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NOTES ON THE NEANDERTHAL BEHAVIOUR DURING THE ISOTOPE STAGE 3 IN THE ALPINE FRINGE OF ITALY

OSSERVAZIONI SUL MODO DI VITA DEI NEANDERTALIANI DURANTE LO STADIO ISOTOPICO 3 NELLE ALPI ITALIANE

Riassunto breve - Le Alpi italiane furono una regione nota ai Neandertaliani nelle ultime due migliaia di decenni della loro esistenza. I dati archeologici provenienti da siti in riparo sottoroccia e all'aperto provano che questi ominidi erano pienamente in grado di approvvigionarsi e sfruttare risorse minerali e animali, mettendo in atto strategie profondamente radicate nei sistemi sociali fin dai periodi più antichi. La presenza umana spazia dal margine delle terre padane ai comprensori prealpini e alpini, gravitando in una fascia caratterizzata da un'elevata e serrata variabilità geo-ambientale. Evidenze cronometriche, ecologiche, economiche e culturali, permettono di identificare forme di adattamento ai cambiamenti climatici e di siti funzionalmente diversificati, oltre ad identificare innovazioni e affinamenti nella tecnologia litica.

Parole chiave: Alpi, *Homo neanderthalensis*, Paleolitico medio, stadio isotopico 3, sussistenza, insediamento.

Abstract - *The Italian Alps were familiar to the Neanderthals during the last twenty thousand years of their existence. The archaeological evidence from several sheltered and open-air sites proves these hominins were totally able to provide for themselves and exploit mineral and animal resources, elaborating strategies that had been deeply rooted in their social system since the earliest periods. Human presence spread from the borders of the Po plain to the pre-alpine and alpine areas, a territory in which the geographical and ecological contexts differ suddenly and markedly. Chronometric, ecological, economic and cultural evidences reveal how they adapted to changes in climate, how they functionally organized their camps for different purposes and also pinpoint innovations and improvements in lithic technology.*

Key words: *Alps, Homo neanderthalensis, Middle Palaeolithic, isotope stage 3, subsistence, settlement.*

Foreword

Numerous Italian scientific contributions concerning Neanderthals during the Middle Palaeolithic consider their behaviour in relation to the distinct geological, ecological and cultural factors that affected the large-scale occupation throughout our peninsula, from the Alps to the southernmost Mediterranean regions (see contributions in BIETTI & MANZI 1990-91; BIETTI & GRIMALDI 1996; MILLIKEN 1999-2000; KUHN 1995; MUSSI 2001; STINER 1994). Authors highlight the role played by the most relevant geographical thresholds, such as the Alps and particularly the Appennines, towards creating a marked contrast between the Tyrrhenian region, subject to the effects of the Mediterranean climate, and the Adriatic-Po regions, situated in a typical continental climatic context characterized by the cyclic emergence of the continental shelf during the glacial expansions.

Even though there are great voids in the records of the earlier phases, evidence of human behaviour becomes more detailed during the Late Pleistocene, particularly in the Oxygen Isotope Stage (OIS) 3, a period relatively better known throughout the peninsula given the high

number of locationally - and functionally - different settlements encountered (KUHN & BIETTI 2000; MILLIKEN 1999-2000; BIETTI & NEGRINO 2007; BONA et al. 2007). Research over the last ten years, in some cases specifically addressed to this period, has produced new data on settlement dynamics, mobility and economic strategies pursued by the Neanderthals from the OIS 4 to the Middle Palaeolithic - Upper Palaeolithic transition. This progress, however, is still at a level lower than that required for interlacing human evidence with the intense climatic variability recorded for this specific interval (e.g. BOND et al. 1992; DANSGAARD et al. 1993) and their effects on ecosystems in Mediterranean Europe (ALLEN et al. 1999; SÁNCHEZ GOÑI et al. 2000; WATTS et al. 1996).

All in all progress in research is a valuable tool for evaluating the different behaviour of humans in the Early Upper Palaeolithic, a phase sometimes recorded at sites previously visited by the Neanderthals. The comparisons mentioned involve the economical and cultural aspects of the Palaeolithic societies across the MP-UP transition and open up crucial implications if we consider the replacement of the Neanderthals by Anatomically Modern Humans (see papers in CONARD 2006; in JÖRIS & ADLER

2008; in proceedings of the Neanderthal Congress held in Bonn, 2006). Rather than making comparisons, this contribution intends to describe Neanderthal landscape ecology in the Pre-Alps, a particular region bounded by the Alps to the north and the Po Plain to the south.

With the exception of a few more or less generic contributions published during the last decade (MILLIKEN 1999-2000; PERESANI 2001a), settlement dynamics across the MP-UP transition in the region concerned have not been an extensively treated subject, nor have there been highly detailed reports or more integrated contributions. A few papers aiming to detect differences or similarities in Neanderthal and AMH behaviour were mostly based on field evidence and on the wrong assumption that the data preliminarily gathered at Grotta Fumane had to be consistent with the subsequent investigations (i.e. BROGLIO 1995; BROGLIO et al. 2003a; GALA & TAGLIACCOZZO 2005), a demonstration of how unsupported the equation is that considers modern behaviour an exclusive sapiens appurtenance (BAILEY et al. 2009; ZILHÃO in press).

Despite the potentially high scientific value of some key sites (Grotta di Fumane, Riparo Tagliente), research into this topic requires a more integrated approach than has been done up to now, and at the same time further efforts need to be taken to increment the bulk of data from the final Middle Palaeolithic. Our archive currently consists of a handful of sites set in the belt between the alluvial plain and the Pre-Alps, namely the area in which Neanderthals and AMH lived and moved.

Landscape, sites and subsistence

The Italian Pre-Alps and the sub-alpine belt are a combination of reliefs that form a discontinuous succession of short chains and mountain groups from the Lago Maggiore to Istria, encompassing a 40 km-wide belt running from the west to the east in the western-middle region and progressively bending towards the north in the eastern transect where it arches facing the plain and the Adriatic Sea to the south. The landscape in the central Pre-Alps and particularly between the Como and Lugano lakes is dissected by deep and narrow valleys, steep slopes of mountains 1800-2000 metres high. Conversely, the Eastern Pre-Alps are limestone massifs and karst high plateaux at an altitude of 1000-1200 m whose summits are more than 2000 m high and are cut by gorges, deep and large valleys or wide basins traversed by the main rivers or holding the most important alpine lakes. To the east, the karst plateau forms a typical flat landscape extending to the Drava Basin. The subalpine zone comprises hills of different origin, such as the Monti Berici karst-plateau and the Colli Euganei cone-shaped volcanic reliefs, two groups isolated from the gravelly alluvial plain.

During the Middle Weichselian, the climate in the prealpine belt caused frost-shattering and rock-fall in

caves and rock-shelters (CREMASCHI 1990) and favoured the establishment of a continental grassland-steppe on the plain (DONEGANA et al. in press; PINI et al. 2009), where typical Asiatic faunal associations spread (SALA 1990). Across the 60-30ka interval, the prevailing zonal vegetation of the plain in the north-Adriatic region includes open birch-conifer forests, xerophytic scrubs and steppe. Broad-leaved trees are represented by *Betula*, *Salix* and *A. glutinosa* type. Phases of contraction of conifer forests and expansion of steppic communities alternate with mixed conifer (*Pinus* and *Picea*) - *Betula* forests (PINI et al. 2009).

Such a scenario should be confirmed in the central Po Plain by the association of mammoth and Irish elk, woolly rhinoceros, steppe bison and elk (SALA 2001) and the expansion of the grassland with ibex, chamois and marmots at low altitude alongside the steppe-dwelling micromammals and tundra-dwelling birds. According to DONEGANA et al. (in press) and PINI et al. (2009), the climate never reached the temperature broad-leaved forests needed to spread throughout the plain, whereas warm temperate taxa are represented only by sporadic pollen occurrences, suggesting the absence of warm-temperate broad leaved forests but not fully excluding their existence in refugia such as the Berici Mounts, where charcoal remains found in caves suggest the use of this wood (CATTANI & RENAULT-MISKOWSKY 1983-1984). Soil formation affected aeolian deposits (CREMASCHI 1990; LANZINGER & CREMASCHI 1988).

The transition from the Mousterian to the Aurignacian inasmuch as it is recorded from the macro-faunal remains and the radiocarbon dataset at Grotta di Fumane seems to fall within the progressive trend leading to cooler and drier conditions presumably at the HE4 (CASSOLI & TAGLIACCOZZO 1991; FIORE et al. 2004; ROMANDINI 2007-2008; HIGHAM et al. 2009). Humans used caves at middle and high altitude in a context of more or less open woodlands with parklands transitive to patchy alpine grasslands and pioneer vegetation. The records show that high altitude cavities were visited alternatively by humans and cave bears (BONA et al. 2007).

Even though Middle Palaeolithic sites are numerous, only few should fall within the time interval taken into account, and this group shrinks further when the chronometrically-dated assemblages are taken into consideration. Numeric ages are currently available for Grotta Fumane (PERESANI et al. 2008; HIGHAM et al. 2009), Grotta San Bernardino (GRUPPIONI 2003), Grotta Broion (PERESANI & PORRAZ 2004), Caverna Generosa (BONA et al. 2007) and Grotta Rio Secco (PERESANI & GURIOLI 2007). Moreover, the undated sites Riparo Tagliente (a single unpublished 54 ± 11 ka TL date was provided at Gliwice Laboratory in 1989), Riparo Mezzena (GIUNTI et al. 2008), Grotta Ghiacciaia (BERTOLA et al. 1999) and Riparo Broion settled in the proximity of the namesake cave (DE STEFANI et al. 2005), should fall

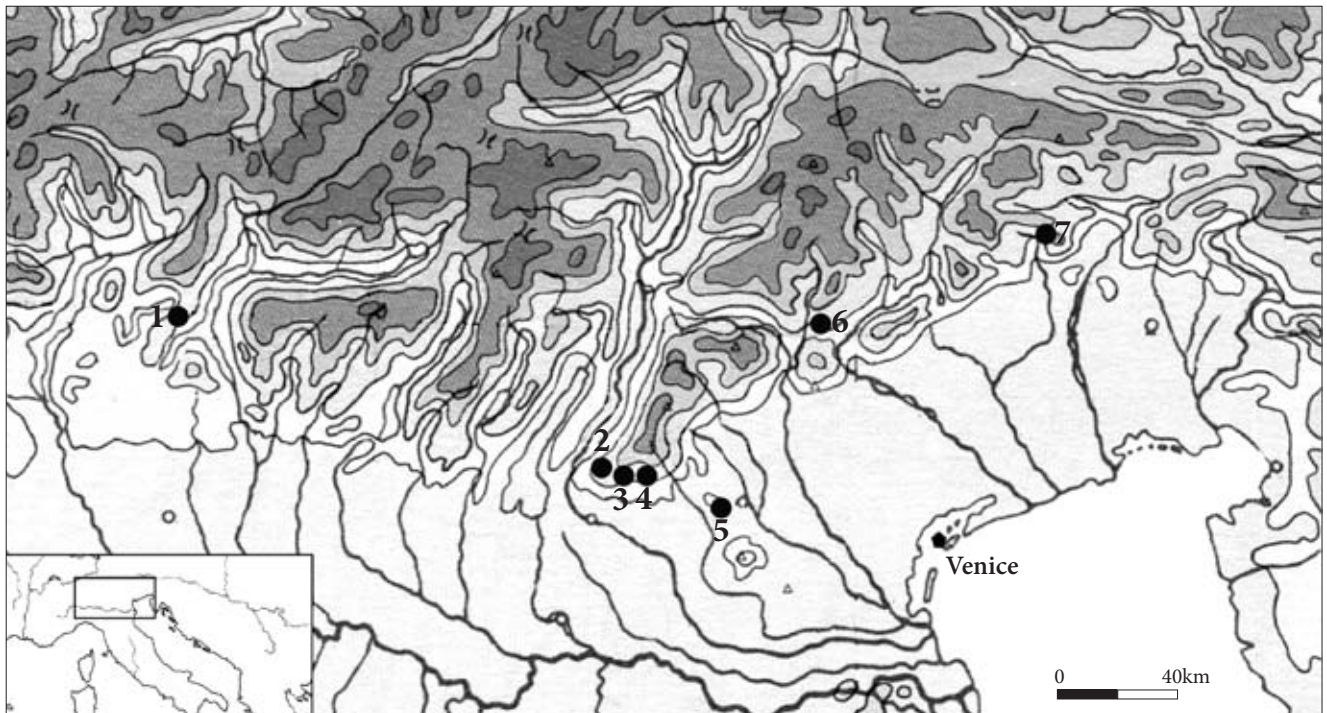


Fig. 1 - Map of Northern Italy showing the Middle Palaeolithic sites mentioned in the text: 1 - Caverna Generosa; 2 - Grotta Fumane and Grotta Ghiacciaia; 3 - Riparo Mezzena; 4 - Riparo Tagliente; 5 - Grotta Broion, Riparo Broion, Grotta San Bernardino; 6 - Monte Avena; 7 - Grotta Rio Secco.
- *Carta dell'Italia settentrionale con i siti del Paleolitico medio menzionati nel testo.*

within the 60-30ka period. This assumption is based on the direct stratigraphic overlapping of the Mousterian sequences by the levels containing Aurignacian lithic and bone implements. Among them, only Riparo Tagliente provides evidence supporting comparisons and tentative correlations with the dated sequences.

All the sites considered are located in morphologically, geologically and ecologically varied contexts (tab. I). Monte Avena at an altitude of 1500 m is the single open-air site that might fall within our time interval. Here, a few Levallois cores and flakes have been recovered in the proximity of flint outcrops from a paleosol attributed to OIS3 (LANZINGER & CREMASCHI 1988).

Human remains have been found at Riparo Mezzena, Grotta Fumane, Grotta San Bernardino and Riparo Tagliente. From a recent revision of the Riparo Mezzena human bone assemblage, palaeogenetic and anatomical data analyses of the jaw and the parietal, frontal and occipital bone fragments have been provided (GIUNTI et al. 2008; CAMELLI et al. 2006). Neanderthals at Grotta Fumane are represented by one deciduous lower molar at the base of layer A11 (GIACOBINI 1992); at Riparo Tagliente by one phalanx and two deciduous teeth, an upper right second molar and an upper left canine in levels 36 and 37 (VILLA et al. 2001). At San Bernardino, the size and morphological features of three remains recovered in unit II, one distal hand phalanx, a probable third lower right molar and a second left lower incisor do not contradict a possible attribution to the Neanderthal group (VACCA & ALCIATI 2000).

Grotta Fumane is one of the most important sites for reconstructing human behaviour both during the MP as much as at the MP-EUP transition. This cave lies along one of the narrow valleys that cut into the southern slopes of the Western Lessini plateau a few kilometres north of the Adige alluvial plain. Mentioned since the nineteenth century, Fumane has been excavated since 1988. The main cavity and few tributary galleries cover almost 80 sq.m at the cave mouth and preserve a 10m-thick cave-fill with many Mousterian (PERESANI & SARTORELLI 1998), Uluzzian (PERESANI 2008) and Aurignacian (BROGLIO et al. 2003a; 2003b; 2006; BROGLIO & DALMERI 2005) levels embedded in the four macro-units (S, BR, A and D) that compose the overall sequence spanning the main climatic events from Early to Late Weichselian (FERRARO 2002).

Regarding the MP-UP transition, a finely stratified sedimentary succession covers the final Mousterian, the Uluzzian and the first Aurignacian embedded in levels formed by frost-shattered breccia, aeolian silt and sands with no evidence at all that any contacts, exchanges or relations between the different cultural occupations occurred. Dwelling structures, lithic assemblages, bone and antler tools, painted stones and pierced molluscan shells record from the unit A2 upwards the arrival of the first Aurignacians in this region and mark a clear discontinuity with the preceding cultural entities (BROGLIO et al. 2006; BROGLIO & GURIOLI 2004). Estimates using chronometrical, lithological and biological data seem to support the idea that the entire late Mousterian-Uluzzian

sequence from A11 to A5 (Mousterian) and from A4 to A3 (Uluzzian) may cover a few thousand years before 41,0 ka BP according to the refined age-model of the sequence (HIGHAM et al. 2009; PERESANI et al. 2008).

The partially explored final Mousterian and Uluzzian levels yielded lithic and faunal remains densely (units A11, A10, A9 and A8, A6) or scarcely (units A5, A4, A3) scattered across the living floor. In the last field campaigns, extensive excavations of the anthropogenic unit A6 discovered an area studded with almost twenty combustion structures and dumped burnt residues bound by a toss-belt made of waste - burnt bones, charcoal and altered flint - rejected during the repeated use of the cave-mouth and connected to a large area dense in flakes and bones. Hearths are simple, used on the ground with no preliminary modification and set at different positions in the layer: at the base, embedded and at the top consequently to the progressive sedimentary aggradation produced by the repeated human visits. Worth underscoring in level A5 is the sole example of a combustion structure partially bounded by stones collected from different points of the cavity (PERESANI et al. in prep.) (fig. 2).

Considered sterile until 2005, layer A3 has recently disclosed a significant archaeological record. From the excavations concluded in 2006, dwelling structures with hearths and a toss-zone have been brought to light, in addition to flakes and bones scattered on the ground and in proximity of the combustion structures. At the present-day state, field evidence suggests the cave was used for short-term purposes involving the knapping of a limited number of flint cobbles and the processing of some preys, mostly ibex and red-deer. Contrary to the underlying Mousterian units, the Uluzzian layers thus

seem to record a weakening in human presence or a change in the mobility of groups (PERESANI 2008).

Grotta San Bernardino and Grotta and Riparo Broion lie in the Berici Mounts, a low-altitude karst plateau gently dipping to the south-west but sharply connected to the alluvial plain along its eastern slope dotted with caves and rockshelters. Grotta San Bernardino was first excavated almost 50 years ago and newly explored from 1986 to 1993 at the entrance between the cave mouth and the slope. The sedimentary succession includes eight litho- and pedostratigraphic units composed of gravels, freeze-thaw breccia, aeolian dust and organic matrix-supported breccia, arranged in accordance with three main palaeoclimatic cycles shifting from damp-temperate to cooler and drier climatic conditions. Several human occupation levels are recorded in this sequence spanning from the Late Middle Pleistocene to the Upper Pleistocene. One of the most intense human occurrences was during OIS 3 in unit II where hearths and burnt residues, temperate-type associated faunal bone remains and lithic implements have been found (GRUPPIONI 2003; PERESANI 1996).

Grotta and Riparo Broion face the alluvial plain and are overhung by a reef limestone wall. Broion cave has distinct locational features in comparison to the settlements of the north-eastern Italian region. It originated from a large karstic pit and comprises a squared entrance which lengthens into a wider gallery and ends in a vast 15m-deep pit where a small cavity named Grotta Leone was intensively used as cave bear den. The small and uncomfortable inhabitable area in the main cavity and at Grotta Leone changed over time due to the aggradation of the cave fill. Light densities of Mousterian lithic artefacts (almost 10 pieces/m³) embedded in deposits

outline\site	Generosa	Fumane	Ghiacciaia	Tagliente	San Bernardino	Grotta Broion
<i>Context</i>	steep slope	stream cut	stream cut	stream cut	cliff	cliff
<i>Altitude</i>	1450	350	250	250	135	135
<i>Dwelling structures</i>	no	++	**	no	+	no
<i>Main hunted game</i>	*	Cervids++ Caprids+ Bovids-	***	Cervids++ Caprids+ Bovids+	Cervids++ Caprids+ Bovids+	*
<i>Lithic provisioning</i>	exogenous	local	local	local	local exogenous	exogenous
<i>Reduction sequences</i>	fractioned	complete	complete	complete	complete fractioned	fractioned
<i>Technology</i>	Levallois	Levallois++ Discoid+ Other	Levallois Other	Levallois	Levallois	Levallois
<i>Anthropic frequentation</i>	ephemeral	persistent	persistent [↑]	persistent	persistent	ephemeral

Tab. I - Outline of the most relevant Mousterian sites considered in this synthesis: Caverna Generosa (layers 2, 11, 12), Grotta di Fumane (layers A12 to A3), Grotta Ghiacciaia (unit 3 with arbitrary levels 35 to 31), Riparo Tagliente (arbitrary levels 37 to 35), Grotta di San Bernardino (unit II), Grotta Broion (layers N1 to H). Key: altitude is expressed in metres a.s.l.; * cave-bear site; ** uncomplete extensive excavation; *** inconsistent sample population; [↑] increasing incidence of other flaking methods to the top of the cultural sequence; + degree of estimated frequency.

- *Profilo dei siti musteriani più importanti presi in considerazione in questa sintesi: Caverna Generosa (strati 2, 11, 12), Grotta di Fumane (strati A12 to A3), Grotta della Ghiacciaia (unità 3 con tagli da 35 a 31), Riparo Tagliente (tagli da 37 a 35), Grotta di San Bernardino (unità II), Grotta Broion (strati da N1 a H). Legenda: altitudine espressa in metri s.l.m.; * grotta a orsi; ** scavo limitato; *** campione poco consistente; [↑] incidenza crescente di altri metodi di scheggiatura verso la sommità della sequenza culturale; + grado di frequenza stimata.*



Fig. 2 - Grotta di Fumane. The hearth discovered in layer A5 partially bounded by slabs.
- *Grotta di Fumane. Il focolare messo in luce nel livello A5 parzialmente attorniato da pietre.*

over 5m-thick have been the subject of integrated studies demonstrating this place hosted during the 50-30 ka interval distinct human occupations in an area dearth in lithic raw material sources (PERESANI & PORRAZ 2004).

Riparo Broion is currently in course of excavation. Fine sediments, stones and carbonate concretions embed four still not explored Mousterian levels (units 13, 9, 7 and 4) in the lower part of a Late Pleistocene sequence with Aurignacian and Gravettian assemblages (DE STEFANI et al. 2005). The sequence seems to provide evidence of repeated human settlements.

Discovered in 1958 and still in course of excavation, Riparo Tagliente lies on the left side of the Pantena valley in the Lessini Mountains. Late Pleistocene deposits form two main sequences separated by an erosional discontinuity: the uppermost sequence is Epigravettian, the lowermost one includes several Mousterian levels with dispersed Aurignacian artefacts at the top. Huge amounts of faunal remains and lithic implements made using flint locally provisioned have been recovered in the still-undated and not extensively explored uppermost Mousterian levels (ARZARELLO & PERETTO 2005).

Again in Monti Lessini, Riparo Mezzena was previously excavated in 1957 and lastly in 1970 by the Verona Museum of Natural History. In the cave fill three layers have been defined: the reworked sediment with Holocene remains and Neanderthal bones at the top (layer I), the II and the III units, still undated although biostratigraphically attributed to MIS3 (PARERE 2008-2009; GIUNTI et al. 2008).

Caverna Generosa is located on the steep southern slope of the Monte Generoso Massif. From the entrance, this cave comprises an initial tunnel through which one enters a first chamber, then a narrow siphon and a larger chamber named "Sala Terminale" where huge accumulations of *Ursus spelaeus* remains and a handful of lithic artefacts have been found. The first discoveries made there induced in 1988 a palaeontologist team to organise a ten-year long program of investigations. Cave fill deposits

number nine lithological units which in some cases display marked taphonomical features produced from faunal turbation in the "Sala Terminale". Radiocarbon measures of cave bear collagen define the uncalibrated 18 ka BP interval ranging from the latest age measured for level 2 and the earliest date from level 6 (BONA et al. 2007).

Grotta Rio Secco is a vast and high shelter with a large tunnel almost occluded by rock-falls located in a karstic gorge in the Pradis Plateau, Carnic Pre-Alps, a gate to enter the inner Alpine region, the upper Tagliamento river basin and the Pre-Alps of western Friuli. The notable paucity of flint in this region makes Grotta Rio Secco a profitable case-study in which it will be possible to explore human mobility and land-use. Two pits excavated in 2002 exposed 1.7 m of the thick sedimentary succession made of reworked deposits, stones and boulders and a lowermost loose breccia (unit 5) with lithic artefacts and faunal remains. The radiocarbon age $37,790 \pm 360$ ^{14}C BP (PERESANI & GURIOLI 2007) was measured from the collagen of a cut-marked ungulate diaphysis.

Hunting and related activities are recorded at Fumane, Riparo Tagliente and San Bernardino although no evidence related to food provisioning has been found at Caverna Generosa and Grotta Broion and no data have yet been provided from Riparo Broion and Grotta Rio Secco. Faunal assemblages and taphonomic data indicate the main hunted ungulates during the final Mousterian and the Uluzzian were mostly red-deer and roebuck with subordinate chamois and ibex. The presence of Bos/Bison, giant deer, elk and wild boar is weak as well as of other mammals such as hare, marmot and beaver. Macromammals at Fumane including hunted ungulates from levels A12 to A4 are typical of close woodlands although ibex, marmot and some birds - Alpine cough and Rock Ptarmigan Adak - suggest Alpine grasslands were still present and expanded during the later periods (CASSOLI & TAGLIACCOZZO 1991). In late Mousterian levels 35, 36 and 37 at Riparo Tagliente the most common ungulates are roe deer, red deer, ibex and chamois that

were seasonally (i.e. in springtime) exploited on-site. Marmots were also hunted and processed for their pelts (THUN-HOHENSTEIN & PERETTO 2005).

The predominant association of hunted ungulates is in accordance with the ecological conditions in the proximity of each specific site and shows it shifted in function of climatic oscillations. San Bernardino, Fumane and presumably Riparo Tagliente (Thun-Hohenstein, pers. comm.) share similar exploitation models consisting in the selection of young adult and adult prey and in primary butchering. Capture of hare, beaver, marmot and some carnivores (bear, fox, mustelids) is also well documented and might suggest the recovery of pelts.

Lithic economy and the circulation of flint implements

The distribution of suitable lithic sources (flint, jasper, radiolarites) in the Italian Pre-Alps varies extremely as a result of the complex Jurassic to Tertiary sedimentary basins combined with the tectonic activity responsible for dislocating, deforming and fracturing limestones and other rocks. Primarily in the Veneto Pre-Alps, limestones contain huge amounts of finely-textured flint largely exploited for its high quality and copiousness. Among several types, grey flint from the Biancone limestones and other less common varieties reveal excellent properties when knapped. The areas considered suitable for supplying finely-textured flint span from the Lombard Pre-Alps to the Belluno region including the Euganean Hills.

Although abundant, these rocks were not always exploitable due to the size of the cobbles, to uneasy access, to dense fissures affecting the flint beds and nodules and to the distribution of primary exposures, often scattered across high mountain ridges and far from the main river valleys. Loose deposits originated by the weathering of the bedrock are also varied and better distributed. They should be considered as possible flint supply localities: blocks, nodules, pebbles and rounded flint cobbles can be extracted for instance from Oligocene-Miocene and Pleistocene clastic units, palaeosoils, river and stream gravelly plains as well as from glacial and fluvio-glacial deposits.

Lithic indicators of techno-economic behaviour in this region during the final Mousterian reveal how human land-use varied accordingly to the geographical location and function of the sites. There are many different situations, spanning from excellent flint supply contexts (Grotta Fumane and Riparo Tagliente), to places almost (Caverna Generosa) or totally devoid in lithic sources in the critical 5km range (Grotta and Riparo Broion, Grotta Rio Secco). Relations between the suitability of lithic and other critical resources are subtle, some sites being placed at an intermediate (Broion) or marginal (Rio Secco) position across regions that normally offer more favourable conditions for subsistence and lithic production.

At Caverna Generosa, a few flakes and Levallois flakes demonstrate Mousterians were equipped with end-products and radiolarite provisioned elsewhere from lowland sources. Levallois flakes and by-products prove that lithic reduction sequences were fractionated in space and time across the covered area and that cores were used as portable lithic kits. Conversely, thin chert slabs in the local bedrock were ignored. Radiolarites supplied thick flakes with strong edges (BONA et al. 2007).

The lithic implements recovered at Grotta Broion are currently among the best examples we have to investigate the aforementioned way Mousterians used to run their lithic economy. The wide geographic perspective, peculiarities in human occupation and in physical surroundings suggest the cave was a specialized site placed at an intermediate position between two economic districts. It was occupied repeatedly on a short-term basis during which tool production and curation played a marginal role within the deeply rooted overall land-use system.

Given the very high proportion of exogenous flint, end-products and retouched implements, the peculiar features of lithic sets support the hypothesis that raw material circulated in the form of cores to be introduced onto the site as mobile caches from groups during their transits (PERESANI & PORRAZ 2004; PORRAZ 2005). Furthermore, flexible production goals imply various adjustments and a major tolerance in incorporating less normalized blanks in tool manufacture (PORRAZ & PERESANI 2006).

However, Grotta Broion remains a singular example on which lithic economy can be studied in marginal contexts where this type of resource lacks. The other cases taken into consideration in this work are either void of detailed sedimentary sequences (i.e. Caverna Generosa) or are unfit for inferring differences in the exploitation of raw material, although they may preserve finer stratigraphies. Whereas Grotta San Bernardino lies in a distinct economic context, Grotta Fumane and Riparo Tagliente lie in lands where suitable flint comes in a wide variety of types, the selection of which fulfils the technological rather than economical requirements. Preliminary data at Fumane suggest the Uluzzians carefully selected fine-textured cobbles for producing bladelets rather than using coarse-textured flint, a rock commonly exploited for discoid and Levallois flake-making by the Mousterians and for blade making by the Aurignacians (BROGLIO et al. 2003a).

Lithic technology and economy at Grotta San Bernardino - unit II - relates to the suitability of flint with different properties in the surroundings (1-5 km) and to high-quality siliceous rocks from further sources (20 km or more) in the Euganean Hills and in the central-western Lessini (80 km). Reduction sequences on locally-provisioned blocks/nodules were carried out fully on-site as well as fractionated sequences involving partially-exploited cores. Although many tools were shaped at the cave, a relevant number of them had been introduced at variable degrees of reduction. Flake-manufacture is characterized

by intense core exploitation, high reduction and technical variants of the most-used Levallois modality, the recurrent unidirectional. It has been thought that such exploitation might be related to long-term and complex human occupations (PERESANI 1996).

At Fumane flint blocks, cobbles and slabs were locally supplied across the plateau and in stream cuts. Levallois technology is recorded in all the lithic assemblages across the late Mousterian sequence (units A11, A10, A6, A5 and A4) except unit A9 and the overlying A8 horizon, in which the Discoidal flaking method becomes exclusive (fig. 3). Levallois production remains unvaried regardless of the different rocks chipped and the fractionation or completeness of the reduction sequence. From the onset to the main production phase, the most commonly adopted modality is the recurrent unidirectional aiming to extract long flakes and few points, before turning to the recurrent centripetal pattern at the terminal steps of core reduction, a method commonly used to optimize the exploitation of the residual volume. Such a shift in flaking procedures should also be interpreted as deliberate choices aimed to shaping short cutting edges usable for short-term tasks, regardless of the artefact outline. Unidirectional flakes rather than the centripetal, cortical and other types of flakes were mostly shaped into side-scrapers, rare points and notched implements.

The abrupt technological change which occurs in units A8 and A9 is due to the exclusive appearance of the discoid lithic industry, extensively used regardless of the different types of exploited flint (PERESANI 1998). Core reduction frequently required diverse choices and technical solutions leading to the core being modified to produce pseudo-Levallois points, backed flakes with thin opposite edges and subcircular, quadrangular or triangular flakes shaped into simple and transverse scrapers, points and denticulates. Functional analyses have demonstrated how these tools accomplished scraping or cutting wood and wet or dry skin (LEMORINI et al. 2003).

The Mousterian sequence ends in units A3 and A4. Recently explored over a vast area, this stratigraphic group provides evidence of repeated short-term occupations in which lithic artefacts and anthropically-modified ungulate bones were scattered or clustered near combustion structures lighted on the ground with no preliminary preparation. Although unidirectional Levallois reduction is still present in layer A4, both the levels record innovative lithic technologies unknown in the underlying units. Besides the manufacture of very few wide flakes, other data reveal the ephemeral appearance of the blade volumetric concept and of further methods involving the exploitation of flake-cores.

Blade production is organized according to several reduction sequences aiming to obtain short blades and bladelets from cores with one striking platform. As in the case of flake technology, innovation is also evident from the appearance of splintered pieces and of the re-

touched toolkit such as end-scrapers and several backed knives unknown in the previous Levallois and Discoid assemblages. Backed knives are comparable to the Uluzzian-type tools since they comprise a back opposed to a thin edge (PERESANI 2008).

The Uluzzian at Fumane is a very isolated case in the cultural scenario at the end of Neanderthal life in the north-Adriatic area. Scarce site visibility, state of research and sparse human population may be some of the factors which can be taken into account to explain the reason why this techno-complex has been found in only one site. To this end, investigations in progress on the Fumane record will certainly contribute to define the timing and the modalities with which the Middle Palaeolithic-Upper Palaeolithic bio-cultural scenario unfolded and related with the surrounding regions.

At Riparo Tagliente the Mousterian lithic assemblages recovered from a pit and a trench excavated tens of years ago prove that flints were supplied from slope waste deposits in the proximity of the site and from the coarse gravel stream bed facing the site. Nevertheless, specific flint was used in blade production from level 37 upwards. The Levallois method was still used in the uppermost sequence, although the uni- and bidirectional modalities figure as more used from cut 37 upwards than the centripetal, mostly applied in earlier levels. Discoid and a low-elaborated flake-making methods were intended to produce flakes and may be ascribed to specific reduction sequences or, conversely, before discarding the exploited Levallois core (ARZARELLO & PERETTO 2005). Retouched tools are more varied in the upper levels (37-34) where intense, long-term or repeated occupations are suggested by larger amounts of lithic and faunal remains than in earlier times.

The presumed flexibility observed within the Levallois production at Riparo Mezzena layer III has been inferred from the existence of preferential, recurrent unidirectional and centripetal flakes. Since comparable artefacts have been observed at open-air sites ascribed to the minimum Eemian interglacial age (PERESANI 2001b) and not at sheltered sites dated to the MIS4-MIS3 time interval, such a flexibility at the highest level involving the contemporary use of these modalities in the Mezzena layer III system of flint exploitation has to be fully demonstrated and moreover discussed in the light of taphonomical data. In fact, despite the presence in layer III of several thin anthropic levels proving that human occupations were distinct and repeated, the methodology used during the excavations of the 50s had removed the entire layer without providing detailed distinctions of the sedimentary units. Furthermore, a presumed turning from the most used recurrent unidirectional modality to the centripetal requires major techno-economical explanations. The same consideration is valid in the case of the preferential modality, which in the final Middle Palaeolithic sites played a very ephemeral role (GIUNTI et al. 2008).

Similarities observed among reduction sequences handled with Levallois recurrent uni-directional modalities,

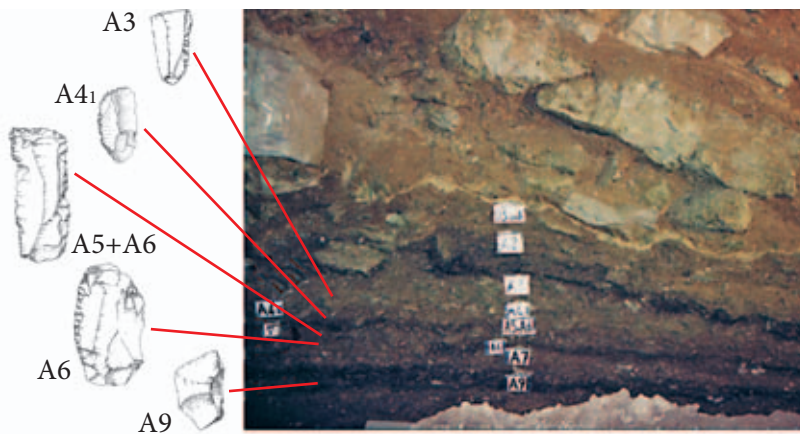


Fig. 3 - The MP-UP transition visible on the main section at Grotta Fumane with the dominant technological outline reported for each LMP and Uluzzian layer (see also PERESANI et al. 2008 and HIGHAM et al. 2009 for details on the chronological layout).

- La transizione Paleolitico medio - Paleolitico superiore registrata nella sezione principale di Grotta Fumane con rappresentazione dei principali profili tecnologici riportati per ogni livello del Paleolitico medio finale ed Uluzziano (vedi anche PERESANI et al. 2008 e HIGHAM et al. 2009 per dettagli sulla risoluzione cronologica).

their variants and the recurrent centripetal methods at the final reduction steps, reveal how this process was well rooted in the Mousterian lithic production. The goals and significance of such a behaviour have to be explained in terms of economic usefulness once assumed that this constant and systematic strategy used in lithic production aimed to obtain elongated blanks, a procedure becoming exclusive between 60 and 30 ky in the Levallois system regardless of the fact that variability increases, as proved by the appearance of the discoid and other methods at the end of the Middle Palaeolithic.

Conclusions

The final Middle Palaeolithic in the North of Italy is recorded in a handful of sheltered sites and very few open-air settlements which were visited for short-term occupations or repeatedly used to accomplish complex tasks mostly aimed at exploiting mineral, non-mineral and subsistence resources. Huge quantities of lithic raw material as well as the geomorphic and ecological variability in the belt between the upper alluvial plain and the Pre-Alps, depict the context in which Neanderthals lived and circulated in accordance with a model of low residential mobility (FIORE et al. 2004; PERESANI 2001a; PORRAZ 2005). Once the topographic position is considered, the main caves in the Venetian Pre-Alps hosted complex and intense human visits in which lithic production was intimately integrated with the acquisition, processing and consumption of ungulates (FIORE et al. 2004; PERESANI 2001a; THUN-HOHENSTEIN & PERETTO 2005).

These contexts were connected with ephemeral camps settled far from the primary mineral sources and used as waypoints for exploiting the landscape at the edge of some mountain districts. Caverna Generosa may be interpreted as a refugia location at constrained high altitude and bio-climatic conditions that might well be integrated within the seasonal movements in the western Lombard Pre-Alpine area. The fractioned tool production sequences pointed out by lithic implements should be considered the most useful indicators of anticipation

in human behaviour and the different ways these items circulated (PERESANI & PORRAZ 2004). Flint provisioning and lithic economy were thus fully organized and reveal how human land-use varied accordingly to the geographical location and function of the sites.

The movements covering the overall geographic sector in order to accomplish defined tasks are an expression of how social organization coped with the lithic sources, variably distributed and exploited. Data demonstrate that the last Neanderthals were familiar with the particular geographical and ecological conditions in this mountain region and that they coped with the critical distribution of the resources. Settlement systems were logistically structured in accordance with the vertical displacement of economic activities at highlands, viewed like the boundaries of the neanderthal territory.

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