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LITHIC PRODUCTIONS DURING THE FIRST HALF OF THE MIDDLE PLEISTOCENE (MIS 19-12) IN THE ITALIAN PENINSULA: AN OVERVIEW.

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ABSTRACT: Archaeological record of the Italian peninsula during the first half of the Middle Pleistocene is characterised by a limited number of sites. In the last decade, new systematic research allowed to refine chronostratigraphies and to improve the contextual and technological information. Here, we report an overview of the Italian archaeological sites between MIS 19 and MIS 12 with the main aim to evaluate the current state of our knowledge on the technological behaviours from the earliest Middle Pleistocene sites where *Homo heidelbergensis* appears to the emergence of hominins with Neanderthal-like morphology.

Keywords**:** Lower Palaeolithic, Italian peninsula, Middle Pleistocene, lithic technology, small flaking and large cutting tools.

1. INTRODUCTION

Archaeological evidence ascribed to the first half of the Middle Pleistocene has conspicuously improved over the last decades in Western Europe. However, notwithstanding increased research and more discoveries, the available information is highly fragmented and insufficient at different levels.

From a technological perspective, the early Middle Pleistocene in Western Europe is marked by the emergence of the Acheulean technology (e.g., Barsky & de Lumley, 2010; de Lumley et al., 1984; Despriège et al., 2010; Moncel et al., 2019, 2020; Piperno, 1999; Scott & Gibert, 2009), that some authors linked to the first appearance datum of *Homo heidelbergensis* (e.g., Moncel et al., 2019; Stringer, 2012).

Nevertheless, assemblages lacking large cutting tools (LCTs[1]) and multi-layered sites with an alternation of lithic series with or with no or very rare LCTs are known in Western Europe and they do not pattern into a two-phase periodization (Abruzzese et al., 2016; Ashton et al., 1992; Aureli et al., 2015, 2016; Biddittu, 1971, 1972; Carbonell et al., 1999; Cauche et al., 2004; Crovetto, 1993; Gallotti & Peretto, 2015; Moncel et al., 2020; Nicoud et al., 2015, 2017, 2020; Parés & Pérez-Gonzalez, 1999; Parfitt et al., 2005; Peretto, 1994; Piperno, 1999; Preece & Parfitt, 2012; Rocca et al., 2016, 2019, 2020; Rose, 1992; Santagata, 2016; Segre & Biddittu, 2009; Tuffreau & Lamotte, 2010).

In the Italian peninsula, there are no archaeological sites between Marine Isotope Stage (MIS) 19 and MIS 17 and sites recorded in an indisputable stratigraphic context between MIS 17 and MIS 12 are few and fragmented both temporally and spatially. However, different interpretations have been proposed to draw the tempos and modes of the settlement in this time-span and the related technical behaviours (e.g., Grifoni & Tozzi, 2006; Orain et al., 2012).

Here, we present an update of the data available in scientific literature on those sites systematically investigated and with a constrained chronological framework (Fig. 1). Our main aim is to draw up an overview of the

[1] LCTs are intended here as shaped or retouched tools with a length or width > 10 cm. They include massive scrapers, handaxes, picks, bifaces, and cleavers. Bifaces are intended in a technological perspective as LCTs whose morphology «résulte de l'aménagement simultané de deux convexités, de manière à ce que l'une soit à l'image de l'autre en fonction d'un plan d'équilibre bifacial […] De l'intersection de ces deux convexités naît une silhouette «lissée» par retouche, qui se distribue par rapport à un plan d'équilibre bilatéral» (Roche & Texier, 1991: 102). Cleavers (sensu Tixier, 1956) are intended here as LCTs obtained either by flaking only, or by flaking followed by shaping. The cutting edge must be left unretouched, i.e. it is the outcome of the flaking of the blank. Bifacial pieces with a bit achieved by shaping or by lateral tranchet blow technique are not cleavers but beveled handaxes (Inizan et al., 1999).

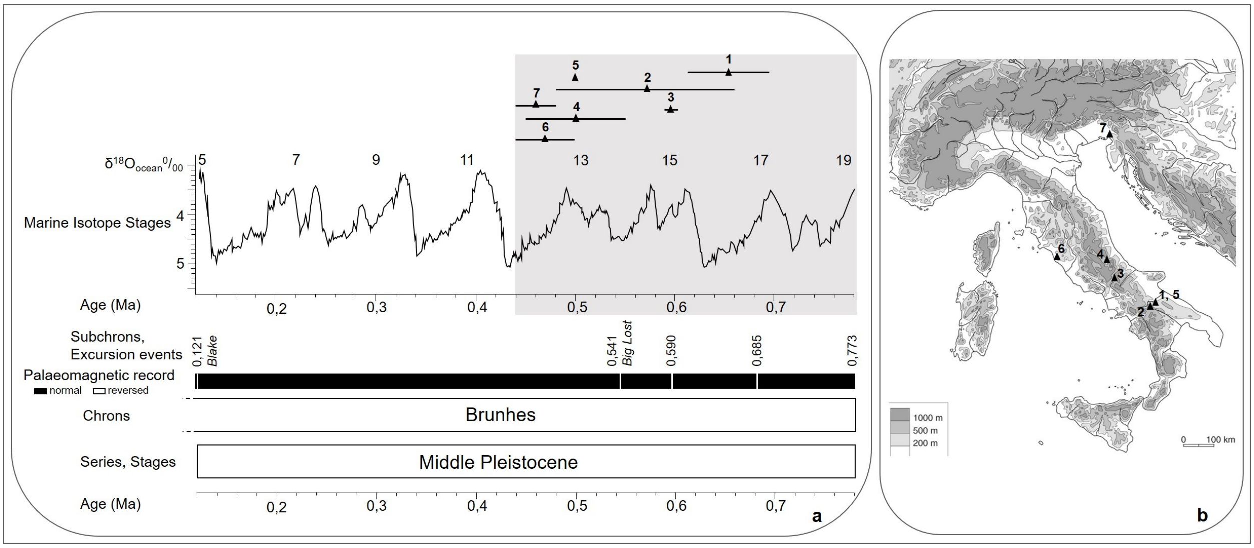

Fig. 1 - Middle Pleistocene Italian sites analysed, in relation to the chronology (a) and to the geographical location (b). 1. Notarchirico (Basilicata); 2. Cimitero di Atella (Basilicata); 3. Isernia La Pineta (Molise); 4. Valle Giumentina (Abruzzo); 5. Loreto (Basilicata); 6. Ficoncella (Lazio); 7. Visogliano (Friuli Venezia Giulia). See main text for references on archaeological site chronology. Chronological chart modified from Cohen & Gibbard (2019) (graphic processing: G. Lembo).

current state of knowledge on site context, chronostratigraphies, faunal composition, and, in particular, on lithic analyses in the Italian peninsula between the early Middle Pleistocene sites (MIS 17/15; Piperno, 1999; Moncel et al., 2020) where *Homo heidelbergensis* appears and the emergence of hominins with Neanderthal-like morphology, approximately dated to MIS 12 (Zanolli et al., 2018).

2. AN OVERVIEW OF THE MIDDLE PLEISTOCENE SITES IN ITALY DURING MIS 19 - MIS 12

2.1. Notarchirico (Basilicata, southern Italy)

The archaeological site of Notarchirico is located in the Venosa basin (Basilicata), which covers more than 60 km and is known for its prehistoric heritage since the 19th century (Bulgarelli et al., 1999). The fluvial-lacustrine Middle Pleistocene succession of this basin represents the sedimentary filling of a palaeovalley located between the Vulture volcano and the Murge massif (Apulian foreland) (Caruso et al., 2012). The basin fill is composed of three litho-stratigraphic units (Lefèvre et al.,1994,1999, 2001, 2002; Raynal et al., 1998) which can be correlated with the sequence of eruptive units produced by Monte Vulture (Giannandrea et al., 2006; La Volpe & Principe, 1989, 1994). The oldest unit, the Fonte del Comune Formation, is contemporary with the initial phases of volcanic activity. It is surmounted by two embedded volcano-sedimentary units, the Piano Regio and Tufarelle Formations, contemporary with the major early Middle Pleistocene phases of the volcanic activity of Monte Vulture.

The site of Notarchirico was discovered in 1979 and excavated from 1980 to 1995 by M. Piperno (Piperno, 1999). The stratigraphic sequence is mainly composed of volcanoclastic sediments deposited and reworked in an alluvial environment belonging to the Piano Regio Formation (Lefèvre et al., 2010). During Piperno's excavations in the 1980s, several archaeosurfaces (α, A, A1, B, C, D, E, E1, F, G, G1, H, and I) were discovered in a seven-metre thick fluvial-derived sedimentary sequence rich in volcanic materials from the neighbouring Monte Vulture stratovolcano (Lefèvre et al., 2010). Above layer F several direct tephra fallouts are located (Raynal et al., 1999; Vernet et al., 1999), which form the Notarchirico Tephra Complex (levels 2-1 to 2-5), dated to 640±40 ka by thermoluminescence on quartz (Pilleyre, 1991; Pilleyre et al., 1999). At the top of the site, levels 1-6 are composed of reworked volcanic sands, which geochemical composition highlighted their similarity to a major tephrostratigraphic marker of the Tufarelle Formation (Pereira et al., 2015; Raynal et al., 1998).

New radio-isotopic data assessed that the whole Notarchirico sequence was deposited in probably <70 ka, between 670±4 ka (14 ka) and 614±4 ka (12 ka) (Pereira et al., 2015), i.e., mainly during the glacial MIS 16, confirming the previous lithostratigraphic analyses (Lefèvre et al., 1999).

Since 2016, new fieldwork at Notarchirico, directed by M.-H. Moncel, opened a 30-m-long trench on the side of Notarchirico hill, at the base of the previously studied sequence. Four archaeological layers were identified: three of them correspond to layers F, G, and I of the Piperno's excavations; layer J was discovered at the very base of the sequence (Moncel et al., 2020). $^{40}Ar/^{39}Ar$ constrain these layers between 668±6 ka and 695±6 ka (Moncel et al., 2020).

The faunal assemblage belongs to the 'Ponte Galeria' faunal unit. The main species found are *Elephas* (=*Palaeoloxodon*) *antiquus*, *Dama clactoniana*, *Bos primigenius* and *Bison schoetensacki*. The lower layers (E/E1, F, and G) yielded poorly preserved faunal fragments. Fauna from the higher layers (a, sub-a, A/A1, B and D) is in better condition, including new species such as *Cervus elaphus* and *Megaloceros solilhacus*. Faunal list of the Moncel's excavation is almost similar to that of the youngest layers α and A of Notarchirico (Cassoli et al., 1999; Moncel et al., 2020). Two species are newly reported: *Hippopotamus antiquus* in layers G and I1, and *Macaca sylvanus* ssp. in layer G (Moncel et al., 2020).

Several species of micromammals were identified, principally in horizon E1 (*Pliomys episcopalis, Chionomys nivalis, Microtus* sp. and *Arvicola cantiana*), indicating a cold climate typical of a Middle Pleistocene glacial period in the Italian peninsula (Sala, 1999). An open and cold environment is confirmed by palynological analysis (Cattani, 1996).

In scientific literature, Notarchirico is recurrently presented as a site «characterised by repeated periods of occupation, for the most part related to butchery activities, as illustrated by the Elephant Butchery area […] (Piperno & Tagliacozzo, 2001)» (Pereira et al., 2015: 641). Nevertheless, an archaeozoological analysis has been performed only on the faunal remains from layer α, showing that faunal remain accumulation evidences a multiple origin (Tagliacozzo et al., 1999), and from layers F, G, I1, I2, and J where no clear cut marks or anthropic bone breakages were identified (Moncel et al., 2020). The association between artefacts and bones in the Elephant Butchery area (layers A-A1-B) has been taken as granted than proved, even if Lefèvre et al. (1994: 109) asses that: «[…] ces observations conduisent à distinguer la mise en place des sédiments de celle du crâne (pas d'apport en masse), mais ne permettent pas d'aller plus loin en ce qui concerne le mode de dépôt de ce dernier (flotté puis échoué, ou mort sur place), à plus forte raison donc les causes de sa mort […] Reste posée la question de la réalité de l'association éléphant/restes lithiques. Si association il y a, tous les objets présents dans la lentille de gravier lui appartiennent-ils? Sinon, comment les distinguer?». Thus, the association between elephant remains and lithic artefacts is still an open issue.

In the upper part of the sequence (layer α), a fragment of a human femur, attributed to *Homo heidelbergensis*, was discovered in 1985 (Mallegni et al., 1991; Pereira et al., 2015).

The lithic artifacts recorded during excavations at Notarchirico are about 3600, approximately 2500 from Piperno's excavation and 1152 from Moncel's excavation (Tab. 1). Part of the artefacts belonging to Piperno's excavation were left on the archaeological surfaces for museum purposes (Piperno, 1999). Notarchirico is well known for the alternance of layers with "bifaces" (A, A1, B, D, F, G/G1, I2) and layers lacking "bifaces" (α, C, E, E1, H, I, J). Two type of raw materials of local origin, abundantly available in the paleochannels, have been used: silicite[2] pebbles, cobbles, nodules and tablets, as well as limestone cobbles and rare boulders. Flakes and cores are mainly on silicite and the heavy-duty component (including LCTs) mainly on limestone cobbles (Piperno, 1999; Moncel et al., 2020).

The lithic assemblages of the different archaeological layers have not been entirely studied and according to a homogeneous approach (Tab. 1). If the LCTs have recently been analysed in a technological perspective (Moncel et al., 2019; Santagata, 2012, 2016), and some of them according to a techno-functional approach (Nicoud, 2011), small flaking is known for layers B, E/E1 (Santagata, 2016), F, G, I1, I2, J (Moncel et al., 2020). Only the artefact assemblage from layer α have been entirely analysed following a typo-metrical approach (Piperno, 1999).

In the basal part of the sequence (layers F, G, I1, I2, J) cores are unifacial, unifacial centripetal-cordal, and multifacial. They are mainly on silicite, very few on limestone. Flaking follows the natural shape of the silicite nodules (semi-rotation of the cores to exploit more than one flaking surface), rectification of the striking platform is limited, and the technique is the freehand percussion.

According to the flaking methods, flake butts are cortical or plain, rarely dihedral or facetted. Flaking products as well as raw nodules are retouched (5 to 20%) on one or several edges by marginal, abrupt or denticulate retouch. Convergent tools are rare.

The heavy-duty component is composed by unifacial shaped cobbles (chopper-cores), some of which are pointed. Several LCTs on limestone cobbles or flakes and large silicite nodules were found (Tab. 1). The shaping involves a large part of the periphery and surface of the artefacts managing the bifacial volume and the equilibrium of the two faces and producing symmetrical or plano-convex cross-sections. Sometimes retouch regularizes the edges.

In layer B, small flaking on silicite and limestone includes chopper-cores, multifacial multidirectional cores and bipolar-on-anvil cores. Shaping produces: 1) choppers on limestone cobbles, some of them with two convergent edges creating a point; 2) handaxes on limestone and silicite, usually shaped on cobbles, showing a high morpho-technical variation; 3) cleavers-like on cobbles (Santagata, 2016). The latter are not cleavers *sensu stricto* (Tixier, 1956), because they do not show an unretouched transversal cutting edge belonging to flaking.

In layers E/E1, silicite cores with limited cortex, mainly unifacial unidirectional with a cortical striking platform, are smaller than those in layer B. Their size seems more related to the very small size of the blank than to an overexploitation. Cores with bifacial and multifacial irregular exploitation are also present and usually overexploited. There are no LCTs in these layers and shaping is limited to rare bifacial choppers. Some flakes were retouched into denticulated scrapers (Santagata, 2016).

Only data on LCTs are available for the other layers. Moncel et al. (2019) published the analysis of the LCTs identified in the Notarchirico sequence and assessed that «hominins had the capacity to manage bifa-

[2] In scientific literature, the terms flint and chert are controversial depending on whether they are used by geologists, archaeologists, petrographers or sedimentologists. Following Delvigne et al. (2020), here we use the general term silicite for sedimentary silicified rocks of chemical, biochemical or diagenetic origin of various types including flint, chert, silcrete, and jasperoid.

Site	Environmental setting	Level	m^2	Dating	MIS	N. lithic pieces	N. LCTs	Raw material	Lithic analysis	N. faunal remains	Hominin remains
Notarchirico Basilicata, Southern Italy	Fluvially emplaced sedimentary sequence	α (Piperno's excavation)	~70	Between 695±6 ka and 612±5 ka ($^{40}Ar/^{39}Ar$) (Pereira et al., 2015; Moncel et al., 2020)	End of 17 – beginning 15	950 (Piperno, 1999)	0 (Piperno, 1999); 8 in A-Alpha- Base A1 combined (Moncel et al., 2019)	Small silicite nodules and limestone cobbles from secondary sources	Typometrical (Piperno et al., 1999). Technological analysis only of bifacial and bifacial tool (Moncel et al., 2019)	1606 (Piperno, 1999)	*Homo heidelbergensis,* a femur fragment (Mallegni et al., 1991; Pereira et al., 2015)
		A (Piperno's excavation)	~120			316 (Piperno, 1999)	2 (Piperno, 1999)		Technological analysis only of bifacial and bifacial tool (Moncel et al., 2019)	544 (Piperno, 1999)	
		A1 (Piperno's excavation)	24			41 (Piperno, 1999)	9 (Piperno, 1999)		Technological analysis only of bifacial and bifacial tool (Moncel et al., 2019)	85 (Piperno, 1999)	
		B (Piperno's excavation)	133 (remains left in situ on 105)			351 (Piperno, 1999)	10 (Piperno, 1999) 11 (Moncel et al., 2019)		Technological analysis of 106 artefacts (Santagata, 2012, 2016)	26 (Piperno, 1999)	
		C (Piperno's excavation)	20 (remains left in situ on 8)			78 (Piperno, 1999)	0 (Piperno, 1999)		Not analysed	35 (Piperno, 1999)	
		D (Piperno's excavation)	25 (remains left in situ on 10)			300 (Piperno, 1999)	2 (Piperno, 1999) 2 (Moncel et al., 2019)		Technological analysis only of 2 bifaces (Moncel et al., 2019)	26 (Piperno, 1999)	
		E (Piperno's excavation)	44			155 (Piperno, 1999)	0 (Piperno, 1999)		Technological analysis of 106 artefacts (Santagata, 2012, 2016)	207 (Piperno, 1999); 204 from layers E and F combined (Moncel et al., 2020)	
		E1 (Piperno's excavation)	20			286 (Piperno, 1999)	0 (Piperno, 1999)			143 (Piperno, 1999)	
		F (Piperno and Moncel's excavations)	30 (Piperno's excavation), 8 (Moncel's excavation)			? (Piperno, 1999) 439 (Moncel et al., 2020)	10 (Moncel et al., 2020)		Technological (Moncel et al., 2019)	1218 (Moncel et al., 2020)	
		G/G1 (Piperno and Moncel's excavations)	Test trench (Piperno's excavation), 10 (Moncel's excavation)			? (Piperno, 1999) 344 (Moncel et al., 2020)	5 (Moncel et al., 2020)		Technological (Moncel et al., 2020)	569 (Moncel et al., 2020)	
		H (Piperno and Moncel's excavations)	Test trench (Piperno's excavation), 6 (Moncel's excavation)			? (Piperno, 1999) 43 (Moncel et al., 2020)	0 (Moncel et al., 2020)		Technological (Moncel et al., 2020)	236 (Moncel et al., 2020)	
		I (Piperno's test trench, only 1 artefact)	I1 26 (Moncel's excavation)			247 (Moncel et al., 2020)	0 (Moncel et al., 2020)		Technological (Moncel et al., 2020)	1681 (Moncel et al., 2020)	
			I2 26 (Moncel's excavation)			71 (Moncel et al., 2020)	2 (Moncel et al., 2020)		Technological (Moncel et al., 2020)	167 (Moncel et al., 2020)	
		J (Moncel's excavation)	4			8 (Moncel et al., 2020)	0 (Moncel et al., 2020)		Technological (Moncel et al., 2020)	6 (Moncel et al., 2020)	
Cimitero di Atella Basilicata, Southern Italy	Volcanoclastic and lacustrine sediments	L (Borzatti's excavation)	~30	480 ka (UVS Masseria Granata) (Di Muro, 1999)	15-13	N. A.	N. A.	Small fluvial silicite pebbles, rare quartzite and radiolarite	Typometrical (Borzatti von Löwenstern et al., 1997)	N. A.	
		F (Borzatti's excavation)	~30	Between 660-650 ka (UVS Masseria Boccaglie; layers A-E) and 480 ka (UVS Masseria Granata; layer L) (Di Muro, 1999)		7887 (Abruzzese et al., 2016; Rocca et al., 2016)	8 (unifacial large tools) (Abruzzese et al., 2016; Rocca et al., 2016)		Techno-functional analysis of 638 artefacts selected for taphonomical reasons (Abruzzese et al., 2016; Rocca et al., 2016)	N. A.	
		New layer at the top of layer F (Rocca et al. excavation)	~30 (Rocca et al. excavation)			265 (Rocca & Aureli, 2019) + 411 (Rocca et al., 2020)	0 (Rocca et al., 2019; 2020)		Preliminary technological analysis (Rocca et al., 2019, 2020)	26 determined (Rocca & Aureli, 2019)	
Isernia La Pineta Molise, Central southern Italy	Travertine deposition, lacustrine clays, alluvial sediments	3s1-5	~70		15-14	660*	Not analysed	Silicite tablets and limestone cobbles from secondary sources	Not analysed	1083*	
		3s6-9	~80	587±2 ka ($^{40}Ar/^{39}Ar$) (Peretto et al., 2015)		2869*	0 (Rufo et al., 2009)		Technological of 39 artefacts (Rufo et al., 2009)	3071*	
		3s10	~20	583±3 ka ($^{40}Ar/^{39}Ar$) (Peretto et al., 2015)		171*	0 (Crovetto, 1994)		Technological of 114 artefacts (Crovetto, 1994)	84*	
		3coll	~75	586±2 ka ($^{40}Ar/^{39}Ar$) (Peretto et al., 2015) 610 ± 10 ka (40Ar/39Ar) (Coltorti et al., 2005)		7723*	0 (Rivera Pérez, 2016 ; Rufo et al., 2009)		Technological of 6557 artefacts (Rivera Pérez, 2016) + 133 artefacts (Rufo et al., 2009)	7057*	*Homo* sp. (cf. *heidelbergensis*), a deciduous tooth (Peretto et al., 2015)
		3a (sect I)	~200			5099*	0 (Crovetto, 1994; Rufo et al., 2009)		Technological of 334 artefacts (Crovetto, 1994) + 160 artefacts (Rufo et al., 2009)	8584*	

		3a (sect II)	~50			2101 (Crovetto, 1994)	0 (Crovetto, 1994)		2101 (Crovetto, 1994)	N. A.	
		3c	~60	>585±1 ka (U4) ($^{40}Ar/^{39}Ar$) (Peretto et al., 2015)		718*	0 (Gallotti & Peretto, 2015)		Technological of 350 artefacts (Gallotti & Peretto, 2015)	737*	
Valle Giumentina Abruzzo, Central Italy	Glaciofluvial-lacustrine and alluvial sedimentation, palaeosols	42 or ALB-42 (Radmilli and Nicoud's excavations)	48 (Nicoud's excavation)		15/14-12	18 (Radmilli, 1965) 223 (Nicoud et al., 2016)	0 (Radmilli, 1965; Nicoud et al., 2016)	Blocks of different types of local silicite	Typometrical (Radmilli, 1965) Techno-functional analysis (Nicoud et al., 2016)	6 (Nicoud et al., 2016)	
		40 or LABM-40 (Radmilli and Nicoud's excavations)	40 (Nicoud's excavation)	456 ± 2 ka ($^{40}Ar/^{39}Ar$) (Villa et al., 2016)		55 (Radmilli, 1965) 395 (Nicoud et al., 2017)	1 (Nicoud et al., 2017)		Typometrical (Radmilli, 1965) Preliminary analysis (Nicoud et al., 2017)	1 (Radmilli, 1965) 1 (Nicoud et al., 2017)	
		37 or SLM-37 (Radmilli and Nicoud's excavations)	35 (Nicoud's excavation)			502 (Radmilli, 1965) 328 (Nicoud et al., 2017)	5 (Radmilli 1965)		Typometrical (Radmilli, 1965) Preliminary analysis (Nicoud et al., 2017)	1 (Radmilli, 1965)	
		33 or ABF-33 (Radmilli and Nicoud's excavations)	30 (Nicoud's excavation)			423 (Radmilli, 1965) 591 (Nicoud et al., 2020)	0 (Radmilli, 1965; Nicoud et al., 2020)		Typometrical (Radmilli, 1965) Preliminary analysis (Nicoud et al., 2020)	1 (Radmilli, 1965)	
		30 or LAN2-30 (Radmilli excavation)	N. A.	531 ± 5 ka ($^{40}Ar/^{39}Ar$) (Villa et al., 2016)		147 (Radmilli, 1965)	0 (Radmilli, 1965)		Typometrical (Radmilli, 1965)	1 (Radmilli, 1965)	
		24 or LN-24 (Radmilli and Nicoud's excavations)	N. A.	556±6 ka ($^{40}Ar/^{39}Ar$) (Villa et al., 2016)		4 (Radmilli, 1965)	0 (Radmilli, 1965)		Typometrical (Radmilli, 1965)	N. A.	
		20 (Radmilli excavation)	N. A.			84 (Radmilli, 1965)	0 (Radmilli, 1965)		Typometrical (Radmilli, 1965)	N. A.	
Loreto Basilicata, Southern Italy	Lacustrine deposits, reworked tephra	A	20	~500 ka (tephrostratigraphic correlations with the volcanic activity of Mt Vulture, after Lefèvre et al., 2010) Paleomagnetic data (Gagnepain, 1996)	13 ?	528 (Crovetto, 1993)	1? (Crovetto, 1993)	Silicite pebbles/cobbles/tablets and limestone cobbles from secondary sources	Technological (Crovetto, 1993)	N.A.	
Ficoncella Toscana, Central Italy	Alluvial/ floodplain deposits	FIC1	6	Between ~499 ka and 441± 8 ka ($^{40}Ar/^{39}Ar$) (Aureli et al., 2015; 2016)	13	409 (Aureli et al., 2015; 2016)	0	Small marine/fluvial pebbles of silicite (unknown provenance) and big cobbles of local limestone	Techno-functional analysis (Aureli et al., 2015, 2016; Rocca et al. 2016)	364 (Boschin et al., 2018)	
Visogliano Friuli Venezia Giulia, Northern Italy	Collapse deposits, loess or loess-like sediments, colluvia of redsoils	40 (rockshelter A)	N. A.		13-10?	N. A.	0 (Abbazzi et al., 2000)	Big nodules of local limestone, small riverine pebbles, collected in the alluvial deposit of the nearby rivers	Descriptive report (Abbazzi et al., 2000)	N. A.	
		41 (rockshelter A) — Breccia in locus B, correlated to layers 41-44 of rockshelter A	N. A.	356+46/-41 ka (ESR-U series) (Falguères et al., 2008)							Locus B 1 tooth (Vis.1), 1 fragment of jaw (Vis.2), 2 fragments of teeth; *Homo heidelbergensis (?)* showing a Neanderthal-like morphological dental template (Zanolli et al., 2018)
		42 (rockshelter A)	N. A.								1 tooth (Vis.3)
		43 (rockshelter A)	N. A.								
		44 (rockshelter A)	N. A.	482+99/-81 ka (ESR-U series) (Falguères et al., 2008)		Levels 44-46 More than 2000, mostly concentrated in level 44 (Abbazzi et al., 2000)					2 teeth (Vis4., Vis.5)
		45 (rockshelter A)	N. A.	439+58/-54 ka (ESR-U series) (Falguères et al., 2008)							1 tooth (Vis.6)
		46 (rockshelter A)	N. A.								

Tab. 1 - Main characteristics of the Middle Pleistocene Italian sites between MIS 19 and MIS 12. N. A.=Not Available data. *Unpublished data (data updated to the 2018 excavation).

cial volumes by alternate or face-by-face shaping during glacial stage MIS 16 (676-621 ka), when raw materials were of appropriate quality. Several series of removals contributed to rectify the edges and the tip. The tools present sinuous edges despite the sporadic use of final retouch, on account of the use of limestone pebbles instead of flint nodules. We observed a mixture of bifaces *sensu stricto* and not finished bifacial tools depending on the extension of shaping» (Moncel et al., 2019: 20).

However, there is no consensus on this interpretation. Results of the LCTs analysis performed by E. Nicoud (2011) adopting a techno-functional approach show that «D'un point de vue techno-morphologique et en comparaison avec le reste de l'outillage, aucun objet relevant d'une conception bifaciale singulière n'a été mis en évidence» and that lithic productions of macro-tools are characterised by «[…] une chaîne opératoire courte de confection d'outil(s) sur galets […]» (Nicoud, 2011: 324).

2.2. Cimitero di Atella (Basilicata, southern Italy)

Cimitero di Atella is an open-air site (ca. 480 m asl) located in the village of Atella (Potenza, Basilicata), about 10 km to the south of the Monte Vulture and 30 km to the west of Loreto and Notarchirico. It has been investigated since 1990 under the direction of prof. Borzatti von Löwenstern - Università di Firenze (Borzatti von Löwenstern et al., 1990, 1997, 1998) and, since 2014, under the direction of R. Rocca in a new project led by the École française de Rome (Abruzzese et al., 2016; Rocca & Aureli, 2019; Rocca et al., 2020).

The site was located on the shores of a lake developed during the Middle Pleistocene (Borzatti von Löwenstern et al., 1998). According to geological and geomorphological studies on the Atella basin area and on the basis of the presence of handaxes, the site was attributed to the early Acheulean (Borzatti von Löwenstern et al., 1997).

Two archaeological layers (F and L) were identified within a stratigraphy composed of volcanoclastic and lacustrine sediments. The stratigraphic sequence presents, at the base, several sterile silt layers (A-E), lake deposits composed of limno-volcanic sediment. These are covered by the Acheulean layer (F) interpreted as landslides of the lake shores. At the top, there are a sandy deposit of lacustrine origin (I) and a volcanoclastic layer containing a small lithic assemblage (L) (Borzatti von Löwenstern et al., 1997; Abruzzese et al., 2016). These archaeological layers were heavily affected by post-depositional processes (Rocca & Aureli, 2019; Rocca et al., 2020).

In 2018 and 2019 several test pits in a new area contiguous to the Borzatti's excavation revealed the existence of a less disturbed layer, at the top of layer F. This new layer, still under study, yielded lithic and faunal remains in a good state of preservation (Rocca & Aureli, 2019; Rocca et al., 2020).

The chronology of the site was constrained thanks to the correlation with Vulture eruptive events (Di Muro, 1999). The dating of the Acheulean layer F should be comprised between 660-650 ka (UVS Masseria Boccaglie; layers A-E) and 480 ka (UVS Masseria Granata; layer L). However, this interpretation needs to be confirmed (Abruzzese et al., 2016; Rocca et al., 2016).

The faunal remains, generally very altered, mainly consist of *Palaeoloxodon antiquus* (Borzatti von Löwenstern et al., 1997), *Bos primigenius* and cervids (*Dama, Cervus* and *Capreolus*) (Zucchelli, 2000; 2002). The revision of the historical collections and the preliminary data from the new excavations confirm the presence of *Palaeoloxodon*, fallow deer, and bovid. However, the distinction between *Bos* and *Bison* needs to be demonstrated (Rocca & Aureli, 2019; Rocca et al., 2020).

Lithic industry (Tab. 1) was mainly knapped on silicite pebbles/cobbles collected near the site, and only to a lesser extent on quartzite and porous radiolarite (with a higher degree of alteration) (Borzatti von Löwenstern et al., 1992; Sozzi et al., 2004).

Previous typometrical analysis recognised a poorly structured lithic industry, composed by small flakes, cores, small tools (difficult to classify), knapping waste, and handaxes. The handaxes (*n*=50) were manufactured exclusively on porous radiolarite. The small size of the industry was linked to the use of bipolar percussion on anvil (Borzatti von Löwenstern et al., 1997).

The lithic industry of layer F was recently revised with a technological and techno-functional approach. On 7887 pieces, only 638 (8% of the entire set) were analysed due to taphonomical reasons, excluding the non-anthropic items (with a very poor state of preservation) (Abruzzese et al., 2016; Rocca et al., 2016). The selected sample is composed by few cores (2%) exploited through a SSDA method (Forestier, 1993), flakes (42%), retouched flakes (25%, the majority are notches), small tools (30%), and few large tools (1%). The presumed handaxes are now interpreted as large tools unifacially shaped (bifacially shaped in only one case) obtained on large flakes of radiolarite (Abruzzese et al., 2016).

On the other hand, the small tools represent an important part of the assemblage: shaped on natural blanks or flakes, are generally thick, with a flat surface opposed to a convex surface and with different cutting edges (front, convergence, denticulate) (Abruzzese et al., 2016; Rocca et al., 2016). The whole lithic industry is very altered, mechanically and chemically (mainly pseudo-retouch, smoothness and, to a lesser extent, patina) (Abruzzese et al., 2016; Rocca et al., 2016).

Preliminary data from the new recently identified layer confirm the technological revision performed so far: the lithic assemblage is mainly composed by small flakes related to the confection/retouch of few small tools in silicite, lacking LCTs (Rocca & Aureli, 2019; Rocca et al., 2020).

2.3. Isernia La Pineta (Molise, central southern Italy)

Isernia La Pineta is an open-air site (of about 350 square meters, over two different sectors) located a few kilometers from the town of Isernia (Molise). The systematic excavations, under the direction of prof. Carlo Peretto - Università di Ferrara, began in 1979 and are still in progress (e.g., Lembo, 2015; Peretto, 2013; Peretto et al., 2015). At 457 m asl, the site lies inside the main filling of the Upper Volturno river basin (Brancaccio et al., 1997; Coltorti & Cremaschi, 1983; Van Otterloo & Sevink, 1983).

The stratigraphic sequence is made of fluvial, lacustrine and volcanic sediments. From bottom to top, 5 sedimentary units were recognized (Coltorti et al., 2005; Peretto et al., 2015): Unit 5, lacustrine clays; Unit 4, travertines; Unit 3, palustrine deposits with sands and thin layers of gravels, subdivided in several sub-units (3F, 3E, 3D); Unit 2, gravels with thin layers of sands; Unit 1, a colluvium sequence, including a pyroclastic fall dated at 499±13 ka ($^{40}Ar/^{39}Ar$, 2σ; Coltorti et al., 2005).

Four archaeosurfaces (3c, 3a, 3s10 sect. I, 3a sect. II) have been identified and excavated.

3c is the oldest occupation layer, contemporaneous with Unit 4: archaeological and paleontological remains lie at the top of calcareous tufa. 3a is characterised by a high concentration of faunal remains (mostly of large bones) and of silicite and limestone artefacts. Above 3a, lies 3coll, a pyroclastic layer (debris-flow) rich in archaeological materials (Marrocchino & Vaccaro, 2006). Previously dated at 610±10 ka ($^{40}Ar/^{39}Ar$; Coltorti et al., 2005), 3coll was recently dated at 586±2 ka ($^{40}Ar/^{39}Ar$; Peretto et al. 2015).

The most recent chronological analysis constrains the age of the archaeosurfaces to the end of MIS 15, more precisely between 583 ka (Unit 4 deposition age) and ca. 561 ka, at the beginning of the full glacial MIS 14 (Peretto et al., 2015).

An isolated human deciduous incisor was discovered in 2014 within the archaeological layer 3coll, related to an undetermined *Homo*, i.e. *Homo* sp. (Peretto et al., 2015).

Numerous macro-mammals have been identified, characteristic of the Middle Galerian, mainly consisting of the following taxa: *Elephas* (*Palaeoloxodon*) *antiquus*, *Hippopotamus* cf. *antiquus*, *Stephanorhinus hundsheimensis*, *Bison schoetensacki*, *Praemegaceros solilhacus*, *Cervus elaphus* cf. *acoronatus*, *Dama* cf. *roberti*, *Capreolus* sp., *Sus scrofa*, *Hemitragus* cf. *bonali*. Among the carnivores, the most abundant remains belong to *Ursus deningeri*. Only one tooth of *Panthera leo fossilis* and a mandible of *Panthera pardus* were identified (Ballatore & Breda, 2013; Breda et al., 2015; Channarayapatna et al., 2018; Peretto et al., 2015; Sala, 1996; Thun Hohenstein et al., 2004, 2005, 2009).

Zooarchaeological analysis (Anconetani & Peretto, 1996; Malerba et al., 2000; Peretto et al., 2004; Pineda et al., 2020; Thun Hohenstein et al., 2005, 2009) suggests a relative homogeneity in the taxonomic representation models along the sequence. Evidence of carcass processing is documented through anthropic breakage (mainly on skulls, jaws and long bones) and in the form of cut marks on bone surfaces. The predominance of bison and, to a lesser extent, rhinoceros and bears, is the result of anthropic selection. The predominance of cranial elements and forelimbs and, among the remains of bison, the predominance of adult and sub-adult individuals is explained by the selective transport of the carcasses (Thun Hohenstein et al., 2009).

Among the small mammals, the best represented species are *Arvicola mosbachensis*, *Sorex* aff. *runtonensis*, *Pliomys episcopalis* and *Microtus* (*Terricola*) *arvalidens* (Sala, 1996).

All these data, combined with pollen studies, suggest that the climate was probably more arid and cooler than at present and the environment was characterized by an arboreal steppe, with the presence of pounds of water and deciduous forests in the surrounding area (Accorsi et al., 1996).

The lithic industry (studied so far ca. 50% of the lithic assemblages, Tab. 1) is focused on small-medium flake production, lacking LCTs. It is made with local raw materials, mainly different types of silicite tablets and only to a lesser extent limestone cobbles, collected in secondary position in the immediate vicinity of the site. Until the first decade of the 2000s, the lithic industry of Isernia La Pineta was considered unstructured and opportunistic, lacking tools deliberately retouched. Based on the '80s -'90s and early 2000s analysis on the lithic assemblages from a small portion of 3a and 3c, it was suggested that the tools were the accidental result of intense bipolar exploitation of silicite tablets (Crovetto, 1994; Longo et al., 1997; Minelli et al., 2004; Peretto, 1994).

On the contrary, recent techno-economic studies of 3c (Gallotti & Peretto, 2015) and 3coll layers (Peretto et al., 2015; Rivera Peréz, 2016) considerably reduce the use of bipolar technique on anvil (not documented in 3c layer; Gallotti & Peretto, 2015) and demonstrate that retouch was a deliberate and specific phase and not the occasional result of intense bipolar exploitation.

In general, the silicite lithic industry of Isernia La Pineta is characterized by relatively long sequences of reduction which show a high degree of planning. The mental templates and the technical criteria employed in small flaking are not opportunistic and unstructured as previously inferred, witnessed by: the use of different methods (unifacial unidirectional, multifacial unidirectional, and discoid; Fig. 2); the mastery of the discoid method, regardless of the size and shape of the blank; the selection of specific forms for a specific production; the systematic use of retouch in order to produce small tools (denticulates, notches, and sidescrapers) (Gallotti & Peretto, 2015).

The local limestone cobbles were exploited mainly for flaking and rarely for shaping (Arnaud et al., 2017). Small-medium flakes were obtained by direct hard-hammer percussion through simple and short reduction sequences, mostly using a unifacial unidirectional method (Gallotti & Peretto, 2015) or by the exploitation of one to three not prepared striking platforms (Rufo et al., 2009). Few choppers were recovered in the 3a and 3coll layers (Rufo et al., 2009); rare retouched flakes were recovered in the 3coll layer (Rivera Peréz, 2016).

2.4. Valle Giumentina (Abruzzo, central Italy)

Valle Giumentina is a Pleistocene open-air site, located in a small intermountain basin (at 740 m a.s.l), on the northwestern side of the Majella Mountain massif, in Abruzzo (central Italy). Several archaeological layers were identified in a ca. 25 m thick sedimentary sequence, made of alluvial and lacustrine/marshy deposits and paleosols. The site was investigated, in the 1950s and 1960s, by prof. Radmilli - Università di Pisa, over a surface of approximately 40 m^2 (Radmilli, 1965). Attribution of Valle Giumentina deposits to the Rissian and Würmian glacial stades was based on sedimentary data and not on the typology of the lithic industries

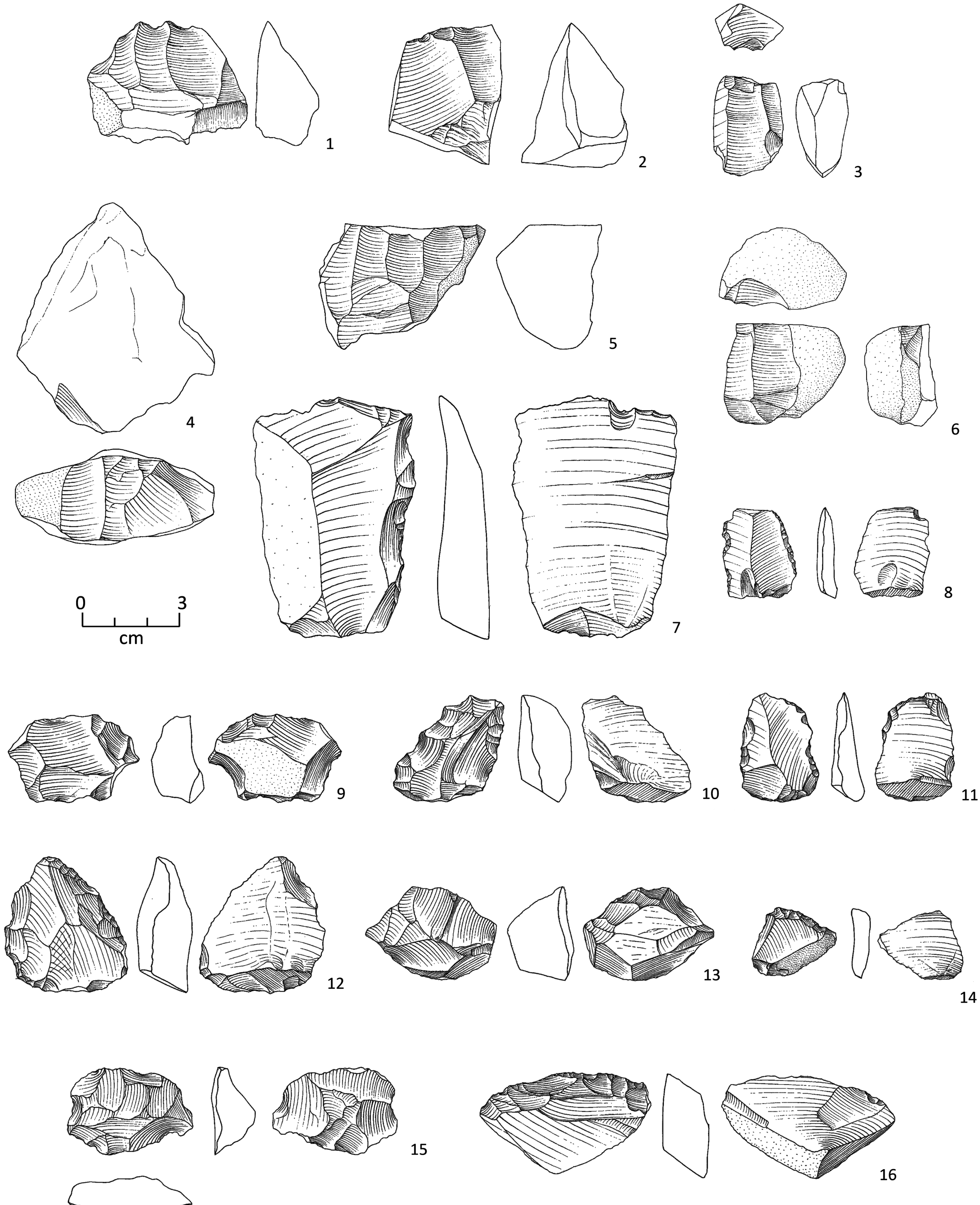

Fig. 2 - Isernia La Pineta, layer 3c. Silicite artefacts. 1-6: unifacial unidirectional cores; 7, 8: retouched flakes with unidirectional negative scars on the dorsal face; 9, 13, 15: discoid cores; 10-12, 14, 16: retouched flakes belonging to a discoid flaking. Drawings: M. Pennacchioni.

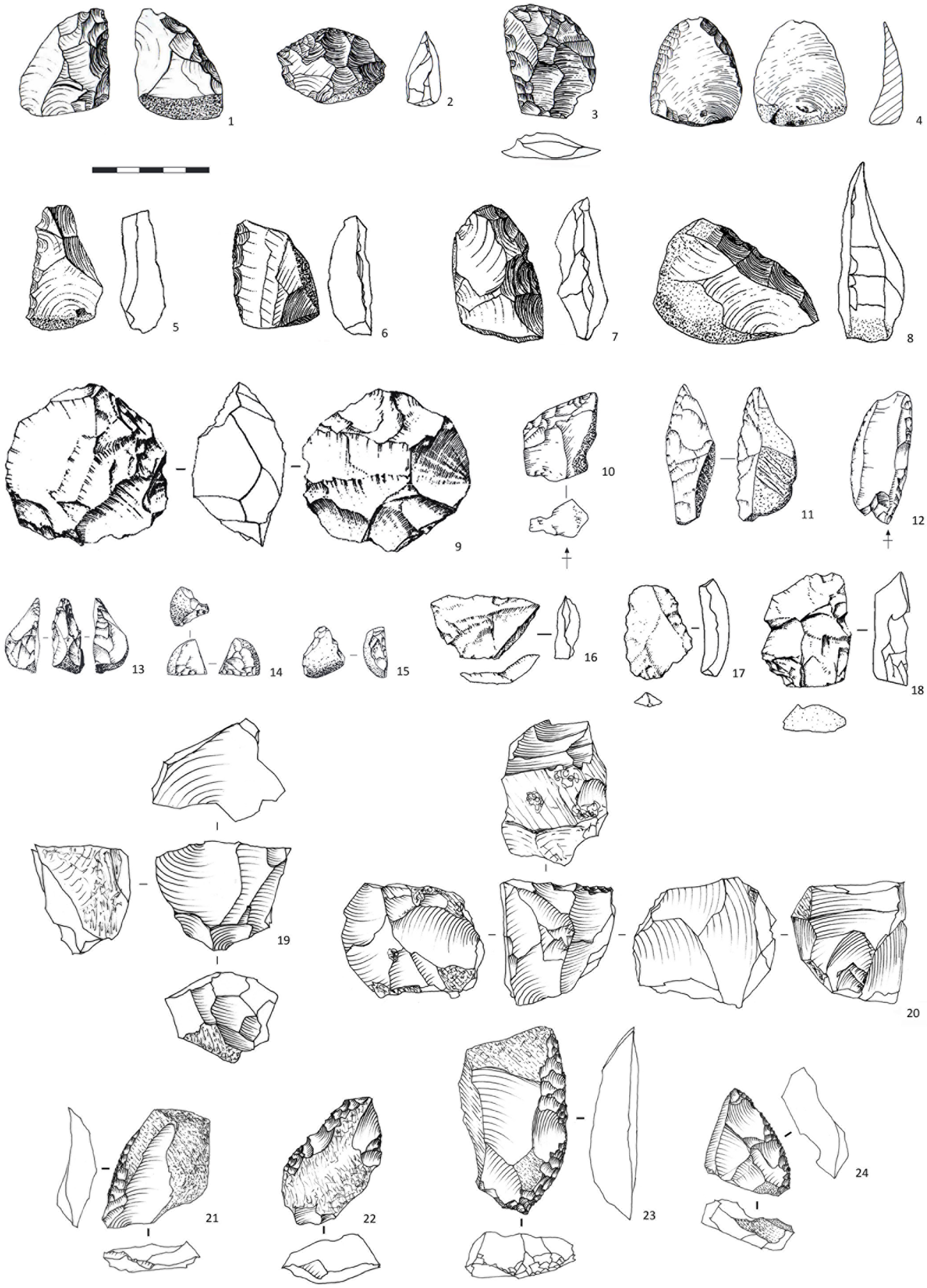

Fig. 3 - 1-8: silicite small tools from Loreto layer A (modified after Crovetto, 1993); 9-18: silicite discoid core (9), silicite small tools (10-15), and limestone flakes (16-18) from Visogliano, rockshelter A, levels 40-45 (modified from Abbazzi et al., 2000); 19-24: silicite cores (19, 20) and small tools (21-24) from Valle Giumentina, layer 33 (modified after Nicoud et al., 2015).

(Demangeot & Radmilli, 1966).

In particular, the archaeological layers were described, from the bottom to the top, as: Clactonian (named "Evolved Clactonian of Valle Giumentina facies") (layers 20, 24, 30, 33, 40, 42), according to the presence of tools on thick flakes; Acheulean (layer 37), with only five handaxes and handaxe flakes; Levalloisian (layer 45, 46), to design a mixed industry (probably not *in situ*) including Levallois products (Radmilli, 1982; Radmilli, 1965). The presence of the Acheulean layer among the layers assigned to the Clactonian, confirmed the hypothesis of scholars supporting the coexistence and contemporaneity of these two industries (Radmilli, 1982).

The rare faunal remains belong to *Ursus* sp. and *Cervus elaphus* (Radmilli, 1965).

New systematic archaeological excavations and interdisciplinary research started in 2012 and still in progress under the direction of E. Nicoud, allowed to acquire new chronostratigraphical, paleoenvironmental, and archaeological data (Limondin-Lozouet et al., 2017; Nicoud et al., 2015, 2016, 2017, 2020; Villa et al., 2016a). The new studies have reduced the marshy contribution, recording glaciofluvial-lacustrine sedimentation during glacial periods and pedogenesis and/or alluvial sedimentation during interglacials (Villa et al., 2016b).

Five main litho-pedostratigraphic units, named Sedimentary Units (SU), were recognised and correlated with the Radmilli's excavation. From bottom to top (Villa et al., 2016a, b): SU5, a thick fluvial gravel deposit, which overlies the Miocene limestone bedrock; SU4, lacustrine and marshy calcareous sediments, indicating the formation of a shallow lake; SU3, clayey organic deposits, attesting the evolution from lacustrine to marshy environments, containing archaeological layer 20; SU2, calcareous silt and clay, containing 24, 30, and 33 archaeological layers; SU1, sandy/silty sediments, interbedded with four palaeosols, containing 37, 40, 42, 45, and 46 archaeological layers.

$^{40}Ar/^{39}Ar$ dating, and other palaeoenvironmental and tephrochronological data, assigned the whole succession to the MIS 15-MIS 12 interval. More precisely, the Clactonian layers 24, 30, and 40 (LN-24, LAN2-30, and LABM-40, according to the new excavations) are dated at 556±6 ka, 531±5 ka, and 456±2 ka, respectively (Villa et al., 2016a). Therefore, according to the recent dating, the Acheulean layer SLM-37 should be dated between ~ 530 and 450 ka.

With the recovery of the excavations, a techno-economic approach in the study of lithic industries was introduced and the use of 'Clactonian' term was dismissed (Nicoud et al., 2015). Only a small sample of the lithic assemblage excavated in the 1950s has been reviewed (Tab. 1; Nicoud et al., 2015). Therefore, data are partial and must be considered with caution. The lithic industry was made from blocks of different types of silicite, locally available and recovered in secondary position. The state of preservation is generally good. In 20, 30, 33, 40, 42 layers exclusively short flaking sequences are attested. Cores are exploited through SSDA method (Forestier, 1993), producing flakes of a very varied morphology. Retouched flakes (mainly sidescrapers and denticulates) are thick, cortical or semi-cortical, with the retouched cutting edge opposite to a back (Nicoud et al., 2015; Fig. 3: 19-24). Only in the Acheulean layer (37) a shaping production coexists with one or more flaking sequences. In this layer, were recovered 11 flakes, three sidescrapers, six notches, two atypical points, five handaxes and 475 debris, of which the majority are thin flakes linked to the bifacial shaping (Radmilli, 1965) but also to flaking (Nicoud et al., 2015).

As the research is still in progress, only preliminary data from excavation's reports are available for the lithic assemblages from the recently excavated layers LABM-40, SLM-37, and ABF-33 (Nicoud et al., 2017, 2020) (Tab. 1). The lithic assemblages of silicite are composed of cores, small flakes and small tools. A handaxe was recovered in LABM-40 (Nicoud et al., 2017).

Complete and detailed data are available only for the recently excavated layer ALB-42 (Nicoud et al., 2016). A technological approach combined with a techno-functional analysis (Böeda, 2001) was used to analyse lithics (n=223) recovered in this layer.

The ALB-42, investigated over a surface of ca. 48 m^2, is the last archaeological layer before the occurrence of Levallois and it covers the 456±2 ka dated layer (LABM; Villa et al., 2016a). The scarce faunal remains (n=32) belong to *Cervus elaphus* and *Microtus arvalis*. Striae and chopping evidence were detected on a thoracic vertebral spine (Nicoud et al., 2016).

The lithic assemblage is mostly composed of flakes (n=183), retouched flakes (n=28), and few cores (n=3), suggesting a fragmentation of the lithic production. However, some refits indicate an *in situ* production and suggest limited post-depositional disturbances. There are no LCTs in this layer. Several methods were used, including: a "tranches de saucisson" method (Turq, 1989), an alternating surfaces method resembling the SSDA method (Forestier, 1993), and an orthogonal flaking (*sensu* Ashton et al., 1994). These methods were ascribed to a single concept of core volumetric structure, in which the block selection represents a crucial phase. The accurate selection of surfaces with suitable volumetric characteristics, allowed to exploit the core by a short series of removals without any preparation of the striking platform or the flaking surface. Backed flakes are frequent. The scaled retouch creates various types of cutting-edges on different kinds of blanks. Tools belong to the typological categories of scrapers (lateral or distal), back knives, notches, and denticulates (Nicoud et al., 2016).

2.5. Loreto (Basilicata, southern Italy)

Since the end of the 19th century, the site of Loreto in the Venosa Basin, located on a hill few kilometers from Notarchirico, has been investigated. A.C. Blanc conducted the first excavations between 1956 and 1961, directed by G. Chiappella. Between 1974 and 1981, the Musée d'Anthropologie préhistorique de Monaco carried out new research, directed by L. Barral and S. Simone with the collaboration of G. Chiappella. The archaeological layer A was excavated on a surface of ~20 m^2 and yielded faunal remains and lithic artefacts (Crovetto, 1993).

The faunal list of layer A includes *Palaeoloxodon* cf. *antiquus*, *Dicerorhinus etruscus, Equus stenonis,* *Equus* cf. *süssenbornensis, Equus hydruntinus, Equus altidens, Hippopotamus* cf. *amphibius, Bison schoetensacki, Megaceros solilhacus, Dama nesti, Dama dama, Capreolus* cf. *affinis, Capreolus* cf. *süssenbornensis, Ursus deningeri, Canis* cf. *arnensis, Canis etruscus,* Hyaenidae sp., *Felis pardus, Homotherium* sp., and *Oryctolagus cuniculus* (Alberdi et al., 1988; Bonifay, 1977). Several authors considered Loreto stratigraphic sequence and faunal composition older than Notarchirico site on the basis of (bio)stratigraphic correlations (e.g., Belli et al., 1991; Caloi & Palombo, 1980). According to Bonifay (1977) and Caloi & Palombo (1979a, 1979b, 1980), this fauna belongs to the Günz-Mindel glacial periods or to the beginning of the Mindel; other authors suggested they are of Cromerian stage (Angelelli et al.,1978); Alberdi et al. (1988), based on the study of equidae remains, assessing that fauna belongs to the beginning of the Middle Pleistocene.

New geological research based on a lithostratigraphic approach in the Venosa basin allowed a reappraisal of the Notarchirico and Loreto stratigraphic correlations (Lefèvre et al., 1993, 1994, 1999, 2001, 2002; Raynal et al., 1998). The succession of Loreto deposits from the foot of the hill to the top is as follows (Lefèvre et al., 2010):

1) banks of conglomerates with a reverse magnetic polarity (Gagnepain, 1996);
2) highly heterometric conglomerates, formed by some hyper-concentrated lahar (*sensu lato*) flows, corresponding to Member A of the Tufarelle Formation;
3) a succession of reworked tephras and horizontal limestone banks, indicating sedimentary lacustrine environments; two grey scoria fallouts are inserted into this unit which characterize the Member B of the Tufarelle Formation;
4) ascending further uphill, the series gradually becomes less epiclastic in a *sensu lato* lacustrine environment where archaeological layer A lies on an encrusted emersion surface. These surfaces can be correlated to the base of Member C. This Member has been dated to 484±8 ka (Brocchini et al., 1994), 494±5 ka, and 530±22 ka (Villa & Buettner, 2009) based on stratigraphic correlations;
5) the upper facies of the basin fill which contains deposits related to the Upper Acheulean are difficult to characterise due to the absence of outcrops.

Accordingly, layer A at Loreto site is younger than the Notarchirico sequence corresponding to the Member C of the Tufarelle Formation and is approximately dated to 500ka on intra-basin stratigraphic correlations (Lefèvre et al., 2010). Pereira (2017) confirms that this stratigraphic correlation is the most plausible, but the new ^{40}Ar / ^{39}Ar results unfortunately do not give a precise chronological constraint for this site.

Layer A yielded 528 lithic objects (Tab. 1), analysed by C. Crovetto (1993). Crovetto's study represents a pioneering technological analysis of a Lower Palaeolithic complex in Italy. Furthermore, it is even more exemplary because it concerns not only the entire artefact assemblage, but also the natural materials recorded during the excavation.

Artefacts were flaked on silicite cobbles, pebbles, and tablets of small dimensions and larger limestone cobbles. Silicite assemblage (*n*=307) is composed by cores and flakes, most of them retouched (46% of the flakes). Silicite cores are unifacial unidirectional or bipolar and multifacial multidirectional irregular or orthogonal, some of them with a preferential flaked surface. Striking platforms are usually cortical or rectified by one-two removals. The flaking method in not related to a specific blank. Knappers indifferently used rounded cobbles, angular cobbles, and tablets. Reduction sequences are short and cores show remaining cortical surfaces. Negative scars on the dorsal face of the flakes are in agreement with the flaking methods identified on the cores, but they are also centripetal. Retouched flakes are side-scrapers with denticulated and stepped retouch, denticulates, notches, end-scrapers, becks, and small points (Fig. 3: 1-8).

Limestones assemblage is mainly composed by cobbles with few removals (simple cores *sensu* Delagnes & Roche 2005), chopper-cores with unifacial or bifacial removals, few cores and flakes, rarely retouched. Limestone cores are multifacial with an orthogonal exploitation. Knappers used the flat surface of angular/rounded cobbles as first striking platform and conducted an orthogonal multifacial flaking rotating the core and respecting the original orthogonal angles among the faces. Accordingly, this method shows a high capacity of adaptation to the natural blank.

S. Simone (1980) also classified an “Abevillian biface”, not studied by C. Crovetto because at the time it was on display in the exhibition “I primi abitanti d'Europa” (Crovetto, 1993).

2.6. Ficoncella (Lazio, central Italy)

The site of Ficoncella is located near Tarquinia, northern Latium (central Italy). At ca. 70 m a.s.l., the site is part of the Plio-Pleistocene Tarquinia basin, which extends for almost 40 km along the Latium Tyrrhenian margin. Discovered during the 1990s, it was investigated since 2010 until 2015 under the direction of D. Aureli (Aureli et al., 2012, 2015, 2016).

A small excavation area yielded, in a single archaeological layer (named FIC 1), a small lithic industry associated with parts of an elephant carcass, remains of ungulates, and a hyaena coprolite. Faunal and lithic remains may have been buried shortly after emplacement by alluvial/floodplain deposits (Aureli et al., 2015, 2016; Boschin et al., 2018).

Three main depositional units were identified within a stratigraphic sequence containing floodplain deposits. The lowest unit (FIC 1) is made up of sandy to silty sediments, containing several tephra layers and the archaeological horizon. The features of FIC 1 are consistent with the ‘Fall A pumice unit’, from a Plinian eruption in the Sabatini volcanic district, dated at ca. 499 ka. A 2-3 m thick ignimbritic deposit (FIC 2), dated at 441± 8 ka ($^{40}Ar/^{39}Ar$), cover this unit. This dating is consistent with the attribution to the ‘Tufo Rosso a Scorie Nere’ from Sabatini Volcanic Complex. FIC 3 is the uppermost unit, consisting of silty deposits (Aureli et al., 2015, 2016). Therefore, the human occupation occurred during the MIS 13. More precisely, the archaeological layer is comprised between a tephra layer attributed to a Sabatini eruption (dated to ~499 ka) and an ignimbrite unit (FIC 2), dated to 441±8 ka.

The faunal assemblage (*n*=364) is mainly composed by remains of a single elephant carcass (*Palaeoloxodon antiquus*) and largely fragmented bones of cervids and bovids (*Equus* sp., *Dama* sp., and *Capreolus* sp.). An impact notch on bone and some cone and conchoid flakes from intentionally fractured skeletal elements were found. Gnawing marks were identified on some elephant bones (Boschin et al., 2018).

The lithic material was analysed through a technological approach combined with a techno-functional approach and use wear analysis (Tab. 1; Aureli et al., 2015, 2016; Rocca et al., 2016).

Despite the incompleteness and the fragmentation of the reduction sequence, the presence of refittings (*n*=10) and the state of preservation indicate that knapping took place *in situ*. It is a small tool industry, in which LCTs are absent. The set (*n*=409) is composed by a large number of small debris (*n*=296), initial and production flakes, retouched flakes and cores (Aureli et al., 2015). Two major reduction sequences were identified: the first one, represented by few pieces, concerns the exploitation of large cobbles of local limestone, in order to obtain medium/large flakes with robust and long cutting- edges; the second sequence, that represents the majority, is performed on marine/fluvial pebbles of silicite (and occasional on quartz) whose provenance is not known, in order to obtain 'small-tools', with several cutting-edges (Aureli et al., 2015, 2016).

Three main groups of tools were identified, i.e. the *spina* (a small pointed part of the tool with a trihedral section, and a central ridge), the mini-rostrum (small robust bevel with an important angle with a slightly denticulate delineation) and the rectilinear edges (Aureli et al., 2016). Although the blanks are issued from different stages of the reduction sequence (such as initial flakes and/or residual fragments), tools (*n*=27) are generally thick, with a flat surface opposite to a convex surface, with one or two backs. These backs, natural or prepared by a blow, may have played an important role in the grip and the transmission of energy (Aureli et al., 2015; Rocca et al., 2016).

The use-wear analysis revealed traces related to action on soft or medium hard materials, especially through cutting, whittling, and scraping (Aureli et al., 2016; Boschin et al., 2018; Rocca et al., 2016). Therefore, butchery activities related to skinning or meat exploitation may have taken place at the site, although there is no evidence of cut marks (Boschin et al., 2018).

Ficoncella was interpreted as the result of different occupations in a short time range: between the death of the elephant and its burial, the area was probably frequented alternatively in a very short period of time by animals and humans (Aureli et al., 2015, 2016). However, even if we consider that the human occupation was linked to the elephant carcass (scavenging?), it is difficult to know: a) the order of their frequentation (animals/humans) and their degrees of competition; b) if the human occupation is strictly coeval with the fauna accumulation; c) if the animals died at site due to natural factors or if their carcasses where brought there by hominins (Aureli et al., 2015; Boschin et al., 2018).

2.7. Visogliano (Friuli Venezia Giulia, northern Italy)

The Visogliano shelter (110 m asl) is located in the Trieste Karst, in north-eastern Italy. The site, discovered in 1975, yielded lithic, faunal and human remains in two distinct areas of a karstic doline originated by the collapse of a cave: in a rock shelter (Shelter A) and in a cemented breccia outside the rock shelter (Breccia B), about 30 m to the west of the shelter (Abbazzi et al., 2000; Cattani et al., 1991; Tozzi, 1994).

The infill deposit of the rock shelter A (about 12 m thick) is formed by: 1) an upper horizon (layer 10) formed by colluvia of red soils; 2) an intermediate horizon (layers 11-39), composed of loess or loess-like sediments, deposited during a glacial period with alternating humid-cold and dry-cold phases; 3) a lower horizon (layers 40-46), deposited in non-glacial conditions and characterised by the presence of products of the collapse of an underground karstic system. The deposit of the external breccia (Breccia B), about 3m thick, is formed by very cemented layers with sedimentological and paleontological characteristics similar to the lower horizon of the shelter (Abbazzi et al., 2000; Cattani et al., 1991). However, a direct stratigraphical correlation between the two areas is prevented by an erosion surface, filled up with Late Pleistocene red soils and calcareous blocks (Falguères et al., 2008).

Combined ESR/U-series analyses dated the lower layers to a period between 350-500 ka, in agreement with micromammal and biostratigraphical studies (Falguères et al., 2008). However, these dates (obtained on herbivore teeth), must be considered with caution, due to the wide error range of the oldest analysed layers and some discrepancies with faunal, stratigraphic, and pedosedimentary context.

The oldest analysed layers (44 and 41) range between 482 ka (482+99/-81) and 356 ka (356+46/-41) with a wide error range of 15-20%. These ages can be compared to the direct U-series age (390+indet./-229 ka) obtained on the Vis.2 mandible fragment found in the breccia layers of locus B. However, the correlation between the two areas is not secure. The combined age estimates of the intermediate layers (39-24) range between 445 and 383 ka, suggesting a contemporary deposition with the lower layers. This appears to be in contrast with the abrupt change in pedosedimentary conditions and faunal content recorded between layers 40 and 39. The available data from the uppermost layers (layers 13 and 11) provide too old ages, which are inconsistent with all the other geochronological and stratigraphic data (Falguères et al., 2008).

The faunal assemblage can be referred to the Middle-Late Galerian. The entire stratigraphic sequence is dominated by *Microtus* cf. *arvalinus*, and the red deer *C. elaphus acoronatus* (Masini & Sala, 2007). While *Crocidura*, *Terricola*, *Macaca*, and fairly abundant fallow deer (*Dama clactoniana*) occur in the temperate climate lower layers (Abbazzi et al., 2000).

The human remains are represented by five teeth, two fragments of teeth, and a fragment of jaw. Four teeth were discovered in the lowest layers (45, 44, 42), which resemble the most ancient specimens of the Middle Pleistocene (Abbazzi et al., 2000; Mallegni et al., 2002). More recently, a comparative high resolution endostructural assessment of five teeth from Visogliano reveals a Neanderthal-like morphological dental template, clearly distinct from the modern humans (Zanolli et al., 2018).

On the basis of a typological analysis of the lithic industries (Tab. 1), different cultural traditions were identified. While the upper horizon is characterised by frequent carinated side scrapers mostly made of silicite, in the intermediate horizon, the tool assemblage is strongly microlithic with a high percentage of denticulates. The set is made of silicite, except some rare limestone artefacts. The lithic assemblage of the oldest layers (46-40 of shelter A and almost all of Breccia B) is mainly made on local limestone and more rarely on silicite and volcanic rock. The set is mostly composed of cores, choppers (cores?), flakes, and two protobifaces. The silicite assemblage shows 'Tayacian' traits: the few tools - mainly denticulates, side scrapers, Quinson-type tools, and Tayac points - are small and thick, with a high carinal index, with a simple and semi-abrupt retouch and an often-raised Quina-type retouch (Abbazzi et al., 2000; Grifoni & Tozzi, 2006; Fig. 3: 9-18).

3. DISCUSSION AND CONCLUSIONS

This overview of the sites and lithic productions in the Italian peninsula between MIS 19 and MIS 12 shows that archaeological data are dispersed both in time and space. In addition, different theoretical/methodological approaches have been adopted in the study of lithic assemblages, which cannot be simply superimposed to each other without previously discussing them. In some cases, different approaches have been used to study the industries coming from different layers of the same site, in parallel to the methodological changes in the course of the research history (Tab. 1). The results of a holistic and homogeneous approach to the techno-complexes are not yet available, despite the efforts made in the last decade. Accordingly, the informative potential of technical components may be taken with caution before using it as an index of cultural markers to identify technical traditions.

The Middle Pleistocene opens with an absence of sites. A large chronological gap separates the late Early Pleistocene sites, Pirro Nord and Ca' Belvedere di Monte Poggiolo, which yielded core-and-flake based technology (Arzarello et al., 2012, 2016; López-García et al., 2015; Muttoni et al., 2011; Peretto et al., 1998), from the earliest Middle Pleistocene site, Notarchirico, whose oldest layer is close to 700 ka. It is difficult to evaluate the duration of this interval because the ages of ~1.6-1.3 Ma for Pirro Nord (e.g., Arzarello et al., 2012; López García et al., 2015; Pavia et al., 2012) and ~1.0 for Monte Poggiolo (Falguéres, 2003; Gagnepain et al., 1998; Peretto et al., 1998; Peretto, 2006) have been recently criticized by Muttoni et al. (2011, 2018) based both on magnetostratigraphical and biochronological data. They proposed an age of >0.78 Ma for Pirro Nord and ~0.85 Ma for Monte Poggiolo (Muttoni et al., 2011, 2018).

This gap enables to discuss about a local origin of the Notarchirico industries, which represent one of the earliest Western European Acheulean documenting the production of LCTs in a period comprised between the MIS17/16 transition to the beginning of MIS 15 (Moncel et al., 2020).

Moncel et al. (2020) assessed that the ability to manage bifacial volume is therefore observed in other Acheulean sites of Western Europe dated between 700 and 600 ka (Antoine et al., 2016; Ashton & White, 2003; Despriée et al., 2011; Hurel et al., 2016; Iovita et al., 2017; McNabb et al., 2018; Moncel et al., 2013, 2016a, 2016b, 2018, 2019). Accordingly, Notarchirico is interpreted not as an isolate case, but as part of a common background documenting a technological shift from pre-existing industries. However, E. Nicoud (2011, 2013), using a different approach, argued that LCTs from Notarchirico sequence do not belong to a bifacial shaping procedure, but they are just the products of short chaînes opératoires for cobble tool manufacture. Beyond the different interpretations, it is clear that the number of artefacts that can be attributed to the handaxe *sensu lato* category (to avoid the controversial uses of the term "biface") is limited compared to the other components of the lithic assemblages (Moncel et al., 2019; Santagata, 2016; Tab. 1). A recent review of the industries of the nearby Cimitero di Atella site reconsidered the attribution of many artefacts to handaxes, that are very poorly represented (Abruzzese et al., 2016).

Notarchirico and Cimitero di Atella yielded also archaeological layers without LCTs. The alternance of "bifacial" and "non bifacial" units has been interpreted as the co-existence of human species that produced different technologies, or as the outcome of different functional needs (Gallotti, 2016; Santagata, 2016). At the current state of knowledge, a detailed reconstruction of the early Middle Pleistocene technical behaviours in this area of the Venosa basin is premature. It is equally premature to explain the presence/absence of LCTs both from techno-economic, techno-functional, and human biological perspectives. Firstly, the partial knowledge of the small flaking systems does not allow: 1) to analyse similarities and/or differences precisely in that production which is present in all layers of the sequence; 2) to identify the number and relationships between the different chaînes opératoires; 3) to interpret the status of the production of LCTs in the technical system. The contextual absence of taphonomic and functional data for most part of the archaeological layers does not allow to evaluate the role played by post-depositional processes and functional needs in the composition of the different lithic assemblages.

Even if the production of LCTs from Notarchirico shares a common technological background on a Western European scale, it remains a sporadic phenomenon on a local scale both at Notarchirico and at Cimitero di Atella. At ~500 ka, the production of LCTs disappears in the Venosa basin, as documented by the layer A industry of the Loreto site (Crovetto, 1993).

This evidence could be even more significant if we consider that, regardless the approach in lithic studies, LCTs production is almost totally absent in lithic assemblages between MIS 15 and MIS 12, before a surge from MIS 11 onwards.

Many scholars have repeatedly highlighted how the numerically consistent presence of small tools in sites with core-and-flake based assemblages is a common trait in the Italian peninsula between MIS 15 and MIS 12. Following a typological approach in small and large tool analysis, Grifoni & Tozzi (2006) identified the emergence of cultural traditions in this period: 1) a 'Tayacian' group, characterised by small lithic industry; 2) a 'denticulate' group found exclusively in Visogliano A; 3) a 'Clactonian' group characterised by large, thick, but rarely carinated flakes, a large number of scrapers, few denticulates, absence or exceptionality of handaxes; 4) an 'Acheulean' group. Although this analysis also includes sites without an indisputable stratigraphic context and chronological constraints and although the research advancement has led to the abandonment of terms such as 'Tayacian' and 'Clactonian', results show the difficulty of typologically grouping the industries of the first half of the Middle Pleistocene into a uniform entity.

The role played by small tools in drawing technical scenarios was earlier underlined by L. Cattani et al. (1991) and C. Crovetto (1993), who pointed out their technical similarities among Loreto, Isernia, Visogliano, and penecontemporaneous central European sites. Recent techno-functional studies compared assemblages from central Europe with Italian sites confirming that small tools share the same "tools conception" (Aureli et al., 2015, 2016; Rocca 2016a, 2016b, Rocca et al., 2016). R. Rocca (2016a, 2016b) identified in central Europe assemblages lacking LCTs characterised by a great variability of small tools on different types of blanks and the presence of original technical traditions. However, small tools are also present in Western European assemblages containing LCTs (Nicoud, 2013; Rocca, 2013; Rocca et al., 2016).

A high percentage of small tools has been assessed also at Isernia La Pineta thanks to a technological revision of the layer t.3c industry (Gallotti & Peretto, 2015). The technical features described are shared by other Western European sites dated between ~0.8 and ~0.6 Ma, independently from the occurrence of LCTs. This is relevant in cultural terms, as the same technological knowledge seems to be shared by knappers in a specific time period.

It is evident that the technical behaviours dated between MIS 17/16 and MIS 12 in the Italian peninsula are extremely diversified. The research of the last decade allowed to refine the chronostratigraphic framework of some sites and to investigate the "non-LCTs" component in greater detail. However, a homogeneous and comprehensive study of all lithic series from stratigraphic contexts is still lacking and prevents the possibility of detailed comparisons among the various industries of the Italian peninsula and of evaluating them in a European context.

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AUTHOR CONTRIBUTIONS

B.M., R.G. and G.L. conceived and designed the paper. B.M. wrote the paper with the contribution of R.G. and G.L. All authors discussed the results and contributed to the final manuscript.

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