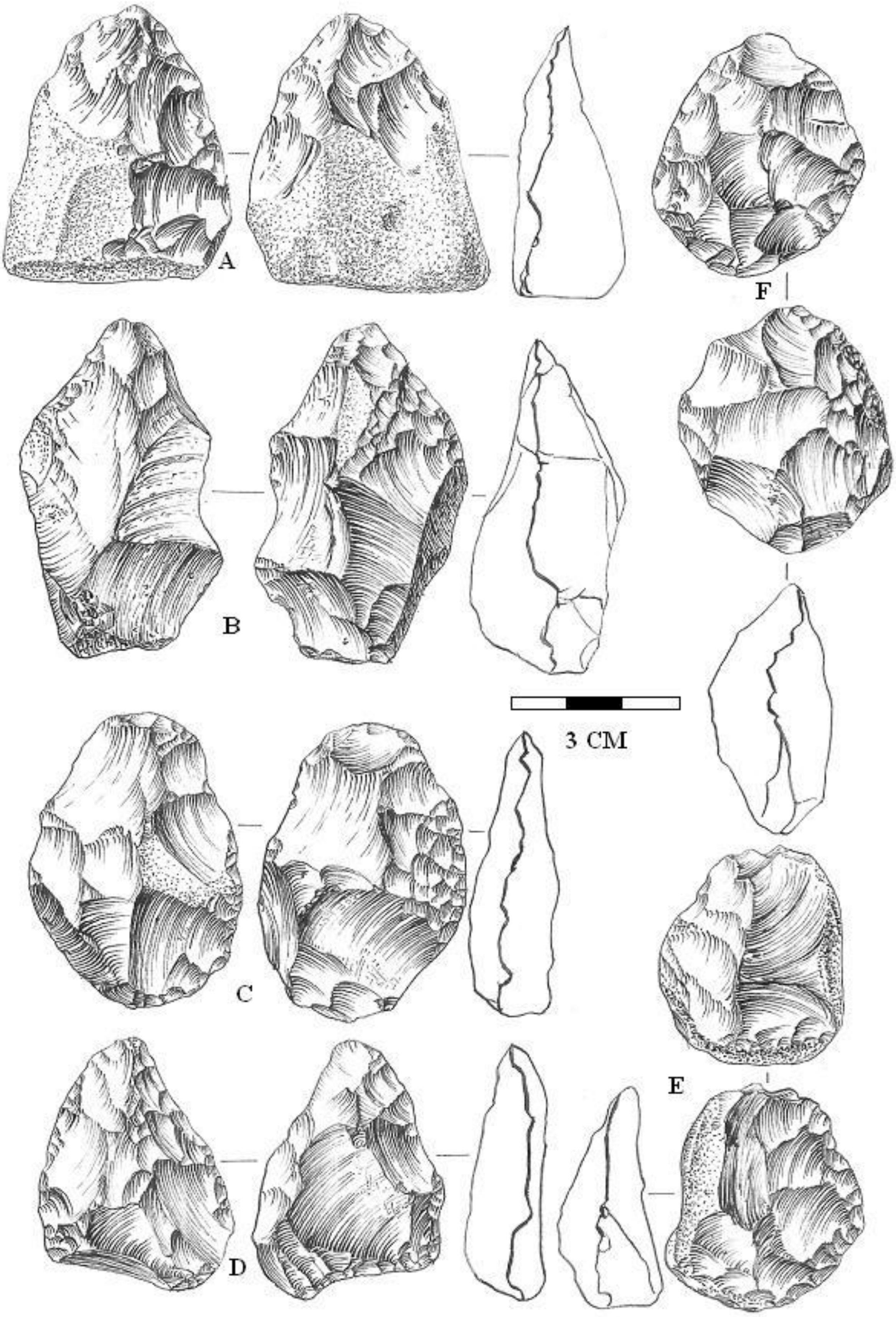


Fig. 5.11: *A-F: Bifacial tools from Oosthoven (after Van Peer and Verbeek 1994)*

In terms of typology four main groups of bifacial tools are present at this site (Table 5.17). Backed bifacial tools are most common, followed by classic handaxes, unifaces and bifacial scrapers, indicating the varied nature of the bifacial tools present in the Oosthoven assemblage.

OOSTHOVEN (n:18)	BIFACIAL TYPOLOGY	
Classic handaxes	4	22.2%
Backed bifacial tools	7	38.9%
Leaf-shaped bifacial tools	0	0.00%
Backed bifaces	4	22.2%
Bifacial scrapers	3	16.7%
TOTAL	**18**	**100.00%**

Table 5.17: *New simplified classification of the bifacial tools from Oosthoven*

- ***Site Interpretation***

The Middle Palaeolithic site of Oosthoven is located on a sandy slope near a small river in the northern part of Belgium. During a warmer phase in the last glacial cycle Neanderthals visited this location and left behind a lithic assemblage characterised by the use of discoidal, laminar and Levallois reduction methods and a toolkit dominated by side scrapers and bifaces. These bifaces have rather small dimensions and both back and symmetric types are present. This dominance and variety of bifacial tools give Oosthoven a very specific character, evoking links with both the MTA and KMG industries. Despite its relatively small size and poor chrono-stratigraphic position, this site is a good example of an assemblage that questions the classic MTA – KMG distinction and does not fit into the current framework of Middle Palaeolithic bifacial entities. Moreover this site has the potential to be re-examined in many ways, including new fieldwork and dates (Ruebens and Van Peer 2011).

GROTTE DU DOCTEUR

- ***Location***

The cave 'Grotte du Docteur' is situated in the valley of the small Roua river, close to its confluence with the Méhaigne (a tributary of the Meuse), near Huccorgne, in Southern Belgium (Fig. 5.12) (Ulrix-Closset 1973, 1975; Miller *et al.* 1998).

- ***History of research***

The site was discovered by, and name after, doctor F. Tihon in 1886. He immediately started excavation at the cave and together with J. Fraipont removed over 900m2 of sediment from the cave. A few years later E. Doudou undertook some further excavations. In the 1970s J. Detexhe and J. Haeck dug two test pits to further investigate the site (Di Modica 2010) and most recently, in 1998, the Université de Liege undertook new work to gain a better understanding of the stratigraphic sequence (Miller *et al.* 1998 and 1999).

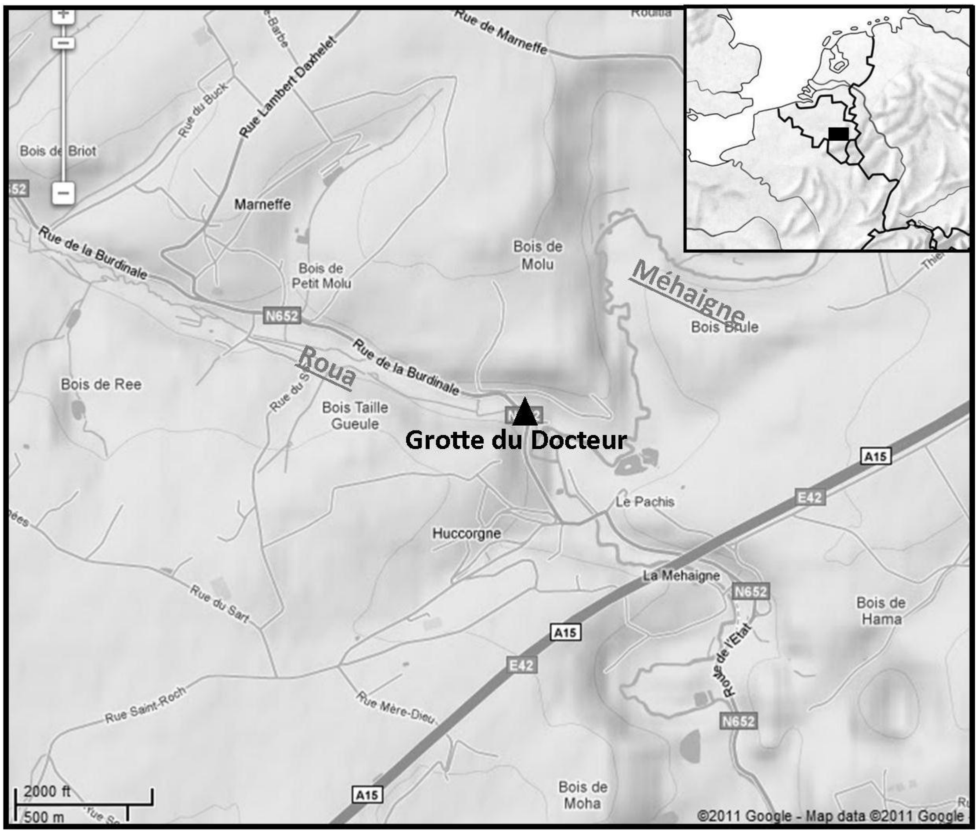


Fig. 5.12: *Location of the cave site of Grotte du Docteur (Southern Belgium)*

- ***Site formation and stratigraphy***

Grotte du Docteur comprises a deep stratigraphic sequence, ranging from the Middle Palaeolithic to the Neolithic (Miller *et al.* 1998). The original excavators distinguished 5 main stratigraphic units. Layer 2 (later reclassified by Miller as layer 4) consists of Middle Palaeolithic stone tools and abundant faunal remains, and is the one relevant to this study. It is very likely that the lithic assemblages from Grotte du Docteur have undergone some reworking, and even mixing, since their original discard. This is indicated by the worn edges and large number of broken artefact (see also Chapter 6). This reworking can be linked to both the hyena occupation of the site and the continuous influx of sediment and rainwater in the cave (Miller *et al.* 1998).

- ***Chronological position***

Although several bone samples from throughout the stratigraphic sequence were radiometrically dated, there are no unambiguous absolute dates available for the Middle Palaeolithic layer. Together with the presence of a few Gravettian and Magdalenian artefacts and bone tools, this demonstrates the palimpsest nature of the Grotte du Docteur assemblages (Di Modica 2010).

- ***Palaeoecological context***

Within the Middle Palaeolithic layer over 5,000 faunal remains were recovered representing 19 different animal species. Horse (*Equus sp.*) is by far the best-represented species with an MNI of 124, followed by hyena (*Crocuta crocuta)*, rhinoceros (*Coelodonta antiquitatis*), bovids and mammoths (*Mammuthus primigenius*) (Miller *et al.* 1998).

- ***The lithic assemblage***

1,600 lithic artefacts were discovered at the cave of Grotte du Docteur. These are made on flint coming from local sources and the most diagnostic characteristics are the use of the Levallois and discoidal flaking techniques, the presence of scrapers and the wide application of bifacial retouch. When M. Ulrix-Closset reanalysed the Grotte du Docteur assemblage only 230 pieces could be located, indicating that a lot of material got lost after the excavation (Ulrix-Closset 1973). She noted in the collection the presence of very large flake blanks (>15cm), which could easily be retouched in a variety of (bifacial) tools. Although the collection of Grotte du Docteur is primarily characterised by a wide application of the bifacial retouch technique, also a variety of unifacial tools are present, including various scraper forms (single, double, end, transverse, offset and convergent), notches, denticulates and retouched points.

Because of the large variety of bifacial tools present, this assemblage has in the past been classified as 'Mousterian with bifacial retouch' (Ulrix-Closset 1973) and more recently been linked to the German *Keilmessergruppe* (Jöris 2004, 2006).

- ***New analysis - the bifacial tools***

The Middle Palaeolithic assemblage of Grotte du Docteur is currently held at both the Université de Liège and the Musée Curtius (also in Liège, Belgium). All the artefacts present in both collections were included in the data analysis. During the most recent excavation campaign (1998-1999) only few Middle Palaeolithic artefacts were recovered, not including any bifacially flaked tools. Therefore this material was not analysed in detail.

In previous studies of the Grotte du Docteur collection it has been stated that around 40% of the tools are bifacially retouched, including bifaces, backed bifaces and foliates. During my data collection trip 45 bifacial tools were available to study and analysed in detail. 9 were broken and therefore not all attributes could be recorded. The dimensions of the Grotte du Docteur bifaces range between 39 and 112 mm and are on average 71.00mm long, 46.14mm wide and 20.42mm thick (Table 5.18). For 22 bifacial tools the type of blank used could be recognised. Half of the bifacial tools were made on nodules and pebbles, while the other half is made on (non-Levallois) flakes (Table 5.19).

Grotte du Docteur (n:36)	Min.	Max.	Median	Average	St. Dev
Max. Length (mm)	39.00	112.00	71.00	71.00	20.55
Max. Width (mm)	32.00	81.00	45.00	46.14	10.30
Max. Thickness (mm)	11.00	39.00	20.00	20.42	6.45

Table 5.18: *Linear measurements of the bifacial tools from Grotte du Docteur*

Only 7 of the 36 unbroken bifacial tools (19%) do not contain any cortex remnant (table 5.19). In general the majority of the artefacts (58%) contain a small amount of cortex (<25%). Several artefacts (19%) show a larger cortex remnant and only one piece (3%) has cortex over more than 50% of its surface.

Grotte du Docteur	Technological Attributes									
Cortex	**none**		**1-25%**		**25-50%**		**50-75%**		**75-100%**	
	7	19.4%	21	58.3%	7	19.4%	1	2.8%	0	0.00%
Cross section	**Plano-convex**		**Bi-convex**		**Bi-plano**		**Plano-convex/ plano-convex**		**Irregular**	
	26	57.8%	9	20.0%	0	0.0%	0	0.0%	10	22.2%
Blank	**Flake**		**Nodule**		**Unknown**					
	11	24.4%	11	24.4%	23	51.1%				
Edge angles	**<35**		**35-65**		**>65**					
	8	19.5%	27	65.9%	6	14.6%				

Table 5.19: *Technological attributes of the bifacial tools from Grotte du Docteur*

The large majority (65%) of the edges had angles between 35 and 65 degrees (Table 5.19). Only 6 tools (15%) exhibited edge angles of more than 65°. The cross-sections of all the unbroken bifacial tools were registered (Table 5.19). Over 57% of the tools had a plano-convex section while around 20% have a biconvex section. The 22% irregular sections relate to sections which were very variable and difficult to classify.

Next, the analysed bifacial tools from Grotte du Docteur were matched with the simplified typological framework created in Chapter 4. Both classic and backed bifaces (natural prehensile back opposite a bifacially retouched cutting edge) form important parts of the collection (26 and 34% respectively). Furthermore also leaf-shaped bifacial artefacts form a significant presence (21%) whilst bifacial scrapers and partial bifaces occur less frequent (11 and 8%).

Grotte du Docteur (n:38)	BIFACIAL TYPOLOGY	
Classic handaxes	10	26.3%
Backed bifacial tools	13	34.2%
Leaf-shaped bifacial tools	8	21.1%
Partial bifaces	3	7.9%
Bifacial scrapers	4	10.5%
TOTAL	38	100.0%

Table 5.20: *New simplified classification of the bifacial tools from Grotte du Docteur*

- ***Site Interpretation***

The cave of Grotte du Docteur was frequented by Neanderthals, based on the stratigraphy and characteristics of the lithics, probably during the Late Middle Palaeolithic (MIS 5-3). The location provided good shelter, a variety of subsistence resources (both in the river valley and on the plateau) and there were abundant outcrops of flint nearby. The complete production sequence (*chaîne opératoire*) is present at this location resulting in a large amount of discarded stone tools. The majority of these artefacts are patinated and most of the edges are slightly worn indicating that the assemblage has undergone some reworking before it final deposition. Neanderthals knapped at Grotte du Docteur flint nodules collected from local primary sources and used several reduction methods (including Levallois and discoidal techniques) to obtain flakes. These flakes were then further retouched into tools. The wide use of the bifacial retouch technique is remarkable, although unifacial tools occur as well (mainly scrapers and some notches, denticulates and points).

Within the bifacial tools a variety of types occur, manufactured on both flakes and nodules. Three main bifacial tool categories are present (symmetric bifaces, backed bifaces and leaf-shaped bifacial tools). Furthermore the assemblage also comprises some bifacial scrapers and unifaces. The large variety within these bifacially flaked tools (different sizes, sections and outline shapes) indicates that the bifacial retouch method was applied to all blanks available and not restricted to one specific type and therefore Ulrix-Closset's attribution to a Mousterian with bifacial retouch is in my opinion justified, representing 'mixed' assemblages which are neither MTA, neither KMG.

5.4.4 Discussion

A large variety of bifacial tools is present on sites all over Belgium. In addition to the reanalyses of Oosthoven and Grotte du Docteur, data from 18 other Belgian sites was collided to come to a more complete understanding of the Belgian late Middle Palaeolithic bifacial tools (Table 5.21a and 5.21b).

- *Chronology and environment*

In Belgium Late Middle Palaeolithic bifacial tools have been recovered both from open-air and cave settings, and both in stratified position and as surface material (Table 5.21a). Environmental information is available for some sites and overall it is seen that Neanderthals occupied Belgium in a mosaic of different environmental and temporal settings (Di Modica 2010).

Interpreting these Belgian biface-rich assemblages is in many cases hampered by a lack of detailed chrono-stratigraphic understanding and therefore the Belgian record does not allow reconstructing a detailed chronological framework for these biface-rich sites. The Belgian record has suffered from old excavations techniques and is therefore poorly understood in terms of precise chronology. From the 442 Belgian Middle Palaeolithic find spots only 26 contain sufficient chronostratigraphic information (Pirson and Di Modica 2011) and from these 26 only 2 comprise bifacial tools. One bifacial foliate has been recovered from Veldwezelt-Hezerwater VBLB which can be placed in MIS-5b and the two handaxes from Sclayn layer Ia date to MIS-3. Furthermore the poorly published handaxe series from Godarville can be assigned to MIS 5d-a (Ruebens and Di Modica 2011). Overall the chronographic information that is currently available does indicate that during the Late Middle Palaeolithic bifacial tools formed an important component of the Neanderthal toolkit, and this both during MIS-5 and MIS-3 (Table 5.21a).

SITE	LOCATION	LAYER	DATE	FAUNA	ENVIRONMENT	MAIN REFERENCE
Aalter Hageland	open-air	surface	MIS 5-3	–	–	Crombé and Van Der Haegen 1994
Aalter Nieuwendam	open-air	surface	MIS 5-3	–	–	Crombé and Van Der Haegen 1994
Couvin	cave		MIS-3	bovids, horse	temperate	Pirson *et al.* 2009
Franquenies	open-air	–	MIS 5a/4	–	–	Michel and Haesaerts 1975
Goyet	cave	–	unknown	–	–	Toussaint *et al*. 1998
Grotte du Docteur	cave	–	unknown	horse, rhinoceros, bovid, mammoth	temperate	Ulrix-Closset 1973
Kemmelberg	open-air	–	unknown	–	–	Crombé and Van Der Haegen 1994
Kesselt	open-air	–	MIS 4/3	woolly rhinoceros, horse, deer, bison	cold	Lauwers and Meijs 1985
Oosthoven	open-air	–	MIS 5-3	–	moderate	Ruebens 2005
Ottenburg	open-air	surface	unknown	–	–	Van Peer 1986
Ramioul	cave	–	unknown	–	–	Ulrix-Closset 1975
Rotselaar	open-air	surface	unknown	–	–	Van Peer 1982
Sainte-Walburge	open-air	–	unknown	–	–	Ulrix-Closset 1975
Sclayn	cave	Ia	MIS-3	–	–	Otte *et al.* 1998
Snauwenberg	open-air	–	unknown	–	–	Kolen *et al.* 1999
Spy	cave	–	unknown	–	–	Ulrix-Closset 1975
Trou Magrite	cave	–	unknown	–	–	Ulrix-Closset 1975
Veldwezelt-Hezerwater	open-air	VBLB	MIS 5a/4	–	–	Bringmans 2006
Vollezele-Congoberg	open-air	–	MIS-5	bovids, horse	–	Vynckier *et al.* 1986

Table 5.21a: *Overview of the characteristics of the main Belgian sites rich in bifacial tools, their location, data, fauna and environment*

- *Lithic variability*

The Belgian Late Middle Palaeolithic bifacial tools are predominantly produced on flint; only at the site of Franquenies phtanite is the dominant raw material (Table 5.21b). The Belgian assemblages are of relative large size, containing several hundreds of lithic artefacts. Conversely, the amount of bifacial tools is very variable and ranges from 1 to 78 (Table 5.21b). Although bifacial tools are common they often occur in rather small numbers (10 sites have less than 10 bifacial tools). The Levallois method was used in the vast majority of the assemblages; discoidal and laminar techniques are also common. A wide array of unifacial tools occurs at most sites, including scrapers and points.

The two assemblages that were analysed in detail, Oosthoven and Grotte du Docteur, are good examples of the type of bifacial variability that occurs in Belgium. Both these assemblages contain a mix of bifacial scrapers, classic handaxes, backed bifacial tools and partial bifaces. A lot of variety is furthermore present in terms of the used blanks, metric dimensions, cross-sections and outline shapes. This shows that, especially at Grotte du Docteur, the bifacial retouch was applied to a variety of blanks.

SITE	DOMINANT RAW MATERIAL	ASSEMBLAGE SIZE	FLAKING METHODS	FLAKE TOOLS	BIFACIAL TOOLS	Classic	Backed	Leafshaped	Partial	Bif. Scraper
Aalter Hageland	flint	300	Levallois, discoidal	scrapers, backed knives, limaces	15	√	–	–	–	√
Aalter Nieuwendam	flint	300	Levallois, discoidal	scrapers	7	√	–	–	–	√
Couvin	flint	?	laminar	unifacial leaf points	7	–	–	√	–	–
Franquenies	phtanite	>1,000	Levallois	scrapers	>3	√	–	–	–	–
Goyet	flint	?	Levallois	scrapers, limaces	28	√	√	–	–	–
Grotte du Docteur	flint	230	Levallois, discoidal	scrapers, points, notches, denticulates	48	√	√	√	–	–
Kemmelberg	flint	?	Levallois, discoidal	scraprs, points, backed knives, denticulates, notches	>5	√	√	–	–	–
Kesselt	flint	700	Levallois, discoidal, laminar	scrapers	6	√	–	√	–	–
Oosthoven	flint	107	Levallois, discoidal, laminar	scrapers, point, denticulate	21	√	√	–	√	√
Ottenburg	flint	–	Levallois		>5	√	–	–	–	√
Ramioul	flint	?	Levallois	scrapers, notches, denticulates	15	√	√	–	–	–
Rotselaar	flint	180	Levallois, laminar	scrapers	8	√	–	–	–	–
Sainte-Walburge	flint	8,000	Levallois, laminar	scrapers, points, backed knives	>20	√	√	–	–	–
Sclayn	flint	?	Levallois, laminar	scrapers, backed knives, notches, denticulates	2	√	–	–	–	–
Snauwenberg	flint	1,000	Levallois, discoidal	?	>20	–	√	–	–	√
Spy	flint	?	?	?	78	√	√	-	-	-
Trou Magrite	flint	?	?	scrapers, points, backed knives, notches, denticulates	40	√	–	–	–	–
Veldwezelt-Hezerwater	flint	350	Levallois, laminar	scrapers	1	–	–	√	–	–
Vollezele-Congoberg	flint	>1,000	Levallois, discoidal, laminar	scrapers, points, notches, denticulates, nat backed knives	5	√	–	√	-	√

<u>**Table 5.21b**</u>: *Overview of the characteristics of the main Belgian sites rich in bifacial tools and their lithic assemblages*

When adding the data from the other 17 Belgian sites to this picture (Table 5.21b) it becomes clear that on all but three sites classic handaxes occur, making this the most common bifacial tool type in Belgium, followed by backed bifacial tools and bifacial scrapers. Leaf-shaped pieces also occur regularly while partial bifaces are rarer. Furthermore it is noted that these backed bifacial tools nearly always occur in combination with classic handaxe types. Taking this into account, I suggest a two-fold distinction for the Belgian assemblages rich in Late Middle Palaeolithic bifacial tools:

- Assemblages with classic handaxes
- Assemblages with a mix of bifacial tools, including backed and leaf-shaped tools

Firstly, several assemblages are dominated by classic handaxes, e.g. Franquenies, Trou Magrite and Rotselaar. Despite the fact that many of this type of assemblages comes from problematic contexts, in my opinion the rich Belgian record does provide enough evidence to argue in favour of the presence of an MTA entity in Belgium. Secondly, a large number of Belgian assemblages contains a mix of different bifacial tool types, such as classic handaxes, backed and leafshaped bifacial tools. It is remarkable that these backed bifacial tools nearly always occur alongside classic handaxes. This seem to indicate that while a clear KMG entity is absent in Belgium, since assemblages dominated by backed and/or leaf-shaped bifacial tools are absent, a clear KMG influence is present in the area, as illustrated by the low but common presence of backed and leaf-shaped bifacial tools.

These new analyses highlight that many Belgian Late Middle Palaeolithic sites contain a mix of bifacial tool types, noncompliant with the current framework of Middle Palaeolithic entities. They therefore question the nature of the MTA-KMG dichotomy (Ruebens 2007), making Belgium a crucial region to come to a better understanding of the characteristics and behavioural implications related to the Late Middle Palaeolithic bifacial tools.

5.5 Britain

5.5.1 Introduction

In comparison to continental Europe, the British Middle Palaeolithic is represented by a limited archaeological record. Moreover, our knowledge of this British Middle Palaeolithic record is hampered by the fact that the majority of the sites were excavated early on by antiquarians, resulting in bad sampling strategies, few radiometric dates and loss of material. More recently, some new excavations (e.g. Lynford (Boismier *et al.* 2003)) and interpretative summaries (e.g. White 2006; Scott 2010; Wragg Sykes 2009; White and Pettitt 2011; Pettitt and White 2012) have shed new light on the occupation of Britain by Neanderthals and show that despite the small sample size the record is still informative.

The British Middle Palaeolithic can be divided into an early (late MIS-9/early MIS-8 until early MIS-6) and late phase (British Mousterian, end MIS-4 until mid MIS-3 (60-35kya BP)) (White and Jacobi 2002), separated by a period of abandonment (MIS-6-4) (Ashton and Lewis 2002). In this PhD the focus will be on this second phase of occupation. Assemblages from this late Middle Palaeolithic phase occur all over the southern half of the country, as far north as Nottinghamshire (e.g. Creswell Crags) and also at offshore localities (e.g. area 240; Fig. 5.13).

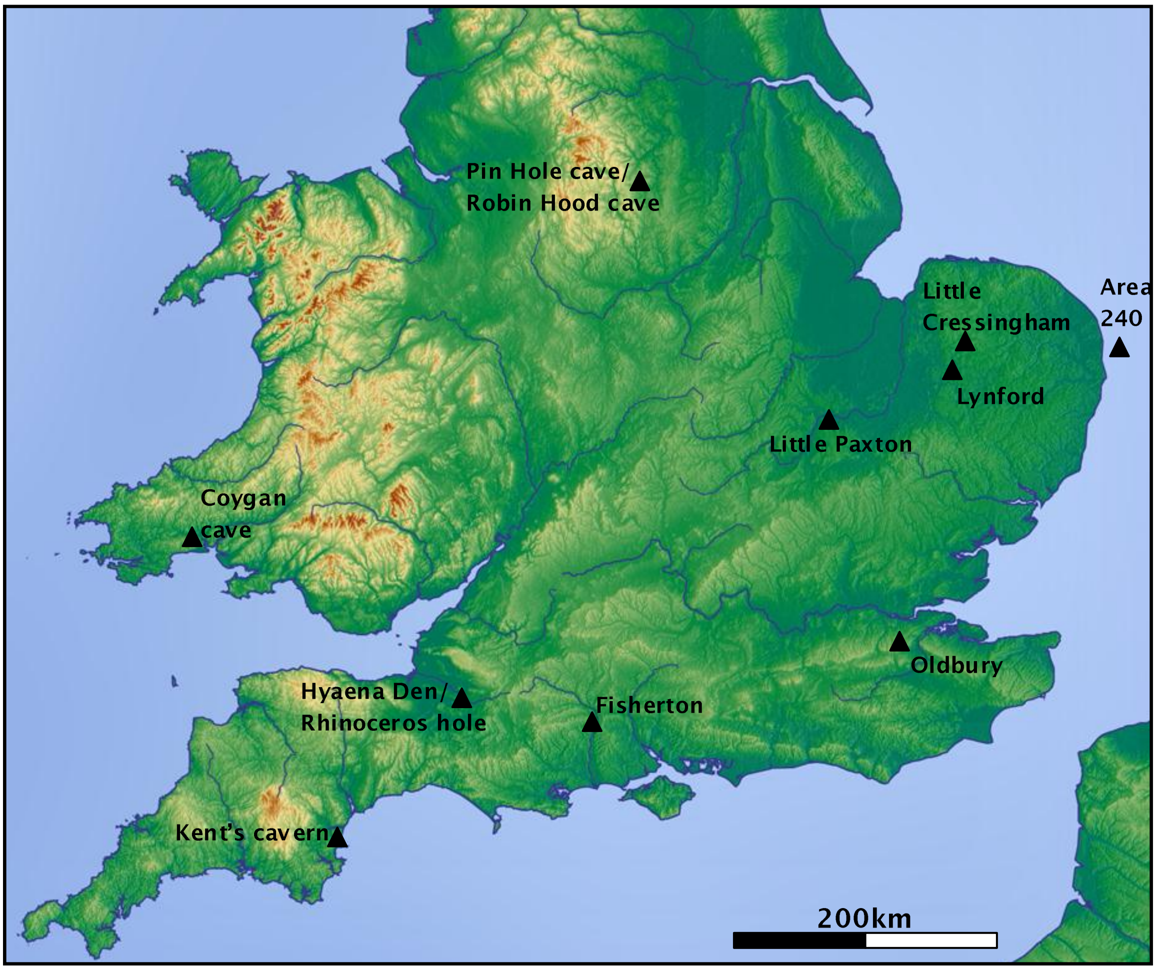


Fig. 5.13: *Location map with the main British Late Middle Palaeolithic find spots*

Both open-air and cave sites yielded late Middle Palaeolithic artefacts and concentrations of sites do seem to occur around the major river systems (e.g. Thames and Great Ouse) (White and Pettitt 2011). In general the British Late Middle Palaeolithic assemblages are rather homogenous and characterised by their rather small size, low occurrence of the Levallois technique and regular presence of bifaces. These assemblages seem to indicate that Britain was visited by small, highly mobile groups of Neanderthals during MIS-3 (Wragg Sykes 2009, 2010), a period for which it is presumed that Britain was connected to the European landmass (White and Pettitt 2011).

5.5.2 The bifacial entities

In general British Mousterian assemblages are not much different from their continental counterparts and are characterised by generic flake tool types (scrapers, points, notches and denticulates) and discoidal and Levallois flaking methods, although the latter does seem to be associated mainly with the Early Middle Palaeolithic phase, and not with Neanderthals. Several sites also contain bifacially flaked tools (Wragg Sykes 2010). The most diagnostic artefact hereby is the *bout coupé* handaxe, which can be seen as the hallmark of the re-colonisation of Britain by Neanderthal populations during MIS-4/3 (White and Jacobi 2002).

Bout coupé handaxes are defined as being roughly symmetrical, cordiform handaxes with a straight or slightly convex butt and two clear angles formed at the intersection of the butt and lateral margins (Fig. 5.14; White and Jacobi 2002). After a lot of debate (e.g. Coulson 1986) it is now generally accepted that these *bout coupé* handaxes are a genuine part of the archaeological record. Even though some variability exists within the *bout coupé* form, all these handaxes appear within distinct temporal and spatial limits (ca. 60-40kaBP, White and Jacobi 2002). *Bout coupé* handaxes have been recovered from over 145 findspots spread over Britain, from Devon to Derbyshire (Fig. 5.13) White and Pettitt 2011). Although the majority of *bout coupé* handaxes are isolated and/or surface finds (Tyldesley 1987), they give a good idea of the spread of the Mousterian over Britain, indicating a rather wide, but low-density, distribution, including both cave sites (e.g. Kent's Cavern (White and Pettitt 2011) and Coygan Cave (Aldhouse-Green *et al.* 1995) and open-air locations (e.g. Lynford (Boismier *et al.* 2003).

Fig. 5.14: *Bout coupé handaxes from Coygan Cave (photos taken by R. Wragg Sykes and used with permission)*

5.5.3 The studied assemblages

Larger, well-excavated Mousterian sites are rare in Britain. The main exception is the site of Lynford, which moreover contains a dominating proportion of bifacial tools and has therefore been selected to be studied in more detail.

LYNFORD

- ***Location***

The open-air site of Lynford (Mundford, Norfolk, Eastern England, Fig. 5.15) is located in a disused quarry on the southern side of the floodplain of the river Wissey (Boismier *et al.* 2012). Archaeological material is found in association with a palaeochannel feature which has been preserved over a length of 21 m with a maximum width of 12 m (Boismier *et al.* 2003).

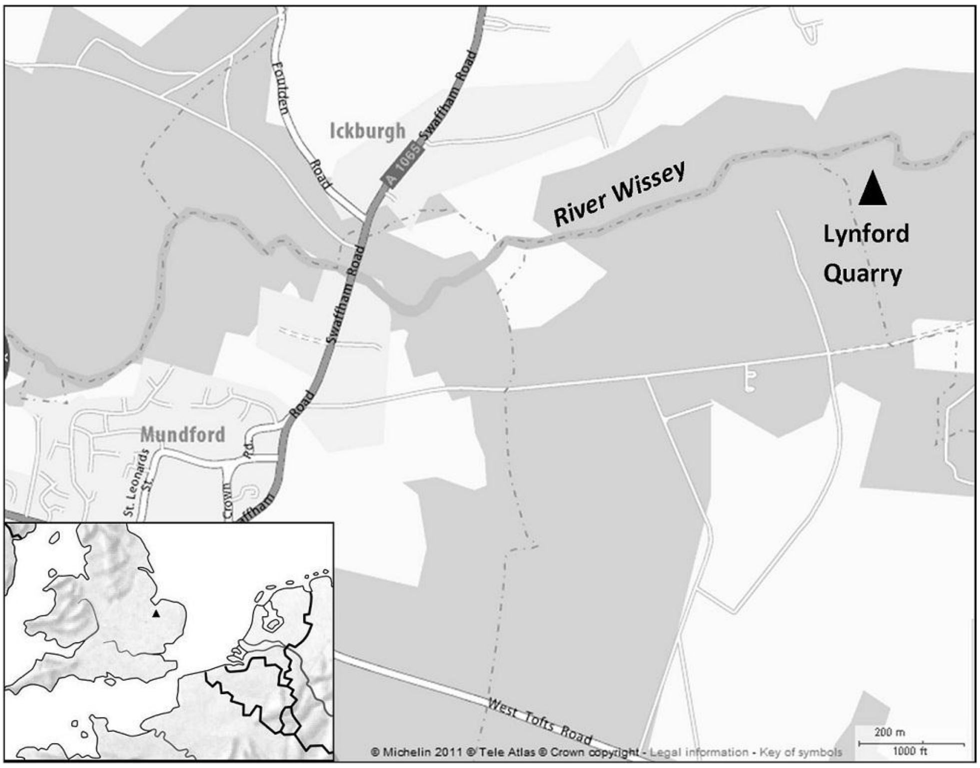


Fig. 5.15: *Location of the site of Lynford Quarry (Mundford, Norfolk, UK)*

- ***History of research***

During an archaeological watching brief at Lynford Quarry several mammoth remains and stone tools were noted. The site of Lynford was subsequently excavated during a 6-month campaign by the Norfolk Archaeology Unit in 2002 (Boismier *et al.* 2003). In total over 2,000 lithic artefacts and 35,000 faunal remains were recovered (Boismier *et al.* 2012).

- ***Site formation and stratigraphy***

The archaeological material was found in relation to a palaeochannel with a dark organic fill which is buried under 2-3 m of bedded sands and gravels. This palaeochannel feature can be interpreted as a cut-off from a meandering river channel representing a small basin or oxbow lake filled with standing or slow-moving water (Boismier *et al.* 2003).

The stratigraphic sequence at the site is threefold. Firstly there are basal deposits consisting of a series of gravel and sand-filled features of fluvial origin on top of chalk limestone bedrock. Next, there is a series of main palaeochannel deposits composed of a series of clay, sand and silt layers occasionally dispersed by coarse gravels. On top of these is dark organic sediment deposited by low-energy moving water containing the majority of the archaeological material (Boismier *et al.* 2003).

Overall the Lynford site can be seen as a palimpsest accumulation of material caused by different episodes of bank collapse, mud or debris flow and general fluvial activity (Boismier *et al.* 2003). Both the faunal and lithic materials suggest a secondary context but with no major fluvial transport (White 2012).

- ***Chronological position***

A series of OSL dates have been conducted throughout the stratigraphic sequence. The basal deposits came back with a result of 83,000 ± 8,000 BP (OxL-1337). The sediments containing the majority of the artefacts have delivered dates of 64,000 ± 5,000 BP and 67,000 ± 5,000 BP, indicating a MIS-3 date for the channel and its infill. Finally the upper deposits have also been dated to MIS-3 age (OSL: 55,000 ± 4,000 BP) (Boismier *et al.* 2003). More recently also two samples of woolly mammoth have been dated by AMS C14 methods (results of >49,700 and 53,700 ± 3,100) indicating that the true age of the site is over 50,000 years (Schreve *et al.* 2012).

- ***Palaeoecological context***

The rich amount of palaeobiological and palaeoenvironmental data (including pollen, plants and molluscs) allows drawing up a detailed picture of the palaeoecological context of the site. The palaeochannel water body was located in a marshy area within a cool open grassland landscape and was most likely used by large animals as a watering hole. These animals were mainly cold or cool-adapted herbivore species, representative of the Pin Hole Mammal Assemblage zone, a proxy of MIS-3 (Boismier *et al.* 2003; Shreve 2006; Shreve *et al.* 2012).

The mammal remains are dominated by mammoth (*Mammuthus primigenius*) who form over 90% of the assemblage, but also woolly rhinoceros (*Coelodonta antiquitatis*), reindeer (*Rangifer tarandus*), horse (*Equus ferus*), bison (*Bison priscus*) and wolf (*Canis lupus*) are present. These faunal remains vary in condition (as do the lithics) and the presence of a variety of weathering stages suggests differential exposure. It has therefore been suggested that the faunal remains were not deposited as a single homogenous event but as separate events throughout the existence of the channel environment (Smith 2010, 2012; Boismier *et al.* 2012). Many bones exhibit traces of gnawing by predator-scavengers but on the other hand there is no direct evidence for hominin bone surface modification (Smith 2010, 2012; Shreve *et al.* 2012). Much of the modification appears to relate to the extraction from marrow, suggesting scavenging behaviour.

- ***The lithic assemblage***

Around 2,720 lithic artefacts were collected from Lynford Quarry and these are manufactured on locally available flint. The majority of the artefacts are small chips and spalls (around 73%). Only few cores are present and indications of the use of the Levallois technique are sparse. Furthermore around 30 flake tools are present consisting of 14 denticulates, 8 notches and 8 scrapers. Also 8 pieces with non-diagnostic retouch occur. On the other hand over 60 bifaces are present, dominating the toolkit, and therefore this assemblage has been assigned to the MTA.

The vast majority of the artefacts are in fresh condition and indicate no major fluvial transport. The presence of several refits do show an amount of vertical and horizontal displacement, indicating that the assemblage is not in an in situ position but does occur spatially proximate to its original primary context (White 2012). Therefore the lithics from Lynford will be treated in this PhD as a single assemblage.

109 of the artefacts were analysed for use wear traces. On almost all artefacts post-depositional modifications erased virtually all evidence of past tool use (Donahue and Evans 2012), one artefact was used for butchery and five were clearly unused.

- ***New analysis – the bifacial tools***

The collection of Lynford Quarry is currently held at the Northamptonshire Archaeology Unit and all the present material was studied (not including two bifaces which were currently on museum display) and will be discussed in more detail below.

From the 57 analysed bifacial tools, 8 were broken and therefore not all attributes could be recorded. The bifaces from Lynford are on average 10.1cm long, 7.3cm wide and 2.3cm thick (table). The maximum width is always located in the basal part of the tool (tip length on average 7.9cm) creating mainly flat cordiform types.

Lynford (n:46)	Min.	Max.	Median	Average	St. Dev
Max. Length (mm)	66.20	177.00	97.20	101.42	26.53
Max. Width (mm)	45.00	113.80	70.20	73.12	15.44
Max. Thickness (mm)	12.80	49.20	23.30	23.70	6.61

Table 5.22: *Linear measurements of the bifacial tools from Lynford*

Recording the technological attributes was often made difficult by the large amount of retouch all over the perimeter of the artefact. For 18 pieces it was clear they were made on a flake while for 5 pieces the blank was a nodule/pebble (Table 5.23). This indicates a clear preference for large flakes as the blanks for the bifaces.

LYNFORD	Technological Attributes									
Cortex	**none**		**1-25%**		**25-50%**		**50-75%**		**75-100%**	
	29	55.8%	20	38.5%	1	1.9%	2	3.8%	0	0.0%
Cross section	**Plano-convex**		**Bi-convex**		**Bi-plano**		**Plano-convex/ plano-convex**		**Irregular**	
	19	38.0%	27	54.0%	0	0.0%	0	0.0%	4	8.0%
Blank	**Flake**		**Nodule**		**Unknown**					
	18	31.6%	5	8.8%	34	59.6%				
Edge angles	**<35**		**35-65**		**>65**					
	18	36.7%	29	59.2%	2	4.1%				

Table 5.23: *Technological attributes of the bifacial tools from Lynford*

The elaborate retouch on these bifaces is also indicated by the low amount of cortex left on the pieces. 80% of the bifaces has no or small (<25%) cortex remnant (Table 5.23). Two artefacts contain over 50% cortex, indicating the large variability of bifacial tool types in the assemblage. The majority of the angles of the cutting edges of the bifacial tools fall between 35 and 65 degrees (50.9%). Edge angles of less than 35 degrees are also common (31.6%) while angles from over 65 are rare (3.5%) (Table 5.23). When looking at the cross-section of the bifaces from Lynford both biconvex (46%) and plano-convex (33%) sections occur regularly (Table 5.23).

When the bifacial tools from Lynford are classified using the simplified typological framework (Table 5.24), it is clear that leaf-shaped artefacts and bifacial scrapers are absent in the collection. The assemblage is clearly dominated by symmetric bifaces (mainly cordiform types, including some *bout coupé*`s, but also some flat triangular ones). Furthermore some unifaces and backed bifaces are present although the latter might include some roughouts and does not contain any typical KMG *Keilmesser* types.

LYNFORD (n:45)	BIFACIAL TYPOLOGY	
Classic handaxes	38	66.7%
Backed bifacial tools	1	1.8%
Leaf-shaped bifacial tools	0	0.00%
Partial bifaces	5	8.8%
Bifacial scrapers	1	1.8%
TOTAL	45	100.00%

Table 5.24: *New simplified classification of the bifacial tools from Lynford*

- ***Site Interpretation***

The site of Lynford consists of a palaeochannel feature containing a large amount of stone tools and animal bones. All factors, including OSL and AMS C14 dates and the characteristics of the lithic and faunal assemblages, indicate a date in MIS-3. Throughout the accumulation of the material the site was slightly disturbed (e.g. bank collapse), but the near mint condition of the artefacts and the large quantity of small debitage indicates that the effect of the disturbances was minimal. Nevertheless the assemblage does represent a palimpsest comprising several episodes of natural and human accumulation processes.

The Neanderthals at Lynford knapped flint nodules collected from local primary sources. Only few cores and cortical flakes are present and few flakes were retouched into tools, this in contrast with the dominant occurrence of bifaces. The high number of both large and small biface thinning flakes indicates that these bifaces were knapped on the spot. The conducted reanalysis of the Lynford bifaces shows that they are dominantly made on flakes and have a symmetric appearance with most often a biconvex section. Therefore the interpretation of the assemblage as a British representative of the MTA industry (Boismier *et al.* 2003; White 2012) can in my opinion be justified.

5.5.4 Discussion

The rich open-air site of Lynford is an exceptional site in an otherwise small and limited record of Neanderthal occupation in Britain. The British Late Middle Palaeolithic is mainly known through a large amount of isolated finds and some smaller assemblages. Although over 20 main find spots are known (Pettitt and White 2011), larger stratified sites with a significant amount of bifacial tools are rare, further stressing the unique nature of

Lynford. To further contextualise the finds from Lynford, data from 11 other British Late Middle Palaeolithic contexts were collected (Table 5.25a and 5.25b).

- Chronology and environment

In Britain Late Middle Palaeolithic bifacial tools come from both cave and open-air locations, both from stratified context and as surface material (Table 5.25a). The vast majority of these sites can be placed securely in MIS-3, confirming the generally accepted MIS 6-4 occupational abandonment of Britain (but see Wenban-Smith 2010 for recent discovery of MIS-5 flakes). Radiometric dates, a combination of C14 (including AMS and ultrafiltration), OSL, Uranium-series and ESR dates, are available for five of the biface-rich British Mousterian sites: Lynford, Hyena Den, Coygan Cave, Kent's Cavern and Rhinoceros Hole. These all cluster in MIS-3 (see Chapter 2, Table 2.2; White and Pettitt 2011). Moreover the MIS-3 phase in Britain is associated with a specific fauna assemblage, the Pin Hole Mammal Assemblage Zone (MAZ), containing woolly mammoth (*Mammuthus primigenius*), wild horse (*Equus ferus*), woolly rhinoceros (*Coelodonta antiquitatis*), reindeer (*Rangifer tarandus*) and bison (*Bison priscus*) (Currant and Jacobi 2001). This fauna is moreover indicative of a cool, grass steppe environment. Based on this fauna association and the general idea of abandonment of Britain during MIS6-4, all the British Late Middle Palaeolithic handaxes can be assigned to MIS-3.

SITE	LOCATION	LAYER	DATE	FAUNA	ENVIRONMENT	MAIN REFERENCE
Area 240	open-air	–	MIS-3	unknown	unknown	De Loecker 2010
Coygan Cave	cave	–	MIS-3	pin hole MAZ	cool, grass steppe	Aldhouse-Green *et al.* 1995
Fisherton	open-air	–	MIS-3	pin hole MAZ	cool, grass steppe	Green *et al*. 1983
Hyena Den	cave	Cave earth	MIS-3	pin hole MAZ	cool, grass steppe	Tratman *et al.* 1971
Kent's cavern	cave	Loamy cave eart	MIS-3	pin hole MAZ	cool, grass steppe	Campbell and Sampson 1971
Little Cressingham	open-air	–	unknown	unknown	unknown	Wymer 1985
Little Paxton	open-air	–	MIS-3	pin hole MAZ	cool, grass steppe	Tebutt *et al.* 1927
Lynford	open-air	–	MIS-3	pin hole MAZ	cool, grass steppe	Boismier *et al.* 2012
Oldbury	?	–	unknown	unknown	unknown	Cook and Jacobi 1998
Pin Hole Cave	cave	Lower cave earth	MIS-3	pin hole MAZ	cool, grass steppe	Jacobi *et al.* 1998, 2006
Rhinoceros Hole	cave	–	MIS-3	pin hole MAZ	cool, grass steppe	Proctor *et al.* 1996
Robin Hood Cave	cave	Lower cave earth	MIS-3	pin hole MAZ	cool, grass steppe	Coulson 1990

Table 5.25a: *Overview of the characteristics of the main British sites rich in bifacial tools, their location, date, fauna and environment*

– Lithic variability

British Late Middle Palaeolithic bifacial tools are mainly made on flint, although artefacts on other raw materials such as chert and quartzite also occur (Table 5.25b). Evidence for the use of the Levallois method is sparse, discoidal and non-standardised (irregular) flaking methods dominate. Where flake tools are present they contain the generic Middle Palaeolithic range of scrapers, notches and denticulates, while points are scarcer (Table 5.25). Half the assemblages contain less than 100 artefacts and only the localities of Lynford and Area 240 (located offshore of Norfolk) contain a significant portion of bifacially worked tools (>30). Classic handaxes are the dominant bifacial tool type in the British Late Middle Palaeolithic. Cordiform forms, including *bout coupés* dominate, while triangular forms are very rare (Wragg Sykes 2009). Other bifacial tool types are very rare and overall no KMG influences, as indicated by the presence of backed or leaf-shaped bifacial tools, can be recognised in the British Late Middle Palaeolithic.

Because of the dominant presence of classic handaxes it is in my opinion justified to use the term Mousterian of Acheulean Tradition in relation to these British sites. Furthermore, can the British *bout coupé* phenomenon be seen as a well-defined spatio-temporal unit restricted to MIS-3 Britain (White and Pettit 2011; for further discussion and interpretations of these spatial and temporal trends see Chapter 7).

SITE	DOMINANT RAW MATERIAL	FLAKING METHODS	FLAKE TOOLS	ASSEMBLAGE SIZE	BIFACIAL TOOLS	Classic	Backed	Leafshaped	Partial	Bif. Scraper
Area 240	flint			88	33	√	–	–	–	–
Coygan Cave	igneous rocks	–	–	5	3	√	–	–	–	–
Fisherton	flint	–	–	2	2	√	–	–	–	–
Hyaena Den	flint, greensand chert	irregular	scrapers, notches, denticulates	>41	4	√	–	–	–	–
Kent's cavern	flint, greensand chert	Levallois	scrapers	1,400	>7	√	–	–	–	–
Little Cressingham	flint	–	–	3	1	√	–	–	–	–
Little Paxton	flint	laminar, discoidal	scrapers, denticulate, nat backed knives	236	7	√	–	–	–	√
Lynford	flint	irregular	scrapers, notches, denticulates	2,700	57	√	√	–	√	√
Oldbury	flint	discoidal	scrapers, nat backed knives, notches, denticulates	>500	13	√	–	–	√	–
Pin Hole Cave	quartzite, flint	discoidal, irregular	scrapers, denticulates	118	2	√	–	–	–	–
Rhinoceros Hole	flint	–	–	4	1	√	–	–	–	–
Robin Hood Cave	quartzite, ironstone, flint	discoidal, irregualr	scrapers, denticulates, notches	500	8	√	–	–	–	–

Table 5.25b: *Overview of the characteristics of the main British sites rich in bifacial tools and their lithic assemblages*

5.6 Northern France

5.6.1 Introduction

France is characterised by a very rich Late Middle Palaeolithic archaeological record. Because of the large number of sites relevant to this thesis, the description of the French record is split in two parts – Northern and Southern France. The northern half of France (Fig. 5.16) consists out of three main geographical areas: a western part, including Brittany and Normandy; a central part, comprising several river valleys (e.g. Somme, Seine, Oise, Aisne and Marne); and an eastern part, including Burgundy.

In the *western part* numerous Middle Palaeolithic sites have been identified since the 19th century along the coastlines and in the Armorican Massif (Cliquet 2001). Western French sites are often large, open-air, surface collections with an overrepresentation of bifacial tools due to collector's bias. In the Armorican Massif the local raw material is glossy sandstone and flint is sparse, providing different raw material availabilities than in the rest of France (Launay and Molines 2005).

The *central area* forms part of the wider Western European plain and Middle Palaeolithic material was recovered early on, especially in the main river valleys (Tuffreau 1971, 1976, 1977, 1989, 1990 and 1991). Large-scale rescue excavations of the last two decades unearthed another dozen Late Pleistocene Middle Palaeolithic sites, e.g. Saint-Amand-les-Eaux (Inrap 2007; Koehler 2009; Locht *et al.* 2010; Roebroeks *et al.* 2011). Fewer Middle Palaeolithic sites are known from *north-eastern France,* both with and without bifacial tools. Mainly in the Vanne valley several Middle Palaeolithic sites have been discovered, e.g. Villemaur-sur-Vanne and Champlost (Gouédo 1999) and these have recently been the subject of a regional study (Depaepe 2001, 2007).

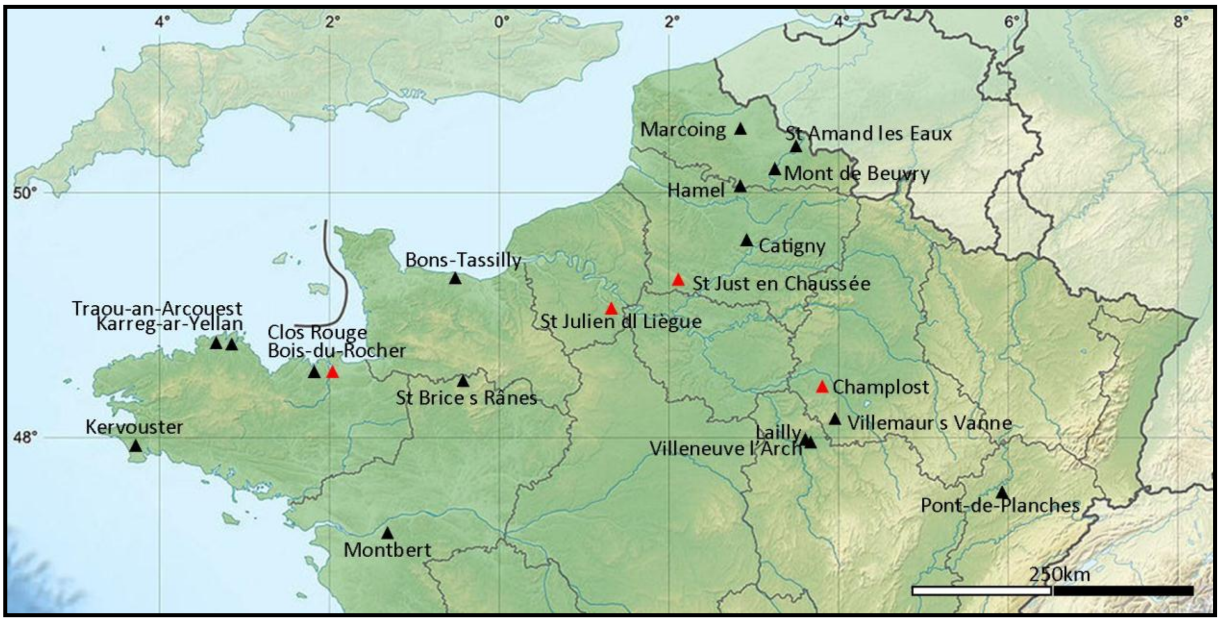


Fig. 5.16: *Location of the main Middle Palaeolithic sites in Northern France rich in bifacial tools (in red the sites that are analysed in detail)*

Few of the sites in the northern half of France are radiometrically dated. Based on stratigraphic sequences (e.g. Lautridou and Cliquet 2006) it seems that Northern France follows the same occupation cycle as neighbouring areas, with occupation during MIS-5, an occupational hiatus in MIS-4 and reoccupation during MIS-3 (see Chapter 2; Tuffreau 1990; Antoine *et al.* 2003; and Roebroeks *et al.* 2011). A vast proportion of the Northern French Late Middle Palaeolithic assemblages contain bifacial tools and several regional entities have been defined and these are presented below.

5.6.2 The bifacial entities

Across the northern half of France a large variety of bifacial tools is known from Late Middle Palaeolithic (Fig. 5.15) and four entities have been distinguished (Table 5.26). Caves are rare in this area and hence open-air sites dominate.

Entity	Occurrence	Characteristics	Main sites
Bois-du-Rocher group or Mousterian with bifacial tools	open-air and rockshelter sites	handaxes, partial bifaces, backed bifaces and bifacial scrapers	Bois-du-Rocher, Karreg ar Yellan, Clor Rouge, Goaréva, Kervouster, Bons-Tassilly, Traou-an-Arcouest
Mousterian of Acheulean Tradition (MTA)	Open-air sites	large triangular handaxes	Marcoing, Catigny, St Just en Chaussée
Mousterian with small bifaces	Open-air sites	small, symmetric handaxes	Saint-Brice-sous-Ranes, Hamel, St Amand les Euax, Saint-Julien-de-la-Liegue
Charentian with Micoquian influence	Open-air sites	classic handaxes and asymmetric bifacial tools	Champlost, Lailly <Beauregard> A, Villeneuve-l'Archeveque A, Riencourt-les-Bapaume B1, Germolles, Blanzy, Bissy-sur-Fley

Table 5.26: *Characteristics of the bifacial entities present in Northern France*

In north-western France assemblages with a large proportion of bifacial tools are very common, both on large open-air sites and in coastal rock shelters. Because of the clear similarities between these assemblages, they were initially grouped in the 'Bois-du-Rocher' group, named after the large open-air site of Bois-du-Rocher (see further on; Molines et al. 2001). Assemblages from this group, e.g. Kervouster, Clos Rouge, Bons-Tassilly, Traou-an-Arcouest and Karreg-ar-Yellan, are characterised by a generalised application of bifacial retouch, resulting a dominant presence of handaxes, partial bifaces, backed bifacial tools and bifacial scrapers. Currently, the term Mousterian with bifacial tools is preferred for this entity (see Chapter 2; Monnier 1990; Cliquet *et al.* 2001; Molines *et al.* 2001; Bourdin 2006). Within some of these assemblages, but also in other Northern French collections, a 'Mioquian' influences has been claimed, expressed predominantly by the presence of backed and leaf-shaped bifacial tools (see Chapter 2 and Table 5.26).

Further north, in the area around the Paris basin, classic MTA handaxes, which are small, cordiform or triangular or even *bout coupé* in shape, are present (Cliquet 2001, Tyldesley 1987). Especially larger triangular handaxes seem to be distinctive to this area (Soressi 2002; for a reassessment see Chapter 7, section 7.2.2). In addition, typical KMG artefacts are absent, such as *Keilmesser* and leaf points, but also small, more irregular/asymmetrical bifaces occur. In Normandy, these small handaxes dominate several assemblages. They occur in large numbers and have been grouped under the label 'Mousterian with small bifaces' (Chapter 2, Cliquet et al 2001, 2004).

The exact characteristics and validity of these four Northern French entities requires further analyses and to represent this large variability four assemblages formed part of the attribute analysis.

5.6.3 The studied assemblages

Four northern French sites, all containing a significant proportion, but different types, of bifacial tools have been selected to form part of a detailed attribute analysis: Saint-Julien de la Liègue, Saint-Just en Chausée, Bois-du-Rocher and Champlost. Both Saint-Just en Chausée and Champlost contain around 30 bifacial tools and were recovered by excavations. Conversely, Northern France is also characterised by very large assemblages which contain high numbers of bifacial tools but which are recovered from the surface, hence lacking detailed chronostratigraphic information. Because of the richness of the bifacial tools in this type of assemblages two of them were chosen to be studied: Saint-Julien de la Liègue and Bois-du-Rocher. Both these sites have been published in detailed and their bifacial tools have been subjected to several studies (Daniel 1965; Monnier and Etienne 1978; Cliquet and Lautridou 1988; Pinoit 1999; Molines *et al.* 2001; Launay and Molines 2005; Bourdin 2006). By combining stratified and un-stratified assemblages it is aimed to get a complete picture of the variability present amongst northern French Late Middle Palaeolithic bifacial tools.

SAINT-JULIEN DE LA LIÈGUE

- ***Location***

The open-air site of Saint-Julien de la Liègue consists of four concentrations of finds (les Bruyères-Capri, les Gros-Grès, le Bois-l'Abbé and les Buissons-Brûlés) spread over a three kilometre area. All four find spots cover more than 300m² and are located on the left bank of a small stream, '*Ru de Bizay*', located on a plateau between the river valleys of the Seine and Eure rivers (Daniel 1965; Fig. 5.17).

- ***History of research***

The site was discovered at the end of the 19th century and L. Coutil was the first to collect a large number of artefacts, including many handaxes, from the site (Daniel 1965). Coutil never published his collections from Saint-Julien de la Liègue in detail and therefore the exact location of where he collected the material is unknown.

From 1923 until 1928 R. Daniel collected more material from the different find concentrations (Daniel 1965). Another 8,000 flint artefacts were collected by G. Pillet and P. Oden in the 1970s and 1980s (Cliquet and Lautridou 1988). In total over ten thousand artefacts were collected at Saint-Julien de la Liègue, including over 1,500 handaxes.

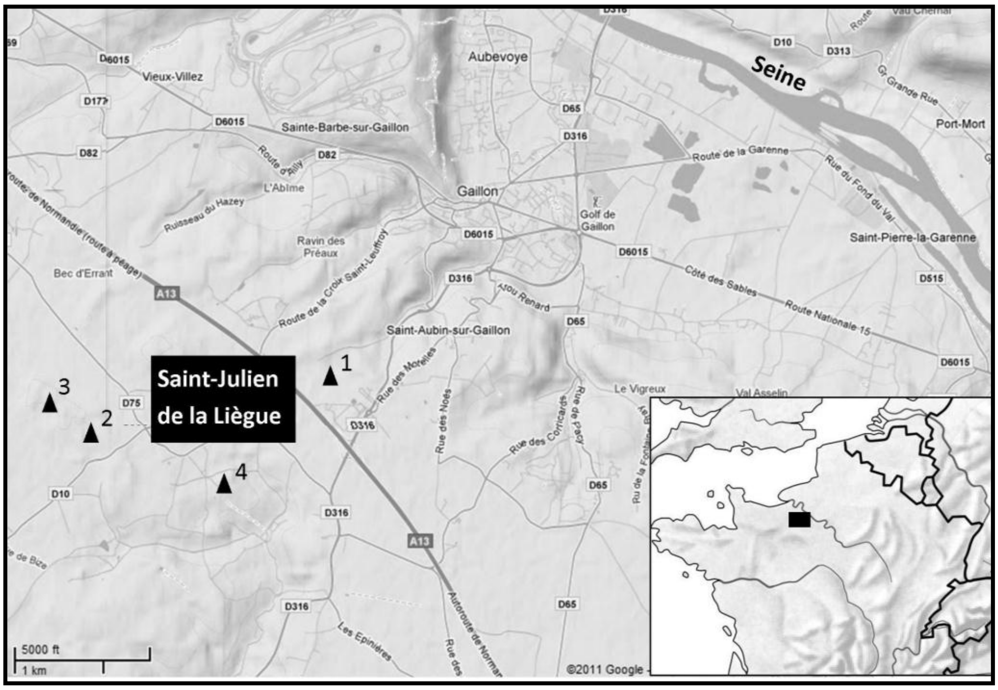


Fig. 5.17: *Location of the four find concentrations around Saint-Julien de la Liègue (Eure, France) (1-Les Bruyères-Capri ; 2-Gros-Grès ; 3-Bois l`Abbé ; 4-Buissons Brûlés)*

- *History of research*

The site was discovered at the end of the 19th century and L. Coutil was the first to collect a large number of artefacts, including many handaxes, from the site (Daniel 1965). Coutil never published his collections from Saint-Julien de la Liègue in detail and therefore the exact location of where he collected the material is unknown.

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- *Site formation, stratigraphy and chronological position*

In the 1980s J-P. Lautridou dug several test pits in the area to gain a better understanding of the stratigraphic position of the lithic assemblages coming from Saint-Julien de la Liègue. The lithics are situated in a zone between an MIS-5 layer and pleniglacial loess. The lithic assemblages cannot be assigned to a more chronostratigraphic position and could therefore have originated at any point during the MIS-5 to 3 time period (Cliquet and Lautridou 1988).

- ***Palaeoecological context***

No palaeoecological indicators were found in relation with any of the lithic assemblages coming from Saint-Julien de la Liègue.

- ***The lithic assemblage***

In total over 10,000 lithic artefacts were recovered from the four Saint-Julien de la Liègue find spots. The largest find spots are Bois l'Abbé and Gros Grès and the characteristics of both their assemblages are very similar.

Cores only represent around 2% of the assemblages and mainly irregular forms are present. On each site three Levallois cores were found and around 300 Levallois flakes, indicating the regular use of this technique. Around 3,000 flakes are present on each site of which around 10% is retouched into tools. The flake tools from Saint-Julien de la Liègue are heavily dominated by scrapers of various types (including bifacial ones). Furthermore also notches and denticulates occur and a low number of backed knives. Also Upper Palaeolithic tool types such as end scrapers and burins are well-represented (Cliquet and Lautridou 1988).

The most characteristic element of the Saint-Julien de la Liègue find spots are small handaxes, of which over 1,500 have been found (Cliquet 1995).

- ***New analysis – the bifacial tools***

The lithic material collected from the Saint-Julien de la Liègue sites is currently held at the musée d'Art-Histoire-Archéologie in Evreux. The material comprises artefacts collected by different people and at different periods in time and in general the material is not sorted by find spot. It is therefore impossible to distinguish between the different locations. In total 215 handaxes coming from Saint-Julien de la Liègue were analysed in detail and treated as one entity since it is generally accepted that the different findspots all contain a similar lithic industry (Daniel 1965, Cliquet and Lautridou 1988).

182 bifaces were unbroken and could be measured. On average these bifaces are 58.82mm long with outliers of 39 and 107mm. The standard deviation is quite small and indicates that 68% of the bifaces are between 45 and 72mm long (Table 5.27).

St Julien de la Liègue (n:182)	Min.	Max.	Median	Average	St. Dev
Max. Length (mm)	39.00	107.00	55.00	58.82	13.28
Max. Width (mm)	28.00	77.00	43.00	45.36	9.22
Max. Thickness (mm)	8.00	31.00	16.00	16.64	4.00

Table 5.27: *Linear measurements of the bifacial tools from Saint-Julien de la Liègue*

The technological attributes recorded indicate that a vast proportion (at least 20%) of the bifacial tools was made on flakes. For none of the pieces could it be established with certainty that they were made by façonnage (Table 5.28). The intense shaping of the bifacial tools is indicated by the fact that only 8.79% of them have a cortex remnant and this cortex remnant is always covering less than 25% of the tool's surface (Table 5.28). The bifacial tools were shaped in a variety of ways resulting in a variety of cross-sections being represented in the assemblage. Plano-convex sections are most common (63.7%) and this is in accordance with the observation that a significant proportion of the artefacts are made on flakes. Secondly bi-convex sections are common (33.3%) and finally some isolated examples of bi-plano (1.8%) and plano-convex/plano-convex sections (1.2%) were identified (Table 5.28). The edge angles on the bifacial tools mostly fall within the 35-65° category (94.4%) with more acute angles also occurring (5.6%) but broader angles totally absent (Table 5.28).

ST-JULIEN DL LIEGUE	Technological Attributes									
Cortex	**none**		**1-25%**		**25-50%**		**50-75%**		**75-100%**	
	166	91.2%	16	8.8%	0	0.0%	0	0.0%	0	0.0%
Cross section	**Plano-convex**		**Bi-convex**		**Bi-plano**		**Plano-convex/ plano-convex**		**Irregular**	
	107	63.7%	56	33.3%	3	1.8%	2	1.2%	0	0.0%
Blank	**Flake**		**Nodule**		**Unknown**					
	36	16.7%	0	0.0%	179	93.3%				
Edge angles	**<35**		**35-65**		**>65**					
	10	5.6%	168	94.4%	0	0.0%				

Table 5.28: *Technological attributes of the bifacial tools from Saint-Julien de la Liègue*

From the 208 bifacially flaked pieces I analysed and that were complete enough to be assigned to a typological category, 204 are classic handaxes, making this the dominant tool type in the Saint-Julien de la Liègue assemblage. Some leaf-shaped bifacial tools and bifacial scrapers are present but in very low numbers (Table 5.29).

ST JULIEN DL LIEGUE (n:209)	BIFACIAL TYPOLOGY	
Classic handaxes	200	93.0%
Backed bifacial tools	0	0.0%
Leaf-shaped bifacial tools	7	3.3%
Partial bifaces	1	0.5%
Bifacial scrapers	1	0.5%
TOTAL	209	100.00%

Table 5.29: *New simplified classification of the bifacial tools from Saint-Julien de la Liègue*

Previous interpretations have linked the Saint-Julien de la Liègue bifacial tools to the Central European leaf point assemblages (Cliquet and Lautridou 1988). Although leaf-shaped bifacial tools do occur, in my opinion the vast majority of the Saint-Julien de la Liègue material can be classified as small symmetric handaxes and can therefore be linked to the MTA rather than the KMG.

- ***Site Interpretation***

Neanderthals regularly visited the left bank of the '*ru de Bizay*' stream near Saint-Julien de la Liègue, leaving behind over 10,000 flint artefacts. Due to erosional processes these artefacts are currently lying on the surface and four main concentrations occur over a 3km area. Chronostratigraphic and palaeoecological information is poor and based on some geological test pits it is assumed that the material was left during MIS 5-3.

The lithic assemblages from all four locations are very similar and because of the lack of provenience data in the studied collection of Saint-Julien de la Liègue all the analysed material is treated here as one entity. Only a few cores have been collected and these are either of irregular or Levallois type. Of the vast amount of flake blanks around 10% are Levallois flakes. A further 10% are retouched into tools and the tool kit is dominated by different forms of scrapers. The collection is further dominated by the presence of over 1,500 bifaces. These are in general of small dimensions (between 50 and 70mm) and occur in a variety of shapes (mainly cordiform, discoidal and ovate), although typologically speaking they nearly all fall within the symmetric handaxes category. Because of the small dimensions of these bifaces and the presence of some leaf-shaped bifacial tools this assemblage is a good example of the variability present in the northern French bifacial tools.

SAINT-JUST-EN-CHAUSSÉE

- ***Location***

The open-air site of Saint-Just-en-Chaussée is located on the left bank of the Arré river (Oise, Northern France (Fig. 5.18)). The material has been recovered from several locations in and around a now disused brickyard (Tuffreau 1977).

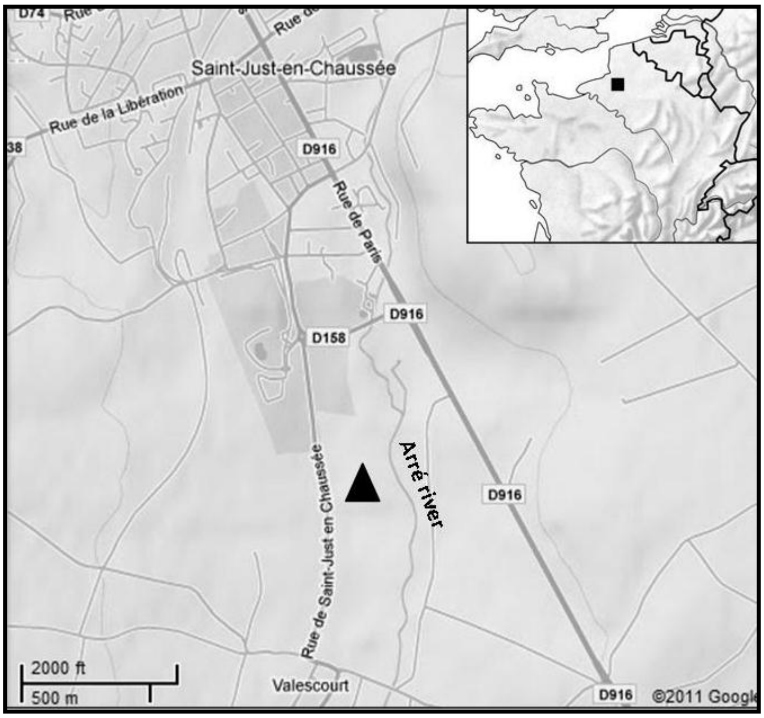


Fig. 5.18: *Location of the Middle Palaeolithic site (Δ) near Saint-Just-en-Chaussée (Oise, France)*

- ***History of research***

The first Palaeolithic artefacts were discovered in the Binant brickyard before the First World War. Subsequently, H. Kelley undertook a first excavation but only published a selective sample of the artefacts he discovered. In the 1950s further material was collected by F. Bordes and P. Fitte (Bordes 1954) and in 1976 A. Tuffreau conducted two more test pits together with P. Dupont to get a better understanding of the stratigraphic sequence (Tuffreau 1977).

- ***Site formation and stratigraphy***

The Binant brickyard was used for the exploitation of loam and was abandoned in the 1950s. Both Bordes and Tuffreau have published the stratigraphic sections from their work at Saint-Just-en-Chaussée (Tuffreau 1977). They both distinguish a series of recent loam layers and a series of loam layers from the Early Weichselian. These loam layers lay on top of an Eemian palaeosoil which has Saalian gravel layers below. Within this stratigraphic sequence three archaeological layers can be distinguished (Tuffreau 1977):

- a patinated Mousterian assemblage with bifaces coming from an upper loam layer
- an unpatinated Mousterian assemblage with no bifaces from a lower loam layer
- an Acheulean assemblage associated with Saalian gravels

We are interested here in this top layer because of the presence of bifacial tools.

- ***Chronological position***

The Saint-Just-en-Chaussée site has not been dated radiometrically. The Middle Palaeolithic artefacts are all found in loam layers which overlay a loess complex attributable to the Eemian. These Weichselian loam layers are overlain by a pedological horizon which is interpreted as the soil of Kesselt, dated to 28,200 BP (Tuffreau 1977). Therefore, based on their stratigraphic position, the artefacts can be placed within the MIS 5d-3 time bracket, but a more fine-grained attribution is impossible.

- ***Palaeoecological context***

No palaeoecological indicators are known for the site of Saint-Just-en-Chaussée.

- ***The lithic assemblage***

The assemblage from the upper loam layer, '*1er niveau humique',* comprises material collected by P. Dupont, P. Fitte and H. Kelley. Both Levallois flakes and cores are present, indicating a frequent use of this reduction technique. In total around 258 flake tools and 59 bifaces were excavated. These flake tools are dominated by different types of scrapers and further also notches, denticulates, Mousterian points and backed knives are present (Tuffreau 1977). Besides many single scrapers also two bifacial scrapers (with a plano-convex section) are present. The bifaces are mainly of (sub)cordiform and (sub)triangular form (Tuffreau 1977).

– ***New Analysis – bifacial tools***

The bifacial tools from Saint-Just-en-Chaussée are partially held at the Musée de l'Homme (collection H. Kelley) and partially in l'Institut de Paleontologie Humaine, both in Paris. Due to time constraints only the handaxes present in the Musée de l'Homme collection (n:) were studied. 23 unbroken bifacial tools were measured and on average the bifaces from Saint-Just-en-Chaussée are rather large with an average length of 108.74mm and average width of 74.22m (Table 5.30).

St Just en Chaussée (n:23)	Min.	Max.	Median	Average	St. Dev
Max. Length (mm)	63.00	158.00	107.00	108.74	24.26
Max. Width (mm)	47.00	111.00	75.00	74.22	17.57
Max. Thickness (mm)	15.00	40.00	22.00	24.61	7.00

Table 5.30: *Linear measurements of the bifacial tools from Saint-Just-en-Chaussée*

For the large majority of the pieces (73.91%) it was impossible to determine if they were made on a flake or a nodule (Table 5.31). The bifacial tools from Saint-Just-en-Chaussée are intensely shaped and only one piece has a cortex remnant of over 25% (Table 5.31). Half of the tools have a bi-convex and the other half a plano-convex section (Table 5.31). Furthermore all these bifacial tools have dominating edge angles that fall between 35 and 65 degrees (Table 5.31).

St-Just-en-Chaussée	Technological Attributes									
Cortex	none		1-25%		25-50%		50-75%		75-100%	
	9	39.1%	13	56.5%	1	4.4%	0	0.0%	0	0.0%
Cross section	Plano-convex		Bi-convex		Bi-plano		Plano-convex/ plano-convex		Irregular	
	11	47.8%	11	47.8%	0	0.0%	0	0.0%	0	0.0%
Blank	Flake		Nodule		Unknown					
	2	7.4%	4	14.8%	21	77.8%				
Edge angles	<35		35-65		>65					
	0	0.0%	23	100.0%	0	0.0%				

Table 5.31: *Technological attributes of the bifacial tools from Saint-Just-en-Chaussée*

The handaxes from Saint-Just-en-Chaussée form a coherent group and typologically speaking all 25 analysed pieces can be classified as classic handaxes. This includes large flat triangular handaxes which have been defined as the hallmark of the northern French MTA (Soressi 2002) (Table 5.32).

ST JUST EN CHAUSSÉE (n:25)	BIFACIAL TYPOLOGY	
Classic handaxes	25	100.0%
Backed bifacial tools	0	0.0%
Leaf-shaped bifacial tools	0	0.0%
Partial bifaces	0	0.0%
Bifacial scrapers	0	0.0%
TOTAL	25	100.0%

Table 5.32: *New simplified classification of the bifacial tools from Saint-Just en Chaussée*

- ***Site Interpretation***

On the bank of a small river near the village of Saint-Just-en-Chaussée Neanderthals regularly passed by during the MIS 5-3 time period and left behind several stratified lithic assemblages. The most recent of these assemblages contains a significant number of symmetrical handaxes and has therefore been assigned to the MTA (Tuffreau 1977).

The reanalysis of the Saint-Just-en-Chaussée handaxes confirms the MTA assignment and further defines the Saint-Just-en-Chaussée handaxes as a coherent group. Although the handaxes were both make on flakes and on nodules, their intense shaping as indicated by the small cortex remnant, does often not allow anymore for the blank to be identified on most pieces. The handaxes have both biconvex and plano-convex cross sections and edge angles that fall between 35 and 65 degrees. The handaxes are rather large (average of 108.74mm) with a minimum value of 63.00mm. The triangular outline shape stands out and therefore the site of Saint-Just-en-Chaussée can be interpreted as a classic example of a northern French MTA site, as previously defined (Soressi 2002).

BOIS-DU-ROCHER

- ***Location***

A large amount of Palaeolithic artefacts were found near Bois-du-Rocher (village of Saint-Hélen, Côtes-d'Armor, Brittany). This open-air site is located 6km north of Dinan on a 75m high hill that dominates the valley of the Rance river in the Armorican Massif (le Commandant Cazenave 1919; Fig. 5.19). The Palaeolithic material was found on the surface spread out over an area of more than 5 hectares (Molines *et al.* 2001).

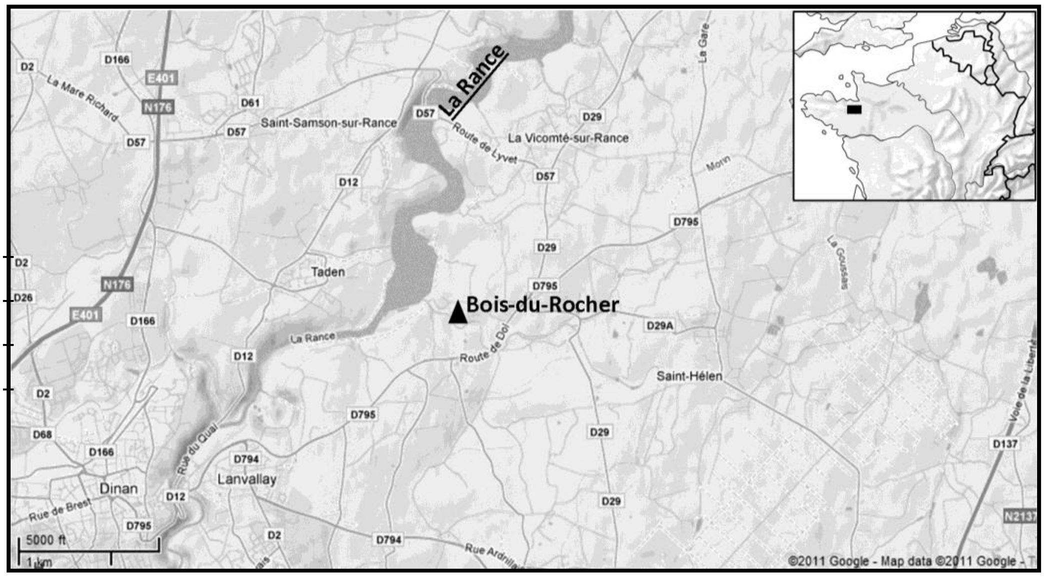


Fig. 5.19: *Location of the Middle Palaeolithic site Bois-du-Rocher (Saint-Helen, Cotes-d'Armor)*

- ***History of research***

The site has been known since the 1870s and several people have collected lithic material at the location, resulting in a complex series of old and more recent collections, some of which are unpublished (Launay and Molines 2005). Because of the collector's bias related with these old surface collections, it is difficult to assess how representative the current collections are and what is and was really present at Bois-du-Rocher. It is clear that handaxes dominate the assemblage, and over 2,000 bifacial tools have been collected.

- ***Site formation and stratigraphy***

Not much is known about the stratigraphic position of the Bois-du-Rocher artefacts. The vast majority of the material has been found lying on the current surface and lack any stratigraphic information.

- ***Chronological position***

The exact chrono-stratigraphic position of the site remains unknown. Based on comparisons with the nearby site of Clos Rouge, which is similar both in typo-technological and stratigraphic factors, a position within MIS-5 has been proposed (Molines *et al.* 2001).

- ***Palaeoecological context***

No palaeoecological indicators have been recorded in relation to this site.

- ***The lithic assemblage***

Flint does not occur naturally in the Armorican Massif. The local raw material, of which a source was present at Bois-du-Rocher, is glossy sandstone which is fine-grained and can be knapped in a similar way to flint (Launay and Molines 2005; Bourdin 2006). The vast majority of the artefacts are made out of this raw material although some pieces on quartz and imported flint were found as well.

The assemblage is dominated by unretouched flakes (74%) and blades (7,1%). The Levallois technique is only sporadically used and 75% of the cores are of discoidal type (Molines *et al.* 2001). The Bois-du-Rocher toolkit is dominated by scrapers (over 600), denticulates (ca. 120) and notches (ca. 60). Some Upper Palaeolithic tool types such as end scrapers (ca. 30) and burins (ca.5) appear as well (Launay and Molines 2005).

The most dominating element in the Bois-du-Rocher tool kit are handaxes. In total around 2,000 bifaces were collected. These occur in a variety of forms including cordiform, subcordiform, ovates and discoidal. The bifacial tools represent 55% of the current assemblage and their typological identification has become difficult because many of them are broken. The Bois-du-Rocher bifacial tools formed the subject of several recent studies and is overall a well-researched assemblage (Bourdin 2006). A sample of these bifaces was conducted to a more detailed attribute analysis here and this new data can be combined with the published data to come to a full understanding of the bifacial characteristics.

- ***New analysis – bifacial tools***

The Bois-du-Rocher lithic material is currently spread over different museums in France. Part of the collection is present in the Musée de l'Homme (Paris) as part of the Vayson de Pradenne collection. In total 58 Bois du Rocher bifaces were analysed, giving a general idea of the typo-technological characteristics of this assemblage but the proportions should not be interpreted as fixed figures since in total over 2,000 bifaces were collected over this 5 hectares large site.

All of the 58 Bois-du-Rocher bifaces from the Musée de l'Homme collection that were analysed were unbroken so all attributes could be recorded. The biface sample that was analysed was a homogenous group in relation to its dimensions as represented by the small standard deviations (Table 5.33). On average the bifaces are 69.71mm long, 54.33mm wide and 21.69mm thick.

Bois du Rocher (n:58)	Min.	Max.	Median	Average	St. Dev
Max. Length (mm)	41.00	115.00	67.00	69.71	12.51
Max. Width (mm)	35.00	89.00	54.00	54.33	9.18
Max. Thickness (mm)	13.00	40.00	21.00	21.69	4.75

Table 5.33: *Measurements of the bifacial tools from Bois-du-Rocher*

Technologically speaking the Bois-du-Rocher bifaces form a coherent group with the vast majority having no cortex remnant (94.83%) and all tools having edge angles that fall within the 35-65 degrees category (Table 5.34). Half of the cross-sections are plano-convex in nature and the other half biconvex. For most pieces it was not possible to determine the blank used but at least 20% are made on flakes.

Bois-du-Rocher	Technological Attributes									
Cortex	**none**		**1-25%**		**25-50%**		**50-75%**		**75-100%**	
	55	94.8%	2	3.5%	1	1.7%	0	0.0%	0	0.0%
Cross section	**Plano-convex**		**Bi-convex**		**Bi-plano**		**Plano-convex/ plano-convex**		**Irregular**	
	27	47.4%	29	50.9%	0	0.0%	1	1.8%	0	0.0%
Blank	**Flake**		**Nodule**		**Unknown**					
	12	20.7%	1	1.7%	45	77.6%				
Edge angles	**<35**		**35-65**		**>65**					
	0	0.0%	58	100.0%	0	0.0%				

Table 5.34: *Technological attributes of the bifacial tools from Bois-du-Rocher*

It needs to be taken into account that the studied bifaces do not form a representative sample of the bifacial tools that are present at the site of Bois-du-Rocher. Of the ones studied nearly 97% are symmetric handaxes and furthermore one uniface and one bifacial scraper were present (Table 5.35). When looking at the outline form of these handaxes they are all quite similar and mainly cordiform and amygdaloid in shape.

BOIS-DU-ROCHER (n:58)	BIFACIAL TYPOLOGY	
Classic handaxes	56	96.6%
Backed bifacial tools	0	0.0%
Leaf-shaped bifacial tools	0	0.0%
Partial bifaces	1	1.7%
Bifacial scrapers	1	1.7%
TOTAL	58	100.0%

Table 5.35: *Typological classification of the bifacial tools from Bois-du-Rocher*

- ***Site interpretation***

On the right bank of the Rance river, north-eastern Brittany, Neanderthals left behind a large amount of stone tools dispersed over several hectares. The stratigraphic position of the lithics is badly understood and it appears that the assemblage correlates to MIS-5. The vast majority of Bois-du-Rocher artefacts are made on the locally available glossy sandstone. Because of the selective manner in which the artefacts have been collected the bifacial tools are overrepresented and over 2,000 of them were recovered. Despite this collectors' bias, it still stands beyond doubt that bifacial tools form the major component of this assemblage. The 58 handaxes that were reanalysed here form a coherent group, are between 41 and 110mm long, commonly made on flakes and symmetric, most often cordiform, in shape. Past morphometric (Monnier and Etienne 1978) and technological (Launay and Molines 2005) analyses of larger proportions of the Bois-du-Rocher collection have led to the identification of a variety of symmetric outline shapes and manufacturing characteristics. Both an attribution to the MTA and to the Mousterian with bifacial tools has been suggested. A KMG influences was not clearly expressed in the studied sample and does not come forward strongly in the published overviews of the site. The large amount of small cordiform MTA-type handaxes justifies evoking links with the MTA but because of the variable nature of the bifacial tools an attribution to the Mousterian with Bifacial Tools seems most suited.

CHAMPLOST

- ***Location***

The open-air site of Champlost *'Le Dessous de Bailly'* is located in the Yonne department of Burgundy (Fig. 5.20). The site is situated in a valley, on the bank of the Créanton-Brumance river, a small tributary of the Armançon river, in a location where it confluences with another small stream.

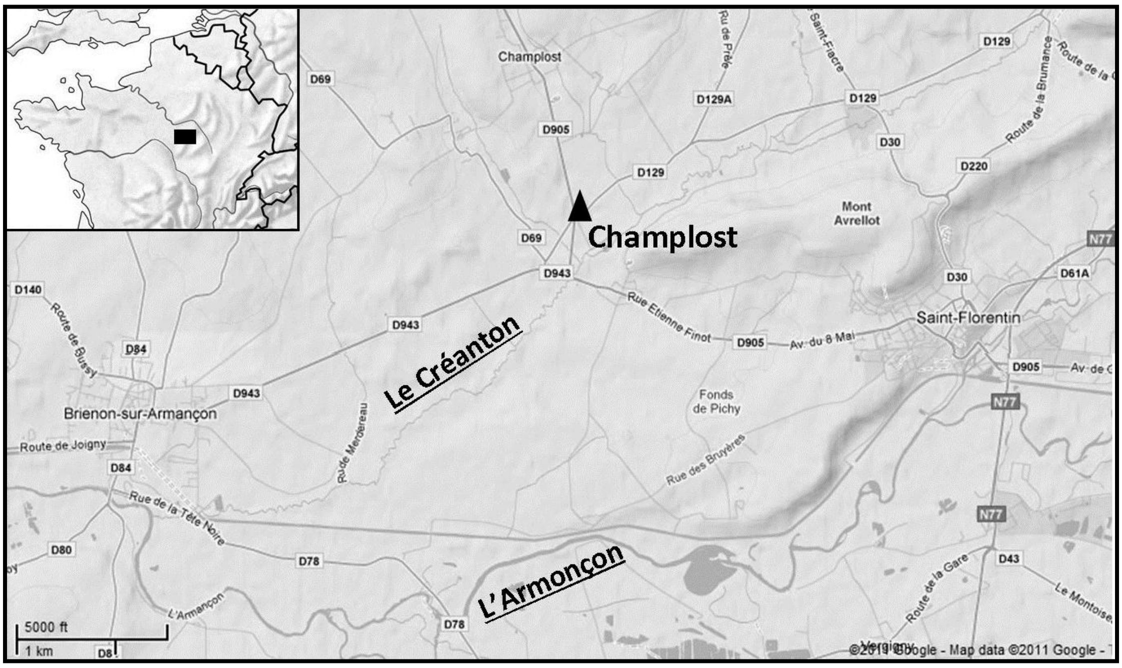


Fig. 5.20: *Location of the Middle Palaeolithic site Champlost (Burgundy)*

- ***History of research***

The first Palaeolithic artefacts were discovered at Champlost at the beginning of the 20th century when M. Morel re-cultivated the field. In 1981 the site got rediscovered when M. Genreau started collecting lithics which were lying exposed on the field. From 1981 until 1984 the finds were contextualised by systematic fieldwalking and test pits (Gouédo 1999). In addition to the surface material, from 1982 until 1992 several excavation campaigns were undertaken under the direction of C. Girard/Farizy. From 1982 until 1987 excavations concentrated on the northern part of the site, while the 1988-1992 excavations took place 40 metres further south, in the so-called southern sector. Overall 200m² were excavated, exposing a single archaeological layer, rich in artefacts throughout all the sectors (Farizy 1988, Girard and Krier 1982).

Because the original excavator of the site, Catherine Farizy, passed away, a lot of the material of Champlost still remains unstudied. The most important work on the site is the PhD thesis of Jean-Marc Gouédo who analysed the surface material and part of the excavated material from the northern section (Gouédo 1999). A larger study of all the Champlost material (including the several surface collections, the material excavated from the test pits, and from the southern and northern sector) is absent.

- ***Site formation and stratigraphy***

The stratigraphic position of the Champlost material is well-defined since several stratigraphic sections in the area have been studied. The Champlost site is located within an alluvial plain and within the stratigraphic sequence three main alluvial events can be distinguished. All the archaeological material is confined to one single layer within these events.

- ***Chronological position***

In the 1980s an attempt to date the site through TL methods failed. Therefore in 1992 R. Grün ESR dated several of the animal teeth. These dates indicated an 45-65ka age bracket for the site (48,100 ± 4,4000 ka (EU) and 56,700 ± 4,200 ka (LU) (Gouédo 1999). The lithic material from Champlost can thus be placed in MIS-3, making it one of the youngest Middle Palaeolithic open-air sites in Northern France (Gouédo 1988).

- ***Palaeoecological context***

At Champlost over 1,000 faunal remains were collected. These animal bones have not yet been studied in detail but it is clear that the fauna at the site is dominated by bovids (aurochs or bison) and further horse and cervid remains are present (Gouédo 1999). Because of the dominance of fragmented long bone shafts and the lack of skulls and foot bones it has been suggested that only parts of the animal were brought back to be processed on the site (Farizy and David 1992). A significant proportion of the bones are burnt and also charcoal is present on the site suggesting the presence of a combustion feature.

- ***The lithic assemblage***

The lithic assemblage of Champlost consists of material collected from the surface through field walking campaigns as well as material recovered from buried positions during excavation campaigns. The complete assemblage contains over 2,000 lithic artefacts and these have formed the subject of several separate studies (Gouédo 1999; Lhomme 1993).

All the Champlost artefacts are made out of flint, which was locally available. Some pieces of sandstone are present on the site but they are unworked. The lithic assemblage is characterised by the use of the Levallois technique, the abundance of scrapers and the presence of small bifacial tools.

- ***New analysis – bifacial tools***

All the lithic material from the Champlost site is currently held at the Musée de Préhistoire d'Ile de France in Nemours. In total 30 bifacial tools could be located in the assemblage in Nemours, 28 of which are unbroken. The dimensions of the tools vary a lot with lengths ranging from 38 to 124mm. On average the bifacial tools from Champlost are 67.21mm long, 48.00mm wide and 15.36mm thick (Table 5.36).

Champlost (n:28)	Min.	Max.	Median	Average	St. Dev
Max. Length (mm)	38.00	124.00	61.00	67.21	22.55
Max. Width (mm)	33.00	101.00	44.00	48.00	13.95
Max. Thickness (mm)	10.00	28.00	15.00	15.36	4.85

Table 5.36: *Linear measurements of the bifacial tools from Champlost*

For over half of the bifacial tools it could be identified that they were manufactured on a flake blank (60.71%) (Table 5.37). This is also reflected by the fact that 75% has a plano-convex cross-section (Table 5.37). Biconvex section do also occur (17.86%). Only one piece has a cortex remnant of over 25% and 78.57% even does not have any cortex remaining on its surface (Table 5.37). The vast majority of these bifacial tools furthermore have edge angles falling between 35 and 65 degrees (Table 5.37).

CHAMPLOST	Technological Attributes									
Cortex	none		1-25%		25-50%		50-75%		75-100%	
	22	78.6%	5	17.9%	1	3.6%	0	0.0%	0	0.0%
Cross section	Plano-convex		Bi-convex		Bi-plano		Plano-convex/ plano-convex		Irregular	
	21	80.8%	5	19.2%	0	0.0%	0	0.0%	0	0.0%
Blank	Flake		Nodule		Unknown					
	17	53.1%	0	0.00%	15	46.9%				
Edge angles	<35		35-65		>65					
	1	3.6%	27	96.4%	0	0.0%				

Table 5.37: *Technological attributes of the bifacial tools from Champlost*

The varied nature of the Champlost bifacial tools is furthermore indicated by the different types of bifacial tools present at the site (Table 5.38). Symmetrical handaxes are the most common tool category (43.33%), closely followed by bifacial scrapers (33.33%).

Additionally also leaf-shaped bifacial tools (13.33%), backed bifacial tools (6.67%) and unifaces (3.33%) are present in the assemblage.

Table 5.38: *New simplified classification of the bifacial tools from Champlost*

CHAMPLOST (n:30)	BIFACIAL TYPOLOGY	
Classic handaxes	13	43.3%
Backed bifacial tools	2	6.7%
Leaf-shaped bifacial tools	5	16.7%
Partial bifaces	1	3.3%
Bifacial scrapers	9	30.0%
TOTAL	30	100.0%

- ***Site interpretation***

The open-air site of Champlost is located at the confluences of two small streams and material has been recovered both through surface exposure and excavation. The site has been dated to MIS-3 and delivered a rich faunal assemblage dominated by bovids, horse and cervids. Over 2,000 lithic artefacts were collected from the location and the assemblage is characterised by the use of local flint, application of the Levallois method and a toolkit dominated by scrapers. Furthermore at Champlost over 30 bifacially flaked tools occur. The reanalysis of these bifaces shows that they are varied in terms of measurements and technological attributes, with a preference for small sizes, flake blanks and plano-convex sections. All 5 categories of the bifacial tool typological framework are present with a dominance of symmetric handaxes and backed bifaces.

In the past the assemblage of Champlost has been linked to the KMG (Farizy 1995; Gouédo 1999) and this reanalysis confirms a Central European influence in the assemblage although small handaxes occur as well. Therefore Champlost is once again an example of an assemblage that does not fit with the MTA or KMG and belongs to a so-called mixed entity containing a variety of bifacial tools.

5.6.4 Discussion

Bifacial tools are a common occurrence in the Late Middle Palaeolithic record across Northern France. This record is very variable and to fully understand the variability among the assemblages and their chronological and environmental settings, data from 15 site reoports was collated and added to the new data obtained from these four key assemblages (Table 5.39a and 5.39b) to allow for a full discussion of their characteristics.

- *Chronology and environment*

Caves are absent in Northern France, so Late Middle Palaeolithic bifacial tools are generally recovered from open-air localities; exceptions being the coastal rock shelters in Brittany (Table 5.39a). Bifacial tools have been found both in stratified depositions as well as on the surface. Palaeoenvironmental indicators are very rare and faunal preservation is generally poor in this region (Table 5.39a).

The open-air sites of Northern France are characterised by deep and detailed stratigraphic sequences. These sequences are relateively well-understood and the presence of certain humic soils and loess layers can be correlated to specific climatic events, providing a degree of chronological control (Tuffreau 1971; Antoine *et al.* 1999; Lautridou *et al.* 1999; Depaepe 2007). Based on these pedostratigraphic correlations several Northern French sites rich in bifacial tools have been correlated to MIS-5 (e.g. Molinons <Le Grand Chanteloup> site Est (Depaepe 2007) and Marcoing (Sommé and Tuffreau 1971)), MIS-4 (Lailly <Tournerie> I (Depaepe 2007)) and MIS-3 (Villeneuve-L'Achevêque A and Lailly <Beauregard> A (Depaepe 2007)).

SITE	**LOCATION**	LAYER	**DATE**	**FAUNA**	**ENVIRONMENT**	**MAIN REFERENCE**
Bois-du-Rocher	open-air	surface	MIS-5	–	–	Molines *et al.* 2001
Bons-Tassilly	open-air	–	MIS 5-3	–	–	Cliquet *et al.* 2001
Catigny	open-air	–	MIS 5 (?)	–	–	Tuffreau 1976
Champlost	open-air	–	MIS-3	bovid, horse, cervid	–	Gouédo 1999
Clos Rouge	open-air	–	MIS-5	–	–	Molines *et al.* 2001
Hamel	open-air	–	MIS 5-3	–	–	Tuffreau 1971
Karreg-ar-Yellan	rockshelter	–	MIS-4	–	–	Monnier 1989
Kervouster	open-air	–	MIS 4/3	–	–	Molines *et al.* 2001
Lailly <Tournerie>	open-air	I	MIS 4/3	–	–	Depaepe 2007
Marcoing	open-air	surface	MIS-5	–	–	Tuffreau 1971
Molinons <Le Grand Chanteloup>	open-air	A site Est	MIS-5	–	–	Depaepe 2007
Montbert	open-air	surface	MIS 5-3	–	–	Gouraud and Tessier 1990
Mont de Beuvry	open-air	surface	unknown	–	–	Marcy 1991
St Amand les Eaux	open-air	–	MIS-3	–	–	Inrap
St Brice sous Rânes	open-air	–	MIS 5-3	–	–	Cliquet *et al.* 2009
St-Julien de la Liègue	open-air	–	MIS 5-3	–	–	Cliquet and Lautridou 1988
St-Just en Chaussée	open-air	upper	MIS-5	–	–	Tuffreau 1977
Traou-an-Arcouest	rockshelter	–	MIS-3	–	–	Molines *et al.* 2001
Villeneuve-l'Archevêque	open-air	C	MIS-5	–	–	Depaepe 2007

Table 5.39a: *Overview of the characteristics of the main northern French sites rich in bifacial tools, their location, date, fauna and environment*

Other sites, such as Hamel and Catigny, were also placed in MIS-5 based on their stratigraphic correlation but in a less straightforward way. These chronostratigraphic correlations are not always without problems and caution needs to prevail. For example at the site of Saint-Illiers the 'soil of St Acheul' which is generally correlated to MIS-3 was dated and turned out to be over 200,000 years old (Koehler 2009).

The majority of the open-air sites in Western France (Brittany and Normandy) are large surface collections and hence lack chronological control. Therefore, these sites are undated and could have their origin in both MIS-5 or 3. Based on some, ambiguous, stratigraphic indicators, the assemblage of Bois-du-Rocher is generally interepreted as MIS-5 (Molines *et al*. 2001), while the assemblages of Karreg-ar-Yellan and Goaréva are seen as belonging to MIS-3 (Monnier 1986, 1990) but these needs correlation require more scientific confirmation (Bourdin 2006).

Several radiometric dates have been obtained for Northern French assemblages. Even though the original stratigraphic sequence at Champlost was interpreted as belonging to MIS-5, a series of ESR dates securely placed the assemblage within MIS-3 (Farizy 1995). Recently, MIS-3 dates has also been obtained by OSL dating for the site of Pont-des-Planches, which is rich in a wide array of bifacial tools (Lamotte *et al.* in press), Saint-Amand les Eaux (Inrap 2007; Claud 2008), and Saint-Brice-Sous-Rânes (Cliquet *et al.* 2009). Overall it appears that bifacial tool entities occurred across Northern France both during MIS-5 and 3.

- *Lithic variability*

The lithic assemblages in northern half of France are generally made on flint, with exception of the Brittany sites which are dominated by glossy sandstone and quartzite. The Levallois method is attested and discoidal and laminar flaking methods are common (Table 5.39b). Assemblages are often very large, several contain over 10,000 pieces. The number of bifacially worked tools in these assemblages is also rather elevated, with half of the assemblages containing over 50 bifacial tools (Table 5.39b).

The detailed study of the assemblages of Bois-du-Rocher, Saint-Just en Chaussée, Champlost and Saint-Julien de la Liègue, combined with data from another 17 northern French biface-rich sites illustrates that all five bifacial tool categories are represented in this area. There is a very clear dominance of classic handaxes and a lack of assemblages dominated by backed bifacial tools (Table 5.39b). The most common occurrences are small bifaces of various shape and larger triangular handaxes. Based on this review of the Northern French Late Middle Palaeolithic bifacial tools, a general division can be made between:

- Assemblages dominated by handaxes; this includes both the Mousterian of Acheulean Tradition with large triangular handaxes and the Mousterian with small bifaces (e.g. Saint-Just en Chaussée and Saint-Brice-sous-Rânes) .

- Assemblages with a wider variety of bifacial tools; previously grouped in the Mousterian with Bifacial Tools or in the Charentian with Micoquian influence. Handaxes occur in these assemblages but alongside a wider spectrum of bifacial tools which express a KMG affinity (e.g. Champlost and Saint-Julien de la Liègue).

This section highlights how during the Late Middle Palaeolithic in Norhtern France bifacial tools form an important component of the Neanderthal tool kit. A variety of types and forms occur, including classic MTA bifaces, few KMG tool types and a range of small bifaces. Because of the manifestation of this variability and the location of the area in between the KMG and MTA core areas, the Northern French assemblages will hold crucial clues to come to a better understanding of Late Middle Palaeolithic bifacial tool variability (see further analyses in Chapter 6 and 7).

SITE	DOMINANT RAW MATERIAL	FLAKING METHODS	FLAKE TOOLS	ASSEMBLAGE SIZE	BIFACIAL TOOLS	Classic	Backed	Leafshaped	Partial	Bif. Scraper
Bois-du-Rocher	glossy sandstone	Levallois (rare), discoidal, laminar	scrapers, notches, denticulates, end scrapers, burins, piercers	5,645	1,926	√	–	–	√	√
Bons-Tassilly	flint	Levallois	scrapers	>1,000	>50	√	–	–	–	√
Catigny	flint	Levallois, discoidal	scrapers, backed knives, notches, denticulates	623	28	√	–	–	√	√
Champlost	flint	Levallois	scrapers, points	2,000	30	√	√	√	√	√
Clos Rouge	glossy sandstone	Levallois (rare)	scrapers	?	>35	√	–	–	–	√
Hamel	flint	Levallois, discoidal	scrapers	451	?	√	–	–	–	–
Karreg-ar-Yellan	microgranite, flint	Levallois (rare)	?	?	?	√	–	–	–	√
Kervouster	glossy sandstone	Levallois (rare)	?	3,421	41	√	–	–	√	√
Lailly <Tournerie>	flint	Levallois	scrapers, points, backed knives	3,616	12	√	–	–	√	–
Marcoing	flint	?	?	324	39	√	–	–	–	√
Molinons <Le Grand Chanteloup>	flint	Levallois	scrapers, denticulates, point, backed knives	423	5	√	–	–	–	–
Montbert	quartzite	Levallois, laminar	?	230	98	√	–	–	√	√
Mont de Beuvry	flint	–	–	11	11	–	√	–	–	–
St Amand les Eaux	flint	?	?	10,000	ca. 60	√	–	√	–	√
St Brice sous Rânes	flint	Levallois	scrapers	100,000	>200	√	–	–	–	–
St-Julien de la Liègue	flint	Levallois, discoidal	scrapers, notches	>10,000	1,500	√	–	√	–	√
St-Just en Chaussée	flint	Levallois	scrapers	ca. 350	59	√	–	–	–	–
Traou-an-Arcouest	microgranite, flint	Levallois (rare)	?	?	?	√	–	–	–	√
Villeneuve-l'Archevêque	flint	Levallois, irregular	scrapers, point	130	16	√	–	–	–	–

<u>**Table 5.39b**</u>: *Overview of the characteristics of the main northern French sites rich in bifacial tools and their lithic assemblages*

5.7 Southern France

5.7.1 Introduction

The southern half of France comprises a wide and varied geographic area and the southwestern and southeastern parts are characterised by different Middle Palaeolithic archaeological signatures. *Southeastern France* includes the region of the Central Massif (including the Tarn Valley), Mediterranean France (including the Rhône valley, its confluents and its estuary plain) and the pre-alps (including the Jura region) (Fig. 5.21). A vast number of Mousterian assemblages is present in this area but bifacial tools are sparse. Moreover, are they often undated even though well-contextualised by comprehensive new studies (Szmidt 2003; Deaujard and Moncel 2010; Moncel and Deaujard 2012)

Fig. 5.21: *Location of the main biface-rich sites in Southern France, including a more detailed map of the Dordogne region*

South-western France, and especially the Dordogne region, has provided the foundation for our knowledge on the European Middle Palaeolithic. The area has been intensely and extensively studied and is well-understood in terms of Neanderthal behaviour; e.g. raw material transport (Geneste 1985, Turq 2000), transport of bifaces (Soressi and Hays 2003) and chronological successions (Mellars 1996). The river valleys in this area (e.g. Dordogne, Vézère and Couze) are extremely rich in Middle Palaeolithic sites, contain plenty of bifacial tools and several eponym sites are located here (e.g. Le Moustier, La Micoque, La Ferrassie) (Fig. 5.21; Peyrony 1925, Bordes 1960).

5.7.2 The bifacial entities

Bifacial tools are scarce in *Southeastern France*. Szmidt (2003) for example studied over 200 Mousterian assemblages from Mediterranean France and concluded that the Mousterian of Acheulean Tradition industry is absent across this region. Classic handaxes do occur in the Tarn River valley further west (Jaubert 2001). Over 50 Mousterian assemblages from this area contain handaxes (e.g. Petit Nareye (Fig. 5.21), indicating that the MTA does occur east of its Dordogne core area.

Larger bifacial assemblages have been found in the *Jura and Burgundy regions*. The best examples are the caves of Verpillière I and II at Germolles, which are currently still being excavated (Frick 2010, Floss *pers. comm.*) and contain both a KMG and MTA assemblage (Floss 2005; Desbrosse *et al.* 1976). Results of the new investigations are awaited to be able to assess the characteristics and chronostratigraphy of these bifacial assemblages. The presence of KMG elements in Eastern France is also apparent through the site of La Baume de Gigny where backed bifacial knives with a lateral tranchet blow occur (Fig. 5.21; Campy *et al.* 1989). Again, the chronostratigraphic data at this site is not fine-grained enough to allow a clear placement in time; a general characteristic of the bifacial tools recovered from this region.

Conversely, in *Southwestern France* bifacial tools form a more substantial part of the late Neanderthal toolkit. The Dordogne region is the core area of the MTA (for a definition see Chapter 2) and cordiform handaxes have been recovered from over 300 find spots, especially open-air localities between the major river valleys (Mellars 2006; Soressi 2002). Over 30 radiometric dates have been obtained from these MTA and indicate a predominant occurrence throughout MIS-3 (Table 2.4; Guibert *et al.* 2008). The Southwestern French MTA is well-understood through several specialised studies; e.g. technology (Soressi 2002), mobility (Soressi and Hays 2003), raw material (Turq 2000), use-wear analyses (Claud 2008, 2012) and zooarchaeology (Rendu 2010).

Additionally, several Late Middle Palaeolithic sites in Southwestern France contain KMG type bifacial tools. Although the upper layers of La Micoque are of unknown age and the assemblages seem to have been reworked by fluvial action (Texier 1993 and 1996; Débenath *et al.* 1991) it is clear that the upper layer 6 contains a significant number of backed bifacial knives (Rosendahl 2004 and 2006). Also at Abri du Musée in Les Eyzies (Detrain *et al.* 1991; Bourguignon 1992) these backed bifacial tools were found in a supposed Late Middle Palaeolithic context (see further on).

Finally, also further south, around the *Pyrenees*, sites occur that contain Late Middle Palaeolithic bifacial tools; e.g. Basté at Saint-Pierre d'Irube (Thibault 1976) and Grotte Noisetier (for a detailed overview of Middle Palaeolithic sites in this region see Thiébaut *et al.* 2011). Previously, based on the presence of cleavers, somee of these assemblages have been grouped together in the Vasconian (Bordes 1953); an entity which is not included in further analyses (for a description and reasons see Chapter 2).

Overall, within Southern France there is a contrasting presence of Late Middle Palaeolithic bifacial tools, which can be grouped into four main entities (Table 5.40).

Entity	Occurrence	Characteristics	Main sites
Mousterian of Acheulean Tradition (MTA)	both open-air and cave sites	Small cordiform handaxes	Le Moustier, Pech de l'Azé I, Haut de Combe Capelle, La Rochette, Grotte XVI, Jonzac, Fonseigner
Keilmessergruppe	rockshelter	backed and leaf-shaped bifacial tools	Abri du Musée
'mixed' entity	both open-air and cave sites	classic handaxes and asymmetric bifacial tools	Germolles, Baume de Gigny
Vasconian	both open-air and cave sites	cleavers	Basté, Noisetier cave

Table 5.40: *Characteristics of the bifacial entities present in Southern France*

5.7.3 The studied assemblages

Since Southwestern France is the main region in the southern half of France containing Late Middle Palaeolithic bifacial tools, four sites from this region, and more specifically from the Dordogne, were selected for detailed analysis. This includes three large classic MTA sites (Le Moustier, Pech de l`Azé I and Haute de Combe Capelle/Abri Peyrony) and the exceptional site of Abri du Musée containing backed bifacial tools.

LE MOUSTIER

- ***Location***

Le Moustier is located in the Dordogne region near the confluence of the Vézère and Vimont rivers (Fig. 5.21). The site consists of two superposed rock shelters, both being discovered early on (1860 and 1907). The upper rock shelter is the eponym site of the Mousterian and was totally emptied out at the beginning of the 20th century (Peyrony 1930). The lower rock shelter, situated 13.5 m below, is known for its secure chronology and deep stratigraphic sequence. Because of the richness of both the archaeological material and the contextual information the latter will form the focus in this study.

- ***History of research***

The lower rock shelter at Le Moustier was discovered in 1907 by Otto Hauser (Hauser 1911) and excavated by Denis Peyrony from 1910 onwards (Peyrony 1930). Within a four meter deep stratigraphic sequence Peyrony discovered abundant faunal and lithic material together with the remains of a Neanderthal new-born (Soressi 1999). Furter investigations took place by Bordes and Bonifay (1969) and Laville and Rigaud (1973).

- ***Site formation and stratigraphy***

At Le Moustier twelve stratigraphic units were distinguished, eight containing archaeological material (Fig. 5.22). Layers A to F consist of sediments rich in clay that have been deposited by floods of the Vézère river. Conversely, layers G-K are cryoclastic in nature and contain unrolled pieces of limestone, indicating the alteration of the rock shelter by frost (Geneste *et al.* 1991). Layer G can be subdivided in four smaller stratigraphic units which, together with the analysis of the pollen from this layer, represent climatic fluctuations throughout the main G layer (Laville and Rigaud 1973).

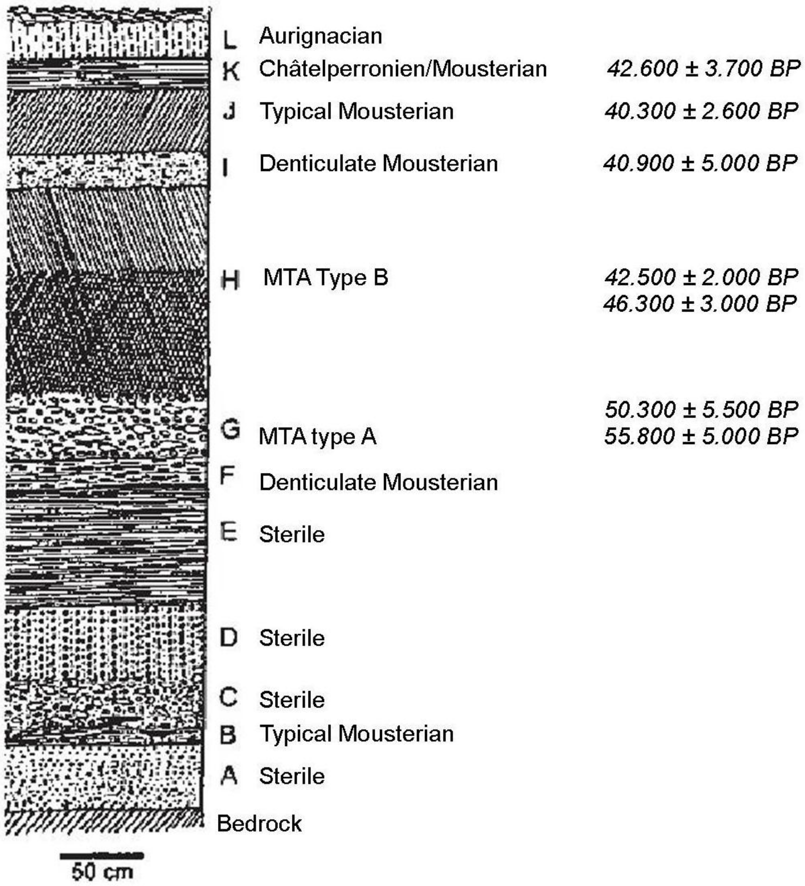


Fig. 5.22: *Stratigraphic sequence of the Le Moustier lower rock shelter and the dates obtained by TL (after Peyrony 1930).*

- ***Chronological position***

Throughout the sequence 34 pieces of burnt flint have been TL dated (Geneste *et al.* 1986). The dates were all consistent and cover the period between 55,800 ± 5,000 BP and 42,500 ± 2,000 BP (MIS-3, Fig. 5.22). Recently also 13 teeth from layers G and H were ESR dated (Mellars and Grün 1991) and also confirmed TL dates (G: 39.700 ± 2.400 (EU) /

41.000 ± 2.600 (LU); H: 43.000 ± 2.300 (EU) / 47.000 ± 2.500 (LU)) (for a more detailed overview of the dates see Chapter 2; Table 2.4).

- ***Palaeoecological context***

The site has is rich in fauna and although a detailed study is lacking it is clear that a large number of different species are represented at Le Moustier with a dominance of bovids (bos or bison), followed by red deer (*Cervus elaphus*) and horse (*Equus caballus*) (Peyrony 1930). This combination of species indicates a mix of open and closed environments with bovids, horse (*Equus caballus)*, reindeer (*Rangifer tarandus*) and woolly rhinoceros (*Coelodonta antiquitatis*) indicating an open environment and red deer (*Cervus elaphus*) and wild boar (*Sus scrofa*) a more closed environment (Garefalakis 2009).

- ***The lithic assemblage***

Eight of the stratigraphic units contain archaeological material and seven of them can be assigned to a Mousterian variant. Two layers (G and H) contain bifacial tools and will form the focus of this study. In both these layers the dominant raw material is local flint although some pieces are made on quartzite and Bergerac flint (Garefalakis 2009). The two assemblages are rich in scrapers, notches and denticulates and the Levallois method was frequently used (Soressi 1999). Because of the lower number of handaxes layer H has been assigned to the Mousterian of Acheulean Tradition Type B. Conversely, Layer G contains over 4,500 lithic artefacts, including over 300 bifaces, and is a classic example of a Mousterian of Acheulean Tradition Type A site.

- ***New analysis – bifacial tools***

The material from Le Moustier is dispersed over different institutes all over the world. The analysis here is based on the material that could be accessed at the Musée National de Préhistoire at Les Eyzies. In total 323 bifaces from Le Moustier layer G were analysed. 23% were broken and therefore not all attributes could be recorded. The recording of the dimensions of the bifacial tools highlights a range of metric variation, with maximum lengths ranging from 40 to 124 mm and averaging around 66.08mm (Table 5.41).

Le Moustier – G (n:250)	Min.	Max.	Median	Average	St. Dev
Max. Length (mm)	40.00	124.00	65.00	66.08	12.95
Max. Width (mm)	33.00	88.00	51.00	51.85	93.80
Max. Thickness (mm)	11.00	46.00	20.00	21.36	57.31

Table 5.41: *Measurements of the bifacial tools from Le Moustier (layer G)*

Many pieces are intensly retouched and therefore it was only possible to recognise the used blank on 35% of the sample; 39 bifacial tools were made on nodules (15%) and 54 on flakes (21%; Table 5.42). This intensity of retouch is also indicated by small cortex remnants (Table 5.42). 81 artefacts (32%) have no cortex and 148 (58%) have a cortex remnant covering less than 25% of the surface. Only 24 bifacially worked tools (10%) have a cortex remnant larger than 25%.

The majority (91%) of the bifacial tools from Le Moustier-G have edge angles between 35° and 65° (Table 5.42). Angles of less than 35° and more than 65° are rare, each representing around 5%. The cross-section of the bifacial tools could be classified for 248 pieces (Table 5.42). Biconvex sections are most common and occur in 59% of the cases. Furthermore also plano-convex sections occur regularly (23%).

LE MOUSTIER-G	**Technological Attributes (n:182)**									
Cortex	**none**		**1-25%**		**25-50%**		**50-75%**		**75-100%**	
	81	32.0%	148	58.5%	19	7.5%	5	2.0%	0	0.00%
Cross section	**Plano-convex**		**Bi-convex**		**Bi-plano**		**Plano-convex/ plano-convex**		**Irregular**	
	56	22.6%	147	59.3%	0	0.0%	0	0.0%	45	18.1%
Blank	**Flake**		**Nodule**		**Unknown**					
	54	16.7%	39	12.1%	230	71.2%				
Edge angles	**<35**		**35-65**		**>65**					
	13	5.3%	224	90.7%	10	4.0%				

Table 5.42: *Technological attributes of the bifacial tools from Le Moustier (layer G)*

In terms of typology, classic handaxes clearly dominate the Le Moustier-G assemblage (92.5%) (Table 5.43). Backed bifacial tools (3.6%), partial bifaces (3.6%) and leaf-shaped bifacial tools (0.3%) all occur only in very low numbers (Table 5.43).

LE MOUSTIER-G (n:257)	**BIFACIAL TYPOLOGY**	
Classic handaxes	238	92.6%
Backed bifacial tools	8	3.1%
Leaf-shaped bifacial tools	2	0.8%
Partial bifaces	9	3.5%
Bifacial scrapers	0	0.0%
TOTAL	257	100.0%

Table 5.43: *New simplified classification of the bifacial tools from Le Moustier*

Additionally, sixteen bifacial tools from layer H, assigned to MTA type B, were available for analyses at the National Prehistory Museum in Les Eyzies. Nine specimens were broken, meaning only 7 complete bifacial tools from this layer could be analysed. The attributes for these Le Moustier - H bifaces are all similar to the attributes recorded from layer G. They are all classic handaxes, have biconvex or plano-convex sections and edge angles between 35 and 65 degrees. On average they are 83mm long, 63mm wide and 27mm thick. Because of the small sample size, not allowing statistically significant comparisons, this collection will not be addressed throughout further analyses.

- ***Site interpretation***

The lower rock shelter of Le Moustier was repeatedly occupied by groups of Neanderthals during MIS-3, leaving behind various types of lithic assemblages. Two of these contain bifacial tools, layer G and H. Layer H is considered as MTA type B and only contains 16 handaxes. Conversely, Layer G contains over 300 bifaces and over 250 were analysed in detail here. They are predominantly made on local flint and where it was possible to determine the blank, both nodules and flakes could be identified. The bifaces are intensely shaped and only very rarely (1%) have a cortex remnant covering over 25% of the surface. The edge angles fall dominantly in the 35-65° category and the cross-sections of the bifacial tools are dominantly biconvex (59%) although plano-convex sections also occur regularly (23%). The bifacial tools are rather small (ca.66mm long) and are predominantly classic handaxes, with other bifacial tool types being rare. Therefore, the site of Le Moustier - G is a classic example of the MTA entity in Southwestern France, represented by a clear abundance of cordiform handaxes and scarcity of other bifacially worked tools.

HAUT DE COMBE CAPELLE (ABRI PEYRONY)

- ***Location***

Haut de Combe-Capelle (also known as Abri Peyrony) forms part of a cluster of four Palaeolithic sites (Fig. 5.23) located on the northern slope of the valley of the Couze river, a southern tributary of the Dordogne River (Delluc and Delluc 2004). The four localities (Roc de Combe Capelle, Haut de Combe Capelle, Combe Capelle Bas and Plateau de Ruffet) together span a sequence from the Lower to Upper Palaeolithic. So far, at Abri Peyrony only Middle Palaeolithic material has been recovered *in situ* (Dibble and Lenoir 1995).

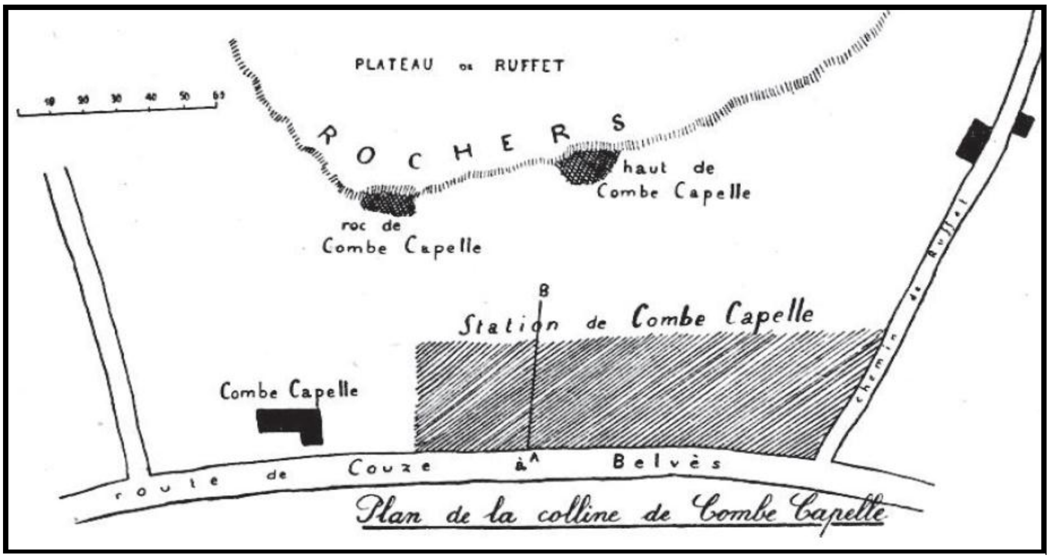


Fig. 5.23: *Plan of the Combe Capelle slope with the location of Combe Capelle Bas (A-B line is the trench), Roc de Combe Capelle, Haut de Combe Capelle (Abri Peyrony) and Plateau de Ruffet (Peyrony 1943)*

- ***History of research***

The site was first excavated in 1925 by Denis Peyrony (Peyrony 1925). In line with the collector's bias of that time, Peyrony mainly focused on the collection of handaxes and diagnostic retouched tools. A few years after his excavations Paul Fitte screened his backdirt and recovered a large number of tools and flakes, which are housed in his private collection (Dibble and Lenoir 1995).

In 1990 the site was revisited to establish if any *in situ* material remained (Dibble and Lenoir 1995). A small test pit was opened and a small pocket *of in situ* sediment was uncovered. The test pits from Dibble and Lenoir yielded, in contrast to the old collections, many small retouch flakes and several biface thinning flakes, indicating knapping took place at the site. These finding resulted in a more elaborate research projected. New work was undertaken at the site in 2009, 2010 and 2012 by the Max Planck Institute (Shannon McPherron) and the University of Bordeaux (Michel Lenoir) (Lenoir *et al.* 2010, 2011). A trench was dug between the old test pit and the cliff face. Thousands of lithics were recovered, both from the old back-dirt as well as from *in situ* locations, and publications of detailed analyses are currently awaited.

- ***Site formation and stratigraphy***

Peyrony differentiated two stratigraphic layers containing archaeological remains, situated on two bedrock terraces (Peyrony 1925). This was confirmed by the new fieldwork but the relationship between the upper and lower terrace still remains unclear. The sediment at the site is severely brecciated and all the artefacts are heavily patinated, indicating water running through the sediments. The site is located at the foot of a cliff but there are no indications there was a roof creating a rock shelter (Miller *pers comm.*).

- ***Chronological position***

New radiometric dates were undertaken as part of the 2010 fieldwork campaign and the results are currently awaiting publication.

- ***Palaeoecological context***

The rich faunal remains from Haut de Combe Capelle are dominated by bovids (bos and bison), but also horse (*Equus* sp.), deer, reindeer (*Rangifer tarandus*), fox (*Vulpes vulpes*), wolf (*Canis lupus*) and cave lion (*Panthera leo spelaean*) are represented (Dibble and Lenoir 1995). A more detailed analysis of the fauna is on-going (Lenoir *et al.* 2010).

- ***The lithic assemblage***

The artefacts are made on a variety of flint, mostly from local contexts, although some more exotic flint types are also represented (Turq 2010). Both Levallois and discoidal reduction methods are in use and a variety of flake tools occur (e.g. scrapers, denticulates and notches) (Lenoir and Dibble 1997). Because of the predominant presence of handaxes and the common occurrence of backed knives the assemblages from both terraces have previously been described as MTA.

- ***New analysis – the bifacial tools***

Currently the Haut de Combe Capelle material is partly kept in Perigueux (Musée d'Art et d'Archéologie du Périgord) and partly in Les Eyzies (Musée Nationale de Préhistoire). Both museums were visited and a total of 191 bifacial tools from Combe Capelle were analysed in detail. 18 pieces (9.4%) are broken, not allowing all attributes to be recorded. They have wide-ranging dimensions, are between 4.5 and 12cm long, with an average maximum length of 7.4cm, width of 5.8 ± 1.2cm wide and thickness of 2.3 ± 0.6cm (Table 5.44).

Abri Peyrony (n:173)	Min.	Max.	Median	Average	St. Dev
Max. Length (mm)	45.00	120.00	72.00	74.35	15.70
Max. Width (mm)	36.00	88.00	57.00	58.09	11.54
Max. Thickness (mm)	7.00	41.00	23.00	23.39	6.34

Table 5.44: *Measurements of the bifacial tools from Abri Peyrony*

In 66% of the cases it is impossible to identify the type of blank that was used (Table 5.45). From the identifiable blanks 6% are nodules/pebbles and 28% flakes. The difficulty to identify these blanks can be linked to the intensity of the shaping, something which is also indicated by the cortex data (Table 5.45). Only 4% of the bifacial tools have cortex covering more than 25% of the surface; 44% has no cortex remaining at all and 53% has a cortex remnant of less than 25%. The large majority of the edge angles (90%) fall within the 35-65° category (Table 5.45). Angles wider than 65° are very rare while acute angles, <35°, have been recorded on almost 10% of the bifacial tools. The cross-sections are predominantly plano-convex (59%) and biconvex (26%) (Table 5.45).

ABRI PEYRONY	Technological Attributes									
Cortex	none		1-25%		25-50%		50-75%		75-100%	
	77	43.8%	93	52.8%	5	2.8%	1	0.6%	0	0.0%
Cross section	Plano-convex		Bi-convex		Bi-plano		Plano-convex/ plano-convex		Irregular	
	102	58.6%	45	25.9%	0	0.0%	0	0.0%	27	15.5%
Blank	Flake		Nodule		Unknown					
	11	5.8%	49	25.7%	118	68.6%				
Edge angles	<35		35-65		>65					
	16	9.3%	155	90.1%	1	0.6%				

Table 5.45: *Technological attributes of the bifacial tools from Abri Peyrony (Haut de Combe Capelle)*

The application of the new typological framework to the Haut de Combe Capelle collection highlights the dominance of classic handaxes (87%). All other bifacial tool types are represented as well, but in very low numbers (Table 5.46). It must be noted that this low number might be caused by collector's bias, and analysis of the newly excavated material can help further contextualise this handaxe dominance.

ABRI PEYRONY (n:181)	BIFACIAL TYPOLOGY	
Classic handaxes	153	84.5%
Backed bifacial tools	3	1.7%
Leaf-shaped bifacial tools	1	0.01%
Partial bifaces	19	10.5%
Bifacial scrapers	5	2.8%
TOTAL	181	100.00%

Table 5.46: *New simplified classification of the bifacial tools from Abri Peyrony*

- ***Site interpretation***

On the slope of Combe Capelle a very rich MTA assemblage is present, represented by hundreds of, mainly cordiform, handaxes. Because of the selective nature of the original artefact collection not much is currently known about the rest of the assemblage. It seems that biface thinning flakes and backed knives are rather sparse, although this needs to be confirmed by the results of the on-going fieldwork and lithic analyses.

The handaxes are mainly made on locally available flint. The original used blanks were difficult to determine but there seems to be a preference for flakes (28%). Cortex rarely (in 7% of the cases) remains and the edge angles fall are predominantly between 35 and 65°. The cross-sections are mainly plano-convex (59%) although also biconvex sections occur regularly (26%). The Haut de Combe Capelle handaxes are on average 74mm long but have a rather large standard deviation of 15,7mm, indicating large metric variation in the collection. In terms of typology, all five bifacial tool types are present but classic handaxes dominate, validating previous attributions of the material to the MTA.

PECH DE L'AZÉ I

- ***Location***

Pech de l'Azé (Carsac-Aillac, Dordogne) is a cluster of several Lower and Middle Palaeolithic rock shelters situated some 50 meters above the floor of the small Enea river valley, a tributary of the Dordogne river (Fig. 5.21, Texier 2006b). For this study the focus is on Pech de l'Azé I, located at the entrance of a tunnel-like cave, which contains multiple Late Middle Palaeolithic layers rich in handaxes (Soressi 2002).

- ***History of research***

The rock shelter of Pech de l'Azé I was discovered early on in the 19th century (Bordes 1954), making it one of the oldest recognised Palaeolithic find spots. Subsequently, several excavation campaigns took place at the site, the main ones by Peyrony and Capitan (1929-1930), and Vaufrey and Bordes (1948-1951). Further excavations took place in 1970-1971 by Bordes and in total over 40.000 artefacts have been recovered from Pech I, of which many remain unpublished (Soressi *et al.* 2002). In 1999 a new project (McPherron *et al.* 2001) was started to reanalyse the existing Bordes collection and to conduct some new (limited) excavations (Soressi *et al.* 2008).

- ***Site formation and stratigraphy***

The stratigraphic sequence at Pech I consists of a mix of numerous limestone blocks, coming from the roof and walls of the rock shelter, and a clayish sand matrix emplaced by run-off (Soressi *et al.* 2008). Because of a very fast sedimentation rate preservation is good since the archaeological remains fossilised quickly. Seven stratigraphic units have been distinguished (Fig. 5.24; Bordes 1954); four containing archaeological material (lithics, fauna and remains of hearths) (Bordes 1954, Bordes 1955). This study will focus on the layers 4 and 5 which are richest in bifacial tools.

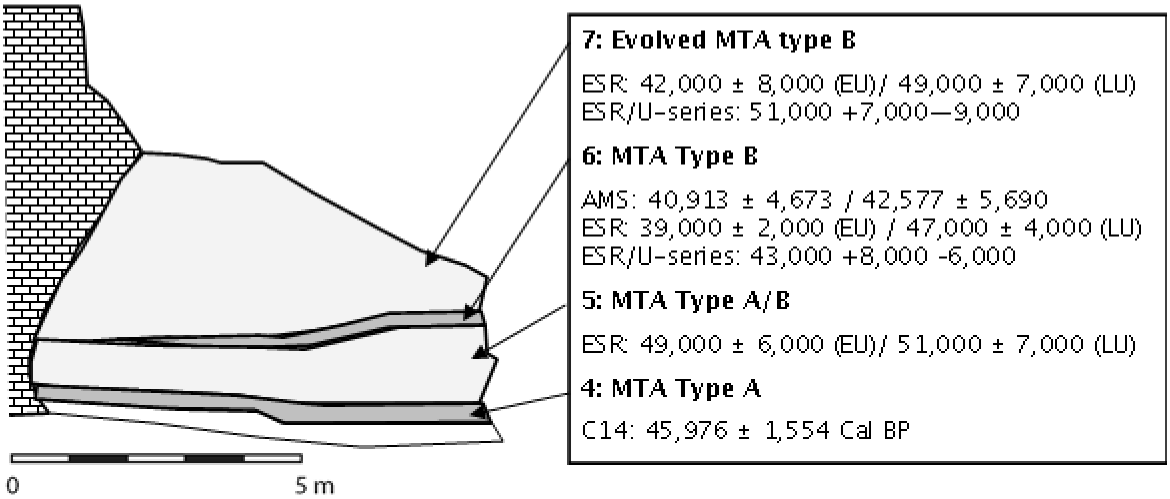


Fig. 5.24: *Schematic overview of the stratigraphic sequence at Pech de l'Azé I and of the correlated radiometric dates (redrawn after Soressi 2002)*

- ***Chronological position***

The Pech I sequence has been extensively dated. In the 1970's radiocarbon dates were obtained from several kilos of burned bone (Soressi 2002). Furthermore, AMS C14 dating of unburned bone, coupled ESR/U-series and general ESR dating on mammalian teeth were conducted (Soressi *et al.* 2007). The results of these different dating methods indicated a date in MIS-3 for all 4 layers (layer 4 (42,230 ± 1.340 BP); layer 5 ESR range of 43,000-58,000 BP) (Fig. 5.22; Chapter 2, Table 2.4).

- ***Palaeoecological context***

The fauna in all the Pech I layers is quite similar and dominated by red deer (*Cervus elaphus*), followed by bovids (both *Bison priscus* and *Bos primigenius*) (Rendu *et al.* 2010). The lack of carnivore bones and bones with carnivore damage indicate we are dealing with Neanderthal accumulations (Soressi *et al.* 2008). The faunal remains indicate a forested environment, and the association with an extinct equid (*Equus Hydruntinus*) and roe deer (*Capreolus capreolus*) confirm the association with MIS-3 (Armand *et al.* 2001). Additionally, several Neanderthal remains were found. In 1909 Peyrony discovered the well-preserved skull and mandible of a two-year old Neanderthal child, which most likely can be linked to layer 6 (MTA type B; Maureille and Soressi 2000).

- ***The lithic assemblage***

The largest find category at Pech I are stone tools, with over 50,000 artefacts recovered. As mentioned above, the stone tool assemblages from all four layers can be assigned to the MTA complex. In general these assemblages are characterised by the production of bifaces and the presence of denticulates, notches, backed knives, end scrapers and piercers. The varying proportion of these tool categories, mainly the increase through time of Upper Palaeolithic tool types and the decrease of bifaces, made Bordes put these MTA assemblages in a chronological evolution from MTA type A to MTA type B (Fig. 5.22; Bordes 1954 and 1955; see also Chapter 2).

Alongside the lithics, 500 pieces of pigments (mainly manganese dioxide) of which 250 expose clear use traces were found (Soressi *et al.* 2008). Microscopic analyses and experimental work indicate that they were used both scraped on chert and on softer materials (such as dried and human skin) (Soressi and D`Errico 2007; for a further discussion see Chapter 8).

- ***New analysis: bifacial tools***

The material from Pech de l'Azé I is held at the Musée National de Préhistoire at Les Eyzies. For this PhD the bifacial tools from layer 4 and 5 were examined in detail. These layers contain the largest number of handaxes (155 for layer 4 and 14 for layer 5, as opposed to 4 for layer 6 and 8 for layer 7 (Soressi 2002)). For layer 4 82 unbroken bifaces were measured, indicating that they are rather small and on average 59mm long, 46mm wide and 17mm thick (Table 5.47). Their maximum length varies, between 31 and 105mm, but standard deviation are low, indicating they form a rather homogenous group.

Pech de l'Azé I (n:82)	Min.	Max.	Median	Average	St. Dev
Max. Length (mm)	31.00	105.00	56.00	59.55	16.59
Max. Width (mm)	22.00	75.00	42.50	45.71	11.48
Max. Thickness (mm)	8.00	39.00	17.00	17.23	5.23

Table 5.47: *Measurements of the bifacial tools from Pech de l'Azé I (layer 4)*

The used blank could only be determined for one third of the bifacial tools (Table 5.48). 28% are made on flakes and 4% on nodules/pebbles. In line with Le Moustier and Haut de Combe Capelle, the difficulty to determine these blanks can be linked to the intense shaping and retouching of the bifacial tools. This is confirmed by the general lack of cortex (Table 5.48). Only 6% of the bifacial tools has a cortex remnant covering more than 25% of the surface of the bifacial tool. 46% has no cortex remain at all and 48% has a cortex remnant of less than 25%. The edge angles are predominantly between 35 and 65 degrees wide (87%) (Table 5.48), with wider angles being very rare (1%) and acute angles (<35°) slighltly more common (12%). The bifacial tool cross sections are predominantly plano-convex (46%) and biconvex (33%) (Table 5.48) and many pieces have an irregular, varying cross section (20%).

PECH DE L'AZE I - 4	Technological Attributes									
Cortex	**none**		**1-25%**		**25-50%**		**50-75%**		**75-100%**	
	38	46.3%	39	47.6%	4	4.9%	1	1.2%	0	0.00%
Cross section	**Plano-convex**		**Bi-convex**		**Bi-plano**		**Plano-convex/ plano-convex**		**Irregular**	
	38	46.3%	27	32.9%	1	1.2%	0	0.0%	16	19.5%
Blank	**Flake**		**Nodule**		**Unknown**					
	23	27.71%	3	3.61%	57	68.67%				
Edge angles	**<35**		**35-65**		**>65**					
	10	12.2%	71	86.6%	1	1.2%				

Table 5.48: *Technological attributes of the bifacial tools from Pech de l'Azé I (layer 4)*

The bifacial tool kit from Pech de l'Azé I layer 4 is clearly dominated by classic handaxes (Table 5.49), forming 95% of the collection. A single leaf-shaped artefact and two partial bifaces are also present, while bifacial scrapers and backed bifacial knives are completely absent. These reanalyses confirm previous MTA assignments.

PECH DE L'AZÉ - 4 (n:82)	BIFACIAL TYPOLOGY	
Classic handaxes	78	95.1%
Backed bifacial tools	0	0.00%
Leaf-shaped bifacial tools	1	1.2%
Partial bifaces	3	3.6%
Bifacial scrapers	0	0.00%
TOTAL	82	100.00%

Table 5.49: *New simplified classification of the bifacial tools from Pech de l'Azé I (layer 4)*

In addition to layer 4, 22 bifacial tools from layer 5, of which 18 are unbroken, were studied. The recorded attributes are similar to layer 4, with the large majority being heavily patinated and having slightly worn edges. Five bifacial tools are made on flakes while for the other tools the blank was no longer identifiable. 90% have a cortex remnant of less than 25% and the same proportion have edge angles that fall between 35 and 65 degrees. Cross sections are mainly biconvex and plano-convex. The bifacial tools are on average 69mm long, 55mm wide and 22mm thick and in terms of typology they represent one uniface and 17 classic handaxes. The homogeneity of this layer has been questioned (Soressi 2002), opening up the possibility that artefacts from layers mixed, and the Pech de l'Azé layer 5 assemblage will not be included in further analyses in this study.

- ***Site Interpretation***

The slope of Pech de l'Azé (Carsac-Aillac, Dordogne) was frequently occupied by Neanderthals during MIS-3, leaving behind their stone tools on a variety of locations. In the cave of Pech de l'Azé I all Middle Palaeolithic layers contain handaxes, making it one of the few sites with multiple MTA assemblages. Layer 4 is the richest, containing 32,740 artefacts, including around 150 handaxes and 25,000 preparation flakes, of which 90% are handaxe thinning flakes.

The vast majority of the handaxes are made on local flint although some exotic raw materials were also identified (Soressi 2002). Because of the intense shaping of the handaxes it was difficult to determine the used blanks. This was only possible in one third of the cases and flakes seem to dominate. Only 6% of the handaxes have a cortex remnant covering more than 25% of the surface, indicating intense shaping. The edge angles fall largely (87%) between 35 and 65 degrees and both biconvex (33%) and plano-convex (46%) cross-sections are present. The Pech I bifacial tools are on average rather small (around 60mm long) and clearly dominated by classic handaxes, making this a classic Southwestern French MTA site.

ABRI DU MUSÉE

- ***Location***

In Les Eyzies de Tayac (Dordogne, France) rescue excavations were undertaken in anticipation of the planned expansion of the French National Museum for Prehistory. The museum is located in a cluster of rock shelters near the confluence of the Vézère and Beune rivers (Fig. 5.21) and a series of Middle Palaeolithic artefacts was recovered (Detrain *et al.* 1991).

- ***History of research***

During the excavations the area of the museum was divided in four zones and test pits revealed a Middle Palaeolithic find horizon in Zone II (lower rock shelter, south of the museum entrance). From January until May 1991 this area was excavated, revealing a high concentration of faunal and lithic remains (Detrain *et al.* 1991). A detailed report on the excavation and the results of the faunal and lithic analyses has not yet been published.

- ***Site formation and stratigraphy***

In this Zone II, seven stratigraphic units have been distinguished. The Middle Palaeolithic assemblage was embedded in unit V, consisting of a mix of sandy and loamy lenses. These indicate a fluvial origin of the deposit related to both the Vézère and Beune rivers. The lack of big pebbles in the deposit indicates the rather gentle flow of the rivers (Detrain *et al.* 1991). Several refits between the lithic artefacts further indicate that the material has not been transported over large distances (Legrand *in press* and *pers. obs.*).

- ***Chronological position***

The chronological position of the assemblage is still debated. TL dates were impossible because of the lack of burned elements. Based on the stratigraphic sequence dates in both MIS-5 and MIS-3 are possible (Detrain *et al.* 1991).

- ***Palaeoecological context***

The Abri du Musée site contains a rich faunal assemblage dominated by mammoth (*Mammuthus primigenius*), reindeer (*Rangifer tarandus*) and red deer (*Cervus elaphus*) (Guadelli as quoted in Bourguignon 1992). These animals are indicative of a cold, open environment and do not allow a finer chronological position of the assemblage.

- ***The lithic assemblage***

A full analysis of the lithic assemblage (including use-wear analyses and refits) is currently in press. The assemblage has been attributed to the Middle Palaeolithic based on the dominance of the Levallois technique and the abundant presence of side scrapers. Furthermore various types of bifacial tools are present and these are studied in detail here. Another important characteristic of the Abri du Musée assemblage is the application of the para-burin technique to many unifacial and bifacial tools. Moreover, tranchet blow spalls are found in raw materials of which no other tools have been found, indicating the mobility of these artefacts (for a discussion see Chapter 8). So far the application of this technique has only been rarely attested on sites south of the Loire river (Bourguignon 1992).

- ***New analysis - bifacial tools***

Currently, the entire Abri du Musée lithic collection from is stored at the Musée National de Préhistoire in Les Eyzies. In total 30 bifacially flaked artefacts are present and all were reanalysed for this study. Five artefacts are broken, not allowing all attributes to be recorded. Linear measurements indicate that the bifacial tools from Abri du Musée are on average 70,9mm long, 47,4mm wide and 17,5mm thick (Table 5.50).

Abri du Musée (n:25)	Min.	Max.	Median	Average	St. Dev
Max. Length (mm)	40.00	140.00	69.00	70.88	19.36
Max. Width (mm)	33.00	73.00	48.00	47.40	10.10
Max. Thickness (mm)	8.00	53.00	16.00	17.48	8.40

Table 5.50: *Measurements of the bifacial tools from Abri du Musée*

The vast majority of the bifacial tools are made on flakes, including several Levallois flakes. Only one piece could with certainty be identified as being made on a nodule (Table 5.51). All the bifacial tools have a cortex remnant of less than 50%, of which over 80% has a cortex remnant of less than 25%. The edge angles are predominantly lower than 35° (70%) or between 35 and 65° (30%). Tools with edges of over 65° are absent (Table 5.51). The cross-sections of the bifacial tools are dominated by plano-convex ones (72%) and only two specimens have a biconvex section (Table 5.51).

ABRI DU MUSÉE	Technological Attributes									
Cortex	**none**		**1-25%**		**25-50%**		**50-75%**		**75-100%**	
	7	26.9%	14	53.8%	5	19.2%	0	0.0%	0	0.0%
Cross section	**Plano-convex**		**Bi-convex**		**Bi-plano**		**Plano-convex/ plano-convex**		**Irregular**	
	16	69.6%	2	8.7%	0	0.0%	0	0.0%	5	21.7%
Blank	**Flake**		**Nodule**		**Unknown**					
	21	70.0%	1	3.3%	8	26.7%				
Edge angles	**<35**		**35-65**		**>65**					
	19	70.4%	8	29.6%	0	0.0%				

Table 5.51: *Technological attributes of the bifacial tools from Abri du Musée*

Three main types of bifacial tools are present at Abri du Musée (Table 5.52). Half the artefacts can be classed as backed bifacial tools (54.5%) and a third can be labelled as bifacial scrapers (31.8%). Both leaf-shaped bifacial tools and classic handaxes occur but in very low numbers (Table 5.52). Because of their fragmentary nature or the non-diagnostic, non-continuous character of the bifacial retouch eight bifacially worked tools could not be added to this framework.

ABRI DU MUSÉE (n:22)	BIFACIAL TYPOLOGY	
Classic handaxes	1	4.5%
Backed bifacial tools	12	54.5%
Leaf-shaped bifacial tools	2	9.1%
Partial bifaces	0	0.0%
Bifacial scrapers	7	31.8%
TOTAL	22	100.0%

Table 5.52: *New simplified classification of the bifacial tools from Abri du Musée*

- ***Site Interpretation***

The Abri du Musée rock shelter contains a rich Middle Palaeolithic horizon. No radiometric dates are available, but based on the stratigraphy a date in the Late Middle Palaeolithic has been suggested. The rich faunal assemblage, dominated by mammoth, indicates a cold, open environment. The lithic assemblage is characterised by the use of the Levallois technique, the abundant presence of side scrapers and backed bifacial knives. These backed bifacial knives are preferably made on flakes, have some cortex remaining and have dominant edge angles of less than 35°. The cross-sections are in general plano-convex, which can be linked to the use of flake blanks (see Chapter 6).

A large metric variability is indicated by the large standard deviation for all the linear measurements. In terms of typology the assemblage is dominated by backed bifacial tools and bifacial scrapers. This feature together with the common use of the para-burin technique (Bourguignon 1992) gives this site a KMG character. Therefore the site of Abri du Musée stands out in a region where the dominant Middle Palaeolithic bifacial tool is the cordiform MTA handaxe (e.g. Le Moustier, Pech de l'Azé I and Haut de Combe Capelle), making this a crucial assemblage to investigate the nature of the KMG-MTA relationship.

5.7.4 Discussion

In addition to the reanalyses of these four sites, data from 12 well-published Southern French assemblages rich in bifacial tools was collated (Table 5.53a and 5.53b), allowing for a discussion on the chronology, environment and lithic variability in the area.

- Chronology and environment

In Southwestern France Neanderthals deposited Late Middle Palaeolithic bifacial tools in a variety of settings, including rock shelters, caves and open-air localities (Table. 5.53a). Most assemblages are recovered from stratified positions and also faunal remains were preserved. Bovids, horse and cervids are the dominant faunal species, although also mammoth and reindeer remains are found in association with Late Middle Palaeolithic bifacial tools, indicating both mixed and open environments (Table 5.53a).

Southwestern France is characterised by a dense cluster of radiometric dates (for a recent summary see Guibert *et al.* 2008). Over 430 dates are available for Southwestern

France Middle Palaeolithic sites, including over 70 for assemblages which contain bifacial tools. These are mainly related to MTA cave sites such as Le Moustier (G and H), La Rochette (layer 7), Grotte XVI (layer C), Pech de l'Azé I (5, 6 and 7) and Pech de l'Azé IV (Chapter 2; Table 2.4). Moreover the sites of Barbas III (layer 4) and Fonseigner were dated and all indicate a dominant MIS-3 presence for the MTA assemblages in this area. Few sites with bifacial tools have chronostratigraphic data indicating an age older than MIS-3 (Grotte Marcel Clouet (MIS-4; Matilla and Debénath 2003), Barbas (MIS-6), Moulin du Milieu (MIS-6; Turq 1992, 2000). For KMG influence in this area, such as at the sites of Germolles and Abri du Musée, no chronological information is yet available.

SITE	LOCATION	LAYER	DATE	FAUNA	ENVIRONMENT	MAIN REFERENCE
Abri du Musée	rock shelter	VIII	MIS 5-3	mammoth, red deer, reindeer	cold, open	Detrain *et al.* 1991
Barbas III	open-air	C.4	MIS-3	_	_	Boëda *et al.* 1996
Basté	open-air	4	unknown	–	–	Chauchat and Thibault 1968
Fonseigner	open-air	Dsup	MIS-3	bovids, mammoth, roe deer, reindeer	_	Geneste 1985
Germolles	cave	–	unknown	–	–	Frick 2010
Grotte Noisetier	cave	1	MIS-3	red deer, ibex	temperate, wooded	Mourre *et al.* 2008
Grotte XVI	cave	–	MIS-3	–	–	Kervazo and Texier 2006
Haut de Combe Capelle (Abri Peyrony)	rock shelter	–	MIS-3	bovids, horse, cervids	–	Lenoir *et al.* 2010
Jonzac	rock shelter	7	MIS-3	bovids, horse, reindeer	–	Jaubert *et al.* 2008
La Baume de Gigny	cave	VIII	unknown	–	–	Campy *et al*. 1989
Le Moustier	rock shelter	G	MIS-3	bovids, horse, reindeer	mixed	Laville and Rigaud 1973
La Quina	rock shelter	6d	MIS-3	bovids, horse, reindeer, red deer	–	Debénath and Jelinek 1998
La Rochette	rock shelter	7	–	–	–	Soressi 2002
Marcel Clouet	cave	5&4	MIS-4	horse, bovid, hyena, cervids	–	Matilla and Debénath 2003
Pech de l'Azé I	cave	4	MIS-3	bison, red deer, roe deer, reindeer	forested	Soressi 2002
Petit Nareye	open-air	–	unknown	–	–	Tavoso 1976

Table 5.53a: *Overview of the characteristics of the main southern French sites rich in bifacial tools, their location, date, fauna and environment*

- Lithic variability

The vast majority of bifacial tools from Southern France are made on flint, usually coming from a variety of sources (Table 5.53b). Levallois and discoidal methods were predominantly used to obtain flakes in these assemblages. The tool kit exists mainly of scrapers and backed knives, but also notches and denticulates are common. On average, the Southern French assemblages are relatively large, with 9 out of 16 sites containing more than 1,000 artefacts. The number of bifacial tools is variable and remarkable is the common occurrence of assemblages containing over 100 handaxes; e.g. Abri Peyrony, Le Moustier, La Rochette and Pech de l'Azé I (Table 5.53b).

SITE	DOMINANT RAW MATERIAL	FLAKING METHODS	FLAKE TOOLS	ASSEMBLAGE SIZE	BIFACIAL TOOLS	Classic	Backed	Leafshaped	Partial	Bif. Scraper
Abri du Musée	flint	Levallois, discoidal	scrapers	>1,000	30	√	√	–	–	√
Barbas III	flint	discoidal	scrapers, backed knife	>100	1	√	–	–	–	–
Basté	flint	?	?	?	19	√	√	–	–	√
Fonseigner	flint	Levallois	scrapers, notches, denticulates	2,067	7	√	–	–	–	√
Germolles	flint	Levallois, discoidal	scrapers, points, notches, denticulates	?	?	√	√	–	–	–
Grotte Noisetier	quartzite	discoidal, Levallois	scrapers, denticulates	422	2	√	–	–	–	–
Grotte XVI	flint	?	?	2,500	19	√	–	–	–	–
Haut de Combe Capelle (Abri Peyrony)	flint	Levallois, discoidal	scrapers, backed knives	>2,000	191	√	√	√	√	√
Jonzac	flint	Levallois, discoidal	scrapers, denticulates, notches, end scrapers	>1,000	>10	√	–	–	–	√
La Baume de Gigny	chert and flint	Levallois, discoidal	scrapers	270	7	–	√	–	–	√
Le Moustier	flint	Levallois, discoidal, laminar	scrapers, backed knives, notches, denticulates	>4,500	323	√	√	√	√	–
La Quina	flint	Levallois, discoidal	scrapers	588	?	√	–	–	√	–
La Rochette	flint	discoidal, laminar	backed knives, scrapers	3,500	235	√	–	–	–	√
Marcel Clouet	flint	Levallois, discoidal	scrapers, points, backed	175	5	√	–	–	–	–
Pech de l'Azé I	flint	Levallois, laminar	scrapers, backed knives	32,740	155	√	–	√	√	–
Petit Nareye	flint and quartzite	Levallois, discoidal	scrapers	>1,000	?	√	–	–	–	√

__Table 5.53b__: *Overview of the characteristics of the main southern French sites rich in bifacial tools and their lithic assemblages*

The assessment of these 16 sites highlights the clear dominance of classic handaxes, the common occurrence of bifacial scrapers, and the rarity of backed and leaf-shaped bifacial tools in Southern France. On some sites, especially in Southeastern France, the latter occur in larger proportions, representing a *Keilmessergruppe* affinity (e.g. Germolles and La Baume de Gigny). Conversely, these KMG elements such as prondniks, *Faustkeilblätter*, Halbkeile and *Keilmesser*, seem to be as good as absent in southwestern France, with exception of the site of Abri du Musée (Les Eyzies), where KMG features such as prondniks and the para-burin technique occur regularly. The anomaly of this site is further explored in Chapters 7 and 8.

The assemblages with classic handaxes have been grouped together in the Mousterian of Acheulean Tradition and occur dominantly and in large numbers in Southwestern France (e.g. Haut de Combe Capelle, Le Moustier, Jonzac, Grotte XVI, la Rochette and Pech de l'Azé). MTA handaxes occur as far east as the Tarn Valley and as far north as the Charente but are absent in Southeastern France. The reanalysis of the handaxes from three MTA type sites has confirmed that they are small, thin and predominantly cordiform in shape. A lot of variability is present among the bifacial tools in these assemblages and also partial handaxes and bifacial scrapers occur sporadically. However, it is the dominance of cordiform bifaces that makes these assemblages stand out from other regions in France.

The above overview and new analyses have confirmed the regional dominance of cordiform handaxes in Southwestern France, confirming it as the core area of the MTA, but also the presence of a KMG affinity, resulting in more varied bifacial tool assemblages, in Southastern France.

5.8 Discussion: Initial and Genuine Variability Patterns

This chapter comprehensively illustrated that bifacial tools are a common occurrence at Late Middle Palaeolithic sites across the study area (Germany, the Netherlands, Belgium, Britain and France). Alongside a regional overview of the occurrence of different bifacial tool types and entities, 14 study sites were also contextualised. Results from the reanalysis of 1,303 bifacial tools were outlined, together with background information for each site locality. In addition, data was collated for a further 66 sites rich in bifacial tools through a review of the current literature. Through the integration of information from these 80 sites containing Late Middle Palaeolithic bifacial tools several inferences can be made regarding their chronology, environmental settings, lithic and bifacial tool variability.

- *Chronology and environment*

Bifacial tools formed a common part of the Neanderthal toolkit across Western Europe. They occur throughout the duration of the Late Middle Palaeolithic period and in a mosaic of environmental settings and locations. Firstly, it is clear that Late Middle Palaeolithic bifacial tools occur in caves, rock shelters and open-air localities. Where palaeoenvironmental data is available it is clear that they occur both in temperate, forested and cold, open environments; for a further discussion on site location and function, see Chapter 8, section 8.3.2.

Secondly, chrono-stratigraphic information is lacking for many sites. Especially in Belgium, the Netherlands and Western France most assemblage lack radiometric dates and/or contextual information (see Chapter 2, Table 2.4). Many sites are placed in the broad MIS5-3 time range but making more fine-grained temporal assignments is impossible with the current data. Conversely, it does seem clear that in the whole study area bifacial tools occur both during MIS-5 and 3. It is generally envisaged that large parts of Western Europe were abandoned during MIS-4 (Chapter 2) and few bifacial tool assemblages can be assigned to this specific time period. More detailed temporal patterns for the Late Middle Palaeolithic bifacial tools are discussed in Chapter 7, section 7.3.

- *Lithic variability*

The general characteristics of 80 assemblages containing bifacial tools were assessed in this chapter, indicating the presence of both larger-scale differences and similarities. A first overall characteristic is that across the study area bifacial tools are predominantly made on locally available fine-grained raw materials, such as flint and chert. The main exception is Brittany, where flint is sparse so the local glossy sandstone and micro-granite were used. Secondly, in the majority of assemblages several flaking methods were applied, including Levallois, discoidal and laminar reduction methods. No specific patterns of variation seem to be present among the flaking methods used in thise bifacial tool assemblages. Thirdly, in all assemblages a wide spectrum of flake tools is present, commonly including scrapers, points, notches and denticulates. The lack of variability in these aspects of the lithic material justifies a further exclusive focus on bifacial tools, but previously claimed trends among flaking methods are briefly reassessed in Chapter 7, Section 7.3.2.

Conversely, among the Late Middle Palaeolithic bifacial tools themselves a large amount of variability was noted, higher than previously acknowledged. Firstly, Late Middle Palaeolithic sites with bifacial tools occur across Western Europe but their abundance does vary regionally; the best example being their near absence in Southeastern France. Secondly, there are great differences in the quantities of bifacial tools. In Britain and the Netherlands, the Middle Palaeolithic record is mainly represented by isolated finds and assemblages with over 30 bifacial tools are rare. Conversely, in Belgium, France and Germany, several larger, stratified well-excavated assemblages rich in bifacial tools are present. Especially in Northern, Western and Southern France assemblages containing several hundreds of bifacial tools are a common occurrence.

Finally, a lot of variability seems to exist among the typo-technological characteristics of the bifacial tools. Firstly, the validity of this variability was assessed by reanalysing 80 Late Middle Palaeolithic bifacial tool assemblages according to the newly developed classificatory scheme (Chapter 4), allowing a uniform comparison across regions and research traditions. This reassessment indicated that all five bifacial tool types occur across Western Europe but genuine differences exist among bifacial tool types and entities between regions, regardless of the typological framework. The main difference hereby is the dominance of classic handaxes in France, and their near absence in Germany (e.g. compare Table 5.9b to Table 5.53b). The wide presence of each bifacial tool type, and the fact that the record is more variable than a mere MTA-KMG dichotomy, is expressed through the existence of a plethora of taxonomic entities defined by specific bifacial tool characteristics. Testing the validity of these entities re quires a more detailed, large-scale comparative study and this is conducted in Chapter 7.

Secondly, these differentiation patterns were further characterised by a detailed comparison of the proportions of each bifacial tool type in each of the 14 study sites (Table 5.54). Bois-du-Rocher was excluded since only a fraction of the bifacial tool collection was studied. On this table sites are ranked by their percentage of classic handaxes (low to high). This simplified framework facilitates comparison and again it becomes clear that there is a genuine difference between assemblages dominated by classic handaxes and assemblages where this tool type is absent. A clear negative correlation between classic handaxes on the one hand and leaf-shaped bifacial tools, bifacial scrapers and backed bifacial tools on the other hand is illustrated (Table 5.44). The sites from Southwestern France (Haut de Combe Capelle, Pech de l'Azé I and Le Moustier) contrast with the sites from Germany, represented by Königsaue and Sesselfelsgrotte. These differing typo-technological trends are assessed in more detail in Chapter 6.

Site	Nr	Classic handaxes	Partial bifaces	Leafshaped bifacial tools	Bifacial scrapers	Backed bifacial tools
Konigsaue	15	0.0%	0.0%	53.3%	13.3%	33.3%
Sesselfelsgrotte	114	1.8%	4.4%	30.0%	33.3%	29.8%
Abri du Musée	22	4.5%	0.0%	9.1%	31.8%	54.5%
Oosthoven	18	22.2%	22.2%	0.0%	16.7%	38.9%
Grotte du Docteur	38	26.3%	7.9%	21.1%	10.5%	34.2%
Champlost	30	43.3%	3.3%	16.7%	30.0%	6.7%
Sint-Geertruid	18	63.2%	0.0%	5.3%	10.5%	21.1%
Lynford	45	66.7%	8.8%	0.0%	1.8%	1.8%
Haut de Combe Capelle	181	84.5%	10.5%	0.0%	2.8%	1.7%
Le Moustier	257	92.6%	3.5%	0.8%	0.1%	3.1%
St Julien de la Liegue	209	93.0%	0.5%	3.3%	0.5%	0.0%
Pech de l'Azé I	82	95.1%	3.6%	1.2%	0.0%	0.0%
St Just en Chaussée	25	100.0%	0.0%	0.0%	0.0%	0.0%

Table 5.54: *Typological classification of the bifacial tools from the 14 studied collections (the red to green colour scale reflects high (green) and low (red) percentages)*

This overview of the Late Middle Palaeolithic bifacial tools from five Western European countries and 80 sites allows recognising some intitial variability trends. A clear opposition exists between the Southwestern and Northeastern part of the study area. Classic MTA sites are rare east of the Rhine River and no classic KMG sites occur west of the Rhine. Classic handaxes occur only rarely in assemblages east of the Rhine, while all other bifacial tool types have a more widespread occurrence. Further southwest, in the core area of the MTA, assemblages are dominated by classic handaxes, with few other bifacial tools alongside. In all regions, and especially in the Netherlands, Belgium and Northern France, assemblages occur with a varied record of bifacial tools is present, including both classic handaxes and backed bifacial tools; as illustrated by the percentage of Oosthoven, Grotte du Docteur, Champlost and Sint-Geertruid on Table 5.54.

This chapter established that when reanalysing a substantial sample (80 sites and 1,303 bifacial tools) of late Middle Palaeolithic bifacial tools in Western Europe by a simplified, uniform typological framework, differentiation trends can be identified which cannot be linked to epistemological or classification issues and therefore must represent differences in Neanderthal behaviour. These initial descriptions, comparisons and analyses allow formulating a positive answer to Research Question 1 and following genuine trends:

- An opposition between the Southwestern and Northeastern parts of the study area
- A negative correlation between classic handaxes on the one hand and leaf-shaped and backed bifacial tools on the other hand
- The presence of a large number of assemblages which contain a wide variety of bifacial tools, including both classic handaxes and backed bifacial tools

The specifics of these genuine variability patterns can now be assessed in more detail by conducting extensive comparative analyses between bifacial tool types, assemblages and entities in relation to their typo-technological characteristics (Chapter 6) and spatial and temporal occurrences (Chapter 7).

Chapter 6:

Results I

Analysis of Typo-Technological Attributes

6.1 Introduction

Results from the comprehensive overview of the Late Middle Palaeolithic bifacial tool record from a pan-European perspective (Chapter 5), using the new classificatory scheme (Chapter 4), highlighted the existence of genuine variability patterns (Research Question 1). A macro-regional dichotomy was observed between the Southwestern and Northeastern parts of the study area, together with patterns of typo-technological variation. This chapter focusses on the latter by providing an in-depth analysis of the techno-typological characteristics of the bifacial tools from the selected study sites. These analyses are confined to the micro-scale of analysis (Chapter 3) and discuss differences between individual bifacial tools, tool types and assemblages in relation to Research Question 2:

What are the distinctive typo-technological characteristics of the bifacially worked tools present during the Late Middle Palaeolithic (MIS 5d-3; ca. 115-35 ka BP) in Western Europe (Germany, France, The Netherlands, Belgium and Britain)?

A total of 22 technological and typological attributes (Chapter 4) were recorded for 1,303 bifacial tools from 14 key assemblages. These attributes provide information related to the condition, technological, typological and metrical characteristics of these bifacial tools. This chapter is structured around three aspects of the assemblages:

1. The integrity of the assemblages is discussed by looking at the condition of the various artefacts within an assemblage, including patination, edge wear and breakage patterns.
2. The processes by which the bifacial tools were knapped are assessed by recording technological attributes such as raw material, blank, cortex and backing.
3. The results of these knapping processes are analysed in more detail, including the characteristics of the retouch, cross sections, edge angles, shape and size of the bifacial tools.

These three-fold analyses aim to recognise genuine, data-driven, typo-technological patterns in the Western European Late Middle Palaeolithic bifacial tool record and will detail differences both at the tool type and assemblage level.

6.2 Artefact Condition and Assemblage Integrity

The 14 assemblages were recovered from different settings (cave, rock shelter and open air, see tables Chapter 5) and collected using different methodologies (stratified or surface; Chapter 4; Table 4.3). The sample contains two cave sites, three rock shelters and nine open-air localities. Nine assemblages were recovered from stratified positions, whilst three are surface collections. The taphonomic histories of these assemblages were analysed in more detail to assess the integrity of the collections and the appropriateness of comparing them. Both the physical condition of the artefacts (edge wear and breakage) and the presence of chemical alterations (patina and staining) were assessed.

6.2.1 Artefact condition

The edge wear data (Table 6.1) shows that heavily abraded bifacial tools are very rare at all study locales. Conversely, four sites are dominated by pieces with fresh edges and six by artefacts with slightly abraded edges. Another four sites contain a mix of fresh and slightly abraded bifacial tools. This indicates that the majority of the assemblages (10 out of 14) have undergone post-depositional processes that have affected the edges of the artefacts. Because of the lack of heavily abraded artefacts it can be stated that the effects of these post-depositional processes were only minimal.

Breakage patterns were recorded on bifacial tools at the vast majority of the 14 study sites, exception being Bois-du-Rocher. The absence of broken pieces at this site is related to the fact that only a selective sample was analysed for this thesis. The percentage of broken tools ranges from 0 to 41% with an average of 15% (Table 6.1). There seems to be no link between the amount of edge wear and the proportion of broken bifacial tools. For example at Sesselfelsgrotte the majority of bifacial tools are in fresh condition, but 40% of them are broken. Moreover, is it difficult to relate this fracturing to a point in time; i.e. related either to tool breakage during manufacture, during use or after discard. The relatively low percentage of broken bifacial tools in these assemblages confirms that even though post-depositional processes occurred, the disturbance was not major.

The specific causes of chemical alterations, and especially patination, are still poorly understood. It is generally assumed that patination occurs in relation to exposure to air and water (Röttlander 1975; Burroni *et al.* 2002). The patination data of the bifacial tools in the sample is variable. In four assemblages no patination occurs, in five assemblages the bifacial tools are heavily patinated and in five assemblages a mix of different types of patination occurs (Fig. 6.1; Table 6.1). Staining is only present in the assemblage of Sint-Geertruid where it occurs as iron stains.

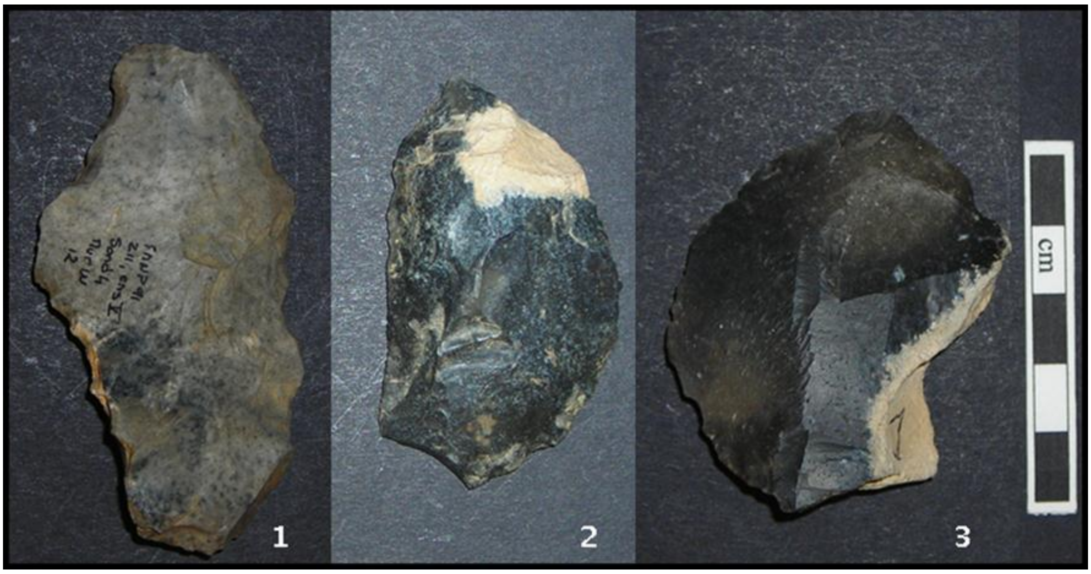


Fig 6.1: *Varying patination on artefacts from Abri du Musée:*
1: heavily patinated, 2: slightly patinated, 3: not patinated

ARTEFACT CONDITION	EDGE WEAR			BROKEN		PATINATION			TOTAL
	fresh	slightly	heavily	Yes	No	none	slightly	heavily	
Le Moustier	215 *66.8%*	107 *33.2%*	0 *.0%*	73 *22.6%*	250 *77.4%*	80 *24.8%*	166 *51.4%*	77 *23.8%*	**323** ***100.0%***
Pech de l'Azé I	26 *25.7%*	74 *73.3%*	1 *1.0%*	19 *18.8%*	82 *81.2%*	12 *11.9%*	32 *31.7%*	57 *56.4%*	**101** ***100.0%***
Lynford	57 *100.0%*	0 *.0%*	0 *.0%*	8 *14.0%*	49 *86.0%*	55 *96.5%*	2 *3.5%*	0 *.0%*	**57** ***100.0%***
Sint-Geertruid	22 *91.7%*	2 *8.3%*	0 *.0%*	2 *8.3%*	22 *91.7%*	3 *12.5%*	18 *75.0%*	3 *12.5%*	**24** ***100.0%***
Königsaue	18 *100.0%*	0 *.0%*	0 *.0%*	7 *31.8%*	15 *68.2%*	15 *83.3%*	2 *11.1%*	1 *5.6%*	**22** ***100.0%***
Sesselfelsgrotte	156 *100.0%*	0 *.0%*	0 *.0%*	64 *40.8%*	93 *59.2%*	146 *93.6%*	6 *3.8%*	4 *2.6%*	**157** ***100.0%***
Abri du Musée	23 *76.7%*	7 *23.3%*	0 *.0%*	5 *16.7%*	25 *83.3%*	7 *23.3%*	14 *46.7%*	9 *30.0%*	**30** ***100.0%***
Haut de Combe Capelle	3 *1.6%*	187 *97.9%*	1 *.5%*	18 *9.4%*	173 *90.6%*	1 *.5%*	23 *12.0%*	167 *87.4%*	**191** ***100.0%***
St Just en Chaussée	1 *3.7%*	26 *96.3%*	0 *.0%*	4 *14.8%*	23 *85.2%*	0 *.0%*	2 *7.4%*	25 *92.6%*	**27** ***100.0%***
Champlost	0 *.0%*	32 *100.0%*	0 *.0%*	5 *15.6%*	27 *84.4%*	0 *.0%*	0 *.0%*	32 *100.0%*	**32** ***100.0%***
Bois du Rocher	0 *.0%*	58 *100.0%*	0 *.0%*	0 *.0%*	58 *100.0%*	53 *91.4%*	0 *.0%*	5 *8.6%*	**58** ***100.0%***
St Julien de la Liègue	0 *.0%*	215 *100.0%*	0 *.0%*	35 *16.3%*	180 *83.7%*	0 *.0%*	0 *.0%*	215 *100.0%*	**215** ***100.0%***
Oosthoven	7 *35.0%*	13 *65.0%*	0 *.0%*	3 *14.3%*	18 *85.7%*	1 *4.8%*	2 *9.5%*	18 *85.7%*	**21** ***100.0%***
Grotte du Docteur	4 *8.9%*	41 *91.1%*	0 *.0%*	9 *20.0%*	36 *80.0%*	3 *6.7%*	14 *31.1%*	28 *62.2%*	**45** ***100.0%***
TOTAL	***532*** ***40.8%***	***764*** ***58.6%***	***2*** ***0.2%***	***252*** ***19.3%***	***1051*** ***80.7%***	***214*** ***16.4%***	***202*** ***15.5%***	***163*** ***12.5%***	***1303*** ***100.0%***

Table 6.1: *The physical and chemical alteration of the artefacts by site*

6.2.2 Assemblage integrity

The condition of the bifacial tools is summarised in Table 6.2 in relation to the geographic location of the site and the stratigraphic position of the assemblage. At open-air localities and in cave sites fresh artefacts appear as well as assemblages dominated by slightly abraded tools. Assemblages where both fresh and slightly worn artefacts are present occur both in rock shelters and open-air localities. Overall no link can be made between the amount of edge wear and the location of the site or the position (surface/stratified) of the assemblage (Table 6.2).

Furthermore, there is no patterning in the data in relation to the patination of artefacts. Although all the heavily patinated assemblages originate from open-air localities, assemblages with no or slight amounts of patination have been recovered from open-air sites as well. The rock shelter assemblages are characterised by a mix of patinated and unpatinated artefacts, just as they are typified by a mix of slightly worn and fresh artefacts. One of the cave assemblages is dominantly unpatinated while the other one contains a mix of patinated and unpatinated tools. In general the bifacial tools recovered from rock shelter and cave localities have a relatively high number of broken bifacial tools; averaging around 24%. In the open-air collections the percentage of broken artefacts is more variable, ranging from 0 to 32% (Table 6.2). This data indicates no clear correlation between patination and breakage patterns and the location of the site or stratigraphic position of the assemblage. Rather, the condition data seems to reflect the complex and varied site formation processes at action at all these sites.

	Location	Position	Edge Wear	Patination	Broken
Grotte du Docteur	cave	stratified	slightly	mix	20%
Sesselfelsgrotte	cave	stratified	fresh	none	41%
Le Moustier	rock shelter	stratified	fresh & slightly	mix	23%
Pech de l'Azé I	rock shelter	stratified	fresh & slightly	mix	19%
Abri du Musée	rock shelter	stratified	fresh & slightly	mix	17%
Königsaue	open-air	stratified	fresh	none	32%
Oosthoven	open-air	stratified	fresh & slightly	heavily	14%
Lynford	open-air	stratified	fresh	none	14%
Saint-Just-en-Chaussée	open-air	stratified	slightly	heavily	4%
Haut de Combe Capelle	open-air	stratified	slightly	heavily	2%
Champlost	open-air	stratified	slightly	heavily	0%
Saint-Julien de la Liègue	open-air	surface	slightly	heavily	16%
Sint-Geertruid	open-air	surface	fresh	mix	8%
Bois-du-Rocher	open-air	surface	slightly	none	0%

Table 6.2: *Overview of the condition of the artefacts in relation to the location of the site and position of the assemblage*

Within each assemblage, the majority of the bifacial tools have similar conditions, indicating parallel deposition processes and their overall homogeneous nature. This is observed for eight assemblages, Lynford, Königsaue, Sesselfelsgrotte, Saint-Just en Chaussée, Champlost, Bois-du-Rocher, Saint-Julien de la Liègue and Haut de Combe Capelle. The other six assemblages have bifacial tools in varying conditions; Grotte du Docteur, Abri du Musée, Pech de l'Azé I and Le Moustier, Oosthoven and Sint-Geertruid. These variable conditions occur at open-air, cave and rock-shelter localities, as well as in stratified and surface collections. Especially in closed cave and rock shelter systems this artefact condition variability could be partly related to differential post-depositional and taphonomic processes in different parts of the site. The common occurrence of different artefact conditions within one assemblage, and within a variety of site types, indicates that they are caused by a variety of processes. Therefore, differential artefact condition alone, should not be used to question the integrity of these assemblages, but other aspects of the assemblage should be taken into account.

In this Late Middle Palaeolithic bifacial tool sample only at the surface site of Sint-Geertruid can the homogeneity of the assemblage be questioned; this based on a combination of artefact condition data, collection history, and location/position of the assemblage. Throughout this thesis the artefacts from Sint-Geertruid will be treated as one entity but such questionable integrity will be considered when making behavioural interpretations (Chapter 8).

Overall, the condition data suggests the integrity of the vast majority of the study sites. Although many assemblages underwent slight post-depositional modifications, it appears that all the bifacial tools in the individual assemblages were deposited roughly around the same time. Therefore, in this thesis all the bifacial tools from each assemblage are grouped together and analysed as one broadly contemporaneous entity. However, it is important to remain aware of the palimpsestual nature of some assemblages, such as Grotte du Docteur and Sint-Geertruid.

6.3 Manufacture Processes

The processes underlying the manufacture of the bifacial tools were assessed by analysing the raw material and the blank type used and in particular the presence of cortex remnants and backing on the blanks.

6.3.1 Raw Material

The raw material type was identified for all 1,303 bifacial tools (Table 6.3). In all assemblages there is a strong dominance of locally available fine-grained raw materials, mainly flint but also chert and glossy sandstone (*grès lustré*). These fine-grained materials form between 80 and 100% of all the studied assemblages (Table 6.3). Conversely, more exotic raw materials, such as quartz, quartzite and radiolarite, were only sporadically used and are restricted to specific sites. The best example of this is at Sessefelsgrotte where a wider range of raw materials have been used (Richter 1997; Table 6.3).

The exclusive presence of flint on most sites does not necessarily indicate a single raw material source. At several sites different types of flint can be distinguished, and especially for Southwestern France the origins of these flint types are known. For example at Haut de Combe Capelle recent work has indicated the presence of at least 11 different raw material types coming from sources ranging from a few metres away to over 20 kilometres away (Turq 2010). Also at the British site of Lynford different types of flint from different origin sources have been identified (White 2012).

Other Middle Palaeolithic biface-rich assemblages for which raw material distances have been examined also indicate the strong use of local raw material (Floss 1994; Soressi and Hays 2003; Çep *et al.* 2011), confirming that, in general, local raw materials were favoured in Middle Palaeolithic assemblages (Féblot-Augustins 1993, 1999; Turq 2000; Bourguignon *et al.* 2006; Slimak and Giraud 2007).

RAW MATERIAL	flint	chert	gres	quartz	quartzite	radiolarite	other	Total
Le Moustier	321	0	0	2	0	0	0	**323**
	99.4%	*.0%*	*.0%*	*.6%*	*.0%*	*.0%*	*.0%*	***100.0%***
Pech de l'Azé I	101	0	0	0	0	0	0	**101**
	100.0%	*.0%*	*.0%*	*.0%*	*.0%*	*.0%*	*.0%*	***100.0%***
Lynford	57	0	0	0	0	0	0	**57**
	100.0%	*.0%*	*.0%*	*.0%*	*.0%*	*.0%*	*.0%*	***100.0%***
Sint-Geertruid	24	0	0	0	0	0	0	**24**
	100.0%	*.0%*	*.0%*	*.0%*	*.0%*	*.0%*	*.0%*	***100.0%***
Königsaue	22	0	0	0	0	0	0	**22**
	100.0%	*.0%*	*.0%*	*.0%*	*.0%*	*.0%*	*.0%*	***100.0%***
Sesselfelsgrotte	2	126	0	0	11	8	10	**157**
	1.3%	*80.3%*	*.0%*	*.0%*	*7.0%*	*5.1%*	*6.4%*	***100.0%***
Abri du Musée	30	0	0	0	0	0	0	**30**
	100.0%	*.0%*	*.0%*	*.0%*	*.0%*	*.0%*	*.0%*	***100.0%***
Haut de Combe Capelle	191	0	0	0	0	0	0	**191**
	100.0%	*.0%*	*.0%*	*.0%*	*.0%*	*.0%*	*.0%*	***100.0%***
St Just en Chaussée	27	0	0	0	0	0	0	**27**
	100.0%	*.0%*	*.0%*	*.0%*	*.0%*	*.0%*	*.0%*	***100.0%***
Champlost	32	0	0	0	0	0	0	**32**
	100.0%	*.0%*	*.0%*	*.0%*	*.0%*	*.0%*	*.0%*	***100.0%***
Bois du Rocher	4	0	54	0	0	0	0	**58**
	6.9%	*.0%*	*93.1%*	*.0%*	*.0%*	*.0%*	*.0%*	***100.0%***
St Julien de la Liègue	215	0	0	0	0	0	0	**215**
	100.0%	*.0%*	*.0%*	*.0%*	*.0%*	*.0%*	*.0%*	***100.0%***
Oosthoven	20	0	0	0	1	0	0	**21**
	95.2%	*.0%*	*.0%*	*.0%*	*4.8%*	*.0%*	*.0%*	***100.0%***
Grotte du Docteur	44	1	0	0	0	0	0	**45**
	97.8%	*2.2%*	*.0%*	*.0%*	*.0%*	*.0%*	*.0%*	***100.0%***
Total	**1090**	**127**	**54**	**2**	**12**	**8**	**10**	**1303**
	83.7%	***9.7%***	***4.1%***	***0.2%***	***0.9%***	***0.6%***	***0.8%***	***100.0%***

Table 6.3: *The different raw materials of the bifacial tools by site*

RAW MATERIAL	flint	chert	gres	quartz	quartzite	radiolarite	other	Total
classic	774	3	52	1	0	0	0	**830**
	93.3%	*0.4%*	*6.3%*	*1.0%*	*0.0%*	*0.0%*	*0.0%*	***100.0%***
backed	55	25	0	0	3	2	4	**89**
	61.8%	*28.1%*	*0.0%*	*0.0%*	*3.4%*	*2.2%*	*4.5%*	***100.0%***
leaf-shaped	36	32	0	0	0	0	2	**70**
	51.4%	*45.7%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*2.9%*	***100.0%***
bif scraper	33	29	1	0	5	2	2	**72**
	45.8%	*40.3%*	*1.4%*	*0.0%*	*6.9%*	*2.8%*	*2.8%*	***100.0%***
partial	44	3	1	0	2	0	1	**51**
	86.3%	*5.9%*	*2.0%*	*0.0%*	*3.9%*	*0.0%*	*2.0%*	***100.0%***
TOTAL	**942**	**92**	**54**	**1**	**10**	**4**	**9**	**1112**
	84.7%	***8.3%***	***4.9%***	***0.1%***	***0.9%***	***0.4%***	***0.8%***	***100.0%***

Table 6.4: *The different raw materials of the bifacial tools by tool type*

The nodules of these fine-grained raw materials vary both in size and shape, which can influence the final shape of the bifacial tool. For example at the site of Sesselfelsgrotte thin plaquettes of chert occur (Fig. 6.2). These plaquettes are thin and flat and can only be knapped in a restricted fashion. Furthermore, the small size of some bifacial tools has been linked to the small size of the available raw material nodules, although these links do not always hold up and other factors can cause small dimensions as well (e.g. Oosthoven; Ruebens 2005; for a discussion see Chapter 7, Section 7.2.2).

Fig 6.2: *Tabular chert plaquette from Sesselfelsgrotte (Southern Germany)*

Table 6.4 demonstrates no clear link between the type of bifacial tool and the type of raw material. Classic and partial handaxes are predominantly made on flint. For bifacial scrapers, leaf-shaped and backed bifacial tools flint and chert are the most common raw material types. This difference can mainly be related to the plentiful occurrence of flint near to the French sites and a more varied raw material spectrum on the German sites.

In summary, raw material data indicates the predominant use of local fine-grained raw materials in all assemblages. These raw material nodules can occur in a variety of sizes and shapes but there seems to be no link between the type of raw material used and the type of bifacial tool manufactured. Potential raw material constraints and their effects on bifacial tool variability are further assessed and interpreted in Chapter 8 (Section 8.3.1).

6.3.2 Blanks

Bifacially worked tools can be manufactured both by façonnage (also known as form shaping), and by shaping and retouching a blank obtained by debitage. The intense shaping and/or retouch of these bifacial tools often removes the distinct features that are crucial for distinguishing between these different blank types. Because of this, it was impossible to determine the blank type for approximately two thirds of the bifacial tools (Table 6.5).

BLANK	nodule/ pebble	natural fragment	flake	indeter-minate	Total
Le Moustier	39 *12.1%*	1 *0.3%*	53 *16.4%*	230 *71.2%*	**323** ***100.0%***
Pech de l'Azé I	3 *3.0%*	0 *0.0%*	23 *22.8%*	75 *74.3%*	**101** ***100.0%***
Lynford	5 *8.8%*	0 *0.0%*	18 *31.6%*	34 *59.6%*	**57** ***100.0%***
Sint-Geertruid	1 *4.2%*	0 *0.0%*	4 *16.7%*	19 *79.2%*	**24** ***100.0%***
Königsaue	0 *0.0%*	0 *0.0%*	8 *36.4%*	14 *63.6%*	**22** ***100.0%***
Sesselfelsgrotte	41 *26.1%*	3 *1.9%*	40 *25.5%*	73 *46.5%*	**157** ***100.0%***
Abri du Musée	1 *3.3%*	0 *0.0%*	21 *70.0%*	8 *26.7%*	**30** ***100.0%***
Haut de Combe Capelle	11 *5.8%*	0 *0.0%*	49 *25.7%*	131 *68.6%*	**191** ***100.0%***
St Just en Chaussée	4 *14.8%*	0 *0.0%*	2 *7.4%*	21 *77.8%*	**27** ***100.0%***
Champlost	0 *0.0%*	0 *0.0%*	17 *53.1%*	15 *46.9%*	**32** ***100.0%***
Bois du Rocher	1 *1.7%*	0 *0.0%*	12 *20.7%*	45 *77.6%*	**58** ***100.0%***
St Julien de la Liègue	0 *0.0%*	0 *0.0%*	36 *16.7%*	179 *83.3%*	**215** ***100.0%***
Oosthoven	5 *23.8%*	0 *0.0%*	7 *33.3%*	9 *42.9%*	**21** ***100.0%***
Grotte du Docteur	11 *24.4%*	0 *0.0%*	11 *24.4%*	23 *51.1%*	**45** ***100.0%***
Total	**122** ***9.4%***	**4** ***0.3%***	**301** ***23.1%***	**876** ***67.2%***	**1303** ***100.0%***

Table 6.5: *The blanks of the bifacial tools by site*

BLANK	nodule/pebble	natural fragment	flake	indeter-minate	Total
classic	56 *6.7%*	0 *0.0%*	151 *18.2%*	623 *75.1%*	**830** ***100.0%***
backed	22 *24.7%*	0 *0.0%*	26 *29.2%*	41 *46.1%*	**89** ***100.0%***
leaf-shaped	10 *14.3%*	0 *0.0%*	19 *27.1%*	41 *58.6%*	**70** ***100.0%***
bif scraper	10 *13.9%*	2 *2.8%*	41 *56.9%*	19 *26.4%*	**72** ***100.0%***
partial	1 *2.0%*	1 *2.0%*	42 *82.4%*	7 *13.7%*	**51** ***100.0%***
TOTAL	**99** ***8.9%***	**3** ***0.3%***	**279** ***25.1%***	**731** ***65.7%***	**1112** ***100.0%***

Table 6.6: *The blanks of the bifacial tools by tool type*

Bifacial tools manufactured on flake blanks were identified in all 14 assemblages. These flake blanks were obtained by a variety of debitage methods, including Levallois and discoidal methods (see also chapter 5). Bifacial tools made through façonnage (nodules or pebbles) are also very common, although never seem to dominate (Table 6.5). Only at the site of Königsaue, Champlost and St Julien de la Liègue could no façonnage blanks could be identified.

The flatness value, width divided by thickness, also gives an indication of the original blank used to create the tools (Mellars 1996). The histograms in Appendix 1 indicate the frequency of the different refinement value classes. Low values indicate a stocky appearance of the tool and can be linked to the façonnage and high values indicate more refined, flake blanks. These values indicate a dominant use of flake blanks in the assemblages of Champlost, Königsaue and Lynford. In all other assemblage a more varied blank use pattern was present, with both low and high refinement values, confirming the use of both façonnage and debitage blanks for the bifacial tools.

The blank data can also be used to recognise further trends between the different bifacial tool types (Table 6.6). This data confirms that the blanks of the classic handaxes are more difficult to identify due to intense shaping and retouching. Regardless, it is clear that classic handaxes were manufactured both on nodules/pebbles and flake blanks. The same holds true for the backed and leaf-shaped bifacial tools. For bifacial scrapers and partial handaxes the blank could be more easily determined and a preference for flake blanks exists. Calculating the flatness values of the different bifacial tool categories (Appendix 2) again indicates the large amount of variability in the blanks used for both the manufacture of classic handaxes and backed bifacial tools.

Overall, these data need to be cautiously interpreted particularly considering that for many specimens the original blank could not be determined. Conversely, the data indicates that in the majority of assemblages bifacial tools were created both by faconnage and on flake blanks. Most bifacial tool types are made by both these techniques as well. Therefore this data hints at considerable variation in production patterns within the assemblages and within the bifacial tools types across the whole study area.

6.3.3 Cortex

The total amount of remaining cortex on the complete surface of the bifacial tool was recorded for all unbroken specimens (Table 6.7). The absence/presence of cortex gives further indications about blank use and intensity of shaping. In the sample bifacial tools containing over 50% of cortex are very rare (2.1%, Table 6.7). More variability seems to be present in the 25-50% category with the assemblages of Sesselfelsgrotte, Abri du Musée and Grotte du Docteur reaching values of around 20%. This is especially remarkable for Abri du Musée where a clear dominance of flake blanks was in use. In all other assemblages there is a strong dominance of cortex remnants of less than 25%.

CORTEX	Absent	<25%	25-50%	50-75%	>75%	Total
Le Moustier	81 *32.0%*	148 *58.5%*	19 *7.5%*	5 *2.0%*	0 *0.0%*	**253** ***100.0%***
Pech de l'Azé I	38 *46.3%*	39 *47.6%*	4 *4.9%*	1 *1.2%*	0 *0.0%*	**82** ***100.0%***
Lynford	29 *55.8%*	20 *38.5%*	1 *1.9%*	2 *3.8%*	0 *0.0%*	**52** ***100.0%***
Sint-Geertruid	12 *54.5%*	10 *45.5%*	0 *0.0%*	0 *0.0%*	0 *0.0%*	**22** ***100.0%***
Königsaue	9 *60.0%*	5 *33.3%*	1 *6.7%*	0 *0.0%*	0 *0.0%*	**15** ***100.0%***
Sesselfelsgrotte	31 *31.3%*	36 *36.4%*	20 *20.2%*	8 *8.1%*	4 *4.0%*	**99** ***100.0%***
Abri du Musée	7 *26.9%*	14 *53.8%*	5 *19.2%*	0 *0.0%*	0 *0.0%*	**26** ***100.0%***
Haut de Combe Capelle	77 *43.8%*	93 *52.8%*	5 *2.8%*	1 *0.6%*	0 *0.0%*	**176** ***100.0%***
St Just en Chaussée	9 *39.1%*	13 *56.5%*	1 *4.3%*	0 *0.0%*	0 *0.0%*	**23** ***100.0%***
Champlost	22 *78.6%*	5 *17.9%*	1 *3.6%*	0 *0.0%*	0 *0.0%*	**28** ***100.0%***
Bois du Rocher	55 *94.8%*	2 *3.4%*	1 *1.7%*	0 *0.0%*	0 *0.0%*	**58** ***100.0%***
St Julien de la Liègue	166 *91.2%*	16 *8.8%*	0 *0.0%*	0 *0.0%*	0 *0.0%*	**182** ***100.0%***
Oosthoven	10 *47.6%*	10 *47.6%*	1 *4.8%*	0 *0.0%*	0 *0.0%*	**21** ***100.0%***
Grotte du Docteur	7 *19.4%*	21 *58.3%*	7 *19.4%*	1 *2.8%*	0 *0.0%*	**36** ***100.0%***
TOTAL	**553** ***51.5%***	**432** ***40.3%***	**66** ***6.2%***	**18** ***1.7%***	**4** ***0.4%***	**1073** ***100.0%***

Table 6.7: *The cortex remnants of the bifacial tools by site*

CORTEX	Absent	<25%	25-50%	50-75%	>75%	Total
classic	430 *57.1%*	294 *39.0%*	27 *3.6%*	2 *0.3%*	0 *0.0%*	**753** ***100.0%***
backed	13 *15.5%*	52 *61.9%*	13 *15.5%*	6 *7.1%*	0 *0.0%*	**84** ***100.0%***
leaf-shaped	31 *56.4%*	15 *27.3%*	7 *12.7%*	1 *1.8%*	1 *1.8%*	**55** ***100.0%***
bif scraper	26 *43.3%*	19 *31.7%*	10 *16.7%*	2 *3.3%*	3 *5.0%*	**60** ***100.0%***
partial	25 *50.0%*	20 *40.0%*	5 *10.0%*	0 *0.0%*	0 *0.0%*	**50** ***100.0%***
TOTAL	**525** ***52.4%***	**400** ***39.9%***	**62** ***6.2%***	**11** ***1.1%***	**4** ***0.4%***	**1002** ***100.0%***

Table 6.8: *The cortex remnants of the bifacial tools by tool type*

At the sites of Bois du Rocher (grès) and Saint-Julien de la Liègue over 90% of the bifacial tools does not exhibit any cortex at all. This cortex data illustrates the typo-technological variability within these assemblages. Within most assemblages varying cortex remnants are present, indicating variabitliy both in terms of used blanks and intensity of shaping.

Furthermore, the cortex data shows a clear distinction between classic handaxes and backed bifacial tools. Classic handaxes rarely (3.9%) have a cortex remnant of over 25% and on 57.8% no cortex is remaining at all (Table 6.8). For the backed bifacial tools there is a reversed pattern with 22.9% of the backed pieces having over 25% of cortex on their surface and only 14.5% having no cortex remnant at all. These values indicate the more intense shaping of the handaxes and leaf-shaped bifacial tools, which contrasts with the more variable cortex remnant on backed bifacial tools. Around half of the leaf-shaped bifacial tools do not have any cortex remaining and this can be linked to the predominant use of flakes for these leaf shaped pieces (Table 6.6). Again, this data indicates variability within the different bifacial tool types, most types can contain a variable amount of cortex remnant, although in general pieces with over 50% of cortex remnant are rare.

6.3.4 Backing

For each bifacial tool the presence or absence of a natural or truncated (steeply retouched) back was recorded (for definitions see Chapter 4). This is aimed at gaining further information about the used blank and the techno-typological concept of the tool. At 10 sites backed blanks were used for the manufacture of bifacially worked tools (Table 6.9). In general backed pieces are not a common occurrence in the sample. Only at the sites of Abri du Musée, Grotte du Docteur, Königsaue and Sesselfelsgrotte they are present on over one third of the bifacial tools. Bifacial tools with a truncated back are even more rare and only noted at Königsaue and Sesselfelsgrotte.

When looking at the presence of backing on the different bifacial tools types (Table 6.10) a clear correlation between classic handaxes and blanks with no back is noted (Table 6.10). The back of backed bifacial tools is mainly of natural origin. Amongst bifacial scrapers backing is also a regular occurrence while leaf-shaped bifacial tools and partial bifaces are mainly made on blanks without a back. The backing data can furthermore be correlated to the blank data (Table 6.11), making it clear that backs occur both on façonnage and flake blanks.

Overall, it is clear that although backing occurs sporadically in most assemblages, it is a phenomenon which is only used in a dominant fashion in certain assemblages (Abri du Musée, Grotte du Docteur, Königsaue and Sesselfelsgrotte) and in relation to certain tool types (backed bifacial tools) (for a further discussion on tool concepts see Chapter 7, section 7.2.2).

BACKING	no	natural	truncated	TOTAL
Le Moustier	241 *96.4%*	9 *3.6%*	0 *0.0%*	250 *100.0%*
Pech de l'Aze I	82 *100.0%*	0 *0.0%*	0 *0.0%*	82 *100.0%*
Lynford	45 *93.8%*	3 *6.3%*	0 *0.0%*	48 *100.0%*
Sint-Geertruid	20 *83.3%*	0 *0.0%*	4 *16.7%*	24 *100.0%*
Königsaue	8 *66.7%*	5 *38.5%*	0 *0.0%*	13 *105.2%*
Sesselfelsgrotte	66 *58.4%*	45 *39.8%*	2 *1.8%*	113 *100.0%*
Abri du Musee	13 *50.0%*	13 *50.0%*	0 *0.0%*	26 *100.0%*
Haut de Combe Capelle	168 *98.2%*	3 *1.8%*	0 *0.0%*	171 *100.0%*
St Just en Chaussée	23 *100.0%*	0 *0.0%*	0 *0.0%*	23 *100.0%*
Champlost	25 *89.3%*	3 *10.7%*	0 *0.0%*	28 *100.0%*
Bois du Rocher	58 *100.0%*	0 *0.0%*	0 *0.0%*	58 *100.0%*
St Julien de la Liègue	177 *99.4%*	1 *0.6%*	0 *0.0%*	178 *100.0%*
Oosthoven	7 *53.8%*	6 *46.2%*	0 *0.0%*	13 *100.0%*
Grotte du Docteur	22 *62.9%*	13 *37.1%*	0 *0.0%*	35 *100.0%*
TOTAL	955 *89.9%*	101 *9.5%*	6 *0.6%*	1062 *100.0%*

Table 6.9: *The backs of the bifacial tools by site*

BACK	no	natural	truncated	TOTAL
classic	749 *100.0%*	0 *0.0%*	0 *0.0%*	**749** ***100.0%***
backed	0 *0.0%*	80 *93.0%*	6 *7.0%*	**86** ***100.0%***
leaf-shaped	56 *91.8%*	5 *8.2%*	0 *0.0%*	**61** ***100.0%***
bif scraper	38 *79.2%*	10 *20.8%*	0 *0.0%*	**48** ***100.0%***
uniface	46 *97.9%*	1 *2.1%*	0 *0.0%*	**47** ***100.0%***
TOTAL	**889** ***90.4%***	**96** ***9.8%***	**6** ***0.6%***	**991** ***100.8%***

Table 6.10: *The backs of the bifacial tools by tool type*

	nodule/ pebble	natural fragment	flake	indeterminate	TOTAL
no	72	3	240	638	953
	7.6%	*0.3%*	*25.2%*	*66.9%*	*100.0%*
natural	27	0	34	42	103
	26.2%	*0.0%*	*33.0%*	*40.8%*	*100.0%*
truncated	1	0	0	5	6
	16.7%	*0.0%*	*0.0%*	*83.3%*	*100.0%*
TOTAL	100	3	274	685	1062
	9.4%	*0.3%*	*25.9%*	*64.7%*	*100.3%*

Table 6.11: *Correlations between the blank and the presence of a back*

6.3.5 Summary

The above presented data indicates that the vast majority of the bifacial tools under study here are made on locally available fine-grained raw materials. These raw materials can occur in nodules of a variety of shape and sizes but overall, within this sample, no clear link can be recognised between the raw material type and the tool type. Furthermore both the blank and cortex data indicate a lot of variability in the manufacture processes both within assemblages and within bifacial tool types. Only the presence of artefacts with a back seems a phenomenon restricted to certain assemblages and tool types.

6.4 Manufacture Results

The artefacts resulting from the manufacture process are further examined through a detailed examination of their retouch, cross section, edge angles, size and shape.

6.4.1 Retouch

The retouch removals on the bifacial tools were assessed by recording the morphology of the flake scars, the extent to which the retouch penetrates the surface of the tool and the direction of the retouch removals, including the use of the para-burin technique (lateral removals as defined in Chapter 4). The morphology of the retouch removals is predominantly scalar, both in relation to the assemblages (Table 6.12) and the different bifacial tool types (Table 6.13). More variability exists in relation to the extent of the retouch removals. Some assemblages are dominated by retouch removals covering the entire surface of the tool. Others are dominated by short and long retouch removals, and finally some assemblages are characterised by varying retouch extents (Table 6.12). While the retouch on all the bifacial tool types is dominantly scalar, the extent of these removals does vary according to the tool type. In general bifacial scrapers are characterised by short and long removals, while classic and partial handaxes show more covering retouch.

RETOUCH	Morphology				Extent				Total
	scalar	stepped	parallel	sub-parallel	short	long	invasive	covering	
Le Moustier	252	0	0	0	1	7	8	236	**252**
	100.0%	*0.0%*	*0.0%*	*0.0%*	*0.4%*	*2.8%*	*3.2%*	*93.7%*	***100.0%***
Pech de l'Azé I	82	0	0	0	1	3	0	78	**82**
	100.0%	*0.0%*	*0.0%*	*0.0%*	*1.2%*	*3.7%*	*0.0%*	*95.1%*	***100.0%***
Lynford	56	0	0	0	0	3	0	52	**55**
	100.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*5.5%*	*0.0%*	*94.5%*	***100.0%***
Sint-Geertruid	22	1	0	0	2	5	1	15	**23**
	95.7%	*4.3%*	*0.0%*	*0.0%*	*8.7%*	*21.7%*	*4.3%*	*65.2%*	***100.0%***
Königsaue	16	0	0	0	0	8	0	8	**16**
	100.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*50.0%*	*0.0%*	*50.0%*	***100.0%***
Sesselfelsgrotte	143	5	0	7	93	43	5	12	**153**
	92.3%	*3.2%*	*0.0%*	*4.5%*	*60.8%*	*28.1%*	*3.3%*	*7.8%*	***100.0%***
Abri du Musée	27	0	0	0	14	5	0	7	**26**
	100.0%	*0.0%*	*0.0%*	*0.0%*	*53.8%*	*19.2%*	*0.0%*	*26.9%*	***100.0%***
Haut de Combe Capelle	176	0	0	0	1	11	1	163	**176**
	100.0%	*0.0%*	*0.0%*	*0.0%*	*0.6%*	*6.3%*	*0.6%*	*92.6%*	***100.0%***
St Just en Chaussée	23	0	0	0	0	0	0	23	**23**
	100.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*	***100.0%***
Champlost	27	1	0	0	0	0	8	20	**28**
	96.4%	*3.6%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*28.6%*	*71.4%*	***100.0%***
Bois du Rocher	58	0	0	0	0	0	2	56	**58**
	100.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*3.4%*	*96.6%*	***100.0%***
St Julien de la Liègue	182	0	0	0	0	0	0	182	**182**
	100.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*	***100.0%***
Oosthoven	3	0	0	0	2	2	0	15	**19**
	100.0%	*0.0%*	*0.0%*	*0.0%*	*10.5%*	*10.5%*	*0.0%*	*78.9%*	***100.0%***
Grotte du Docteur	45	0	0	0	5	9	10	21	**45**
	100.0%	*0.0%*	*0.0%*	*0.0%*	*11.1%*	*20.0%*	*22.2%*	*46.7%*	***100.0%***
Total	**1112**	**7**	**0**	**7**	**119**	**96**	**35**	**888**	**1138**
	97.7%	***0.6%***	***0.0%***	***0.6%***	***10.5%***	***8.4%***	***3.1%***	***78.0%***	***100.0%***

Table 6.12: *The retouch characteristics of the bifacial tools by site*

RETOUCH	Morphology				Extent				Total
	scalar	stepped	parallel	sub-parallel	short	long	invasive	covering	
classic	750	0	0	0	3	8	11	731	**753**
	100.0%	*0.0%*	*0.0%*	*0.0%*	*0.4%*	*1.1%*	*1.5%*	*97.1%*	***100.0%***
backed	80	1	0	1	28	22	11	27	**88**
	97.6%	*1.2%*	*0.0%*	*1.2%*	*31.8%*	*25.0%*	*12.5%*	*30.7%*	***100.0%***
leaf-shaped	65	2	0	0	16	16	3	32	**67**
	97.0%	*3.0%*	*0.0%*	*0.0%*	*23.9%*	*23.9%*	*4.5%*	*47.8%*	***100.0%***
bif scraper	66	4	0	2	32	21	5	12	**70**
	91.7%	*5.6%*	*0.0%*	*2.8%*	*45.7%*	*30.0%*	*7.1%*	*17.1%*	***100.0%***
partial	46	0	0	1	2	8	2	39	**51**
	97.8%	*0.0%*	*0.0%*	*2.2%*	*4.0%*	*16.0%*	*4.0%*	*76.5%*	***100.0%***
TOTAL	**1007**	**7**	**0**	**4**	**81**	**75**	**32**	**841**	**1029**
	97.9%	***0.7%***	***0.0%***	***0.4%***	***7.9%***	***7.3%***	***3.1%***	***81.7%***	***100.0%***

Table 6.13: *The retouch characteristics of the bifacial tools by bifacial tool type*

	from lateral sides	from tip	mix	none	1 removal on one face	multiple removals on one face	1 removal on both faces	multiple removals on both faces	TOTAL
Le Moustier	7	0	243	250	0	0	0	0	250
	2.8%	*0.0%*	*97.2%*	*100.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*
Pech de l'Azé I	0	0	82	82	0	0	0	0	82
	0.0%	*0.0%*	*100.0%*	*100.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*
Lynford	1	0	48	47	0	0	0	0	49
	2.0%	*0.0%*	*98.0%*	*100.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*
Sint-Geertruid	2	0	22	24	0	0	0	0	24
	8.3%	*0.0%*	*91.7%*	*100.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*
Königsaue	1	0	12	13	0	0	0	0	13
	7.7%	*0.0%*	*92.3%*	*100.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*
Sesselfelsgrotte	10	0	86	104	5	0	0	0	96
	10.4%	*0.0%*	*89.6%*	*95.4%*	*4.6%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*
Abri du Musée	0	0	25	16	4	3	1	1	25
	0.0%	*0.0%*	*100.0%*	*64.0%*	*16.0%*	*12.0%*	*4.0%*	*4.0%*	*100.0%*
Haut de Combe Capelle	8	0	163	171	0	0	0	0	171
	4.7%	*0.0%*	*95.3%*	*100.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*
St Just en Chaussée	0	0	23	23	0	0	0	0	23
	0.0%	*0.0%*	*100.0%*	*100.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*
Champlost	0	0	28	28	0	0	0	0	28
	0.0%	*0.0%*	*100.0%*	*100.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*
Bois du Rocher	0	0	58	58	0	0	0	0	58
	0.0%	*0.0%*	*100.0%*	*100.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*
St Julien de la Liègue	0	0	179	179	0	0	0	0	179
	0.0%	*0.0%*	*100.0%*	*100.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*
Oosthoven	0	0	8	10	0	0	0	0	8
	0.0%	*0.0%*	*100.0%*	*100.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*
Grotte du Docteur	0	0	35	36	0	0	0	0	35
	0.0%	*0.0%*	*100.0%*	*100.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*
TOTAL	29	0	1012	1041	9	3	1	1	1041
	2.8%	0.0%	97.2%	100.0%	0.9%	0.3%	0.1%	0.1%	100.0%

Table 6.14: *The retouch directions of the bifacial tools by site*

	from lateral sides	from tip	mix	none	1 removal on one face	multiple removals on one face	1 removal on both faces	multiple removals on both faces	TOTAL
classic	15	0	734	747	0	0	0	0	747
	2.0%	*0.0%*	*98.0%*	*100.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*
backed	1	0	77	68	8	3	1	1	81
	1.3%	*0.0%*	*98.7%*	*84.0%*	*9.9%*	*3.7%*	*1.2%*	*1.2%*	*100.0%*
leaf-shaped	4	0	49	59	1	0	0	0	60
	7.5%	*0.0%*	*92.5%*	*98.3%*	*1.7%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*
bif scraper	5	0	39	50	0	0	0	0	50
	11.4%	*0.0%*	*88.6%*	*100.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*
uniface	1	0	46	47	0	0	0	0	47
	2.2%	*0.0%*	*97.8%*	*100.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*
TOTAL	26	0	945	971	9	3	1	1	985
	2.6%	*0.0%*	*95.9%*	*98.6%*	*0.9%*	*0.3%*	*0.1%*	*0.1%*	*100.0%*

Table 6.15: *The retouch directions of the bifacial tools by tool type*

There is more variation in retouch on leaf-shaped and backed bifacial tools, with artefacts occurring with short, long and covering retouch (Table 6.13). This data confirms the homogeneity within the classic handaxes and the more varied nature of the other bifacial tool types, especially the backed pieces.

Previously, it has been argued (Soressi 2002) that the direction of the retouch removals is a distinctive feature separating the KMG and MTA assemblages (Chapter 4, Fig. 4.10). For the bifacial tools studied here the retouch removals are generally multidirectional (Table 6.14). However, the data related to the presence of removals coming from the tip, the so-called para-burin removals, does confirm this dichotomy. These removals were only recorded in the assemblages of Königsaue and Sesselfelsgrotte (Table 6.14) and predominantly on backed bifacial tools (Table 6.15). This confirms the idea that the para-burin technique is not commonly used amongst Late Middle Palaeolithic bifacial tools in Western Europe and is a technique restricted to certain assemblages and to certain bifacial tool types (for a further discussion see Chapter 7, Section 7.2.2).

6.4.2 Cross section

The cross sections of the unbroken bifacial tools were classified into five categories (Chapter 4; Fig. 4.6; Table 6.16). This data shows that in general biplano and plano-convex/plano-convex cross sections are rare. Biplano sections for example were only recorded in the assemblage of Königsaue. Conversely, plano-convex and biconvex sections are most common, while some tools often also had to be placed in the irregular category, mainly because the section varied over the extent of the tool. While some assemblages contain a mix of both these cross sections types (e.g. Saint-Just en Chaussée and Bois-du-Rocher), others seem to have a clear preference for either biconvex or planoconvex sections (e.g. Königsaue and Abri du Musée).

In relation to the different bifacial tool types only for the partial bifaces is one section-type dominant, namely plano-convex (Table 6.17). For all other tool types a mix of cross sections occurs. For classic handaxes both biconvex and planoconvex sections are common. These two types also dominate within the leaf-shaped bifacial tools, although there appears to be a stronger occurrence of plano-convex. Both backed bifacial tools and bifacial scrapers commonly have both irregular and plano-convex sections. Overall the data indicates that biconvex sections are clearly linked to classic handaxe types while planoconvex sections occur in all five bifacial tool categories (Table 6.17).

CROSS SECTION	biconvex	plano-convex	biplano	plano-convex/ plano-convex	irregular	Total
Le Moustier	147 *59.3%*	56 *22.6%*	0 *0.0%*	0 *0.0%*	45 *18.1%*	**248** ***100.0%***
Pech de l'Azé I	27 *32.9%*	38 *46.3%*	1 *1.2%*	0 *0.0%*	16 *19.5%*	**82** ***100.0%***
Lynford	27 *54.0%*	19 *38.0%*	0 *0.0%*	0 *0.0%*	4 *8.0%*	**50** ***100.0%***
Sint-Geertruid	15 *65.2%*	5 *21.7%*	0 *0.0%*	0 *0.0%*	3 *13.0%*	**23** ***100.0%***
Königsaue	0 *0.0%*	7 *53.8%*	2 *15.4%*	0 *0.0%*	4 *30.8%*	**13** ***100.0%***
Sesselfelsgrotte	7 *6.9%*	27 *26.7%*	1 *1.0%*	1 *1.0%*	65 *64.4%*	**101** ***100.0%***
Abri du Musée	2 *8.7%*	16 *69.6%*	0 *0.0%*	0 *0.0%*	5 *21.7%*	**23** ***100.0%***
Haut de Combe Capelle	45 *25.9%*	102 *58.6%*	0 *0.0%*	0 *0.0%*	27 *15.5%*	**174** ***100.0%***
St Just en Chaussée	11 *50.0%*	11 *50.0%*	0 *0.0%*	0 *0.0%*	0 *0.0%*	**22** ***100.0%***
Champlost	5 *19.2%*	21 *80.8%*	0 *0.0%*	0 *0.0%*	0 *0.0%*	**26** ***100.0%***
Bois du Rocher	29 *50.9%*	27 *47.4%*	0 *0.0%*	1 *1.8%*	0 *0.0%*	**57** ***100.0%***
St Julien de la Liègue	56 *33.3%*	107 *63.7%*	3 *1.8%*	2 *1.2%*	0 *0.0%*	**168** ***100.0%***
Oosthoven	4 *19.0%*	8 *38.1%*	0 *0.0%*	0 *0.0%*	9 *42.9%*	**21** ***100.0%***
Grotte du Docteur	9 *25.0%*	26 *72.2%*	0 *0.0%*	0 *0.0%*	1 *2.8%*	**36** ***100.0%***
Total	**384** ***36.8%***	**470** ***45.0%***	**7** ***0.7%***	**4** ***0.4%***	**179** ***17.1%***	**1044** ***100.0%***

Table 6.16: *The cross sections of the bifacial tools by site*

SECTION	biconvex	plano-convex	biplano	plano-convex/ plano-convex	irregular	Total
classic	349 *47.3%*	321 *43.5%*	2 *0.3%*	3 *0.4%*	63 *8.5%*	**738** ***100.0%***
backed	3 *3.9%*	34 *44.2%*	0 *0.0%*	0 *0.0%*	40 *51.9%*	**77** ***100.0%***
leaf-shaped	11 *19.3%*	29 *50.9%*	3 *5.3%*	0 *0.0%*	14 *24.6%*	**57** ***100.0%***
bif scraper	3 *5.9%*	27 *52.9%*	1 *2.0%*	1 *2.0%*	19 *37.3%*	**51** ***100.0%***
partial	2 *4.1%*	43 *86.0%*	0 *0.0%*	0 *0.0%*	5 *10.2%*	**50** ***100.0%***
TOTAL	**368** ***37.8%***	**454** ***46.7%***	**6** ***0.6%***	**4** ***0.4%***	**141** ***14.5%***	**973** ***100.0%***

Table 6.17: *The cross sections of the bifacial tools by tool type*

A comparison of the cross section data with the blank types elucidates two main trends. Firstly, biconvex sections occur both on nodule/pebble and flake blanks (Table 6.18). This relates back to the fact that classic handaxes are made both by façonnage and debitage (Table 6.18). Moreover, this again shows that mainly amongst these classic handaxes it is very difficult to determine the original blank due to the intense shaping of these tools. Secondly, there is a clear correlation between plano-convex sections and flake blanks, which is unsurprising taking into account the general outline shape of a flake.

	nodule/ pebble	natural fragment	flake	indeterminate	TOTAL
biconvex	44	0	37	303	**384**
	11.5%	*0.0%*	*9.6%*	*78.9%*	***100.0%***
plano-convex	23	1	195	252	**470**
	4.9%	*0.2%*	*41.4%*	*53.5%*	***100.0%***
biplano	0	0	2	5	**7**
	0.0%	*0.0%*	*28.6%*	*71.4%*	***100.0%***
plano-convex/ plano-convex	1	0	0	3	**4**
	25.0%	*0.0%*	*0.0%*	*75.0%*	***100.0%***
irregular	30	2	40	107	**179**
	16.8%	*1.1%*	*22.3%*	*59.8%*	***100.0%***

Table 6.18: *Comparison between the cross section and the blank of the bifacial tools*

6.4.3 Edge angles

The dominant angle of the cutting edge(s) on each bifacial tool were recorded and placed into one of three broad categories (Chapter 4; Fig. 4.9; Table 6.19). The generic trend that emerges from these data is that Late Middle Palaeolithic bifacial tools most commonly have edge angles that fall between 35 and 65 degrees (Table 6.19). Angles of over 65 degrees are very rare. Edges of less than 35 degrees do dominate some assemblages (e.g. at Lynford, Königsaue, Sesselfelsgrotte, Abri du Musée and Oosthoven). This indicates that most bifacial tools could be used for a variety of cutting movements, and the occurrence of angles of less than 35 degrees indicate a common use for intrusive, penetrating cutting movements (Chapter 4; Keeley 1980; Soressi 2002).

When organising the data by tool type, it is clear that classic handaxes have cutting edges in the 35-65 degrees category (Table 6.20). More variable edge angles are recorded for the other tool types, although the 35-65 category is always dominant. Especially for the backed and leaf-shaped bifacial tools angles of less than 35 degrees are a common occurrence and angles of over 65 occur very sporadic. This demonstrates that the classic handaxes are a more homogenous entity whilst other bifacial tool types are more varied. The functional aspects of the bifacial tools, as partly illustrated by the edge angles, are further explored in section 8.3.3.

EDGE ANGLE	<35°	35-65°	>65°	Total
Le Moustier	13	224	10	**247**
	5.3%	*90.7%*	*4.0%*	***100.0%***
Pech de l'Azé I	10	71	1	**82**
	12.2%	*86.6%*	*1.2%*	***100.0%***
Lynford	18	29	2	**49**
	36.7%	*59.2%*	*4.1%*	***100.0%***
Sint-Geertruid	1	21	2	**24**
	4.2%	*87.5%*	*8.3%*	***100.0%***
Königsaue	4	7	0	**11**
	36.4%	*63.6%*	*0.0%*	***100.0%***
Sesselfelsgrotte	44	71	7	**122**
	36.1%	*58.2%*	*5.7%*	***100.0%***
Abri du Musée	19	8	0	**27**
	70.4%	*29.6%*	*0.0%*	***100.0%***
Haut de Combe Capelle	16	155	1	**172**
	9.3%	*90.1%*	*0.6%*	***100.0%***
St Just en Chaussée	0	23	0	**23**
	0.0%	*100.0%*	*0.0%*	***100.0%***
Champlost	1	27	0	**28**
	3.6%	*96.4%*	*0.0%*	***100.0%***
Bois du Rocher	0	58	0	**58**
	0.0%	*100.0%*	*0.0%*	***100.0%***
St Julien de la Liègue	10	168	0	**178**
	5.6%	*94.4%*	*0.0%*	***100.0%***
Oosthoven	4	9	0	**13**
	30.8%	*69.2%*	*0.0%*	***100.0%***
Grotte du Docteur	8	27	6	**41**
	19.5%	*65.9%*	*14.6%*	***100.0%***
Total	**148**	**898**	**29**	**1075**
	13.8%	***83.5%***	***2.7%***	***100.0%***

Table 6.19: *The average angle of the retouched edges on the bifacial tools by site*

EDGE ANGLE	<35°	35-65°	>65°	Total
classic	56	677	12	**745**
	7.5%	*90.9%*	*1.6%*	***100.0%***
backed	29	45	9	**83**
	34.9%	*54.2%*	*10.8%*	***100.0%***
leaf-shaped	27	32	0	**59**
	45.8%	*54.2%*	*0.0%*	***100.0%***
bif scraper	15	44	2	**61**
	24.6%	*72.1%*	*3.3%*	***100.0%***
partial	7	37	4	**48**
	14.6%	*77.1%*	*8.3%*	***100.0%***
TOTAL	**134**	**835**	**27**	**996**
	13.5%	***83.8%***	***2.7%***	***100.0%***

Table 6.20: *The average angle of the retouched edges on the bifacial tools by tool type*

6.4.4 Size

The dimensions of the Late Middle Palaeolithic bifacial tools were explored by analysing several linear measurements and calculated ratios (Chapter 4; Fig. 4.12). Length, width and thickness reflect principal sources of variation and the calculated ratios additionally characterise the overall sizes and shapes present in the assemblages (Bordes 1961; Roe 1968; Chauhan 2010; Shipton and Petraglia 2010; Iovita and McPherron 2011). In this section metric variability within and between assemblages, and within and between bifacial tool types, is assessed to recognise differential manufacture processes and tool concepts.

Table 6.21 shows the average length, width and thickness values and their standard deviations for the unbroken bifacial tools from all 14 sites. On average the Late Middle Palaeolithic bifacial tools in this sample are 67.92 ± 21.07mm long, 50.80 ± 19.53mm wide and 14.29 ± 6.79mm thick. Three assemblages have bifacial tools which are clearly larger than the average dimensions, with the bifacial tools of Lynford and Saint-Just en Chaussée, averaging above 10cm in length. Conversely, five assemblages have bifacial tools which are smaller in all measurements than the average values, with the extremes being Oosthoven and Sesselfelsgrotte which have average lengths of less than 5cm (Table 6.21).

The metric variability within the assemblages is further assessed by looking at size histograms (Appendix 3), which indicate what size classes are most common in each assemblage. This data shows the wide range of sizes in some assemblages, e.g. Haut de Combe Capelle and Grotte du Docteur, contrasting with the near exclusive dominance of small or large bifacial tools in other assemblage, e.g. Oosthoven, Saint-Julien de la Liègue, Lynford and Saint-Just en Chaussée. Similar patterns of metric variability come forward in the comparisons of the histograms for refinement (Appendix 1) and elongation (Appendix 4), indicating differences both within and between assemblages.

To test the statistical significance of these differences the Kruskal-Wallis test was applied. This non-parametric test was utilised because the measurement data of the sample is not normally distributed; this was tested with the Shapiro-Wilks W-test and resulted in non-significant p-values of 0.000 for all measurements. Kruskal-Wallis is the non-parametric equivalent of the one-way analysis of variance (ANOVA) and allows for comparisons between more than two samples that are independent. A detailed overview of the Kruskal-Wallis test results can be found in Appendix 5, presenting pairwise comparisons between the metric data of the different assemblages with; significant p-values being smaller than 0.05 and presented in bold.

The results of the Kruskal-Wallis tests indicate overlap between the metrical dimensions of the assemblages. For none of the measurements a single assemblage stands out, the values always overlap with another assemblage.

MEASUREMENTS (mm.)		Length (L)	Width (W)	Thick-ness (T)	Elongation (L/W)	Flatness (W/T)	Refinement (T/W)
Le Moustier (n: 250)	Mean	66.08	51.85	21.36	**1.28**	2.52	0.41
	St. Dev.	*12.95*	*9.38*	*5.73*	*0.14*	*0.50*	*0.08*
Pech de l'Azé I (n: 82)	Mean	59.55	45.71	17.23	1.31	2.76	0.38
	St. Dev.	*16.59*	*11.48*	*5.23*	*0.18*	*0.68*	*0.09*
Lynford (n: 49)	Mean	**101.42**	**73.12**	23.70	1.38	**3.21**	0.33
	St. Dev.	*26.53*	*15.44*	*6.61*	*0.15*	*0.72*	*0.08*
Sint-Geertruid (n: 18)	Mean	98.64	61.91	27.33	1.75	2.36	0.47
	St. Dev.	*25.11*	*20.56*	*11.46*	*0.48*	*0.80*	*0.14*
Königsaue (n: 15)	Mean	85.40	45.40	12.80	**1.94**	3.73	0.29
	St. Dev.	*28.34*	*7.83*	*3.41*	*0.66*	*0.98*	*0.08*
Sesselfelsgrotte (n: 94)	Mean	**49.84**	**34.62**	**12.00**	1.52	3.09	0.37
	St. Dev.	*14.75*	*10.70*	*4.16*	*0.54*	*1.11*	*0.15*
Abri du Musée (n: 25)	Mean	70.88	47.40	17.48	1.52	2.99	0.37
	St. Dev.	*19.36*	*10.10*	*8.40*	*0.31*	*0.85*	*0.16*
Haut de Combe Capelle (n: 173)	Mean	74.35	**58.09**	23.39	1.29	2.60	0.40
	St. Dev.	*15.70*	*11.54*	*6.34*	*0.16*	*0.64*	*0.09*
St Just en Chaussée (n: 23)	Mean	**108.74**	**74.22**	24.61	1.49	3.15	0.34
	St. Dev.	*24.26*	*17.57*	*7.00*	*0.23*	*0.82*	*0.10*
Champlost (n: 28)	Mean	67.21	48.00	15.36	1.40	3.27	0.33
	St. Dev.	*22.55*	*13.95*	*4.85*	*0.31*	*0.92*	*0.08*
Bois du Rocher (n: 58)	Mean	69.71	54.33	21.69	1.29	2.55	0.40
	St. Dev.	*12.51*	*9.18*	*4.75*	*0.13*	*0.36*	*0.06*
St Julien de la Liègue (n: 180)	Mean	**58.82**	45.36	16.64	1.30	2.79	0.37
	St. Dev.	*13.28*	*9.22*	*4.00*	*0.15*	*0.52*	*0.07*
Oosthoven (n: 16)	Mean	**42.13**	**33.50**	14.44	1.26	2.40	0.43
	St. Dev.	*6.35*	*4.49*	*3.20*	*0.14*	*0.44*	*0.09*
Grotte du Docteur (n: 36)	Mean	71.00	46.14	20.42	1.54	**2.36**	0.44
	St. Dev.	*20.55*	*10.30*	*6.45*	*0.31*	*0.50*	*0.09*
Total (n: 1047)	**Mean**	**67.92**	**50.80**	**19.53**	**1.45**	**2.84**	**0.38**
	St. Dev.	***21.07***	***14.29***	***6.79***	***0.28***	***0.70***	***0.10***

Table 6.21: *Average linear measurements and ratios and their standard deviations for the bifacial tools by assemblage (values in bold are the ones which are most statistically different based on the results of the Kruskal-Wallis tests presented in Appendix 5).*

MEASUREMENTS (mm.)		Lengt h (L)	Width (W)	Thick-ness (T)	Elongation (L/W)	Flatness (W/T)	Refinement (T/W)
classic (n: 830)	Mean	68.92	**53.22**	**20.54**	**1.30**	2.69	0.39
	St. Dev.	*20.24*	*13.67*	*6.25*	*0.17*	*0.60*	*0.08*
backed (n: 89)	Mean	66.00	42.25	16.93	1.59	2.72	0.41
	St. Dev.	*24.46*	*13.38*	*6.80*	*0.41*	*1.02*	*0.13*
leaf-shaped (n: 70)	Mean	66.91	42.37	**13.78**	1.67	**3.30**	**0.34**
	St. Dev.	*20.17*	*12.39*	*6.74*	*0.62*	*1.00*	*0.16*
bif scraper (n: 72)	Mean	60.38	43.35	15.13	1.41	3.07	0.36
	St. Dev.	*19.35*	*12.39*	*5.63*	*0.30*	*0.98*	*0.11*
partial (n: 51)	Mean	65.42	49.19	18.63	**1.33**	2.73	0.39
	St. Dev.	*21.75*	*14.04*	*5.14*	*0.18*	*0.71*	*0.09*
TOTAL	**Mean**	**67.92**	**50.80**	**19.53**	**1.35**	**2.74**	**0.39**
	St. Dev.	***21.07***	***14.29***	***6.79***	***0.28***	***0.72***	***0.99***

Table 6.22: *Average linear measurements and ratios and their standard deviations for the bifacial tools by tool type (values in bold are the ones which are most statistically different based on the results of the Kruskal-Wallis tests presented in Appendix 6).*

Conversely, the differences between the extreme values in the sample are significant (these values are presented in bold on Table 6.21). This mainly relates to the large size of the artefacts from Saint-Just en Chaussée and Lynford, and the small sizes at Sesselfelsgrotte, Oosthoven and Saint-Julien de la Liègue. Both the width and length data follow this pattern, while less of the differences in thickness are significant and mainly the assemblage of Sesselfelsgrotte stands out for this measurement (Appendix 5).

Furthermore, the standard deviations of these measurements are an indication of the amount of size variability that is present within the assemblages. The assemblages with the largest dimensions (Lynford and Saint-Just en Chaussée) are also the ones with the largest internal variation, indicating that besides the extremely large specimens (>10cm) also much smaller bifacial tools occur. Conversely, the small assemblages have small standard deviations although they are joined by other assemblages, such as Le Moustier, Pech de l'Azé I, Haut de Combe Capelle and Saint-Julien de la Liègue, indicating the homogenous nature of the bifacial tools in these assemblages in terms of their dimensions.

These linear dimensions only differ slightly between the different bifacial tool types (Table 6.22). Overall the average lengths of the bifacial tools only vary a little, with classic handaxes being the largest and bifacial scrapers the smallest, but according to the Kruskal-Wallis test none of these differences in length are statistically significant (p-values of 0.000). Significant differences in width and thickness do exist (Appendix 6) and these mainly relate to the classic handaxes although the leaf-shaped artefacts are by far the thinnest. Overall classic handaxes are the longest, widest and thickest tool type but conversely do not have the largest standard deviations. These can be found in the backed bifacial tool type, indicating the more homogenous nature of the classic handaxes and the more variable nature of the backed artefacts.

These patterns can be further explored by looking at the calculated elongation, flatness and refinement values (Table 6.21 and 6.22). The differences between these values were also tested by the Kruskal-Wallis one-way analysis of variance (detailed results in Appendix 6). In terms of flatness and refinement, the leaf-shaped bifacial tools are the only ones that stand out, and they are significantly more refined (thinner) than the other tool types. For elongation, significant differences relate to classic handaxes being the least elongated tool type together with the partial bifaces. Moreover the standard deviation of the classic handaxe measurements indicate that they are by far the most homogenous tool type, with low standard deviations for all calculated ratios, standing in sharp contrast with the high values for the leaf-shaped and backed bifacial tools (Table 6.22). This discrepancy is also expressed in relation to the assemblages where a dichotomy is notable between assemblages with low and high standard deviations. These values and their significance are further explored in Chapter 7 (section 7.2.2).

The dimensions of the bifacial tools can furthermore be correlated to the different technological features such as blank, cross section, cortex remnant, retouch extent and edge angles (Appendix 7). This data indicate the presence of two main tool concepts. Firstly, there are longer and thicker bifacial tools which are characterised by biconvex sections and covering retouch and are made both by façonnage and on flake blanks. Secondly, there are smaller, thinner (more elongated) plano-convex tools which are made on flakes (Fig. 6.3).

Fig 6.3: *An average classic handaxe and backed bifacial tool with indication of their dimensions, illustrating the more elongated (L/W) and refined (W/T and T/W) nature of the latter (scale 1:1)*

This detailed assessment of the dimensions of the Late Middle Palaeolithic bifacial tools indicates the presence of a large amount of metric variability in the sample, but also the occurrence of certain specific trends, both in relation to differing linear measurements and calculated ratios. These metric trends are further explored from a pan-European perspective in Chapter 7 (section 7.2.2).

6.4.5 Shape

The overall shape of the bifacial tools was assessed by placing them into different typological schemes. Firstly, they were classified according to the 24 bifacial tool types that are currently used in the literature. Secondly, they were integrated into the new simplified classification (Chapter 4). This allowed for comparisons and an assessment of the usefulness of the newly developed simplified classification scheme. Types are visually identified by assessing different aspects of their definitions, such as outline shape, extent of retouch and presence of a back; for detailed definitions of the different tool types see Chapter 4, Section 4.2.2.

Table 6.23 gives a detailed breakdown of the presence/absence of 24 different bifacial tool types in each assemblage. The immense complexity of classifying the tools in this ways is immediately evident, making comparisons between the different assemblages complicated. Moreover, assigning the bifacial tools to one of these detailed tool types was not always straightforward, and hence also a category ‘Other’ exists. The table indicates that each of these 24 bifacial tool types are present in the sample, illustrating a high amount of shape variability.

Table 6.24 details the result of the application of the simplified typological framework to each assemblage (see also Chapter 5). On top of the percentages of the different bifacial tool types, this table gives an indication of the number of bifacial tools that could not be classified into this framework; mainly because of their fragmentary nature but also because of undiagnostic, uncontinuous bifacial retouch. This table demonstrates the predominance of classic handaxes in the sample (74.64%) but also the common occurrence of all other bifacial tool types. Compared to Table 6.23, this simplified scheme facilitates more straightforward comparisons between the assemblages and a detailed comparison of the values allows distinguishing three different types of assemblages:

1. Assemblages with a dominant presence of classic handaxes (>60%) and very low occurrence of any other bifacial tool type.
   Le Moustier, Pech de l’Azé I, Lynford, Haut de Combe Capelle, Saint-Just en Chaussée and Saint-Julien de la Liègue

2. Assemblages which contain a mix of different bifacial tool types, including classic handaxes, and no single type represents over 50% of the bifacial tool total.
   Sint-Geertruid, Champlost, Oosthoven and Grotte du Docteur

3. Assemblages where classic handaxes are absent or very rare (<5%) and other tool types such as bifacial scraper, leaf-shaped and backed bifacial tools dominate.
   Königsaue, Sesselfelsgrotte and Abri du Musée

These typological trends can be combined with the other typo-technological data to come to a comprehensive understanding of Late Middle Palaeolithic bifacial tool variability (See discussion, Section 6.5). Moreover, the presence of spatial and temporal trends amongst the bifacial tool shapes is further discussed in Chapter 7, section 7.2.2.

6.4.6 Summary

This section illustrated the large amount of variability present amongst Late Middle Palaeolithic bifacial tools. The retouch, although predominantly scalar, can have variable extents, and also the cross sections, edge angles, dimensions and overall shape of the tools is variable. Moreover it was demonstrated that the classic handaxes form a homogenous group with the smallest standard deviations, while the other tool types seems more variable in their attributes. The reclassification moreover led to the recognition of three distinct typo-technological trends among the assemblages.

	Le Moustier	Pech de l'Aze I	Lynford	Sint-Geertruid	Konigsaue	Sesselfelsgrotte	Abri du Musee	Haut de Combe Capelle	St Just en Chaussee	Champlost	Bois du Rocher	St Julien de la Liegue	Oosthoven	Grotte du Docteur	TOTAL
triangular biface	25	10	3	0	0	0	0	4	3	0	1	7	0	1	**54**
	46.3%	*18.5%*	*5.6%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*7.4%*	*5.6%*	*0.0%*	*1.9%*	*13.0%*	*0.0%*	*1.9%*	***100.0%***
cordiform biface	143	49	31	6	0	0	0	113	12	5	25	100	3	0	**487**
	29.4%	*10.1%*	*6.4%*	*1.2%*	*0.0%*	*0.0%*	*0.0%*	*23.2%*	*2.5%*	*1.0%*	*5.1%*	*20.5%*	*0.6%*	*0.0%*	***100.0%***
discoidal biface	26	3	0	1	0	0	0	10	0	3	6	19	1	0	**69**
	37.7%	*4.3%*	*0.0%*	*1.4%*	*0.0%*	*0.0%*	*0.0%*	*14.5%*	*0.0%*	*4.3%*	*8.7%*	*27.5%*	*1.4%*	*0.0%*	***100.0%***
ovate biface	15	6	1	3	0	0	1	9	1	2	13	36	0	2	**89**
	16.9%	*6.7%*	*1.1%*	*3.4%*	*0.0%*	*0.0%*	*1.1%*	*10.1%*	*1.1%*	*2.2%*	*14.6%*	*40.4%*	*0.0%*	*2.2%*	***100.0%***
thick lanceolate biface	3	0	0	0	0	0	0	3	0	0	0	0	0	2	**8**
	37.5%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*37.5%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*25.0%*	***100.0%***
thick ficron	3	0	0	0	0	0	0	0	1	0	0	0	0	0	**4**
	75.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*25.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	***100.0%***
thick amygdaloide	2	0	0	0	0	0	0	0	5	0	9	3	0	0	**19**
	10.5%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*26.3%*	*0.0%*	*47.4%*	*15.8%*	*0.0%*	*0.0%*	***100.0%***
Klausennische Keilmesser	0	0	0	1	0	15	0	0	0	0	0	0	1	3	**20**
	0.0%	*0.0%*	*0.0%*	*5.0%*	*0.0%*	*75.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*5.0%*	*15.0%*	***100.0%***
Bockstein-messer	0	0	0	1	1	12	0	0	0	0	0	0	1	3	**18**
	0.0%	*0.0%*	*0.0%*	*5.6%*	*5.6%*	*66.7%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*5.6%*	*16.7%*	***100.0%***
Königsaue Keilmesser	0	0	0	0	4	0	0	0	0	1	0	0	0	0	**5**
	0.0%	*0.0%*	*0.0%*	*0.0%*	*80.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*20.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	***100.0%***
Pradnikmesser	0	0	0	0	0	0	10	0	0	0	0	0	0	0	**10**
	0.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	***100.0%***
Ciemnamesser	0	0	0	0	0	1	0	0	0	0	0	0	0	0	**1**
	0.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	***100.0%***
Balver Keilmesser	0	0	0	0	0	0	1	1	0	0	0	0	0	0	**2**
	0.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*50.0%*	*50.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	***100.0%***
Lichtenberger Keilmesser	0	0	0	0	0	0	0	0	0	0	0	0	1	0	**1**
	0.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*	*0.0%*	***100.0%***
Buhlener Keilmesser	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**1**
	0.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*100.0%*	***100.0%***
Uniface	9	3	5	0	0	5	0	19	0	1	1	1	4	3	**51**
	17.6%	*5.9%*	*9.8%*	*0.0%*	*0.0%*	*9.8%*	*0.0%*	*37.3%*	*0.0%*	*2.0%*	*2.0%*	*2.0%*	*7.8%*	*5.9%*	***100.0%***
Fäustel	0	0	0	0	0	1	0	0	0	0	0	0	0	7	**8**
	0.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*12.5%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*87.5%*	***100.0%***
bifacial scraper	0	0	1	1	2	37	7	5	0	8	1	1	3	2	**68**
	0.0%	*0.0%*	*1.5%*	*1.5%*	*2.9%*	*54.4%*	*10.3%*	*7.4%*	*0.0%*	*11.8%*	*1.5%*	*1.5%*	*4.4%*	*2.9%*	***100.0%***
leafshaped scraper	0	0	0	0	0	18	0	0	0	2	0	0	0	0	**20**
	0.0%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*90.0%*	*0.0%*	*0.0%*	*0.0%*	*10.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	***100.0%***
limande	1	0	0	0	0	0	0	0	0	2	0	0	0	0	**3**
	33.3%	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*66.7%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	***100.0%***
Faustkeilblatt	1	1	0	0	5	8	2	0	0	1	0	3	0	3	**24**
	4.2%	*4.2%*	*0.0%*	*0.0%*	*20.8%*	*33.3%*	*8.3%*	*0.0%*	*0.0%*	*4.2%*	*0.0%*	*12.5%*	*0.0%*	*12.5%*	***100.0%***
Leafpoint	0	0	0	0	1	5	0	1	0	0	0	4	0	1	**12**
	0.0%	*0.0%*	*0.0%*	*0.0%*	*8.3%*	*41.7%*	*0.0%*	*8.3%*	*0.0%*	*0.0%*	*0.0%*	*33.3%*	*0.0%*	*8.3%*	***100.0%***
bifacial point	0	0	0	0	1	0	0	0	0	0	0	0	0	0	**1**
	0.0%	*0.0%*	*0.0%*	*0.0%*	*100.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	***100.0%***
roughout	3	0	3	0	0	0	0	0	0	0	0	0	0	0	**6**
	50.0%	*0.0%*	*50.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	***100.0%***
other	26	13	6	9	1	13	6	13	2	4	2	13	6	11	**125**
	20.8%	*10.4%*	*4.8%*	*7.2%*	*0.8%*	*10.4%*	*4.8%*	*10.4%*	*1.6%*	*3.2%*	*1.6%*	*10.4%*	*4.8%*	*8.8%*	***100.0%***
fragment	66	16	7	2	7	42	3	13	3	3	0	28	1	6	**197**
	33.5%	*8.1%*	*3.6%*	*1.0%*	*3.6%*	*21.3%*	*1.5%*	*6.6%*	*1.5%*	*1.5%*	*0.0%*	*14.2%*	*0.5%*	*3.0%*	***100.0%***
TOTAL	**323**	**101**	**57**	**24**	**22**	**157**	**30**	**191**	**27**	**32**	**58**	**215**	**21**	**45**	**1303**
	24.8%	***7.8%***	***4.4%***	***1.8%***	***1.7%***	***12.0%***	***2.3%***	***14.7%***	***2.1%***	***2.5%***	***4.5%***	***16.5%***	***1.6%***	***3.5%***	***100.0%***

Table 6.23: *Classification of the bifacial tools according to the 25 bifacial tool types in used in the literature*

	classic	backed	leaf-shaped	bif scraper	partial	total ID	Un ID	TOTAL
Le Moustier	238	8	2	0	9	**257**	66	**323**
	92.61%	*3.11%*	*0.78%*	*0.00%*	*3.50%*	*100.00%*	*20.43%*	
Pech de l'Aze I	78	0	1	0	3	**82**	19	**101**
	95.12%	*0.00%*	*1.22%*	*0.00%*	*3.66%*	*100.00%*	*18.81%*	
Lynford	38	1	0	1	5	**45**	12	**57**
	84.44%	*2.22%*	*0.00%*	*2.22%*	*11.11%*	*100.00%*	*21.05%*	
Sint-Geertruid	12	4	1	1	0	**18**	6	**24**
	66.67%	*22.22%*	*5.56%*	*5.56%*	*0.00%*	*100.00%*	*25.00%*	
Königsaue	0	5	8	2	0	**15**	7	**22**
	0.00%	*33.33%*	*53.33%*	*13.33%*	*0.00%*	*100.00%*	*31.82%*	
Sesselfelsgrotte	2	34	35	38	5	**114**	43	**157**
	1.75%	*29.82%*	*30.70%*	*33.33%*	*4.39%*	*100.00%*	*27.39%*	
Abri du Musée	1	12	2	7	0	**22**	8	**30**
	4.55%	*54.55%*	*9.09%*	*31.82%*	*0.00%*	*100.00%*	*26.67%*	
Haut de Combe Capelle	153	3	1	5	19	**181**	10	**191**
	84.53%	*1.66%*	*0.55%*	*2.76%*	*10.50%*	*100.00%*	*5.24%*	
St Just en Chaussée	25	0	0	0	0	**25**	2	**27**
	100.00%	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*100.00%*	*7.41%*	
Champlost	13	2	5	9	1	**30**	2	**32**
	43.33%	*6.67%*	*16.67%*	*30.00%*	*3.33%*	*100.00%*	*6.25%*	
Bois du Rocher	56	0	0	1	1	**58**	0	**58**
	96.55%	*0.00%*	*0.00%*	*1.72%*	*1.72%*	*100.00%*	*0.00%*	
St Julien de la Liègue	200	0	7	1	1	**209**	6	**215**
	95.69%	*0.00%*	*3.35%*	*0.48%*	*0.48%*	*100.00%*	*2.79%*	
Oosthoven	4	7	0	3	4	**18**	3	**21**
	22.22%	*38.89%*	*0.00%*	*16.67%*	*22.22%*	*100.00%*	*14.29%*	
Grotte du Docteur	10	13	8	4	3	**38**	7	**45**
	26.32%	*34.21%*	*21.05%*	*10.53%*	*7.89%*	*100.00%*	*15.56%*	
TOTAL	**830**	**89**	**70**	**72**	**51**	**1112**	**191**	**1303**
	74.64%	***8.00%***	***6.29%***	***6.47%***	***4.59%***	***100.00%***	***14.66%***	

Table 6.24: *Application of the simplified classificatory scheme onto the bifacial tools tool type percentages are in relation to the total amount of identifiable pieces, the unidentifiable percentage relates to the total number of bifacial tools in the assemblage (identifiable plus unidentifiable)*

Classic Handaxes	• made on both nodules and flakes, but no backed blanks • biconvex and planoconvex cross sections • covering retouch, no or very small cortex remnant • edge angles fall between 35 and 65 degrees • largest dimensions but least elongated • smallest standard deviations for all measurements and ratios
Backed bifacial tools	• made on both nodules and flakes • dominance of blanks with a natural back • planoconvex and irregular sections • substantial cortex remnant • short, long or covering retouch and sporadic use of the para-burin technique • edges angles are either <35 or between 35-65 • large variability in terms of overall dimensions
Leaf-shaped bifacial tools	• made on both nodules and flakes, but no backed blanks • biconvex, planoconvex or irregular cross sections • small cortex remnant • short, long or covering retouch • edges angles are either <35 or between 35-65 • most refined and most elongated tool type
Bifacial scrapers	• dominance of flake blanks, both with and without back • planoconvex and irregular sections • small cortex remnant • short, long or covering retouch • edges angles are either <35 or between 35-65 • smallest dimensions
Partial bifaces	• nearly exclusively on flake blanks, no backed blanks • clear dominance of planoconvex sections • small cortex remnant • long and covering retouch • edges angles are either <35 or between 35-65 • average dimensions and ratios

Text box 6.1: *Summarising overview of the technological and metrical characteristics of the five bifacial tool types present in the simplified classificatory scheme*

6.5 Discussion: Micro-scale Variation among Late Middle Palaeolithic Bifacial Tools

This attribute-based comparative study of 1,303 Late Middle Palaeolithic bifacial tools allowed for a data-driven micro-scale characterisation of not only the bifacial tools themselves, but also each assemblage as a whole. To begin with, the integrity of the assemblages was assessed and no data emerged to justify the exclusion of certain assemblages from the analyses. At each locality the artefacts seem to have been deposited roughly at the same time, allowing to treat each collection of bifacial tools as one analytical entity. This is not to deny the palimpsest nature of some of the collections; especially at Sint-Geertruid. Subsequently, the study of the manufacture processes and results led to the recognition of several of variability trends on the micro-scale of analysis, both at the level of the individual tools and at the level of the complete assemblages.

1. TOOL TYPE LEVEL

The techno-typological characteristics of each bifacial tool type are summarised in Text Box 6.1. One of the main findings of this research is the recognition of large amounts of variability amongst individual bifacial tools at the micro-scale. This variability occurs despite the fact that the large majority of the artefacts are made on fine-grained raw materials. Exact typo-technological variation was established through a detailed attribute by attribute comparison. Previous studies mainly focused on the most diagnostic bifacial tool types, such as *bout coupé's*, *Keilmesser*, cordiform, triangular or small handaxes. In contrast, by applying the detailed attribute-based approach developed for this thesis to the complete record of bifacial tools present in an assemblage, it could be demonstrated that alongside these diagnostic bifacial tool types a more varied record of bifacial tools co-exists (see Tables 6.24 and 6.25).

Late Middle Palaeolithic bifacial tools were produced using different methods, as expressed by the use of a variety of blanks and the presence of varying cortex remnant, cross sections, edge angles and overall dimensions. Conversely, despite this variability several techno-typological characteristics are specific to certain tool types. This justifies classifying these artefacts together in the five defined categories as well as indicating that different knapping processes could lead to similar knapping results. Moreover, few transitional forms between these tool types exist, further stressing their concepts as distinct types. Characteristics which are restricted, and hence defining, to each tool type can be summarised as:

1. Classic handaxes are the only tool type for which biconvex sections are a common occurrence and covering retouch predominates. This bifacial tool type has the largest dimensions, but least elongated form, indicating the rather rounded shape of the handaxes. Their linear measurements and ratios have the smallest standard deviations, indicating the rather homogenous nature of the classic handaxe group.

2. Backed bifacial tools have by definition a backed edge, which is most often natural, partly explaining the larger cortex remnant still present on these pieces. The paraburin technique, characterised by lateral tranchet blows, was only recorded on this tool type. A lot of variability is present in all their other technological attributes and in their dimensions.

3. Leaf-shaped bifacial tools are commonly made on flake blanks and the most refined and most elongated tool type. They are one of the few tool types that often have edge angles of less than 35 degrees but are very variable in their other attributes.

4. Bifacial scrapers are most commonly made on flake blanks, have relatively small dimensions and can have a variety of cross sections and edge angles. By definition the retouch on these pieces is predominantly short or long.

5. Partial bifaces form a rather standardised group with little variability in all attributes, including a preference for flake blanks and planoconvex sections and small cortex remnants.

This micro-comparison of individual bifacial tools and types illustrates a large amount of variability, both in the manufacture processes and in the manufacture results. This elevated variability seems to reflect opportunistic, flexible, versatile knapping behaviour although each bifacial tool type also has specific characteristics which can imply imposition regardless of the raw material, blank or techniques used (Text box 6.1; for a further discussion see Chapter 8, section 8.3).

2. ASSEMBLAGE LEVEL

These micro-scale analyses also require comparing the bifacial tools from an inter-assemblage perspective. The detailed typo-technological characteristics of the 14 individual assemblages can be found in Appendix 8. Clear differences, but also clear similarities, are present between these 14 assemblages. Furthermore, the data indicates the presence of three different typo-technological groups of assemblages, complementing the initial variability patterns described at the end of Chapter 5. The characteristics of these three groups can be found in Text Box 6.2 and can be summarised as:

Group 1: classic handaxes dominant

This group is categorised by a low occurrence of most tool types, but a dominant presence of classic handaxes (>60%). Amongst their typo-technological attributes and measurements little variability is present, indicating the rather standardised nature of this group. Varying elongation and refinement values confirm the presence of varying shapes amongst classic handaxes, something that will be explored in more detail in Chapter 7.

Group 2: variety of bifacial tools

Group 2 is represented by a more varied record of bifacial tool types, always including a significant portion of classic handaxes, but with no single tool type over 50%. The bifacial tools in this assemblage group have a variety of cross sections and blanks and refinement and elongation values that fall below the overall sample value.

Group 3: classic handaxes absent

In group 3 classic handaxes are absent or very rare (<5%) and the dominant bifacial tool types are either leaf-shaped or backed bifacial tools. A lot of variability is present in the cross sections, and edge angles of less than 35 degrees are common. Moreover, the para-burin technique is used in these assemblages. Their refinement and elongation values are rather high, indicating lesser refined and more elongated tools.

Group 1: **Classic handaxes dominant**	• Made on both nodules and flakes • Biconvex and planoconvex sections • Covering retouch and very small cortex remnants • Edge angles between 35 and 65 degrees • Predominance of classic handaxes • Low standard deviations in size • Varying refinement and elongation values
Group 2: **Variety of bifacial tools**	• Made on both nodules and flakes • Biconvex, planoconvex and irregular sections • Presence of backed blanks, small cortex remnant • Varying retouch extents • Edge angles <35 or between 35 and 65 • Wide variety of bifacial tools, always including classic handaxe types • Lower than average refinement and elongation values
Group 3: **Classic handaxes absent**	• Often made on flake blanks • Many irregular sections but also biconvex and planoconvex • High proportion of backed blanks • Moderate cortex remnants • Frequent occurrence of edge angles <35 degrees • Application of para-burin technique • Absence of classic handaxes, dominance of backed or leaf-shaped bifacial tools • Above average refinement and elongation values

Text box 6.2: *Summary of the typo-technological characteristics of the three types of assemblages that can be distinguished based on differential types of bifacial tools*

This chapter provided a detailed characterisation of the technological and typological characteristics of the Late Middle Palaeolithic bifacial tools by comparing both individual tools and assemblages. The identified tripartite typo-technological pattern (Text box 6.2) can now be further contextualised. Both the spatial and temporal extent of these three groups is assessed by incorporating further data available from site publications.

Chapter 7:

Results II
Analysis of Spatial and Temporal Patterns

7.1 Introduction

The detailed attribute analyses of the bifacial tools from the 14 study sites resulted in the recognition of three typo-technological entities in the Western European Late Middle Palaeolithic record (Chapter 6). This newly identified tripartite pattern is now further contextualised by assessing the existence of temporal and spatial patterns within and amongst these groups. Previous studies of Middle Palaeolithic assemblages usually employ an intra-regional focus; e.g. concentrating on Britain (Wragg Sykes 2009; White and Pettitt 2011); the Meuse Valley (Ulrix-Closset 1975); Northern France (Depaepe 2007; Koehler 2009); Southeastern France (Moncel and Daujeard 2010) or Mediterranean France (Szmidt 2003). Inter-regional comparisons, bridging knowledge from different areas, are less frequently undertaken. This chapter will provide the first pan-European perspective on spatial and temporal patterns amongst Late Middle Palaeolithic bifacial tools and is aimed at answering Research Question 3:

What patterns of spatial and temporal differentiation are identifiable amongst the Late Middle Palaeolithic Western European bifacial tools beyond the MTA/KMG dichotomy?

And the resulting *SUB QUESTION:*

Are the so-called 'mixed' assemblages, which contain both KMG and MTA bifacial tools, a real phenomenon?

Assessing both these questions and wider variabililty patterns, relating to both the meso- and macro-scales of analysis, requires the integration of the data from the 14 key assemblages with detailed, published information available from other sites. Data from a maximum of 80 sites (see also Chapter 5) is integrated in detail and presented in appendices 9 and 10. Throughout this chapter previous claims of chronological and regional differentiation are reassessed and it will be illustrated that:

1. The three typo-technological entities identified in Chapter 6 have distinct geographic occurrences, correlating to three macro-regional entities (MTA, KMG and Mousterian with bifacial tools (MBT)) (section 7.2.1).
2. A 'mixed' entity containing both classic handaxes and backed bifacial tools is a genuine occurrence and can be equated with the MBT (macro-scale) (section 7.2.1).
3. Based on the current evidence more detailed regional trends can only be identified within the MTA entity. Other regional entities blend in when the lithic record is assessed from a pan-European perspective (section 7.2.2).
4. On a macro-chronological scale, Late Middle Palaeolithic bifacial tools have little metric variation in contrast to their Lower Palaeolithic counterparts (section 7.3.1).
5. Currently, the lithic record is too coarse-grained to allow for the identification of further chronological trends within the Late Middle Palaeolithic bifacial tools, contrasting with previous claims (section 7.3.2).

7.2 Spatial Patterning

Bifacial tools are commonly used to define region-specific Late Middle Palaeolithic entities, both at a macro-regional and regional scale. Currently, two main macro-regional industries, the MTA and KMG, are distinguished alongside a plethora of regional entities (for an overview see Chapter 2). In this section the validity and characteristics of these entities are established in detail. Firstly, at a macro-scale, the spatial distributions of the three typo-technological entities established in Chapter 6 are examined. Secondly, at a meso-scale, the validity of the regional entities is reassessed using a new, Western European perspective to evaluate, and then define their criteria, including metrics, technology and typology.

7.2.1 Macro-regional entities

The bifacial tools from 80 Western European assemblages, including primary data from 14 sites, were reassessed using a new classificatory scheme (Chapter 4). This is the first time these bifacial tools have been compared using a common, and consistent, methodological framework. The dominant bifacial tool types from these assemblages are summarised in Appendix 10. Correlating the typo-technological characteristics of the assemblages with their geographic locations identified several macro-regional trends (Table 7.1) and helped to define distinct geographical limits for the three typo-technological entities defined in Chapter 5.

Dominant bifacial tool type	classic	backed	leaf-shaped	partial	bif. Scraper
Northern Germany	–	√	√	–	–
Southern Germany	–	√	–	–	√
the Netherlands	√	–	–	–	–
Britain	√	–	–	–	–
Belgium	√	√	–	–	√
Northern France	√	–	–	–	–
Eastern France	√	–	–	–	√
Western France	√	–	–	–	–
Southwestern France	√	–	–	–	–

Table 7.1: *Overview of the different regions of the study area and the bifacial tool types which regularly dominate the assemblages in this area.*

In Germany, assemblages are primarily dominated by backed and sometimes by leaf-shaped bifacial tools (e.g. Königsaue) or bifacial scrapers (e.g. Sesselfelsgrotte). In Belgium, from the nine assemblages studied five are dominated by classic handaxes, two by backed bifacial tools and two by bifacial scrapers (Appendix 10). This diversity is absent in the rest of the study area where the vast majority of the assemblages are dominated by classic handaxes; for example in France 23 out of 25 assemblages are handaxe dominated. It is only in Central/Eastern France where assemblages dominated by bifacial scrapers also occur. Partial bifacial tools, including *Halbkeile* and unifaces, occur in various regions but never dominate.

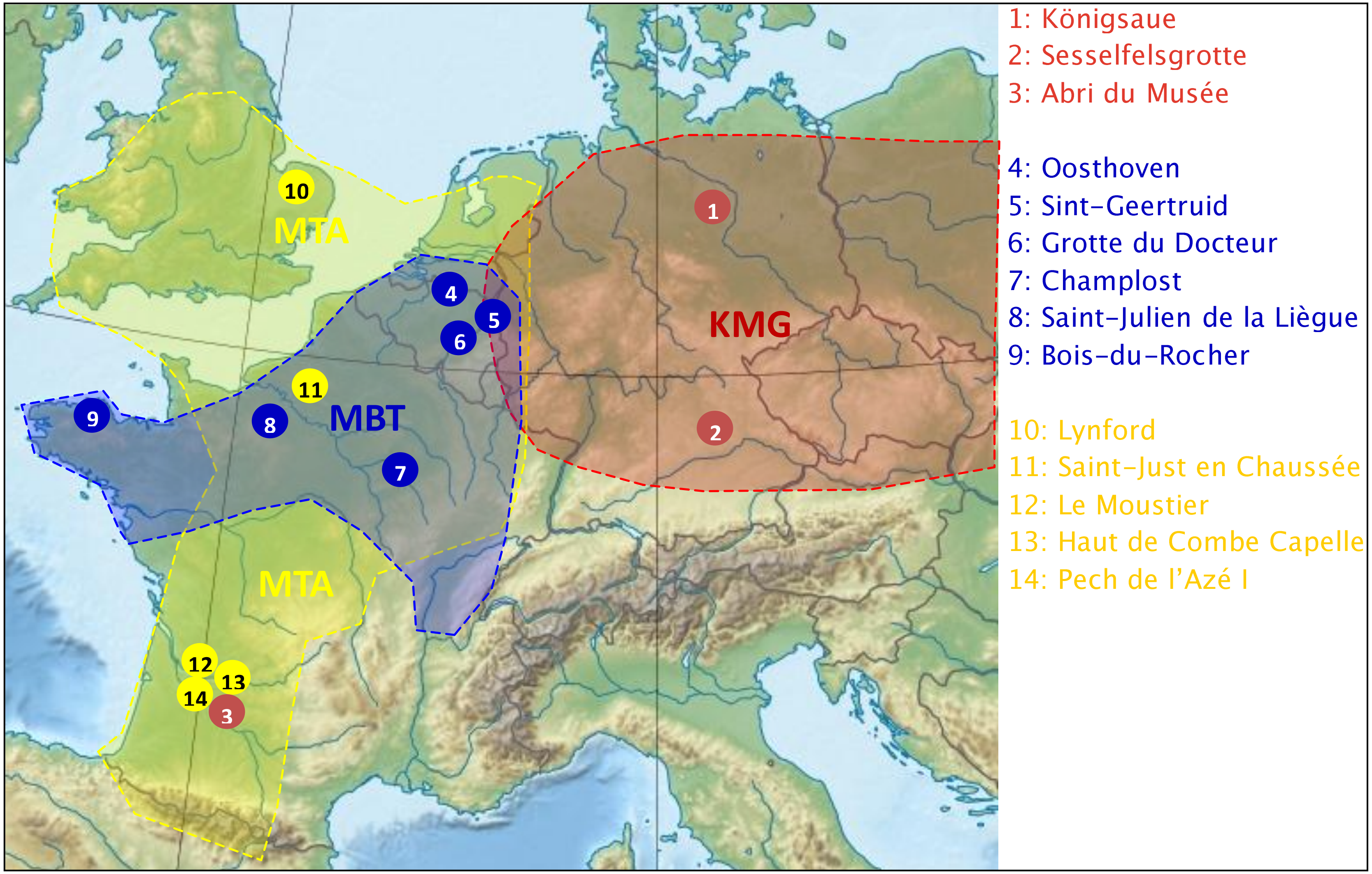
It is clear that there is a clear relationship between the presence/absence of certain bifacial tools; classic handaxes rarely occur with backed bifacial tools and vice-versa. A threefold macro-regional differentiation is present between the eastern part of the study area (backed and leaf-shaped bifacial tools), the central part (classic handaxes, backed bifacial tools, and bifacial scrapers) and the western part (dominance of classic handaxes). This spatial patterning indicates that the typo-technological groups defined throughout Chapter 6 each have restricted geographic occurrences or spatial limits and can be equated to three macro-regional entities (Fig. 7.1):

Group 1: classic handaxes dominant
Occurrence: *the Netherlands, Britain, Belgium, Northern France, Eastern France, Western France and Southwestern France*
Key assemblages: *Le Moustier, Pech de l'Azé I, Saint-Just en Chaussée, Lynford, Haut de Combe Capelle (Abri Peyrony)*
Macro-regional entity: *Mousterian of Acheulean Tradition*

Classic handaxes are the dominant bifacial tool type west of the Rhine River. Assemblages dominated by cordiform and triangular handaxes appear absent in Germany but occur over all other regions of the study area. In Southwestern and Northern France these assemblages have been previously grouped in the Mousterian of Acheulean Tradition (Soressi 2002). Furthermore, various authors have claimed that MTA handaxes also occur in regions outside of France (White and Jacobi 2002; Niekus *et al.* 2011). These further regional trends are assessed later on in this chapter together with a justification to expand the definition of the MTA to include these assemblages from outside of France (see section 7.3.3).

Group 2: classic handaxes absent
Occurrence: *Germany*
Key assemblages: *Königsaue, Sesselfelsgrotte, Abri du Musée*
Macro-regional entity: *Keilmessergruppe*

Assemblages rich in bifacial tools but without classic handaxes predominantly occur in Germany, east of the Rhine river. Currently, one main exception is known, Abri du Musée in Southwestern France. This site is in need of further contextualisation (see Chapter 5). Beside the common occurrence of bifacial scrapers and leaf-shaped bifacial tools, these assemblages are mainly characterised by backed bifacial tools (Table 7.1) and can be equated to the existing *Keilmessergruppe* entity (Chapter 2).



<u>Fig 7.1:</u> *Map of the macro-regional distinction between the Mousterian of Acheulean Tradition (MTA), Mousterian with Bifacial Tools (MBT) and Keilmessergruppe (KMG); numbers represent assemblages from which primary data was collected in this PhD*

Group 3: variety of bifacial tools

Occurrence: *the Netherlands, Belgium, Northern France, Eastern France, Western France*

Key assemblages: *Oosthoven, Grotte du Docteur, Champlost, Sint-Geertruid, Saint-Julien de la Liègue, Bois-du-Rocher*

Macro-regional entity: *Mousterian with Bifacial Tools*

Assemblages that contain a mix of bifacial tool types, including classic handaxes and backed bifacial tools, occur over a widespread area. These are located in the region between the classic core areas of the MTA (Southwestern France) and KMG (Germany) (Fig. 7.1). Some of these assemblages contain a wide variety of bifacial tools, while others, such as Saint-Julien de la Liègue are more difficult to classify but placed in this category based on the clear presence of leaf-shaped bifacial tools, a characteristic which seems absent in the classic MTA. This PhD has established, for the first time, the macro-regional nature of these assemblages. In the past, these mixed assemblages were differentially labelled by scholars in different areas and defined on varying criteria (see Chapter 2, 5 and section 7.2.2). The mixed nature of this third macro-regional typo-technological is labelled here as 'Mousterian with Bifacial Tools'. This term was originally introduced in relation to assemblages from Brittany (see Chapter 2) and is adhered to here because it best represents the dominant, but varied, nature of the bifacial tools in these assemblages.

This tripartite macro-regional pattern forms an overarching framework but, importantly, allows space for further internal variability. The presence of additional regional trends and entities is assessed in more detail below and allows for the further, detailed characterisation of these three macro-regional entities.

7.2.2 Regional patterns

Currently, ten different Late Middle Palaeolithic entities rich in bifacial tools are distinguished in Western Europe (Chapter 2). These entities all have restricted geographic occurrences, as expressed by region-specific bifacial tool characteristics. An initial assessment indicates that they have been defined in different ways, based on different criteria, including metric, technological and/or typological aspects (Table 7.2). Some entities reflect the presence of specific morphological types, restricted average dimensions or a specific mix of typological and technological features. To integrate and assess these entities from a pan-European perspective it is therefore necessary to reassess these defining criteria in detail. Moreover, the regional extent of these entities is currently at risk of being a mere reflection of the work domain of different academic traditions since wider integrative studies are lacking. Therefore, for this PhD these entities are reassessed through an incorporation of data across institutional and academic boundaries.

Within a single spatial scale, the region, quite contrasting patterns can be produced at different categorical scales. Here, the bifacial tools are studied from three categorical levels: metrics, technology and typology. Moreover the validity of the definition of each of these entities is re-evaluated to better understand spatial differentiation.

Entity	Region	Chronology	Bifacial hallmark	Defining criteria
MTA with cordiform handaxes	Southwestern France	MIS 3	cordiform handaxes	typological
MTA with triangular handaxes	Northern France	MIS 5 and 3	large triangular handaxes	Typological and metric
MTA with bout coupé handaxes	Britain	MIS 3	bout coupé handaxes	typological
Keilmessergruppe	Germany and Central Europe	MIS 5 and 3	Keilmesser and Fausstkeilblätter	typological and technological
Mousterian with bifacial retouch	Belgium	unknown	wide range of bifacial tools	typological and technological
Mousterian with bifacial tools	Western France	Unknown	Wide range of bifacial tools	Typological and technological
Charentian with Micoquian influence	Eastern France	MIS 3, MIS 5?	wide range of bifacial tools	typological and technological
Mousterian with small bifaces	Normandy	MIS 3, MIS 5?	small handaxes	metric
'Mixed' entities	Germany and Belgium	MIS 3, MIS 5?	Wide range of bifacial tools	Typological and technological

__Table 7.2:__ *Overview of the different Late Middle Palaeolithic entities rich in bifacial tools which are currently being distinguished in the study area*

1. METRIC CRITERIA

Metric characteristics, including several length and width measurements and calculated ratios, have been used since the 1960's to define and categorise different bifacial tool, and especially handaxe, types (Bordes 1961; Roe 1968; Wymer 1968; see also Chapter 6). While in the French speaking world these measurements and ratios are merely used to divide them into different types (e.g. cordiform, subcordiform, triangular, discoid and ovate (Bordes 1961)), in the English speaking world they are also used to make metric comparisons between assemblages (McPherron 1994, 1995; Iovita 2008; Iovita and McPherron 2011) and even regions (Chauhan 2010; Shipton and Petraglia 2010).

Few studies of Middle Palaeolithic bifacial tools incorporate metric data (e.g. Wragg Sykes 2009) and this is often done within an Acheulean comparative framework (Emery 2009; Iovita and McPherron 2011). Furthermore, metric analyses have predominantly focused on what is labelled here as classic handaxes. Amongst the *Keilmessergruppe* assemblages few studies analyse their metric variability in detail (Jöris 2001, 2003; Iovita 2008), although dimensions are mentioned in site reports (Veil *et al.* 1994; Richter 1997; Pastoors 2001; Jöris 2001).

Despite a general lack of detailed metric analysis of Late Middle Palaeolithic bifacial tools and the lack of broader comparative studies, such data has been frequently used to define specific regional entities (Table 7.2). The appropriateness and validity of these metric criteria are analysed here through an inter-regional comparative study of linear measurements, calculated ratios (elongation and refinement) and coefficients of variation.

Linear measurements

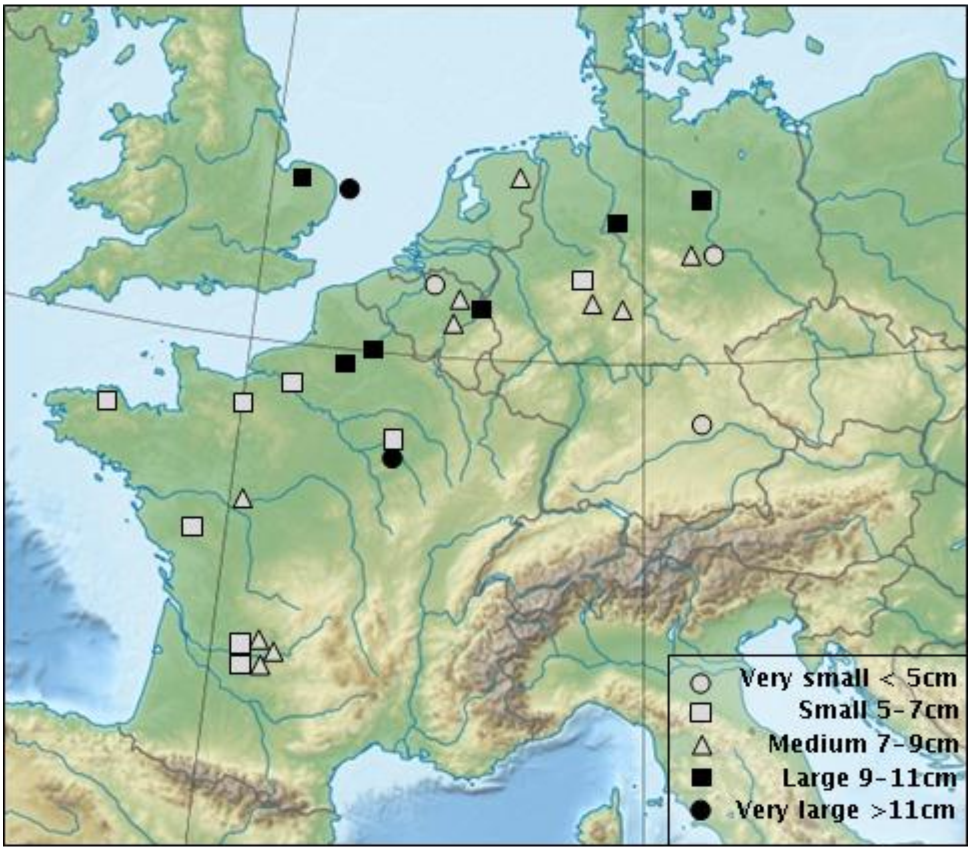
The small or large average length of the bifacial tools has been used as a defining criterion for two regional entities (Table 7.2). A small average maximum length is the defining characteristic of the 'Mousterian with small bifaces' in Normandy and their typo-technological characteristics are seen as less important (e.g. Saint-Brice-sous-Rânes and Saint-Julien de la Liègue (Cliquet and Lautridou 1988; Cliquet *et al.* 2001; Cliquet *et al.* 2011). Conversely, the large lengths of the handaxes in Northern France are seen as one, but not the only, defining characteristics of the MTA in this region (Soressi 2002). Furthermore, handaxes of reduced dimensions have been identified and described as peculiar and dominant on several sites throughout Western Europe, including Sesselfelsgrotte and Neumark Nord 2/0 in Germany (Richter 1997; Brühl and Laurat 2010); Oosthoven in Belgium (Ruebens and Van Peer 2011; Ruebens and Di Modica 2011); Champlost in Eastern France (Gouédo 1999) and Pech de l'Azé I in Southwestern France (Iovita and McPherron 2011).

The causes of these small or large dimensions can vary and can be related to raw material characteristics, amount of reduction or resharpening and preference of the knapper. Currently, the evaluation of the 'small' or 'large' size of the bifacial tools in an assemblage is done on a site by site basis and no larger scale comparative studies have been conducted up to now. In addition, detailed metric data are rarely available in site reports. To assess genuine metric differences between the Western-European Late Middle Palaeolithic bifacial tool data from the 14 key assemblages are incorporated with results from 15 published site reports (Appendix 9).

This study focuses on the maximum length measurements of the bifacial tools since length is the value which has been used in the past to distinguish entities and is most commonly available in the literature. The average length of the Late Middle Palaeolithic bifacial tools, 7.8cm (Appendix 9) is used here as a midpoint to define five size groups:

1. **Very small**: average length below 5cm
2. **Small**: average length between 5 and 7cm
3. **Medium**: average length between 7 and 9cm
4. **Large**: average length between 9 and 11cm
5. **Very large**: average length more than 11cm

Plotting average tool length on a map of Western Europe (Fig. 7.2) illustrates that in varios regions bifacial tools occur in varying dimensions. At a pan-European perspective no distinct regional entity with small bifacial tools exists. The assemblages from Northern France which in the past have been assigned to the 'Mousterian with small bifaces' have lengths between 5 and 7cm, which is small, but within the range of for example the MTA in Southwestern France (for detailed information see Appendix 9; also for example compare the size histograms of Pech de l'Azé I and Saint-Julien de la Lièguen as presented in Appendix 3). Assemblages dominated by small bifacial tools occur across Western Europe (Fig 7.2) and small average lengths are therefore not a region-specific feature.



<u>Fig 7.2:</u> *Geographic representation of the average maximum lengths of the bifacial tools divided into five size categories (raw data available in Appendix 9)*

Larger bifacial tools appear to have a more restricted occurrence. They are absent in Southern and Western France, while their occurrence is common in Northern France, the Netherlands, Britain and Germany (Fig. 7.2). The opposition between the large MTA handaxes in Northern France and the smaller ones in Southwestern France is hereby confirmed.

In Belgium, Germany, Northern and Eastern France assemblages with varying average maximum lengths occur. Furthermore, bifacial tools of different sizes seem to occur in geographic proximity in these regions, as is for example the case in Northern Belgium/Southern Netherlands (Oosthoven-Sint-Geertruid) and Central France (Champlost-Lailly <Tournerie>). For example, in the Vanne Valley small bifacial tools occur in vicinity of sites where handaxes of more than 10cm are present as well (also see Depaepe 2007).

This assessment of the average lengths of the bifacial tools from 29 Late Middle Palaeolithic assemblages indicates the large amount of metric variability within Western Europe. Small bifacial tools are a widespread phenomenon, not restricted to certain regions or entities, and the presence of large handaxes in Northern France is the only regional trends that can be sustained. At a pan-European perspective average length does not appear to be a good criterion to identify regional differentiation. Therefore, two other metric aspects are assessed here to provide a further assessment of regional trends.

Elongation and refinement values

Elongation (length divided by width) and refinement (thickness divided by width) give an indication of how narrow (elongated) and thin (refined) an artefact is (Chapter 4). Although bifacial tools with similar elongation or refinement values can still have very different outline shapes, these ratios are indicative of the overall proportions of the bifacial tools and the variability amongst them.

The data collected and collated here allows for a comparison of refinement and elongation values for Late Middle Palaeolithic bifacial tools across Western Europe. Such an approach has never previously been attempted. In relation to the Middle Palaeolithic, these ratios have mainly been mentioned in respect to the Southwestern French MTA (Iovita and McPherron 2011). The MTA values seem to cluster quite closely, confirming the homogenous nature of this entity (Iovita and McPherron 2011), and it is therefore explored if these values can be used to further typify or identify regional trends.

Firstly, plotting flatness against elongation on a scatter diagram (Fig. 7.3) illustrates the amount of variability present among the assemblages for which metric data was available. The assemblages scatter widely over the plot but the majority of the assemblages (11 out of 20) fall within the third quadrant. This includes all the Southwestern France MTA sites and indicates the less elongated and less refined nature of the bifacial tools in these assemblages.

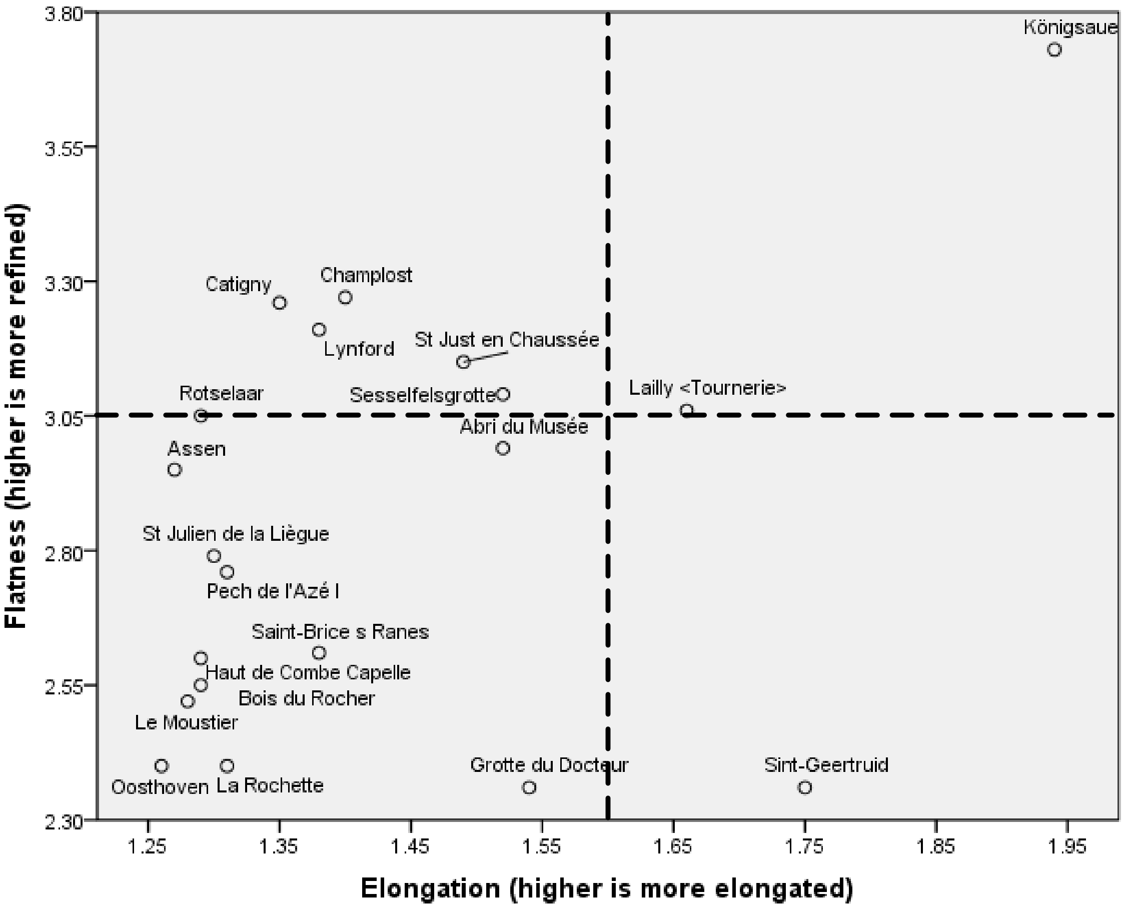


Fig 7.3: *Plot of the average elongation and refinement values for the bifacial tools in the different Late Middle Palaeolithic assemblages*

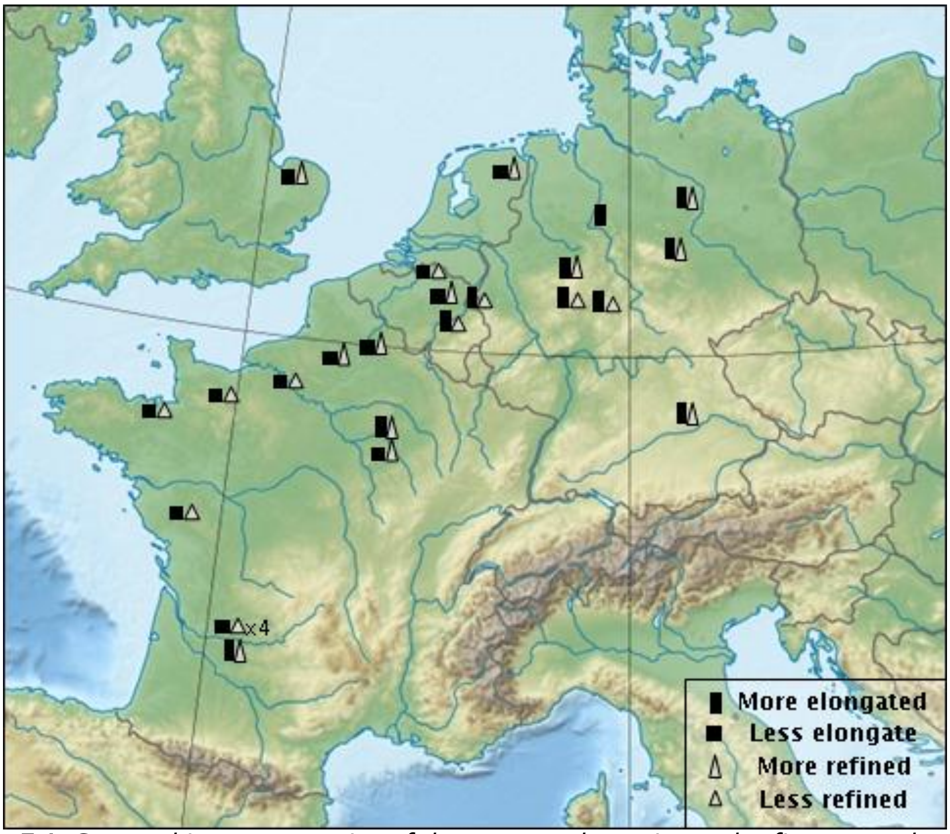


Fig 7.4: *Geographic representation of the average elongation and refinement values of the Late Middle Palaeolithic bifacial tools (raw data available in Appendix 9)*

Secondly, the presence of regional trends is explored through a comparative analysis of elongation and refinement values (Fig. 7.4). A detailed overview of the values per site can be found in Appendix 9 and the average elongation value for this sample of bifacial tools is 1.47 and 0.38 for refinement. Subsequently, assemblages with above average values are classified as more refined or elongated, and assemblages with below average values as less refined or elongated (Fig. 7.4). Several regional trends can be highlighted from this data:

1. The handaxe-dominated assemblages from Southwestern and Western France have low elongation and refinement values, indicating that they are rather thick and broad.
2. In Northern France, Britain and the Netherlands the bifacial tools are more refined (thinner), relating to their longer average lengths.
3. In Germany, assemblages stand out by high elongation values and variable refinement values.

The elongation and refinement data confirms the tripartite macro-regional patterning:

- MTA: low elongation and low refinement, especially in Southwestern France
- KMG: high elongation and variable refinement, including at Abri du Musée
- MBT: variable elongation and variable refinement, e.g. in Belgium different types of assemblages occur alongside each other

This indicates that MTA in Southwestern France and the KMG in Germany can be seen as homogenous entities bordering an area with more metric variability, which is located in between these two entities.

Coefficients of variation (CV)

A consistent way of measuring the overall variability within and across assemblages is provided by the coefficient of variation (CV). This ratio is calculated by dividing the assemblage's standard deviation by its mean and is indicative of the overall range of metric variation present in the assemblage. Firstly, the coefficients of variation were calculated for six metric variables (Length, Width, Thickness, Elongation, Flatness and Refinement). On top of the 14 key assemblages, detailed metric data was available for the bifacial tools from 12 site reports and the values for all 26 assembles are presented on Table 7.3; the lower the CV value, the smaller the amount of variation. Secondly, the average CV of an assemblage was calculated by averaging the CV's for the 6 metric variables and these values were then used to assess the presence of regional tendencies (Fig. 7.5). The average CV of the sample clusters around 0.234 and based on this midpoint thee categories were defined (Fig. 7.5).

COEFFICIENTS OF VARIATION	Length (L)	Width (W)	Thick-ness (T)	Elonga tion (L/W)	Flat ness (W/T)	Refine ment (T/W)	Avera ged CV
Königsaue	0.33	***0.17***	***0.27***	0.34	0.26	0.26	0.272
Sesselfelsgrotte	0.30	0.31	0.35	0.35	0.36	0.4	0.345
Lichtenberg	***0.15***	***0.20***	0.39	***0.09***	0.25	0.26	***0.223***
Salzgitter-Lebenstedt	***0.23***	0.24	–	***0.09***	–	–	***0.187***
Wahlen	***0.23***	0.27	0.32	0.22	0.24	0.26	0.257
Buhlen	0.41	0.34	0.39	***0.16***	0.26	0.26	0.303
Balve	0.34	***0.15***	***0.17***	0.29	***0.23***	***0.2***	***0.230***
Sint-Geertruid	0.25	0.33	0.42	0.28	0.34	0.29	0.318
Assen	***0.21***	***0.21***	***0.26***	***0.09***	***0.16***	***0.17***	***0.183***
Lynford	0.26	***0.21***	***0.28***	***0.11***	***0.22***	0.26	***0.223***
Area 240	***0.09***	-	-	-	-	-	–
Oosthoven	***0.15***	***0.13***	***0.22***	***0.11***	***0.18***	***0.2***	***0.165***
Grotte du Docteur	0.29	0.22	0.32	0.20	***0.21***	***0.21***	0.242
Rotselaar	0.31	0.24	***0.22***	***0.09***	***0.23***	***0.2***	***0.215***
St Just en Chaussée	***0.22***	0.24	***0.28***	***0.16***	0.26	0.28	0.240
St Julien de la Liègue	***0.23***	***0.20***	***0.24***	***0.11***	***0.19***	***0.18***	***0.192***
Catigny	***0.20***	***0.20***	0.32	***0.17***	0.33	0.29	0.252
Champlost	0.34	0.29	0.32	0.22	0.28	*0.25*	0.283
Lailly <Tournerie>	***0.15***	***0.20***	***0.20***	***0.16***	0.29	0.46	0.243
Bois du Rocher	***0.18***	***0.17***	***0.22***	***0.1***	***0.14***	***0.14***	***0.158***
St Brice sous Rânes	***0.10***	***0.07***	***0.16***	***0.08***	***0.16***	***0.17***	***0.123***
Le Moustier	***0.20***	***0.18***	***0.27***	***0.11***	***0.2***	***0.21***	***0.195***
Pech de l'Azé I	0.28	0.25	0.30	***0.14***	0.25	***0.24***	0.243
Haut de Combe Capelle	***0.21***	***0.20***	***0.27***	***0.13***	0.25	***0.22***	***0.213***
La Rochette	***0.23***	***0.22***	***0.23***	***0.12***	***0.19***	–	***0.198***
Abri du Musée	0.27	***0.21***	0.48	0.21	0.29	0.43	0.315
SAMPLE AVERAGE	**0.24**	**0.22**	**0.29**	**0.17**	**0.24**	**0.25**	**0.235**

Table 7.3: *Coefficients of variation values for 3 linear measurements and 3 calculated ratios for the bifacial tools from 14 assemblages (bold and italic values are below the sample average)*

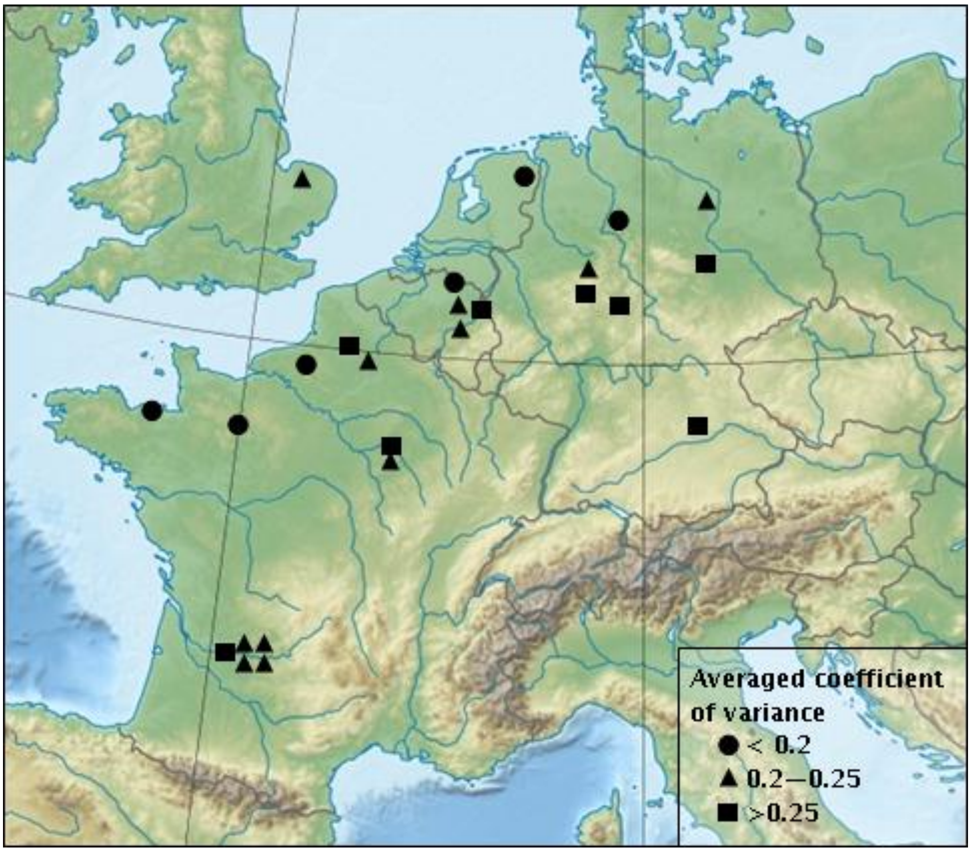


Fig 7.5: *Geographic representation of the average coefficient of variances values of the Late Middle Palaeolithic bifacial tools (raw data values in Appendix 9)*

These CV values further confirm the differences in metric variability between the MTA, KMG and MBT entities. In relation to the MTA, it is clear that assemblages dominated by classic handaxes have below average CV's. Furthermore, the Southwestern France MTA assemblages have very similar averaged CV values, clustering between 0.20 and 0.25, indicating their very homogenous nature. Conversely, the majority of the KMG assemblages exhibit high CV values, indicating a higher amount of metric variability within this entity. In the MBT region, Northern France, Belgium and The Netherlands, assemblages with both high and low CV values occur, indicating the less homogenous nature of this entity. No further regional trends can be observed based on the current sample.

This quantitative reassessment of metric data from a large sample of Late Middle Palaeolithic bifacial tools at an inter-regional scale illustrates that:

1. Considerable metric variability exists among Late Middle Palaeolithic bifacial tools, with the largest piece in the database being 177mm, the smallest 15mm and the average 78.9mm (Appendix 9).
2. Assessing length values alone is not enough to come to a full appreciation of this variability and the regional trends among them.
3. Refinement, elongation and the coefficients of variation all indicate the presence of macro-regional trends, confirming the tripartite distinction between the MTA core area in Southwestern France, the KMG core area in Germany and the presence of an area with a more variable record of bifacial tools in between.

4. Further regional trends cannot be highlighted based on the analyses of this sample of Late Middle Palaeolithic bifacial tools. The 'Mousterian with small bifacial tools' is part of a wider European phenomenon of assemblages with small bifacial tools. Conversely, the distinction within the MTA of larger handaxes in Northern France and smaller ones in Southwestern France does hold up.

These metric analyses allowed for a further characterisation of the macro-regional entities and a re-evaluation of the use of this data to identify region-specific bifacial tool characteristics.

2. TECHNOLOGICAL CRITERIA

Technological criteria are used to define 5 of the 9 regional entities, although always in combination with typological criteria (Table 7.2). In general, throughout Chapter 6 it was demonstrated that a lot of variability exists among the technological characteristics of the Late Middle Palaeolithic bifacial tools. It was demonstrated that they have been manufactured in a variety of ways across the study area, resulting in a large amount of variety in the individual technological attributes across Western Europe. In general, they were manufactured on fine-grained raw materials both by formshaping and on flake blanks, resulting in variable cross sections, cortex remnants and edge angles.

Conversely, some technological aspects occur less frequently and have been used as defining criteria for some entities. The exact nature of these criteria does vary and includes the presence of backed blanks, the overall concept of the tools, a wide application of bifacial retouch, the use of specific resharpening techniques, and the maintenance of shape regardless of size. The exact spatial occurrences of these four technological characteristics can now be reassessed based on this new wide-ranging database of Late Middle Palaeolithic bifacial tools.

Blank use and overall tool concept

The use of backed blanks is another defining criteria of the KMG entity (Chapter 2). Analyses throughout Chapter 6 confirmed that backed blanks are not commonly used for the production of Late Middle Palaeolithic bifacial tools (Section 6.3.2 and 6.3.4) but are dominantly used in Germany and hence in the KMG entity. Blanks with a back, most often natural but also accentuated by steep retouch, are frequently selected to be turned into bifacial tools in the eastern part of the study area, are sporadically used in the central part, but are very rare in the Southwestern region.

This differential blank use can furthermore be linked to differences among the overall concepts of the bifacial tools, more specifically to variation in the morphology of both the distal (pointed or not) and proximal parts (retouched or not). The selected blank will influence the possibilities in relation to the presence of potential active and non-active zones (Boëda 1997; Pinoit 2001; Bourdin 2006). Active zones hereby related to areas that potentially can be retouched and/or used. Several studies have looked in more detail at the differential presence of these active zones on Late Middle Palaeolithic bifacial tools and four overall tool concepts can be distinguished (Fig. 7.7; Bourdin 2006) with the active zones being restricted to: 1. One edge and the distal part of the tool

2. Two converging edges
3. The whole perimeter of the tool
4. Only the distal end

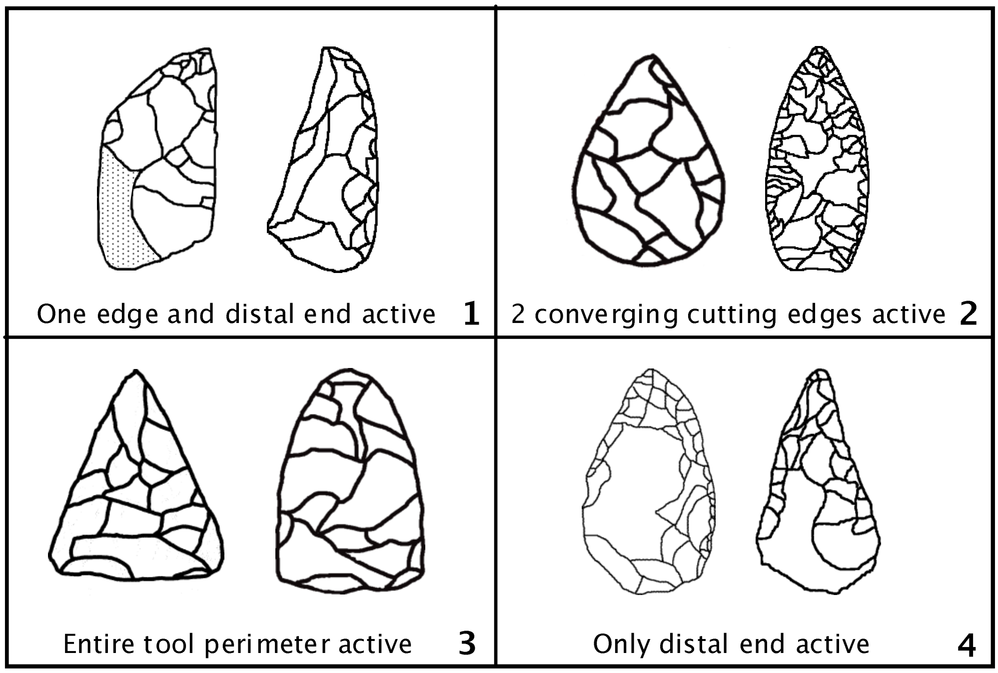


Fig 7.6: *Overview of the different concepts of potential active zones of the bifacial tools*

This study allowed for the first time for the observation of regional differences among the occurrences of these four tool concepts. East of the Rhine, in the KMG entity, the dominant bifacial tool concept relates to the opposition between a blunt back and a retouched sharp cutting edge (tool concept 1). This concept results in asymmetric bifacial tools. Some of the *Keilmesser* have a point created by two convergent edges but this always in an asymmetric fashion with one of the edges being remarkably shorter. Conversely, west of the Rhine, the dominant tool concept relates to the presence of two convergent cutting edges with a point generally in the middle of the artefact. Both of these cutting edges have similar morphologies and based on the characteristics of the base this can either relate to tool concepts 2 or 3.

These tool concepts confirm the MTA/KMG dichotomy with types 1 dominant east of the Rhine opposed to a dominance of types 2 and 3 west of the Rhine. More data is needed to assess the different concepts present within the MBT entity, but analyses of several assemblages from Brittany hint at the common occurrence of all 4 types in this entity (Bourdin 2006). Assessing more detailed regional trends, within these three macro-regional entities, requires a larger amount of detailed data, which is currently not available. A recent study of the British Late Middle Palaeolithic handaxes indicated the common occurrence of worked basal cutting edge in this area (Wragg Sykes 2009, 2010) and hence the potential for regional trends to be expressed through these overall tool concepts.

Wide application of bifacial retouch

A technological distinction can be made between assemblages where bifacial retouch is restricted to certain well-defined tool types and assemblages where a wider, less standardised, application of bifacial retouch is present. This wide application of bifacial retouch has been described as a defining technological criterion for two regional entities, the Mousterian with Bifacial Retouch in Belgium (Ulrix-Closset 1975) and the Mousterian with Bifacial Tools in Western France (Monnier 1990; Bourdin 2006). In these entities a generalised application of bifacial retouch can be observed on the majority of the blanks, resulting not only in a high proportion of bifacial tools, but also in a wide variety of bifacial tool types. Tools are hereby not restricted to one of the four overall tool concepts, but a more opportunistic and generalised use of bifacial retouch seems to have taken place.

From a regional perspective, this technological criterion is restricted to the northern half of France, Belgium and the Netherlands. Good example are the assemblages of Bois-du-Rocher (Brittany) and Grotte du Docteur (Belgium) where bifacial retouch, with varying extents, is applied to a variety of blanks resulting in the combined presence of handaxes, backed and leaf-shaped bifacial tools. This technological feature can therefore be seen as a defining criterion of the macro-regional Mousterian with Bifacial Tools entity.

Resharpening techniques

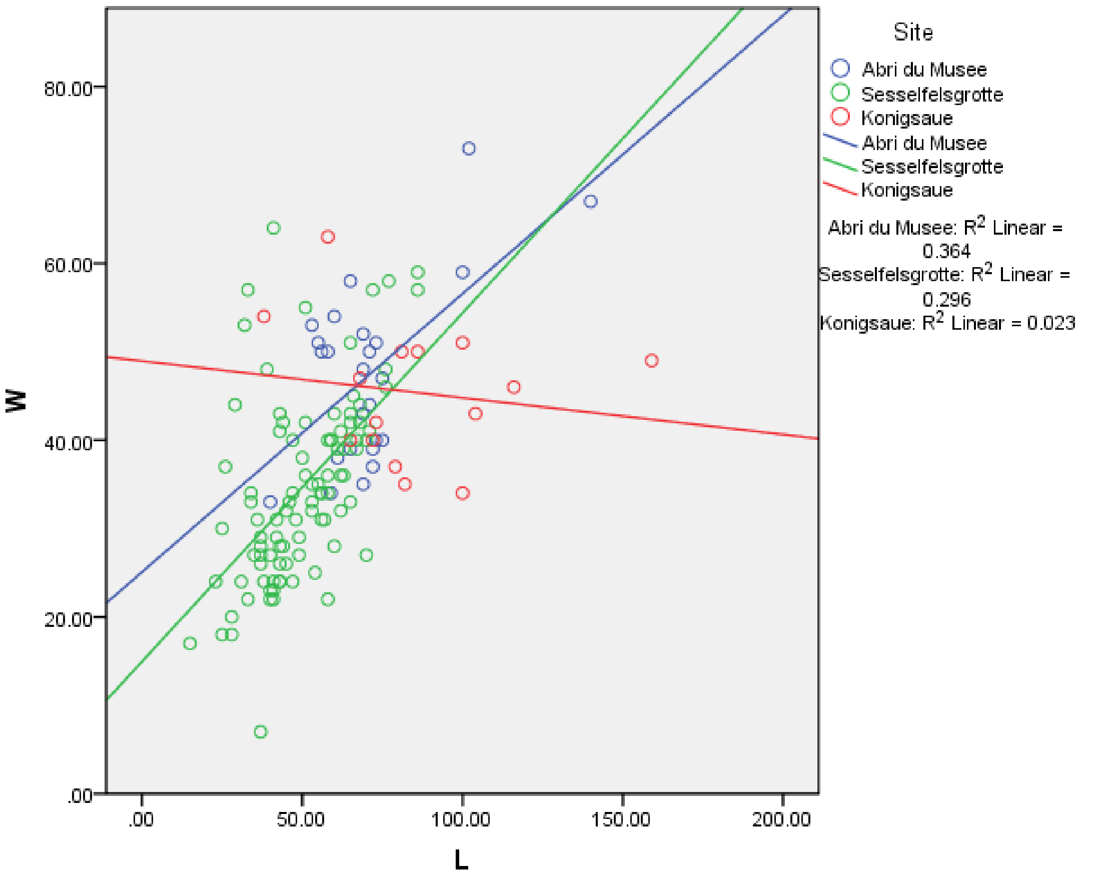
Many examples exist of bifacial tools which have been resharpened, which can be achieved using various methods. Previous interpretations of resharpening techniques highlighted differences between the MTA and KMG bifacial tools (Soressi 2002; Chapter 2). MTA handaxes are viewed as being resharpened by removals coming from the lateral sides, while KMG bifacial tools were rejuvenated by removals from the tip, the so-called para-burin technique (Chapter 4; Fig. 4.11).

This study of 14 assemblages together with an extensive literature review, confirms the dominant use of this para-burin technique in the German KMG assemblages (Jöris 1992, 1994, 2001, 2006, 2012; see also Table 7.3). Examples do exist outside of Germany, for example at the Eastern French site of Germolles (Frick 2010), though this has not been securely placed within a chronological framework. The site of Abri du Musée in Southwestern France is the only example of the use of this technique during the Late Middle Palaeolithic this far south. The para-burin technique has not been recorded in relation to any of the MTA assemblages. It is also important to note that this technique is not used in all of the KMG entities (Jöris 2004). Overall this study confirms a restricted occurrence for the para-burin resharpening technique, most commonly in KMG contexts.

Maintenance of shape

In relation to the resharpening of Late Middle Palaeolithic bifacial tools a second claimed technological distinction between the MTA and KMG relates to the maintenance of the overall outline shapes of the bifacial tools regardless of their size or position in the reduction sequence (Iovita 2008, 2009, 2010). Studies on the relationship between size and shape assess the allometric or isometric nature of the bifacial tools within an assemblage. Isometry relates to the phenomenon where changes in size do not result in changes in shape and allometry to the opposite phenomenon. Recent work on MTA handaxes points towards an isometric pattern for these tools with a clear maintenance of shape, contrasting with an isometric pattern for the KMG bifacial tools (Iovita 2009; Iovita and McPherron 2011). These patterns were established both by detailed calliper based morphometric analyses and elliptical fourier analyses (*ibid.*).

In a more simplified way these isometric and allometric tendencies can be validated by calculating the length-width correlations for the bifacial tools from this study's 14 assemblages. This was achieved using simple linear regression models, identifying the dependence of width on length in the assemblages indicating if changes in length cause changes in width. Three graphs were created, each representing the assemblages from one of the macro-regional entities; assemblages dominated by classic handaxes (MTA; Fig. 7.8), assemblages dominated by backed bifacial tools (KMG; Fig. 7.7 and assemblages that contain a wider variety of bifacial tools (MBT; Fig. 7.9). Each graph represents a scatter plot with the values for each bifacial tool and a fitted regression line with the associates R^2 values. This statistical value estimates the 'goodness of fit' of the line and represents the percentage variation of the data explained by the fitted line; the closer the points to the line, the higher the R^2 value, the better the fit, the more width and length are dependable.



<u>**Fig 7.7:**</u> *Length-Width correlation for the assemblages dominated by backed bifacial tools*

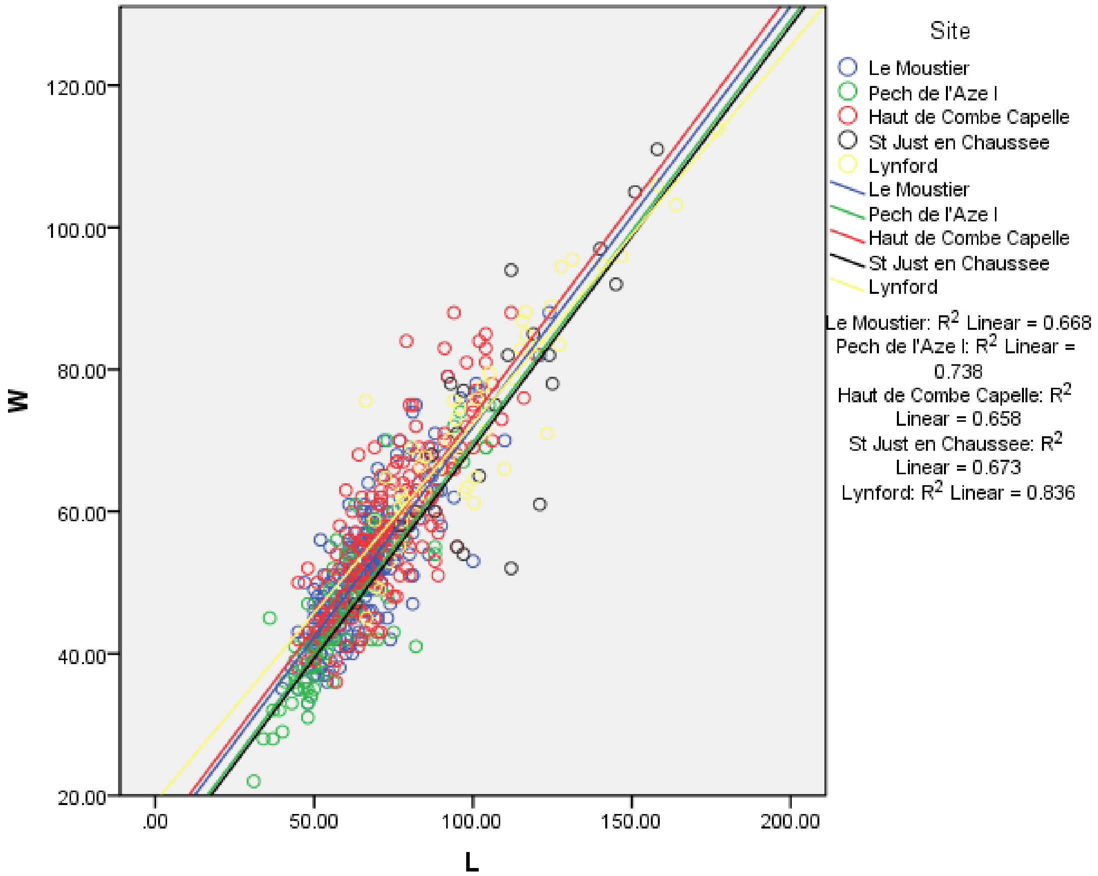


Fig 7.8: *Length-Width correlation for the assemblages dominated by classic handaxes*

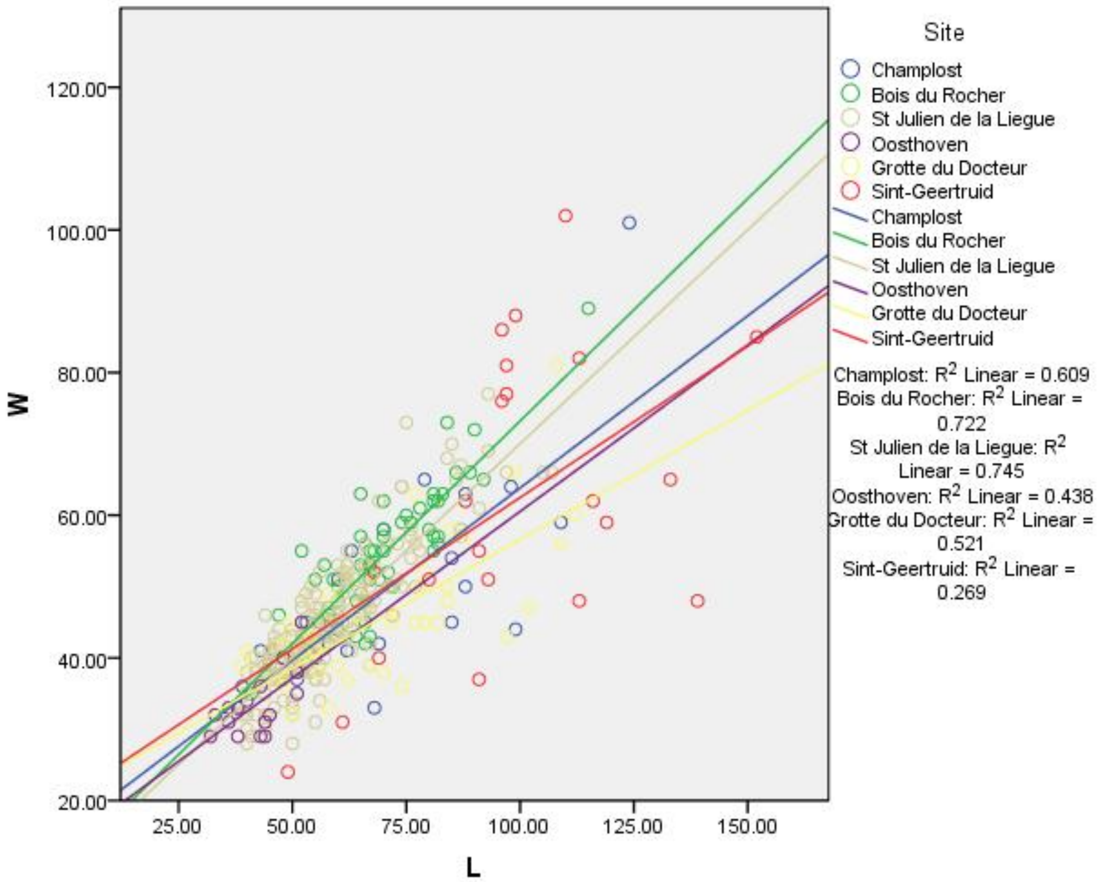


Fig 7.9: *Length-Width correlation for the assemblages dominated by a wide variety of bifacial tools*

Although the precise meaning of a strong Length – Width correlation can be criticised, these graphs are conform to previously identified macro-regional trends:

1. In Germany a weak correlation (values lower than 0.4) is observed and this relates to assemblages dominated by backed bifacial tools (Fig. 7.7). This confirms the previously suggested allometric pattern for the KMG.
2. Assemblages dominated by classic handaxes, which occur especially in Southwestern France, show a strong correlation, with values clustering between 0.65 and 0.85 (Fig. 7.8). Together with the elongation and refinement data this can be interpreted as indicative of a more isometric pattern in the MTA, indicating the maintenance of a particular form throughout the different stages of reduction (Iovita 2008, 2009, 2010; Iovita and McPherron 2010; Wragg Sykes 2009, 2010).
3. In the central part of the study area varying correlations can be observed, with values ranging between 0.25 and 0.70 (Fig. 7.9), relating to assemblages with a variety of bifacial tools. The high values for Bois-du-Rocher and Saint-Julien de la Liègue need to be interpreted with caution since these only represent a selective sample of the vast amounts of bifacial tools present at these localities.

The assessment of these five technological criteria shows that several aspects of bifacial tool technology differ by region and hence can be valid criteria to define regional entities. Currently, this regional differentiation is mainly represented at the macro-regional level and a distinction can be made between:

- *The area east of the Rhine (KMG)* with the use of the para-burin technique, backed blanks, a tool concept that opposes between a blunt back and a retouched cutting edge and a weak Length-Width correlation.
- *Southwestern France, Northern France and Britain (MTA),* with no backed blanks, a tool concept that concentrates on two converging cutting edges, and a strong correlation between length and width.
- *The area of Belgium, the Netherlands, Northern and Western France (MBT),* with a wide application of bifacial retouch, resulting in the use of various blanks, the presence of varying bifacial tool concepts and variable Length-Width correlations.

These technological criteria are always used in conjunction with the typological aspects of the bifacial tools which are further explored below.

3. TYPOLOGICAL CRITERIA

Previous research has heavily focused on typology, concentrating on overall morphology and outline shapes of the bifacial tools (Chapter 3; Bordes 1961; Bosinski 1967; Wymer 1968; Roe 1968). Therefore, it is not surprising, that the presence of certain types and forms of bifacial tools has been used as a defining criterion for 8 of the 9 regional entities, the only exception being the ‘Mousterian with small bifaces’ (Table 7.3). This is indicative of the large morphological variation that exists both among bifacial tools and within bifacial tool types. These criteria not only relate to the morphological difference between a backed bifacial tool and a classic handaxe but also to the different shapes that exist within each of these tool categories.

Typological variation at a macro-regional scale was illustrated throughout Chapter 5 (Table 5.54), at the end of Chapter 6 (section 6.4.5) and confirmed at the beginning of this chapter (Table 7.2). This section focusses on assessing if any further typological variation within the five bifacial tool categories has regional significance. Alongside an in-depth typological assessment of the bifacial tools from the 14 study sites, this section also integrates available data from 36 other Late Middle Palaeolithic biface-rich assemblages. Many site publications do not accurately record the exact numbers of the different bifacial tool types and forms. Therefore, this typological reassessment had to focus on the dominant bifacial form and the absence of certain forms within an assemblage rather than the exact proportions of the different forms. Furthermore this literature-based assessment focused on assemblages which contain over 15 classifiable bifacial tools, so variability within each assemblage can be taken into account as well, as expressed through the presence of other common forms. Overall, 50 Western European assemblages containing various bifacial tools were reassessed (Appendix 10) and several trends could be observed:

Backed bifacial tools

This category mainly relates to backed bifacial knives or *Keilmesser.* This tool type has been further divided into seven morphological sub-types, mainly based on the shape of the tip and extent of the prehensile back (Chapter 4; Bosinski 1967; Kulakovskaya *et al.* 1993; Jöris 2006, 2012). Regional differentiation within these *Keilmesser* types is frequently mentioned in the literature but few studies provide actual data to support these claims. It needs to be noted hereby that several of the *Keilmesser* sub-types have only recently been defined (e.g. Lichtenberger *Keilmesser*) and are therefore not well-integrated in the literature, especially in these older reports. Therefore similar types of *Keilmesser* can be assigned to different *Keilmesser* types making it very difficult to assess the presence of regional trends based on published site reports. Moreover, several reports just mention *Keilmesser* and do not distinguish or describe their outline shapes further.

Recent discoveries have also altered previous geographic interpretations; e.g. Bosinski viewed the KMG to be absent on the Northern plains of Germany (Bosinski 1967) but finds at Lichtenberg and Neumark-Nord 2/0 (see Fig. 5.1) have recently altered this view (Veil *et al.* 1994; Brühl and Laurat 2010). This is a good example of how our current distribution maps can be influenced by a variety of factors, including intensity of research and preservation conditions.

From the 50 assemblages reassessed here 9 have *Keilmesser* as their dominant bifacial tool form and they also have a common occurrence in 4 other assemblages (Appendix 10). *Bocksteinmesser* are present all over Germany (e.g. at Wahlen, Buhlen, Balve, Sesselfelsgrotte and Königsaue) and the same holds true for *Pradnik or Ciemnamesser* which have been found at Sesselfelsgrotte, Balve and Buhlen. Other types have more restricted occurrences (e.g. Lichtenberger and Königsaue *Keilmesser*) but it is difficult to assess if this is related to their specific definition or their actual geographic restricted occurrence. Also outside of Germany a mix of *Keilmesser* types occurs including Bockstein, Klausennische and Pradnik types, mainly in relation to the Mousterian with Bifacial Tools (Appendix 10).

Leaf-shaped bifacial tools

The leaf-shaped bifacial tool category comprises three main tool types: *Faustkeilblätter*, leaf-points and leaf-shaped scrapers (for definitions see Chapter 4). They occur all over Western Europe but only dominate a few assemblages, e.g. Wahlen in Germany (Fiedler *et al.* 1979/1980). Furthermore, this tool type is common at five of the assemblages in the database, indicating that their dominant area of presence is Germany and Central Europe and their presence decreases towards the west. While they sporadically occur in assemblages in Northern and Eastern France, in relation to the Mousterian with Bifacial Tools, they are rare in MTA contexts both in Southwestern France, Northern France and Britain. In general, leaf-shaped bifacial tools always occur alongside a more dominant tool category, most commonly backed bifacial tools. While at a macro-regional scale they indicate an East-West difference, the typology of the leaf-shaped bifacial tools does not allow the definition of additional regional sub-entities.

Bifacial scrapers

Bifacially worked scrapers, defined by non-invasive bifacial retouch, occur across Europe. This tool type comprises a wide range of morphologies but no distinct sub-types are distinguished; it can be regarded as a flexible concept rather than a strictly defined tool type. 5 out of 50 assemblages are dominated by bifacial scrapers and these are located in various regions, including Germany (Salzgitter-Lebenstedt and Sesselfelsgrotte), Belgium (Aalter Hageland and Snauwenberg) and Eastern France (Champlost) (Appendix 10). Furthermore they occur frequently at three other locales and generally they occur in MTA, KMG and MBT contexts. Overall, the presence of bifacial scrapers does not allow for any regional differentiation, neither on the macro-regional nor on the regional scale.

Partial bifaces

Partial bifaces can have various morphologies and include both *Halbkeile* and unifaces (Chapter 4). Within the wide-ranging spectrum of Late Middle Palaeolithic bifacial tools in this sample these partial bifaces are a marginal phenomenon. They occur across the study area but mainly in low numbers, exceptions being the sites of Haut de Combe Capelle (Southwestern France) and Girardière (Western France). Furthermore, they are present in some KMG contexts, and this mainly in the form of *Halbkeile* (e.g. at Bockstein (Bosinski 1967). Besides a general distinction with *Halbkeile* more common in the east and unifaces in the west, this tool type does not allow for any further regional differentiation to be made.

Classic handaxes

In Western Europe classic handaxes are by far the most common Late Middle Palaeolithic bifacial tool type (Chapter 5). They occur not only in a widespread area but also often in high numbers, really dominating tool kits. Over 10 different sub-types have been defined based on differential outline shapes and overall morphology (Chapter 4). Several of these handaxe sub-types have been linked to specific spatio-temporal units, especially in relation to MTA sub-entities (Chapter 2; Table 7.3; Soressi 2002).

Classic handaxes are the dominant bifacial tool type in 31 out of the 50 assemblages for which data could be collated (Appendix 10). They are further a common occurrence on five other sites, alongside a dominance of either bifacial scrapers or *Keilmesser*. In 19 assemblages different forms of classic handaxes represent both the most dominant and the most common other bifacial tool type, illustrating their absolute dominance in a large number of assemblages.

This data confirms previous macro-regional patterns with the Rhine acting as a boundary, which to the east sees handaxes occur in small numbers, if at all. In terms of handaxe sub-types the data clearly illustrates the wide-spread occurrence of cordiform handaxes, dominating assemblages in the Netherlands, Britain, Belgium, Northern France, Central/Eastern France, Western France and Southwestern France (Appendix 10). They are furthermore the most frequent handaxe type in 25 of the 31 classic handaxe-dominates assemblages. Alongside this general dominance of cordiform handaxes, regional differentiation can be observed in the presence/absence of the other handaxe types which occur in conjunction with the cordiform specimens:

- *Bout coupé handaxes* are very common in British Late Middle Palaeolithic assemblages and are very rare elsewhere.
- *Triangular handaxes* are most dominant in Northern French assemblages, confirming the specific MTA variant in this region. They also occur sporadically alongside cordiform handaxes in the Netherlands, Belgium and Central/Eastern France but are very sparse in Britain, Southwestern and Western France.
- *Cordiform handaxes* dominate assemblages in Western and Southwestern France; an area where all other handaxe types occur only in very low numbers.
- *Ovate and discoidal handaxes* never dominate assemblage but occur commonly in low numbers all over France and in Belgium and the Netherlands.

The data presented here illustrates that, currently, typological criteria can only be used to identify further regional entities among classic handaxes and namely within the MTA. Leaf-shaped bifacial tools, bifacial scrapers and partial bifaces do not express clear regional differentiation. For the *Keilmesser* and the KMG the potential for regional trends is clear but the data is currently too coarse-grained to allow a detailed assessment. The collection of additional primary data, which is beyond the scope of this thesis, is needed to be able to assess the exact spatial occurrence of the specific *Keilmesser* sub-types. Within the MTA three main regional trends exist:

- *bout coupé* handaxes are mainly restricted to Britain and rare in other regions.
- triangular handaxes are frequent in Northern France and very sporadic elsewhere.
- cordiform shapes are dominant in assemblages in Southwestern France, while all other shapes occur infrequently in this region.

Overall, it is clear, that typology is the only criterion that currently allows for distinctions to be made both at the macro-regional and regional level, justifying the strong typological focus in the definition of some of the previously identified entities (Table 7.3).

7.2.3 Discussion – consolidation and characterisation of the spatial trends

The three typo-technological tendencies identified throughout Chapter 6 have now been placed within their spatial context. The collation of data from bifacial tools from up to 80 Late Middle Palaeolithic assemblages (Appendices 9 and 10) allowed for the first time to come to an integrative understanding of the spatial characteristics of the bifacial tool phenomenon. A pan-European approach, crossing academic boundaries, focused on the reassessment of metric, technological and typological aspects. At a macro-scale, the MTA, KMG and MBT were established and confirmed as being three distinct macro-regional entities with limited spatial occurrences. Moreover, this reassessment of various defining criteria allowed for an additional characterisation of these three entities.

Establishing trends at the meso-scale was less straightforward, with problems relating to epistemology, quality of site reports as well as the general coarse-grained nature of the Middle Palaeolithic record. It was illustrated that several of the regional entities currently in use do not have distinct features when looking at their characteristics from an inclusive European perspective. This especially holds true in relation to the Mousterian with bifacial retouch, Mousterian with bifacial tools, Charentian with Micoquian influence, Mousterian with small bifaces and the so-called ‘mixed’ entities. Each set of criteria does point towards the presence of regional differentiation but this is predominantly between macro-regions and more specifically between the northeastern, southwestern and central parts of the study area.

The analyses conducted throughout this section now allows for a detailed consolidation and characterisation of the three macro-regional entities, including a discussion on their metric, technological and typological features as well as their internal spatial variation.

1. MOUSTERIAN OF ACHEULEAN TRADITION (MTA)

Classic handaxes dominate the bifacial tool kit west of the River Rhine. Although a lot of variability exists in the morphologies of these handaxes, the homogenous nature of these assemblages is expressed by their low coefficients of variation (Table 7.3), strong length-width correlations (Fig. 7.8) and consistent overall tool concepts (p. 241). Besides forming a strong macro-regional entity these handaxe assemblages also indicate further regional differentiation. This is mainly expressed in the typology of the handaxes (Appendix 10) and the opposition between the dominant occurrence of cordiform handaxes and restricted manifestation of *bout coupé* and triangular types.

The term Mousterian of Acheulean Tradition (MTA) is used here as an umbrella for this macro-regional trend. In its original definition (Peyrony 1930; Bordes 1961; see also Chapter 2) the MTA is distinguished by the presence of handaxes and backed knives (e.g. Abri Audi knives (Bordes 1961)). Within France this led to a specific use of this term, creating the need to define other entities for biface-rich entities that lack these backed knives (e.g. Mousterian with small bifaces; Mousterian with bifacial tools). Elsewhere, this backed knife component was disregarded, making the presence of cordiform/triangular handaxes the only defining MTA characteristic. In Britain the term MTA is commonly used in relation to the *bout coupé* phenomenon (Coulson and Coulson 1970; Boismier *et al.* 2003; White and Jacobi 2002; Wragg Sykes 2009; White and Pettitt 2011), even though backed knives are a rare occurrence in the British Mousterian. Also in the Netherlands the stray finds of handaxes are often assigned to the MTA (Stapert 1985; Deeben *et al.* 2005) and the recent cluster of 30 handaxes from Assen has been published as an MTA assemblage (Niekus *et al.* 2011). Another example of the problematic definition of the MTA is the site of La Folie in the Charente region where an assemblage has been assigned to the MTA based on the presence of backed knives, despite the absence of handaxes or handaxe manufacture (Bourguignon *et al.* 2002, 2006).

Conversely, other scholars have stressed how the MTA is the only Mousterian industry in Southwestern Europe with elongated backed pieces (Soressi 2004). The importance of this presence of backed knives is related to the idea of a successive link with the Châtel-perronian, which is seen as evolving from the MTA type B which in itself is a successor of the MTA type A (Chapter 2; Pelegrin 1990, 1995; Soressi 2002; Pelegrin and Soressi 2007; Bordes and Teyssandier 2011). The Châtelperron knife shows many similarities with the MTA backed knives and the MTA and Châtelperronian are often claimed to have identical geographic distributions, both these elements suggesting evolutionary links.

Both this evolutionary link and the relevance of using backed knives as a defining characteristic can now be questioned. Firstly, it is clear that the MTA is not the final expression of the Mousterian in Southwestern France. At several sites the MTA is overlain by either a Denticulate Mousterian or a Levallois Mousterian with large scrapers (Guibert *et al.* 1999; Jaubert *et al.* 2011). Secondly, the validity of the MTA type B entity, with few handaxes and plenty of backed knives, seems questionable. This typo-technological entity is only recorded at a very limited number of sites which are mainly located in rock shelters in Southwestern France and seems absent in other regions where both the MTA type A and Châtelperronian do occur (e.g. Central France). Moreover, these MTA-B assemblages always overlie an MTA-A and at several localities are directly overlain by an Upper Palaeolithic industry, meaning that these assemblages could be the result of mixing or poor understanding of the context and stratigraphy at some of these sites. Thirdly, many MTA sites, even in Southwestern France, do not contain backed knives (Claud 2008), which should prompt a long overdue reassessment on how to define the MTA, its extent and relationship to the Châtelperronian.

Solving this issue requires a wider study into the presence of backed knives in the Mousterian, not just the MTA, something that falls far beyond the scope of this PhD. What is important here is the differential use of the term MTA inside and outside of France. The analyses conducted in the first section of this chapter demonstrated the large overall similarities within assemblages dominated by classic handaxes and their homogenous nature, and this in relation to their metrics, technological and typological aspects. In my opinion this justifies the use of the term MTA outside of France and for assemblages that lack backed knives. This research has illustrated that across Europe a phenomenon of Mousterian assemblages dominated by classic handaxes occur and the most appropriate label to unite these assemblages is the MTA.

2. KEILMESSERGRUPPE (KMG)

The KMG entity, restricted to the Eastern part of the study area, is a rather well-defined phenomenon (Chapter 2) and its distinct nature is also apparent from the analyses in this chapter. This entity is characterised by high elongation values (Fig. 7.4) and a high amount of metric variation within the assemblages (Table 7.3). The bifacial tools are commonly made on backed blanks (p. 240) and the dominant tool concept is a blunt edge opposite a retouched cutting edge (p. 241). Moreover, there is no strong correlation between the Width and Length of these tools (Fig. 7.7) and the para-burin technique exclusively seems to apply to the bifacial tools in this entity (p. 242). In terms of typology the assemblages are dominated by backed bifacial tools, leaf-shaped bifacial tools and/or bifacial scrapers (see also Chapters 2 and 5).

Although the KMG stands strong as a distinct macro-regional unit, based on the current information available for the *Keilmesser* no additional regional trends can be observed. This is related to the fact that currently a rather disjointed view exists on the variation within the *Keilmessergruppe* entity (see also p. 246) caused by:

- A complex history of research, complicated by the common introduction of new terms, types and entities.
- A strong focus on a restricted number of key assemblages, without integration of the lesser understood KMG collections.
- The creation of more *Keilmesser* sub types, which are not yet integrated in the literature, and are therefore difficult to assess the genuine presence of absence of all *Keilmesser* types in the various assemblages.

In general, the need to define a new type of *Keilmesser* at each of these sites hints at the fact that local conditions, such as raw material (e.g. Sesselfelsgrotte, Fig. 6.2), might have played an important role in the morphologies of the backed bifacial tools (for a more detailed discussion see Chapter 8, section 8.2). This together with the larger amounts of variability generally observed amongst *Keilmesser* and in *Keilmesser* assemblages indicates that this is a rather flexible tool concept, but with a strong typo-technological concept, requiring a backed edge opposite sharp cutting edge but flexible overall outline shape.

The core area of the KMG in Western Europe is located in Germany but a 'Micoquian' or KMG influence is mentioned for certain assemblages out of the German core area. This influence can mean different things in different contexts. Sometimes it relates to the presence of backed bifacial tools, sometimes to a more varied record of bifacial tools, and sometimes to the occurrence of leaf-shaped bifacially worked artefacts. Overall, it is clear that in these 'mixed' assemblages these tool types never dominate the assemblage to the same extent as they do in the German core area. Moreover, they often seem to occur together with a significant number of classic handaxes, a tool type which is very rare in the KMG, hinting at the distinct nature of these assemblages.

The only exception hereby is the site of Abri du Musée in Southwestern France where the assemblage is dominated by backed bifacial tools and the para-burin technique is frequently applied. Currently, it is difficult to interpret this assemblage since it cannot be securely placed within a temporal framework and the complete lithic and faunal assemblage has not yet been published. This site does have the potential to be a classic Late Middle Palaeolithic KMG assemblage in Southwestern France. What the presence of this KMG assemblage this far south might mean in terms of Neanderthal behaviour is further explored in Chapter 8.

3. MOUSTERIAN WITH BIFACIAL TOOLS (MBT)

The central part of the study area, located in between the MTA and KMG core areas, has always been more poorly understood in relation to bifacial tool occurrences. The existence of an entity which does not fit in with a simple MTA/KMG dichotomy has been claimed by various authors and led to the definition of several regional entities (Chapter 2; Table 7.2). In relation to this, the label 'Mousterian with Bifacial Tools' was introduced to typify assemblages rich in a variety of bifacial tools in Western France (Chapter 2). Recently these assemblages in Western France have been described as a homogenous technological entity (Bourdin 2006), characterised by a wider application of bifacial retouch to a variety of blanks resulting in a variety of bifacial tool types. The analyses conducted in this chapter indicate for the first time that the regional extent of this entity can be expanded to incorporate assemblages rich in various bifacial tools, including both classic handaxes and backed bifacial tools, in Northern France, but also in Eastern France, Belgium and the Netherlands. Conversely, this entity is absent in Britain and not known from secure contexts in Germany (e.g. potential presence at Wahlen (Fiedler *et al.* 1979/1980).

This chapter represents the first integrative analysis of a group of these assemblages and allows for both a consolidation and characterisation of this macro-regional entity. The MBT is characterised by considerable variability among the bifacial tools, including different metric dimensions as well as technological concepts (see Table 7.3; Fig. 7.9; p. 241-242). In terms of typology this entity is characterised by a more varied record of bifacial tool types, always including a significant proportion of classic handaxes. These characteristics justify the preference here for the term 'Mousterian with bifacial tools' since this term clearly indicates the presence of bifacial tools but does not presume any correlation with the presence of handaxes or backed bifacial tools.

When reassessing the criteria used to distinguish these entities, such as the Mousterian with bifacial retouch, Mousterian with bifacial tools, Charentian with Micoquien influence, Mousterian with small bifaces and the so-called mixed entities, it became clear that when analysed from an inter-regional rather than intra-regional perspective many assemblages and entities blend in, making their current distinctions invalid. This is especially the case in Northern and Western France and includes assemblages labelled as having a 'mixed' nature of 'Micoquian' influence. These analyses indicate the common grounds of all these entities and therefore argue in favour of them being integrated under the macro-regional umbrella term of the 'Mousterian with Bifacial Tools'. Additionally this indicates that a mixed entity is a real occurrence in the archaeological record and has a specific geographic range; west of the KMG distribution, but overlapping with the northern half of the MTA expansion.

Overall, the analyses in this section demonstrated the clear presence of well-defined patterns in the spatial occurrences of the Late Middle Palaeolithic bifacial tools, both at the macro- and meso-scale. If similar patterns can be observed amongst their chronological occurrences is explored in the next section.

7.3 Temporal Patterning

Besides spatial trends, several chronological tendencies have been described by various researchers in the context of Late Middle Palaeolithic bifacial tools. This relates both to patterns of absence and presence as to changes in typo-technological features. In this section these temporal claims are reassessed by placing the available chronological data within a broader European context. Firstly, at a macro-scale, previous claims about the distinct nature of the Late Middle Palaeolithic bifacial tools are clarified through a brief comparison with their Lower Palaeolithic counterparts. Secondly, at a meso-scale, chronological change among the Late Middle Palaeolithic bifacial tools themselves is further explored, including the restrictedness of certain temporal occurrences as well as the occurrence of time-specific typo-technological variations.

7.3.1 Macro-scale temporal contextualisation

From the onset of Palaeolithic research, Late Middle Palaeolithic bifacial tools have been categorised as being distinct from their Lower Palaeolithic counterparts (de Mortillet 1883; Commont 1906; Monnier 2006 and references therein; Villa 2009). The Acheulean handaxes are seen as more variable in size and shape and include large pointed forms (Iovita and McPherron 2011). Conversely, Middle Palaeolithic bifacial tools are smaller and with a scarcity of pointed forms. Furthermore, MTA handaxes have been described as being more standardised in shape, and as having higher refinement values and more regular edges (Soressi 2002; Wragg Sykes 2009; Emery 2010; Iovita and McPherron 2011).

Currently, differences between Lower and Middle Palaeolithic bifacial tools, and especially handaxes, are based on empirical observations with quantitative comparisons of the two time periods being sparse (Iovita and McPherron 2011). Therefore, to test previous assumptions a comparison of bifacial tool measurements from both the Lower and Middle Palaeolithic is required. The vast majority of publications on European Acheulean assemblages do not provide metric data. Conversely, detailed metric studies of East Asian and African handaxe collections are more common (Shipton and Petraglia 2010; Chauhan 2010). Despite these in-depth studies of Lower Palaeolithic handaxe measurements; there has been less research focus on the dimensions of Middle Palaeolithic bifacial tools due in part to a strong focus on Levallois technology. This is clearly illustrated by the lack of metric data in the majority of French site reports (Cliquet *et al.* 2001), although exceptions exist (Tuffreau 1976).

The comparison of biface metric data from Lower and Middle Palaeolithic sites was geographically restricted to Western Europe in order to reduce the effects of raw material diversity. Over 1,200 Lower Palaeolithic handaxe measurements were accumulated from the literature and compared to over 1,700 Late Middle Palaeolithic bifacial tools, including 1,170 MTA handaxes; the latter represents a combination of data collected for this PhD and from detailed publications (Table 7.4).

This quantitative data confirms previously documented patterns and highlights the distinct nature of the Late Middle Palaeolithic bifacial tools. Bifacial tools from the Late Middle Palaeolithic are, on average, smaller than those from the Lower Palaeolithic (78.91mm versus 111.13mm (Table 7.4). This remains the case for length, width and thickness. Moreover, Late Middle Palaeolithic artefacts are in general broad and thin; while Lower Palaeolithic handaxes are more elongated and thicker (Table 7.4). Furthermore, MTA handaxes are distinct by having very low coefficients of variation for both elongation and refinement, indicating greater standardisation in regard to their overall proportions (see also discussion at the end of section 7.2).

	Sample Size	Length	Width	Thick-ness	Refine-ment	Elon-gation	Data Source
Boxgrove (UK)	376	114.67	73.92	27.6	0.37	1.55	Iovita and McPherron 2011
		25.6	*14.2*	*5.59*	*0.05*	*0.15*	
Warren Hill (UK)	148	98.23	67.64	29.24	0.43	1.45	Emery 2009 and Marshall *et al.* 2002
		27.59	*13.87*	*9.74*	*0.11*	*0.11*	
Corfe Mullen (UK)	138	*121.49*	*75.65*	*37.94*	*0.5*	*1.62*	Marshall *et al.* 2002
		27.35	*14.02*	*12.14*	*0.15*	*0.29*	
Broom Pits (UK)	253	*125.82*	*81.54*	*36.35*	*0.44*	*1.54*	Marshall *et al.* 2002
		35.68	*17.14*	*10.24*	*0.09*	*0.25*	
Gouzeaucourt H (F)	180	79.99	53.72	21.35	0.4	1.49	McPherron 1999
		16.61	*9.42*	*4.35*	-	*0.21*	
Cagny-la-Garenne (F)	120	122.09	69.9	38.8	0.56	1.76	McPherron 1999
		25.14	*12.44*	*11.3*	-	*0.27*	
St. Acheul - Atelier Commont (F)	50	*115.6*	*67.8*	*30.1*	*0.44*	*1.71*	Vignal and Alimen 1952
		0.94	*0.37*	*0.25*	-	-	
Average Acheulean	1,265	**111.13**	**70.02**	**31.63**	**0.45**	**1.59**	
		22.70	*11.64*	*7.66*	*0.10*	*0.21*	
CV		*0.20*	*0.17*	*0.24*	*0.22*	*0.13*	
Average LMP	1,748	**78.91**	**54.37**	**19.98**	**0.38**	**1.43**	
		17.71	*11.71*	*5.63*	*0.10*	*0.24*	
CV		*0.22*	*0.22*	*0.28*	*0.26*	*0.17*	
Average MTA	1,170	77.76	59.18	22.25	0.38	1.32	
		17.39	*10.33*	*2.54*	*0.03*	*0.09*	
CV		*0.22*	*0.17*	*0.11*	*0.08*	*0.07*	

Table 7.4: *Comparison of metric data of Acheulean and Late Middle Palaeolithic bifacial tools (average maximum value in mm. with indication of standard deviation and coefficient of variations (CV)) (Acheulean values collected from published literature, LMP values from 23 assemblages presented in Appendix 9, MTA values averaged from the classic MTA assemblages of Le Moustier, Pech de l'Azé I, Haut de Combe Capelle, La Rochette, Croix-Guémard (Deux-Sevres), St Just en Chaussée and Catigny)*

More detailed macro-chronological analyses are beyond the scope of this thesis but these comparisons indicate that although many similarities exist between the Lower and Middle Palaeolithic bifacial tool concepts, the Late Middle Palaeolithic bifacial tools stand out as a more homogenous entity and therefore needs to be considered on its own, as a discrete and distinct entity which is of importance for further behavioural interpretations (see Chapter 8).

7.3.2 Meso-scale temporal variations

A lot of variability exists among the Late Middle Palaeolithic bifacial tools in Western Europe (Chapters 5 and 6) and alongside spatial differences several chronological tendencies have also been claimed. These assertions relation to two main observations:

1. Chronological change in relation to the presence or absence of bifacial tools
2. Changes within the typo-technological characteristics of the bifacial tools over time

1. TEMPORAL PRESENCE/ABSENCE

Within the Late Middle Palaeolithic, an 80,000 year long time period, several fluctuations occur in climatic conditions and subsequently in demography (Chapter 2). In many Western European regions occupation was probably not continuous and several trends in the presence of bifacial tools can be observed. A main observation relates to differences in relation to the climatic deterioration of MIS-4. The general low number of MIS-4 sites in Western Europe (Chapter 2; Roebroeks and Hublin 2009) has been extrapolated to specific trends of chronological change within the KMG into a concept named '*proglacial dislocation*' (Jöris 2002, 2003, 2004 and 2006). This term refers to the decrease of sites and potential depopulation of areas during MIS-4 and their subsequent repopulation during MIS-3. Few sites with bifacial tools can be assigned to MIS-4.

In Northern France, besides this absence of MIS-4 assemblages (Goval 2008), a negative correlation has been noted between a high density of MIS-5 sites in Northern France and a low density of MIS-5 sites in Southwestern France (Koehler 2009). Koehler furthermore suggests an inverse situation for MIS-3 based on a detailed study of both biface-rich and biface-poor assemblages in the Paris Basin (Koehler 2009).

A third bifacial tool presence/absence trend relates to the restricted spatio-temporal nature of the *bout coupé* handaxes, which are found predominantly in Britain and this after a period of clear depopulation (Chapter 5; Pettitt and White 2011). Based on the current evidence, this *bout coupé* phenomenon, restricted to MIS-3 Britain, seems the best example of a clearly defined spatio-temporal unit within the Late Middle Palaeolithic (White and Jacobi 2002; White and Pettitt 2011).

To test these temporal tendencies all the chronological data currently available for assemblages with Late Middle Palaeolithic bifacial tools was collated (Chapter 2; Table 2.4) and placed within their geographical context (Fig. 7.10). It needs to be emphasised that for the vast majority of Late Middle Palaeolithic assemblages no detailed chronological information is available. Currently, 38 related assemblages can securely be positioned in time; all others can only generically be placed within the MIS 5d-3 framework. The dated assemblages represented on Figure 7.10 must therefore be regarded as merely a selective sample of the hundreds of Late Middle Palaeolithic sites with bifacial tools that exist.

Placing these assemblages on a map allows for the first time an assessment of the temporal tendencies within the Late Middle Palaeolithic bifacial tools across Western Europe. It is apparent that there is variation in the quantity and quality of the data; chronological information is very sparse for Belgium, the Netherlands and Brittany, while concentrations of radiometric dates are available for Britain and Southwestern France. Furthermore several assemblages have been dated using radiometric techniques, whilst others are placed in a climatic phase based on detailed stratigraphic sequences (Fig. 7.10).

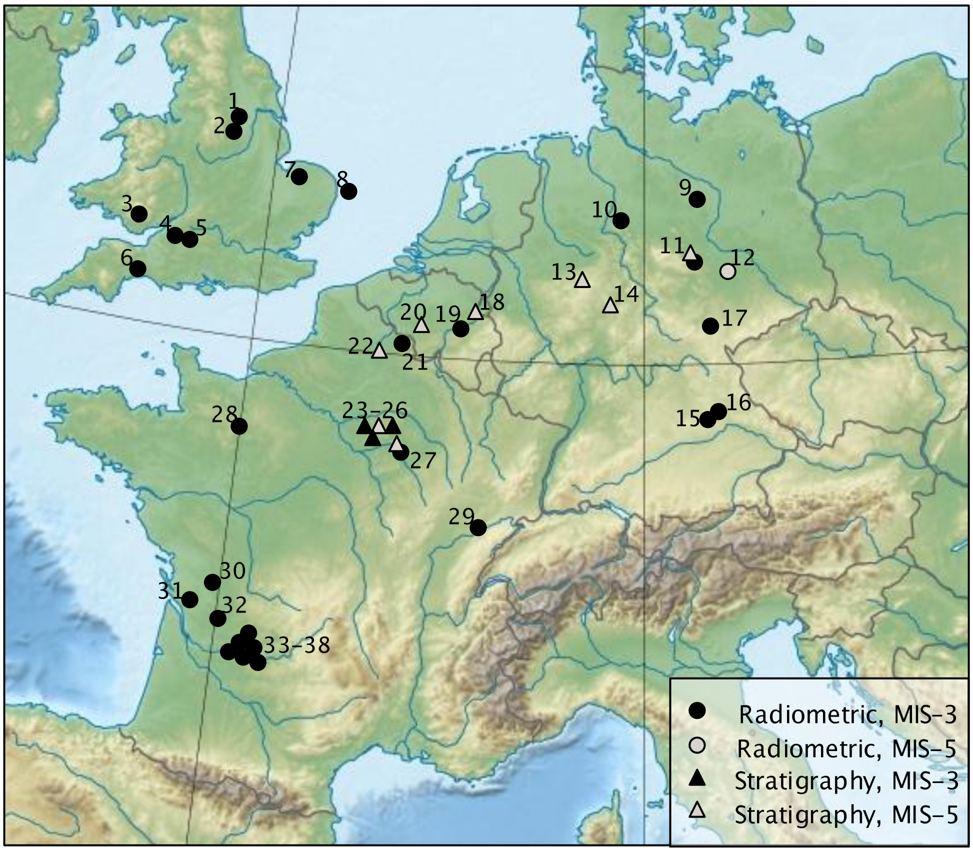


Fig 7.10: *Geographical distribution of the LMP sites rich in bifacial tools that can be placed in time securely, with indication of their MIS-3 or MIS-5 date and radiometric or stratigraphic dating method*

1: *Pin Hole;* ***2:*** *Ash Tree Cave;* ***3:*** *Coygan Cave;* ***4:*** *Hyena Den;* ***5:*** *Rhinoceros hole;* ***6:*** *Kent's Cavern;* ***7:*** *Lynford;* ***8:*** *Area 240;* ***9:*** *Lichtenberg;* ***10:*** *Salzgitter-Lebenstedt B1;* ***11:*** *Konigsaue;* ***12:*** *Neumark-Nord 2/0;* ***13:*** *Balve;* ***14:*** *Buhlen;* ***15:*** *Sesselfelsgrotte;* ***16:*** *Abri I Schulerloch;* ***17:*** *Gamsenberg-Oppurg;* ***18:*** *Veldwezelt-Hezerwater VBLB;* ***19:*** *Sclayn Ia;* ***20:*** *Godarville;* ***21:*** *Saint-Amand-les-Eaux;* ***22:*** *Marcoing;* ***23-26:*** *Villeneuve-L'Archevêque A, Molinons, Lailly <Tournerie>, Lailly <Beauregard> A;* ***27:*** *Champlost;* ***28:*** *Saint-Brice-sous-Rânes;* ***29:*** *Pont-des-Planches; 30****:*** *La Quina;* ***31:*** *Jonzac;* ***32:*** *Fonseigner;* ***33-38:*** *Le Moustier, La Rochette, Grotte XVI, Barbas III, Pech de l'Azé I and IV.*

Whilst caution should be exercised when comparing and interpreting the chronological data, several general inter-regional trends can be identified:

1. In **Britain** Late Middle Palaeolithic bifacial tools occur exclusively during MIS-3, with the oldest site being at the MIS-4/3 boundary (Lynford; ca. 60,000 BP) and the youngest sites around 45-40,000 BP (Pin Hole and Ash Tree Cave).

2. Currently, neither radiometric nor stratigraphic data is available to assess the chronological position of the bifacial tools in the **Netherlands**.

3. A clear lack of dated assemblages is also the case for **Belgium, Western and Eastern France**. The few sites which do have chronostratigraphic information seem to point towards a presence of bifacial tools during both MIS 5 and 3.

4. Both **Northern France and Germany** contain sites which are dated by a secure pedo-stratigraphic correlation or by radiometric dates and these illustrate the presence of bifacial technologies both during MIS-5 and 3.

5. Currently **Southwestern France** MTA handaxes have only been securely assigned to MIS-3 and no secure MIS-5 contexts are known.

Overall, current chronological data confirms the occurrence of several absence/ presence trends among the Late Middle Palaeolithic bifacial tools. Firstly, none of the bifacial tools can currently be placed in MIS-4 although some assemblages do cluster at the MIS-4/3 boundary (e.g. Lynford, Lichtenberg, Gamsenberg and Grotte XVI). It is difficult to assess if this MIS-4 absence is a genuine behavioural trend or related to the coarse-grained nature of the Middle Palaeolithic chronological record (see also Chapter 2). Secondly, a differential pattern exists between Northern and Southwestern France, with assemblages in Southwestern France being restricted to MIS-3, while in Northern France both MIS-5 and 3 bifacial tools occur. Thirdly, the bifacial tools in Britain are restricted to MIS-3 while in Germany they occur both during MIS-5 and 3. The behavioural inferences of these temporal trends are discussed in Chapter 8 in relation to Neanderthal population dynamics.

2. TEMPORAL TYPO-TECHNOLOGICAL TRENDS

Besides these general chronological tendencies, the integration of this temporal data also allows for a reassessment of several changes over time within the typo-technological characteristics of the Late Middle Palaeolithic bifacial tools. This mainly relates to the KMG and MTA since chronostratigraphic information for the MBT is in general very sparse. Previously, internal evolution trends have been highlighted for both the KMG and MTA. Moreover, changes in typology or technology are often based on evidence coming from sites where several assemblages rich in bifacial tools are interstratified. Sites like this are rare, and mainly occur in Southwestern France and Germany. Such sites should be treated with caution since these assemblages often originate from old excavations where the distinction between the different horizons is not always clear or justified (e.g. Pech de l'Azé I (Chapter 5). Despite these general interpretive problems and the low number of securely dated assemblages several chronological tendencies can be reassessed.

For the KMG, the trends mainly focus on the internal evolution within the overall shape of the *Keilmesser*, their proportion within assemblages and the presence of certain flaking and rejuvenation methods (Chapter 2; Bosinski 1967; Richter 1997; Jöris 2002, 2004, 2006). Three main trends have been claimed:

1. Assemblages with use of the Quina technique are claimed to be older than those with use of the Levallois method (Richter 1997).

2. The use of the para-burin technique is seen as a chronological marker for late MIS-5 (Jöris 2004, 2006).

3. *Keilmesser* with a convex cutting edge (Königsaue type) are seen as predating their counterparts with rectilinear cutting edges (Bockstein type; Chapter 4; Bosinski 1967; Jöris 2004).

For the MTA, claimed chronological differences relate to the internal evolution of specific typo-technological characteristics, including:

1. The internal evolution within Southwestern France from MTA type A to an MTA type B with less handaxes and more retouched backed knives (Chapter 2; Bordes and Bourgon 1951).

2. A chronological discrepancy between the large MIS-5 triangular handaxes in Northern France and the smaller, cordiform MIS-3 handaxes in Southwestern France (Soressi 2002).

3. A successive bifacial tool pattern in Northern France, especially in the Vanne Valley, relating to the presence of KMG elements in MIS-5d-c, triangular handaxes in MIS-5a and cordiform handaxes in MIS-3 (Depaepe 2007).

To assess these temporal patterns from a pan-European perspective, typo-technological data was available and collated for 29 assemblages which contain a significant number of bifacial tools and have been securely placed in time (Table 7.5). The subsequent techno-typological analysis of these dated assemblages first of all indicates no differential trends in flaking methods (Table 7.5). The Levallois, discoidal and laminar techniques were commonly used across Western Europe throughout both MIS 5 and 3. Dated assemblages that employ the Quina method are sparse, preventing a detailed analysis and discussion of the importance of this method in these biface-rich assemblages, including in relation to the KMG. In Southwestern France, the Quina Mousterian was generally seen as older than the MTA but recently it has been demonstrated that Quina assemblages also occur which are contemporaneous or even more recent than the MTA (Turq *et al.* 1999; Jaubert *et al.* 2001) further questioning the appropriateness of using Quina technology as a temporal marker. Conversely, the para-burin technique was identified in three of the dated KMG assemblages and these all cluster in MIS-5 (Table 7.5). This resharpening technique therefore has good potential for being a chronological marker but requires further confirmation by the addition of more dated assemblages.

In terms of typological trends, it is clear that all five bifacial tool types occur both during MIS-5 and 3 (Table 7.5). Establishing more detailed chronological trends is, based on the current evidence, difficult. For the KMG *Keilmesser* 9 assemblages in Western Europe have dates and for the MTA handaxes trends can be assessed based on 17 dated assemblages (Table 7.5). The previous claimed pattern of Königsaue *Keilmesser* being older than Bockstein *Keilmesser* therefore seems preliminary, especially also because few sites with stratifying KMG assemblages exist.

Site	MIS	Averaged calBP	Debitage	classic	backed	leafshaped	partial	bif. Scraper	Dominant shape	Technology
Neumark Nord 2/0	5	92,000 ± 5,000	Levallois, other	–	√	√	–	√	Königsaue/Wolgograd Keilmesser	
Königsaue	5	–	**Levallois, discoidal, laminar**	–	√	√	–	√	**Königsaue/Wolgograd Keilmesser**	**para-burin**
Balve	5	–	Levallois, discoidal, laminar	–	√	√	√	√	Balver/Tata Keilmesser	para-burin
Buhlen	5	–	Levallois	–	√	√	√	√	Buhlener Keilmesser	para-burin, Quina
Marcoing	5	–	Levallois, discoidal	√	–	–	–	√	(sub) triangular handaxe	
Villeneuve l'Archevêque C	5	–	Levallois, other	√	–	–	–	–	too fragmented	
Gamsenberg	3	61,050 ± 7,750	other	–	√	–	–	√	unknown	
Grotte XVI	3	60,000 ± 3,325	?	√	–	–	–	–	cordiform handaxe	
Lichtenberg	3	57,000 ± 6,000	Levallois, other	√	√	√	–	√	Lichtenberger Keilmesser	
Saint-Amand-les-Eaux	3	55,000 ± 4,000	?	√	–	√	–	√	unknown	
Lynford	3	53,700 ± 3,100	**other**	√	–	–	√	–	**cordiform handaxe**	
Champlost	3	52,000±4,300	**Levallois**	√	√	√	√	√	**bifacial scrapers**	
Schulerloch	3	51,400 ± 4,500	Levallois, dicoidal	–	√	–	–	√	atypical Keilmesser	
Fonseigner	3	50,500 ± 5,300	Levallois	√	–	–	–	√	cordiform handaxe	
Pech de l'Azé IV	3	49,747 ± 3,408		√	–	–	–	–	cordiform handaxe	
Pont-des-Planches	3	49,700 ± 6,750	Levallois, discoidal	√	√	√	–	–	cordiform handaxe	
Le Moustier	3	49,025 ± 3.825	**Levallois, discoidal, laminar**	√	√	√	√	–	**cordiform handaxe**	
Pech de l'Azé I	3	45,976 ± 1,554	**Levallois, laminar**	√	–	√	√	–	**cordiform handaxe**	
La Quina	3	45,850 ± 4,350	Levallois, discoidal	√	–	–	√	–	cordiform handaxe	
Barbas III	3	45,064 ± 1,526	discoidal	√	–	–	–	–	cordiform handaxe	
Salzgitter-Lebenstedt B1	3	44,484 ± 464	Levallois, laminar	√	√	√	√	√	bifacial scrapers	
Sesselfelsgrotte	3	43,435 ± 1,151	**Levallois, discoidal, laminar**	√	√	√	√	√	**bifacial scrapers**	**Quina**
Coygan Cave	3	43,937 ± 2,660		√	–	–	–	–	bout-coupé handaxe	
Saint-Brice-sous-Rânes	3	41,060 ± 2,940	Levallois	√	–	–	–	–	cordiform handaxe	
Jonzac	3	40,872 ± 1,422	Levallois, discoidal	√	–	–	–	√	cordiform handaxe	
La Rochette	3	40,781 ± 985	discoidal, laminar	√	–	–	–	√	cordiform handaxe	
Molinons <Le Grand Chanteloup>	3	–	Levallois	√	–	–	–	–	(sub) triangular handaxe	
Lailly <Tournerie>	3	–	Levallois	√	–	–	√	–	cordiform handaxe	
Haut de Combe Capelle	3	–	**Levallois, discoidal**	√	√	√	√	√	**cordiform handaxe**	

Table 7.5: *Techno-typological characteristics of the Late Middle Palaeolithic assemblages rich in bifacial tools which can currently be placed in time securely (in bold the assemblages which have been reanalysed in this thesis)*

The internal MTA type A to B evolution was already questioned in section 7.2 and also in relation to the chronological trends in the Vanne Valley further data is needed. Conversely, several chronological trends among the MTA handaxe typologies can be confirmed. It is clear that *bout coupé* handaxes are restricted to MIS-3 and also in Southwestern France the cordiform MTA handaxes predominantly occur during MIS-3. Trends in relation to the triangular handaxes from Northern France are more difficult to sustain since it concerns fewer assemblages and these have been associated with both MIS-5 and 3 (e.g. recent dates from Saint-Amand-les-Eaux around 43,000 BP (Table 2.4)).

Overall, establishing temporal trends among the Late Middle Palaeolithic bifacial tools is difficult, but not completely impossible, based on the current set of well-dated assemblages. These potential temporal trends are now discussed in relation to the three macro-regional Late Middle Palaeolithic bifacial tool entities.

7.3.3 Discussion – the preliminary nature of the temporal trends

Despite a range of dating techniques, including thermoluminescence (TL), optical stimulated luminescence (OSL), electron spin resonance (ESR), uranium series and radiocarbon dating (C14), the chronological framework for the Middle Palaeolithic is still rather poor. This can largely be attributed to the recovery of many assemblages during old excavations and a corresponding lack of contextual information. This chronological control does improve in relation to the Late Middle Palaeolithic when sites fall within the C14 dating range, although the suitability of the application of this technique in Middle Palaeolithic contexts has been questioned (as illustrated by Higham 2011; and recently confirmed by Reimer *et al.* 2009 and Talamo *et al.* 2012). Besides radiometric dating techniques some assemblages are placed within a temporal framework based on their stratigraphic origin, often in combination with micro- and macro-mammal climatic indicators. Even when combining all these different methods, the Middle Palaeolithic remains a coarse-grained period and currently only 38 assemblages rich in bifacial tools can be placed in time securely. Interpreting chronological trends therefore needs to be done with the necessary caution and with acknowledging its preliminary nature.

A first general temporal pattern relates to the influence of the cold period MIS-4 on the general distribution pattern of Neanderthal occupation in Western Europe (Chapter 2; Hublin and Roebroeks 2009; Jöris 2004). Currently, none of the assemblages rich in bifacial tools can be securely attributed to this climatic phase. Other occupational patterns are more difficult to sustain. For example, although the large number of Northern French MIS-5 sites is indeed impressive, current research indicates there was also a very clear Neanderthal presence in Northern France during MIS-3. A similar pattern holds true for Southwestern France where even though the MTA seems to cluster in MIS-3, several MIS-5 assemblages do occur as exemplified with sites with deep sequences such as Pech de l'Azé II and IV, Grotte Vaufrey, Combe Grenal and Coudoulous (Guibert *et al.* 2008). Overall it appears that Neanderthals were present all over Western Europe during both MIS-5 and 3, the only potential exception being Britain.

Secondly, several temporal tendencies can be identified in relation to the three macro-regional typo-technological entities:

1. MOUSTERIAN OF ACHEULEAN TRADITION (MTA)

Despite occurrences in Belgium and the Netherlands, chronological information in relation to the MTA entity is only available from Britain, Northern France and Southwestern France. Overall, 17 MTA assemblages are dated and allow for a preliminary assessment of specific trends in handaxe morphologies. It needs to be noted hereby that the Northern French MTA variant rich triangular handaxes only relates to around 10 assemblages and assignments to MIS-5 are based on pedostratigraphic correlations which reliability differs between sites. Conversely, the strong dominance of MIS-3 sites in Southwestern France, correlated with cordiform handaxes, and in Britain, corresponding with *bout coupé* handaxes are strong trends confirmed by a relative high number of radiometric dates. Therefore, based on this reassessment of the MTA chronological data it can be stated that specific temporal variation exists within the MTA entity.

2. KEILMESSERGRUPPE (KMG)

Models of internal chronological change within the KMG entity are difficult to assess and sustain. The KMG entity contains far fewer sites than the MTA and at the moment temporal trend suggestions are based on, and applied to, around 30 European sites of which 23 are located within Western Europe (Jöris 2006). From these 23 only 9 are securely dated making a successive model with five different types of KMG as yet unsustainable. Moreover it has been illustrated here (Table 7.5) that trends in flaking methods do not hold up and epistemological issues make the trends in *Keilmesser* types difficult to assess. The link between the para-burin technique and MIS-5 is the best evidenced internal trend within the MTA, but overall models of different successive KMG groups are too preliminary and need to be backed up by more sites.

3. MOUSTERIAN WITH BIFACIAL TOOLS (MBT)

Chronostratigraphic information for the MBT entity is very sparse. Currently only three potential MBT assemblages have been dated (Champlost, Saint-Brice-sous-Rânes and Pont-des-Planches, Table 7.5). In general, the MBT entity is currently badly understood both in terms of chronological occurrence as well as internal typo-technological evolution. More dated assemblages, especially from Belgium, the Netherlands, Eastern and Western France are needed before a detailed chronological assessment of this macro-regional entity will be possible.

In sum, this reassessment of the chronological Late Middle Palaeolithic bifacial tool data shows that most assemblages rich in bifacial tools could have an origin during the rather warm phases of either MIS-5 or 3. 38 assemblages can be placed in time more precisely, and spread out over Western Europe this number is rather low. Both at the assemblage and regional level it is impossible to assess the successive or contemporaneous nature of different sites and therefore only a coarse chronological picture can be established. The only sustainable temporal patterns that came forward in this work relate to:

1. the MIS-3 *bout coupé* phenomenon in Britain
2. the pre-dominant use of the para-burin technique in MIS-5
3. the MIS-3 date of the MTA assemblages in Southwestern France

7.4 Discussion: Meso- and Macro-scale Variation among Late Middle Palaeolithic Bifacial Tools

This chapter combined new primary data from 14 assemblages with data collated from various detailed site publications. As a result, it allowed for the first time a detailed assessment of the presence of both meso- and macro-scale spatial and temporal trends among the Late Middle Palaeolithic bifacial tools in Western Europe. This assessment indicates that several previous claims of regional and temporal differentiation cannot be sustained based on the current morphometric, technological, typological and chronological data. Conversely, several genuine patterns of variation could be established, both at a meso- and macro-scale, and the tripartite typo-technological macro-regional pattern (Chapter 6) could also be characterised in more detail (Table 7.6).

1. SPATIAL TRENDS

- *Macro-scale of analysis (macro-regional)*

At the beginning of this chapter it was illustrated that the three typo-technological entities established throughout Chapter 6 have specific geographic ranges and can be equated to three macro-regional entities. The Mousterian of Acheulean Tradition, characterised by classic handaxes, occurs not only in Southwestern France, but also in Northern France, Belgium, the Netherlands and Britain. Secondly, the *Keilmessergruppe* entity, known by its backed bifacial knives, has a strong core in Germany and occurs only very sporadically west of the Rhine River. Thirdly, a new entity was collated under the label Mousterian with Bifacial Tools, typified by the presence of a wide variety of bifacial tools. The MBT occurs overlapping with the MTA but distinct from the KMG in the area of the Netherlands, Belgium, Northern, Western and Eastern France.

This macro-regional tripartite pattern is furthermore confirmed by differences in metric, technological and typological characteristics (Table 7.6). In the Eastern part of the study area KMG assemblages are characterised by high elongation values, variable refinement values, high coefficients of variation, the use of backed blanks, the para-burin technique, the dominance of bifacial tool concept 1, and an allometric size-shape pattern. In the Western part of the study area the MTA assemblages form a coherent group as indicated by low elongation, refinement and coefficients of variation values, as well as a dominance of tool concepts 2 and 3 and an isometric size-shape pattern. In the central or middle part of the study area the MBT entity expresses a wide application of bifacial retouch and subsequent high amounts of variation in elongation, refinement, coefficients of variation and length-width correlations.

- *Meso-scale of analysis (regional)*

Neither metric nor technological criteria allow for further spatial trends to be identified within this threefold macro-regional pattern. Only typological characteristics and more specifically differences in dominant bifacial form, relating to morphology and outline shape illustrate regional differentiation. Currently, these regional differences can only be sustained for classic handaxes. In other areas of Western Europe fewer sites are available and in-depth comparisons based on publications are still strongly hampered by the use of differing terms and types; e.g. the continuously increasing numer of *Keilmesser* sub-variants. Within the classic handaxe category a distinction was observed in terms of the presence and absence of vertain forms. Forms that typify certain regions are *bout coupé* handaxes in Britain, triangular handaxes in Northern France and cordiform handaxes in Southwestern France.

2. TEMPORAL TRENDS

- *Macro-scale of analysis*

After a significant decline in the Early Middle Palaeolithic (Chapter 2), bifacial tools form a regular component of the Neanderthal tool kit all over Western Europe throughout the Late Middle Palaeolithic. It was established that, on a quantitative basis, compared to their Lower Palaeolithic counterparts, the Late Middle Palaeolithic bifacial tools are in general smaller in size and more elongated and refined in nature. Moreover, it is clear that the MTA handaxes form a more standardised entity than the Lower Palaeolithic handaxes as expressed through their low coefficients of variation (Table 7.4). More detailed Lower – Middle Palaeolithic comparisons are beyond the scope of this thesis but establishing the unique nature of the Late Middle Palaeolithic bifacial tools is important in light of further behavioural interpretations (Chapter 8, section 8.2).

- *Meso-scale of analysis*

Detailed chronological information is available for 38 Western European assemblages rich in Late Middle Palaeolithic bifacial tools. There is a significant lack of radiometric dates for Belgium, the Netherlands and Western France, not allowing any chronological inferences to be made in relation to the MBT. For the KMG, it is clear that this entity occurs in Germany both during MIS-5 and 3. With only nine dated assemblages, further models of internal temporal evolution within the German KMG, should, for the moment, be treated cautiously. The clearest chronological KMG marker seems to be the association between the para-burin technique and MIS-5 but this also requires confirmation by more secure dates.

Within the MTA entity meso-scale chronological variation can be assessed through a set of 17 dated assemblages from Britain, Southwestern and Northern France. In terms of absence/presence it is clear that while the MTA is present during both MIS-5 and 3 in Northern France, assemblages in Britain and Southwestern France have predominantly been related to MIS-3. Moreover, these MIS-3 assemblages are explicitly associated in Britain with *bout coupé* handaxes and in Southwestern France with cordiform types (Table 7.6), making these the clearest examples of spatio-temporal units currently identifiable among Late Middle Palaeolithic bifacial tools.

	Mousterian of Acheulean Tradition (MTA)	Mousterian with Bifacial Tools (MBT)	Keilmessergruppe (KMG)
Geography	concentration in Southwestern France, Northern France and Britain occurrences in Belgium, the Netherlands and Central France MTA elements very rare east of Rhine	concentration in Belgium, Northern, Western and Eastern France occurrences in the Netherlands contains both MTA and KMG elements	concentration in Germany very sporadic occurrences Southwestern France KMG elements occur commonly west of Rhine
Chronology	during both MIS-5 and 3	unknown, during both MIS-5 and 3?	during both MIS-5 and 3
Internal evolution	Britain: MIS-3 and *bout-coupé* SW France: MIS-3 and cordiform elsewhere both MIS-5 and 3	unkown	difficult to assess temporal trends para-burin potential marker for late MIS-5
Raw Material	dominance of local fine-grained material	dominance of local fine-grained material	dominance of local fine-grained material
Blanks	both flake blanks and façonnage	wide application of bifacial retouch to a variety of blanks	both flake blanks and façonnage use of blanks with a natural back
Tool concepts	dominance of concepts 2 and 3	variable, all 4 concepts possible	dominance of concept 1
Shaping	both planoconvex and biconvex sections covering retouch, low cortex remnant	variety of sections variable retouch	dominance of planoconvex sections less intense retouch, larger cortex remnant
Typology	dominance of classic handaxes	variety of bifacial tools, including both classic handaxes and backed types	dominance of backed and leaf-shaped bifacial tools
Variability	low coefficients of variance	variable coefficients of variance	high coefficients of variance
Metrics	average length of bifacial tools around 7cm low elongation low refinement	average length of bifacial tools around 7cm variable elongation variable refinement	average length of bifacial tools around 7cm high elongation variable refinement
Site function	both cave and open-air both isolated finds and concentrations	both cave and open-air both isolated finds and concentrations	both cave and open-air both isolated finds and concentrations
Use	mainly butchery and woodworking use of hafting sparse	use-wear analysis sparse but the variable tool concepts and edge angles indicate variety of uses	butchery, woodworking, scraping hide ample evidence for hafting
Resharpening	rejuvenated from the sides maintenance of shape regardless of size	no para-burin technique variable correlation between L and W	para-burin technique shape varies according to size

Table 7.6: *Overview of the spatial, temporal and typo-technological characteristics of the three Late Middle Palaeolithic Western European macro-regional entities rich in bifacial tools*

Throughout Chapters 5, 6 and 7 it was established that genuine patterning can be observed amongst Late Middle Palaeolithic bifacial tools using a single, simplified methodology. Recognising these patterns is but one part of the puzzle, the next question is what this might mean in terms of Neanderthal behaviour during MIS-5 to 3.

Chapter 8:

Discussion
Late Middle Palaeolithic Bifacial Tools and Neanderthal Behaviour:
A multi-scalar interpretation

8.1 Introduction

Chapters 5, 6 and 7 identified the presence of genuine patterns of typo-technological, temporal, macro-regional and regional variation in the Western European Late Middle Palaeolithic bifacial tool record. The establishment of these patterns inevitably leads to questions on their underlying causes and behavioural meaning. These are discussed in this chapter in relation to Research Question 4:

How can the presence or absence of macro-regional variability patterns in the Late Middle Palaeolithic record of Western Europe be interpreted in relation to wider Neanderthal behaviour?

And the resulting SUB QUESTIONS:

- *What causal factors can help explain the observed regional differentiation?*
- *If a 'mixed' entity exists, how does it fit with different ideas on the dynamics within and between the MTA and KMG?*

This chapter integrates the theoretical concepts outlined in Chapter 3 with the newly established perspective on Late Middle Palaeolithic bifacial tool variability (Chapters 6 and 7) and the current state of knowledge on Neanderthal behaviour. Firstly, it is important to briefly accentuate the unique nature of the Late Middle Palaeolithic and its bifacial tools. Identifying the distinct nature of this time period (MIS 5d-3) and the distinctive interpretive potential of these bifacial tools provides a necessary broader context for understanding and contextualising any behavioural interpretations. Subsequently, these behavioural inferences focus on two aspects:

1. What factors explain the identified distinct patterns of bifacial tool variation? Is this variability the result of differences in raw material, site function, tool function, resharpening and use-life and/or social transmission and culture?

2. What aspects of Neanderthal behaviour can help explain the three-fold macro-regional pattern MTA-MBT-KMG? How does this macro-regional patterning fit with current understandings of Neanderthal population dynamics, including population size and density, migration and extinction, mixing and hybridity.

The final section of this chapter details how this research adds to the ever-expanding corpus of knowledge on Neanderthal behaviour. Throughout this thesis the Late Middle Palaeolithic bifacial tools were assessed from three scales of analyses, with each scale also allowing for a differential interpretation of the observed variability. Together with the incorporation of data for the first time from a pan-European perspective, this allows to come to a unique comprehensive understanding of Late Middle Palaeolithic bifacial tool variability as well as its underlying causes and associated Neanderthal behaviour.

8.2 The Late Middle Palaeolithic and Bifacial Tools: Distinct Interpretive Potential

Both the distinct nature of the Late Middle Palaeolithic time period and the unique interpretive potential of bifacial tools need to be emphasised to contextualise further behavioural inferences. In the past, researchers have frequently highlighted differences in the Western European archaeological record between the earlier (MIS-9 to 5e) and later (MIS-5d to 3) phases of the Middle Palaeolithic (Mellars 1996; Gamble 1999; Richter 2000; White and Pettitt 2011; Scott 2011). These differences include variation in the lithic assemblages but also changes in palaeoanthropological features (emergence of 'classic Neanderthals' – Hublin 1998; Tattersall and Schwartz 2008), genetic signatures (Hublin 1998; Briggs *et al.* 2009) and behavioural practice. The latter referring to an increase in the appearance of structured intra-site variability, single species hunting, use of bone tools, use of pigments and the potential appearance of burial practices (Kolen 1999; Gaudzinski and Roebroeks 2000; Villa and d'Errico 2001; Vaquero *et al.* 2004; Soressi and d'Errico 2007; Dusseldorp 2008; Langley *et al.* 2008; Zilhao *et al.* 2010; Pettitt 2011; Gaudzinski-Windheuser and Kindler 2012; Zilhao 2012).

Neanderthal skeletal features gradually evolved across Western Europe from MIS-11 onwards (for a discussion on the exact timing of the Neanderthal lineage see Hublin 2009; Stringer 2012). Neanderthals with a full package of classic skeletal features appear to occupy Western Europe mainly after MIS-6 (Hublin 1998; Tattersall and Schwartz 2008). Therefore, for the Late Middle Palaeolithic in Western Europe we are dealing exclusively with a single species of hominin; 'classic' Neanderthals and all subsequent interpretations relate to this species.

Genetic evidence highlights differences between Early Middle Palaeolithic and Late Middle Palaeolithic Neanderthal populations. Recent analyses of Neanderthal mtDNA genomes estimated that the most recent common Neanderthal mtDNA ancestor lived around ca. 109,800 BP (Briggs *et al.* 2009), so within MIS-5. This DNA analysis confirms previous studies, which suggested a recent re-colonisation of parts of the Neanderthal range, probably at the beginning of MIS-5 (Hublin 1998). Moreover, the similarities between the Teshik Tash (Uzbekistan) and Scladina (Belgium) mtDNA sequences further support the idea of a recent Neanderthal expansion during MIS-5 (Briggs *et al.* 2009; Fabre *et al.* 2009). This data further indicates the distinctness of the Late Middle Palaeolithic time period, as well as the occurrence of population changes and movements throughout the Late Middle Palaeolithic, something that is explored in more detail in Section 8.4.

In the tool kit of these classic Neanderthals bifacially worked tools once again become a common component all over Europe and this from MIS-5 onwards (Chapter 2). The emergence and subsequent disappearance of specific lithic technologies is a recurrent feature throughout the Middle Palaeolithic. The exact reasons for these pulses of lithic technologies are difficult to explain, especially when the coarse-grained nature of the Middle Palaeolithic record is taken into account (Davies 2012). Lithic technologies were regularly re-invented in unconnected spatial and temporal settings. This reappearance of bifacial tools is a unique feature of the Late Middle Palaeolithic record and also provides a distinct interpretive potential (Chapter 3). Previous research indicated that bifacial tools played a unique role in Neanderthal tool kit (Chapter 3) and this was confirmed by analyses throughout this thesis (Chapter 6, 7 and 8). Late Middle Palaeolithic bifacial tools can therefore be regarded as:

- Potentially used in a variety of activities, as indicated by use-wear analyses and confirmed here by the dominance of edge angles between 35 and 65 degrees which allow for a variety of cutting movements (Chapter 6; Table 6.19).

- Repeatedly resharpened and recycled, as illustrated by secondary retouch on the handaxes (e.g. at Lynford) as well as by the use of the para-burin technique (e.g. at Abri du Musée), indicating their longevity and curated nature.

- Highly mobile, as highlighted both by the presence, although in low numbers, of artefacts in exotic raw materials, as well as by the fragmentation of the knapping process in the landscape, as exemplified by the presence of assemblages with bifacial tool debitage but no actual bifacial tools; e.g. Ash Tree Cave in Britain (White and Pettitt 2011).

- Potential indicators of social and/or symbolic behaviour, because of their elaborate design, complex knapping process and extended use-lives and the general observation that the investment of time and energy in the manufacture process of a handaxe is difficult to explain in purely functional terms (Chapter 3)

The Late Middle Palaeolithic is furthermore the first archaeological period where it is possible to recognise the presence of specific types of technologies and tool types in restricted time ranges and regions. This regionalism is recognisable both during MIS-5 (Depaepe 2007; Goval 2008; Koehler 2009) and MIS-3 (Richter 2000; Soressi 2002; White and Jacobi 2002); earlier than previously assumed (Mellars 1996; Gamble 1999; Richter 2000). This PhD has further illustrated that it is predominantly recognisable in relation to bifacial tools, both at a macro-regional (MTA-KMG-MBT) and regional scale (regional MTA variants). It is argued here that this regionalism cannot solely be linked to the emergence of a better resolution for the Late Middle Palaeolithic record (Davies 2012). Large numbers of Western European Lower and Early Middle Palaeolithic are known, and there are no grounds to assume that if similar distinct regional trends were present in the lithic technologies and artefact morphologies throughout these time periods they still need to be identified.

Generally, it is clear that the Late Middle Palaeolithic in Western Europe is associated with a unique hominin species, 'classic Neanderthals', and a specific behavioural repertoire, including the reappearance of bifacial tools and the emergence of region-specific lithic variation. The specific nature of these bifacial tools and the effort invested in their manufacture provide the potential for unique glimpses into Neanderthal lifestyles and social/cultural behaviour. The typo-technological, spatial and temporal patterning identified in this thesis will now be linked further to behavioural interpretations.

8.3 Unravelling Late Middle Palaeolithic Bifacial Tool Variability

A variety of factors may influence both the initial physical appearance of a lithic tool and the final form in which it is discarded, and subsequently recovered, from the archaeological record (for an overview see Chapter 3). Each of these factors have been studied, in depth, as explanations for Mousterian variability (Chapter 3) but have not yet been applied to either bifacial tools or at a pan-European scale. In general, the morphology of a bifacial tool can be seen as resulting from a dynamic process affected by multiple factors. These factors are investigated here to see whether they can explain the specific regional and macro-regional patterns identified throughout this thesis (Chapters 5, 6 and 7). Can the regional differences observed among Late Middle Palaeolithic bifacial tool types be explained by varying raw material availability and constraints, functional requirements, settlement patterns, resharpening trajectories and/or socio-cultural behaviour?

8.3.1 Raw material

Middle Palaeolithic stone tool assemblages are predominantly made on local raw materials, although some assemblages also contain a low proportion of materials from exotic sources (Féblot-Augustins 1993, 1999, 2008; Turq 2000; Soressi 2004b; Bourguignon *et al.* 2006; Meignen *et al.* 2009; Kuhn 2011; Spinapolice 2012). The availability of these raw materials and the specific nature, including the size and shape of the available raw material nodules, have been identified as important factors to explain certain variability trends within and between Mousterian assemblages (Dibble 1990; Dibble and Rolland 1992; Mellars 1996; Chapter 3). Here the effects of raw material variability are for the first time assessed from a pan-European perspective and in relation to Western European Late Middle Palaeolithic bifacial tools.

At a micro-scale it is clear that raw material availability and characteristics can influence the overall shape and size of an individual bifacial tool. Throughout this thesis that was best illustrated in relation to the presence of thin chert plaquettes that clearly restrict the shape of the artefact; e.g. at Sesselfelsgrotte (Chapter 5) and also at the Eastern French site of Montarlot-les-Champlitte (Lamotte *et al.* 2009). Furthermore, variability within *Keilmesser* forms has been related to the use of differential blanks, including thick flakes, flattened pebbles, angular or tabular chunks of raw material (Veil *et al.* 1994; Jöris 2001, 2006). This raw material influence has also, but to a lesser extent, been noted in relation to classic handaxes, e.g. use of river pebbles versus larger pieces from primary flint sources at Lynford (Wragg Sykes 2009; White 2012).

Furthermore, restricted nodule size has often been suggested as an explanatory factor for the existence of small bifacial tools. Although this probably holds true for the ad hoc occurrence of small artefacts in some assemblages, this does not explain the dominance of small bifacial tools in areas where large nodules of flint are a common occurrence. Furthermore research into the small size of the Oosthoven bifacial tools has indicates that these small dimensions do not correlate with the size of the raw material nodules available in the vicinity of the site (Ruebens 2005), indicating that raw material is not the sole factor in influencing the appearance, or size, of a bifacial tool.

At a regional scale differences between raw material availability can explain some patterns, both in relation to the absence or presence of bifacial tools as well as to the precise characteristics of the bifacial tools. For example, a lack of large flint nodules has been cited as a causal factor in the absence of MTA handaxes from Southeastern France (Turq 2000). Also, in the Armorican Massif in Western France, where flint is absent, the nature of the glossy sandstone nodules has been described as having an influence on the bifacial tool types and forms (Launay and Molines 2005). Within Germany different types of raw material occur in different regions but as highlighted by Bosinski, the same type of bifacial tools are made on different raw materials, including flint, chert, radiolarite and quartzite (Bosinski 1967).

Conversely, from a macro-regional perspective it is clear that fine-grained raw materials, such as flint and chert, are the dominant raw materials used for all Western European Late Middle Palaeolithic bifacial tools (Chapter 6, Section 6.3.1)). The vast majority of the sites containing bifacial tools seem to be located in direct proximity of primary or secondary context flint (Soressi 2004b; Claud 2008). Moreover, where different types of raw material occur, the same debitage and façonnage methods seem to be applied to all raw materials, indicating their non-restrictive nature (Richter 1997; Moncel and Daujeard 2010).

Therefore, it is argued here that raw material availability and constraints only played a significant role in the manufacture processes of Late Middle Palaeolithic bifacial tools at a site based scale. Regional and macro-regional differentiation cannot be explained by differential raw material characteristics. Firstly, it is clear that the macro-regional and regional patterning identified among the Late Middle Palaeolithic bifacial tools does not correspond with macro-regional or regional differences in raw material types. Although within Western Europe there are some differences in terms of the occurrences of flint, e.g.

sparser in Northern Germany (Bosinski 1967) and the Armorican Massif (Launay and Molines 2005), these trends do not correspond with the observed bifacial tool variability. Secondly, it is clear that all bifacial tool types, including *Keilmesser* and classic handaxes, were made both on nodules and flake blanks and a variety of fine-grained raw materials. This indicates the imposition of the tool type regardless of the original blank or nodule (Chapter 6; Section 6.3.2). Thirdly, at several localities changes within the techno-typological characteristics of the bifacial tools occur without corresponding changes in raw material availability or constraints. For example for the MTA this has been observed in relation to the higher retouch intensity of some of the Pech de l'Azé I assemblages, as well as in relation to changes from MTA type A to B (Soressi 2004b). Finally, for the British handaxes it was noted that they were reduced and curated even in locations where raw material was abundantly available (Wragg Sykes 2009, 2010).

Overall, the Late Middle Palaeolithic record indicates an imposition of bifacial tool type and form which is, in most cases, independent of the raw material or blank type. This is not to diminish the effect of raw material on a micro-scale (e.g. in relation to the different *Keilmesser* types), but to stress that the identified variability patterns cannot be explained solely in relation to raw material availabilities and/or constraints.

8.3.2 Site function

The potential function of a site can be reconstructed both by its location in the landscape as well as by the types of lithic and faunal remains present (Chapter 3, Section 3.2.2). At a micro-scale it is clear that Late Middle Palaeolithic assemblages rich in bifacial tools occur in a variety of topographic and environmental settings (for an overview see Tables in Chapter 5). Detailed interpretations are often hindered by the sparseness of palaeoenvironmental data, such as fauna and pollen, at the vast majority of these sites due to both preservation issues and poorly recorded excavations.

Topographic conditions do vary at a regional scale, with cave and rock shelters absent in the Netherlands, Northern Belgium, Northern France and Northern Germany but this difference is not reflected in the bifacial tool assemblages. MTA, MBT and KMG assemblages all occur in both cave and open-air localities (Chapter 5) and are commonly associated with water and raw material sources. Sites where faunal remains are preserved indicate that a wide variety of animal species are found in conjunction with MTA, MBT and KMG sites (Chapter 5), including indicators of both cold and forested environments, again indicating the variable environmental settings these bifacial tools are associated with.

Based on the absence/presence of bifacial tools and/or their debitage three types of sites can furthermore be distinguished (see Chapter 3, Section 3.2.2; Turq 2007; Claud 2008) and applied to the assemblages under study here:

1. Transition sites

Only debitage, no bifacial tools themselves

This type of site is, by definition, not analysed in this study because the focus here is on the bifacial tools themselves. These sites are commonly represented in the Western European Late Middle Palaeolithic record, for example at Ash Tree Cave in Britain (White and Pettitt 2011) where handaxe thinning flakes were recovered from contexts in which actual bifaces were absent.

2. Processing sites

No debitage, only bifacial tools themselves

At these localities bifacial tools were discarded but not manufactured. These sites could for example be represented by some of the isolated bifacial tool find spots, a phenomenon which is observed across Western Europe, especially in Britain and The Netherlands.

3. Manufacture and/or residential sites

Close to raw material, both debitage and bifacial tools present

All 14 key assemblages belong to this category since they contain a mix of the actual bifacial tools and their manufacture waste. Moreover, as argued by Claud (2008), these assemblages, all contain bifacial tools in various phases of manufacture. It is argued that at these sites bifacial tools were made and used, but also carried away to be used elsewhere and then brought back to be resharpened or reused for different functions. This model is especially useful in trying to explain the incredibly large amount of variation that can be observed at sites which contain very large amounts of bifacial tools (e.g. Le Moustier, Pech de l'Azé I, Haut de Combe Capelle, Saint-Julien de la Liègue, Sesselfelsgrotte and Lynford). This concept has also been applied to the KMG where Keilmesser variability is related to raw material characteristics and different stages of reduction (Jöris 2006).

Differential site functions can help explain certain aspects of Middle Palaeolithic variability, especially at a micro-scale, but not the larger spatial trends. This was for example illustrated in relation to the regional groupings identified in MIS-5 Northern France (Koehler 2009) where each entity comprised both short-term and long-term occupations. Sites which probably served different functions (e.g. short stop versus habitation) can have similar overall lithic characteristics (Koehler 2009). A similar situation can be envisaged for the Late Middle Palaeolithic bifacial tools where distinct types of bifacial tools are recovered in various quantities, in various environmental settings, in varying combination with other lithic tool types and technologies and this in relation to both site types 2 and 3. In sum, the MTA, MBT and KMG entities all comprise a sites with different characteristics which could have had various functions.

In this context, it needs to be pointed out that researchers must be cautious and aware of site formation processes when attempting to identify Palaeolithic site functions. At many localities taphonomic factors might have rearranged the original assemblage. Moreover, cave sites and surface collections frequently represent palimpsests, preventing individual occupation events to be distinguished. Despite these limitations, it is clear that site function can explain some of the differences between assemblages, especially with regards to the quantity of bifacial tools at a site. Conversely, site function does not provide a sufficient explanation for larger-scale regional patterns. Within large regions similar tasks would have been performed and therefore the consistent presence or absence of specific types of bifacial tools in this area cannot be explained merely by referring to site function.

8.3.3 Tool function

The function of a stone tool can be reconstructed through microscopic use wear analyses, as well as by assessing the overall concept of the tool, including its edge angles, active and non-active zones and potential prehensile modes. For the Late Middle Palaeolithic bifacial tools micro-wear analyses are limited but indicate that they could be used in a variety of tasks (for an overview see Chapter 3 and Table 3.2; Veil *et al.* 1994; Soressi and Hays 2003; Claud 2008, 2012; Rots 2009; Donahue and Evans 2012). This is confirmed by the dominant presence of edge angles between 35 and 65 degrees allowing a variety of cutting and scraping movements (Chapter 6; Table 6.19). Overall, within the MTA, MBT and KMG entities bifacial tools were used for butchery, wood and hide working activities. Moreover there does not seem to be a clear link between the type of bifacial tool and the activities performed.

The variable functional nature of the Late Middle Palaeolithic bifacial tools is also expressed in the diversity of their morphological and technological overall tool concepts (see Chapter 7, section 7.2.2). This variability mainly relates to the characteristics of the non-cutting sides of the artefact. Firstly, the morphology of the basal part varies from being blunt or unworked to being an extra cutting edge. The presence of a worked base is a feature which is common on triangular and *bout coupé* handaxes, specimens which have restricted geographical occurrences. The reason for the presence of this third cutting edge is currently unknown and is a feature of Late Middle Palaeolithic handaxes which is yet to be studied in detail.

Secondly, a conceptual difference seems to exist between the MTA, where the majority of the bifacial tools have a rounded base and two convergent cutting edges, and the KMG where tools with an opposition between one dominant lateral cutting edge and a thick blunt back dominate (see Chapter 7, section 7.2.2). The functional relevance of this observation can be questioned based on the assemblage of Grotte XVI (Soressi and Hays 2003) where the use-wear indicates the presence of a prehensile non-used edge on the MTA bifaces, which would suggest, at this site, that the tools were used in a similar way as the KMG backed knives. Regardless, the presence of a back is a feature that does stand out exclusively in KMG entities.

Conclusive information about the mode of prehension of bifacial tools is rather sparse. It is generally assumed that many pieces were handheld and this would not leave behind any visible traces (Claud 2008; Rots 2009). Hafting traces have been identified both on MTA handaxes (e.g. Pech de l'Azé I (Anderson-Gerfaud 1990)) and KMG bifacial tools (Rots 2009). Conversely, on several assemblages macroscopic and microscopic evidence indicates no evidence for hafting at all (e.g. at Grotte XVI for MTA (Soressi and Hays 2003) and at Lichtenberg for KMG (Veil *et al.* 1994).

Overall, Late Middle Palaeolithic bifacial tools were used in various ways for various functions and a lot of the detailed functional analyses are still in an early stage of development. Currently, differential uses can explain some of the variability at the micro-scale, although it is difficult to assess what came first, tool use of morphology. Conversely, these differential tool functions or uses cannot solely explain the larger trends. In all assemblages a combination of points and cutting edges with similar edge angles are present, indicative of similar functional needs. Moreover, in my opinion, it is most likely that both classic handaxes and backed bifacial knives were both used in handheld and fitted (hafted) fashions and the limited use-wear analyses also indicate no link between morphological type and function.

Therefore, the observed regional variability might indicate that groups responded to similar functional needs in slightly different ways, potentially expressed in differing overall tool concepts or prehension modes. However, different tool functions alone cannot explain the observed larger-scale variability patterns among Late Middle Palaeolithic bifacial tools.

8.3.4 Resharpening and use-life

Late Middle Palaeolithic bifacial tools are characterised by having extend use-lives. They are curated objects which were carried around in the landscape and repeatedly resharpened and recycled (Chapter 3, Section 3.4.2). This has been illustrated both by use-wear studies and by secondary retouch patterns, both for classic handaxes (Soressi 2002, 2004b; Soressi and Hays 2003; Claud 2008; Wragg Sykes 2009) and backed bifacial knives (Jöris 2006; Iovita 2008). It can be envisaged that this resharpening process had an important effect on the final form of the discarded bifacial tools.

The repeated reuse of bifacial tools can help explain the observed large amount of variability, especially for assemblages containing a large number of bifacial tools (see also section 8.3.2; Claud 2008). Moreover, within all assemblages a variety of forms are present. In relation to the KMG it has been argued that some of the *Keilmesser* forms do not represent distinct types but are part of a continuum of shapes representing different stages of resharpening (Jöris 2001, 2006). Conversely, the overall characteristics of the five main bifacial tool types remain distinct throughout the reduction process (e.g. presence of back); few transitional forms have been identified (p. 43); and do not allow to be explained away by a reduction continuum. Furthermore within the MTA shape maintenance has been observed regardless of size or further reduction (see Chapter 7, section 7.2.2; Iovita 2008, 2009, 2010).

In sum, resharpening can be seen as an important influential factor for the morphological variability observed amongst Late Middle Palaeolithic bifacial tools on a micro-scale. However, resharpening cannot explain the regional and macro-regional trends which were established throughout this PhD. The clear absence of backed pieces, triangular shapes or specific *bout coupé* forms in certain geographical areas cannot be explained solely by referring to resharpening trajectories and shape continuums.

8.3.5 Social transmission and culture

Within Late Middle Palaeolithic contexts culture is often brought forward in explanatory frameworks for lithic variability (Veil *et al.* 1994; Mellars 1996; Richter 2000; Soressi 2002; Jöris 2004; Depaepe 2007; Wragg Sykes 2009; Emery 2010; Koehler 2009; O'Brien 2010; White 2011). In my opinion, although the presence of different ethnic groups in the Mousterian, as Bordes once described (Bordes 1961), can generally be refuted, this does not mean that the whole idea of cultural variation should be abandoned. An important, and often neglected, factor is the exact definition of culture in this context (Dibble *et al.* 2006). As set out in Chapter 3, culture can be defined in different ways and in Palaeolithic contexts its meaning is often not made explicit. Therefore in this section it is explored which culture concepts are appropriate and relevant in explaining the larger-scale Late Middle Palaeolithic bifacial tool variability patterns.

Firstly, culture in an ethological meaning – *information acquired from other group members through learning or imitation that can lead to variation in behaviour* – is already present among non-human primates (Chapter 3) and can also be envisaged to be present amongst Neanderthal populations. Among the Late Middle Palaeolithic bifacial tools there is clear variation (Chapter 5, 6 and 7) and the making of bifacial tools can be seen as information that was learned from other group members (Noble and Davidson 1996; Lycett and Gowlett 2008).

The Culturally Mediated Migration (CMM) concept (Premo and Hublin 2009; Chapter 3) indicates that cultural differentiation across regional subpopulations was already present in the Middle Pleistocene, and hence also in the Neanderthal world. Moreover Premo and Hublin point out the possibility that boundaries and barriers between Neanderthal groups might have been reflected in the existence of distinct typo- and technological variation through time and across space. In this context, the MTA and KMG have been described as two different cultural units (Soressi 2002, 2004b, 2005). Cultural units hereby relate to the use of different methods and techniques to satisfy equivalent needs at the same time in neighbouring regions (Sackett 1990; Wynn 1996; McBreartry and Brooks 2000; Barham

2001). Furthermore, Soressi describes the MTA as a technical tradition transmitted from generation to generation (Soressi 2004b). This all implies that a link between the regional variation observed amongst Late Middle Palaeolithic bifacial tools and different lines of social transmitted information seems conceivable and worth exploring further.

Culture in an anthropological sense implies – *a system of knowledge present within a group that rests on the presence of shared conventions or norms.* For the Late Middle Palaeolithic the presence of culture in an anthropological meaning is regularly mentioned and this in various contexts by various authors (Richter 2000; Jöris 2004; Depaepe 2007; Koehler 2009). Variation in lithic technology is hereby interpreted as the reflection of different cultural groups or traditions which made bifacial tools according to different group norms. Richter for example identified several social memory units in Late Middle Palaeolithic Europe (Richter 2000). Social memory is hereby defined as "the *ability of a group of humans to maintain a specific set of information by means of tradition over many generations*". The MTA and KMG are seen as two different Social Memory Units, two different pools of inherited skills which occur in specific exchange networks (Richter 2000).

Crucial to the use of these anthropological definitions of culture is the presence of shared group norms. In my opinion, this is a difficult concept to identify in the Palaeolithic archaeological record for which stone tools are the main information source. It not only assumes that the final forms in which stone tools were discarded reflect such group norms, it also implies that such norms were initially imposed on the flint knapping methods and their results. Middle Palaeolithic debates on culture should therefore not merely focus on this ambiguous concept.

Another relevant notion that recently has been brought forward in debates about culture in the Palaeolithic is the distinction between cultural performances and cultural capacities (Haidle and Conard 2011; Chapter 3). Based on the Late Middle Palaeolithic spatio-temporal units identified here, what cultural capacity can be envisaged for Neanderthals? A *composite or cumulative cultural capacity*, relating to the combined use of different objects into single units, is clearly present among Neanderthals. This is indicated by the use of both compound adhesive and hafted tools; e.g. birch bark pitch at Königsaue (Grünberg *et al.* 1999; Mania 2002b) and Inden-Altdorf (Pawlik and Thissen 2011), bitumen at Gura Cheii-Rânov Cave (Romania) (Cârciumaru *et al.* 2012) and hafting traces at for example Sesselfelsgrotte (Rots 2009).

Therefore the main question relates to the identification of the next step of cultural capacity, a *collective or communal culture*, which relates to the awareness of a group identity, potentially expressed in the archaeological record by complementary tool sets and communication tools (Haidle and Conard 2011). Examples of complementary tool sets, such as bone and arrow, are absent (or invisible) in the Neanderthal archaeological record (Lombard and Haidle 2012). Conversely, potential communication tools, and ornaments in particular, do occur sporadically in the Middle Palaeolithic (Roebroeks *et al.* 2012; Zilhao 2012) and their use seems to increase in Late Middle Palaeolithic contexts (d'Errico and Soressi 2002, 2006; Soressi and d'Errico 2007; Langley *et al.* 2008; Zilhao *et al.* 2010). The ways in which these ornaments were used remains unclear but recent studies of the pigments found in MTA contexts do not exclude their use in ornamentation contexts (Soressi and d'Errico 2007; Soressi *et al.* 2008).

Uthmeier furthermore proposes that cultural norms are reflected in Neanderthal tools but these artefacts were not used to communicate cultural identity (as quoted in Haidle and Conard 2011). He proposes that Neanderthals only showed a low degree of group identity which was moreover not deliberately addressed. In general, low population densities during the Middle Palaeolithic (see section 8.4) could have translated into low connectedness between groups resulting in a low survival rate of regional traditions, potentially causing archaeological invisibility (Kuhn 2012). Therefore, the cultural performance recognised in the archaeological record should be seen as separate from the cultural capacity of the Neanderthals as a species.

Overall, there is a growing body of evidence (see Soressi and d'Errico 2007; Langley *et al.* 2008; Mellars 2010; Peresani *et al.* 2010; Zilhao 2012; Morin and Laroulandie 2012 and references therein) which points towards the fact that Neanderthals had a collective cultural capacity. Bifacial tools, and especially handaxes, can be seen as potential carriers of related social and/or cultural information. The distinct regionally restricted occurrence of specific types of bifacial tools both on a macro-regional and regional scale can therefore be interpreted as another factor indicating the presence of cultural variation among Neanderthal groups. Regional differentiation can hence be seen as reflecting different traditions of social learning. The presence of enigmatic dominating tool types such as *bout coupé*, triangular or cordiform forms reflects shared norms in the making of these tools. It is difficult to assess whether these handaxes were used as communication tools or expressed a sense of group identity is but, in my opinion, this was definitely a possibility.

Further research into the use of pigments and the presence of symbolic behaviour in Neanderthal contexts is needed to provide further understanding of the emergence of regional time-space units and cultural variation amongst the Late Middle Palaeolithic bifacial tools. At present the data indicates that both the presence of different traditions of social learning and different group norms can be seen as important causes for the observed regional and macro-regional differences among Late Middle Palaeolithic bifacial tools.

8.3.6 Summary:

In this section it was argued that the regional differences among Late Middle Palaeolithic bifacial tools cannot be explained merely be referring to adaptations to local circumstances, such as differences in raw material, tool function, site function and/or resharpening trajectories. Although it is clear that all these factors play an important role in the overall final shape of each individual bifacial tool, another sphere of interpretation is needed to explain the distinct regional differences. Therefore, it is proposed here that culture, in the sense of traditions of social learning, is an important causal factor for the observed variability. Additionally, it is argued that Late Middle Palaeolithic Neanderthals had a collective culture capacity, as defined by Haidle and Conard (2011), and the appearance of regionalism among Late Middle Palaeolithic bifacial tools might provide a glimpse of different Neanderthal cultures, as defined by anthropology, relating to the existence of different shared norms and potentially group identities.

8.4 Linking Regional Differentiation and Population Dynamics

The regional trends observed amongst bifacial tools throughout MIS-5d to 3 cannot be solely explained in terms of adaptations to local conditions, but imply a degree of cultural variation among Neanderthal groups. Being able to recognise different cultural traditions in the archaeological record, even in its most basic sense – implying the existence of different traditions of social learning without any assumption regarding norms or identity – allows for further explorations of the dynamics between these populations. This section explores Neanderthal behaviour to see whether factors of population size, density, mobility, extinctions, migrations and interactions, can shed further light on the characteristics of the three-fold macro-regional MTA-KMG-MBT pattern (Chapter 7).

8.4.1 Population size and density

Several lines of evidence point towards a low population density for the Middle Palaeolithic. Firstly, biological and ecological studies characterise Neanderthals as top-level carnivores (Bocherens *et al.* 2001; Richards 2007; Richards *et al.* 2008) with a high basal metabolic rate and high daily energy expenditure (Churchill 2006; Macdonald *et al.* 2009). These high energetic requirements have furthermore been linked to a high residential mobility, shorter occupation time per site and a reduced effective foraging radius (Verpoorte 2006; Macdonald *et al.* 2009). A reduced foraging radius would imply a low population density (Roebroeks *et al.* 2011). Secondly, studies of Neanderthal mtDNA also indicate a small effective population size for Neanderthals (Hawks 2008) with estimates of fewer than 3,500 females (Briggs *et al.* 2009).

Exact estimates of Neanderthal population size and densities are very preliminary and even called a 'black art' by some (Kuhn 2012). Generally, they are based both on comparisons with densities of modern hunter-gatherer groups and data available from raw material transport distances. Based on neocortex size estimates Aiello and Dunbar envisage an average Neanderthal group size to be around 145 (Aiello and Dunbar 1993). Estimates for population densities moreover range from 0.386 to 2.00 per 100 km^2 (Richter 2006; Roebroekes *et al.* 2011). Extrapolated to the whole Neanderthal range (ca. 10 million km^2) this would imply a maximum population comprising between 38,600 and 200,000 individuals. For the study area of this thesis (ca. 1.1 million km^2) this would lead to a total Neanderthal population between 4,246 and 22,000 individuals and this number is probably an overestimation, since not all areas would have been continuously occupied. Based on raw material transport distances the foraging area per Mousterian group of 25 individuals has been estimated to be around 80–100km in diameter (Richter 2006). This is comparable to the calculations of Layton (in press) indicating a minimum community radius to be around 50km with a maximum of around 100km. Applied to the MTA this leads to a population estimate between 470 and 750 individuals and for the KMG between 1,240 and 1,940 (Richter 2006). Although these exact numbers are very preliminary, all estimates suggest a small population size and low density during the Late Middle Palaeolithic.

8.4.2 Neanderthal group mobility

Neanderthals are often described as highly mobile hunter-gatherers exploiting wide-ranging territories (Féblot-Augustins 1993; Mellars 1996; Gamble 1999; Fernandez-Laso *et al.* 2011). The mobility of Neanderthal individuals and groups is hinted at through an analysis of strontium signatures from Neanderthal fossils. Although this method is not yet flawless (Nowell and Horstwood 2009) initial results do confirm the mobile nature of Neanderthal life and its expanded foraging ranges (Richards *et al.* 2008; Verna *et al.* 2010).

A more indirect way of analysing Neanderthal mobility patterns is analysing the origins of the different types of raw material present at a site (Féblot-Augustins 1993, 1999, 2009; Gamble 1996, 1998 and 1999; Soressi and Hays 2003; Slimak and Giraud 2007). In general, Middle Palaeolithic assemblages contain a strong component of local raw materials, combined with a variety of artefacts which have been brought in over 15-20 kilometres, including both finished end products and preformed cores (Bourguignon *et al.* 2006; Meignen *et al.* 2009, see also section 8.3.1). This can also be deduced from the presence of marine resources inland (e.g. shells; Arrizabalga 2009). In Western Europe maximum transport distances are restricted to around 100km, while in Central Europe distances of around 200-300km have been reported (Féblot-Augustins 1993; Slimak and Giraud 2007). These large distances are in general still rather rare but do seem to occur more commonly in Central and Eastern Europe than in Western Europe.

Furthermore, several authors have demonstrated the portability of Late Middle Palaeolithic artefacts, which is also indicative of Neanderthal group mobility (Richter 1997; Soressi and Hays 2003; Wragg Sykes 2009, 2010). For example, it has been clearly illustrated for the British Mousterian that handaxes were transported over long distances (Wragg Sykes 2009, 2010). Assemblages occur which contain traces of handaxe manufacture but not the handaxes themselves, indicating their mobile and curated nature.

The curated nature of the MTA handaxes in Southwestern France came forward through a detailed study of the assemblage of Grotte XVI (Soressi and Hays 2003). The handaxes from this site are all made on non-local raw materials and the lack of manufacture debris indicates they were not made at his site location.

Currently, mobility patterns within the KMG are mainly based on lithic raw material provenance data. Most assemblages are predominantly made on local raw material (e.g. Buhlen (Jöris 2001), Lichtenberg (Veil *et al.* 1994) and Salzgitter-Lebenstedt (Pastoors 2001). Fewer assemblages contain bifacial tools made on a variety of raw materials, coming from numerous sources (e.g. Sesselfelsgrotte, Richter 1997). The curation potential of *Keilmesser* is indicated by the application of the para-burin technique. For example, at the site of Abri du Musée in Southwestern France para-burin tranchet spalls have been found in raw materials for which no tools are present, indicating that the *Keilmesser* themselves were carried around (Bourguignon 1992). Moreover, KMG bifacial tools also occur as isolated finds (Bosinski 1967) and together with raw material distances of over 200km this indicates the high mobility of the KMG groups.

Overall, different lines of evidence, including strontium analyses and raw material provenance data, indicate the highly mobile lifestyle of Neanderthal groups, including both the MTA and KMG entities.

8.4.3 Migrations and local extinctions

The Late Middle Palaeolithic period comprises several climatic fluctuations, including the extremely cold period of MIS-4 and the highly oscillating MIS-3 (Tzedakis *et al.* 2007; Chapter 2, section 2.2.2). The effects of these climatic changes, which would have inevitably affected resource availability, have been discussed by various authors in relation to Neanderthal population dynamics (Richter 2000; Depaepe 2007; Roebroeks and Hublin 2009; Bradtmoller *et al.* 2010; Roebroeks *et al.* 2011; Dalen *et al.* 2012; Davies 2012).

These climate-triggered population movements have also been hypothesised in relation to the internal variability observed both in KMG and MTA contexts. For the MTA this is most clearly expressed by the coinciding of the emergence of *bout coupé* handaxes with the recolonisation of Britain during MIS-3 (White and Jacobi 2002; White and Pettitt 2011). Some researchers have furthermore hinted at the arrival of different Neanderthal groups in Northern France after MIS-4 since the MIS-5 and 3 lithic assemblages are so distinct, with blade technology being restricted to MIS-5 (Depaepe 2007). For the KMG this has also been suggested in relation to the concept of '*proglacial dislocation*' (Chapter 7; Jöris 2002, 2004, 2006). Once again, the exact nature of these models needs to be tested by obtaining more dated assemblages but overall, it is clear that fluctuations in climate and environment would have impacted on Neanderthal groups. The presence of KMG elements as far south as the Dordogne (e.g. Abri du Musée) can potentially also be explained by population migration (see section 8.5).

Recently, it has been highlighted that Neanderthal populations could have responded in different ways to these changing environments, indicating a high probability of local population extinctions instead of mere migrations (Hewitt 1999; Hublin and Roebroeks 2009; Premo and Kuhn 2010). The classic view of Neanderthals migrating southwards during periods of climatic deteriorations tracking their habitats does not hold up when taking into account that populations were already present in the south. Moreover, recent hypotheses highlight that the local environment would not have sustained a large influx of Neanderthal groups. During the Middle Palaeolithic the carrying capacity of the environment is regarded as being low (Roebroeks *et al.* 2011) and it therefore can be envisaged that on a local scale Neanderthal populations became extinct several times and areas were repeatedly reoccupied (Fabre *et al.* 2009; Davies 2012; Kuhn 2012).

The occurrence of population migration and extinction is reflected in the genetic evidence. mtDNA evidence and low genetic diversity point towards a genetic population turnover during the Late Middle Palaeolithic (around MIS-5) in the Western part of the Neanderthal world, which would have been followed by a period of migration to the East (Hublin 1998; Briggs *et al.* 2009; Fabre *et al.* 2009; Dalen *et al.* 2012).

Finally, it needs to be taken into account that changes in Neanderthal behaviour and material culture as reactions toward climatic change are not always visible in the archaeological record. It has been argued that "*cultural change in Late Pleistocene Europe needs a very robust climatic signal before it becomes visible in the coarse-grained archaeological record*" (Bradtmöller *et al.* 2010). In general the temporal resolution of the Late Middle Palaeolithic record might still be too coarse to detect rapid climatic impact on cultural systems but it is clear that Neanderthal groups were highly mobile and both migrated and went locally extinct in response to climatic and environmental changes.

8.4.4 Population stability and interactions

Besides population size and density, the stability of a population also influences the interactions within and between groups, and hence the nature of the archaeological record. It can generally be envisaged that hunter-gatherer populations, including Neanderthal groups, underwent cycles of growth and decline (Boone 2002; Stiner and Kuhn 2006). Small, sparse groups of Neanderthals could imply loose social networks and potentially greater geographic diversity. Conversely, to leave a recognisable behavioural signal, information must be persistently passed on from generation to generation, which implies a certain degree of population stability (Kuhn 2012). Studies on population stability and their effects on material culture are not yet well-developed in Palaeolithic contexts. Reconstructing the stability of Neanderthal populations in general, and in relation to the Late Middle Palaeolithic time period in specifics, is therefore still difficult at the moment.

Dialogues about Middle Palaeolithic population interactions are often restricted to discussions relating to the potential contact between groups of Neanderthals and groups of modern humans (Conard 2006 and references therein; Green *et al.* 2010; Barton and Riel-Salvatore 2011). The contacts among Neanderthal groups themselves are much more sporadically discussed, and the evidence more difficult to reconstruct (Mellars 2004; Lalueza-Foz *et al.* 2010; Eriksson and Manica 2012; Rendu *et al.* 2012).

The existence of geographically distinct population groups is a feature already commonly observed amongst chimpanzee populations (Kamilar and Marshack 2011; Luncz *et al.* 2012 and references therein) and can also be demonstrated for Neanderthals. Firstly, palaeoanthropological studies indicate the existence of regional differences in Neanderthal skeletal features (Rosas *et al.* 2006). Secondly, genetic analyses point toward the presence of large distinct regional groups among European Neanderthals (Caramelli *et al.* 2006; Fabre *et al.* 2009; Dalen *et al.* 2012). The study of Fabre and colleagues for example distinguishes three different geographic groups of Neanderthals (Western Europe, Southern Europe, and Western Asia), and furthermore incorporates eco-geographical borders which could have had an impact on Neanderthal migration (Fabre *et al.* 2009). Thirdly, the macro-regional MTA-MBT-KMG patterning established in this thesis is another factor that can indicate the presence of distinct Neanderthal groups in Western Europe.

Studies into how these different geographically distinct Neanderthal groups would have interacted are still in an early stage of development. For example, recent zooarchaeological work interpreted the high densities of animal remains at the sites of Les Pradelles (reindeer) and Mauran (bison) as potential indicators of periodic aggregation sites for groups of people based on ethnographic comparisons (Rendu *et al.* 2012). Furthermore, the recent DNA study of 12 Neanderthals recovered from the site of El Sidron (Spain) hints at patrilocal mating behaviour because in contrast to the males, each of the females carried different mtDNA lineages (Lalueza-Foz *et al.* 2010). Changes in population interactions, including between groups of Neanderthals, have furthermore been brought forward as potential prime factors stimulating behavioural change (Mellars 2004). For example, it has been suggested that the climatic deterioration during MIS-4 would have led to more intense social interactions between Neanderthal groups in the most favourable areas, including Southwestern France (Mellars 2004).

Finally, ethnographic evidence can also be used to assess the nature of interaction between groups of hunter-gatherers. In ethnographic accounts inter-group exchange of artefacts, ideas and even people are a regular occurrence. Within the Neanderthal world it can be envisaged that interactions between different groups of Neanderthals would have been a necessity to sustain the overall Neanderthal population. No population group can survive in isolation (Birdsell 1967; Wobst 1974). The exact social processes that would have occurred between these Neanderthals groups are difficult to reconstruct, but in general a distinction can be made between:

1. **Direct contact or demic dispersals** can occur where populations have face to face contact triggered by population movements. In the archaeological record it is assumed that demic dispersals can be recognised by the transfer of a complete *chaîne opératoire*. All the production phases of the specific bifacial tool type will be present (Davies 2012).
2. **Indirect contact or acculturation** can occur and is defined as the social transmission (diffusion) of ideas from one population to another (Davies 2012). In the archaeological record this is reflected by the experimental application of specific aspects of a *chaîne opératoire*. Examples are the application of a new *chaîne opératoire* to local raw material, the transfer of only specifics aspects of a *chaîne opératoire* or the emulation of a tool type.

In my opinion, interactions between different groups of Neanderthals are very difficult to recognise in the Middle Palaeolithic record. Neanderthals seem to have flexible knapping strategies and standardised *chaîne opératoires* which are difficult to identify and hence so-called experimental applications, indicative of indirect contact, are nearly impossible to recognise in the Neanderthal stone tool record. Conversely, the presence of assemblages containing both KMG and MTA bifacial tools, and this especially in the area between the KMG and MTA core areas, hints at the potential contact between groups carrying MTA or KMG artefacts and the archaeological reflection of this contact (see section 8.5).

8.4.5 Summary

The different lines of evidence related to Neanderthal population dynamics allow for Neanderthals to be described as top-level carnivores with high daily energy expenditures who are furthermore characterised by:

- A reduced effective foraging radius
- A small effective population size
- A low overall population density
- A highly mobile lifestyle, which moreover includes frequent migrations, re-colonisations and local extinction which can be triggered by climatic oscillations
- The presence of regionally distinct groups, which moreover regularly interacted

The existence of different groups of Neanderthals can be correlated with the MTA-KMG dichotomy. These MTA and KMG entities should be seen as dynamic in nature, including both frequent migrations and local extinctions. The presence of KMG elements as far south as the Dordogne (e.g. Abri du Musée) but lack of MTA elements east of the Rhine can also be explained in term of population dynamics, more specifically, in relation to the larger size of the KMG population, the higher mobility of the KMG groups suggested by greater lithic transport distances and the more frequent southward movement of climate-triggered migrations. Finally, the presence of assemblages in between the MTA and KMG areas that contain a mix of both classic MTA and KMG bifacial tools indicates the potential interaction between these groups.

8.5 Discussion: A New Multi-scalar Interpretation of Late Middle Palaeolithic Bifacial Tool Variability

Throughout this chapter various aspects of the current understanding of Late Middle Palaeolithic Neanderthal behaviour were correlated with patterns observed through a new and comprehensive study of bifacial tools (Chapters 5, 6 and 7). In this section, the data and behavioural interpretations are linked up from three scales of analysis: the micro-scale (tool-type and assemblage level), the meso-scale (regional level) and the macro-scale (macro-regional level). It is assessed how Late Middle Palaeolithic bifacial tool variability can both be explained and interpreted in different ways based on the scale of analysis utilised. In addition to this interpretative exercise, the limitations of the data and subsequently the interpretations are pointed out in relation to each scale of analysis.

8.5.1 Macro-scale of analysis

At a macro-scale three main trends in Late Middle Palaeolithic bifacial tool variation were observed and these are now placed within their behavioural context:

1. The dichotomy between the MTA and KMG entities
2. The presence of a third entity – the Mousterian with Bifacial Tools (MBT) – located between the MTA and KMG core areas
3. The sporadic occurrence of KMG elements south and west from its core region.

1. MTA AND KMG: TWO DIFFERENT CULTURAL TRADITIONS

Data: The extensive study of Western European Late Middle Palaeolithic bifacial tools in this thesis allowed establishing a clear dichotomy between the MTA and KMG entities (Chapters 5, 6 and 7). Firstly, in terms of regional occurrence the KMG is centred in Germany and Central Europe while the MTA is concentrated in Southwestern France (Chapter 5) but also occurs in Northern France, Britain, Belgium and the Netherlands (Chapter 7). The Rhine River seems to act as a rough border between these two macro-regional entities. Secondly, in relation to the bifacial tool characteristics, the MTA contains a strong dominance of classic handaxes, while the KMG is characterised by a high occurrence of backed and leaf-shaped bifacial tools and an absence of these classic handaxes (Chapter 6). Thirdly, clear differences also exist between the two entities in terms of technological and typological concepts and variations (e.g. use of the para-burin resharpening technique Chapter 7). This MTA-KMG distinction holds up regardless of the classificatory frameworks applied and can hence be seen as a genuine pattern in the Late Middle Palaeolithic record.

Interpretation: Both KMG and MTA assemblages occur in wide geographic regions, each covering over 400,000 km^2. In both areas good quality fine-grained raw materials were commonly available and the vast majority of the bifacial tools are made on locally available flint and chert. The MTA and KMG each comprise various types of assemblages (e.g. large concentrations versus isolated finds) which are moreover located in varying topographic and environmental settings, including both open-air and cave sites. Although use-wear analyses are still limited, the current evidence indicates that the bifacial tools from both entities do not have morphologies restricted to a specific use and were commonly used for butchery, wood and/or hide working activities. Although differences in overall tool concepts and prehension modes exist, it is also clear that hafting occurred in both entities and that in general the Late Middle Palaeolithic bifacial tools were used in varying ways for multiple functions. They also commonly had long use-lives and a significant body of evidence points towards the fact that both MTA and KMG bifacial tools were regularly resharpened, re-used and recycled. When bringing together all these different lines of evidence it becomes clear that the macro-regional KMG-MTA distinction cannot be explained solely as adaptations to differing local contexts (section 8.3).

Instead, it is argued here that the macro-regional MTA and KMG entities reflect two distinct cultural traditions, in the sense of two well-defined spatial-temporal traditions of social learning (for definitions see Chapter 3 and section 8.3.5). Different ways of making bifacial tools were passed on from generation to generation in a uniform way, leaving behind distinct recognisable signatures in the archaeological record. This geographic diversity can also be linked to the fact that the boundaries of the MTA entity are closely related to natural borders (Pyrenees in the south, Massif Central in the southeast, Saône and Rhine rivers in the northeast). This does not imply these boundaries were impermeable but does imply they could have restricted the general movement of Neanderthal groups. The geographic distance between the MTA and KMG core areas; Southwestern France and Germany are over 1,000km apart; can further help explain the existence of different cultural traditions. As illustrated for non-human primate culture, there is a strong link between geographic proximity and the number of cultural traits shared (Kamilar and Marshack 2012). The geographic distance between these core areas implies that, in a sparsely occupied Neanderthal world, contact between these two regions would have been low, allowing the development of specific ways of making bifacially worked tools during both MIS-5 and 3.This east-west, KMG-MTA dichotomy, and the presence of larger-scale geographic groupings among Neanderthals can further be strengthened by palaeoanthropological, genetic, demographic and raw material provenance data (section 8.4).

Overall, this thesis suggest that it was a cultural habit to make either a handaxe or backed bifacial knife and this resulted in two different lineages of social transmitted behaviour. Culture hereby is in the first place meant in an ethological sense, as socially transmitted behaviour passed on from generation to generation in which variation can occur. Secondly, it is argued that the KMG-MTA dichotomy adds to the growing body of evidence towards a collective cultural capacity for Neanderthals, opening up the possibility that these differences also reflect differences in group norms or even a sense of group identity (section 8.3.5).

Limitations: The contemporaneous occurrence of the MTA and KMG entities during both MIS-5 and 3 is now well-established based on 38 dated assemblages (Chapter 2 and 7). The distinct nature of the bifacial tools from these two entities has been clearly demonstrated throughout this thesis to be genuine (Chapter 5 and 6). The main interpretive limitation therefore relates to the relatively low number of KMG sites, which are spread around Germany, compared to the MTA. But, in general, Germany is a well-researched area and even the discovery of few MTA handaxes in this area would not disprove this overall pattern and its interpretation as cultural variation. Furthermore, it should be emphasised that the macro-regional patterning in this thesis only relates to assemblages with bifacial tools, and at the same time a vast number of assemblages without bifacial tools were present as well, which can provide a different pattern of regional variation. Overall, this macro-regional pattern should be regarded as an overarching framework within which a lot more variability existed.

2. AT A CROSSROAD OF INFLUENCES: THE MOUSTERIAN WITH BIFACIAL TOOLS (MBT)

Data: Throughout this thesis the presence of a third macro-regional entity in the Western European Late Middle Palaeolithic record was established. This entity is present in Belgium, the Netherlands, Northern, Western and Eastern France and is characterised by the wide application of bifacial retouch to a variety of blanks, resulting in a large but varied record of bifacial tools, commonly including classic handaxes, backed and/or leaf-shaped bifacial tools (Chapter 5, 6). Based on a unifying study of metric, technological and typological criteria it was argued to abandon some of the previous regionally defined entities in favour of grouping these assemblages with a variety of bifacial tools under the label 'Mousterian with bifacial tools' (MBT) (Chapter 7). Analyses throughout this thesis allowed for the first time to establish the existence of this entity from a pan-European perspective, together with a detailed characterisation of specific typo-technological features (Chapter 6 and 7).

Interpretation: In line with the MTA and KMG, the macro-regional occurrence of the MBT entity does not allow for an interpretation solely based on local adaptive factors. I would argue that this entity is not a third cultural tradition but rather emerged as the result of contact between KMG and MTA groups. While geographic distance provokes cultural variation, geographic proximity reduces this variation. The 'mixed' MBT assemblages seem to cluster in the Meuse, Yonne/Seine/Vanne and Saône river systems, located in between the MTA and KMG core areas. It can be envisaged that small, highly mobile groups of KMG Neanderthals would come in contact with other groups of Neanderthals while moving southwards, potentially in response to climatic changes (Fig. 8.1). Additionally, the movement of Neanderthals with MTA handaxes northwards is also illustrated by the re-colonisation of Britain during MIS-3 with the distinct *bout coupé* handaxe tradition. Therefore the area of Belgium, the Netherlands and the northern half of France (including Western France, Central France and Eastern France) can be seen as a transition or border zone at a crossroad of influences.

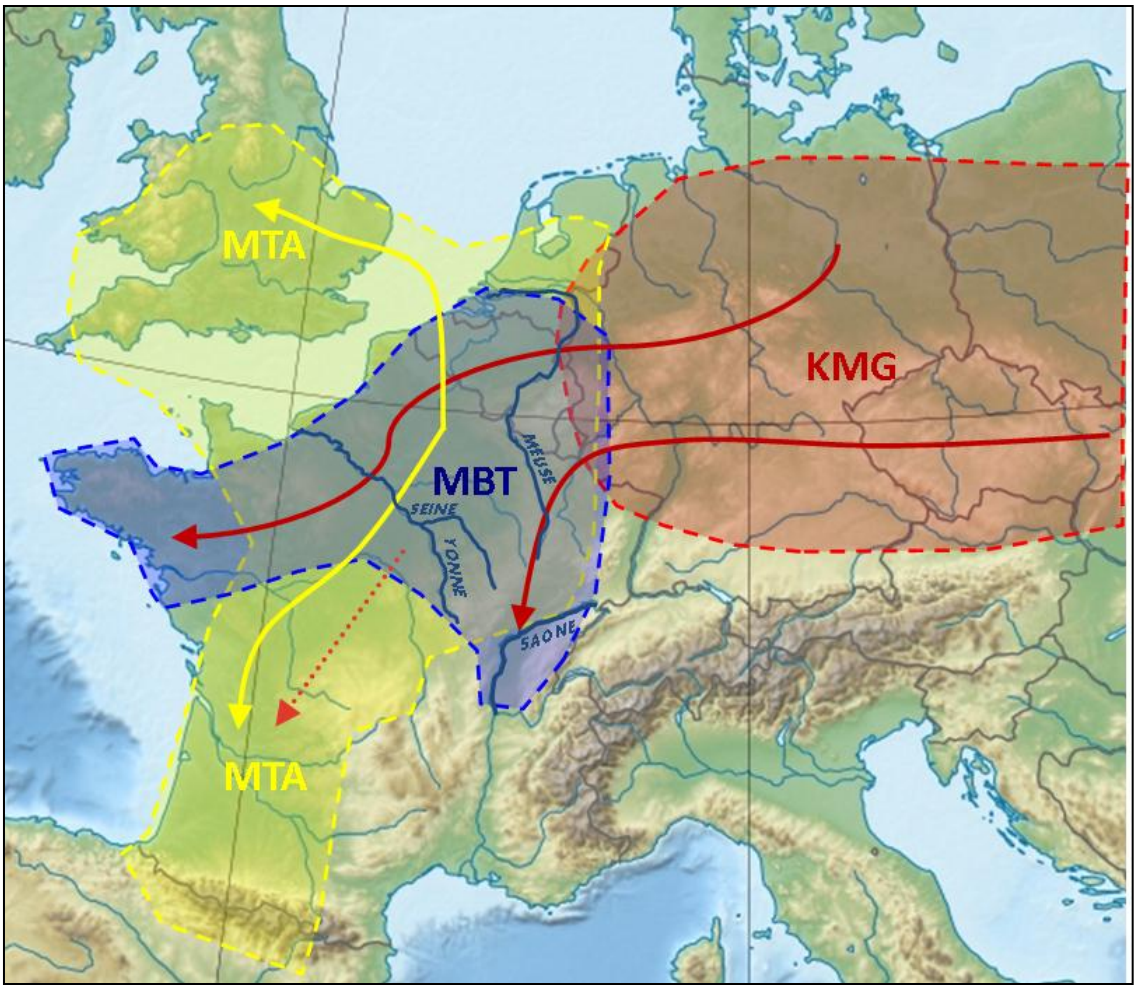


Fig. 8.1: *Map representing the different geographical distributions of the Mousterian of Acheulean Tradition (MTA), Mousterian with bifacial tools (MBT) and Keilmessergruppe (KMG) entities as well as potential directions of population migrations (as indicated by arrows)*

In this MBT area influences from both the south and east would have been more easily absorbed. The passing through of these different influences resulted in assemblages containing a more varied record of bifacial tools, including both MTA classic handaxes and KMG backed bifacial knives. The mixed nature of these assemblages seems to indicate that it is not a third cultural tradition rather that a less strict or less developed lineage of socially transmitted behaviour was at play in this area, adopting the various influences. Because of the varied nature of these bifacial tools, and the fact that each bifacial tool type can be produced on a variety of blanks, it is difficult to assess if we are dealing here with direct or indirect contact, the exchange of ideas and/or artefacts. In my opinion, it is most likely that a combination of all these processes took place.

Limitations: The main restriction with the interpretation of the MBT entity is the problematic lack of contextual information for many assemblages coming from this transition zone. In the first place, this relates to the scarcity of chronological information. Based on the presence of MTA and KMG assemblages in both MIS-5 and 3 it can be anticipated that MBT assemblages also occurred throughout the entire Late Middle Palaeolithic. Currently, few assemblages have been dated (Chapter 7) and more radiometric dates are a requirement to come to a better understanding of this entity. Secondly, several of the MBT assemblages were either recovered from the surface or from palimpsestual cave contexts, allowing their integrity to be questioned. Conversely, their presence is also known from more straightforward contexts such as at the open-air site of Oosthoven and Champlost (Chapter 5). The taphonomic integrity of each individual assemblage needs to be carefully examined before assigning it to this 'mixed' entity.

Another limitation relates to our current understanding of Neanderthal social life and population dynamics, including migrations and interactions. Based on the current coarse-grained Middle Palaeolithic record it is difficult to assess if these MBT assemblages can be related to the movement of people, ideas or both. Overall, interpreting the MBT as resulting from a transition or overlap zone is an idea that fits the current archaeological record. Further supportive data is needed to consolidate this trend in the future, especially in relation to more contextual data and radiometric dates for Late Middle Palaeolithic bifacial tool assemblages from the Netherlands, Belgium and Eastern France (e.g. on-going work at Sint-Geertruid, Oosthoven, Pont-des-Planches and Germolles).

3. THE WIDESPREAD DISTRIBUTION OF KMG ELEMENTS: POPULATION MOVEMENTS?

Data: MTA handaxes only occur very sporadically east of the Rhine River (Chapter 7). Several isolated find spots are known, especially in Western Germany (Chapter 5), and few handaxes occur infrequently in larger assemblages such as Wahlen and Salzgitter-Lebenstedt (Chapter 5). It is clear that classic MTA assemblages, with large numbers of handaxes and an absence of other bifacial tools, are not present in Germany or the rest of Central Europe. Conversely, KMG bifacial tools occur on a more regular basis outside of the KMG core area, and this as far south as the Dordogne (e.g. Abri du Musée (Chapter 5)). Backed and leaf-shaped bifacial tools occur in poorly understood surface collections (e.g. Mont de Beuvry) as well as in recent excavated sites (e.g. Pont-des-Planches), in open-air localities (e.g. Oosthoven) as well as in stratified caves (e.g. Germolles) (Chapter 5). The analyses here show that these widespread occurrences are not related to epistemological issues but are a genuine phenomenon. Moreover it was demonstrated that this relates to the spread of both typological features (backed and leaf-shaped bifacial tools) and technological aspects (use of backed blanks and para-burin technique) (Chapter 6).

Interpretation: The absence of classic handaxes east of the Rhine River implies that the making of these handaxes was not part of the culture, or socially transmitted information, present in this area. Contrastingly, only few classic KMG assemblages are present in Southwestern France, and these are not without contextual problems (e.g. La Micoque). Therefore it can be concluded that the making of backed and leaf-shaped bifacial tools was not common practice in this area. The distribution outside of Germany, of these few KMG assemblages and a larger amount of assemblages with KMG elements (as illustrated by the MBT), does require a behavioural explanation and can be linked to current models of population movements and interactions.

In general, the creation of 'hybrid' material culture can be the result of a variety of processes, most often including the transmission of either ideas (acculturation) or people (demic diffusion) (Chapter 3). The presence of an isolated, classic, although undated, KMG assemblage as far south as the Dordogne region seems to imply demic diffusion rather than acculturation. This because the complete *chaine opératoire* is present, without traces of experimentation, although these might be difficult to recognise in the stone tool record. Conversely, the regular presence of KMG elements in the MBT overlap zone, can rather be seen as the result of both acculturation and/or demic dispersal.

It can therefore be envisaged that small, mobile KMG Neanderthal groups would make southward movements, commonly passing through the MBT region but only sporadically making it as far south as Abri du Musée (Fig. 8.1). The dichotomy between the wide-spread KMG elements and more restricted distribution of classic handaxes might be related to the higher mobility of the KMG populations (as indicated by raw material transport distances) as well as to the fact that climatic deteriorations would make movements southward more common, although northward movements were also possible as indicated by the MIS-3 re-colonisation of Britain.

Limitations: Chronological information in relation to the spread of KMG elements south of Germany is sparse. At present two classic KMG assemblages have been excavated in the Dordogne: La Micoque (layer N/6) and Abri du Musée. Both of these collections are undated and therefore interpretations in relation to the material found here, and potential population movements, should be made cautiously. The presence of KMG elements on a sporadic basis all over Belgium and France is well established (Chapter 5) but many of these assemblages come from problematic contexts, making interpretations preliminary. Concentrations in the Meuse, Vanne and Saône river valleys could moreover reflect research intensity rather than a real density in the archaeological record. Finally, the two behavioural concepts, the higher mobility in Central Europe and the link between these southwards movements and climatic deteriorations, are preliminary and require further testing against more data.

8.5.2 Meso-scale of analysis

At a meso-scale, analyses focused on the identification of further spatial and temporal trends within the three established macro-regional entities.

Data: Throughout this thesis is was illustrated that regionalism in the Middle Palaeolithic record not only relates to macro-regional trends but is also expressed by the restricted spatial distribution of certain bifacial tool types within these macro-regional entities. While macro-regional distinctions were notable in metric, technological and typological aspects of the assemblages, further regional trends mainly seem to relate to variety within overall morphologies (Chapter 7).

Within the KMG a lot of variability exists among the bifacial tools, including the presence of seven *Keilmesser* sub-types, and several, especially temporal trends, have been argued to exist within this entity (Chapters 2 and 7). A reassessment here allowed to conclude that the current KMG record contains too few dated assemblages and too much epistemological confusion to sustain these trends. More data is also a requirement for the MBT, for which at the moment no distinct meso-scale trends are distinguished (Chapter 7).

Conversely, in the MTA three regional variants can be identified, typified by *bout coupé*, triangular and cordiform handaxe types. It was furthermore noted that these specific handaxe forms always occur alongside a wider continuum of biface shapes but the overall regional differentiation between the dominant handaxe shapes, relating both to the absence and presence of certain types, is still clear. In Britain cordiform handaxes dominate and *bout coupé* forms are very common. Besides a few isolated examples the latter does not occur on a frequent basis in any other region and therefore makes the British record distinct. Triangular handaxes are a common occurrence in Northern France and are conversely absent in Britain and only occur in low numbers on Southwestern French sites. Cordiform types are by far the dominant type in Southwestern France although it needs to be noted that they always occur alongside a wide variety of ovate and discoid types.

<u>Interpretation</u>: How can this specific regional patterning in handaxe shapes be linked to Neanderthal behaviour? Firstly, this patterning cannot be explained solely by differences in raw material, resharpening, tool or site function but implies a level of cultural variation. In line with the macro-regional patterning these differences in handaxe forms can also be seen as reflecting different traditions of social learning. In my opinion these handaxes can be interpreted as flexible, multifunctional tools with a high curation potential perfectly suited for a highly mobile lifestyle but also ideal candidates to carry an amount of social information. If it is accepted that Neanderthals potentially had a collective cultural capacity (section 8.4) then these time-space units and the emergence of this more complex cultural geography during the Late Middle Palaeolithic favour the presence of shared norms or group identities in Neanderthal populations. The absence of meso-trends in the MBT can be related to this entity not being its own cultural tradition but a mix of influences. Conversely, it seems probable that clear spatio-temporal trends are present within the KMG (e.g. link between MIS-5 and para-burin technique) but requires a new up-to-date reassessment of the record through a uniform comparative methodological framework.

<u>Limitations</u>: Limitations at this scale of analysis are once again related to poor chronological control and the general coarse-grained nature of the Middle Palaeolithic record. Although *bout coupé* handaxes in Britain and cordiform handaxes in Southwestern France are clearly restricted to MIS-3, triangular handaxes seem to occur in Northern France during both MIS-5 and 3. Moreover, at the moment in other parts of Middle Palaeolithic Europe this type of well-defined spatio-temporal units are currently difficult to assign and it is difficult to assess if they are not present or obscured by larger aggregative trends. Especially in relation to the KMG more chronological control and more detailed

studies into the regional occurrences of the specific *Keilmesser* types are a must before such units can be defined.

Another important limitation relates to the question of inferring cultural meaning in an anthropological sense, from the Middle Palaeolithic stone tool record. I would agree with the statement that Neanderthal stone tools are, in general, influenced by a variety of processes which can often obscure their cultural value if any was even present at all. Conversely, while I accept these interpretive limitations I have tried to traverse these by using multiple, pan-European scales of analysis. I think that there are enough changes in the Late Middle Palaeolithic and enough clear trends among the Late Middle Palaeolithic bifacial tools in specifics, which I regard as having a realistic potential to carry social meaning, to suggest the presence of cultural variation.

8.5.3 Micro-scale of analysis

Analyses at the micro-scale of analysis focused on differential characteristics of the bifacial tools (Chapter 6), including intra- and inter-assemblage variability.

Data: Both among individual bifacial tools and within individual assemblages a large amount of variability was noted in the techno-typological characteristics of the Late Middle Palaeolithic bifacial tools (Chapter 6). All bifacial tool types are made both on nodules and on flake blanks and can occur in the archaeological record in a variety of sizes and with a wide range of outline shapes. Assessing the nature of the individual bifacial tools did allow for a more precise characterisation of the different bifacial tool types. Different technological and typological aspects are restricted to certain tool types (Text box 6.1). Furthermore three types of assemblages could be distinguished based on varying typo-technological characteristics (Text box 6.2).

Interpretation: In contrast, to the meso- and macro-scales of analysis, various aspects of the bifacial tool variability at this level can be explained by referring to adaptations to differing local conditions. Individual bifacial tools can therefore be seen as the result of a dynamic interplay of various factors such as the local environment (including raw material), site function, tool function, resharpening and the individual knapper's knowledge and skills, including learned cultural behaviour. The study of Late Middle Palaeolithic bifacial tools from this micro-scale does not allow further inferences to be made in relation to population dynamics but does indicate the flexibility of Neanderthal behaviour where they can obtain similar end products with varying methods and techniques.

Limitations: When analysing Late Middle Palaeolithic bifacial tools from a micro-scale it is easy to become overwhelmed in detail and lose perspective on the wider characteristics and trends. Moreover, studying assemblages from a local level resulted in the definition of more and more types and terms, complicating wider comparisons and risking to obscure genuine differentiation patterns.

8.5.4 Summary

Late Middle Palaeolithic bifacial tools exhibit a high amount of typo-technological variation and combined with past epistemological and comparative issues this created an inaccessible database at risk of obscuring genuine diversity trends. This thesis structured this variability by assessing the record through three different scales of analysis, allowing a fuller understanding of the variability, their causes and wider behavioural inferences.

While on a micro-scale local conditions had an important effect on the final characteristics of the bifacial tool, trends on the meso- and macro-scales require an element of cultural variation for them to be explained. On a macro-regional level this in the first place can be related to culture in an ethological sense, as learned behaviour transmitted over generations with the potential of leading into variation. Combined with the further occurrence of specific spatio-temporal units, as expressed by the existence of regionally restricted handaxe types, this can be seen as one more factor pointing towards a collective cultural capacity for classic Neanderthals, implying the existence of shared norms and potentially a sense of group identity.

Moreover, the wide-ranging spread of KMG elements and the occurrence of a 'mixed' entity, the MBT, allow for further inferences on Neanderthal population dynamics. It is argued here that the two cultural traditions MTA and KMG regularly came in contact in the MBT area, a crossroad where varying influences were readily assimilated. Moreover, KMG groups seem to have been highly mobile, frequently making movements west and south, potentially in response to climatic events. Sporadically, these demic diffusions of KMG groups made far south, explaining the sporadic presence of KMG assemblages in the Dordogne.

Overall, the way in which we can recognise cultural signatures and population interactions in the Middle Palaeolithic record is still in an early stage of development. Further work on the existing Late Middle Palaeolithic collections, in combination with new discoveries, will allow researchers to build up a more fine-grained picture of Neanderthal behaviour and hence the importance of collective culture and group interactions and migrations among these Neanderthal populations.

Chapter 9:

Conclusion

This thesis forms a new contribution to studies of Middle Palaeolithic variability using a new methodology and original primary data to assess typo-technological, spatial and temporal variability among Western European Late Middle Palaeolithic bifacial tool assemblages. Representing the first wider European perspective, it incorporates data from up to 80 lithic assemblages and through detailed primary analysis of the bifacial tools and subsequent contextualisation at various scales, has demonstrated:

1. The presence of distinct typo-technological characteristics both within and between bifacial tool types and assemblages (Chapter 6).

2. Differences in the spatial distributions of the Late Middle Palaeolithic bifacial tools; both the MTA and KMG are identified as distinct, but internally relatively homogenous, entities that border an area with considerable bifacial variation incorporating tool types and concepts from both these core regions and defined here as the 'Mousterian with Bifacial Tools' (MBT) (Chapter 7).

3. The interpretive shortcomings of merely focussing on local adaptive factors to explain variability; and hence the need for an additional sphere of interpretation, suggested here to relate to cultural variation (Chapter 8).

4. The potential effects of population movements and interactions on the occurrence and characteristics of specific bifacial tool types; whereby the MTA and KMG can be seen as two different cultural traditions and the Mousterian with Bifacial Tools as a border zone entity where influences from both the East and West were absorbed (Chapter 8).

Overall, this research was directed towards answering four main research questions and three sub questions:

RESEARCH QUESTION 1:

Is the MTA/KMG dichotomy the result of genuine differences in Neanderthal behaviour or an artificial creation caused by the existence of different academic traditions which analyse and interpret archaeological data in different ways?

The use of a new classification scheme for Late Middle Palaeolithic bifacial tools (Chapter 4) simplified and facilitated a typo-technological comparison of 14 key lithic assemblages. The same scheme was used to reclassify the bifacial tools from a further 66 published Western European Late Middle Palaeolithic assemblages (Chapter 5), overcoming previous epistemological and classification issues. Employing a consistent, uniform methodology and descriptive terminology highlighted genuine differences in bifacial tool distribution with:

1. A clear dominance of backed and leaf-shaped bifacial tools and near absence of classic handaxes east of the Rhine, equated to the KMG entity.

2. A dominant occurrence of classic handaxes and sporadic presence of backed and leaf-shaped bifacial tools west of the Rhine, correlating to the MTA.

This thesis has conclusively demonstrated that the MTA/KMG dichotomy does reflect genuine behavioural variation in the archaeological record, regardless of the classificatory framework, and the exact nature of this variation was further explored through the remaining research questions.

RESEARCH QUESTION 2:

What are the distinctive typo-technological characteristics of the bifacially worked tools present during the Late Middle Palaeolithic (MIS 5d-3; ca. 115-35 ka BP) in Western Europe (Germany, France, the Netherlands, Belgium and Britain)?

The database created for this study is unique amongst Middle Palaeolithic lithic analyses, collating 1,303 Late Middle Palaeolithic bifacial tools from different areas of Western Europe. Such a large dataset allowed for the first, and currently only, data-driven pan-European analysis and discussion of the typo-technological characteristics of these tools, illustrating that the amount of variability present at a site level (micro-scale) is larger than previously acknowledged (Chapter 5 and 6).

The vast majority of the bifacial tools are made on locally available fine-grained raw materials. Conversely, there is no preferred method for production with evidence for the common use of both form-shaping and flake blanks at most sites and in relation to most tool types. This created significant morphological variation. Beside diagnostic types, such as *Keilmesser*, *bout coupé*, cordiform or triangular handaxes a more varied record of bifacial tools co-exists (Chapter 6). However, several characteristics do occur that are more tool-specific, such as the extent of the retouch and the overall outline, including the presence or absence of a back (see Text Box 6.1 for a detailed discussion).

At an assemblage-level, through distinct typo-technological characteristics three main groups can be distinguished (Text Box 6.2):

1. Assemblages dominated by classic handaxes (>60%)
2. Assemblages characterised by a wide variety of bifacial tools, always including a certain amount of classic handaxes
3. Assemblages where classic handaxes are absent and backed and/or leaf-shaped bifacial tools are the dominant type.

The analyses throughout Chapter 6 provided a detailed characterisation of the Late Middle Palaeolithic bifacial tools, establishing the distinct nature of the five different bifacial tool types and the presence of three typo-technological assemblage groups.

RESEARCH QUESTION 3:

What patterns of spatial and temporal differentiation are identifiable amongst the Late Middle Palaeolithic Western European bifacial tools beyond the MTA/KMG dichotomy?

The presence of genuine spatial and temporal patterns was evaluated by reassessing previously identified chronological and regional differences. This study confirmed Late Middle Palaeolithic bifacial tools as distinct from their Lower Palaeolithic counterparts. They form an important component of the toolkit from MIS-5d onwards (Chapter 2, 5 and 7). Currently, 38 assemblages rich in bifacial tools can be securely placed within the MIS 5d-3 framework. In the Netherlands, Belgium and Western France there is a general lack of secure chronological data, not allowing for any temporal tendencies to be recognised in relation to the MBT. Conversely, it is clear that the MTA and KMG occur both during MIS-5 and 3, with no bifacial tool assemblages currently securely assigned to MIS-4. Too few KMG assemblages can be placed in time precisely to allow for elaborate models of internal variation to be sustained, in contrast to previous interpretations (Chapter 7). Conversely, the MTA occurrence in Britain and Southwestern France seems to primarily relate to MIS-3, indicating the presence of specific spatial-temporal units within the MTA.

From a macro-regional scale it was illustrated that the three different assemblage groups which were distinguished based on their bifacial tool characteristics (Chapter 6), also have distinct regional distributions. Differences between these entities relate to metric variability, the presence of specific technological concepts and different bifacial tool types and forms. A first distinction is made between:

Keilmessergruppe (KMG)
East of the Rhine river (Germany)
Metric: high amount of metric variability and high elongation values
Technological: common use of backed blanks and the para-burin technique, with the dominant tool concept relating to one blunt edge opposite a retouched cutting edge
Typological: dominance of backed bifacial tools (including various types of *Keilmesser*), bifacial scrapers and leaf-shaped bifacial tools

Mousterian of Acheulean Tradition (MTA)
West of the Rhine river (the Netherlands, Belgium, Britain, Northern and Southwestern France)
Metric: low amount of metric variability, low refinement and elongation values
Technological: dominance of tool concepts with two converging cutting edges, strong correlation between length and width, no backed blanks and no para-burin removals
Typological: dominant occurrence of classic handaxes and very low occurrence of all other bifacial tool types

This research also reassessed the validity of ten additional regional entities rich in bifacial tools currently distinguished in Western Europe, based on metric, technological and typological criteria (Chapter 7). It became apparent that when analysed at a pan-European scale several of these entities blend in, not sustaining their existence as distinct regional groups. Only typological criteria, relating to the dominant bifacial tool form, reflect meso-scale geographic trends. Currently, only the data within the MTA is fine-grained enough to allow regional distinctions, which can be seen between assemblages dominated by *bout coupé* handaxes (MIS-3 Britain), cordiform handaxes (MIS-3 Southwestern France) and triangular handaxes (MIS-5 and 3 Northern France) (Chapter 7).

Overall, this thesis is the first reassessment of previous spatial and temporal claims among Late Middle Palaeolithic bifacial tools, confirming the presence of the macro-regional MTA/KMG dichotomy but challenging the validity of the plethora of regional entities.

SUB QUESTION:

Are the so-called 'mixed' assemblages, which contain both KMG and MTA bifacial tools, a real phenomenon?

In addition to the MTA and KMG this thesis also recognised a third macro-regional unit within the Late Middle Palaeolithic bifacial tool record. This entity relates to assemblages previously described as 'mixed' and contains a more varied record of bifacial tools, including both classic handaxes and backed and/or leaf-shaped bifacial tools (Chapter 6). Moreover it was illustrated that this entity occurs in the Netherlands, Belgium, Northern, Western and Eastern France (Chapter 5 and 7). It is proposed to group these assemblages, which can, overall, be seen as a real phenomenon, under the term 'Mousterian with Bifacial Tools (MBT)'. This group has the following characteristics:

Mousterian with Bifacial tools (MBT)

Central part of study area (the Netherlands, Belgium, Northern, Western and Eastern France)

<u>Metric</u>: high amount of metric variability

<u>Technological</u>: wide application of bifacial retouch, variable tool concepts

<u>Typological</u>: variety of bifacial tool types, including both classic handaxes and backed bifacial tools

In general, this inter-regional comparative study has illustrated the existence of clear spatial trends in the typo-technological characteristics. This patterning occurred from MIS-5 onwards, continued throughout the Late Middle Palaeolithic time period, and is expressed mainly in relation to regional differences in bifacial tool types and forms.

RESEARCH QUESTION 4:

How can the presence or absence of macro-regional variability patterns in the Late Middle Palaeolithic record of Western Europe be interpreted in relation to wider Neanderthal behaviour?

The distinct nature of both the Late Middle Palaeolithic record and the bifacial tool type allow for specific inferences on Neanderthal behaviour to be made. This assessment was based on the three scales of analysis highlighted throughout this thesis, with each scale providing a unique perspective on observed variability and its causes, as well as different potential inferences in relation to Neanderthal population dynamics.

SUB QUESTION

What causal factors can help explain the observed regional differentiation?

It appears that a combination of factors can be used to explain the variability observed amongst Late Middle Palaeolithic bifacial tools. Henceforth, the Late Middle Palaeolithic record, and bifacial tools in particular, should be viewed as a dynamic interplay of various factors. These include, but are not restricted to, the local environment (including raw material), site function, tool function, resharpening and the individual knapper's knowledge and skills, including learned cultural behaviour. It is clear that local conditions, such as raw material, resharpening, tool and site function are an important causal factor and can explain much of the observed variability. However, at both the regional and macro-regional scale some of the variability cannot be explained through current frameworks relating to local conditions. For this level of variation, and at such different scale, a wider, and less easily observed, causal factor requires consideration; culture. At a macro-regional scale and with an ethological definition (see p. 277) the MTA and KMG could be interpreted as two different cultural traditions. Thus, the production of a classic handaxe or backed/leaf-shaped bifacial tool was a cultural habit.

From a regional perspective it is argued here that the occurrence of specific spatio-temporal units, as expressed by the existence of regionally restricted handaxe types, is a new corroborative indication to add to the growing corpus of evidence to suggest the existence of a collective cultural capacity amongst Neanderthals. For example the making of *bout coupé* handaxes can be seen as reflecting shared norms within that Neanderthal group and a potential sense of group identity.

SUB QUESTION

If a 'mixed' entity exists, how does it fit with different ideas on the dynamics within and between the MTA and KMG?

In contrast to the 'cultural units' of the MTA and KMG, the MBT does not represent a third cultural tradition but reflects the geographic position of this region on the border between the MTA and KMG. Hence, this zone, where east and west meets, illustrates a mixed assemblage where influences from both were more readily absorbed. The regular movements of both MTA and KMG groups are reflected by, for example, the spread of the MTA to Britain in MIS-3 and the occurrence of KMG elements as far south as the Dordogne. The exact mechanisms of the interactions between the different Neanderthal groups are difficult to reconstruct but it is argued here that potentially both direct and indirect contact took place.

A cultural discussion of Late Middle Palaeolithic bifacial tool distribution and variation helps to explain the presence of 'mixed' assemblages, the occurrence of isolated KMG types as well as the very sporadic presence of classic KMG assemblages outside of its core area (e.g. Abri du Musée).

This comprehensive study of Western European Late Middle Palaeolithic bifacial tools adds to debates both on the causes of stone tool variability as well as to discussions on Neanderthal behaviour, two topics with much room for further debate.

FURTHER WORK

This thesis is only a first step in gaining a more complete understanding of the complex nature of the Late Middle Palaeolithic, bifacial tools and Neanderthal behaviour. This work can be taken forward in various ways and some suggestions for future directions are discussed below:

Regional variability within the KMG entity

A new in-depth study into the regional trends among the KMG bifacial tools is called for. This could be achieved with the new methodological framework established in this thesis and would allow to examine the wide bifacial variability through a coherent typo-technological framework. Moreover, this could include an expansion of the study area further to the east.

Increasing chronological control

Establishing a more fine-grained chronological framework is a must to achieve a better understanding of the patterns observed here. An increase in dated assemblages would be welcome for the entire study area, but dating programmes should specifically focus on the area of the Netherlands, Belgium, Northern, Western and Eastern France, the Mousterian with Bifacial Tools (MBT) and the wide-spread sporadic occurrence of KMG elements. In these contexts good candidates for dating would for example be Oosthoven, Abri du Musée and Germolles.

The definition of the MTA and evolutionary links with the Chatelperronian

Further research is needed into the exact definition of the MTA entity and more specifically the occurrence of retouched backed knives in association with classic handaxes outside of

Southwestern France. This could shed new light on the geographic and evolutionary links between the MTA and Châtelperronian entities.

Regionalism among non-biface assemblages

More detailed studies are needed into the presence of distinct spatio-temporal trends in non-biface assemblages throughout the Middle Palaeolithic; e.g. in relation to blade technology (MIS-5 France), the Quina Mousterian (MIS-4) and the use of para-burin technique (e.g. at La Cotte de St Brelade and Mesvin)

Detailed studies of tool concepts and potential uses

Another area in which there is much scope for further work is the overall tool concepts present in the Late Middle Palaeolithic, their potential uses and modes of prehension. This could be achieved by incorporating detailed studies into active and non-active zones with innovative experimental studies.

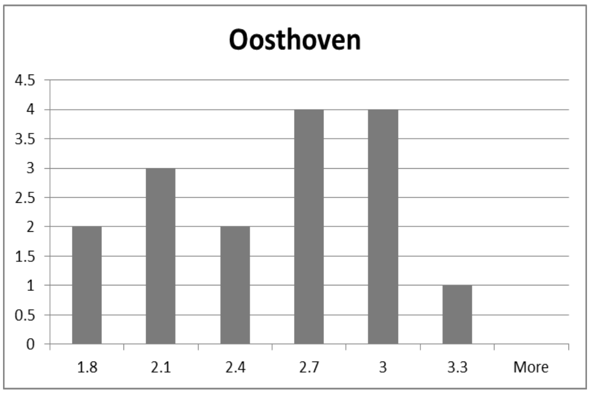
CONCLUDING REMARKS

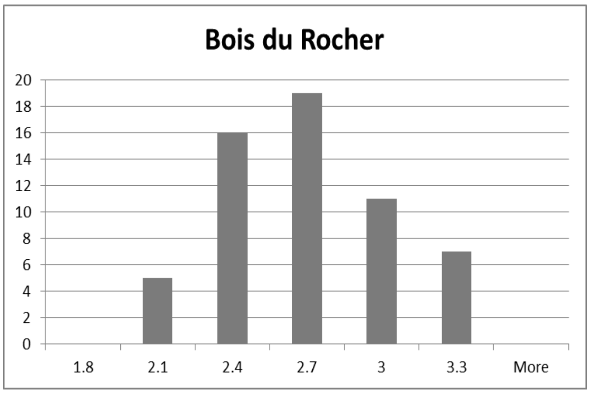
This thesis provided new insights into Neanderthal behaviour expressed through variability within the Late Middle Palaeolithic bifacial tool record. Not only was the presence of a three-fold macro-regional pattern established, this thesis also produced a unique multi-scalar behavioural explanation for the observed patterning. It is clear that the understanding of differential Neanderthal behaviour in the Late Middle Palaeolithic is only in an early stage of development. It can be anticipated that new sites will be discovered, new methodologies developed and new ideas brought forward, all allowing to provide further perspectives on the research problem at hand. With this thesis I hope to have triggered a widening of the debate, in favour of lesser studied areas, and allowed for a new glimpse into the interpretive potential of Late Middle Palaeolithic bifacial tools and its correlation with different aspects of Neanderthal behaviour.

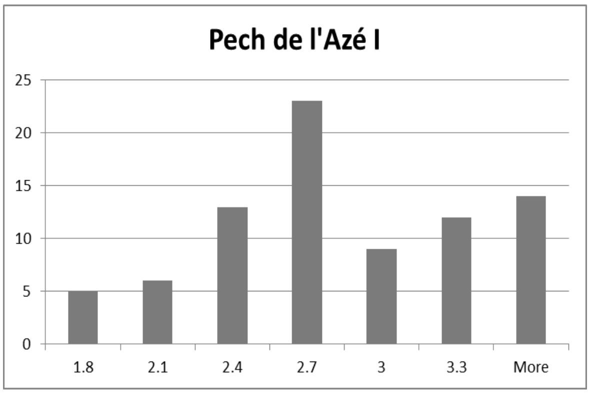
Appendices

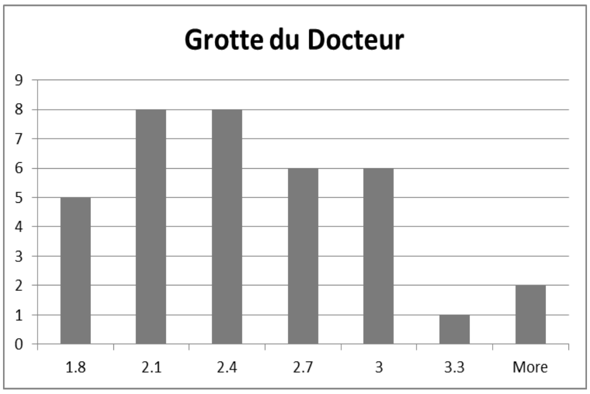
Appendix 1: Flatness Histograms by site

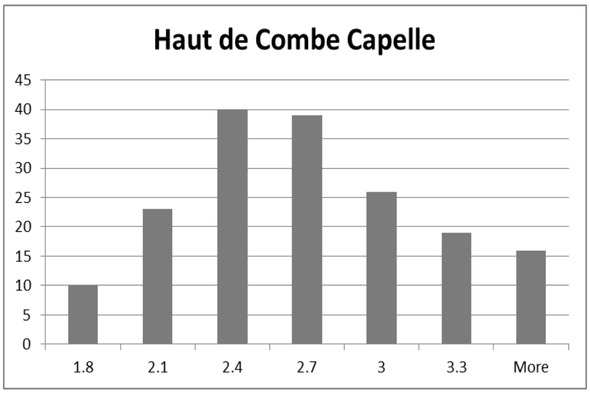
The flatness value, width divided by thickness, gives an indication of the original blank used to create a tool. Low values indicate a stocky appearance and can be linked to the façonnage or formshaping; high values indicate more refined, flake blanks (for a discussion see Chapter 6, section 6.3.2).

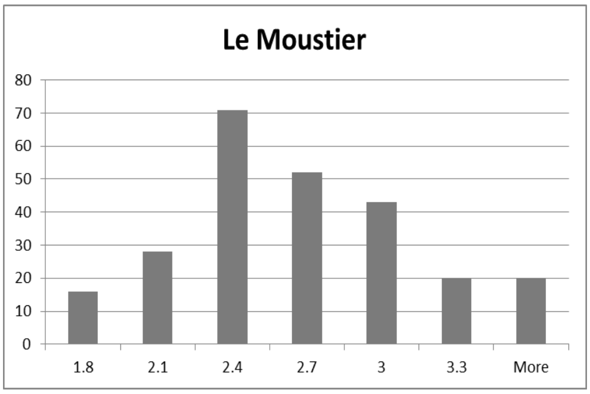


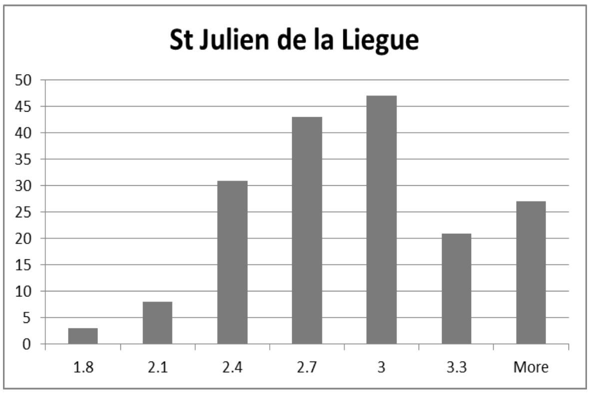








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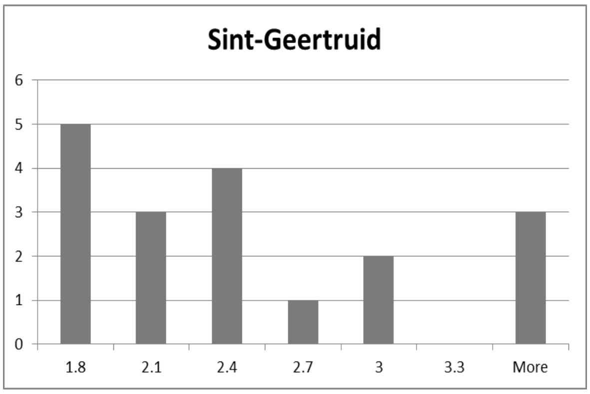
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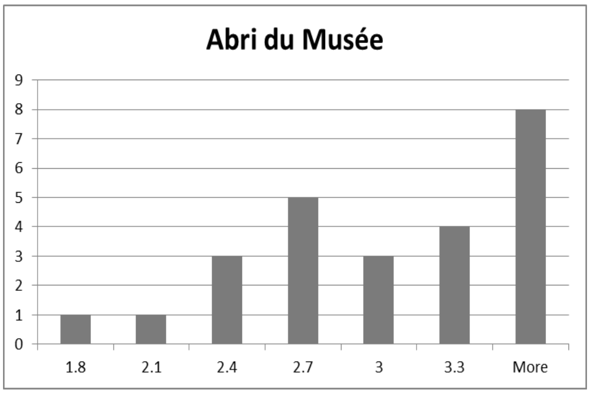
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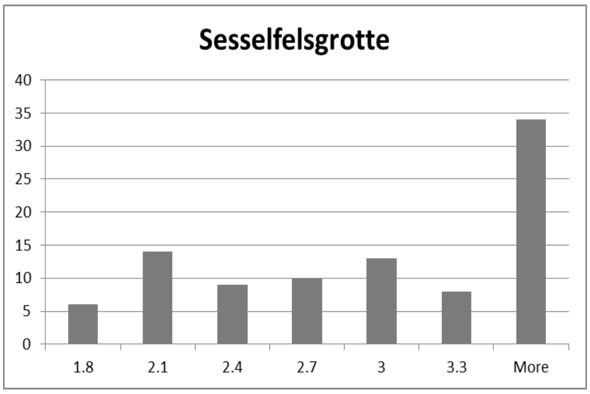
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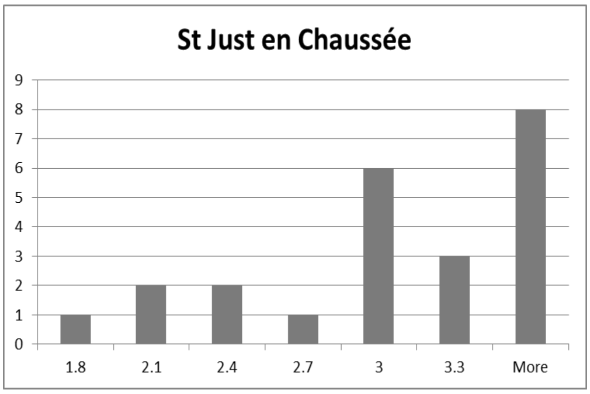
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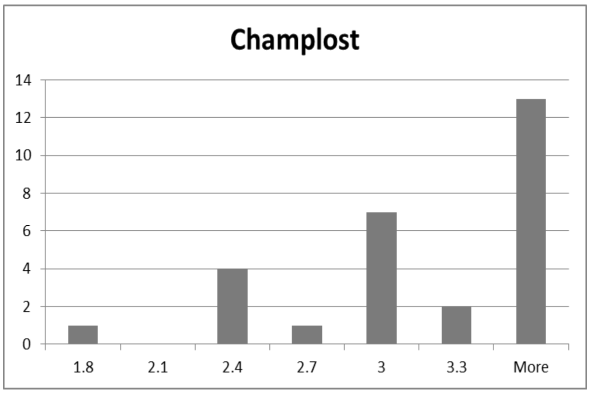
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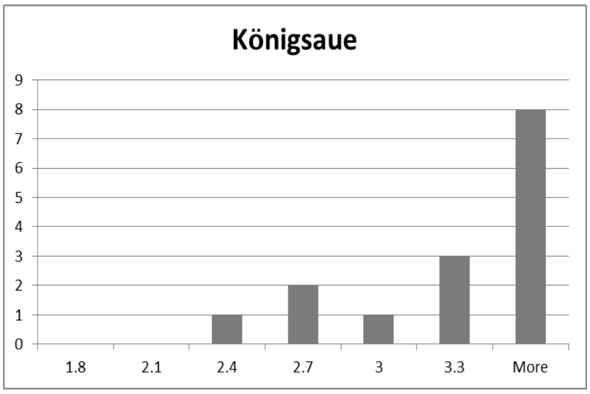
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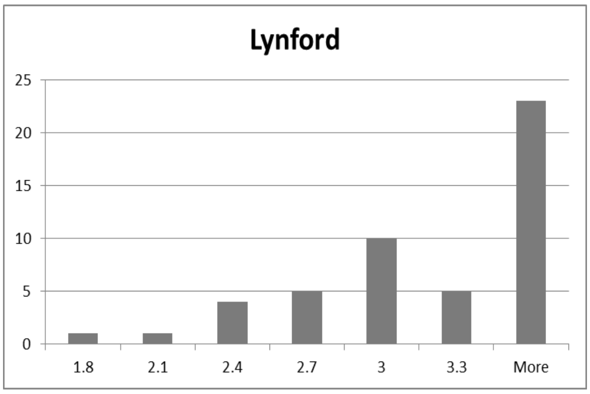
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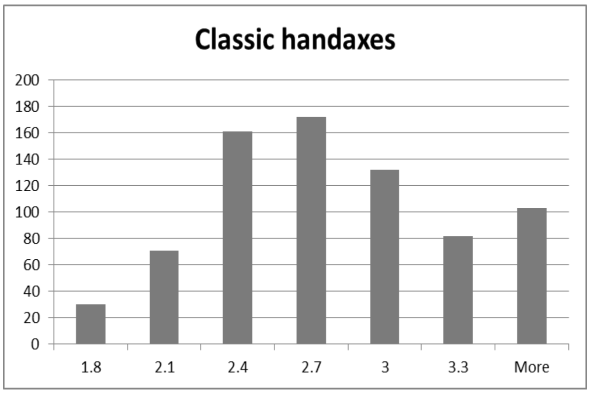
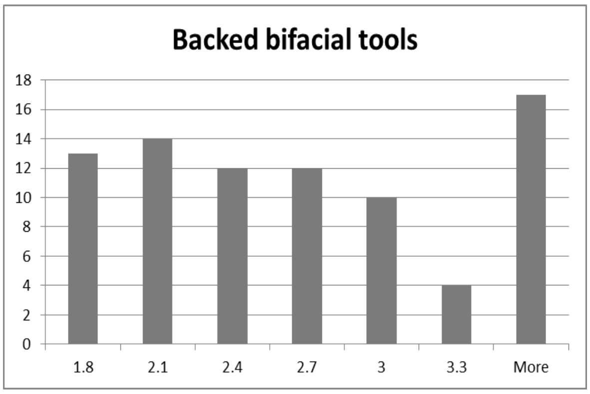
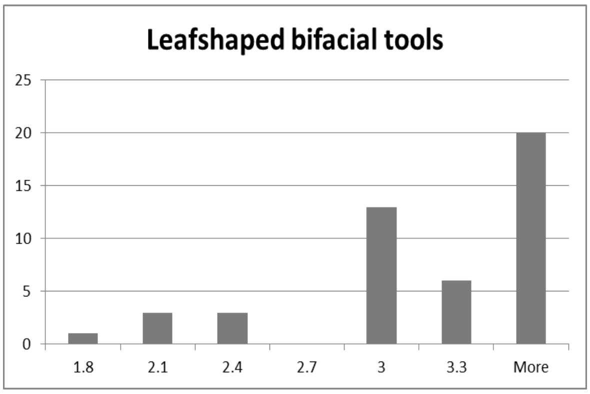
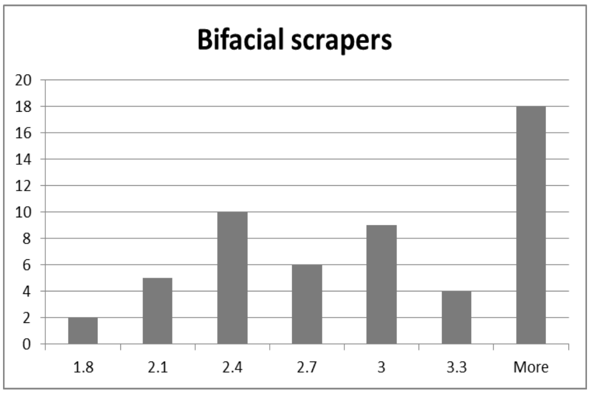
Appendix 2: Flatness Histograms by bifacial tool type

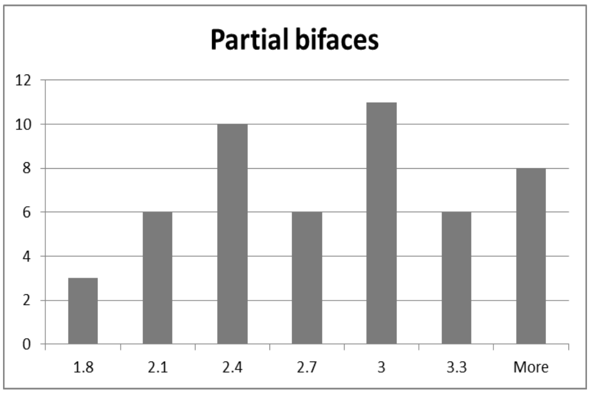
The flatness value, width divided by thickness, gives an indication of the original blank used to create a tool. Low values indicate a stocky appearance and can be linked to the façonnage or formshaping; high values indicate more refined, flake blanks (for a discussion see Chapter 6, section 6.3.2).





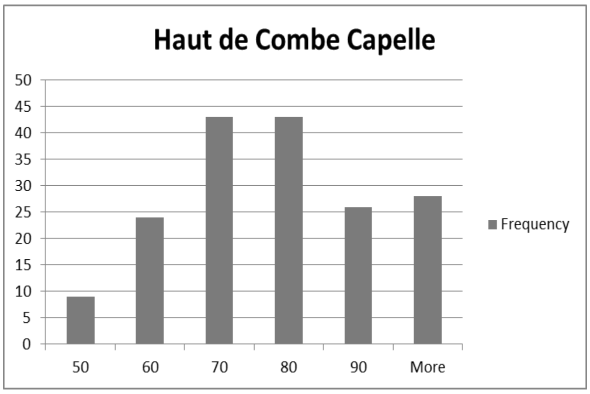


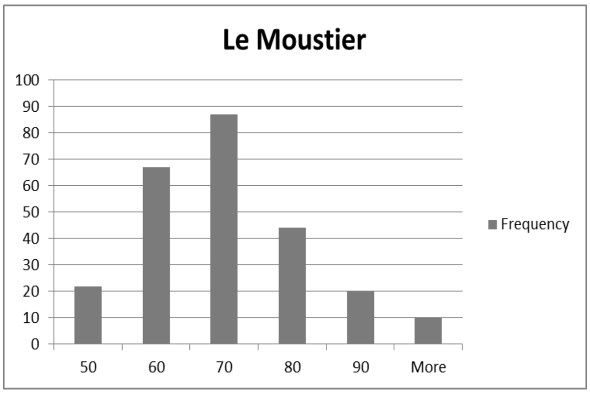


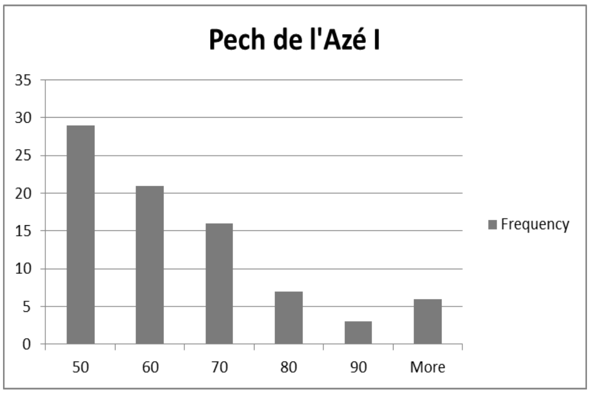


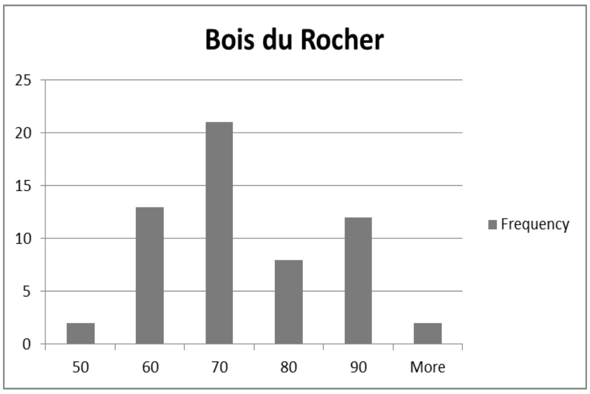
Appendix 3: Size histograms

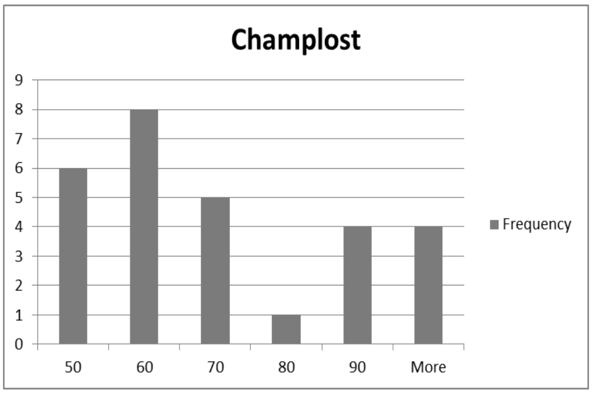
The metric variability within the assemblages can be assessed by looking at size histograms to indicate which size classes are most common in each assemblage. The below size histograms represent the maximum length of the bifacial tools, expressed in millimetre. For a further discussion on these values see Chapter 6 (Section 6.4.4).

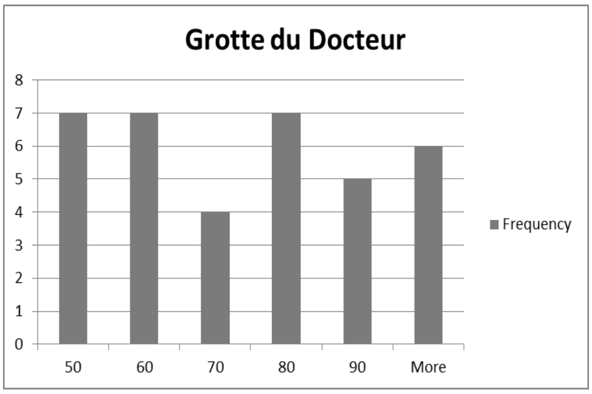


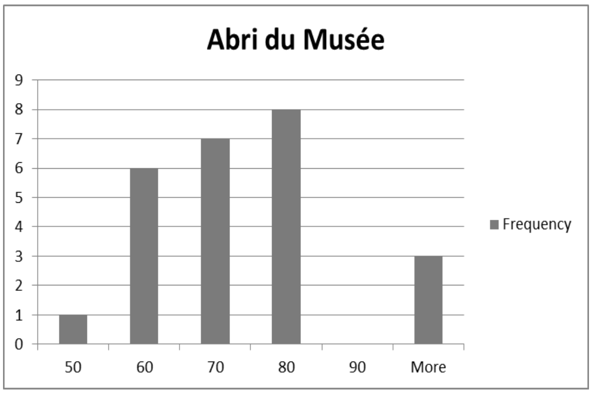


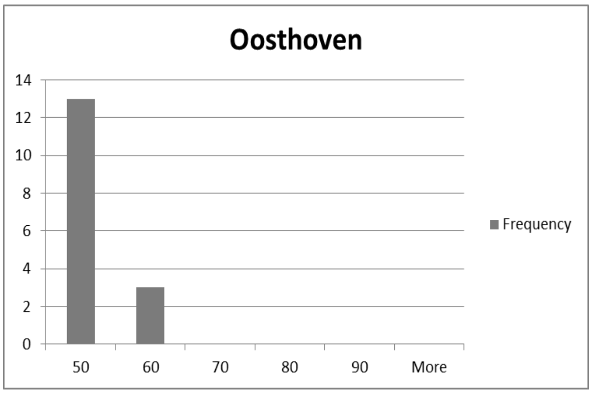


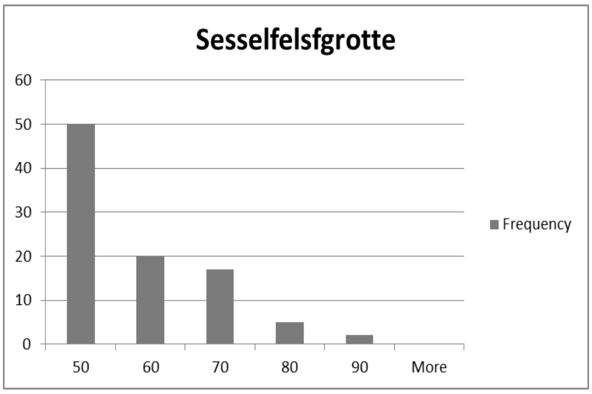


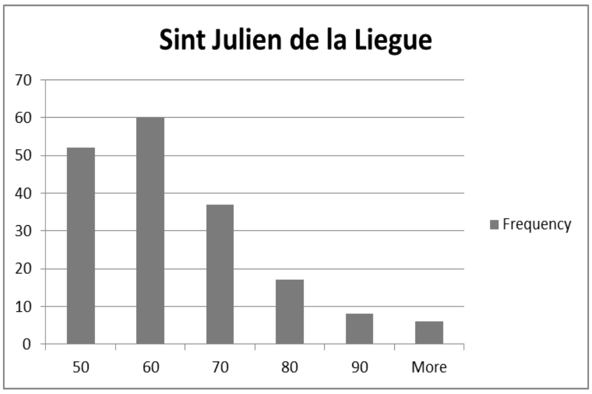


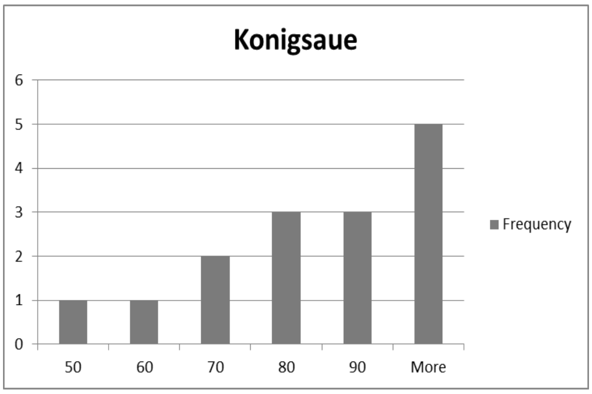


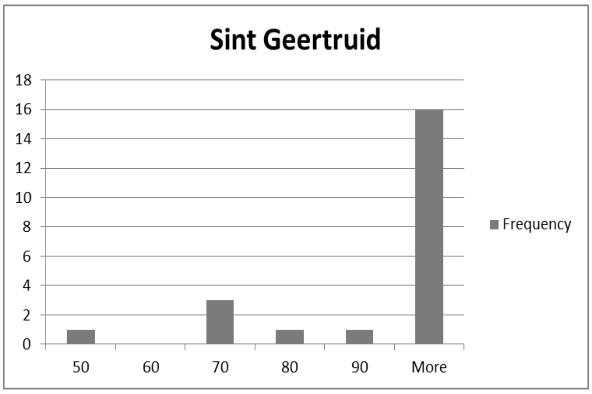


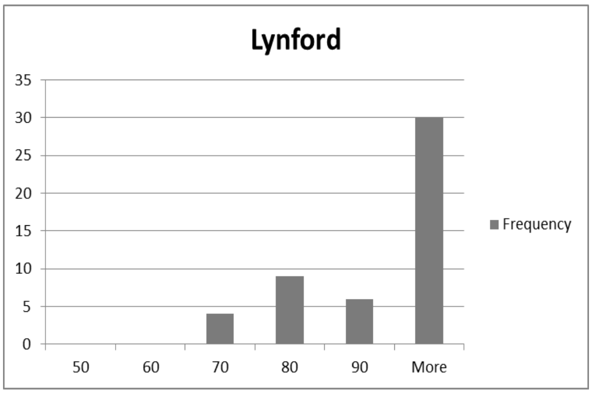

Oosthoven
14
12
10
8
6
4
2
0
50
60
70
80
90
More
Frequency

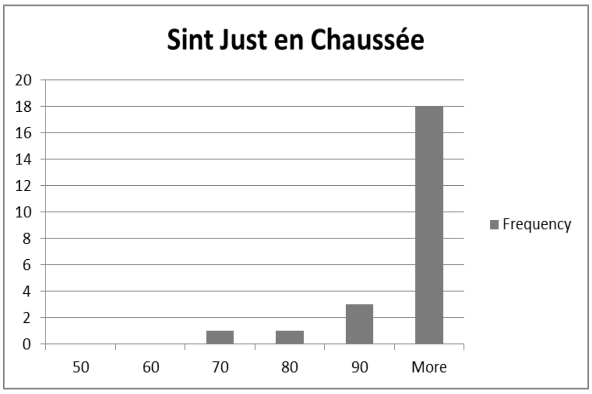

Sesselfelsfgrotte
60
50
40
30
20
10
0
50
60
70
80
90
More
Frequency


Sint Julien de la Liegue
70
60
50
40
30
20
10
0
50
60
70
80
90
More
Frequency


Konigsaue
6
5
4
3
2
1
0
50
60
70
80
90
More
Frequency

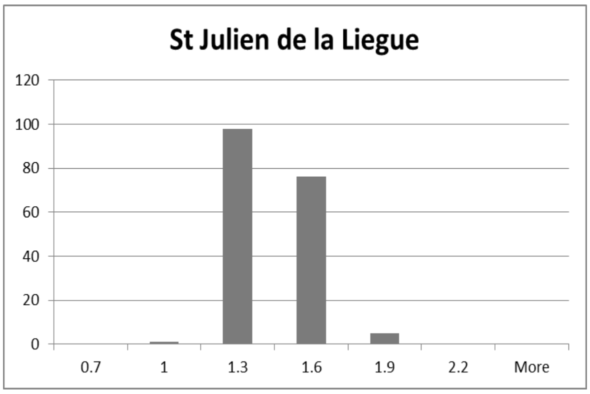

Sint Geertruid
18
16
14
12
10
8
6
4
2
0
50
60
70
80
90
More
Frequency

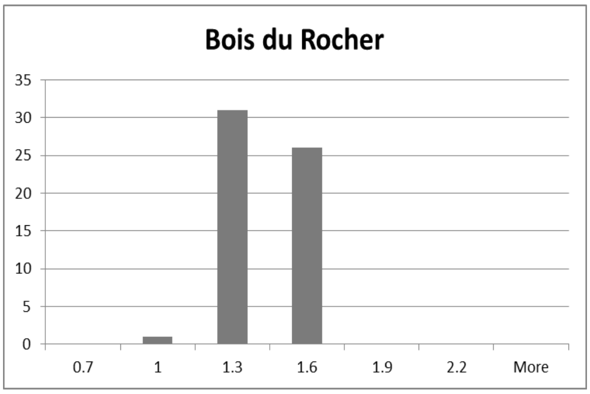

Lynford
35
30
25
20
15
10
5
0
50
60
70
80
90
More
Frequency

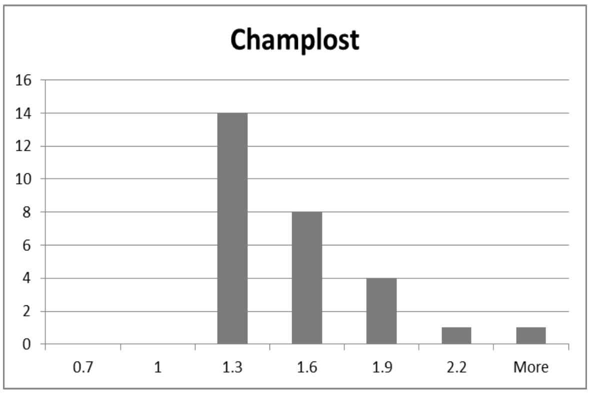

Sint Just en Chaussée
20
18
16
14
12
10
8
6
4
2
0
50
60
70
80
90
More
Frequency

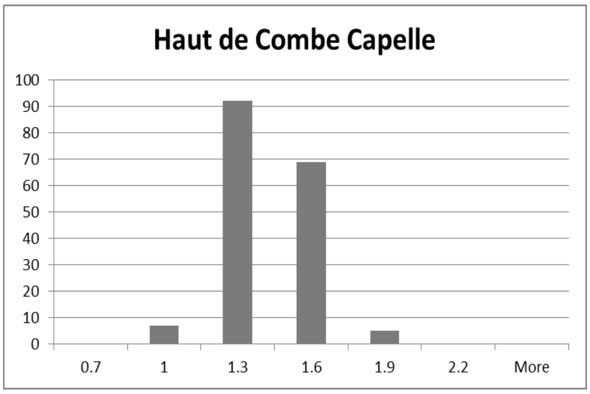
Appendix 4: Elongation Histograms by site

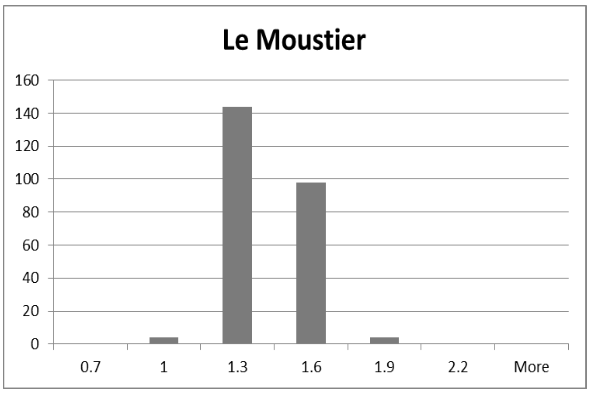
Patterns of metric variability can be explored by comparing histograms for elongation (Appendix 4), indicating differences both within and between assemblages (for a discussion see Chapter 6, Section 6.4.4).

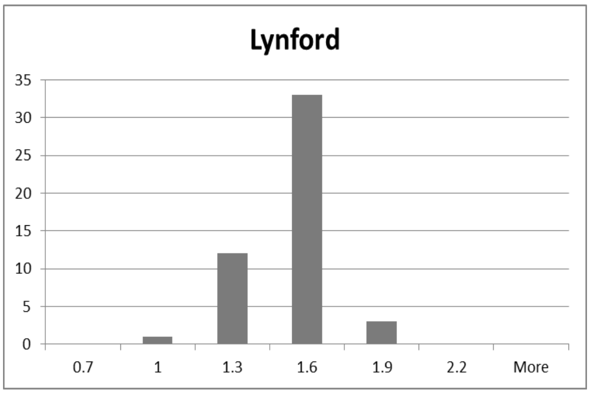


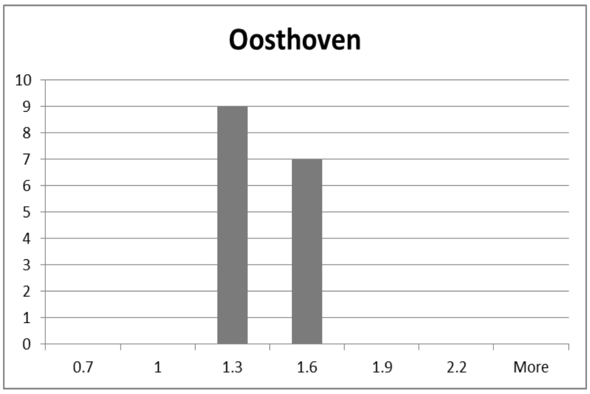


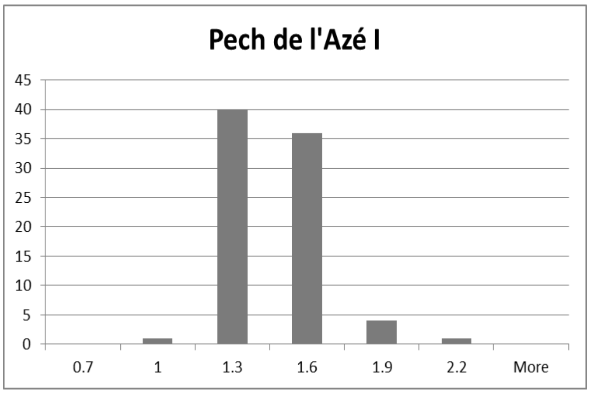


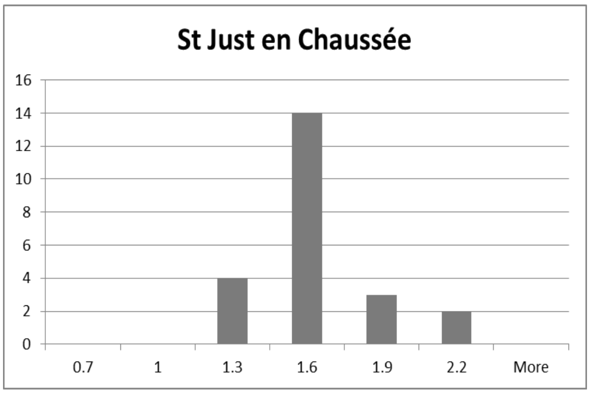


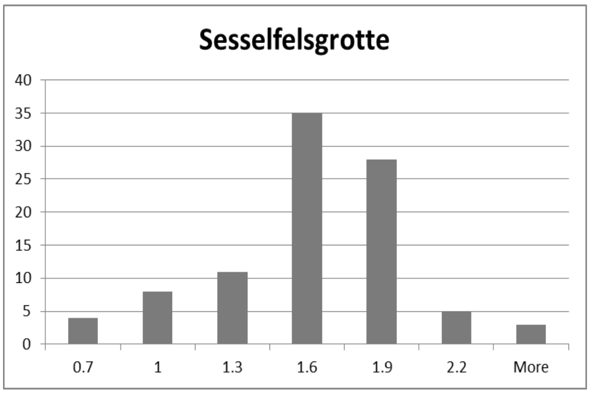


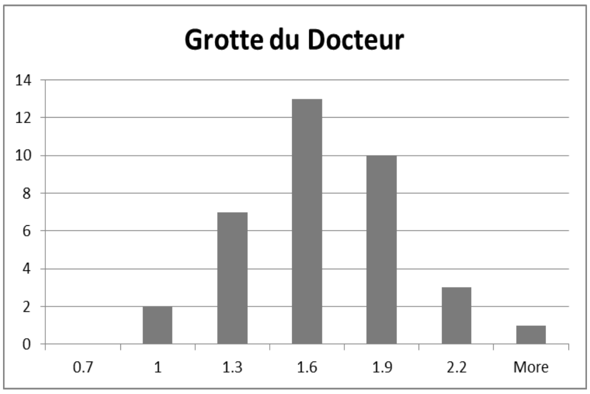


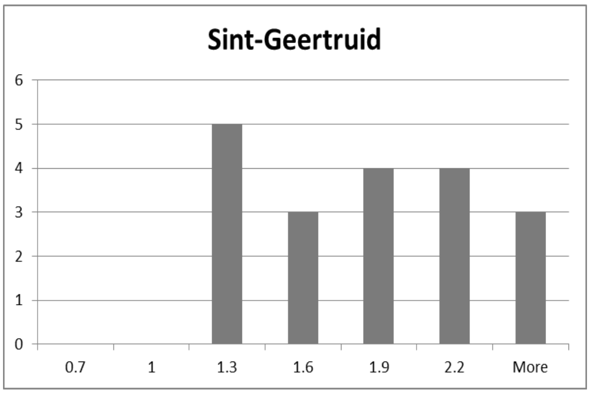


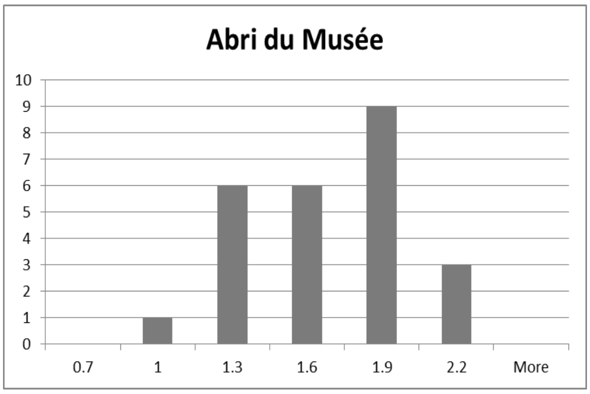


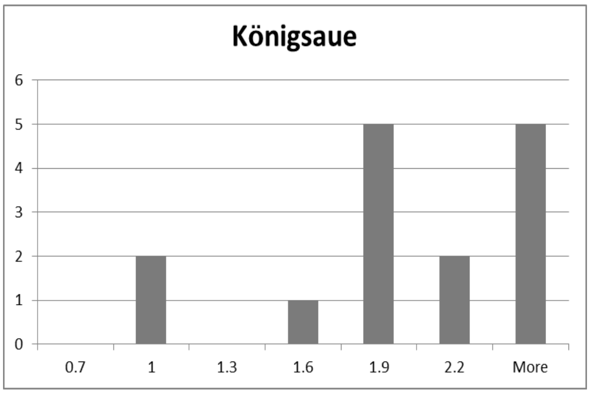

St Just en Chaussée
16
14
12
10
8
6
4
2
0
0.7
1
1.3
1.6
1.9
2.2
More


Sesselfelsgrotte
40
35
30
25
20
15
10
5
0
0.7
1
1.3
1.6
1.9
2.2
More


Grotte du Docteur
14
12
10
8
6
4
2
0
0.7
1
1.3
1.6
1.9
2.2
More


Sint-Geertruid
6
5
4
3
2
1
0
0.7
1
1.3
1.6
1.9
2.2
More


Abri du Musée
10
9
8
7
6
5
4
3
2
1
0
0.7
1
1.3
1.6
1.9
2.2
More


Königsaue
6
5
4
3
2
1
0
0.7
1
1.3
1.6
1.9
2.2
More

Appendix 5: Kruskal-Wallis non-parametric test results for measurements by assemblage – max. length

The value above the diagonal is the standard test statistic, and below the diagonal the p-value (values in bold are <0.05 and statistically significant)

KRUSKAL-WALLIS MAX. LENGTH	Königsaue	Sesselfelsgrotte	Sint-Geertruid	Lynford	Oosthoven	Grotte du Docteur	Champlost	St Just en Chaussée	St Julien de la Liègue	Bois du Rocher	Le Moustier	Pech de l'Azé I	Haut de Combe Capelle	Abri du Musée
Königsaue	–	5.957	1.206	1.710	–6.129	–1.876	0.797	7.972	–4.627	–1.723	–2.822	–4.279	–1.130	–1.636
Sesselfelsgrotte	**0.000**	–	8.699	12.263	–2.020	5.509	3.797	9.933	3.245	6.930	7.490	3.008	10.551	4.985
Sint-Geertruid	1.000	**0.000**	–	0.392	–7.933	–3.623	–4.362	0.840	–7.294	–3.607	–5.189	–6.687	–3.129	–3.210
Lynford	1.000	**0.000**	1.000	–	–9.402	–4.924	–5.670	0.594	–10.848	–5.173	–8.030	–9.450	–4.998	–4.227
Oosthoven	**0.000**	1.000	**0.000**	**0.000**	–	–5.412	4.352	8.777	3.677	6.033	5.633	3.662	7.265	5.210
Grotte du Docteur	1.000	**0.000**	**0.027**	**0.000**	**0.000**	–	–1.041	4.612	–3.128	–0.015	–0.974	–3.128	1.486	0.161
Champlost	0.797	**0.013**	**0.001**	**0.000**	**0.000**	1.000	–	5.307	–1.658	–1.476	0.445	–1.658	2.624	1.106
St Just en Chaussée	1.000	**0.000**	1.000	1.000	**0.000**	**0.000**	**0.000**	–	8.571	4.682	–6.446	–7.867	–4.320	–4.115
St Julien de la Liègue	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.024**	1.000	**0.000**	–	4.929	5.046	0.312	8.821	3.321
Bois du Rocher	1.000	**0.000**	**0.028**	**0.000**	**0.000**	1.000	1.000	**0.000**	**0.000**	–	–1.722	–4.095	1.284	–0.148
Le Moustier	0.435	**0.000**	**0.000**	**0.000**	**0.000**	1.000	1.000	**0.000**	**0.000**	1.000	–	3.549	–4.508	–1.028
Pech de l'Azé I	**0.002**	0.239	**0.000**	**0.000**	**0.000**	0.160	1.000	**0.000**	1.000	**0.004**	**0.035**	–	–6.694	–2.921
Haut de Combe Capelle	1.000	**0.000**	0.160	**0.000**	**0.000**	1.000	0.791	**0.001**	**0.000**	1.000	**0.001**	**0.000**	–	–1.076
Abri du Musée	1.000	**0.000**	0.121	**0.002**	**0.000**	1.000	1.000	**0.004**	0.820	1.000	1.000	0.318	1.000	–

Appendix 5: Kruskal-Wallis non-parametric test results for measurements by assemblage – max. width

The value above the diagonal is the standard test statistic, and below the diagonal the p-value (values in bold are <0.05 and statistically significant)

KRUSKAL-WALLIS MAX. WIDTH	Königsaue	Sesselfelsgrotte	Sint-Geertruid	Lynford	Oosthoven	Grotte du Docteur	Champlost	St Just en Chaussée	St Julien de la Liègue	Bois du Rocher	Le Moustier	Pech de l'Azé I	Haut de Combe Capelle	Abri du Musée
Königsaue	–	2.633	2.956	5.700	3.651	0.066	0.363	4.973	–0.073	2.754	2.136	0.052	3.734	0.495
Sesselfelsgrotte	0.770	–	7.270	13.701	–0.928	3.839	3.925	10.243	5.598	9.162	10.741	4.943	13.558	3.972
Sint-Geertruid	0.284	**0.000**	–	2.697	–6.005	–3.582	–3.078	2.216	–4.470	–0.767	–1.897	–4.061	0.068	–2.833
Lynford	**0.000**	**0.000**	0.636	–	–9.256	–7.569	–6.624	–0.124	–10.561	–4.568	–7.131	–9.243	–4.182	–6.185
Oosthoven	0.567	1.000	**0.000**	**0.000**	–	–3.340	3.497	8.090	5.598	6.306	6.014	3.651	7.609	3.576
Grotte du Docteur	1.000	**0.011**	**0.031**	**0.000**	**0.076**	–	0.367	6.107	–0.220	3.663	3.071	–0.028	5.376	0.543
Champlost	1.000	**0.008**	**0.190**	**0.000**	**0.043**	1.000	–	5.464	0.653	–2.976	2.283	–0.448	4.380	0.178
St Just en Chaussée	**0.000**	**0.000**	1.000	1.000	**0.000**	**0.000**	**0.000**	–	7.543	3.461	–4.969	–6.933	–2.908	–5.153
St Julien de la Liègue	1.000	**0.000**	**0.001**	**0.000**	**0.020**	1.000	1.000	**0.000**	–	5.414	6.011	0.259	9.626	0.850
Bois du Rocher	0.536	**0.000**	**1.000**	**0.000**	**0.000**	**0.023**	0.266	**0.049**	**0.000**	–	–1.577	–4.563	1.368	–2.658
Le Moustier	1.000	**0.000**	**1.000**	**0.000**	**0.000**	0.194	1.000	**0.000**	**0.000**	1.000	–	4.346	–4.422	1.936
Pech de l'Azé I	1.000	**0.000**	**0.004**	**0.000**	**0.024**	1.000	1.000	**0.000**	1.000	**0.000**	**0.001**	–	–7.387	–0.643
Haut de Combe Capelle	**0.017**	**0.000**	1.000	**0.003**	**0.000**	**0.000**	**0.001**	0.331	**0.000**	**0.001**	**0.001**	**0.000**	–	–3.942
Abri du Musée	1.000	**0.006**	0.420	**0.000**	**0.032**	1.000	1.000	**0.000**	1.000	0.715	1.000	1.000	**0.007**	–

Appendix 5: Kruskal-Wallis non-parametric test results for measurements by assemblage – max. thickness

The value above the diagonal is the standard test statistic, and below the diagonal the p-value (values in bold are <0.05 and statistically significant)

KRUSKAL-WALLIS MAX. THICKNESS	Königsaue	Sesselfelsgrotte	Sint-Geertruid	Lynford	Oosthoven	Grotte du Docteur	Champlost	St Just en Chaussée	St Julien de la Liègue	Bois du Rocher	Le Moustier	Pech de l'Azé I	Haut de Combe Capelle	Abri du Musée
Königsaue	–	0.213	5.859	6.059	0.760	4.100	1.361	5.611	2.488	5.410	5.490	2.689	6.486	2.054
Sesselfelsgrotte	1.000	–	8.452	10.483	1.229	6.730	2.298	8.260	5.720	9.740	12.552	5.389	14.087	3.244
Sint-Geertruid	**0.000**	**0.000**	–	–0.739	–5.146	–2.625	–5.353	–0.393	–5.690	–1.624	–2.295	–5.012	–1.624	–4.425
Lynford	**0.000**	**0.000**	1.000	–	–5.261	–2.405	–5.708	0.294	–6.946	–1.138	–2.103	–5.720	–0.260	–4.545
Oosthoven	1.000	1.000	**0.000**	**0.000**	–	–3.284	0.519	4.881	1.517	4.582	4.600	1.764	5.636	1.242
Grotte du Docteur	**0.000**	**0.000**	0.768	1.000	0.093	–	–3.271	2.256	–3.238	1.448	1.119	–2.525	2.653	–2.262
Champlost	1.000	1.000	**0.000**	**0.000**	1.000	0.097	–	5.070	–1.148	–4.917	5.137	1.460	6.432	0.855
St Just en Chaussée	**0.000**	**0.000**	1.000	1.000	**0.000**	1.000	**0.000**	–	5.390	1.196	–1.849	–4.692	–0.524	–4.123
St Julien de la Liègue	1.000	**0.000**	**0.000**	**0.000**	1.000	0.110	1.000	**0.000**	–	5.950	8.088	0.648	10.117	0.010
Bois du Rocher	**0.000**	**0.000**	1.000	1.000	**0.000**	1.000	**0.000**	1.000	**0.000**	–	–0.739	–4.733	1.179	–3.746
Le Moustier	**0.000**	**0.000**	1.000	1.000	**0.000**	1.000	**0.000**	1.000	**0.000**	1.000	–	5.535	–2.897	3.759
Pech de l'Azé I	0.653	**0.000**	**0.000**	**0.000**	1.000	1.000	1.000	**0.000**	1.000	**0.000**	**0.000**	–	–7.390	0.368
Haut de Combe Capelle	**0.000**	**0.000**	1.000	1.000	**0.000**	0.726	**0.000**	**1.000**	**0.000**	1.000	0.343	**0.000**	–	–5.024
Abri du Musée	1.000	0.107	**0.001**	**0.001**	1.000	1.000	1.000	**0.003**	1.000	**0.016**	**0.016**	1.000	**0.000**	–

Appendix 5: Kruskal-Wallis non-parametric test results for measurements by assemblage – max. elongation

The value above the diagonal is the standard test statistic, and below the diagonal the p-value (values in bold are <0.05 and statistically significant)

KRUSKAL-WALLIS ELONGATION	Königsaue	Sesselfelsgrotte	Sint-Geertruid	Lynford	Oosthoven	Grotte du Docteur	Champlost	St Just en Chaussée	St Julien de la Liègue	Bois du Rocher	Le Moustier	Pech de l'Azé I	Haut de Combe Capelle	Abri du Musée
Königsaue	–	1.848	-1.136	-2.528	-4.119	-1.469	-3.339	-1.368	-4.691	-4.472	-5.191	-4.397	-4.937	-1.738
Sesselfelsgrotte	1.000	–	0.563	-1.318	-3.574	0.318	-2.576	0.257	-5.870	-4.682	-7.160	-4.773	-6.362	-0.239
Sint-Geertruid	1.000	1.000	–	-1.424	-3.348	-0.262	-2.414	-0.246	-3.898	-3.655	-4.495	-3.559	-4.190	-0.640
Lynford	1.000	1.000	1.000	–	-2.551	1.342	-1.361	1.156	-3.194	-2.832	-4.058	-2.708	-3.602	0.726
Oosthoven	**0.003**	**0.032**	**0.074**	0.979	–	-3.425	1.315	3.153	0.842	0.655	0.389	0.898	0.580	2.851
Grotte du Docteur	1.000	1.000	1.000	1.000	0.056	–	-2.448	-0.090	-4.433	-3.978	-5.209	-3.919	-4.790	-0.446
Champlost	0.077	0.909	1.000	1.000	1.000	1.000	–	2.183	0.947	0.987	-1.564	-0.761	-1.279	1.820
St Just en Chaussée	1.000	1.000	1.000	1.000	0.147	1.000	1.000	–	3.644	3.415	-4.250	-3.310	-3.942	0.257
St Julien de la Liègue	**0.000**	**0.000**	0.090	0.127	1.000	**0.001**	1.000	**0.024**	–	-0.230	-1.221	0.194	-0.640	3.248
Bois du Rocher	**0.001**	**0.000**	**0.023**	0.421	1.000	**0.006**	1.000	0.058	1.000	–	-0.580	0.353	-0.220	3.043
Le Moustier	**0.000**	**0.000**	**0.001**	**0.004**	1.000	**0.000**	1.000	**0.002**	1.000	1.000	–	-1.140	-0.517	-3.873
Pech de l'Azé I	**0.001**	**0.000**	**0.034**	0.617	1.000	0.080	1.000	0.085	1.000	1.000	1.000	–	0.701	-2.921
Haut de Combe Capelle	**0.000**	**0.000**	**0.003**	**0.029**	1.000	**0.000**	1.000	**0.007**	1.000	1.000	1.000	1.000	–	3.558
Abri du Musée	1.000	1.000	1.000	1.000	0.396	1.000	1.000	1.000	0.106	0.213	**0.010**	0.317	**0.034**	–

Appendix 5: Kruskal-Wallis non-parametric test results for measurements by assemblage – max. flatness

The value above the diagonal is the standard test statistic, and below the diagonal the p-value (values in bold are <0.05 and statistically significant)

KRUSKAL-WALLIS FLATNESS	Königsaue	Sesselfelsgrotte	Sint-Geertruid	Lynford	Oosthoven	Grotte du Docteur	Champlost	St Just en Chaussée	St Julien de la Liègue	Bois du Rocher	Le Moustier	Pech de l'Azé I	Haut de Combe Capelle	Abri du Musée
Königsaue	–	2.540	-4.696	-1.006	-4.101	-5.139	-0.978	-1.373	-3.077	-4.227	-4.904	-3.406	-4.528	-1.892
Sesselfelsgrotte	1.000	–	-3.651	2.324	-2.838	-4.455	1.827	1.077	-0.949	-3.102	-4.938	-1.656	-4.000	0.392
Sint-Geertruid	**0.000**	**0.024**	–	4.949	0.343	0.030	4.415	3.750	3.298	1.427	1.249	2.581	1.596	3.276
Lynford	1.000	1.000	**0.000**	–	-4.088	-5.843	-0.069	-0.629	-3.291	-4.780	-6.445	-3.654	-5.698	-1.307
Oosthoven	**0.004**	0.413	1.000	**0.040**	–	0.352	3.704	3.127	2.479	0.883	0.659	1.893	0.975	2.673
Grotte du Docteur	**0.000**	**0.001**	1.000	**0.000**	1.000	–	5.026	4.209	4.121	1.673	1.546	3.116	1.968	3.693
Champlost	1.000	1.000	**0.001**	1.000	**0.019**	**0.000**	–	-0.507	2.530	3.960	-4.971	-2.940	-4.447	-1.108
St Just en Chaussée	1.000	1.000	**0.016**	1.000	0.161	**0.002**	1.000	–	1.677	3.119	-3.891	-2.122	-3.438	-0.561
St Julien de la Liègue	0.190	1.000	0.069	0.091	1.000	**0.003**	1.000	1.000	–	-2.631	-4.876	-0.971	-3.680	0.980
Bois du Rocher	**0.002**	0.175	1.000	**0.000**	1.000	1.000	**0.007**	0.165	0.775	–	-0.545	1.561	0.036	2.534
Le Moustier	**0.000**	**0.000**	1.000	**0.000**	1.000	1.000	**0.000**	**0.009**	**0.000**	1.000	–	-2.729	-0.858	-3.269
Pech de l'Azé I	0.060	1.000	0.897	**0.024**	1.000	0.167	0.299	1.000	1.000	1.000	0.579	–	1.957	-1.482
Haut de Combe Capelle	**0.001**	**0.006**	1.000	**0.000**	1.000	1.000	**0.001**	0.053	**0.021**	1.000	1.000	1.000	–	2.808
Abri du Musée	1.000	1.000	0.960	1.000	0.684	**0.020**	1.000	1.000	1.000	1.000	0.098	1.000	0.453	–

Appendix 6: Kruskal-Wallis non-parametric test results for measurements by tool type

The value above the diagonal is the standard test statistic, and below the diagonal the p-value (values in bold are <0.05 and statistically significant)

There is no table for maximum length since this measurement did not produce any statistically significant results. For a discussion see Chapter 6, section 6.4.4.

Kruskal-Wallis Max. Width	Classic Handaxes	Backed bifacial tools	Leafshaped bifacial tools	Bifacial Scrapers	Partial bifaces
Classic Handaxes	–	6.822	5.365	4.981	1.938
Backed bifacial tools	**0.000**	–	-0.215	-0.561	-2.846
Leafshaped bifacial tools	**0.000**	1.000	–	0.313	-2.410
Bifacial Scrapers	**0.000**	1.000	1.000	–	-2.113
Partial bifaces	0.789	0.066	0.239	0.519	–

Kruskal-Wallis Max. Thickness	Classic Handaxes	Backed bifacial tools	Leafshaped bifacial tools	Bifacial Scrapers	Partial bifaces
Classic Handaxes	–	5.003	8.370	6.169	1.744
Backed bifacial tools	**0.000**	–	0.010	1.606	-1.824
Leafshaped bifacial tools	**0.000**	**0.010**	–	3.410	-4.713
Bifacial Scrapers	**0.000**	1.000	1.000	–	-3.107
Partial bifaces	1.000	1.000	**0.000**	**0.028**	–

Kruskal-Wallis Max. Elongation	**Classic Handaxes**	**Backed bifacial tools**	**Leafshaped bifacial tools**	**Bifacial Scrapers**	**Partial bifaces**
Classic Handaxes	–	−8.319	−7.896	−4.049	−1.212
Backed bifacial tools	**0.000**	–	−0.826	2.308	4.406
Leafshaped bifacial tools	**0.000**	1.000	–	2.855	4.767
Bifacial Scrapers	**0.001**	0.315	0.065	–	1.989
Partial bifaces	1.000	**0.000**	**0.000**	0.700	–

Kruskal-Wallis Max. Flatness	**Classic Handaxes**	**Backed bifacial tools**	**Leafshaped bifacial tools**	**Bifacial Scrapers**	**Partial bifaces**
Classic Handaxes	–	0.947	−5.404	−2.567	−0.218
Backed bifacial tools	1.000	–	−4.975	−2.691	−0.792
Leafshaped bifacial tools	**0.000**	**0.000**	–	2.103	3.718
Bifacial Scrapers	0.154	0.107	0.532	–	1.673
Partial bifaces	1.000	1.000	**0.003**	1.000	–

Appendix 7: Measurements and calculated ratios correlated with various technological attributes

All meausuremtns in millimetre, with indication of their standard deviations, for a discussion see Chapter 6, section 6.4.4.

CROSS SECTION		L	W	T	TL	Elongation	Flatness	Refinement
biconvex	Mean	71.85	55.19	21.36	53.03	1.30	2.67	0.39
	St. Dev.	*23.15*	*15.14*	*6.67*	*18.27*	*0.19*	*0.59*	*0.09*
plano-convex	Mean	67.02	49.43	18.71	48.54	1.38	2.75	0.38
	St. Dev.	*19.14*	*12.40*	*5.77*	*15.48*	*0.32*	*0.67*	*0.10*
biplano	Mean	74.60	45.20	11.60	54.00	1.64	3.94	0.26
	St. Dev.	*31.58*	*12.70*	*2.79*	*24.85*	*0.53*	*0.82*	*0.05*
plano-convex/ plano-convex	Mean	50.25	43.50	14.00	40.33	1.18	3.33	0.32
	St. Dev.	*12.04*	*8.81*	*5.48*	*8.02*	*0.29*	*1.00*	*0.10*
irregular	Mean	64.06	47.34	19.15	49.09	1.38	2.74	0.40
	St. Dev.	*19.16*	*14.20*	*8.30*	*15.52*	*0.28*	*0.95*	*0.13*

BLANK		L	W	T	TL	Elongation	Flatness	Refinement
nodule/ pebble	Mean	70.49	49.91	21.71	54.44	1.44	2.59	0.42
	St. Dev.	*25.88*	*16.95*	*10.90*	*18.47*	*0.30*	*0.87*	*0.13*
natural fragment	Mean	43.00	40.00	12.00	0.00	1.05	3.34	0.30
	St. Dev.	*24.04*	*4.24*	*1.41*	*0.00*	*0.49*	*0.04*	*0.00*
flake	Mean	65.33	48.41	17.82	48.20	1.37	2.86	0.37
	St. Dev.	*19.20*	*12.86*	*5.90*	*15.83*	*0.28*	*0.79*	*0.10*
indeterminate	Mean	68.74	51.97	19.97	50.61	1.34	2.70	0.39
	St. Dev.	*20.97*	*14.35*	*6.22*	*17.01*	*0.28*	*0.66*	*0.09*

CORTEX		L	W	T	TL	Elongation	Flatness	Refinement
Absent	Mean	65.50	49.37	18.33	47.68	1.34	2.81	0.37
	St. Dev.	*18.69*	*12.26*	*5.64*	*15.00*	*0.25*	*0.67*	*0.09*
<25%	Mean	71.30	53.42	21.34	53.51	1.36	2.61	0.41
	St. Dev.	*23.18*	*15.97*	*7.19*	*18.68*	*0.31*	*0.68*	*0.11*
25-50%	Mean	67.13	47.97	18.43	52.33	1.43	2.85	0.38
	St. Dev.	*22.65*	*15.88*	*8.13*	*17.52*	*0.30*	*0.95*	*0.10*
50-75%	Mean	70.89	48.10	19.59	54.27	1.49	3.12	0.38
	St. Dev.	*20.36*	*12.45*	*12.46*	*14.42*	*0.22*	*1.31*	*0.15*
>75%	Mean	53.00	32.33	11.33	0.00	1.80	3.10	0.36
	St. Dev.	*8.66*	*9.61*	*4.93*	*0.00*	*0.80*	*1.31*	*0.14*

EDGE ANGLE		L	W	T	TL	Elongation	Flatness	Refinement
<35°	Mean	71.51	48.68	16.19	54.70	1.51	3.19	0.34
	St. Dev.	*24.32*	*15.49*	*6.56*	*19.66*	*0.47*	*0.89*	*0.12*
35-65°	Mean	67.73	51.59	20.02	50.08	1.32	2.69	0.39
	St. Dev.	*20.42*	*14.00*	*6.58*	*16.51*	*0.23*	*0.65*	*0.09*
>65°	Mean	66.89	45.67	22.58	46.87	1.49	2.17	0.50
	St. Dev.	*21.20*	*11.98*	*7.23*	*14.17*	*0.38*	*0.76*	*0.13*

RETOUCH EXTENT		L	W	T	TL	Elongation	Flatness	Refinement
short	Mean	55.39	38.07	14.18	40.91	1.50	3.01	0.38
	St. Dev.	*17.97*	*12.30*	*6.80*	*13.67*	*0.41*	*1.18*	*0.13*
long	Mean	61.94	42.55	15.20	45.09	1.49	3.03	0.37
	St. Dev.	*18.07*	*10.87*	*5.70*	*15.87*	*0.34*	*0.97*	*0.13*
invasive	Mean	73.18	48.21	19.18	53.25	1.54	2.70	0.40
	St. Dev.	*20.76*	*12.81*	*7.49*	*18.94*	*0.31*	*0.76*	*0.10*
covering	Mean	69.25	52.67	20.36	50.77	1.32	2.69	0.39
	St. Dev.	*21.13*	*13.95*	*6.43*	*16.87*	*0.25*	*0.63*	*0.09*

Appendix 8: Detailed typo-technological characteristics of the 14 key assemblages

GROUP 1: CLASSIC HANDAXES DOMINATED	
Le Moustier	• Made both on nodules and flake blanks • Low proportion of backed blanks • Few cortex remaining • Biconvex and planoconvex cross sections • Dominance of covering retouch • Edge angles mainly between 35 and 65 degrees • Below average elongation and refinement • Predominance of classic handaxes
Pech de l'Azé I	• Made both on nodules and flake blanks • No backed blanks • Few cortex remaining • Biconvex and planoconvex cross sections • Dominance of covering retouch • Edge angles mainly between 35 and 65 degrees • Below average elongation and average refinement • Predominance of classic handaxes
Lynford	• Made both on nodules and flake blanks • Low proportion of backed blanks • Few cortex remaining • Biconvex and planoconvex cross sections • Dominance of covering retouch • Edge angles off less than 35 and between 35 and 65 degrees • Below average elongation but high refinement • Predominance of classic handaxes
Bois du Rocher	• Made predominantly on flakes • No backed blanks • Few cortex remaining • Biconvex and planoconvex cross sections • Dominance of covering retouch • Edge angles between 35 and 65 degrees • Below average elongation and refinement • Predominance of classic handaxes

St Julien de la Liegue	• Made predominantly on flakes • Very low proportion of backed blanks • Few cortex remaining • Dominance of Biconvex and planoconvex cross sections but also biplane and planoconvex/planoconvex sections • Dominance of covering retouch • Edge angles between 35 and 65 degrees • Below average elongation but higher refinement • Predominance of classic handaxes
Haut de Combe Capelle	• Made both on nodules and flake blanks • Low proportion of backed blanks • Few cortex remaining • Biconvex and planoconvex cross sections • Dominance of covering retouch • Edge angles between 35 and 65 degrees • Below average elongation and refinement • Predominance of classic handaxes
St Just en Chaussée	• Made both on nodules and flake blanks • No backed blanks • Few cortex remaining • Biconvex and planoconvex cross sections • Dominance of covering retouch • Edge angles between 35 and 65 degrees • Above average elongation and refinement • Predominance of classic handaxes

GROUP 2: VARIETY OF BIFACIAL TOOLS	
Champlost	• Made predominantly on flakes • Low proportion of backed blanks • Few cortex remaining • Biconvex and planoconvex cross sections • Dominance of invasive and covering retouch • Edge angles between 35 and 65 degrees • Below average elongation but higher refinement • Presence of classic handaxes, leafshaped and backed bifacial tools
Sint-Geertruid	• Made both on nodules and flake blanks • No backed blanks • Few cortex remaining • Biconvex and planoconvex cross sections • Short, long and covering retouch • Edge angles mainly between 35 and 65 degrees • High elongation but below average refinement • Presence of classic handaxes and backed bifacial tools
Oosthoven	• Made both on nodules and flake blanks • Moderate proportion of backed blanks • Few cortex remaining • Biconvex, planoconvex and irregular cross sections • Dominance of covering retouch but also short and long retouch present • Edge angles off less than 35 and between 35 and 65 egrees • Below average elongation and refinement • Presence of classic handaxes, bifacial scrapers and backed bifacial tools
Grotte du Docteur	• Made both on nodules and flake blanks • High proportion of backed blanks • Around 22% of artefacts has cortex remnants of >25% • Biconvex and planoconvex cross sections • Occurrence of all types of retouch • Occurrence of all types of edge angles • Above average elongation but lower refinement • Presence of classic handaxes, bifacial scrapers, leafshaped and backed bifacial tools

GROUP 3: CLASSIC HANDAXES ABSENT	
Königsaue	• Made predominantly on flakes • Low proportion of backed blanks • Few cortex remaining • Planoconvex, biplano and irregular sections • Long and covering retouch • Edge angles off less than 35 and between 35 and 65 degrees • Use of the para-burin technique • Above average elongation and refinement • Dominance of leafshaped and backed bifacial tools
Sesselfelsgrotte	• Made both on nodules and flake blanks • High proportion of backed blanks • Around 33% of artefacts has cortex remnants of >25% • Mainly planoconvex and irregular cross sections • Dominance of short and long retouch • Edge angles off less than 35 and between 35 and 65 degrees • Use of the para-burin technique • Above average elongation and refinement • Dominance of leafshaped, backed bifacial tools and bifacial scrapers
Abri du Musée	• Made predominantly on flakes • High proportion of backed blanks • Few cortex remaining • Mainly planoconvex and irregular cross sections • Dominance of short and long retouch • Dominance of edge angles of less than 35 degrees • Above average elongation and refinement • Dominance of backed bifacial tools and bifacial scrapers

Appendix 9: Summary of the bifacial tool measurements

To assess genuine metric differences between the Western-European Late Middle Palaeolithic bifacial tools data from 14 key assemblages are incorporated with detailed data available from 15 published site reports (section 7.2.2).

		Length (L)	Width (W)	Thick-ness (T)	Elongation (L/W)	Flatness (W/T)	Refinement (T/W)
GERMANY							
Königsaue (n: 15)	Mean	85.40	45.40	12.80	1.94	3.73	0.29
	St. Dev.	*28.34*	*7.83*	*3.41*	*0.66*	*0.98*	*0.08*
Sesselfelsgrotte (n: 94)	Mean	49.84	34.62	12.00	1.52	3.09	0.37
	St. Dev.	*14.75*	*10.70*	*4.16*	*0.54*	*1.11*	*0.15*
Neumark Nord 2/0		35-45					
THE NETHERLANDS							
Sint-Geertruid (n: 18)	Mean	98.64	61.91	27.33	1.75	2.36	0.47
	St. Dev.	*25.11*	*20.56*	*11.46*	*0.48*	*0.80*	*0.14*
Assen (n: 8)	Mean	78.00	60.14	21.25	1.27	2.95	0.35
	St. Dev.	*16.26*	*12.67*	*5.49*	*0.11*	*0.48*	*0.06*
BRITAIN							
Lynford (n: 49)	Mean	101.42	73.12	23.70	1.38	3.21	0.33
	St. Dev.	*26.53*	*15.44*	*6.61*	*0.15*	*0.72*	*0.08*
Area 240 (n: 17)	Mean	125.14					
	St. Dev.	*11.39*					
BELGIUM							
Oosthoven (n: 16)	Mean	42.13	33.50	14.44	1.26	2.40	0.43
	St. Dev.	*6.35*	*4.49*	*3.20*	*0.14*	*0.44*	*0.09*
Grotte du Docteur (n: 36)	Mean	71.00	46.14	20.42	1.54	2.36	0.44
	St. Dev.	*20.55*	*10.30*	*6.45*	*0.31*	*0.50*	*0.09*
Rotselaar (n: 7)	Mean	81.29	62.29	20.71	1.29	3.05	0.34
	St. Dev.	*25.12*	*15.18*	*4.59*	*0.12*	*0.70*	*0.07*
NORTHERN FRANCE							
St Just en Chaussée (n: 23)	Mean	108.74	74.22	24.61	1.49	3.15	0.34
	St. Dev.	*24.26*	*17.57*	*7.00*	*0.23*	*0.82*	*0.10*
St Julien de la Liègue (n: 180)	Mean	58.82	45.36	16.64	1.30	2.79	0.37
	St. Dev.	*13.28*	*9.22*	*4.00*	*0.15*	*0.52*	*0.07*
Catigny (n: 25)	Mean	99.68	74.72	24.68	1.35	3.26	0.34
	St. Dev.	*20.4*	*14.74*	*7.93*	*0.23*	*1.08*	*0.10*

		Length (L)	Width (W)	Thick-ness (T)	Elongation (L/W)	Flatness (W/T)	Refinement (T/W)
EASTERN FRANCE							
Champlost (n: 28)	Mean	67.21	48.00	15.36	1.40	3.27	0.33
	St. Dev.	*22.55*	*13.95*	*4.85*	*0.31*	*0.92*	*0.08*
Lailly <Tournerie> (n: 11)	Mean	117.91	72.55	24.91	1.66	3.06	0.37
	St. Dev.	*17.79*	*14.77*	*5.09*	*0.26*	*0.87*	*0.17*
WESTERN FRANCE							
Bois du Rocher (n: 58)	Mean	69.71	54.33	21.69	1.29	2.55	0.40
	St. Dev.	*12.51*	*9.18*	*4.75*	*0.13*	*0.36*	*0.06*
Saint-Brice sous Ranes (n: 16)	Mean	61.63	44.81	17.45	1.38	2.61	0.39
	St. Dev.	*6.10*	*3.24*	*2.74*	*0.11*	*0.41*	*0.07*
SOUTHWEST FRANCE							
Le Moustier (n: 250)	Mean	66.08	51.85	21.36	1.28	2.52	0.41
	St. Dev.	*12.95*	*9.38*	*5.73*	*0.14*	*0.50*	*0.08*
Pech de l'Azé I (n: 82)	Mean	59.55	45.71	17.23	1.31	2.76	0.38
	St. Dev.	*16.59*	*11.48*	*5.23*	*0.18*	*0.68*	*0.09*
Haut de Combe Capelle (n: 173)	Mean	74.35	58.09	23.39	1.29	2.60	0.40
	St. Dev.	*15.70*	*11.54*	*6.34*	*0.16*	*0.64*	*0.09*
La Rochette (n: 210)	Mean	69.61	53.28	22.21	1.31	2.40	**0.42**
	St. Dev.	*16.08*	*11.81*	*5.13*	*0.15*	*0.46*	
Croix-Guémard (Deux-Sevres) (n: 407)	Mean	6.63	5.64		*1.18*		
	St. Dev.						
Abri du Musée (n: 25)	Mean	70.88	47.40	17.48	1.52	2.99	0.37
	St. Dev.	*19.36*	*10.10*	*8.40*	*0.31*	*0.85*	*0.16*

Appendix 10: Summary of the dominant bifacial tool types and forms

For a discussion see Chapter 7, sections 7.2.1 and 7.2.2.

Region	Site	classic	backed	leafshaped	partial	bif. Scraper	Dominant form	Common forms
Germany	Balve	–	√	√	√	√	Balver / Tata Keilmesser	Faustkeilblätter
	Buhlen	–	√	√	√	√	Pradnikmesser	Bocksteinmesser
	Gamsenberg	–	√	–	–	√	unknown	unknown
	Königsaue	–	√	√	–	√	Königsaue / Wolgograd Keilmesser	Faustkeilblatter
	Lichtenberg	√	√	√	–	√	Lichtenberger Keilmesser	leafshaped and bifacial scrapers
	Neumark Nord 2/0	–	√	√	–	√	Königsaue / Wolgograd Keilmesser	bifacial scrapers
	Salzgitter-Lebenstedt B1	√	√	√	√	√	bifacial scrapers	leaf-shaped and backed bifacial tools
	Schulerloch	–	√	–	–	√	atypical Keilmesser	Buhlener Keilmesser
	Sesselfelsgrotte	√	√	√	√	√	bifacial scrapers	Klausennische and Bocksteinmesser
	Wahlen	√	√	√	√	√	leaf-shaped bifacial tools	Königsaue / Wolgograd Keilmesser
the Netherlands	Assen	√	–	–	√	–	cordiform handaxes	triangular handaxes
	Mesch-Mescherheide	√	√	–	–	–	unknown	unknown
	Sint-Geertruid	√	√	√	–	√	cordiform handaxes	ovate handaxes
Britain	Area 240	√	–	–	–	–	cordiform handaxes	*bout coupé* handaxes
	Lynford	√	–	–	√	–	cordiform handaxes	*bout coupé* handaxes
	Coygan Cave	√	–	–	–	–	*bout coupé* handaxes	none
Belgium	Aalter Hageland	√	–	√	–	√	bifacial scrapers	cordiform handaxes
	Grotte du Docteur	√	√	√	√	√	Klausennische and Bockstein-messer	cordiform handaxes
	Goyet	√	√	–	–	–	cordiform handaxe	*Keilmesser*
	Oosthoven	√	√	–	√	√	*Keilmesser*	cordiform handaxes
	Ramioul	√	√	√	–	–	classic handaxes	backed bifacial tools
	Rotselaar	√	–	–	–	–	cordiform handaxes	triangular handaxes
	Snauwenberg	–	√	–	–	√	bifacial scrapers	cordiform handaxes
	Spy	√	√	√	–	–	cordiform handaxes	leaf-shaped bifacial tools
	Trou Magrite	√	–	√	√	√	cordiform handaxes	ovate handaxes

Region	Site	classic	backed	leafshaped	partial	bif. Scraper	Dominant form	Common forms
Northern France	Catigny	√	–	–	√	√	triangular handaxes	cordiform handaxes
	Hamel	√	–	–	–	–	cordiform handaxes	unknown
	Marcoing	√	–	–	–	√	triangular handaxes	cordiform handaxes
	Saint-Amand-les-Eaux	√	–	√	–	√	unknown	unknown
	St Julien de la Liegue	√	–	√	–	√	cordiform handaxes	ovate handaxes
	Saint-Just en Chaussée	√	–	–	–	–	triangular handaxes	cordiform handaxes
Central/ Eastern France	Champlost	√	√	√	√	√	bifacial scrapers	cordiform handaxes
	Germolles	√	√	–	–	–	triangular and cordiform handaxes	various Keilmesser, incl. pradnikmesser
	Lailly <Tournerie>	√	–	–	√	–	cordiform handaxes	triangular handaxes
	Pont-des-Planches	√	√	√	–	–	cordiform handaxes	triangular handaxes
Western France	Bois-du-Rocher	√	–	–	√	√	cordiform handaxes	ovate handaxes
	Girardière	√	–	–	√	√	cordiform handaxes	partial bifacial tools
	Kervouster	√	–	–	√	√	cordiform handaxes	ovate handaxes
	Montbert	√	–	–	√	√	cordiform handaxes	various bifacial tools
	Saint-Brice-sous- Rânes	√	–	–	–	–	cordiform handaxes	ovate handaxes
South-western France	Abri du Musée	√	√	–	–	√	Pradnikmesser	bifacial scrapers
	Barbas III	√	–	–	–	–	cordiform handaxes	unknown
	Basté	√	√	–	–	√	Handaxes with unwoked base	unknown
	Fonseigner	√	–	–	–	√	cordiform handaxes	unknown
	Grotte XVI	√	–	–	–	–	cordiform handaxes	triangular handaxes
	Haut de Combe Capelle	√	√	√	√	√	cordiform handaxes	partial bifacial tools
	Jonzac	√	–	–	–	√	cordiform handaxes	unknown
	Le Moustier	√	√	√	√	–	cordiform handaxes	discoidal and triangular handaxes
	La Rochette	√	–	–	–	√	cordiform handaxes	ovate handaxes
	Pech de l'Azé I	√	–	√	√	–	cordiform handaxes	triangular handaxes

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