

THE STRUCTURE OF MIDDLE PALAEOOLITHIC VARIABILITY:
A MULTIVARIATE ASSESSMENT

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ABSTRACT

Four theories concerning the nature of lithic variability in the Middle Palaeolithic of Western Europe and their corresponding evaluations of Neanderthal behaviour are examined using a critical, historical approach and a multivariate statistical analysis of 103 lithic assemblages. The critical examination identifies historical trends, theoretical biases and relationships between the archaeological data and theories concerning Neanderthal behaviour. The results of the statistical tests support the continuous distribution of artifact frequencies across defined assemblage types and mutual covariation within broad morphological tool classes. The lack of discrete categories argues against the stylistic interpretations of Bordes and the functional interpretations of Binford. Instead the results lend support to the Rolland and Dibble model which emphasizes raw material constraints and artifact reduction intensity. The results of the statistical research also support chronological patterns identified by Mellars and point to relationships in the data which have a bearing on the interpretation of Neanderthal behaviour.

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for Bennett

INTRODUCTION

Over a century has passed since the enigmatic Neanderthal remains were first associated with the Middle Palaeolithic (or Mousterian) stone tool industry of Western Europe. The current diversity of opinions concerning the biological and behavioural status of this group of evolved hominids points out that we do not yet understand them or the tools they made. In many ways they remain elusive. There are many reasons for this. Depending on who you ask, the Middle Palaeolithic in Western Europe stretches back in time to between 115 and 250 thousand years ago. Perhaps more perplexing is the *relatively* sudden disappearance of the Neanderthals. They were more similar to modern humans than any living creature but were still sufficiently different in their physical morphology.

Their remoteness in time, their disappearance and their different physiques undoubtedly stimulated interest in Neanderthals but have also clouded the interpretation of their behaviour. To advance our understanding of Neanderthals we must make apparent the biases that are introduced into theories of their behaviour. Rather than simply exposing these biases, however, and potentially dissolving our inquiry into finger pointing and relativist despair, we must also examine data and look for structures within it. The data dealt with in the present study are the distributions of the various stone tool types their relationships with each other and their relationships to the assemblage types defined for the Western European Middle Palaeolithic (see Appendix A). A fundamental issue linking this data to theories concerning Neanderthal behaviour is the nature of Middle Palaeolithic variability. The demonstrated differences between Middle Palaeolithic assemblages must be explained. What factors are the causes of the differences and what is the nature of the differences?

Since World War II, four major theories have explained the differences between Western European Middle Palaeolithic assemblages: 1) François Bordes' stylistic and ethnic explanation; 2) Lewis and Sally Binford's functional explanation; 3) Paul Mellars' chronological explanation; and 4) Nicolas Rolland and Harrold Dibble's explanation of differential stone tool reduction and raw material constraints. Each of these theories rests upon different perceived structures in the data. These structures, in turn, form the basis for behavioural interpretations. The present study examines these theories in two ways.

First, it will clarify the biases in these theories by placing them in historical

context. Many of the issues in the modern debate, as well as the terminology and methodology employed, were developed in a previous era of research. The first chapter examines the early research which influenced the modern debate. During this period the interpretation of Neanderthal and human behaviour was predominantly shaped by ideas from biological theory. The important discoveries and theoretical developments concerning Neanderthal behaviour and the description and classification of Middle Palaeolithic archaeological assemblages are presented in this chapter. The second chapter presents the four dominant theories with regard to: 1) the extent to which ideas were adopted from the previous era; 2) how the complexity of Neanderthal behaviour is evaluated in these theories; 3) the nature of the categories employed by the authors; and 4) the degree to which the empirical observations are integrated with behavioural interpretations.

The second way in which the present study evaluates these theories is through a statistical examination of the structure of Western European Middle Palaeolithic assemblages and the distribution of artifact types. Multivariate statistical methodology and a discussion of previous, relevant multivariate analyses are presented in the third chapter. The fourth chapter presents a new multivariate assessment of 103 Western European Middle Palaeolithic assemblages, consisting of a principal components analysis, a factor analysis, a discriminant analysis and two cluster analyses of the aforementioned assemblages. The goals of these tests are primarily to describe: 1) the relationships between the various artifact types defined by François Bordes; 2) the relationships between the assemblage types, also defined by Bordes; and 3) the relationships between the artifact and assemblage types. A fundamental issue concerning the nature of Middle Palaeolithic variability is whether or not the assemblage and artifact types are discrete entities, or whether they form a continuum of variability.

Many of the theories concerning Neanderthal behaviour, outlined in the second chapter, are dependent upon whether or not the typological categories employed for the Middle Palaeolithic represent discrete behavioural units. The relationships between the structure of the data and the theories employed are presented in the fifth chapter. The interpretation of Neanderthal behaviour in the Middle Palaeolithic of Western Europe will be discussed in light of both the historical and statistical examination.

The goal of the present study is to critically evaluate the dominant theories

concerning Middle Palaeolithic variability and their associated behavioural interpretations. It will examine these theories in their historical context, evaluate the logic they employ, and examine the data set upon which these theories rest. The relationships between data and theory are complex. Data is organized and presented using theory; theory, however, must be limited by what the empirical data can support. Theories concerning the archaeological record are not simply produced through an examination of data alone; they are constructed from both previous theories and archaeological data. In addition, general intellectual trends and methodologies incorporated from other intellectual endeavors are employed in the construction of archaeological theory. The data set and the multiple theories pertaining to Middle Palaeolithic variability are all interrelated in a complex web of historically constructed meaning. It is hoped that the present study will clarify these relationships and point toward new directions in understanding the nature of this variability and the nature of Neanderthal behaviour.

I EARLY THEORIES

The prehistoric man was cursing us, praying to us, welcoming us - who could tell? . . . We could not understand because we were too far and could not remember, because we were travelling in the night of first ages, of those ages that are gone, leaving hardly a sign - and no memories.

- Joseph Conrad, *Heart of Darkness*.

The interpretation of Neanderthal and human behaviour in the period from 1859 to the 1940s was predominantly shaped by ideas from biological theory. The concept of evolution included the notion that humans differed both from other creatures and among themselves as a result of natural processes. Although this concept certainly advanced the understanding of human biology and behaviour, it was also rooted in ideas about social evolution and a competitive view of society. The Victorian values of progress and the proclivity to categorize formed the backdrop for theories of social and biological evolution, as well as for racial theory. These ideas mutually reinforced each other and had a direct impact on the interpretation of the archaeological and fossil evidence from this period.

At an empirical level, the archaeological record was described using methods borrowed from other disciplines. Palaeontological models were employed in defining and categorizing the archaeological material. The archaeological record was divided into discrete categories analogous to those current in palaeontology at the time. Such a process gave archaeology a logical analytical framework and a degree of rigour. When coupled with the human fossil record, however, these artificially discrete categories reinforced negative behavioural interpretations of the Neanderthal as well as of certain living human populations. The relationship between palaeontological models and the archaeological data, on the one hand, and evolutionary theory and behavioural interpretations, on the other, helped define the study of human prehistory and the Middle Palaeolithic in particular. Many of the issues raised at that time remain part of the discourse of prehistory.

Since 1886 the Middle Palaeolithic of Western Europe (then known as the Mousterian) has been associated with the remains of the enigmatic Neanderthal hominids. The history of the interpretation of the Middle Palaeolithic in Europe has been heavily coloured by this juxtaposition. The present chapter will examine the discovery of the Neanderthal, the identification of the Mousterian and the theoretical impact of their juxtaposition. The history of the interpretation of the Neanderthal and their stone tools will be followed in this chapter until the advent of World War II. Particular emphasis will be placed on the influence of

European value systems and the broader societal context of archaeology. Throughout this period, the biological and palaeoarchaeological records were increasingly interpreted in terms of racial and imperial ideology. Of course, several different modes of thought existed in this period and many of them had an impact on the emerging discipline of archaeology. These ideas included (but are not restricted to) uniformitarian geology, the concept of a great human antiquity, biological evolution (including Darwinism), social evolution and the diffusion of cultures. All of these concepts are interrelated and often reinforced one another, and many were linked in some way to the dominant ideologies of racism and imperialism.

Two general aspects of the study of the Middle Palaeolithic can be identified during this period: 1) the archaeological record, or the discovery and interpretation of sites, artifacts and assemblages of artifacts, and 2) the interpretation of the Neanderthal remains in terms of human biological evolution. For much of the history of archaeology, the interpretation of the archaeological record has been strongly influenced by that of the biological record: "Until recent decades ... with rare exceptions the flow of information between these disciplines was unidirectional, with archaeologists being the recipients" (Trigger 1989: 17). Both of these currents of thought will be examined, and the linkages between them will be discussed. Biological evolution and social evolution before 1950 were not as theoretically distinct as they appear to be today. Social evolutionary theory underlay Darwin's human evolution model, which in turn supported the new "social Darwinist" position. It is important to note that in the last century the modern boundaries between the different disciplines were less distinct than in recent decades (Roebroeks 1993: 1).¹

THE ASSOCIATION OF STONE TOOLS WITH EXTINCT FAUNA

The "establishment of human antiquity" has been discussed widely elsewhere (see Grayson 1983, Trautman 1992, Van Riper 1993); only a brief sketch will be presented here. At the 1859 meeting of the British Association in Aberdeen, Charles Lyell announced his support for an extended human antiquity, beyond the accepted biblical chronology (Trautman 1992: 382).² Precipitating this announcement was the acceptance of the association of human-made stone tools and extinct megafauna, such as mammoths at both Brixham cave in England and in the gravel pits near Amiens in the Somme Valley in France. Lyell's admission

to a change of view represented a dramatic shift in the conception of the past, both for himself and for European intellectual culture as a whole.

At this same meeting Lyell also announced a friend's forthcoming publication: Charles Darwin's book *The Origin of Species* appeared later that same year. Although the antiquity of humanity has subsequently been most closely associated with the debates surrounding Darwin and Alfred Wallace's theories of evolution through natural selection, these two concepts were in fact distinct in several regards. According to Thomas Trautman, "although the revolution in ethnological time [as a product of the discovery of human antiquity] came about simultaneously with the publication of *The Origin of Species*, was quickly assimilated by Darwin and was necessary to the extension of his theory to the human species, it did not come from Darwin and indeed came about by a distinct path" (1992: 381). However, Trautman adds, "as soon as it broke out, the revolution in ethnological time was absorbed into the larger issue of transmutation of species" (1992:383).

UNILINEAL EVOLUTION IN THE ARCHAEOLOGICAL RECORD

Evolution itself was not a new idea; it had been espoused by Lamarck in biology, and social evolution was already a popular theory before 1859. The writers of the Scottish enlightenment had proposed a progression of human culture and Lyell believed in uniformitarian evolution in geology and non-human palaeontology (see Daniel 1975: 64). Darwin and Wallace's specific contribution was the theory of evolution "... by Means of Natural Selection or the Preservation of Favoured Races in the Struggle for Life," a scientifically demonstrable mechanism by which evolution occurred (Darwin 1985 [1859]). Darwin later applied this theory to humans in *The Descent of Man* (1871), where he refers the reader to Lyell's *The Geological Evidences of the Antiquity of Man with an Outline of Glacial and Post-Tertiary Geology and Remarks on the Origins of Species* (1873 [1863]) and John Lubbock's *Prehistoric Times as Illustrated by Ancient Remains and the Manners and Customs of Modern Savages* (1869 [1865]). Roebroeks argues in his *Das Bild vom Urmenschen im Wandel der Zeit* that Darwin projected the established competitive nature of Victorian society onto the development of natural species (1993: 7).³ The specific idea of natural selection resulted from Thomas Malthus' observations on human population; according to Darwin the struggle for existence "is the doctrine of Malthus applied with

manifold force to the whole animal and vegetable kingdoms...” (1985: 117). Malthus’ views were part of the growth of “classical” economics and the affirmation of middle-class virtues that emerged in the late 18th century. Social evolution certainly preceded Darwinian evolution, as attested by the works of Herbert Spencer and others.

Bruce Trigger suggests that the first behavioural interpretations of the archaeological record, rooted in social evolution, were in many ways a direct extension of the Victorian world-view and middle-class virtues.⁴ Palaeolithic archaeology received both its name and its first theoretical treatment from John Lubbock in his *Prehistoric Times* (1869[1865]). Appearing only six years after the general acceptance of a lengthy human antiquity, Lubbock’s work was one of great synthesis that brought together most of the intellectual currents discussed above. Lubbock accepted the antiquity of humankind, social and biological evolution, and the notion of the psychic unity of humanity. In fact, the mutual coherence of these ideas, rooted in the doctrine of progress, made them easily integrated. Lubbock also paved the way for the racist and imperial interpretation of the archaeological record.

Before examining Lubbock’s interpretations, a few points about the archaeological record must be addressed. The first of these is that the *three age system* of Stone Age, Bronze Age and Iron Age, first discussed by Lucretius in the first century B.C., had been adopted in the early 19th century by the Scandinavian archaeologists Christian Thomsen, Sven Nilsson and Jens Worsaae to explain the sequence of the artifact record in Denmark (Trigger 1989: 73-86). Although Scandinavian archaeology “was largely ignored by the antiquarians of France and England,” Lubbock was certainly aware of this system and in 1866 translated some of Nilsson’s work into English (Trigger 1989: 87; Daniel 1975: 79).

Another advance was the work done by Edouard Lartet and Henry Christy in the Perigord region of France. Lartet, a magistrate, with the assistance and support of the English banker Christy, began a series of excavations in the Vézère valley. They excavated the famous sites of La Madeleine, Le Moustier and Les Eyzies. In 1864 they published their first article on the Perigord caves in the *Revue Archéologique* (Daniel 1975: 95). At this point, their main contribution was that “the Stone Age was not a single and simple phase of human culture but rather a succession of phases” (Daniel 1975: 96). They felt that the three sites of Le Moustier, Laugerie Haute and La Madeleine were not sufficiently uniform to

warrant the same classification. Henry Christy “proposed classifying prehistoric stone implements into three periods: (i) the oldest, those of the Drift or Diluvium, (ii) those found in caves, and (iii) the youngest, those found on the surface” (Daniel 1975: 100). Lartet, on the other hand, preferred a palaeontologically based sequence divided into periods associated with faunal remains. These periods were, from oldest to youngest, the Cave Bear stage, the Mammoth and Woolly Rhinoceros stage, the Reindeer stage and the Auroch or Bison stage. Later he accepted the view that the first two were not temporally distinct (Trigger 1989: 95). The site of Le Moustier, which later became the type assemblage for the Mousterian or European Middle Palaeolithic, was assigned to the “new Cave Bear and Mammoth period” (Trigger 1989: 95). To this sequence, Felix Garrigou added an earlier Hippopotamus Age. Lartet subsequently refined this sequence into three stages, Lower, Middle and Upper, known more often at that time as Hippopotamus, Cave Bear and Mammoth, and Reindeer ages (Daniel 1975: 100-101).

John Lubbock was particularly well suited to providing the first synthesis of prehistory. A Fellow of the Royal Society and a neighbour of Darwin, Lubbock had visited the sites in the Somme Valley and “found two implements” (Lubbock 1869; 333, 338). Lubbock’s most lasting contribution to archaeology was the division of the Stone Age into the Palaeolithic and the Neolithic periods, in addition to the Bronze and Iron Ages. The four periods were defined as follows (1869: 2-3):

- I. That of the Drift; when man shared the possession of Europe with the Mammoth, the Cave Bear, the Woolly-haired Rhinoceros, and other extinct animals. This we may call the “Palaeolithic” period.
- II. The later or polished Stone Age; a period characterized by beautiful weapons and instruments made of flint and other kinds of stone This we may call the “Neolithic” period.
- III. The Bronze Age
- IV. The Iron Age

Lubbock used both Christy’s distinction between Cave and River-Drift sites (Chapters X and XI of *Pre-historic Times*, 1869, respectively) and Lartet’s faunal associations. Thus, in 1865 the discipline of Palaeolithic archaeology emerged and, according to Trigger, “quickly acquired a high-profile role alongside geology and palaeontology in the debates concerning a question of escalating interest” (1989:94).

The discovery of human-made artifacts and sequences based on technology (flaked vs. polished) begged for a behavioural interpretation. Lubbock used an analogy from palaeontology (1869: 416):

Deprived . . . of any assistance from history, but relieved at the same time from the embarrassing interference of tradition, the archaeologist is free to follow the methods which have been so successfully pursued in geology - the rude bone and stone implements of bygone ages being to the one what the remains of extinct animals are to the other . . . if we wish clearly to understand the antiquities of Europe, we must compare them with the rude implements and weapons still, or until lately, used by the savage races in other parts of the world. In fact, the Van Diemaner and South American are to the antiquary what the opossum and the sloth are to the geologist.

Lubbock examines the behaviour of the Hottentots, Veddahs, Andaman Islanders, Australians, Tasmanians, "Feegee Islanders," Maories, Tahitians, Tongans, "Esquimaux," North American Indians, Paraguay Indians, Patagonians, and last (and perhaps least to him), the "Fuegians" (1869). Lubbock's view of these cultures is somewhat less than sympathetic (1869: 571):

The mental sufferings which they thus undergo, the horrible tortures which they sometimes inflict on themselves, and the crimes which they are led to commit, are melancholy in the extreme . . . Their real condition is even worse and more abject than that which I have endeavored to depict.

Lubbock's views were a product of his times, and represent a broadly unilineal version of social and biological evolution. In "assuming the common origin" and "the unity of the human race," he believed that these "lowest races" were "at least as far advanced as were our ancestors" (1869: 573, 575). Tim Murray argues that "the whole rationale of [this work] was that present savagery was a reliable guide to the early history of Europeans" (1992: 732). However, Lubbock did have a view of culture that was less simplistic and deterministic than others (1869: 539):

The civilisation, moreover, of the Stone Age differs not only in degree, but also in kind, varying according to the climate, vegetation, food, etc.; from which it becomes evident - at least to all those who believe in the unity of the human race - that the present habits of savage races are not to be regarded as depending directly on those which characterised the first men, but on the contrary as arising from external conditions, influenced indeed to a certain extent by national character, which is after all but the result of external conditions acting on previous generations.

Following the biological evolutionary concept of natural selection, he believed that these external conditions acted as selective forces. He cited Alfred Wallace in support of the notion of the success and spread of the “better and higher specimens of our race” (1869: 579). In addition, Lubbock does not seem to make direct connections between sites, or archeological periods, and modern “primitive” groups, as later authors did.

Edward Tylor, who had worked with Christy, was another contemporaneous author who presented a similar, basically unilineal scheme which was articulated in his *Researches into the Early History of Mankind* (1865; Bowler 1992: 725). He too made distinct parallels between the ancient Stone Age and modern groups: “wherever the use of stone instruments, as they were used in the Stone Age proper, is to be found, there the Stone Age has not entirely passed away” (1865: 191). However, Tylor appears to be more moderate than Lubbock, stating that (1865: 368-369):

Every attempt to trace back the early history of civilization tends, however remotely, towards an ultimate limit - the primary condition of the human race, as regards their knowledge of the laws of nature and their power of modifying the outer world for their own ends. Such lines of investigation . . . seem to enable the student to see back through the history of human culture to a state of art and science somewhat resembling that of the savage tribes of modern times But if we may judge that the present condition of savage tribes is the complex result of not only a long but an eventful history . . . *it does not seem likely that any tribe known to modern observers should be anything like a fair representative of primary conditions.* Still, positive evidence of anything lower than the known state of savages is scarce in the extreme [*italics mine*].

Tylor and Lubbock’s notion of the unity of humankind and their conceptions of human culture prevented them from pushing these analogies any further.

Building on the works of Lartet, Christy and Lubbock, Gabriel de Mortillet, a geologist and palaeontologist, offered a more detailed unilineal sequence for the archaeological finds in France. Upon returning from exile due to his participation in the Paris revolution of 1848, he began to work on the history of humanity; he founded the journal *Matériaux pour l’Histoire positive et philosophique de l’Homme* in 1864 (Trinkaus and Shipman 1992: 101; Daniel 1975: 103). De Mortillet was a student of Lartet and helped him organize the prehistory exhibit at the 1867 Paris Exposition (Daniel 1975: 103). Despite close links, de Mortillet rejected the explicitly palaeontological criteria upon which

Lartet based his sequence of culture. He favoured archaeological criteria instead and substituted the names of archaeological sites for Lartet's faunal categories. In 1869 de Mortillet proposed four epochs: the epoch of Le Moustier, or Mousterian; the epoch of Solutré, or Solutrean; the epoch of Aurignac, or Aurignacian; and the epoch of La Madeleine, or Magdalenian (Daniel 1975: 104). Besides naming these epochs after the sites, he used artifactual criteria for their identification. For example, the Mousterian, our specific area of interest, was characterized by tools made on stone flakes and the lack of worked bone (Daniel 1975: 103). Each site exhibited a characteristic set of diagnostic artifacts, creating a sort of "index fossil" or *fossile directeur*, analogous to those used in palaeontology. By 1883, de Mortillet had expanded his chronology for the Stone Age to include six stages; the Aurignacian dropped out due to de Mortillet's uncertainty concerning its placement and three others were added (Daniel 1975: 105):

- (6) Robenhausien;
- (5) Magdalenian;
- (4) Solutrean;
- (3) Mousterian;
- (2) Chellian;
- (1) Thenaisian.

In 1897 this scheme was further expanded to encompass the protohistorical and historical eras (see Trigger 1989: 97). De Mortillet's overarching interest was in establishing human progress as a law of nature (Trigger 1989: 100).

Glyn Daniel convincingly argues that de Mortillet's scheme had less to do with defining culture types than with linear periods of time (1975: 106-109).⁵ In essence, although rejecting palaeontological labels, de Mortillet stuck close to a geological and palaeontological interpretation, extending what has been called the palaeontological model in palaeolithic archaeology (Dibble and Rolland 1992: 5). It is worth noting that for all of these early authors, the importance of their schemes was viewing the artifacts as chronological markers, which "encouraged a non-cultural view of artifacts" (Trigger 1989: 99). The goal was simply to establish that progress occurred, rather than to explain the behaviour that underlay the archaeological record. With regard to behavioural interpretation, all of these researchers utilized ethnography; however, they did not state that nineteenth century "primitive" cultures were simply evolutionary leftovers from a bygone era.⁶ As Tylor recognized, due to the unity of humankind principle, they too must have evolved: "neither Lubbock nor Tylor could argue that the Van Diemaners

were 'frozen moments' from the Palaeolithic. Indeed the intellectualistic concept of culture they shared dictated that this could not be so" (Murray 1992: 733). The connection was forged, however, between modern primitive cultures and the Stone Age artifacts being excavated in Europe; the eventual "practical result was that the Van Diemaners and the South Americans *did* become the fossil representatives of the Palaeolithic" (Murray 1992: 733). This association was due in part to the erosion of the notion of the unity of humankind (see Trigger 1989: 111).

Before continuing, it is worth taking stock of what achievements had been made in Palaeolithic archaeology. The first, most obvious event, was the expansion of time depth to human existence and cultural development. This newly discovered antiquity also played a crucial role in the development of modern cultural and social anthropology (Trautman 1992). Only six years after this discovery the discipline of Palaeolithic archaeology was given a name and recognized as an intellectual pursuit. Almost immediately, as in the case of Lartet and Christy, work began in earnest throughout Europe, but especially in France, to excavate, describe and categorize Stone Age materials. In this period, geological and palaeontological models were exclusively employed to explain the archaeological record. The emphasis was on providing evidence for progress, rather than on giving an explanation of that progress. Considering the relative infancy of the study of Palaeolithic archeology, this is not surprising, and this work did lay the foundations for subsequent research. Chronological concerns remain a cornerstone of archaeological analysis for the Palaeolithic and other periods. As for behavioural interpretations, the use of ethnographic analogy was promoted in prehistory. Equivalences were made between a culture's technological and its social and cultural "progress."

In this era of research, the Mousterian was named and identified as a distinct archaeological period. De Mortillet "is most often credited with a comprehensive theoretical treatment of this period" (Dibble and Rolland 1992: 2). He successfully used artifactual criteria to designate the Mousterian, and placed it in a broader context in the evolution of the Palaeolithic in France. Many of de Mortillet's period names remain in use, although they now often designate industrial variants, or assemblage types, rather than temporal periods. To this day the term Mousterian is still used, often with a geographical modifier (e.g., Levantine Mousterian). However, many authors prefer the more inclusive term

Middle Palaeolithic for all of the industrial complexes of the “Mousterian” period.⁷

HUMAN EVOLUTION AND THE NEANDERTHAL REMAINS

The association between Palaeolithic and modern cultures and the application of Darwinian evolution to human populations contributed to a racial interpretation of the archaeological record. As mentioned above, the theory of natural selection came in part from a particularly European view of society as expressed in the works of Thomas Malthus. The implications of Darwin’s work seemed obvious, especially when it was coupled with the recently extended human antiquity. As biological entities, humans must have evolved according to the general law of natural selection and must have shared an ancestor with the great apes, the creatures showing the greatest morphological similarity to them. As stated above, when Darwin published his *Descent of Man*, he referred to the “high antiquity of man” and the insights of Lubbock (1871: 170). At the end of this work, in an often cited passage, Darwin made an explicit link between contemporary primitive cultures and stages in human biological evolution (1871: 171):

The main conclusion arrived at in this work, namely that man is descended from some lowly-organised form, will, I regret to think, be highly distasteful to many persons. But there can hardly be a doubt that *we are descended from barbarians*. The astonishment which I felt on first seeing a party of Fuegians on a wild and broken shore will never be forgotten by me, for the reflection at once rushed into my mind - *such were our ancestors* [italics mine].

By the time he wrote *Descent of Man*, Darwin had coupled his own biological evolutionary theory with the social and archaeological evolutionary theory of Lubbock and others to form a new synthesis. Although Darwin believed in a common origin of humanity, the selective process had operated since that origin to produce significant differences between the races. Although these differences were not enough to call the different races different species, he believed that they accounted for the innate superiority of one group (the Europeans) over the others (Bowler 1992: 724).⁸

At this point certain other events in the history of the idea of human evolution should be noted. Chronologically, the discovery of the famous remains of the *Neander Tal* in Germany preceded both the establishment of human antiquity (as defined above) and the publication of Darwin’s and Wallace’s theory

of natural selection. Although other skeletal remains such as the Gibraltar and Engis skulls were discovered before the German specimen and are today recognized as Neanderthals, we are presently concerned with the intellectual discovery of Neanderthal Man, which is forever tied to that valley in Germany. In August of 1856, in the Neander Tal (literally and ironically, "The Valley of the New Man"), two grottos at Feldhofer yielded the enigmatic hominid remains (see Trinkaus and Shipman 1992: 5-7). The Neanderthal remains, considered by many to represent a new human type, were largely ignored in Germany because of the views of the eminent anatomist, doctor and scholar Rudolf Virchow, who despised anything resembling the doctrine of evolution (Trinkaus and Shipman 1992: 57-8). Virchow believed that each race had a separate origin and had not changed. He opposed evolution on the grounds that it was linked to the romantic *Naturphilosophie* that was fashionable in Germany. Virchow and many of his contemporaries in Germany viewed the Neanderthal specimen as a pathological modern human.

It was Virchow's intellectual rival, Ernst Haeckel, who accepted and promoted the ideas of evolution in Germany. Although Virchow's views were supported by his preminence and seniority, those of Haeckel grew steadily in popularity. Part of Haeckel's success was his support for the *Naturphilosophie* that Virchow rejected. By 1868 Haeckel had begun publishing a series of human pedigrees. He believed that the Neanderthal was a transitional form between apes and humans (Trinkaus and Shipman 1992: 146).

The reception of the Neanderthal remains in France was mixed. The schools of Broca and de Mortillet were prepared to accept them as evidence for evolution, but the *Museum National d'Histoire Naturelle*, which was still influenced by the legacy of Georges Cuvier's anti-evolutionary stance, did not. Paul Broca, founder of the *Société d'Anthropologie de Paris*, did not accept the Neanderthal as an ancient hominid, despite the fact that he supported the tenets of descent with modification and natural selection (Trinkaus and Shipman 1992: 84, 103). Broca did not, however, wholeheartedly endorse the emergent "Darwinism." In 1873, at the *Museum National d'Histoire Naturelle*, Jean-Louis-Armand de Quatrefage and Ernest Jules Hamy explained the fossil record with reference to the migration of racial groups such as the "Cannstadt race," which included the Neanderthal specimen (Trinkaus and Shipman 1992: 109). In so doing they denied that evolution had taken place. In 1886 Paul Topinard, Broca's

successor at the *Société d'Anthropologie* used the fossil record to support evolution (albeit cautiously), and called for more specimens (Trinkaus and Shipman 1992: 123-125).

In 1861 a description of the Neanderthal remains appeared in English. By this time Darwinism was making serious inroads into the scientific establishment (Trinkaus and Shipman 1992: 81). Although *The Origin of Species* did not specifically mention human evolution except for the phrase “Light will be thrown on the origin of man and his history,” the implications of the theory were well-known, making Darwin uncomfortable (Darwin 1985: 458). As noted above, evolution was not a new idea but in the earlier part of the 19th century had been overshadowed by the idea of the fixity of species. Once published, both Darwin’s and Alfred Wallace’s theories concerning evolution gained credibility and became entangled in the debate over human evolution.

In 1860 Thomas Huxley drew the general public into this debate at a dramatic meeting of the British Association at Oxford, where he openly argued in favor of evolution against Bishop Wilberforce before a sell-out crowd. He criticized Wilberforce’s appeals to religious prejudice (see Trinkaus and Shipman 1992: 80). In 1864 Huxley expanded his views on human evolution in *Man’s Place in Nature*, stating that “there would be no rational ground for doubting that man might have originated, in the one case, by the gradual modification of a man-like ape; or in the other case, as a ramification of the same primitive stock as those apes” (Huxley 1864: 164). He also endorsed many of the notions of social evolution, especially the idea of a progress to a “nobler future” (Huxley 1864: 161). For Huxley, the Neanderthal remains were slotted into the human evolutionary sequence; he believed that the specimen was human but that it was “truly the most pithecoïd of known human skulls” (Huxley cited in Trinkaus and Shipman 1992:87).

By the time that Darwin wrote *The Descent of Man*, models of human evolution included both biological and social evolution and the archaeological and fossil record. By extension, ideas concerning modern human racial and cultural diversity were integrated into these models. This view of human progress subsequently developed into the racial and imperial thinking that characterized the late 19th and early 20th centuries. Racism as an ideology, however, cannot be considered to have been invented at this time. It has its own history, but with the intellectual developments of the latter half of the 19th century it developed a new

form, one which harnessed new developments in science to its specific ends. The development of racist archaeology can only be seen in terms of the synthesis of the many currents of thought presented here. From the birth of Palaeolithic archaeology to World War II, these threads converged and, less often, diverged. The bulk of them, however, point toward a persistent theme: the racially motivated interpretation of Neanderthal behaviour.

RACE AS EXPLANATION OF THE ARCHAEOLOGICAL RECORD

Prejudice has deep roots in the Western European tradition, but racism proper involves the identification of race. In other words, racism differs from cultural prejudices in that differences are viewed as *inherent* or biological. Racism has a long history, and various methods to classify and describe the “races” of men have existed. The Enlightenment era gave further impetus to the tendency to classify and codify and to define man’s place in nature. The naturalist Carl von Linné (Carolus Linnaeus, 1707-1778), who invented the Linnean system of nomenclature, divided humans into several races, each with a specific character (Mosse 1985:20). Implicit in many of these schemes was the association of character and appearance. According to George Mosse, this shift marked the rise of racial stereotypes (1985: Ch. 2). All of these developments shaped racial thinking and had an impact on the developing field of physical anthropology. The shift to race as a fixed, inherent character was still to occur, however.⁹

A number of factors underwrote the rise of racism. One of these was the notion of “the other.” Much has been said about the mental construct of the other. One of the more notable recent views is that of Edward Said. In his *Orientalism* (1978) he maintains that “the Oriental was linked thus to elements in Western society (delinquents, the insane, women, the poor), having in common an identity best described as lamentably alien” (1978: 207). One can easily substitute most “others,” including the Neanderthal, for the term Oriental. These linkages were not only “subjacent” but explicit. Lubbock himself equated savagery with the lowest classes (Lubbock 1869: 588):

Out of 130,000 persons committed to prison in England and Wales during the year 1867, only 4137 could read and write well. In fact, our criminal population are mere savages, and most of their activities are but injudicious and desperate attempts to live in the midst, and at the expense, of a civilised community.

Such equivalences seem to come from an extension of the known to the unknown; thus the lowest rung of one's own society is equated with the savage at the far end of the world.¹⁰ Other cultures and groups are often simply described as "foils" or inversions of one's own group. Another factor which underwrote racial attitudes was political. Such valuations were often made by the group in a superordinate position of power; hence the negative sign in the structural equation was applied to the subjected rather than the subjector, whether within or outside Western culture.¹¹

Both these structural and political views of the other (they are not really separable) were applied to the archaeological and human fossil data. The Stone Age was not only described using metaphors from racial and imperial thinking, but also became a metaphor *for* such thinking. As mentioned above, Trigger cites the gradual decline of the ideal of the unity of humankind as a part of this process. From more moderate stances both Lubbock and Tylor, in their later works, seem to have moved away from the unity principle which had once restrained their work. Room for inherent differences had entered Tylor's work; he remarked that (1881: 74):

. . . there seems to be in mankind inbred temperment and inbred capacity of mind. History points the great lesson that some races have marched on in civilization while others have stood still or fallen back, and we should partly look for an explanation of this in differences of intellectual and moral powers between such tribes as the native Americans and Africans, and the Old World nations who overmatch and subdue them.

In 1893 Tylor wrote "On the Tasmanians as Representatives of Palaeolithic Man" in the *Journal of the Royal Anthropological Institute*. Here he states (1893: 152):

The Tasmanian specimens and records now place us in full view of the state of *a people in the Palaeolithic stage*, who may have lasted on in their remote and unvisited home from the distant ages when rudely chipped stones grasped in the hand were still the best implements of mankind . . . [italics mine].

In his 1913 edition of *Prehistoric Times*, Lubbock, now Lord Avebury, cited Ernst Haeckel, the German biologist, in support of the bushmen's proximity to the apes in the scale of evolution (1969 [1913]: 437; see Bowler 1992).¹² The "lowest" modern tribes had indeed come to be seen as living fossils of the Palaeolithic.

THE ASSOCIATION OF NEANDERTHALS AND MOUSTERIAN ARTIFACTS

Interpretations of the Neanderthal specimen quickly fell into the models set forth by biological evolution, which had through Darwin's (1871) synthesis been fused with social evolution and had already taken on a racist aspect. After the discovery of the Feldhofer Neanderthal, a number of other Neanderthal remains were unearthed.¹³ Another important fossil find of this era was the discovery of essentially modern-looking, ancient human fossils at Cro-Magnon in association with stone and bone tools.

In 1886 a spectacular find changed the study of both the Middle Palaeolithic in Europe and the Neanderthals permanently. This was the discovery of two nearly complete Neanderthal skeletons, in sound geological context, with Mousterian tools. The skeletons and stone tools were discovered in July 1886 in the cave of Spy d'Orneau, near Liège in Belgium, by an amateur archaeologist and lawyer, Marcel de Puydt and a geologist, Maximin Lohest (Trinkaus and Shipman 1992: 126). Lohest invited an anatomist from Liège, Julien Fraipont, to examine the skeletons and together they wrote a monograph which was published in 1887. According to Trinkaus and Shipman (1992: 128):

. . . [the monograph] showed without doubt that the remains were "eminently Neanderthaloid" and unquestionably old . . . their assessments were extremely persuasive.

The authors believed that the remains were human, but apelike, rather than intermediaries between ape and humans. They thought that because of their anatomy, the Neanderthals must have walked with bent knees (see Trinkaus and Shipman 1992: 129). They were viewed as bent-kneed, shuffling, apish cavemen, an image which lives to this day in the popular imagination (see Stringer and Gamble 1993: 26-30). In the 1890s attention turned briefly away from the Neanderthals to Eugène Dubois' dramatic ancient *Pithecanthropus* finds in Java. In this decade many believed that the Neanderthals were primitive and apelike, but still human ancestors.

FROM UNILINEAL TO BRANCHING EVOLUTION

As evolutionary thought continued to be applied to prehistory, it had to change to accommodate the data. The model of branching evolution, which was explicit to biological evolution in *The Origin of Species*, began to be applied to human races and cultures after 1859. In the biological model a single species,

under the influence of natural selection and random mutation, diverges to form variants or *incipient species*; over time these diverge to form *distinct species*, or one *branch* may die out (Darwin 1985: 155-169; see diagram). Darwin employed the analogy of a branching *tree of life* (1985: 171):

The affinities of all the beings of the same class have sometimes been represented by a great tree. I believe this simile largely speaks the truth. The green and budding twigs may represent existing species; and those produced during each former year may represent the long succession of extinct species. At each period of growth all the growing twigs have tried to branch out on all sides, and to overtop and kill the surrounding twigs and branches, in the same manner as species and groups of species have tried to overmaster other species in the great battle for life.

Here we see the vicious and competitive view of nature that Darwin espoused. When this model was applied to humans, the different races became the incipient species, or variations, a view that Darwin seems to have held. In the battle for life, one subspecies would eventually come out on top, or two separate species would be formed. The competitive aspect of Western society was turned back on itself, in the guise of biological theory. As Daniel points out (1975: 117):

by 1875 few were prepared to argue that the stages represented a natural development which took place uniformly all over the world, even if at varying rates in different localities. Most prehistorians were already arguing for a number of invasions to account for the more sudden cultural changes.

It was no coincidence that this change in the intellectual climate occurred along with growing imperialism. The application of this branching model to human races, archaeological "cultures," and the Neanderthals marks the interpretation of the Mousterian record after the turn of the century, although antecedents were clearly in place by the 1870s. The concomitant change in the nature of the data set was the increasing diversity in the fossil and assemblage record, for which there had to be an account. The dominant model for explaining Middle Palaeolithic archaeological variability in this period (1886 - 1945) was the branching evolution pattern, which took on a clearly racial and usually racist aspect. Race and nationhood became equated, and it was believed widely that imperialism followed the laws of nature dictated by the branching model of evolution.¹⁴

NEANDERTHALS EXPELLED FROM THE HUMAN LINEAGE

The Spy Neanderthals marked a turning point in the interpretation of Neanderthals and the Mousterian. The biological and archaeological record became more closely intertwined for the Palaeolithic. The bent-kneed, beetle-browed ape-man would soon be expelled from the direct ancestry of humans. Although some of this was surely due to the Spy analysis, a number of factors contributed. The association of the Middle Palaeolithic with the Neanderthal, and the association of essentially modern humans, the Cro-Magnons, with an Upper Palaeolithic industry, created an explanatory dilemma. Their relatively close proximity in the European sequence seemed to preclude a direct evolution from one to the other.

As mentioned above, a dramatic increase in the discovery of artifact assemblages and fossils led to a greater diversity in the archaeological record. One of the more dramatic finds of this era was the discovery of the site of Krapina in Croatia. The excavation, conducted by Karl Dragutin Gorjanović-Kramberger, a palaeontologist at the University of Zagreb, and completed in 1906, yielded remains from about seventy individuals according to Trinkaus and Shipman (1992: 172).

In 1907 William Sollas, an Oxford geologist, wrote the first detailed description of the Gibraltar skull which had been discovered in 1848 and had been recognized as a Neanderthal by Falconer in 1864 and again by Broca in 1869 (Trinkaus and Shipman 1992: 172-3). In that same year a jaw was discovered at Mauer near Heidelberg. Because it was older and more massive than those of the Neanderthals, some thought that it was from either a separate human type or a pre-Neanderthal. In 1908, much to the resentment of the French, Otto Hauser, a German-Swiss amateur and antique dealer, found a complete skeleton of an adolescent Neanderthal at the site of le Moustier, immediately beneath where Edouard Lartet had worked (Trinkaus and Shipman 1992: 176). The following year, at Combe Capelle he found a skeleton with modern anatomy, in association with Aurignacian (Upper Palaeolithic) tools, immediately above a Mousterian layer (Trinkaus and Shipman 1992: 178).

French scholars, who were not to be outdone by foreign interlopers, made a number of important finds on French soil. Perhaps the most important fossil find for creating a lasting image of the Neanderthal was the discovery of the so-called Old Man of La Chapelle-aux-Saints. This fossil was excavated in 1908 by

three French priests, the Abbés Amédée and Jean Bouyssonie and L. Bardon. They believed that the skeleton had been buried deliberately (Boule and Vallois 1957: 201). Two other important finds were made shortly thereafter: Denis Peyrony and Louis Capitan discovered two Neanderthals, a male and a female, at La Ferrassie in 1909; and in 1910 Henri Martin discovered bones from two other Neanderthals at La Quina. All of these skeletons were sent to Marcellin Boule at the Museum National d'Histoire Naturelle.

Boule and his colleagues took over from Gabriel de Mortillet the most prominent positions in French prehistory. In the early part of the 20th century there was an institutional conflict between the Museum National d'Histoire Naturelle and the more extreme École d'Anthropologie, now staffed by Adrien de Mortillet and Paul Girod (Sackett 1981: 87). Michael Hammond states that "Marcellin Boule had an alternative vision of scientific politics and of evolutionary change. Science should avoid controversial social issues as much as possible" (1988: 119).¹⁵ Both this institutional framework and the growing inconsistency of the database pushed these French scholars towards the model of branching evolution to explain every aspect of the Palaeolithic record.

Boule's first theoretical statement on the branching model came when he interpreted the human remains found at the Grimaldi site (1901). He believed that the modern human discovered there had either lived extremely close in time to or had coexisted with Neanderthals as represented by Mousterian tools (Hammond 1988: 119). He thus sought to prove that, considering the morphological differences between the two groups, Neanderthals could not have been the ancestors of modern humans. Once the fossil remains began to pour in after 1908, he was in a good position to argue this point. The La Chapelle-aux-Saints skeleton, which came across his lab bench first, became the prototypical Neanderthal for most English and French scholars for many years.

Marcellin Boule's analysis had a distinct impact on the interpretation of the Neanderthal and the Mousterian in four important ways: 1) he systematically dehumanized the Neanderthal remains whenever he could and emphasized their more "primitive" nature; 2) he systematically compared the Neanderthal to the "least developed groups of mankind," particularly the Australian peoples, thus extending the metaphors of the preceding generation, although in a new way; 3) he explained the Mousterian stone tool complex in terms of his evolutionary model; and 4) he advocated a pre-Sapiens model, whereby modern humans were

said to have evolved in Europe alongside the Neanderthal.

With regard to the first point, there are a number of idiosyncracies in Boule's reconstruction. His preliminary assessment of the skeleton appeared in 1908 in *L'Anthropologie*, whereas a more complete analysis, using material from La Ferrassie to fill in fossil gaps, was published from 1911 to 1913 in the *Annales de Paléontologie* (Boule and Vallois 1957: 213, 213fn; see Trinkaus and Shipman 1992: 190). In light of modern re-analysis of this skeleton, it is clear that Boule's theories of human and Neanderthal evolution preceded and heavily influenced his interpretation. Trinkaus and Shipman state (1992: 190):

What is remarkable is that, despite Boule's evident scholarship and care, the monograph is also astonishingly wrong in many of its conclusions. He took the Old Man of La Chapelle-aux-Saints as the 'type' of Neanderthals . . . and painted a detailed picture of Neanderthal anatomy that became the revealed truth. And this truth showed Neanderthals as terribly primitive and apish, in no way a possible ancestor of the glorious Cro-Magnons who followed them so quickly in time.¹⁶

Boule's view of the Neanderthal in human evolution was reiterated in *L'Homme fossiles*, first published in 1921 (Boule and Vallois 1957).¹⁷

From anatomical point to anatomical point, Boule never gave the specimen the benefit of the doubt regarding its possible humanity. The description of the skull in *Fossil Men* begins with the following statement (1957: 214):

The skull of the man from La Chapelle-aux-Saints looks strange even to the eyes of an observer only slightly acquainted with anatomy. First its great size strikes us Next we are impressed with its bestial appearance or rather by the general effect of its simian characters.

Words such as *strange* and *bestial* offer a subjective impression of the specimen which is less than flattering. The rhetorical dimension of the work alone is sufficient to betray Boule's underlying concerns: the denigration of the Neanderthal and its expulsion from the human lineage. The large bony brow (superorbital torus) of the Neanderthal is described as heightening "an appearance of ferocity" (1957: 222).

Boule also interpreted specific elements of the fossil in an attempt to demonstrate its divergence from human forms. The "general flattening of the skull," "its absence of forehead," the degree of sexual dimorphism, "the retreating character of chin," the "separation of the first toe," "the backward position of the

foramen magnum which must have caused the body to incline forward” and the bent-kneed gait all testify to its primitiveness (Boule and Vallois 1957: 218, 222, 225, 241-242). A number of these features, particularly the separation of the first toe, the forward incline of the body and the bent-kneed gait, have all been subsequently rejected as erroneous.¹⁸

In order to establish the branching pattern, Boule pushed a number of anatomical points towards his interpretation (1957: 223):

This fossil Man, which in so many of his characters approaches the Apes more than any other Man, is nevertheless so widely divergent from them as regards his nasal region, that instead of being simian in this respect, he might rather be looked upon as *ultra-human* . . .

In addition to the nasal region, Boule found the dentition of the Neanderthal to be essentially the same as that of a human. The combination of clearly primitive features (in his estimation) and these essentially human and “ultra-human” traits became the key premise in his adoption of a branching pattern (1957; 255).

The second feature of Boule’s work was the systematic comparison of the Neanderthals to living human populations. When he was willing to accept humanlike features of the anatomy, the comparison was always to so-called primitive groups. For the dental patterns, “the points of resemblance are with savage, not civilized races” (1957: 231). He used an essentially cultural description (savage, not civilized), to compare an anatomical feature, dentition. When he compared Neanderthal stature with various “ethnographic groups,” his list included many of the set of “primitives” which Lubbock used in 1865. The Australians served as Boule’s benchmark of savagery (1957: 252):

It can no longer be asserted that the Australians are descended from our Mousterians All that can be admitted in this respect is that the Australian group of Men, *certainly one of the least developed groups of modern mankind*, is less far removed than other races from the primitive forms, and that, in consequence, it ought to have certain characteristics in common with the Neanderthal type [italics mine].

This analysis is interesting because it states that although they are not Neanderthals, groups such as the Australians remain underdeveloped, lesser forms of humanity.¹⁹ Boule also placed primitive groups such as the Andamans, Australians and African Negroes in a continuum of cranial capacity with anthropoid apes on one end and Frenchmen on the other (1957: 245).²⁰ Not incidentally, Boule found a means to explain away, in terms of cognitive ability,

the relatively large cranial capacity of the Neanderthal.

The third point, related to the debate concerning “his psychic attributes; his mental life,” on which Boule denigrates the Neanderthal is the position of the Mousterian artifact assemblages. He simply dismisses them as follows (1957: 245):

First of all we may appeal to archaeological evidence. All the Mousterian handiwork known to us is very primitive and rude in character, and does not argue in favour of the superiority of the brain which conceived and created it.

The final point of importance in Boule’s analysis is his advocacy of the pre-Sapiens model. Boule believed that in both the European Lower and Middle Palaeolithic, humans and Neanderthals had followed separate evolutionary branches, the humans ultimately winning in the Upper Palaeolithic. When more skeletal material from the Lower Palaeolithic began emerging, it was divided into pre-Sapiens and pre-Neanderthals (see Boule and Vallois 1957: 177-192). Boule and Vallois summarize the relationship between *us* and *them* as follows (1957: 256):

... we have seen that Men of different physical structure, the probable ancestors of the various races of *Homo sapiens*, had existed in Europe since the Lower Pleistocene alongside the precursors of the Neanderthals. Cro-magnon man, who seems suddenly to have replaced Neanderthal Man in France, appears to us like the descendant of this primitive stock, which was particularly well endowed and whose evolution in a progressive direction was more regular and sustained. By contrast with this line, that of the Neanderthals represents the product of a different branch, now withered, a belated form, a survival of ancestral prototypes.

There is no better example of the explicit application of the branching model of evolution to human prehistory than this. This competitive view of the interaction between “modern humans” and the Neanderthals became the hallmark of evolutionary interpretation in Europe for this era.

THEORETICALLY CAUTIOUS ARCHAEOLOGY IN FRANCE

Boule’s interpretation of the fossil record was mirrored by the early discoveries of Henri Breuil in the field of Palaeolithic archaeology. Although much of Breuil’s work focused on the Upper Palaeolithic, including the well-known cave-painting sites, his findings appear to have reinforced the branching model for the Lower and Middle Palaeolithic. A particular discovery concerning

the Mesolithic helped bring the branching or multilinear model to the fore in archaeology. According to Glynn Daniel (1975: 239):

In 1909 in the Grotte de Valle, near Gibaja (Santander), in North Spain, Breuil and Obermaier discovered a classic Azilian deposit together with microlithic flints of the typical Tardenoisian form, "After this discovery", as Osborn said [see below], "it could no longer be questioned that the Azilian and Tardenoisian were contemporary." What was true for the Mesolithic, namely the contemporaneity of several of the supposed "epochs," appeared also to be true as each of the other great "stages" of human culture was studied. In the Lower and Middle Palaeolithic detailed studies revealed many industries instead of the simple succession Chellian (or Abbevillian), Acheulian, Mousterian.

This discovery and subsequent finds set the precedent in the field. It was shown that there were contemporaneous traditions in the Upper Palaeolithic, the Mesolithic and the Neolithic in Europe. The extension of such patterns to the Middle Palaeolithic, however, has remained a contentious issue. This model still sets the tone for the modern debate concerning Middle Palaeolithic variability; posited assemblage types or *traditions* are often considered to be discrete entities, despite evidence and arguments to the contrary.

The motivations for employing the branching model for the Palaeolithic in French prehistorical studies are complex. Michael Hammond argues that "the multilinear paradigm also had considerable appeal in France because it helped to sidestep questions of causation and materialism in analyzing evolutionary change" (1988: 128). In its French manifestation, the apparent complexity of the multilinear model helped to defer critical interpretive issues.²¹

James Sackett states that *straight archaeology* was emerging in this period (1981: 87):

In this approach researchers tend to dismiss palaeoethnological interpretation as mere speculation, and - invoking the principle of unripe time - defer the writing of culture history to some unspecified point in the future "when the data are in." They cultivate instead a narrow devotion to the empirical content of the archaeological record, engaging in intensive programs of excavation and preoccupying themselves with the **typology of artifacts and the structure of sites from which they derive.**

For the most part, the proclivity to categorize, sort into regional variations and identify discrete entities implicitly supported the branching model of cultural and biological evolution. The application of these empirical techniques and methods

paralleled the branching model and extended the palaeontological orientation begun in the previous period of French archaeology. Unlike de Mortillet and Lubbock's use of diagnostic artifacts for outlining a unilineal temporal system, the emphasis was to "delineate the major cultural traditions and industries which make up their successive temporal subdivisions" (Sackett 1981: 89). Synchronic variation was recognized in terms of the *fossiles directeurs*. From this perspective, such variation, often regional, became the basis for new traditions which formed new evolutionary branches.

The recognition of variability in the Middle Palaeolithic or Mousterian *per se*, began just prior to World War I with the work of M. Boursillon.²² He made the first detailed excavation and study of le Moustier, the *type site* for the Mousterian (Boursillon 1906). His goal was to examine minutely the layers in the site and document the transitions in de Mortillet's sequence involving the Mousterian. He excavated the *abri supérieur* of le Moustier and developed a typology of the tools he found (Boursillon 1906). Although this typology was more opportunistic and functional than descriptive and not rigorous by modern standards, it still described a wide range of artifacts, adequately demonstrating significant differences between the archaeological strata (Rolland in press a). *Bifaces* were viewed as a hallmark of the preceding Acheulian period. Boursillon made the important observation that there were bifaces or handaxes in the middle and upper layers and an absence of them in the base layer at the *abri supérieur*, thus documenting a lack of handaxes for many layers and their subsequent reappearance in the record (1906: 317-318, 320). The role and position of bifaces in the Mousterian later became one of the more controversial issues in the modern era. Boursillon's documentation of a transition from the Middle to the Upper Palaeolithic at the site was also important to later debates. There was, however, no record of a transition from the preceding Acheulian to the Mousterian (Boursillon 1906: 317; 1911: 298-299). Although the *abri supérieur* contained a good cross-section of the possible variability of the Middle Palaeolithic for this region according to modern typologies, problems in interpreting this body of information include the loss of the archaeological materials and Boursillon's untimely death.

The next major figure was V. Commont, whose work appeared in 1909 and 1913. Commont incorporated the concept of the Levallois core preparation technical facies in his definition of the Mousterian (1913: 56-57, 59). In addition,

he retained the diachronic orientation of de Mortillet, expanding it within this period using terminology such as *Moustérien ancien*, *Moustérien classique*, and *Moustérien supérieur* (or *évolué*). Thus for Commont, Mousterian was a broad term, in many ways congruous with modern definitions. Rolland identifies three important observations of Commont: (1) a greater antiquity of Northern European Mousterian assemblages; (2) regional differences in evolutionary trajectories between northern French and southern French sites in the “evolved Mousterian;” and (3) a consideration of the impact of regional circumstances (access to materials, length of occupation, etc.) on the production of tool characteristics (here his concept of facies became important; Rolland in press a; Commont 1913: 138-140). These important points remained understated until the subsequent era in Middle Palaeolithic research. Commont, retaining a Mortilletian scope, appears to have said little on the broader interpretive issues. However, his understanding of the processes of tool manufacture and the identification of factors relevant to these processes were sophisticated for his time. Because of his comparison of regional differences and an emphasis on the impact of local conditions, Commont went beyond the scope of the theoretically cautious archaeology of this period.

In this era D. Peyrony had the most enduring impact on subsequent research. In addition to excavating numerous sites and setting forth an assemblage typology, Peyrony fit his empirical observations to the ideas of the day, most notably branching evolution, which was particularly dominant between the world wars. Like Bourlon, Peyrony’s descriptions were based primarily on excavations at the site of le Moustier (Peyrony 1930). His goal was to work out a regional chronology for the Perigord region (Rolland in press a). Peyrony excavated in the abri supérieur of the site in 1905 and published his results some 25 years later in a two-page summary (1930: 50-51). The site was subsequently exhausted by Hauser when he discovered the skeleton mentioned above. The role of the abri supérieur was likely played down due to Hauser’s negative influence. Most of Peyrony’s work was based on the *abri inférieur*, although he (mis-)used both his own data and Bourlon’s from the upper rock shelter.

Peyrony divided the assemblages he studied into two separate traditions (1930: 175). The first of these was the *Moustérien de Tradition Acheuléenne* (or *MTA*; 1930: 74). He considered this tradition, present in three layers of the abri inférieur, to have been derived from the preceding Acheulian. According to

Peyrony, this type was also present at the base of the abri supérieur sequence discussed by Bourlon, and could be identified by the presence of cordiform bifaces (handaxes), backed knives and *racloirs* (side scrapers), all of which show a “short” form of retouch (Peyrony 1930: 49, 74). The second tradition was the Typical Mousterian. This was found in several layers at Le Moustier as well as at La Ferrassie and La Quina, and contained numerous *racloirs* and points, all showing a “long” retouch (1930: 58-59).

This twofold system synthesized and categorized the variability within the Mousterian that was first recognized by Bourlon. Peyrony’s specific interpretations of this variability set the stage for the subsequent debate concerning the variability within the Middle Palaeolithic. His assertion that the base layer of the upper rock shelter of Le Moustier contained bifaces led him to conclude that the two types of assemblages he identified were in fact the remains of distinct, parallel toolmaking traditions. In essence, he posited that the two assemblages were interstratified throughout the Mousterian era, and one could not have developed into the other. The assertion that the base layer contained bifaces clearly contradicted the findings of Bourlon: Peyrony attributed the MTA label to layer 8 of the classic sequence of the abri supérieur. Bourlon, on the other hand, unequivocally indicated the absence of bifaces from that same layer (1911: 298-299). Peyrony mentioned neither Bourlon’s findings of a clustering of (what would now be recognized as) MTA layers near the top of the sequence nor the transition to Upper Palaeolithic industry types (Rolland in press a; Bourlon 1906: 317-318, 320). Peyrony attributed these parallel toolmaking traditions to distinct Mousterian ethnic groups or tribes, who were made up of different, autonomous, groups of Neanderthals who nevertheless did influence each other (1930: 171-172). Although chronological change was still discussed (as in the development of the MTA from the Acheulian), synchronic variability became the predominant concern of prehistorians. The interstratification of Mousterian assemblage type variants, particularly at Le Moustier, has remained a widely accepted postulate since that time despite its tenuous claim to validity (Rolland in press a).

Henri Breuil was the last major figure in this period to influence the study of the Middle Palaeolithic. He was a prolific writer and excavator who placed the Middle Palaeolithic within a broader chronological frame. Like Peyrony, Breuil was instrumental in extending the branching evolutionary model, and in his case almost doing so to the point of absurdity. Although Breuil made a number of

important observations, he relegated even minor technological or typological variants to independent branches of his broader scheme. Breuil introduced a whole range of terms which no longer remain in current usage to represent these different traditions, e.g., Abevillian, Levalloisien, Tayacian, Mousterien des Grottes, etc. (Rolland in press a; see Breuil and Lantier 1959:149-155).

Breuil's primary work on the Middle Palaeolithic was in the Somme Valley, where he proposed his own model of parallel phylums for the European early Stone Age. He emphasized the continuity of different traditions through multiple eras such as the Lower, Middle and Upper Palaeolithic. For each tradition, he indicated a set of diagnostic stone-flaking techniques or typological features (see Rolland in press a). Perhaps the most problematic of Breuil's traditions was his *Levalloisien* tradition. He thought the similarly named technical process of core reduction represented a toolmaking tradition independent of the others. Although Commont had recognized this technical process as a facies in the geological sense, cross-cutting various regional and chronological dimensions, Breuil linked it to yet another independent tradition. Breuil's Levalloisien extended back in time, where it emerged from the *flake industry phylum* in the Lower Palaeolithic (Rolland in press a). Another of Breuil's phyla was the *biface industry phylum*, which included the Abevillian, the Acheulian, the Micoquian and the Mousterian with bifaces (MTA in Peyrony's usage).

Breuil's isolation of the *Moustérien des Grottes*, or Cave Mousterian, was an important observation. This complex of both technical and typological characteristics was considered to have a polythetic origin (Rolland in press a). In many ways Breuil anticipated subsequent observations (e.g., the effect of residence patterns on the formation of archaeological assemblages), but was constrained by his overarching evolutionary model. Breuil also divided Peyrony's Typical Mousterian into two distinct technical facies associated with the size of flint nodules, with two types of *debitage*, one producing smaller and the other larger flakes (Rolland in press a). The latter, known as Clactonian *debitage*, was to be found at the site of La Quina.

In general, despite many important observations, Breuil's theoretical position and evolutionary model (including his synthesis of the variability and the criteria employed in his nomenclature) lacked rigour and was marked by (Rolland in press a):

Une certaine confusion ou ambivalence entre techniques de débitage et typologie, entre faciès ou types d'industries ou traditions, mènent à réifier en entités distinctes ou en phases des variations mineures ou mal définies.

The overextension of the branching evolutionary model, with each minute variation linked to a different toolmaking tradition or group, led to great confusion in his work.

Despite the taxonomic confusion of this era, there was growing recognition of the diversity of the materials found in Mousterian sites. This recognition led to the theoretical problem of explaining the range and nature of Middle Palaeolithic variability. Both the "discovery" of lithic variability and the need to explain it have had a profound impact on the study of the Middle Palaeolithic as well as the theoretical models employed to this day.

For all of the early researchers and Mousterian taxonomists, the dominant models were from biology and the geological sciences. Both the extension of the branching evolutionary model, particularly in Peyrony and Breuil's work, and the use of palaeontological and geological models support Sackett's assessment of this era as devoted primarily to classification and the delineation of "cultural traditions" (1981: 89). The notion of parallel traditions involved simple equations: The presence or absence of certain tool types or technical processes (fossiles directeurs) in an assemblage indicated different preferences between ethnic groups or toolmaking traditions. The identification and naming of toolmaking traditions said little about the *behaviour* of the toolmakers themselves.

Sackett goes to some length to demonstrate that "the fundamental patterning in the artifactual and fossil records is essentially the same and that, as a consequence, culture history can be regarded and accounted for in essential *organic* terms" (1981: 90). Natural stratigraphy, rooted in geological changes, was equated with cultural stratigraphy as an extension of the geological and palaeontological models. In fact, many of the major transitions in the Palaeolithic record are still rooted in strictly geological phases, rather than in processes of culture change. Since both the fossil record and the archaeological record were rooted in the same systematics, they mutually reinforced one another. Although Sackett states that the archaeologists generally avoided "cultural" interpretation, Boule used the archaeological data to support his interpretations. As such, Boule's *biological* interpretations stood out as the *cultural* interpretation for this

period (Boule and Vallois 1957: 257):

In the Mousterian period it [the Neanderthal] represented a belated type existing side by side with the direct ancestors of *Homo Sapiens*; its relation to the latter was similar to that which exists at the present day between the races we call inferior and the superior races.

THE IMPERIAL SYNTHESIS: THE MOUSTERIANS IN BRITISH PREHISTORY

British scholarship pertaining to the Mousterians was different from that of the French in this era. Three main factors contributed to this. The first was the difference in political and social atmospheres; the pressures felt by the French scholars were either not present or different in England. The second factor was the relative scarcity of Mousterian sites in England. The third was the “discovery” of a notorious British fossil, *Eoanthropus dawsoni*, or Piltdown man. In spite of these factors, in the realm of human palaeontology there was an uneasy theoretical bridge between two important figures in the French and British traditions, Marcellin Boule and Sir Arthur Keith. This bridge centred on the application of the branching model to the archaeological and fossil record. The British position took on a distinctly imperial cast, and much cultural interpretation took place, probably because of Britain’s place in the sun.

It is useful to note the public image of the Neanderthal in Britain. Two depictions will be presented, that of the Neanderthal in the *Illustrated London News*, which has recently been discussed by Stephanie Moser (1992), and the portrayal of the Neanderthal by H.G. Wells in both his short story, “The Grisly Folk” and his *Outline of History*. These works conveyed a persistent image; they were not only misguided caricatures of Neanderthals, but were soundly based on the scholarship of the day.

The first depiction was published in the *Illustrated London News* on February 27, 1909 under the title “The most important anthropological discovery for fifty years.” The article referred to the discovery of the Old Man of La Chapelle-aux-Saints. Included was a brief discussion of the importance of the find and a comparison of cranial capacities. What was striking about the article was its large, double-paged fold-out drawing made by Kupka, originally published one week earlier in *L’Illustration* with an article by Marcellin Boule. The drawing was of a Neanderthal looking out of his cave in southwestern France. He was naked, hairy, and bent-kneed; his somewhat confused and quizzical face protruded; he was holding a club; and there was a human-looking skull lying on

the doorstep. Inside his cave there were a few human-looking bones, a boulder and what looked like a large bird nest, likely his bed. He was muscular and a somewhat sinister shadow was cast on the rockface. He looked like he would bash your brains out and eat you for dinner if you stumbled across him in a dark cave. Underneath this image was the following statement (1909: 312):

It is not the artist's intention to depict merely a type of prehistoric man, but the actual man whose skull was found recently in the Department of Corrèze Our drawing can fairly claim to be the first that has shown with any scientific certainty prehistoric man in his habit as he lived.

From an archaeologist's perspective it is remarkable that in the drawing there are no stone tools, which the Neanderthal must have made, possessed and used. The figure is little more than a slightly upright gorilla (in the pre-Fossey stereotype); the only evidence of tool use is the handle of the club he is holding, which could simply be a branch. Moser states that "the image contains the theory developed by Marcellin Boule in association with his analysis of the skeletal remains from La Chapelle-aux-Saints" (1992: 836). Such images are "influential documents which play a part in the shaping of archaeological debates" (Moser 1992: 831). At the very least, it was a potent popular image that has survived to the present in the public imagination.

The second depiction of the Neanderthal was in Wells' short stories and his synthetic history. "The Grisly Folk" was published in 1921 and was likely worked on at the same time as *The Outline of History*, which appeared as a fortnightly magazine from late 1920 through 1921.²³ In "The Grisly Folk," Wells begins by discussing the Neanderthal in intellectual terms before turning to a fictional account of the meeting of modern men and Neanderthals. He states that "the true men must have come into the habitat of the Neandertaler, and the two must have met and fought. Some day we may come upon the evidences of this warfare" (1928 [1921]: 680). In addition to the visual image of the Neanderthal as "hunchbacked and very big and low, a grey hairy wolf-like monster" he imparted a crucial mental difference to them: "we cannot conceive in our different minds the strange ideas that chased one another through those queerly shaped brains" (1928: 682, 686). He believed that modern humans had "laws and self-restraints" while the Neanderthals did not; "the two races were intolerable to each other" (1928: 681, 690). The demise of the Neanderthal was described in the following manner: "Great Paladins arose in that forgotten world, men who stood forth and

smote the grey man-beast face to face and slew him” (Wells 1928: 690-691). This is the branching model in dramatic form. In *The Outline of History*, Wells states that “this species of *Homo* [*neanderthalensis*] had certainly a very different mentality from ours; its individuals were not merely simpler and lower than we are, they were on another line” (1921: 52). Furthermore, the Neanderthal’s extinction was explained in terms of the competition between this simpler and lower species and our own (Wells 1921: 54-55):

The appearance of these truly human Post glacial Palaeolithic peoples was certainly an enormous leap forward in the history of mankind They dispossessed *Homo Neanderthalensis* from his caverns and his stone quarries.

This vision of replacing lower races by modern ones mirrored Imperial ideology.

Wells’ description was not simply a product of his imagination; such events were foretold in the scientific literature of his day. A perusal of Wells’ references provides an index to the well-known scientific literature on the subject for this era (Wells 1921: 39):

In this and the next chapters the writer has used Osborn’s *Men of the Old Stone Age*, Sollas’ *Ancient Hunters*, Dr. Keith’s *Antiquity of Man*, W.B. Wright’s *The Quaternary Ice Age*, Worthington Smith’s *Man the Primeval Savage*, F. Wood Jones’ *Arboreal Man*, H.G.F. Spurrell’s *Modern Man and his Forerunners*, O.T. Mason’s *Origin of Invention*, Parkyn’s *History of Prehistoric Art*, Salomon Reinach’s *Repertoire de l’Art Quaternaire* and various of the papers in Ray Lankester’s *Science from an Easy Chair*.

The first three references will be examined below.

1912 was an important year in British Palaeolithic studies. It marks the passing from one period to the next, when the Neanderthal was firmly expelled from the human lineage. The primary event in the new period was the discovery of the infamous Piltdown remains, which seemed to fulfill the prophecies of the pre-Sapiens model. It is instructive to see how the scholars involved in the discovery viewed themselves. Before this event the place of the Neanderthal was somewhat unclear in British scholarship.

In 1911 William Sollas wrote *Ancient Hunters and their Modern Representatives*. This work bridges the gap between the eras, but is very complex. Sollas, who earlier described the Gibraltar skull, mixes the unilineal model of Lubbock and de Mortillet with the branching evolutionary model. His compromise position was found in the diffusionist model, and he cites William

Halse Rivers Rivers (1911: vii). Rivers, Grafton Elliot Smith and William Perry were all leading proponents of the diffusion of cultures from a core culture area. Sollas believed that in the core area “evolution” occurred along the lines of de Mortillet and Lubbock, while the peripheral areas were the passive recipients of culture (see 1911: vii-viii). The most peripheral cultures, both geographically and technologically, were throwbacks to a particular phase in the European sequence (Sollas 1911: 85). Sollas thought that the Australians and the Neanderthals were not exactly the same (1911: 161-2):

the Australians are a lower race than the Neanderthal; at the same time, they are more closely aligned to it than any other; and we may regard the Australian as a survival from Mousterian times, but not as a direct descendant of the Mousterian races of Europe.

Sollas goes so far as to call the modern Australians “the Mousterians of the Antipodes” (1911: 170). He not only believed that the “more brutal Australians” were “almost identical in profile with some forms of Neanderthal skull,” but that there were marked similarities in their stone tools, which Tylor and Lubbock had compared previously with Palaeolithic implements (1911: 161, 170-175). The equation of both their morphology and their lithic culture led Sollas to imply that the customs of the Australians were like those of the Neanderthals. When detailing Australian funeral customs, for example, he said that they might shed light on the funeral practices at La Chapelle-aux-Saints (1911: 200). What must be made clear, however, is that the point of Sollas’ argument was not that the Neanderthals were sophisticated, but rather that the Australians were not. The Tasmanians were even lower than the Australians, who in turn were actually lower than the Neanderthals in Sollas’ estimation. He thought that the Tasmanians were a Lower Palaeolithic race. Sollas describes their extermination with the death of Truganini in 1877 (1911: 87):

It is a sad story, and we can only hope that the replacement of a people with a cranial capacity of only about 1200 c.c. by one with a capacity one-third greater may prove ultimately of advantage in the evolution of mankind. The world certainly needs all the brains it can get

The idea of successive colonizing races replacing the previous colonizing races is a clear analog to contemporaneous colonial policies. Sollas not only used a colonial metaphor to explain the data, but used the data to establish imperial ideology as a law of nature (1911: 383):

What perhaps is the most impressive in each of the cases we have discussed is this: that the dispossession by a newcomer of a race already in occupation of the soil has marked an upward step in the intellectual progress of mankind. *It is not the priority of occupation, but the power to utilize, which establishes a claim to the land.*

Hence it is a duty which every race owes to itself, and to the human family as well, to cultivate by every possible means its own strength: directly it falls behind in the regard it pays to this duty . . . it incurs a penalty which *natural selection, the stern but benevolent tyrant of the organic world*, will assuredly exact, and that speedily, to the full [italics mine].

Natural selection, “the doctrine of Malthus,” is applied to living human populations as an organic truism. In this context the notions of race and nation (or culture) are fused, and are acted upon by the “stern but benevolent tyrant.” In fact, Sollas extended the racial competition analogy further, and argued essentially that the diversity in tool “style and finish,” i.e., lithic variability, offered “a contradiction to that amazing doctrine which asserts the equality of individual men” (1911: 176-7).

Although the Neanderthals were not yet expelled from human ancestry (as they were in Sollas’ 1924 edition of *Ancient Hunters*), the branching model of social and biological competition and selection was forcefully applied to the data. Although done in a very crude fashion, it was also applied to the issue of lithic variability *within* archaeological traditions.

Before the Piltdown discovery, some British scholars still included the Neanderthal in the human family. Sir Arthur Keith, who later reversed his position and made his reputation on Piltdown’s back, believed until 1911 that there was a Neanderthal phase in human evolution. In May of that year he published a visual rebuttal to the La Chapelle-aux-Saints image in the *Illustrated London News*. Keith’s depiction was very different than the previous one: A white, bearded man, wearing at least some fur, sits in his cave making a stone tool. He has a string of beads and animal teeth around his neck, a cosy fire burns in the background and a well crafted, hafted spear points upward in the foreground. Moser points out that this image is more archaeologically oriented than Kupka’s reconstruction. The archaeological evidence is brought to the fore and evidence of stone tools, fire and hunting predominate. This image went the way of the Neanderthal in Keith’s own mind and was replaced with Boule’s image. Moser describes Keith’s motivations for abandoning the Neanderthal

phase hypothesis:

Keith (1949: 265) gives two reasons for withdrawing his support for the Neanderthal Phase thesis. He claims that his views were 'rejected out of hand by the leading authorities of the time' (Keith 1946: 141), and that the influence of the French palaeontological community [i.e., Boule] also led him to change his mind (Keith 1950: 318-19).

In 1911 Boule's monographs on La Chapelle-aux-Saints were beginning to appear and to penetrate the academic world (Hammond 1988: 121). Keith's main theoretical purpose throughout his career was to extend human ancestry and to promote the idea that "humans had acquired a large brain and erect stature much earlier than had been thought" (Moser 1992: 839; see also Trinkaus and Shipman 1992: 196-9, 210). The Neanderthal phase was thus expendable. The timing of Keith's conversion, just prior to Piltdown's discovery, has led some to suspect his involvement in this scientific fraud.

On November 21, 1912, a brief article in the *Manchester Guardian* proclaimed the discovery of a new fossil human and stated that "there seems to be no doubt whatever of its genuineness" (cited in Trinkaus and Shipman 1992: 203). This first public announcement, which has been described as "an artfully constructed leak," set the tone for its near unanimous acceptance among British scholars (Trinkaus and Shipman 1992: 204). Dubbed *Eoanthropus dawsoni*, "Dawson's dawn man," after Charles Dawson, its purported discoverer, this new fossil conveniently fulfilled many expectations about what a proper human ancestor should look like. The dawn man had a large cranial vault but an apelike jaw. This combination of features implied that an essentially human braincase was one of the first steps in the evolution of man. A certain amount of national pride appears to have been at stake. There had been few major finds in England dating from the crucial periods because much of England was glaciated during the Palaeolithic. Hammond points out that "many people seemed pleased that his early man with such a large and precocious brain was English and had chosen the rolling hills of Sussex for his home" (1988: 128).

Keith accepted the Piltdown remains as part of the human heritage in *The Antiquity of Man* (1916 [1915]: 396):

It is a skull with dimensions above the average and with certain peculiar characters, but in its general conformation it does not differ materially from human skulls of the modern type. The characters which mark Neanderthal skulls are all absent.

Pitldown was considered to be a good morphological ancestor to humans, in large part because its cranium *was* that of a modern human. The coupling of the Pitldown evidence in Britain and Boule's La Chapelle-aux-Saints reconstruction in France became the cornerstone of the pre-Sapiens theory. Modern humans evolved from either a Pitldown or one of his close relatives, and coexisted and competed with the Neanderthal in Europe. Boule himself accepted the cranium of Pitldown as authentic, but "had reservations about the jaw," and Breuil appears to have supported its authenticity (Trinkaus and Shipman 1992: 207).²⁴ A contributing factor in the acceptance of Pitldown was the downplay of dating methods and archaeological evidence in England (Hammond 1988: 122-3).²⁵

Although Keith devoted some space to the Mousterian period and its stone tools, his interpretations were more rooted in his biological theory and the imperial model (1916: 135-6):

The most marvellous aspect of the problem raised by the recognition of Neanderthal man as a distinct type is his apparently sudden disappearance. He is replaced, with the dawn of the Aurignacian period, by men of the same type as now occupy Europe. What happened at the end of the Mousterian period we can only guess, but those who observe the fate of the aboriginal races of America and of Australia will have no difficulty in accounting for the disappearance of *Homo neanderthalensis*. A more virile form extinguished him.²⁶

Elsewhere in Keith's writings, race and nation are equated: "nation and race are but different degrees of the same evolutionary movement" (1967 [1931]: 56).

Although he was not an English author, Henry Fairfield Osborn should be considered in the corpus of writers sharing this imperial perspective. Osborn, a member of the Royal Society and honorary doctor at both Oxford and Cambridge, was one of the foremost writers in the English-speaking world on the Old Stone Age. Wells appears to have followed Osborn's interpretation of the Neanderthal more closely than those of other authors (Wells 1921: 52fn). Compared to Sollas and Keith, Osborn's discussion of the archaeological record is more sophisticated. Under the guidance of Henri Breuil and others he visited many sites in France (1930 [1915]: vii). The outcome of his tour and research was *Men of the Old Stone Age: Their Environment, Life and Art* (1915).

Although Osborn remained agnostic about the association of the Pitldown cranium with the jaw and stated that "the Pitldown race is not ancestral to either the Heidelbergs or the Neanderthals," he believed its cranium was an extinct

offshoot of *Homo sapiens* and more closely related to modern humans than Neanderthals (1930: 144; see diagram 491). Osborn considered Neanderthals to be non-human, and held closely to Boule's comparisons of Neanderthals and Australians (1930: 224-7, 243-4). For the Australians, Osborn introduced the term Neanderthaloid: "races resembling the Neanderthal species may be characterized as 'Neanderthaloid'" (1930: 218).

In describing "Mousterian times," Osborn appealed to the archaeological record of Compton in advocating a three-stage "advance of the Mousterian industry;" he stated that the Mousterian was "not, however, marked by industrial progress or invention" (1930: 248, 252). After a reasonable discussion of the tool types which existed, demonstrating his knowledge of the record, he went on to discuss the demise of the Neanderthal (1930: 252, 260):

In the whole racial history of western Europe there has never occurred so profound a change as that involving the disappearance of the Neanderthal race and the appearance of the Crô-Magnon race. It was the replacement of a race lower than any existing human type by one which ranks high among the existing types in capacity and intelligence.

The Cro-Magnons were accepted as essentially European and thus given a high ranking vis-à-vis modern races at the dawn of the Upper Palaeolithic, despite the fact that Osborn thought they were migrants from outside Europe (1930: 261). As in the previous analyses, and despite a somewhat more sophisticated analysis, Osborn upheld the tenets of branching evolution and racial competition.

GERMAN VIEWS OF THE ÜRMENSCHEN

In Germany, during the first half of the twentieth century, biological arguments concerning human origins were influenced by the later writings of Ernst Haeckel. Haeckel outlived Virchow and died in 1919. He integrated his views on race with evolutionary theory. He believed that the differences between human races were greater than differences between recognized animal and plant species and the differences resulted in superior and inferior types (Haeckel 1973: cited in Roebroeks 1993: 14). Haeckel had also become a proponent of the eugenics movement (Trinkaus and Shipman 1992: 211). Although he believed in a common ancestor (*Homo primigenius*) for each of his proposed twelve types of humans, he felt that the lowest types were more closely related to the *Urmenschen* (Roebroeks 1993: 13-15). These lower types were

distinguished by their woolly hair (*Ulotrychi*).

Hugu Obermaier was a prominent German archaeologist from this period. He worked primarily in Southern Germany and Spain and wrote *Der Mensch der Vorzeit* (1912). Obermaier explained the evolution of humanity in ways similar to those of Sollas but his work was shaped by the *Kulturkreis* school of ethnology, primarily the work of Father Wilhelm Schmidt, rather than the English diffusionists (Roebroeks 1993: 10). The *Kulturkreis* school was interested in combining Christian theology and evolutionary theory. They believed that material and mental culture developed in conjunction, forming a culture circle in a core area. Obermaier believed that three consecutive culture circles emerged and spread over humanity in prehistoric times, each “invading” the previous circle (Roebroeks 1993: 10). The first “Eolithic” circle resulted in a primitive form of humanity, in both biology and culture. The second circle, the “Old Palaeolithic,” resulted in a highly developed stone tool culture and a “well documented death cult” (Obermaier 1912: cited in Roebroeks 1993: 10). The final circle, the “Young Palaeolithic,” was highly developed and above the level of contemporary *Naturvolker*. According to Obermaier, the first circle, associated with the early Neanderthals, also included the cultures of the African Pygmies, Australians and Tasmanians (Roebroeks 1993: 10). He did not provide many ethnographic parallels for the second and third stages but it is clear that the late Palaeolithic was associated with the works of European craftsmen. Although the Pygmies, Australians and Tasmanians were associated with the early Neanderthals, he felt that these first circle cultures were essentially human. It is also important to note that Obermaier worked with and was sanctioned by the Abbé Breuil (see Daniel 1975: 239; Osborn 1930: ix).

The model of a separate evolution of Neanderthals and humans, their competition and the ultimate success of humans, remained dominant in Western Europe until the outbreak of World War II. It closely mirrored and in many cases intellectually supported nationalist, imperial and colonial policies. The competition between Neanderthals and humans was described in the same terms as the competition between Western peoples and the indigenous peoples of Australia and the Americas. This *imperial synthesis*, as Trigger calls it, was not only applied to European archaeology but was incorporated into various regional, colonial traditions of archaeological interpretation in the Americas, Africa, New

Zealand and Australia (1989: 110-147). The prehistory of Europe was seen in terms of “natural” laws that were shared with racial and imperial theory. The replacement of one race or nation by another was seen as a pattern of progress that would ultimately lead to the betterment of humanity. There were various expressions of this policy: forced submission to Western cultural norms, massive migrations of peoples throughout the world, the eugenics movement, and outright extermination. Archaeological theory accepted such replacement as natural and applied it to the data at hand. In turn, it used evidence from the past to promote racial theory as policy. In effect, the replacement of Neanderthals in Europe by those considered to be the forebearers of modern Europe became a perfect metaphor for colonial and eugenicist policy. Sollas’ discussion of the Tasmanians is an excellent example of this and other authors were clearly thinking along similar lines.

NEW FINDS: THE GROWTH OF VARIABILITY IN THE FOSSIL AND ARCHAEOLOGICAL RECORDS

From the 1920s on the pre-Sapiens theory was held most strongly in France and England. This was due in large part to the prestige and position of both Keith and Boule in their respective countries. Keith became Sir Arthur Keith in 1921, and Boule “now had almost complete control of French paleoanthropology” (Trinkaus and Shipman 1992: 209-210). The rigour of the pre-Sapiens model was slowly eroded, however, as new fossils were discovered. Many of the newer finds were made outside of Europe, often by people outside of the mainstream of English and French scholarship. In 1911 a skull was found in Rhodesia by an African miner; it appeared morphologically intermediate between Neanderthal and human but some bones looked more archaic than both. In southern Africa Raymond Dart and Robert Broom found a host of new, more apelike skulls: the now famous *Australopithecines* or “southern apes.” In 1926, at Zhoukoudian in China, a series of fossils was emerging under the guidance of the Canadian Davidson Black. These fossils were at first called *Sinanthropus pekinensis* but are now considered to be *Homo erectus*. After Black’s death in 1934, his work was continued by a German Jew in exile, Franz Weidenreich, who found more remains and had the good sense to make casts of the skulls, the originals becoming lost after the outbreak of the Sino-Japanese War. In the 1930s two Dutch palaeontologists continued the work of Dubois in Java and found

several remains there. Back in Europe two more skulls were found that were neither fully Neanderthal nor modern human. The skull from Steinheim-an-den-Murr, Germany (1933) “was small and rounded . . . yet had a large browridge” and skull fragments from Swanscombe, near Kent, England (1935) were missing the crucial brow region. Both were of considerable antiquity. In Palestine some archaic yet modern-looking skulls were found near Mount Carmel under the supervision of Dorothy Garrod, the first female professor at Cambridge. However, a number of Neanderthal skulls were also found in the same area at the same time. These were the first “true Neandertals outside Europe” (Trinkaus and Shipman 1992: 249). It was disconcerting that the Neanderthals appeared to be more recent than the “archaic” humans, and the archaic humans appeared to have “Neanderthaloid” traits. Another problem that emerged later was the apparent association of Mousterian tools with non-Neanderthals.

The response to most of these finds was predictable. As Michael Hammond states (1988: 117):

In the physical anthropology of human evolution, the period between 1911 and the end of World War II was striking in that mankind was left virtually ancestorless. One by one, all major fossil populations were assigned to dead-end branches in our evolutionary tree. The pithecanthropines from Java and China, the Neanderthals from Europe, the australopithecines from Africa - all were seen as failed evolutionary experiments whose morphological specializations had doomed them to extinction without ancestry.

One of the crucial problems faced by the pre-Sapiens supporters on both sides of the channel was the lack of any finds to support their theories. No further Piltowns were found, for obvious reasons, despite Keith’s attempts to interpret certain fossils otherwise (see Hammond 1988: 130). Older *Homo* fossils in Europe and elsewhere, such as the Rhodesia find and both Swanscombe and Steinheim, failed to meet the expectations of these theorists and were variously positioned in the existing models.²⁷

In physical anthropology interpretations from outside the European metropole were beginning to offer new theoretical positions. Two researchers, Franz Weidenreich and Aleš Hrdlička warrant specific mention. Hrdlička demonstrated considerable diversity in human morphology both within and between racial groups, and thought that recognition of great variability in human morphological make-up would go a long way towards explaining variability in the fossil record. He believed in an essentially unilineal evolution of human forms, the

morphological differences between specimens being simply part of a normal, broad statistical population. The other advocate of a broad unilineal evolution was Franz Weidenreich, who on the basis of the Chinese fossils believed that “the regional variations in human form now recognized as racial differences were very ancient indeed, going back to the geographically separated populations of *Homo erectus*” (Trinkaus and Shipman 1992: 271).

At the same time, the archaeological record was gradually beginning to build up for the Mousterian in France but was usually interpreted only at an empirical level. Furthermore, the Mousterian finds in Palestine were increasing, considerably expanding the database, the diversity of which was growing and begged for a more structured analysis of the assemblage types and artifact typologies. Most finds were still being interpreted in light of the existing theories, but gradually the need for new models was becoming apparent.

CONCLUSIONS

Palaeolithic archaeology emerged as a discipline in the period from 1859 to the 1940s. Beginning with the recognition of the association of stone tools with extinct fauna, Palaeolithic archaeology almost immediately became intertwined in the debate concerning human origins and evolution. As early as 1865, Tylor and Lubbock compared the Stone Age with modern “primitive” populations. By the turn of the century, these populations were viewed in terms of the dominant evolutionary theories of the day. Nationalist, racist and imperial ideologies shaped these discussions. The cultural interpretations of the fossil record were often phrased in terms of racial theory and the progress of humankind. The first “cultural” interpretations of the fossil record were essentially unilineal, a progression of cultural phases. Modern “primitive” societies provided direct ethnographic analogies for the cultural record. A key assumption was that similar levels of technology between archaeological finds and modern groups meant that all aspects of the society were at similar levels of development. De Mortillet, although avoiding direct ethnographic analogies, presented an elaborately worked out sequence of archaeological periods for Europe, which became the standard chronology for the Palaeolithic for some time.

Following a roughly parallel trajectory was the growing recognition of hominid fossils that were not fully modern. The earliest fossil find, and the group to which this study applies, is the Neanderthal. Because of the morphological

differences between this fossil population and modern humans, racial theories were applied to them. It was not until 1886 that the Neanderthals were fully accepted as a non-modern human population.

At the same time, Neanderthals were associated with the Mousterian tool complex and this forced a cultural explanation of their behaviour. After the 1880s interpretations of the Middle Palaeolithic were strongly influenced by the biological evolutionary model, which by this time had applied the notion of branching evolution to human populations as an explanation of race. Neanderthals were viewed in terms of this branching model and as a result became part of the racial debate. Some authors, such as Sollas, equated the Neanderthals with modern populations. At the least, the Neanderthals were usually compared to the so-called “lesser” races; even when the Neanderthals were thought to be subhuman, they were considered to be more closely related to “lesser” races such as the Australians (e.g., by Boule).

It has often been said that the biological model provided the basis of interpretation for the archaeological record. In many ways this is true. If we look at the genealogy of the biological model itself, however, at least as expressed in terms of human populations, social evolutionism and racial theory cannot be extricated from it. Darwin himself explained the theory of natural selection in terms of the doctrine of Malthus, a theory rooted in human affairs. Evolution, whether unilineal, multilineal, social, biological or racial, had roots in the Victorian view of progress and the proclivity to categorize. The biological model placed imperial, racial and social theory on a respectable, scientific footing in the first half of this century. There is an unavoidable circularity in the interaction of these “ways of knowing,” which were all mutually reinforcing one another. If there was a dominant paradigm for this era it was the West’s view of itself as the wise ones: *sapiens sapiens*. Both the biological and archaeological record of human history was viewed from the perspective of progress, i.e., social evolution.

The cultural interpretations of the Mousterian for the period from around 1900 to the 1940s were influenced by the confusion of race and culture, which were seen by many to be intrinsically related, or even equated (e.g., Keith). At the same time, with the discovery of synchronic variability within Mousterian artifact assemblages, important observations were made concerning the archaeological record at a strictly empirical level of analysis. Many of these observations formed the basis for the post-war or “modern” debate concerning lithic variability in the

Middle Palaeolithic. However, interpretations of behaviour remained rooted in the biological model. Theoretically cautious archaeology in France, where the bulk of the finds were made, deferred the cultural interpretations either to the racial theorists or to an unspecified time "when the data are in."

At both levels of analysis, the categorization of races, cultures and archaeological traditions into discrete entities was necessary to the theories of the period. In the first phase, when unilineal theories were dominant, the variability in the archaeological data was fitted into time periods at the empirical level of analysis. De Mortillet's work exemplifies such a process. The palaeontological model was followed, with artifact types acting as index fossils for a period. With regard to the cultural interpretation, as in the writings of Tylor, Lubbock and Sollas, such chronological periods were equated with discrete modern cultures and later discrete races. In the second phase, when synchronic variability was recognized, artifact types became diagnostic of parallel cultural traditions which were considered to be discrete. These were explicitly related to different racial groups or different species of hominids. On this level, the theory of the survival of the fittest was applied to explain the archaeological data. Eventually the "better" or more progressive parallel tradition succeeded in the struggle for life. The winning group was equated both structurally and explicitly with European society or the "white" race. The behavioural interpretation was borrowed from imperial ideology. The replacement of the Neanderthals by modern humans (read Europeans) was explicitly equated with the replacement of the world's aboriginal populations with white settlers. That such replacement was apparently found continuously throughout history and now prehistory led theorists to present this as a progressive law of nature. All of this rested on the partitioning of human cultures, archaeological assemblages, and hominid fossil types into discrete units. Variability in all of these records was interpreted in terms of categories which were inherently different and unequal.

¹ “. . . daß im vorigen Jahrhundert die heutigen Grenzen zwischen den verschiedenen Disziplinen verschwommener waren.”

² One common method of dating the biblical creation, and thus human antiquity, was to combine genealogical calculations from the bible with astronomical and historical evidence. The most famous calculation was performed by Archbishop James Ussher, who dated Creation to October 23, 4004 B.C. (Grayson 1983: 27). Charles Lyell, using the contemporaneity of “the human race” and *Elephas meridionalis*, gave two possible dates for the first “human” occupation of Europe - 88,000 and 224,000 years ago (Lyell 1873[1863]: 231, 335).

³ “Darwin hatte die etablierten Konkurrenz-Verhältnisse der Viktorianischen Gesellschaft auf die Entwicklung der natürlichen Arten projiziert.” Engels was, of course, one of the first to point this out.

⁴ Trigger enumerated five points which “were to become the basis of popular evolutionary thinking among the European middle classes;” these were 1) psychic unity; 2) cultural progress as the dominant feature of human history; 3) progress characterizes not only technological development but all aspects of human life, including social organization, politics, morality and religious beliefs; 4) progress perfects human nature, not by changing it but by progressively eliminating ignorance, passion, and superstition; and 5) progress results from the exercise of rational thought to improve the human condition; (1989: 57-8).

⁵ Daniel points out that “De Mortillet had arranged the collections in the Saint-Germain Museum according to his carefully graded subdivisions. He was infuriated because the curator of the Museum, Alexander Bertrand, changed the word Epoch on the labels in every case to Type. Adrien de Mortillet characterized this action as a craven compromise with the opponents of prehistory;” (1975: 125-6).

⁶ “De Mortillet was also influenced by a strong ethnological interest in cultural evolution during the second half of the nineteenth century” (Trigger 1989: 99).

⁷ For a discussion of these terminological problems see Mellars 1996: 4-6.

⁸ Darwin seems to have had the idea of “incipient species” in mind.

⁹ This idea was seen in Immanuel Kant’s *Von den Verschiedenen Rassen der Menschen* (*The Different Races of Mankind*, 1795). Although he upheld the common, biblical origin of humankind, he believed that races were groups which had maintained their purity through internal forces (Grayson 1983:147). Though not different species, they were separate and static (see Mosse 1985: 30-31). In contrast to this monogenist position, another school proposed separate origins for each of the different races. In 1774 Henry Home (Lord Kames) had argued such a position, stating that the different races were so physically and linguistically distinct that they could not have come from a single origin (Grayson 1983: 147). Many polygenists followed. Robert Knox and James Hunt, prominent in Darwin’s time, “were arguing that the non-white races were distinct species with different mentalities which would prevent them ever becoming civilized” (Bowler 1992: 721).

¹⁰ See Clive Gamble’s article, “Archaeology, History and the Uttermost Ends of the Earth - Tasmania, Tierra del Fuego and the Cape” (1992), for a discussion of the analogy between geography and time.

¹¹ There are notable exceptions to this, however, e.g., working class chauvanism towards immigrants and positive views of foreign lands as expressed in romantic literature.

¹² Haeckel became the primary exponent of evolution in Germany and often clashed with Virchow. Haeckel’s views incorporated Darwinian evolution, cosmic progress and the particularly nasty form of nationalist racism that was growing in Germany in the 1860s and 70s. In 1868 he proposed twelve different races, and thought that the difference between some of these races was greater than the differences which zoologists and botanists had recognized in plant and animal species. Haeckel ultimately became a proponent of the eugenics movement (Roebroeks 1993: 14; Trinkaus and Shipman 1992: 112-8).

¹³ In 1866 a chinless, apelike, yet otherwise human jaw from La Naulette in Belgium was discovered in association with extinct fauna, but was only later associated with Neanderthals. In 1874 and 1876 there were finds in Pontnewydd in Wales, and Rivaux in France, and in 1880, a Neanderthal child's mandible was found in Moravia. Broca viewed the Naulette specimen as transitional between ape and human, but many others did not accept this view (Trinkaus and Shipman 1992: 104-5). The Pontnewydd and Rivaux remains were for the most part ignored and the Moravian finds, despite their association with Mousterian implements, were denigrated by Virchow (Trinkaus and Shipman 1992: 123).

¹⁴ One of the more telling "confusions" of race and nationhood is found in a perplexing work by Sir Arthur Keith (see below) who had this to say in an Open Public Lecture for the Royal Anthropological Institute either in late 1929 or early 1930: "a nation always represents an attempt to become a race; nation and race are but different degrees of the same evolutionary movement" (1967: 56). "I believe that only knowledge, education, experience can help men to bridge the gulf of race - to bridge it not in a physical sense, but in a mental one" (Keith 1967: 64). In other words, race (inherent characteristics) and culture (education, knowledge) were equated.

¹⁵ Paul Graves further speculates that his position had to do with "his context in French Roman Catholic scholarship" (1991: 514). In response to this statement in the Comments section of Grave's *Current Anthropology* article, Francesco d'Errico states, "The only work cited by Graves that treats the historical reasons for Boule's interpretation is that of Hammond. According to the latter, Boule was influenced by the moderate attitude of his mentor, Gaudry, against the evolutionary and anticlerical position of the Ecole d'Anthropologie founded by de Mortillet. Hammond, however, neglects to mention Boule's own well-known anticlericalism and his uncompromising character . . ." (1991: 529). Graves replies in turn, "I have rechecked my assertions concerning Boule's Catholicism versus his alleged 'anti-clericalism' (d'Errico) and still fail to see how a colleague of the Abbé Breuil and Teilhard de Chardin, the director of a Catholic institution (the Institut de Paléontologie Humaine), and a staunch opponent of the anti-clerical de Mortillet (and the atheist Musée de l'Homme) could himself have been anti-clerical . . . Breuil and Boule may not have been the most devout of Catholics and . . . they may have missed Mass from time to time, but this is a long way from anti-clericalism" (1991: 535).

¹⁶ Trinkaus himself re-analysed the La Chapelle-aux-Saints material in 1985 in the *American Journal of Physical Anthropology* and is one of the foremost experts on Neanderthal anatomy in the United States.

¹⁷ *L'Homme fossiles* went through two editions under Boule's hand and was reissued in 1946 and 1952 with revisions by Henri Vallois, who succeeded Boule at the Museum National d'Histoire Naturelle. It was translated into English in 1957 and has often served as a textbook in Physical Anthropology.

¹⁸ See Trinkaus and Shipman 1992. The relation of the other traits to the normal range of human variation has been debated; however see Wolpoff 1989 and Stringer and Andrews 1988.

¹⁹ It should be pointed out that this quote is taken from the 1957 translation of the 1952 French version done with Vallois' revisions. Despite the change in *Zeitgeist* in scholarship that followed World War II, it is important to note the continuity that exists across what might be called a paradigmatic boundary. Vallois, as pupil and successor of Boule in the French academic tradition, might have felt a personal loyalty in upholding his intellectual ideas, thus contributing to such continuity. Such interpretive continuity is a marked aspect of French Palaeolithic research; see Audouze and Leroi-Gourhan 1981.

²⁰ This same table shows the extent of small-minded territorialism that characterized this era. A dichotomy is even established within France: Boule pointed out that the Parisians have a smaller cranial capacity than the Auvergnese (1957: 245).

²¹ See note 14. Hammond cites the power of the Catholic church in French scholarship as a probable cause for this. It is true that the church was uncomfortable with the ideas of evolution and a great human ancestry, the ultimate exile of Teilhard de Chardin being testimony. The participation of a good number of French clerics in these scholarly endeavours precludes a simplistic interpretation of the political and religious motives of the era. Trinkaus and Shipman state that "the Bouyssonie brothers formed part of a newly active 'modernist' movement within the French Catholic Church . . . It was all part of a struggle to find a compromise that would enable him [Amédée] and others like him to retain their religious faith and yet reconcile it with the increasingly incontrovertible evidence of evolution and other laws of nature;" it was Breuil himself who suggested to the Bouyssonies that they turn the fossils over to Boule (1992: 184-5).

²² His publications are dated from 1905, 1907, 1910, and 1911 Rolland in press a.

²³ The Neanderthal is not only discussed in its own right in *The Outline of History* but recurs later in the work: "Every now and then the reader of Roman history, reading it in terms of debates and measures, policies and campaigns, capital and labour, comes upon something that gives him much the same shock he would feel if he went down to some unknown caller in his house and extended his hand to meet the misshapen hairy paw of *Homo neanderthalensis* and looked up to see a chinless, bestial face" (1921: 303-4). Wells seems to have been smitten with the idea of the Neanderthal as the bogeyman. Even better is the following quotation, "A shambling, hairy, brutish, but probably very cunning creature with a big brain *behind*;" so someone, I think it was Sir Harry Johnston, has described *Homo neanderthalensis*. To this day we must still use similar terms to describe the soul of a politician" (Wells 1921: 308).

²⁴ Vallois was keen to point out Boule's reservation in his introduction to the 1957 edition: "As many readers will know, the founder author of *Fossil Men* was originally one of the strongest opponents of the view that the Piltdown jawbone belonged to the same creature as the human braincase. At first he had no doubt that the jawbone was that of a fossil ape; but he wavered in this view when pieces of a second Piltdown braincase were found at another site in association with a molar tooth like one of those in the original jawbone" (1957: 3). This second discovery was apparently enough to keep the skeptics at bay for quite some time.

²⁵ Hammond states ". . . given the premise that a number of morphologically different species and genera in the family *Hominidae* existed at the same time in prehistory, and given that these populations could co-exist for hundreds of thousands of years, it followed logically that the crucial decisions about the ancestral relationships among these populations could not be based upon chronological grounds and the relative dating techniques available at the time. Also, since most of these non-*sapiens* populations were thought to have demonstrated little or nothing in the way of significant cultural development, the key decisions were unlikely to be based on paleoarchaeology" (1988: 122). As for relative dating methods, fluorine and nitrogen dating techniques had been used sporadically from the 1860s in other fields (Hammond 1988: 123).

²⁶ There is of course, a strong gender bias pervading the last statement of this paragraph. As stated previously, there was a tendency among writers of this and other periods to associate different types of "others." Here the Neanderthal becomes effeminate, less virile. Much of the discussion surrounding early humans was phrased in masculine terms.

²⁷ The last fossil to be considered a "pre-Sapiens" candidate was the skull fragment discovered in the cave at Fontéchevade in 1947. This fossil was associated with an industry called the Tayacian, a crude industry dating from the late Lower Palaeolithic/early Middle Palaeolithic. This skull fragment lacked the browridges and occipital region which are most diagnostic of Neanderthals. Based on other measurements and comparisons with the skulls from La Chapelle-aux-Saints, Cro-Magnon and Piltdown, Boule and Vallois concluded that "the forehead of the Fontéchevade Man was therefore shaped like that of modern Man and quite differently from that of Neanderthal Man" (1957:190). It is now considered to be a Neanderthal specimen.

2 FOUR MODERN THEORIES

"I have a picture of this stone. Mal used it to cut a branch. See! Here is the part that cuts."

Mal took the stone from Ha, felt the weight, frowned a moment, then smiled at them.

"This is the stone I used," he said. "See! Here I put my thumb and here my hand fits round the thickness."

He held up the stone, miming Mal cutting a branch.

"The stone is a good stone," said Lok. "It has not gone away. It has stayed by the fire until Mal came back to it."

-William Golding *The Inheritors*

The next major era in the study of the European Middle Palaeolithic or Mousterian complex begins essentially with the work of François Bordes following World War II. This temporal division is somewhat arbitrary because there was continuity between the eras both in theory and in approaches to the data. On the other hand, the differences are significant enough to warrant treating them as separate eras. At present four major models have been presented to explain the assemblage variability first recognized and interpreted by Peyrony. There is a reasonable degree of consensus that these four models are the most relevant to the issue (see Jelinek 1988: 200-201; Kuhn 1992: 116; Mellars 1996: 315; Otte 1992: 47; Rolland 1990: 360-363). These positions are: 1) Bordes' view that Mousterian assemblage differences reflected stylistic and ethnic differences; 2) Lewis and Sally Binford's interpretation of functional variation; 3) Paul Mellars' reassertion of a chronological patterning of at least some of the industrial types recognized by Bordes; and 4) most recently, Nicolas Rolland and Harold Dibble's synthesis, wherein lithic variability is viewed as continuous and is related both to raw material constraints and to degree of artifact reduction. Each of these positions will be examined in terms of a number of issues, all ultimately related to the construction and interpretation of the categories employed in the study of Middle Palaeolithic stone tool assemblages in Western Europe.

The following points will be assessed for each of the positions. The first issue is the extent to which ideas were adopted from the previous era, both in terms of interpretations (e.g., behavioural sophistication of the Neanderthals) and orientations toward the data (e.g., the palaeontological orientation mentioned in Chapter One). Related to this first issue is the extent to which models from palaeontological and human evolutionary studies are applied to behavioural interpretations, and how the complexity of Neanderthal behaviour is evaluated. Another issue is the nature of the categories employed by the authors, i.e., are

they continuous or discrete? Finally, the degree to which the empirical observations are integrated with and reinforce the interpretations will be examined.

“The issue of Middle Palaeolithic variability exists at two operational levels; firstly, descriptive and classificatory, and secondly, choice of interpretive models” (Rolland 1981: 17). The present chapter will present and critique the dominant models in the recent era at both of these operational levels. A fundamental issue raised by Rolland (1990: 375) is to what extent

the classic distinction (Boas 1940) between ‘race’ and culture as independent variables, established for all living and past representatives of the *Homo sapiens sapiens* species, cannot be assumed for earlier hominid grades or palaeospecies.

Essentially the issue boils down to whether or not “archaic” forms of *Homo sapiens*, including the Neanderthals, can be considered to have culture or the capacity for culture. Realistically, despite many attempts to the contrary, this question must be resolved through the examination of archaeological remains, i.e., the material remains resulting from the socially transmitted *behaviour* of human or hominid groups in the past, rather than through imputed or inferred biological capacities.¹ How archaeological remains are interpreted and the degree to which biological capacity is *assumed* will be examined when relevant.

The main reason for assessing all these levels of analysis and interpretation is the recognition that analysing the nature of assemblage variability among the Neanderthal populations of Western Europe is part of a broader intellectual pursuit, namely, understanding the origins and nature of human behaviour. An understanding of the interplay between the data, the structuring of that data and the behavioural theories employed is essential. It is also important to place this pursuit in historical perspective.

PRELUDE TO THE PRESENT ERA

After World War II there appeared two positions which in many ways bridged pre- and post-war concepts. The first position was that of L. Pradel, who in 1950 presented a synthesis of the work of the French prehistorians of the Mousterian (Rolland in press a). She integrated many of their observations and theoretical positions into a single work which summarized and reaffirmed the branching models of Breuil and Peyrony but also added several important observations and included non-utilitarian objects in her discussion (Rolland in

press a). Her work is important because it synthesized and compared various theories and expanded the scope of French Middle Palaeolithic studies.

The second position is that articulated by Charles McBurney in his 1948 Ph.D. dissertation at the University of Cambridge. His work is important in a number of ways, primarily in its introduction and use of new methodologies in the study of the Middle Palaeolithic. His theoretical position, however, did not differ radically from the previous era. His work marked a change in the approach of British authors to the Middle Palaeolithic. In many ways his thesis was a product of the Cambridge tradition, which professionalized prehistoric archaeology in Britain after receiving official status as a discipline in 1926 (Clark 1989: 2). McBurney was one of the first graduate students produced by this system and in 1952 he was appointed to a University Lectureship (Clark 1989: 53, 60). The scientific and professional approach developed by scholars such as McBurney, Miles Burkitt, Dorothy Garrod (who is important for her study of the Mousterian of the Middle East), Graham Clark and Glyn Daniel stands in contrast with the speculations of Keith and Sollas. The Cambridge approach is also important because of its close links with social anthropology at Cambridge. McBurney was also the graduate supervisor of Paul Mellars and Nicolas Rolland, whose positions are discussed below. Despite their differences, McBurney's approach to the archaeological data influenced these authors.

McBurney was the first author to employ advanced statistical methods to the data. He used both descriptive methods such as frequency distributions, measures of central tendency and metrical attributes of artifacts, and inferential methods such as various tests of significance (Rolland in press a). His approach was broad and comparative. He incorporated a geographic perspective to the nature of Middle Palaeolithic variability, placed the Middle Palaeolithic into its environmental context and examined the role of raw materials in assemblage composition (Rolland in press a). This said, his work was summary and incorporated many unproven hypotheses (Rolland in press a). His unedited and unpublished Ph.D. thesis remains the primary source for his views. His theoretical position upheld two archaeological traditions, the Levalloisian and the Mousterian. However, he noted important chronological and geographical distributions within these traditions (Rolland in press a). In short, his work entailed a new approach to studying the nature and distribution of Middle Palaeolithic assemblages rather than a major shift in interpretation.

THE BORDES SYSTEM

François Bordes provides the most direct link between the previous era and the present one.² He was born in the Périgord region of France and as a youth met Denis Peyrony, who was then the curator of the Museum of Prehistory at Les Eyzies. As a teenager Bordes excavated at the site of Roc de Gavaudon. In 1936 he entered the University of Bordeaux and studied geology and botany. When World War II broke out he first served as a cadet officer and later became a member of the Maquis, living as a fugitive. During this time Bordes married his wife, Denise de Sonnevile-Bordes, who later became an important scholar of the Upper Palaeolithic in France. He served in the Free French Marine Infantry in 1944 and was severely injured by a grenade, which freed him from military service. He then resumed his studies at the Institut de Paléontologie Humaine (I.P.H.) in Paris under the tutelage of Raymond Vaufrey, who is best known for his archaeological work in North Africa.³ From 1945 to 1946 Bordes undertook a study of the loess deposits in the Somme and Seine basins, which furnished the material for his doctoral dissertation at Paris in 1951. In 1948, at Vaufrey's request, Bordes began to excavate at Pech de l'Azé in the Périgord. Until 1951 he worked there with Maurice Bourgon, a local schoolteacher and friend (Bordes 1972: 12). In 1949 Bordes and Bourgon "developed a method based on elementary statistics, which takes into account the totality of the artifacts rather than a few selected as characteristic" (Bordes 1972: 48; Bordes and Bourgon 1951). This method grew into what is known as the *système Bordes* for artifact and assemblage classification.

Following the creation of this system, Bordes became professor of prehistory at the University of Bordeaux, where he created his now famous laboratory at the Institut de Préhistoire (subsequently the Institut du Quaternaire). Perhaps his best known excavations were at Combe Grenal, which he excavated from 1953 to 1965, and Pech de L'Azé, which he returned to in 1967 (see Bordes 1972). In addition to his high profile in France, Bordes gained a worldwide reputation as an excavator and author. He studied sites and collections in Europe, the Middle East, and North Africa. Bordes also maintained an interest in North American and Australian archaeology and ethnography. He held numerous visiting professorships in North America, including those at the Universities of California, Chicago, and Arizona, and students from around the world worked at Bordes' laboratory. Another aspect of his career was his

mastery of many of the lithic manufacturing techniques which he studied; this enthusiasm stimulated the development of experimental lithic technology studies. Intellectually he is most often remembered for the development of his descriptive typology and his longstanding debate over Middle Palaeolithic variability with Lewis Binford. Bordes died in Arizona in 1981.

In a number of ways Bordes revolutionized the study of the Middle Palaeolithic. He introduced the most current techniques in archaeology to the study of Middle Palaeolithic sites. His concern for a proper stratigraphic method, sedimentological methods, dating methods, palynological methods, and modern excavation techniques marked a significant change from the previous period (see Bordes 1972: Chapter Two). He also introduced well-defined criteria for the categorization of tools and assemblages.

Bordes' Artifact Typology

The categorization of tools is the best place to begin describing Bordes' work because his interpretation of Middle Palaeolithic variability ultimately rests on the recognition of the various lithic artifacts as distinct. In 1961 his *Typologie du Paléolithique Ancien et Moyen* was published at the University of Bordeaux as a monograph in two volumes, one with text and diagrams and the other with plates (Bordes 1961b).⁴ This monograph served as a handbook for the classification of Middle Palaeolithic artifacts found throughout Eurasia until the typology was revised and updated by André Debénath and Harold Dibble (1994). Every archaeological typology incorporates a set of assumptions, and Bordes was relatively explicit about his (1961b: 10):

L'étude des industries nous a montré que la typologie avait, pour la compréhension de ces industries, plus d'importance que la technique de fabrication des objets . . . il convient de se souvenir que, aux temps préhistoriques comme de nos jours, *la technique n'est jamais qu'un moyen*, l'outil, défini par sa morphologie ou son usage, étant la fin On peut toujours, dans n'importe quelle matière première . . . , obtenir la forme extérieure que l'on désire, en appliquant la technique convenable.

Bordes thought that each distinguishable morphological type had a cognitive reality in the mind of the toolmaker. Stylistic differences existed within the same broad functional category, e.g., Bordes recognized 21 variants of the same functional type, the racloir or sidescraper. The formal type preceded and guided the manufacture of the tool in the desired exterior form.

The 84 (21 biface, and 63 other) tool types themselves were defined primarily by morphological criteria: "That is, the overall form of the object and the location of retouch or modification are the principal criteria used in classification, although technological criteria (i.e., processes of manufacture) are considered to some extent" (Debénath and Dibble 1994: 5). The tools' names were usually given according to their perceived function, but sometimes were related to their general appearance, the location of their initial discovery, or the method of manufacture (Bordes 1961b: 2; Debénath and Dibble 1994: 5). Bordes retained a term whenever there was general acceptance of the referent of the term (1961b: 2; see Appendix A). For illustrations of several tools by Bordes' types, see Appendix B.

Each type is considered distinct and given a brief description and criteria for its classification. For example, a simple, straight racloir (sidescraper) is distinguished from a simple convex one by the presence of a convex curvature on the retouched edge; both are "simple," however, in that only one edge of the flake is retouched and that edge is "plus ou moins parallèle à l'axe de l'eclat" (Bordes 1961b: 25). Although most of the definitions are concise and straightforward, some are more subjective, e.g., the distinction between typical and atypical types. Debénath and Dibble point out that these are "in fact, judgments regarding the quality of manufacture" (1994: 5). Other distinctions such as that between the Mousterian point and convergent racloirs may also be subjective (Debénath and Dibble 1994: 5). Some categories are distinguished on relative grounds rather than on the presence or absence of certain traits, e.g., the difference between a Mousterian point and an elongated Mousterian point. Although Bordes gives a precise criterion to distinguish these two types, i.e., the length of an elongated Mousterian point is equal to or greater than two times its maximum width, this point of distinction is in fact arbitrary and unlikely (granting Bordes' assumptions for the moment) to reflect a cognitive distinction for the toolmaker. The question of whether or not these tool types represent discrete categories, as Bordes presumed, is still debated in the literature.⁵

In addition to the tool types, Bordes insisted on the collection of other sets of information. He included two sets of indices, one technological and the other typological (Bordes and Bourgon 1951: 3-5; Debénath and Dibble 1994: 176). The technical indices included the Levallois Index, the Faceting Index, the Blade Index, and the Quina Index; the typological indices included the Typological Levallois Index, the Scraper Index, the Biface Index and the Charentian Index as

well as four typological groups, the Levallois Group (Group I), the Mousterian Group (II), the Upper Palaeolithic Group (III)⁶ and the Denticulate Group (IV) (see Appendix A for precise definitions). He also collected information on the types of raw material used and counted the number of unretouched non-Levallois flakes, although these were not part of his typology per se.

Bordes' method quickly standardized the terminology and categorical methods employed by fieldworkers throughout France and many other parts of Europe, Asia and Africa. Other typologies were developed, but none had the impact of Bordes' system, which succeeded due to a number of reasons. It was not only the first rigorous application of a well-defined methodology but it was *Bordes' system*. The institutional framework, his laboratory, his widespread travels and his flamboyant reputation helped pave the typology's way. Bordes became the undisputed authority on the Middle Palaeolithic in France and elsewhere. His method was also helped by the fact that the bulk of European Middle Palaeolithic sites are found in southwestern France, Bordes' backyard.

Bordes' Assemblage Typology

The next level of analysis which Bordes standardized and made more rigorous was his assemblage typology. His typology for the Middle Palaeolithic depended on the application of his typological system in a quantitative manner, rather than simply using *fossiles directeurs*. Bordes defined his assemblage types using the relative proportions of certain artifact types. He used a relatively straightforward method to interpret the various proportions of artifacts. The first step was the use of cumulative graphs, on which the cumulative proportions of artifacts were plotted on the y axis of a line graph along the x axis, which consisted of the 63 primary tool types in order (see Appendix A). The cumulative graphs showed three main types of curves (Bordes and de Sonneville-Bordes 1970: 61-2):

The first one characterizes assemblages rich in scrapers (more than 50%) and low in denticulates . . . The second is characterized by a moderate percentage of side scrapers and a rather lower percentage of denticulates The third one is characterized by the low percentage of side scrapers (from about 4% to 20%) and a strong to very strong percentage of denticulates (up to 60%), always greater anyway than the percentage of scrapers.

When one combines "the cumulative graphs with the secondary discriminants,

one arrives at the [assemblage] classification... used" (Bordes and de Sonneville-Bordes 1970: 62). The secondary discriminants range from technical indices (e.g., Levallois Index) to the presence or absence of particular tool types (e.g., bifaces, making this type a *fossile directeur* in practice). Using this method, Bordes defined four main assemblage groups, two of which have subtypes. The main groups are the Charentian with Quina and Ferrassie subtypes, Typical Mousterian, Mousterian of Acheulian Tradition (MTA) including subtypes a and b, and finally Denticulate Mousterian (see Bordes 1961a; 1972; Bordes and de Sonneville-Bordes 1970, etc.). On the cumulative graphs, Quina, Ferrassie and some Typical Mousterian make up the first graph, Typical Mousterian and MTAA make up the second graph and Denticulate Mousterian and MTAB make up the last graph (Bordes and de Sonneville-Bordes 1970: 61-3). Quina and Ferrassie are distinguished from each other by their relative proportions of Levallois flaking (the latter having a much higher proportion), the MTA types are distinguished from the rest by an abundance of backed knives and the presence of bifaces, and MTA b is distinguished from MTA a by the presence of many Upper Palaeolithic tool types (typological group III). The broadest category appears to be the Typical Mousterian, which may represent two incipient subtypes (Bordes and de Sonneville-Bordes 1970: 63).

Based on the relative proportions of the racloirs, Bordes and de Sonneville-Bordes presented a series of histograms to demonstrate that each of the four major types represented a *discrete* population in a statistical sense (and, as will be seen later, in a behavioural sense; 1970: 69, Figures 15 and 16). These histograms showed apparently discrete modalities using a sample of 88 assemblages. Despite the fact that the populations shared the bulk of the tool types and the distinctions were often made on relative proportions alone, Bordes considered these major groups to be distinct. This has subsequently been proven not to be the case, because the polymodal distributions that Bordes and de Sonneville-Bordes presented have been shown to be statistically insignificant (Dibble and Rolland 1992: 6). Nonetheless, the separation of each assemblage type into a discrete category remains an important aspect of Bordes' method and interpretation.

Bordes' Chronostratigraphic Interpretations

Before turning to Bordes' interpretive scheme, it is important to note another set of empirical observations, the chronostratigraphic relationships

between the various assemblage types. His position on this issue is that all of the Mousterian groups were interstratified in an unpredictable fashion, and that there appeared to be no direct association between climatic periods and assemblage type (Bordes 1960; 1961a; 1968; 1973; Bordes and de Sonneville-Bordes 1970). According to Bordes, the only assemblage type to show a progression from one type to the other was within the MTA assemblage type, MTAA evolving into MTAB (Bordes 1961a: 804). When discussing this issue, Bordes usually mentioned Peyrony's discovery of the interstratification of the MTA and Typical variants (1961a: 804):

Doubt was first cast on the validity of this straightforward scheme by the great French prehistorian Denis Peyrony. In the lower shelter at the classic site of Le Moustier (Dordogne, southwestern France), he found several layers of Mousterian of Acheulian traditions *between* two layers of Typical Mousterian.

Bordes and de Sonneville-Bordes state (1970: 65-6):

We shall try here to dispose, quite definitely we hope, of the antiquated hypothesis that the different types of Mousterian represent an evolution This theory was first contradicted when D. Peyrony, in the lower shelter at Le Moustier, found the Mousterian of Acheulian Tradition sandwiched between two Typical Mousterian layers.

Bordes' Behavioural Position

Both Bordes and Peyrony interpreted the differences in Mousterian assemblages as being caused by differing tribes (Rolland in press a). Bordes continued the tradition of using the branching model of cultural evolution from the previous era. His explanation for both the chronostratigraphic record, the (purported) polymodal distribution of artifact types and the discrete assemblage categories was that they were made by different ethnic groups which coexisted and interacted little for the duration of the Middle Palaeolithic. He saw continuity within these parallel branches, each having roots in the Lower Palaeolithic. Based on his examination of Lower, Middle and Upper Palaeolithic archaeological assemblages, Bordes explained that (1958: 180):

Une hypothèse concilierait les deux points de vue, archéologique et anthropologique [physique]. Au niveau de la glaciation rissienne existerait un type humain relativement indifférencié, Swanscombe-Steinheim, porteur des industries acheuléennes et clactoniennes. Au cours du dernier interglaciaire se serait faite une double

différenciation anthropologie, peu sensible au point de vue archéologique, conduisant certaines tribus vers le type *sapiens*, les autres vers le type néandertal. Au Würm, cette évolution divergente se serait accélérée, aboutissant pour certaines tribus au cul-de-sac néandertalien, pour d'autres au type *sapiens*, indépendamment du type de civilisation, le vrai type *sapiens* n'apparaissant que simultanément avec le Paléolithique supérieur.

Here Bordes adopted the European pre-Sapiens hypothesis of Boule, Vallois and others, and integrated this with the "tribal" model of Peyrony. Bordes associated the pre-Sapiens group with the MTA industrial type, which he believed evolved into the early Upper Palaeolithic industries in the Perigord (Périgordian I, later dubbed Chatelperronian) (1958: 179; 1968: 220). He thought that "if we have to fix on any Mousterian as being more evolved than the others, it is ... the Mousterian of Acheulian tradition" (1960: 101). The "evolved" nature of the MTA, as well as the fact that no hominid remains had been associated with this industry type, supported Bordes' notion that the MTA was associated with the pre-Sapiens (see Bordes 1968: 105, 220).

Despite the fact that Bordes thought that the MTA industry was more evolved than the others, and thus by implication the pre-Sapiens more advanced than the Neanderthals, he believed that the Neanderthals were much more advanced than was generally thought. In other words, although he accepted the pre-Sapiens hypothesis of Boule and Vallois (1957), he did not accept the behavioural interpretation which they presented (1961a: 803, 810):

One of the stages in the history of mankind in which there has been the most popular interest is that linked with Neanderthal man. The imagination is caught by this being, close enough to *Homo sapiens* to be called a man, but distant enough, in shape as well as in time, to appear in a way an "alien" in the sense in which the word is used by science fiction writers.⁷ Hence, many misconceptions are to be found in popular books, even textbooks, the most common being the one about the "brutish Neanderthals." Reconstructions show him as only a little better off than the big apes, and his tools (Mousterian) are described as "crude" by people who would not, to save their lives, be able to make them. The truth is indeed quite different. And even if some anthropologists deny to Neanderthal man (*sensu stricto*) the right to be counted among our direct ancestors, one thing is sure: these ancestors of ours were at a cultural level very like that of the Mousterian peoples.

Although Bordes had ideas similar to those of Boule and others, he did not agree with the evaluation of Neanderthal behaviour that they presented. The passage

concerning the textbooks appears to be directed at Boule and Vallois's *Fossil Men*.

Bordes continued to defend his model and interpretation of Middle Palaeolithic variability against those presented by other researchers. Most notable are his rejections of Lewis and Sally Binford's and Paul Mellars' positions.

Discussion

Debénath and Dibble present three main criticisms of Bordes' artifact typology: 1) its subjective component, mentioned above; 2) "virtually none of the type categories have been demonstrated quantitatively to represent discrete modalities of variability among artifacts and may instead represent partitions along a continuum of variability;" and 3) it uses several criteria inconsistently (1994: 5-6). Other criticisms include the inclusion and/or exclusion of certain artifact types. Bordes includes unretouched flakes made using Levallois technology, but excludes other unretouched flakes made using non-Levallois techniques. He also includes some types which appear to be the result of post depositional damage rather than actual retouching (types 46-50).

Despite these criticisms, Bordes artifact typology has been widely accepted and remains in use to this day (with minor revisions). One of the reasons for its widespread use is that, in spite of Bordes' assumptions, it is essentially descriptive. Another advantage is its extensiveness: 84 reasonably well-defined descriptive types are potentially more useful than a handful of broad, poorly defined categories. Its widespread acceptance also makes it attractive to use; one can compare the artifact assemblages of one site with those of a previously published one. No one has yet produced a better typological system for the Middle Palaeolithic.

Like the tool types themselves, the assemblage terminology exhibits a great deal of continuity with the previous era. However, again like the tool typology, the categorical methods used are explicit and much more rigorous. There is a shift from designating certain tool types as diagnostic (with the possible exception of the bifaces), to using relative frequencies and statistical methods (albeit basic ones). Bordes explicitly rejected Breuil's notion of a separate Levalloisien group, choosing to see it as a facies as Commont did: "Actually such findings [Levallois manufacture] represent only a facies of various Mousterian groups, found in

places where flint was plentiful and readily available . . ." (Bordes 1961a: 806). Bordes definition of the MTA was essentially the same as Peyrony's except that it was divided into two groups. The lack of recognition of a separate MTAb subtype by Peyrony may in part be related to the rarity of this assemblage type. Bordes also used the term Typical Mousterian. The recognition of the Charentian as a separate group was foreshadowed by Breuil's observations of differences at La Quina, which left its name to Bordes' subtype. The Charentian type was named after the province in France where both La Quina and La Ferrassie are located. The Denticulate Mousterian is given a previously ignored importance in Bordes' system. The denticulate and notched tools which distinguish this subtype are not attractive tools; they are relatively simple, thick flakes with one or more notches taken from them. They were likely overlooked or downplayed when there was an emphasis on *fossiles directeurs*; when a numerical approach is used, however, they become very important to understanding lithic variability.⁸

Bordes' acceptance of Peyrony's stratigraphy causes problems with his chronostratigraphic interpretation. The data is actually ambiguous at best with regard to the association of assemblage types at Le Moustier (Rolland in press a). In this instance the problematic use of concepts developed in a previous era are perpetuated; a critical examination of Peyrony's sources and Bourlon's publications reveal genuine discrepancies. This part of the empirical analysis shows the greatest degree of influence from the interpretive level. There is a reciprocal relationship between both Bordes' and Peyrony's views of assemblage chronostratigraphy and their interpretations of multiple tribes.

The degree of theoretical continuity between Bordes and authors such as Peyrony has led James Sackett to state (1981: 96):

In this connection it is relevant to note that the Bordesian revolution which began the present era entailed a **change in method, not theoretical perspective**, and that much of the legacy may still in fact remain.

This argument should not be overextended, however, because there are a number of important differences. The first aspect which differed from the previous era was Bordes' grounding of his interpretive model in his empirical studies. He conceived of and presented two operational levels as an integrated whole (Bordes 1961a; Bordes and de Sonneville-Bordes 1970, etc.). He seems to

have had a clear interpretive position *prior* to the final, systematic working out of his typological studies. Although one must agree with Sackett that Bordes' interpretive models are borrowed from the previous era, the ways in which he synthesized those ideas, the empirical basis he presented to support them, and the evaluation of Neanderthal sophistication differed. There is both continuity and discontinuity.

Bordes' approach to the categories he employed shows little change in theoretical perspective. Although he changed the manner in which the categories were constructed, using more rigorous methods, his interpretive approach shared much with the interpretation of the *fossiles directeurs* of the previous era. As Sackett has pointed out, "some of the claims made for the integrity of the so-called 'morphological' tool classes which make up the Bordesian type-lists are not unlike those made for **natural categories**" (1981: 96). Each typological category Bordes constructed was viewed both as "inherently discontinuous" (as paleospecies are) and as having a corresponding reality in the real world (Sackett 1981: 90).

Another important issue in Bordes' research is the interplay between his empirical model and his interpretive one. The interplay between levels is sophisticated and they reinforce and depend on each other. Bordes employs a distinctive behavioural model in his artifact typology. Although primarily descriptive, his definitions are based on an assumption of stylistic differences with clear cognitive dimensions (Bordes 1961b: 10). Bordes' tool types represent ideal forms which correspond to intentional forms in the mind of the artifact's maker. He thus assumes that there are cognitive processes similar to those of modern humans. He extends this degree of cognitive sophistication to the Neanderthals, despite the fact that the pre-Sapiens have more "evolved" toolmaking industries.

In a similar line of reasoning, Bordes views each of the assemblage types as distinct traditions with self-contained ethnic identities. The distribution of artifacts across these traditions reflects cultural norms. Bordes goes to great lengths to explain why this is so, despite criticisms raised by anthropologically oriented archaeologists (Bordes 1972: 147):

If one supposes that a Mousterian of Acheulian tradition man married a Quina woman, she might have gone on using the thick scrapers to which she was accustomed, but we doubt that her daughters would have done the same.⁹

Bordes and de Sonneville-Bordes state (1970: 65):

Intermarriages are difficult to assert or negate, but all the history of Europe shows . . . that man exchanges his genes more readily than his customs.

Empirically, such arguments are dependant on: 1) Bordes' assertion that the assemblage types were discrete populations in a quantitative and qualitative sense; 2) the stratigraphic model presented initially by Peyrony, i.e., the tribes must have been contemporaneous to exchange their genes; and 3) Bordes' definition of the tool types as stylistic, e.g., the daughters of the Quina woman are, in essence, described as being "assimilated" into the MTA culture, they thus made a different culturally prescribed tool kit. Thus, all levels of Bordes' interpretation of lithic variability are integrated theoretically.

Bordes' work presents a major shift in the study of the Middle Palaeolithic through the introduction of a typological method that is still in use today. However, Bordes retained much from, and had an appreciation for, the work of the previous era. This simultaneous conservatism of theory and revolution of method makes the notion that Bordes' work represented a paradigmatic shift in the study of the Middle Palaeolithic problematic. Bordes' development of a typological method was in part the product of necessity. The recognition and interpretation of the lithic variability, first presented before World War II, and the immense growth in the numbers of artifacts and assemblages uncovered, required a more rigorous method of analysis. Fortunately Bordes presented a broad, descriptive, and relatively thorough typological method. The fact that the typological method remains in use despite major shifts in its interpretation is ultimate testament to its utility. This does not mean that it is necessarily the best possible typological system, but rather that it has been really useful thus far. Bordes' interpretive dimension, rooted in the previous era, has given way to more parsimonious interpretations.

BINFORDS' FUNCTIONAL TOOL KITS

The first serious criticism of Bordes' system was presented by Lewis and Sally Binford in 1966. Using statistical methods and the latest computing abilities they proposed what is known as the functional argument, a fundamentally different interpretation of Middle Palaeolithic variability. They believed that the distribution of *functional artifact tool kits* across the assemblage types best explained the variability in the lithic record, rather than the existence of cultural

toolmaking traditions. Although their position differed from Bordes' view on a number of issues, most notably interpretive ones, they shared a number of assumptions with him as well.

Before examining the arguments of Lewis and Sally Binford, it is worth while examining their role in the *New Archaeology* of the 1960s. Lewis Binford became one of the most vocal proponents of this approach to the archaeological record. In many ways this approach stemmed from the *neo-evolutionary* positions of the American ethnologists Julian Steward and Leslie White, whose ideas were essentially materialist, viewing "human behaviour as shaped more or less exclusively by non-human constraints" (Trigger 1989: 292). Steward's approach was broadly *ecological* and his model of *multilinear evolution* is well known. His work was very influential in the emerging field of cultural ecology. White's views, on the other hand, were more "materialistic and narrowly deterministic" according to Trigger (1989: 290). White had two primary notions of culture, the first being that human culture is dependent upon the capacity to symbol (1988[1949]: 337). In fact, this view had evolutionary implications for White: "It was the symbol which transformed our anthropoid ancestors into men and made them human" (1988: 335). Culture to White was thus an exclusively human trait. The second central feature of White's view was that culture required energy for its functioning and that the level of sociocultural complexity was determined by its ability to harness that energy (1988). White formulated a famous cultural equation, $E \times T \rightarrow C$, where E is energy, T is technology and C is culture (1988). In short, "the technological factor is therefore the determinant of a cultural system as a whole" (1988: 339).¹⁰ White advocated that cultural anthropology or *culturology* be a study of cause and effect modelled on the natural sciences (1949). His model of cultural evolution is deterministic, reductionist, and as Trigger states, "it reflects one of the principal themes of American social-science scholarship, which has been described as privileging the relationship between technology and society at the expense of other kinds of relations . . ." (1989: 291). For obvious reasons, both Steward's and White's materialist perspectives were attractive to archaeologists. They championed the material aspects of culture (which happen to be those which survive) and gave technological remains great predictive value.

Lewis Binford was a student of Leslie White at the University of Michigan. White's views of culture as well as the general trend toward ecological

approaches in American anthropology shaped his theoretical position. He said that most aspects of a culture could be predicted from the material remains (1968: 22):

It is highly improbable that the multiple, independent variables which determined the form of an item or the distribution of items should be restricted to only one component of a cultural system. This means that data relevant to most, if not all, the components of past sociocultural system [sic] *are* preserved in the archaeological record . . .

This statement is rooted in Binford's notions concerning archaeological research design. Binford believed that "we can recover, both from the nature of the populations of artifacts and from their spatial associations, the fossilized structure of the total cultural system" (1964: 425). He thought that a random sampling of that population of artifacts would result in sufficient data to reconstruct the "total cultural system," including "kinship, economic and political" structures (1964: 425). Such structures would be isolated "by the demonstration of consistent between-class correlations and mutual co-variations among classes of artifacts and other phenomena" (L. Binford 1964: 425).¹¹

Trigger provides an apt summary of Leslie White's influence on Lewis Binford (1989: 296):

As a student of Leslie White, Binford was predisposed to believe that there were strong regularities in human behaviour and that there was little difference between explaining a single instance of social change and a whole class of similar changes.

Binford was an advocate of scientific generalizations and believed that propositions about human behaviour could be tested using the hypothetico-deductive method (1968: 16-23). He stated that a "traditional" or inductive/categorical approach to archaeology "serves only to clarify information already available; it cannot increase our knowledge" (1968: 23). Binford said that the hypothetical-deductive process must be based on sound inference, but that only rigorous testing could advance our knowledge. He believed that understanding and scientifically explaining "the *variability* in the archaeological record" was one of the principal aims of the New Archaeology (1968: 26, italics mine). Underlying much of Binford's research was an emphasis on cultural processes and the systematic relationships between components of culture and the environment. Human behaviour, as inferred from the archaeological record, was to be

explained in such terms rather than as assemblages of traits or in terms of categories alone.

Binford and Binford's 1966 Study of "Functional Variability"

Although Lewis later became the more active member of the Binford duo, Sally provided the main link to the study of the Middle Palaeolithic. Her work at the site of Mugharet es Shubbabiq in Israel and her training in Bordes' system provided data for this (Binford and Binford 1966: 243; S. Binford 1968: 51). In their 1966 article, "A Preliminary Analysis of Functional Variability in the Mousterian of Levallois Facies," they began by stating the possible interpretations which had been set forth previously: 1) that each assemblage type represented a different season of occupation; 2) that each assemblage type was associated with a different environment; and 3) that the different Mousterian groups represented different groups of people, this last being Bordes' view (1966: 239). After noting Bordes' refutation of the first two points, they raise a number of objections to his interpretation. The first of these (as implied by Bordes' tribal hypothesis) is that stylistic variations "tend to cluster spatially in direct relationship to the amount of social distance maintained between societies" (Binford and Binford 1966: 240). The "fact" that the different assemblage types are interdigitated is cited as evidence against Bordes' hypothesis (Binford and Binford 1966: 240):

In view of the demonstrated alternation of industries, one must envision a perpetual movement of culturally distinct peoples, never reacting to or coping with their neighbors. Nor do they exhibit the typically human characteristics of mutual influence and borrowing. Such a situation is totally foreign, in terms of our knowledge of *sapiens* behaviour.¹²

The next step in Binford and Binford's argument was to provide an alternative, rigorous model to explain the variability demonstrated in the lithic record. They sought to explain "the composition of assemblages in terms of variations in human activities" (1966: 241). They believed that "the units of 'causation' of assemblage variability are separate activities" and thus (1966: 241):

Since a summary description of a given assemblage represents a blending of activity units and their determinants, it becomes essential to partition assemblages of artifacts into groups of artifacts that vary together, reflecting activities.

Each archaeological assemblage was viewed as a product of different activities

which could be identified by the co-varying artifact groups. Factor analysis was chosen as the method to determine the underlying factors of assemblage composition (for a description and a critique of the methodology employed, see Chapter Three). Once a group of artifacts were found to co-vary together the *function* of the factor was determined through “analogy with the tools of living peoples, tool wear, and associations with refuse” (Binford and Binford 1966: 243).

The sample of 16 assemblages used for this study came from two sites in the Near East and from one (single assemblage) site in Northern France. Forty variables, based primarily on Bordes’ typology of 63 artifact types as well as *discs* and unretouched flakes and blades, were used in the study (Binford and Binford 1966: 243-4).¹³ Each artifact type was given two possible a priori functional interpretations (Binford and Binford 1966: 244, Table 1).

The tests were run, yielding five separate factors, and the results were analysed in terms of their hypothesis. They sought to explain the meaning of the factors and whether they reflected functional or stylistic criteria (Binford and Binford 1966: 245). Their reasoning was as follows (for the first factor, 1966: 249):

Since the artifacts [strongly correlated with the first factor] . . . share determinants and behave as a unit with respect to other tools in the assemblage and since archaeological assemblages are the fossil remains of human activities, we postulate that the variables diagnostic for a factor represent a functionally related set of tools.

Based on which tools were most strongly associated with each factor, and on their *a priori* functional interpretation for each tool, they presented a “suggested activity,” a “type of activity” and an “analogy to Bordes’ types” for each factor (1966: 259, Table VII). The first factor was interpreted as representing the “manufacture of tools from non-flint materials” and was analogous to Bordes’ Typical Mousterian. The second factor represented “killing and butchering” and Bordes’ Ferrassie type. The third factor was associated with “cutting and incising (food processing)” activities and Bordes’ Mousterian of Acheulian Tradition. The fourth factor represented “shredding and cutting (of plant materials?)” and Bordes’ Denticulate. The fifth and final factor, like the third factor, was associated with “killing and butchering” and the Ferrassie type (Binford and Binford 1966: 259). The factors represented tool kits which “vary independantly of one another and may be combined in numerous ways” (Binford and Binford 1966: 292).

The various activities and their corresponding tool kits were then divided

into two general types, maintenance and extractive tasks, the former including factors I and III, and the latter the remaining factors (Binford and Binford 1966: 268):

For technologically simple societies we can distinguish between two broad classes of activities: extraction and maintenance. Extractive activities are those that center around the direct procurement of subsistence items or of raw materials to be used in the manufacture of artifacts. Maintenance activities are related to the preparation and distribution of subsistence goods already on hand and to the processing of on-hand raw materials in the production of tools.

Employing the distribution of the various factors and the locations of the sites, they proposed a twofold settlement pattern based on the maintenance/extraction division. When there was a preponderance of maintenance factors (I, III), the assemblage would be classified as a *base camp* and when there was a preponderance of extractive factors (II, IV, V), the assemblage would be classified as a *work camp* (Binford and Binford 1966: 268). Other types of settlements are possible in this system, depending on the degree of mobility of the group. Some assemblages may contain both extractive and maintenance factors. According to the Binfords' reasoning, work camps far from the base camp likely would contain some maintenance activities. They related the different settlement types to Fred Gearing's notion of structural poses (Binford and Binford 1966: 268):

. . . the society itself varies throughout the course of an annual cycle and goes through a number of *structural poses* (Gearing 1962). The ways in which various members of a society are organized and how they cooperate at different times of the year vary with the characteristics of activities performed at different times of the year.

Thus, a seasonal dimension is added to their equation.

In their conclusion, the Binfords referred to Leslie White's notion of culture as "man's extrasomatic means of adaptation" and said that their theory best reflected this viewpoint (Binford and Binford 1966: 289). In addition, they stated (1966: 289):

The value of our results lies chiefly in the realm of methodology, and these methodological developments are inextricably predicated on a theoretical position

They said specifically (Binford and Binford 1966: 293):

The provocative results of our study suggest to us that the methods of analysis used here are potentially useful for formulating testable

hypotheses about social organization and evolutionary culture change within prehistoric communities.

The Development of Lewis Binford's Behavioural Position

The authors restated their position in subsequent articles (Binford and Binford 1969, S. Binford 1968) and Lewis Binford, in particular, continued to defend the functional approach to the Middle Palaeolithic for many years. In 1971, at the Research Seminar in Archaeology and Related Subjects at the University of Sheffield, François Bordes, Lewis Binford and Paul Mellars presented their views on the notions of culture change, with particular reference to the Middle Palaeolithic (Renfrew 1973). Binford used this meeting as a forum to answer criticisms of the functional hypothesis, and clarified and expanded his position. In his 1973 paper resulting from this meeting, much of Binford's argument was directed toward a single thesis, that there were "major organizational differences between middle and upper palaeolithic cultural systems" and thus (1973: 234, 236):

... (a) the middle and upper palaeolithic typologies are measuring substantially different kinds of variability, or (b) there is a contrast in the character of variability between the middle and upper palaeolithic period.

In short, the variability documented in the archaeological record prior to the upper palaeolithic appears to lack any significance whatsoever with regard to the ethnic composition of groups.

Binford goes even further in suggesting that in fact, "ethnicity may not have always been a component of the cultural evolution of man" (1973: 244).

Binford's position was developed in part from further multivariate studies of Middle Palaeolithic variability at the site of Combe Grenal (which were never published) and his own ethnographic study of the Nunamiut Eskimo, which he had undertaken before the 1971 seminar (1973: 241).¹⁴ His study of Combe Grenal isolated fourteen factors underlying the various assemblages (over 50 Middle Palaeolithic levels at the same site; see Bordes 1972), in which he found "some statistical clustering of factors corresponding nicely with directional changes in the environment" (Binford 1973: 236). He had thus found support for an environmental correlation with his factors, and "a good correspondance between the stability of the environment and the stability of the assemblage form"

(Binford 1973: 232). This supported the functional hypothesis; the composition of assemblage types in a single location were stable until a time of environmental change, “which would tend to modify the utility of locations for particular use” (Binford 1973: 241). The distribution of factors, and thus activities, would change when the environment was altered significantly. Another aspect of Binford’s position was that he rejected Bordes’ arguments that some assemblages showed year-round occupation. He supported his own claims of seasonal variability by refuting an analysis of reindeer teeth on which Bordes had based his position (Binford 1973: 239; see Bordes 1961a: 806). Binford, in essence, used these data to add credibility to the argument that the different assemblages represented different structural poses.

The Nunamiut data, however, supported an entirely different viewpoint. Binford said (1973: 242):

The most striking fact to emerge from this research is that with regard to artifacts *per se* there is little correlation between what is done and the artifacts remaining.

Although this contradicted the initial premises of the 1966 study, that the composition of assemblages reflects (directly) human activities (Binford and Binford 1966: 241), Binford managed to incorporate this ethnographic observation into his theoretical stance. The patterns of variation in modern human societies and in those of the Middle Palaeolithic were thus fundamentally different. He noted that the Nunamiut tended to curate and transport their tools for future use, and only discarded them when they were no longer useful. The more the tools were curated, the less there was a correlation between the archaeological record and the behavioural context (Binford 1973: 242). For the tools to reflect activities (which they apparently did in 1966), they must have been “produced expediently and discarded in the immediate context of use” (Binford 1973: 243).

Binford further supports the notion that the two time periods were fundamentally different by arguing that (1973: 245):

. . . the character of variability as documented for the Mousterian was manifest in different proportional frequencies between similar tool forms in different locational contexts. Among contemporary peoples ethnicity is more frequently directly demonstrable through morphological variations between different localized groups with respect to analogous functional classes of tools.

Variability in the Mousterian is primarily in proportions of tools, thus reflecting

the distribution of function, while in contemporary societies the variability involves “conscious ‘stylistic’ characteristics” and is geographically localized (Binford 1973: 243).

In his later writings, Binford continually defended the position that the Middle Palaeolithic and previous periods were socially organized in a fundamentally different manner than the periods from the Upper Palaeolithic onwards. In his 1985 article “Human Ancestors: Changing Views of Their Behaviour,” he challenges the so-called *consensus* view that early hominids were hunters (Binford 1985: 292). In this argument, he refers back to the “Mousterian problem,” stating (1985: 312):

... I became convinced that the organization of the hunting and gathering way of life, among these relatively recent ancestors, was quite different than that among fully modern *Homo sapiens sapiens*. If this was true then the almost “human” lifeways depicted in the “consensus” view of the very early hominids stood out as an extremely unlikely condition.

The most recent version of Binford’s views in this matter create a direct link between “fully modern man” (i.e., *morphologically* modern fossils) and the “systematic hunting of moderate to large animals” and thus modern human behaviour (1985: 321). This is further supported by the emergent *Out-of-Africa* view that modern human anatomy and behaviour emerged simultaneously and relatively late in Africa. Binford used data from Klasies River Mouth in South Africa to demonstrate the “shift to the presence of fully modern forms of men” (1985: 315):

... there was a trend toward increases in hunting through the sequence at Klasies that was roughly coincident with the anatomical shift to more modern types of humans.

In many publications involving Middle Palaeolithic behaviour, Binford repeatedly denounced evidence for systematic hunting of larger animals, the working of bone, and prepared hearths before the Upper Palaeolithic (see particularly Binford 1982: 177-81).

Discussion

Some general comments are in order concerning the Binfords’ approach and the New Archaeology. One of the major problems of this school is the over-extension of the hypothetico-deductive method, at the expense of sound inductive

use of the data.¹⁵ Binford placed his interpretive models and testing of propositions derived from those models well before the soundness of his data. His methods of testing his propositions were problematic (see Chapter Three). The strongest aspect of Binford's programme is the emphasis on the understanding of cultural processes rather than simply describing the succession of cultural phases or branches. This notion, *when properly applied*, certainly has advanced the understanding of the archaeological record. Generally, many of the problems of the New Archaeology were related to its narrow focus. Often researchers tried to understand complex cultural events in terms of a very limited number of variables, and lacked a holistic, historical perspective (see Trigger 1989: Chapter 8).

Before examining the points of continuity with previous authors, the Binfords' behavioural position and the nature of the categories used, some inherent problems in the formulation of the functional hypothesis will be discussed. I will argue below that the statistical methodology was flawed, but note here that many of the flaws are logical. The argument is essentially circular, the premises of the 1966 study assuming its conclusion. In stating that the archaeological record preserves the activities of human populations and that this can be "read" and subsequently reconstructed, Binford and Binford essentially assume functional variation before they begin. Each variable is given an a priori functional interpretation and the factors are assigned functions based on these. When the factor analysis split morphologically similar tools between factors, Binford and Binford gave them different functional interpretations. The best example of this is the difference between notches and denticulates. According to Debénath and Dibble, denticulates are simply "blades or flakes which present two or more contiguous notches," while notches have either single notches or notches that are not adjacent (1994: 104-107). They are also obviously correlated in Western European samples (see Bordes 1961a: 805). Nonetheless, the Binfords assign notches to a maintenance factor (I) and denticulates to an extractive factor (IV).¹⁶ Ra cloirs are also found in all but one of the factors (and thus widely different functional activities), despite their being essentially typological subdivisions of a similar tool group (Bordes 1961b). The 1966 article forces the data to fit the conclusions (and assumptions).

When the Nunamiut study challenged the initial assumptions, Lewis Binford still contended that the functional interpretation applied to the Middle

Palaeolithic but not to subsequent groups. It should be noted that the initial assumptions of Binford and Binford's 1966 paper were formulated on the premise that "*the minimal social processes and organizational principles exhibited by human groups today were operative in the past*" (1966: 291; italics theirs). The Nunamiut findings imply that groups before the Upper Palaeolithic were unable to plan very far ahead (lack of curation) and their tool use was simple and expedient. By extension, they could not hunt large animals.

Criticisms of the functional hypothesis are not meant to deny the possibility of a functional dimension in Middle Palaeolithic stone tool variability, but to question the Binfords' assertion that the differential distribution of functional tool kits are the primary cause of Middle Palaeolithic variability. Their conclusion was based on an inherently flawed argument.

Despite the radical claims of the Binfords, there is a great amount of continuity with previous research. Firstly, they use François Bordes' artifact typology, accepting the typological distinctions as real and only questioning their meaning. This is most clearly articulated in Binford's 1973 paper (1973: 235):

. . . I suggest that the middle palaeolithic typology incorporates few if any stylistically significant characteristics and is therefore a better instrument for monitoring pure behavioural variation.

It is also implicit in the 1966 study, however, that the artifact types represent discrete categories. The fact that morphologically similar categories were given alternate functional meanings supports the notion that Binford and Binford viewed the artifact *categories* themselves as meaningful units in terms of behaviour. The Binfords in fact extend the analogy with palaeontological research of the previous generations (Sackett 1981: 90):

. . . the cultural entities recognized in archaeological systematics are to be regarded as natural categories, which - in the manner, say, of organic species - are inherently discontinuous and do not modify their form from one context to the next.

The functional tool kits follow this analogy as well, because they are said to be independent and behaviourally real. The distribution of the factors comprises assemblage variability, not a context-based change within the factors themselves. As Dibble and Rolland point out (1992: 5):

Thus, the paleontological model provided the first major method and theory paradigm for Paleolithic research and set up the logical possibilities that ultimately led to the Bordes-Binford debate.

However, the controversy that ensued had at its heart an assumption on the part of both parties that the analytical units under investigation, i.e., the lithic types, were discrete units and behaviourally real and that they gave rise to assemblages that reflected discrete behaviours.

The second aspect of continuity is more direct. The Binfords accept Peyrony's problematic stratigraphic interpretation, and thus the interstratification or interdigitation of the various Mousterian industries. The Binfords' argument that stable, independent tool kits were differentially distributed throughout the Middle Palaeolithic depends logically on two points, the contemporaneity of the different assemblage types and their lack of chronological development.

These areas of continuity bring forth the general issue of the nature of the categories employed. The Binford and Binford study sought a new level of analysis, between the artifactual level and the assemblage level, which might better explain the variability in the lithic record of the Middle Palaeolithic. The functional tool kits, deduced from factor analysis, became the most important set of variables rather than the artifacts or assemblages themselves. The artifacts in Bordes' system were the diagnostic group, their proportions dividing the assemblage types into ethnic traditions. Despite methodological and logical problems, the Binford study provides an important concept for more recent views concerning the interpretation of Middle Palaeolithic variability. This is the notion that "the different assemblages represented 'facies' of a single, though heterogeneous, Mousterian entity" (Dibble and Rolland 1992: 4). This was a major point of contrast with the arguments of Bordes. The initial criticisms of Bordes' interpretation mentioned in the 1966 article have a great deal of intuitive appeal (Binford and Binford 1966: 240). I might add that Binford allowed for some contextual factors such as the environment in explaining the distribution of the functional tool kits.

Finally, the functional argument of the Binfords' study ultimately led to a strongly negative conception of Neanderthal (and all other pre-modern hominid populations') behaviour. This arose in part from the Nunamiut study and led Binford to posit fundamental differences between anatomically modern humans and all other fossil hominid groups. This again demonstrates the interplay between empirical and interpretive issues. In this case the logical interplay is more convoluted than in Bordes' interpretive and empirical system. What was initially a logical necessity or assumption of the 1966 article essentially became the

reason to deny pre-Upper Palaeolithic populations any behavioural complexity. This view of early hominid behaviour relates to the issue Rolland raised in the interpretation of Middle Palaeolithic behaviour - whether race or anatomical morphology and culture are dependant variables for earlier hominids. Binford associates modern human behaviour exclusively with anatomically modern humans. This appears to be based on faulty reasoning and biological assumptions.¹⁷

MELLARS' REDISCOVERY OF THE TEMPORAL DIMENSION

Paul Mellars was a student of Charles McBurney at the University of Cambridge, and although their approaches differed in many ways, an emphasis on the systematic and quantitative use of data was shared. Mellars' theoretical stance was a product not only of the Cambridge tradition of archaeology of the likes of Dorothy Garrod and McBurney, but also of the approaches of the New Archaeology. In his recent book, *The Neanderthal Legacy: An Archaeological Perspective from Western Europe*, he states (1996: 7):

As a product and great admirer of many aspects of the New Archaeology of the mid-1960s, I regard myself, in many respects, as a committed processualist . . .

Mellars does not believe, however, that the lengths to which the functional position has been put by Binford and others have been entirely productive. He thinks that the functional alternative has almost become "an *a priori credo* to be pursued and defended against almost any alternative interpretation" (1996: 7). Mellars advocates placing Neanderthal behaviour in a demographic perspective and incorporating a wide variety of data. He thinks that the varying views of Neanderthal behaviour postulated by the palaeontological and biological scholars of human evolution have been far too polarized (see below), and that the truth lies somewhere between the extremes set forth by such arguments (1996: 8).

The Périgord Chronology

Although Mellars study of "The Chronology of Mousterian Industries in the Périgord Region of South-West France" (1969) is concerned primarily with chronological and stratigraphic issues, it is important to the meaning and interpretation of lithic variability in the Middle Palaeolithic of Europe. It places in doubt the notion that the various assemblage types presented by Bordes are

contemporaneous. This observation has serious implications for the behavioural interpretations set forth by both Bordes and the Binford, whose positions logically rest upon the contemporaneity of the assemblage types (Mellars 1969: 136):

Such issues evidently have a crucial bearing on several problems relating to the cultural interpretation of the industries which are in dispute - for example, the extent to which distinct Mousterian 'cultures' may have cohabited, throughout long periods, within the same territory, or the likelihood that two or more industrial variants were manufactured by one and the same social group.

Not surprisingly, Mellars arguments were criticized considerably by both François Bordes and Lewis Binford (Bordes 1973; Binford 1973).

Mellars' arguments for chronological ordering specifically apply to four of the assemblage types: Ferrassie Mousterian, Quina Mousterian and MTA types a and b. The latter two were, of course, recognized by Bordes to have a temporal dimension. The primary source for the ordering of these assemblages in time is the stratigraphic sequence of assemblages at the site of Combe Grenal in the Périgord region (see Mellars 1969: 143, Figure 3). The Middle Palaeolithic or "Würmian deposits attain a thickness of over 10 meters, and within these deposits 55 distinct stratigraphic levels have been identified" and span both Würm I and Würm II glaciations (Mellars 1969: 137).

Mellars begins by examining the relative positions of the Quina and MTA variants. He states that these types are both abundant and typologically distinct throughout the region (1969: 141). Both of these assemblage types show a "strikingly localized distribution in the Combe Grenal sequence" as well as "a strongly marked tendency for M.T.A. horizons to be stratified *above* Quina levels" at at least 12 sites (Mellars 1969: 142-144, Figure 3). In addition, at a number of sites, the MTA industries have been located just beneath Upper Palaeolithic assemblages, and no non-MTA assemblage has ever been found between two MTA horizons (Mellars 1969: 144). It should be recalled that Bordes thought that the MTA type b evolved into an early Upper Palaeolithic industry. There are important differences between faunal remains in these assemblage types. Reindeer remains are abundant or dominant in most Quina assemblages, but in the MTA they are "very scarce" (Mellars 1969: 145). This indicates that milder conditions were in place during the MTA occupations than during the Quina ones (Mellars 1969: 145). Mellars calculated the probability of such a stratigraphic

relationship occurring randomly to be “of the order of 1 in 2,000 [$p = 0.0005$]; in other words, the feature must be regarded as ‘highly significant’ in a statistical sense” (1969: 146).

Another important observation that Mellars made was the relationship between Ferrassie and Quina types. These two assemblage types “share many features in common” and were considered by Bordes to have been subtypes of the broader Charentian group, the Ferrassie type having a greater proportion of Levallois flaking, lower frequencies of transverse racloirs, more points and “pointed” racloirs, and thinner tools (Mellars 1969: 150; see Appendix A). At Combe Grenal, all of the nine Quina industries were “superimposed above five Ferrassie industries . . . without any indication of an overlapping of the two types” (Mellars 1969: 151). When Mellars wrote this, one of the problems in making generalizations about the position of these two types was the “relative scarcity” of Ferrassie forms; however, some “Quina-above-Ferrassie” examples are cited (Mellars 1969: 150, 151). Chronologically, these industry types are adjacent at two sites, without any intervening types. In addition, the Ferrassie assemblages often cluster around the Würm I and Würm II transition (Mellars 1969: 156). Wherever Quina and Ferrassie occur together, or when multiple assemblages of either type are present, there is evidence of an evolutionary pattern in the distribution of artifact types (Mellars 1969: 155):

What seems especially significant is that the same typological “trends” as those which separate the Ferrassie and Quina variants can be observed clearly *within* the Ferrassie horizons at the Abri-Chaudourne and La Ferrassie, and *within* the Quina levels at Petit-Puymoyen and Combe-Grenal.

Going from the earlier to later layers, there is a decrease in Levallois flaking and an increase in transverse racloirs, as well as a consistent shift in striking platform technology (Mellars 1969: 154). Mellars thus demonstrated *continuity* across two of Bordes categories’ as well as an evolutionary pattern.

With regard to the Typical and Deniculate Mousterian, the remaining two assemblage categories or *industries* to use Mellars’ terminology, there is no straightforward chronological sequence and both occur in “widely separated points of time” (1969: 158). A possible reason for the lack of chronological patterning is typological: These two variants are the least distinctive in terms of characteristics, mainly reflecting proportions of artifact types, whereas the other variants have distinctive features such as technological attributes (Levallois

manufacture) or diagnostic tool types (handaxes and backed knives) (1969: 158). The Denticulate Mousterian does appear to be restricted to two relatively distinct periods of time, before and after the Charentian industries at Combe Grenal. The meaning of this restriction and its relation to the other assemblage types, however, is unclear.

Mellars' Behavioural Position

The next issue Mellars addresses concerning the nature of the Middle Palaeolithic assemblage types is the meaning or behavioural interpretation of these categories. In a recent article Mellars states (1992: 31):

. . . the stratigraphic distribution of the Ferrassie, Quina, and MTA industries outlined above provides strong support for Bordes' contention that these three variants do indeed represent significant taxonomic and behavioural entities within the specific context of the southwest French industries.

Again, the typological entities have behavioural reality, but this time the reasoning presented is somewhat different. Mellars cites differences in technology, artifact form and the presence of assemblage-specific tool types (e.g., bifaces and backed knives) as reflecting behavioural differences, rather than simply the proportion of types (1992). Mellars states that the most important difference is between the MTA variants and the others (1992: 39):

All of the present indications are therefore that the relatively sudden and abrupt appearance of the MTA industries within the southwest French sites represent a fundamental and wide-ranging change in the whole character of lithic technology.

This is related to the evolution of MTA types to Upper Palaeolithic types first articulated by Bordes, although in this case it is applied to Neanderthals and not pre-Sapiens. Mellars stated that "the arguments in favour of ethnic and cultural continuity between the Châtelperronian and latest Mousterian populations in southwest France are virtually conclusive" (1973: 273). This view was later substantiated by the 1979 discovery of a Neanderthal in a Châtelperronian context at Saint-Césaire, in association with Upper Palaeolithic, Châtelperronian tools (Trinkaus and Shipman 1992: 376; ApSimon 1981).

Discussion

As mentioned above, Mellars takes a somewhat intermediate stand on the

valuation of Neanderthal behaviour. In his discussion of the differences between Middle and Upper Palaeolithic technology, he points to differences in material technology, subsistence activities, and social organization, but says the aforementioned evolutionary pattern extends across the Middle to Upper Palaeolithic boundary (1973: 270-273). The bulk of the Middle Palaeolithic is considered to be more simple than the Upper Palaeolithic; however, these differences are shown with specific reference to archaeological information rather than biological capacity, and are in many cases quantitative rather than absolute (see Mellars 1973). In his most recent work, Mellars makes two assumptions in describing "The Neanderthal Mind" (1996: 366):

. . . that there were no significant contrasts between the mental capacities of Neanderthal and modern human populations, and that such contrasts should be inferred only after a rigorous and essentially sceptical analysis of the available archaeological evidence makes this conclusion at least highly plausible if not inescapable.

He does not, however, rule out the possibility. Mellars essentially agrees with my introductory statement that this issue can only be resolved through the examination of archaeological remains, rather than through imputed or inferred biological capacities. Many of the differences may best be explained in cultural or historical, rather than strictly biological terms.

In evaluating Mellars' continuity with the previous era, his findings at first glance could be compared to the early evolutionary positions of de Mortillet; however, this is in many ways inappropriate. Mellars accepts the nature of the variability in the record and does not posit a straightforward logical progression of types. His approach is more systematic and has a strong empirical basis. Mellars also contradicted the dominant position of his day concerning the stratigraphy of the Périgord. In one of the first critical analyses of Peyrony's findings, Mellars compared them with Boursin's alternative explanation for the same archaeological sequence (Mellars 1969: 142). The points of continuity are the use of Bordes' typology, and the assumption, to a certain degree at least, that the categories represented are natural or behaviourally real ones. Mellars does allow, however, for the effects of environmental circumstance and admits to some of the categories being continuous rather than discrete (Quina and Ferrassie).

The interplay between the levels of Mellars' theory is sound; he builds most of his theoretical points on his empirical findings. The passage cited above concerning his assumptions about Neanderthal behaviour indicates a careful

approach to making interpretations, and a concern not to force data to fit conclusions. He uses data inductively rather than relying on an exclusively hypothetico-deductive approach.

THE ROLLAND-DIBBLE SYNTHESIS: NON-CULTURAL CAUSES OF VARIABILITY

The most recent of the four positions derives from the work of Nicolas Rolland and Harold Dibble, who presented their *New Synthesis* in 1990. This joint position was built upon the work of two researchers of different perspectives and different backgrounds. Their essential point was that certain demonstrable factors, which are neither related to style nor function, underlie lithic variability for the Middle Palaeolithic of Western Europe. Furthermore, these authors have attempted to demonstrate that this variability, in terms of both Bordes' tool and assemblage types, is not discrete but continuous (Rolland and Dibble 1990: 480). Instead of stylistic and ethnic factors, as in Bordes' interpretive model, and instead of functional categories, as in Binford's model, Rolland and Dibble posit that "raw-material constraints and different degrees of artifact-reduction intensity constitute more basic and observable factors of variability" (1990: 480). Contributing to both the raw-material constraints and reduction intensity are factors such as site occupation intensity and environmental factors affecting group mobility.

Rolland's Interpretation of Middle Palaeolithic Variability

In 1977 Rolland presented a brief summary of a quantitative analysis of 120 assemblages. His findings suggested "the possible importance of non-cultural causes for [Middle Palaeolithic] variability" (1977: 251). The empirical basis for these findings was a comparison of implements (all regularly retouched tools) "plus all irregularly retouched, utilised or blank Levallois and non-Levallois flakes and blades" (Rolland 1977: 251). Whereas the implement frequencies for Bordes' assemblage types showed separation into two groups (Charentian and non-Charentian), there was also considerable overlapping of ranges: "the Typical and MTA show intermediary values overlapping with other industry types" (Rolland 1977: 251). In addition, Rolland presented data on "frequency variations for artifact sub-categories among Middle Palaeolithic industries" and "ratios of flakes and blanks to cores" (1977: 251-2, Table 1). The frequencies of these variables show a *continuous* range of variation, consistent with that for the implement

frequencies, and “that differential blank production and secondary modification are correlated” (Rolland 1977: 251). The range of variations suggest that environmental factors result in the economizing of lithic material. Another feature of this initial study suggests that the distribution of implement types is unimodal rather than polymodal as in Bordes’ *rauloir* distribution. Furthermore, the distribution of implements is dependent primarily on the frequency of *rauloir*s rather than other tool types such as notches and denticulates (Rolland 1977: 252).

The continuous distribution of tool types, and the importance of one class of tools (*rauloir*s: types 9-29) in shaping that distribution, call into question both the ethnic argument of Bordes and the functional argument of the Binford (Rolland 1977: 252). Rolland elaborated further in a more lengthy article “The Interpretation of Middle Palaeolithic Variability” (1981), in which the interpretive implications of the distribution of the artifact types is more systematically worked out, and more data is presented to confirm the continuous distribution of implement frequencies. Rolland begins by placing his arguments concerning lithic variability in a general methodological perspective. He adopts a number of working concepts which differ from those of previous authors. He states that hominids rely on available stone tools for their subsistence, palaeolithic assemblages are primarily the remains of residence camps and are roughly comparable, these assemblages “are the material residues of activities by ancient hominid groups, their contents historically derived and socially transmitted,” the Middle Palaeolithic is a stage or a technocomplex rather than a discrete entity, and that there are complex but explainable diachronic processes in the data (Rolland 1981: 19-20). This set of premises incorporates a broader definition of culture than either Bordes or the Binford use and phrases the variability debate in terms of that definition.

Rolland then turns to the results of his quantitative analyses of the data. As mentioned in the 1977 study, the continuous degree of flaking and trimming of tools demonstrates a correspondence with Bordes’ assemblage types. The differential manufacture of implements is related in a predictable fashion to an assemblage’s assigned type. The implications of this study establish an interpretive incompatibility between its results and prevailing interpretations (Rolland 1981: 22):

Named Mousterian entities, on the one hand, are equated with predominantly internal or socio-historical mechanisms. Differential implement manufacture, on the other, is identified with the need to

make maximum use of relatively scarce lithic material owing to external circumstances . . .

Rolland uses various means to explain this incompatibility. After rejecting models such as that of Bordes which posit independent toolmaking cultures, and models which correlate distinct traditions with external factors, he generally accepts a third: "Differential implement manufacture and primary flaking are due entirely to adaptive responses to external conditions" (1981: 25). In this perspective artifacts are stone tool implements which are discarded following "successive modifications through wear and resharpening," known as the "Frison effect" (Rolland 1981: 25, following Frison 1968).¹⁸ This model views the bulk of assemblage variability as reducible to two general artifact groups, racloirs, and notches and denticulates (types 9-29 vs. types 42, 43). This is based on the observation that assemblages with high proportions of implements are dominated by racloirs, while assemblages with low implement frequencies are dominated by notches and denticulates. The distribution of assemblage types occurs along a continuum of the two poles of high implement/racloir and low implement/notches and denticulates.

An understanding of what these general tool classes represent is crucial to explaining this distribution. A racloir is an implement with "one or more continuous regular lines of trimming along the piece's long axis" while notches and denticulates are "characterised by single or multiple notches, large or small serrations" (Rolland 1981: 26; see Appendix B). Although functional interpretations are tentative, there appears to be a general difference between these tools. Racloirs are generally considered to be cutting, and possibly scraping tools, while notches and denticulates are generally thought to be used for sawing, scraping, scoring and grooving. Further, racloirs appear to have been used to process softer materials such as meat and skins, while notches and denticulates were used for materials such as bone and wood. There are also differences in raw material used, with better quality flints being reserved for racloirs, and coarser stones such as chert and quartz used for notches and denticulates. Racloirs tend to be made from larger flakes and subsequently retouched. Unretouched flakes were often utilized as simple knives and may be functionally classed with the racloirs.

The differences between the proportions of these tool types suggests that raw material economizing is an underlying reason for the continuous variability

(Rolland 1981: 28):

For racloirs and related implement forms, this would result from situations when fine-grained stones were less accessible and expendable, requiring the prolongation of tools' lifespans by repeated resharpening of cutting flakes, instead of their being discarded or replaced at an early stage.

Rolland concludes that "differential attrition rates operated for racloirs and for denticulates and notches, owing to differences in function" (1981: 28). Racloirs were worn out more quickly and thus resharpened and discarded more often than notches and denticulates. In assemblages where racloirs are most dominant (Charentian assemblages), there were also specialized forms of "restoring efficient cutting edges," which further supports the model (Rolland 1982: 28). Methods of trimming and retouching restored edges to implements which might have been discarded in other contexts.

Rolland provides contextual evidence from non-lithic sources to support the claim for raw material economizing. Both palaeoclimatic and geographical data are given. Rolland compares palaeoclimates with assemblage types (1981:30; Table 1). Industry types generally correspond to palaeoclimate type, although the correspondences are not direct. The modal positions for Denticulate Mousterian, Typical Mousterian, Ferrassie and Quina assemblage types are different in terms of climate. Denticulate types are most abundant in temperate, wet climates; Typical in mild, wet climates; Ferrassie in cold, wet climates; and Quina in cold, dry climates.¹⁹ Although there appears to be overlap between geographical areas and assemblage types, there are some regularities. Charentian-like assemblages tend to occur in more continental and modern temperate zones of Western Eurasia, while Denticulate occurrences are generally more southern and western in location.

Rolland concludes his 1981 paper by presenting three interpretive models which examine cultural processes which may underlie these distributions. Given the climatic fluctuations, *seasonal variations* could induce different access to resources and settlement locations, both of which would affect access to and use of raw materials. Transhumance of Middle Palaeolithic populations is presented as a reasonable possibility. *Population growth* would also affect the access to raw materials. As populations grow, local groups may disperse in response to stresses on the carrying capacity of resources, thus affecting the lithic resource base. A third factor, *social morphology*, could affect raw material availability. Local

groups and settlements may differ in their degrees of “sedentism/concentration as opposed to mobility/dispersion” (Rolland 1981: 33). All of these models are presented on the basis of ethnographic analogy. They all imply “that the many named Mousterian Complex entities refer, in fact, to particular states of transformation undergone by the same industrial complex under conditions varying through time” (Rolland 1981: 14). Whereas Bordes’ assemblages types do reflect differences in the distribution of types, these differences are proportional and continuous rather than absolute.

Dibble’s Lithic Reduction Model

Following Rolland’s 1981 paper, Harold Dibble provided new evidence, based on artifact attribute analysis, which reinforced Rolland’s model and led to their New Synthesis. Dibble’s position is based primarily on the quantitative analysis of racloirs. In 1984 Dibble presented an analysis of this class of tools in assemblages from Bisitun, Iran and showed that the different types of racloirs represented “a continuous sequence of reduction, instead of three distinct functional or stylistic classes” (1984: 431). In a subsequent analysis he incorporated material from the French Middle Palaeolithic and applied his model of lithic reduction to the present area of study (Dibble 1987, see also Dibble 1989).

Bordes’ racloir types can be divided into four major classes depending on the number and location of retouched edges (Dibble 1987: 109; see Appendices A and B):

- (1) simple single-edged scrapers that have one lateral retouched edge; (2) double scrapers, with two non-joining retouched edges; (3) convergent scrapers, which exhibit two edges that come together to form a point, usually at the distal end of the flake; and (4) transverse scrapers - those with a single retouched edge opposite the striking platform

According to the reduction model discovered with the Bisitun material, simple, single-edged racloirs are transformed into double scrapers when retouched so that a parallel edge is added. Further retouching of double scrapers ultimately results in the flaked edges coming together opposite the striking platform to form a convergent racloir. Transverse scrapers were not present at Bisitun. Dibble compared each of these classes of racloirs using the following metrical criteria: (1) the intensity of retouch (measured by the proportions of light, medium, hard or stepped retouch on the racloirs); (2) the dimensions of length, width, thickness and

the ratios of flake area to platform surface area; and (3) the angle of skew of the working edge from the initial flake axis as measured from the striking platform (Dibble 1987).

On the first measure, Dibble found that the intensity of retouch varied with the class of racloir. Lighter retouch intensity was most common on simple, single-edged racloirs, and heavy retouch was most common on double and convergent racloirs. Convergent racloirs had the highest proportions of heavy and stepped retouch. Transverse racloirs showed retouch that was nearly as heavy as the convergent ones. According to the reduction model, this data suggested that heavier retouch was associated with more reduced forms. In addition, transverse scrapers, showing heavy retouching, were discovered to be near the end of a reduction sequence.

The data on the mean lengths, widths and thicknesses support the reduction model. Simple and double racloirs showed the longest lengths and were similar to each other in their mean lengths, while convergent and transverse racloirs were shorter. This makes sense because only after the retouched edges converged would material be removed from the end of the flake. The shortness of the transverse racloirs shows that a different process of reduction was involved. When a tool is retouched, it is retouched more at the end opposite the striking platform since it is thinner than the end at the platform. This explains why the two edges converge. Conversely, when there is only one heavily retouched edge, it gradually shifts its angle in relation to the striking platform (Dibble 1987: 112, Figure 2). This has been verified with transverse racloirs. The ratio of flake area to platform area is consistent with the reduction intensity model.

The final measure is the angle of skew. Here retouch intensity and length of artifact are correlated with the degree of skew of the retouched edge. This supports the proposition that convergent and transverse racloirs are the product of extensive retouch and implement modification. These measurements also support the notion of a "continuous relation between this angle of skew and the other variables that reflect reduction" (Dibble 1987: 114).

Using a battery of statistical tests, Dibble found that there was significant support for the reduction model in the metrical data. He concludes the metrical analysis with the following (Dibble 1987: 115):

Thus, virtually every morphological aspect that was observed on

the scrapers from each of these sites corresponds to what would be expected if the reduction sequence were operating.

In addition, each attribute (intensity of retouch, length, angle of skew, etc.) showed continuous distribution across the types rather than polymodality.

Dibble next examines the relationship of this model to Bordes' typology. The four major classes of scrapers which he analysed were fit into a generalized reduction sequence and presented schematically as a flowchart (1987: 115). The reduction sequence begins with the initial modification of a flake (likely after initial usage). This trimming of a flake along the axis of the tool results in one of the single racloir types. When this is subsequently resharpened, two possibilities emerge. The racloir may be continuously retouched on one side, resulting in a transverse racloir type by the process mentioned above. If a second edge is added, the tool becomes one of the double racloir types. Through heavy retouch, it becomes a convergent racloir. Another possibility is the *déjeté* type of racloir. This results when a second edge is "retouched after the angle of the first working edge is greater than 45 degrees relative to the axis of flaking" (Dibble 1987: 116). Thus four major classes of racloirs (simple [types 9-11]; double [types 12-17]; convergent [types 18-20] and transverse [types 22-24]) and a single tool type (*déjeté* [type 21]) are accounted for by this model (see Appendix A). These tool categories, rather than representing discrete stylistic or functional types, are partitions along a continuum of reuse and modification, the final form resulting from the point of discard along one of the reduction trajectories. This model represents 15 of Bordes' recognized tool types. Thus by implication, the reduction model accounts for nearly one quarter of the tool categories. In addition, as mentioned previously, this class of tools is abundant in most assemblages. The reduction model explains a significant amount of the potential variability in assemblage composition.

Dibble suggests that "this model may help to isolate specific factors underlying the typological variability that is apparent among Middle Paleolithic industries of the Old World" (1987: 116). He also refers to the models presented by Rolland in 1977 and 1981 (Dibble 1987: 116). The perspectives of Rolland and Dibble are compatible in many ways. This ultimately led to their synthesis position presented in 1990 in *American Antiquity*. The data presented by Dibble on the potential causes for the different racloir types fits well with Rolland's observations on their role in assemblage composition. As Rolland stated in 1977;

“racloirs constitute the most dynamic artefactual element in Middle Palaeolithic assemblages” (1977: 252). They are also compatible on an interpretive level because the processes of lithic economizing discussed by Rolland (1981) would result in intensive retouching of tool types as evidenced by more extensive racloir resharping. The net result would be more variability in terms of types of racloirs and an increase in racloir manufacture when lithic economizing was practised.

The New Synthesis

In addition to synthesizing their previous works, Rolland and Dibble presented new data and interpretive models which strengthened their respective positions. They presented a broader historical or *self-reflective* viewpoint. They discussed palaeontological and other influences on the creation of the typological system still used and endeavoured to make potential biases explicit (Rolland and Dibble 1990: 481-2; Dibble and Rolland 1992: 2-4). The cornerstones of their argument are: (1) that variability in both assemblage types and artifact types (e.g., racloirs) occurs continuously, and that these categorical entities are not discrete but represent different aspects of a single phenomenon; (2) that “raw material constraints and different degrees of artifact-reduction intensity constitute more basic and observable factors of variability than function and style;” and (3) these factors are in turn related to “toolmaking and tool-rejuvenation processes and/or by differential occupation intensity induced by environmental circumstances” (Rolland and Dibble 1990: 480). Other factors, such as stylistic drift, function and diachronic change are cited as other possible, albeit secondary factors (Rolland and Dibble 1990: 480, 490-492).

Rolland and Dibble's Behavioural Positions

Despite the fact that their empirical bases and general interpretive models point toward the same interpretations regarding the nature of assemblage variability, the two authors present different views concerning the behavioural complexity of Middle Palaeolithic toolmakers (and Neanderthals in particular). Dibble's position is best described as agnostic, whereas Rolland's infers a relatively advanced degree of cognitive complexity for “pre-Upper Paleolithic” populations.

Dibble's views are phrased in terms of the evidence for symbolic

expression among Middle Palaeolithic populations in both Europe and the Middle East (thus both for “archaic *Homo sapiens*” and Neanderthal populations). In 1987, Dibble and Philip Chase discussed this topic in terms of four classes of archaeological data: “lithic types and assemblages,” “burials,” “rituals other than burials” and “art.” In discussing stone tools they argued (Chase and Dibble 1987: 266):

. . . in order to infer symbolism, one must show that the patterning observed in lithic structures reflects arbitrary, or noniconic, relationships between the symbols (the artifacts themselves) and their referents. The problem is to sort out the effects of the other factors of raw material, technology, and function and thus arrive at the iconological residue . . .

According to the lithic reduction model, the bulk of variability in the form of artifacts is the result of non-stylistic factors such as reuse and modification of form. The continuous distribution of attributes across types suggests that the recognized types did not represent desired end products in the minds of their makers (Chase and Dibble 1987: 268). Other factors such as technology employed and function of the tools, together with reduction intensity, can sufficiently account for the variability expressed, leaving no room for the “iconological residue.” Chase and Dibble state (1987: 268):

Thus, it is far from proven that the “types” that have been defined for the Lower and Middle Palaeolithic industries demonstrate particular cognitive categories of the prehistoric hominids who made and used those tools.

The evidence from the tools neither supports nor “denies the existence of linguistic categories” such as icons or symbols (Chase and Dibble 1987).

Non-typological aspects of the tools appear to be better measures of *cultural* behaviour. Several types of tools, especially the bifaces, show a concern for symmetry in their manufacture. Chase and Dibble think this may indicate “some esthetic appreciation on the part of those hominids” (1987: 269). Non-lithic evidence is cited to support such an appreciation (Chase and Dibble 1987: 280-283). Another aspect which may demonstrate cultural behaviour is differential choices of technologies or emphases on tool types. Differences between different assemblages in these aspects is by itself insufficient to demonstrate cultural choice, because other factors can more parsimoniously explain them. However, certain tool types and technologies employed show interregional variation. For

example, bifacial foliate points are found in numerous assemblages throughout Eastern and Central Europe but are absent elsewhere. Assemblages of contemporaneous age in the Near East show an abundance of Levallois flaking. Factors such as environment, activity, or raw material abundance do not seem to underly these differences: “they are the best candidates for ‘isochrestic’ styles (i.e., functionally equivalent alternatives in morphology and technology)” (Chase and Dibble 1987: 270). Cultural choices are being made between different technological and morphological systems rather than stylistic ones per se.

Chase and Dibble conclude their analysis of the evidence for symbolism among stone tools by stating that (1987: 271).

Admittedly, the lithic evidence is not conclusive. The point that we are making is not that the lithic evidence demonstrates a lack of symbolic thought. The point is that it does not demonstrate its presence.

Such a statement has led to what is essentially an agnostic position on this issue. A similar conclusion is reached when each of the four classes of archaeological data is discussed. According to their criteria, the data does not provide evidence for symbolic thought. Chase and Dibble cannot, however, prove the lack of symbolic thought. They do not infer the inability to symbol, just that “what is not apparent is that symbolism played a significant role in their adaptations” (1987: 284-5). Isolated examples of symbolism in material culture may in fact demonstrate that such a capacity did exist, but not that it was a regular and vital component of their behaviour.

Dibble further elaborated this agnostic position in his 1989 article “The Implications of Stone Tool Types for the Presence of Language During the Lower and Middle Palaeolithic” (1989: 428):

The purpose of this paper was to argue against the use of lithic types as evidence for early symbolic behaviour. The primary conclusion is not that pre-modern hominids did not talk, but rather that the kinds of lithic evidence discussed here do not demonstrate that they did.

In short, Dibble leaves the issue open to debate and offers only a lack of evidence from the lithic record.

Rolland’s position differs somewhat from that of Dibble. In his paper, “Middle Palaeolithic Socio-Economic Formations in Western Eurasia: An Exploratory Survey,” he examines a host of socio-economic factors such as

population, subsistence, technology, and settlement in relation to the issues of interassemblage variability. He places the Middle Palaeolithic in a developmental time-frame and compares it to both the Lower and Upper Palaeolithic. During the Middle Palaeolithic, a number of features appear for the first time, having developed from the Lower Palaeolithic (Rolland 1990: 373-374). Overall hominid population increased throughout this period, due mostly to geographical expansion into harsher climates without an overall increase in density. Subsistence pursuits became more intensive but not extremely specialized (this did not occur until well into the Upper Palaeolithic). New settlement patterns emerged in the Middle Palaeolithic and caves, shelters and artificial dwellings were more regularly used. Improvements in the use of fire, butchering and lithic technologies are noted. Intentional burials, often with evidence of "crypto-aesthetic activities," emerge. In general, overall variability in both lithic and non-lithic archaeological classes show an increase from the Lower Palaeolithic through the Middle Palaeolithic. Many of the innovations and patterns developed in the Middle Palaeolithic continue well into the Upper Palaeolithic. When viewed from a broad, socio-economic perspective, however, change began to occur at a more dramatic rate as time passed (Rolland 1990: 374).

Rolland's interpretation of Middle Palaeolithic and Neanderthal behaviour relies on this broad, synthetic view of human evolution, where the Middle Palaeolithic is considered a developmental stage. The Middle Palaeolithic is undoubtedly more simple than any known human culture and many Upper Palaeolithic cultures. The reasons for this can be explained without recourse to biological determinism (Rolland 1990: 375-6). Rolland believes that "historical and social factors remain exclusively responsible for culture's capacity for exponential growth rates and elaboration" (1990: 377).

The near absence of symbolism in the Middle Palaeolithic is cited as a potentially "serious objection to an exclusively cultural explanation for differences between the Middle and Upper Palaeolithic" (Rolland 1990: 376). Most of the examples given as evidence for symbolism are ambiguous and only a very few are certain. Two possibilities present themselves: Either these hominids did not have the capability to symbol or "it was latent and remained unexpressed materially because Middle Palaeolithic repertoires were still too rudimentary and utilitarian" (Rolland 1990: 376).

The presence of language is still hotly debated, but Rolland offers two

reasons why Middle Palaeolithic hominids likely had capabilities for speech. Sufficient cranial capacity, the flexion of the base of the skull and the locations of the vocal organs could suggest the capacity for speech (Rolland 1990: 377). The interrelation between technical skill and linguistic ability has been argued. The relatively advanced technical abilities required for such tasks as Levallois manufacture suggests that comparably complex sequences are present in the linguistic domain. The place of these hominids along evolutionary trajectories, however, is the strongest suggestion for the use of language (Rolland 1990: 377):

Both palaeoanthropic and neoanthropic grades or evolutionary strains of *Homo sapiens* have more in common than not (in spite of some unquestionable differences), when compared with earlier human evolutionary groups. This indicates that Neanderthals and pre-Neanderthals had already attained an advanced level along the hominid biological hominization trajectory, including probably capabilities for speech and symbolic behaviour.

In general, the expression of Middle Palaeolithic culture and its development over time (Rolland 1990: 377):

suggests a gap between the somatic *capabilities* for culture attained by palaeoanthropic populations and the Middle Palaeolithic's *actual* developmental level This gap corresponds perhaps more with limits inherent in the cultural repertoires themselves for cumulative growth, than with innate limitation of the populations who produced them.

Discussion

This last model explaining lithic variability and Neanderthal (or Middle Palaeolithic in general) behaviour differs most notably from the previous positions on its structuring and the interpretation of the categories used. Rolland and Dibble's models suggest that Bordes' assemblage and artifact categories are not discrete but represent partitions of continuous phenomena. Factors beyond the traditional stylistic, functional, and even temporal ones are said to contribute to the variability within and between these categories. The assemblage types are not distinct behavioural entities themselves, but rather the product of a single, adaptive, behavioural complex distributed throughout Western Eurasia and parts of Africa. Regional differences occur, but the specific processes discussed by Rolland and Dibble account for the bulk of the lithic variability in the Middle Palaeolithic.

The nature and use of Bordes' assemblage and artifact types in Rolland

and Dibble's writing is clearly distinct from those of the earlier era of research. Much of this is due to the recognition of the influence of strict palaeontological analogies, and the conscious rejection of them. Of course, many continuities exist at a number of levels, such as the use of Bordes' typology itself and observations from earlier periods; however, the overall approach differs significantly. Much of Rolland and Dibble's work builds upon the observations made in the present era and the points of continuity are mainly with models in this era. Although the underlying principles of Bordes typologies' are rejected, the typologies themselves are accepted as reflecting real differences in the archaeological material. For example, Dibble's many tables of morphological attributes indicate that there is a difference between a simple racloir and a convergent one (1984). It is the meaning of these differences that is different. Rather than representing stylistic forms, the differences are products of specific behavioural patterns such as raw material selection and artifact reduction. The tools are also not discrete entities; a simple scraper can be transformed into a convergent one. The categories which Bordes presented represent significant differences in the archaeological data but are more elastic than his model indicates. The differences are relative rather than absolute, both in terms of typology and behaviour.

The view that the Mousterian Complex, or Middle Palaeolithic in general, is part of a single heterogenous entity owes much to the work of Binford and Binford. Despite the rejection of the functional argument itself, Rolland and Dibble uphold the idea that the differences can best be explained in terms of behavioural processes. Lewis Binford also was one of the first in the modern debate to indicate the influence of environmental factors on assemblage composition, and even suggested a number of points, such as seasonal differences and group mobility, that were retained in the Rolland and Dibble model.

Although the role of the environment is given a more prominent place in Rolland and Dibble's writings, they reject the "random" interstratification of Western European assemblages, as articulated by Peyrony and later by Bordes and the Binfords, and accept Mellars' chronological patterning in its place. This is another clear and conscious break with the previous era.

The greatest difference with other theorists is the nature of the categories employed. As mentioned above, the most important premise underlying the Rolland and Dibble model is that the variability in Middle Palaeolithic assemblages and in many of the tool types is continuous. Underlying this is the

notion that variability is multi-causal (Rolland and Dibble 1990: 493). According to Rolland, the factors contributing to variability are distributed normally, as multi-causal phenomena tend to be, (e.g., as in a binomial distribution; Rolland, personal communication). Rolland's recent research has indicated that the Quina variant is distributed in Europe as the "tail" of a natural population distribution (Rolland in press b). This further supports the proposition that the various assemblages of the Middle Palaeolithic are part of a generalized phenomena and are a single population in a statistical sense. As Dibble has demonstrated, similar distributions tend to occur for the tool types themselves, and are indicative of a continuous process of use, reuse, modification and ultimate discard. Environmental factors influence the distribution of the various artifact types in a process which is somewhat analogous to directional selection in biological populations. This would explain why there is not a direct one-to-one correlation between environmental type and assemblage type (as in Rolland and Dibble 1990: 489, Figure 2).

Because the various assemblage and artifact types represent partitions of a continuum and are multi-causal, there is little if any direct correlation to "cultural" categories such as style and function. Although behavioural processes were obviously involved in the creation of the archaeological remains, this model challenges the idea that these behaviours can be directly read from the stone tools or their distribution. Thus, in their interpretive models, Rolland and Dibble reject a stylistic component to the stone tool assemblages. Evidence for behaviours such as symbolism and language cannot be read directly from the distribution and form of tool types in this era. Interpretively, this has led Dibble to his agnostic position that stone tools are not useful as evidence for symbolism or language (Dibble 1989: 428). Rolland's suggestion that groups such as the Neanderthal had some degree of linguistic and cognitive sophistication comes from many lines of evidence indicative of "socio-economic formations" rather than from the tool and assemblage categories themselves (Rolland 1990). Although both Rolland and Dibble's interpretive models differ somewhat, they both seem to be well integrated with their empirical observations.²⁰ Both use the empirical data in a cautious manner and do not make great deductive or interpretive leaps as some of the earlier researchers did. There is a recognition of the strengths and limits of the data, and their views are built more upon the data than the data is shaped to their views.

With regard to the valuation of Neanderthal behaviour, both uphold the

notion that these groups did not have behavioural systems analogous to modern human groups, and that there were fundamental differences. These differences are, however, interpreted from the archaeological data rather than from imputed biological capacities. Both contend that these groups likely had capacities similar to our own, but that their behavioural *expressions* were different (Chase and Dibble 1987: 285; Rolland 1990: 377). The authors appear to disagree on the extent of those differences, however.

CONCLUSIONS

Several authors' models on the structure and meaning of Middle Palaeolithic variability have been presented in this chapter and examined from an historical and critical perspective. Specifically, the nature and interpretations of the categories employed by the authors have been examined, with regard to their valuation of Neanderthal behaviour, their continuity with previous models and the integration of theoretical levels. These themes are summarized in Table 2.1.

Generally speaking, the degree of continuity with the previous era differs from author to author and tends to decrease over time. In spite of the rigorous typologies presented by Bordes, there does not appear to have been a paradigmatic "revolution" in the study of the Middle Palaeolithic between the eras. There is a high degree of continuity, particularly in the interpretive realm, but the explicitly racist and imperialist models have been dropped by most authors. The equation of *race* (defined here as a morphological or genetic population) with behaviour, however, still occurs in the present era at a level that is not made explicit. Neanderthals are still considered to be inferior in capacity to modern humans on two counts: They looked different and they did not survive. This seems to be the ultimate basis on which they are judged.

The equation of human behaviour, i.e., the *capacity* for culture and symbolism, with anatomically modern humans only is made by several authors. In the models presented above, Lewis Binford makes this assumption. Other authors also hold such a view. A notable example is the work of Iain Davidson and William Noble (1993). These authors create a binary dichotomy and argue that "all human ancestors without language should be considered as closer to chimpanzees than to modern humans in their behaviour" (1993: 363). Modern humans are viewed as superior because of their exclusive ability to use complex language, as expressed primarily in the florescence of symbolic artifacts in the

Table 2.1. Recent Models to Explain Middle Palaeolithic Variability.

	Bordes	Binford(s)	Mellars	Rolland/Dibble
Nature of categories employed	Discrete artifact and assemblage categories.	Discrete artifact and toolkit categories.	Distinct, but chronologically patterned assemblage categories.	Continuous artifact and assemblage categories.
Interpretation of categories	Natural types correspond to discrete behaviours (artifact and assemblages).	Natural types correspond to discrete behaviours (functional toolkits).	Assemblage types are patterned chronologically and behaviourally different.	Artifact and assemblage types are products of adaptive responses to changing environments.
Causes of artifact variability	Different stylistic forms.	Different functions.	Chronological and stratigraphic relationships.	Differential reduction, raw material constraints.
Causes of assemblage variability	Different ethnic traditions.	Distribution of toolkits.	Chronological and stratigraphic relationships.	Differential distribution of implements as response to local circumstance.
Cultures	Multiple groups, multiple species.	One.	Successive.	One technocomplex with isochrestic regional variation.
Behavioural implications for Neanderthals	Complex: ethnic traditions and species differences.	Simplistic: lack of planning, little large game hunting.	Behavioural differences to modern humans, not biological.	Behavioural differences to modern humans. Dibble: agnostic re: complexity. Rolland: evidence of complexity.

Upper Palaeolithic of Europe (e.g., Davidson and Noble 1993; Davidson 1991). They use the Rolland and Dibble model to support the contention that Neanderthals lacked language, despite the fact that neither Rolland nor Dibble actually state this (Davidson and Noble 1993: 378). Christopher Stringer and Clive Gamble (1993) also contend that modern human behaviour is the exclusive domain of recent, essentially modern humans. Their argument has received support from the analysis of mitochondrial deoxyribonucleic acid (mtDNA), which

posits a recent, single African origin of modern humans.²¹

There is an element of biological determinism implicit in these assumptions concerning the differences between Neanderthals and “anatomically modern humans.” The “success” of modern humans is presented in a manner similar to the interpretations presented in the previous chapter. Their advantage is often expressed in terms of inherent biological differences, and the Neanderthals are considered to be a different species (e.g., Davidson 1991; Stringer and Gamble 1993). There is a direct association between the success of one group and its biological fitness. Other alternatives, such as demography (Zubrow 1989), socio-historical events and the relationship between the groups are often ignored.²²

Though one cannot call the positions of authors such as Binford, Davidson and Noble racist, one can challenge the assumptions upon which they are based. Their imputed distinctions between behavioural forms and biological forms are just as often based upon the prior categorical constructs employed as they are on the actual evidence. One of the problems with the comparison of Neanderthal and modern human behaviour is that it is often anachronistic, because it compares Upper Palaeolithic humans with Middle Palaeolithic Neanderthals (see Stringer and Gamble 1993: 198, 216-218). The so-called radical distinction between the Middle and Upper Palaeolithic in Western Europe, and thus between Neanderthals and humans, may therefore be less real than apparent. The role of the Neanderthal, Châtellperonian, Upper Palaeolithic industry is a case in point. There is considerable evidence, as both Mellars and Bordes indicate, of a local development for Upper Palaeolithic forms that cannot easily be explained by diffusion of new ideas from modern humans (Mellars 1973: 273; Bordes 1961: 804). As Rolland states, the differences in behaviour may be better explained with reference to “historical and social factors [which] remain exclusively responsible for culture’s capacity for exponential growth rates and elaboration” (1990: 377). One must not forget that for much of their history, when they lived contemporaneously, Neanderthals and “modern human ancestors” shared near identical tool-making industries and abilities. In addition, they may have coexisted in the same region for several millenia in the Middle East (see Mellars 1989: 354-5, 370).

The use of palaeontological models is another area in which there has been considerable continuity between the eras of study. Three of the authors presented equate, to varying degrees, the categories employed with actual

differences in behaviour. This assumes that the categories are “natural” (Sackett 1981). Behavioural systems differ from biological ones, however. The mechanisms which underly morphological differences in tools are not necessarily analogous to morphological divergences between species. This does not mean that behaviour does not underlie the archaeological record, but rather that the categories employed may not correspond with those behaviours in a one-to-one fashion. Different causes may in fact underlie the same morphological pattern (e.g., following Rolland and Dibble, a mild and wet climate with scarce resources or a very cold and dry climate with more resources may result in nearly identical distributions of implements, and be categorized as the same assemblage type; Rolland and Dibble 1990: 489).

The interplay between the interpretations of Neanderthal behaviour and the empirical data is complex. All the authors’ models appear to have some relationship to the manner in which the data is constructed. The discreteness of the categories employed by Bordes suggested stylistic and ethnic differences and thus implied a degree of complexity among the Neanderthal tool-makers. Binford, assuming that there was a direct correlation between discrete functional tool kits and direct remains of activities, proposed fundamentally different patterns of behaviour for the Middle and Upper Palaeolithic. Mellars’ belief that the assemblage types reflect real behavioural differences led him to propose the progression of different behavioural patterns associated with the assemblage types. Finally, Rolland and Dibble’s model, rejecting the discreteness of the tool and assemblage categories, shifts the focus for evidence of complexity to the understanding of adaptive systems in an ecological perspective. If they are correct that “non-cultural” causes such as the intensity of tool reduction and raw material availability are the primary causes of lithic variability for this era, and that the categories are continuous rather than discrete, the conclusion ultimately must be that the assemblage *types* and the artifact *types* tell us *less* about the structuring of Neanderthal behaviour than previous models suggest. However, by shifting the emphasis to other lines of evidence such as raw material availability and settlement patterns, rather than keeping an exclusive focus on lithic assemblages as predictive of culture, their model simultaneously may ultimately be more illuminating of Neanderthal behaviour.

If there is an important interplay between the structuring of the empirical data and the theories employed, an understanding of the nature of the structuring

of the data will help one assess each of the theoretical positions presented. In this regard, the Bordes' typological system must be subjected to scrutiny if we are to better understand how the artifact categories relate to one another, how the assemblage categories relate to one another, and how the artifact and assemblage categories relate to each other. When it is better understood how these categories are related (specifically, whether or not they are discrete), the choice of interpretive models will become more apparent.

¹ A definition of culture should include both its adaptive and normative aspects (Rolland 1981: 19). Rolland suggests that "Archaeological cultures are the material residues of activities by ancient hominid groups, their contents historically derived and socially transmitted" (1981: 19). Material culture is the result of "social action" (Graves 1994: 167). Evidence for "culture" should involve the documentation of sufficient complexity in that social action, rather than simply the presence or absence of direct evidence of symbolism, or imputed biological differences. Evidence for such complexity may include the extent of networks for lithic procurement, complexity in the manufacturing of stone tools, evidence related to settlement size and the nature of subsistence pursuits. In addition, because cultural knowledge is socially transmitted and can be passed on to subsequent generations, the aforementioned evidence should show patterns of cumulative development.

² Biographical data taken from Jelinek 1982, unless otherwise noted.

³ Vaufrey did excavate in the Périgord at Pech de l'Azé, but only published a preliminary report of his excavations there in 1933. He also excavated at Ehringsdorf in Germany (Bordes 1960: 101; 1972: 12).

⁴ 61 of the tool types listed in Appendix A were introduced in Bordes and Bourgon's "Le Complexe Moustérien: Moustériens, Levalloisien et Tayacien" (1951: 6).

⁵ Debénath and Dibble, despite their collaboration on the revised *Handbook of Palaeolithic Typology*, disagree on this crucial issue (1994: 6).

⁶ These represent types which became common and more refined in the Upper Palaeolithic rather than Upper Palaeolithic artifact types per se.

⁷ It should be noted here that Bordes himself was a science fiction writer under the *nom de plume* of Francis Carsac, an alternative mode of expression which "brought him a modest fame in that literary realm" (Jelinek 1982: 786; Carsac 1996).

⁸ In fact, in the following statistical analysis, notches and denticulates are some of the very few universally present artifact types in this sample.

⁹ This statement is even more unusual since we see the co-mingling of MTA (pre-Sapiens) and Quina (Neanderthal) populations. Another interesting aspect of this statement is that Bordes assumes a patrilocal residence pattern.

¹⁰ White was a critic of the notion of free will and believed that culture was deterministic (1949: 413).

¹¹ This statement foreshadows the Binford's use of factor analysis, which essentially provides a statement concerning the nature of such correlations and patterns of covariance.

¹² The authors cite Peyrony's 1930 study in this regard.

¹³ Only 40 variables were used since some of the types were not present. In addition, some artifact types, such as double racloirs were lumped into a single category (nos. 12-17, see Appendix A).

¹⁴ His research on Combe Grenal extended his theoretical position of functional variation explicitly to Western Europe and particularly southwestern France.

¹⁵ I do not believe that the hypothetico-deductive method should not be used, but rather that there must be an order in which archaeological inquiry takes place. Archaeology must be inductive first and hypothetico-deductive second. A simple, practical reason for this is that one rarely has the opportunity to simply go out into the field and test a proposition. Many sites are the product of salvage excavations, and research must take place relatively quickly. Another reason is that sites can generally only be excavated once; archaeology is irreversible. By asking a specific question, or testing a specific proposition, one may leave out data that is of use to future investigators with different questions. The maximum amount of data must be collected and through an understanding of that data and the *structure* of the variables documented vis-à-vis each other, testable questions should be raised. The use of strong inference is important in hypothesis formation. Sound inductive or inferential research is paramount to the formation of good hypotheses. See Geoffrey Samuel (1990: 8-11) for a discussion of the use of such models in anthropological inquiry.

¹⁶ The same holds true for Mousterian points and elongated Mousterian points. Despite their high correlation and arbitrary typological distinction (see above, note 5), they are divided into separate factors (II and IV).

¹⁷ One of these assumptions may be related to Leslie White's view that culture is an exclusively human trait. According to White's reasoning the capacity to symbol is the threshold between humans and animals (1988: 335, 337).

¹⁸ Rolland recently has renamed the "Frison effect," "the Commont effect." Rolland states that the latter (1996; 132-133):

... term is interchangeable with the "Frison effect" concept but preferred because of anteriority, and its direct relevance to the Middle Palaeolithic.... Commont observed that most sites in the Somme were adjacent to accessible flint seams, while some ... lay atop thick alluvium or sand mantles concealing flint beds. Assemblages from the former contained mostly plain or minimally retouched Levallois pieces, while in the latter, trimmed "Mousterian-like" tools (points, racloirs) become common

¹⁹ The assemblage types appear to be normally distributed across palaeoclimate type.

²⁰ The differences in interpretation between these authors are in part due to differences in methodology. Dibble's work more closely follows a hypothetico-deductive methodology, whereas Rolland's work involves more synthesis and is generally more inductive (see Dibble and Debénath 1991: 218 on Dibble's approach).

²¹ Numerous methodological criticisms have been made of the use of mtDNA and many of the results supporting an African origin of essentially modern humans have been challenged by prominent geneticists (see Barinaga 1992).

²² To illustrate the latter point, there are numerous examples throughout history of the disappearance of modern human populations (e.g., the Tasmanians). There are also countless groups (whether cultures or biological populations) which have disappeared before the advent of historical records. Many explanations can be offered for such disappearances without resort to biological differences. Differences in population sizes, intergroup hostility, behavioural differences such as group endogamy or different forms of social organization, acquired resistance to diseases, etc., all contribute to the "success" of one group over another. The question remains unanswered as to whether or not such differences may provide more parsimonious explanations of the "disappearance of the Neanderthal" than imputed differences in cognitive capacity. Much work remains to be done concerning the nature of the similarities and differences between contemporaneous populations of ancient hominids before anachronistic arguments for superiority are entertained. By using the species concept, the racist implications of associating anatomical differences with behavioural superiority are conveniently obscured.

3 MULTIVARIATE STATISTICS AND
 THE MIDDLE PALAEOLITHIC

Il nous a semblé qu'une étude statistique pourrait contribuer à éclaircir le problème, étude portant à la fois sur la typologie et les techniques de débitage.

-François Bordes and Maurice Bourgon "Le Complexe Moustérien: Moustériens, Levalloisien et Tayacien"

In recent years archaeology has increasingly adopted a scientific approach and statistical representations of data have become more commonplace. Many of the theories presented in Chapter Two concerning the nature of Middle Palaeolithic variability rest at some level on statistical observations. These statements range in complexity from Bordes' graphical presentation of the distribution of racloir frequencies to Binford and Binford's multivariate factor analysis. The latter study exemplifies the ambitions of New Archaeology to embrace statistical techniques in the formulation of the processualist approach, and to present itself as a serious science of past life ways. Interestingly enough, the strong association between the New Archaeology and quantitative methods has led authors such as Orton to state that "it is wrong to see quantitative methods simply as an adjunct of the 'New Archaeology'" (1988: 597). In many ways the New Archaeology overestimated the usefulness and simplicity of statistical presentations. To a certain extent there has been a loss of faith in these techniques and their validity has been questioned. This came about in part as a rejection of the principles and tenets of the (no longer new) New Archaeology (see Baxter 1994: 8). Mike Baxter, among others, advocates the separation of quantitative approaches from any particular school of thought in archaeology (1994: 8). The present chapter does make such a separation.

This chapter will examine the application of multivariate statistics to Middle Palaeolithic variability. It will briefly present the principles of multivariate statistical theory and the types of tests employed and discuss previous multivariate analyses of Middle Palaeolithic (Mousterian) stone tool assemblages in light of both statistical theory and the theoretical positions outlined in Chapter Two.

EXPLORING RELATIONSHIPS IN MULTIPLE DIMENSIONS

Multivariate statistical techniques differ from univariate and bivariate ones because of the increased level of complexity presented by the greater number of variables. Their use and application to archaeological questions need not be so complicated, however. One of the problems with the presentation of statistical

data is the unnecessary mystification and obfuscation that often accompanies it. This can lead either to the uncritical acceptance of a statistical statement or, equally problematical, its outright rejection on the basis of ignorance. Multivariate statistics, if presented properly, can clarify and demystify a large mass of otherwise incomprehensible data.

The primary use of multivariate statistics in archaeology, and in social science research in general, is to explore the relationships that exist between a large number of variables and to summarize those relationships more simply. As Baxter states (1994: 2):

The class of techniques dealt with largely revolves around the problem of reducing a table, or data matrix, of n rows and p columns to a state where some form of two- or three-dimensional summary of the data is possible. Often two-dimensional graphical displays are used, and these may be inspected to see if archaeologically useful information is revealed and to present revealed 'structure' or 'pattern' in a compact and interpretable way.

Unlike univariate statistics, less attention is paid to statistical inference and distribution theory, particularly in social science research. This usage of multivariate statistical tests is termed *exploratory* rather than *confirmatory*, or in other words the techniques are used to describe relationships between many variables rather than to test specific hypotheses about them (Baxter 1994: 1; Kim and Mueller 1978a: 9). The multivariate approach to archaeological and other social science data is thus usually inductive and inferential rather than hypothetical and deductive. This said, however, multivariate statistical methods can and have been used to test specific hypotheses. Rather than discussing multivariate statistical theory in general, it is perhaps easiest to present two common but different multivariate methods and compare them with other commonly used methods. Principal components analysis is archetypical of one class of tests and cluster analysis is archetypical of another.

Before discussing the multivariate methods employed, it is generally assumed that the population from which the data for analysis is drawn is multivariate normally distributed. It is common practice to use data transformations to achieve or approximate this requirement. Baxter discusses a number of transformations (1994: 40-42; 45-47; see below). In addition, some form of standardization of the variables is often used, particularly when artifact frequencies are used and when variables are of different orders of magnitude.

Converting to percentages is the most common form of standardization when frequencies of items form the data set.

Principal Components Analysis

According to Dunteman, the aim of principal components analysis is to reduce a large number of variables “to a smaller, conceptually more coherent set of variables” (Dunteman 1989: 5). It does this by linearly transforming the original set of variables into a “smaller set of uncorrelated variables” (Dunteman 1989: 7). It is especially useful for reducing a set of data with many intercorrelated variables to a smaller set of uncorrelated *components*. Each component is essentially a linear equation of all of the original variables. These k components (variables) are derived from the original p variables so that the new components “maximise the variance accounted for in the original variables” (Dunteman 1989: 9). In short, according to Dunteman, “principal components analysis searches for a few uncorrelated linear combinations of the original variables that capture most of the information in the original variables” (1989: 10).

Perhaps the easiest way to visualize this type of analysis is to present it in graphical terms. Imagine the original data set as a set of cases. Each case (n , e.g., archaeological assemblages) is described in terms of variables (p , e.g., artifact types). The geometrical space which the cases occupy has p dimensions, each case, n , being a point in that space. As any number of dimensions beyond three is difficult to visualize, let us consider a set of cases described in terms of three variables which form the x , y and z axes in Cartesian space. The cases, located in three-dimensional space, appear as a cloud or *swarm* of points around the axes. In principal components analysis, each component is a line through that space. Thus, the equation of the line for each i (for $i = 1, \dots, p$) principal component y is:

$$y_i = a_{i1}x_1 + a_{i2}x_2 + \dots + a_{ip}x_p, \quad (1)$$

where x is each original variable of which there are p of them, and the a s are constants. This equation can also be expressed in terms of the original variables:

$$x_i = a_{i1}y_1 + a_{i2}y_2 + \dots + a_{ip}y_p \quad (2)$$

where x represents the original i variables, a represents the p coefficients for each i variable, and y represents the p components. In determining the first line through the swarm, the equation which maximizes the amount of variance accounted for is chosen with the constraint that “the sum of the squared weights is equal to one” (Dunteman 1989: 11). Returning to the graphical model “the first

principal component is the line of *closest fit* to the n observations in the p dimensional space" (Dunteman 1989: 10; emphasis mine). Subsequent lines are drawn which account for the remaining variance in a likewise fashion, with the condition that the components are not correlated (i.e., they are *orthogonal* [at right angles] in geometric terms).

Principal components analysis bases these linear composites on either the covariation or the correlation matrix of the variables. The correlation matrix, being "a covariance matrix of standardized variables," is most commonly used (Dunteman 1989: 15; see Baxter 1994: 65-66 for a discussion of the choice of matrix in archaeology). Essentially "the goal of principal components is to decompose the correlation matrix" (Dunteman 1989: 21). Referring to the linear equation above, the variation expressed in the correlation matrix is explained in terms of weighting vectors (the values of a , commonly referred to as *eigenvectors* or *latent vectors*) and the variance accounted for by each component (referred to as the *eigenvalue* or *latent root* of each linear equation). The values of a (eigenvectors) and the variances (eigenvalues) of each equation are solved using matrix algebra.¹

The product of these calculations is a set of equations equal in number to the original number of variables. The equations are ranked in order of the amount of variance (as an indicator, generally speaking, of the amount of information) for which they account. Various criteria have been suggested with regard to the number of principal components to retain, usually based on the amount of variance for which they account (Baxter 1994: 59; Dunteman 1989: 22-23). The eigenvectors provide a statement about the relationship of each original variable to the principal component. These values are often converted to *loadings*, which are simply the correlation coefficients of the variables with the principal components. These data, in concert with the eigenvalues (amount of variance accounted for by the component), make a statement about the relative importance of the original variables in accounting for the variability in the data set. Further, if a group of variables in the same equation have high loadings of equal sign they are said to co-vary together. High loadings with different signs co-vary inversely. Principal components analysis thus can be used as an *R-technique* of analysis because it deals with the similarities and relationships between features of the cases in a population (Johnson 1968: 2).

Principal components analysis can also be used to compare the cases themselves, and can thus also be considered as a *Q-technique* analysis (Johnson

1968: 2). For each case, a *principal component score* is calculated. This is simply the solution of the linear equation (Equation 1) presented above for each case: The sum of the values for each variable x multiplied by the eigenvectors a yield the principal component score. These scores can be used to compare cases. The scores are often plotted in two and three dimensions to show the relationships between the cases and whether there is significant patterning among them (see Baxter 1994: 48-49).

In summary, principal components analysis may be used for the following tasks: 1) to examine the relationship between cases using multiple variables simultaneously; 2) to examine the interrelationships between many variables simultaneously; and 3) to combine the above to examine which variables “affect the structure in the data and how” (Baxter 1994: 48-49). Another use of principal components analysis is to reduce a large set of variables to a smaller set which has high correlations with the principal components; variables which covary together may also be lumped together (Dunteman 1989: 9). These new variables account for the greatest amount of the overall variance and can be used in other analyses (see below).

Factor Analysis and Rotation of Principal Components

Factor analysis is related to but distinct from principal components analysis. One of the problems in distinguishing these two techniques is that there is a certain amount of confusion as to what constitutes factor analysis. One difficulty is that “a majority of reported ‘factor analyses’ in archaeology are really PCA with rotation;” principal components analysis is even considered by some to be a form of factor analysis (Baxter 1994: 86). Both principal components analysis with rotation and factor analysis proper will be discussed below.

Once the principal components have been calculated, they may be rotated. Again it is best to think in terms of the geometrical model. Rotation simply means *rotation*; the axes (the lines defined in Equation 1) are rotated around the origin in p dimensional space. They are rotated so that the coefficients of the variables (loadings) in the lines are either large or small. “Thus, the rotated axes will be characterised by variables with high (positive or negative) coefficients and with coefficients on other variables close to zero” (Baxter 1994: 83). In essence, the component lines are rotated away from the optimal (statistically speaking) conditions of the initial calculation so that they are interpreted more easily. There

are two types of rotation, *orthogonal* and *oblique*. Orthogonal rotation upholds the condition that the various components remain at right angles to one another during rotation (discussed above), whereas oblique rotation does not. The most common form of rotation used is *varimax* rotation, an orthogonal technique (Baxter 1994: 84; see Kim and Mueller 1978b: 35-36 for the varimax equation). Usually only the most important components (based on the selection criterion used) are rotated.

Baxter points out that “opinions on the usefulness of rotation vary” (1994: 84). Those who have objections or concerns with rotation are statisticians, whereas those who use rotation are more often than not social scientists.² Problems with rotation include the loss of statistical optimality (mentioned above) and the proliferation of different methods of rotation which yield different results (Baxter 1994: 84). Although interpretation may be enhanced by rotation, the statistical reliability of those interpretations may be reduced.

The use of factor analysis is even more contentious among statisticians (Baxter 1994: 85). Despite its deceptive similarity to principal components analysis, factor analysis (usually performed with rotation) involves different criteria and assumptions at the outset. Whereas principal components analysis can simply be performed on a set of data and then interpreted, factor analysis “assumes the existence of a system of underlying factors and a system of observed variables” (Kim and Mueller 1978a: 8). The major difference between the techniques is that whereas principal components analysis attempts to account for the maximum amount of variance among the observed values, factor analysis attempts to “account for the *correlation* between the variables” (Kim and Mueller 1978b: 17). In doing so it assumes that there are both common and unique factors which underly the variance in the data; “the unique factors do not contribute to the covariation between variables” (Kim and Mueller 1978b: 8). The common factors are derived in factor analysis.

More information is required in order to partition the variance into common and unique factors. The number of factors to be extracted must be supplied. In principal components analysis the number of components to “keep” is determined by a criterion after the calculation. Factor analysis bases its calculations upon the existence of a hypothetical number of factors, k . Even the existence of factors itself is assumed, whereas in principal components analysis the criterion used to select the number of components may result in no

components at all. As Baxter states, “it is rarely obvious what an appropriate value of k is. Different choices can result in rather different factors being obtained” (1994: 88). The choice of number of factors often involves a subjective element (Baxter 1994: 88; see Kim and Mueller 1978b: 41-45). Once the initial factors are calculated, again using matrix algebra, they are usually rotated. The equation for the factor coefficients expressed in terms of the original variables is

$$x_i = a_{i1}y_1 + a_{i2}y_2 + \dots + a_{ik}y_k + e_i \quad (3)$$

where x represents one of the original i variables, a represents the k coefficients for each i variable, y represents the k factors and e represents the unique factor for each i variable. Note that there are k rather than p factors and the unique factors (e) are not present in Equation 2. As in principal components analysis, the proportion of the variance accounted for (derived from eigenvalues) and the loadings of the variables (derived from eigenvectors) on each factor are presented.³ These are essentially interpreted in the same manner as in principal components analysis, but their statistical reliability is more tenuous. With regard to the last point Baxter argues (1994: 87):

Unless there are good reasons for believing in the reality of these constructs (in some sense), it is arguable that the factor model should not be used at all.

Discriminant Analysis

The final statistical method which explains the variance among multiple variables is discriminant analysis. This method differs from both principal components analysis and factor analysis in that it explains the multivariate variance in terms of given categories. Discriminant analysis uses several variables to study the differences between groups or to classify cases into these groups. As in both factor and principal components analysis, discriminant analysis explains the variance in a population using “linear combination[s] of the discriminating variables which are formed to satisfy certain conditions” (Klecka 1980: 15). As in the previous methods, these can be visualized as lines through multidimensional space. William Klecka describes this model as follows (1980: 16):

Let us consider the discriminating variables as axes that define a p -dimensional space. Each data case is a point in this space with coordinates that are the case’s values on each of the variables. If the groups differ in their behaviour with respect to these variables, we can imagine each group as being a swarm of points concentrated in some portion of this space. While the groups may overlap somewhat, their respective “territories” are not identical. To

summarize the position of a group, we can compute its “centroid.” A group centroid is an imaginary point which has coordinates that are the group’s mean on each of the variables. Because each centroid represents the typical position for its group, we can study them to obtain an understanding of how the groups differ. As it turns out, we do not need so many dimensions to completely represent the relative positions of the group centroids. At the most, we need one less dimension than the number of groups.

Thus for k groups, there are $k - 1$ linear equations, known as canonical discriminant functions, which explain the differences between the groups. The formula for the canonical discriminant function is:

$$f_{km} = u_0 + u_1X_{1km} + u_2X_{2km} + \dots + u_pX_{pkm}, \quad (4)$$

where f is the value (score) on the canonical discriminant function for case m in the group k ; x is the value of the discriminating variable (from 1 to p) for case m in group k ; and u is the coefficient which produces the desired characteristics in the function. The coefficients are determined so that the group means on the first canonical discriminant function are as different as possible. The second function, in addition to maximizing the differences of the group means, must not correlate with the values on the first function, i.e., the two must be orthogonal. This process is continued for each canonical discriminant function (Klecka 1980: 16). The equations are calculated so that the variance between groups is maximized and the variance within groups is minimized. This is again calculated using matrix algebra.⁴

Because of the nature of the calculations performed and the fact that we are discriminating between groups, certain criteria for the original variables used must be met. The variables used must be free from high correlations with one another, or in other words, “no variable may be a linear combination of other discriminating variables Likewise, two variables which are perfectly correlated cannot be used at the same time” (Klecka 1980: 9). In addition, the population covariance matrices should be the same for each group, and each group should be drawn from a population with a multivariate normal distribution. It has been pointed out, however, “that discriminant analysis is a rather robust technique which can tolerate some deviation from these assumptions” (Klecka 1980:61).

The functions produced can be interpreted by “(1) examining the relative positions of the data cases and group centroids and (2) studying the relationship between the individual variables and the functions” (Klecka 1980: 23). The

coefficients, determined above, are used to position the cases in the reduced dimensional space. The discriminant score, f_{km} , is the position of a case on the axis representing the function concerned. The group centroid is the important value in determining the differences between the groups; it is calculated using the group means in the function equations and represents the "typical" case for the group. The coefficients u are usually presented as both standardized coefficients and as correlations between the discriminating variables and the discriminant functions. The latter are usually presented as *structure coefficients* in a *structure matrix* and are similar to loadings in both factor and principal components analysis (Klecka 1980: 34). Eigenvalues and the proportion of the variance accounted for by each function are also presented.

As mentioned above, the functions produced can explain the position of the groups and cases vis à vis each other. One method of doing this is to plot the discriminant scores for each case in either two or three dimensions to provide a visual model of the groups. One such type of plot is the *territorial plot*, which draws boundary lines between the groups and plots the group centroids in two dimensions (the first two functions) (Klecka 1980: 27-28). In inspecting these plots it should be remembered, however, that the axes (functions) are defined to maximize the differences between the groups. This means that the differences may be accentuated and the *clustering* of the groups may be somewhat artificial.⁵ The position of individual cases may also be noted in such plots. The distance of each case to its own and the other groups' centroids is represented. Sometimes a case may appear to be closer to a group centroid which is different from the group it was initially classified as. When discriminant analysis is performed, it is common practice to reclassify each case based on its canonical discriminant function scores. The scores for each case and each function are calculated and compared to the group centroids for each function. A probability statement is then presented as to which group the case belongs. This may differ from the initial group membership. These *misclassifications* give an indication of both the rigour of the categorization scheme and the validity of the original classifications.

The second set of interpretations made are the relationships between the original discriminating variables and the canonical discriminant functions. The correlations of each variable with each function indicate which variables are important in explaining the *between-group variances*, rather than the total or common variance as in principal components analysis and factor analysis,

respectively. The value of the group centroids on each function can be used in conjunction with this information to give a statement about which variables best discriminate between the groups. The eigenvalues give an indication of the relative importance of the function and the variables.

Cluster Analysis

Cluster analyses use different methods than principal components analysis and related methods do to compare cases. Mathematically, this class of techniques is simpler than those mentioned above. The methods are also the most widely applied multivariate techniques in archaeological research (Baxter 1994: 140). As Baxter states (1994: 140):

Cluster analysis is not a single method; it is a generic term for a wide range of techniques. In archaeology the most common use is to classify a set of 'individuals' (e.g., artefacts, assemblages, graves, etc.) into subgroups such that individuals within a group are similar to each other in some sense and different from individuals in other groups.

Using cluster analysis, one looks for *homostats*. "A homostat is a group of items which have a degree of similarity to each other above a specified minimum" (Johnson 1968: 16). The starting point in such an analysis is a measurement of the similarities or differences between cases. A variety of methods of calculating similarity or difference coefficients exist. These may involve either quantitative data (distance coefficients) or binary data (association coefficients). Distance coefficients simply measure the sum of the differences between each variable for a pair of cases. There are, however, a number of ways of calculating those differences, each of which may be more appropriate for different scales or classes of data (see Baxter 1994: 156-157; Shennan 1988: 199-201; Sneath and Sokal 1973: 121-128). An example of a distance measure is the *Euclidean distance coefficient*, which is "simply the straight-line distance between two points and what its calculation involves, of course, is Pythagoras' theorem" (Shennan 1988: 199).⁶ A distance measure developed by archaeologists for assemblage comparison is *Robinson's index of agreement*. Association measures, on the other hand, measure the similarity or difference between a pair of cases based upon the presence or absence of a series of attributes. Shennan describes this process as follows (1988: 202):

For each pair of items their scores for each attribute are compared

and it is noted whether they match (i.e. are the same) or not. The number of matches is then expressed as a proportion of the total number of attributes.

Generally the differences between the coefficients used are in the manner in which negative matches are handled, or in other words, does the mutual lack of an attribute constitute a genuine similarity? (see Baxter 1994: 149-152; Shennan 1988: 202-204; Sneath and Sokal 1973: 129-135). An example of an association measure is the *Jaccard coefficient*, which disregards negative matches. A third type of coefficient exists to deal with mixed quantitative and binary data; this is *Gower's general coefficient* (see Baxter 1994: 152-3; Shennan 1988: 206-207; Sneath and Sokal 1973: 135-137).

The similarity (or distance) measures are placed into a similarity (or distance) matrix comparing each case to each other. This matrix can itself be examined and reordered to discover relationships between the assemblages. It is usually, however, submitted to some form of cluster analysis. There are two main types of clustering methods: *hierarchical* and *partitioning*. Hierarchical methods may be either *agglomerative* or *divisive* (Shennan 1988: 197):

Hierarchical agglomerative methods start with all the items under consideration separate and then build up groups from these, starting by grouping the most similar items together, then grouping the groups at increasing low levels of similarity until finally all the items are linked together in one large group, usually at a very low level of similarity. Divisive methods start with all the items in a single group and then proceed to divide the groups up successively according to some criterion.

Hierarchical agglomerative techniques are further divided by the method of *linkage* employed. These may include *single linkage*, where cases are added to a cluster on the basis of their similarity to the *nearest neighbour* within the already existing cluster or *average linkage* where cases are added to a cluster on the basis of their similarity to the average values of the existing cluster. Partitioning methods incorporate previous information about the number of groups already present in a set of cases, and the membership of cases in those groups. Here the clusters are formed so that all of the cases are re-sorted into the number of groups specified on the basis of their similarity to one another. *K-means* clustering is an example of such a technique (see Shennan 1988: 226; Baxter 1994:147-148).

The results of hierarchical clustering analyses are normally presented in *dendograms*, which show which cases or groups of cases are linked and at what

level of similarity. Cluster analyses may also be performed as an R-technique of analysis. Here the variables which define the cases are compared. Rather than using one of the similarity (or distance) measures mentioned above, correlation or covariance coefficients are used and then clustered using one of the linkage methods cited above.

Multidimensional Scaling

Another method of presenting similarities or differences between cases or variables is known as multidimensional scaling. This method ranks the similarities or dissimilarities between all pairs of cases (or correlations of variables) in a matrix. The cases are then represented as points in k dimensional space, k being a much lower value than the number of cases (usually two). Hodson, Sneath and Doran describe the aims of the method as follows (1966: 313):

. . . the distances between the points reflect the degree of likeness or unlikeness between the units, to the extent that the more similar two units are, the closer together their corresponding units will be, and vice versa. Thus the method converts the numerical data into a 'map' which is, one hopes, easier to interpret than the original figures. In particular, this 'map' should indicate any clusters or trends implicit within the data.

In order to determine the position of the points in the k dimensional space, a measure of *strain* or *stress* is calculated (Hodson, Sneath and Doran 1966: 313-314; Sneath and Sokal 1973: 249). This "measure of distortion," as Hodson, Sneath and Doran describe it, "indicates the degree to which the configuration of points is *failing* to reflect the actual similarities" (1966: 313). For each case: 1) points are randomly generated in each of the k dimensions and the strain is calculated; 2) the configurations are then recalculated to reduce the strain; and 3) the process is repeated until the lowest strain is reached (Hodson, Sneath and Doran 1966: 313-314). The whole procedure is usually recalculated a few times with different initial random orderings, since the final strain may differ. The configuration of points with the lowest strain is presented graphically, usually as a two-dimensional plot of the points.

PREVIOUS MULTIVARIATE ANALYSES OF MOUSTERIAN ASSEMBLAGES

As mentioned above, in the modern era statistics are intrinsic to many of the arguments concerning Middle Palaeolithic variability. Multivariate methods

were employed in such arguments at a relatively early date in this era. The most notable of these statistical tests was Binford and Binford's 1966 factor analysis. Another important set of multivariate statistical analyses was presented by Paul Callow and Esmie Webb (1977, 1981), who conducted both principal components analyses and discriminant analyses. Other studies will also be examined.

Some of the criticisms of these studies presented below may seem harsh and anachronistic. Today many of the techniques are better understood and easier to perform. However, these statistical studies are still widely cited. More importantly perhaps, the interpretive positions which these studies have given rise to still have currency in the debate concerning Middle Palaeolithic variability. A better understanding of the shortcomings of these studies will help in a critical evaluation of the corresponding theories.

Functional Factors

Leslie Freeman performed the first multivariate analysis of Middle Palaeolithic assemblages. This study was the core of his Ph.D. dissertation, *Mousterian developments in Cantabrian Spain* (1964). It is primarily of historical interest because Freeman was a student of Lewis Binford's and the latter appears to have had considerable input with regard to the choice of techniques used as well as the theoretical position taken (Freeman 1964: 176, 179). Freeman's methods are more explicitly laid out, and in the absence of contrary evidence, it is reasonable to assume that the methods employed by the Binfords were very similar, if not identical, to those of Freeman. In addition, Freeman and Brown published the results of a factor analysis of American Southwest archaeological data using "a similar method of analysis" (Freeman 1964: 175).

The method which Freeman used was called factor analysis, but this study and that by Binford and Binford were actually principal components analyses with rotation (see Baxter 1994: 86). Freeman's study did not assume a number of factors at the outset but used a criterion to select the "factors" after the initial calculation, based upon the amount of variance accounted for (Freeman 1964: 183). In addition he reports that (1994: 184):

the 'principal component analysis' which the machine performed first does not yield the simplest factor structure to account for all the variation in our data. It was, therefore, submitted to an orthogonal transformation . . .

The varimax procedure was the orthogonal rotation used. In calculating the factors, Freeman used a correlation matrix based on the frequencies of 51 tool types, including several of Bordes' types as well as debris, flakes, blades and cores, for 14 assemblages in Cantabrian Spain (1964: 180). Freeman likely did not use percentage scores, but rather raw counts of each type to construct the matrix. George Cowgill, in his article "Archaeological Applications of Factor, Cluster and Proximity Analysis," (1968: 372) states that he

... recomputed the correlations between types used by Freeman and Brown (1964) in their Carter Ranch study, using percentages instead of counts, and discovered that the resulting correlations are lower and also show considerably different patterns, leading to different factor results.

He further argues that "in the absence of contrary evidence, it seems likely that their [Binford and Binford] analysis is also based on raw counts, not percentages" (1964: 373). By extension, Freeman's thesis probably also used raw counts. The results of the analysis also suggest the use of raw counts.

In light of my own analysis and that of Callow and Webb, the results of Freeman's study suggest problems with the structuring of the data consistent with the use of raw counts. Cowgill states (1968: 372):

There are two important pitfalls here. First, if some assemblages are much larger than others, everything is likely to correlate positively with everything, simply because if there is a lot of one category in an assemblage, the chances are it is a big assemblage, with a relatively large amount of everything else. It makes much more sense to convert counts to percentages and use percentages as the variables to be correlated.

As mentioned above in the discussion of multivariate statistical methodology, it is normal practice to standardize data in some form or another, particularly when raw counts are used. The use of percentages is a very rudimentary technique of standardization that is commonly employed.

The results of Freeman's analysis suggested just what Cowgill predicted: that everything correlated positively with everything else. For example, using Freeman's own criteria, 37 of the 51 types were strongly correlated to the first factor (see Freeman 1964: 185, Table 41). Thus one could say that nearly three quarters of the tool types co-varied together. Furthermore, these 37 types were spread across several of the major diagnostic tool categories, such as Levallois flakes, racloirs, several "Upper Palaeolithic" types, notches and denticulates. The

first factor accounted for approximately 75% of the variance (Freeman 1964: 183). Thirty-six types were strongly correlated with the second factor. All but one of the types not correlated with the first factor were correlated with the second. The second factor accounted for approximately 15% of the variance (Freeman 1964: 183). In addition, several types were strongly correlated with more than one factor. This latter point makes interpretation difficult, because the factors are not very distinct. In addition, all of the significant correlations were positive, which also corresponds with Cowgill's assessment.⁷ The only major differences between the first two factors appear to be that implements tend to correlate more with the first factor and unretouched types with the second factor; however, several exceptions to this general pattern exist. Two other factors are identified, but they count for a relatively small proportion of the overall variance.

Turning to Freeman's interpretation of these results, not surprisingly he upholds the functional model later proposed by Binford and Binford for the Middle Palaeolithic. He states earlier in his thesis that "there are only three possible causes for differences between archaeological samples;" these are sampling error, temporal differences and functional differences (1964: 175). In other words, the interpretive possibilities which could be dealt with were severely constrained at the outset. Freeman also, however, addresses the potential stylistic component in the data. In a somewhat convoluted argument, he argues that stylistic factors have no role in shaping the data. He argues that temporal and stylistic factors would result in negative correlations, which are absent (1964: 181). The correlations are likely all positive for methodological reasons.⁸ The presence of these positive correlations is also cited as evidence that the behaviour is non-random (Freeman 1964: 180). Returning to his initial statement of the problem, Freeman is left to account for the patterning in the data with the functional hypothesis.

As for the meanings of the factors themselves, Freeman assigns functional interpretations to them. He does this primarily by examining those types which are only correlated with a single factor. The first factor is characterized by "shredding and scraping activities" based on the presence of sidescrapers, endscrapers, ventrally retouched pieces and perforators (Freeman 1964: 189). The second factor is interpreted as "a butchering-activity factor, with perhaps some woodworking activities like chopping," on the basis of the presence of "bifacial' or perhaps 'rending-cleaving' tools" (Freeman 1964: 189). The third

factor is attributed to random factors and the fourth is "harder to characterize" (Freeman 1964; 187-188). Many of the criticisms of the Binfords' interpretations presented in the previous chapter are also appropriate to Freeman's work, because they essentially present identical theoretical stances. Like the Binfords' study, the fact that morphologically, and arguably functionally, identical and/or similar tool types are significantly correlated with different factors poses serious logical problems with the interpretations.

In general, due to both logical and methodological problems, most of the specific findings and interpretations presented by Freeman may be discounted. Perhaps the only independent observation that may be of value is that implements and unretouched pieces belong to different factors when raw frequencies of tool types are used. This loosely supports Rolland's observation that the differential manufacture of implements explains much of the variability in assemblage types (1977, 1981).

With regard to Freeman's role in the debate outlined in the last chapter, it is apparent that his work strongly supports the Binford program. He rejects the stylistic interpretation proposed by Bordes. It is important to note that Freeman, like Binford and Binford, explicitly upholds the lack of chronological patterning in the data. This seems to be a logical necessity of the functional argument. This observation is at odds with Mellars' findings. In Freeman's later work, he suggests the abandonment of Bordes' typology altogether, because "the larger issues of function versus style in artifact attributes simply cannot be addressed using Bordes' typology" (1992:120). This view is different from that presented in his thesis (1964: 207):

This study demonstrated that the Bordes' types used are well defined for the isolation of functional difference between tool groups.

He remains interested in functional differences in the Cantabrian Mousterian assemblages.

If it is agreed that Freeman's and Binford and Binford's analyses are very similar, the methodological and interpretive considerations mentioned above have an important bearing on one of archaeology's more influential studies. Binford and Binford's analysis, as Cowgill suggests, is inherently flawed.⁹ The extent of these flaws is made more apparent by examining Freeman's study because he goes into more detail concerning methodology. Binford and Binford's paper does

not mention which methods of rotation are used, what criteria for the selection of the factors were used, nor how the original data were structured (Binford and Binford 1966; Cowgill 1968: 371-373). It is reasonable to infer that the data used were in the form of unstandardized frequencies of tool types, the selection of "factors" was based on the proportion of variance accounted for and that varimax rotation was applied to a principal components analysis (see also Baxter 1994: 86 and Cowgill 1968: 371-373).

This also becomes apparent when the factor loadings are examined (Binford and Binford 1966: Tables II-VII). Unlike Freeman's analysis, however, we are not told what proportion of the variance each factor accounts for. This makes interpretation as to their relative importance impossible, except that it is assumed that they are ordered from large to small. The first factor is significantly correlated with many artifact types. All of the significant correlations on this factor are positive. More importantly, however, is that there does not appear to be much structure in terms of morphologically similar types. Several different classes of tools are correlated with this factor; many of them are arguably different in terms of function. Racloirs, Levallois flakes, notches, denticulates and several "Upper Palaeolithic" types share high correlations with this factor. The second factor again has a mix of general tool classes, including points, racloirs, unretouched flakes and blades, and Levallois flakes. It does have a strong negative correlation on a single type (type 56, *rabots*), although this is a rare form (Binford and Binford 1966: 251; Table III). The third factor has high negative correlations with backed knives and unretouched flakes (Levallois and non-Levallois). There are no significant positive correlations with this factor.¹⁰ The remaining two factors again have high positive loadings for a general mix of types. As mentioned in the previous chapter, obviously similar morphological and functional types are spread across different factors, for example, different types of racloirs are found in four of the five factors and even various forms of "simple" racloirs are highly correlated with three different factors. This again undermines the functional interpretation. The lack of discrimination between broad morpho-functional classes of tools and the predominance of high positive correlations (except for one factor) strengthens the argument that the Binfords used raw data frequencies rather than proportions.

Like Freeman's analysis, most of the findings of Binford and Binford must be rejected on both methodological and logical grounds. Their analysis does not

support the interpretations made. The only factor which seems to have some interpretability is the third factor, which has high negative loadings on both backed knives and unretouched flakes and blades. This may again be related to the differential proportions of implements to unretouched flakes and blades. Without the proportion of the variances presented, however, it is next to impossible to attribute a meaning to any of the factors, except perhaps the first, provided they are in rank order. High correlations with a factor accounting for very little variance may be of no consequence to the overall structure of the data.

The role of Binford and Binford's 1966 paper in the intellectual debate concerning Middle Palaeolithic variability is very important. Despite a certain degree of intuitive appeal, there is not much evidence in support of their arguments. Furthermore, both Freeman's and Binford and Binford's factor analysis results are not supported by subsequent analyses, including those presented below.

Multidimensional Scaling: The Assessment of Taxonomic Resemblance

The next significant pair of analyses are those presented by Doran and Hodson, and Paul Mellars. Doran and Hodson's brief article, "A Digital Computer Analysis of Palaeolithic Flint Assemblages," used multidimensional scaling to depict the degree of similarity between 16 Mousterian assemblages in France, Greece, Spain and Italy (1966). Two analyses were performed, one using the artifact types in Bordes' essential count as the variables and the other using the artifact types in Bordes' real count (Doran and Hodson 1966: 688). The distribution of the essential data suggests that there are two or three separate groupings of sites. The "real" data uphold the two groupings but are configured slightly differently with up to four clusters. On the basis of the distribution of the various assemblage types suggested by Bordes, Doran and Hodson conclude that (1966: 689):

It would be unwise to draw general conclusions from the analysis of so few assemblages as this. However, it may be noted that the three main clusters which suggest themselves in the two-dimensional configurations correspond broadly, though not completely, with the main divisions of the Mousterian which Bordes suggests . . .

One cluster corresponds with the Charentian types, and the other corresponds with Typical, Denticulate and MTA types, with another smaller division between Typical, and Denticulate and MTA (Doran and Hodson 1966: 689). Another

important observation that Doran and Hodson make is that “the arrangement of the stratified assemblages is consistently with earlier assemblages to the right of the latter” on their graphs (1966: 689). This observation suggests that there is indeed chronological patterning in the data. In some ways this is predictable since MTA assemblages, which appear later in the sequence, are typologically distinct.

Three general criticisms of this paper are apparent. The first is the choice of variables. The use of only the essential and real counts ignores other variables which have turned out to be important, e.g., unretouched non-Levallois flakes and blades, and bifaces. The second criticism is the use of similarity coefficients and the methods of representing those similarities. Dibble and Rolland demonstrate that randomly generated data, consistent with the range of variation present among the artifact types in the Middle Palaeolithic, will cluster into distinct groups when cluster analysis is used (1992: 6-8). What this proves is that the named assemblage types represent different proportions of the various artifact types. According to Dibble and Rolland, the problem is that “the variables used to define the groups are the same ones used to assess the significance of those groups” (1992: 6). When similarity coefficients are used some cases will invariably be more similar to others and some cases will be more different. Similar cases will tend to be of the same group because of the way the categories are constructed. Whether they are truly discrete may not be apparent from such studies. It is useful to note, however, that some assemblages of different types are “clustered” together in Doran and Hodson’s analysis and may represent more of a continuum than suspected.¹¹ The third criticism involves the spread of the cases in geometric space. Without a scale, it is difficult to assess the significance of the division of the groups into clusters. In addition, the small number of cases examined makes any interpretation tentative, as Doran and Hodson themselves point out (1966: 689). It may simply be that, due to random sampling error, the missing cases between the clusters were not part of the sample. This problem can only be improved by the use of more assemblages, which were simply not available to the authors of this study.

Another multidimensional scaling analysis worth mentioning is that presented in Mellars’ Ph.D. thesis (cited in Mellars 1996: 180). This analysis was performed on 33 Mousterian assemblages from southwestern France, and was undertaken by Hodson for Mellars (Callow and Webb 1981: 131). He used the full

list of Bordes types (real count) and calculated similarity coefficients using percentages. The results of this analysis show two clear clusters. What is interesting about this analysis is that the clusters differ from those presented by Doran and Hodson. In Mellars' analysis, one cluster contains Ferrassie, Quina, Typical and MTA type A, while the other contains MTA type B and Denticulate assemblages. There appears to be clear patterning in the data, which Mellars says is attributable in large part to the "overall frequency of racloirs in the different assemblages" (1996: 180). Comments and criticisms similar to those on Doran and Hodson's analysis apply to this one.

With regard to multidimensional scaling, it is worthwhile to briefly mention the work of Stefanka Ivanova, who conducted two multidimensional scaling analyses on 15 Middle Palaeolithic sites from the Balkan Peninsula (1979). One analysis was based on a similarity coefficient comparing assemblages and the other used correlation coefficients between features at that site. She identified two basic groups, but most of the material she examined was similar to Charentian Mousterian assemblages.

Principal Components and Discrimination.

Perhaps the most thorough and rigorous multivariate analyses of Middle Palaeolithic assemblages to date were conducted by Paul Callow and Esmie Webb in their articles "Structure in the S.W. French Mousterian" (1977) and "The Application of Multivariate Statistical Techniques to Middle Palaeolithic Assemblages from Southwestern France" (1981). They conducted both principal components analyses and *canonical variates analyses*, which is simply another term for discriminant analysis (see Klecka 1980: 37). Their analysis used 96 assemblages from southwestern France.

Rather than using the artifact types as variables like in the previous analyses, Callow and Webb primarily used the technological and typological indices, as well as the characteristic groups defined by Bordes, in addition to *limace* and notched tools (1981: 131; see Appendix A). In addition, in order to better approximate normal distributions for the variables, the arcsine transformation was applied to the percentage frequencies of each variable (Callow and Webb 1981: 132):

This has the effect of reducing skewness in the distributions by 'stretching' them in the region of 0 and 100%, but leaving the shape of the curve unaltered for values near 50%.

Callow and Webb then proceeded to perform the principal components analysis on these transformed variables. The analysis was performed without rotation.

The results of the principal components analysis yielded three significant components, the first accounting for 40% of the total variance, the second 24% and the third 10% (Callow and Webb 1981: 133). Only those components with eigenvalues greater than one were selected (Callow and Webb 1981: 133). The first component had its strongest positive loadings on the Quina retouch index, the racloir index, the Charentian index, and the Mousterian tool group (II); the strongest negative loadings were on the Denticulate tool group (IV) and notches (Callow and Webb 1981: 133; Table 3). The second component had strongest loadings on the Levallois tool group (I), the Levallois index, and both the facetting and the restricted facetting indices (Callow and Webb 1981: 133, Table 3). The third component had significant positive loadings with the backed knives index, the handaxe (biface) index and the "Upper Palaeolithic" tool group (III), and strong negative loadings on the Levallois tool group (I) and the limaces (Callow and Webb 1981: 133, Table 3).

When the principal components were plotted on a scattergram, "none [were] particularly well defined, except perhaps the Quina group" (Callow and Webb 1981:133). There is, however, clear patterning in the data, i.e., the different assemblage types are generally localized in the graphical space, although they overlap (see Callow and Webb 1981: 134, Figure 1). In addition, Callow and Webb performed clustering analyses on both the component scores and the untransformed data. In these analyses "only the Quina type was consistently recovered intact" (Callow and Webb 1981: 133).

In conclusion, based on the distribution of the principal component scores, Callow and Webb state that (1981: 133):

The results of the above analysis, while suggesting perhaps that the criteria proposed by Bordes for the partition of the Mousterian have been consistently applied, fail to provide justification for preferring his interpretations to any other because of the apparent distributional *continuity* (emphasis mine).

They highlight what they see as several limitations of principal components analysis. Their primary criticism is that principal components analysis "does not distinguish between inter- and intra-population and continuum variance" (Callow and Webb 1981: 133).

They thus thought that a canonical variates (discriminant) analysis would be more applicable because it would address the above mentioned criticism (Callow and Webb 1977; 71). This was done following what appear to be standard procedures. Their analysis does not present the structure matrix and thus does not state which variables are correlated with the discriminant functions. They did, however, plot the “canonical variates” and reallocate the cases to groups. The plots tend to show better discrimination between the various groups than did the principal components analysis, and Callow and Webb state that “very few of the assemblages proved to require reallocation” (1981: 135). However, in terms of the scatterplots, they state (Callow and Webb 1981: 135):

The Quina type is well isolated from the rest and among the other groups far less overlap occurs than was the case for the principal components analysis, *although they are still not well separated* [emphasis mine].

To better discriminate between the groups, Callow and Webb excluded well separated populations in turn. They removed the Quina type and the MTA type b assemblages. This showed better discrimination between the groups, but Typical and Ferrassie Mousterian did not appear to be discrete using this method. As in the principal components analysis, the groups in all of the plots of the canonical variates were generally localized in graphical space.

Methodologically, there are major flaws in Callow and Webb’s analysis. They discuss the techniques employed and present their results in a straightforward manner, however their choice of variables and the conclusions reached are problematic. The use of the indices means that their results are quite derived. Bordes’ indices, particularly the artifact groups, contain more theoretically derived information than the morphologically based artifact types. In fact, some of the indices are calculated using Bordes’ essential count, which ignores all unretouched artifacts (see Appendix A). Because they do not include unretouched non-Levallois flakes as variables, this potentially important artifact type is underrepresented in their analysis. In addition, some of the variables they use characterize similar phenomena, e.g., the racloir index and the Mousterian tools group (III) measure almost identical phenomena.¹² This could have the effect of giving too much weight to a single class of artifacts. Variables such as the racloir index and the Mousterian group are likely to be linearly related to one another, thus violating a prerequisite assumption of discriminant analysis.

Callow and Webb's conclusions seem to be at odds with their statistical findings (1981: 137):

. . . it should be apparent from the illustrations that there is considerable justification for the partition of the southwest French Mousterian assemblages proposed by Bordes. Not only are the typological and technological data multimodal in character, but it is possible to identify several discrete clusters of assemblages corresponding to his suggested variants. The primary goal of this investigation, to confirm or deny the existence of such clusters, would, therefore, seem to have been achieved.

Although it is clear from their diagrams that the various assemblage types proposed by Bordes are localized in graphical space, it is not clear, with the exception perhaps of the Quina variant, that they are either discrete or multimodal. Based on the plots presented by Callow and Webb, I plotted the frequency distributions of their canonical variates (Figure 3.1). There does not appear to be a strong tendency toward a multimodal distribution on either of them. The better separation of the groups in the discriminant analysis and this technique's proposed suitability for assessing the discreteness of groups is also open to question. As mentioned previously, each discriminant function maximizes the distance between each group. When presented graphically, both in Callow and Webb's plots and the frequency distributions, the degree of separation between groups will thus be accentuated. The fact that the groups were not that well separated, as Callow and Webb admit, argues against their conclusions regarding their discriminant analysis.

As a twist ending to their article, Callow and Webb (1981) briefly mention a comparable study they performed on southeast French material which yielded different results. These data showed a much greater degree of continuity using canonical variates than the southwest data did. They argue that there may be regional differences, that the southeast data is too poor, or that Bordes' typology is more useful in the Perigord region where it was developed (Callow and Webb 1981: 137-8).

These analyses are related to the main theoretical positions of this era in an interesting way. First of all, they support Bordes' contention that the groups are distinct. However, they defer the issue of whether they represent "activity facies or socio-cultural groups" to other classes of data such as climate, raw material studies and location (Callow and Webb 1981: 137). The southeast data were used to suggest some potential geographical limitations to Bordes' typological system.

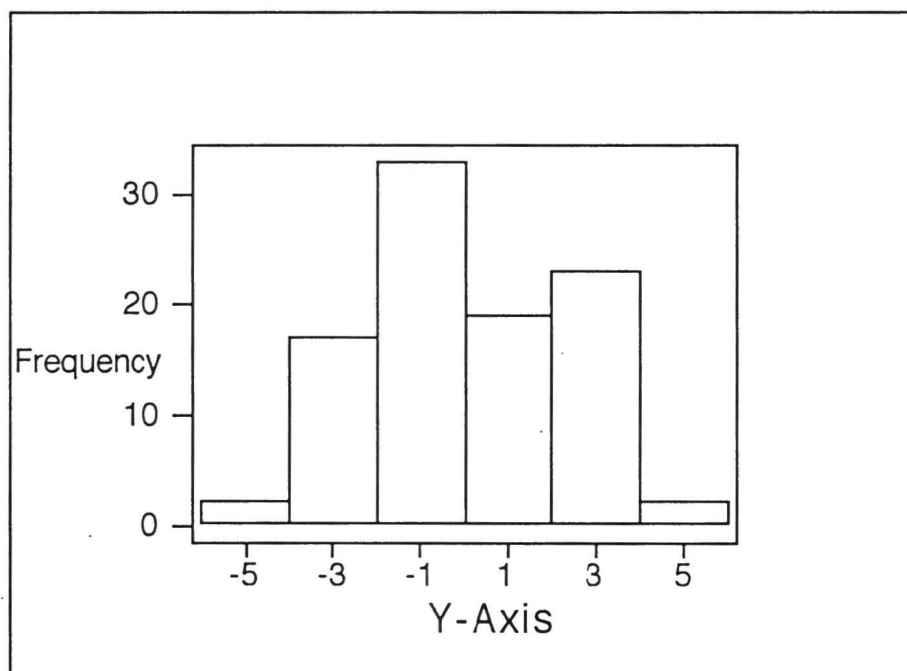
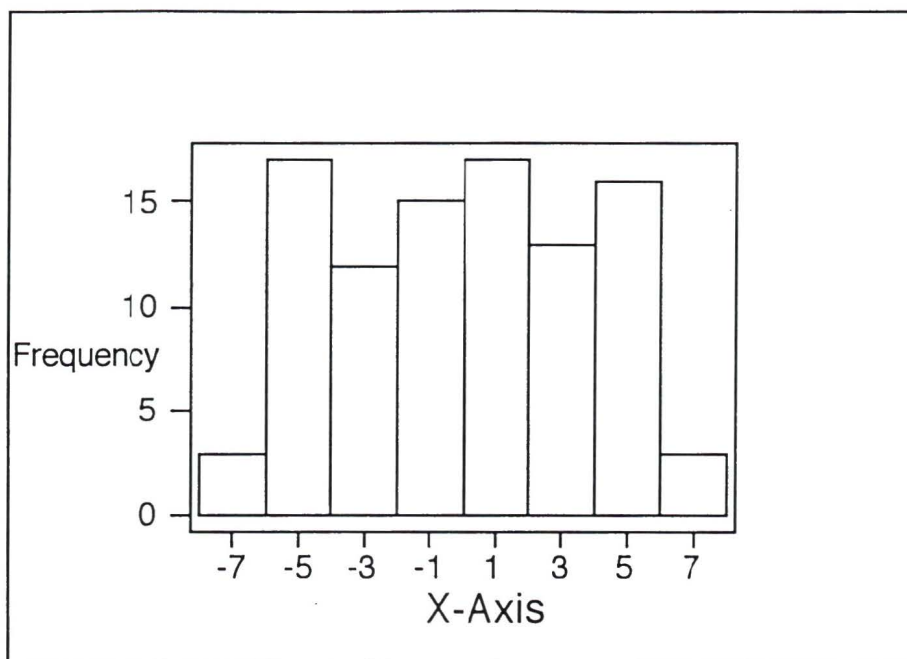


Figure 3.1. Distribution of Canonical Variates Scores in Callow and Webb (1981: Figure 2).

Callow and Webb also use their data to question Mellars' view that Quina assemblage types replace Ferrassie. They state that the discontinuity between these groups may argue against this position (Callow and Webb 1981: 137):

... if Mellars is correct in suggesting that one replaces the other over time, the existence of a cline might have been expected. To maintain his view it is necessary to postulate either a very rapid transition from one type to the other which failed to survive in the archaeological record, or an under representation of transitional assemblages representing a rather slower rate of change.

Mellars, however, uses Callow and Webb's article to uphold the separation of Bordes' assemblage types (1996: 182-183). Callow and Webb's support of the discreteness of the assemblage types undermines one of Binford's positions, that the assemblages types themselves were not a primary level of analysis. Their interpretations argue against the Rolland and Dibble model, which posits the continuity of assemblage types.

One of the problems with Callow and Webb's position may be that there was a general lack of theoretical alternatives with which to explain their data. Rolland's key papers were published almost at the same time as theirs (in 1977 and 1981) and thus his theoretical position may not have been available. They seem to have fallen back on an orthodox position due to the lack of alternatives. The continuity of the assemblage types did not seem to be a major alternative when their articles were written. Although their analysis argues against other aspects of Binford's position (specifically, their principal components analysis failed to show the existence of functional groups), they likely did not consider continuity as a realistic option. This, coupled with the problematic interpretation of the results of their discriminant analysis, led to their conclusions.

Another example of the use of principal components analysis should be noted. In 1992, Victoria Cabrera Valdes and Frederico Bernaldo de Quiros presented the results of a principal components analysis for the Middle Palaeolithic materials in Spain. They used only four variables, the tool groups (I-IV) proposed by Bordes, and ran their tests on both northern and peninsular Spanish assemblages (Cabrera Valdes and Bernaldo de Quiros 1992: 104). The results of both tests were similar in that two clusters were formed, one dominated by denticulates and the other by racloirs. Judging by the scatterplots presented, most of the discrimination was on the first component (accounting for 50% of the variance), which likely had high positive loadings for racloirs and high negative loadings for denticulates (Cabrera Valdes and Bernardo de Quiros 1992: 104-105). The criticisms of this analysis primarily concern the choice of variables. The use of only the four groups begs the question, why use principal components analysis

at all? Group II (Mousterian tools) probably could have been plotted against Group IV (denticulate tools) with similar results. Again, the variables chosen are highly derived and potentially contain an over-abundance of theoretical information.

DISCUSSION

The present chapter has examined both multivariate statistical theory and previous multivariate analyses of Middle Palaeolithic assemblages. These multivariate analyses are summarized in Table 3.1. In general, many of the previous studies have problems associated with low sample size or problems with the variables selected for analysis. Specifically, the studies of Freeman, Binford and Binford, and Doran and Hodson all use fewer cases (assemblages) than variables (artifact types). This is partly related to the availability of materials, however, the number of cases should exceed the number of variables for statistical reasons. Another problem in these analyses was the use of problematic variables; the use of indices in Callow and Webb and in Cabrera Valdes and Bernardo de Quiros has problems associated with the theoretically derived nature of the variables as well as with strong linear relationships between them. To better understand the nature of Middle Palaeolithic variability, an analysis of Middle Palaeolithic assemblages should include Bordes' artifact types, a large number of assemblages and careful attention to statistical methodology. The analyses discussed in this chapter will be assessed below in light of my own analyses below.

Table 3.1. Multivariate Analyses of Middle Palaeolithic Assemblages

	Freeman	Binford and Binford	Doran and Hodson	Mellars	Callow and Webb	Cabrera Valdes and Bernaldo de Quiros
Number of Assemblages	14	16	16	33	96	40
Variables Used	Bordes Types (51).	Bordes Types (40).	Bordes Essential and Bordes Real counts.	Bordes Real count.	Bordes Indices (plus notches and limaces).	Bordes' Diagnostic Groups (I - IV).
Statistical Tests Used	Principal components analysis with rotation.	Principal components analysis with rotation.	Multidimensional scaling.	Multidimensional scaling.	Principal components analysis and "canonical variates analysis."	Principal components analysis.
Interpretations Supported	Functional factors/toolkits.	Functional factors/toolkits.	Bordes assemblage typology upheld.	Patterning in data is the primarily due to the distribution of racloirs.	Bordes assemblage typology upheld, multimodal distribution based on discriminant analysis.	Two groups differentiated by the distribution of racloirs and denticulates.

¹ Refer to Dunteman 1989 for details on the various equations and methods used.

² "Historically, factor analysis [where rotation methods began] was developed and used in the social sciences, particularly by psychologists" (Baxter 1994: 88).

³ For details on the various equations and methods used, refer to Kim and Mueller 1978a and 1978b.

⁴ Refer to Klecka 1980 for details on the various equations and methods used.

⁵ Significance tests for comparing the group centroids do exist. However, Baxter states that "tests of significance of group differences tend to perform 'too well' and lead to the conclusion that differences are highly significant" (1994: 196).

⁶ Euclidean distance coefficient:

$$d_{ij} = \left(\sum_{k=1}^n (x_{ik} - x_{jk})^2 \right)^{1/2}$$

⁷ If the correlations were a function of the size of the assemblages, all tool types would be correlated with all other types. In terms of factor loadings, this would mean that all of the significant correlations would be of the same sign on a single factor. A mixture of both positive and negative correlations on a single factor would suggest that tool types behaved differently, or inversely from one another, a scenario not likely if everything correlated with everything else as a function of assemblage size. Another observation in this regard is that only one type is not significantly *positively* correlated with the first two factors. This type, flakes with abrupt and alternating retouch (type 46), is strongly positively correlated with the third factor and is considered to be the result of post depositional damage (Debénath and Dibble 1994: 5).

⁸ See previous footnote.

⁹ see Chapter 2, for more details concerning the Binford and Binford analysis.

¹⁰ See previous footnote.

¹¹ If one sees two groups, one cluster contains Charentian types and the other contains the remaining types. If one sees three groups, the Denticulate Mousterian and the MTA types are still clustered together (Doran and Hodson 1966: 689).

¹² The racloir index is calculated by dividing the proportion of racloirs (types 9-29) by the total count, while the Mousterian group divides types 5-29 by the total count.

4 THE STRUCTURE OF THE DATA

What is argued here is that the generation of inferences regarding the past should not be the end-product of the archaeologists work. While an awareness of as great a range of variability in sociocultural phenomena as possible and the citation of analogy to living peoples are not belittled here, the main point of our argument is that independent means of testing propositions about the past must be developed. Such means must be considerably more rigorous than evaluating an author's position by judging his professional competence or intellectual honesty.

-Lewis Binford, "Archaeological Theory and Method."

The present statistical analysis was initially proposed by Nicolas Rolland to assess the factor analysis conducted by Lewis and Sally Binford in the 1960s. From the beginning the goal was both to assess the known data using multivariate statistics and to evaluate a theoretical position. The initial concept was simply to conduct a factor analysis using a new data set, thus replicating the Binfords' experiment. The issue of whether multivariate statistics could assess the nature of Bordes' proposed typology was at the heart of such an analysis, as it was for Binford and Binford.

A preliminary analysis was conducted under the guidance of Leland Donald in order to refine the choice of methodology for the thesis. The problems inherent in the Binfords' factor analysis became apparent at an early stage in the design of this research program. The preliminary analysis involved the use of 30 Middle Palaeolithic assemblages, some of which were part of the original analysis done by the Binfords (e.g., Mugharet es-Shubbabiq; 1966). A principal components analysis, a discriminant analysis and several clustering analyses were conducted using only percentages of Bordes' real count and bifaces as variables. Based on these initial tests, a number of refinements were chosen for the final analysis.

The present analysis consists of 1) a principal components analysis, 2) a factor analysis, 3) a discriminant analysis and 4) two cluster analyses of Western European Middle Palaeolithic assemblages. The goals of these tests are primarily to describe 1) the relationships between the various artifact types defined by Bordes, 2) the relationships between the assemblage types and 3) the relationships between the artifact and assemblage types. More specifically, they will assess how the artifact types are related to each other and what proportion of the overall variance they account for; they will describe how the assemblage types are distributed multivariately; and they will reveal which artifact types are important in distinguishing between those assemblage types. These observations will

contribute to a better understanding of the nature of lithic variability in Western European Middle Palaeolithic assemblages and will provide data to test the usefulness of Bordes' typology. A fundamental issue is whether or not the assemblage and artifact types are discrete entities, or whether they form a continuum of variability.

These questions cannot be answered by a set of statistical tests on the distribution of artifact types alone. The results of these tests must be compared to other classes of data and assessed in terms of alternate theoretical positions. Conversely, however, these tests will have a bearing on the interpretation of those classes of data and theoretical positions.

THE DATA: ASSEMBLAGES, ARTIFACT TYPES AND TRANSFORMATIONS USED

The sample of assemblages used for the present analyses was taken from published material and from the notes of Nicolas Rolland. Use was made of archaeological assemblages from France, Spain, and Italy which dated from the Middle Palaeolithic period, primarily from the onset of the *Würm ancien* to the appearance of the Upper Palaeolithic (ca. 40,000-35,000 BP, depending on region).¹ Assemblages from Germany were not included because they contain unique tool types (*Blattspitzen* or bifacial foliated tools) and unique assemblage types (the German "Micoquian"); they appear to be part of a central European complex (Bordes 1968: 109-110). Assemblages were selected for the use of Bordes' typology, reporting completeness (i.e., data was available for all variables used, see below), and other statistical criteria (see below). The study is designed to be comprehensive of available assemblages which meet these criteria, rather than a sample of them.² The assemblages used are listed in Appendix C.

The reasons why artifact types rather than other types of variables were used are numerous. One of the simplest reasons is that they are a readily accessible form of data which is used in most of the published (and unpublished) descriptions of artifact assemblages. In addition, this form of data is different from that used by Callow and Webb (1977, 1981), thus avoiding a mere replication of their study. The artifactual data is less derived than the indices. The use of artifact types avoids any artifact being counted twice, which is possible in the use of the various indices and artifact groups defined by Bordes. Although there are well-known problems with Bordes' artifact typology (such as its arbitrary division into tool classes and its obvious emphasis on "stylish" tools such as racloirs and

points), it is the best of those widely used. Of the different classes of data used in the Bordes system, it is the least derived and is primarily a descriptive morphological categorization (see Bordes 1961b; Debénath and Dibble 1994). One of the obvious advantages of using these defined types is that most of the theoretical positions concerning the nature of Middle Palaeolithic variability are discussed in terms of them.

One problem with the use of this typology, however, is that several authors report the frequencies of the various types differently. It is common practice to group some of the types together in broader classes, e.g., the double racloirs (types 12-17) are often reported as a single variable. In order to create like units of comparison, the most inclusive of these conventions were retained. Further, those artifact types which, when calculated, never exceeded 1% of the total for an assemblage were not used. In addition to the artifact types outlined by Bordes, the various bifaces were counted as a single variable, as were unretouched non-Levallois flakes and blades. This resulted in the set of variables shown in Table 4.1. Thirty-nine variables were used.

To better approximate the normal distribution for the variables, Fisher's arcsine transformation was used:

$$y = \text{asin}(x^{1/2}), \quad (1)$$

where x ranges from 0 to 1 (i.e., 0 to 100%). This transformation is commonly used for data expressed in proportions (Baxter 1994: 46). It better differentiates between values with low and high percentages than the untransformed data does. Values near 0% remain unchanged, values near 50% are increased by a relatively constant amount, and values near 100% are increased by the greatest amount (Figure 4.1).

Callow and Webb, who also used this transformation, state that "this has the effect of reducing skewness in the distributions by 'stretching' them in the region of 0 and 100%, but leaving the shape of the curve unaltered for values near 50%" (1981: 132). It also helps to reduce the impact of autocorrelation, because it affects the values in the high and low ranges. The inclusion of unretouched Levallois flakes and blades, which are present in large quantities in many assemblages (an average of approximately 50% of the artifacts), has caused many of the other tool types to be represented by much smaller proportions. In a hypothetical assemblage in which this artifact class represented 50% of the artifacts counted, the remaining 38 artifact types account for the remaining 50%

Table 4.1. **Artifact Types Used in Multivariate Analysis.**

Type 1	Typical Levallois flakes
Type 2	Atypical Levallois flakes
Type 3	Levallois points
Type 4	Retouched Levallois points
Type 5	Pseudo-Levallois points
Type 6	Mousterian points
Type 8	Limaces
Type 9	Single, straight racloirs (scrapers)
Type 10	Single, convex racloirs
Type 11	Single, concave racloirs
Types 12-17	Double racloirs
Types 18-20	Convergent racloirs
Type 21	Skewed (déjeté) racloirs
Types 22-24	Transverse racloirs
Type 25	Racloirs on ventral surface
Type 27	Racloirs with thinned back
Type 28	Racloirs with bifacial retouch
Type 29	Racloirs with alternate retouch
Types 30-31	End-scrapers
Types 32-33	Burins
Types 34-35	Borers
Type 36	Typical backed knives
Type 37	Atypical backed knives
Type 38	Naturally backed knives
Type 39	Raclettes
Type 40	Truncations
Type 42	Notches
Type 43	Denticulates
Type 44	Alternate retouched becs
Type 45	Flakes with irregular retouch on interior
Types 46-7	Thick flakes with abrupt and alternating retouch
Types 48-49	Thin flakes with abrupt and alternating retouch
Type 50	Bifacially retouched flakes
Type 54	End-notched flakes
Type 55	Hachoirs
Type 59-61	Chopping tools
Type 62	Miscellaneous
	Bifaces (handaxes)
	Unretouched non-Levallois flakes and blades.

of the artifacts, and thus the use of a data transformation was required. The effect of this transformation on a single artifact type (simple convex racloirs) is shown in Figure 4.2. This transformation was not used with the cluster analysis.

As a rule of thumb, Flury and Reidwyl suggest that for principal component analyses the number of observations (total artifact count) for each case be ten times as large as the number of variables (1988: 9). This rule of thumb was not upheld because a somewhat lower number of artifacts significantly increased the number of cases used in the analysis. Only assemblages whose total artifact

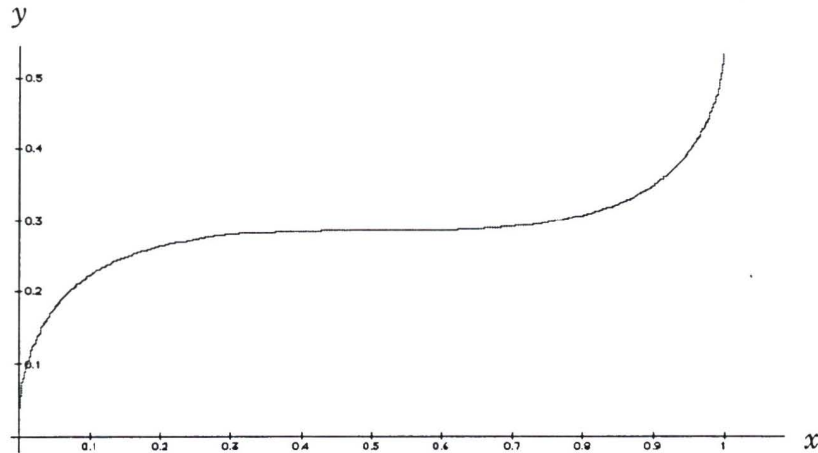


Figure 4.1. Additive effect (y) of arcsine transformation on original variable (x); $y = \text{asin}(x^{1/2}) - x$.

count including bifaces and unretouched non-Levallois flakes and blades was greater than 300 were used. This is a statistical trade-off because both the number of cases and the total number of observations per case improve the statistical reliability of the tests performed. For the discriminant analysis, the number of observations well exceeded that indicated by this rule of thumb because a smaller number of variables was used. One hundred and three assemblages were used in this analysis (see Appendix C).

A correlation matrix comparing each of the variables was made before the more elaborate multivariate tests were computed. This matrix was briefly examined and served as a check on the results of the other analyses. All calculations were performed using Minitab 10.5x except the discriminant analysis, which was calculated using SPSS 6.1.

PRINCIPAL COMPONENTS ANALYSIS

The principal components analysis was performed on both the covariance and correlation matrices using 39 variables and 103 assemblages. The covariance matrix yielded extremely low eigenvalues and thus did not explain the total variance in the population well (largest eigenvalue = 0.028). A brief examination of the principal component loadings for this test indicated the influence of the relative magnitude of the variables. Only those variables with relatively large values had high loadings. The results using the correlation matrix were both more satisfying and more intuitively appealing. As the correlation matrix is essentially the standardized form of the covariance matrix, the relative sizes of the

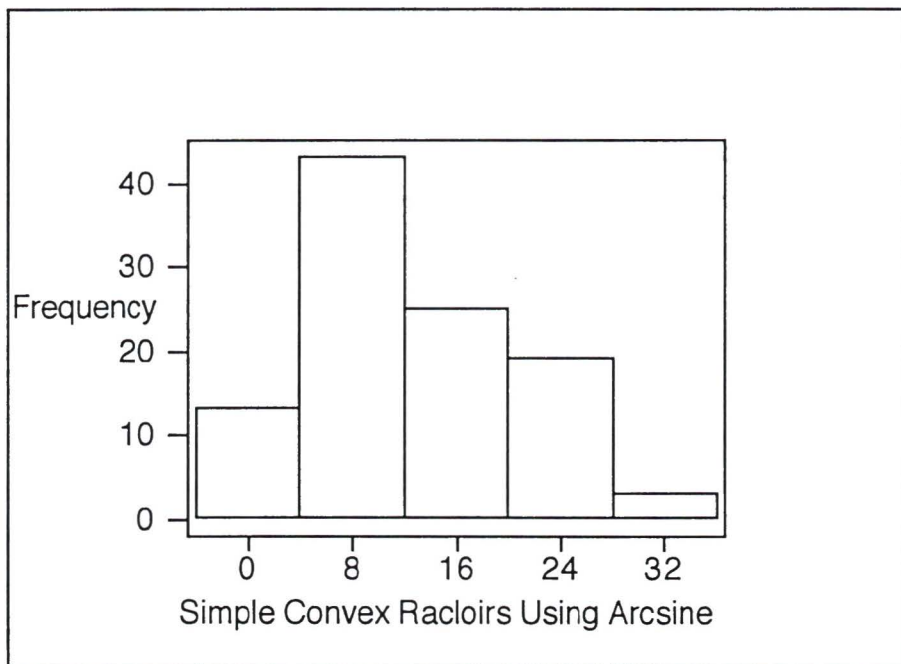
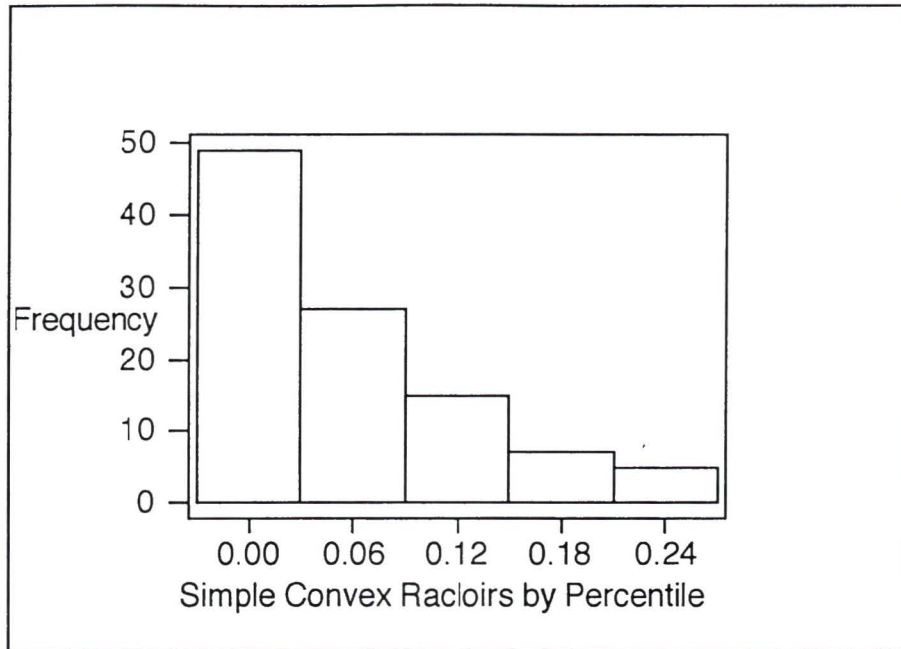


Figure 4.2. Effect of Arcsine Transformation on a Single Variable Type (Simple Convex Raclairs).

variables were less important (see Baxter 1994: 65-66).

The principal components analysis yielded as many principal components as there were variables and a number of methods of selecting a significant number were considered. One standard method of choosing the number of

principal components is to use only those whose eigenvalue exceeds 1 (Baxter 1994: 59). This method yielded 10 principal components. Another common method is to decide upon a proportion of variance accounted for, 70% and 80% being common choices (Baxter 1994: 59). This method yielded 8 components at 70%. A third method, known as the scree plot method, examines the changes in the amount of variance accounted for by each component and looks for a levelling off of values (Baxter 1994: 59-61). Based on the scree plots for the principal components, four components were retained for interpretation, accounting for 52.5% of the total variance (see Figure 4.3). These components are presented in turn (Tables 4.2 - 4.5) with their eigenvalues, proportion of variance accounted for and their loadings.

The first principal component (Table 4.2) has highest negative loadings on racloirs and highest positive loadings on flakes and blades. Among the racloirs with high loadings on this component, types 9 through 24, excluding type 11, seem to co-vary together the most closely. This is also supported by the correlation matrix. Types 8 through 24 and types 27 through 29 are all relatively strongly correlated with this component. Type 8, limaces, although not considered racloirs per se are "according to most authors . . . considered as points or convergent

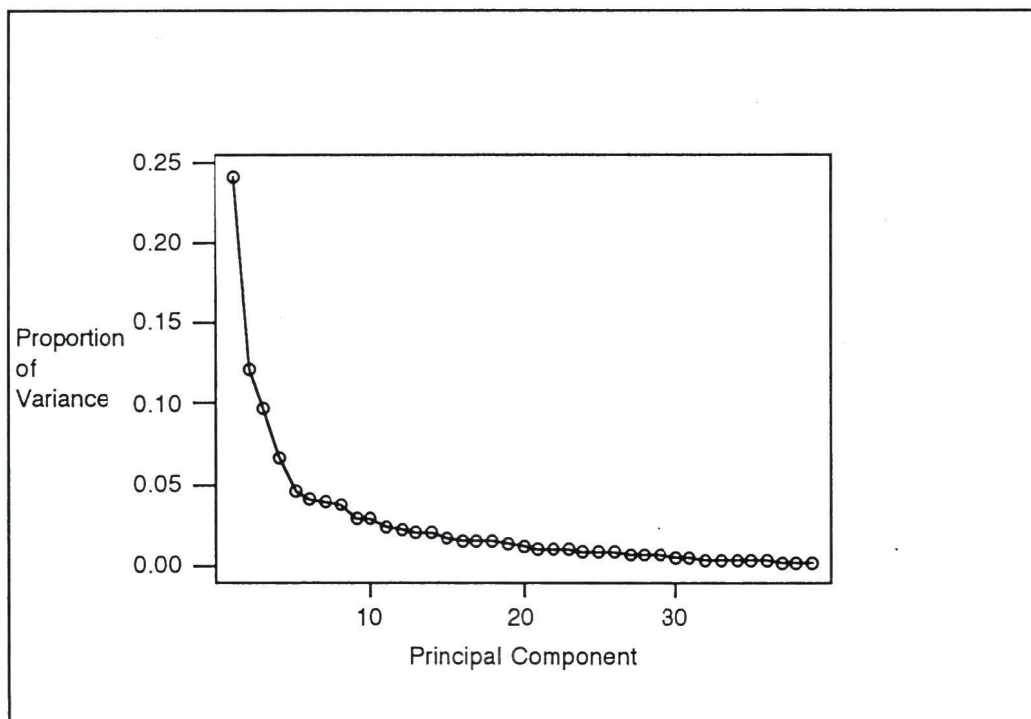


Figure 4.3. Scree Plot of Principal Components by Proportion of Variance.

Table 4.2. First Principal Component.

Variable	Loading
Type 10	-0.297*
Type 21	-0.297*
Types 12-17	-0.289*
Types 18-20	-0.287*
Type 9	-0.280*
Types 22-24	-0.274*
Type 28	-0.253*
Type 8	-0.243*
Type 27	-0.239*
Type 11	-0.202*
Type 29	-0.185*
Types 30-31	-0.169
Type 6	-0.168
Type 62	-0.162
Type 25	-0.162
Types 32-33	-0.083
Type 4	-0.072
Type 55	-0.051
Types 34-35	-0.045
Type 39	-0.043
Type 40	-0.028
Bifaces	-0.019
Type 54	-0.016
Type 1	-0.013
Type 50	0.000
Type 3	0.001
Type 44	0.006
Type 36	0.019
Types 59-61	0.033
Type 2	0.040
Type 42	0.043
Type 37	0.045
Types 48-49	0.066
Types 46-47	0.069
Type 45	0.096
Type 43	0.101
Type 38	0.113
Type 5	0.155
Flakes/Blades	0.216
Eigenvalue	9.397
Proportion of variance	0.241

* represents highest absolute loading for this variable among the first four components.

scrapers" (Debénath and Dibble 1994: 66). In addition, Dibble considers this type as a potential product of his racloir reduction scheme (1987: 116).

Unretouched non-Levallois flakes and blades co-vary inversely with the

racloirs. This is apparent in the correlation matrix as well. This component should be interpreted as the inverse relationship between racloirs and unretouched non-Levallois flakes and blades, accounting for the most significant proportion of the total variance in the present sample (approximately 24%).

The second component (Table 4.3) is less easily interpretable. Represented are three important classes of tools with high positive loadings: backed knives, notches and denticulates, and bifaces. These types all occur in MTA type assemblages. In addition, three other types appear to be included in this group with high loadings: pseudo-Levallois points, racloirs retouched on the ventral surface, and pieces retouched on the ventral surface (Types 5, 25, and 45 respectively).

There are three backed knife types, two of which are considered “real” backed knives, whereas type 38, naturally backed knives, is considered to be “unretouched flakes or blades that have a sharp cutting edge on one margin and a natural cortical surface (the ‘back’) on the opposing edge which is perpendicular or nearly so, to the interior surface” (Debénath and Dibble 1994: 53-54; see also Bordes 1961: 33). They are categorized as “technologically defined tools” by Debénath and Dibble (1994: 40: 53). This classification aside, they are reasonably correlated with typical backed knives in the correlation matrix ($r = .41$) and apparently behave in a similar fashion to the real backed knives. Backed knives increase significantly in importance in MTA assemblages, particularly typical backed knives. Handaxes, which only occur significantly in MTA assemblages, are also relatively strongly correlated with this type.

Notches and denticulates also share high positive loadings with this component. These types correlate positively with the backed knives to a certain extent, probably due to their relative prominence in MTA type assemblages. It is interesting to note that in the preliminary analysis, this type was inversely correlated with the racloir types on the first component. This did not occur when unretouched non-Levallois flakes were included among the variables. Notches and denticulates are negatively correlated with both racloirs and non-Levallois flakes and blades. There appears to be a triangular relationship between these variable types; each of these types is negatively correlated with each other.

The remaining positively correlated types require further explanation. Pseudo-Levallois points are considered to be a form of unretouched flake and are reasonably correlated with the backed knife types and notches and denticulates

Table 4.3. Second Principal Component.

Variable	Loading
Type 36	0.335*
Type 42	0.310*
Type 37	0.302*
Type 45	0.281*
Type 38	0.273*
Type 43	0.243*
Type 5	0.211*
Type 25	0.204*
Bifaces	0.203*
Type 3	0.194
Type 54	0.191
Type 4	0.165
Type 40	0.161
Type 39	0.159*
Types 32-33	0.149*
Types 30-31	0.142
Type 1	0.136
Types 34-35	0.132
Type 29	0.126
Type 62	0.080
Type 50	0.079
Types 48-49	0.073
Type 55	0.060
Type 6	0.041
Type 28	0.035
Types 46-47	0.030
Type 11	0.028
Type 27	0.015
Type 9	0.010
Type 2	0.007
Types 59-61	-0.008
Types 12-17	-0.011
Type 44	-0.013
Type 8	-0.018
Type 21	-0.040
Types 18-20	-0.061
Types 22-24	-0.061
Type 10	-0.077
Flakes/Blades	-0.268*
Eigenvalue	4.708
Proportion of variance	0.121

* represents highest absolute loading for this variable among the first four components.

on the correlation matrix ($r > 0.4$). Racloirs on the ventral surface and pieces with ventral retouch appear to be related by the location of their retouch; however, they are not significantly correlated with each other. Type 25 is positively

correlated with notches, denticulates and backed knives, whereas the other racloir types are not. It thus appears that both notches, denticulates and backed knives are the important variables on this component; variables which are positively correlated with them share high positive loadings on this component. Types 39 and 32-33 have their highest loadings on this component; however, they are not strongly correlated with it.

The only significant negative loadings on this factor are the non-Levallois unretouched flakes and blades. This variable is negatively correlated with many variables, and thus tends to be inversely correlated with all "implement" types.

Some of the interpretive problems with this component may be a product of the conditions placed on principal components analysis. The condition that the components must be orthogonal and that the first component must account for the greatest proportion of the variance means that the loadings on subsequent components may be less "optimal" in an interpretive sense. In general, however, this component represents notches, denticulates and backed knives versus unretouched non-Levallois flakes. It accounts for roughly 12% of the total variance in the sample.

The third principal component (Table 4.4) has high positive loadings for artifacts of Levallois manufacture and Mousterian points. The highest significant negative loadings are for miscellaneous artifacts and pieces with light, abrupt alternate retouch. This component accounts for approximately 10% of the total variance.

The positive loadings are relatively easy to interpret. Simply put, these types are indicative of Levallois technology. Mousterian points are a general class of points. They may, however, be made from Levallois points: "the presence of 'significant retouch' is what distinguishes Mousterian point types made on Levallois points from type 4 - retouched Levallois points" (Debénath and Dibble 1994: 62). The correlation between Mousterian points and type 4 is 0.47 on the correlation matrix.

The types with high negative loadings on this component are less easy to interpret. Miscellaneous artifacts are "intentionally retouched pieces whose morphology does not truly fit any existing categories" (Debénath and Dibble 1994: 122). This category includes morphologically distinct types which are too rare to warrant a category of their own and tools which are composites of other types. It is a catch-all category for those intentionally retouched pieces which are not

Table 4.4. Third Principal Component.

Variable	Loading
Type 1	0.419*
Type 3	0.376*
Type 2	0.335*
Type 4	0.301*
Type 6	0.242*
Types 12-17	0.100
Type 38	0.093
Types 59-61	0.081
Types 18-20	0.072
Type 36	0.060
Type 27	0.049
Type 21	0.036
Type 50	0.034
Type 45	0.016
Type 29	0.010
Type 37	0.007
Type 40	-0.003
Type 5	-0.003
Type 9	-0.004
Type 10	-0.013
Bifaces	-0.019
Type 25	-0.034
Type 39	-0.041
Type 11	-0.049
Type 8	-0.057
Types 32-33	-0.058
Flakes/Blades	-0.059
Types 46-47	-0.070*
Type 28	-0.079
Types 22-24	-0.108
Type 54	-0.108
Type 55	-0.118
Type 44	-0.159
Types 30-31	-0.184*
Type 42	-0.188
Types 34-35	-0.196
Type 43	-0.237
Types 48-49	-0.253*
Type 62	-0.255*
Eigenvalue	3.790
Proportion of variance	0.097

* represents highest absolute loading for this variable among the first four components.

classified into other types. Types 48-49, thin pieces with abrupt alternate retouch, are often considered to be “geologically” retouched pieces and are not normally considered to be tools (Debénath and Dibble 1994: 114). Since the absolute

loadings are much higher for the positive, Levallois types, this component should simply be interpreted as a Levallois component.

The fourth component (Table 4.5) has its highest positive loadings on types 40 and 44, truncated flakes and alternate burinated becs. Its highest negative loadings are on types 59-61 and type 50. Perhaps the most notable aspect of all of these types is that none of them are particularly abundant. Their average occurrences across the assemblage types are less than 1%. The best interpretation of this component may be the contribution of rare types. Neither the positive nor the negative loaded types bear any obvious relationships to each other in terms of technology or function.

To summarize the results of the principal components in terms of the variable loadings, there are three *interpretively* important components out of the four selected. These first three components together account for approximately 46% of the total variance. The first component is dominated by racloirs and unretouched non-Levallois flakes and blades, the second by notches, denticulates and backed knives and correlated artifact types versus unretouched non-Levallois flakes and blades, and the third type is dominated by Levallois technology. These variables are the most important in terms of explaining the variability in Western European Middle Palaeolithic assemblages (Table 4.6). The task of reducing the bulk of Middle Palaeolithic variability to a smaller set of variables (as functions of the principal components) has been accomplished.

The second task in which principal components analysis can aid is the nature of the distribution of cases. This is done by plotting the principal component scores for each case. The first three components were used in such plots, presented in two dimensions (Figures 4.4 - 4.6). Each assemblage type is given a different symbol so that both the cases and groups can be compared. In addition, the distributions of the principal component scores are presented in histograms and box plots by assemblage type (Figures 4.7 - 4.12). Whereas there appears to be some general patterning in the distribution of assemblage types, the groups overlap significantly in multivariate space when viewed on the scatter plots. There is no clear separation into discrete clusters. The greatest separation between the groups is on the first component and there is significant overlap between different assemblage types (see Figure 4.4, 4.10). Furthermore, the frequency distributions of the scores do not show any tendency to multimodality (Figures 4.7 - 4.9).

Table 4.5. Fourth Principal Component.

Variable	Loading
Type 40	0.427*
Type 44	0.353*
Type 54	0.205*
Type 39	0.201
Types 34-35	0.200*
Type 2	0.195
Type 4	0.189
Type 62	0.182
Type 1	0.123
Type 55	0.110
Types 48-49	0.090
Types 30-31	0.086
Type 6	0.077
Type 37	0.068
Type 11	0.063
Types 12-17	0.062
Type 9	0.060
Flakes/Blades	0.055
Types 46-47	0.042
Bifaces	0.028
Type 21	0.016
Types 18-20	0.007
Type 10	-0.019
Type 3	-0.020
Type 42	-0.027
Type 36	-0.045
Type 27	-0.061
Type 5	-0.091
Types 32-33	-0.096
Types 22-24	-0.122
Type 38	-0.143
Type 8	-0.149
Type 25	-0.153
Type 43	-0.171
Type 29	-0.179
Type 45	-0.182
Type 28	-0.198
Types 59-61	-0.207*
Type 50	-0.334*
Eigenvalue	2.572
Proportion of variance	0.066

* represents highest absolute loading for this variable among the first four components.

The nature of the general patterning is best illustrated through the use of box plots which show the ranges of the various assemblage types on each principal component (Figures 4.10 - 4.12).³ This information, in conjunction with

Table 4.6. Interpretation of Principal Components.

Component	Interpretation	Proportion of Variance
1	Racloirs vs. unretouched non-Levallois flakes and blades	24%
2	Notches, denticulates and backed knives vs. unretouched non-Levallois flakes and blades	12%
3	Levallois manufacture	10%

the loadings on the principal components, can provide important clues to the causes of the variation in the sample. In addition, an analysis of variance was performed for each of the three components using Tukey's pairwise comparisons at a 90% confidence interval. The pairwise comparisons show which assemblage types are significantly similar to each other for each component.

The first component, as illustrated in Figure 4.10, shows the relative importance of racloirs versus unretouched non-Levallois flakes and blades by assemblage type. A high (positive) score on the first component would indicate an assemblage which has a higher relative proportion of unretouched non-Levallois

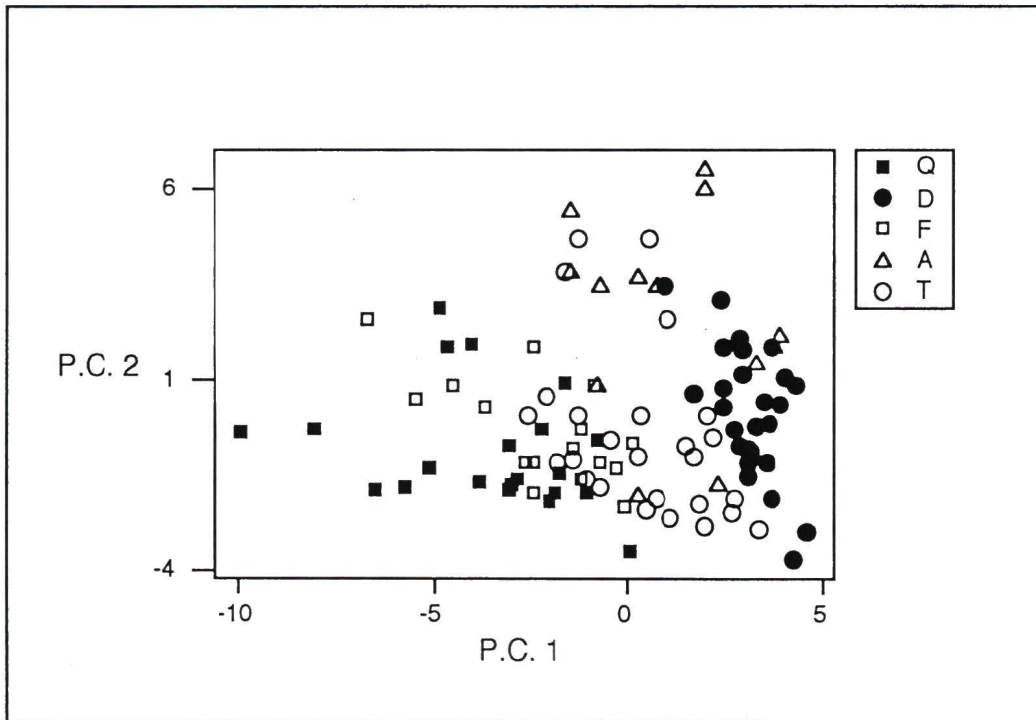


Figure 4.4. Principal Component (P.C.) Scores 1 and 2 by Assemblage Type (Q = Quina, D = Denticulate Mousterian, F = Ferrassie, A = Mousterian of Acheulian Tradition, T = Typical Mousterian).

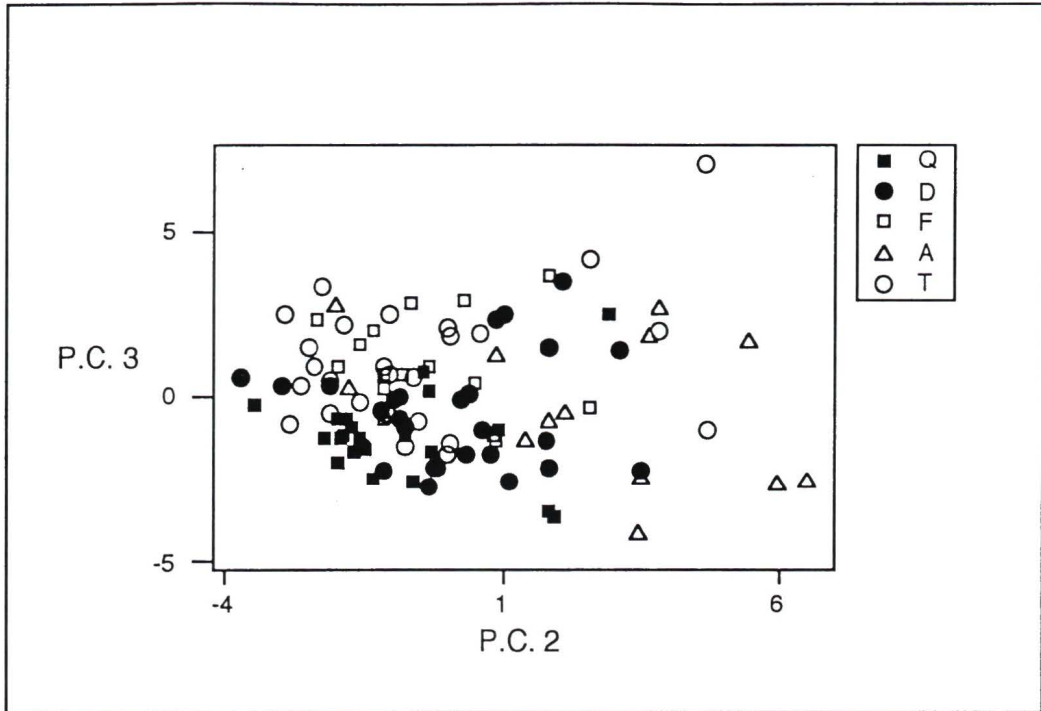


Figure 4.5. Principal Component Scores 2 and 3 by Assemblage Type (Q = Quina, D = Denticulate Mousterian, F = Ferrassie, A = Mousterian of Acheulian Tradition, T = Typical Mousterian).

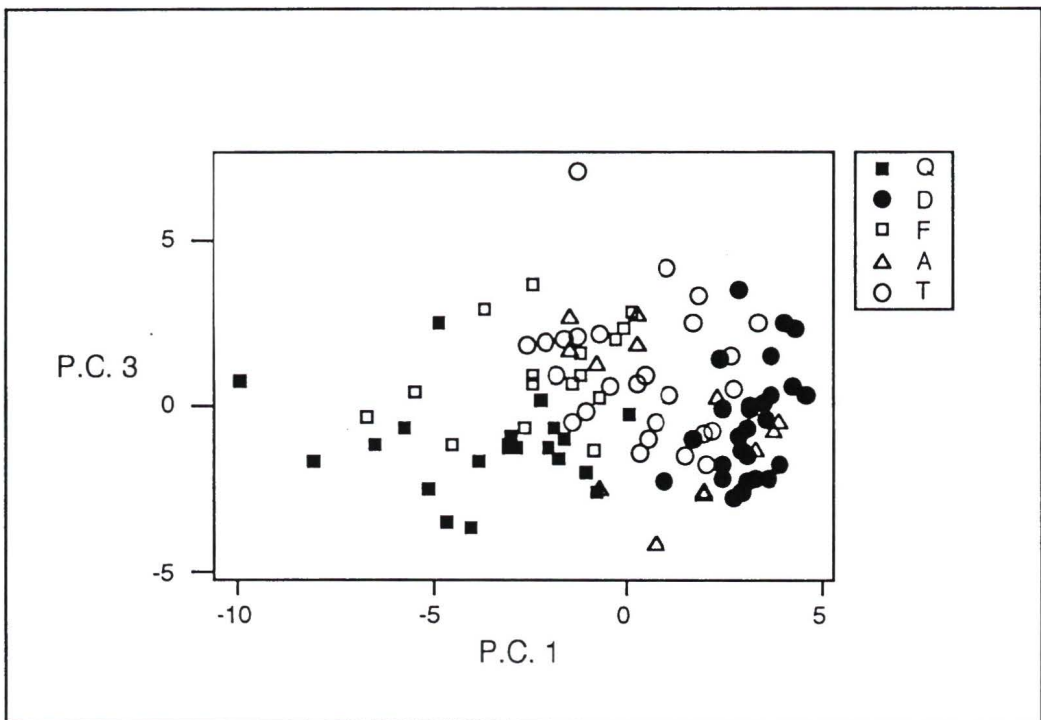


Figure 4.6. Principal Component Scores 1 and 3 by Assemblage Type (Q = Quina, D = Denticulate Mousterian, F = Ferrassie, A = Mousterian of Acheulian Tradition, T = Typical Mousterian).

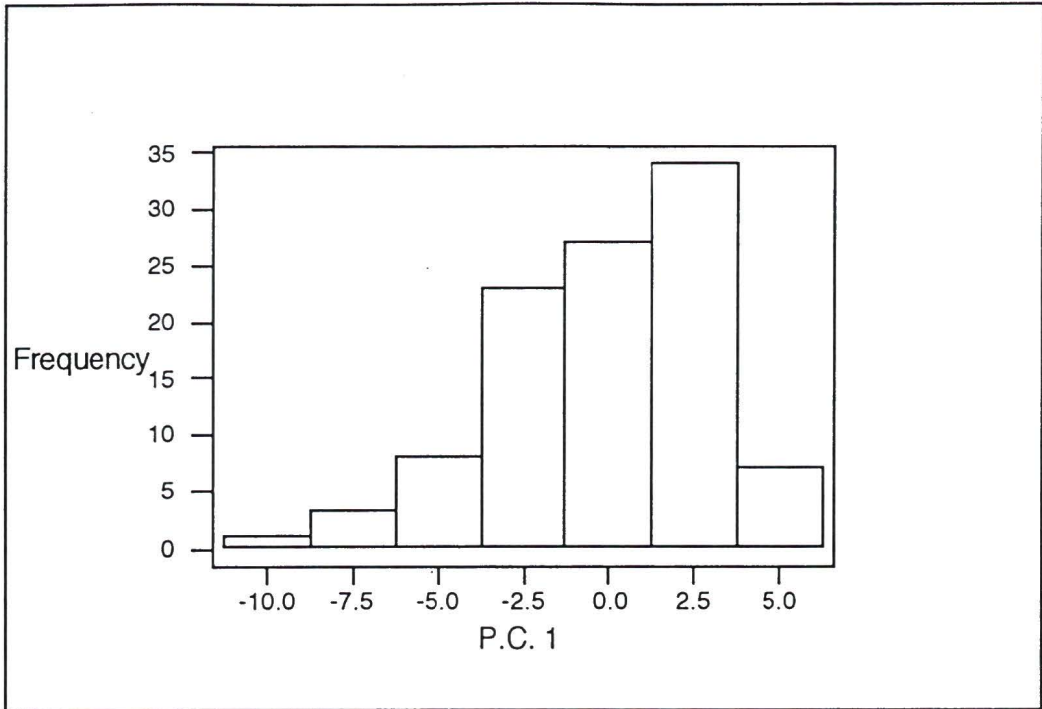


Figure 4.7. Frequency Distribution of Principal Component 1 Scores.

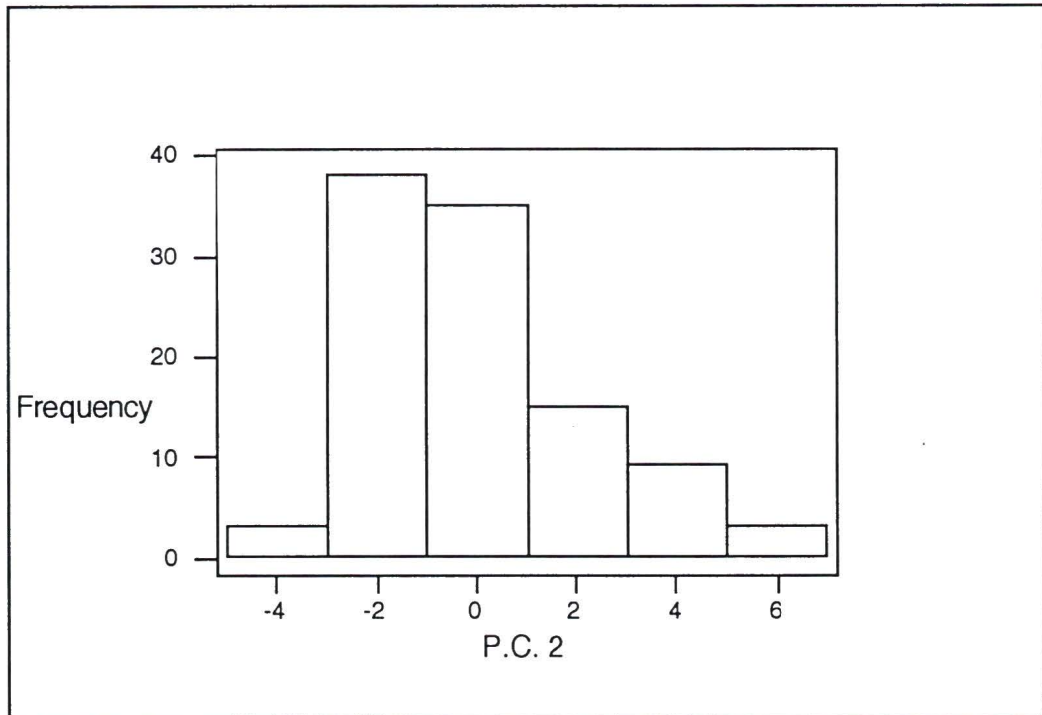


Figure 4.8. Frequency Distribution of Principal Component 2 Scores.

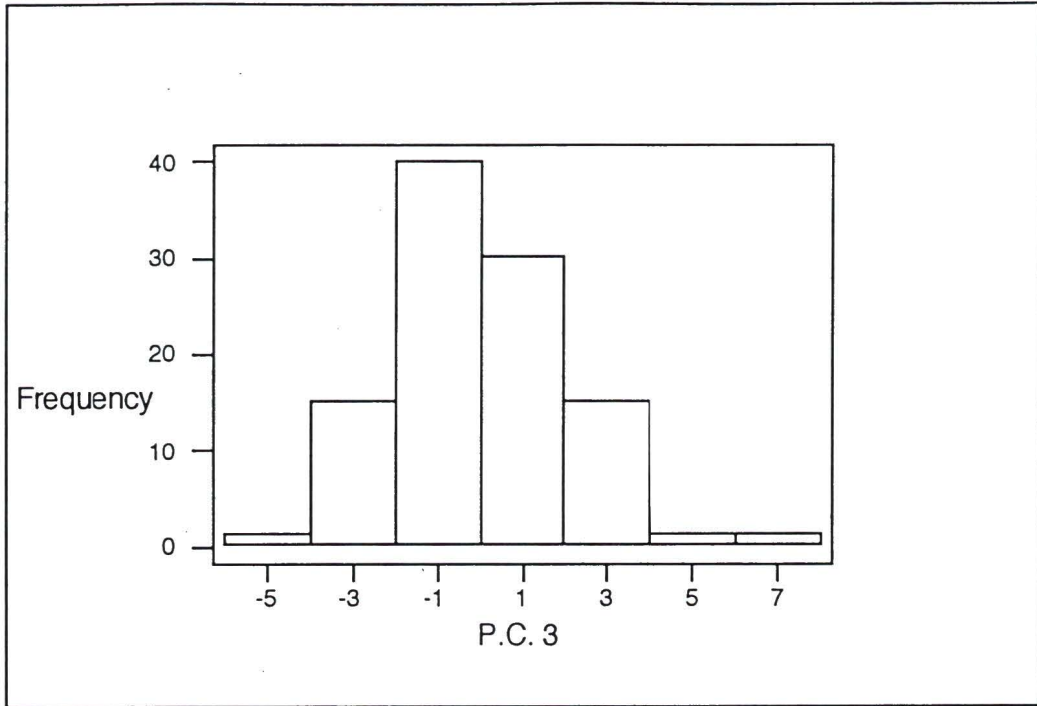


Figure 4.9. Frequency Distribution of Principal Component 3 Scores.

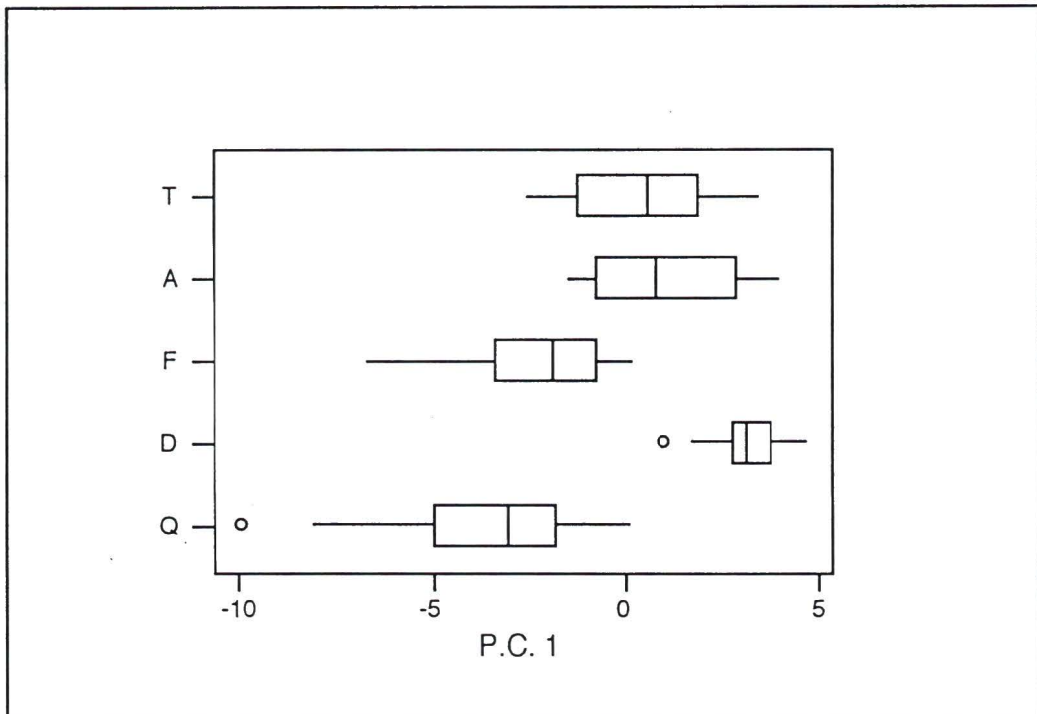


Figure 4.10. Box Plots of Principal Component 1 Scores by Assemblage Type (Q = Quina, D = Denticulate Mousterian, F = Ferrassie, A = Mousterian of Acheulian Tradition, T = Typical Mousterian).

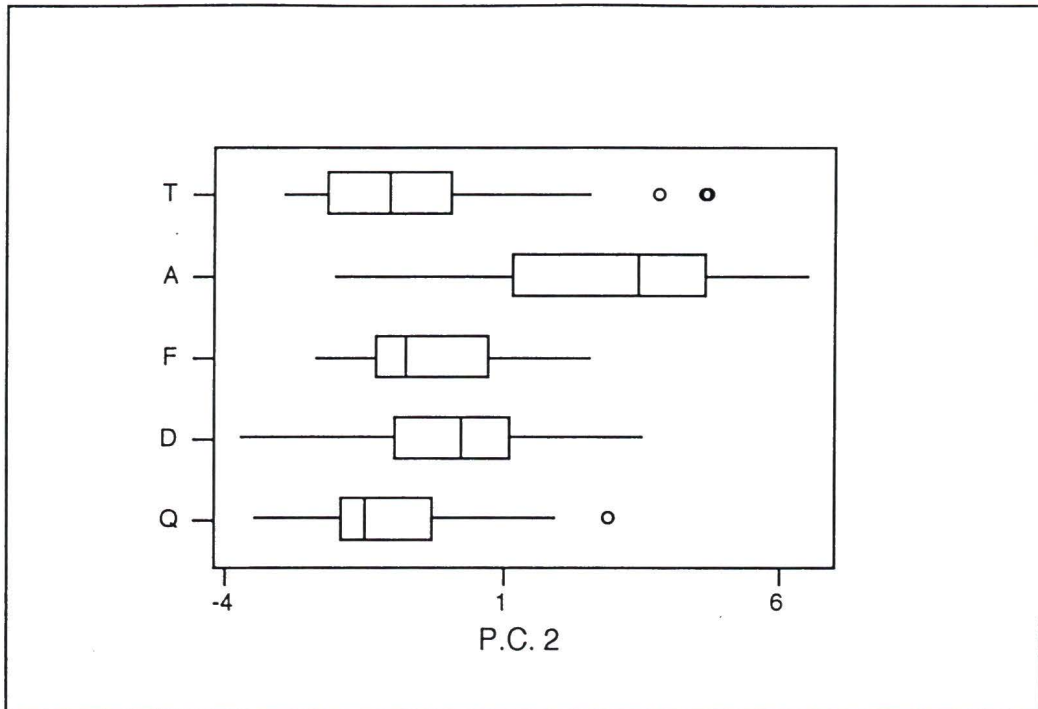


Figure 4.11. Box Plots of Principal Component 2 Scores by Assemblage Type (Q = Quina, D = Denticulate Mousterian, F = Ferrassie, A = Mousterian of Acheulian Tradition, T = Typical Mousterian).

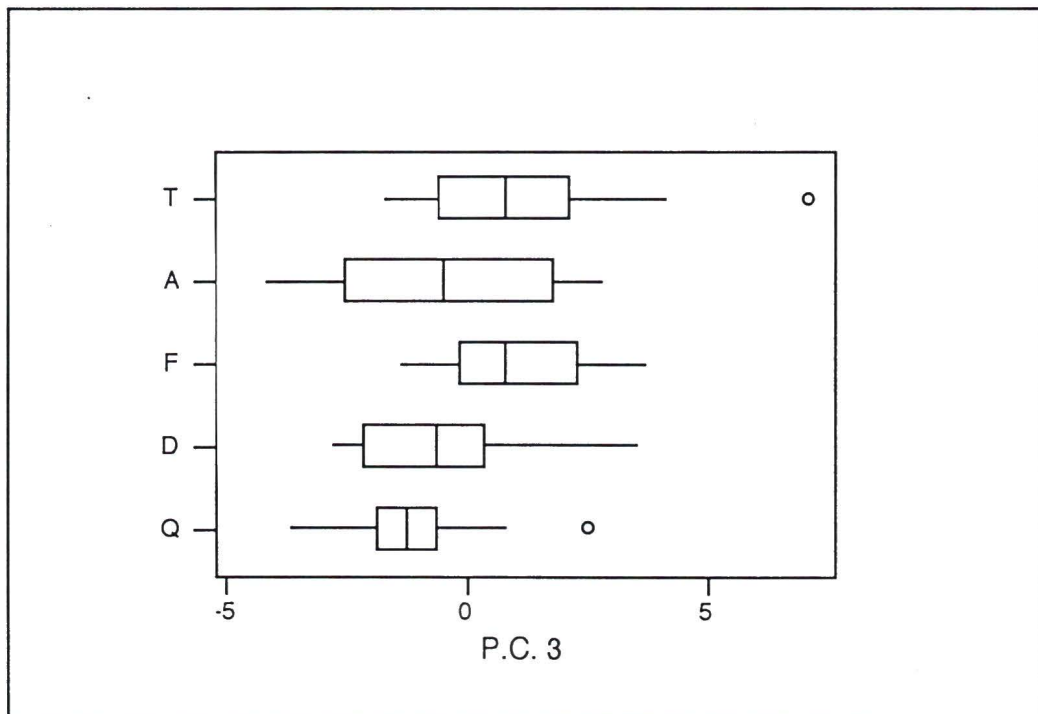


Figure 4.12. Box Plots of Principal Component 3 Scores by Assemblage Type (Q = Quina, D = Denticulate Mousterian, F = Ferrassie, A = Mousterian of Acheulian Tradition, T = Typical Mousterian).

flakes and blades and a lower relative proportion of racloirs. A low (negative) score, on the other hand, would indicate relatively few unretouched non-Levallois flakes and blades and abundant racloirs. The box plot for this component shows that the principal component score ranges and median values for the assemblage types are distributed across the total range. From high to low score values, the artifacts are ranked in the following order: 1) Denticulate Mousterian, 2) MTA, 3) Typical Mousterian, 4) Ferrassie Mousterian and 5) Quina Mousterian. Thus Denticulate is characterized by high counts of unretouched non-Levallois flakes and blades and low racloirs counts, whereas Quina is characterized by high counts of racloirs and low counts of unretouched non-Levallois flakes and blades. The intervening assemblage types fit into this pattern. As one progresses from Denticulate to Quina, the proportions of racloirs increase and the proportions of unretouched non-Levallois flakes and blades decrease. The pairwise comparisons showed that Ferrassie and Quina were not significantly different at a 90% confidence interval; neither were the MTA and Typical Mousterian Assemblages. The remaining types appear to be different from each other.

The second principal component primarily differentiates between MTA assemblages and the remaining ones (Figure 4.11). This is undoubtedly due to the significant presence of backed knives and handaxe types in this assemblage type, both of which are positively correlated with this variable. High proportions of backed knives and the presence of handaxes are diagnostic of MTA assemblages. The only other assemblage type which stands out is Denticulate Mousterian. It has a higher median value than the remaining types, which are similar in their ranges and median values. This is due to the high relative proportions of denticulates and notches, positively correlated with this component. The pairwise comparisons showed that Denticulate, Typical, Quina and Ferrassie were not significantly different from one another at a 90% confidence level, whereas MTA was significantly different from each of the other types.

The third component shows a spread like the first, although the groups are closer to each other (Figure 4.12). This component is indicative of artifact types using Levallois technology. Levallois artifact types are positively correlated with this component. The highest scores for this component are on Ferrassie and Typical Mousterian assemblage types, however, MTA assemblages show a broad range of scores. Quina Mousterian has the lowest median value and the smallest range on this score. Quina has long been recognized to have a general absence or

very low counts of Levallois artifacts (Bordes and de Sonneville Bordes 1970: 63). Denticulate Mousterian also has a low median value. The distribution of the types is clarified by the pairwise comparisons. The MTA type is not significantly different from any of the other types, probably due to its broad range. The Denticulate Mousterian type is not significantly different from Quina, and Ferrassie is not significantly different from Typical.

A few general conclusions can be reached on the basis of the distribution of these assemblage types. First, the relative distributions of racloirs versus unretouched non-Levallois flakes and blades account for the greatest amount of variance in the sample as well as differentiate between the groups better than the other components. The second principal component differentiates MTA assemblages from the rest, primarily due to the relative prominence of the backed knife types. The ranges do overlap, however, and this type does not appear to be multimodal. The third principal component separates the assemblage types into two apparent groups on the basis of the proportions of Levallois technology. Denticulate and Quina assemblages have lower proportions of Levallois technology, and Ferrassie and Typical have higher proportions. The MTA assemblage type's range straddles both of these groupings. This component, however, accounts for the least variance of the three. Another interesting observation is that MTA assemblages consistently have the widest ranges on all of the components. It should be remembered that this type, in practice, is usually divided into two subgroups, MTA a and b, but was not divided for purposes of analysis here.

Although there are differences between assemblage types on the scores, their ranges overlap. Taken as a whole, the distribution of each principal component does not show evidence of multimodality. There are several areas of overlap between assemblage types on each principal component.

FACTOR ANALYSIS

A factor analysis was calculated to more easily interpret the loadings of the variables and to redo the Freeman and Binford analyses using current methods and data. In particular, the second principal component seemed to mix a number of types together, and the loadings on the components were not high for the most part. On the basis of the principal components analysis, using the correlation matrix, the factor analysis was calculated on the assumption that there were three

underlying factors. The factor analysis was calculated using the maximum likelihood method, with varimax rotation to the final solution. The loadings for each factor are presented (Tables 4.7 - 4.9). As noted above, rotation produces only high loadings or loadings near zero. As factor analysis is a more problematic method and involves many assumptions concerning the nature of the variance, the results of this analysis are restricted to the interpretation of the loadings. It should be noted that the distributions of the assemblage types by their factor scores showed no obvious clustering.

The first factor (Table 4.7) reinforces the pattern apparent in the first principal component, the distribution of racloirs versus unretouched non-Levallois flakes and blades. As in the first component, the highest loadings are on racloir types 9-24, excluding type 11. All of these types have loadings greater than 0.8. All of the racloir types except type 25 have loadings greater than 0.5.

The second factor (Table 4.8) shows a different pattern from the second component. Notches and denticulates clearly dominate this factor and appear to form a group, as do backed knives. The members of each of these groups are adjacent to each other on the ranked loadings. The use of rotation seems to have better differentiated these different tool classes. As in the principal components analysis, the second factor also shows an inverse correlation between these artifact types and unretouched Non-Levallois flakes. Although the artifact loadings are presented in a different order, the highest correlations on this factor are essentially the same as the highest correlations on the principal component. Again, using different methods, factor analysis supports the findings of the principal components analysis.

As with the previous factors, the third (Table 4.9) upholds the interpretations of the principal components analysis, but shows a clearer patterning of the variables. On this factor only types 1-4, all Levallois artifacts, have significant loadings. This provides strong support for the presence of a Levallois "factor."

Together, these three factors account for 41.8% of the variance in the sample. This value is less than in the principal components analysis, but the interpretability of the loadings is significantly improved. The factor analysis provides independent support for the results of the principal components analysis. Furthermore, on the assumption that there are three factors underlying the variance in Western European Middle Palaeolithic assemblages, one can say

Table 4.7. First Factor.

Variable	Loading
Type 10	0.923*
Type 21	0.897*
Types 22-24	0.870*
Types 12-17	0.855*
Types 18-20	0.853*
Type 9	0.843*
Type 28	0.776*
Type 8	0.743*
Type 27	0.677*
Type 11	0.604*
Type 29	0.531*
Type 62	0.514*
Types 30-31	0.513*
Type 25	0.460*
Type 6	0.442*
Types 32-33	0.240
Type 4	0.159
Type 39	0.143
Type 55	0.141*
Types 34-35	0.139
Type 54	0.067
Bifaces	0.045
Type 40	0.042
Type 50	0.037
Type 44	-0.036
Type 36	-0.048
Type 3	-0.063
Type 1	-0.064
Type 42	-0.072
Types 59-61	-0.092*
Types 48-49	-0.116
Type 37	-0.123
Types 46-47	-0.180*
Type 2	-0.201
Type 45	-0.239
Type 43	-0.241
Type 38	-0.299
Type 5	-0.426
Flakes/Blades	-0.680*
Eigenvalue	8.904
Proportion of variance	0.228

* represents highest absolute loading for this variable among the three factors.

that racloirs, unretouched non-Levallois flakes and blades, notches and denticulates, and Levallois technology are the most important variables in explaining that variance (i.e., variability).

Table 4.8. Second Factor.

Variable	Loading
Type 42	0.752*
Type 43	0.676*
Type 45	0.599*
Type 36	0.571*
Type 38	0.569*
Type 37	0.511*
Type 5	0.430*
Type 54	0.371*
Type 25	0.368
Types 32-33	0.346*
Bifaces	0.300*
Types 30-31	0.296
Types 48-49	0.288*
Types 34-35	0.283*
Type 3	0.248
Type 50	0.237*
Type 39	0.227*
Type 29	0.216
Type 62	0.211
Type 40	0.172
Type 4	0.130
Types 46-47	0.126
Type 28	0.118
Type 55	0.101
Type 1	0.086
Type 11	0.036
Types 59-61	0.016
Type 8	0.004
Type 27	-0.014
Type 44	-0.023
Type 9	-0.044
Type 6	-0.078
Types 22-24	-0.081
Type 2	-0.117
Types 12-17	-0.139
Type 21	-0.157
Type 10	-0.198
Types 18-20	-0.213
Flakes/Blades	-0.548
Eigenvalue	4.025
Proportion of variance	0.103

* represents highest absolute loading for this variable among the three factors.

DISCRIMINANT ANALYSIS

As discussed previously, the principal goals of discriminant analysis are to describe the differences between groups in terms of a set of variables and to

Table 4.9. Third Factor.

Variable	Loading
Type 1	-0.947*
Type 3	-0.714*
Type 2	-0.700*
Type 4	-0.607*
Type 6	-0.433
Types 12-17	-0.276
Type 40	-0.214*
Type 38	-0.200
Types 18-20	-0.198
Type 36	-0.189
Type 21	-0.142
Type 27	-0.137
Type 45	-0.108
Type 37	-0.104
Type 29	-0.099
Bifaces	-0.097
Type 9	-0.096
Types 59-61	-0.072
Type 25	-0.071
Type 11	-0.049
Type 50	-0.046
Types 32-33	-0.031
Type 39	-0.019
Type 54	-0.007
Type 10	0.003
Type 5	0.046
Types 46-47	0.050
Type 8	0.076
Type 28	0.080
Type 55	0.081
Type 44	0.109*
Type 42	0.154
Types 30-31	0.162
Types 34-35	0.185
Type 22-24	0.195
Type 62	0.252
Types 48-49	0.317*
Flakes/Blades	0.360
Type 43	0.364
Eigenvalue	3.378
Proportion of variance	0.087

* represents highest absolute loading for this variable among the three factors.

assign or reassign cases to those groups. The analysis is based on the group membership of the cases, which is provided a priori. In the present analysis, the groups are defined as the five assemblage types discussed (Mousterian of

Acheulian Tradition (a and b combined), Denticulate, Typical, Ferrassie and Quina). A different set of variables was used for this analysis because the variables in discriminant analysis should be free of high correlations with each other (Klecka 1980: 9). The variables used were based on those which had high loadings with the first 10 principal components (i.e., those with eigenvalues ≥ 1). Since each principal component is orthogonal to, i.e., not correlated with, each other, high correlations are minimized. In addition, groups of variables which co-varied together were typologically similar and had high mutual correlations (based on the correlation matrix), were lumped into single classes of variables (see Table 4.10). With this method, a broad set of variables was used and the conditions placed on the discriminating variables were upheld.

The discriminant analysis resulted in four canonical discriminant functions (number of groups minus one). Like the principal components analysis, the "loadings" are presented as correlation coefficients between the canonical discriminant function and the variable. In the case of discriminant analysis, however, the variance accounted for is that which maximizes the *variance between groups* and minimizes variance within groups. Thus, the loadings show which tool types are important in describing the differences between the given groups. The "structure" of the first canonical discriminant function is presented

Table 4.10. Artifact Types Used in Discriminant Analysis

Types 1, 3, 4	Levallois artifacts*
Types 9, 10, 12-24	Racloirs
Type 11	Single concave racloirs
Types 32,33	Burins
Types 34,35	Borers
Types 36-37	Backed knives ^b
Type 39	Raclettes
Type 40	Truncations
Types 42, 43	Notches and denticulates
Types 46-47	Thick flakes with abrupt and alternating retouch
Types 48-49	Thin flakes with abrupt and alternating retouch
Type 50	Bifacially retouched flakes
Type 55	Hachoirs
Types 59-61	Chopping tools
Type 62	Miscellaneous
	Bifaces (handaxes)
	Unretouched non-Levallois flakes and blades

*Type 2, atypical Levallois flakes were excluded because they were not significantly correlated (≤ 0.4) with types 3 and 4, Levallois points and retouched Levallois points.

^bNaturally backed knives were excluded since they were not significantly correlated (≤ 0.41) with types 36 and 37.

in Table 4.11.

The first canonical discriminant function is clearly dominated by a single variable, the racloirs. This variable is highly correlated with this function and the canonical discriminant function accounts for a significant proportion of the variance accounted for (70%). It is interesting to note that notches and denticulates as well as flakes and blades share the strongest negative correlations with this function; however, their correlation coefficients are small compared with that of the racloirs. This function is simply interpreted as the influence of the racloirs.

The highest correlation with the second discriminant function (Table 4.12) is the biface variable. Backed knives also have a relatively high correlation with this function, however. Both of these types are clearly diagnostic of MTA type assemblages. The importance of bifaces ($r = 0.76$) is interesting when this factor is compared with the results of the principal components analysis. In that analysis, although this artifact type was correlated positively with the second component, it did not have the same clout as it does in the discriminant analysis. Thus, while

Table 4.11. Structure of First Canonical Discriminant Function.

Variable	Correlation
Types 9-24	0.715*
Type 11	0.238
Type 62	0.205
Type 55	0.055
Types 32-33	0.054
Type 39	0.033
Types 59-61	-0.006
Type 40	-0.011
Types 34-35	-0.026
Type 50	-0.031
Types 48-49	-0.048
Types 1, 3-4	-0.053
Types 46-47	-0.117*
Types 36-37	-0.143
Bifaces	-0.144
Flakes/Blades	-0.158
Types 42-43	-0.216
Eigenvalue	6.092
Proportion of variance	0.701

* represents highest absolute loading for this variable among canonical discriminant functions.

Table 4.12. Structure of Second Canonical Discriminant Function.

Variable	Correlation
Bifaces	0.760*
Types 36-37	0.456*
Types 9-24	0.280
Type 62	0.243*
Type 11	0.185
Types 42-43	0.164
Type 55	0.112
Type 50	0.106
Type 39	0.082
Types 32-33	0.072
Type 40	0.030
Types 34-35	0.018
Types 48-49	-0.019
Types 46-47	-0.044
Types 1, 3-4	-0.048
Types 59-61	-0.062
Flakes/Blades	-0.165*
Eigenvalue	1.405
Proportion of variance	0.162

* represents highest absolute loading for this variable among canonical discriminant functions.

not accounting for a particularly large proportion of the overall variance, this type is an important diagnostic variable. Backed knives account for a greater proportion of the overall variance (as indicated by the principal components analysis), but are not as diagnostically important. However, the backed knife variable does contribute to the between group variance on this function. Flakes and blades have the highest negative correlation with this variable, yet this correlation is not very strong. The interpretation of this canonical discriminant function is the contribution of bifaces and backed knives to the between group variance. This function may also be interpreted as the MTA function.

The third function (Table 4.13) is most highly correlated with two variables, notches and denticulates (Type 42-43), and Levallois artifacts (Type 1, 3-4). The interpretation for this function is notches and denticulates (positive correlation) versus Levallois artifacts (negative correlation). What is important about this factor is that notches and denticulates are less important diagnostically than the total variance which they account for in the principal components analysis. They share the 10% of the variance accounted for by this function

Table 4.13. Structure of Third Canonical Discriminant Function.

Variable	Correlation
Types 42-43	0.473*
Type 50	0.223*
Types 48-49	0.165*
Types 59-61	0.116
Types 32-33	0.114
Types 9-24	0.043
Flakes/Blades	0.008
Type 11	-0.025
Type 55	-0.028
Type 62	-0.038
Types 34-35	-0.062*
Types 46-47	-0.073
Types 36-37	-0.123
Type 39	-0.156
Bifaces	-0.169
Type 40	-0.297*
Types 1, 3-4	-0.467*
Eigenvalue	0.905
Proportion of variance	0.104

* represents highest absolute loading for this variable among canonical discriminant functions.

among themselves.

The fourth function (Table 4.14), accounting for about 4% of the variance, is not very important in discriminating between groups. Raclettes are the most highly correlated with this function. The interpretation for this function should, however, be its relative insignificance. Raclettes, according to Debénath and Dibble, "probably most often reflect post-depositional damage" (1994: 101). They are also a relatively rare artifact type, as are all of the variables which are most highly correlated with this function.

Two methods prevail among several ways to display the role of these functions in terms of the distribution of cases. One is to plot each *case* on coordinates corresponding to the canonical discriminant functions as they are in principal components analysis. The other is to describe the locations of the *groups* in those coordinates. The latter is often done by comparing the group means for each function, as presented in Table 4.15. Another method, using only the first two functions, is called the territorial map. This method plots the group centroids as well as lines which delineate classificatory boundaries (based on the

Table 4.14. Structure of Fourth Canonical Discriminant Function

Variable	Correlation
Type 39	0.597*
Type 40	0.268
Types 1, 3-4	0.262
Types 32-33	0.255*
Type 55	0.198*
Types 36-37	0.152
Types 48-49	0.092
Types 42-43	0.084
Bifaces	0.006
Type 50	-0.015
Types 9-24	-0.025
Types 34-35	-0.053
Types 46-47	-0.110
Flakes/Blades	-0.147
Type 62	-0.158
Types 59-61	-0.187*
Type 11	-0.268*
Eigenvalue	0.294
Proportion of variance	0.038

* represents highest absolute loading for this variable among canonical discriminant functions.

classification schemes discussed below). The territorial map is presented in Figure 4.13.

The position of the group centroids is an example of the mean score for each group, and thus the relative position of each group in terms of the discriminant functions. On the first canonical discriminant function, the racloir function, the group means for Denticulate and MTA assemblages are nearly identical (-2.550 and -2.540, respectively), whereas the remaining assemblage types are evenly distributed. The greatest group mean on this function is the

Table 4.15. Canonical Discriminant Functions Evaluated at Group Means.

Group	Function 1	Function 2	Function 3	Function 4
Quina	3.464	0.539	0.906	-0.431
Denticulate	-2.550	-0.833	0.985	0.114
Ferrassie	2.285	-0.324	-0.555	1.071
MTA	-2.540	2.732	-0.401	0.106
Typical	-0.286	-0.737	-1.213	-0.483

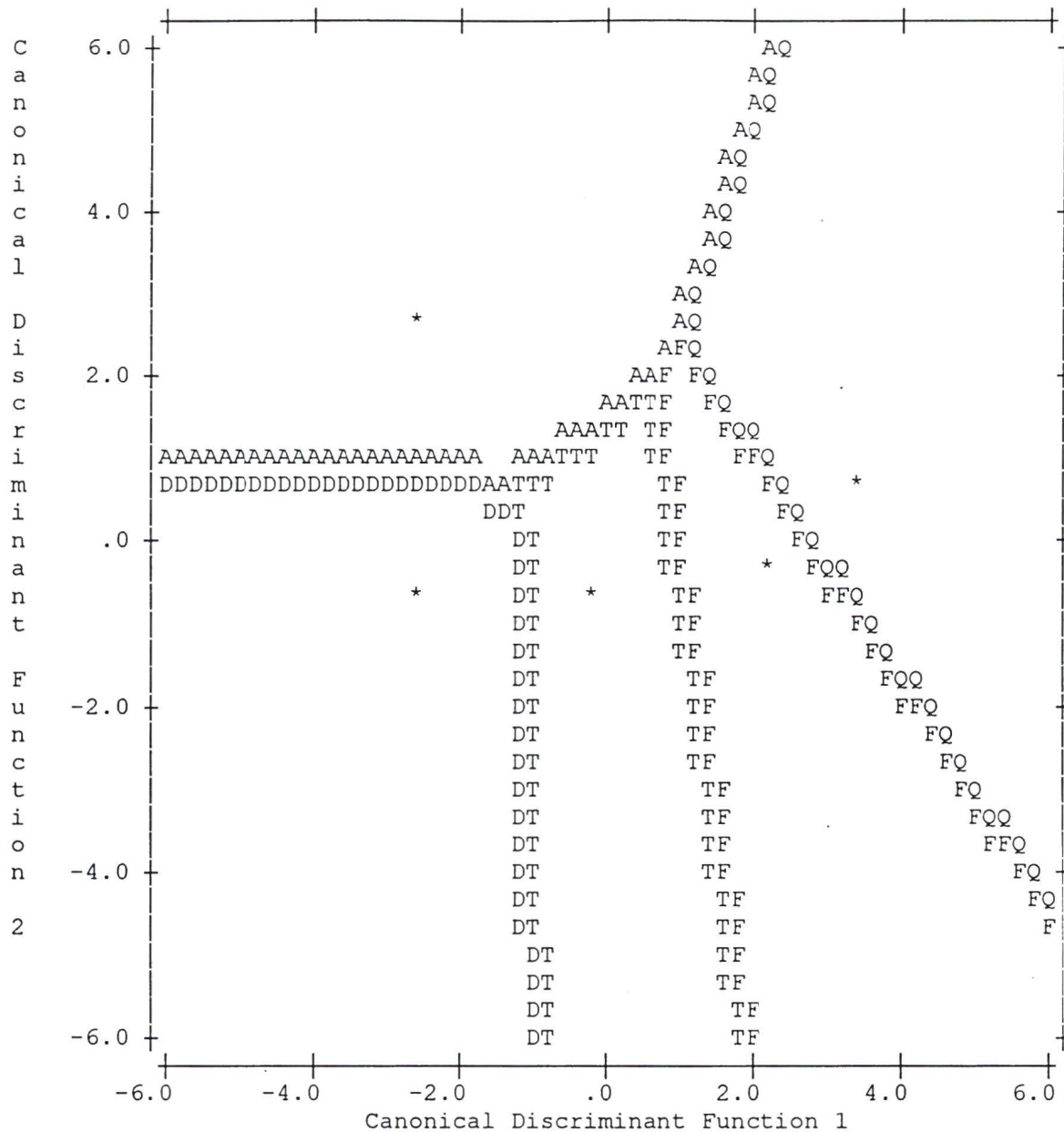


Figure 4.13. Territorial Map of Canonical Discriminant Functions 1 and 2 (* indicates a group centroid; Q = Quina, D = Denticulate Mousterian, F = Ferrassie, A = Mousterian of Acheulian Tradition, T = Typical Mousterian).

Quina group, with its abundant racloirs. The lowest mean score on this function is shared between Denticulate and MTA, with their low proportions of racloirs. The range in group scores from low to high is: 1) Denticulate Mousterian/MTA; 2) Typical Mousterian; 3) Ferrassie Mousterian; and 4) Quina Mousterian.

The second function divides the assemblage types into two groups, MTA and the rest. MTA has a high group mean for this function, whereas the

remaining types are just above and below zero. The high value of MTA is attributable to the presence of bifaces and the relative abundance of backed knives. The slightly higher values of Ferrassie and Quina on this function are probably not attributable to the presence of bifaces or an abundance of backed knives, but rather to their very high proportions of racloirs, which are positively correlated with this variable, thus influencing the scores on this function ($r = 0.280$; see Table 4.12).

The third function has highest mean values for Quina and Denticulate assemblage types, and lowest values for Typical Mousterian. Ferrassie and MTA have values near each other and lie between Typical and Quina/Denticulate. Because two important classes of tools have high correlations for this function, the interpretation is less straightforward. Denticulate obviously has a high mean on this function because notches and denticulates are highly correlated with this function. Quina likely has a high mean on this function because of its relative absence of Levallois technology which is negatively correlated with this function. Ferrassie is far in terms of geometric space from Quina because it has a higher proportion of Levallois technology, which is one of the primary means to distinguish between these types. MTA, often having abundant notches and denticulates, tends to have greater proportions of Levallois technology than Denticulate Mousterian. In addition, bifaces are negatively correlated with this function, although not to a very significant amount. This will still have some affect on the central position of MTA assemblages on this function. Typical Mousterian assemblages have relatively high proportions of Levallois technology (comparable to Ferrassie) and relatively few notches and denticulates in relation to Denticulate Mousterian. This explains its negative group mean on this function.

The fourth function, in addition to not being very significant in terms of amount of variance accounted for, discriminates between groups the least of any of the functions presented. This further attests to its relative insignificance.

The final aspect of discriminant analysis is to assess the position of the cases in reference to the discriminant functions and the group means. One method is to plot the values on the coordinate plane using the discriminant scores. A plot of the first two functions is presented in Figure 4.14. When compared with the territorial plot, this plot shows how the clusters of cases overlap. This is particularly important when one recalls that discriminant analysis maximizes the

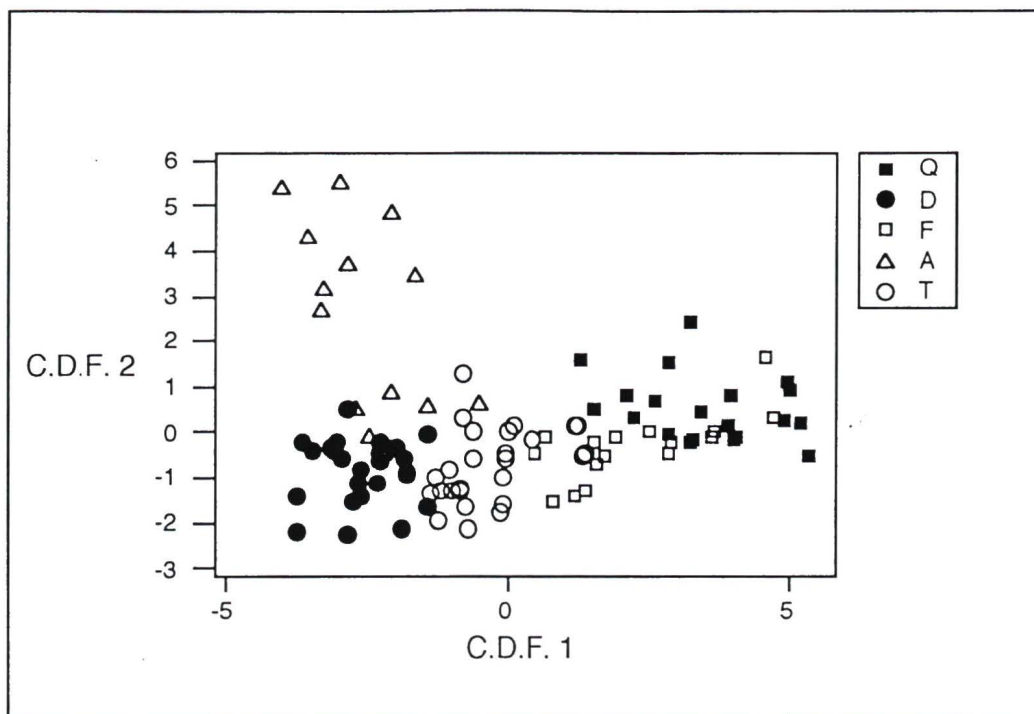


Figure 4.14. Canonical Discriminant Function (C.D.F.) Scores 1 and 2 by Assemblage Type (Q = Quina, D = Denticulate Mousterian, F = Ferrassie, A = Mousterian of Acheulian Tradition, T = Typical Mousterian).

between group variance in these cases. If they are discrete, these groups should be separated on this plot. They are not, because several cases of different types overlap. The x axis primarily shows the distribution of racloirs, and the y axis shows the distribution of handaxes and backed knives. Although cases from each group overlap with those of others, there is a clear patterning to the distribution of the cases. Each group centroid is distinct (as shown on the territorial map) and the cases are distributed across a spectrum. Those MTA assemblages which both have a high proportion of bifaces and backed knives form a cluster of their own on this graph, showing a separation from the group. This cluster does not seem to correspond to the division of MTA into subgroups a and b as the proportion of denticulates and notches and racloirs does not influence this clustering (see Bordes and de Sonneville-Bordes 1970: 63). This subgroup of MTA assemblages may be *discontinuous*.

The second, and perhaps more rigorous method to analyse the cases is to reclassify them using the derived canonical discriminant functions. This is done by comparing the score for each case on each function with the different group centroids. The comparison involves the use of the Mahalanobis distance measure

between the case and the centroid (see Klecka 1980: 44). Using this measure, the probability that the case belongs to each group is measured and the case is reclassified according to the group with the highest probability of membership. This was performed on the present set of cases and resulted in 16 misclassifications of the total 103 cases, or approximately 15% of the cases. This is a significant proportion of misclassifications. The nature of the misclassifications is important, however. All of the misclassifications were of a predictable type: They were all on the territorial boundaries as presented in Figure 4.13. The misclassifications are summarized in Table 4.16. Rather than suggesting the poverty of the classification system as a whole, the fact that all of the misclassifications were of a predictable nature suggests continuity across the assemblage types. It is difficult to interpret cases which lie midway between the group centroids.

Another possibility, suggested by Callow and Webb's analysis of Southeastern French data, is that groups outside of the Perigord region do not fit easily into Bordes' classification scheme. If this were so, the misclassifications should not be from the "classic" region. In fact, several of the misclassifications were from classic sites which Bordes himself excavated, including Combe Grenal and Pech de l'Aze. The misclassified sites came from a variety of regions and sites.

In general, discriminant analysis is useful in presenting which variables best discriminate between the defined assemblage groups. These variables are racloirs, bifaces, backed knives, Levallois flakes, and notches and denticulates. When the canonical discriminant functions are used to assess the distribution of the cases and assemblage types, the analysis suggests that the groups overlap

Table 4.16. Misclassifications of Cases by Assemblage Type.

Type of Misclassification (initial to reclassification)	Number of Cases
MTA to Denticulate	3
MTA to Typical	2
Denticulate to Typical	1
Typical to Denticulate	2
Typical to Ferrassie	1
Ferrassie to Typical	3
Ferrassie to Quina	3
Quina to Ferrassie	1

significantly in terms of the artifact types mentioned. Despite this overlap, however, the assemblage types seem to represent *partitions* of a continuous distribution.

CLUSTER ANALYSIS

A cluster analysis was performed on the data using Robinson's Index of Agreement as a measure of similarity. The data used for this analysis were in the form of untransformed percentages for all of the artifact types present in the sample, including those excluded from the previous analyses for being infrequent. Robinson's Index is calculated by subtracting the lower from the higher percentile score for each artifact type between a pair of assemblages. The total of these differences, subtracted from 200, is the similarity score. These similarity scores range from 0 to 200 (see Robinson 1951: 296-297). These pairs of differences were calculated for each possible pair of assemblages to form a distance matrix using the following Visual Basic for Excel 5.0 program:

```
Function ROBINSON(Column1, Column2)

    Sum = 0
    Rowstart = 6
    Rowend = 53
    For Counter = Rowstart To Rowend
        Value1 = Cells(Counter, Column1).Value
        Value2 = Cells(Counter, Column2).Value
        Sum = Sum + Abs((Value1 * 100) - (Value2 * 100))
    Next Counter
    ROBINSON = 200 - Sum

End Function
```

Once the 10,609 cells of this matrix were calculated, they were converted into standard similarity measures (out of 100) and entered as a matrix into Minitab 10.5x. The distance matrix was clustered using average linkages and a dendrogram was plotted. The results of this clustering are presented in Figure 4.15.

At a similarity level of 50, there were five clusters. One of the clusters was very large, including the bulk of the assemblages. In order to best present the clustering visually, eight clusters were chosen (at 58.3 similarity) and the largest was further subdivided into two. These eight clusters are numbered on Figure 4.15. The composition of these clusters is presented in Table 4.17.

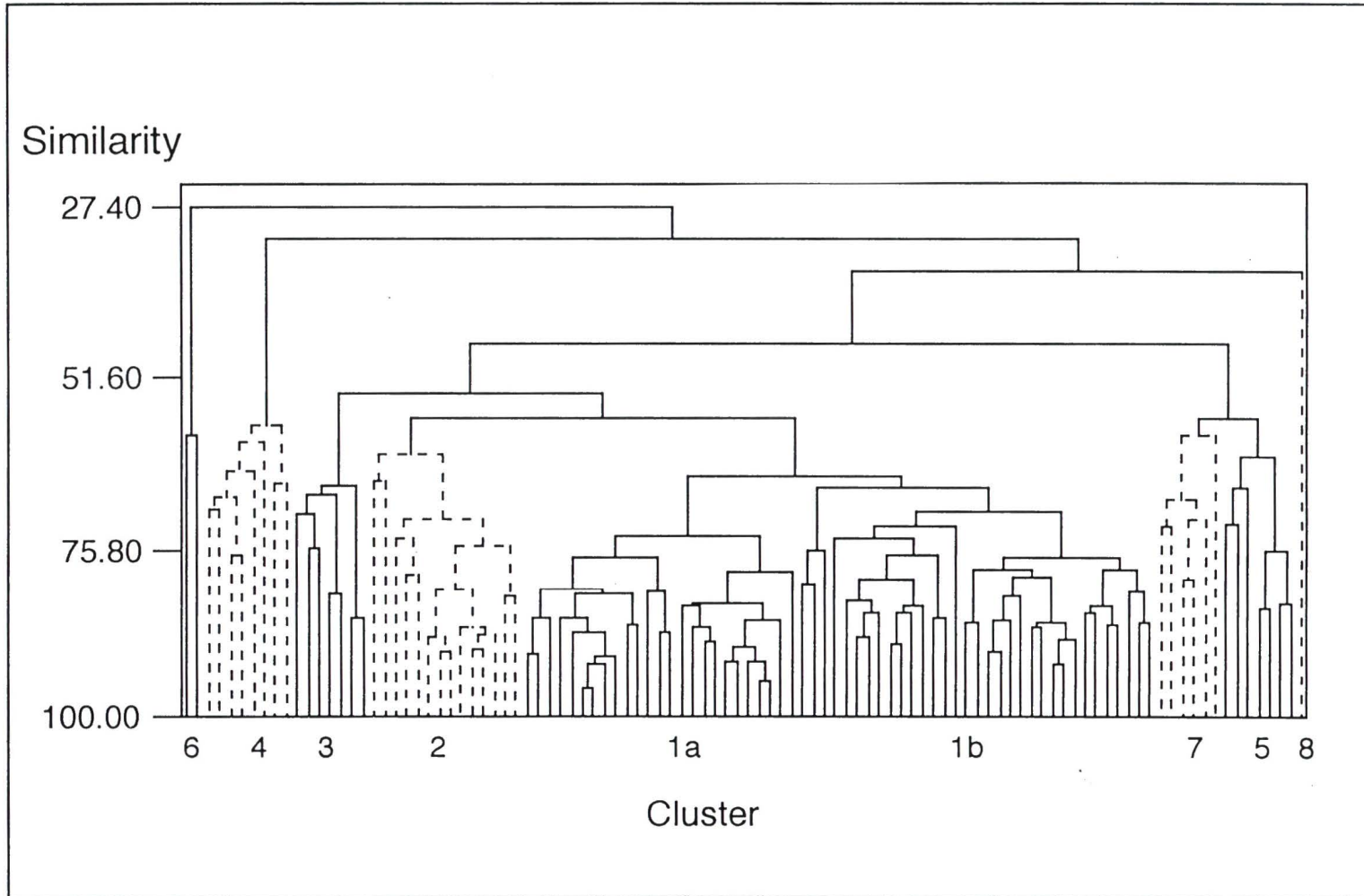


Figure 4.15. Dendrogram Using Robinson's Index of Agreement (see Table 4.17).

Table 4.17. Composition of Clusters by Assemblage Type using Robinson's Index of Agreement.

Cluster	Number of Cases	Number of Cases by Assemblage Type				
		A	D	T	F	Q
1a	25	4	15	5	0	1
1b	33	2	4	14	12	1
2	14	0	0	0	0	14
3	7	4	3	0	0	0
4	8	0	0	0	3	5
5	7	1	5	1	0	0
6	2	1	0	1	0	0
7	6	1	0	3	2	0
8	1	0	0	1	0	0

A = Mousterian of Acheulian Tradition, D = Denticulate Mousterian, T = Typical Mousterian, F = Ferrassie, and Q = Quina.

Using Robinson's Index of Agreement, only two clusters, 2 and 8, contained assemblages of a single type. Cluster 8, a single Typical Mousterian assemblage, may be discounted because it was the only case in the cluster. This leaves the clustering of Quina assemblages. The remaining clusters all contain more than one assemblage type. Cluster 1b, at a relatively low level of similarity, contains members of all of the assemblage types.

Although the results of this analysis suggest that the assemblage groups may be less discrete than previously presented, it suffers from a number of flaws. The most apparent is that it seems to replicate the results of the cluster analysis presented by Dibble and Rolland (1992: 9). This analysis was conducted using random data, subject to the limitations presented by using percentages and the possible ranges of Middle Palaeolithic assemblages. The randomly generated assemblages were then typed using Bordes' system. The results were remarkably similar to the present analysis (see Dibble and Rolland 1992: 9, Figure 1.2). Because no data transformations were used in the present clustering analysis, the results probably reflect the constraints on the data which were identified by Dibble and Rolland, i.e., "that the input variables are the same ones used to define the groups" (1992: 8). Thus both cluster analyses will approximate Bordes' classification to the extent that they simply compare the proportions of artifact types between cases.

To avoid the pitfalls of using raw percentile data and the classificatory issues mentioned above, a second clustering analysis was performed on the data using the principal component scores for each case on the first three principal

components. This was done using a Euclidean distance measure and average linkage. The results are presented in Figure 4.16. At a similarity level of 50, there were only two clusters. As in the previous analysis, eight clusters which better divided the data into similar groups (at 71.6 similarity level) were chosen. The composition of these clusters is given in Table 4.18.

The clusters in this analysis are better defined than those in the previous cluster analysis. No clusters contain all of the assemblage types; however, no cluster is of only one type. The clusters seem to partition the range of variation. Except for cluster 2, no cluster containing Denticulate assemblages also contains Quina assemblages; they are the most different according to the previous multivariate analysis.⁴ In general this analysis is of limited use, except that it generally supports the notion of the continuity of assemblage types. Methodological problems for the second cluster analysis include the equal weight given to the three principal components, which in fact represent quite different proportions of the overall variance. The results were, however, more satisfactory than using untransformed percentage data.

DISCUSSION

The multivariate analyses presented here suggest a number of observations regarding the issue of Middle Palaeolithic variability. Two specific questions were asked: 1) Do the artifact types defined by Bordes represent discrete entities or are they partitions of a continuum of variability? 2) Do the assemblage types defined by Bordes represent discrete entities, or are they partitions of a continuum of variability?

The first question is more difficult to answer with the present data set. Ultimately, reference must be made to the distribution of specific attributes of the artifacts, rather than just their relative frequencies. However, the fact that in the principal components and factor analyses, several artifact types of the same general type, e.g., racloirs, backed knives, Levallois artifacts, etc., co-varied together, indicates that these classes of tools "behave" together in relationship to the remaining variables. This suggests that several of Bordes' artifact types represent somewhat arbitrary partitions of a broader tool class. The similarities between these artifact types seem to overcome their "stylistic" differences. In addition, these groupings seem to be more important than functional similarities with other morphological types. Such a pattern of covariance, based primarily on

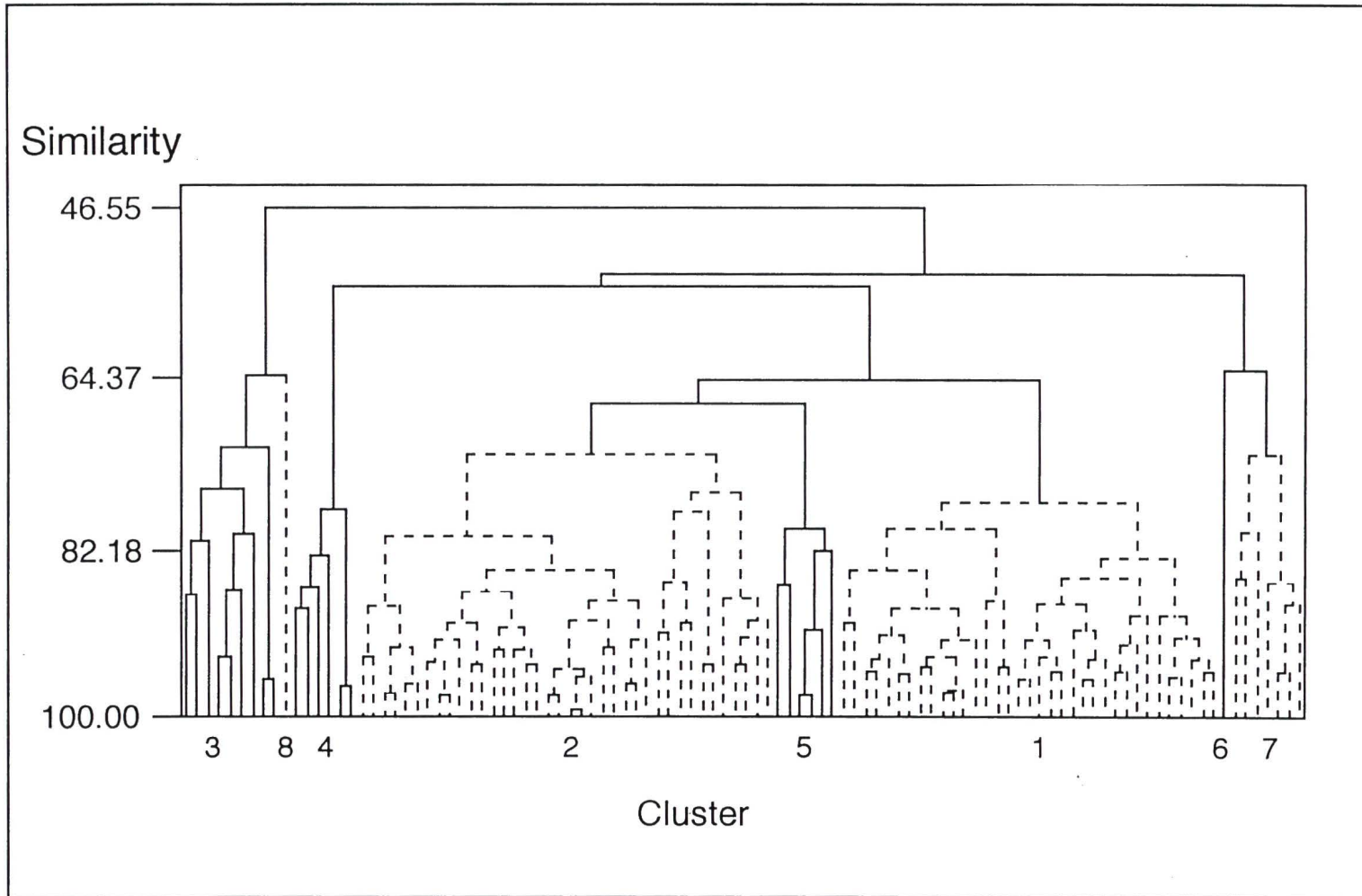


Figure 4.16. Dendrogram Using Principal Component Scores and Euclidean Distance (see Table 4.18).

Table 4.18. Composition of Clusters by Assemblage Type using Principal Component Scores.

Cluster	Number of Cases	Number of Cases by Assemblage Type				
		A	D	T	F	Q
1	35	2	0	10	11	12
2	38	4	21	12	0	1
3	9	0	0	0	3	6
4	6	4	1	1	0	0
5	6	0	5	1	0	0
6	1	0	0	1	0	0
7	7	3	0	1	2	1
8	1	0	0	0	0	1

A = Mousterian of Acheulian Tradition, D = Denticulate Mousterian, T = Typical Mousterian, F = Ferrassie, and Q = Quina.

morphological or technological similarity, implies that several of the artifact types which Bordes proposed partition continuous distributions. These observations must be verified with reference to the attributes of the tools themselves.

With regard to the second issue, the analyses presented above suggest that in general, the assemblage types form a continuous distribution of variability, particularly between Denticulate, Typical, Ferrassie and Quina assemblage types. The group which appears to be the most different from the rest is the MTA assemblage type. This group, although similar in many respects to both Denticulate and Typical Mousterian assemblages, is differentiated primarily by the presence of bifaces and much higher frequencies of backed knives. The differences between the other assemblages are primarily in terms of differences in *proportions* of different types. MTA types, in contrast, are usually different in absolute terms; their tool kit is different.

Another important observation, which has relevance to the issue of the distribution of assemblage types but is not the result of multivariate analysis, is the presence of a *universal tool kit*. Notches and denticulates are the only artifacts of Bordes 63' types which are universally present. The presence of unretouched non-Levallois flakes and blades is also universal. Taken together these types, i.e., notches, denticulates and unretouched non-Levallois flakes and blades, are diagnostic of Denticulate Mousterian assemblages. In addition, of those assemblages chosen for this analysis, Denticulate Mousterian is most abundant. Figure 4.14, in which the cases are plotted by their discriminant scores, shows that Denticulate Mousterian assemblages form a *baseline* assemblage. An

increase in racloir frequencies (first discriminant function) will result in progressively different assemblage types (Typical, Ferrassie and Quina). An enrichment of backed knives and the presence of handaxes will result in MTA type assemblages. This suggests continuity between all of the assemblage types, That continuity, however, is of a specific form. *Enrichment* of the baseline assemblage (Denticulate Mousterian) in two different ways will result in different types of assemblages.

ASSESSMENT OF PREVIOUS MULTIVARIATE ANALYSES

The goal of the present chapter is to present a new analysis of Middle Palaeolithic assemblages. Methodological issues arising from previous multivariate analyses were discussed in the previous chapter. The results of the present analysis will now be compared to the results of those studies.

Hopefully, the present principal components analysis and factor analysis conducted in conjunction with the methodological issues raised will lay to rest the findings of Binford and Binford's factor analysis. Using current statistical methods, there is no evidence whatsoever for the tool kits proposed by Binford, Binford (1966) and Freeman (1964). There do appear to be some functional differences between artifact groups, but only in a very broad sense. The principal component and factor loadings, as well as the correlation matrix, suggest that certain typological groups, such as racloirs, notches and denticulates, backed knives, and Levallois technology, co-vary together. These groups may differ in terms of function; however, it is important to note that several functionally similar groups do not covary together.

Specific comments concerning Doran and Hodson's, and Mellars' analyses cannot be made because a multidimensional scaling analysis was not undertaken. However, some general points concerning clustering may be made. The clusters which Doran and Hodson and Mellars suggest are not apparent in the present data set. This is due in part to the greater number of assemblages used. The presence of more assemblages could have filled in the gap between the clusters defined by them. The present analysis does, however, uphold Mellars' observation that racloirs are the primary cause of the variation in the sample (Mellars 1996: 180).

In many ways the present statistical results are similar to those in Callow and Webb's analysis. The interpretation of those results differs, however. Their

principal components analysis yielded three important components. The first had high loadings on indices in which racloirs were prominent (Quina Index, Racloir Index, Charentian Index and Mousterian Group Tools). Notches and denticulates were also highly negatively correlated with this component. The second component had high loadings on Levallois, faceting and blade indices. The third component had high loadings on the trimmed backed knives index, the biface index and the "Upper Palaeolithic" tool group. Essentially, although the loadings and the component compositions differed, the same tool types were considered important in their analyses and the present analyses (see Callow and Webb 1981: 133). Their principal components analysis failed to yield specific clusters.

Callow and Webb's canonical variates analysis (discriminant analysis) showed a nearly identical pattern of distribution to the present analysis when the cases were plotted in two dimensions (compare Callow and Webb 1981: Figure 2 with Figure 4.14 above). Although they did not provide the structure of the canonical variates, based on the nearly identical distribution of the cases, they must have been similar to the structures I obtained. Their graph, however, does show a slightly greater separation between the assemblage types. Recall, however, that their violation of one of the assumptions of discriminant analysis, may have accentuated some between group variance.⁵ Their conclusions are problematic; there is little support for multimodality among the assemblage types (see Figure 3.1). The similarities between their analysis and mine provide independent support for the present results, even though Callow and Webb's conclusions differ.

CONCLUSIONS

The conclusions of my multivariate statistical analysis support the continuous distribution both of several artifact types across assemblages and the overlapping of the assemblage types proposed by Bordes. This does not, however, imply that these types are distributed randomly. There is clear patterning to the data. Bordes' assemblage types represent specific partitions of a continuous distribution. The assemblage types do overlap and several assemblages are categorically liminal. Some MTA assemblages may be discontinuous with the others on the basis of their proportions of bifaces and backed knives.

A subset of Bordes' artifact types accounts for the greatest proportion of the overall variance in these Western European Middle Palaeolithic assemblages. It includes, in basic order of importance, racloirs, unretouched non-Levallois flakes and blades, backed knives, bifaces, and Levallois artifacts. The importance of these artifact types was supported by three different multivariate analyses, principal components analysis, factor analysis and discriminant analysis. A summary of the results of the multivariate analysis are presented in Table 4.19.

Table 4.19. Summary of Results of Multivariate Analysis.

Relative Importance of Artifact Types for Explaining the Total Variation in Sample

1. Racloirs
2. Unretouched non-Levallois flakes and blades
- 3a. Backed knives
- 3b. Notches and denticulates
4. Levallois manufacture

Relative Importance of Artifact Types for Explaining Between Group Differences

1. Racloirs
2. Bifaces
3. Backed knives
- 4a. Levallois manufacture
- 4b. Notches and denticulates

Distribution of Assemblage Types

Primary axis of variation
Distribution of racloirs = continuous

Low	↑	Denticulate/MTA
	↓	Typical
		Ferrassie
High		Quina

Secondary axis of variation
Distribution of bifaces and backed knives = discontinuous?

Low	↑	Denticulate/Typical/Quina/Ferrassie
	↓	
High		MTA

¹ Middle Palaeolithic industries have been reported as early as 250,000 BP in oxygen-isotope stage 8, which extends the age of the Middle Palaeolithic considerably. The onset of the Early Würm is now dated at 115,000 BP, or oxygen-isotope stage 5d (Dibble and Rolland 1992: 2).

² There are of course many problems associated with the notion of sampling in archaeology. As Shennan states "It is obvious that no archaeological sample can be considered a random sample of what was once present" (1988: 58).

³ On a box plot, the "box" represents the values between the first and third quartile, the centre line represents the location of the median value. The "whiskers" extend from the box to the lowest and highest observations that are inside the region defined by these limits:

$$\text{Lower Limit: } Q_1 - 1.5(Q_3 - Q_1)$$

$$\text{Upper Limit: } Q_3 + 1.5(Q_3 - Q_1)$$

Outliers are those observations which fall outside of this region, marked, in this case, with an "o" (Minitab 1995: 19-20).

⁴ The single Quina assemblage that was in this cluster was the quartz series from Mas-Viel. The different material upon which the tools of this assemblage was made likely led to its association with this cluster. It is not typical of Quina assemblages.

⁵ Specifically, the separation of the Quina group from the rest may be the result of the double weighting given to racloirs, because the racloir index and Mousterian tool groups were both used as variables (see Appendix A).

5 NEANDERTHAL BEHAVIOUR
AND STONE TOOLS

L'Homme de Néanderthal, avec sa connaissance probable du langage, ses industries lithiques et ses rites funéraires, ne peut être considéré comme vivant à l'état de nature: son niveau culturel l'oppose, cependant, à ses successeurs néolithiques avec une rigueur toute comparable - bien que dans un sens différent - à celle que les auteurs du XVII^e ou du XVIII^e siècle prêtaient à leur propre distinction.

- Claude Lévi-Strauss *Les Structures Élémentaires de la Parenté*

This chapter examines the relationships between the statistical findings and the theories employed to explain Middle Palaeolithic assemblage variability. It asks which of the theories in the modern debate concerning lithic variability best explains the nature of the data as presented in the multivariate analysis. The interpretation of Neanderthal behaviour is discussed based on the present findings and the supported modern models.

THE EVALUATION OF THE DOMINANT THEORETICAL POSITIONS

Bordes' Stylistic Variation Model

Bordes' artifact typology was built on the assumption that there were stylistic differences between the various artifact types. According to Bordes, the morphological and technological differences between the defined artifact types are the intentional products of preconceived design norms (1961b: 10). In Bordes' estimation, the different artifact types correspond directly to behavioural patterns among their makers. Therefore, each artifact type represents a discrete behavioural entity. For example, simple racloirs and double racloirs differ in behavioural terms because of the different design norms they embody. The present multivariate analysis, however, does not support the notion that several of Bordes' artifact types are discrete. If simple and double racloirs reflected different styles and were potentially made by different flint-knapping traditions one would not expect them to be strongly correlated. The products of different stylistic traditions would tend not to co-occur in the same assemblages. In the present analysis, however, morphologically similar tool types such as these *are* usually strongly correlated. In addition, several broad morphological and technological tool groups (e.g., racloirs, notches and denticulates, backed knives and Levallois flakes and points) identified in the multivariate analysis behave as units in relation to the remaining variables. These groups of types not only have strong correlations with each other but are related to other artifact types in a

consistent manner. For example, simple racloirs are correlated with double racloirs in a strong, positive relationship, and both are strongly and negatively correlated with unretouched non-Levallois flakes and blades. This suggests that they are strongly related phenomena. The possibility that stylistic (isochrestic) differences occur in broader geographical distributions was not tested in the present study, which was restricted to Western European assemblages.

Instead of each tool type representing a separate design norm, as Bordes implied, many of the tool types appear to be variants of a broader class of tools. This does not imply that the different tool classes are not different in a morphological sense, but rather that they do not differ significantly in a behavioural sense. Since the various tool types within a given class behave similarly in a statistical sense, they are probably interchangeable in a behavioural sense. Racloirs are the best example of this: simple racloirs are, generally speaking, not distributed differently from double racloirs; thus the two are likely to be interchangeable, because they are morphologically similar classes of tools which occur in similar proportions in similar circumstances. Other differences suggested by Bordes appear to be artificial, such as the difference between typical and atypical tool types. As mentioned above, this designation is often a subjective one, and is not borne out in the present analysis.

Having criticized the somewhat arbitrary division of tool types *within* broader morphological tool classes, it appears that several of Bordes' general artifact *classes* are defined in a meaningful sense. Almost all of the racloir types designated as such by Bordes behave as a group, as do the Levallois artifacts and the backed knives. These classes of tools behave as single units because they *co-vary together*.

A final criticism of Bordes artifact typology is that it excludes important artifact types. Unretouched non-Levallois flakes and blades are an important class of artifact but are excluded from Bordes' essential and real counts. There is clear evidence that unretouched flakes were utilized as cutting tools (Dibble and Rolland 1992: 13). These artifacts figured prominently in the principal component and factor analyses.

Bordes' assemblage typology consists of two theoretically distinct propositions. The first is the actual definition of these types in terms of the different proportions and/or presence of the different artifact types. The second argument is that these assemblage types are discrete. The general definitions of

Bordes' assemblage types are borne out by the present analysis; that they are discrete is not. A comparison of the distribution of the different principal component, factor, and discriminant functions scores of the different assemblage types with Bordes' definitions shows that they are suitably defined (Bordes and de Sonneville-Bordes 1970: 62-63). According to Bordes, both Quina and Ferrassie have a "very high percentage of side scrapers," Typical Mousterian has a "variable" percentage of them and Denticulate Mousterian has a "low to very low percentage" of them (Bordes and de Sonneville-Bordes 1970: 62-63). This distribution is presented graphically by the distribution of the first principal component and the first discriminant function (Figures 4.4, 4.10, and 4.14). The tool classes which distinguish MTA assemblages from the rest, bifaces and backed knives, were recognized as such by Bordes (see Figure 4.14; Bordes and de Sonneville-Bordes 1970: 63). The primary difference between Ferrassie and Quina, i.e., the relative proportions of Levallois flaking, is also borne out by the present analysis (discriminant function 3, principal component 3; Table 4.16, Figure 4.12).

As mentioned above, however, the differences are usually in relative proportions and the types partition a spectrum of variation, particularly the distribution of racloirs, which is the most important variable for explaining the total variation in the sample. Although the central measures of the groups may differ on any principal component, the distributions of the principal component scores are unimodal (see Figures 4.7-4.9). This argues against Bordes' contention that the assemblage types are significantly different on the basis of a multimodal distribution of racloirs. The racloirs are distributed unimodally.¹ Bordes' chronological interpretation will be addressed when Mellars' position is evaluated.

The empirical basis for Bordes' behavioural interpretations have been undermined by the present analysis. There is no evidence in favour of stylistic differences between tool types, and the assemblage groups do not appear to be discrete categories. Thus the argument that different tribes or even different species of toolmakers were responsible for the different artifact and assemblage types is not supported. In addition, the argument that Neanderthal populations were relatively sophisticated because they had "style" cannot be supported. This, of course, does not necessarily mean that they were not sophisticated, but rather that Bordes' argument is based on a faulty premise, and thus is unsound.

Binford and Binford's Functional Hypothesis

As pointed out in Chapter Three, there is no support for the existence of the functional tool kits which Binford and Binford (1966) proposed for the Middle Palaeolithic. The factors and principal components derived in the present analysis are entirely different from those presented by Binford and Binford and by Freeman. In addition, the different "factors" derived in the present analysis only differ in terms of function in a very general sense. Functionally similar yet morphologically different tools are not significantly positively correlated (e.g., racloirs and backed knives, racloirs and unretouched flakes) and functionally different tools are significantly positively correlated (e.g., notches and backed knives). The factors reflect morphological differences between the tools or differences in their manufacture. Functional differences are secondary.

One interpretation presented by Binford and Binford that is upheld by the present analysis is that the assemblage types are essentially distributed continuously. This continuity is not, however, due to the differential distribution of functional tool kits, but rather to the differential distribution of broad morphological and technological tool classes.

Because there is no support for the existence of functional tool kits, the argument for the simplicity of Neanderthals which Lewis Binford (1973, 1985) bases on the functional argument, cannot be supported.

Mellars' Chronological Observations

Mellars' chronological argument is in some ways more difficult to assess than the previous analyses because no temporal data were used in the present analysis. However, if chronologically transitional assemblages are also *categorically* transitional in a manner predicted by Mellars, this study should provide support for his arguments. The assemblages from Combe Grenal form a basis for such a comparison because they are one of the cornerstones of Mellars' argument. Many of the Middle Palaeolithic assemblages from Combe Grenal were incorporated in the present analysis (see Appendix C).

Mellars argues that there are significant chronological relationships between three of Bordes' assemblage types: Ferrassie, Quina and MTA. The relationship between Ferrassie and Quina shows an important chronological component. The Ferrassie assemblages at Combe Grenal occur before the Quina ones, and over time, the Ferrassie assemblages become increasingly like Quina

ones through the enrichment of “Quina type” artifacts and a reduction in Levallois technology (Mellars 1969: 154). Mellars is in fact arguing for chronological continuity across these assemblage types. In the discriminant analysis presented in Chapter Three, there were a number of misclassified assemblages at Combe Grenal. One of these, layer 27, was originally classified as a Ferrassie assemblage but was reclassified as a Quina assemblage. Although only one layer was involved, this misclassification seems to support Mellars’ argument that there was a transition from Ferrassie to Quina at Combe Grenal. The late Ferrassie assemblage was sufficiently like a Quina assemblage to be reclassified as such.

After the end of the Quina sequence, the Denticulate Mousterian recurs at Combe Grenal. This chronological transition is also marked by a number of misclassifications. What is interesting about this chronological pattern is that Quina and Denticulate Mousterian assemblages are opposite extremes in the spectrum of variation. Quina assemblages are marked by high racloir counts and relatively few unretouched flakes and blades, whereas Denticulate Mousterian assemblages are marked by relatively few racloirs and an abundance of unretouched flakes and blades as well as a plethora of notches and denticulates. The misclassifications which occur on this chronological boundary are very interesting. The last Quina assemblage in this sequence (layer 17) was reclassified as a Ferrassie assemblage and the first Denticulate assemblage following the Quina ones was reclassified as a Typical Mousterian assemblage. This covers the entire range of variation in terms of assemblage types as predicted by the proportions of racloirs (on both the principal components and the discriminant functions). These misclassifications suggest a more gradual transition than previously suspected. There appears to be a shift in the proportion of racloirs consistent with a continuous range of variation.

The nature of the MTA type is important to the chronological argument because both Bordes and Mellars recognized that it evolved into the Chattelperronian type of the Upper Palaeolithic sequence. These types occur consistently late in the sequence, although they occur earlier in the north than they do in the classic region of southwestern France. The fact that MTA assemblages appear to be the most distinctive of all of the types, that they differ in terms of a different tool kit (bifaces and extremely abundant backed knives), and they consistently showed the greatest range on the principal component scores,

support this assemblage type's status as an "evolved" Mousterian form. The nature of MTA assemblages will be discussed in more detail below.

In addition to his position on the chronological distribution of Middle Palaeolithic assemblages, Mellars also argues that the different assemblage types are distinct. In fact, he uses Callow and Webb's analyses to support this position (1996: 181-183). The discreteness of these assemblage types is not supported by the present analysis.

It appears that certain key components of Mellars' proposed chronology are supported by the present multivariate analysis. The evolved nature of the MTA assemblages has important behavioural implications (discussed below).

Rolland and Dibble's New Synthesis

The empirical basis which underlies Rolland and Dibble's theory concerning lithic variability in the Middle Palaeolithic depends on the continuous distribution of the assemblage types and the continuity between artifact types, particularly racloirs. The present multivariate analysis provides strong support for this and a number of other specific features of these authors' theory. The distribution of several artifact types as well as the distribution of the assemblage types suggests continuous spectra of variability rather than the existence of discrete categories.

As stated above, the present multivariate analysis does not provide a *definitive* answer as to whether or not the various artifact types represent partitions of a continuum. This must ultimately be addressed with a detailed analysis of the distribution of attributes across the various artifact types. The present analysis does, however, suggest that groups of morphologically or technologically similar artifact types co-vary together. This suggests that these groups are strongly related in behavioural terms. The differences between them thus do not appear to be the product of "cultural differences," since either stylistic or functional differences would result in differential distributions of the subtypes of these broader tool classes.

Two important findings in the multivariate analysis support specific observations made by Rolland and Dibble. The first is that, generally speaking, implements and unretouched flakes and blades are inversely related. The more implements there are, the fewer flakes, and vice-versa. This is reflected in the first two principal components, where the implement types are inversely related

to the unretouched non-Levallois flakes (see Tables 4.2 and 4.3). The second specific relationship identified by the multivariate analysis is that racloirs vary inversely with the unretouched flakes and blades. This relationship accounts for the most significant proportion of the overall variance in the sample. Both of these points are described and discussed by Rolland and Dibble (Rolland 1977: 251; Rolland and Dibble 1990: 485).

The inverse correlation between the racloirs and the unretouched flakes and blades supports the reduction model. The inverse relationship is best explained by the transformation of those flakes (which were often utilized) into racloirs. The specific causes and the nature of this "differential reduction," however, need to be determined with reference to the distribution of attributes (see Dibble 1987). The relative importance of the racloirs in explaining both the total variance and in discriminating between assemblage types supports the attention they have been given by researchers such as Dibble.

The second major empirical issue which underlies Rolland and Dibble's model is the discreteness of the assemblage types. The present analysis, particularly the discriminant analysis, upholds their contention that "there is little evidence to support the existence of discrete assemblage groups in the Middle Palaeolithic" (Rolland and Dibble 1990: 483). Particularly important in this regard is the distribution of the racloirs, which Bordes' suggested was multimodal. No evidence for multimodality on any of the multivariate *scores* was found among the assemblage types, with the possible exception of some MTA assemblages (discussed below). Based on the distribution of the various principal component scores, the assemblages appear to be part of a single, though heterogenous entity. The differences between four of the assemblage types is best explained by the distribution of racloirs (and implements). These differences are compatible with the reduction model. Denticulate assemblages have fewer retouched tools. As more retouched tools (e.g., racloirs) are added the number of flakes decreases and the assemblages appear more like Typical Mousterian assemblages. When more retouched items are present the assemblages appear more like Ferrassie and Quina assemblages. This spectrum of variation is clearly presented in Table 4.14.

A criticism of the reduction model in terms of assemblage distribution is the role of the MTA.² The real differences between this type and the rest need to be made explicit. Related to this, it should be stressed that the Denticulate Mousterian assemblage type appears to be a *baseline* type. The enrichment of

this assemblage type with racloirs results in progressively different assemblage types (Denticulate to Typical to Ferrassie to Quina). This distribution is compatible with Rolland and Dibble's contention that (1990: 480):

. . . raw material constraints and different degrees of artifact-reduction intensity constitute more basic and observable factors of variability than function and style.

The enrichment of this assemblage type with backed knives and the presence of bifaces results in MTA type assemblages. It should also be noted that the low proportions of Levallois flaking in Quina assemblages (on the third principal component) are also consistent with the economizing of raw materials and the reduction model.

Although Rolland and Dibble are correct to give priority to racloirs, notches and denticulates and unretouched flakes and blades in their discussion of lithic variability (1990: 486, Figure 1), the present study identifies other tool types which are important in accounting for differences in assemblages, including backed knives and Levallois manufacture. The present analysis provides a useful, quantified expression of the importance of racloirs and these other tool types.

Discussion

The multivariate analysis presented in Chapter Four supports the continuous distribution of the bulk of the assemblages in the sample. In addition, preliminary support for the continuous distribution of several of Bordes' artifact types is made. These findings are most parsimoniously explained by the Rolland and Dibble synthesis. Their empirical observations are essentially compatible with the patterns of variation made apparent by the multivariate analysis. In addition, support is made for chronological transitions between assemblage types at the site of Combe Grenal. The differences between MTA assemblages and the others uphold the notion that this type is an evolved form. It is different in absolute terms from the remaining assemblages (see below). Key features of Mellars' chronological argument are supported by the present analysis.

The multivariate analysis presented here failed to demonstrate patterns of distribution consistent with Bordes' stylistic argument and Binford and Binford's functional argument. However, certain aspects of these theorists' positions are supported. Though not discrete, Bordes did outline important patterns in the

distribution of assemblage types. There do appear to be differences between the assemblages; however, these differences appear to be continuous and support a spectrum of variation, rather than the existence of discrete categories. Although the results of the principal components analysis and the factor analysis were entirely inconsistent with both Binford and Binford's and Freeman's "factor" analyses, the notion that the Mousterian or Western European Middle Palaeolithic is a single though heterogenous entity rather than a collection of distinct groups is supported by the present analysis. In addition, underlying factors appear to be responsible for a continuous distribution of the defined assemblage types. These factors are based more on morphology and technology than functional variation, although some basic functional differences exist between important types. The existence of discrete functional tool kits, however, is not supported.

On the basis of the distribution of artifacts and assemblages, the Rolland and Dibble model best explains the nature of Middle Palaeolithic variability. Several key features in the data, in addition to the empirical basis which the present analysis supports, support the basic findings of Rolland and Dibble. Factors such as toolmaking and rejuvenation, differential occupation intensity and group mobility induced by environmental changes are likely candidates to explain the distributions presented (as argued by Rolland and Dibble 1990). The chronological differences posited by Mellars also appear to be supported. As Rolland and Dibble note, these chronological patterns are consistent with environmental shifts (at least for Denticulate, Typical, Ferrassie and Quina assemblage distributions; see Rolland and Dibble 1990: 488-490).

BEHAVIOURAL INTERPRETATIONS

Having provided support for the models proposed by Rolland and Dibble and the chronological relationships proposed by Mellars, a statement concerning Neanderthal behaviour in the Middle Palaeolithic must be made. It has been noted that Rolland and Dibble's behavioural interpretations differ somewhat, despite their shared empirical and basic behavioural ideas. Mellars also has a somewhat different position concerning behaviour.

I believe that Neanderthal behavioural *capacities* were essentially identical to those of *Homo sapiens sapiens* during the period in which they coexisted. This view differs from those which contend that Neanderthals had

different cognitive capacities than humans. A fundamentally different hypothesis underlies my position. The *null hypothesis*, to use statistical parlance, should be that Neanderthal cognitive capacities were not significantly different than contemporaneous *Homo sapiens sapiens*. The assertion that Neanderthals had fundamentally different cognitive capacities than contemporaneous humans is my *alternative hypothesis*. Before support can be given to the alternative hypothesis, sufficient data must exist to reject the null hypothesis. Evidence supporting the null hypothesis comes primarily from adaptive and evolutionary cultural processes which are apparent in the data. Crucial to this position is the evolved status of MTA assemblages and other signs of the cumulative growth of cultural systems. Neanderthal behaviour does appear to be different from any known living human group. However, anatomically modern humans of the Middle Palaeolithic show patterns of behaviour which are similar to that of Neanderthals during the Middle Palaeolithic and are *also* different from those of any known living human population. Although outside the present area of analysis, this is most apparent in regions like the Levant, where both modern humans and Neanderthals shared essentially indistinguishable technologies.

Status of the MTA Variant

I believe that the Neanderthals constituted an adaptive population, which showed evidence of increased social and technological specialization as time passed. A discussion of the status of the MTA variant is necessary here to support this argument. Much of this discussion will centre on what makes this type different from the rest. The obvious difference is the presence of bifaces. Although the Mousterian of Acheulian tradition gets its name from the Lower Palaeolithic Acheulian tradition, the bifaces of the MTA are qualitatively different from those found in the Lower Palaeolithic (see Mellars 1996: 124-130).³ These distinctive forms of bifaces are missing from all of the other Mousterian variants (Bordes 1961a: 804-805; Mellars 1996: 130). Furthermore, the shift to backed knives and the gradually increasing proportions of "Upper Palaeolithic" tools in the MTA suggests, as Mellars states, "a fundamental and wide-ranging change in the whole character of lithic technology" (1992: 39). As Bordes himself noted, "it is in fact very difficult to distinguish between a very late Mousterian of Acheulian tradition and an early Périgordian I [Châtelperronian]" (1961a: 804). The changes in the MTA suggest a refinement of technology, marking the beginning of a

transition to the Upper Palaeolithic. It should be recalled that the Châtelperronian industry has been associated directly with Neanderthal biological remains.

Bifaces are an interesting form of tool. Robert Kelly suggests three different “organizational roles” for this type of tool: 1) they may be used as cores as well as tools; 2) they may be used as durable “long use-life tools” as they are easy to retouch repeatedly; and 3) they may be formed as the result of shaping processes which were not intentional (such as for hafting) (1988: 719). Kelly suggests that “the use of a biface in each of these roles is related to a combination of raw material distribution and a group’s mobility strategy” (1988: 731). Since bifaces are both a readily available source of flakes which can be used as cutting tools as well as a durable form of tool, they have a high “edge-to-weight ratio” (Kelly 1988: 718). This makes them an excellent candidate for curated tools. They are an efficient, multi-purpose form of technology, not unlike a primitive Swiss Army knife. Although they may not be perfectly suited for any particular task, they are a good choice of tool to take on longer journeys because they perform a variety of roles. As Kelly states (1988: 720):

In general, the longer the logistical foray the greater the likelihood that a variety of tasks requiring stone tools will have to be performed, particularly if the group must remain overnight.

In addition to their portability and their usefulness on longer excursions, they are also more common when suitable raw material is not available. This is compatible with the curation concept. If one is not sure if raw material is available or it is a long distance away, a portable core/tool would come in handy. When raw material was abundant, handaxes would not be as necessary. In addition, a more durable edge is more suitable when resources are scarce.

There are two classes of supporting evidence for this theory. The first is that there appears to be greater mobility in the late Middle Palaeolithic, when bifaces are found. Roebroeks, Kolen and Rensink argue that the lithic procurement networks in the Late Middle Palaeolithic show an expanding range of territory covered (1988: 30):

the most important changes in the size of the lithic raw material procurement networks occur in the Late Middle Palaeolithic, and that the differences between the Late Middle and the Early Upper Palaeolithic are not very obvious *in this respect*.

Their data was based exclusively on European materials, i.e., Neanderthals in the

Middle Palaeolithic. This attests to the great mobility of these late “Mousterians.” Distances of stone materials from their original source are as high as 300 km among Neanderthals in the Late Middle Palaeolithic (Roebroeks et al. 1988: 26-27, Table 1). Roebroeks et al. show a continuous increase in such distances through the Middle Palaeolithic (1988: 28; Figures 2-5). The people who left behind the MTA assemblages were a mobile population. This is also supported by the large proportion of MTA assemblages found in open air sites (Mellars 1996: 260).

The second class of supporting evidence is more circumstantial. There *may* have been somewhat less access to raw materials during this time period. To a certain extent, greater mobility may imply a less predictable source of raw materials, although this may not be a sufficient cause itself (Kelly 1988: 719-721). At the end of the Middle Palaeolithic sequence there appears to be a cooling trend (Mellars 1969: 140). Although the MTA assemblages were made in “somewhat milder climatic conditions than those which prevailed during the occupation of the Quina horizons,” the climate may have induced limited patterns of raw material economizing (Mellars 1969: 145). Climatic differences are also suggested by the distribution of faunal types in the MTA layers at Combe Grenal. These layers showed an increase in reindeer remains, a cold climate fauna, compared to the preceding layers of Denticulate and Typical Mousterian assemblages, but not to the extent of their presence in Ferrassie and Quina assemblages (Mellars 1969: 138, Figure 2).

Both of these lines of evidence support behavioural interpretations for the use of bifaces. There appears to be a qualitatively different adaptive response than that of an increase in racloir manufacture. It is interesting that the baseline assemblage type (Denticulate Mousterian), for whatever reason, is enriched in a different manner than it is in Ferrassie and Quina assemblages. In terms of the discriminant scores of the previous chapter, this different pattern is apparent in Figure 4.14. There appear to be different adaptive responses resulting in qualitatively different assemblage types. It has been argued that Quina and Ferrassie assemblages were produced by less mobile populations (Rolland and Dibble 1990: 488). This may be the underlying cause of the different adaptive responses. The combination of intermediary or changing climatic patterns and increased group mobility may underly the change to an MTA tool kit.

The nature of this change and the transition from Middle to Upper Palaeolithic assemblages (via MTA assemblages) must be explored further. It

does appear, however, that this change in MTA assemblages is the result of an *evolution*, an *adaptive* change in *tool kit* corresponding with the temporal dimension. Coupled with the increased use of bifaces, there are other shifts in tool kit, including a much more abundant use of backed knives and an enrichment of “Upper Palaeolithic” tools, especially in MTA type b. It is also interesting to note that on most of the principal component scores (Figures 4.10 - 4.12), MTA assemblages show relatively large ranges of variation. This is consistent with a trend toward diversification.

Both the evolved (evolving) form of Western European Middle Palaeolithic and the Châtelperronian industry associated with the Neanderthal give us a better picture of the cognitive *potential* of Neanderthals than do earlier assemblage types extending back through the Middle into the Lower Palaeolithic. It has been argued that the most obvious reason for assuming that anatomically modern humans were cognitively advanced is because modern humans are. The classic Neanderthals, for whatever reason, never had the opportunity to develop their full cognitive potential since they disappeared sometime before 30,000 years ago. However, they did show levels of sophistication very similar to *contemporaneous Homo sapiens sapiens*. I would argue, as Mellars does (1996: 366), that until there is substantial proof otherwise (which there does not yet appear to be), we should assume that Neanderthals were equivalent in cognitive capacity to humans. In light of the historical examination made in Chapters One and Two, this is a more tenable hypothesis than the contrary.

Neanderthal Behaviour

Assuming that Neanderthals had similar cognitive *capacities* to those of humans, this does not predict the *nature* of their behaviour. During the Middle Palaeolithic, Neanderthal behaviour was both qualitatively and quantitatively different than in the subsequent Upper Palaeolithic. The ultimate question is how those differences can be explained. Can they be explained with reference to innate abilities or social-historical processes? There are convincing arguments for the latter. Because the present examination primarily discusses stone tool technology and the distribution of artifact types, this is the best place to start. The present analysis supports the positions of Rolland and Dibble concerning lithic variability and the chronological patterning of Mellars. One of the ultimate implications of the Rolland and Dibble model is that stone tools themselves tell us

less about behaviour than was hoped for when the previous models were used. Because “non-cultural causes” may account for a significant proportion of the variation among assemblages (particularly Denticulate, Typical, Ferrassie and Quina assemblages), this variation cannot be directly related to cultural patterns. Previous models such as Bordes’ and Binford and Binford’s suggested a direct correlation between the categories employed and actual behaviours. These correlations were imputed, respectively, by employing stylistic and functional hypotheses. Such direct relationships are not supported by the present multivariate analysis. Because different “styles” of a single morphological type do not differ significantly in their distribution, there do not appear to be different “tribes” or traditions in the Western European Middle Palaeolithic, and functional differences do not appear to be a prominent cause of variation in the sample. Processes such as differential reduction intensity of the artifacts (particularly racloirs) and settlement intensity are more probable candidates for explaining the bulk of the variability.

Rolland points out that “different implement manufacture and primary flaking are due entirely to adaptive responses to external conditions” (1981: 25). The increased racloir manufacture, and the more intensive use of materials before their ultimate discard is an *adaptive response*. Specifically, this response is *economizing*. It could be argued that this is not the result of forethought, and that the archaeological remains reflect a pattern of the toolmakers picking up already used tools and resharpening them. This does not explain important differences, however, particularly between Ferrassie and Quina assemblages. There appears to be a decrease in Levallois manufacture over this boundary at sites like Combe Grenal, a transition which corresponds to a deteriorating climate (Mellars 1969: 153, Figure 4). Quina assemblages are much more abundant in cold and dry climates than Ferrassie assemblages (Rolland and Dibble 1990: 489, Figure 2). Levallois manufacture is more material intensive and results in thinner flakes than other techniques. According to Rolland and Dibble (1990: 491):

... the change in preference from the Levallois flaking of the Ferrassie type towards the preform selection and trimming techniques of Quina-type assemblages may be related to a need for greater efficiency in the production of suitable blanks in anticipation of lithic material parsimony.

It is this *anticipation* which suggests an adaptive response, rather than a passive reflection of local circumstance. As noted above, the switch to MTA type

assemblages with their greater mobility also suggests a different adaptive response, although the causes are arguably more complex and poorly understood.

The shift from Bordes' and Binford's interpretive models to Rolland and Dibble's involves a subtle difference in approach. Bordes suggested that the proportions and types of tools themselves are predictive of cultural differences. Differences in cognitive templates were seen as reflecting the existence of different cultures. The emphasis is on ideational differences rather than social ones. Binford, on the other hand, upheld discrete functional interpretations for the tools and discrete functional tool kits. Although his model implied social differences, the artifacts themselves were constructed for specific functions. As in Bordes' model, this implies that the artifact types were intentionally manufactured endproducts based on a cognitively defined function. Both of these models are predicated on an association between the category and a particular, discrete, cultural pattern. Rolland and Dibble's model, on the other hand, implies that the various artifact and assemblage types are by-products of *social* behaviour, i.e., shared adaptive responses to varying circumstances. The categories employed are not direct remains of specific behaviours. In fact, the forms and distributions of artifacts are the result of multiple causes (Rolland and Dibble 1990). The distributions are the result of causes such as raw material availability, occupation intensity, and choice of flaking technique. These in turn are affected by different local circumstances such as climatic differences, resource distributions and geographical location (Rolland and Dibble 1990). The assemblages produced are by-products of social adaptations to varying circumstances rather than encapsulated behaviours. The differences between assemblages result from the modification of a single, basic behavioural repertoire adapting to these circumstances (with the possible exception of the MTA variant which incorporates qualitative differences).

The above makes behavioural interpretations from stone tools more difficult and the interpretative models employed more "thick." However, because they must incorporate other classes of data, they are likely to be both more appropriate and broader in scope. The Rolland and Dibble model is not predicated on the distribution of artifacts or artifact traits themselves, but correlations between these distributions and other variables such as climate, geography, chronology, settlement patterns, etc. Bordes' and Binford's interpretive models, on the other hand, discuss other factors to a certain extent,

but are based primarily on the categorical differences themselves. As discussed in Chapters One and Two, there are clear historical precedents for their positions.

A different behavioural model has been suggested for understanding Mousterian lithic technology. Steven Kuhn's book, *Mousterian Lithic Technology: An ecological perspective* explains the differences in lithic manufacturing technology employed at a small number of Pontinian Mousterian sites on the Italian coast (1995). This work is primarily a regional study, although he applies his conclusions from these sites to the general issue of Middle Palaeolithic variability.⁴ This model differs from the Rolland and Dibble model, and Kuhn rejects certain elements of the lithic reduction model.

For the Pontinian assemblages, Kuhn states that "much of the inter-assemblage variation in retouch frequency and stone tool reduction is not attributable to the availability of pebbles, but instead reflects the effects of foraging and site use patterns" (1995: 158). In his second chapter, Kuhn sets forth two economic strategies which would result in different archaeological remains. The first, the *provisioning of mobile individuals*, "places a premium on portability, on maximizing the utility of artifacts per unit weight" (Kuhn 1995: 36). Kuhn asserts that this is best accomplished by transporting retouched tools, and thus the corresponding archaeological record will be heavily reworked. In contrast, the *provisioning of places* "relaxes the constraints associated with continuous transport" (Kuhn 1995: 37). In the latter strategy stones are brought to the occupation site and accumulated, thus producing a surplus of raw materials for stone tool manufacture.

On an empirical level, Kuhn supports his model by correlating faunal materials with lithic strategies. Although the Pontinian Mousterian assemblages are *typologically* uniform, he elaborates the differences between assemblages in terms of technology used and the degree of reduction (or "lithic raw material economy") (Kuhn 1995: 47, Chapters 4 and 5). The Pontinian assemblages have traditionally been categorized as a variant of the Quina/Charentian type with tools made from small pebbles (Kuhn 1995:47). Kuhn presents two patterns of lithic resource use, each associated with a different faunal procurement strategy. The tool kit associated with scavenged fauna (i.e., predominantly cranial elements) appears to contain a greater degree of retouching, greater scraper reduction, a higher proportion of oversized artifacts and a higher proportion of centripetal

cores (Kuhn 1995: 143, 145 - 7, Figures 5.6 - 5.10). The tool kit associated with “ambush hunted” fauna (i.e., “nearly complete anatomical representation”) is associated with lower proportions of the above mentioned criteria. Based on these associations, Kuhn concludes that “the production and treatment of stone tools in the Pontinian Mousterian co-varied closely with the procurement of ungulate resources” (1995: 149).

The provisioning of people (a highly reworked lithic strategy) is associated with scavenging (Kuhn 199: 150):

Scavenging as a tactic of animal procurement is entirely consistent with a highly mobile lifestyle and short-term, even ephemeral, occupations. By their very nature, scavengable carcasses are dispersed resources.

The provisioning of places (a less worked lithic strategy) is associated with ambush hunting (Kuhn 1995: 151):

Ambush hunting, the main tactic of game acquisition behind the second group of Mousterian faunas, fits well with a heightened emphasis on provisioning of more prolonged and substantial occupations with tools or raw materials.

In his last chapter, Kuhn discusses the implications of his model for the Pontinian “in its Mousterian context” (1995: Chapter 6). Although he states that “there is no reason to expect patterns and correlations observed among the sites in coastal Latium to hold true across the vast range of the Middle Palaeolithic,” he briefly touches on a number of cases pertaining to the Mousterian as a whole (1995: 157). He discusses Levallois flaking and the Quina Mousterian. Kuhn states that Levallois flakes are “most likely to be made of ‘exotic’ raw materials,” and “are especially suitable as supports for transported artifacts” (1995: 157). “Flat, thin radial Levallois flakes provide a lot of edge per unit weight, making them eminently suitable for mobile toolkits” (Kuhn 1995: 159). Kuhn argues that (1995: 158):

when taken as a unit the Quina Mousterian of southwest France represents a major exception to this general pattern. Quina assemblages appear to be the most heavily reduced and extensively exploited of all Middle Palaeolithic occurrences in western Europe....

He then discusses Rolland’s observations that the Quina type is associated with cold climate conditions and that they were less mobile. He recognizes that

Rolland's model contradicts his own and states that "one possible answer is that we may be dealing with a peculiar and distinctive combination of tactics in the Quina Mousterian" (Kuhn 1995: 159). His ultimate suggestion is that (1995: 159):

The heavy retouch typical of these materials may therefore not be a function of *either* long-term maintenance *or* recycling of artifacts, but rather of the particular functional context in which they were applied.

Although Kuhn's position appears to be well argued, there are a number of criticisms of its relevance to the broader issue of Neanderthal behaviour in the Middle Palaeolithic. The first is the nature of the sample. As Francis Harrold states, "one's attention keeps returning to the terribly small sample of four caves" (1996: 522). In addition to being a small sample, it is regionally and typologically restricted. Although the differences between the assemblages he examines are real, they are slight when compared to other Mousterian assemblage types and regional variants. Another major problem with the sample is the state of the archaeological collections themselves. The excavations were conducted in the 1940s and 1950s and suffer from poor excavation and recording procedures (see Kuhn 1995: 78-80). "As was common practice at the time, the locations of bones and artifacts were recorded only by trench and geological (or arbitrary) level. Point proveniencing was not practiced, even for the most 'important' finds" (Kuhn 1995: 79). Regarding the faunal materials, "unidentified bones had often been discarded" (Harrold 1996: 520). Depending on who identified the bones and the criteria for identifiability used, serious biases in the sample could have been introduced. Certain skeletal elements are more identifiable than others (e.g., cranial elements). This could have a bearing on the validity of the faunal analysis.

When Kuhn extends his argument beyond the coast of Italy, he faces difficulties. He presents Levallois technology as suitable for transported artifacts. Although Levallois flakes arguably have a good cutting edge-to-weight ratio, they do not appear to be durable tools. Thin Levallois flakes are likely to break or be quickly consumed. Bifaces, as durable tool/cores seem to be a more plausible candidate for a mobile tool kit (Kelly 1988: 718). If we accept the MTA variant as a mobile population, this is an additional problem for Kuhn's model. The MTA assemblage type is both less heavily reduced than Quina, Ferrassie and Typical Mousterian industries (as presented in Figure 4.10), and is lower in Levallois technology than Typical and Ferrassie assemblage types (as presented in Figure

4.12).

Kuhn's characterization of Quina industries as anomalous is also problematic. The heavily reduced Quina industry is found almost exclusively in enclosed sites and often in colder climates. These cold climates were, however, rich in terms of animal biomass (steppic, dry environments), predominantly large herbivores. Reindeer is the most common fauna preserved in Quina assemblages (Rolland 1996: 137). The locations of the Quina sites are also important. The enclosed Quina occupation sites "were positioned strategically for monitoring reindeer herds movements and concentrations on the valleys and scheduling exploitation strategies" (Rolland 1996: 138). Evidence for occupation duration and intensity comes from the analysis of reindeer remains (e.g., seasonality studies), fauna to lithic ratios, and artifact deposit densities, not just the degree of artifact reduction (Rolland 1996: 139). These all suggest intensive residence and restricted mobility, and potentially an "ambush hunting" economic strategy (Rolland 1996: 140). Although Kuhn is willing to dispense with a necessary correlation between hunting and lack of mobility (1995: 160), the Quina case calls into question his more fundamental model of the provisioning of places. As set out in Kuhn's second chapter, where his general model is set forth, "unmodified flakes and debris and minimally modified retouched pieces should be relatively common" in "assemblages representing more prolonged occupational events or regular, predictable reuse of places" (Kuhn 1995: 37). This does not appear to be the case in southwestern France and calls into question the general applicability of Kuhn's model. The present statistical analysis does not support Kuhn's contention that Quina assemblages are anomalous or functionally different. Although Kuhn presents an interesting regional study, his model does not provide a significant explanation for the *overall* nature of Middle Palaeolithic behaviour in Western Europe.

Future Models

Paul Graves, among others, said that "material culture is fundamentally social" in nature (1994: 165). This must be taken into account when making behavioural interpretations. Social production and use of artifacts, not what they represent in and of themselves as *forms*, will elucidate social behaviour and culture. Tool use and production is a dynamic process and lithic material is a relatively plastic medium. Tools are created, modified, resharpened, discarded or

curated depending on the social and/or natural *environment* in which they are employed. The manner in which tools have been created, modified, etc. will thus provide insights into the interaction between the user of the tool and his/her social and natural environment. Emphasis must be placed on the socially mediated interaction rather than on the tool itself. Tools are an important aspect of this system of interaction but they are not behaviours themselves.

The Neanderthals produced an adaptive tool kit which served them well for a relatively long period of time. This does not imply that their behaviour was static; it adapted to varying circumstances in different time periods. These adaptations resulted in the non-random but continuously distributed patterns of variation presented in the multivariate analysis. The Middle Palaeolithic showed important changes from the preceding Lower Palaeolithic and various forms of Upper Palaeolithic technology ultimately evolved. As Rolland states (1990: 374):

The Middle Palaeolithic presents, therefore, a majority of traits reminiscent of, or persisting from, the Lower Palaeolithic but with several new elements, some of them appearing only with the Early Würm Some manifestations continue well into the Upper Palaeolithic . . . and give this Middle Palaeolithic a transitional character.

Such a pattern of continuity suggests that developmental cultural processes were in operation throughout the Palaeolithic and greatly increased through the terminal Middle Palaeolithic into the Upper Palaeolithic. This pattern represents a cumulative expansion of socio-cultural networks and processes rather than a major shift in human behavioural *capacity*. The developing processes show significant elements of continuity with preceding eras. The Neanderthals of Eurasia showed many elements which later flourished in the Upper Palaeolithic among *Homo sapiens sapiens*.

In light of the present analysis, the first and most obvious of these elements is a successful subsistence strategy based in part on a flexible tool kit which successfully adapted to a wide range of climatic types over time (ranging from wet temperate climates to extremely cold and dry continental climates). Neanderthal settlement and group mobility patterns, evidenced by stone tool distributions and other classes of data, also showed adaptive changes and regional variation (Rolland 1990: 358-359). Non-lithic data also suggests that Neanderthals constructed artificial structures, buried their dead, used wooden spears, made some bone tools, utilized fire extensively, and engaged in various methods of

hunting (Mellars 1996: 227, 375-381; Rolland 1990: 354-359; Vincent 1988: 188-189, 194-5). Although symbolism likely did not play an important role in their adaptive strategies, there is significant evidence for the intentional use of pigments and limited evidence for aesthetic appreciations, including manufactured non-utilitarian items (Mellars 1996: 369-375).

Future models of Neanderthal behaviour must examine the social nature of the archaeological record. They must be based on *inductively* sound hypotheses, tested properly. The nature of Neanderthal behaviour should not dwell on issues of cognitive capacity, but the expression of social action. This must include a discussion of non-lithic data such as climate, faunas exploited, geographic distribution of sites, spatial distributions of artifacts and features in the sites, as well as taphonomic and geological processes. Hypothesis formation should result from examining relationships in the data rather than being generated abstractly or from ethnographic observations alone. These relationships in the data should form the basis of reconstructing social relationships.

¹ See Dibble and Rolland 1992:6-7. They are skewed towards lower proportions.

² In Rolland and Dibble's 1990 article, discussion of the MTA variant is limited and not included in important figures such as Figure 2 (1990: 489).

³ "The distinctively broad, squat forms of these tools can be differentiated quite easily from the more elongated Acheulian or Micoquian handaxes on the basis of simple length-over-breadth measurements" (Mellars 1996: 127).

⁴ Because this study was essentially regional in scope, (despite its title, see McPherron 1997: 166), Kuhn's model was not discussed in Chapter Two.

CONCLUSION

Many behavioural interpretations concerning Neanderthals remain inconclusive. However, it is clear that Neanderthal behaviour showed developments and adaptations through time and ultimately developed into an Upper Palaeolithic manifestation. There is strong evidence for the presence of cultural-historical processes, which are similar in extent but different in detail from contemporaneous *Homo sapiens sapiens*. Many specific features of Neanderthal behaviour remain in dispute, including the nature of lithic variability.

In order to come to a better understanding of Neanderthal behaviour, I have: 1) examined the development of the major theories concerning the nature of lithic variability and the history of behavioural interpretations associated with those theories; 2) discussed and critiqued previous multivariate statistical analyses related to Middle Palaeolithic variability; 3) conducted my own multivariate analysis of Western European Middle Palaeolithic (Neanderthal) assemblages; and 4) re-evaluated the dominant theories concerning lithic variability and discussed the implications of my research for behavioural interpretations of Neanderthals.

HISTORICAL EXAMINATION

The modern debate concerning lithic variability in the Middle Palaeolithic of Western Europe (outlined in Chapter Two) shows important continuities with the previous era of research (Chapter One). This early period of research (1859 to the 1940s) established both a terminological framework and a methodological and conceptual framework for the interpretation of Neanderthal behaviour and Middle Palaeolithic assemblage and artifact variability. Evolutionary models (whether unilinear or branching) and racial rhetoric set many of the questions and provided many of the answers concerning the interpretation of the archaeological record in this period. In addition, the use of palaeontological models established a form of categorical imperative which lasted into the modern era. The discreteness of these artifact based categories were often interpreted in terms of competing ethnic traditions, species and/or races, particularly in the first half of the present century. The theories of Bordes and Binford show the greatest continuities with this previous era of research. Both authors associated discrete archaeological categories with discrete behaviours, although in fundamentally different ways. In addition, these authors' behavioural models were influenced by models in the previous era.

Four dominant models were presented in the second chapter to explain the

nature of Middle Palaeolithic variability: 1) Bordes' stylistic and ethnic model; 2) Lewis and Sally Binford's functional model; 3) Mellars' chronological model; and 4) Rolland and Dibble's model of continuous variation and artifact reduction.

PREVIOUS STATISTICAL RESEARCH

Most of the previous statistical analyses relating to the nature of lithic variability in the Middle Palaeolithic have been problematic. Early studies have been plagued by either small sample sizes or methodological problems. More recent studies, which use Bordes' indices, are open to criticism because of the theoretically derived nature of these variables and strong linear relationships between the variables used. The best of the previous statistical studies, that of Callow and Webb, shows important relationships in the data; their conclusions concerning Middle Palaeolithic variability, however, can be criticized for not necessarily following their statistical findings.

STATISTICAL FINDINGS

The most important results from the multivariate statistical analysis presented in Chapter Four are those concerning the relationships between the different artifact types, between the different assemblage types, and between artifact and assemblage types (see Table 4.19).

Many morphologically similar artifact types seem to co-vary together across the assemblages studied. The best example of this is the racloir tool group. Based on their positive covariation, most of the racloir types appear to be different aspects of the same phenomenon (see Table 4.2). They are typologically similar and behave together as a group in a statistical sense. The same can be said for such groups of artifacts as those made with Levallois technology (types 1-4), notches and denticulates (types 42-43), and backed knives (types 36-37) (see Tables 4.3 - 4.4). Certain artifact types co-vary inversely with each other, suggesting important relationships in the data. Examples of this include the inverse relationship between racloirs and unretouched non-Levallois flakes and blades (see Table 4.2). The more racloirs there are, the fewer unretouched flakes and blades, and vice versa.

The other primary observation derived from statistical analysis concerns the relationships between the defined assemblage types. The primary difference between the assemblage types, in terms of the distribution of artifact types, is the distribution of racloirs (see Figures 4.4, 4.10 and 4.14). This distribution is continuous rather than multimodal, as suggested previously (see Figure 4.7). Other important artifact types

(unretouched non-Levallois flakes and blades, backed knives, notches and denticulates, and Levallois tools) contribute to the overall variation in the assemblages. The only artifact types which appear to have a discontinuous distribution are the backed knife types and the bifaces (see Figure 4.14). The bifaces are the most discontinuous in their distribution, because they only occur in one assemblage type. The backed knife types are only very abundant in the same type, Mousterian of Acheulian tradition. On the first three principal components, accounting for nearly 50% of the overall variance, there appears to be only one cluster of assemblages as no significant gaps occur between assemblage types. Statistical tests whose goals were to differentiate groups failed to fully separate the assemblages into their a priori assigned groups.

Despite the significant overlap of the assemblage categories in multivariate space, there was clear patterning in the data. Many of the defined assemblage types can be distinguished by their relative proportions of racloirs. In addition, MTA assemblages can be differentiated from the rest by the presence of backed knives and bifaces (Principal Component 2 and Canonical Discriminant Function 1), and Quina and Ferrassie assemblages can be distinguished by their relative proportions of Levallois tools (Principal Component 3).

EVALUATION OF THE DOMINANT THEORIES AND BEHAVIOURAL INTERPRETATIONS

The present examination points to both continuous variability and chronological patterning in the distribution of stone tools in Western European Middle Palaeolithic assemblages. This provides empirical support for Rolland and Dibble's theory of Middle Palaeolithic variability and the chronology outlined by Mellars. Specifically, the variability in Middle Palaeolithic assemblages is continuous and stone tool reduction intensity and raw material economizing appear to be more likely candidates to explain that variability than style or function. The differences between these assemblages result from adaptive responses to varying environmental circumstances. In addition, the chronological relationships between Quina and Ferrassie Mousterian and the evolved status of the MTA variant are supported by the present analysis.

Theories explaining Middle Palaeolithic variability should be related to behavioural interpretations by examining the social role of material culture in Neanderthal contexts. Stone tools, although the best preserved and most scrutinized aspect of the Middle Palaeolithic archaeological record, are only part of a broader picture. The present examination of the dominant theories and the data concerning lithic variability in the Western European Middle Palaeolithic or Mousterian period

settles outstanding issues and points toward new interpretations of Neanderthal behaviour. New approaches require a critical understanding of the history of the discipline, a critical assessment of the current theories in that discipline, and a critical examination of the data using properly conducted qualitative and quantitative analysis.

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A LA MÉTHODE BORDÈS

BORDES' TOOL TYPES:

Levallois Tools

1. Typical Levallois flakes/Éclats Levallois typique
2. Atypical Levallois flakes/Éclats Levallois atypique
3. Levallois points/Pointes Levallois
4. Retouched Levallois points/Pointes Levallois retouchées

Mousterian Points and Limaces

5. Pseudo-Levallois points/Pointes Pseudo-Levallois
6. Mousterian points/Pointes Moustériennes
7. Elongated Mousterian points/Pointes Moustériennes allongées
8. Limaces/Limaces

Scrapers

9. Single scrapers, straight/Racloirs simples droits
10. Single scrapers, convex/Racloirs simples convexes
11. Single scrapers, concave/Racloirs simples concaves
12. Double scrapers, straight/Racloirs doubles droits
13. Double scrapers, straight-convex/Racloirs doubles droits-convexes
14. Double scrapers, straight-concave/Racloirs doubles droits-concaves
15. Double scrapers, convex-convex/Racloirs doubles biconvexes
16. Double scrapers, concave-concave/Racloirs doubles biconcaves
17. Double scrapers, convex-concave/Racloirs convexes-concaves
18. Convergent scrapers, straight/Racloirs convergents droits
19. Convergent scrapers, convex/Racloirs convergents convexes
20. Convergent scrapers, concave/Racloirs convergents concaves
21. Skewed scrapers/Racloirs déjétés
22. Transverse scrapers, straight/Racloirs transversaux droits
23. Transverse scrapers, convex/Racloirs transversaux convexes
24. Transverse scrapers, concave/Racloirs transversaux concaves
25. Scrapers on interior surface/Racloirs sur face plane
26. Abrupt scrapers/Racloirs à retouche abrupte
27. Scrapers with thinned back/Racloirs à dos aminci
28. Scrapers with bifacial retouch/Racloirs à retouche biface
29. Alternate scrapers/Racloirs alternes

Upper Palaeolithic Tool Types

30. Typical endscrapers/Grattoirs typiques
31. Atypical endscrapers/Grattoirs atypiques
32. Typical burins/Burins typiques
33. Atypical burins/Burins atypiques
34. Typical borers/Perçoirs typiques
35. Atypical borers/Perçoirs atypiques
36. Typical backed knives/Couteaux à dos typiques
37. Atypical backed knives/Couteaux à dos atypiques
38. Naturally backed knives/Couteaux à dos Naturel
40. Truncations/Éclats et Lames Tronqués

Notches and Denticulates

- 42. Notches/Encoches
- 43. Denticulates/Denticulés
- 51. Tayac points/Pointes de Tayac
- 52. Notched triangles/Triangles à encoche
- 54. End-notched flakes/Encoches en bout d'éclat

Raclettes, Tranchets, Alternate retouched becs, Pseudo-microburins, Hachoirs and Rabots

- 39. Raclettes/Raclettes
- 41. Mousterian tranchets/Tranchets Moustériens
- 44. Alternate retouched becs/Becs burinants alternes
- 53. Pseudo-microburins/Pseudo-microburins
- 55. Hachoirs/Hachoirs
- 56. Push-planes/Rabots

Stemmed Points and Tools

- 57. Stemmed points/Pointes Pédonculées
- 58. Stemmed tools/Outils Pédonculées

Bifacial foliates

- 63. Bifacial foliates/Pièces foliacées bifaces

Miscellaneous Pieces

- 62. Miscellaneous/Divers

Utilized Flakes, Prepared Flakes and Pseudo-tools

- 45. Flakes with irregular retouch on interior/Éclats à retouche sur face plane
- 46-47. Thick flakes with abrupt and alternating retouch/Éclats à retouche abrupte ou alterne épaisse
- 48-49. Thin flakes with abrupt and alternating retouch/Éclats à retouche abrupte ou alterne mince
- 50. Bifacially retouched flakes/Éclats à retouche biface

Choppers, Chopping Tools, Inverse Choppers

- 59. Choppers/Choppers
- 60. Inverse choppers/Choppers inverses
- 61. Chopping-tools/Chopping-tools

* All tool types are presented in English and French and are divided according to the chapters in Bordes 1961b; English names following Debénath and Dibble (1994). Bordes distinguished between *real* and *essential* counts when describing assemblages. The real count is all tools (types 1-63), whereas the essential count includes only those tool types with deliberate retouch (thus excluding types 1-3 and types 45-50).

BORDES' INDICES:

Technological indices:

- IL. Levallois index: The proportion of Levallois flakes, blades and points (retouched or not) relative to the total non-biface assemblage.
- IF. Faceting index: The proportion of faceted or dihedral platforms relative to the total recognized platforms.
- IFs. Strict Faceting index: The proportion of faceted platforms relative to the total recognized platforms.
- ILam. Blade index: The proportion of blades (flakes whose length ≥ 2 x width) relative to total complete flakes, blades and points.
- IQ. Quina Index: The proportion of racloirs exhibiting Quina retouch (prominent stepped retouch).

Typological indices:

- IB. Biface index: The proportion of bifaces relative to the total tool count (types 1-63) plus bifaces.
- IR. Scraper index: The proportion of racloirs (types 9-29) relative to the total tool count.
- ILty. Typological Levallois index: This type may be calculated using either Bordes real or essential counts. For the real count the index is the proportion of types 1-4 relative to the total tool count, whereas for the essential count the index is the proportion of type 4 relative to the total essential tool count.
- IAu. Unifacial Acheulian Index: The proportion of backed knives (types 36 and 37 only) relative to the total tool count.
- IC. Charentian Index: The proportion of single convex scrapers (type 10) and transverse scrapers (types 22 - 24) relative to the total tool count.

Diagnostic groups:

- I. Levallois Group: The proportion of Levallois tools (types 1-4) relative to the total tool count. Identical to ILty (real).
- II. Mousterian Group: The proportion of racloirs and "points" (types 5 - 29) relative to the total tool count.
- III. Upper Palaeolithic Group: The proportion of "Upper Palaeolithic" tools (types 30 - 37 and 40) relative to the total tool count.
- IV. Denticulate Group: The proportion of Denticulates (type 43) relative to the total tool count.

BORDES' ASSEMBLAGE TYPES:

Charentian group:

Quina type (Q)

Ferrassie type (F)

Mousterian of Acheulian Tradition:

Sub-type A (MTA a)

Sub-type B (MTA b)

Typical Mousterian (MT)

Denticulate Mousterian (MD)

Summary of Assemblage Type differences:

Assemblage Type	Scrapers	Notches and Denticulates	Bifaces/ Bkd. Knives	Levallois
Quina	Very High	Low	Absent	Very Low
Ferrassie	Very High	Low	Absent	High
Typical	Variable	Medium	Absent	Variable
MTA a	Variable	High	Variable	Variable
MTA b	Low	High	Low/high	Variable
Denticulate	Low	High	Absent	Variable

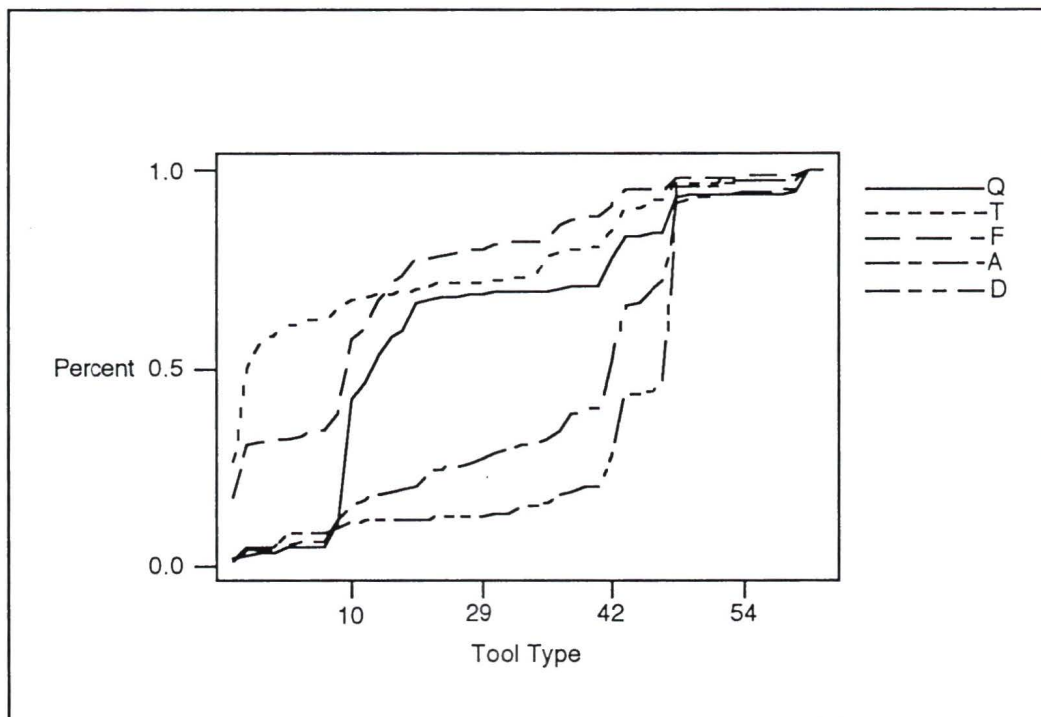


Figure A.1. Cumulative graph comparing assemblage types (based on assemblages from present sample; Q = Quina, T = Typical Mousterian, F = Ferrassie, A = MTA, D = Denticulate Mousterian).

B ARTIFACT ILLUSTRATIONS

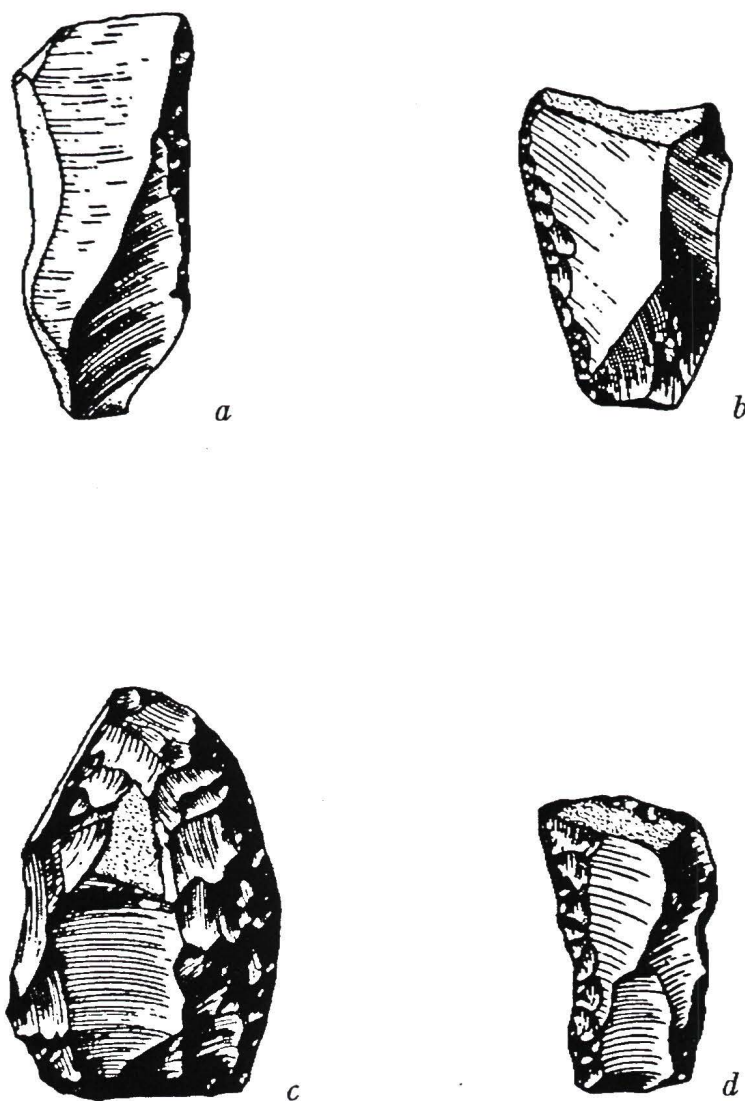


Figure B.1. Single Racloirs: a,b) Single, straight racloirs (Type 9); c) Single, convex racloir (Type 10); d) Single, concave racloir (Type 11). After Bordes 1961b.



Figure B.2. Other Racloirs: a) Convergent, straight racloir (Type 18); b) Convergent, convex racloir (Type 19); c) Skewed (déjeté) racloir (Type 21); d) Transverse, straight racloir (Type 22). After Bordes 1961b.

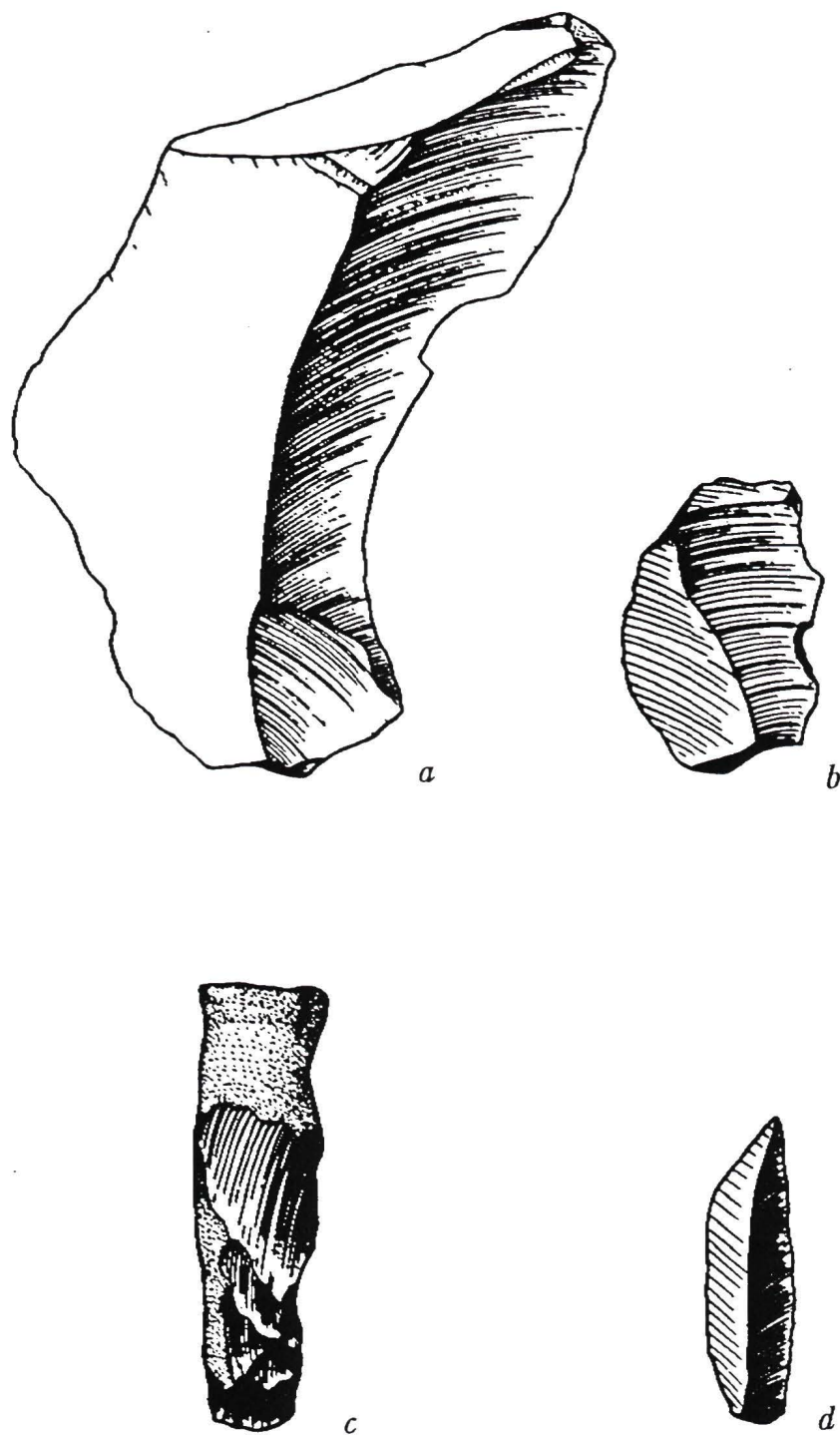


Figure B.3. Unretouched Non-Levallois Flakes and Blades: a,b) flakes; c,d) blades. After Bordes 1961b.

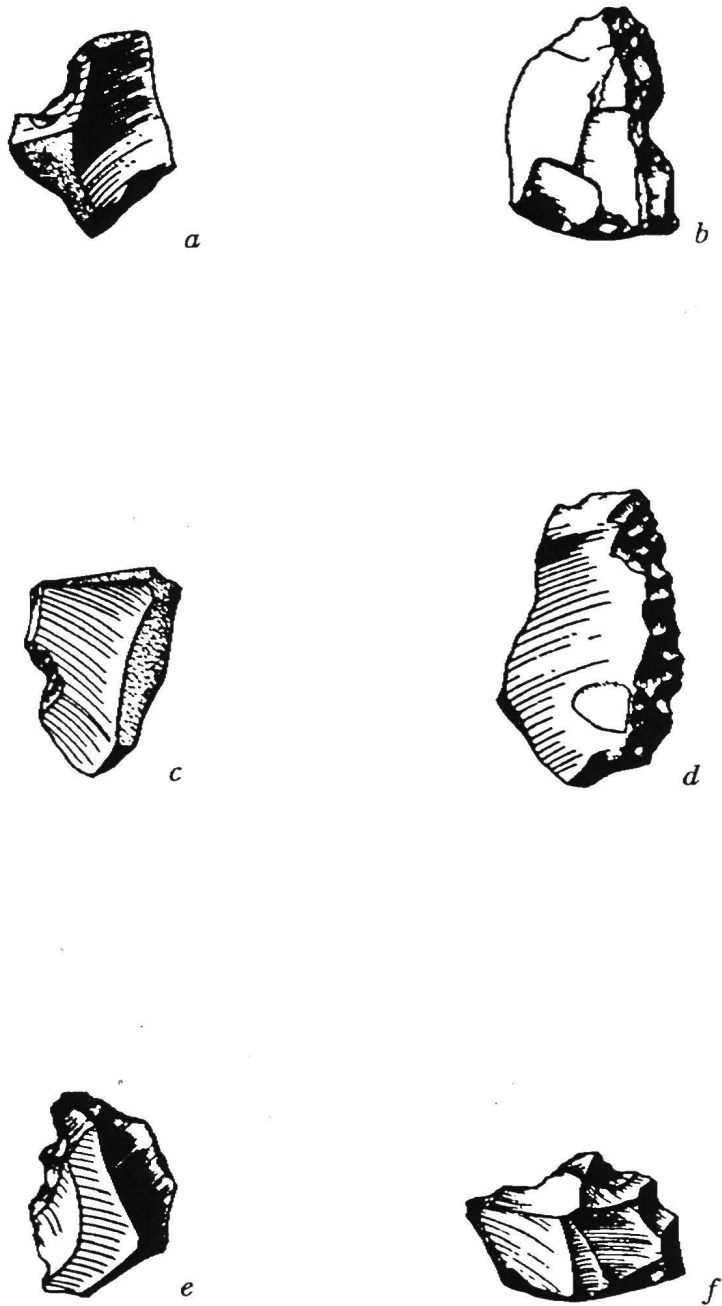


Figure B.4. Notches and Denticulates: a-c) Notches (Type 42); d-f) Denticulates (Type 43). After Bordes 1961b.

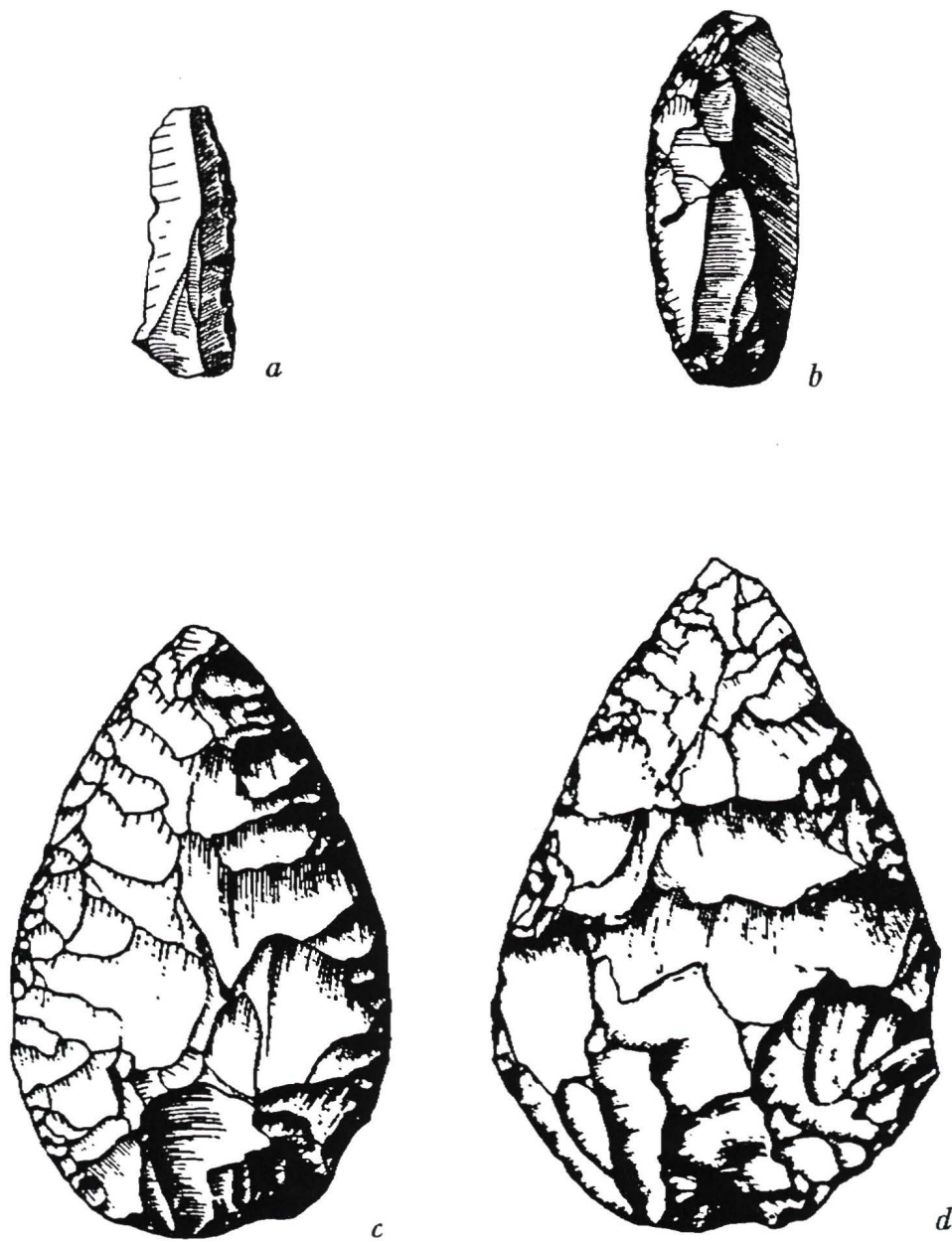


Figure B.5. Backed Knives and Bifaces: a,b) Typical backed knives (Type 36); c) Ovate biface; d) Cordiform biface. After Bordes 1961b.

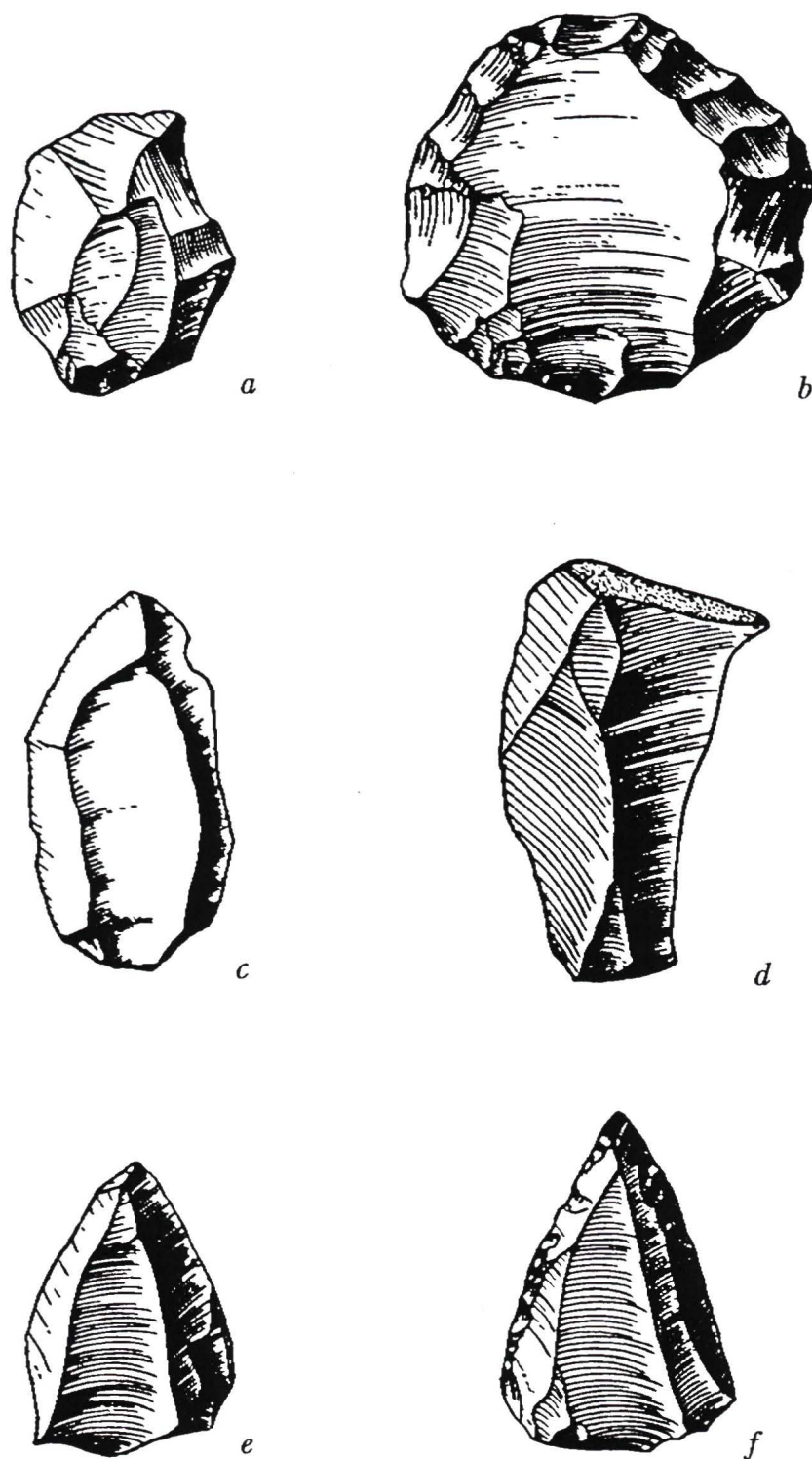


Figure B.6. Levallois Manufacture: a-c) Typical Levallois flakes (Type 1); d) Atypical Levallois flake (Type 2); e) Levallois point (Type 3); f) Retouched Levallois point (Type 4). After Bordes 1961b.

C 103 MIDDLE PALAEOOLITHIC
ASSEMBLAGES

ASSEMBLAGES USED IN PRESENT ANALYSIS

Site	Level (if applicable)	Assemblage Type
Abri Armand Chadourne	A	D
Abri Armand Chadourne	C	F
Abri Caminade-Est	M1b+s	T
Abri Caminade-Est	M2b+s	F
Abri Caminade-Est	M3b+s	F
Abri Romani	10-11-12-13	D
Abri Romani	C 9-9a-9b	D
Abri Romani	C 4-6-8	D
Abri du Maras	1	A
Bas-Guillotte		F
BaumeVallee		F
Blanzay		F
Bouheben	1	T
Bouheben	1'	T
Busigny		T
Catigny		A
Chinchon		Q
Combe Grenal	7	T
Combe Grenal	10	T
Combe Grenal	11	D
Combe Grenal	12	D
Combe Grenal	13	D
Combe Grenal	14	D
Combe Grenal	15	D
Combe Grenal	16	D
Combe Grenal	17	Q
Combe Grenal	19	Q
Combe Grenal	20	D
Combe Grenal	21	Q
Combe Grenal	22	Q
Combe Grenal	23	Q
Combe Grenal	24	Q
Combe Grenal	25	Q
Combe Grenal	26	Q
Combe Grenal	27	F
Combe Grenal	28	F
Combe Grenal	29	F
Combe Grenal	30	F
Combe Grenal	32	F
Combe Grenal	33	F
Combe Grenal	35	F
Combe Grenal	36	T
Combe Grenal	37	T
Combe Grenal	38	D

Combe Grenal	39	T
Combe Grenal	40	T
Combe Grenal	42	T
Combe Grenal	47	T
Combe Grenal	50	T
Combe Grenal	50A	T
Combe Grenal	52	T
Combe Grenal	54	T
Cova Negra		Q
Cueva del Conde	D	D
Dau		A
Ermitage	I	F
Fonseigner	Dmi	T
Fonseigner	DS	A
Fonseigner	E	T
Fonseigner	F	T
Fontaine		Q
Grainfollet à Saint-Suliac		A
Grotta di Torra Nave	13	T
Grotte du Bison	H	D
Grotte de L'Hyene	IVb1	D
Grotte de L'Hyene	IVb3	T
Grotte du Renne	XI	D
Grotte du Renne	XII	D
Grotte Tournal	1	D
Grotte Tournal	2	D
Grotte Tournal	4	D
Grotte Tournal	5	D
Grotte de Rigabe	G	T
Grotte du Figuier	1	Q
Hamel		A
Haute-Roche	inferior (1)	Q
Haute-Roche	middle (2)	D
Houpeville	claire	T
Lycée		F
Madeleine- sur-Loing		D
Mas-Viel	A	Q
Mas-Viel	B	Q
Mas-Viel	Quartz	Q
Mauran		D
Mont-Dol		F
Oissel		T
Pech de L'Azé	3	A
Pech de L'Azé	4	A
Pech de L'Azé	5	A
Pech de L'Azé	6	A
Pech de L'Azé	7	A
Pech de L'Azé	B	A

Pech de L'Azé	C	A
Petit Puymoyen	2	Q
Petit Puymoyen	brèche	Q
Petit Puymoyen	grotte	Q
Roc		D
Roc de Marsal	10	Q
Roc de Marsal	11-11a-11b	Q
Ruisseau de Graviers	II	T
San Andrea di Sabaudia		D
San Francesco		D
Trinité Sud		T



Figure C.1. Location of Selected Sites in Statistical Study: 1) Mont Dol; 2) Catigny; 3) Arcy-sur-Cur; 4) Combe Grenal; 5) Pech de l'Azé; 6) Cueva del Conde; 7) Tournal; 8) San Francesco; 9) Cova Negra; 10) San Andrea di Sabaudia. (Light shading represents countries chosen for the present analysis and darker shading represents higher concentrations of known Middle Palaeolithic sites).

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