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Blade and bladelet reduction systems in the Italian Middle Paleolithic

The case of Grotta del Cavallo, (Nardò – Lecce)

Leonardo Carmignani^{1, 2} & Lucia Sarti³

Abstract

Evidence of the presence of blade tool technology has been confirmed in northern Europe from at least the latter part of the Middle Pleistocene (MIS 7-6). During MIS 5 these productions cover a larger area, which includes northwestern Germany, central France, and occasionally the south of France. It is only during MIS 4-3 that the blade production strategy begins to appear in southern Europe, including the Italian peninsula. Based on the present state of research, these three phases appear as on-and-off events without clear evolutionary continuity. The FIIIe and FIII d levels of Grotta del Cavallo in Lecce (Italy) have yielded abundant lithic material predominated by two main reduction systems: the first originating from a Levallois concept by centripetal, unidirectional, and bidirectional methods, and the second stemming from a blade volumetric reduction system. The presence of separate reduction systems aimed at obtaining bladelets highlights the technological variability.

Keywords: Grotta del Cavallo, Blades, Bladelets, Middle Paleolithic.

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1. Introduction

Within the European continent, the oldest evidence of blade production is found in northern Europe during MIS 8/7. These productions are obtained by primarily using two reduction systems: a volumetric concept, such as that noted at the sites of Saint-Valery-sur-Sommès (Heinzelin & Haesaerts 1983), Bapaume-les Osiers (Koehler 2008) and Therdonne (Loch *et al.* 2010) in France, and Rissori in Belgium (Adam 1991); and by a Levallois concept such as that observed at the site of Biache-Saint-Vaast in France (Böeda 1988). At the sites mentioned, blade production is rarely the predominant kind; on the contrary, it is systematically associated with other production systems, among which the most frequent is the Levallois concept aimed at mainly producing flakes.

In MIS 5, following their prolonged disappearance, coinciding with the MIS 6 glaciation peak, these productions returned, occupying a wider area that included north-west Germany with the sites of Tonchesberg (Conard 1990), Rheindahlen (Bosinsky 1986), and Wallertheim (Conard & Adler 1997), and central France, with the sites of Angé (Locht *et al.* 2008) and Vinneuf (Gouédo 1994). These productions are also found, albeit sporadically, in the south of France, at sites such as that of Cantalouette 4 (Blaser *et al.* 2012).

At the same time, in northern France and Belgium we see a return of blade production at many sites: Rencourt-lès-Bapaume (Ameloot & Hejden 1993), Saint-Germain-des-Vaux (Révillion & Cliquet 1994), Seclin (Révillion & Tuffreau 1994), Bettencourt-Saint-Ouen (Locht 2002), Blangy – Tronville (Depaepe *et al.* 1999), and Etouteville in France (Delagnes & Ropars 1996), and Rocourt in Belgium (Otte 1994a).

At all these sites, we detect great variability in blade reduction systems, which prevents us from grouping them under a common denomination. The initial stages of the productions observed for the above industries rarely entailed the preparation of a crested blade. More common was the direct exploitation of the raw material's natural morphology. Unidirectional or bidirectional methods were applied to guide the removals. During the exploitation process, the knapping can follow a *tournant* or *semi-tournant* rhythm. The raw materials used can be pebbles, roundish nodules, slabs, or flake-cores. In the same way, even if flint is the most common raw material noted, other lithotypes such as quartzarenites, limestones, and jaspers were also used.

The debate on the emergence of these productions, which at present is thought to have taken place during the Middle Pleistocene, is still ongoing. Some authors have suggested that, in some specific cases, blade production could have been an opportunistic method leading to the use optimisation of the raw materials, which may have motivated the production of elongated removals instead of flakes (Conard 1990). This, however, may not have been the case in areas rich in raw materials, where the presence of these productions has also been noted. Other authors have suggested a relationship between blade production and environmental crises (Otte 1994b). The duration of the blade phenomenon and its diffusion to areas that differ greatly from one another suggests that single explanations for the origin and spread of this phenomenon need to be treated with caution.

Unlike in northern Europe, the appearance of laminar production in the south of France and the Italian Peninsula shows some delay. Even if in the south of France blades appear for the first time in MIS 5, such as at Cantalouette IV (Blaser 2012), they

become more visible during MIS 4-3, such as at the sites of Abris Du Maras (Moncel 1996), Baume Flandin (Moncel 2005), and Champ Grand (Slimak 1999).

While it is now certain that blades were produced during the Middle Paleolithic, the production of bladelets, obtained by means of an independent reduction system, was much less common and only occurred during the final phases of the Mousterian period. In Europe, some bladelet production has been noted at the sites of El Castillo and Cueva Morin in Spain (Maíllo-Fernández *et al.* 2004), at Champ Grand (Slimak & Lucas 2005) and Combe Grenal in France (Faivre 2012), at Fumane and at Grotta del Cavallo in Italy (Peresani 2011, Carmignani 2010), and at Balver Höhle in Germany (Pastoors & Tafelmaier 2010).

Recently, the presence of bladelet production noted at the site of Riparo del Molare in Italy would push back the date of its first presence to MIS 5 (Aureli and Ronchitelli in this volume).

The presence of laminar production in the Italian peninsula has not been clearly confirmed prior to MIS 4. The chronologies of the sites where the use of blade technology has been noted are in fact concentrated around the final phases of the Middle Paleolithic and, in particular, the first part of MIS 3.

In terms of its geographic distribution, blade production does not seem to be linked to a specific area or a specific environment. In Italy, blade production has been found in the south at the site of Santa Croce and at Grotta del Cavallo (Boscatto *et al.* 2011, Carmignani 2010), in the center at Grotta Breuil (Grimaldi 1996), Grotta Reali (Peretto C. Ed. 2012, Arzarello *et al.* 2004), and in the north at Riparo Tagliente (Arzarello & Peretto 2005, 2004), Fumane (Peresani 2011), Grotta di San Francesco, and Madonna dell'Arma (Tavoso 1988, Cauche 2007). The only exception seems to be the site of Cave dell'Olio, which have been dated to MIS 9 (Fontana, Peretto 2009). For the site of San Francesco the chronology remains uncertain.

Generally speaking towards the end of the Mousterian in the Italian peninsula there seems to be greater differentiation in the production systems; among these, blade production is one of the most evident expressions. The origin of this differentiation can be traced back to the wider issue concerning the key role the blade plays in relation to its morpho-functional peculiarity and the preponderant role it has in the Upper Paleolithic.

2. The site

Grotta del Cavallo in the south of Italy is a coastal cave by the Ionian Sea located approximately 10 meters b.s.l. The site contains one of the most important Middle Paleolithic archaeological sequences of the Italian peninsula.

The cave was first studied by Arturo Palma di Cesnola in 1961, who carried out the first test pit which was followed, two years later, by the first excavation campaign (Palma di Cesnola 1963). In the years that followed other excavation campaigns were carried out, highlighting the long Middle and Upper Paleolithic sequences present at the site (Palma di Cesnola 1964, 1965, 1967).

At the end of the 1970s, new works had to take place at the site, as in the interim, illegal excavations had been carried out, thus disturbing the site. It was at this time that the University of Siena, in collaboration with the Soprintendenza ai Beni Archeologici della Puglia, closed the cave. Starting in 1986, L. Sarti re-opened the site and a larg-

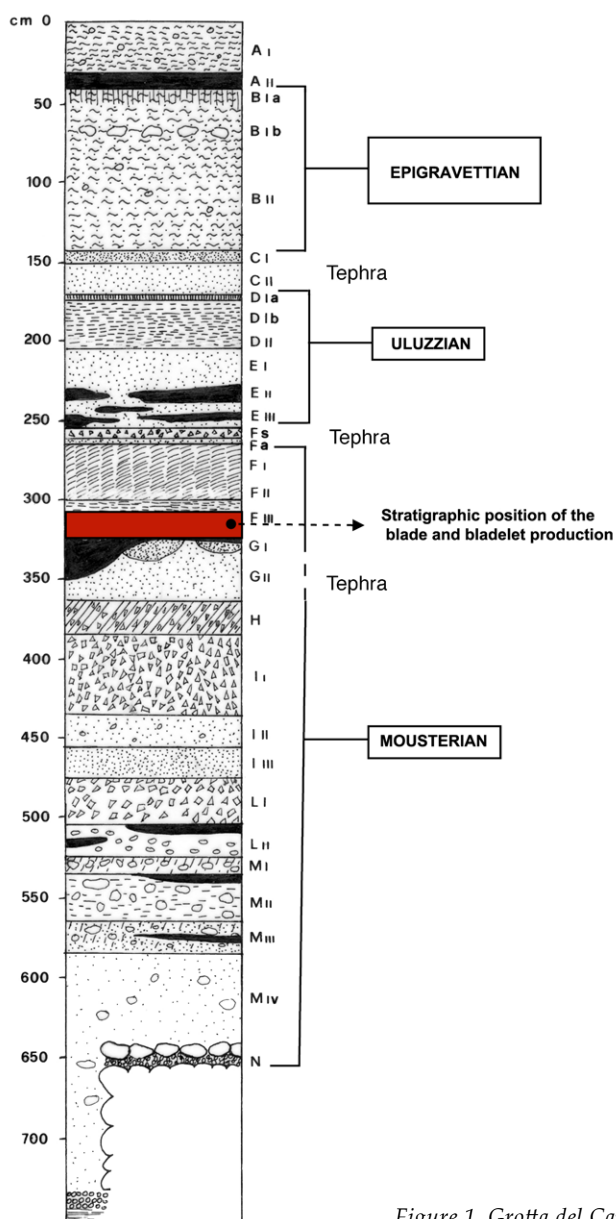


Figure 1. Grotta del Cavallo. Stratigraphic sequence.

er surface (12 sq. m) was excavated. Although the sequence proposed by Palma di Cesnola was confirmed by the new excavations, these also allowed for the stratigraphy to be described in greater detail and permitted the gathering of a greater amount of data (Sarti et al *in press*; Trenti et al *in press*).

Layer FIII, the subject of the present study, was, during its excavation, divided into five sub-levels (FIIIa, FIIIb, FIIIc, FIIId, FIIIe) based on the different concentrations of anthropic evidence.

The laminar production comes from sub-levels FIIIe and FIIId, which rest on a thick layer of tephra (Fig.1). At the top of level FIII, levels FII-FI mark the end of the Mousterian sequence (Sarti *et al.* 1998- 2000).

3. Methods

The lithic products from Grotta del Cavallo were analysed using a *chaîne opératoire* approach following Pelegrin (1991), and supported by the quantitative presentation of technological categories (Inizan *et al.* 1995). The identification of the Levallois concept follows the guidelines set out by E. Boëda (1994). In terms of the Discoid production, we used the definition put forward by E. Boëda (1993, 1991), also taking into consideration broader criteria (Peresani 1998, Slimak 2003). Given the absence of the refitting reconstruction of the reduction sequences, we used the mental refitting method proposed by Pelegrin (1995). The techniques were identified according to the experimental studies carried out by Pelegrin (1991, 2000). Volumetric and Levallois blade productions were distinguished by means of the volumetric structure analyses (Boëda 1988, 1990, 1991). Diacritical analysis was applied to cores and blanks in order to reconstruct the chronological order of the scars (Dauvois 1973).

Deeply patinated pieces on which the correct reading of the scars was not possible, and pieces with disorganized scars, the positioning of which did not allow us to reliably associate them with a specific reduction sequence, were classified as generic flakes.

4. Reduction systems of level F of Grotta del Cavallo

4.1. Main technological patterns

Sub-levels FIIIe and FIIIId produced a large amount of lithic industries mostly concentrated in the FIIIe sub-level (11192 pieces), with smaller numbers found in sub-level FIIIId (1151 pieces). A large number of pieces are undetermined fragments and generic flakes which cannot be linked to a specific reduction system. Leaving out the undetermined pieces, the diagnostic material amounts to 4908 pieces in FIIIe and 558 in FIIIId (Table 1). The production in both the sub-levels is associated with three main reduction systems: blade and bladelet volumetric systems, and a Levallois system. The Levallois system is present with the centripetal, unidirectional, bidirectional, and convergent methods. Sub-layers FIIIc and FIIIb, although they had less pieces, seem to show the same kinds of production as FIIIe and FIIIId. The Mousterian sequence ends with levels FII-FI, highlighting a clear techno-typological break compared to level FIII. In fact, FI-FII levels show the disappearance of blade production and the Levallois concept, which, in turn, are replaced by a Discoid system (Fig. 2). This break, which is visible in the reduction system, is also accompanied by a different management strategy of the raw material (Romagnoli *et al.* 2016).

The lithic industry contains a large amount of retouched tools, which will not be discussed in detail in the present study. In general, the retouched pieces in FIIIe and FIIIId mainly comprise Mousterian points and scrapers, while in levels FII and FI, the presence of denticulated pieces is marked, followed by that of splintered pieces. The latter, it should be noted, are completely absent in the lower levels (Sarti *et al. in press*).

	Level FIIe		Level FIIId	
	n.	%	n.	%
Generic flake >20 mm.	619	5,5	64	5,6
Generic flake <20 mm.	1325	11,8	119	10,3
Undetermined fragments >20 mm.	1429	12,8	94	8,2
Undetermined fragments <20 mm.	2911	26,0	316	27,5
Determined pieces	4908	43,9	558	48,5
Total	11192	100	1151	100

Table 1. Determined and undetermined pieces.

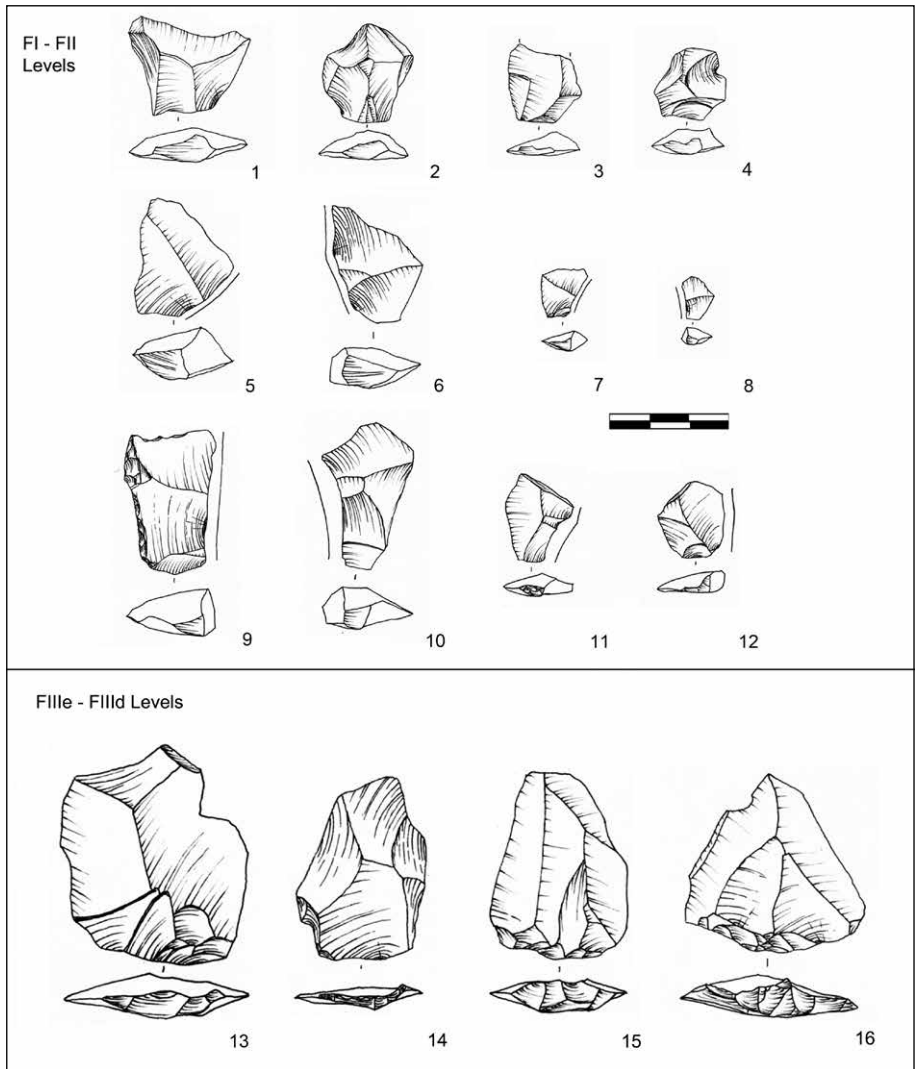


Figure 2. Flake production. (1-12) Discoïd production from levels FI – FII, (13-16) Levallois production from the FIIe-FIIId sub-levels (drawn by L. Carmignani).

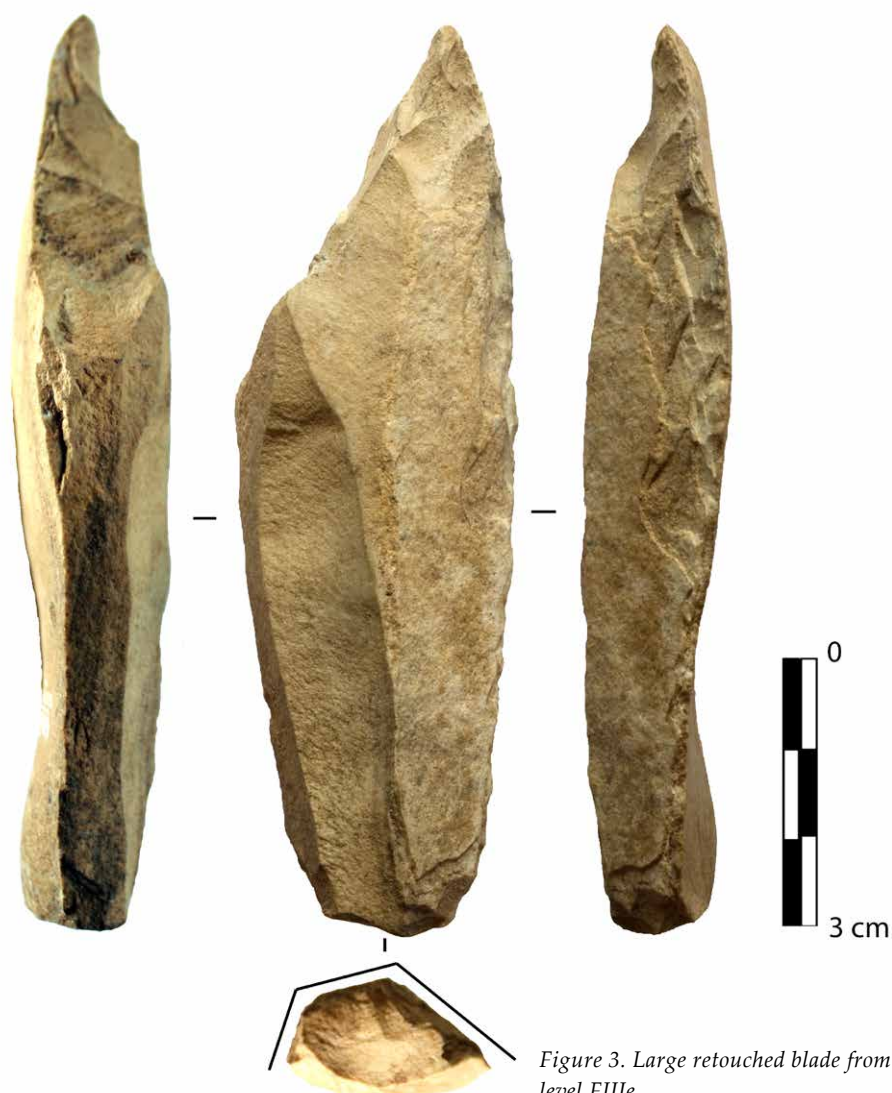


Figure 3. Large retouched blade from level FIIIe.

4.2. Blade and bladelet production systems in sub-levels FIIIe and FIIId

The blade production found in sub-levels FIIIe and FIIId comprises 783 pieces in the case of the former and 64 pieces in the latter (Table 2). Ten cores associated with this production were found in level FIIIe, whereas only two were recovered from FIIId. A large part of the blades are fragmented. Complete blades from level FIIIe amount to 254 pieces (32.4%), while 42 (65.5%) were found in FIIId (Table 3). Except for rare blades, which are over 7cm in length, the majority of the pieces indicate a small or medium-sized production (Fig. 3) (Carmignani 2010).

The raw materials used are limestone slabs collected locally a few hundred meters from the cave (Sarti *et al.* 2017). The reconstruction of the *chaîne opératoire* suggests that all stages of the production were carried out at the site (Table 4). The technique employed during the whole production process was direct percussion with the hard hammer.

	Level Fille		Level FIIId	
	n.	%	n.	%
Blade production	783	16,0	64	11,5
Flake production	4125	84,0	494	88,5
Total	4908	100	558	100

Table 2. Flake and blade production quantification.

	Level Fille		Level FIIId	
	n°	%	n°	%
Complete blades	254	32,9	42	67,7
Distal fragments	96	12,4	2	3,2
Mesial fragments	104	13,5	8	12,9
Proximal fragments	140	18,1	9	14,5
Apex broken	90	11,6	1	1,6
Base broken	86	11,1	0	0,0
Siret fracture	3	0,4	0	0,0
Total	773	100	62	100

Table 3. Integrity of blade production.

	Level Fille		Level FIIId	
	n.	%	n.	%
Blades with cortex >50 %	57	9,7	2	3,8
Blades with cortex <50 %	92	15,6	10	18,9
Blades "en tranche"	9	1,5	0	0,0
Unilateral crested blades	14	2,4	0	0,0
Bilateral crested blades	12	2,0	2	3,8
Debordant blades	85	14,4	8	15,1
Blades	277	47,0	28	52,8
Rejuvenation blades	33	5,6	1	1,9
Cores	10	1,7	2	3,8
Total	589	100	53	100

Table 4. Blade production techno-types and cores. Excludes undetermined broken blades.

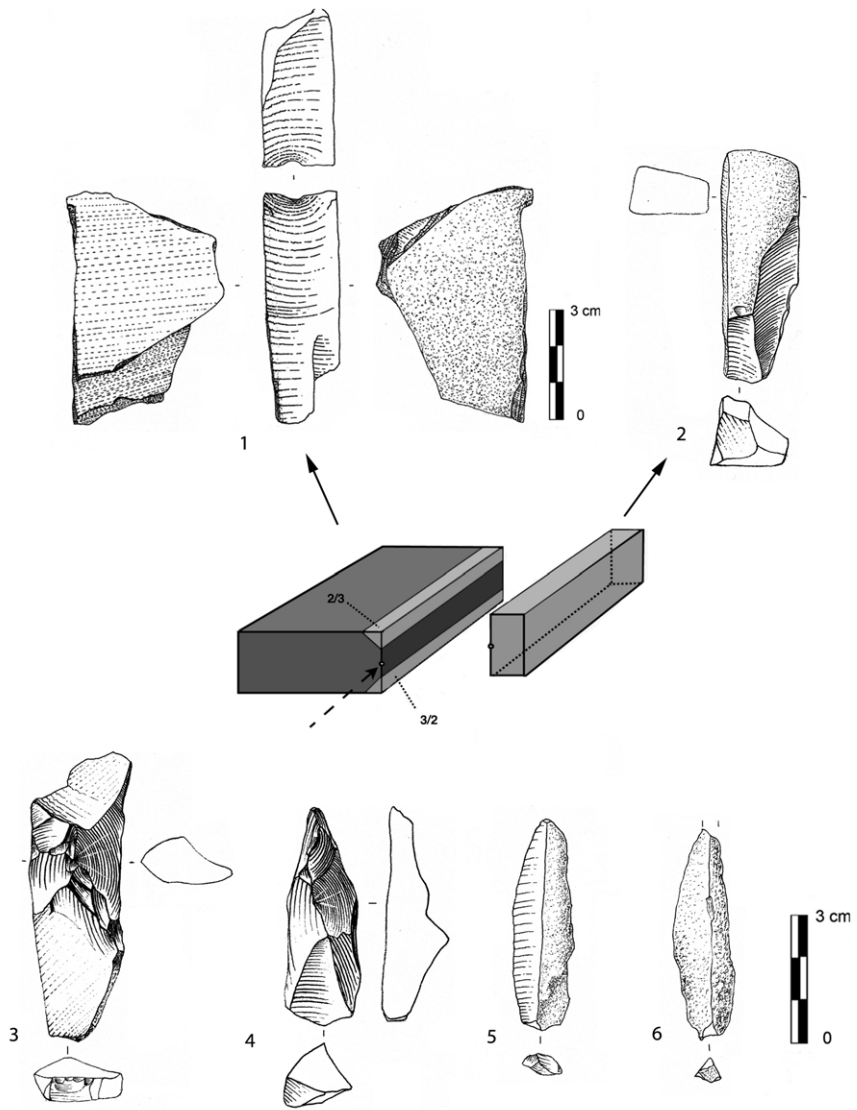


Figure 4. Initial production stage. (1) Core “sur tranche”, (2) blank with quadrangular cross section, (3, 4) crested blades with two prepared versants, (5, 6) cortical blades (drawn by C. Tessaro; models by C. Carmignani).

The collected raw materials have a natural prismatic or sub-prismatic morphology that is suited to the direct knapping of blades without the need for a particular preparation of the core. When the configuration of the cores is present, it does not show any standardization, but instead, a wide range of technical solutions are used to correct the eventual imperfections of the block.

The presence of many cortical platforms indicates a direct extraction of removals using a natural striking platform. Preparation of the striking platform takes place at the point when the natural angle does not fulfil the technical requirements.

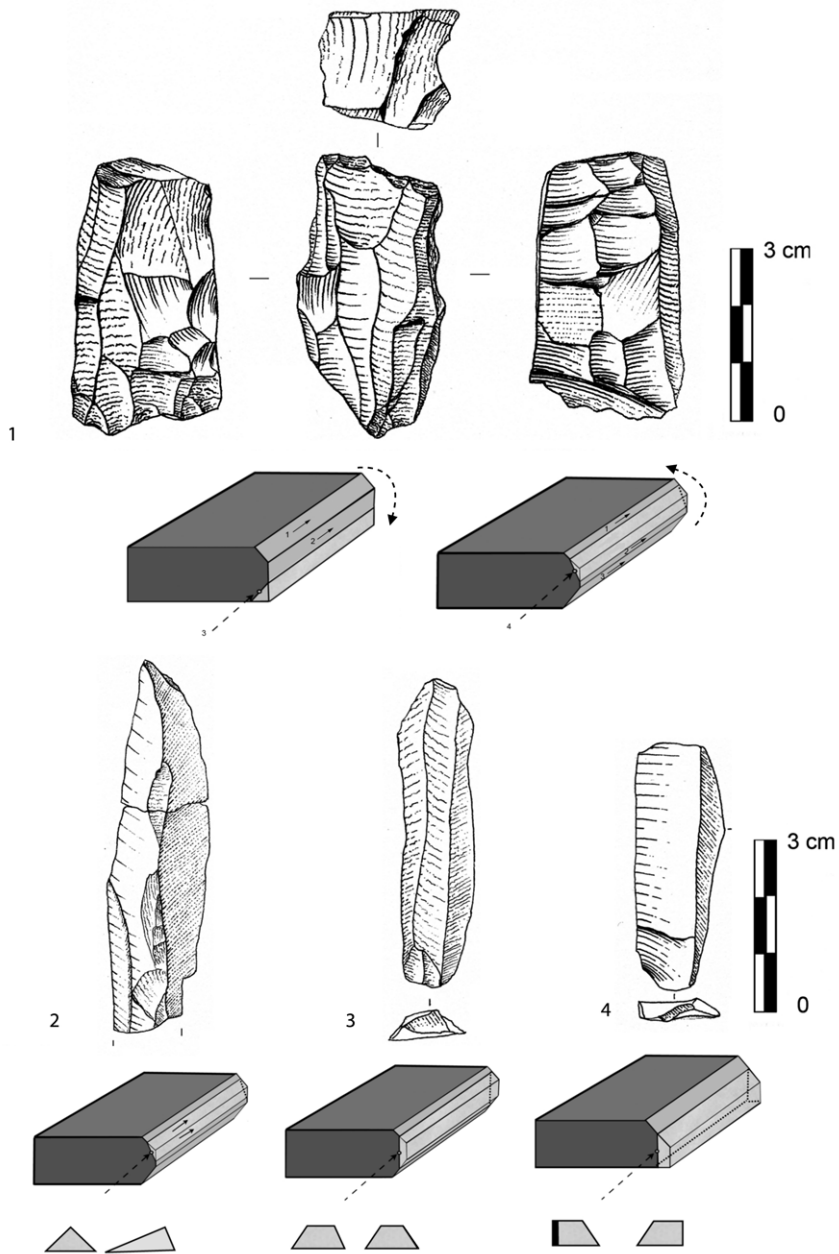


Figure 5. Main production stage. (1) core, (2, 3) blade with symmetrical cross section (4) blade with asymmetrical cross-section (drawn by C. Tessaro, models by C. Carmignani).

In the majority of cases, the initial knapping phase is based on the direct extraction of a cortical blade that exploits the dihedral angle naturally present on the slabs (Fig. 4 no. 6).

A second option, which is very rare, consists of the preparation of a crested blade, which is used as a guide in the first detachment (Fig. 4 nos 3, 4).

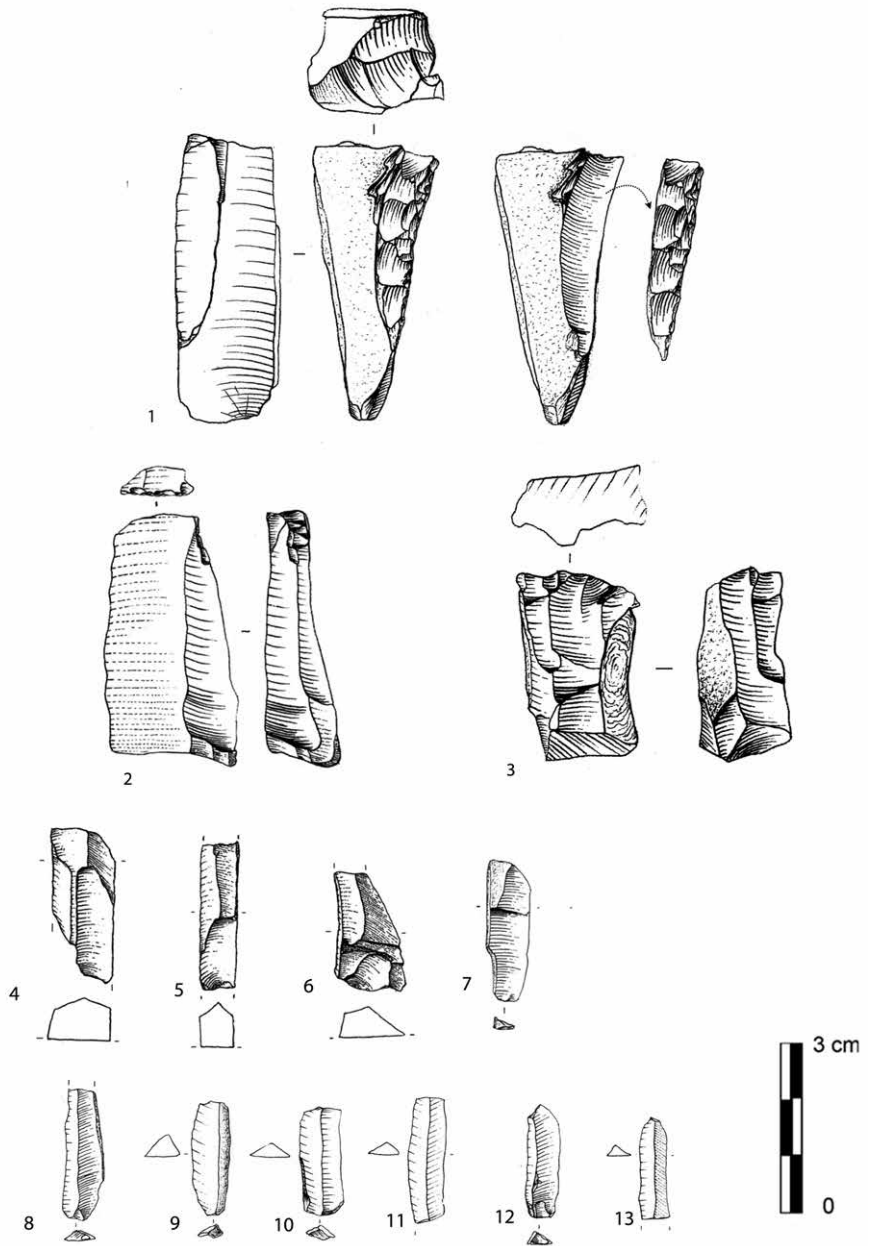


Figure 6. Bladelet production. (1) Core-flake with one refitted bladelet, (2, 3) Bladelet cores (4-7) rejuvenation bladelets, (8-13), bladelets (drawn by C. Tessaro).

Another method, used to initiate the slab exploitation process, includes removing a *tranche*, creating two new dihedrals (Fig. 4 nos 1, 2). This technical solution is also employed to correct eventual accidents occurring during the *débitage* stage, making it possible to continue the exploitation.

The maintenance of the lateral convexities of the flaking surface is carried out through the extraction of *débordant* blades (pre-determinate/pre-determinant),

which guide the exploitation following a semi-tournant rhythm. In rare cases, the creation of a second striking platform opposite the main one is carried out in order to manage the distal convexity. The production system illustrated allows the obtention of two techno-types of blade: blades with symmetrical cross sections and blades with asymmetrical cross sections or debordant blades (Fig. 5 nos 2, 3, 4).

The blades have parallel edges and a straight profile. The direct production of blades with convergent edges is sporadic and can be considered as not predetermined. The convergence is instead often obtained through retouch, which in some cases, modifies the distal part of the blades (Fig. 3).

In sub-level FIIIe, of the 773 elements (intact and fragmented) that can be attributed to blade knapping, 160 have been modified through retouch with a transformation rate of 20.7%.

Besides laminar production, we also encounter the presence of an independent production kind aimed at producing bladelets through the exploitation of flake-cores. The exploitation of bladelet cores is carried out through a short series of unidirectional detachments. We can distinguish three types of volumes used as cores: simple flakes (Fig. 6 n. 2), flakes *with* a quadrangular cross section deriving from an exploitation “*sur tranche*” (Fig. 6 n. 1), and a small number of slab fragments (Fig. 6 n. 3). As is the case in blade production, the configuration of the bladelet cores on flakes is based on the use of some technological expedients that require minimal preparation of the cores.

The initial stage of bladelet production usually entails a first removal that exploits one of the edges of the flake. The preparation of a one-sided crested-bladelet has been noted, but this is a rare occurrence (Fig 6 n. 1).

The lack of a systematic management strategy of the core and, more specifically, a lack of control of the distal convexity often leads to the abandonment of the bladelet cores after a short series of detachments. Flaking accidents are solved through the extraction of a rejuvenation bladelet with the aim of reinitializing the knapping surface, allowing a second series of detachments (Fig. 6 nos 4, 5, 6, 7). Only one core shows a more elaborate management of the volume by rear-lateral removals aimed at the center of the flaking surface (Fig. 5 n. 1).

5. Blade and bladelets in the Italian peninsula during the Middle Paleolithic: A possible summary?

It is important to begin by noting that our attempt to carry out a precise comparison between the blade production of Grotta del Cavallo and other similar evidence present in the Italian peninsula turned out to be an arduous task for different reasons: lack of homogeneity among the data sets, methodological differences in the study of the lithic industries, and lack of a uniform terminology.

Generally, under the term ‘blade’ or ‘bladelet’, are all the elements that in an undifferentiated way mainly correspond to a morphometric feature (length > 2width). According to us, this feature is not sufficient to attribute with certainty a group of elongated products to a real systematic and pre-determinate production of blades. A small number of elongated pieces can be obtained in a non-systematic way, even

through some reduction systems that are not specifically orientated towards production of blades.

In order to work with a corpus of data that is as homogeneous as possible and for a coherent comparison to be made, we only considered reliable those lithic industries that have been analysed through a technological approach.

The blade production of Grotta del Cavallo is placed within a well-known kind of variability known from the production systems of the Middle Paleolithic. In Italy, from a geographic point of view, volumetric blade productions are present with no particular trends from north to south: in the Apulia region, there are Grotta Santa Croce (Arrighi *et al.* 2009) and Riparo Oscurusciuto (Boscatto *et al.* 2011), Grotta Reali in Molise (Peretto 2012), Grotta Breuil in Lazio (Bietti & Grimaldi 1993, Grimaldi 1996, Lemorini 2000), and Riparo Tagliente (Arzarello & Peretto 2004, 2005) and Grotta Fumane (Peresani 2011) in the Veneto region.

The technique systematically used is that of direct percussion with a hard hammer. The main method used, with a few specific exceptions, is the unidirectional kind.

As observed in other parts of Europe, the raw material used does not seem to hinder nor favour the production of elongated frames. In fact, volumetric laminar productions are applied on pebbles of different morphologies and dimensions, as well as on slabs, flakes-cores, or nodules (Table 5). We can say the same thing concerning the lithology of the raw materials used, which include flints, jaspers, quartzarenites, or limestones. The initial knapping phases exploit, in almost the majority of cases, the natural morphology of the blocks. Initial configuration of the volume seems to be based on the selection of the correct morphology of the available raw materials. In a few rare cases, such as at Grotta del Cavallo or again at Grotta Reali, the configuration phase can provide the preparation of a crested blade. The recourse to this technical expedient, when present, is, however, quantitatively minor and never assumes a standardized and systematic role. At Grotta del Cavallo, the construction of a crested blade is mostly applied in the advanced production phase to correct flaking accidents.

In terms of quantities, laminar productions are always in the minority and are consistently associated to flake productions obtained by different production systems, among which the Levallois, Discoid, and the SSDA seem to be the most recurring (Table 5).

In the Italian peninsula, during MIS 4 and MIS 3, the spread of blade production by volumetric exploitation seems to coincide with a wider phenomenon, which can be summarised, in general terms, as a tendency towards searching for elongated products.

In fact, during this same time period, a tendency of the Levallois concept to produce blades by unidirectional or bidirectional methods seems to emerge (Table 5). As was noted for the volumetric laminar production, this aspect has also been noted for the entire Italian peninsula, showing no clear patterns: in the Liguria region, at the sites of Riparo Mochi and Barma Grande (Yamada 1997, 2004), in the Veneto region at Fumane (Peresani 2011), in the Campania region at Riparo del Poggio (Caramia, Gambassini 2006) and Castelcivita (Gambassini 1997), and in the Apulia region at Riparo dell'Oscurusciuto (Boscatto *et al.* 2011).

This apparent parallelism, which emerges as an interesting research theme, especially in terms of techno-functional aims, has not yet been fully explored.

Regions	Site name	Levels	Blade reduction systems	Raw material	Blade configuration systems	Blade methods	Mains flakes reduction systems associated	Chronology	MIS	References
Liguria	Barma Grande	I3-1	Levallois (blade)	Pebbles	-	-	Discoid	-	3	Yamada 1997
	Riparo Mochi	I sublevels 51-43	Levallois (blade)	Pebbles	-	-	Centripetal Levallois	-	3	Yamada 2004
	San Francesco	-	Volumetric (blade)	-	Crested blade	Unipolar?	-	-	?	Tavoso 1988
Veneto	Madonna dell'Arma	levels. I – II	Levallois (blade) + Volumetric (blade)	Pebbles	-	-	Centripetal Levallois	str.II 73100±4400 BP	4	Cauche 2007
	Riparo Tagliente	I37-34	Volumetric (blade) - Levallois (blade)	Pebbles Nodule	Selection of natural morphology	Unipolar	Centripetal Levallois "Opportunistic" sensu Arzarello 2004"	-	3	Arzarello, Peretto 2004,2005
	Fumane	A5-A6	Volumetric (blade/bladelet)	Blocks Nodule Slabs	Selection of natural morphology	Unipolar	Centripetal Levallois	A5 14C 40.150±350 A5 14C 41.650±650 A5 14C 40.460±360 A6 U/Th e ESR 38.000±4000	3	Peresani 2011
Tuscany	Grotta del Capriolo	INF SUP	Levallois (blade)	Pebbles Blocks	-	Unipolar	Centripetal Levallois	39.000 U/Th BP	3	Dini,Koheler 2009
	Buca della Iena	A1+B1 B2 B3	Levallois (blade)	Pebbles Blocks	-	-	Centripetal Levallois	41.000 U/Th BP	3	Dini,Koheler 2009
Campania	Riparo del Poggio	9-10	Levallois (blade)	Pebbles	-	-	Centripetal Levallois	str.9 43800±3500 BP	3	Caramia,Gambassini 2006
	Grotta di Castelcivita	XIII-VI	Levallois (blade)	Pebbles	-	Unipolar	Centripetal Levallois	Liv XI 39.100±1300 BP 42.700±900 BP	3	Gambassini 1997
Lazio	Grotta Breuil	3,4,5,6	Bipolar percussion (elongated flakes /blade)	Pebbles	Selection of natural morphology	Unipolar Bipolar	Centripetal reduction systems	US 3-6 36.600 ± 2700 ka BP US 4-7 33.000 ± 4000 BP US 5 35.000 BP (non cal.)	3	Grimaldi 1996 Lemorini 2000 Grimaldi,Spinapolice 2010

Regions	Site name	Levels	Blade reduction systems	Raw material	Blade configuration systems	Blade methods	Mains flakes reduction systems associated	Chronology	MIS	References
Molise	Grotta Reali	2abc 2B/2γ 5	Volumetric (blade/ bladelet) + Levallois (blade)	Slabs Pebbles Nodule	Selection of natural morphology + Crest (rare)	Unipolar	Discoid Levallois (Uni-Bip; Centr; Linear) "Opportunistic" sensu Arzarello 2004"	US 2γ 33.544 ± 540 BP (non cal.) US 5 35.650 ± 600 BP (non cal.) 36.620 ± 260 BP (non cal.) 40.040 ± 590 BP (non cal.)	3	Peretto 2012 Arzarello et al. 2004
Apulia	Grotta di S.Croce	546 535	Volumetric (blade/ bladelet)	Pebbles, Nodule	Selection of natural morphology	Unipolar	Discoid	-	4	Arrighi et al. 2009
	Oscuruscuto	1.2.3	Levallois (blade)	Pebbles	Selection of natural morphology	Unipolare	Centripetal Levallois	US 1 38.500±800	3	Boscato et al. 2011 Villa et al. 2009
	Grotta del Cavallo	Filid File	Volumetric (blade/ bladelet)	Slabs	Selection of natural morphology + Preparation of crested blades	Unipolar	Levallois (Uni-Bip; Centr; Conv.)	-	4-3	Carmignani 2010

Table 5. Sites with blade production during the MIS 4/3 in the Italian peninsula.

In the case of Grotta del Cavallo, the unidirectional and bidirectional Levallois methods, although present, are aimed at the production of quadrangular and sub-quadrangular flakes, which only sporadically reach an index of laminar lengthening. The systematic and predetermined production of blades has been attempted exclusively through the laminar volumetric system. At Grotta del Cavallo, we seem to glimpse a clear distinction, in terms of techno-functional aims, between volumetric blade production and unidirectional-bidirectional Levallois methods. In other cases, as for instance at Riparo Tagliente, both the production systems, Levallois and volumetric, generate blades, but also, in this case, with distinct techno-functional structures (Carmignani *in press*).

Regardless of the production systems employed during MIS 4-3, a common macro phenomenon seems to take shape, which finds its uniqueness in creating blades using different reduction systems; in the case of the Levallois through a re-adaptation of the pre-existing volumetric concept, while, in the case of the volumetric systems, through completely innovative production systems.

In this respect, it will be important in our opinion to compare, in greater detail, the ephemeral bladelet production that appears during the last phase of the Middle Paleolithic with that of the Upper Paleolithic. A recent work that has highlighted a connection between the Châtelperronian and Pro-Aurignacian bladelets at the site of Quinçai (France) encourages future research to point in that direction (Roussel *et al.* 2016).

The last issue that we would like to discuss concerns the geographic setting of these productions. The Middle Paleolithic of the Italian peninsula is systematically found in cave or shelter sites. This differs to the blade production of northern Europe, which is found in open-air sites (Table 5).

It remains to be verified whether this difference is the result of research bias or if instead these locality differences are actually linked to different population dynamics between the central-north and south areas of Europe.

The problems connected to the spread of the laminar phenomenon in the final Mousterian phases in the Italian peninsula need to be investigated, both in terms of the innovative element it represents and its relationship with the pre-existing techno-cultural substratum. Given the current state of research, and even if some general features are emerging, this overview does not allow us to frame the laminar phenomenon within a univocal model. The chronological delay that we see between the laminar production of the Italian peninsula, apparently concentrated in MIS 3, and that of the south of France, already present starting from MIS 5 (*e.g.* Blaser *et al.* 2012), leaves us with different possible scenarios. A comparative study of the laminar production of southern Europe will clarify whether we are facing a phenomenon of technical convergence with different invention and spread centres or, if instead, this phenomenon can be tracked to a single innovative centre from which it spread to other peripheral areas.

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