Chapter 5

Diversity of Lithic Production Systems During the Middle Paleolithic in France

Are There Any Chronological Trends?

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ABSTRACT

The technological approaches developed in Western Europe during the last two decades aim to define different systems of debitage (used here as a noun to denote the process of producing blanks). For the Middle Paleolithic, the best documented are the Levallois debitage system, the laminar production system, the discoidal debitage system, and the Quina debitage system. Their geographical and chronological distributions show some general trends: a greater diversity of the production systems coexisting within the same region (especially in Southwestern France) at the end of the Middle Paleolithic; an increased use of the systems characterized by a low degree of blank predetermination (Quina and discoidal systems, Levallois recurrent centripetal method), and the emergence of a flexible, multifunctional toolkit with a high curation potential. These changes can be attributed to groups with different technical traditions who kept their own fundamental technical identity but who also adopted similar mobility patterns during the unstable climatic period at the end of the Middle Paleolithic, resulting in shared forms of socioeconomic behavior (frequent population moves and increased residential mobility).

INTRODUCTION

Ever since the first half of the 20th century, when Breuil defined the Middle Paleolithic as a period of flake-based industries characterized by a notable stability in tool types, it has been widely accepted that this period remained remarkably uniform both geographically and chronologically. However, the Middle Paleolithic of Western Europe, and more particularly the French Middle Paleolithic, is actually highly diversified. This notion of diversity was already implicit in the typological approach advocated by Bordes (1950), which led to the recognition of five Mousterian facies based on the relative proportions of retouched tool types (Bordes 1953, 1981). Recently the perception of this diversity in Western Europe has been greatly refined by the development of technological approaches. Despite the fact that technical traditions persisted longer in the Middle Paleolithic than in later time periods, it is now quite obvious that the idea of the Middle Paleolithic being a homogeneous period should be dismissed, at least for Western Europe.

Over the last two decades, approaches based on the concept of *chaîne opératoire* (Cresswell 1982; Lemonnier 1986; Karlin *et al.* 1991) have aimed to characterize lithic production systems in terms of production methods, blank morphology, and transformation of these blanks into tools. Using a systemic approach of lithic production, these studies reveal a diversity of technical strategies for the Middle Paleolithic that is probably as wide as the diversity recorded in the Upper Paleolithic, although differently structured. Indeed, despite the fact that a relatively limited number of sites have been analyzed with this focus on technical systems, results already demonstrate the range and diversity of stone tool production systems. How this diversity is patterned in time and space is precisely what we will now discuss.

The technological approaches (the so-called "*chaînes opératoires*" approach in the French literature) have allowed scholars not only to recognize various stages in lithic tool making (a topic not developed in this paper) but also to investigate the basic conceptual processes which underlie the sequence of manufacturing steps in stone tool production. Different ways of organizing and exploiting cores in three dimensions (*i.e.*, *"conceptions volumétriques"* in the French literature) have been identified, along with their respective end-products and by-products. The pioneering work carried out by Boëda (1986, 1994) focused initially on the Levallois concept and its variability, as expressed in different reduction modalities. This work was followed later by the identification of other production methods: "discoidal method" (Boëda 1993), "alternating platform technique" (Ashton 1992) or "clactonian method" (Forestier 1993), "Quina method" (Bourguignon 1996, 1997), "laminar production system" (Boëda 1990; Revillion 1994), the "Kombewa-like Les Tares method" (Geneste and Plisson 1996), the "Pucheuil-type method" (Delagnes 1993) and the "bifacial shaping method" ("*chaîne opératoire de façonnage bifacial*".) The latter strategy aims at the production of bifaces with different roles: depending on the assemblages, the bifaces have been used as long use-life tools, as "cores" (Soressi 2002), or as tool-blanks (Boëda *et al.* 1990, 1996). Since the mid-1980s, many lithic assemblages have been studied within this conceptual framework, which has helped to expand our knowledge of the internal variability within each system (Geneste 1988; Turq 1989; Boëda *et al.* 1990; Boëda 1991; Delagnes 1992; Jaubert 1993; Meignen 1993; Locht and Swinnen 1994; Jaubert and Farizy 1995; Texier and Francisco-Ortega 1995; Delagnes and Ropars 1995; Geneste *et al.* 1997, among others). In fact, these lithic production systems are far from rigid, and due to their inherent flexibility, the various flaking modalities recognized do not always match up to the limits of our conventional technological categories (see below). For example, it is clear that the traditional binary opposition "Levallois"/non-Levallois" or "elaborated/non-elaborated debitage" should be abandoned.

In this paper, we will deal with the four main debitage systems (ignoring for the moment the bifacial shaping system) that are the best documented in the Middle Paleolithic: the Levallois debitage system, the laminar production system, the discoidal debitage system and the Quina debitage system. The Levallois system has been extensively studied and its internal variability is now well known (outside of Europe as well), while the Quina concept, more recently described, is much less thoroughly documented. This must be kept in mind when we compare the spatial and chronological distribution of these lithic technical systems.

DIVERSITY OF MIDDLE PALEOLITHIC PRODUCTION SYSTEMS

Levallois Debitage System

Based on experimental and archaeological studies, Boëda (1994, 1995) described a specific volumetric organization of the core which he used to define the Levallois concept. The core is first shaped in order to get two asymmetrical convex intersecting surfaces. These two surfaces do not have the same function: one is used for the production of predetermined flakes (flaking surface from which the Levallois blanks are struck), while the other is used as a striking platform surface. Creating the lateral and distal convexities of the flaking surface allows the knapper to produce Levallois blank(s) with a controlled morphology. The fracture planes for detachment of Levallois blanks are parallel or subparallel to the plane of intersection between the two surfaces (Figure 1). Blanks can be produced following different methods: the recurrent methods (with either unidirectional, bidirectional, or centripetal removals), through which several predetermined flakes are produced from the same flaking surface, and the preferential method in which a single Levallois blank is produced from each flaking surface.

The blanks produced by these different methods are quite diversified in terms of morphology and size. Nevertheless all flakes possess long cutting edges with very acute edge angles and more or less symmetrical shapes and cross-sections. Uni- and bidirectional recurrent methods focus on the production of quadrangular blanks, sub-triangular when the unidirectional removals are convergent. Less standardized and more diversified end-products result from the centripetal recurrent method, while the preferential methods lead to more rigidly predetermined shapes (large

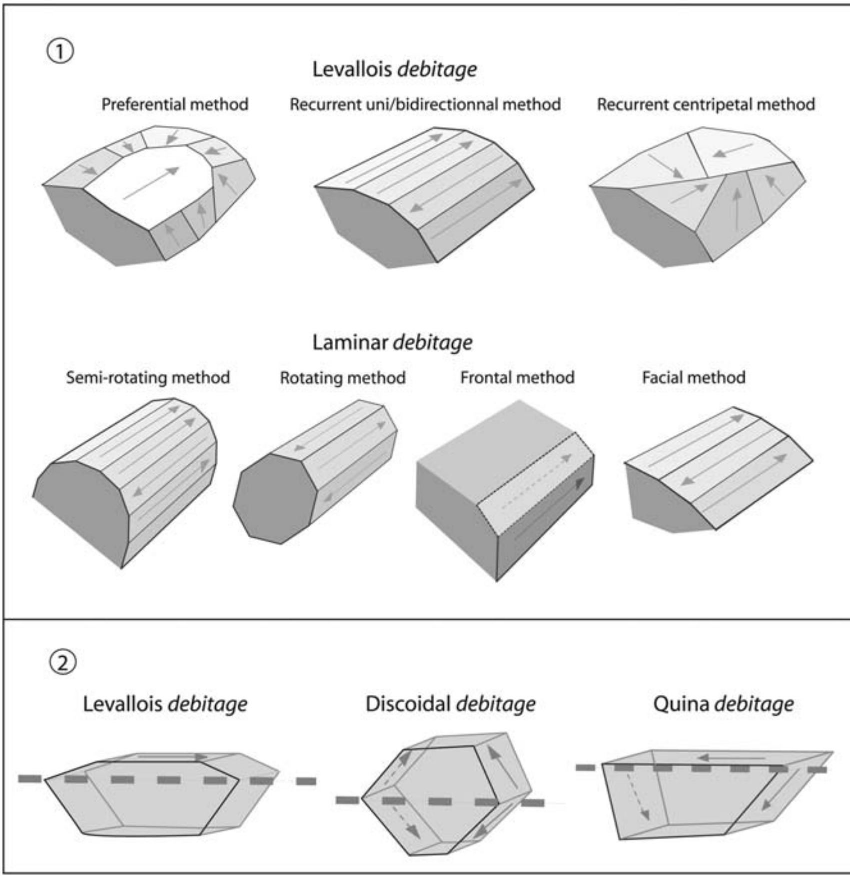

Figure 1. The major methods of production related to the Levallois and laminar *debitages*; 2. schematic representation of the volumetric conception for the Levallois, the discoidal and the Quina *debitages* (redrawn after Bourguignon 1997).

oval Levallois flakes or Levallois points, depending on how the core was initially prepared).

In some assemblages, the Levallois flakes are produced in order to closely fit the planned morphology of the final tools, especially in the case of preferential or recurrent uni/bidirectional flaking methods described, for instance, in the assemblages of Biache-St-Vaast IIA (Boëda 1988a) and Vaufrey, levels VII and VIII (Geneste 1988). In these cases, the Levallois products are either lightly retouched (a type of retouch that enhances the original morpho-functional attributes) or left unretouched (and probably used as such). On the other hand, other assemblages are characterized by blanks that are quite diversified in shape and size, requiring more investment in retouch in order to get the intended morpho-functional characteristics, for instance in the assemblages of the Abri Suard at La Chaise-de-Vouthon (Delagnes 1991).

Laminar Production System

Laminar production is the main production system in several Middle Paleolithic sites, characterized by various flaking strategies (Ameloot-Van der Heijden 1993b; Revillion 1994; Revillion and Tuffreau 1994a; Delagnes 1996a; Locht 2002). Boëda (1988a, 1990) pointed out some critical features which distinguish blade production strategies from those of the Levallois system. Most importantly, the core-volume organization is radically different: the active surface of the core from which the removals are struck extends along most, if not all the core's periphery rather than being restricted to one delimited surface (see Figure 1).

Blade cores can be reduced according to four different strategies: semi-rotating method, rotating method, frontal method and facial method (Delagnes 2000 and references therein). These different options may occur in full or partial combination in the archaeological assemblages, the semi-rotating method being most common. Variability is also expressed in the number of striking platforms present on the cores (one or two opposed). The method of core reduction (recurrent unidirectional or bidirectional) generally involves the production of crested blades, although this is not an absolute rule. Usually, Middle Paleolithic blade cores are only minimally prepared, and the volume is not thoroughly shaped out before starting the production of blades. The blades were detached with a hard hammer and consequently show significant variation in shape and size.

In Middle Paleolithic assemblages, blade production is generally found in combination with flakes produced following the Levallois concept, the later being in most cases the dominant mode of reduction (*e.g.*, the sites of Lailly/le domaine de Beauregard B and Bettencourt-Saint-Ouen, level N2B3: Locht and Swinnen 1994; Locht 2002). The Levallois recurrent uni/bidirectional methods are most commonly associated with laminar production systems in Mousterian assemblages. The need to produce quadrangular elongated blanks which implied the use of this peculiar method could have contributed in the same assemblages to the emergence of a blade production. The few blades that are retouched are modified through marginal retouch. In fact, the laminar production in the Middle Paleolithic is a unique phenomenon, clearly distinct from Upper Paleolithic blade production in the striking technique used (direct percussion with a stone hammer) as well as in the way core volume was exploited, in the characteristics of the end-products and in its systematic association with flake production.

Discoidal System

Defined by Boëda (1993) and given a rather different meaning from the discoidal/Mousterian debitage described by Bordes (1961), the discoidal core reduction strategy has been recognized in many sites, and a significant amount of variability noted (Jaubert 1993; Locht and Swinnen 1994; Peresani 1998; Pasty 2000). In a classic discoid system the core possesses two highly convex surfaces, but unlike Levallois, neither assumes priority over the other: both surfaces can alternately be used for flake detachment or as striking platform. Most often this strategy is based on a recurrent centripetal reduction of the core, with the removals struck from platforms extending around the core's entire periphery. In distinction to the Levallois system, both surfaces, highly convex, intersect each other at a relatively high angle (see Figure 1). Such a volumetric construction often results in cores with a bi-pyramidal (eventually pyramidal) morphology. The end-products of discoid production systems are generally short and asymmetrical. They include *pseudo-Levallois* points, short *débordant* flakes, and quadrangular flakes.

Quina System

Recently defined by Bourguignon in a study based on several Quina Mousterian assemblages (Bourguignon 1996, 1997), this reduction strategy is not yet well documented and many other Quina assemblages should be re-examined. This reduction strategy is more flexible than the previous ones (see Turq 1989; Bourguignon 1997), but all variants clearly share the principle that the core is reduced by exploiting two surfaces which intersect at a low angle. Like the discoidal method, neither surface takes priority over the other, and both are alternately used as flaking and striking platform surfaces. The core reduction is mostly recurrent, in that many blanks are detached, and the series of removals are unidirectional, following fracture planes alternatively secant and parallel to the intersection of the two surfaces (see Figure 1). As a result of the absence of initial core shaping end-products are frequently cortical. They are generally short and thick, with a triangular cross-section and are characterized by a wide butt that is oriented at an obtuse angle to the ventral face. In most Quina Mousterian assemblages, these blanks were used mainly for the production of various sidescrapers on the lateral and transversal edges, some of them characterized by fairly heavy invasive retouch (the "Quina retouch"), creating a convex working edge with a remarkably constant steep angle (Bourguignon 1997). Re-sharpening, recognized by characteristic flakes, is a frequent activity (Lenoir 1986; Meignen 1988). Interestingly, these flakes are sometimes themselves recycled into scrapers. All the Quina assemblages studied are globally characterized by high ratios of retouched tools (see Rolland 1981). In a few cases, however, the diagnostic Quina blanks were not shaped by heavy Quina retouches but left unretouched or lightly modified into sidescrapers and/or denticulates, as observed in Sclayn layer 5 and Combe-Capelle Bas (Dibble and Lenoir 1995; Bourguignon 1998).

The degree of predetermination of the end-products, *i.e.*, the control of their morpho-functional characteristics, varies between all these flaking systems. The level of predetermination is relatively high in the preferential Levallois method, the laminar system and in the Levallois recurrent uni/bidirectional methods. The morphology of the end-products is predetermined to a lesser degree in the Levallois recurrent centripetal method and in the Quina and the discoidal systems.

It is worth noting that these four major reduction strategies, as well as several other lithic production systems previously mentioned, are sometimes associated in the same assemblage (Tables 1 and 2), each of them presumably associated with different functional applications, as for instance at Riencourt-les Bapaume in level CA (Beyries 1993). Moreover, in some assemblages, the coexisting flaking

Table 1. List of the major sites illustrating the diversity of the production systems during the Middle Paleolithic in Northern and Southwestern France (only sites subjected to chronological and technological studies have been reported)

Site (levels)	Chronology* (isotopic stage)	Dominant production system	Secondary production system	Mousterian facies	References
		North/Northwestern France			
Salouel	stages 8-beginning 7	LP	LRU		Ameloot-van der Heidjen *et al.*, 1996
Le Pucheuil (C-A)	end stage 8-beginning 7	LRU	BS		Delagnes, 1996a
Bagarre (7)	stages 8 to 6	LP			Boëda, 1994; Tuffreau *et al.*, 1975
Longavesnes	stages 8 to 6	LRU	LRC		Ameloot-van der Heidjen, 1993a
Champvoisy	stage 7	LRU		F	Tuffreau, 1989
Biache-Saint-Vaast (IIA, IIbase)	end stage 7-beginning 6	LRU		F	Boëda, 1988, 1994; Tuffreau and Marcy, 1988
Le Pucheuil (B)	beginning stage 6	LP, LRU			Delagnes, 1996b
Etouvie	stage 6	LP			Tuffreau, 1995
Querqueville	stage 5e	LRU	BS	M	Clet *et al.*, 1991
Roisel	stage 5e	LP	LRC, LRU		Gautier, 1989
Vinneuf (N1)	stages 5d-c	BP	BS	M	Gouedo *et al.*, 1994
Seclin	stages 5d-c	BP	LRC, LRU		Révillion, 1994
Saint-Germain-des-Vaux I	stages 5d-c	LRU, LRC, LP, BP			Révillion and Cliquet, 1994
Riencourt-les-Bapaume (CA)	stage 5c	BP	LRC		Ameloot-van der Heijden, 1993b
Etoutteville	stages 5b-a	LRU, BP			Delagnes, 1996c
Lailly/le domaine de Beauregard (B)	stage 5a	LRU	BP, BS		Locht and Ferdouel, 1994
Molinons/le Grand Chanteloup	stage 5a	LRU	BS	MTA or T ?	Locht *et al.*, 1994
Bettencourt-Saint-Ouen (N2B3)	stage 5a	LRU	BP		Locht ed., 2002
Auteuil	stage 5	LRU	LRC, LP	T	Swinnen *et al.*, 1996
Le Petit Saule (2)	stage 5	LRU	LRC, BP		Locht, 1997

(*Continued*)

Table 1. (*Continued*)

Site (levels)	Chronology* (isotopic stage)	Dominant production system	Secondary production system	Mousterian facies	References
Saint-Vaast-La-Hougue (inf.)	stage 5	LRU		D	Guette, 2002
Champlost	stage 5	LRU, LP, LRC	BS	M	Gouedo, 1988
Houppeville	stage 5	LRU	LRC	T	Vallin, 1992
Goareva	stage 5 or 4 ?	LRU, LRC			Huet, 2002
Hermies (sup.)	stage 4	LP			Masson and Vallin, 1993
Lailly/Le Fond de la Tournerie (I)	stage 4	LRU	LRC, BS	MTA or T ?	Depaepe and Brassinne, 1994
Bois du Rocher	stage 4	D	BS		Molines *et al.*, 2001
Beauvais	end stage 4 or stage 3	D		T	Locht and Swinnen, 1994
Corbehem	stage 3	LRC		T	Boëda, 1994; Tuffreau, 1979
Butte d'Arvigny	stage 3	LRU, LRC, BP			Gouedo *et al.*, 1994
Hénin-sur-Cojeul (G)	stage 3	LRC	LRU	T	Marcy *et al.*, 1993
		South-Western France			
Moulin du Milieu (VIII to XI)	stages 8 to 6 ?	LRC	BS	MTA	Turq, 2000
Grotte Vaufrey (VII, VIII)	stage 6	LRU		T	Geneste, 1985; Rigaud ed., 1988
Abri Suard	stage 6	LRU		T	Delagnes, 1990, 1992
Coudoulous I	stage 6	D	LRC		Jaubert and Mourre, 1996
Fontéchevade (EI)	stage 5e ?	D			Meignen *et al.*, Tournepiche : *unpublished*
La Borde	older than stage 5b	D	LRC	D	Jaubert *et al.*, 1990; Jaubert and Farizy, 1995
Le Rescoundudou (C1)	stage 5	LRC	LRU		Jaubert *et al.*, 1992
Abri Bourgeois-Delaunay (10, 9)	stage 5	LRU		T	Delagnes, 1992
Coursac	stage 5	LRU	LRC, BS	MTA (A)	Geneste, 1985
Artenac (7)	stage 5	Q			Delagnes : *unpublished*
Artenac (6c)	stage 5	LRC		F	Delagnes *et al.*, 1999

Coupe-Gorge/Montmaurin	stage 5	D	BS		Gaillard, 1982; Jaubert and Bismuth, 1996
Combe-Grenal (38)	stage 5	LRC		D	Delagnes, 1992
Combe-Grenal (36)	stage 5a	LRC		T	Turq, 2000
Les Canalettes (2 to 4)	stage 5a	LTC	LRU	T	Meignen, 1993
La Plane	stage 5 or 4 ?	LRC	LRU, BS	MTA	Turq, 2000
Les Forêts	post. stage 5	D	BS	M	Folgado *et al.*, 1997; Brenet and Folgado, *in press*
Champs de Bossuet	post. stage 5 or 7 ?	D		D	Bourguignon *et al.*, 2000
Combe-Grenal (35)	stage 4	LRC	LRU	F	Delagnes, 1992
Combe-Grenal (31 to 28)	stage 4	LRC		T	Turq, 2000
La Quina (3, G3-N)	older than stage 3	Q		Q	Bourguignon, 1997; Debénath *et al.*, 1998
Mauran	end stage 4 or stage 3	D		D	Farizy *et al.*, 1994
Marillac (9, 10)	stage 4 or 3 ?	Q		Q	Meignen, 1988; Bourguignon, 1997
Hauteroche (C)	stage 4 or 3 ?	Q		Q	Bourguignon, 1997
Combe-Grenal (22)	stage 3	Q		Q	Turq, 2000
Combe-Grenal (14)	stage 3	D		D	Bourguignon and Turq, *in press*
Combe-Grenal (6, 7)	stage 3	LRC		T	Turq, 2000
Fonseigner (F, E, DMI)	stage 3	LRC	LRU	T	Geneste, 1985
Fonseigner (Dsup)	stage 3	LRC	LRU, BS	MTA (A) or T ?	Geneste, 1985, 1990
Le Moustier	stage 3	LRU	BS	MTA (A)	Soressi, 1999
Pech-de-l'Azé I (4)	stage 3	LRU	BP, BS	MTA (A)	Soressi, 2002
Espagnac	stage 3	D	Q	Q	Jaubert *et al.*, 2001
Sous les Vignes	stage 3	D	Q	Q	Turq *et al.*, 1999
Roc de Marsal	stage 3	Q		Q	Turq, 2000
Camiac	stage 3	D		D	Lenoir, 1980
Saint-Césaire	stage 3	D		D	Guilbaud, 1993
Fréchet	stage 3	D		T	Jaubert and Bismuth, 1996

*based on chrono/biostratigraphy and/or radiometric datations.
LRU: Levallois recurrent unidirectional; LRC: Levallois recurrent centripetal; LP: Levallois preferential; BP: Blade production; D: Discoidal debitage; Q: Quina debitage; BS: bifacial shaping; T: Typical; F: Ferrassie; Q: Quina; D: Denticulates; MTA: Mousterian of Acheulean Tradition; M: Micoquian.

Table 2. List of the major sites illustrating the diversity of the production systems during the Middle Paleolithic in Southeastern France (only sites subjected to chronological and technological studies have been reported)

Site (levels)	Chronology* (isotopic stage)	Dominant production system	Secondary production system	Mousterian facies	References
		South-Eastern France			
Orgnac 3 (3, 2)	stages 10, 9	LRC	LP		Moncel and Combier, 1992
Orgnac 3 (1)	stages 10, 9	LP	LRC		Moncel and Combier, 1992
Les Mourets	stages 6 or 5e ?	LRU	LRC		Bernard-Guelle, 1998–1999
Bérigoule (I)	stage 5 ?	LRU, LRC		F	Texier and Francisco-Ortega, 1995
Saint-Marcel d'Ardèche	end stage 5 or stage 3 ?	D		T	Moncel, 1998
Abri du Maras (8 to 4)	stages 4 or 3 ?	LRC	LRU	T or F ?	Moncel, 1996
Abri du Maras (1)	stages 4 or 3 ?	LRU	LRC	F or Q ?	Moncel, 1996
L'Hortus	stages 4, 3	LRC		T	de Lumley de and Licht, 1972
Grotte Mandrin (1 to 4)	stages 4, 3	LRU			Yvorra and Slimak, 2001
Esquicho-Grapaou	stage 3	Q		Q	Bourguignon, 1997
La Roquette	stage 3	Q		Q	Meignen, 1981

*based on chrono/biostratigraphy and/or radiometric datations.
LRU: Levallois recurrent unidirectional; LRC: Levallois recurrent centripetal; LP: Levallois preferential; BP: Blade production; D: Discoidal debitage; Q: Quina debitage; BS: bifacial shaping; T: Typical; F: Ferrassie; Q: Quina; D: Denticulates; MTA: Mousterian of Acheulean Tradition; M: Micoquian.

methods were carried out on different types of raw material. For instance, at Sclayn layer 5 in Belgium, discoidal, Quina and Levallois products were manufactured from three different types of raw materials (Moncel 1998b). At Coudoulous I, les Fieux, and La Borde, discoidal debitage was used mostly on quartz/quartzite and Levallois method applied to flint (Jaubert and Farizy 1995; Jaubert and Mourre 1996). All these examples clearly illustrate the complexity and variability of the lithic technical systems within the Western European Middle Paleolithic.

GEOGRAPHIC AND CHRONOLOGICAL DISTRIBUTIONS

We now turn to the geographic and chronological distributions of these four technical systems in order to better understand their meaning. As we have stressed previously, it must be kept in mind that our understanding of these production systems suffers from the limited number of sites that have been studied from a technological perspective, as well as from the lack of reliable chronological data. Only the assemblages with large samples and for which technological and chronological information is available are taken into consideration here.

The Levallois concept is the most widespread set of Middle Paleolithic production systems. While the Levallois concept covers a large geographic area (Figure 2), it should be noted that this reduction strategy is absent or rare in regions with low quality raw materials (Pyrenees, Eastern and Central France, Brittany), but remarkably well represented in the three large areas discussed here: Northern, Southwestern and Southeastern France. Assemblages from Northern France are dominated by the recurrent uni- and bidirectional patterns of exploitation while the centripetal method is quite rare. To the contrary, the latter is very common in lithic industries from Southwestern France. The preferential method (one blank per prepared surface), present in Northern France, has not been identified as the dominant method in any southern assemblage. No trends are recognized in Southeastern France, but this may result from the relatively small sample of well-studied sites in this region. The Levallois concept is documented throughout the entire Middle Paleolithic period, but may have appeared earlier in the northern area (Tables 1 and 2).

No clear break in the chronological distribution of the different Levallois methods is apparent, but some general trends may be pointed out (Figure 3). First, the uni- and bidirectional modalities prevailed during the Early Middle Paleolithic and lasted until the end of the period. This trend, already emphasized by Geneste (1990), is best expressed in the northern region, where the Levallois recurrent centripetal modality is quite rare during the Early Middle Paleolithic. In contrast, this strategy became largely dominant after Oxygen Isotope Stage 5, mainly in Southwestern France.

The blade production system, relatively circumscribed in space and time, is limited to more or less 10 sites (and only five, if we consider only the sites where this production is abundantly represented). Most Mousterian sites with blade technology are located in the western part of the North-European plain (Northern France,

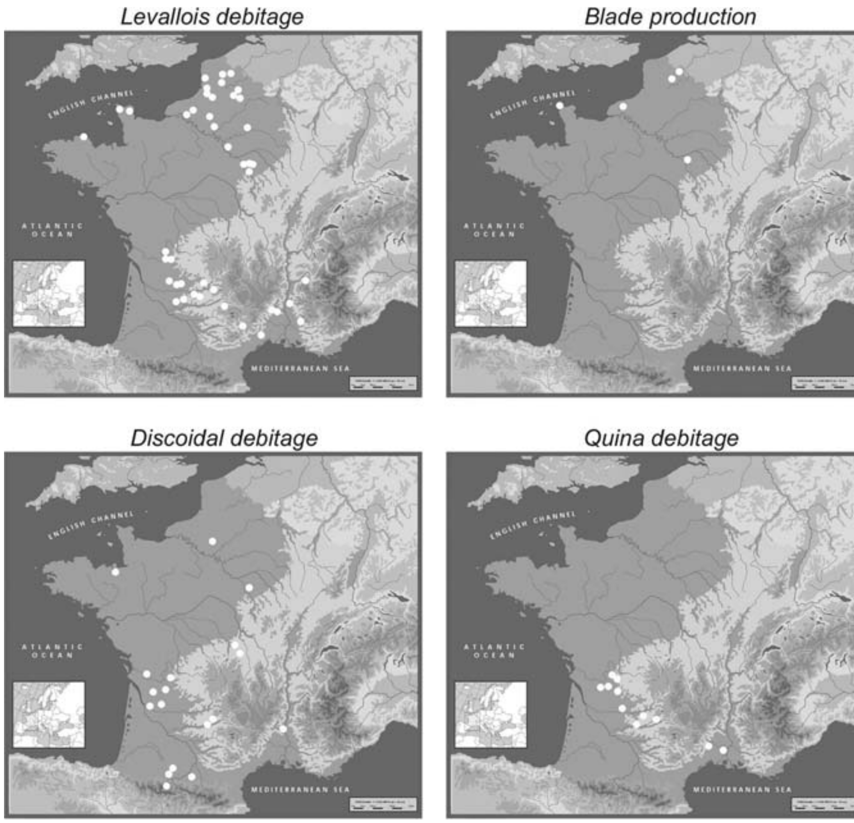

Figure 2. Geographical distribution of the 4 production systems (the sample of sites corresponds to the list detailed in tables 1 and 2).

Southern Belgium and Western Germany; see Figure 2), and span a relatively short chronological period (see Figure 3). Blade production systems appeared first in early Middle Paleolithic industries during the penultimate glaciation (Oxygen Isotope Stage 6), and are particularly well represented at the very beginning of the last Glacial (Oxygen Isotope Stage 5).

In the context of the Middle Paleolithic in Northern France, blade production should be considered as a technical phenomenon with a very restricted distribution in time, and unrelated, on the basis of the available data, with Early Upper Paleolithic blade production (Delagnes 2000). However, this situation may be entirely different in Southwestern France. In a few assemblages attributed to the Mousterian of Acheulean Tradition (for instance, Pech de l'Aze I, level 4), dated to the end of the Late Middle Paleolithic (Isotope Stage 3), elongated flakes were struck from semi-rotating cores following a reduction strategy close to the laminar concept (Soressi 2002). The hypothesis of a technological link with the Châtelperronian had been suggested by several authors (Pelegrin 1995; Soressi 2002).

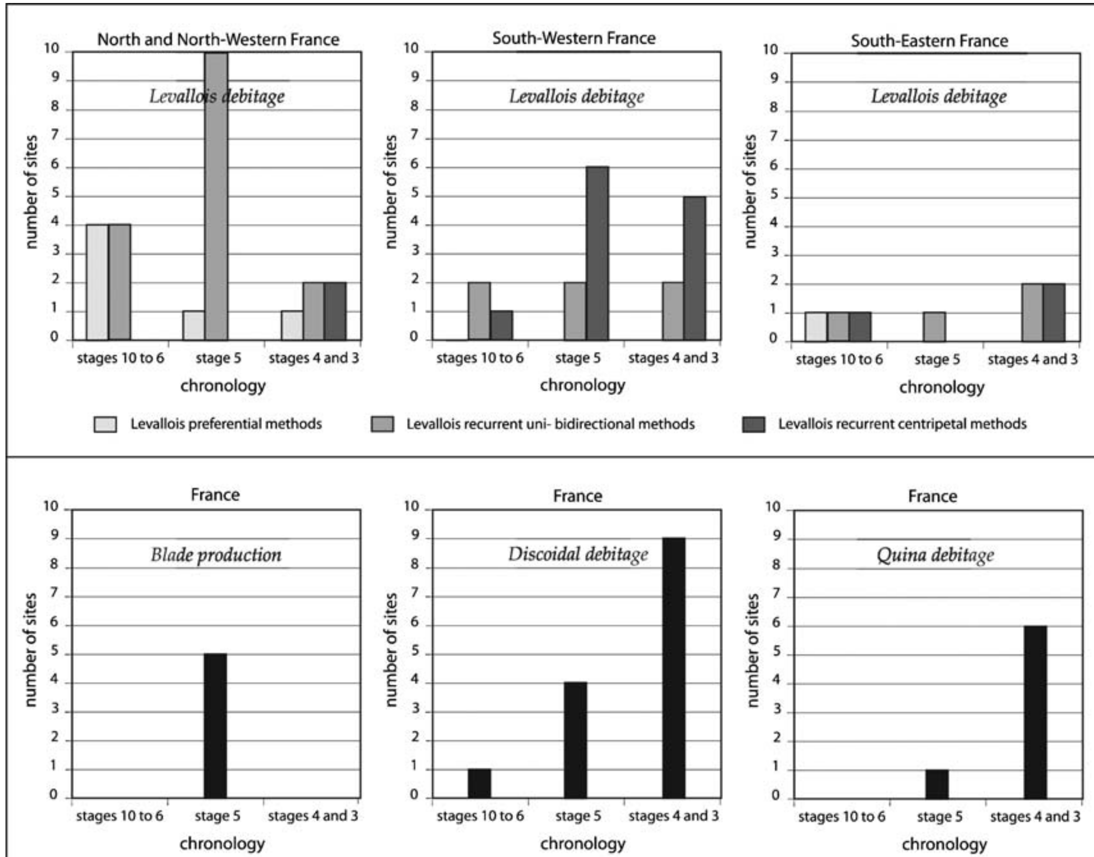

Figure 3. Chronological distribution of the Levallois methods and of the laminar, the discoidal and the Quina *debitages* during the Middle Paleolithic.

The discoidal method, less widely spread than Levallois, is common in regions where flint is scarce, such as the Pyrenees area and Catalonia in Spain (Jaubert and Farizy 1995) but also in Charente and Perigord where flint resources are abundantly available (see Figure 2). This system is frequently associated with raw materials of poor quality such as quartz or quartzite. However, this correlation is only partial, and discoidal assemblages made on flint are also documented in regions with high-quality raw materials, as seen in Northern (*e.g.*, Beauvais [Locht and Swinnen 1994]) and Southwestern France (*e.g.*, Saint Césaire [Guilbaud 1993]; Champs de Bossuet [Bourguignon 2000; Bourguignon and Turq 2003]). The discoidal production system spans a large block of time (see Figure 3), from at least Oxygen Isotope Stage 6 through Isotope Stage 3: it is particularly common at the very end of the Middle Paleolithic (Stage 3).

Geographic and chronological distributions for the Quina system are probably underestimated in our study due to the limited number of technological studies of these assemblages. The Quina system has been recorded in many areas of Southern and Central France (see Figure 2), as well as in Belgium, but only sporadically in Spain. This method is totally absent in Northern France. This production system seems to appear at the end of Oxygen Isotope Stage 5 (*e.g.*, Artenac level 7), but without the characteristic Quina retouch, and becomes more common during the Later Middle Paleolithic (mostly in Isotope Stage 3, see Figure 3).

DISCUSSION

The analysis presented here highlights the diversity of technical behaviors in tool manufacture and management during the Middle Paleolithic. This diversity is first seen in the development of very different types of lithic production systems, with their own respective goals and constraints. The morphological, functional characteristics of the tools—mainly the forms and angles of working edges and the morphology of zones suitable for prehension—were controlled by Middle Paleolithic tool makers, sometimes from the beginning of the reduction sequence. This diversity is also reflected by the combination of different types of reduction sequence (as well as bifacial shaping), with their own respective goals, within a single assemblage.

Due to space constraints, we will not attempt to review all the factors lying behind this intra- and inter-site variability. However, it is important to note that the observed diversity is probably the result of the interaction of several factors: raw material availability, the intended function of the tool (in relation with the site function within a territory), and the range of technical knowledge available to be used by Middle Paleolithic groups in response to the previous two factors. The role played by each of these factors has generated several debates, summarized by Mellars (1996). In this regard, the variability observed cannot be simply reduced to environmental or functional factors. The tool morphology—seen not from a typological standpoint, but rather from a technological perspective, that is, taking into account the entire shape of the tool—certainly fits the intended function, but the particular way artifacts were made (*i.e.*, the production methods) stemmed from a socially meaningful body of knowledge transmitted from generation to generation (Mauss 1936; Levi-Strauss 1976; Rogers 1988; Pelegrin 1990; Lemonnier 1992; Dobres and Hoffman 1994). Methods of blank production and transformation following specific processes represent in our opinion the best markers for identifying groups who shared a set of technical traditions.

At a broad regional scale, the results discussed here also show the coexistence *sensu lato* (taking into account the low degree of chronological resolution) of several lithic production systems. Southwestern France, and more specifically Perigord, is a good example: very different production systems, such as the Levallois, the discoidal, the Quina, and the bifacial shaping methods, were present at the same time, especially during Isotope Stage 3. If it is true that common production systems resulted from technical knowledge socially transmitted by groups that shared comparable technical behaviors, the previous propositions indicate that human groups with different technical traditions coexisted, at least in certain areas. During the Middle Paleolithic, population density was probably generally low, which would explain the existence of "separate patterns of technological development fostered by the variable degrees of social distance maintained between the human populations involved" (Mellars 1996).

It also seems that in Southwestern France, groups with different technical traditions occupied the same rockshelters or caves, replacing each other over time, a pattern that was recognized previously based on the identification of typological facies in sites like Combe Grenal and Pech de l'Aze. These results suggest frequent large-scale population moves within this region. Such moves appear to have been less numerous in Southeastern France where the stratigraphic sequences are technologically more homogeneous. This pattern, especially obvious in Perigord, is probably related to the specific local climatic and ecological conditions of Southwestern France (Mellars 1996; Turq 1999). The influence of the oceanic system on the climate, resulting in comparatively mild winters, would have increased the development of plant resources during the year, which in turn would have had a major impact on the overall regional carrying capacity in animal herds (Mellars 1996). Moreover, the contrasting topographic zones, the abundance of river valleys functioning as migration trails, as well as the availability of rockshelters/caves and good quality raw materials would have represented attractive factors for hunter-gatherer groups throughout the Middle Paleolithic period (Mellars 1996; Turq 1999 and references therein).

Are there chronological trends within the Middle Paleolithic? We can unequivocally answer "yes": we do observe chronological trends in lithic production systems during the Middle Paleolithic. However, given the lack of precision of radiometric dating for this period, only rough chronological trends can be proposed.

The most significant chronological pattern is found at the end of the Middle Paleolithic, during Oxygen Isotope Stage 3 and possibly in late Stage 4. These changes consist of a diversification of the production systems (see Tables 1 and 2; Figure 3), and an increased use of these systems characterized by a low degree of blank predetermination, especially the Quina and discoidal systems and the

Levallois recurrent centripetal method. This diversity in production methods is especially clear in Southwestern France, where it is associated with an increased number of occupied sites. During the same period, the great plains of Northern France were depopulated (Tuffreau 1992; Roebroeks and Tuffreau 1999; Antoine *et al.* 2003). Indeed, human occupation in these northern regions is mostly limited to the temperate climatic phases and the beginning of the glacial episodes. The area was abandoned when the climate got more rigorous.

The territory of France, located at the extremity of the European continent, was characterized by topographic and ecological diversity. This region may have been the source of several population shifts as human groups moved from unfavorable areas to more bountiful ones during the most rigorous climatic oscillations. The overall severe conditions of Isotope Stage 4 and the short and dramatic fluctuations during Stage 3, as suggested by ice-core data (Dansgaard *et al.* 1993), may have triggered these displacements and/or replacements of populations. Instability in the availability of plant and animal resources may have been associated with a higher level of mobility.

This last point is confirmed by studies of lithic raw material transport used in toolkit manufacture. According to Féblot-Augustins (1993, 1999), raw material transfers over medium to long distances were more frequent during the Late Middle Paleolithic in Europe. The chronological trends we observed towards the use of lithic production systems characterized by a low degree of end-product predetermination during the late Middle Paleolithic could have been related to the mobility patterns of the Neandertal groups, following the model proposed by Binford (1980). According to this model, high residential mobility would have led to the production of a portable, multifunctional toolkit, intended for general use and requiring a low degree of predetermination but likely subject to much retouch and re-sharpening (Hovers 1997 and references therein).

Indeed, in some industries, blanks showing a lower level of investment in predetermination during core reduction are associated with tools with high use, recycling and/or curation potential. Tools of the Quina type, their large blanks allowing the successive transformation of the working edges, are excellent examples of this principle. In other industries, blanks were transformed into tools with little additional modification. These tools are common, for example, in assemblages including a discoid reduction sequence, like the Denticulate Mousterian, and in some assemblages with a recurrent Levallois reduction sequence. These characteristics fit with "the lithic technologies of residentially mobile groups which are geared toward the production of highly portable assemblages dominated by blanks meant to be used for immediate purposes and then re-sharpened as needs arise" (Adler 2002).

Thus, at the end of the Middle Paleolithic, the Western part of Europe may have been frequented by prehistoric groups carrying different technical traditions but who nonetheless adopted the same kind of mobility pattern in response to environmental factors. The observed diversity in lithic production systems as well as an increased residential mobility at the end of the Middle Paleolithic have no counterparts in areas with less strongly fluctuating climatic conditions and more stable animal resources, such as the Central Levant. The available data for the latter area show a greater homogeneity in lithic production systems, in that assemblages with Levallois reduction sequences dominate the picture from Stage 5 on, albeit exhibiting the full variability of this particular lithic production system. Moreover, evidence points to a relatively low level of residential mobility during the Late Middle Paleolithic (based on radiating system) (Meignen *et al.* this volume). These results underline the adaptive capacities of Neandertal hunter-gatherer groups. Confronted with an unstable climate they nevertheless kept the same fundamental technical identity (as seen in their lithic production systems), but modified their raw material economies, and the composition and management of their toolkits as a function of the local economic conditions.

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