The Middle Pleistocene site of Guado San Nicola (Monteroduni, Central Italy) on the Lower/Middle Palaeolithic transition

Carlo Peretto[a], Marta Arzarello[a], Jean-Jacques Bahain[b], Nicolas Boulbes[c], Jean-Michel Dolo[e], Eric Douville[f], Christophe Falguères[b], Norbert Frank[f,g], Tristan Garcia[h], Giuseppe Lembo[a], Anne-Marie Moigne[b,c], Brunella Muttillo[a], Sébastien Nomade[f], Alison Pereira[a,b,f,i], Maria Angela Rufo[a], Benedetto Sala[a], Qingfeng Shao[b,j], Ursula Thun Hohenstein[a], Umberto Tessari[k], Maria Chiara Turrini[a], Carmela Vaccaro[k]

[a] Sezione di Scienze preistoriche e antropologiche, Dipartimento di Studi Umanistici, Università degli Studi di Ferrara, C.so Ercole d'Este I, 32, Ferrara, Italy

[b] Département de Préhistoire, Muséum national d'histoire naturelle, UMR7194 du CNRS, Paris, France

[c] Centre Européen de Recherches Préhistoriques (EPCC), Tautavel, France

[d] Dipartimento di Scienze della Terra, Università degli Studi di Siena, Italy

[e] CEA, I^{2}BM, Orsay Cedex, France

[f] Laboratoire des Sciences du Climat et de l'Environnement, LSCE/IPSL, UMR 8212 CNRS-CEA-UVSQ, Domaine du CNRS, F-91198 Gif-sur-Yvette Cedex, France

[g] Institute of Environmental Physics, Heidelberg University, Germany

[h] CEA, LIST, Laboratoire National Henri Becquerel, 91191 Gif-sur-Yvette Cedex, France

[i] Ecole Française de Rome, 67 Piazza Farnese, Roma, Italy

[j] College of Geography Science, Nanjing Normal University, China

[k] Dipartimento di Fisica e Scienze della Terra, Università degli Studi di Ferrara, Via Saragat 1, Ferrara, Italy

Corresponding Author Prof. Carlo Peretto - Dipartimento di Studi Umanistici, Università degli Studi di Ferrara, C.so Ercole I d'Este 32, 44100 Ferrara - Italy. E-mail address: carlo.peretto@unife.it – tel +39 0532 293702.

Abstract

The archaeological site of Guado San Nicola (Monteroduni, Central Italy), under excavation since 2008, is located in the Upper Volturno Valley, near the top of a fluvial terrace attributed to the Middle Pleistocene.

Several anthropic levels have been recognized within a stratigraphic sequence of more than two meters in thickness, characterized by alternating gravelly and sandy fluvial layers rich in pyroclastic

materials, attributable to the end of MIS 11– beginning of MIS 10, according to the obtained radiometric dates ($^{40}Ar/^{39}Ar$ and ESR/U-series).
In this paper we discuss the chrono-stratigraphic record, the paleontological and zooarchaeological data and we provide a detailed techno-economic analysis of the lithic industry, characterized by the coexistence of handaxes and Levallois debitage.
The site of Guado San Nicola actually represents the oldest evidence of the emergence of prepared-core technologies in the Italian Peninsula, adding new data to the debate on the Lower/Middle Palaeolithic transition in Western Europe.

Keywords: Guado San Nicola, Upper Volturno Valley, Middle Pleistocene, Lower/Middle Palaeolithic transition, handaxes, Levallois

1. Introduction

During the recent decades the debate on the transition from the Lower to the Middle Palaeolithic, i.e. from the Mode 2 to the Mode 3 technologies of Clark (Clark, 1969), has assumed increasing importance, together with the proliferation of archaeological sites throughout Europe.
The appearance of the Levallois method, traditionally marking this transition, in association with changes in the cognitive and social spheres and in behavioural strategies, is currently dated to the end of MIS 9 and the beginning of MIS 8 in Western Europe (e.g., Baena et al., 2014; Fontana et al., 2013; Moncel et al., 2011; Picin et al., 2013; White and Ashton, 2003; Wiśniewski, 2014), although the emergence of the concept of predetermination seems to be referred to earlier periods in some sites of northern France, as early as MIS 12 at Cagny Cemetery, MIS12–11 at Cagny la Garenne and MIS 9 at Cagny l'Epinette and Gentelles (Lamotte and Tuffreau, 2001; Lamotte, 1995; Moncel et al., 2011; Tuffreau, 1995; Tuffreau et al., 2008, 1995), and of Iberian Peninsula, such as Gran Dolina TD10 and Ambrona site, dated to MIS 10-9 (de Lombera-Hermida et al., 2015; Ollé et al., 2013; Santonja et al., 2015; Terradillos-Bernal and Díez Fernández, 2012).
The origin of the prepared-core technologies in Europe is still an object of intense debate, mainly focused around two different hypothesis: 1) African single origin (monocentric model) (e.g., Foley and Lahr, 1997); 2) European multiple origins (or polycentric model), developping as an *in situ* evolution of bifacial technology (e.g., Rolland, 1995; Tuffreau, 1995) or from simple prepared-core technologies originated "through a gradual transformation of existing core technologies and a fusion of elements of both façonnage and debitage" (White and Ashton, 2003, p. 605). In this sense, the diffusion of the prepared-core technologies could constitute an "evolutionary adaptation practiced

by diverse human populations irrespective of taxonomic affiliation or environment", therefore they cannot be considered as "proxies for hominin demographic changes" (Adler et al., 2014, p. 1612). For some authors the emergence of the Levallois method seems to be closely related to the development of hafted technology, considered as a 'modern' concept typical of Middle Palaeolithic. Recent research on the Near Eastern Mousterian reveals that the Levallois's specificity to directly produce standardized and various tools can be interpreted as one of the key drivers of this conceptual evolution during this period of transition (Boëda, 2013; Bonilauri, 2010).

While the chronology of the introduction of the Levallois method is relatively well known and well established for the North of Europe and South of France, it appears to be less evident for the Mediterranean area and in particular for the Italian peninsula (Fontana et al., 2013; Picin et al., 2013). The Italian context has played a marginal role in the debate over the appearance of Mode 3 technologies due to the rarity of well-dated sites and the lack of accurate stratigraphic and geochronological contexts (e.g., Fontana et al., 2013; Gallotti and Peretto, 2014; Nicoud, 2011; Palma Di Cesnola, 2001, 1992; Picin et al., 2013) and the absence of detailed technological analysis of the lithic assemblages (Fontana et al., 2013; Gallotti and Peretto, 2015; Nicoud, 2011), which makes correlations between sites a very hard and risky task.

In this context, the recent excavation of the Middle Pleistocene site of Guado San Nicola (Monteroduni, Central Italy) provides valuable information to the debate on the Lower/Middle Palaeolithic transition, offering the possibility to examine the emergence and development of prepared-core technologies and its relation with the Acheulean.

The site of Guado San Nicola, discovered in 2005 in conjunction with the investigation of the Acheulean site of Colle delle Api (Arzarello and Peretto, 2006; Coltorti et al., 2006; Ricciardi, 2006; Sala and Thun Hohenstein, 2006), is located only 100 m from Colle delle Api and has been subjected to systematic exploration since 2008. The excavation of an area of 98 m^2 revealed a stratigraphic sequence of more than two meters thick, in which several archaeological levels were recognized. These levels are rich in lithic and paleontological remains, including handaxes and Levallois pieces, and attributed to the end of MIS 11 – beginning of MIS 10 by means of biostratigraphy as well as geochronological data using the $^{40}Ar/^{39}Ar$ and ESR methods (Bahain et al., 2014; Nomade and Pereira, 2014).

The well documented archaeological record, the well-established chrono-stratigraphic context, the presence of innovative cultural elements such as the mastery of the Levallois method, make Guado San Nicola one of the main sites that could contribute to the better understanding of human settlement in the Italian peninsula and in the Mediterranean basin.

2. Site location and geo-morphological setting

The site of Guado San Nicola is located on the left bank of the Volturno River, approximately 2 km north-west of Monteroduni (Molise, Central Italy), at ca. 250 meters a.s.l and ca. 30 metres above the present-day floodplain of the Volturno river. In this sector the Upper Volturno river Valley separates the major orographic systems of the Molise Apennines, the southern reliefs of the Matese and the western reliefs of the Mainarde.

The site is situated near the top of the oldest fluvial terrace (Ist order) (Brancaccio et al., 2000, 1997; Coltorti and Cremaschi, 1981), which is delimited to the west by the Volturno river, to the north by the Lorda stream, a tributary of the Volturno river, and to the south by a small valley originating from a spring rising from the distal part of an alluvial fan (Fig. 1) (Coltorti and Pieruccini, 2014). The terrace belongs to the Main Infill Unit (Brancaccio et al., 2000, 1997), corresponding to the "main filling" of the nearby Isernia basin (Coltorti and Cremaschi, 1981). This morpho-lithostratigraphic unit, which represents the first cycle of Quaternary deposition in the Monteroduni area, mainly consists of polygenic gravely, silty and clayey deposits that contained interstratified tephra layers (Brancaccio et al., 2000). It has been attributed to the Middle Pleistocene on the basis of morphostratigraphic considerations, radio-isotopic dating of volcanic deposits found in the succession as well as palaeomagnetism, both obtained from the archaeological site of Isernia La Pineta (Coltorti and Cremaschi, 1981; Coltorti et al., 2005, 1982; Van Otterloo and Sevink, 1983).

3. Chronostratigraphy

The systematic exploration of the Guado San Nicola site allows for the identification of an articulated two meters thick stratigraphic sequence. A stratigraphic core, made to the depth of 20 meters in the immediate vicinity of the excavation, and a series of stratigraphic sections investigated in the area, have confirmed the sequence highlighted in the excavated area.

From bottom to top, the exposed stratigraphic sequence in the excavation area is composed of the following stratigraphic units (S.U.) (Fig. 2) (Turrini et al., 2014):

S. U. E: deposit of gravels, composed of sub-angular and sub-rounded clasts of different sizes in a sandy matrix; sterile level;

S. U. D: alternated layers and lenses of pyroclastic deposits rich in phenocrysts of sanidine and piroxene, subordinate micro pumice fragments, and a cinerite matrix with abundant fine-grained ash (with a low percentage of ash to fine-grained particles rich in Palagonite tuff); no archaeological remains;

S. U. C: coarse to fine-grained ash layer with sub-rounded and sub-angular pumice and rock fragments, rich in pyroclastic sediments and reworked pumices. This unit, characterized by the abundance of lithic and faunal remains, is dated to 400 ± 9 ka by $^{40}Ar/^{39}Ar$ dating on the reworked sanidine grains (maximum age) (Nomade and Pereira, 2014);
*S. U. B*C*: gravels with a pyroclastic matrix investigated only in a limited portion of the excavation area; this unit is interpreted as a debris flow; it contains a high concentration of lithic and faunal remains in a good state of preservation;
S. U. B: gravels with sub-rounded and sub-angular clasts in a cinerite rich in ash of pyroclastic products and altered glass matrix; this unit, locally constituted by two different debris flows, is rich in lithic and faunal remains in a good state of preservation;
*S. U. A*B*: lens of gravely-cinerite matrix of brown colour, identified in a limited part in the northern limit of the excavated area; this unit, which represents a further sedimentary entity attributable to a debris flow sequence, contains archaeological remains;
S. U. A: micro pumice with a low presence of cinerite and gravels, produced by an earth flow; this unit, lacking archaeological material, displays an homogenous population of sanidine crystals ($^{40}Ar/^{39}Ar$ single crystals extracted from pumices) giving a proposed deposition age of 379 ± 8 ka (Nomade and Pereira, 2014);
S. U. TUFI: pyroclastic deposit with an abundance of coarse pumice dispersed in a fine-grained matrix. This unit, sterile from an archaeological viewpoint, is rich in pumices and other materials of pyroclastic origin, locally turned red due to alteration processes; single crystal $^{40}Ar/^{39}Ar$ dating on sanidines extracted from the pumices gave an homogeneous age of 345 ± 9 ka (Nomade and Pereira, 2014) and is considered as the age of deposition of this unit.

The stratigraphic sequence highlighted in the excavated area, mostly consisting of pyroclastic sediments deposited in a braidplain that during its deposition had injections of pyroclastic deposits with well-defined topographic levels, is overlain by a coarse gravel-dominated braided system (S.U. Ghiaie).

The top of the stratigraphic sequence, corresponding to the top of the alluvial terrace, is weathered by a deep, leached, rubified relict paleosoil (Argillisoil), characterised by a succession of de-carbonated and argillic horizons, with strongly corroded flint and limestone clasts (Coltorti and Pieruccini, 2014).

The above mentioned radio-isotopic ages made using $^{40}Ar/^{39}Ar$ methods are in agreement with Electron Spin Resonance and Uranium series (ESR/U-series) method applied on 6 teeth of horse and rhinoceros from the units C, B*C and B (Bahain et al., 2014) that gave an average age of 364 ±

36 ka. Altogether the radio-isotopic investigations prove that the Guado San Nicola sequence was deposited during the MIS 11/MIS 10 transition.
In summary, this sequence shows, at its base, coarse fluvial sediments which indicate a braided channel's path in rapid aggradation during a cold and arid period, while at the top of the sequence the sedimentary structures of the archaeological levels indicate wandering or meandering paths, therefore the advent of a marked climatic improvement.
The stratigraphic sequence suggests a typical floodplain environment, attributable to the ancient course of the Volturno river. During the evolution of this part of the plain the alluvial fan intersected the braided plain (Turrini et al., 2014).

4. Faunal analyses

The faunal assemblage, belonging to units C, B*C, B and A*B, is mainly composed of the remains of *Cervus elaphus acoronatus*, Cervidae, *Equus ferus* ssp., followed by *Palaeoloxondon* sp., *Bos primigenius* and *Stephanorhinus kirchbergensis, Ursus* sp., *Dama* sp. Megacerini are very rare (Table 1). Considering the scarcity of identified remains in each stratigraphic unit, which does not allow identifying variations within the faunal sequence, the assemblage was considered as a whole, occurring for a relatively short time of stratigraphic units deposition (Sala et al., 2014).
This faunal composition suggests the occurence of a paleoenvironment constituted by woodland and shrubbed areas, mostly occupied by cervids, and open grassland, populated by elephants, aurochs and horses, that should refer to one or more temperate or warm temperate phases, due to the presence of Merk's rhinoceros and aurochs, together with the absence of cold indicators. The presence of *Cervus elaphus acoronatus*, typical of the Galerian mammal age (MA), and of horse with a relatively large body size, allows the attribution to the Fontana Ranuccio faunal unit (FU) (Gliozzi et al., 1997; Masini and Sala, 2011), confirming the assignment of the site to the latest part of the MIS 11, despite being located on the southern margins of the geographical distribution of *Equus ferus* populations.
The zooarchaeological analysis (Sala et al., 2014) of some elephant, aurochs and rhinoceros diaphyses led to the identification of intentional fractures associated with anthropic activities aimed at marrow recovery. Cut marks have been recognized on several anatomically and taxonomically determined remains of horse (Fig. 3) and rhinoceros, allowing their attribution to different stages of butchery.
The low quantity of identified remains, the scarce anatomical representation of carcasses and the bad bone preservation, prevent the reconstruction of the modalities of prey exploitation.

The abundance of deer antlers (Fig. 4), together with the presence of peculiar marks on the surface of the burrs of four shed antlers seems to reflect an interest in their collection and probable use as hammers for the knapping of lithic material.

In conclusion, the zooarchaeological analysis of the faunal remains suggests that the assemblage represents the result of anthropic accumulations, subsequently modified by different post-depositional factors of edaphic nature.

5. Lithic industry

5.1 Materials and methods

The lithic industry was mostly obtained by the exploitation of flint and only occasionally by the exploitation of limestone. The limestone assemblage, mainly consists of unworked material and does not allow reconstructing reduction sequences or the techno-economic system, therefore in this work we refer exclusively to the flint lithic industry.

The flint lithic assemblage analysed, recovered from excavation fields 2008-2012, amounts to 4,168 elements and is divided as follows: 1,417 in the S.U. C, 626 in the S.U. B*C, 2,018 in the S.U. B and 107 in the S.U. A*B (Table 2).

Several types of flint have been recognised, grouped according to their texture, granulometry and colour. To simplify the attribution here we distinguish just four main groups: aphanitic flint, micro-brecciated flint, macro-brecciated flint, silicified limestone.

For the lithic analysis a methodological approach that intends to reconcile typological and technological aspects (Inizan et al., 1999), integrating the typological approach with its positioning in the chaîne opératoire (Leroi-Gourhan, 1964), has been adopted. The classification of the cores was made on the basis of the identification of the knapping method, taking into account the number of percussion plans and their relationship, the presence/absence of prepared percussion plans, the management of the debitage and the sequence of reduction, the latest knapping products and the causes of abandonment. The analysis of the handaxes takes into account, in addition to the metric aspects (sizes and shapes, presence/absence of bilateral and bifacial equilibrium, retouching characteristics, type of the original blanks, etc.), the identification of the main stages of bifacial shaping (Inizan et al., 1999), in order to reconstruct the production process.

5.2 Composition of the lithic assemblage

The lithic assemblage is characterized by two components, one linked to bifacial shaping and one linked to debitage (core reduction), with the use of different methods that lead to the exhaustive exploitation of raw material. Secondary reduction sequences are poorly attested. Retouched tools are rare and mostly obtained from the retouch of flakes, which almost exclusively result from an opportunistic debitage. Handaxes were produced at the expense of slabs of flint and only very rarely from flakes. The representation of handaxes is not very high with respect to the composition of the whole lithic industry (from 3% in S.U. C to 4% in S.U. B) but it is significant when compared with the other instruments and constitutes between 35% and 40%.

The composition of the lithic assemblage remains, more or less, stable along the stratigraphic sequence (Muttillo et al., 2014) (Table 2).

5.3 Raw material and taphonomic aspects

The lithic industry was mostly obtained from different types of flint. The exploitation of the limestone, silicified limestone and jasper is definitely rare in all stratigraphic units, while the most exploited type is aphanitic flint, especially in the S.U. C and B*C, followed, in a lesser percentage, by micro-brecciated flint and macro-brecciated flint, the latter increases in percentage in the S.U. B and A*B at the expense of aphanitic flint.

Raw material is locally available near the site, as testified by the presence of outcrops recorded in the High Volturno Valley (Brancaccio et al., 2000) and was collected in a secondary position within the detrital deposits in the form of slabs. Blocks of flint with a roughly parallelepiped shape, partially covered by cortex, poorly preserved and with dimensions between 5 and 15 cm, are the most common forms recorded within the unworked materials, especially in the S.U. C. The majority of the raw material used has a good attitude to knapping and a high degree of silicification, though types of flint consistently characterised by a series of parallel and crossed fracture planes were also found.

The presence of inclusions and fracture planes that characterizes some types of flint does not seem to affect the technical choices of the knappers. The characteristics of the raw material have influenced the debitage reduction sequences more in terms of length than management of the core, and did not affect the component of bifacial shaping. Therefore, the absence of a qualitative selection based on the material is particularly appreciable in the bifacial shaping, that is conducted regardless of the type of raw material. Finally there is no differentiation between the raw material selected for debitage and the raw material exploited for bifacial shaping (Muttillo et al., 2014).

The lithic industry was affected by moderate sediment transport. This phenomenon is less pronounced for the remains from S.U. B and B*C which have a very good state of preservation even if dislocations and redistribution of weak entities are observed. The state of preservation of the artefacts in the S.U. C is altered, both in mechanical terms and, to a lesser extent, in

physical-chemical terms, while the state of preservation in the S.U. B*C, B and A*B is substantially fresh.
The state of integrity of the products for all levels amounted to low values (24%). The knapping accidents recorded are generally referred to fractures contemporary to the debitage (simple breaks, Siret fractures, languette fractures) but there are also characteristics related to the use of the artefact. The causes of fragmentation can also be found in post-depositional phenomena (transport, trampling, etc.), especially for the S.U. C.

5.4 Debitage methods

The representation of the debitage methods, inferred from the analysis of flakes and cores (Table 3), is more or less stable along the stratigraphic sequence, revealing a prevalence of the S.S.D.A. (Système par Surface de Débitage Alterné) method (Forestier, 1993), followed by Discoid debitage (Boëda, 1993) *sensu sticto* and discoid debitage *sensu lato* (Mourre, 2003). The presence of the Levallois method (Boëda, 1994, 1993, 1991) is rare but significant and increases upward along the stratigraphic sequence, especially in the S.U. B*C and B, where the aim of obtaining products with a predetermined shape becomes more evident.
The intense exploitation of the cores recorded for all methods, together with the presence of a mixed technical system aimed at the maximum exploitation of the raw material, testify to the high productivity of the debitage. The cores are usually exploited until the exhaustion of the raw material and are abandoned prematurely only when fractures of the raw material occur, influencing the organisation of the debitage, or in the case of a knapping accident (usually hinged flakes) that would require a technical investment too high for the restoration of adequate convexities and angles.
The dimensional data of knapping products cluster in small-medium values in all anthropic levels.
The S.S.D.A. method. The S.S.D.A. method (Forestier, 1993) in all anthropic levels involves the use of 2 – 7 striking platforms (usually orthogonal), progressively created with the advance of core reduction, through unidirectional exploitation. Each surface is used for the detachment of 2 or more flakes, the negatives of which serve as striking platforms for a further series of detachments. The lack of any preparation of the core implies the almost complete absence of characteristic flakes. Flakes display an extremely varied morphology, which depends on the morphology of the starting block, the organisation of the debitage and the length of the reduction sequence. These flakes, that generally present a length/width ratio greater than 1:1, have a flat butt and the negatives on the dorsal face are mostly orthogonal and to a lesser extent unipolar.

Cores generally have a high degree of exhaustion: the abandonment is due to the depletion of raw material and, only to a lesser extent, to the lack of adequate technical criteria for the continuation of debitage. Shorter reduction sequences are attested when the flint is fissured or on broken blocks, exploited through 2-3 unipolar detachments from 1-3 non-consecutive percussion plans. The latest knapping products correspond to flakes of small size, generally quadrangular, in some cases hinged, due to the presence of fissures in the raw material. The S.S.D.A. method exploited the aphanitic and brecciated types of flint.

S.s. and *s.l.* discoid debitage (Fig. 8). As mentioned above, in this work we refer to a discoid debitage *sensu stricto*, corresponding to the Boëda definition (Boëda, 1993), and discoid debitage *sensu lato*, in which the inclination and the hierarchy of the removals could be variable from the strict definition (Mourre, 2003).

Therefore in the Guado San Nicola lithic assemblage the discoid debitage *s.l.* is characterized by the exploitation of a peripheral striking platform that separates two convex surfaces, generally asymmetric, through the detachment of short and slightly invasive flakes conducted in a centripetal direction. Cores are more or less roughly exploited on one surface and, only rarely and partly, also on the other surface. The plane of the detachment of flakes is generally sub parallel to the intersection of the two core surfaces, not secant as in the discoid method *s.s.*, lacking the typical characteristic of self-maintenance of the convexities. There is some variability in thickness, in the degree of the exploitation of the surfaces, in the morphology of the section and in the symmetry or asymmetry of the surfaces. The abandonment usually coincides with the depletion of one of the convexities. Knapping products have mostly centripetal negatives on the dorsal face and, to a lesser extent, unipolar; butts are flats and only seldom dihedrals; often the flaking angle is greater than 90°.

The discoid cores *s.s.*, on the other hand, are characterised by two opposite convex asymmetric surfaces, alternatively exploited as striking platforms and flaking surface (the two surfaces are not hierarchized). Flakes are detached according to a plane that is secant to the plane of intersection of the two surfaces (sub-parallel when the core is overexploited), from the perimeter of the core. The cores clearly attributable to a discoid conception are relatively few, even though the possibility of an application of opportunistic scheme in the final stage of reduction should not be underestimated, as can be seen in some cores with characteristics intermediate between the discoid/S.S.D.A. methods. The abandonment of the cores is due largely to the depletion of the raw material and, to a lesser extent, to the flattening of one of the two convexities that would have required a shaping out of the core for the re-creation of a convexity.

The exploitation in a centripetal direction produces small quadrangular products, wider than longer, with a thick proximal part and a thinner distal part, with flat butts and to a lesser extent dihedral. The exploitation in a tangential direction produces overflowing flakes, which are characterized by a thickening of the distal or lateral side, flat butt, small size, length/width ratio generally not greater than 1:1, centripetal and to a lesser extent crossed negatives on the dorsal face; it also produces pseudo-Levallois point, typically *déjeté* and quite thin, which are characterized by flat or dihedral butts and of small size.

Few transverse and axial crested flakes have also been recorded, characteristic products which constitute technical expedients functioning to restore the convexity of the discoid core when a marked convexity becomes inaccessible through the detachments conducted from the overhang of the core (Peresani, 1998). The final products correspond to small quadrangular flakes, sometimes hinged, generally with a length/width ratio equal to 1:1. These methods exploited the aphanitic and brecciated types of flint.

The application of this method, which has the peculiar characteristic of self-maintenance of the convexity, allows for the full exploitation of the raw material and implies a certain dimensional and morphological standardization of the derived products. Moreover the absence of hierarchy between the two surfaces results in a considerable increase in productivity of the core (Peresani, 1998).

<u>Levallois method</u> (Figs. 5, 6 and 7). The Levallois method (Boëda, 1994, 1993, 1991) is rarely applied in the S.U. C but becomes more frequent upward in the stratigraphic sequence, and offers a wider response to the morphological and technical criteria of this conception, together with a greater representation of the different stages of the reduction process. The Levallois assemblage (Table 4), revealing a careful preparation/management/maintenance of flaking platforms and convexities, testifies the ability to prepare and re-prepare cores aimed at the production of predetermined flakes.

The assemblage is fresh in the stratigraphic units considered and the most exploited types are the aphanitic and micro-brecciated flint, in very few cases macro-brecciated flint and silicified limestone.

The cores with a Levallois reduction sequence are 20 and are all well preserved. The exploitation is intensive and normally pursued until the total exploitation of the raw material volume. The raw material, according to the Levallois flakes, is better than the one utilized for bifacial shaping as no fractured slabs or cobbles are exploited. The raw material consists of ovoid cobbles and quadrangular slabs and both morphologies are exploited by recurrent centripetal, unipolar and lineal Levallois method (Boëda, 1994). In rare cases big flakes are also utilized as blank cores, applying a centripetal debitage. In the lineal and recurrent unipolar debitage the abrasion is performed just in correspondence with the striking platform used for that production phase. The lateral and distal convexities are prepared mainly by overflowing flakes, except for the lineal debitage, for which the preparation of the convexities is only made by centripetal debitage.

Levallois flakes (n = 96), mostly referring to the *plein debitage* phase and to a lesser extent to the (re-) preparation of the convexities, are obtained through a recurrent Levallois method, mainly unipolar and, to a lesser extent, centripetal and lineal methods.

The size of the flakes, generally small-medium, is greater for the preferential products than the recurrent flakes. The unipolar method, usually attested to the final stages of production, generates products that tend to be longer than wider. The butts are dihedral or flat, with the same percentage, and only to a lesser extent facetted. Levallois points and blades (n = 2), as well as retouched Levallois flakes (5 sidescrapers, 2 notches and 1 denticulate), are extremely rare. It should be noted that 2 conjoining Levallois flakes were discovered in the S.U. B*C; these two overflowing flakes, functional to the preparation of the core convexities, are ascribable to a recurrent centripetal debitage.

5.5 Retouched tools

Retouched tools (Fig. 9) are not very frequent but, however, along the stratigraphic sequence, there is a gradual upward increase in the percentage of the tools, with a greater diversification, as well as systematization and standardization of retouching characters.

The retouched pieces are mostly composed of sidescrapers and denticulates, followed by a moderate percentage of retouched notches; other instruments, such as endscrapers, Tayac points, flakes with abrupt retouch, are very rare. Along the stratigraphic sequence there is an upward increase of denticulates and notches together with a decrease of sidescrapers. Among the sidescrapers simple convex scrapers, bifacial scrapers and convex convergent scrapers acquire greater weight (Table 5).

Retouching is generally direct, scaled, short, partial, discontinuous, semi-abrupt to abrupt although, along the stratigraphic sequence, it becomes more invasive, low, bifacial and sub-parallel.

Instruments are obtained almost exclusively on flakes resulting from the S.S.D.A. debitage (rarely on Levallois and discoid flakes), and only in rare cases, on blanks of a different nature, such as small block fragments and indeterminable fragments. In the first case retouching slightly modified the edges of the flakes (the dimensional range is the same) and, in the second case, endorsed an initial morphology that did not require radical transformations (Muttillo et al., 2014).

Retouched tools are mostly obtained on aphanitic flint but also on brecciated flint, in accordance with the general exploitation of the whole lithic assemblage; therefore it is not recognizable that a particular type of raw material was selected for tool production.

5.6 Bifacial shaping

The bifacial shaping is mainly made on slabs and rarely on flakes. In most cases the original forms of blanks used for bifacial shaping were flattened slabs of flint of medium dimensions, characterized by two parallel and opposing surfaces with cortex and by a relatively limited thickness.

While aphanitic flint is the most exploited type for the shaping of handaxes, the exploitation of brecciated types is also attested, as well as a poor quality raw material with numerous fracture planes, overcoming the limitations imposed by the raw material.

The bifacial reduction sequence is fragmented and the best represented phases refer to the regularization of the edges with respect to the bilateral equilibrium plan. In particular the stage concerning the creation of a peripheral striking platform is undertaken most often just at the distal part, through direct percussion by hard hammer; the phase referring to the creation of a morpho-dimensional bifacial equilibrium is undertakes often just at the point, through direct percussion by hard hammer and/or (in most cases) direct percussion by soft organic hammer; finally, the last stage concerning the regularization of the edges with respect to the bilateral equilibrium plan, is undertaken often just at the point, through direct percussion by soft hammer, seldom by hard hammer.

Handaxes (Fig. 10) generally have a bifacial and bilateral asymmetry or only partial symmetry, while they rarely involve a good control of bifacial and bilateral equilibrium. The technical investment is concentrated on the shaping of the distal part, while the basal part generally preserves the cortex or is not shaped at all. A morphological and dimensional heterogeneity characterizes the set, although the pointed shapes prevail over the ovate ones and the handaxes mostly cluster in the 60-90 mm size range in length and 40-60 mm size range in width. Although there is a dimensional and morphological variability among the handaxes, the technical investment was focused on the shaping of the point and distal edges, which could represent the effective functional part.

Does not seem to exist any relationship between handaxes's morphology and type of raw material, contrary to the "raw material model" reported by Ashton and White (2003), that identifies in pointed forms the result of an adaptation to the limitations imposed by raw material.

The use of the soft organic hammer allows the production of very thin invasive flakes. These flakes (n = 40, S.U. C; n = 38, S.U. B*C; n = 60, S.U. B), mostly refer to the latest stages of bifacial shaping and present an optimal state of preservation. Bifacial shaping flakes are rarely used as blanks for tools.

Although the retouch is not homogeneous, even in the same specimen, it is generally scaled, deep, non-invasive but accurate, flat and sub-parallel with respect to the distal part. The point is carefully shaped in one third of the cases, through a low, better structured and covering retouch, achieved, in most cases, by direct percussion with a soft hammer. The edges are, in half of the cases, slightly sinusoidal or sinusoidal and they tend to be rectilinear, especially in the distal part and along the point. The fractures recorded are contemporary to the shaping, but there are also flexion fractures associated with the use of the instrument (Muttillo et al., 2014).

6. Discussion and conclusions

The systematic excavation of the Guado San Nicola site, located near the top of the oldest Middle Pleistocene terrace in the Upper Volturno Valley, allowed for the identification of four anthropic levels recorded in a stratigraphic sequence, more than two metres thick, mostly consisting of fluvial sandy sediments rich in pyroclastic material, deposited in a braided river plain with well-defined topographic levels.

The faunal association suggests a temperate or warm temperate climate and a diversified environment characterized by woodland and even shrubbed areas, mostly populated by cervids, and open grassland, occupied by elephants, aurochs and horses. The presence of *Cervus elaphus acoronatus* and *Equus ferus*, points to a correlation with the Fontana Ranuccio faunal unit, allowing its attribution to the end of MIS 11, which is further confirmed by radio-isotopic dating methods ($^{40}Ar/^{39}Ar$ and ESR/U-Th). The zooarchaeological analysis, apart from the identification of intentional bone fracturing and cut marks related to the subsistence activities carried out *in situ*, led to the recognition of peculiar marks on several shed antler burrs, probably related to knapping activities.

The analysis of the lithic assemblages from the stratigraphic units C, B*C, B and A*B allows for an interpretative hypothesis on the techno-economic behaviour, in terms of objectives, technical choices and production methods, of human groups who occupied the area of Guado San Nicola during the Middle Pleistocene.

The lithic industry is characterised by a component linked to bifacial shaping and a component linked to debitage, with the use of different methods (S.S.D.A., discoid and Levallois) which lead to more or less exhaustive exploitation of the raw material.

Evidence for ramification of reduction sequences is rarely attested. Few cores are obtained from the exploitation of the ventral surface of flakes used as supports. Handaxes are obtained from the exploitation of slabs of flint and only in a very few cases from flakes. Retouched tools are rare and are obtained almost exclusively from flakes resulting from the S.S.D.A. debitage. In very few cases bifacial shaping flakes are used as blanks for tools.

It is recognizable that there is a relative stability in the maintenance of the technical behaviour along the stratigraphic sequence, in terms of: absence of qualitative selective choices regarding raw material, especially for the bifacial shaping; high productivity and effectiveness of the technical systems; full mastery of the discoid method and an increasing mastery, along the stratigraphic sequence, of the Levallois method; low representation of retouched tools; high representation of handaxes and a clear intentionality at obtaining pointed handaxe shapes; use of the soft hammer for the final stages of bifacial shaping.

Considering the plurality and complexity of the European Acheulean phenomenon, in which the handaxe constitutes a definite minority element within the lithic industry (Nicoud, 2011, 2013), Guado San Nicola acquires even more significance in relation to the importance and diversity of the bifacial reduction sequence. Unfortunately the rarity of sites in a good lithostratigraphic context and with consistent lithic assemblages constitutes a serious limitation for understanding the chronology, nature and development of the biface-based assemblages in western Europe (Nicoud, 2011, 2013), and this is particularly true for the Italian Peninsula. There are no strong evidences that confirm the precedence of core-and-flake industry compared to biface-based assemblages, considering the problematic nature of the dates associated with the first (Villa, 2001) and the contemporaneity of the two types of industry (Gallotti & Peretto, 2015).

Moreover, the emergence of the Levallois debitage, and its coexistence with handaxe technology, constitutes an aspect of great importance, rekindling the debate on the origin, chronology and evolution of prepared-core technologies (Mode 3) in Europe and their relationship with previous technical complexes (Mode 2); in summary, if we have to consider the emergence of this new technological aspect as a shift with previous behaviour or, on the other hand, as a progressive transition.

Indeed the site of Guado San Nicola dates back to the end of MIS 11 and currently represents the oldest evidence of Levallois technology in the Italian peninsula, testifying to the emergence of Levallois debitage and its increasing mastery.

All anthropic levels display the same technological substratum and a gradual evolution of the lithic industries: it is not recognizable as a technological discontinuity along the stratigraphic sequence, corroborating the hypothesis of an *in situ* evolution from the local late Acheulean, as proposed by some authors (e.g., Adler et al., 2014; White and Ashton, 2003). The presence of the Levallois debitage on a typical Acheulean substratum seems to suggest that the core-prepared technology developed as a natural consequence of the exploitation of two separate convex surfaces from a peripheral striking platform, common to both the Levallois and the bifacial shaping technology (Arzarello et al., 2014).

Along the stratigraphic series it is recognizable that there is an improving mastery of the predetermination strategies and an increasing systematization and standardization in tool production, as mentioned for other 'transitional' sites, i.e. Orgnac 3, Southern France (Moncel et al., 2011).

Nonetheless, the evidence of a 'behavioural' evolution in technological terms does not enable us to draw conclusions about the social and adaptive changes that accompanied the cultural transition from the Lower to the Middle Palaeolithic (Arzarello et al., 2014).

Acknowledgements

We thank the Direzione Regionale per i Beni Culturali e Paesaggistici del Molise and the Soprintendenza per i Beni Archeologici del Molise for their collaboration expressed during the field and laboratory activities. We also thank the Provincia di Isernia and the Centro Europeo di Ricerche Preistoriche di Isernia for their logistical support during the excavation. Moreover we would like to thank the Università degli Studi di Ferrara for having made available the equipment and laboratories and for the financial support for field, restoration and laboratory activities (FAR 2008-2014, PhD grants and in particular the Ecole Française de Rome, PHC Galileo, project n°28237WA, MNHN ATM "HNS"). Finally, we would like to express thanks to all national and international institutions that have provided qualified staff and laboratories for scientific analysis.

References

Adler, D., Wilkinson, K., Blockley, S., Mark, D., Pinhasi, R., Schmidt-Magee, B., Nahapetyan, S., Mallol, C., Berna, F., Glauberman, P., Raczynski-Henk, Y., Wales, N., Frahm, E., Jöris, O., MacLeod, A., Smith, V., Cullen, V., Gasparian, B., 2014. Early Levallois technology and the Lower to Middle Paleolithic transition in the Southern Caucasus. Science 345, 1609–1613.

Arzarello, M., Lembo, G., Muttillo, B., Peretto, C., Sala, B., 2014. Considerazioni conclusive, in: Muttillo, B., Lembo, G., Peretto, C. (Eds.), L'insediamento a Bifacciali Di Guado San Nicola, Monteroduni, Molise, Italia. Annali dell'Università degli Studi di Ferrara, pp. 147–149.

Arzarello, M., Peretto, C., 2006. L'Acheuleano di Colle delle Api. L'industria litica, in: Peretto, C., Minelli, A. (Eds.), Preistoria in Molise. Gli Insediamenti Del Territorio Di Isernia. Aracne Editrice, Roma, pp. 139–143.

Baena, J., Moncel, M.-H., Cuartero, F., Chacon Navarro, G.M., Rubio, D., 2014. Late Middle Pleistocene genesis of Neanderthal technology in Western Europe : The case of Payre site (south-east France). Quaternary International. doi:10.1016/j.quaint.2014.08.031

Bahain, J.-J., Shao, Q., Falguères, C., Garcia, T., Douville, E., Frank, N., 2014. Datation du site de Guado San Nicola par les méthodes de la résonance de spin électronique et du déséquilibre dans les familles de l'uranium combinées (ESR/U-Th), in: Muttillo, B., Lembo, G., Peretto, C. (Eds.), L'insediamento a Bifacciali Di Guado San Nicola, Monteroduni, Molise, Italia. Annali dell'Università degli Studi di Ferrara, pp. 53–56.

Boëda, E., 1991. Approche de la variabilité des systèmes de production lithique des industries du Paléolithique inférieur et moyen: chronologie d'une variabilité attendue. Technique et Culture 17, 37–79.

Boëda, E., 1993. Le débitage discoïde et le débitage Levallois récurrent centripète. Bulletin de la Société préhistorique française 90, 392–404.

Boëda, E., 1994. Le concept Levallois: variabilité et méthodes. CNRS Éditions, Paris.

Brancaccio, L., Cinque, A., Di Crescenzo, G., Santangelo, N., Scarciglia, F., 1997. Alcune osservazioni sulla tettonica quaternaria nell'alta valle del F. Volturno (Molise). Il Quaternario 10, 321–328.

Brancaccio, L., Di Crescenzo, G., Rosskopf, C., Santangelo, N., Scarciglia, F., 2000. Carta geologica dei depositi quaternari e carta geomorfologica dell'Alta Valle del fiume Volturno (Molise, Italia meridionale). Note illustrative. Italian Journal of Quaternary Sciences 13, 81–94.

Clark, G., 1969. World Prehistory: A New Outline. Cambridge University Press, London.

Coltorti, M., Cremaschi, M., 1981. Depositi quaternari e movimenti neotettonici nella conca di Isernia, in: C.N.R. (Ed.), Contributi Conclusivi Alla Realizzazione Della Carta Neotettonica d'Italia. P.F.G., Sottoprogetto Neotettonica, pp. 173–188.

Coltorti, M., Cremaschi, M., Delitala, M., Esu, D., Fornaseri, M., McPherron, A., Nicoletti, M., Van Otterloo, R., Peretto, C., Sala, B., Schmidt, V., Sevink, J., 1982. Reversed magnetic polarity at an early Lower Palaeolithic site in Central Italy. Nature 300, 173–176.

Coltorti, M., Feraud, G., Marzoli, A., Ton-That, T., Voinchet, P., Bahain, J.-J., Minelli, A., Thun Hohenstein, U., Peretto, C., 2005. New 40Ar/39Ar, stratigraphic and palaeoclimatic data on the Isernia La Pineta Lower Palaeolithic site, Molise, Italy. Quaternary International 131, 11–22.

Coltorti, M., Pieruccini, P., 2014. Guado San Nicola Acheulean site: preliminary remarks on the litho-, morpho- and pedo-stratigraphical setting, in: Muttillo, B., Lembo, G., Peretto, C. (Eds.), L'insediamento a Bifacciali Di Guado San Nicola, Monteroduni, Molise, Italia. Annali dell'Università degli Studi di Ferrara, pp. 13–24.

Coltorti, M., Ravani, S., Pieruccini, P., 2006. Geoarcheologia del sito Acheuleano di Colle delle Api (Monteroduni, Isernia), in: Peretto, C., Minelli, A. (Eds.), Preistoria in Molise. Gli Insediamenti Del Territorio Di Isernia. Aracne Editrice, pp. 123–135.

De Lombera-Hermida, A., Bargalló, A., Terradillos-Bernal, M., Huguet, R., Vallverdú, J., García-Antón, M.-D., Mosquera, M., Ollé, A., Sala, R., Carbonell, E., Rodríguez-Álvarez, X.-P., 2015. The lithic industry of Sima del Elefante (Atapuerca, Burgos, Spain) in the context of Early and Middle Pleistocene technology in Europe. Journal of Human Evolution 82, 95–106. doi:10.1016/j.jhevol.2015.03.002

Foley, R., Lahr, M., 1997. Mode 3 technologies and the evolution of modern humans. Cambridge Archaeological Journal 7, 3–36.

Fontana, F., Moncel, M.H., Nenzioni, G., Onorevoli, G., Peretto, C., Combier, J., 2013. Widespread diffusion of technical innovations around 300,000 years ago in Europe as a reflection of anthropological and social transformations? New comparative data from the western

Mediterranean sites of Orgnac (France) and Cave dall'Olio (Italy). Journal of Anthropological Archaeology 32, 478–498.

Forestier, H., 1993. Le Clactonien: mise en application d'une nouvelle méthode de débitage s'inscrivant dans la variabilité des systèmes de production lithique du Paléolithique ancien. Paléo 5, 53–82.

Gallotti, R., Peretto, C., 2015. The Lower/early Middle Pleistocene small débitage productions in Western Europe: New data from Isernia La Pineta t.3c (Upper Volturno Basin, Italy). Quaternary International 357, 264–281.

Gliozzi, E., Abbazzi, L., Argenti, P., Azzaroli, A., Caloi, L., Capasso Barbato, L., Di Stefano, G., Esu, D., Ficcarelli, G., Girotti, O., Kotsakis, T., Masini, F., Mazza, P., Mezzabotta, C., Palombo, M., Petronio, C., Rook, L., Sala, B., Sardella, R., Zanalda, E., Torre, D., 1997. Biochronology of selected mammals, mollusco and ostracods from the Middle Pleistocene to the Late Pleistocene in Italy. The state of the art. Rivista Italiana di Paleontologia e Stratigrafia 103, 369–388.

Inizan, M.-L., Reduron-Ballinger, M., Roche, H., Tixier, J., 1999. Technology and Terminology of Knapped Stone. Cercle de Recherches et d'Études Préhistoriques, Nanterre.

Lamotte, A., 1995. Données nouvelles sur l'Acheuléen de l'Europe du Nord-Ouest. Bulletin de la Société préhistorique française 92, 193–200.

Lamotte, A., Tuffreau, A., 2001. Les industries acheuléennes de Cagny (Somme) dans le contexte de l'Europe du Nord-ouest, in: Tuffreau, A. (Ed.), L'Acheuléen Dans La Vallée de La Somme et Paléolithique Moyen Dans Le Nord de La France: Données Récentes. CERP, pp. 149–153.

Leroi-Gourhan, A., 1964. Le geste et la parole I: Techniques et langage. Albin Michel, Paris.

Masini, F., Sala, B., 2011. Considerations on an integrated biochronological scale of italian Quaternary continentals mammals. Il Quaternario - Italian Journal of Quaternary Sciences 24, 193–198.

Moncel, M.-H., Moigne, A.-M., Sam, Y., Combier, J., 2011. The Emergence of Neanderthal Technical Behavior: New Evidence from Orgnac 3 (Level 1, MIS 8), Southeastern France. Current Anthropology 52, 37–75.

Mourre, V., 2003. Discoide o pas discoide? Réflexions sur la pertinence des critères techniques définissant le débitage discoide, in: Peresani, M. (Ed.), Discoid Lithic Technology. Advances and Implications. Archaeopress, Oxford, pp. 1–17.

Muttillo, B., Arzarello, M., Peretto, C., 2014. L'industria litica in selce, in: Muttillo, B., Lembo, G., Peretto, C. (Eds.), L'insediamento a Bifacciali Di Guado San Nicola, Monteroduni, Molise, Italia. Annali dell'Università degli Studi di Ferrara, pp. 79–142.

Nicoud, E., 2011. Le phénomène acheuléen en Europe Occidentale: approche chronologique, technologie lithique et implications culturelles (PhD dissertation). Université de Provence, Università di Roma Sapienza.

Nomade, S., Pereira, A., 2014. Datation 40Ar/39Ar du site de Guado San Nicola, in: Muttillo, B., Lembo, G., Peretto, C. (Eds.), L'insediamento a Bifacciali Di Guado San Nicola, Monteroduni, Molise, Italia. Annali dell'Università degli Studi di Ferrara, pp. 49–52.

Ollé, A., Mosquera, M., Rodríguez, X.P., de Lombera-Hermida, A., García-Antón, M.D., García-Medrano, P., Peña, L., Menéndez, L., Navazo, M., Terradillos, M., Bargalló, A., Márquez, B., Sala, R., Carbonell, E., 2013. The Early and Middle Pleistocene technological record from Sierra de Atapuerca (Burgos, Spain). Quaternary International 295, 138–167. doi:10.1016/j.quaint.2011.11.009

Palma Di Cesnola, A., 1992. Le nostre attuali conoscenze sull'Acheuleano italiano, in: Peretto, C. (Ed.), I Primi Abitanti Della Valle Padana. Monte Poggiolo Nel Quadro Delle Conoscenze Europee. Jaca Book, Milano, pp. 137–150.

Palma Di Cesnola, A., 2001. Il Paleolitico inferiore e medio in Italia. Museo Fiorentino di Preistoria "Paolo Graziosi," Firenze.

Peresani, M., 1998. La variabilité du débitage discoïde dans la grotte de Fumane (Italie du Nord)/The variability of discoid production at the grotte de Fumane. Paléo 10, 123–146. doi:10.3406/pal.1998.1133

Picin, A., Peresani, M., Falguères, C., Gruppioni, G., Bahain, J.J., 2013. San Bernardino Cave (Italy) and the Appearance of Levallois Technology in Europe: Results of a Radiometric and Technological Reassessment. PLoS ONE 8, 4–11.

Ricciardi, S., 2006. L'Acheuleano di Colle delle Api. Gli studi palinologici, in: Peretto, C., Minelli, A. (Eds.), Preistoria in Molise. Gli Insediamenti Del Territorio Di Isernia. Aracne Editrice, pp. 135–136.

Rolland, N., 1995. Levallois technique emergence: single or multiple? A review of the euro-african record, in: Dibble, H.L., Bar-Yosef, O. (Eds.), The Definition and Interpretation of Levallois Technology. Prehistory Press, Madison, pp. 333–359.

Sala, B., Boulbes, N., Moigne, A.-M., Thun Hohenstein, U., 2014. L'insieme faunistico del giacimento, in: Muttillo, B., Lembo, G., Peretto, C. (Eds.), L'insediamento a Bifacciali Di Guado San Nicola, Monteroduni, Molise, Italia. Annali dell'Università degli Studi di Ferrara, pp. 59–78.

Sala, B., Thun Hohenstein, U., 2006. L'Acheulano di Colle delle Api. I vertebrati fossili, in: Peretto, C., Minelli, A. (Eds.), Preistoria in Molise. Gli Insediamenti Del Territorio Di Isernia. Aracne Editrice, pp. 136–138.

Santonja, M., Pérez-González, A., Panera, J., Rubio-Jara, S., Méndez-Quintas, E., 2015. The coexistence of Acheulean and Ancient Middle Palaeolithic techno-complexes in the Middle Pleistocene of the Iberian Peninsula. Quaternary International 1–11. doi:10.1016/j.quaint.2015.04.056

Terradillos-Bernal, M., Díez Fernández, J.-C., 2012. La transition entre les Modes 2 et 3 en Europe: le rapport sur les gisements du Plateau Nord (Péninsule Ibérique). L'Anthropologie 116, 348–363. doi:10.1016/j.anthro.2012.06.001

Tuffreau, A., 1995. The variability of Levallois technology in Northern France and neighbouring areas, in: Dibble, H.L., Bar-Yosef, O. (Eds.), The Definition and Interpretation of Levallois Technology. Prehistory Press, Madison, pp. 413–427.

Tuffreau, A., Antoine, P., Chase, P.G., Dibble, H.L., Ellwood, B., van Kolfschoten, T., Lamotte, A., Laurent, M., Mc Pherron, S.P., Moigne, A.-M., Munaut, A.-V., 1995. Le gisement acheuléen de Cagny-l'Épinette (Somme). Bulletin de la Société préhistorique française 92, 169–192.

Tuffreau, A., Lamotte, A., Goval, E., 2008. Les Industries acheuléennes de la France septentrionale. L'Anthropologie 112, 104–139.

Turrini, M.C., Lembo, G., Peretto, C., Tessari, U., Vaccaro, C., 2014. La serie stratigrafica, in: Muttillo, B., Lembo, G., Peretto, C. (Eds.), L'insediamento a Bifacciali Di Guado San Nicola, Monteroduni, Molise, Italia. Annali dell'Università degli Studi di Ferrara, pp. 25–48.

Van Otterloo, R., Sevink, J., 1983. The quaternary evolution of the Upper-Volturno Basin, in: Coltorti, M., Terzani, C., Cremaschi, M. (Eds.), Isernia La Pineta. Un Accampamento Più Antico Di 700.000 Anni. Calderini, Bologna, pp. 35–39.

White, M.J., Ashton, N.M., 2003. Lower palaeolithic core technology and the origins of the Levallois method in North-Western Europe. Current Anthropology 44, 598–609.

Wiśniewski, A., 2014. The beginnings and diversity of Levallois methods in the early Middle Palaeolithic of Central Europe. Quaternary International 326-327, 364–380.

FIGURES

Fig. 1. Guado San Nicola. Geomorphological sketch of the area and site location. From Coltorti and Pieruccini, 2014.

Fig. 2. Guado San Nicola. Stratigraphic sequence with $^{40}Ar/^{39}Ar$ dating. 1. Pyroclastics; 2. Archaeological remains; 3. Soils. Modified from Coltorti and Pieruccini, 2014.

Fig. 3. Guado San Nicola. *Equus ferus*: Right 4^{th} metacarpal bone (A) with cut marks (B, C). Photo: M. Bertolini; photo stereomicroscope/SEM: U. Thun Hohenstein.

Fig. 4. Guado San Nicola. *Cervus elaphus acoronatus*: A) basal portion of a shed antler with broken brow and bez tines; B) on the burr several sub-parallel notches are evident (C, D) that have a probable origin in their use as a percussor. Photo: M. Bertolini; photo stereomicroscope: U. Thun Hohenstein.

Fig. 5. Guado San Nicola. Levallois method. 1, 2: recurrent cores (S.U. B); 3, 4: recurrent flakes (3, S.U. B*C; 4, S.U. B); 5: preferential flake (S.U. B); 6: retouched preferential flake (S.U. C); 7: retouched flake (S.U. C). Drawings: B. Muttillo.

Fig. 6. Guado San Nicola. Levallois method. 1-4: recurrent cores (1, 3: S.U. B*C; 2, 4: S.U. C). Drawings: B. Muttillo.

Fig. 7. Guado San Nicola. Levallois method. 1: preferential core (S.U. B); 2: recurrent core (S.U. B); 3, 4: recurrent unipolar flakes (3, S.U. B; 4, S.U. C); 5-7: preferential flakes (5, S.U. C; 6, 7: S.U. B*C). Photo: A. Priston.

Fig. 8. Discoid method. 1: *s.s.* discoid core (S.U. B); 2, 3: *s.l.* discoid cores (S.U. C); 4-7: discoid flakes (4-6, S.U. B; 7, S.U. B*C); 8: retouched discoid flake (S.U. C). Drawings: B. Muttillo.

Fig. 9. Guado San Nicola. Retouched blanks (1, 4: S.U. B; 2, 3: S.U. C). Drawings: B. Muttillo.

Fig. 10. Flint handaxes (1, 2: S.U. B; 3: S.U. C). Photo: A. Priston.

Table 1. Guado San Nicola. Faunal composition grouped by stratigraphic unit. In the S.U. C elephant is overestimated due to the presence of fragments of tusk and dental plates.

Table 2. Guado San Nicola. Composition of the flint lithic assemblage grouped by stratigraphic unit. For statistical purposes the S.U. A*B is not significant given the paucity of the lithic pieces and the incompleteness and fragmentation of the operational chain. We use the term "debris" to refer to "any shapeless fragment, when the means by which it was fractured cannot be identified" (Inizan et al., 1995, p. 34).

Table 3. Guado San Nicola. Frequency of cores grouped by knapping method and stratigraphic unit. S.U. A*B is not statistically significant for the paucity of the cores.

Table 4. Variability of Levallois method, grouped by stratigraphic unit.

Table 5. Composition of the tool-kit, grouped by stratigraphic unit.