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Editorial

MesoLife. A Mesolithic perspective on Alpine and neighbouring territories

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Key words

- MesoLife conference
- Mesolithic
- Holocene
- Alpine region
- south-central Europe

Parole chiave

- Convegno MesoLife
- Mesolitico
- Olocene
- regione alpina
- Europa centro-meridionale

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Summary

This volume represents the first part of the conference proceedings "MesoLife. A Mesolithic perspective on Alpine and neighbouring territories" which took place at the Museo "Vittorino Cazzetta" of Selva di Cadore (Belluno, Italy) from 11th to 14th June 2014. The conference aimed at investigating the role played by the Alps in favouring or preventing contacts and cultural exchange during the first part of the Holocene. Thanks to contributions from neighbouring regions the picture could be enlarged to a European scale and gave the opportunity to compare and discuss adaptation dynamics to different environments and geographical contexts both from a synchronic and diachronic viewpoint.

Summary

Questo volume rappresenta la prima parte degli atti del convegno "MesoLife. A Mesolithic perspective on Alpine and neighbouring territories" che si è svolto presso il Museo "Vittorino Cazzetta" di Selva di Cadore (Belluno) dall'11 al 14 giugno 2014. Il convegno ha avuto per obiettivo quello di valutare il ruolo svolto dalle Alpi nel favorire o ostacolare i contatti e gli scambi culturali durante la prima parte dell'Olocene. Grazie ai contributi inerenti le regioni limitrofe è stato possibile portare la discussione ad una scala europea e confrontare le dinamiche di adattamento ad ambienti e contesti geografici differenti, sia da un punto di vista sincronico che diacronico.

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Introduction

The papers published in this volume represent the first part of the conference proceedings "MesoLife. A Mesolithic perspective on Alpine and neighbouring territories" which took place at the Museo "Vittorino Cazzetta" of Selva di Cadore (Belluno, Italy) from 11th to 14th June 2014. The event was organized by the Universities of Ferrara and Siena, the Soprintendenze Archeologia of Veneto and Tuscany, the Municipality of Selva di Cadore and the Association "Amici del Museo" of Selva di Cadore. Altogether 26 communications, 2 key notes and 24 posters, dealing with studies conducted in 8 different countries, gave an overview on the state of the art of Mesolithic research in several regions of Europe.

A special focus was given to on-going research in the Alpine territories, aimed at investigating the role played by the Alps in favouring or preventing contacts and cultural exchange during the Early Holocene. Thanks to contributions from neighbouring regions, extending from Spain and France to Montenegro and Rumania as well as from Southern Italy to Denmark, with a good number of contributions from the Mediterranean area, the picture could be enlarged to a European scale and gave the opportunity to compare and discuss adaptation dynamics to different environments and geographical contexts both from a synchronic and diachronic viewpoint. The conference has also highlighted the variability both in research questions and methods among researchers, which is also reflected by this volume. The two concluding conference trips, directed respectively to the sites of Mondeval de Sora (San Vito di Cadore, Belluno), the block-shelter at 2,130 m a.s.l. famous for its Castelnovian burial, and Staller Sattel/Passo Stalle (Rasun-Anterselva, Bolzano), a Sauveterrian open air site at 2,125 m a.s.l. currently under excavation, gave the opportunity to experience the specific environmental setting of the "Mesolithic" territories located in the sub-Alpine and Alpine belt.

Overview of the papers

The contributions of this volume, which had originally been divided among the 6 thematic sessions ("Mesolithic Landscapes", "Settlement Dynamics", "Subsistence Strategies", "Lithic, Bone & other Technologies", "I versus II Mesolithic", "Mesolithic Territories"), have here been re-organized in a geographical order according to the regional contexts they are dealing with. Besides facilitating the consultation of the volume, this choice arouse from the observation that many papers, thanks to their multidisciplinary approach, deal with more than one topic. In this way the volume guides to a sort of "Mesolithic excursion" throughout Central-Mediterranean Europe (Fig. 1).

Starting from Switzerland, the contribution of *Cornelissen & Bassin* analyses the scrapers of the stratified rock-shelter Arconciel/La Souche at the foot of the pre-Alps. The Authors observe modifications in production and use of this tool category over time, especially in the raw material, the used blanks and the performed action, which may reflect changes in scraper requirements.

Crotti, Guélat, Bullinger & Pignat present the results of the geoarchaeological study carried out at the rockshelter of Château-d'Œx «Sciernes-Picats» (1,180 m a.s.l.). In particular authors analyse the different sedimentary levels of the stratigraphic sequence dating between 11,000 and 6,000 cal BC and compare their main geoarchaeological features with the respective anthropic evidence and material culture.

Mesolithic research in Austria is represented by the work of *Schäfer, Bertola, Pawlik, Geitner, Waroszewski & Bussemer* which gives an overview on the study of Ullafelsen (Northern Tyrol) in the frame of contemporaneous sites. Amongst others, the paper discusses the relationship between the timberline and human land use, transalpine Mesolithic mobility and the activities carried out in the site.

Crossing the Alpine watershed, two papers deal with sites lying in the Adige Valley Basin in Northern Italy.

Gala, Tagliacozzo & Wierer present the bird bone assemblage of Galgenbühel/Dos de la Forca (South Tyrol). Woodland species dominate over water fowl and birds of open habitat, reflecting a mosaic of biotopes near the site. With respect to the neighbouring Mesolithic rock-shelters the assemblage is more numerous. The incidence of different accumulation agents is evaluated on the base of taphonomy and bird ecology.

Thun Hohenstein, Bertolini, Valverde, Dalmeri & Pedrotti discuss the taphonomical data of the Castelnovian faunal sample from Riparo Gaban in Trentino. Hunting was mostly directed towards red and roe deer, with a preference for adult individuals, and towards wild boar. Abundant butchery marks along with evidence of marrow extraction and hard tissue manufacturing attest the long-term occupation of the shelter.

The volume contains several contributions on research conducted in the Belluno Dolomites.

In the frame of a field survey project in the district of S. Vito di Cadore, *Visentin, Fontana, Cavulli, Carrer, Cesco Frare, Mondini & Pedrotti* give insights into highland occupation strategies at 1,900–2,200 m a.s.l. Distribution of lithic scatters along a flat upland band might be related to high altitude paths, whilst the clustering of findspots on passes, ridges and secondary valleys indicate favoured settlement locations.

Berto, Luzi, Guerreschi, Fontana & Valletta illustrate the small mammal assemblage recovered at Mondeval de Sora (Belluno). The assemblage of this high altitude context indicates a shift from a mainly grassland environment, with woodland extending over the present tree-line in the early Holocene, to a less grass-covered environment with exposed rocks during the late Holocene.

The paper by *Colombo, Martinelli, Motella, Castelletti, Fontana, Guerreschi* and *Michetti* reports preliminary results of the analysis of an anthracological sample from the Mesolithic layers of Mondeval de Sora with the aim of contributing at the reconstruction of Early and early-Mid Holocene landscape in the Venetian Dolomites.

The site of Mondeval de Sora and in particular the lithic assemblage from Sector III is also the object of the paper by *Valletta, Fontana, Bertola & Guerreschi*. Thanks to the comparison of the different Sauveterrian layers the evolution of the techno-typological and economic parameters of the lithic assemblages is highlighted.

Franco presents the preliminary results of the recent excavation at the high altitude Castelnovian site of Pian de la Lora which brought to light a rich lithic assemblage together with a structured hearth.

Moving to the west a paper by *Martini, Lo Vetro, Timpanelli, Magri & Poggiani Keller* focuses on the Mesolithic assemblage recovered at Cemmo (Lombardia) in proximity of the famous engraved boulders. Here a typological analysis allowed the identification of a well preserved Sauveterrian layer.

Southward along the Camonica valley, in the town centre of Cividate Camuno, a rich Prehistoric sequence has been identified in the layers underlying a Roman *domus*. *Martini, Baglioni, Magri, Mazzucco & Poggiani Keller* present the results of the typological and traceological analysis carried out on the Sauveterrian assemblage.

Two papers discuss the Mesolithic occupation of the Venetian plain. *Duches, Gilli & Peresani* present new data on the Mesolithic settlements of the Montello hill. In particular, thanks to the analysis of different surface collections, authors have identified some Early Mesolithic artefacts along with the already known Castelnovian ones.

Fontana, Visentin, Mozzi, Abbà, Corradi, Gerhardinger & Primon illustrate the preliminary results of the extensive surveys and palaeoenvironmental reconstruction that are in progress in the area of the river Sile springs. Numerous sites dated from the Late Upper Palaeolithic to the Bronze Age have been discovered and mapped.

Moving to the southern part of the Po plain, *Visentin, Angelucci, Berruti, Bertola, Leis, Marchesini, Marvelli, Pezzi, Rizzoli, Thun Hohenstein, Ziggiotti & Fontana* discuss the Early Holocene environmental setting and settlement system of the Emilian area starting from the rich assemblage of lithic artefacts and organic remains re-

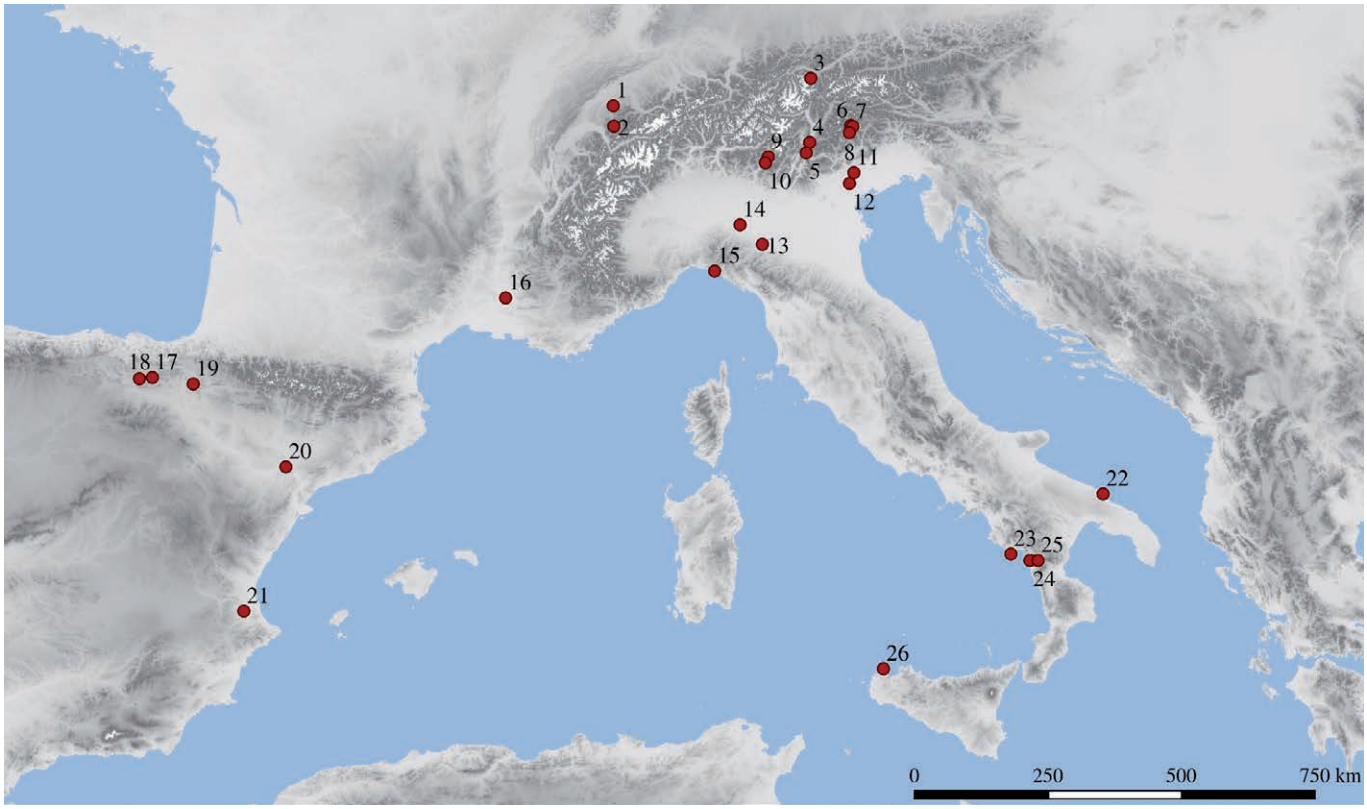

Fig. 1 *- MesoLife. Location of the Mesolithic sites and study areas presented in the volume. 1. Arconciel/La Souche; 2. Château-d'Œx «Sciernes-Picats»; 3. Ullafelsen; 4. Galgenbühel/Dos de la Forca; 5. Riparo Gaban; 6. San Vito di Cadore; 7. Mondeval de Sora; 8. Pian de la Lora; 9. Cemmo; 10. Cividate Camuno; 11. Montello; 12. river Sile springs; 13. Collecchio; 14. Le Mose; 15. Ligurian sites; 16. Mourre de Sève; 17. Atxoste; 18. Mendandia; 19. Artusia; 20. Valmayor XI; 21. Cocina; 22. Grotta della Mura; 23. Grotta della Cala; 24. Grotta del Santuario della Madonna; 25. Riparo del Romito; 26. Isolidda.*

covered at the site of Collecchio (Parma).

In the same area, the site of Le Mose (Piacenza) is the object of a paper by *Marchesini*, *Marvelli*, *Gobbo* and *Rizzoli* that presents new palynological and anthracological data highlighting the environmental evolution of the western Emilian plain during the Preboreal and the Boreal.

Focusing on the Ligurian area *Maggi* & *Negrino* illustrate the "paradoxical" situation of the state of the art on the Mesolithic occupation exclusively represented by several open-air sites mostly located on the rugged eastern bank of the region.

In the following paper we move again outside Italy towards the west, reaching the area of Vaucluse in Southern France. Here *De Stefanis*, *Beyries* & *Binder* focus on the results of use-wear analyses carried out on the lithic assemblage from the Sauveterrian and Castelnovian levels of the site of Mourre de Sève, a rock shelter located close to the Rhône and Ouvèze confluence.

The paper by *Mazzucco*, *Gibaja-Bao*, *Perales-Barrón*, *San Millán-Lomas*, *García-Puchol*, *Rojo Guerra*, *Royo-Guillén*, *García-Martínez de Lagrán*, *Juan-Cabanilles*, *García-Gazolaz* & *Gassin* allows a glimpse to the Iberian peninsula. In this work Authors analyse micro- and microscopically a series of notched blades from five different Late Mesolithic contexts of the Iberian Peninsula in search for traces that can attest the use of such tools.

Moving back to the Italian peninsula we reach the Southern Adriatic coast with a paper by *Calattini* & *Tessaro* dedicated to Grotta delle Mura in Apulia. Authors present layer 2 referred to the early Mesolithic, and describe its rich lithic assemblage from a techno-typological perspective which allows them to reveal a Sauveterrian structure together with elements of the local final Epigravettian.

The site of Grotta della Cala - on the Tyrrhenian coast - is the object of the paper by *Moroni*, *Boscato*, *Allevato*, *Benocci*, *Di Bella*, *Di Pasquale*, *Favilli*, *Manganelli* & *Gambassini* who report preliminary results of the archaeozoological, malacological and anthracological studies regarding Mesolithic layer 7 of the "internal series". Results provide a detailed framework of the local landscape and the subsistence strategies adopted by the Mesolithic groups during the Boreal.

Three papers focus on the Mesolithic levels of the impressive sequence of Grotta del Santuario della Madonna at Praia a Mare (Northern Calabria). In the first one *Tagliacozzo*, *Fiore*, *Lo Vetro*, *Calcagnile* & *Tiné* illustrate the stratigraphic sequence and the dwelling structures recovered at the site, comment the radiocarbon dates obtained and report results of analyses carried out on the Early Mesolithic lithic assemblages attributed to the Undifferentiated Epipalaeolithic.

The second paper by *Fiore*, *Lo Vetro*, *Pino Uria* & *Tagliacozzo* deals with the spatial organization, the faunal assemblage and the lithic industries recovered from several features, amongst which a ritual pit, and combustion structures, identified in the Mesolithic levels excavated between 2008 and 2011. The evidences are interpreted as the result of repeated and short occupations for exploiting a large variety of fauna.

The third one by *Gala*, *Fiore* & *Tagliacozzo* synthetizes results of the analysis of raptor remains from Mesolithic layer I discussing the large number of anthropic traces identified on several bird specimens which belong to this rich sample. Results allow to hypothesize the role of raptors in the diet of the Mesolithic groups besides their exploitation for ornamental and/or symbolic purposes.

Martini, *Lo Vetro* & *Timpanelli* draw our attention on a further Prehistoric site of the same area, Riparo del Romito. By illustrating new excavation results which revealed the presence of a pre-Neolithic sequence overlaying the Upper Paleolithic deposit they place the newly identified Mesolithic assemblages within the context of the "Sauveterrian-like armature complex" of the low Tyrrhenian region.

***Fig. 2** - Foto di gruppo dell'escursione a Mondeval de Sora / Group photo during the excursion at Mondeval de Sora*

***Fig. 2** - Foto di gruppo dell'escursione a Staller Sattel (BZ) / Group photo during the excursion at Passo Stalle (BZ)*

Reaching Sicily, *Lo Vetro*, *Colonese*, *Mannino*, *Thomas*, *Di Giuseppe & Martini* focus on the Mesolithic occupation of Isolidda on the north-western coast of the island, namely on the abundant mollusc remains and the few fragmented herbivore bones. Authors discuss the seasonal data obtained from oxygen isotope analyses on shell carbonates.

Acknowledgements

The meeting was made possible by the support of the Municipality of Selva di Cadore and the Association "Amici del Museo di Selva di Cadore". We are particularly thankful to Silvia Cestaro, Ivano Dall'Acqua, Silvana Domeneghetti, Gildo Rova and Francesco Valletta for contributing to the organisation of the event.

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Lastly we would like to thank Preistoria Alpina, and especially Giampaolo Dalmeri, for publishing the first part of the proceedings and all the conference participants for joining the event and contributing to this volume. The second part of the conference papers is published in Quaternary International.

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Article

Alpine raw materials and the production and use of scrapers at the Swiss Late Mesolithic site of Arconciel/La Souche

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Key words

- Late Mesolithic
- Arconciel/la Souche
- Switzerland
- scrapers
- lithic technology
- use wear analysis

Parole chiave

- Mesolitico recente
- Arconciel/La Souche
- Svizzera
- grattatoi
- analisi technologica
- analisi delle tracce d'uso

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Summary

The well stratified rock shelter site of Arconciel/La Souche, Switzerland was repeatedly occupied between 7100 and 4900 cal BC. It lies in the Sarine river valley at the foot of the Prealps. This paper presents the first preliminary results of the study of the scrapers from this site. Of the chipped stone tool categories, scrapers are the most numerous found at Arconciel/La Souche. A combined technological and microscopic use wear study of the scrapers from three assemblages (*ensemble* 3, 4 and 5) has allowed us to examine the use and production of scrapers as well as how production and use relate to the various raw materials utilised at Arconciel/La Souche. We were able to show that although scraper morphology remained stable over time, there was a significant change in the relationship between raw materials and scraper production as well as the use of scrapers.
This research will be expanded to include other assemblages and chipped stone artefact categories from Arconciel/La Souche, but has already provided important new insights into artefact use-life in the still relatively poorly understood millennium leading up to the end of the Mesolithic on the Swiss Plateau and the nearby Prealps.

Riassunto

Il sito d'Arconciel/La Souche (Svizzera) è un riparo mesolitico scavatosi naturalmente nelle gole della valle della Sarine, ai piedi delle Prealpi. Un'importante stratigrafia attesta la presenza continua dell'uomo che, tra il 7100 e il 4900 a.C., ha soggiornato nel rifugio sotto roccia. Il presente lavoro illustra i risultati preliminari dello studio sui grattatoi, utensili dominanti nel panorama degli strumenti litici scoperti nel sito d'Arconciel/La Souche. Le ricerche portano su tre orizzonti stratigrafici (insiemi 3, 4 e 5). Il nostro approccio, che riunisce dei metodi di analisi tecnologica e di analisi delle tracce d'uso, s'interessa particolarmente a come le differenti materie prime presenti sul sito sono state utilizzate per i processi produttivi dei grattatoi, per la loro lavorazione e per il loro impiego. Abbiamo potuto costatare che, se da una parte le morfologie generali dei grattatoi restano stabili, dall'altra l'utilizzo delle materie prime evolve nel tempo.
Questa ricerca, ancora in corso, fornisce già sin d'ora alcune interessanti ipotesi che saranno da confermare o da invalidare con il proseguimento dello studio su altre categorie di reperti litici del sito d'Arconciel/La Souche. I risultati ci permetteranno di conoscere meglio la fine del Mesolitico a nord delle Alpi svizzere.

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Introduction

The lithic industry from the rock-shelter Arconciel/La Souche is analysed as part of an ongoing research project regarding the end of the Mesolithic in Switzerland. We present the first and preliminary results of a combined technological and micro wear study of scrapers from the site. At 48 %, scrapers are the most numerous tool category of the chipped stone artefact assemblage. Our main focus concerns how both local and imported raw materials relate to the production and use of scrapers and to the scrapers collectively as a tool category rather than as single artefacts. The well-stratified multi-phased site of Arconciel/La Souche provides a rare opportunity to gain insights into the economic, social and technological processes at the end of the Mesolithic on the Swiss Plateau and in the nearby Prealps.

Arconciel/la Souche and the Mesolithic of the Swiss northern Prealps and the Swiss Plateau

The Mesolithic-Neolithic transition of the perialpine areas of Switzerland and its immediate surroundings has - in comparison to other regions of Europe - seen very little attention during the past decades. This is mostly due to a relative lack of well-stratified and well-dated late Mesolithic sites and an apparent absence of identified archaeological sites in much of Switzerland during the 6th millennium BC.

***Fig. 1** - Arconciel/La Souche, August 2012. M. Cornelissen / Arconciel/La Souche, Agosto 2012. M. Cornelissen.*

Many Mesolithic sites on the Swiss Plateau were excavated earlier in the twentieth century and are often either not well stratified or not well dated. Other more recently excavated sites, such as Chateau d´Œx and Oberriet-Unterkobel (Schindler and Wegmüller 2013; Crotti and Pignat 1993) await full publication. Possible exceptions are a number of recently excavated alpine sites such as Bregaglia/Val Forno-Plan Canin, Hospental-Moos and Alterswil/Flue (Cornelissen *et al.* 2013, Auf der Maur and Cornelissen 2013, Mauvilly, Kramer and Arbogast 2011). Although they provide insights into the occupation and the nature of use of these alpine regions, their often small chipped stone assemblages and poor bone preservation seldom allow for significant advances in our understanding of the nature of the occupation of these sites or of the production and use of lithic artefacts during the Mesolithic.

The well-stratified Mesolithic site of Arconciel/La Souche (Fig. 1, 2), excavated between 2003 and 2012, is providing new data and has the potential to greatly increase our understanding of the Mesolithic on the Swiss-Plateau and the social, economic and technological processes taking place during the Late Mesolithic (Perrin *et al.* 2009).

Arconciel/La Souche is located 7 km south of the city of Fribourg at the foot of the Prealps (Fig. 3). The Sarine gorge in which it is situated is of postglacial origin. Between the Late Glacial Maximum and the first recorded occupation of the site at around 7100 cal BC most of the valley and the rock shelter were cut out of the Miocene Molasse by the Sarine river. The rock shelter is ca. 50 m long - of which 16 m were entirely or partly excavated - and 5 m deep (Braillard and Mauvilly 2008).

Up to three meters of stratigraphy dating from 7100 to 4900 cal BC was excavated by the Service Archéologique de l'Etat de Fribourg (SAEF). (SAEF). The site was excavated as a fieldschool in collaboration with the universities of Berne, Neuchâtel, Fribourg and Basel under supervision of Michel Mauvilly (SAEF). Initial analysis show the stratigraphical sequence to consist of six main occupational phases (*ensembles* 1-6, from young to old). These are, often, separated by roof collapse events or natural sedimentation. Some 20 radiocarbon dates enable the excavators to date most of the occupational sequence (Mauvilly *et al.* 2013).

This paper includes the chipped stone artefacts from the 2003 - 2011 campaigns. It consists of a total of 21,402 artefacts (Fig. 4 and 5). The cataloguing of the lithic industry from 2012 is still in progress. With a total number of 773 out of 1,197 tools (2003 - 2011) scrapers are exceptionally numerous at Arconciel/La Souche.

After the lithic industry, faunal remains are the second most abundant finds category at Arconciel/La Souche. They represent wild species and also include some fish remains. Antler and bone artefacts include deer teeth pendants, perforated *Columbella rustica*, a scraper fashioned from a wild boar canine, bone points and awls as well as two antler harpoons (Mauvilly *et al.* 2008a, Mauvilly *et al.* 2013). Three ceramic objects were found at Arconciel/La Souche. Two small pottery sherds were recovered from the bottom of structure 32a, stratigraphically part of *ensemble* 2 (5200 - 4900 cal BC) (Mauvilly *in press*) and a further burnt clay object was recovered from *ensemble* 4, dating to the end of the 7th millennium BC. The excavators have compared this to similar objects, so-called clay stamps or pintadera, known from southeast Europe (Mauvilly *et al.* 2008b).

Modern excavation methods, a well-dated stratigraphy, together with the wide spectrum of finds categories, including botanical and zoological material, make Arconciel/La Souche a site with great potential to increase our understanding of the social, economic and technical processes leading up to the Neolithisation in Perialpine Central Europe.

Methodology

This paper discusses scraper artefact biographies, including the technological processes of production and artefact use leading up to

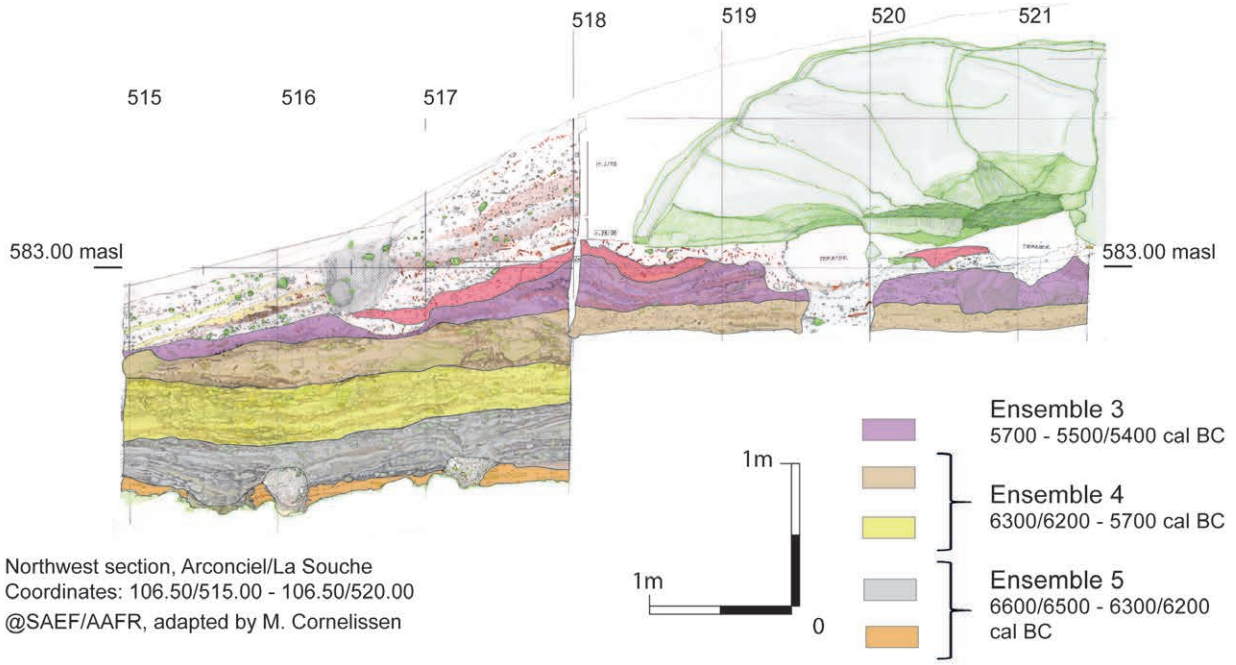

Fig. 2 - Section Arconciel/La Souche showing the stratigraphic location of ensemble 3, 4 and 5. SAEF/AAFR, adapted by M. Cornelissen / Profilo d'Arconciel/La Souche rappresentante la posizione stratigrafica degli insieme 3, 4 e 5. SAEF/AAFR, adattato da M. Cornelissen.

Fig. 3 - Arconciel/La Souche and the Fribourg Prealps. M. Cornelissen / Il riparo sotto roccia d'Arconciel/La Souche, ai piedi delle Prealpi svizzere. M Cornelissen.

and during the process of Neolithisation. Combining technical and microscopic use wear analysis of the lithic artefacts from Arconciel/La Souche allows us to study the entire use-life of single artefacts as well as that of their assemblages; the complex and dynamic patterns of production, use and discard during the Mesolithic on the Swiss Plateau and in the Prealps.

3.1 Sampling

The unusually high proportion of scrapers at Arconciel/La Souche in comparison to other tool categories led us to concentrate on this tool category. We define scrapers as unifacially retouched artefacts, often, but not exclusively, retouched at the frontal or basal ends. These ends often correspond with the distal or proximal end. The term scraper often carries use-related associations (Shott and Scott 1995). We use this term to maintain consistency, reject, however, such a-priory assumed functional associations. The present study concerns the scrapers of three assemblages - *ensembles* 3, 4 and 5 - from the middle of the stratigraphical sequence at Arconciel/La Souche. These *ensembles* represent the richest occupational phases, dating between 6600 and 5400 cal BC.

	Radiolarite		Local Flint		Fine-grained quartzite		Flint		Other raw materials		Total
Scrapers ensemble 3	**72**	**37.5%**	**30**	**15.6%**	**22**	**11.5%**	**68**	**35.4%**	**0**	**0**	**192**
Total 2003-2011 ens. 3	*926*	*36.4%*	*494*	*19.4%*	*759*	*29.8%*	*198*	*7.8%*	*170*	*6.7%*	***2547***
Scrapers ensemble 4	**149**	**56.7%**	**53**	**20.2%**	**31**	**11.8%**	**29**	**11.0%**	**1**	**0.4%**	**263**
Total 2003-2011 ens. 4	*3217*	*41.1%*	*1653*	*21.1%*	*2144*	*27.4%*	*333*	*4.3%*	*482*	*6.2%*	***7829***
Scrapers ensemble 5	**174**	**54.7%**	**93**	**29.2%**	**7**	**2.2%**	**44**	**13.8%**	**0**	**0**	**318**
Total 2003-2011 ens. 5	*316*	*40.5%*	*258*	*33.1%*	*90*	*11.5%*	*85*	*10.9%*	*31*	*4.0%*	***780***

Fig. 4 - Raw materials used for scrapers and the entire artefact collection at Arconciel/La Souche, ensemble ensembles 3, 4 and 5. L. Bassin (preliminary results) / Totale dei grattatoi e dei reperti litici d'Arconciel/La Souche suddivisi per materie prime e secondo gli orizzonti 3, 4 e 5 (risultati preliminari). L. Bassin.

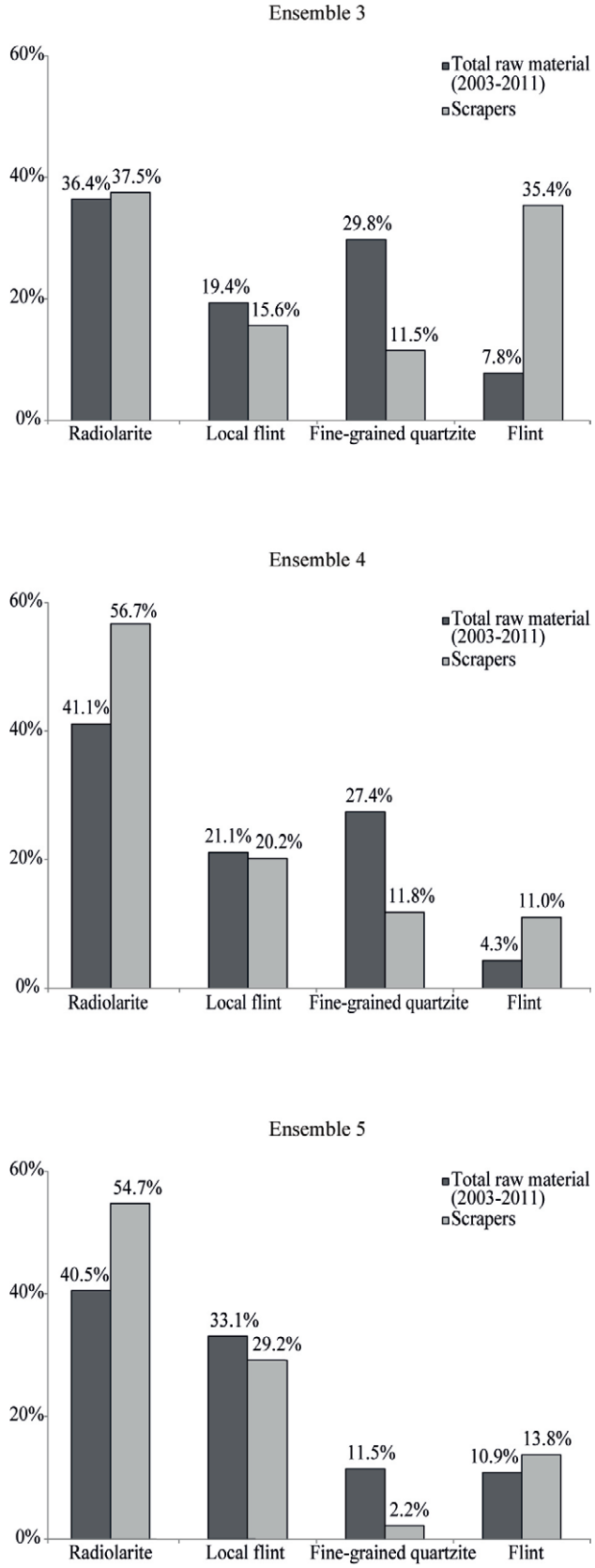

Fig. 5 *- Proportion of raw material used at Arconciel/La Souche for the entire chipped stone collection and for the production of scrapers of ensembles 3, 4 and 5 (temporary results). L. Bassin / Proporzione totale, per gli orizzonti 3, 4 e 5, delle materie prime ritrovate sul sito e delle materie prime ritoccate in grattatoi (risultati preliminari). L. Bassin.*

The oldest of the three, *ensemble* 5 (6600/6500-6300/6200 cal BC) represents the phase with the most frequent occupation. *Ensemble* 4 (6300/6200-5700 cal BC) is a phase with a similarly regular occupation, while *ensemble* 3 (5700-5500/5400 cal BC) is the result of a somewhat less frequent occupation. Of the 773 scrapers included in this study, 318 belong to *ensemble* 5, 263 to *ensemble* 4 and 192 to *ensemble* 3.

For the use wear analysis a total of 38 artefacts were randomly selected from *ensembles* 3 and 4. Only artefacts that were found *in-situ*, i.e. not during sediment sieving, and only artefacts with secure stratigraphical provenance were considered for use wear analysis. No selection was made for morphology, raw material or other criteria. This limited the sample of scrapers that were available for inclusion in the analysis to 7.6 % and 9.4 % of *ensembles* 3 and 4 respectively. For the same reasons only one scraper that was made from non-local flint could be analysed (small findnr. 13,967; *ensemble* 3).

3.2 Technological analysis and lithic raw materials

The high proportion of scrapers amongst the tools at Arconciel/La Souche is marked. In order to study the production and use of this predominant artefact category it was important to describe the morphology and technological characteristics of the scrapers. This included features such as raw-material, artefact blanks, aspects of retouch as well as other technological (e.g. basal fracturing, forms of lateral edge working, curving of the ventral surface) and recurring morphological artefact characteristics. These have been recorded and studied for all scrapers from Arconciel/La Souche, but only the 773 scrapers from the chipped stone artefact assemblages from *ensembles* 3, 4 and 5 are presented here.

Raw material determination was done macroscopically only, although some microscopic raw material sourcing has been done in the past (Mauvilly *et al.* 2002). However, in general it was possible to make a distinction between local raw materials from the Prealps (distance 20 - 30 km) and imported flints (distance over 70 km). Of the artefacts 87 % are produced on three local raw materials: radiolarites (39 %), a type of local and predominantly grey flint (21 %) and a fine-grained quartzite (27 %; *quartzite à grains fins* or *Ölquarzit,* a homogeneous, grainy metamorphosed sandstone). These all outcrop in the nearby Prealps and can be found in the Sarine riverbed in the immediate vicinity of the site as well. Radiolarite is very abundant in the region and, like the local flint, does not have good knapping qualities. The remainder of the artefacts are made from raw materials such as rock crystal, local sandstone and chalk (all < 1%) and flints (5 %) imported from e.g. the Jura mountains, the Geneva region and eastern France (Braillard et al. 2003). The imported flint often has notably superior knapping qualities compared to the local flint.

The results presented here are only preliminary and are still to be placed in the wider context of the entire chipped stone artefact assemblage and other data from Arconciel/La Souche. It is expected that future analysis of other sections of the chipped stone tool assemblage will allow further interpretation.

3.3 Microscopic use wear analysis

This study applies a so-called pragmatic approach to use-wear analysis. It combines low- and high-power analysis (10 - 400x) and focuses on establishing the presences or absence of traces, the used parts of the artefact, the type of use (movement) and to some extent the intensity of use (Grace 1989, Finlayson and Mithen 1997, Smith 2007). The entire artefact was scanned for macroscopic and microscopic use wear traces and (potential) microscopic traces were subsequently investigated in greater detail (Gijn 2014, Smith 2007). Use wear traces were recorded photographically, on drawings and in written form. All artefacts were washed with water and during analysis isoprophyl-alcohol and cotton pads were used to clean them. For the analysis, a Keyence VHX-600 Gen II digital microscope at the Department of Geosciences, University of Freiburg, Switzerland was used.

		Prealpine local raw materials (~ 20 km)			Longer distant (> 70 km - 100 km)
		Radiolarite	Local Flint	Fine-grained quartzite	Flint
Ensemble 3 (5700-5500/5400 cal BC)	Use of raw materials	used in proportion to the quantity of recoverd raw material	used in proportion to the quantity of recoverd raw material	mininal use	preferred raw material
	Blanks	scraper blanks : predominantly flakes, except for an increase in the use of bladelets in comparison to assemblages 4 and 5			
				notable use of bladelets	notable use of bladelets
			frequent use of core preparation flakes		frequent use of core preparation flakes
Ensemble 4 (6300/6200-5700 cal BC)	Use of raw materials	preferred raw material	used in proportion to the quantity of recoverd raw material	mininal use	used more than the proportions of the total quantity of raw materials
	Blanks	scraper blanks : predominantly flakes, except for an increase in the use of bladelets in comparison to assemblage 5			
				notable use of bladelets	
			frequent use of core preparation flakes		frequent use of core preparation flakes
Ensemble 5 (6600/6500-6300/6200 cal BC)	Use of raw materials	preferred raw material	used in proportion to the quantity of recoverd raw material	mininal use	used in proportion to the quantity of recoverd raw material
	Blanks	scrapers blanks : predominantly flakes from all reduction stages			
					notable use of bladelets
			frequent use of core preparation flakes		

Fig. 6 *- Raw materials and blanks used for the production of scrapers at Arconciel/La Souche, ensembles 3, 4 and 5. L. Bassin / Sintesi della gestione delle materie prime e delle scelte dei supporti per i grattatoi degli orizzonti 3, 4 e 5. L. Bassin.*

The use wear study is accompanied by an experimental program. The aims of this was foremost the observation of the differing developments of traces on the main raw materials present within the Arconciel/La Souche chipped stone assemblage. To some extend it also provided comparative material for the analysis of the archaeological material. The experiments comprised of the experimental working of wood (*Corylus avellana* L.), bone (*Cervus elaphus*) and the working of sheep skin (*Ovis orientalis aries*; dry and wet curing) and goat skin (*Capra hircus*; wet curing). Experimental tools were made from radiolarite, local flint and fine grained quartzite. They were used prehensile or hafted. The hafts were usually hazel wood and other materials used in the hafts were birch-tar and either synthetic sinew or sisal string.

Previous work and blind tests have shown that the identification of the worked material is inefficient and inaccurate (Evans 2014, Grace 1989, Betts and Finlayson 1990). This study thus aims less at providing detailed, but uncertain data about worked materials for each individual artefact, but instead aims to provide secure information on the production and use of the artefacts, and especially of the scrapers as a tool category.

Allowing for artefact equifinality, and incorporating the results of the technological studies, use-wear analyses can, depending on the data, provide information on the whole use-life of the tool. This study not only aims to investigate the production and use of artefacts, but also to research artefact categories and even the assemblage as a whole. The combination of both technological and microscopic use-wear analysis to study artefact ontogeny will enable us to abandon traditional typological nomenclature and study the artefact's actual functions and meanings (Finlay 2006, Riede 2006, Ingold 2000, Sternke and Costa 2006). It allows a biographical approach to the chipped stone artefacts and assemblages.

Results

The production system of the scrapers from *ensembles* 3, 4 and 5 was established. It appears that during the more than thousand years covered by these assemblages, scraper morphology and dimension remained virtually unchanged. Morphologically, a number of standard shapes could be recognised. These shapes remain present throughout *ensemblages* 3, 4 and 5. Round to near-to-round shapes dominate. Many are unguiform, others we have classified as pear-shaped. These tools resemble unguiform scrapers, but have one narrower end. Others are classed as crescent shaped. Other forms, such as elongated and irregularly shaped scrapers are relatively rare. Our morphological descriptions largely follow Rozoy (1968) and G.E.E.M. (1975). The proportion of the entire scraper collection in relation to the number of tools in general also remains stable over more than a millennium. A number of specific technological attributes seem to occur consistently throughout the studied assemblages as well. These results raised a number of questions regarding the relationship between tool morphology, production, hafting practices and use and how these might have developed over time.

Scraper dimension varies widely from very small to large pieces

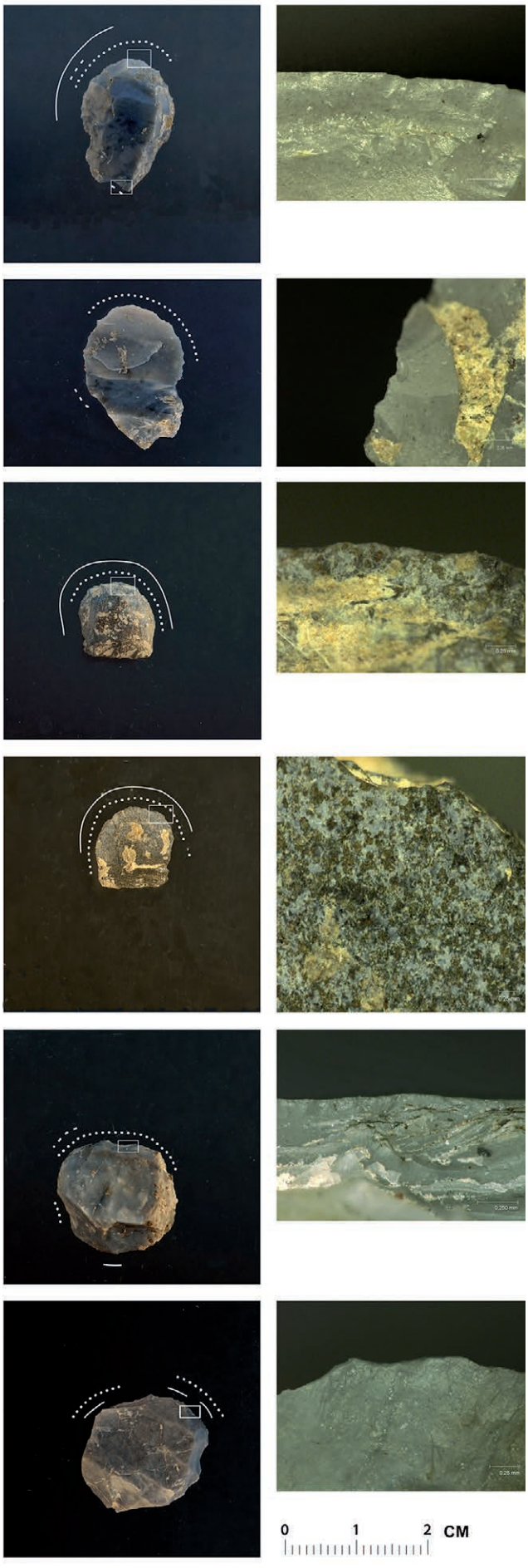

Fig. 7 *- Microscopic use wear traces on scrapers at Arconciel/La Souche. Line: polish; dots: rounding; dashed line: micro-fracturing. 1a & b: Scraper Inv. Nr. 15528, ensemble 4, flint Prealps, pear-shaped, dorsal and ventral view; 1c: rounding and polish, 200x; 1d: micro fracture, 150x. 2a & b: Scraper Inv. Nr. 20571, ensemble 3, fine grained quartzite Prealps, unguiform, dorsal and ventral view; 2c: rounding, 150x; 1d: rounding and polish, micro fracture, 100x. 3a & b: Scraper Inv. Nr. 10965, ensemble 3, radiolarite Prealps, round, dorsal and ventral view; 3c: rounding, 200x; 3d: rounding and polish, 150x. M. Cornelissen / Microtracce di utilizzazione sui grattatoi d'Arconciel/La Souche. 1a & b: Grattatoio inv. Nr. 15528, Orizzonte 4, selce prealpina, tipo a ventaglio, faccia dorsale e ventrale; 1c: arrotondamento e micropoliture, 200x; 1d: microfratture, 150x. 2a & b: Grattatoio inv. Nr. 20571, Orizzonte 3, quarzite a grana fine prealpina, tipo ad unghia, faccia dorsale e ventrale; 2c: arrotondamento, 150x; 1d: arrotondamento e micropoliture, microfratture, 100x. 3a & b: Grattatoio inv. Nr. 10965, Orizzonte 3, radiolarite prealpina, tipo circolare, faccia dorsale e ventrale; 3c: arrotondamento, 200x; 3d: arrotondamento e micropoliture, 150x. M. Cornelissen*

(width: 6.1-41.9 mm; length: 6.6-52.2 mm; thickness: 1.9-17.9 mm). Within this range, scrapers are distributed evenly without forming distinct groups according to size.

However, while scraper morphology and dimensions remain constant for the period represented by *ensembles* 3, 4 and 5, the raw materials chosen for their production varies (Fig. 6). There is a significant discrepancy between the proportion of the various raw materials used for the production of scrapers and that of the overall chipped stone assemblage.

This indicates raw material was purposefully selected for the production of scrapers and that this varied for each of the three assemblages. While fine-grained quartzite remains systematically under-used and local flint remains used in proportion with its general occurrence at Arconciel/La Souche, the use of radiolarite steadily decreases. In *ensembles* 4 and 5 it is the preferred raw material, but in *ensemble* 3 its use has decreased to resemble the proportion of radiolarite in the total chipped stone collection. The use of imported flint for scrapers visibly increases in *ensemble* 3.

Blank selection for production also changes between the three assemblages (Fig. 6). Flakes remain the main type of scraper blank throughout the whole period (73 % in *ensembles* 4 and 5, 68 % in *ensemble* 3). The use of bladelets, however, steadily increases from 9.1 % in *ensemble* 5 to 14 % in *ensemble* 4 and 19 % in *ensemble* 3. In addition, more core reduction flakes made on local and imported flint are employed as scraper blanks. This might be related to the generally small size of cores and their thick cortex.

At this point explanations of these developments remain tentative. However, as the proportions of the various raw materials remain stable in the total assemblage, a simple change in acquisition range can be excluded. A possible explanation might be found in a modification of scraper production responding to a changing use of scrapers over time (see below). This might have led to different demands made of the tools. Further research into the scrapers and the chipped stone assemblage in general is hoped to shed more light on this issue.

We have seen that raw material selection for the production of scrapers changes to some extent over time. The use wear traces, on the other hand, do not indicate differing use of scrapers depending on their different raw materials. Use wear traces do, however, show some change in use over time (see below), which could be related to this shift in raw material selection.

The experiments had already shown, that here is some variation in the development and readability of traces on scrapers made on different raw materials and this was confirmed by the analysis of the archaeological material (Fig. 7). The fine grained quartzite consists of multiple mineral components on which traces develop variedly. Rounding is rather pronounced but not always distinguishable from dense

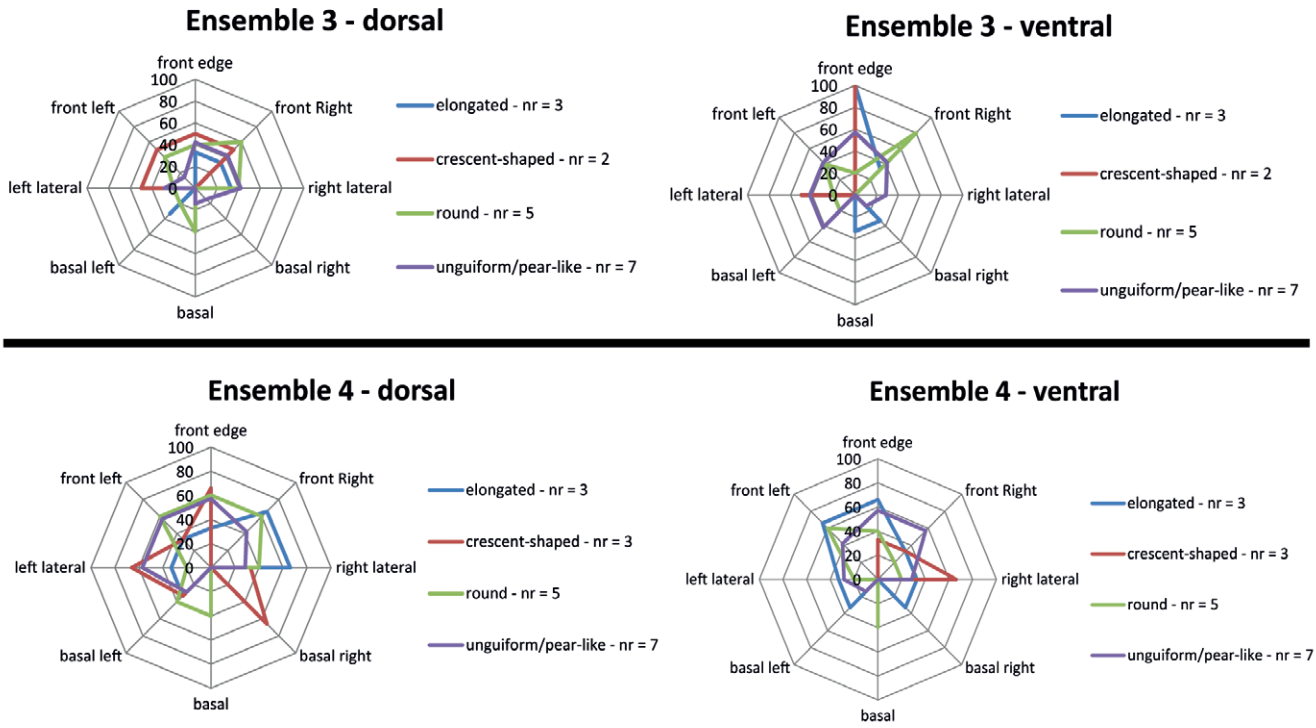

Fig. 8 *- Micro wear trace distribution on scrapers from Arconciel/La Souche ensembles 3 and 4 in % according to morphology. M. Cornelissen / Ripartizione proporzionale delle microtracce sui grattatoi d'Arconciel/La Souche per gli orizzonti 3 e 4 secondo le morfologia. M. Cornelissen*

micro fracturing on these artefacts and polish development depends on the presence of varying mineral components in each particular tool. Due to its material qualities, less polish is observed on scrapers made on fine grained quartzite. Rounding, however is relatively common on these artefacts. While rounding was only observed on relatively few flint scrapers from *ensemble* 3, more rounding was observed on flint scrapers from *ensemble* 4 than on other scrapers from this sample. On the radiolarite and, to a lesser extent, on the local flint, polish is not always easily discernible due to the translucency of these materials. In contrast traces tend to be relatively clear on imported flints. At this point it is not yet possible to interpret this data any further, but the experimental evidence suggests these variations are caused by a difference in trace development and readability, not by use. The data to some extent lack clear patterns, and at least until the use wear analysis of the remaining assemblage is completed, more definitive conclusions remain difficult.

The various raw materials used at Arconciel/La Souche have thus been shown to influence the development of microscopic wear traces and to some extent their readability. It is possible that raw material has also influenced scraper use, but at present there is no direct evidence for it in the studied samples.

The working edge of the studied tools generally seem to have been the front edge and the adjacent corners (the front is morphologically determined, and does not necessarily equal the distal end) (Fig. 8). Interestingly there was a difference in the use between *ensembles* 3 and 4. Scrapers from *ensemble* 4 were more often used in a pushing motion, while those of *ensemble* 3 more in a pulling motion. This is indicated by the general distribution of use wear traces. This is supported by polish distribution as *ensemble* 4 scrapers show significantly more polish on the dorsal distal edge than the *ensemble* 3 tools. Polish and linear features on the dorsal and ventral surfaces confirm that the direction of use would have been along the longitudal axes or diagonal to it.

Two radiolarite scrapers and possibly a further radiolarite and one flint scraper show signs of light resharpening after initial use. There is no indication that these were used in a particular fashion.

Both the intensity of use of the individual artefacts and the number of artefacts displaying evidence of use in each assemblage appear to remain constant over time. There does not seem to have been a significant difference in the intensity of use of the scrapers of different raw materials or morphology.

It is likely that traces on the basal edges of crescent-shaped scrapers (see below) and on the basal sections of other types of scrapers are related to hafting. It is notable that overall, polish and micro-fractures dominate the trace distribution patterns on the basal parts and polish the dorsal and ventral surfaces of the scrapers of both samples. Together with the use related evidence from the frontal parts of the artefacts, it can be concluded that these are largely hafting traces (Rots 2003). This is probably also true of the micro-fractures seen on the dorsal lateral edges of the longer tools and flint scrapers especially. Noteworthy in this light are also the relatively common instances of rounding on the flint scrapers of *ensemble* 4.

It was not possible to demonstrate significant variability in the way different morphological scraper types were used. In fact, the scraper's use seems to have been remarkably consistent, within the two assemblages as well as when comparing between them. However, while trace patterns on the ventral side of many of the *ensemble* 4 artefacts were broadly similar one to another, the pattern on the ventral side of the *ensemble* 3 artefacts appeared very variable, too random to allow any definite conclusions. This diversity also made comparison with the pattern on the *ensemble* 4 artefacts very difficult. Apart from the afore mentioned differences, the crescent-shaped scrapers show some traces - especially micro-fractures - on the basal parts of the artefacts of *ensemble* 4, but such fractures are very rare in *ensemble* 3. The small size of a large number of the scrapers recovered at Arconciel/La Souche are notable. Also, some of the crescent-shaped scrapers are very short. This raised the question whether these are complete artefacts or whether they are distally severed tools. The presence of the use wear traces shows that at least a substantial number of crescent-shaped and small scrapers are complete artefacts and were used as such.

Discussion and conclusions

Scrapers were an important tool category at Arconciel/La Souche between 6600 and 5400 cal BC. The tools were purposefully made to perform a scraping function. The raw materials they were made on varied, but seem to have been chosen with care. Many appear to have been hafted and a large majority was used and there is some indication of tool maintenance after initial use.

Between 6600 and 5400 cal BC, the way raw materials are used to produce scrapers changes. A development in the relationship of local and imported raw materials at Arconciel/La Souche is shown by a decreasing use of local materials and an increased preference for imported ones. This is accompanied by a change in scraper blank selection.

While the production sequence of scrapers made on local materials remains the same, there is a significant change in the reduction sequence of scrapers on imported flint. Also the choice of blanks changes, with an increased importance of bladelets. The end-forms, however, continue to be the same.

The use wear traces too, show limited change with time. 35 of 38 analysed artefacts were used and wear traces suggest that working edges comprise both distal edges and distal corners. In addition, traces on basal edges and especially their corners indicate many tools would have been hafted. Lastly, there are some indications of a change of use over time, with an overall change from a predominance of a pushing to a predominance of a pulling motion. It should be stressed that although it seems these movement patterns predominate in the two studied assemblages they are by no means exclusive, and, as already mentioned, use wear trace patterns observed, especially on the ventral side, in *ensemble* 3 were hard to interpret.

The combined changes seen in technological choices and use can be explained by a behavioural change and this resulted in a change in scraper requirements.

The research presented here is part of the ongoing “Gestures of Transition” project and is to be extended to other artefact categories and additional stratigraphical units. The biographical approach and the integration of the use wear and technological analysis have been shown to be able to provide an added value to the study of chipped stone assemblages and has already allowed new insights into behaviour and artefact use-life in the millennium leading up to the Mesolithic-Neolithic transition just north of the Alps.

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Article

The rockshelter of Château-d'Œx: pedosedimentary record of human occupations in the Swiss Prealps from the Late Glacial to the Mid-Holocene

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Key words

- Alps
- Epipalaeolithic
- Mesolithic
- Sedimentology
- Micromorphology

Parole chiave

- Alpi
- Epipaleolitico
- Mesolitico
- Sedimentologia
- Micromorfologia

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Summary

Situated at an altitude of 1180 m a.s.l., the rockshelter of Château-d'Œx «Sciernes-Picats» is a calcareous block emerging from an alluvial fan. Geoarchaeological investigations show that the lower part of the sedimentary sequence is the result of runoff and frost activity typical of the Bølling-Allerød interstadial. These clastic fining-upward sediments contain at the top the oldest archaeological layer, dated to 11,000 cal BC and characterised by Azilian points. After a sedimentary break during the Younger Dryas, the overlying layer is marked by the effects of cold climate conditions at the beginning of the Holocene. Abundant combustion residues characterize this occupation related to the Late Epigravettian and dated to 9,700/9,500 cal BC. Then fragmentation of the block occurred again and the vegetation gradually colonised the site. Further occupation layers characterised by anthropogenic components belong to the Early Mesolithic. Enlarging of the block fractures by dissolution caused deposition of loamy sediment and collapsing of boulders in the filling. Afterwards, runoff resumed and an important Late Mesolithic occupation dated to 6,000 cal BC took place.

Riassunto

Posto ad una quota di 1.180 m s.l.m., il riparo di Château-d'Œx «Sciernes-Picats» è formato da un grosso masso calcareo che emerge da un conoide alluvionale. Gli studi geoarcheologici mostrano che la parte inferiore della sequenza sedimentaria è il risultato del ruscellamento e dell'azione di gelivazione tipici dell'interstadiale Bølling-Allerød. Questa sequenza di sedimenti detritici, con gradazione diretta, include, al tetto, il più antico livello archeologico datato a 11.000 anni cal BC e caratterizzato dalla presenza di punte aziliane. Separato da un'interruzione sedimentaria corrispondente al Dryas recente, il livello soprastante è marcato dagli effetti delle fredde condizioni climatiche dell'inizio dell'Olocene. Numerosi residui di combustione caratterizzano questa fase d'occupazione riferibile all'Epigravettiano recente e databile a 9.700-9.500 anni cal BC. Sono ancora attestati i fenomeni di gelivazione mentre la vegetazione gradualmente colonizza il sito. I successivi livelli d'occupazione, caratterizzati da una componente antropica, sono attribuibili al Mesolitico antico. L'allargamento per dissoluzione delle fratture nel blocco ha causato la deposizione di sedimenti limo-sabbiosi e la caduta di blocchi nel riempimento. In seguito, è attestata la ripresa dei fenomeni di ruscellamento cui è associata un'importante fase d'occupazione riferibile al Mesolitico recente e databile a 6.000 anni cal BC.

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Fig. 1 - Château-d'Œx «Sciernes-Picats» (Western Switzerland Prealps). The rockshelter, situated at an altitude of 1180 m a.s.l., is surrounded by summits which peak at over 2300 m (Vanil de l'Ecri, Vanil Noir). / Château-d'Œx «Sciernes-Picats» (Prealpi svizzere occidentali). Il riparo, situato a un'altitudine di 1.180 m s.l.m., è circondato da picchi che raggiungono i 2.300 m (Vanil de l'Ecri, Vanil Noir).

Introduction

Research carried out in the rockshelter of Château-d'Œx «Sciernes-Picats» is incorporated within the framework of human occupation in the alpine regions after the last ice age (Crotti *et al.* 2002; Crotti & Bullinger, 2008; Crotti 2008, 2009; Bullinger & Huber 2010). The discoveries in the region of Trentino and Alto Adige (northern Italy) in the 1970's (Bagolini 1972; Broglio 1992; Lanzinger 1996; Bertola *et al.* 2007) followed by those in the northern French Alps (Bintz 1999), have shed new light on this subject and have revealed a first human presence in the mountain zone (900 - 1400 m a.s.l.) during the Late Glacial at the end of the Palaeolithic, followed by increased evidence of settlement in the mountain and subalpine (1400 - 2200 m a.s.l.) zones during the Mesolithic.

In the Central Alps, which correspond to the territory of modern Switzerland, research started at a later stage. The discovery in 1989 of the rockshelter of Château-d'Œx, situated at an altitude of 1180 m a.s.l., in the western Prealps, can be considered as an important breakthrough. Excavations were programmed on a regular basis between 1990 and 1999 and uncovered a long sequence of human settlements since the Azilian at the end of the Allerød, around 11,000 cal BC. Recent investigations were carried out in 2011 in order to complete the stratigraphic observations of the lower levels dating back to the Late Glacial (Crotti & Bullinger 2013).

Sedimentological and micromorphological analyses were undertaken and focused on a profile considered as representative of the shelter's sedimentary sequence. The results of these geoarchaeological investigations are presented here briefly. The reconstituted chronology integrates some archaeological data, in particular the typology of projectile points which characterize the cultural facies of the successive settlements.

Geological context

On a regional scale (fig. 2), the site is located between the tectonic units of the *Simme Nappe* in the Château-d'Oex valley, and the *Préalpes Médianes Nappe* forming the Vanils range on the northern edge of this valley (Plancherel, to be published). The shelter is situated at the foot of a 7 metre high limestone block, whose volume is estimated around 1000 m^3, set on the right edge of an alluvial fan. This fan was formed at the outlet of the Paray valley, surrounded by summits which peak at over 2300 m (Vanil de l'Ecri, Vanil Noir).

The Sciernes-Picats block consists of a massive limestone stratified in meter-thick beds with cracked flint nodules. A microscopic observation shows that this rock is a pale grey micritic limestone, a type of mudstone typical of the Late Jurassic (Malm). A sample taken from the roof of the cavity shows that it was made of a dark grey-brown limestone which turns light grey after alteration, containing calcite veins and stylolites (irregular serrated surfaces formed by pressure dissolution). A small block discovered at the base of the infill was also analysed. It is a fine-grained dark grey-brown limestone which turns light grey-brown after alteration, and is often found in the local sediment in the shape of blunt rocks. This type of grainstone with clastic quartz is related to the Middle Jurassic (Dogger) formation More specifically this is a sparitic limestone with clastic quartz (~5%) and bioclasts, mainly fragments of mollusc tests (max. 10%). Both rocks reveal that the Sciernes-Picats block may have been transported by a debris flow from the Paray valley. This flow of material may have been caused by a breach in the moraine dam due to the thawing of the permafrost after the final glacier withdrawal in the Prealps.

Stratigraphy

The reference profile (fig. 3) is located in the eastern part of the shelter where the sediments are best preserved. Nine main layers have been identified and are described below from the bottom up, with a preliminary field interpretation.

Layer 9: rounded or angular heterometric blocks and stones. Compact matrix composed of angular gravel, slightly sandy silty, pale grey-yellow. Most elements are a mudstone-type limestone similar to the Sciernes-Picats block (Late Jurassic, Malm), others are a yellowy-grey grainstone-type limestone (Middle Jurassic, Dogger).

Debris flow that probably also carried the Sciernes-Picats block.

Layer 8: Pale yellow-brown sandy loam, reasonably well sorted, very compact. Millimetre thick beds of well sorted ochre-yellow silts at the top. Thickness: 8-10 cm.

Runoff deposits, oxidised, slightly pedogenised.

Layer 7: Coarse sand, slightly silty, well sorted, greenish dark grey, some small gravel. Lenticular, widening towards the block; abrupt boundary with the underlying layer. Maximum thickness: 5 cm

Runoff deposit, on erosive contact.

Layer 6: Poorly sorted gravel with some scattered stones. Compact yellowy pale grey sandy silt matrix with gravel. Distinct lower boundary, probably erosive.

The top part of the layer is heterometric and coarser; the middle part contains a large amount of stones and blocks, some of which are cryofractured. The matrix gradually becomes more loamy and brownish yellow near the top, mainly due to bioturbation. Some lateral roots and secondary carbonates are found in the form of pseudomycelium. Thickness: 55-65 cm.

Essentially cryoclastic deposit, slightly pedogenised.

Layer 5: Fairly fine platy gravel (1-5 cm), with a tendency for subhorizontal deposition. Abrupt lower contact, probably erosive, and showing a break in the sedimentation. Some components are corroded, and are very close together near the base of the layer. The matrix is made up of brownish black sandy loam with some charcoal, containing humus and bioturbations. Some lateral roots and pseudomycelium. Thickness: 10 cm.

Deposit formed by cryofracturing of the block, pedogenised and anthropised.

Layer 4: Gravel and stones (1-10 cm) fairly polyhedral. Brown-

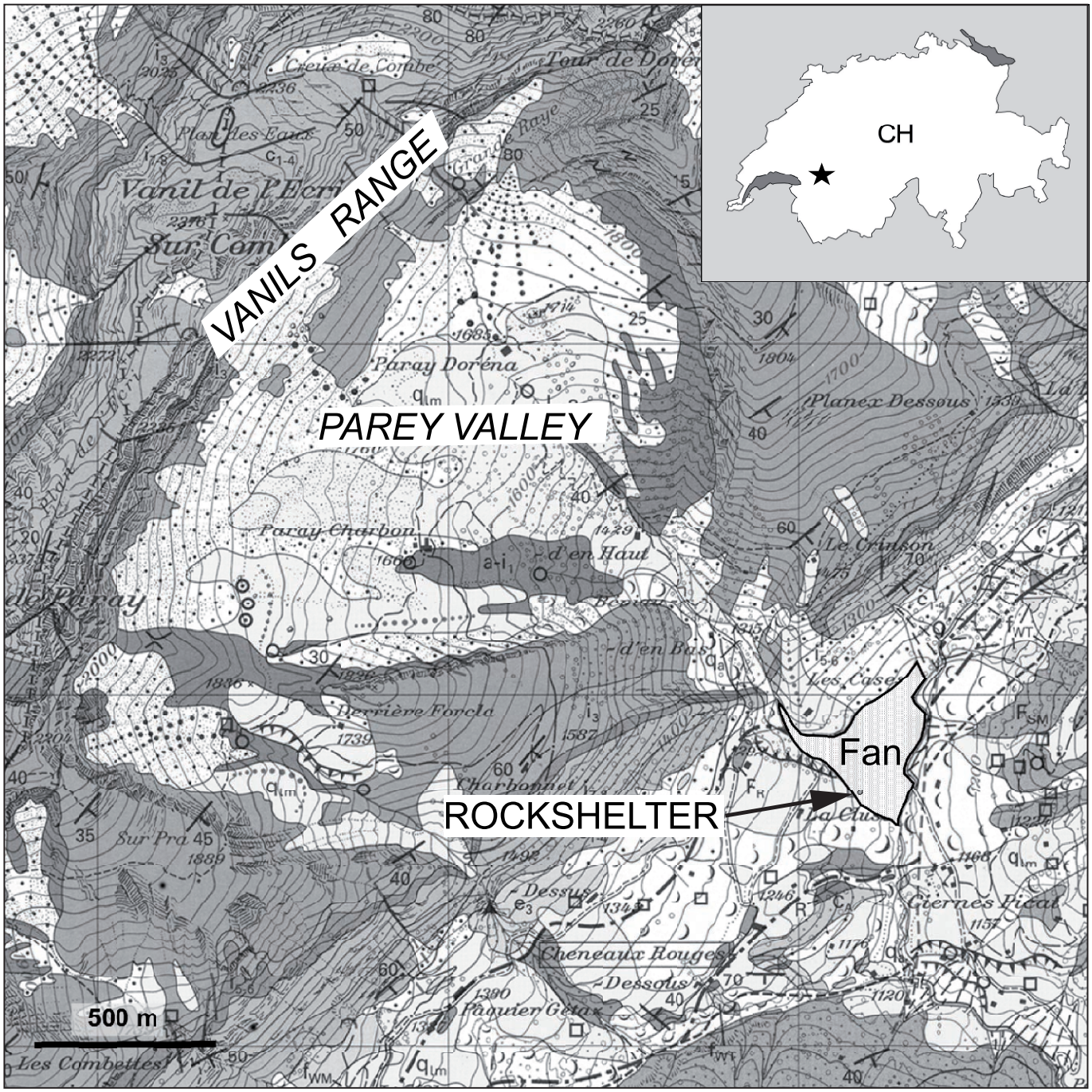

Fig. 2 *- Château-d'Œx «Sciernes-Picats» (Western Switzerland Prealps). Geological map showing the location of the rockshelter. Coordinates 46°30'27"N / 7°10'2"E. / Château-d'Œx «Sciernes-Picats» (Prealpi svizzere occidentali). Carta geologica con la localizzazione del riparo. Coordinate: 46°30'27"N / 7°10'2"E.*

ish black loam matrix, quite meagre, with charcoal, lateral roots and pseudomycelium. The heterometry of this layer differentiates it from the previous one. Thickness: 15-20 cm.

Deposit formed by fragmentation of the block, anthropised.

Layer 3: Gravel. Pale grey-brown silty sand matrix, with some centimetric lenses particularly near the base of the unit. Elements often platy,with a strong tendency for subhorizontal deposition, especially near the southern part of the cross-section beyond the profile. The lower limit is clearly defined by a layer of small blunt stones and blocks. Numerous roots and signs of bioturbation. Thickness: 20 cm.

Deposit of clasts formed by fragmentation or partial collapse, deposit of matrix formed by runoff. Pedogenised and anthropised.

Layer 2: Sediment gradually more humus-bearing and less sandy. Brownish black matrix. Intensive bioturbation and numerous roots. Thickness : 5-10 cm.

Deposit formed by fragmentation of the block and enriched in organic material. Bottom of the topsoil.

Layer 1: Dark brown topsoil, primarily loam, containing a large amount of gravel of variable roundness. High levels of organic matter and numerous roots. Small blocks on the surface have been blunted through dissolution. Thickness: 15 cm.

Current topsoil

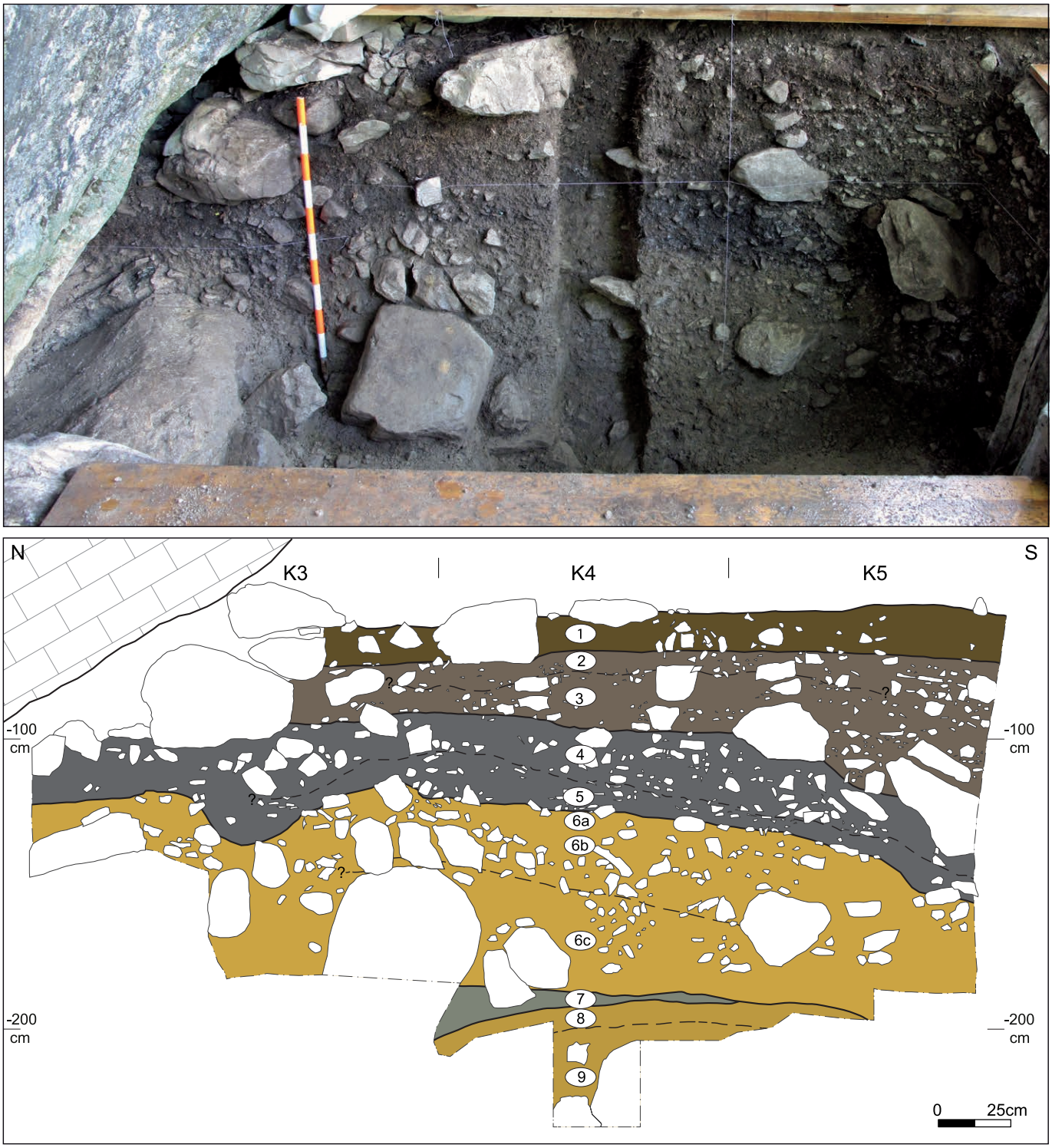

Fig. 3 *- Château-d'Œx «Sciernes-Picats» (Western Switzerland Prealps). Cross-section 11, in the eastern part of the rockshelter fill.*
Top: view of the cross-section.
Bottom: stratigraphic section of the deposits with the reference profile in the central part (K4). At the base, the debris flow which also carried the rockshelter block (layer 9). In the lower part, sandy (layers 8, 7) and coarse deposits (layer 6) originate from runoff and cryofracturing. In the upper part, the gravelly and more pedogenic sediments contain the main human occupation levels (layers 5 to 1). / Château-d'Œx «Sciernes-Picats» (Prealpi svizzere occidentali). Sezione stratigrafica n. 11, nella zona orientale del riparo.
In alto: vista della sezione.In basso: sezione stratigrafica dei depositi con il profilo di riferimento nella zona centrale (K4). Alla base il debris flow *che ha trasportato anche il grande blocco che costituisce il riparo (livello 9). Nella parte inferiore, depositi sabbiosi (livelli 8, 7) e clastici (livello 6) originatisi dal ruscellamento e dalla gelivazione. Nella parte superiore, i sedimenti ghiaiosi e maggiormente pedogenizzati sono quelli più intensamente antropizzati (livelli 5 to 1).*

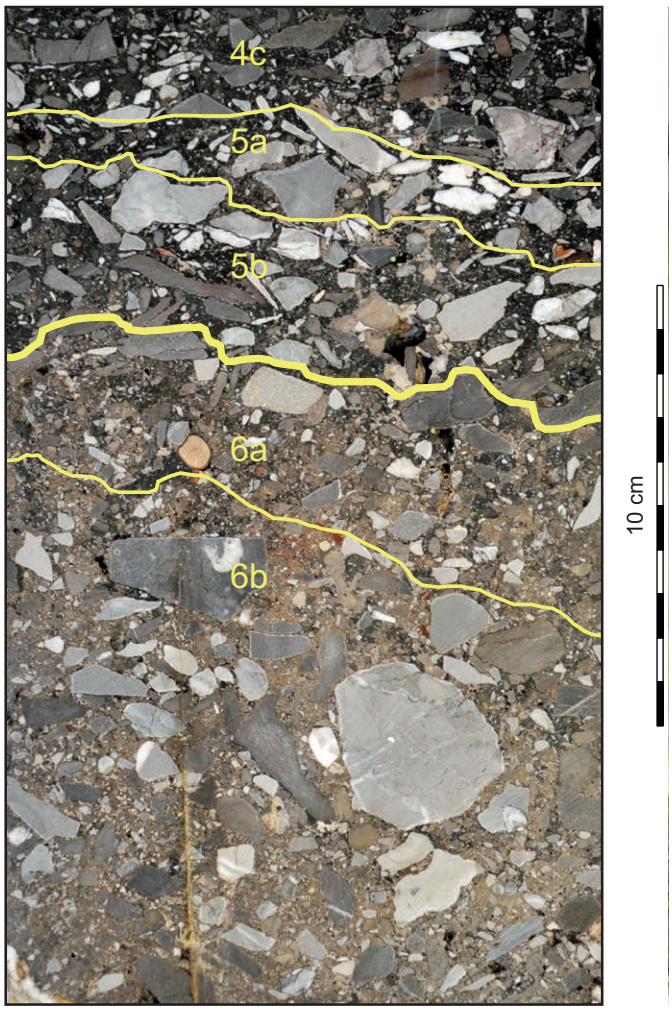

Fig. 4 - Château-d'Œx «Sciernes-Picats» (Western Switzerland Prealps). Vertical polish section through layers 6, 5, and 4 showing the contrast between the coarse clasts in the cryoclastic layers at the bottom and the archaeological levels with some flint artifacts and burnt limestone gravel at the top. / Château-d'Œx «Sciernes-Picats» (Prealpi svizzere occidentali). La sezione sottile verticale dei livelli 6, 5, e 4 evidenzia il contrasto tra i depositi detritici di origine crioclastica alla base e i livelli archeologici contenenti manufatti litici e ghiaie calcaree alterate termicamente al tetto.

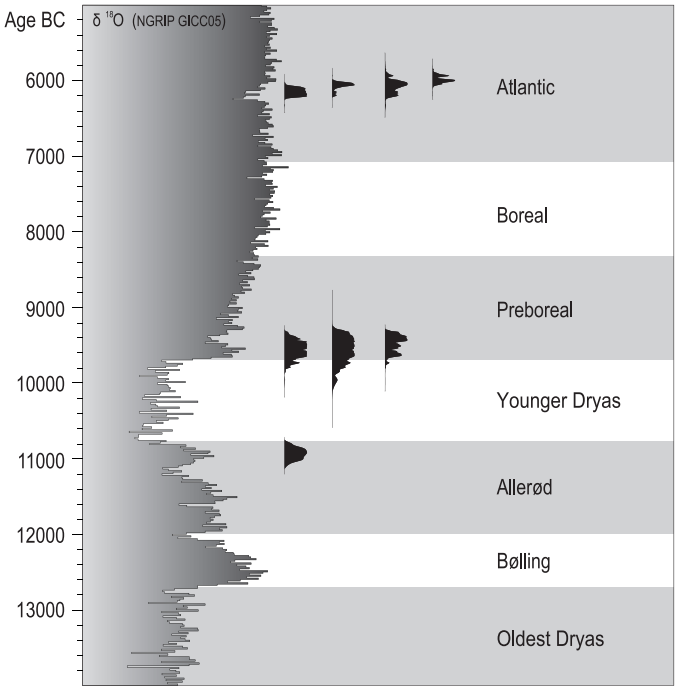

Fig. 5 - Château-d'Œx «Sciernes-Picats» (Western Switzerland Prealps). Calibrated Radiocarbon dates (NTCAL13, Reimer et al. 2013) in relation with the NGRIP GICC05 Curve (Andersen et al. 2005; Svensson et al. 2005). / Château-d'Œx «Sciernes-Picats» (Prealpi svizzere occidentali). Datazioni radiometriche calibrate (NTCAL13, Reimer et al. 2013) rispetto alla curva NGRIP GICC05 (Andersen et al. 2005; Svensson et al. 2005)

Geoarchaeological analyses

The main goals of this study were to clarify the sedimentation dynamics and to detect the traces of human occupation specific to each stratigraphic unit. Different analytical methods were applied. Grain-size analysis and geochemistry of 13 bulk samples of the whole profile were carried out and combined with micromorphology of 3 monoliths encased during field work in the occupation layers, to allow identification of post-sedimentary processes and anthropogenic features (fig. 4). The combination of these approaches has led to a general understanding of site formation processes and palaeoenvironmental conditions at Sciernes-Picats. It is important to note that only one column, in the centre of the rockshelter, was sampled and examined. Lateral sampling control, which might have provided additional information, was, however, not implemented because of the small dimensions of the archaeological site as well as the simple geometry of the layers.

Sedimentation in the shelter

Most of the sediment accumulated in the shelter is endogenous, originating mainly from the ledge, and overall granulometry reveals a predominance of the gravel fraction. Layer 9 is particular because this very coarse deposit, which includes the Sciernes-Picats block, belongs to the upper part of the debris flow. An outwash of this mass created the layer 8, which is composed of sand produced by local runoff, such as meltwater. A rapid inspection under the microscope of the sand fraction of layer 8 confirms that it is not exogenous: the angular grains belong to the same mineral spectrum as the underlying layer.In the cross-section used for this study, it is clear that this surface was eroded before layer 7 was deposited, and the sand and gravel underline the recurrence of runoff. Layer 6 contains a large amount of gravel which is better sorted than the matrix and indicates a period of frequent freeze-thaw cycles. The middle and upper parts of this unit have fewer amounts of coarse elements which remain however in the majority. Micromorphology shows that the increase in silts in layer 5 is due to exogenous influence. The increase of this same fraction, as well as the amount of sand, near the intersection between layers 4 and 3 can be associated with colluviation.

Geochemical analyses show that the environment is basic, saturated in carbonates, with evidence of pedogenesis. The latter appears discreetly at the top of layer 8, the matrix of which is slightly decalcified. Pedogenetic processes become clearly apparent from layer 5 up, with a distinct increase of organic matter coinciding with a decrease of carbonates. Furthermore, human activities greatly influenced the upper part of the infill, starting at the top of layer 6, where phosphates record an anthropogenic input, especially in layers 4, 3a and 2.

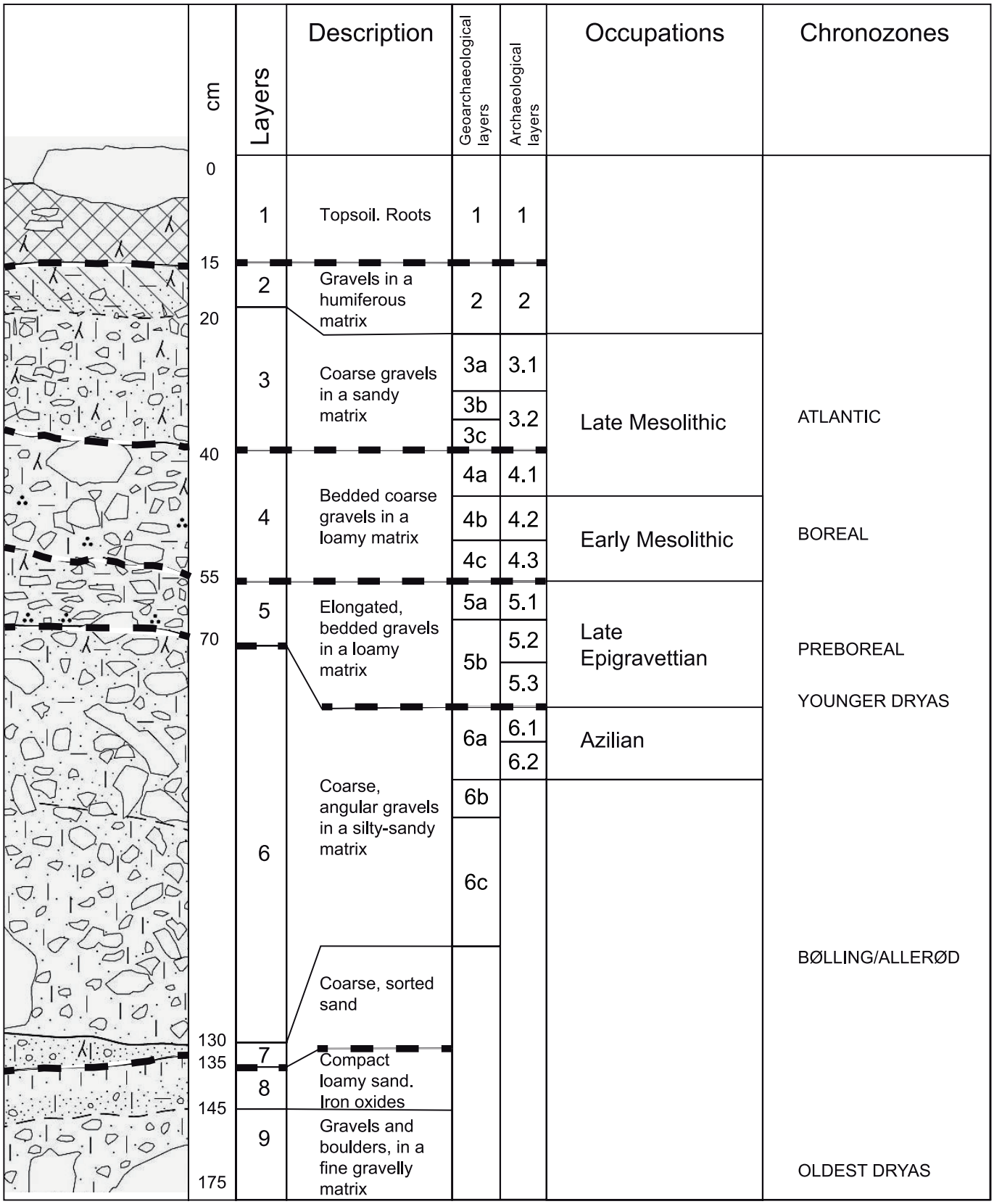

Fig. 6 - Château-d'Œx «Sciernes-Picats» (Western Switzerland Prealps). Stratigraphical table. Dashed lines indicate lacunas. / Château-d'Œx «Sciernes-Picats» (Prealpi svizzere occidentali). Schema stratigrafico. Le linee tratteggiate indicano le lacune.

Chronological reconstruction

The combination of field observations and results of laboratory analyses allow us to recreate the main events, which are set in a more general chronological framework. This reconstruction also integrates some specific archaeological data: radiocarbon dates of human settlement layers (fig. 6) and a brief overview of the projectile points, which are good chrono-cultural markers. The data used here comes from a small area of approximately 5 square metres, basically a trench measuring 3,3 m by 1,5 m located in front of the reference profile. The layers identified in the stratigraphy are, when necessary, further divided into several sub-units that use letters for geoarchaeological distinctions (for example 5b, 5a) and numbers when related to the distribution of archaeological remains (for example 5.3, 5.2, 5.1) (fig. 6).

Oldest Dryas

This sequence begins with a significant debris flow from the Paray valley containing large rubble blocks of various sizes and lithology. This flow might be related to the disappearance of the permafrost in the western Prealps at the end of the Oldest Dryas (Schoeneich, 1998). The Sciernes-Picats block is particularly large and only found enough stability at the front of the moving mass (layer 9). Runoff created gullies on the surface of the flow which were then filled with sand (layer 8). Sedimentation subsequently came to a halt for a while and the sand deposits underwent a chemical alteration in a more temperate climate. After runoff recommenced again locally, perhaps due to meltwater, the debris flow was once more subject to superficial erosion, and a second sandy gravelly layer was formed (layer 7).

Bølling and Allerød

Gelifraction becomes the dominant process as a result of an unstable climate with frequent freeze-thaw cycles: the alpine shelters of this time frame, in carbonate environments, are characterised by a substantial amount of detritism (Bintz *et al.*, 1997 ; Guélat, 2006). The first endogenous formation appears at the foot of the south face of the block in the form of an accumulation of cryoclastic fragments. Vegetation was unable to colonise this layer, although snow and runoff occasionally brought additional sediment. Stratigraphy shows that this layer was divided into two units, separated by a layer of stones which may have originated from a partial collapse of the rock face (layers 6c and 6b). The top of this cryoclastic formation, layer 6a, has a more significant matrix with a larger amount of phosphates, and evidence of trampling reveals a discreet and occasional human occupation of the shelter.

Lithic industries discovered at the top of layer 6 are scarce, characterised by backed points and backed bladelets (fig.7, n° 24-26) dating back to the late Azilian. This first human occupation is radiocarbon dated to around 11,000 cal BC (GrA-55358: 11,020±50 BP, 11,110 - 10,820 cal BC, 2 σ). The analysis was carried out on a bone discovered at the junction between layers 5 and 6. This date coincides with the last temperate phase at the end of the Allerød, just before the cooling of the Younger Dryas (GI-1a , 11,089 - 10,896 BC; Rasmussen *et al.*, 2014, tab. 2).

Younger Dryas and beginning of the Preboreal

The boundary between layers 6 and 5 shows a sudden considerable reduction in sedimentation, which would coincide with the gap often observed in rock shelter stratigraphy during the Younger Dryas, between approximately 10,900 and 9,700 cal BC (Bintz *et al.*,1997 ; Rentzel, 1998). This horizon also marks the beginning of the anthropised sequence: micromorphological analyses show that the sediment contains large amounts of flint shards, bone fragments and charcoal as well as evidence of trampling (layer 5b). Micas were probably deposited by airborne exogenous silts. As indicated by traces of frost marks in the sediment, the climate is still cold and the forest cover has not yet reached the height of the shelter (1200 m a.s.l.). This also applies to the top of this unit (layer 5a) where the frequent evidence of combustion and the lack of trampling differ from the previous layer.

From a chronological point of view, the units 5.3, 5.2 and 5.1 belong to the beginning of the Preboreal, between 9,700 and 9,500 cal BC (ETH-9660: 10,000±95 BP, 10,050 - 9,250 cal BC, 2 σ ; GrA-55355 : 10,020±45 BP, 9,810 - 9,260 cal BC, 2 σ).These dates belong to the beginning of the Holocene, before the « 11,400 BP event », between 9,703 and 9,520 BC (Rasmussen *et al.*, 2014, tab. 2).

Arrowheads include essentially straight and narrow thick backed points as well as backed bladelets (fig.7, n° 1-23) A slightly larger point was uncovered at the bottom of this group (layer 5.3; fig.7, n° 23).

These lithic industries are characteristic of the Late Epipalaeolithic, more specifically the Late Epigravettian, similar to those found at the contemporary Altwasser Höhle shelter discovered north of the Alps in the Upper Rhine Valley (Jagher *et al.*, 2000). These Epigravettian features are also found in the Jura and the Northern Alps (Mevel *et al.*, 2014). At Vitrolles «Saint-Antoine» in the Rhône Valley, typical Late Epigravettian assemblages appear distinctly at the end of the Alleröd (Montoya & Bracco, 2004).

Preboreal, Boreal and beginning of Early Atlantic

The following layer (4c) is distinctly separated from the previous ensemble as a result of a sedimentation lacuna. Micromorphological analyses revealed flint shards and other remnants of human occupation. This coincides with a resumption of the fragmentation process of the block, due to the freeze-thaw cycles, as well as deposits of airborne dust. At the same time, vegetation gradually started to colonize the site. These changes in local conditions are related to the global warming that occurred at the beginning of the Holocene. A new human settlement subsequently occupied the shelter (layer 4b), leaving traces of combustion. This unit has very clearly defined limits and the archaeological remains are different from those in the previous layers: smaller flint shards, altered bone fragments and burnt mollusc shells. While airborne deposits have ceased, biological activity has increased. This confirms the climate improvement initiated during the previous stage, despite a persistence of cold weather as shown by the continuous formation of clasts, which are also produced by the thermal impact of man-made fire on the rock face. Gradually, colluvial loam accumulated in the shelter by percolation of rainwater through newly created cracks in the block (layer 4a). As the atmosphere becomes more and more temperate, frost-induced detritism decreases. Layers 4.2 and 4.3 reveal sporadic settlements. The lithic assemblages are heterogeneous, with various microlith types: obliquely truncated points, backed points, base retouched points, segments and scalene triangles (fig.8, n° 10-20). These technocomplexes belong to the Early Mesolithic. No radiocarbon date is available yet.

A discreet Late Mesolithic microlith assemblage was discovered in layer 4.1, which is at the top of layer 4 (fig.8, n° 7-9).

From Early Atlantic onwards

After a period of reduced sedimentation, illustrated by the distinct limit between layers 4 and 3, the south face of the block seems to have partially collapsed, covering this interface with a bed of stones and small blocks. This phenomenon is frequently observed in the stratigraphy of shelters in the Alps and in the Jura and has become somewhat of a reference layer (Guélat, 1991, 2006 ; Rentzel, 1990, 1998). The collapse was caused by the enlargement of cracks in the rock, stimulated by CO_2-charged solutions in a humid temperate climate related to the vegetation which colonised the top of the block This type of event often occurs during the Early Atlantic

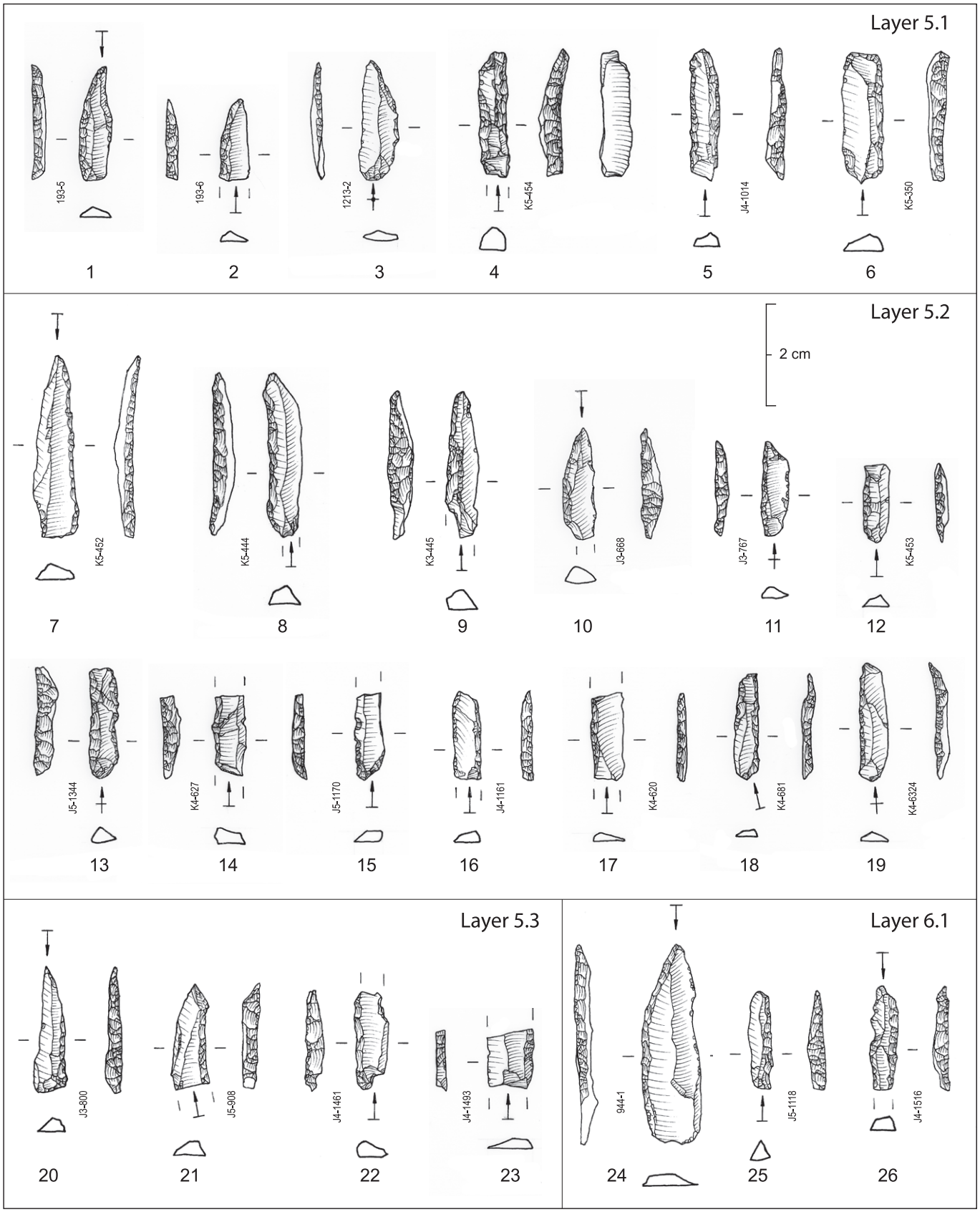

Fig. 7 *- Château-d'Œx «Sciernes-Picats» (Western Switzerland Prealps). Lithic assemblages: Late Epigravettian (layers 5.1-5.3) and Azilian (layer 6.1). 1-3, 7-10, 20: Backed points; 4-6, 11-19, 21-23, 25-26: Backed bladelets; 24: Azilian point. Drawings : Belén Nión. / Château-d'Œx «Sciernes-Picats» (Prealpi svizzere occidentali). Industria litica: Epigravettiano finale (livelli 5.1-5.3) e Aziliano (livello 6.1). 1-3, 7-10, 20: Punte a dorso; 4-6, 11-19, 21-23, 25-26: Lamelle a dorso; 24: Punta aziliana. Disegni: Belén Nión.*

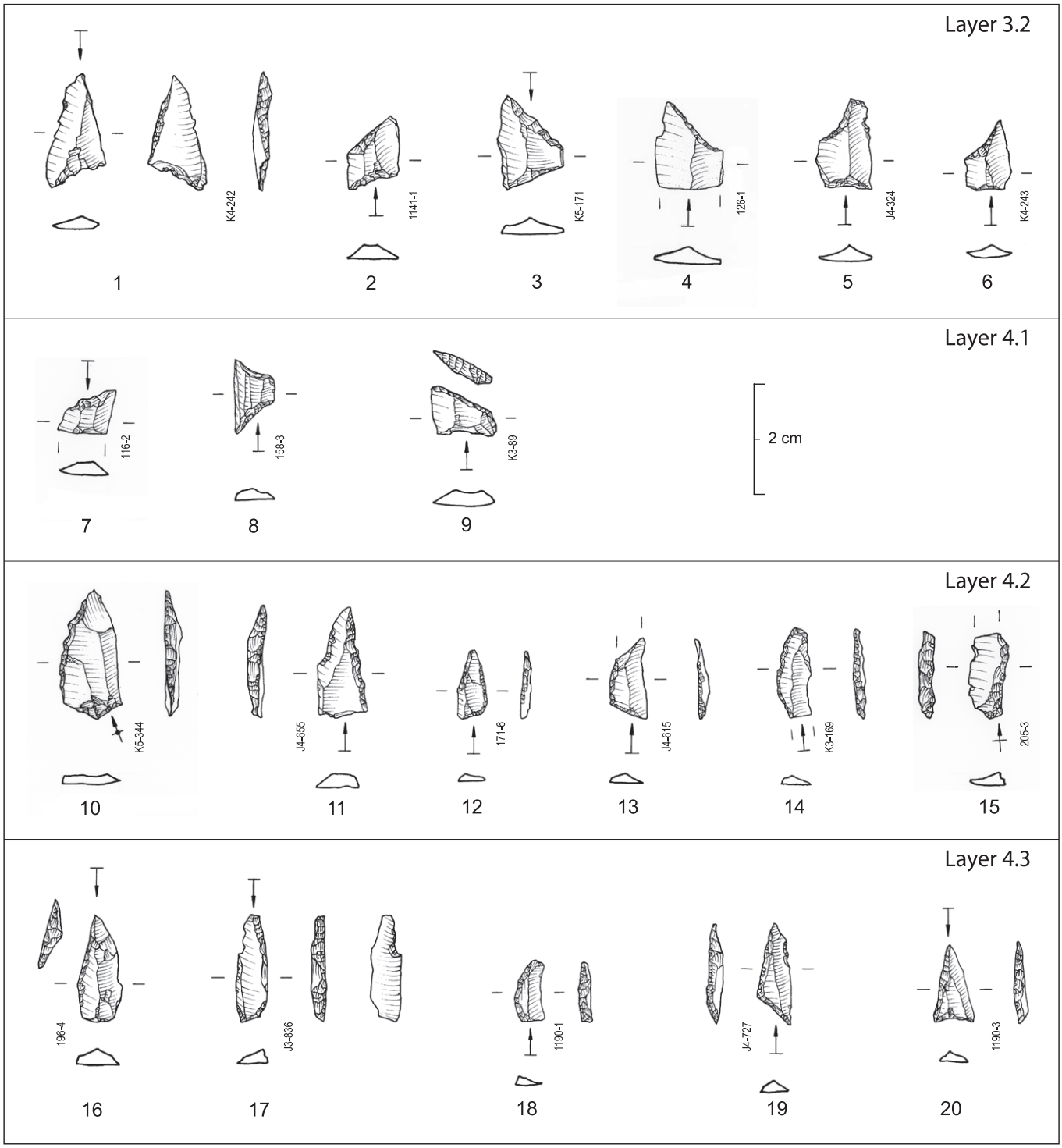

Fig. 8 *- Château-d'Œx «Sciernes-Picats» (Western Switzerland Prealps). Lithic assemblages: Late Mesolithic (layers 3.2 and 4.1) and Early Mesolithic (layers 4.2 and 4.3). 1: Asymmetric triangular arrowhead ("fléchette") 2-9: Trapezes; 10-13, 16-17, 20: Microlithic points; 19: Triangle; 14, 18: Segments; 15: Backed bladelet. Drawings: Belén Nión. / Château-d'Œx «Sciernes-Picats» (Prealpi svizzere occidentali). Industria litica: Mesolitico recente (livelli 3.2 e 4.1) e Mesolitico antico (livelli 4.2 e 4.3). 1: Punta triangolare asimmetrica ("fléchette") 2-9: Trapezi; 10-13, 16-17, 20: Punte microlitiche; 19: Triangolo; 14, 18: Segmenti; 15: Lamella a dorso. Disegni: Belén Nión.*

between 7,000 and 5,000 cal BC.

Subsequently, runoff increases succeeded by the formation of a loam of hydromorphic nature which might be related to the activity of gutters (layer 3c). The following deposit (layer 3b), of a similar nature to the previous one, contained flint shards, large pieces of charcoal and traces of trampling associated with a new human settlement. These remnants of human activities become scarcer in a bioturbated sedimentary accretion (layer 3a). Pedogenetic alterations manifest themselves through the superficial dissolution of clasts. Platy gelifracts appear in the outer part of the fill and are probably related to the formation of concretions on the imbibed rock face.

Archaeological records of human occupation were numerous in layers 3.1 and 3.2, including well-preserved animal remains. These layers were preserved in the whole of the excavated area, as opposed

to the early settlements (layers 6 and 5) which were only found near the reference profile. The lithic assemblages are typical of the Late Mesolithic, characterised by trapezes most of which are asymmetric (fig.8, n° 2-6). An inversely retouched asymmetric « *fléchette* » was also discovered (fig.8, n° 1). All radiocarbon dates confirm the relatively recent nature of the lithic industries and converge to the end of the 7th millennium, around 6,000 cal BC (ETH-9659 : 7190±85 BP, 6,230 - 5,890 cal BC, 2 σ ; GrA-55357 : 7,200±40 BP, 6,120 - 5,990 cal BC, 2 σ ; GrA-55360 : 7,290±40 BP, 6,230 - 6,060 cal BC, 2 σ).

The top part of the fill (layers 2 and 1) is only partially preserved and is characterised by a lacunar sedimentation: organic matter increases greatly followed by a biological mixing of the components. Layers 2 and 1 contain Mesolithic artifacts in secondary position as well as modern elements and structures.

Conclusions

The comparison between sedimentological and archaeological data shows a good convergence and complementarity of these approaches. Unlike human occupation itself, the conservation and recording of consecutive settlements are closely related to sedimentation conditions.

The general stratigraphical table (fig. 6) highlights several lacunas in the sedimentary history of the site (erosion, decrease or absence of sedimentation) as well as important gaps in the sequence of human occupations. The top of layer 6 may have been truncated during the Younger Dryas, creating a hiatus. As a result, some Azilian elements may have disappeared.

On the other hand, a relatively constant sedimentation during the Late Epigravettian, around 9700/9500 cal BC, and during the Late Mesolithic, around 6000 cal BC, allowed an excellent preservation of remains, particularly animal bones. In both cases anthropic elements are numerous and radiocarbon dates converge.

Layers 4.3 and 4.2, which belong to the Early Mesolithic, did not benefit from such favourable circumstances. The sedimentation rate seems to have been inferior and bones are highly fragmented and altered. These layers probably correspond to multiple occupations over a wide time span, which is in accord with the lithic industries.

The top part of the fill, which contains a mixture of Mesolithic and modern artifacts in humiferous deposits (layers 2 and 1), reveals a clear decrease in sedimentation.

It is tempting to correlate these alpine establishments with climatic aspects. With regard to the Sciernes-Picats shelter, it appears that Azilian hunter-gatherers occupied the site during a warm phase at the end of the Alleröd, between approximately 11,100 and 10,900 cal BC. Furthermore, the climate improvement at the beginning of the Preboreal, between 9,700 and 9,500 cal BC coincides with the Late Epigravettian occupations.

Finally, it appears that the Late Mesolithic settlements occurred immediately after a sudden cold and dry phase called the «8,200 BP event» (Lowe *et al.*, 2008; Rasmussen *et al.*, 2014).

The Château-d'Œx « Sciernes-Picats » shelter is a reference site for the Central Alps, with its large chronological sequence and the significant amount of archaeological records which are lacking in open-air alpine encampments. In addition to the geoarchaeological aspects, archaeozoological studies, raw material sources use-wear analysis and lithic technology open up new research opportunities for the study of hunter-gatherer economies in the alpine regions.

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Article

The landscape-archaeological Ullafelsen Project (Tyrol, Austria)

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Key words

- Landscape Archaeology
- Alpine Archaeology
- Mesolithic
- Ecology
- Stone raw material

Parole chiave

- Archeologia del paesaggio
- Archeologia Alpina
- Mesolitico
- Ecologia
- Materie prime litiche

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Summary

The early Mesolithic site at Ullafelsen is at the centre of a landscape-archaeological project on the Mesolithic in Tyrol (Austria). In this project, for the first time in a subalpine open air site in Austria, mesolithic living floors were identified and explored in great detail. The analysis of the natural sedimentation and soil-scientific processes confirmed that Mesolithic people had manipulated the surface of the living floor, for instance to produce organic tar from birch bark through controlled, oxygen-reduced burning processes. Our C14 dating indicates that the use of subalpine sites in the Austrian Alps started as early as the early Preboreal. Analyses of the introduced cherts revealed that they originated from sometimes quite distant geological sources in Bavaria and in northern Italy. This is proof of people crossing the Alps even in the early Holocene and makes contacts between the southern alpine Sauveterrian and the southern German Beuronian technocomplexes highly likely.

Riassunto

Il sito Ullafelsen, datato al Mesolitico antico, è al centro di un progetto di Archeologia del paesaggio che riguarda il Mesolitico in Tirolo (Austria). Questo progetto, per la prima volta in un sito all'aperto in Austria, propone una identificazione e una dettagliata indagine di superfici di abitato mesolitici. L'analisi della sedimentazione naturale e dei processi della formazione del suolo hanno confermato la manipolazione della superficie di abitato da parte dei Mesolitici, per esempio per produrre mastice organico dalla corteccia di betulla attraverso processi di combustione controllati e in ambiente scarso di ossigeno. Le nostre datazioni C14 indicano che nelle Alpi Austriache l'utilizzo dei siti della fascia subalpina ha già avuto inizio nel primo Preboreale. Le analisi delle materie prime silicee hanno rivelato la loro derivazione anche da affioramenti geologici di notevole distanza, ubicati in Baviera e nell'Italia settentrionale. Ciò dimostra l'attraversamento delle Alpi fin dal primo Olocene e rende altamente probabile l'esistenza di contatti tra i techno-complessi del Sauveterriano sudalpino e del Beuroniano della Germania meridionale.

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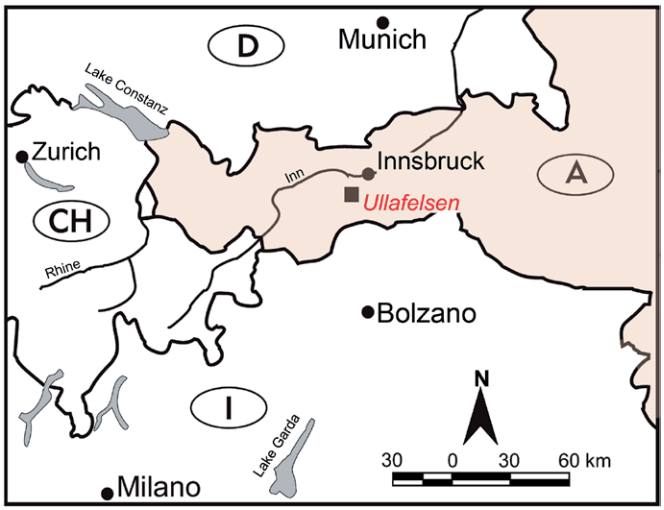

Fig. 1 - Position of the old Mesolithic Ullafelsen site (Fotscher Valley, Stubai Alps) in the western part of Austria (chart D. Schäfer). / Ubicazione del sito Ullafelsen datato al Mesolitico antico (Fotschertal, Alpi dello Stubai) nell'Austria occidentale (mappa D. Schäfer).

Introduction

The discovery of the Tyrolean Iceman (also known as 'Ötzi') in September 1991 in the Ötztal Alps served as a trigger for the emergence of a research focus on high-mountain archaeology at the University of Innsbruck. Our main focus is the early Mesolithic Ullafelsen site in the Stubai Alps, discovered in 1994 (Fig. 1). It is located some 25 km south-west of Innsbruck and forms a distinct rocky outcrop (1869 m.a.s.l.), today with excellent views of the surrounding area (Fig. 3). Its 14 identified fireplaces, more than 7900 stone artefacts of diverse geological and geographic origin, numerous findings of wood tar, as well as observations and analyses of the activities of the Mesolithic people represent a rare and lucky break for prehistoric research. Several finds were here identified for the first time in the central eastern Alps. Because of the significance of the site, the archaeological dig was limited to just 25 m^2 with a view to allowing future generations to come to their own conclusions.

Under these circumstances it is clear that investigations of the site had to be conducted on a very broad, cross-disciplinary basis. This included small comparative digs on other sites, surveys of primary chert deposits, as well as ancillary geoscientific and botanical studies. The overall Ullafelsen Project can therefore be seen as landscape archaeology and/or geoarchaeology in K.W. Butzer's sense (Butzer 1982).

As we began to know more from the documented finds and findings of our dig at the Ullafelsen, an ever more closely integrated debate across soil science, glaciology and archaeology developed in some areas of our work. From this resulted issues to be tackled in joint cross-disciplinary efforts ('Transdisciplinarity' in J. Mittelstraß' sense 2003).

The overall project currently includes:

meteorology / palaeoclimatology; soil science / sedimentology / soil micromorphology; glaciology; botany / palaeobotany / charcoal analysis; chert analyses; cartography; prehistory, including use wear analyses.

Selected themes of the project

Of the results obtained so far (cf. in detail Schäfer 2011a), we will discuss insights on major themes below, including these issues and aspects:

(a) the relation between humans and the environment from the late Glacial to the early Holocene;

(b) the relation between the development of the timber line in the early Holocene and the settlement behaviour of Mesolithic hunter-gatherer groups in our study area;

(c) Are there marker levels in the regional stratigraphy of that period?

(d) Are there identifiable living floors during Mesolithic use of our sites? If so, can these be used to identify specific behavioural patterns of Mesolithic groups?

(e) Which regional and supra-regional resources did the people make use of (chert, minerals, organic matter, etc.)?

(f) When in the early Holocene did people in the central eastern Alps start to use alpine elevations and where did those people come from? What are the key arguments here?

(g) What were the reasons for creating alpine elevation sites during that period and what concrete activities were we able to document in our study area?

There are close links between individual aspects (a) to (g), so that the discussion in section 3 serves to sketch a synthetic overview of the current state of the project. Detailed observations and analyses to the state of knowledge reached in 2010 are found in the individual articles of the first volume on the project (Schäfer 2011a).

Synthesis of the results

Both the Ullafelsen site and that on Kaseralmschrofen from the same early Mesolithic period are located in the Fotscher valley in the northern Stubai Alps. At higher altitudes of neighbouring valleys to the north and south several Mesolithic sites have been identified on Krimpenbachalm and at Franz-Senn-Hütte (Fig. 2). In geological terms the entire area belongs to the Ötztal-Stubai crystalline mountain, with predominantly metamorphous rocks (para- and orthogneisses), without local cryptocrystalline chert deposits that would allow the creation of stone artefacts. However, the high geomorphological and pedogenetic diversity, as well as an abundance of water, plants and game must have made it an attractive area from the earliest Holocene for repeated use by Mesolithic hunter-gatherers.

By the late Würmian local glaciers in the area had already retreated so far that at Ullafelsen we were able to verify distinct soil formation in the Bölling/Alleröd periods (Geitner *et al.* 2011), albeit without finding evidence for late Palaeolithic use in the study site (Schäfer 2011b).

During the Egesen stadial (= Younger Dryas) of the Würm glacial period, the glacier of the Fotscher Ferner pushed forward for the last time to roughly 2 km southwest of the Ullafelsen (Kerschner 2011), but without reaching our study site. Early Mesolithic settlement at the Ullafelsen reached a sudden peak during the middle to the late Preboreal, while we only found occasional fireplaces for the Boreal. It is striking that (at least in the dig itself) late Mesolithic artefacts are completely missing, nor are there any charcoal datings for that period. We derived initial background information from the results of wood type analyses from charcoal from Preboreal and Boreal fireplaces (F1 to F3). They suggest that during the middle Preboreal the Ullafelsen was still above or next to the timber line. The location characteristics associated with such a position (see below) and the good view across the area had worsened as early as the middle Boreal, by which time the Ullafelsen was located in the forest edge ecotone (Oeggl & Schoch 2011). With a further rise of the timber line our study site will have been surrounded by closed forest from about 8.300 BP (uncalibrated) when the last sporadic stays of Mesolithic hunter-gatherers end throughout the valley. Only in the neighbouring Oberberg valley to the south, around today's Franz Senn-Hütte, were there any places with the necessary qualities for creating Mesolithic sites, where major high-altitude paths crossed and which

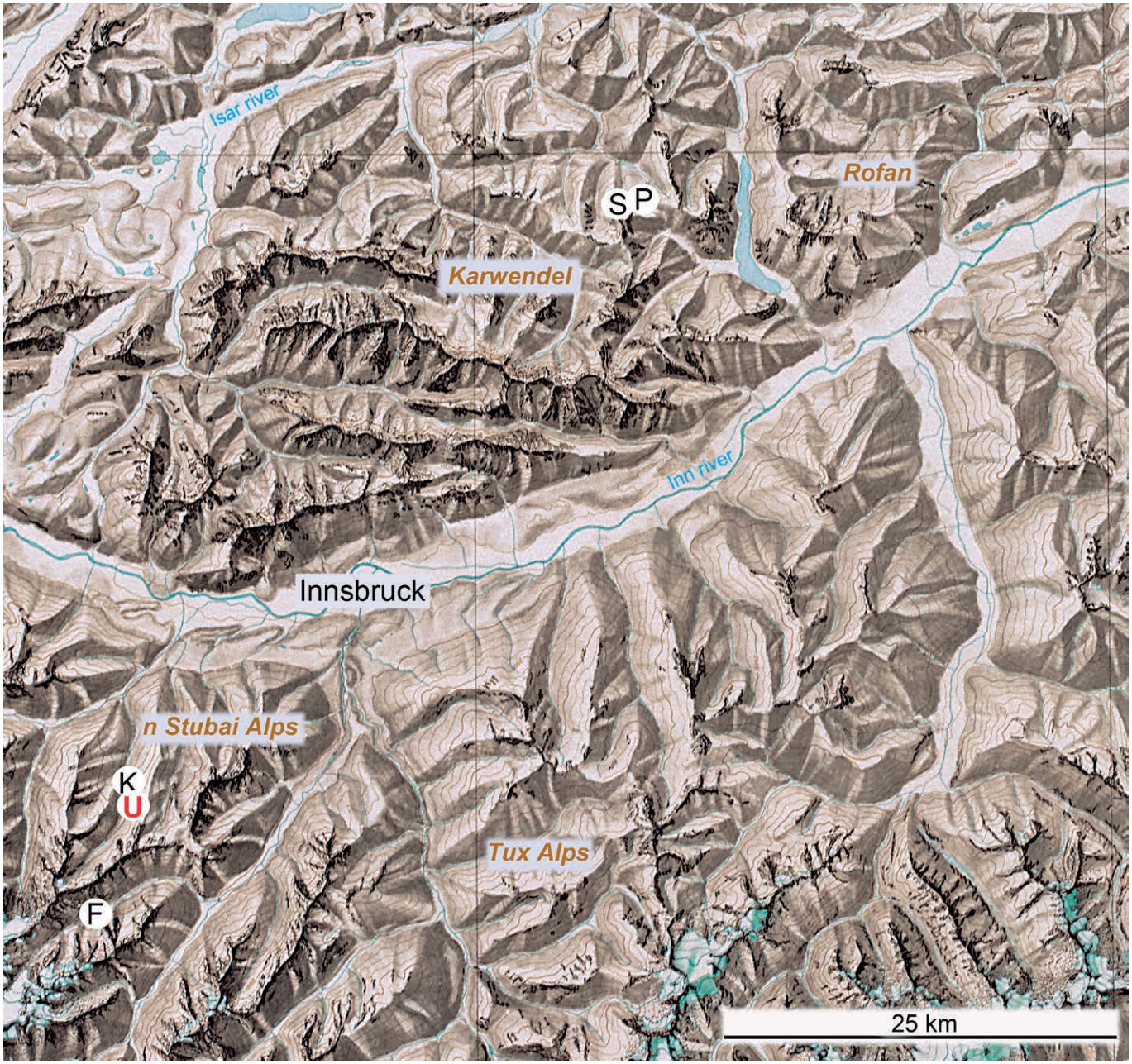

Fig. 2 - Selected old Mesolithic sites and find areas in Tyrol between Rofan and northern Stubai Alps: F-Franz Senn Hütte, U-Ullafelsen, K-Kaseralmschrofen, S-Schleimssattel, P-Pasillalm (chart D. Schäfer) / Selezione di siti e aree di ritrovamenti del Mesolitico antico in Tirolo, tra Rofan e la zona settentrionale delle Alpi dello Stubai: F-Franz Senn Hütte, U-Ullafelsen, K-Kaseralmschrofen, S-Schleimssattel, P-Pasillalm (mappa D. Schäfer).

were above, yet near the timber line (Fig. 2). Such a site is ecologically significant and characterized by a high diversity of plants and habitats and thus promising for game (Oeggl & Wahlmüller 1997).

Not only ibex and deer followed the climate-induced rise in the timber line, so did the hunter-gatherers of our immediate study area between Fotscher valley and Oberberg valley. For analogies in northern Italy, see, for instance, Fedele (1981) and Dalmeri & Lanzinger (1998). This can also be read off the altitudinal position and dating of three find areas with a total of 27 AMS data (conventional AMS data):

* Kaseralmschrofen (Fotscher valley, altitude 1755 m):
1 AMS date: 9860±50 BP
* Ullafelsen (Fotscher valley, altitude 1869 m):
17 AMS data 9580±40 BP - 9240±40 BP; 5 AMS data 8770±80 BP - 8350±40 BP
* 2 sites near Franz-Senn-Hütte (Oberberg valley, altitudes 2060-2150 m):
4 AMS data 8250±40 - 6455±35 BP.

We assume that this model of anthropogenous settlements and altitudes would have to be modified from region to region, as variations in human subsistence strategies, topography, routing of paths and other factors tend to level out other trends across larger areas (Kompatscher & Kompatscher 2011, p. 220, fig. 18).

In terms of stratigraphic detail our findings on Kaseralmschrofen and on Ullafelsen have yielded interesting observations. Here we found a grey silty-fine sandy horizon, the so-called Light Layer (LL). It lies stratigraphically beneath the Holocene humus and typically

Fig. 3 - The plateau of the Ullafelsen during the excavation 2002 (photo D. Schäfer). / Il plateau di Ullafelsen durante lo scavo del 2002 (foto D. Schäfer).

forms the living floor of our Mesolithic people. Our current state of investigation suggests that the LL accumulated primarily by eolian processes. Coarser components from avalanches and anthropogenic influences later probably influenced the composition of its grain size, and in the subsequent Holocene the whole profile came under the influence of podsolization. Judging from our observations on Kaseralmschrofen, aeolian accumulation of the LL might have continued into the Mesolithic settlement period of the site during the oldest Preboreal, as most stone artefacts were found within the LL. The detailed study of character and sequence of the stratigraphic units on Ullafelsen also allows us to identify anthropogenic interference as well as intentional manipulations on the top and within the LL (Fig. 4). In the central part of the Preboreal fireplace 3 (F3), for instance, birch bark has been converted into organic tar in an oxygen-reduced burning process. The Mesolithic people used a mix of LL material and charcoal from surrounding areas to cover the birch bark (Schäfer 2011b, chapter 4.1, pp. 270-296). The surface next to F3 was also levelled in places (Fig. 5). Numerous macroscopic and microscopic remnants of tar were found in the dig itself (Fig. 6) and on the surface of more than 100 stone artefacts. On Kaseralmschrofen, too, many artefacts presented tar residue (Pawlik, internal project documentation). In connection with traces of use, such tar residues often point to functional connections between stone artefacts and with their mounting (Pawlik 2011). A. Pawlik was able to identify the intended use of 323 analysed stone artefacts at Ullafelsen on 139 objects. About 40% of those served as tools (some of them mounted), another 28% as projectiles (mounted laterally or as points). Often artefacts are associated with rehafting and/or retooling processes. Around 9% of the artefacts demonstrate their multifunctional context and present highly individual and specific features. There have been identified leather/fur, bones, antlers and occasionally wood as contact material (Pawlik 2011). The range of retouched forms at Ullafelsen is evidence of artefacts connected with base camp activities (e.g. scrapers, borers, burins, truncations), as well as those associated with hunting camp activities (backed bladelets, triangles, segments, micropoints) (Schäfer 2011b). Ullafelsen and neighbouring Kaseralmschrofen may therefore be considered seasonal base camps for hunting activities in an alpine environment of major ecological and hunting resources.

Indirect proof of the appeal of this landscape comes from the origin of the cryptocrystalline cherts used at these Mesolithic sites, as there are no natural deposits of these rocks in the Stubai Alps themselves. A key investigative focus of project is therefore to describe and identify the origin of these rocks (Fig. 7-8) (Bertola 2011a, 2011b, 2014, Bertola & Schäfer 2011).

At the Mesolithic sites at Franz-Senn-Hütte, Kaseralmschrofen and Ullafelsen we found cherts from the Southern Alps. This is proof of trans-alpine crossings of the main alpine ridge by Mesolithic groups as early as the Preboreal for our study area. The paths across the Alps may have become established in several stages during the early Mesolithic: At the beginning of the Preboreal, on Kaseralmschrofen, only 10.4% of a total of 192 chert artefacts come from the Southern Alps. Nearly 90% of the cryptocrystalline rock comes from

Fig. 4 - Ullafelsen, cross profile square B8 (2003): The grey LL-horizon with overlaying charcoal and evidence for anthropogenic influences (details a and b) (photo D. Schäfer). / Ullafelsen, profilo trasversale del quadrato B8 (2003): l'orizzonte LL, grigio, con carboni sovrapposti ed evidenze di manipolazione antropica (dettagli a e b) (foto D. Schäfer)

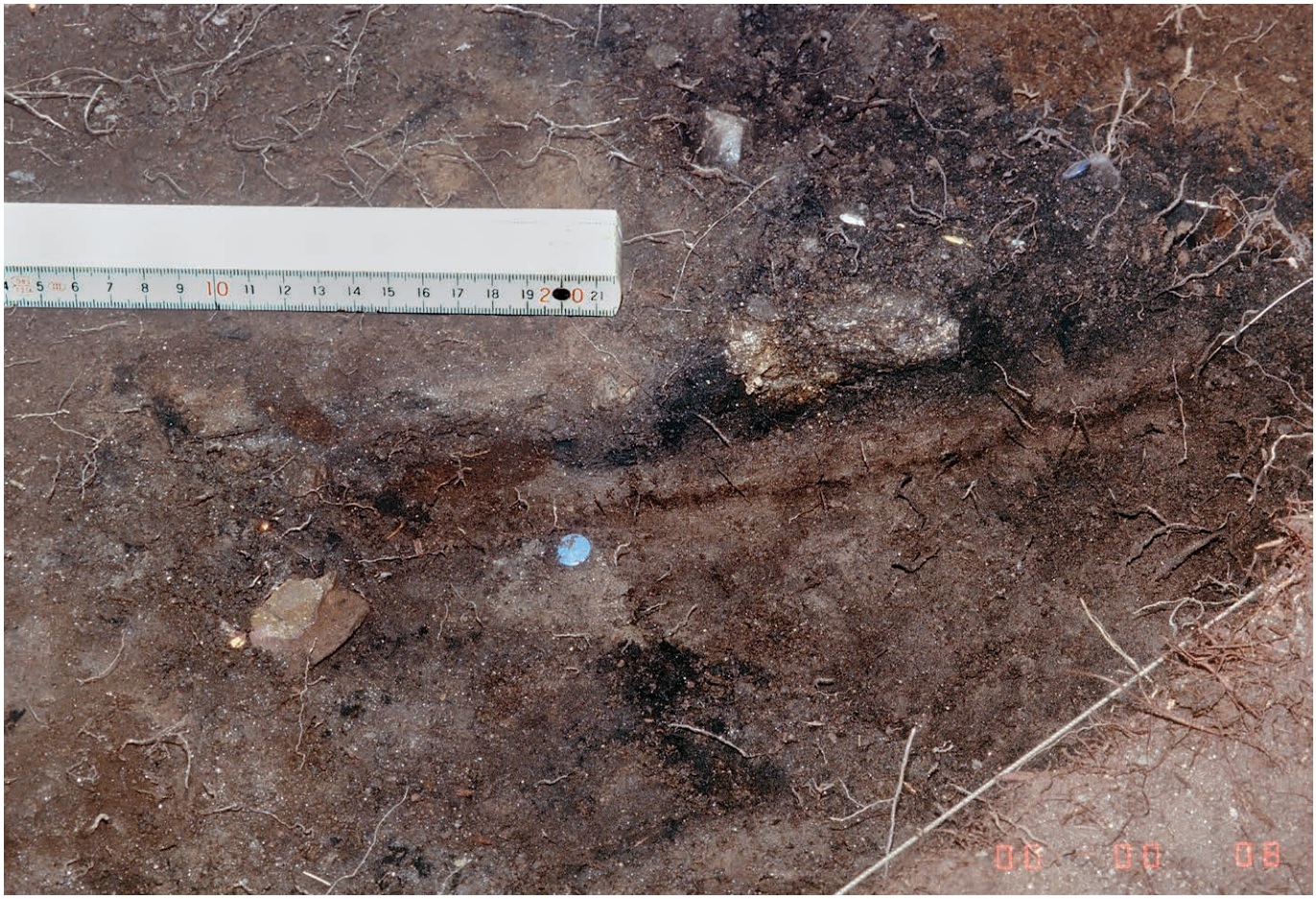

Fig. 5 *- Ullafelsen, cross profile square C7athrough east edge of fireplace 3; fine clastic sedimentes (LL dominating) are covering the charcoal layer. Below the charcoal layer one can see a brown thin sediment which has to be seen as a result of anthropogenic influence (levelling), Aug. 22, 1997 (phot. D. Schäfer). / Ullafelsen, profile trasversale del quadrato C7a attraverso l'angolo orientale del focolare 3; sedimenti a clasti fini (LL predominante) ricoprono il livello carbonioso. Sotto tale livello si può osservare un sedimento marrone sottile che è visto come il risultato di influenza antropica (livellamento), 22 Agosto 1997 (foto D. Schäfer).*

the Northern Limestone Alps (Bertola, internal project documentation). Other factors also suggest that Kaseralmschrofen represents a pioneer stage of early Mesolithic exploration of the central eastern Alps: most artefacts at this site are of relatively large average size,

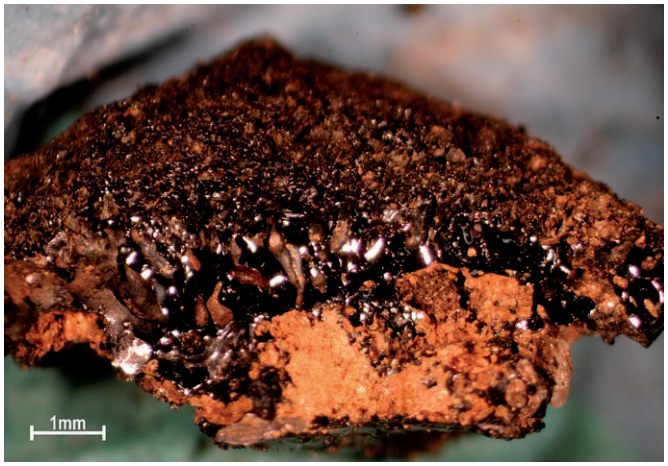

Fig. 3 *- Ullafelsen, mesolithic tar remain (phot. A. Pawlik). / Ullafelsen, residuo di mastice mesolitico (foto A. Pawlik)*

there is hardly any trace of blank form production, instead we found quite a few modified artefacts (13% of all cherts) and blanks brought here from elsewhere. Just a few centuries later, the picture is a rather different one. At Ullafelsen we found most chert artefacts from the Southern Alps on the rim of fireplaces from the middle Preboreal. Here they make up a full 36,7% (n=1082 artefacts) of all analysed cryptocrystalline cherts. For the Ullafelsen finds we were able to identify the origin of the cherts from the Southern Alps as the Valle di Non near Trento (Bertola 2011a, 2014) – i.e. some 100 km south of Ullafelsen across the main Alpine ridge ("SA" in fig. 7). Such rocks were of course brought in to Ullafelsen as part of embedded procurement within seasonal subsistence activities. From the distances covered and their directions we can deduce key parameters for the geographic areas used as well as the potential origin of Mesolithic hunter-gatherer groups, whose presence in the North Tyrolean Fotscher valley has been documented. Such a share of southern alpine cherts in the raw material at a northern alpine site greatly exceeds single finds and points to the existence of by then regularly used transalpine routes. K. and N. Kompatscher have documented numerous such routes, esp. in northern Italy. They found that key factors for the choice of encampment sites along a certain route were, "the strategic position within the territory, a useable area close by, a good view of the surroundings and a supply of water," (Kompatscher & Kompatscher 2011, p. 205). We can safely assume that it were indeed the foragers from the southern Alps themselves who brought the material to the Ullafelsen and processed it, as is evidenced by

Fig. 7 *- Ullafelsen, examples for used stone raw materials of different geographic and geologic origins: SA-south alpine cherts (Scaglia variegata/Scaglia rossa from the Val di Non area, Trento); FA-Upper Jurassic hornstone from the south Franconian Alb (Bavaria), NK-Silex of the Northern Calcareous Alps (Ruhpolding and Chiemgau Formation, Upper Jurassic), BK-rock crystal, central-alpine, Q-local quartz (Fotscher valley) (phot. D. Schäfer). / Ullafelsen, esempi di materie prime litiche sfruttate, di diversa provenienza geografica e geologica: SA-selci sudalpine (Scaglia Variegata/Scaglia Rossa dall'area della Val di Non, Trento); FA-selce del Giurassico Superiore dalla Fränkische Alb (Bavaria), NK-selce delle Alpi calcaree settentrionali (Ruhpolding e formazione di Chiemgau, Giurassico Superiore), BK-cristallo di rocca, Alpi centrali, Q-quarzo locale (Fotschertal) (foto D. Schäfer).*

Fig. 4 *- The position of the Ullafelsen (U) southwest of Innsbruck and the evidence of the lithic raw material groups used at this site: SA-south alpine cherts (Scaglia Variegata/Scaglia Rossa from the Val di Non area, Trento); FA-Upper Jurassic hornstone from the south Franconian Alb (Bavaria), NK-Silex of the Northern Calcareous Alps (Ruhpolding and Chiemgau Formation, Upper Jurassic), BK-mountain crystal , central-alpine, Q-local quartz (Fotscher valley) (chart D. Schäfer). / Posizione di Ullafelsen (U) a sudest di Innsbruck e l'evidenza delle materie prime litiche utilizzate nel sito: SA-selci sudalpine (Scaglia Variegata/Scaglia Rossa dall'area della Val di Non, Trento); FA-selce del Giurassico Superiore dalla Fränkische Alb (Baviera), NK-selce delle Alpi calcaree settentrionali (Ruhpolding e formazione di Chiemgau, Giurassico Superiore), BK-cristallo di rocca, Alpi centrali, Q-quarzo locale (Fotschertal) (mappa D. Schäfer).*

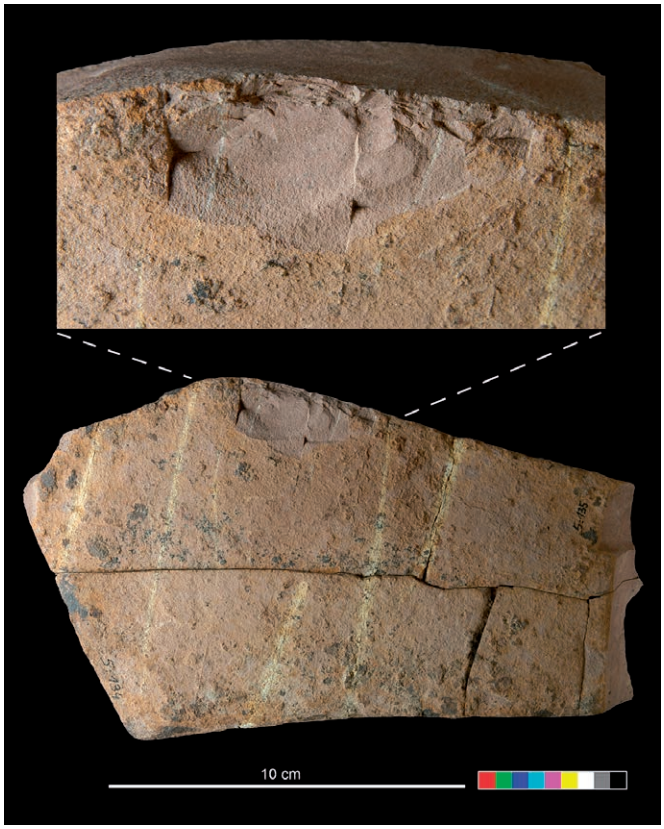

Fig. 7 *- A radiolarite slab from the old mesolithic Schleimssattel 3c site (S in fig. 2). The slab was extracted directly from a primary geological context. After testing the piece was broken into two large fragments and was not used anymore (photo D. Schäfer). / Una lastra di radiolarite dal sito Schleimsattel 3c (Mesolitico antico, S della fig. 2). La lastra è stata estratta direttamente da un contesto geologico primario. Dopo aver testato il pezzo, questo è stato fratturato in due grandi frammenti e abbandonato (foto D. Schäfer).*

the numerous finds of microlithic backed bladelets produced here from southern alpine chert (see among the "SA" group in fig. 7). These tools and typical needle-like points are clearly made in the southern alpine Sauveterrian tradition. One of them ('punta a due dorsi') is made of rock crystal and goes back to the same tradition (see the upper artefact in the "BK" group of fig. 7). The nearest potential natural deposits of rock crystal are in the Tux Alps east of the site and will have been brought along by southern alpine Mesolithic people in the course of crossing the main alpine ridge (Fig. 2). Much further away – some 200 km to the north-northeast as the crow flies – are the Upper Jurassic hornstone deposits of the southern Franconian Alb (the area around Kelheim on the Danube, Bavaria), where about 25% of all artefacts identified at Ullafelsen come from ("FA" in fig. 7). They are not only evidence of the longest transport distance to the Stubai Alps but also of contacts with the southern German Beuronian complex (Bertola & Schäfer 2011). The Ullafelsen inventory does indeed include a long-narrow trapeze of this southern German raw material, a tool shape actually not found in the southern alpine region of the Sauveterrian (see "FA" group in fig. 7, left object in the lower row). The area of the northern Stubai Alps thus suggests an overlap of southern and northern alpine traditions during the early Mesolithic.

The most immediate and also easiest connection, at least from the Stubai Alps to the Franconian Alb, will most likely have been the use of the waterway of the Isar river, which originates in the Karwendel mountains. Depending on where you enter a boat (western / eastern Karwendel as part of the Northern Calcareous Alp), at least about two thirds of the total distance could have been covered in this way.

In just this area of the eastern Karwendel mountains there are regional and (relatively) well suited radiolarites and hornstones of the Upper Jurassic ("NK" in fig. 7). These were used to make 37.4% of all artefacts found at Ullafelsen. We know at least two sites in the eastern Karwendel alone, Schleimssattel 3c and Pasillalm (at around 1560 m), where the local rocks were exploited intensively during the early Mesolithic (Fig. 2). Both workshops for chert exploitation yielded numerous precores, cores, flakes, debris and some microlithic implements (triangles, micropoints, segment, microburins) (Schäfer *et al.* 2006). In the immediate vicinity of the Schleimssattel 3c site the Mesolithic people took up several larger radiolarite slabs from the local (primary) geological context. All of them present an intact cortex without any traces of mechanical wear (from rolling or transport by water) and were processed in situ. One of these slabs was tested for quality by hitting its edge and it broke into two parts and was left unused (Fig. 9) – a unique find in our study area (Schäfer *et al.* 2006, p. 298, fig. 6-7). In the adjoining eastern Rofan range Upper Jurassic radiolarites and hornstones were also exploited during the Mesolithic. In using these, people started from the geomorphologically most advantageous point and created artefacts that were needed in hunting (Kompatscher & Kompatscher 2005).

Of these the typically brick-red radiolarites from the Rofan area in the Northern Limestone Alps of Tyrol usually present the best material characteristics (Fig. 7, see the two upper objects in the "NK" group). They were mainly used regionally, but first finds of this raw material in South Tyrol have been documented, e.g. at Weitenberg Alm (Kompatscher & Kompatscher 2005, p. 33, fig. 16). From what we have learned, transports of northern alpine cherts across the Alps must not be seen as the odd one-off event. We strong suspect that a revision of sites in northern Italy would yield several surprises in this respect. We came across one such surprise when analysing the Mesolithic production of some artefacts from local, often rough crystalline (vein) quartz at Ullafelsen: this material is a common component of metamorphous gneiss deposits in the region, has only limited if not poor fracture-mechanical characteristics, which make it difficult to identify as artificially processed (Schäfer 2014, p. 40, fig. 7). We were, however, able to document artefacts, organic residues and traces of wear on this material and on rock crystal artefacts in several cases at Ullafelsen (Pawlik 2011). The origin of five hematite samples at Ullafelsen remains unclear for the time being.

Conclusion

In the short time span of 20 years, the study of the alpine Mesolithic in Tyrol has yielded astonishing insights into the relation between humans and the environment during the early Holocene. What made it possible was the extensive cooperation between researchers from the natural sciences and the humanities. Building on this foundation and continuing to make use of the existing opportunities is the real legacy of the 'ice man'.

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Article

Bird remains from the Mesolithic site Galgenbühel / Dos de la Forca (Salurn, Bozen/Bolzano, Italy)

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Key words

- Early Mesolithic
- Adige Valley
- rock shelter
- Aves
- palaeoecology

Parole chiave

- Mesolitico antico
- Valle dell'Adige
- riparo
- Aves
- paleoecologia

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Summary

As part of the research project "Living near the water", focused on the Early Mesolithic rock shelter of Galgenbühel/Dos de la Forca located at Salorno, in the Adige Valley (Bozen/Bolzano Province, Northern Italy), about 600 bird remains recovered from the excavations have been analyzed. The 27 identified species belong mainly to Passeriformes (about 250 specimens). The remains of Piciformes, Galliformes (among which the quail, *Coturnix coturnix*, is prevalent) and Gruiformes (belonging to the Rallidae family) are less abundant. Anseriformes, Suliformes, Podicipediformes, Charadriiformes, Columbiformes, diurnal (Accipitriformes and Falconiformes) and nocturnal raptors (Strigiformes) are represented in lower percentages. Forest species are the most frequent, but also species living in other biotopes, such as aquatic and open habitat birds, have been identified; rocky and mountain environments are represented by only two species. The taphonomic analyses did not allow defining the degree of human involvement in the accumulation of the bird bone assemblage.

Riassunto

Nell'ambito del progetto di ricerca "Vivere vicino all'acqua", finalizzato allo studio del riparo sottoroccia di Galgenbühel / Dos de la Forca, localizzato a Salorno, nella Valle dell'Adige (Provincia di Bolzano) e oggetto di frequentazione antropica nel Mesolitico antico, sono stati analizzati circa 600 resti di uccelli recuperati nel corso degli scavi. Le 27 specie individuate appartengono principalmente ai Passeriformes (circa 250 resti). Molto meno abbondanti sono i resti di Piciformes, i Galliformes (tra i quali domina la quaglia, *Coturnix coturnix*) ed i Gruiformes (appartenenti alla famiglia dei Rallidae). Sono presenti in percentuali minori Anseriformes, Suliformes, Podicipediformes, Charadriiformes, Columbiformes, rapaci diurni (Accipitriformes e Falconiformes) e notturni (Strigiformes).
Prevalgono specie boschive, ma sono presenti anche uccelli che frequentano altri biotopi, soprattutto quello acquatico e gli spazi aperti; habitat rocciosi e di montagna sono rappresentati da due sole specie. L'analisi tafonomica condotta su un campione di ossa non ha permesso di definire il grado di coinvolgimento antropico nell'accumulo di questi reperti.

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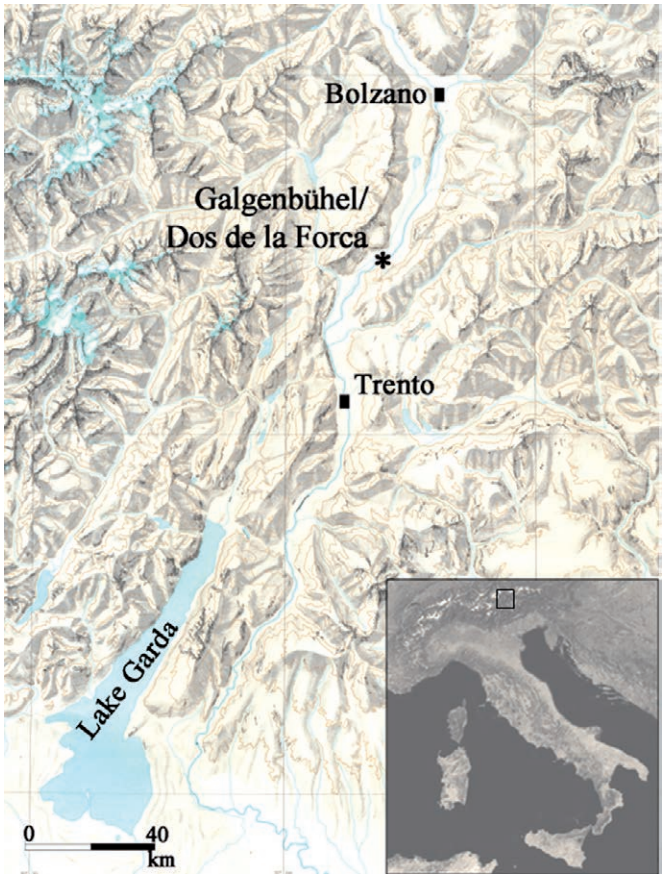


Fig. 1 *- Location of the Galgenbühel/Dos de la Forca site in the Adige Valley (Bozen/Bolzano Province, Italy). / Localizzazione del sito Galgenbühel/Dos de la Forca nella Valle dell'Adige (Bolzano, Italia).*

Introduction

The present research focuses on the study of the avifaunal assemblage recovered during the archaeological excavations in the Galgenbühel/Dos de la Forca rock shelter located at Salurn/Salorno (Bozen/Bolzano, South Tyrol, Italy) (Fig. 1). The site, frequented by Early Mesolithic hunter-fisher-gatherer groups, is placed in the Adige Valley, above a debris cone at 225 m a.s.l., at the foot of a steep rock face (Fig. 2). Deeply covered by debris, the deposit was discovered and partially destroyed during the activity of a gravel quarry ("Cava Girardi") in 1995. The excavation, carried out between 1999 and 2002 in four excavation seasons, was directed by the Ufficio Beni Archeologici of the Autonomous Bolzano Province (Bazzanella & Wierer, 2001; Bazzanella *et al.* 2004).

The excavated area ranges from 4 m^2 in the upper part of the deposit, to a maximum of 18 m^2 in the lower part; unfortunately the original extension of the anthropogenic layers could not be assessed. The anthropogenic levels, interspersed with natural layers of coarse grained debris, form a stratigraphic series with an approximate depth of 2.5 m evidencing a discontinuous human occupation (Fig. 3). Radiocarbon dates, recently integrated by new results, cluster between 8454 ± 46 BP uncal. (7588-7459 cal. BC) and 9265 ± 70 BP uncal. (8699-8301 cal. BC) and indicate human frequentation from the late Preboreal to the mid-Boreal. Several hearths, levels rich in charcoal and ash as well as lenses of burnt sediment are due to repeated fire activity (Coltorti *et al*. 2009). The lithic industry is made employing chert varieties coming from the Cretaceous formations of the Trento platform. The identified provenance areas - the neighbouring Non Valley and the about 40 km distant area of Mount Finonchio - Folgaria Plateau – provide a clue about the minimum

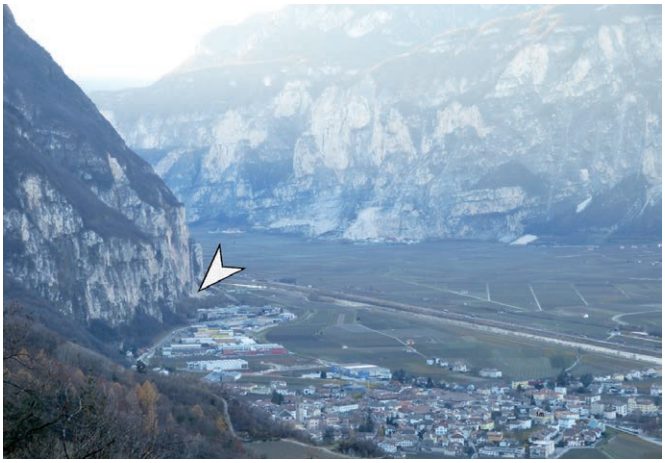


Fig. 2 *- View of the valley bottom near Salurn/Salorno. The arrow indicates the residual debris cone where the site is located* (Photo by U. Wierer)*. / Vista del fondovalle vicino Salorno. La freccia indica il conoide detritico residuale dove il sito è localizzato* (Foto U. Wierer)*.*

mobility range of the groups. Based on the techno-typological features, the industry is referable to the Sauveterrian techno-complex. The lithic production focuses on bladelet manufacture by means of three different reduction sequences. Among the retouched implements, the common tools, mostly denticulates, dominate over microlithic armatures (Bertola *et al*. 2006; Wierer, 2007, 2008; Wierer & Bertola 2016).

The limestone substratum at Galgenbühel allowed a good preservation of the faunal remains, mostly identifiable as waste from human processing. The abundant fish assemblage is dominated by the pike and by several *Cyprinidae* species, including the rudd and the roach, all species living in standing and slow-flowing waters. The nearly exclusive presence of pike bones in phases 4 and 5 indicates a marked specialization in pike fishing (Bazzanella *et al*. 2006, 2007). Hunting and collecting aquatic and semi-aquatic fauna are further documented by the numerous beaver bones, by the otter and the *Emys orbicularis* remains as well as by abundant fragments of *Unio* and *Anodonta* shells (Wierer & Boscato 2006; Girod & Wierer 2012). Ungulate hunting focused mainly on species living in the valley bottom and on the valley slopes, such as wild boar, red deer, and chamois. Taphonomic analyses of *Felis silvestris* provided evidence of carcass treatment of fur-bearing small preys (Crezzini *et al*. 2014). In sum, the species spectrum of Galgenbühel is the result of an economy focusing on wetland and valley bottom resources (Wierer *et al.* in press a). The lack of significant data related to the exploitation of rocky and mountain environments can be explained by the fair distance from high altitude territories (Boscato & Wierer 2009).

Materials and methods

Archaeological excavations were carried out following the stratigraphic units of the deposit. The spatial recording method consisted in the application of a three-dimensional grid, with a spatial excavation unit of 0.5 x 0.5 m. The entire excavated sediment underwent water screening with 1 mm mesh. In order to grasp diachronic changes along the sequence, the excavation units were grouped into 5 different phases, each one representing a palimpsest (Fig. 3).

The bird assemblage was analyzed using the osteological reference collection of the *Museo Nazionale Preistorico Etnografico L. Pigorini* and of the *Istituto Italinano di Paleontologia Umana* in Rome.

The taxonomic list and the relative nomenclature follow the indications of Clements *et al*. (2014). The Minimum Number of Individuals (MNI) was calculated separately for each phase. The data regard-

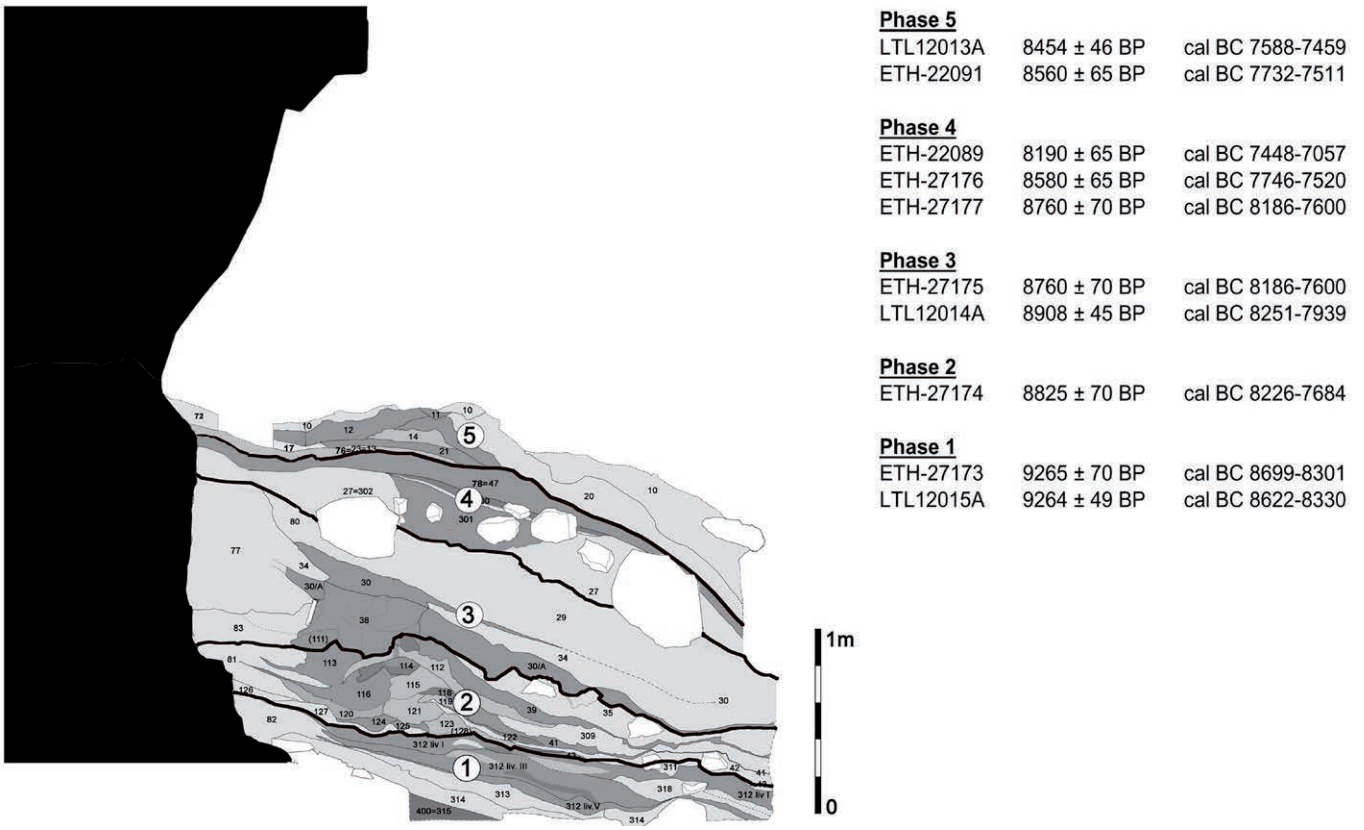


Fig. 3 *-The stratigraphic sequence of Galgenbühel/Dos de la Forca subdivided into 5 phases. [14]C-AMS dates by ETH Zürich and CEDAD Università del Salento, dendrochronological calibration (2 σ) with Oxcal (Bronk Ramsey 2009) (*Drawing by U. Wierer*). / La sequenza stratigrafica di Galgenbühel/Dos de la Forca suddivisa nelle 5 fasi. Datazioni [14]C - AMS (ETH Zürich e CEDAD Università del Salento), calibrazioni dendrocronologiche (2 σ) con Oxcal (Bronk Ramsey 2009) (*Disegno U. Wierer*).*

ing habitat and biology are taken from Spagnesi & Serra (2003-2005) and Spina & Volponi (2008). In order to determine the origin of the accumulation of the bird bone assemblage in the shelter various methods have been employed: spatial distribution, skeletal part representation, bone fragmentation and taphonomy. Bone surfaces were analyzed with a Nikon SMZ 1000 stereomicroscope (15-35x).

Seasonality analyses of the bird remains are object of a specific paper (Wierer *et al.* in press b).

Results

The number of bird remains from the Mesolithic site of Dos de la Forca is about 600 (Tab. 1), spanning the entire period of human occupation, from phase 1 to 5, being particularly numerous in phase 2 (NISP 261) and phase 3 (NISP 182).

The taxonomic identification was possible for 63% of the whole sample (NISP 373); the unidentified remains (NISP 225) consist of diaphysis fragments, phalanges and vertebrae. Twenty-seven species, 20 genera and 14 orders were identified in the bird assemblage. The most represented order is that of the Passeriformes (NISP 248), followed by Piciformes (NISP 32), Galliformes (NISP 27), Gruiformes (NISP 14), Accipitriformes (NISP 10), Columbiformes (NISP 10), Charadriiformes (NISP 9), Strigiformes (NISP 9), Anseriformes (NISP 5), Suliformes (NISP 2), Podicipediformes (NISP 1) and Falconiformes (NISP 1). The Minimum Number of Individuals (MNI) varies if calculated on the basis of the provenience of the remains from each stratigraphic unit (MNI 58), from each sub-phase (MNI 50) or considering only the 5 phases (MNI 44). As already mentioned in the methodological section, for this paper only this latter and lowest MNI was considered (Tab.1).

The bird assemblage is dominated by woodland species found in all phases (Fig. 4). Among these the black grouse (*Tetrao tetrix*) and the fieldfare (*Turdus pilaris*) were identified, as well as some species nesting in broad-leaved tree forest, like the common wood-pigeon (*Columba palumbus*), the Eurasian scops owl (*Otus scops*), the Eurasian jay (cf. *Garrulus glandarius*), and the Eurasian bullfinch (*Pyrrhula pyrrhula*). The green woodpecker (*Picus viridis*) is also present in mixed woodland and in the valley bottom, while the European nightjar (*Caprimulgus europeus*) prefers the sunny and dry hillsides. The Eurasian blackbird (*Turdus merula*), the mistle thrush (*Turdus viscivorus*), and the redwing (*Turdus iliacus*) often frequent woodlands, but also open spaces.

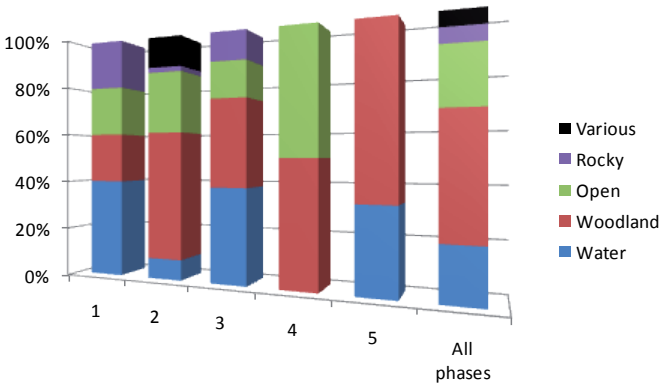
Water birds, though less numerous than woodland species, are present in appreciable percentages in phases 1, 3 and 5, but are absent in phase 4. The assemblage includes the green-winged teal (*Anas crecca*) and two other ducks (probably the Eurasian wigeon, *A. penelope* and the garganey, *A. querquedula*), the little grebe (*Tachybaptus ruficollis*), the cormorant (*Phalacrocorax* cf. *carbo*), the spotted crake (*Porzana porzana*) and the common sandpiper (*Actitis hypoleucos*). The short-eared owl (*Asio* cf. *flammeus*), found usually in wetlands, but related to open country and grasslands, has been dubitatively identified.

The birds typical of open habitat and prairies, like the common quail (*Coturnix coturnix*), are particularly frequent in phase 4, but absent in phase 5. In phase 3 the blue rock-thrush (*Monticola solitarius*), typical of rocky and barren environment, has been recovered, while in phases 1 and 2 the golden eagle (*Aquila* cf. *chrysaetos*) and the Alpine chough (*Pyrrhocorax graculus*), both common in the mountains of South Tyrol, have been found.

In sum, without considering phase 1 for the low number of bird remains, all phases show a nearly constant prevalence of woodland

***Tab. 1** - Bird bones of Galgenbühel/Dos de la Forca recorded by order, family and species. / Resti di uccelli di Galgenbühel/Dos de la Forca suddivisi per ordine, famiglia e specie.*

	Phases	1	2	3	4	5	1-5	Total	
Taxa		NISP						**NISP**	**MNI**
Anseriformes									
Anas cf. *penelope*	Eurasian wigeon			1		1		2	2
Anas cf. *querquedula*	Garganey					1		1	1
Anas crecca	Green-winged teal			1				1	1
Anatidae indet.			1					1	
Galliformes									
Coturnix coturnix	Quail	1	12	5	5			23	5
Tetrao tetrix	Black grouse	1			3			4	3
Podicipediformes									
Tachybaptus ruficollis	Little grebe		1					1	1
Suliformes									
Phalacrocorax cf. *carbo*	Cormorant		2					2	2
Accipitriformes									
Aquila cf. *chrysaetos*	Golden eagle	1						1	1
Accipitridae indet.		2		3	1	2	1	9	
Gruiformes									
Porzana porzana	Spotted crake			4				4	1
Porzana sp.		2		1				3	
Rallidae indet.			2	4	1			7	
Charadriiformes									
Actitis hypoleucos	Common sandpiper			6				6	1
Scolopacidae indet.		1	1					2	
Charadriiformes indet.			1					1	
Columbiformes									
Columba livia/oenas			2		1			3	
Columba palumbus	Common wood-pigeon		1					1	1
Columba cf. *palumbus*			3	2	1			6	4
Strigiformes									
Otus scops	Scops owl		2	3		1		6	3
Asio cf. *flammeus*	Short-eard owl					1		1	1
Strigidae indet.			1	1				2	
Caprimulgiformes									
Caprimulgus europeus	European nightjar			1		2		3	2
Apodiformes									
Apus apus	Common swift		1					1	1
Piciformes									
Picus viridis	Green woodpecker		7					7	1
Picus sp.			1	1				2	
Piciformes indet.			19	2	2			23	
Falconiformes									
Falconidae indet.		1						1	
Passeriformes									
cf. *Garrulus glandarius*	Eurasian jay		5					5	1
Pyrrhocorax graculus	Alpine chough		1					1	1
Corvus corone	Carrion crow			1		1		2	2
Corvidae indet.				2	1			3	
Monticola solitarius	Blue rock-thrush			4				4	1
Turdus merula	Eurasian blackbird		2			1		3	2
Turdus pilaris	Fieldfare		1					1	1
Turdus iliacus	Redwing		3	5				8	2
Turdus cf. *iliacus*						1		1	
Turdus viscivorus	Mistle thrush		1					1	1
Turdus sp.						1		1	
Turdidae indet.				1		2		3	
Sturnus vulgaris	European starling		5					5	1
Pyrrhula pyrrhula	Eurasian bullfinch				1			1	1
Fringillidae indet.			6			1		7	
Passeriformes indet.		4	74	73	32	20		203	
Unidentified bird		9	106	61	23	26		225	
Total		**22**	**261**	**182**	**71**	**61**	**1**	**598**	**44**



Habitat	Phases					
	1	2	3	4	5	All phases
Water	40,0	8,3	38,2	0	33,3	20,8
Woodland	20,0	52,1	35,3	50,0	66,7	46,2
Open	20,0	25,0	14,7	50,0	0	21,7
Rocky	20,0	2,1	11,8	0	0	5,7
Various	0	12,5	0	0	0	5,7
Total %	**100**	**100**	**100**	**100**	**100**	**100**
Total NISP	**22**	**261**	**182**	**71**	**61**	**598**

Fig. 4 *- Biotopes represented by the bird assemblage of the 5 phases. / Biotopi rappresentati nelle 5 fasi.*

species. These are followed by birds of open habitat and by water fowl in variable frequencies, the former well represented in phases 2 and 4, the latter in phases 3 and 5.

As far as age determination is concerned, adult specimens dominate the assemblage; only 18 juvenile bones were identified, all coming from phases 2 and 3. The specimens belong to Anatidae indet. (carpometacarpus), Rallidae indet. (humerus), cormorant (mandible), little grebe (tarsometatarsus), Columbiformes of the size of the wood pigeon (scapula, tarsometatarsus and 3 coracoids, see one of these in figure 5), Columbiformes of the size of the pigeon/stock dove (tarsometatarsus) and from different sized small Passeriformes (coracoid, 3 humeri, carpometacarpus, femur, tibiotarsus and tarsometatarsus). The sex of few individuals could be assessed on the basis of medullary bone, a secondary woven bony tissue that forms in the marrow cavity of female birds during the breeding season (Rick 1975; Driver, 1982; Eda *et al*. 2010). This is the case for two black grouse remains (ulna and carpometacarpus) in phase 4v (Fig. 6).

As regards the distribution of bird remains within the site, they are present in SUs with hearths, associated with lithic industry and faunal remains resulting from human processing. If we consider phase 2, the richest among the five phases as number of remains, it is possible to observe a high concentration of specimens in squares G12 and G13 (Fig. 7). Especially in the latter one there are 141 elements, representing 54% of the 261 total remains, concentrated in quadrants G13 III (65 specimens) and G13 IV (55). Numerous bones were found also in quadrants G 12 I (18 specimens) and II (34 specimens).

Such distribution is also partially valid in the following phase 3, where half of the avian remains recovered (91 out of 182) was concentrated in the same squares and quadrants. In phase 4 the absence of bird remains in these squares should be emphasized, but

Fig. 5 *- Coracoid of a juvenile individual of Columbiformes (*Photo by M. Gala). */ Coracoide di individuo giovanile di Columbiformes (*Foto M. Gala).

in the rest of the excavation no other concentration of bones occurs and the specimens are evenly distributed in the adjacent squares.

It should also be noted that during the excavation no bones in clear anatomical connection were recovered, however during the analysis it was sometimes possible to assign the anatomical elements to a single anatomical portion of the same individual.

Analyzing body part representation, humeri and foot phalanges are the most frequent elements; tarsometatarsi and tibiotarsi are also abundant (Tab. 2). Some species are represented only by wing or hind limb bones (e.g., black grouse in the first case and Eurasian jay in the second), but given the low number of bone remains it is difficult to interpret such skeletal representation.

The analysis of the bird bone surfaces indicated erosive alterations, often limited to small areas, but in some cases more extensive.

Combustion traces were observed on 6 specimens (2 coracoids, scapula, humerus, carpometacarpus, tibiotarsus) of common quail and rail and on 3 shafts of unidentified birds. However, such traces, are not localized on portions such as those usually resulting from cooking on a fire or on coals before consumption, for instance on the articular ends of the meatiest elements (mainly humerus, coracoid, femur, and tibiotarsus) (Cassoli & Tagliacozzo 1997). Furthermore, the presence of 8 completely burned bones from the same stratigraphic unit (SU38), including 4 rear phalanges of diurnal raptors (large sized Accipitriformes) has to be mentioned.

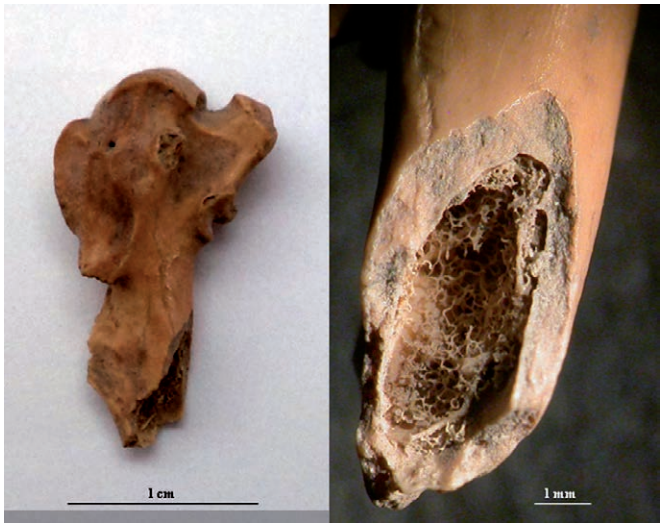


*Fig. 6 - Carpometacarpus of black grouse (Tetrao tetrix) with detail of medullary bone. (*Photo by I. Fiore). */ Carpometacarpo di fagiano di monte (*Tetrao tetrix*) con particolare dell'osso midollare (*Foto I. Fiore).

Damage produced by carnivore activity on the bird bones was rarely observed: 3 specimens (Eurasian widgeon, black grouse and quail) and 2 shafts of unidentified birds show gnaw marks. However, it is not possible to exclude that carnivores acted after the remains were discarded by humans.

Other bones show perforations, thinned fracture margins and very severe erosion, which are surface modifications typical of the action of raptors gastric juices: 5 specimens of rails, 2 remains attributable to quail, 3 to Passeriformes and 2 diaphyses of unidentified birds.

Discussion and conclusion

The bird associations identified reflect a varied environmental and geomorphological setting of the territory around the site. The predominance of woodland species in the assemblages is in line with the Early Holocene forestation of the valley bottom and slopes (Cattani 1977, 1994; Tinner & Vescovi 2007; Kompatscher & Oeggl 2005), interrupted by open environments and by standing and slow flowing waters forming attractive habitats for species such as the quail and water fowl. Besides the existence of various ecological niches, the variety of species may also be explained by the fact that the Adige valley is still now a very important route for migratory birds and represents a very appreciated stopover area. The recovery of bones belonging to young individuals, among which Columbiformes and small Passeriformes as the most frequent, and of medullary bones referable to breeding females (black grouse), suggests that some species used to nest close to the shelter during the summer (Serjeantson 1998).

The bird assemblage is the result of various accumulation agents. Some birds, such as crows (carrion crow and Alpine chough), raptors (golden eagle and owl), pigeons, and little Passeriformes may have died for natural causes, while for others that do not live in caves and shelters (ducks, common quail, black grouse, cormorant, little grebe, spotted crake, and common sandpiper), it is possible to hypothesize the involvement of a predator (humans, carnivores, raptors).

The position of combustion traces on the bones does not clearly indicate cooking for alimentary purposes and may have been the result of natural causes. The same hypothesis may not be valid for the completely burnt phalanges of large sized Accipitriformes that may have been used for ritual or cult purposes.

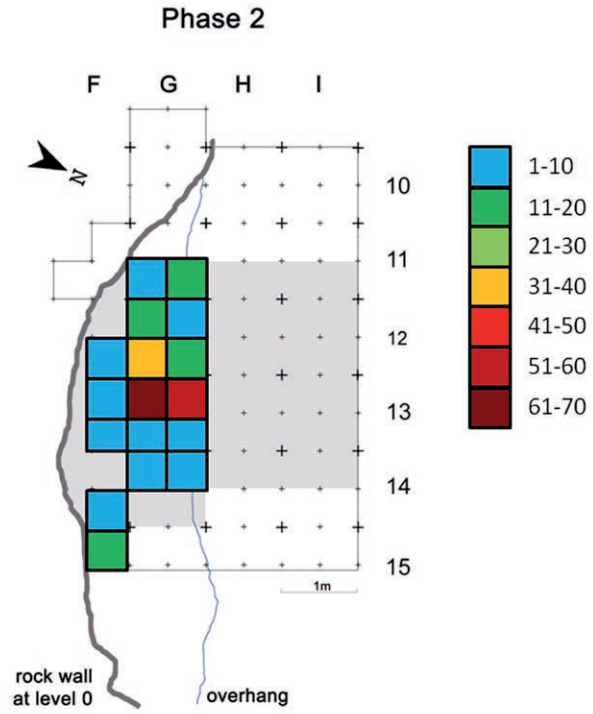


Fig. 7 - Spatial distribution of the bird remains of phase 2. Gridded area indicates area of excavation; grey areas indicate phase 2 excavation without bird remains; other colored squares indicate bird remains of variable frequency. / Distribuzione spaziale dei resti di uccelli nella fase 2. La quadrettatura indica l'area di scavo; le aree in grigio indicano la fase 2 senza resti di uccelli; i quadrati di altri colori indicano la frequenza dei resti di uccelli.

Given the concentration of bird remains in a limited area of the shelter that is repeated over two phases, it is not possible to exclude the presence of a raptor roost and therefore a non-anthropic origin for part of the assemblage. On the other side, the fact that the bird bones were found in the archaeological levels associated to hearth structures, lithic artifacts and faunal remains with cut-marks and in relation with human activities, indicates that humans may have played a role in the accumulation of bird remains. Unlike fishing and mammal hunting, fowling was of secondary importance for the inhabitants of the rock shelter.

The bird assemblage of Dos de la Forca is the most abundant of the Northern Italian Mesolithic. Data from Riparo Soman (Verona) have been already published (Tagliacozzo & Cassoli 1994), while the assemblages from Pradestel, Riparo La Cogola and Vatte di Zambana (Trento) are being analyzed (Gala & Tagliacozzo in progress). With the exception of Pradestel that yielded over 200 bird remains, in the other sites very few bird remains have been collected. Only 4 specimens from level L of Pradestel have been attributed to Anseriformes. Their extreme fragmentation does not allow a sure specific attribution, but the size and some diagnostic features may be referable to a small duck (green-winged teal, *Anas crecca*). The remaining 96% of the identified specimens is attributable to the Passeriformes. At Riparo La Cogola a single specimen (posterior phalanx) from SU 16 attributed to the Early Sauveterian (9430 ± 60 BP uncal.), is currently being identified. Currently no data are available for Vatte di Zambana. At Riparo Soman only one remain of golden eagle was recovered.

At these sites, the preliminary taphonomic studies did not allow to suggest human activity. New research projects, currently still being defined, on the bird bones recovered in Early Mesolithic sites across the Italian peninsula, will allow framing the assemblage from Dos de la Forca within a wider context.

Tab. 2 *- Skeletal part representation of the bird remains in the 5 phases. Head: CRA (skull, mandible, maxilla, quadrate). Axial: VER (Vertebra), RIB (Rib), STE (Sternum), PEL (Pelvis, synsacrum, notarium). Shoulder girdle: FUR (Furcula), COR (Coracoid), SCA (Scapula). Wing: HUM (Humerus), ULN (Ulna), RAD (Radius), CAR (Carpometacarpus) CRP (Carpal), W-P (Wing Phalanx). Hindlimb: FEM (Femur), TIB (Tibiotarsus), FIB (Fibula), TAR (Tarsometatarsus), MET (Metatarsal), F-P (Foot Phalanx). LB (long bone). / Rappresentazione scheletrica degli uccelli nelle 5 fasi. CRA (cranio, mandibola, mascella, osso quadrato). VER (Vertebra), RIB (Costa), STE (Sternum), PEL (Pelvis, synsacrum, notarium). FUR (Furcula), COR (Coracoide), SCA (Scapola). HUM (Omero), ULN (Ulna), RAD (Radio), CAR (Carpometacarpo) CRP (Carpale), W-P (Falange alare). FEM (Femore), TIB (Tibiotarso), FIB (Fibula), TAR (Tarsometatarso), MET (Metatarsale), F-P (Falange posteriore). LB (Osso lungo).*

	Head	Axial				Shoulder girdle			Wing						Hindlimb							Tot
Taxa (NISP)	**CRA**	**VER**	**RIB**	**STE**	**PEL**	**FUR**	**COR**	**SCA**	**HUM**	**ULN**	**RAD**	**CAR**	**CRP**	**W-P**	**FEM**	**TIB**	**FIB**	**TAR**	**MET**	**F-P**	**LB**	
Anas cf. *penelope*												1				1						2
Anas cf. *querquedula*							1															1
Anas crecca							1															1
Anatidae indet.												1										1
Coturnix coturnix						1	5	2	2	2	1	1				1		6		2		23
Tetrao tetrix										1	2	1										4
Tachybaptus ruficollis																		1				1
Phalacrocorax cf. *carbo*	1																			1		2
Aquila cf. *chrysaetos*												1										1
Accipitridae indet.	1	1									1			1						5		9
Porzana porzana												2				1		1				4
Porzana sp.							1		1							1						3
Rallidae indet.							1	1	2	1					1	1						7
Actitis hypoleucos												1			1	1		3				6
Scolopacidae indet.				1														1				2
Charadriiformes indet.																1						1
Columba livia/oenas						1												1		1		3
Columba palumbus													1									1
Columba cf. *palumbus*							3	1										2				6
Otus scops							1				1	2			1			1				6
Asio cf. *flammeus*									1													1
Strigidae indet.								1				1										2
Caprimulgus europeus							1		1			1										3
Apus apus							1															1
Picus viridis							1	1		1	2	2										7
Picus sp.								1				1										2
Piciformes indet.		5		1			4	1	2			2			1	3		3		1		23
Falconidae indet.																				1		1
cf. *Garrulus glandarius*															1			1		3		5
Pyrrhocorax graculus					1																	1
Corvus corone											1				1							2
Corvidae indet.	1	1													1							3
Monticola solitarius							1		1	1		1										4
Turdus merula							2	1														3
Turdus pilaris								1														1
Turdus iliacus	1						1	2	1	1		1			1							8
Turdus cf. *iliacus*										1												1
Turdus viscivorus																1						1
Turdus sp.										1												1
Turdidae indet.									2						1							3
Sturnus vulgaris							1			2								2				5
Pyrrhula pyrrhula																		1				1
Fringillidae indet.									1													1
Passeriformes indet.	7	3		7	1	1	19	10	42	26	3	20		7	11	27		24		4		212
Unidentified bird	6	32	1	1	5		3	4	11	11	2	3	1	8	6	13	1	6	2	67	39	**222**
Total	**17**	**42**	**1**	**10**	**7**	**3**	**47**	**26**	**67**	**48**	**13**	**42**	**2**	**16**	**26**	**51**	**1**	**53**	**2**	**85**	**39**	**598**

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Article

Exploitation of faunal resources at Riparo Gaban (Trento, Italy) during the Late Mesolithic period: preliminary results of archaeozoological and taphonomical analysis

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Key words

- Archaeozoology
- Taphonomy
- Castelnovian
- Riparo Gaban
- Adige Valley - Trento
- Italy

Parole chiave

- Archeozoologia,
- Tafonomia
- Castelnoviano
- Riparo Gaban
- Val d'Adige - Trento
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Summary

Riparo Gaban is a rockshelter located at about 270m a.s.l., near Trento, in a narrow lateral valley on the left bank of river Adige, Northern Italy. This site gives name to the so called "Gaban group" occupying Trento area during the spread of neolithisation, at the end of the VI millennium cal BC. Despite some gaps, the excavations by Bernardino Bagolini in sectors I to V from 1971 to 1979, revealed an impressive stratigraphic series attesting several occupations from late IX to mid-II millennium cal BC. The best known finds unearthed in Mesolithic (Sauveterrian and Castelnovian) and Neolithic layers are undoubtedly object of high artistic value, and realised on bone, antler, and stone. The analysed faunal assemblages derive from Castelnovian levels (IV Sector US E1-4) and are characterised by a high degree of fragmentation due to intentional bones fracturing for marrow extraction.The faunal remains belong mostly to ungulates: red deer, boar and roe deer are the most common species followed by a sporadic presence of ibex and chamois. Small wild mammals and carnivores are poorly attested in all layers. This study reports preliminary taphonomical results of Castelnovian faunal assemblages, in order to identify modifications related to the exploitation of animal carcasses.

Riassunto

Sfruttamento delle risorse animali al Riparo Gaban nel Mesolitico: risultati preliminari delle analisi archeozoologiche e tafonomiche - Riparo Gaban rappresenta uno dei principali siti di riferimento per lo studio del processo di neolitizzazione nelle Alpi e dà il nome al gruppo presente in Trentino durante la diffusione della nuova economia produttiva, alla fine del VI millennio BC cal. Gli scavi condotti da Bernardino Bagolini dal 1971 al 1979 nei sett. I-V hanno messo in luce una sezione stratigrafica che documenta una frequentazione, con alcune lacune, dalla fine del IX alla metà del II millennio a.C. cal. I reperti più noti sono senz'altro gli oggetti di alto valore artistico portati alla luce nei livelli del Mesolitico (Sauveterriano e Castelnoviano) e Neolitico che sono realizzati su osso, palco e pietra. L'insieme faunistico analizzato proviene dai livelli castelnoviani (Settore IV US E1-4) e si caratterizza per un elevato grado di frammentazione a causa della fratturazione intenzionale per l'estrazione del midollo. Gli animali maggiormente rappresentati sono cervo, cinghiale e capriolo seguiti da una sporadica presenza di stambecco e camoscio. I mammiferi selvatici di piccole dimensioni ed i carnivori sono scarsamente. Qui, vengono presentati i risultati preliminari delle analisi tafonomicheper ricostruire le modalità di sfruttamento delle carcasse animali.

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Fig. 1 *- Satellite view of the Adige Valley and location of Riparo Gaban (Trento, Northern Italy). / Veduta satellitare della valle dell'Adige e localizzazione del Riparo Gaban (Trento).*

Introduction

An important synthesis for the understanding of Mesolithic settlement and subsistence strategies in Trentino Alto-Adige, Northern Italy is proposed by R. H. Clark ("The Mesolithic Hunters of the Trentino", 2000). The main aim of this study was to examine both animal resources and lithic material in order to understand Mesolithic subsistence and settlement changes throughout a time span of ca. 3,500 years (Clark, 2000).

Among the analysed sites, Riparo Gaban fauna is composed by a substantial number of 19,023 remains recovered during the field-excavation carried out between 1982 and 1983.

Both Sauveterian and Castelnovian faunal assemblages were characterised by a high degree of fragmentation (Clark, 2000). Red deer, roe deer and wild boar were the most common species followed by ibex and chamois. Small game mammals and carnivores were poorly attested in all layers (Clark, 2000). Clark work did not analyse faunal remains from a taphonomical point of view, therefore any data defining post-depositional phenomena and any difference in the carcass processing were described.

Recently, a huge faunal assemblage deriving from Castelnovian layers (Sector IV SU E1-4) during the field-excavation by Bernardino Bagolini in 1974 was studied by the Authors.

The aim of this work is to present archaeozoological and taphonomical analysis on this unpublished Riparo Gaban faunal assemblage, in order to collect more data about faunal exploitation from Castelnovian occupations, and describe carcass processing.

The site

Riparo Gaban is located on the left side of Adige Valley (Tomasoni *et alii*, 2013, Koszlowski & Dalmeri, 2002) at 260m a.s.l, in Piazzina di Martignano, just a few kilometres northwest of Trento, Northern Italy (Fig. 1). The rockshelter is located on western slope of Monte Calisio, with an eastern exposure, 29m long, 6m high, 2.5-4m deep, and soars for approximately 80m above the current Adige Valley floor (Bagolini 1980, Kozlowski & Dalmeri, 2002).

This site, discovered in 1970, was systematically excavated from 1971 to 1979 under direction of Bernardino Bagolini, Museo Tridentino di Scienze Naturali (Trento), and then from 1982 to 1983 in collaboration with Alberto Broglio, University of Ferrara and Stefan K. Kozlowski, University of Warsaw.

The explored area of about 60m^2 was divided into five sectors (I to V) by B. Bagolini (Fig.2). During the excavations a continuous stratigraphic sequence, spanning from Mesolithic to Early Bronze Ages and partially damaged by three Medieval pits, was highlighted.

Castelnovian layer is about 20cm thick, with a typical whitish appearance and widespread concretion; it was partially damaged in many parts by Medieval pits (Kozlowski & Dalmeri, 2002). Layer E is dated 6968±41 BP uncal (KIA_10363 5979-5726 cal BC 2 σ) on a charcoal sample.

Materials and methods

The analysis were carried out at Laboratory of Archaeozoology and Taphonomy, Department of Humanities, University of Ferrara. This faunal sample has for the first time been examined in Ferrara, since it was included neither in Clark's nor in Griggo's studies (Kozlowski & Dalmeri, 2002). In order to identify species or genus, a total of 1,286 faunal remains were analysed using the osteological reference collection of our laboratory. When a taxonomical attribution was not possible, the unidentified faunal remains were divided by supposed mammal size (large, medium, small size, including intermediate categories), considering shaft fragments dimension and compact bone thickness. All the bone fragments were measured and, when possible, were the osteological measurements by Von den Driesch (1976) also collected. Taphonomical analysis was carried out using a stereo-microscope Leica S6D (6x-40x magnification), with integrated digital camera EC3.

Distinction between climatic and edaphic modifications was performed referring to Beherensmeyer (1978), Malerba & Giacobini (1993), Lyman (1994), Giacobini (1995; 1996). The identification of carnivore and rodent marks was done referring to Binford (1981), Brain (1981), Giacobini (1995), Cilli *et al*. (2000), Thun Hohenstein (2003). After summarising the state of the literature, have intentional fresh bone fracturing for marrow extraction, post-depositional fractures and manufacturing marks been discriminated (Sadek-Kooros, 1972; Myers *et al*. 1980; Shipman *et al*., 1984; Johnson 1985; Villa & Mahieu, 1991; Blasco Sancho, 1992; Lyman, 1994; Peretto *et al*., 1996; Anconetani & Peretto, 1996).

Results

Faunal composition

Faunal assemblage is composed of 1,286 bone fragments (Tab. 1). Although the remains identified only by the anatomical point of view (78.3%) were removed from the count, the ratio of identified remains is particularly high (86.2%).

Unidentified remains, usually 80-90% in similar contexts, are surely under-represented. This biased sample depends on the selection of bone fragments performed during the excavations, as were unidentified remains smaller than 2cm not collected (A. Pedrotti pers. comm.).

However, this faunal assemblage is very interesting being particularly abundant and well preserved. Red deer is the most represented animal with a total of 527 remains (Tab. 1), followed by wild boar (NISP 215) and roe deer (NISP 178). This association can certainly be correlated to an open wooded habitat, with a thick undergrowth near the rock-shelter.

Chamois and ibex are poorly attested by a small number of bone fragments (NISP 19 and 5), due to site location on the valley floor and environmental features (Boscato & Wierer, 2006).

A little amount of identified specimens is present among the carnivore remains (4.8%; Tab. 1). All species are represented by less than ten remains. Wild cat and badger are the animals with a higher NISP followed by wolf, bear and fox (Tab. 1).

Among rodents and lagomorphs, a small number of remains is also attested. Beaver testifies the presence of a nearby stream. Some pond turtle carapace fragments and a humerus suggest a sporadic collection of this animal.

Birds are very scanty in the faunal assemblage (Tab. 1), but three remains belong to a large sized bird of prey, such as a golden eagle.

Exploitation of large mammals

Red deer, wild boar and roe deer were probably the most common species hunted by hunter-gatherers of Riparo Gaban during the Late Mesolithic period. From an anatomical point of view, the red deer is represented by all skeletal portions in the faunal assemblage (Tab. 2). Ribs and vertebrae fragments belonging to a large sized ungulate suggest that the whole red deer carcass was transported into the rock-shelter. It is interesting to emphasise that isolated teeth, carpals, metapodials and phalanges are more abundant than other kind of skeletal elements. This fact conditioned the count of a minimum number of individuals (MNI), mainly estimated on mandibles and isolated teeth. A total of 14 individuals of different age ratio were counted (Tab. 1). Adults are the most abundant individuals with 10 specimens in whole (Tab. 3). The scarcity of young and sub-adult classes is showed by the presence of deciduous teeth at different use-wear stages and many anatomical elements with unfused epiphysis. A sample of six atrophic canines suggests that males were the most hunted game.

As far as the wild boar is concerned, elements of the appendicular skeleton, such as metapodials and phalanges, are dominating (Tab. 2). On the whole, hind and fore limbs are attested by quite similar quantities, excluding that was a selection of anatomical portions made in the killing place. Ribs and vertebrae fragments of medium sized ungulates are also found (Tab. 2), suggesting that killed wild boars were entirely transported into the rock-shelter, and then processed and consumed. The abundance of isolated teeth and mandibular and maxillary fragments with complete or partially complete dental series have yielded interesting data on wild boar age classes. In effect, unlike the red deer, wild boar age categories show a greater heterogeneity with a balance between young and adults/senile individuals. Young and sub-adults, as suggested by Bull & Payne (1982), are presumably less than two years old, and one-year-old in some cases (Tab. 3). The presence of wild boar female canines could support this occurrence, since the puppies follow their mothers until the age of one year, during their displacements in search of the food supply.

Roe deer shows a balanced relationship in body part representation (Tab. 2) and, as for the other ungulates, its carcass was wholly transported into the rock-shelter; effectively, all the anatomical elements are represented. Nevertheless, a lower occurrence of elements belonging to the forelimb suggests that only some body parts were occasionally brought within the site.

As for red deer and wild boar, the roe deer MNI and age-at-death were estimated on mandibles and isolated teeth. Fourteen individuals have been counted (Tabb. 1, 2). Adults are markedly predominant over other age categories, with only two sub-adults and one old individual identified (Tab. 3). Unfortunately, no gender attribution could be possible in order to establish if roe deer hunting was mostly addressed to male individuals.

Chamois and ibex are represented only by few remains (Tab. 1). A single adult ibex and three chamois (two adults and one sub-adults, Tab. 3) have been identified on the basis of dental remains.

The presence of these two animals, even if sporadic, suggests that the Gaban hunter-gatherers moved from the valley towards areas altimetrically higher for hunting these animals. Further analysis will be necessary in order to broaden this perspective.

Exploitation of carnivores and small game mammals

The presence of carnivores within the faunal assemblage is very scarce and consistent with a systematic Humans occupancy of rock-shelter. Data on carnivores age-at-death are scanty due to few identified remains. The badger is represented by at least three individuals: one sub-adult and two adults (Tab. 3). The wild cat is attested by two adults, and for marten, fox, wolf and bear have only one individual been estimated, respectively (Tab. 3). The exploitation of these animals occurred occasionally, and was mainly aimed at fur recovery as proven by the position of the identified cut marks.

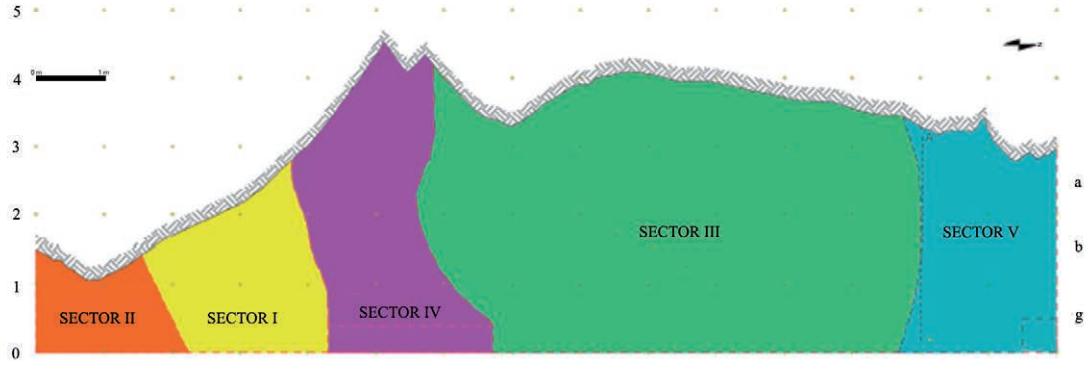

Fig. 2 *- Riparo Gaban. Map of the excavation sectors (I-V). / Riparo Gaban. Planimetria dei settori di scavo (I-V).*

Tab. 1 - Riparo Gaban. NISP and MNI of the faunal assemblage. / Riparo Gaban. NR and NMI dell'insieme faunistico.

Taxon	NISP	%NISP	MNI	%MNI
Lepus europaeus	6	0.5%	1	1.9%
Castor fiber	9	0.8%	3	5.6%
Martes martes	1	0.1%	1	1.9%
Meles meles	8	0.7%	3	5.6%
Felis sylvestris	8	0.7%	2	3.7%
Canis lupus	6	0.5%	1	1.9%
Vulpes vulpes	3	0.3%	1	1.9%
Ursus arctos	4	0.4%	1	1.9%
Medium size carnivores	5	0.5%		
Small size carnivores	4	0.4%		
Total carnivore remains	**54**	**4.8%**	**13**	**24,4%**
Sus scrofa	215	19.4%	10	18.5%
Cervus elaphus	527	47.5%	14	25.9%
Capreolus capreolus	178	16.1%	14	25.9%
Cervidae	2	0.2%		
Capra ibex	5	0.5%	1	1.9%
Rupicapra rupicapra	19	1.7%	2	3.7%
Large size ungulate	36	3.2%		
Large-medium size ungulate	22	2.0%		
Medium size ungulate	42	3.8%		
Total ungulate remains	**1046**	**94.3%**	**41**	**75,6%**
Falconiformes	4	0.4%		
Birds unidentified.	2	0.2%		
Total bird remains	**6**	**0.5%**		
Emys orbicularis	4	0.4%		
Total identified remains	**1110**	**86.2%**		
Unidentified remains	**177**	**13.8%**		
Total	**1287**	**100%**	**54**	**100%**

Hare is documented by one individual, while has beaver been more exploited for the occurrence of three individuals, probably adults.

State of preservation of bone surfaces

Faunal remains are well preserved; effectively, modifications affecting bone surfaces are mostly mild and rarely medium or intense.

Weathering cracks and exfoliation, often abundant in caves and rock-shelters (Beherensmeyer, 1978; Malerba & Giacobini, 1993; Lyman, 1994, Giacobini, 1995; 1996), are the most frequent modifications (Fig. 3). Root etching and fungal hyphae, generally mild and scattered, are also particularly abundant on the bone surfaces. Edaphic modifications, mostly erosions, were found on about 18% of bone assemblage (Fig. 3).

Cortical bone pitting, produced by percolating waters, has been identified on 4.2% of remains, while were blackish or reddish spots linked to the deposition of manganese and iron oxides, recorded respectively on 5.3 and 1.0% of the analysed bones.

Smoothed fracture edges and polishing related to water flow inside the rock shelter are almost absent.

Inside the cave, carnivore and rodent activity are testified by a small number of modifications (Fig. 4) that slightly exceed 4% (NISP 55), confirming the long-term Humans occupation of rock-shelter. Gnawing, pits, puncture marks and scores have been identified on 40 bone remains, located mostly on the epiphyses. Parallel grooves, left by rodent incisors, were found on 15 remains, sometimes coinciding with carnivore gnawing.

Anthropic modifications

Bone surfaces in a good state of preservation allowed to rec-

Tab. 2 - Riparo Gaban. Anatomical elements representation for all taxa. / Riparo Gaban. Rappresentazione della composizione anatomica per ogni taxon.

ANATOMICAL ELEMENT	HARE	BEAVER	MARTEN	BADGER	WILD CAT	FOX	WOLF	BEAR	WILD BOAR	RED DEER	ROE DEER	IBEX	CHAMOIS
Antler										13	1		
Cranium				2					17	14	8		
Upper teeth		1							22	54	20		1
Mandible		2							18	22	23	1	1
Lower teeth		5		1		2	1		40	91	20	1	4
Unidentified teeth									10	25	3		
Hyoid bone								1					
Atlas										3			
Axis										1	2		
Scapula					1					10	2		
Humerus			1		1	1			2	3	17		1
Radius					1				4	15	12		
Ulna		1			2				2	11	3		
Radius-ulna									6	1	1		
Carpals				1				1	1	32	6		
Metacarpal	2			1					3	25	3		2
Hip bone	1								15	14	1		
Pelvis									1		3		
Femur				2					1	6	3		
Patellae									1	3	2		
Tibia				1	1				7	5	4	1	
Fibula									3				
Astragalus					2		1		5	11	6		1
Calcaneus									2	14	1		
Other tarsals									2	7	2		1
Metatarsal	1						1		14	20	12		2
Unidentified metapodials									3	10	1		
Sesamoids										12	1		
Phalanx I	2						1		14	51	9	1	2
Phalanx II								2	15	33	6	1	1
Phalanx III									7	21	6		1
Total	**6**	**9**	**1**	**8**	**8**	**3**	**4**	**4**	**215**	**527**	**178**	**5**	**17**

ognise several marks linked to human actions: 293 remains bear anthropogenic stigmata related to butchery, marrow extraction and animal hard tissues manufacturing (Tab. 4).

The highest number of anthropic marks has been identified on red deer (Tab. 5), thanks to the large number of identified remains belonging to this taxon.

The animal was skinned starting from the first phalanges where short cut marks, localized on the dorsal and palmar surfaces of the

Tab. 3 - Riparo Gaban. MNI and age classes. / Riparo Gaban. NMI e classi di età.

TAXON	NEWBORN	YOUNG	SUB-ADULT	YOUNG-ADULT	ADULT	OLD
Hare					1	
Beaver					3	
Marten					1	
Badger			1		2	
Wild cat					2	
Wolf					1	
Fox					1	
Bear					1	
Wild boar	1	2	2	1	2	2
Red deer		1	3	2	7	1
Roe deer			2		11	1
Ibex					1	
Chamois			1		2	

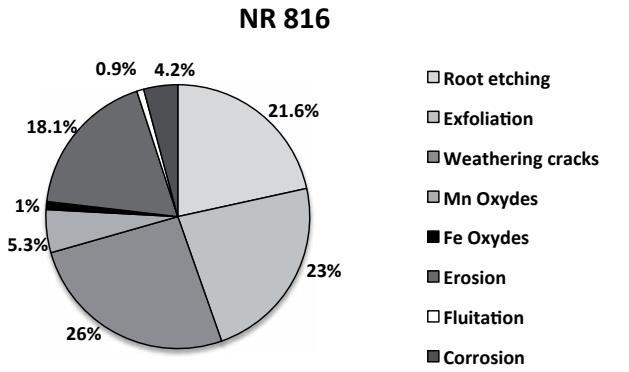

Fig. 3 - Riparo Gaban. Edaphic modifications frequencies within the faunal assemblage. / Riparo Gaban. Frequenza delle alterazioni edafiche identificate nell'insieme faunistico.

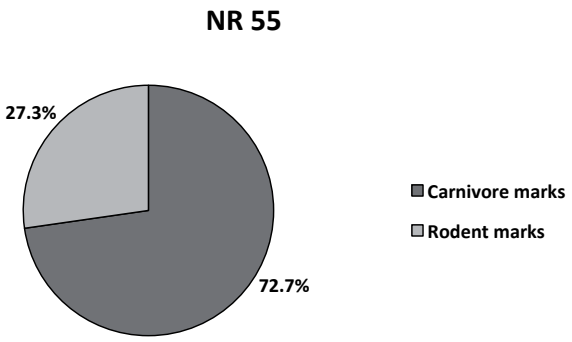

Fig. 4 - Riparo Gaban. Frequencies of carnivore and rodent modifications. / Riparo Gaban. Frequenza delle tracce prodotte da carnivori e roditori.

element, suggest a skin incision. Almost all the cut marks on bear long bones deriving from disarticulation near proximal and distal epiphysis (Fig. 5), indicate an action aimed at partitioning the carcasses into smaller portions. Marks left by muscles removal and meat filleting are less frequent, the first ones characterized by short, often repeated, cuts found on muscular insertion areas, especially on radius, and the latter ones by generally long *striae*, oriented along the bone major axis.

As for the other ungulates, a very few marks left by lithic tools are observed, not allowing any considerations. The most attested actions are mandibles, humeri and tarsals disarticulation (Fig. 6) and muscle mass detachment.

Fresh bone intentional fracturing is very well documented on all the game. Repetitive and systematic fractures were observed on red deer mandibles, metapodials and phalanges; most of these bones show a regular rectilinear fracture according to the sagittal plane.

Two antler and metatarsal fragments show evidence linked to animal hard tissues manufacturing. In effect, *rainurage* marks produced by a lithic tool, practiced for antler baguettes extraction and metatarsus division, have on two supports been identified.

Anthropic marks have been recognised even on some carnivore remains. A bear hyoid bone showing short and deep cut marks has to be noticed, as well as traces of disarticulation on a wild cat humerus and ulna (Fig. 7), confirming the interest of Mesolithic hunter-gatherers for this animal, as recently documented at site in Galgenbühel/Dos de la Forca (BZ) (Crezzini *et al*., 2014). The badger seems to have been exploited for its fur, as shown by a series of cut marks discovered on a partially intact skull. Both hare

Tab. 4 - Riparo Gaban. Anthropic modifications frequency for each taxon. / Riparo Gaban. Frequenza delle tracce antropiche per ogni taxon.

	NISP							
TAXON	CUT MARKS	MANUFACTURING MARKS	ANTHROPIC FRACTURES	NOTCHES	PERCUSSION CONE	IMPACT POINT	TOTAL	% TOTAL
Hare	2						**2**	**0.7%**
Beaver	1						**1**	**0.3%**
Badger	1						**1**	**0.3%**
Wild cat	2		1				**3**	**1.0%**
Bear	1						**1**	**0.3%**
Wild boar	18		22	1			**41**	**14.0%**
Red deer	45	10	94	9	1	3	**162**	**55.3%**
Roe deer	10	4	37	2		1	**54**	**18.4%**
Ibex			1	1			**2**	**0.7%**
Chamois	1		4				**5**	**1.7%**
Large size ungulate	2		3	2			**7**	**2.4%**
Large-medium size ungulate			1				**1**	**0.3%**
Medium size ungulate			4				**4**	**1.4%**
Unidentified remains	6		3				**9**	**3.1%**
Total	**89**	**14**	**170**	**15**	**1**	**4**	**293**	**100%**
% Total	**30.4%**	**4.8%**	**58.0%**	**5.1%**	**0.3%**	**1.4%**	**100%**	

and beaver bear support traces of disarticulation, suggesting an interest for their fur and for alimentary purposes also.

Alterations caused by heat exposure have been identified on 33% of finds (Fig. 8). Burned remains prevail on calcined ones and have different colouring stages, suggesting an exposition to high temperatures for long periods. About 94% of burned remains is characterised by a reddish-brown colour, suggesting that the bone was still wrapped in the flesh when cooked.

These indexes, related to burned bones, cannot be compared to those obtained by Griggo (Kozlowski & Dalmeri, 2002) since the faunal sample here analysed is biased.

Conclusions

The faunal assemblage of Riparo Gaban certainly leads to interesting considerations through archaeozoological and taphonomical analysis, expanding the available data on exploitation patterns of animal resources of the Adige Valley, during Castelnovian period. However, in order to review the osteological materials for a complete taphonomical analysis, will an integration with the samples analysed by Clark (2000) and Griggo in Kozlowski & Dalmeri (2002) from other explored areas of rock-shelter be necessary.

Hunting was undoubtedly and mainly devoted to red deer, as for other sites of Trentino Region (Boscato & Sala, 1980; Clark, 2000). The preference of Late Mesolithic hunters seems to be addressed to adult games, most likely males, due to the high frequency of atrophic canines found in the faunal assemblage. This choice seems to be constrained by the intention to recover a greater quantity of meat and antlers, used for tools and portable art production.

Similar considerations have to be done for the roe deer, consisting of a large number of adult individuals. Unfortunately, specific markers lack information on sex determination to allow adequate data achievement.

Based on the age-at-death estimation, no preferences have been observed for the wild boar, which seems to be hunted both youth and adult. The low incidence of chamois and ibex might suggest a large hunting area or, more reasonably, seasonal movements towards higher altitudes during the summer time, as suggested by other Authors (Bagolini & Broglio 1985, Bagolini & Pedrotti 1996, Clark, 2000, Koszlowski & Dalmeri, 2002).

Carnivores seem to play a marginal role in hunting strategies adopted by the Castelnovian hunters of Riparo Gaban, aimed primarily at small animals like wild cats and badgers. Slaughter marks found on the small wild felid bones are certainly very interesting and can be compared with data collected from Sauveterrian occupations at Galgenbühel/Dos de la Forca (Wierer & Boscato, 2006; Crezzini *et al*., 2014), where has a more intense exploitation of this animal been documented.

Tab. 5 *- Riparo Gaban. Frequencies of antrophic modifications on red deer and their skeletal distribution. / Riparo Gaban. Frequenza delle tracce antropiche e relativa distribuzione sui vari elementi anatomici del cervo.*

ANATOMICAL ELEMENTS	CUT MARKS	ANTHROPIC FRACTURATION	NOTCHES	PERCUSSION CONE	IMPACTS	MANUFACTURING MARKS
Antler		1				2
Cranium	2					
Mandible	5	3	1			
Atlas	1					
Scapula	2	1				
Humerus	1	1				
Radius	7	7	1			
Ulna	1	1				
Pelvis		1				
Femur		1				
Tibia		1				
Patella	1					
Carpals/ Tarsals	7	4			1	
Metacarpal	7	15	4		1	2
Metatarsal	7	14	1			6
Metapodial	2					
Phalanges	2	44	2	1	1	
Total	**45**	**94**	**9**	**1**	**3**	**10**

Fig. 5 *- Riparo Gaban. Red deer tibia (A) with disarticulation cut marks on the distal epiphysis (B & C, details at stereomicroscope). / Riparo Gaban. Tibia di cervo (A) con tracce di disarticolazione sull'epifisi distale (B & C, dettagli allo stereomicroscopio).*

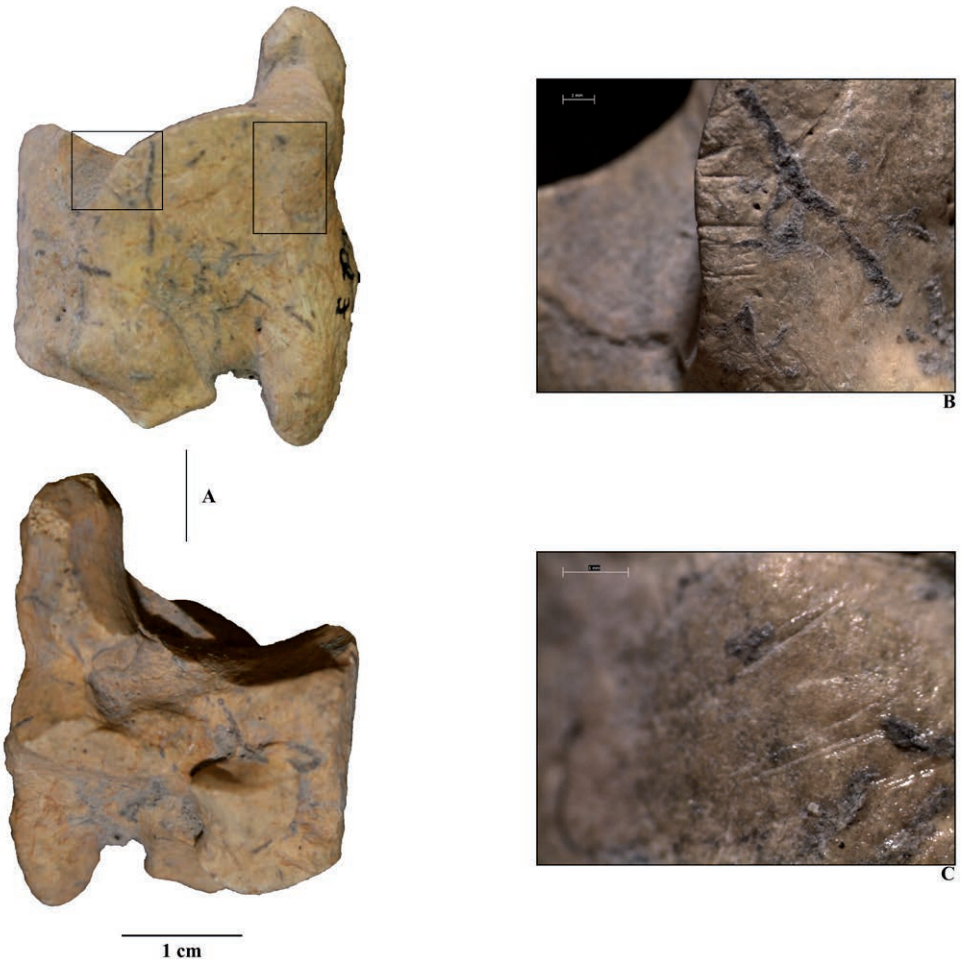

Fig. 6 - Riparo Gaban. Wild boar tarsal (A) with cut marks (B & C, stereomicroscope images). / Riparo Gaban. Tarsale di cinghiale (A) con strie di macellazione (B & C, immagini allo stereomicroscopio).

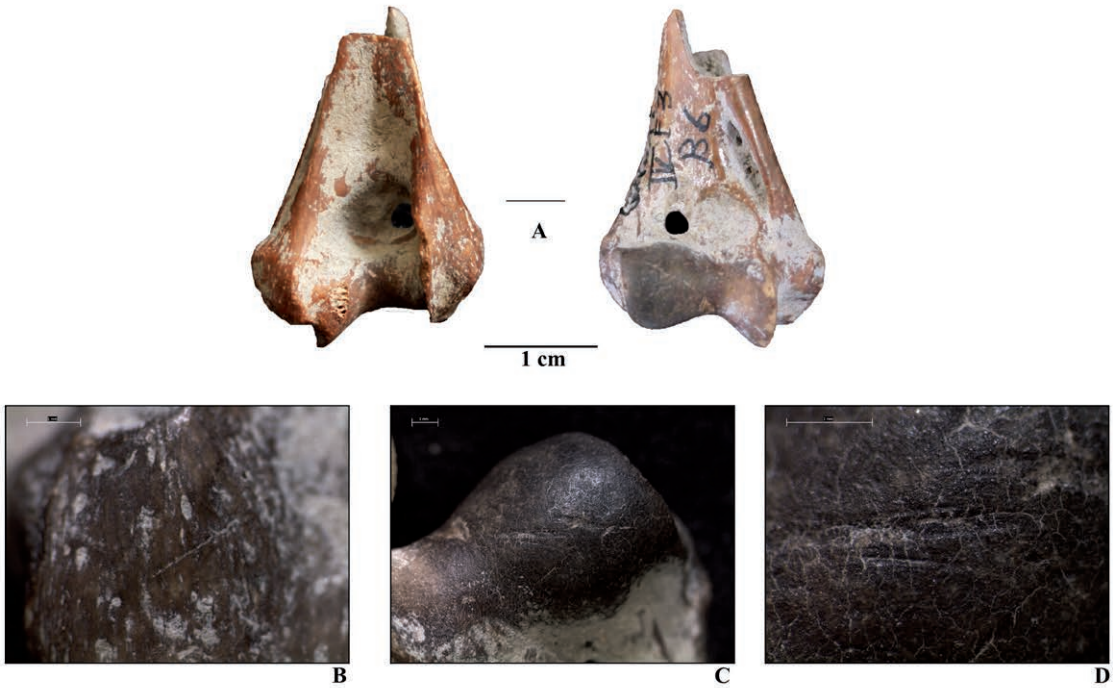

Fig. 7 - Riparo Gaban. Wild cats humerus. Disarticulation cut marks on the distal epiphysis (B, C and D stereomicroscope details). / Riparo Gaban. Omero di gatto selvatico (A) con strie da disarticolazione sull'epifisi distale (B, C e D, dettagli allo stereomicroscopio).

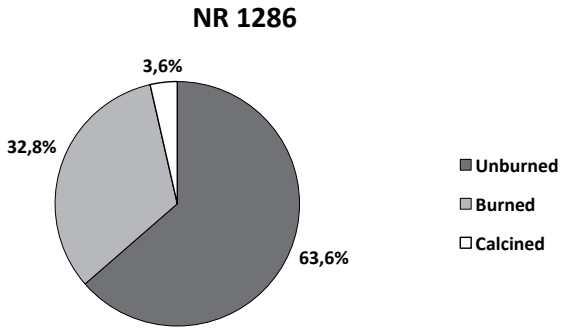

Fig. 8 - Riparo Gaban. Frequencies of unburned, burned and calcined remains. / Riparo Gaban. Frequenza dei reperti non combusti, combusti e calcinati.

Abundant evidence of human activity, such as slaughtering, processing and combustion of hard animal material, compared to the low presence of carnivore marks, suggests an intensive and long-term rock-shelter occupation.

The identified fauna testifies to the presence of an environment characterized by wooded glades, fairly extensive, with dense areas of woodland, where deers and wild boars usually live.

The abundance of red deer, roe deer and wild boar suggests a temperate climate that fits well the dating of Castelnovian cultural complex.

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Article

Exploitation of faunal resources at Riparo Gaban (Trento, Italy) during the Late Mesolithic period: preliminary results of archaeozoological and taphonomical analysis

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Key words

- Archaeozoology
- Taphonomy
- Castelnovian
- Riparo Gaban
- Adige Valley - Trento
- Italy

Parole chiave

- Archeozoologia,
- Tafonomia
- Castelnoviano
- Riparo Gaban
- Val d'Adige - Trento
- Italia

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Summary

Riparo Gaban is a rockshelter located at about 270m a.s.l., near Trento, in a narrow lateral valley on the left bank of river Adige, Northern Italy. This site gives name to the so called "Gaban group" occupying Trento area during the spread of neolithisation, at the end of the VI millennium cal BC. Despite some gaps, the excavations by Bernardino Bagolini in sectors I to V from 1971 to 1979, revealed an impressive stratigraphic series attesting several occupations from late IX to mid-II millennium cal BC. The best known finds unearthed in Mesolithic (Sauveterrian and Castelnovian) and Neolithic layers are undoubtedly object of high artistic value, and realised on bone, antler, and stone. The analysed faunal assemblages derive from Castelnovian levels (IV Sector US E1-4) and are characterised by a high degree of fragmentation due to intentional bones fracturing for marrow extraction.The faunal remains belong mostly to ungulates: red deer, boar and roe deer are the most common species followed by a sporadic presence of ibex and chamois. Small wild mammals and carnivores are poorly attested in all layers. This study reports preliminary taphonomical results of Castelnovian faunal assemblages, in order to identify modifications related to the exploitation of animal carcasses.

Riassunto

Sfruttamento delle risorse animali al Riparo Gaban nel Mesolitico: risultati preliminari delle analisi archeozoologiche e tafonomiche - Riparo Gaban rappresenta uno dei principali siti di riferimento per lo studio del processo di neolitizzazione nelle Alpi e dà il nome al gruppo presente in Trentino durante la diffusione della nuova economia produttiva, alla fine del VI millennio BC cal. Gli scavi condotti da Bernardino Bagolini dal 1971 al 1979 nei sett. I-V hanno messo in luce una sezione stratigrafica che documenta una frequentazione, con alcune lacune, dalla fine del IX alla metà del II millennio a.C. cal. I reperti più noti sono senz'altro gli oggetti di alto valore artistico portati alla luce nei livelli del Mesolitico (Sauveterriano e Castelnoviano) e Neolitico che sono realizzati su osso, palco e pietra. L'insieme faunistico analizzato proviene dai livelli castelnoviani (Settore IV US E1-4) e si caratterizza per un elevato grado di frammentazione a causa della fratturazione intenzionale per l'estrazione del midollo. Gli animali maggiormente rappresentati sono cervo, cinghiale e capriolo seguiti da una sporadica presenza di stambecco e camoscio. I mammiferi selvatici di piccole dimensioni ed i carnivori sono scarsamente. Qui, vengono presentati i risultati preliminari delle analisi tafonomicheper ricostruire le modalità di sfruttamento delle carcasse animali.

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Fig. 1 *- Satellite view of the Adige Valley and location of Riparo Gaban (Trento, Northern Italy). / Veduta satellitare della valle dell'Adige e localizzazione del Riparo Gaban (Trento).*

Introduction

An important synthesis for the understanding of Mesolithic settlement and subsistence strategies in Trentino Alto-Adige, Northern Italy is proposed by R. H. Clark ("The Mesolithic Hunters of the Trentino", 2000). The main aim of this study was to examine both animal resources and lithic material in order to understand Mesolithic subsistence and settlement changes throughout a time span of ca. 3,500 years (Clark, 2000).

Among the analysed sites, Riparo Gaban fauna is composed by a substantial number of 19,023 remains recovered during the field-excavation carried out between 1982 and 1983.

Both Sauveterian and Castelnovian faunal assemblages were characterised by a high degree of fragmentation (Clark, 2000). Red deer, roe deer and wild boar were the most common species followed by ibex and chamois. Small game mammals and carnivores were poorly attested in all layers (Clark, 2000). Clark work did not analyse faunal remains from a taphonomical point of view, therefore any data defining post-depositional phenomena and any difference in the carcass processing were described.

Recently, a huge faunal assemblage deriving from Castelnovian layers (Sector IV SU E1-4) during the field-excavation by Bernardino Bagolini in 1974 was studied by the Authors.

The aim of this work is to present archaeozoological and taphonomical analysis on this unpublished Riparo Gaban faunal assemblage, in order to collect more data about faunal exploitation from Castelnovian occupations, and describe carcass processing.

The site

Riparo Gaban is located on the left side of Adige Valley (Tomasoni *et alii*, 2013, Koszlowski & Dalmeri, 2002) at 260m a.s.l, in Piazzina di Martignano, just a few kilometres northwest of Trento, Northern Italy (Fig. 1). The rockshelter is located on western slope of Monte Calisio, with an eastern exposure, 29m long, 6m high, 2.5-4m deep, and soars for approximately 80m above the current Adige Valley floor (Bagolini 1980, Kozlowski & Dalmeri, 2002).

This site, discovered in 1970, was systematically excavated from 1971 to 1979 under direction of Bernardino Bagolini, Museo Tridentino di Scienze Naturali (Trento), and then from 1982 to 1983 in collaboration with Alberto Broglio, University of Ferrara and Stefan K. Kozlowski, University of Warsaw.

The explored area of about 60m^2 was divided into five sectors (I to V) by B. Bagolini (Fig.2). During the excavations a continuous stratigraphic sequence, spanning from Mesolithic to Early Bronze Ages and partially damaged by three Medieval pits, was highlighted.

Castelnovian layer is about 20cm thick, with a typical whitish appearance and widespread concretion; it was partially damaged in many parts by Medieval pits (Kozlowski & Dalmeri, 2002). Layer E is dated 6968±41 BP uncal (KIA_10363 5979-5726 cal BC 2 σ) on a charcoal sample.

Materials and methods

The analysis were carried out at Laboratory of Archaeozoology and Taphonomy, Department of Humanities, University of Ferrara. This faunal sample has for the first time been examined in Ferrara, since it was included neither in Clark's nor in Griggo's studies (Kozlowski & Dalmeri, 2002). In order to identify species or genus, a total of 1,286 faunal remains were analysed using the osteological reference collection of our laboratory. When a taxonomical attribution was not possible, the unidentified faunal remains were divided by supposed mammal size (large, medium, small size, including intermediate categories), considering shaft fragments dimension and compact bone thickness. All the bone fragments were measured and, when possible, were the osteological measurements by Von den Driesch (1976) also collected. Taphonomical analysis was carried out using a stereo-microscope Leica S6D (6x-40x magnification), with integrated digital camera EC3.

Distinction between climatic and edaphic modifications was performed referring to Beherensmeyer (1978), Malerba & Giacobini (1993), Lyman (1994), Giacobini (1995; 1996). The identification of carnivore and rodent marks was done referring to Binford (1981), Brain (1981), Giacobini (1995), Cilli *et al*. (2000), Thun Hohenstein (2003). After summarising the state of the literature, have intentional fresh bone fracturing for marrow extraction, post-depositional fractures and manufacturing marks been discriminated (Sadek-Kooros, 1972; Myers *et al*. 1980; Shipman *et al*., 1984; Johnson 1985; Villa & Mahieu, 1991; Blasco Sancho, 1992; Lyman, 1994; Peretto *et al*., 1996; Anconetani & Peretto, 1996).

Results

Faunal composition

Faunal assemblage is composed of 1,286 bone fragments (Tab. 1). Although the remains identified only by the anatomical point of view (78.3%) were removed from the count, the ratio of identified remains is particularly high (86.2%).

Unidentified remains, usually 80-90% in similar contexts, are surely under-represented. This biased sample depends on the selection of bone fragments performed during the excavations, as were unidentified remains smaller than 2cm not collected (A. Pedrotti pers. comm.).

However, this faunal assemblage is very interesting being particularly abundant and well preserved. Red deer is the most represented animal with a total of 527 remains (Tab. 1), followed by wild boar (NISP 215) and roe deer (NISP 178). This association can certainly be correlated to an open wooded habitat, with a thick undergrowth near the rock-shelter.

Chamois and ibex are poorly attested by a small number of bone fragments (NISP 19 and 5), due to site location on the valley floor and environmental features (Boscato & Wierer, 2006).

A little amount of identified specimens is present among the carnivore remains (4.8%; Tab. 1). All species are represented by less than ten remains. Wild cat and badger are the animals with a higher NISP followed by wolf, bear and fox (Tab. 1).

Among rodents and lagomorphs, a small number of remains is also attested. Beaver testifies the presence of a nearby stream. Some pond turtle carapace fragments and a humerus suggest a sporadic collection of this animal.

Birds are very scanty in the faunal assemblage (Tab. 1), but three remains belong to a large sized bird of prey, such as a golden eagle.

Exploitation of large mammals

Red deer, wild boar and roe deer were probably the most common species hunted by hunter-gatherers of Riparo Gaban during the Late Mesolithic period. From an anatomical point of view, the red deer is represented by all skeletal portions in the faunal assemblage (Tab. 2). Ribs and vertebrae fragments belonging to a large sized ungulate suggest that the whole red deer carcass was transported into the rock-shelter. It is interesting to emphasise that isolated teeth, carpals, metapodials and phalanges are more abundant than other kind of skeletal elements. This fact conditioned the count of a minimum number of individuals (MNI), mainly estimated on mandibles and isolated teeth. A total of 14 individuals of different age ratio were counted (Tab. 1). Adults are the most abundant individuals with 10 specimens in whole (Tab. 3). The scarcity of young and sub-adult classes is showed by the presence of deciduous teeth at different use-wear stages and many anatomical elements with unfused epiphysis. A sample of six atrophic canines suggests that males were the most hunted game.

As far as the wild boar is concerned, elements of the appendicular skeleton, such as metapodials and phalanges, are dominating (Tab. 2). On the whole, hind and fore limbs are attested by quite similar quantities, excluding that was a selection of anatomical portions made in the killing place. Ribs and vertebrae fragments of medium sized ungulates are also found (Tab. 2), suggesting that killed wild boars were entirely transported into the rock-shelter, and then processed and consumed. The abundance of isolated teeth and mandibular and maxillary fragments with complete or partially complete dental series have yielded interesting data on wild boar age classes. In effect, unlike the red deer, wild boar age categories show a greater heterogeneity with a balance between young and adults/senile individuals. Young and sub-adults, as suggested by Bull & Payne (1982), are presumably less than two years old, and one-year-old in some cases (Tab. 3). The presence of wild boar female canines could support this occurrence, since the puppies follow their mothers until the age of one year, during their displacements in search of the food supply.

Roe deer shows a balanced relationship in body part representation (Tab. 2) and, as for the other ungulates, its carcass was wholly transported into the rock-shelter; effectively, all the anatomical elements are represented. Nevertheless, a lower occurrence of elements belonging to the forelimb suggests that only some body parts were occasionally brought within the site.

As for red deer and wild boar, the roe deer MNI and age-at-death were estimated on mandibles and isolated teeth. Fourteen individuals have been counted (Tabb. 1, 2). Adults are markedly predominant over other age categories, with only two sub-adults and one old individual identified (Tab. 3). Unfortunately, no gender attribution could be possible in order to establish if roe deer hunting was mostly addressed to male individuals.

Chamois and ibex are represented only by few remains (Tab. 1). A single adult ibex and three chamois (two adults and one sub-adults, Tab. 3) have been identified on the basis of dental remains.

The presence of these two animals, even if sporadic, suggests that the Gaban hunter-gatherers moved from the valley towards areas altimetrically higher for hunting these animals. Further analysis will be necessary in order to broaden this perspective.

Exploitation of carnivores and small game mammals

The presence of carnivores within the faunal assemblage is very scarce and consistent with a systematic Humans occupancy of rock-shelter. Data on carnivores age-at-death are scanty due to few identified remains. The badger is represented by at least three individuals: one sub-adult and two adults (Tab. 3). The wild cat is attested by two adults, and for marten, fox, wolf and bear have only one individual been estimated, respectively (Tab. 3). The exploitation of these animals occurred occasionally, and was mainly aimed at fur recovery as proven by the position of the identified cut marks.

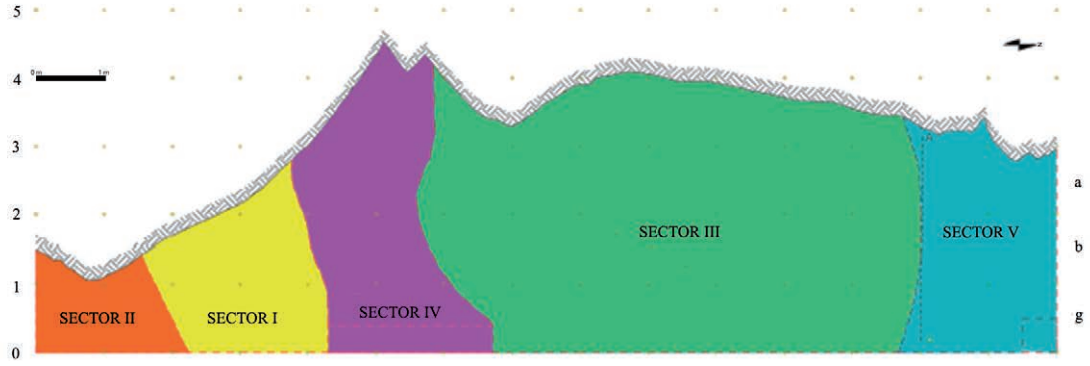

Fig. 2 *- Riparo Gaban. Map of the excavation sectors (I-V). / Riparo Gaban. Planimetria dei settori di scavo (I-V).*

Tab. 1 - Riparo Gaban. NISP and MNI of the faunal assemblage. / Riparo Gaban. NR and NMI dell'insieme faunistico.

Taxon	NISP	%NISP	MNI	%MNI
Lepus europaeus	6	0.5%	1	1.9%
Castor fiber	9	0.8%	3	5.6%
Martes martes	1	0.1%	1	1.9%
Meles meles	8	0.7%	3	5.6%
Felis sylvestris	8	0.7%	2	3.7%
Canis lupus	6	0.5%	1	1.9%
Vulpes vulpes	3	0.3%	1	1.9%
Ursus arctos	4	0.4%	1	1.9%
Medium size carnivores	5	0.5%		
Small size carnivores	4	0.4%		
Total carnivore remains	**54**	**4.8%**	**13**	**24,4%**
Sus scrofa	215	19.4%	10	18.5%
Cervus elaphus	527	47.5%	14	25.9%
Capreolus capreolus	178	16.1%	14	25.9%
Cervidae	2	0.2%		
Capra ibex	5	0.5%	1	1.9%
Rupicapra rupicapra	19	1.7%	2	3.7%
Large size ungulate	36	3.2%		
Large-medium size ungulate	22	2.0%		
Medium size ungulate	42	3.8%		
Total ungulate remains	**1046**	**94.3%**	**41**	**75,6%**
Falconiformes	4	0.4%		
Birds unidentified.	2	0.2%		
Total bird remains	**6**	**0.5%**		
Emys orbicularis	4	0.4%		
Total identified remains	**1110**	**86.2%**		
Unidentified remains	**177**	**13.8%**		
Total	**1287**	**100%**	**54**	**100%**

Hare is documented by one individual, while has beaver been more exploited for the occurrence of three individuals, probably adults.

State of preservation of bone surfaces

Faunal remains are well preserved; effectively, modifications affecting bone surfaces are mostly mild and rarely medium or intense.

Weathering cracks and exfoliation, often abundant in caves and rock-shelters (Beherensmeyer, 1978; Malerba & Giacobini, 1993; Lyman, 1994, Giacobini, 1995; 1996), are the most frequent modifications (Fig. 3). Root etching and fungal hyphae, generally mild and scattered, are also particularly abundant on the bone surfaces. Edaphic modifications, mostly erosions, were found on about 18% of bone assemblage (Fig. 3).

Cortical bone pitting, produced by percolating waters, has been identified on 4.2% of remains, while were blackish or reddish spots linked to the deposition of manganese and iron oxides, recorded respectively on 5.3 and 1.0% of the analysed bones.

Smoothed fracture edges and polishing related to water flow inside the rock shelter are almost absent.

Inside the cave, carnivore and rodent activity are testified by a small number of modifications (Fig. 4) that slightly exceed 4% (NISP 55), confirming the long-term Humans occupation of rock-shelter. Gnawing, pits, puncture marks and scores have been identified on 40 bone remains, located mostly on the epiphyses. Parallel grooves, left by rodent incisors, were found on 15 remains, sometimes coinciding with carnivore gnawing.

Anthropic modifications

Bone surfaces in a good state of preservation allowed to rec-

Tab. 2 - Riparo Gaban. Anatomical elements representation for all taxa. / Riparo Gaban. Rappresentazione della composizione anatomica per ogni taxon.

ANATOMICAL ELEMENT	HARE	BEAVER	MARTEN	BADGER	WILD CAT	FOX	WOLF	BEAR	WILD BOAR	RED DEER	ROE DEER	IBEX	CHAMOIS
Antler										13	1		
Cranium				2					17	14	8		
Upper teeth		1							22	54	20		1
Mandible		2							18	22	23	1	1
Lower teeth		5		1		2	1		40	91	20	1	4
Unidentified teeth									10	25	3		
Hyoid bone								1					
Atlas										3			
Axis										1	2		
Scapula					1					10	2		
Humerus			1		1	1			2	3	17		1
Radius					1				4	15	12		
Ulna		1			2				2	11	3		
Radius-ulna									6	1	1		
Carpals				1				1	1	32	6		
Metacarpal	2			1					3	25	3		2
Hip bone	1								15	14	1		
Pelvis									1		3		
Femur				2					1	6	3		
Patellae									1	3	2		
Tibia				1	1				7	5	4	1	
Fibula									3				
Astragalus					2		1		5	11	6		1
Calcaneus									2	14	1		
Other tarsals									2	7	2		1
Metatarsal	1						1		14	20	12		2
Unidentified metapodials									3	10	1		
Sesamoids										12	1		
Phalanx I	2						1		14	51	9	1	2
Phalanx II								2	15	33	6	1	1
Phalanx III									7	21	6		1
Total	**6**	**9**	**1**	**8**	**8**	**3**	**4**	**4**	**215**	**527**	**178**	**5**	**17**

ognise several marks linked to human actions: 293 remains bear anthropogenic stigmata related to butchery, marrow extraction and animal hard tissues manufacturing (Tab. 4).

The highest number of anthropic marks has been identified on red deer (Tab. 5), thanks to the large number of identified remains belonging to this taxon.

The animal was skinned starting from the first phalanges where short cut marks, localized on the dorsal and palmar surfaces of the

Tab. 3 - Riparo Gaban. MNI and age classes. / Riparo Gaban. NMI e classi di età.

TAXON	NEWBORN	YOUNG	SUB-ADULT	YOUNG-ADULT	ADULT	OLD
Hare					1	
Beaver					3	
Marten					1	
Badger			1		2	
Wild cat					2	
Wolf					1	
Fox					1	
Bear					1	
Wild boar	1	2	2	1	2	2
Red deer		1	3	2	7	1
Roe deer			2		11	1
Ibex					1	
Chamois			1		2	

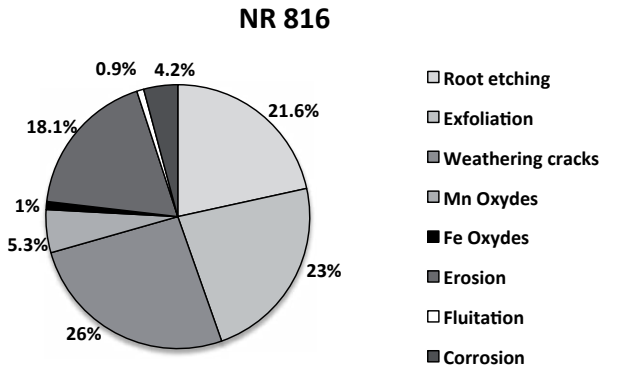

Fig. 3 - Riparo Gaban. Edaphic modifications frequencies within the faunal assemblage. / Riparo Gaban. Frequenza delle alterazioni edafiche identificate nell'insieme faunistico.

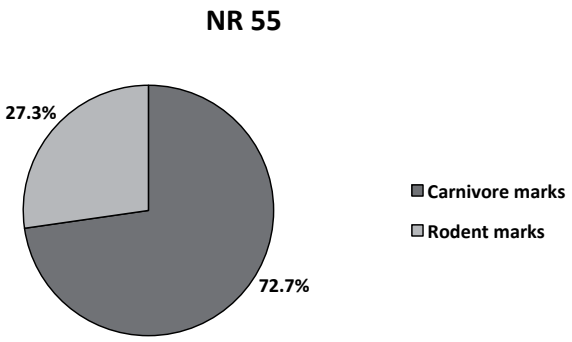

Fig. 4 - Riparo Gaban. Frequencies of carnivore and rodent modifications. / Riparo Gaban. Frequenza delle tracce prodotte da carnivori e roditori.

element, suggest a skin incision. Almost all the cut marks on bear long bones deriving from disarticulation near proximal and distal epiphysis (Fig. 5), indicate an action aimed at partitioning the carcasses into smaller portions. Marks left by muscles removal and meat filleting are less frequent, the first ones characterized by short, often repeated, cuts found on muscular insertion areas, especially on radius, and the latter ones by generally long *striae*, oriented along the bone major axis.

As for the other ungulates, a very few marks left by lithic tools are observed, not allowing any considerations. The most attested actions are mandibles, humeri and tarsals disarticulation (Fig. 6) and muscle mass detachment.

Fresh bone intentional fracturing is very well documented on all the game. Repetitive and systematic fractures were observed on red deer mandibles, metapodials and phalanges; most of these bones show a regular rectilinear fracture according to the sagittal plane.

Two antler and metatarsal fragments show evidence linked to animal hard tissues manufacturing. In effect, *rainurage* marks produced by a lithic tool, practiced for antler baguettes extraction and metatarsus division, have on two supports been identified.

Anthropic marks have been recognised even on some carnivore remains. A bear hyoid bone showing short and deep cut marks has to be noticed, as well as traces of disarticulation on a wild cat humerus and ulna (Fig. 7), confirming the interest of Mesolithic hunter-gatherers for this animal, as recently documented at site in Galgenbühel/Dos de la Forca (BZ) (Crezzini *et al*., 2014). The badger seems to have been exploited for its fur, as shown by a series of cut marks discovered on a partially intact skull. Both hare

Tab. 4 - Riparo Gaban. Anthropic modifications frequency for each taxon. / Riparo Gaban. Frequenza delle tracce antropiche per ogni taxon.

	NISP							
TAXON	CUT MARKS	MANUFACTURING MARKS	ANTHROPIC FRACTURES	NOTCHES	PERCUSSION CONE	IMPACT POINT	TOTAL	% TOTAL
Hare	2						**2**	**0.7%**
Beaver	1						**1**	**0.3%**
Badger	1						**1**	**0.3%**
Wild cat	2		1				**3**	**1.0%**
Bear	1						**1**	**0.3%**
Wild boar	18		22	1			**41**	**14.0%**
Red deer	45	10	94	9	1	3	**162**	**55.3%**
Roe deer	10	4	37	2		1	**54**	**18.4%**
Ibex			1	1			**2**	**0.7%**
Chamois	1		4				**5**	**1.7%**
Large size ungulate	2		3	2			**7**	**2.4%**
Large-medium size ungulate			1				**1**	**0.3%**
Medium size ungulate			4				**4**	**1.4%**
Unidentified remains	6		3				**9**	**3.1%**
Total	**89**	**14**	**170**	**15**	**1**	**4**	**293**	**100%**
% Total	**30.4%**	**4.8%**	**58.0%**	**5.1%**	**0.3%**	**1.4%**	**100%**	

and beaver bear support traces of disarticulation, suggesting an interest for their fur and for alimentary purposes also.

Alterations caused by heat exposure have been identified on 33% of finds (Fig. 8). Burned remains prevail on calcined ones and have different colouring stages, suggesting an exposition to high temperatures for long periods. About 94% of burned remains is characterised by a reddish-brown colour, suggesting that the bone was still wrapped in the flesh when cooked.

These indexes, related to burned bones, cannot be compared to those obtained by Griggo (Kozlowski & Dalmeri, 2002) since the faunal sample here analysed is biased.

Conclusions

The faunal assemblage of Riparo Gaban certainly leads to interesting considerations through archaeozoological and taphonomical analysis, expanding the available data on exploitation patterns of animal resources of the Adige Valley, during Castelnovian period. However, in order to review the osteological materials for a complete taphonomical analysis, will an integration with the samples analysed by Clark (2000) and Griggo in Kozlowski & Dalmeri (2002) from other explored areas of rock-shelter be necessary.

Hunting was undoubtedly and mainly devoted to red deer, as for other sites of Trentino Region (Boscato & Sala, 1980; Clark, 2000). The preference of Late Mesolithic hunters seems to be addressed to adult games, most likely males, due to the high frequency of atrophic canines found in the faunal assemblage. This choice seems to be constrained by the intention to recover a greater quantity of meat and antlers, used for tools and portable art production.

Similar considerations have to be done for the roe deer, consisting of a large number of adult individuals. Unfortunately, specific markers lack information on sex determination to allow adequate data achievement.

Based on the age-at-death estimation, no preferences have been observed for the wild boar, which seems to be hunted both youth and adult. The low incidence of chamois and ibex might suggest a large hunting area or, more reasonably, seasonal movements towards higher altitudes during the summer time, as suggested by other Authors (Bagolini & Broglio 1985, Bagolini & Pedrotti 1996, Clark, 2000, Koszlowski & Dalmeri, 2002).

Carnivores seem to play a marginal role in hunting strategies adopted by the Castelnovian hunters of Riparo Gaban, aimed primarily at small animals like wild cats and badgers. Slaughter marks found on the small wild felid bones are certainly very interesting and can be compared with data collected from Sauveterrian occupations at Galgenbühel/Dos de la Forca (Wierer & Boscato, 2006; Crezzini *et al*., 2014), where has a more intense exploitation of this animal been documented.

Tab. 5 *- Riparo Gaban. Frequencies of antrophic modifications on red deer and their skeletal distribution. / Riparo Gaban. Frequenza delle tracce antropiche e relativa distribuzione sui vari elementi anatomici del cervo.*

ANATOMICAL ELEMENTS	CUT MARKS	ANTHROPIC FRACTURATION	NOTCHES	PERCUSSION CONE	IMPACTS	MANUFACTURING MARKS
Antler		1				2
Cranium	2					
Mandible	5	3	1			
Atlas	1					
Scapula	2	1				
Humerus	1	1				
Radius	7	7	1			
Ulna	1	1				
Pelvis		1				
Femur		1				
Tibia		1				
Patella	1					
Carpals/ Tarsals	7	4			1	
Metacarpal	7	15	4		1	2
Metatarsal	7	14	1			6
Metapodial	2					
Phalanges	2	44	2	1	1	
Total	**45**	**94**	**9**	**1**	**3**	**10**

Fig. 5 *- Riparo Gaban. Red deer tibia (A) with disarticulation cut marks on the distal epiphysis (B & C, details at stereomicroscope). / Riparo Gaban. Tibia di cervo (A) con tracce di disarticolazione sull'epifisi distale (B & C, dettagli allo stereomicroscopio).*

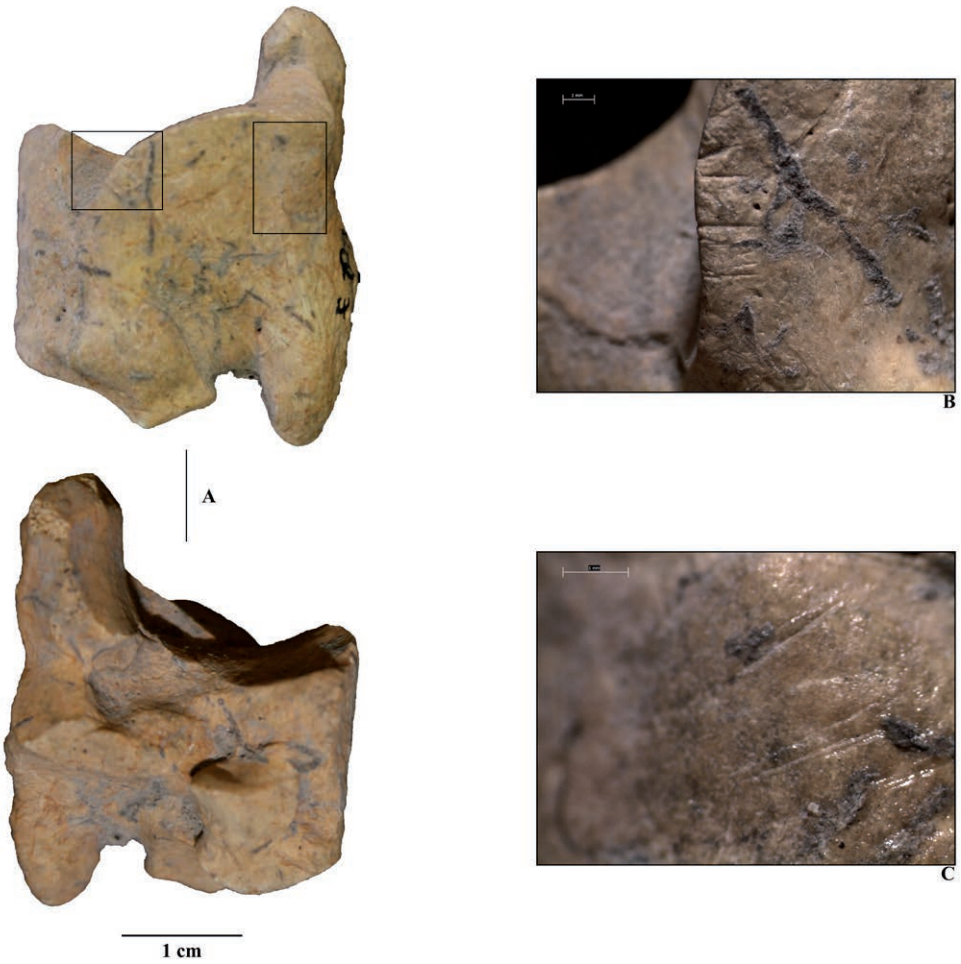

Fig. 6 - Riparo Gaban. Wild boar tarsal (A) with cut marks (B & C, stereomicroscope images). / Riparo Gaban. Tarsale di cinghiale (A) con strie di macellazione (B & C, immagini allo stereomicroscopio).

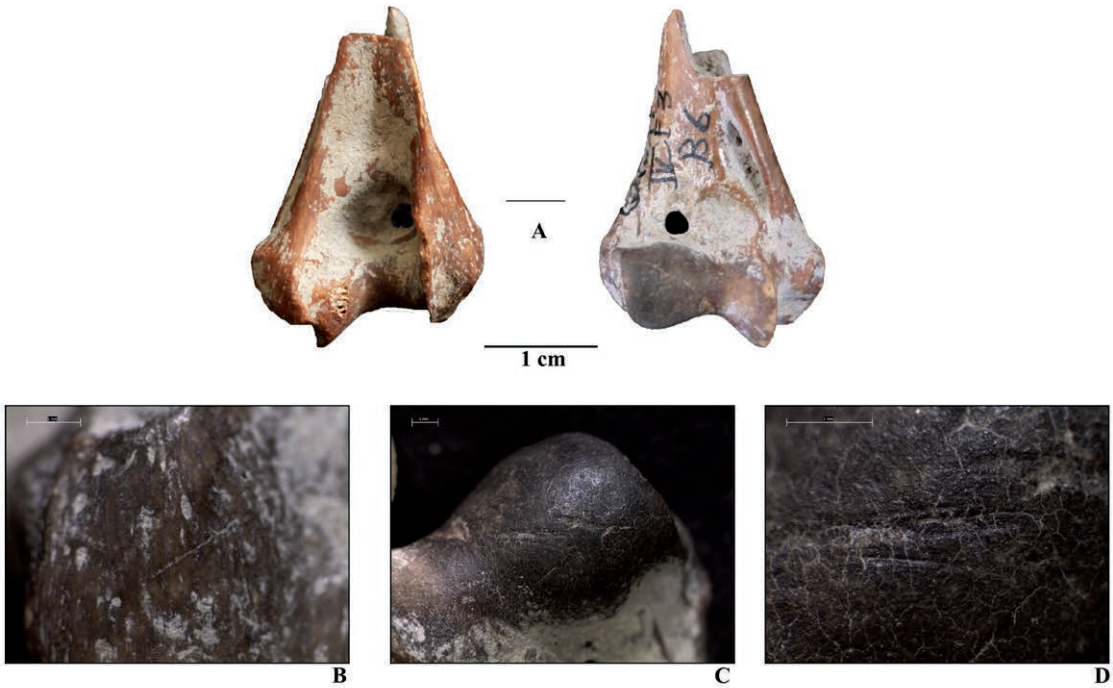

Fig. 7 - Riparo Gaban. Wild cats humerus. Disarticulation cut marks on the distal epiphysis (B, C and D stereomicroscope details). / Riparo Gaban. Omero di gatto selvatico (A) con strie da disarticolazione sull'epifisi distale (B, C e D, dettagli allo stereomicroscopio).

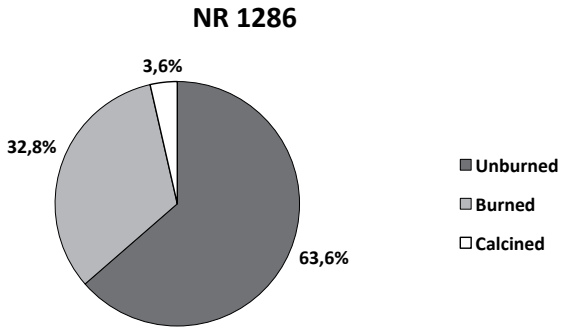

Fig. 8 - Riparo Gaban. Frequencies of unburned, burned and calcined remains. / Riparo Gaban. Frequenza dei reperti non combusti, combusti e calcinati.

Abundant evidence of human activity, such as slaughtering, processing and combustion of hard animal material, compared to the low presence of carnivore marks, suggests an intensive and long-term rock-shelter occupation.

The identified fauna testifies to the presence of an environment characterized by wooded glades, fairly extensive, with dense areas of woodland, where deers and wild boars usually live.

The abundance of red deer, roe deer and wild boar suggests a temperate climate that fits well the dating of Castelnovian cultural complex.

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Article

The "Total Archaeology Project" and the Mesolithic occupation of the highland district of San Vito di Cadore (Belluno, N-E Italy)

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Key words

- Lithic scatters
- Mesolithic
- Belluno Dolomites
- Landscape Archaeology

Parole chiave

- Rinvenimenti litici di superficie
- Mesolitico
- Dolomiti bellunesi
- Archeologia del paesaggio

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Summary

Mesolithic lithic scatters were identified in the highland district of San Vito di Cadore (1800-2700 m a.s.l.) since the late 1970s, mostly enhanced by the discovery of the site of Mondeval de Sora. From 2011 to 2015 a new archaeological survey project was developed in this territory, focusing on the area between Passo Giau and Col de la Puina. A "total archaeology approach" enabled different types of archaeological evidence to be recorded. In this paper the Mesolithic assemblages are presented. Both previously identified and newly recognised find-spots were positioned, described and spatially analysed in connection to the topography of the investigated territory, in order to provide insights on the settlement strategies adopted by the Mesolithic groups in this area.

Riassunto

Il rinvenimento di manufatti mesolitici in alta quota nel territorio di San Vito di Cadore (1800-2700 m s.l.m.) è iniziato durante fine anni '70 del secolo scorso, incentivato dalle ricerche nel sito di Mondeval de Sora. Tra il 2011 e il 2015 è stato sviluppato un nuovo progetto per la ricognizione archeologica di quest'area e, in particolare, del settore fra Passo Giau e Col de la Puina. L'adozione di un "approccio di archeologia totale" ha permesso di registrare numerosi tipi di evidenze, non limitati ai soli manufatti preistorici. In questo contributo saranno prese in considerazione esclusivamente le presenze mesolitiche. Nello specifico, i siti già noti e quelli individuati durante il recente survey sono stati posizionati, descritti e analizzati in relazione alla topografia del territorio al fine di avanzare ipotesi sulle strategie insediative dell'area.

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The total archaeology project: an introduction

Between 2011 and 2016 a new field survey project has started in the upland territory of the ancient "Regole" of San Vito di Cadore (Belluno Dolomites, North-Eastern Italy) involving the Universities of Ferrara and Trento with the collaboration of the Soprintendenza Archeologia del Veneto (Heritage Office for Veneto Region). The research territory includes the areas of Passo Giau, Mondeval de Sora and Malga Prendera-Col de la Puina, located at altitudes spanning between 1800 and 2700 m a.s.l. and delimited - north to south - by the Boite and Cordevole valleys, sub-tributaries of the Piave river.

The main aim of the project is the recording of every evidence of human activity identifiable on the surface, with no chronological restriction. Prehistoric and historical sites, as well as modern and contemporary material evidence of human occupation of the uplands were documented, thus overcoming the traditional chronological boundaries of archaeological research (Visentin et al. 2016, Cavulli et al. 2015). This approach has been called "total archaeology". The same terminology has been used to describe other archaeological projects that integrate different methods and approaches (Olson *et al.* 2013, Evans *et al.* 2006), but has rarely been referred to diachronic landscape analyses, as in the present case. Fieldwork activities followed a multi-scale approach, looking for evidence of different sizes: 1) micro- e.g. artefacts; 2) meso- e.g. rock engravings; 3) macro- e.g. structures and facilities.

The Mesolithic evidence

The discovery of Mesolithic assemblages in the Belluno Dolomites started in the late 1970s with the work of B. Bagolini and

Tab. 1 *- Mesolithic evidence in the uplands of the study area. Altitudes have been estimated using the 5x5 m Digital Terrain Model provided by Regione Veneto. Notes: * uncertain position/unverified during the survey. / Evidenze mesolitiche documentate nell'area di studio. Le quote sono state calcolate attraverso il Digital Terrain Model a maglia 5m fornito dalla Regione Veneto. Note: *posizione incerta/non verificata durante le prospezioni.*

N.	Site	Alt. (m)	Type	Culture	References
1	Costone del Col Piombin 1*	2263	open-air	Sauveterrian	Mondini & Villabruna 1992, Cesco Frare & Mondini 2005
2	Costone del Col Piombin 2	2205	open-air	Sauveterrian	Mondini & Villabruna 1992, Cesco Frare & Mondini 2005
3	Costone del Col Piombin 3	2159	open-air	Sauveterrian	Mondini & Villabruna 1992, Cesco Frare & Mondini 2005
4	Costone del Col Piombin 4	2144	open-air	Sauv. + Castel.	Mondini & Villabruna 1992, Cesco Frare & Mondini 2005
5	Costone del Col Piombin 5	2112	open-air	Sauveterrian	Mondini & Villabruna 1992, Cesco Frare & Mondini 2005
6	Forcella della Puina 1	2035	open-air	Mesolithic	Fontana et al. 2002, Marsale 2003
7	Forcella Giau - VF20	2330	rock-shelter	Sauveterrian	Fontana & Pasi 2002
8	Malga Prendera - VF3	2065	open-air	Sauveterrian	Fontana & Pasi 2002
9	Malga Prendera - VF4	2084	open-air	Mesolithic	Fontana & Pasi 2002
10	Malga Prendera - VF5	2119	open-air	Mesolithic	Fontana & Pasi 2002
11	Malga Prendera - VF24	2110	open-air	Mesolithic	Fontana & Pasi 2002
12	Melei 1	2065	open-air	Castelnovian	Fontana et al. 2002, Cesco Frare & Mondini 2005
13	Melei 2.1*	2155	open-air	Mesolithic	Fontana et al. 2002, Cesco Frare & Mondini 2005
14	Melei 2.2	2140	open-air	Mesolithic	Fontana et al. 2002, Cesco Frare & Mondini 2005
15	Melei 2.3	2138	open-air	Mesolithic	Fontana et al. 2002, Cesco Frare & Mondini 2005
16	Melei 2.4	2130	open-air	Mesolithic	Fontana et al. 2002, Cesco Frare & Mondini 2005
17	Melei 2.5	2132	open-air	Sauveterrian	Lunz 1986, Fontana et al. 2002, Cesco Frare & Mondini 2005
18	Melei 2.6	2137	open-air	Mesolithic	Fontana et al. 2002, Cesco Frare & Mondini 2005
19	Melei 2.7	2139	open-air	Castelnovian	Fontana et al. 2002, Cesco Frare & Mondini 2005
20	Mondeval de Sora - VF1	2135	rock-shelter	S.+C. + Co./Br. Age	Fontana et al. 2009a, 2009b
21	Mondeval de Sora - VF2	2194	rock-shelter	Cast. + Co./Br. Age	Fontana & Pasi 2002
22	Mondeval de Sora - VF16	2142	open-air	Mesolithic	Fontana & Pasi 2002
23	Mont del Fen	1958	open-air	Mesolithic	Fontana et al. 2002, Marsale 2003
24	Piezza	2093	open-air	Sauveterrian	Lunz 1986
25	Pra Comun - Val Costeana 1	1972	open-air	Castelnovian	Cesco Frare & Mondini 2005
26	Pra Comun - Val Costeana 4	1988	open-air	Castelnovian	Cesco Frare & Mondini 2005
27	Pra Comun - Val Costeana 5	1993	open-air	Castelnovian	Cesco Frare & Mondini 2005, Marsale & Reberschak 2007
28	Pra Comun - Val Costeana 6	1992	open-air	Castelnovian	Cesco Frare & Mondini 2005
29	Pra Comun - Val Costeana 7	1988	open-air	Mesolithic	Cesco Frare & Mondini 2005
30	Pra Comun - Val Costeana 8	1994	open-air	Castelnovian	Unpublished
31	Rio Ambrizzola - VF7	2231	open-air	Mesolithic	Fontana & Pasi 2002
32	Rio Ambrizzola - VF18	2191	rock-shelter	Castelnovian	Fontana & Pasi 2002
33	Val Cernera 2	2106	open-air	Mesolithic	Unpublished

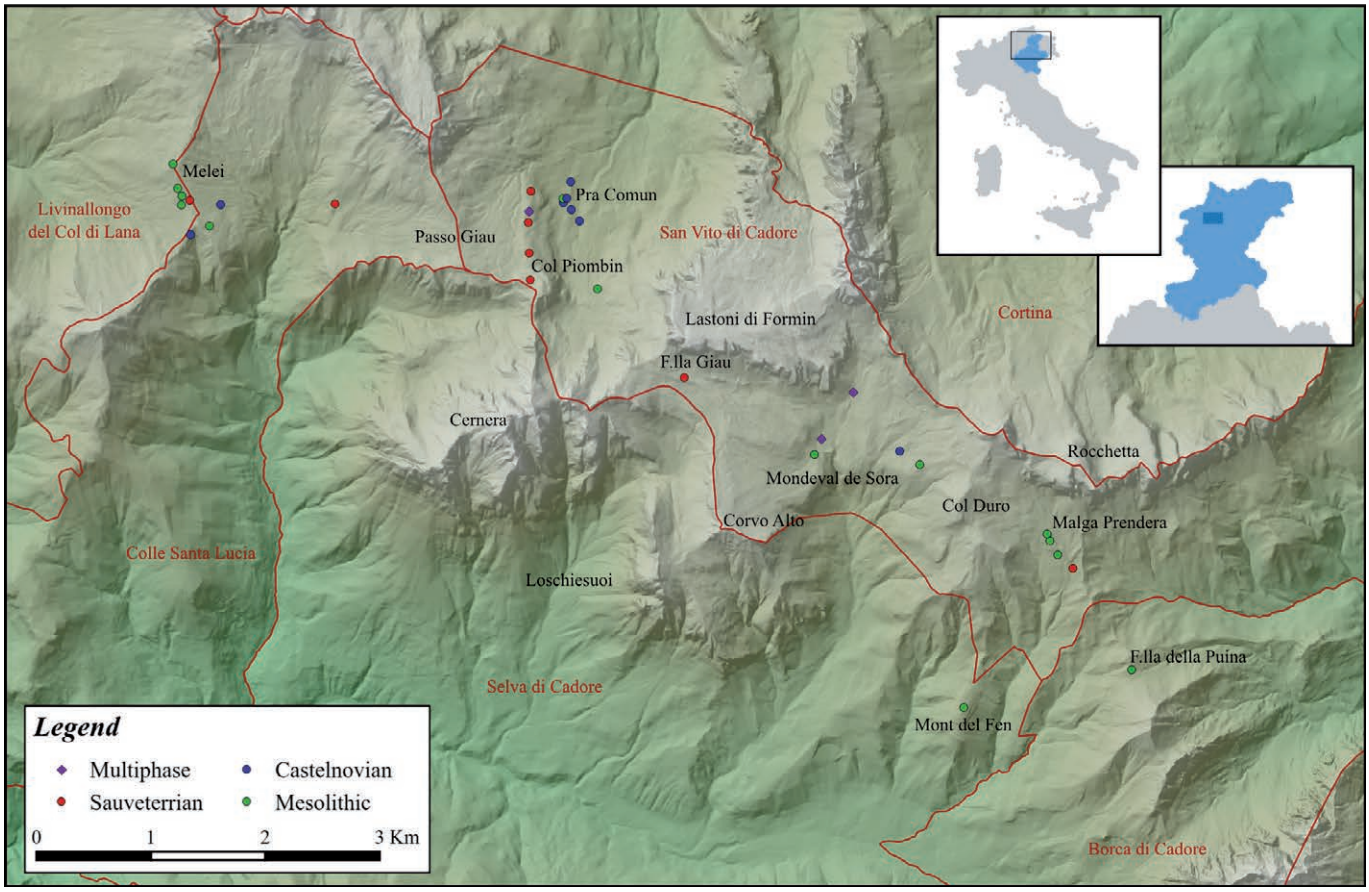

Fig. 1 *- Location of the Mesolithic sites mapped during the survey campaigns and through bibliographic research. / Localizzazione dei siti mesolitici mappati durante le campagne di prospezione e le ricerche bibliografiche.*

D. Nisi (1978) and continued in the following decades with the activity of both academic researchers and amateurs, also enhanced by the discovery of the site of Mondeval de Sora by Vittorino Cazzetta in 1985 (Alciati *et al.* 1992).

Although these field surveys provided a crucial dataset for understanding the Mesolithic occupation of the Belluno Dolomites, no critical review aimed at contextualizing this rich evidence within the wider framework of human occupation of the Dolomites was carried out (Bagolini *et al.* 1980a, 1980b, Broglio & Corai 1980, Mondini & Villabruna 1982, 1992, Lunz 1986, Fontana *et al.* 2002, Fontana & Pasi 2002, Marsale 2003, Cesco Frare & Mondini 2005, Marsale & Rebeschak 2007, Franco 2016). Significant exception is the rock-shelter site of Mondeval de Sora (VF1) which was extensively excavated (sectors I and III) over more than one decade, becoming one of the most important Alpine sites for this time span (Fontana *et al.* 2009a, 2009b, Valletta *et al*. 2016).

The new field survey project started in 2011 in the upland territory of the ancient "Regole" of San Vito di Cadore enabled the position of most of previously identified sites to be verified and some new find-spots to be recognized. The rich record yielded by this territory could be thus re-analysed in a broader perspective. In this paper only the lithic scatters attributable with a good approximation either to the Mesolithic or to one of its two phases (Sauveterrian and Castelnovian) were included, while undetermined assemblages were excluded. All the sites and find-spots were positioned, described and spatially analysed according to the topography of the territory, in order to explore the settlement and exploitation strategies adopted by the Mesolithic groups. The cultural context of published sites and lithic scatters has been inferredaccording to bibliographical information and the analysis of newly found artefacts.

Chronology

66 prehistoric find-spots were mapped in the territory of San Vito di Cadore and only partially in the neighbouring municipalities of Livinallongo del Col di Lana, Colle Santa Lucia, Selva di Cadore and Borca di Cadore. 33 of them could be assigned to the Mesolithic while the others remained undetermined (n. 29, 43.9%) or were attributed to more recent phases (Copper Age, n. 4) (Visentin et al. 2016).

The Mesolithic dataset (Tab. 1) includes two multi-layered sites, Mondeval de Sora VF1 (Early and Late Mesolithic together with more recent phases) and Mondeval de Sora VF2 (Castelnovian and later occupations), one open air site where both an Early and a Late Mesolithic occupation are attested (Costone del Col Piombin 4), eight Sauveterrian sites, eight Castelnovian ones and 14 sites that have been generically attributed to the Mesolithic.

Location of the sites

Almost all the sites are found along a band of territory running south-east to north-west along the watershed that separates the Cordevole/Fiorentina from the Boite valley. It consists of a large and relatively flat high altitude belt stretching for more than 9 km as the crow flies from Melei to Malga Prendera (Fig. 1).

A first cluster of sites is located in the area known as Melei (Fig. 2), west of Passo Giau. Here both Sauveterrian and Castelnovian occupations are attested. Most of the sites are positioned along the ridge spanning between 2130 and 2150 m of elevation, while another one lies on the slope that leads to the pass. Another Sauveterrian site has been identified one kilometre to the east; it was partially destroyed during excavation works for the construction of a parking lot (Piezza); (Fig. 3).

Fig. 2 - Melei. Numerous sites have been identified mostly along the modern path (Photo D. Visentin). / Melei. Lungo la cresta numerosi siti sono stati individuati per lo più in corrispondenza del sentiero (Foto D. Visentin).

Fig. 4 - Costone del Col Piombin. One of the terraces on which Sauveterrian lithic artefacts have been collected (Photo D. Visentin). / Costone del Col Piombin. Uno dei terrazzi su cui sono stati raccolti i manufatti sauveterriani (Foto D. Visentin).

Fig. 3 - Piezza. The Sauveterrian site has been partially destroyed by mechanical excavations (Photo D. Visentin). / Piezza. Il sito è stato in parte distrutto dai lavori di scavo (Foto D. Visentin).

Fig. 5 - Prà Comun - Val Costeana. Numerous Castelnovian sites have been identified along this secondary valley, located at the foot of the Col Piombin (Photo D. Visentin). / Prà Comun - Val Costeana. Lungo questa valle secondaria, posta ai piedi del Col Piombin, sono stati identificati numerosi siti castelnoviani (Foto D. Visentin).

The eastern slope of Passo Giau features one of the richest areas for Mesolithic findings. Five sites were identified on the five terraces that characterise the northern ridge of Col Piombin (Fig. 4). All of them yielded Sauveterrian lithic assemblages. Only one trapeze was collected at site 4, representing the only artefact dated to the Late Mesolithic coming from this area. On the other hand five of the seven sites located on the valley at the foot of the Col Piombin - known as Prà Comun-Val Costeana - are undoubtedly Castelnovian (Fig. 5).

On the eastern slope of Forcella Giau, under a small limestone block located next to the main path, the highest Sauveterrian site of the area (2330 m) was identified (VF 20).

Five Mesolithic sites are attested in the Mondeval de Sora basin among the numerous undetermined lithic scatters (Fontana & Pasi 2002; cfr. Visentin *et al.* 2016). Two of them are represented by rock-shelters with multi-layered sequences. One is the most famous site VF1, occupied during both the Early and Late Mesolithic (Fontana et al. 2009a, b, Valletta et al. this volume), while the second (site VF2) yielded artefacts that can be referred to the Castelnovian and to later periods (Fontana & Pasi 2002). Another Castelnovian assemblage was identified next to a small stream known as “Rio Ambrizzola”, while the last two find-spots, one located near the latter site and the other next to VF1, can generally be attributed to the Mesolithic.

The gentle slope where Malga Prendera (2060-2100 m) is located yielded several lithic scatters. One of them was dated to the Sauveterrian and the others to a generic Mesolithic. This vast area probably represents a palimpsest of numerous occupations covering a large time period, as the identification of lithic artefacts and potsherds attributed to the Copper Age seems to indicate (Bianchin Citton 1992). Unfortunately the area has undergone heavy slope processes caused by anthropic activities and intense natural erosion that have probably led to the destruction of archaeological deposits (Fontana & Pasi 2002). A couple of other sites—Forcella della Puina (2034 m) and Mont del Fen (1959 m)—represent possible links with other highland districts (the former) and the Fiorentina valley bottom (the latter).

Vertical distribution

All the Mesolithic sites in the area are located between 1958 and 2330 m a.s.l. (Fig. 6) and about 40% of them between 2100 and 2150 m. Generally Sauveterrian sites are located at higher altitudes than Castelnovian ones, as none of the latter is located above 2200 m and none of the former under 2050 m. Unfortunately the available

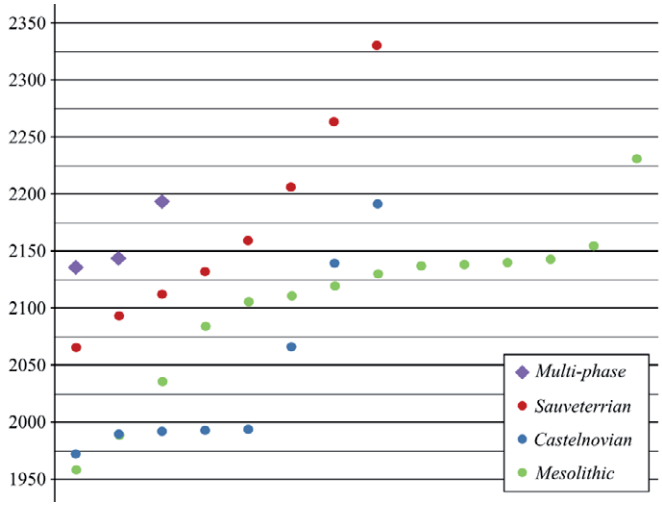

Fig. 6 - Vertical distribution of the sites. / Distribuzione verticale dei siti.

data are too limited to provide any reliable inference. The high presence of Castelnovian sites at about 2000 m is connected to the occurrence of a group of sites of this chronology within a restricted area (Prà Comun - Val Costeana).

Discussion and conclusions

As highlighted by the results of this project, the territories of San Vito di Cadore and the neighbouring municipalities represent a rich and informative area for the reconstruction of highland occupation strategies during the Mesolithic. The great density of find-spots identified in this district confirms the high visibility that characterizes the Mesolithic evidence in the south-eastern sector of the Alpine chain (Fontana et al. 2011). It also enables us to move the attention from the best known area of the Adige drainage basin towards the east, including part of the high Piave valley (namely its right tributaries), and comparing the evidence available from these two territories (Dalmeri & Pedrotti 1994, Fontana 2011).

For what concerns the settlement strategies, one of the most interesting aspects is represented by the topographic distribution of sites along a flat upland band that stretches south-east to north-west along the watershed that separates the Cordevole and Boite drainage basins between 1900 and 2200 m a.s.l. (corresponding to the ecotone zone of the early Holocene tree-line); (Fig. 1); (Visentin et al. 2016, Fontana & Pasi 2002). As for the Adige basin where this model has been previously recognised, the reasons that can explain such distribution are closely connected to the presence of high altitude paths that allow moving across the area with reduced vertical displacements and a good visibility on the surrounding territory (Kompatscher & Hrozny-Kompatscher 2007). Moreover the evidence appears denser around important geographic features such as narrow and large passes, and wide secondary valleys and ridges which represent favourable locations for settlement.

Lastly the number of Castelnovian sites is higher in this territory with respect to Sauveterrian ones, in contrast to what is attested for the Trentino Alto-Adige area (Fontana et al. in press). An intense occupation of this mountain sector can thus be envisaged both during the Early and Late Mesolithic, although available data are too few to attempt a reconstruction of the possible changes of settlement strategies between these two periods.

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Article

Small mammals from Mondeval de Sora (San Vito di Cadore, Belluno): paleoenvironmental differences between early and late Holocene

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Key words

- small mammals
- paleoenvironment
- Holocene
- Mondeval de Sora
- North-Eastern Italy

Parole chiave

- micromammiferi
- paleoambiente
- Olocene
- Mondeval de Sora
- Italia nord-orientale

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Summary

Small mammal fossil remains from Mondeval de Sora (VF1, sectors I and III) have been analyzed in order to allow a reconstruction of the environment surrounding the site throughout the Holocene. A taxonomic study has led to the identification of 14 species while statistics tools as Simpson index and Habitat Weighting method have been applied to examine the assemblage from a biological and ecological perspective. Sector I has yielded a very low number of remains (total N.I. 24) whereas sector III has proved to be richer (total N.I. 148), allowing to observe landscape changes through the sequence between early and late Holocene. In particular, variations in the associations of small mammals indicate a shift from a mainly grassland environment during the early Holocene (Mesolithic macro-unit) to a less grass-covered one with exposed rocks during the late Holocene (Protohistoric and Historic macro-units). Furthermore, the occurrence of Sciurus vulgaris testifies the presence of wooded areas near the site, suggesting a tree limit probably located at a higher altitude than the current one.

Riassunto

I resti fossili di micromammiferi provenienti da Mondeval de Sora (VF1, settore I e III) sono stati studiati allo scopo di ottenere una ricostruzione dell'ambiente nelle immediate vicinanze del sito durante l'Olocene. Lo studio tassonomico ha portato all'identificazione di 14 specie, mentre strumenti statistici come l'indice di Simpson e il metodo dell'Habitat Weighting sono stati impiegati per esaminare l'insieme faunistico dal punto di vista biologico ed ecologico. Il settore I ha restituito un basso numero di resti (N.I. totale 24), mentre il settore III si è dimostrato più ricco (N.I. totale 148) permettendo di osservare attraverso la sequenza i cambiamenti ambientali avvenuti tra l'inizio e la fine dell'Olocene. In particolare, le variazioni nell'associazione di micromammiferi indicano il passaggio da un ambiente prativo con buona copertura del terreno durante l'inizio dell'Olocene (macro-unità mesolitica) ad uno con scarsa copertura e rocce esposte durante la fine dell'Olocene (macro-unità protostorica e storica). Inoltre, la presenza di Sciurus vulgaris testimonia la vicinanza al sito di aree boschive, suggerendo un limite degli alberi probabilmente ad altitudine più elevata rispetto all'attuale.

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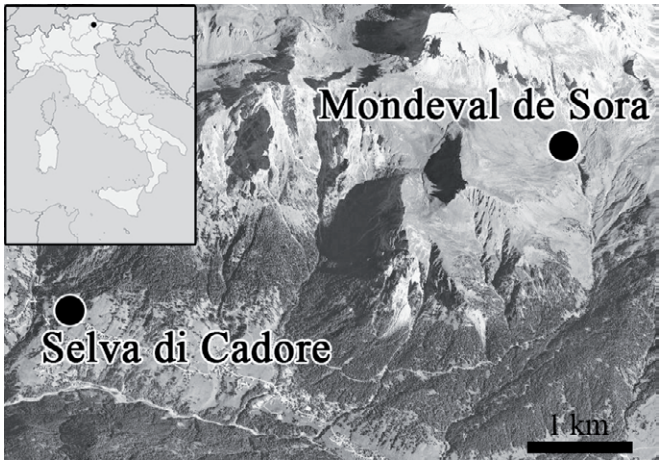

Fig. 1 - Localization of Mondeval de Sora. The site is clearly above the present tree limit. / Localizzazione di Mondeval de Sora. Il sito si trova chiaramente al di sopra dell'attuale limite degli alberi

The site

The Mondeval de Sora terrace is located in the high valley of the Cordevole River, a sub-tributary of Piave River. The site, also known as Val Fiorentina 1 (VF1), is located at 2.150 m a.s.l. (Fig. 1) and lies beneath two shelters of a big erratic boulder in an area surrounded by high elevations and connected to other valleys by large passes (i.e. Passo Giau) and narrow saddles (i.e. Forcella Ambrizzola) (Fontana et al. 2009).

Two sides of the boulder have been investigated from the 1980s to the 2001 (known as sectors I and III). At the base of the two sequences, several Mesolithic layers are present (Sauveterrian and Castelnovian) which are covered by strata that testify human occupation from the Copper age to the sub-actual age (Alciati et al. 1994; Fontana & Guerreschi, 2003; Asolati et al. 2005; Fontana et al. 2009a, b, 2012).

Materials and methods

The small mammals remains analysed consisted of disarticulated bone fragments collected by water-screening using sieves of 1 mm mesh during the excavation campaigns.

The sample coming from the two sectors have been analyzed with a stereo-microscope at 25x magnification. The taxonomic classification follows Wilson and Reeder (2005) except for *Clethrionomys glareolus* which priority has been discussed in Tesakov et al. (2010). Data on the distribution and habitat of the species are in accordance with Amori et al. (2008), Boitani et al. (2003), Mitchell-Jones et al. (1999).The sample has been previously treated with a 1/10 solution of H_2O_2 and H_2O.

The Number of Individuals (N.I., the calculation is based on Stratigraphical Units) has been quantified taking into account the most represented anatomical element, both right and left (Berto & Rubinato 2013). In order to reconstruct the palaeodiversity we have used the Simpson index of Evenness

(1) $1-\Sigma(p_i^2)$

where p_i is the proportion of individuals in the i^{th} species (Harper 2005; Magurran 2004). The evenness index is constrained between 0 and 1. The index has been calculated using PAST 3.04 avoiding redundant determinations. The habitat percentages have been calculated using the Habitat Weighting method (Evans et al. 1981; Andrews 2006; López-García et al. 2010).

28 Stratigraphic Units of sector III have been grouped into three macro-units (Table 1) following Valletta (2012): the Mesolithic macro-unit, corresponding to the early Holocene (Preboreal and Boreal) and the Protohistoric and Historic macro-units related to the late Holocene (Subboreal and Subatlantic).

Results

The total number of individuals calculated for sector I is too low to allow any consideration (N.I. = 24), while sector III has delivered a higher number of remains (N.I. = 148, see Table 2). The dominant *taxon* in the Mesolithic macro-unit of Sector III is *Microtus arvalis* while in the Protohistoric and Historic macro-units *Microtus* (*Terricola*) ex gr. *multiplex-subterraneus* dominates the assemblage (Fig.2). From the bottom to the top of the sequence *Chionomys nivalis* increases and biodiversity seems to raise (as shown by Simpson index, Fig. 3), due to the occurrence of species like *Talpa caeca*, *Talpa europaea* and *Dryomys nitedula*.

Discussion

Small mammal fossil assemblages are usually the result of accumulations of pellets as a consequence of hunting activities of nocturnal birds of prey (Andrews 1990), that are normally opportunistic predators and often have a limited range of action (2-3 km distance from the perch). For this reasons they are considered reliable proxy for environmental and climatic changes.

Mondeval de Sora provides a very peculiar context to small mammal studies because of its high altitude (2150 m a.s.l.). Plan de Frea Site 4, located at 1.930 m a.s.l. (Angelucci et al. 1999) and 30 km far from Mondeval de Sora is the only site that provides a comparison for the Mesolithic layers. In this locality, the biodiversity of the small mammal fauna is higher, while the most common rodent is *Clethrionomys glareolus*. *Sciurus vulgaris* is signaled too, although in an open environment context.

Therefore, the Mondeval de Sora faunal assemblage more likely reflects local variations than the general climatic changes of the Holocene. Looking at the whole sequence, the shift from *Microtus arvalis* to *Microtus* (*Terricola*) ex gr. *multiplex-subterraneus* as a dominant species, the decrease of species adapted to forest habitats and the increase of the rocky component from the Mesolithic to the Proto – and Historic macro-units are remarkable. They testify a change in the area near the site from a grass-dominated landscape during the early Holocene to a less grass-covered environment characterized by exposed rocks during the Subboreal and Subatlantic and very similar to the present one (Fig. 3). The increase of Open Humid environment in Proto- and Historic macro-units can be related to an increase of precipitation during the colder months, while the increase of Rocky environments can be explained with the decrease of forest-related environment. Also, the relatively high percentage of the forest component in the early Holocene unit (up to 10%, given by the occurrence of *Apodemus (Sylvemus*), *Clethrionomys glareolus*, and especially of *Sciurus vulgaris*) testifies the presence of wooded areas in the vicinity of the site (approximately a 2 km radius), at about 2000 m a.s.l.

Finally, the increase of Simpson index (Fig. 3) might be pru-

Tab. 1 - Correspondences between macro-units and Stratigraphical Units (data from Valletta 2012) / Raggruppamento delle Unità Stratigrafiche in macro-unità (dati da Valletta 2012)

VF/1 III macro-units	Stratigraphical Units
Mesolithic	10, 20, 21, 30, 32
Protohistoric	19, 26, 27, 34, 35
Historic	1b, 2, 11, 12, 13, 16, 25, 101

Tab. 2 - Number of Individuals (N.I.) of the three macro-units of Mondeval de Sora, sector VF1/III. / Numero degli Individui (N.I.) per le tre macro-unità di Mondeval de Sora, settore VF1/III.

	VF/1 III macro-units		
	Mesolithic	**Protohistoric**	**Historic**
Apodemus cf. *flavicollis*	1		
Apodemus cf. *sylvaticus*			1
Apodemus sp.			1
M. (*T.*) gr. *multiplex-subterraneus*	4	13	38
Microtus arvalis	29		6
Microtus agrestis		1	
Chionomys nivalis	4	9	14
Clethrionomys glareolus	3	1	3
Dryomys nitedula			1
Muscardinus avellanarius	1		
Sciurus vulgaris	1		
Talpa caeca			2
Talpa cf. *caeca*			1
Talpa europaea			1
Talpa cf. *europaea*			1
Talpa sp.			1
Sorex cf. *alpinus*			1
Sorex gr. *araneus*	3	1	6
Total N.I.	**46**	**25**	**77**

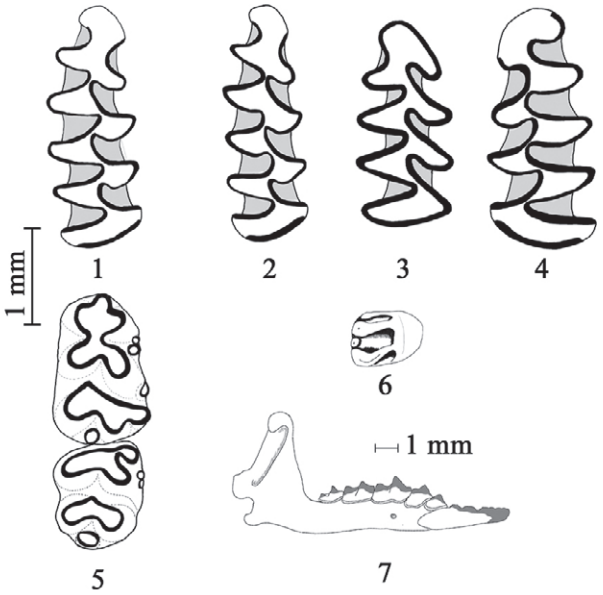

Fig. 2 - General selection of the small mammals from VF1/III site. 1: Microtus arvalis, right M1; 2: M. (T.) gr. multiplex-subterraneus, right M1; 3: Clethrionomys glareolus, right M1; 4: Chionomys nivalis, left M1; 5: Apodemus cf. sylvaticus, right M1-2; 6: Sciurus vulgaris, left M2; 7: Sorex gr. araneus, right mandible. / Micromammiferi da VF1/III (selezione generale). 1: Microtus arvalis, M1 dx; 2: M. (T.) gr. multiplex-subterraneus, M1 dx; 3: Clethrionomys glareolus, M1 dx; 4: Chionomys nivalis, M1 sx; 5: Apodemus cf. sylvaticus, M1-2 dx; 6: Sciurus vulgaris, M2 sx; 7: Sorex gr. araneus, mandibola dx.

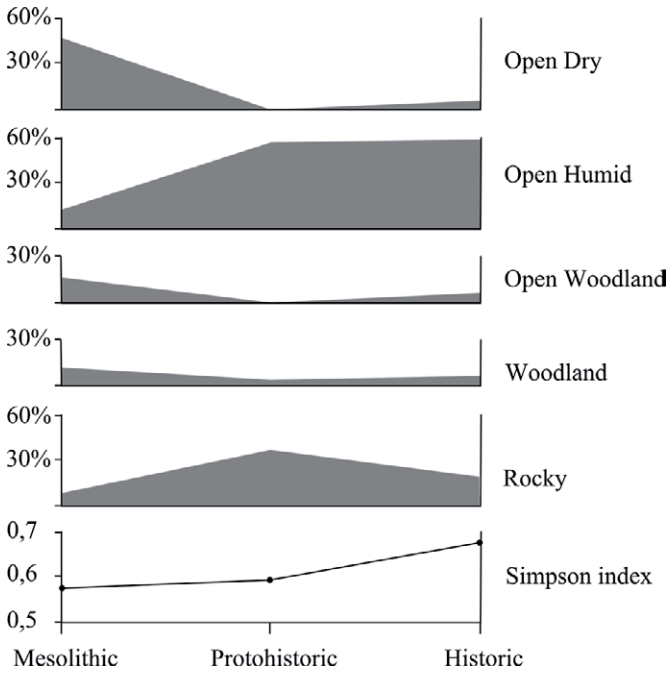

Fig. 3 - Habitat Weighting and Simpson index of Mondeval de Sora VF1/III. / Habitat Weighting e indice di Simpson di Mondeval de Sora VF1/III.

dently related to the general redistribution of biodiversity and faunal change that affects the final moments of Late Pleistocene and the Holocene, especially in northern Italy (Berto 2013).

Conclusions

The small mammals assemblage from Mondeval de Sora represents a unique assemblage in a unique setting reflecting environmental changes from early to late Holocene at a high altitude context. Despite the relative low N.I. there is clear evidence for landscape changes from an open grassland with woodlands extending over the present tree line in the Mesolithic to the Proto-historic and Historic environment which appears very similar to the one that characterizes Val Fiorentina today.

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Article

The Mesolithic lithic assemblage of site VF1-sector III of Mondeval de Sora (Belluno, Italy). Economy, technology and typology

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Key words

- Sauveterrian
- Dolomites
- lithic raw materials
- reduction sequence
- diachronical evolution

Parole chiave

- Sauveterriano
- Dolomiti
- materie prime litiche
- sequenza operativa
- evoluzione diacronica

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Summary

The Mesolithic lithic assemblage of site VF1-sector III of Mondeval de Sora (BL, Italy). Economy, technology and typology. Site VF1 (2,150 m a.s.l.) is located in the wide Mondeval de Sora basin (Belluno, Italy), protected by a dolomite erratic boulder. Sector III is characterized by a well preserved stratigraphic sequence, attesting Mesolithic, Bronze Age and historical occupations. Radiocarbon dates are available for two Mesolithic stratigraphic units, supporting the archaeological attribution of these layers to the Sauveterrian. The typological analysis of the lithic assemblages from the whole Mesolithic sequence along with the reconstruction of provisioning systems and reduction sequences has allowed the contextualization of the early Holocene frequentation of this sector. Evolution of techno-typological and economic parameters through time is highlighted by the comparison between different Mesolithic layers. The picture obtained fits well the general Sauveterrian sequence of the south-eastern Alps.

Riassunto

L'insieme litico mesolitico del sito VF1-settore III di Mondeval de Sora (Belluno, Italia). Economia, tecnologia e tipologia. Il sito VF1 (2.150 m s.l.m.) si trova nell'ampia conca di Mondeval de Sora (Belluno), protetto da un masso erratico di dolomia. Il settore III è caratterizzato da una sequenza stratigrafica ben conservata, con evidenze di frequentazioni durante il Mesolitico, l'età del Bronzo e l'epoca storica. Le datazioni radiometriche disponibili per due livelli mesolitici supportano l'attribuzione di queste unità stratigrafiche al Sauveterriano. L'analisi tipologica degli insiemi litici provenienti dalla sequenza mesolitica, assieme alla ricostruzione delle strategie di approvvigionamento e delle catene operative permettono di ben inquadrare la frequentazione antico olocenica di questo settore. Sulla base del confronto tra i diversi livelli è stato possibile evidenziare che l'evoluzione diacronica di alcuni aspetti tecno-tipologici ed economici ben si integra nel quadro del Sauveterriano dell'area alpina sud-orientale.

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Fig. 1 *- Site VF1 of Mondeval de Sora located under a large erratic dolomite boulder. Sector III lies on the left side and sector I on the right one. / Il sito VF1 di Mondeval de Sora situato sotto un grande masso erratico di dolomia. Il settore III si trova sul lato sinistro e il settore I su quello destro.*

Introduction

The object of this paper is the lithic assemblage yielded by site VF1-sector III, of Mondeval de Sora (S.Vito di Cadore, Belluno, Italy). The importance of this site for the reconstruction of Mesolithic high mountain occupation in the Alps is related to its exceptional preservation that has allowed the survival of a rich lithic assemblage, organic remains and dwelling structures. In particular, sector III presents a high resolution stratigraphic sequence, in which different Mesolithic Stratigraphic Units have been detected. Results of the techno-economical and typological analysis of these Mesolithic layers are here presented aiming at highlighting possible evolutionary trends along the sequence and comparing them to the evidence available for other contemporary sites of the south-eastern Alps.

The study area

Site VF1 is located under a large erratic boulder at the center of the wide Mondeval basin at an elevation of 2,150 m a.s.l., surrounded on the western, northern and eastern side by Dolomitic reliefs and facing south on the Cordevole valley with a steep slope. It is connected by passes and saddles to the surrounding Boite and Zoldo valleys. From sector I, lying under the south-western side of the boulder, comes a thick layer (SU 8) rich in organic and lithic materials and a series of dwelling structures which have been referred to the Sauveterrian period (Fontana & Vullo 2000, Fontana & Guerreschi 2005, Fontana *et al.* 2012). This sector is also well known for the discovery of a Castelnovian burial accompanied by a rich set of grave goods (Fontana *et al.* in press).

Sector III is located on the northern side of the boulder and is characterized by a 50 cm thick stratigraphic sequence (Fig. 1), attesting the occupation of the site during the Mesolithic, the Bronze Age and the historical period (Fontana *et al.* 2009, Fontana *et al*. 2015). Archaeological investigations in this area, carried out between 1996 and 2000, have covered a surface of *ca.* 30 m^2.

The Mesolithic sequence consists of five main stratigraphic units (10, 20, 21, 30, 32) probably representing three main frequentation phases (Valletta 2013) (Fig. 2). In the eastern sector of the excavated area three SUs are superimposed one to another: the sequence starts with SU 10, followed by SU 21 and SU 32, the latter lying upon an archaeologically sterile layer. In the western sector SUs 20 and 30 are separated from the previous series by a preliminary test-pit (see further). These units, separated from one another by a recent bioturbation, lie directly on the sterile soil. Together with SU 10 they represent a single frequentation phase, later than SU 21. Two further layers are considered not reliable for archaeological comparisons: SU 10 “test-pit”, that was identified during a preliminary stratigraphic test-pit and corresponds to

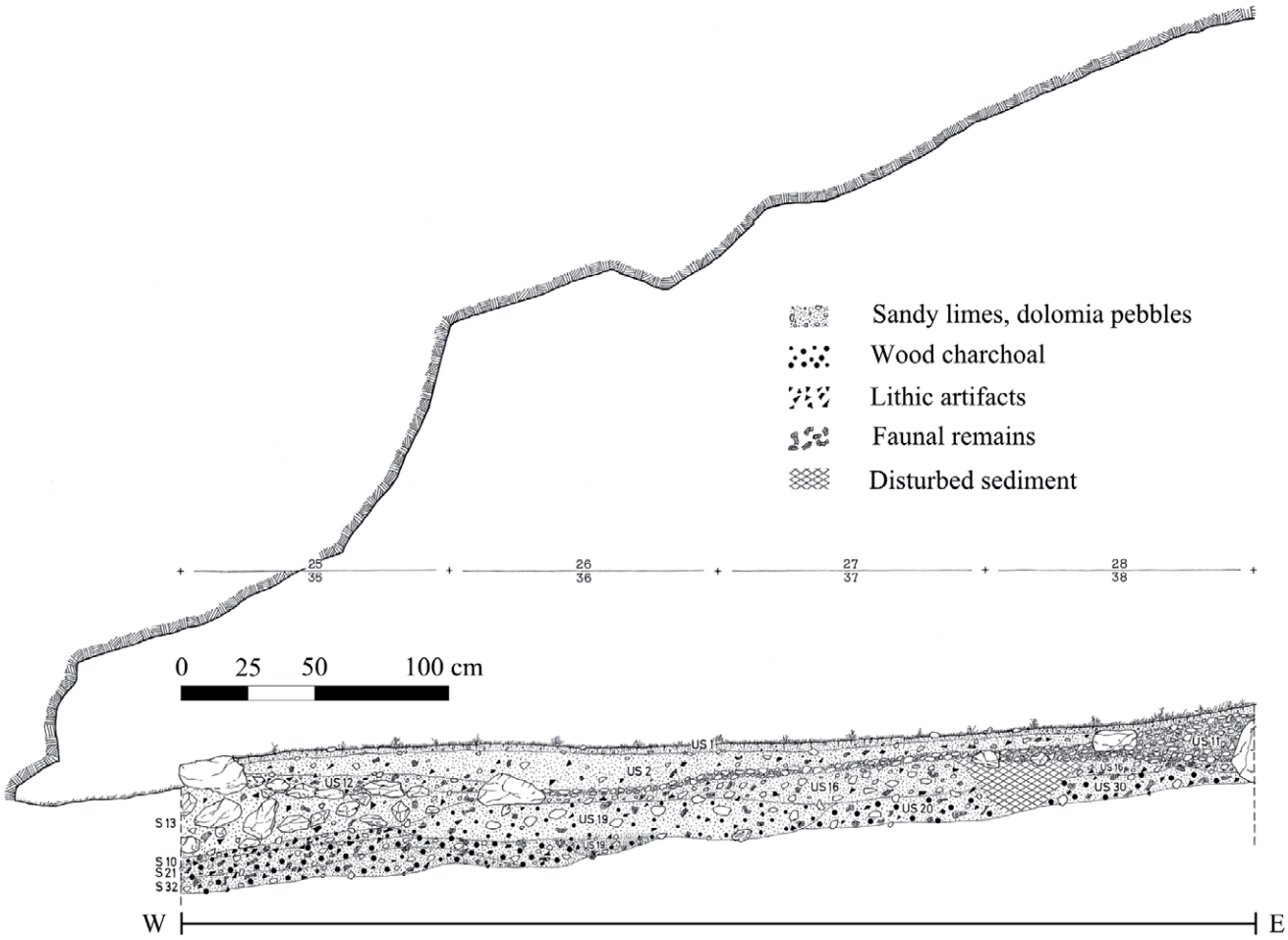

Fig. 2 *- VF1, sector III: longitudinal profile. / VF1, settore III: sezione stratigrafica longitudinale.*

SUs 10-20-30 and 21 (recognized by the extensive investigation), and SU 29, that is located above SU 30 in the outer area of the site but it is partially disturbed by later occupations. Two ^{14}C dates are available respectively for SU 32 (GX-27748: 9,160 ± 90 BP, 8,613-8,243 cal BC) and SU 10 (GX-21797: 8,445 ± 50 BP, 7,587-7,370 cal BC) attesting the attribution of these layers to the Sauveterrian phase of the Mesolithic. The first one refers to the end of the Preboreal and the second one to the Boreal.

The upper part of the sequence is characterized by layers of protohistoric (Bronze Age) and historic age. Concerning the latter, SU 11 yielded two roman coins respectively attributed to Emperors Theodosius I (388 - 393 CE) and Constantine I (306 - 337 CE) or Constans I (337 - 350 CE) that allow a *post quem* dating of this layer and the ones that cover it to the IV century A.D. (Fontana *et al.* 2005).

Methods

This study is focused on the analysis of the chert assemblages from the Mesolithic layers of site VFI-Sector III of Mondeval de Sora. A small quantity of hyaline quartz artifacts was also recovered from the same layers, but it will not be included in this analysis.

The chert assemblage has been studied according to the *chaîne opératoire* approach in order to reconstruct lithic reduction sequences from raw material procurement to discard. Non-orientable *debris*, burned items and items smaller than 5 mm have been separated and counted, while all other elements (*i.e.* retouched blanks and non-retouched blanks bigger than 5 mm and cores) have been singularly analyzed.

In order to reconstruct raw material procurement strategies, the geological sources of the exploited cherts have been identified by comparing geological and archaeological samples by naked eye and microscopic observations (with a Leica MZ6 microscope). The original shape of the raw material exploited has been reconstructed on the basis of cortical surfaces on blanks and cores.

The technological analysis of cores consisted in the description of the reduction methods, considering the relationship between striking platforms and flaking surfaces and the modality of reduction of the latter (frontal, *semi-tournant* etc.). Each blank has been described according to the phase and the specific role occupied in the reduction sequence. In order to identify the final objectives of *débitage*, production blanks have been defined according to simple typometrical data and to their morphology. Typometrical data (*i.e.* length and width) have also been noted for the scars visible on the core surfaces. Discard patterns have been reconstructed on the base of cores size, the phase of the reduction sequence in which reduction was interrupted and the cause that presumably led to their abandonment. In addition to technological analysis, retouched items have been classified according to Laplace's typological list (1964).

Results

The studied assemblage amounts to a total of 5,528 items diagnostic for the reconstruction of reductions sequences (Tab. 1).

Raw material provisioning

Considering the different Stratigraphic Units alltogether, most of the exploited raw material comes from the formations of Scaglia Rossa (45%), Maiolica (20%) and Scaglia Variegata (9%) outcropping on the southern slope of the Belluno Valley, in the Alpago and Longarone areas (Tab. 2) (Visentin *et al*. submitted). Furthermore, the exploitation of local Alpine cherts from the Livinallongo formation (8%) is attested.

Some variability concerns the cortical/non-cortical ratio between local and regional raw materials. The higher incidence of cortical elements on Livinallongo chert artefacts (20% against a 14% incidence of cortical elements on the whole assemblage) can be related to the introduction in the site of some non-prepared blanks of this raw material. The generally low incidence of cortical elements in the whole assemblage suggests that the raw material blanks were preferably carried into the site after a preliminary shaping.

The reduction sequence

Raw materials are mostly exploited as small sized blocks and portions of nodules (74% of the cortical blanks), but along the Mesolithic sequence the reduction of thick flakes is also constantly attested (18%). The higher incidence of cores on flake than of burins suggests that most of the items described as "burin spall" (*i.e.* bladelets with a triangular section detached from a flake edge) could actually correspond to the initialization of *débitage* on the edge of a flake.

The analysis of cores (Fig. 3: a, b) has allowed the identification of one main reduction sequence generally carried out from one single platform according to a *semitournant* method. More rarely, a frontal large or narrow modality from a single plain striking platform is also documented.

The production of *plein débitage* blanks was alternated to the removal of flakes (*sensu lato*) aimed at maintaining the flaking surface (*i.e.* removing scars of hinged flakes and reshaping of distal convexity through the removal of flakes from an opposite striking platform) and the lateral convexities of the cores (backed - often cortical - bladelets and flakes). When the striking platform morphology was no more fit to the extraction of blanks and/or problems occurred on the flaking surface, the platform could be reshaped through the removal of a rejuvenation flake or a *tablette.* Alternatively, the core was reoriented, allowing reduction from a platform which was either orthogonal or opposed to the original one, possibly with the opening of a new flaking surface.

Morphology of production blanks

Measures of the scars on the surfaces of the cores suggest that the *débitage* objectives were mostly represented by elongated blanks (length / width ratio > 2). Most of the scars fall in the length class between 16 and 20 mm (min. 7 mm, max. 22 mm). The objectives identified on the base of the blanks analysis are slightly different: flakes (length / width ratio < 2) and laminar flakes (length / width ratio >1.5 < 2) are better represented than elongated blanks and most products are characterized by length spanning between 11 and 15 mm, even if a wider variability is attested (min. 7 mm, max. 41 mm). The apparent contradiction between these data can be explained by an over-representation among blanks of items discarded as too small or not functional to the crafter's aims. We therefore hypothesize that production mostly focused on elongated items with dimensions spanning between 10 and 40 mm.

Tab. 1 *- VF1, sector III: artifacts from the Mesolithic series, divided by SUs and technological categories (the three shades of grey indicate the attribution of the single SUs to the three identified occupation phases listed from the most recent to the most ancient; the absence of a background is related to layers that cannot be attributed to a specific horizon). / VF1, settore III: manufatti dai livelli mesolitici suddivisi per UUSS e per categoria tecnologica (le tre tonalità di grigio indicano l'appartenenza delle singole UUSS alle tre fasi di occupazione identificate, dalla più recente alla più antica; quelli privi di sfondo non sono riferibili ad un orizzonte specifico della sequenza).*

	SU 10	SU 20	SU 30	SU 21	SU 32	SU 10 test	SU 29
Blanks	538	1,260	497	578	550	479	96
Cores	2	13	2	1	1	0	1
Retouched blanks	85	252	52	121	100	144	30
Waste elements from armatures manufact.	97	302	26	71	55	140	26
TOT.	722	1,827	577	780	706	763	153

Tab. 2 *- VF1, sector III: artifacts per SUs and raw material (geological formation). / VF1, settore III: manufatti suddivisi per UUSS e materia prima (formazione geologica di provenienza).*

	SU 10		SU 20		SU 30		SU 21		SU 32		SU 10 test		SU 29	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Maiolica	82	11%	422	23%	142	25%	174	22%	169	24%	114	15%	28	18%
Scaglia Rossa	179	25%	964	53%	277	48%	352	45%	303	43%	369	48%	65	42%
Scaglia Variegata	52	7%	201	11%	45	8%	84	11%	61	9%	44	6%	14	9%
Livinallogo	23	3%	133	7%	38	7%	67	9%	104	15%	47	6%	15	10%
Eocenic	2	0%	5	0%	-	-	1	0%	1	0%	-	-	2	1%
Undet.	384	53%	102	6%	75	13%	102	13%	68	10%	189	25%	29	19%
TOT.	722	100%	1,827	100%	577	100%	780	100%	706	100%	763	100%	153	100%

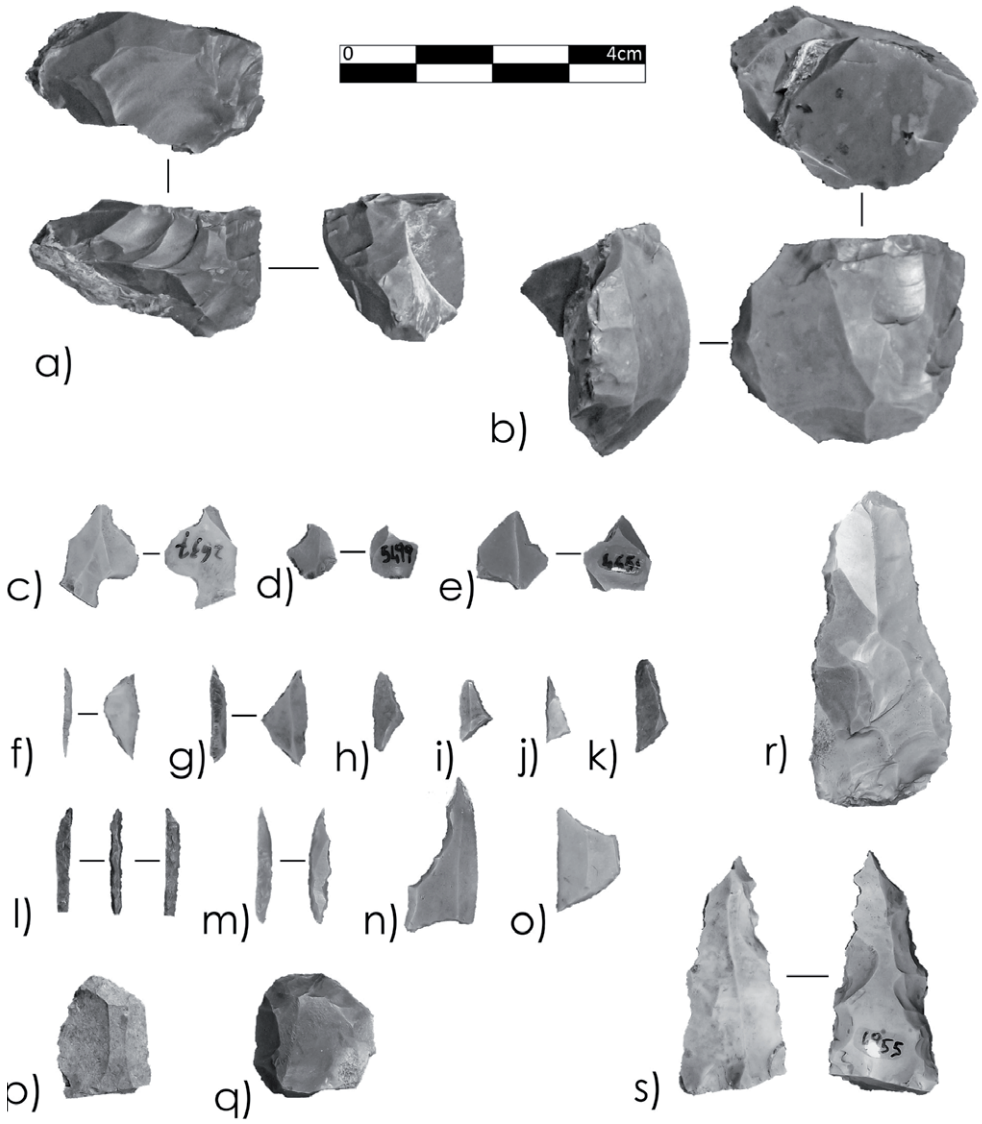

Fig. 3 *- VF1, sector III, lithic assemblage: cores (a, b), microburins (c, d, e), crescent (f), isosceles triangles (g, h), scalene triangles (i, j, k), backed points (l, m), scalene trapeze (n), isosceles trapeze (o), end-scrapers (p, q), retouched blade (r) and denticulate (s). / VF1, settore III industria litica: nuclei (a, b), microbulini (c, d, e), segmento (f), triangoli isosceli (g, h) , triangoli scaleni (i, j, k), punte a dorso (l, m), trapezio scaleno (n), trapezio isoscele (o), grattatoi (p, q), lama ritoccata (r) e denticolato (s).*

Transformation

When determined, the original blanks of microliths and end-scrapers are preferentially represented by flakes and bladelets from the production phase, while burins and other tools are obtained indifferently from any element of the reduction sequence (including cortical and maintenance flakes). The better represented typological categories are geometric and non-geometric microliths (87% of the whole retouched assemblage, Tab.3), while end-scrapers, burins and other tools have sensibly lower values (Tab. 4).

Most microliths (70%) are fragmentary. Among complete ones, the better represented types are scalene triangles (often with three retouched sides, Fig. 3: i, j, k), followed by crescents (Fig. 3: f) and isosceles triangles (Fig. 3: g, h). Backed points are mainly of the double backed type (Fig. 3: l, m). The presence of some trapezes (Fig.3: n, o) from SSUU 10, 20 and 21, probably due to an infiltration from above layers which were then destroyed by more recent occupations, attests that the frequentation of the site continued during the Castelnovian. Abrupt retouched flakes (Fig. 3: r) and truncations (generally with invasive retouch) are the best represented types among tools (Tab. 4). Burins are simple

***Tab. 3** - VF1, Sector III: typology of microliths for each Mesolithic SU. / VF1, Settore III: tipologia delle armature nelle diverse UUSS mesolitiche.*

	US 10		US 20		US 30		US 21		US 32		10 test		US 29	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Backed point	**4**	**5%**	**15**	**7%**	**2**	**5%**	**5**	**4%**	**3**	**3%**	**17**	**13%**	**2**	**8%**
Marginal (PD1)	-	-	-	-	1	2%	1	1%	-	-	-	-	-	-
Deep partial (PD2)	-	-	2	1%	1	2%	3	3%	1	1%	3	2%	-	-
Deep total (PD4)	4	5%	13	6%	-	-	1	1%	2	2%	14	11%	2	8%
Backed bladelet	**-**	**-**	**4**	**2%**	**1**	**2%**	**-**	**-**	**2**	**2%**	**1**	**1%**	**-**	**-**
Marginal (LD1)	-	-	3	1%	-	-	-	-	2	2%	1	1%	-	-
Deep (LD2)	-	-	1	0%	1	2%	-	-	-	-	-	-	-	-
Backed and truncated bladelet	**1**	**1%**	**6**	**3%**	**2**	**5%**	**4**	**4%**	**3**	**3%**	**-**	**-**	**-**	**-**
With single trucation (DT1, 3, 4)	1	1%	4	2%	2	5%	4	4%	2	2%	-	-	-	-
With double truncation (DT2)	-	-	1	0%	-	-	-	-		-	-	-	-	-
Backed and truncated point (DT7)	-	-	1	0%	-	-	-	-	1	1%	-	-	-	-
Geometric	**10**	**13%**	**38**	**17%**	**12**	**28%**	**16**	**14%**	**22**	**26%**	**26**	**21%**	**7**	**29%**
Crescent (Gm1, 2)	2	3%	12	5%	-	-	2	2%	5	6%	10	8%	2	8%
Scalene triangle (Gm3)	4	5%	23	10%	11	26%	12	11%	7	8%	6	5%	4	17%
Isosceles triangle (Gm4)	3	4%	2	1%	1	2%	1	1%	10	12%	7	6%	1	4%
Trapezes (Gm5, 6, 8)	1	1%	1	0%	-	-	1	1%	-	-	3	2%	-	-
Backed fragments (fD)	**54**	**71%**	**122**	**55%**	**20**	**47%**	**75**	**66%**	**44**	**51%**	**71**	**56%**	**14**	**58%**
Backed and truncated fragments (fDT-Gm)	**7**	**9%**	**36**	**16%**	**6**	**14%**	**13**	**12%**	**12**	**14%**	**11**	**9%**	**1**	**4%**
Backed and truncated	2	3%	24	11%	-	-	2	2%	5	6%	3	2%	-	-
Backed and truncated/ Geometric	5	7%	12	5%	6	14%	11	10%	7	8%	8	6%	1	4%
Tot.	**76**	**100%**	**221**	**100%**	**43**	**100%**	**113**	**100%**	**86**	**100%**	**126**	**100%**	**24**	**100%**

and on fracture, while end-scrapers are dominated by frontal short types (Fig. 3: p, q). Denticulates (Fig. 3: s) are mostly represented by a few notches. The presence of several microburins and other waste elements related to the manufacturing of backed microliths (Tab. 5, Fig. 3: c, d, e) suggests that the production of armatures was one of the main activities carried out in the site.

Discard

Discard patterns are attested by a few cores (n. 20). Their generally small size (length and width < 30 mm, thickness < 20 mm) suggests an intense exploitation, even if most of them are discarded before being completely exhausted. Only four cores appear so intensively reduced not to allow any further exploitation. Four cores, all

yielded by SU 20, were discarded during the shaping phase.

Diachronical evolution

Variation of some features among the assemblages yielded by SU 32 (first occupation phase) SU 21 (middle occupation phase) and 10-20-30 (latest occupation phase) suggests some chronological trends in the occupation of the site by the Sauveterrian groups.

Raw material analysis (Tab. 2) shows a higher percentage of local Livinallongo chert in SU 32 assemblage, as well as a higher incidence of cortical elements in this lithological class (*cf. supra*), indicating a provisioning strategy which was more reliant on local raw materials and with reduced preliminary shaping during the first phase of occupation. In addition, a higher reliance on the use of pebbles (12% of the determined original blanks, opposed to a mean value of 5%) as blanks for *débitage* is attested in SU 21 (*cf. supra*).

Some trends are also highlighted by the typological composition of the microliths assemblage (Tab. 3): in SU 32 isosceles triangles are the best represented (12%), while scalene triangles show lower values (8%); in the most recent phases a slight increase is recorded for scalene triangles (11% in SU 21 and in the latest phase), while isosceles ones suffer an abrupt drop (1% in SU 21 and 2% in the latest occupation phase). The percentage of backed points slightly increases, while no significant changes are observed among crescents. Although the number of elements is not very significant in statistical terms, a decline in the incidence of triangles retouched on the three sides (12/17 in SU 32, 6/13 is SU 21 and 20/44 in the latest phase, considering both scalene and isosceles triangles) has also been observed along the sequence.

The typometrical analysis has highlighted a decrease in the mean length of scalene triangles in the middle occupation phase (SU 21, mean length 8.5 mm), while this value is constant in the earlier (9.7 mm) and in the later phases (9.8 mm). The mean width is constant along the whole Mesolithic sequence (3.7 mm in the earlier phases, 3.6 mm in SU 21 and 3.8 mm in the later phase).

Typological analysis of the upper layers

The upper layers of the site, dated to the Bronze Age and the historical period, also contained rich lithic assemblages. Retouched artifacts from these layers have been the object of a preliminary typological analysis. This analysis has revealed a dominance of elements of Sauveterrian typology accompanied by some Castelnovian items and some artefacts of a more recent chronology such as a foliated point and a modern striker (Tab. 6). This aspect can be related to the occurrence of intense mixing events in the most recent phases of occupation of the site that caused severe disturbance of the upper portion of the Mesolithic sequence, which can be thus supposed to be originally more developed.

Tab. 4 *- VF1, Sector III: typology of tools for each Mesolithic SU. / VF1, Settore III: tipologia degli strumenti nelle diverse UUSS mesolitiche.*

	SU 10	SU 20	SU 30	SU 21	SU 32	SU 10 test	SU 29
Burins (B)	-	-	-	1	1	2	-
End-scrapers (G)	1	3	2	-	3	-	1
Truncated bladelets (T)	2	9	4	2	-	4	3
Borers (Bc)	-	-	-	1	1	1	-
Scrapers on blade (L)	-	1	-	-	1	1	-
Side-scrapers (R)	-	1	-	1	-	-	-
Abrupt-retouched flakes (A)	4	6	2	10	5	7	-
Denticulates (D)	1	5	1	-	2	1	2
Fragments with simple retouch (fS)	1	6	1	2	1	2	-
TOT.	9	31	10	17	14	18	6

Discussion and conclusions

The Mesolithic sequence of site VF1-sector III is attributed to the time span included between the end of the Early and the onset of the Late Sauveterrian (*i.e.* the Middle Sauveterrian) on the basis of the radiometric dates obtained from SSUU 32 and 10 (cf. *supra*). A Castelnovian phase of occupation seems also to be attested, as in sector I, although much less intense than the Sauveterrian one and with no possibility to distinguish it stratigraphically. A few items have thus been recovered in the upper Sauveterrian layers as well as in the layers belonging to most recent phases of occupation of the site that seal the Mesolithic series.

As far as the Sauveterrian occupation is concerned, techno-typological comparisons can be carried out with the sequences of two Alpine valley-bottom sites (Romagnano Loc III - Trento, TN and Galgenbühel-Dos de la Forca - Salorno, BZ) and two high-altitude camps (Mondeval de Sora VF1-sector I - S. Vito di Cadore, BL and Frea IV - Selva di Val Gardena, BZ).

The lithic series from Romagnano III (layers from AC 8: 9,200 ± 60 BP, 8,567 - 8,288 cal. BC to AC 3: 8,590 ± 90 BP, 7,938 - 7,486

Tab. 5 *- VF1, Sector III: waste elements from the manufacturing of armatures counted for each Mesolithic SU. Mb: microburins, Mbk: Krukowski microburins, If: notch associated to a fracture. For the definition of "notch flake" cf. Miolo & Peresani (2005). / VF1, Settore III: residui della fabbricazione di armature nelle diverse US mesolitiche. Mb: microbulini, Mbk: microbulini a dorso, If: incavi adiacenti a frattura. Per la definizione di scheggia d'incavo ("notch flake") si veda Miolo & Peresani (2005).*

	SU 10		SU 20		SU 30		SU 21		SU 32		SU 10 test		SU 29	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Mb	66	68%	201	67%	23	88%	49	69%	33	60%	105	75%	18	69%
Mbk	14	14%	50	17%	-	-	6	8%	4	7%	16	11%	5	19%
Double Mb	2	2%	11	4%	-	-	3	4%	-	-	3	2%	-	-
If	7	7%	15	5%	-	-	12	17%	13	24%	4	3%	3	12%
Notch flake	8	9%	25	8%	3	12%	1	1%	5	9%	12	9%	-	-
TOT.	97	100%	302	100%	26	100%	71	100%	55	100%	140	100%	26	100%

Tab. 6 - VF1, Sector III: list of retouched items and cores from the layers overlying the Mesolithic sequence. / VF1, Settore III: elementi ritoccati e nuclei dai livelli soprastanti la sequenza mesolitica.

	N	%
Burins	**2**	**0%**
End-scrapers	**10**	**1%**
Long end-scrapers	1	0%
Short end-scrapers	4	0%
End-scraper fragments	5	0%
Domestic tools (*outils du fond commun*)	**71**	**5%**
Truncated bladelets	34	3%
Notches	2	0%
Denticulates	2	0%
Side-scrapers	1	0%
Retouched flakes	5	0%
Fragments with simple retouch	27	2%
Backed microliths	**189**	**14%**
Backed points	63	5%
Backed bladelets	3	0%
Backed and truncated bladelets	10	1%
Crescents	12	1%
Isosceles triangles	22	2%
Scalene triangles	75	6%
Trapezes	4	0%
Backed fragments	**383**	**28%**
Backed fragments	320	24%
Backed truncated/Geometric fragments	63	5%
Foliates	**1**	**0%**
Gunflints	**1**	**0%**
Waste from armatures	**683**	**50%**
Incomplete backed pieces	5	0%
Microburins	548	40%
Krukowski microburins	52	4%
Notches associated to a fracture	27	2%
Notch waste	51	4%
Cores	**17**	**1%**
TOT.	1,357	100%

cal. BC) and Galgenbühel (from 9,275 ± 70 BP, 8,425 - 8,089 cal. BC to 8,560 ± 65 BP, 7,705 - 7,478 cal. BC) rock-shelters, both located at the bottom of the Adige valley, show several common features with Mondeval VF1-sector III, *i.e.* exploitation of regional raw materials, reduction sequences suited to the original shapes in which the raw material is available and aimed at the production of small irregular flakes and bladelets (Flor *et al.* 2011, Wierer 2008). In spite of the differences observed in the incidence of the diverse retouched artifacts classes, which reflect the specific functional vocations of the three sites (oriented towards the exploitation of resources from wet environments at Galgenbühel, Wierer & Boscato 2006), the diachronical trends highlighted at VF1-sector III in the evolution of the typological structure of the microliths assemblage (increase of scalene triangles and decrease of isosceles ones, decline in triangles retouched on three sides) also fit well those observed in the Middle Sauveterrian sequences of the other two sites (Broglio & Kozlowski 1984, Wierer 2008).

Tab. 7 - Ratios of retouched tools, cores and microliths in the lithic assemblages of Mondeval de Sora (VF 1-III and VF 1-I) and Plan de Frea (Frea IV). / Indici dell'incidenza di strumenti ritoccati, nuclei e armature negli insiemi litici dei siti di Mondeval de Sora (VF 1-III e VF 1-I) e di Plan de Frea (Frea IV)

	VF 1-III	VF 1-I	Frea IV
Microliths/tools (*fond commun*)	6.48	7.4	1.8
Microliths/Microburins	0.95	1.02	1.26

As to highland sites, at VF1-Sector I (Fontana & Vullo 2000, Fontana & Guerreschi 2005, Fontana *et al.* 2012) SU 8 has yielded a radiometric date of 9,185 ± 240 BP, 9,175 - 7,131 cal. BC (GX-21788). Several affinities can be recognized with Sector III concerning raw material economy (exploitation of regional and local cherts), technology (reduction sequence suited to the available raw material shape, unipolar reduction), objectives of the *débitage* (small irregular flakes and bladelets) and typology (assemblage dominated by microliths, especially triangles) (Fontana & Vullo 2000; Cavallari 2010-2011). Lastly, the high altitude rock-shelter of Frea IV is characterized by a well preserved stratigraphic sequence attesting the repeated frequentation of the site as a seasonal camp in the Sauveterrian (Angelucci *et al.* 1998). Particularly, the chronological span attested at VF1-III corresponds to phases F3 and F4 of Plan de Frea IV, which are attributed to the Early and Middle Sauveterrian respectively (between 9,016 and 7,502 cal BC) (Angelucci *et al*. 1998). The assemblages are similar to VF1-III for their technological features (production of irregular flakes and bladelets), typological composition (domination of retouched flakes over end-scrapers and of triangles over double backed points and crescents) and diachronical trends (increase of elongated scalene triangles and decrease of isosceles ones). In addition, the appearance of some trapezes in the upper part of the series attests that in both cases the sites were frequented until the Castelnovian phase of the Mesolithic. A comparison of the main typological indexes from the three sites shows that the lithic assemblages of VF1- sectors I and III appear "more specialised" and with a higher index of microliths over common tools and of microliths over microburins (Tab. 7) that those of Frea IV.

To conclude, the comparison of the three lithic assemblages and the cross-checking with data coming from the study of the faunal assemblages of Frea IV and VF1-I and taphonomy, use-wear and spatial distribution of VF1-I (Angelucci *et al.* 1998, Fontana *et al.* 2009), suggest to interpret these sites as specialised camps oriented towards activities related to the provisioning and exploitation of animal carcasses (preparation of hunting weapons, butchering of carcasses, recovery of fleshy portions, skin working etc.) with an additional residential function (Fontana 2011). The presence in the high altitude Alpine area of sites with more or less marked hunting vocations indicates an articulated settlement pattern with both camps as Frea IV, in which a wider array of activities were carried out (cfr. *supra*), and sites with a higher specialization as VF1-I and III.

Aknowledgments

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Short note

Excavations at the high altitude Mesolithic site of Pian de La Lóra (Val Civetta - Venetian Dolomites, Italy)

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Key words

- Late Mesolithic
- Venetian Dolomites
- hunting station
- seasonal mobility

Parole chiave

- Mesolitico Recente
- Dolomiti Bellunesi
- stazione venatoria
- mobilità stagionale

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Summary

The author describes the preliminary results from the excavations at the high-altitude Mesolithic site of Pian de La Lóra (Val Civetta - Venetian Dolomites, Italy). As showed, the systematic wet sieving of the archaeological deposit led to the discovery of a significant lithic assemblage, made of flint from the southern Prealpine belt and composed by more than a thousand unretouched artefacts, almost a hundred microburins, a few exhausted cores, well represented common tools and several armatures. Field research also brought to light a rare fire pit structure, whose charcoal remains were sampled for paleoenvironmental studies and radiocarbon dated at 7920±50 uncal BP (GrN-31265, 6230-6020 cal BC). Researches, still in progress, allowed the author to identify a Late Mesolithic hunting station, whose ephemeral occupation fosters new reflections on the last hunter-gatherers of northern Italy.

Riassunto

L'autore presenta i risultati preliminari degli scavi effettuati nella stazione venatoria d'alta quota di Pian de La Lóra (Val Civetta - Dolomiti Bellunesi). L'applicazione sistematica del vaglio ad acqua dei sedimenti scavati ha condotto alla scoperta di una ricca e variegata collezione litica prodotta su selce delle Prealpi Venete e culturalmente inquadrabile nel Mesolitico recente sud-alpino, comprensiva di migliaia di manufatti non ritoccati unitamente a nuclei, strumenti comuni, armature microlitiche e numerosi microbulini. Le ricerche hanno inoltre restituito una rara struttura di combustione a pozzetto, il cui contenuto è stato campionato per l'analisi archeobotanica e per l'ottenimento di una datazione radiocarbonica pari a 7920±50 uncal BP (GrN-31265, 6230-6020 cal BC).

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Site location

In July 2007, the Department of Humanities of Ca' Foscari University (Venice) in partnership with the "Gruppo Archeologico ARCA" of Agordo and the "Associazione Amici del Museo di Belluno", carried out the first season of excavations at the site of Pian de La Lóra, an open-air Mesolithic station located at 1930 m a.s.l. in the western fringe of the Civetta Group (Venetian Dolomites - Alleghe, Belluno Province) (Franco 2008) (Fig. 1). Field research, coordinated by the author, focused on a marginal moraine in southern Val Civetta, a spot surrounded by sandstone outcrops of the *Raibliano* formation (Castiglioni 1931), boulders, marshes and a seasonal basin (the eponymous "Lóra") where previous surveys had led to the collection of a few flint artefacts preliminarily attributed to a Late Mesolithic tradition (Cesco-Frare & Mondini 2006) (Fig. 2). This stage progressively entailed the opening of a 12 square meters trench at coordinates 46°22'15" N - 12°01'02" E (WGS84).

Fig. 1 *- Pian de La Lóra. Excavation area at the western fringe of the Civetta Group (photo by the author). / Pian de La Lóra. L'area degli scavi ai piedi del versante occidentale del Gruppo del Civetta (foto dell'autore).*

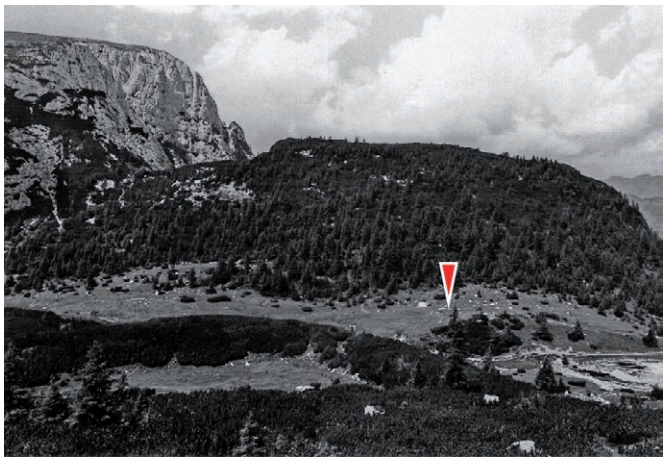

Fig. 2 *- Pian de La Lóra site location in Val Civetta (photo by the author). / Localizzazione del sito di Pian de La Lóra in Val Civetta (foto dell'autore).*

Researches

Since the beginning, research process involved systematic wet sieving of the excavated soil through 1,5 mm sieve mesh, taking advantage of an artificial stream flowing next to the site from a rainwater container at a higher elevation. After removing the topsoil, the archaeological deposit showed a maximum depth of 15-30 cm, depending on the excavated sector. Such variability was directly linked to the natural profile of the sterile base layer, made by an incoherent bed of limestone cryoclasts (Fig. 3). The whole excavation area then showed a basic pedo-stratigraphic profile: a very dark brown and clayish upper level (US1) and a light brown, thinner and slightly coarser lower lever (US2). Almost all the finds, represented only by charcoal fragments and lithic artefacts, emerged from the second one, which was referred to a single short-term occupation. Creating the conditions for later refitting and spatial analysis, flint artefacts recognized at sight in the trench were recorded according to their precise planimetrical coordinates and depth, while all the other finds recovered through wet sieving operations where simply recorded according to their 0,5 meter square of provenance.

Preliminary results

The accurate methodology applied in the excavations led to the discovery of a significant flint assemblage, whose richness and variety went far beyond expectations. Preliminary results from a detailed typological and typometrical analysis still to be published show the presence of more than 1200 unretouched lithic artefacts, most of which burnt or fragmented. As regards the complete specimens, they are mainly composed by microlithic and ipermicrolithic very flat modules, along with a few blades/bladelets whose features (regular, thin, sub-parallel edges) are clearly attributable to a *Montbani* style of production (Rozoy 1978). No pre-cores were found in the assemblage, while it is possible to count at least 5 small polyhedric or prismatic cores with one or two prepared platforms, generally exhausted. Retouched artefacts are equally shared between common tools and armatures. Significantly, the first group consists of 10 end-scrapers on a bladelet or blade-like flake, a single burin on a thick blade with simple *biseau*, one scraper on a flake with a bilateral retouch, a truncation on a bladelet and, most of all, 16 notched or retouched blades/bladelets. Along with them, the toolkit is completed by at least 10 asymmetrical trapezes on a blade/bladelet, 7 hypermicrolithic scalene triangles, one backed segment, one double-backed point and a few other microliths with a steep, abrupt retouch. Furthermore, the artefacts includes a couple of flint spherical hammer-stones and more than a hundred discards from the preparation of geometric projectile points (trapezes and triangles), divided into 89 microburins, 7 bladelets fractured at the notch and other typical residues of trapeze manifacturing/repairing (*chevrons*) (Franco 2013) (Fig. 4).

Supporting the chronological and cultural position of the surface finds earlier collected in the same area, the lithic collection recovered during excavations homogeneously belongs to the Late Mesolithic tradition that spread in Northern Italy between 7900 and 6600 uncal BP, during the Early Atlantic climatic phase. Recently, such preliminary attribution has been proved by radiocarbon dating a small fire pit (Structure 1) unexpectedly brought to light in the last days of the campaign and whose content, fully packed with charcoal fragments of different sizes, was sampled apart for further paleoenvironmental studies. The date obtained is 7290±50 uncal BP (GrN-31265, 6230-6020 cal BC) (Franco 2011), while first results from the archaeobotanical analysis suggest a clear proximity to an open spruce/larch woodland (Nisbet 2008, *pers. comm.*).

Fig. 3 - Pian de La Lóra. The excavation trench till the sterile base layer (photo by the author, from Franco 2008). / Pian de La Lóra. La trincea di scavo sino al livello sterile di base (foto dell'autore, da Franco 2008).

Discussion

Despite the total lack of faunal remains and bone/antler artefacts due to pedogenetical factors, the overall features of the flint assemblage reveal a strong specialization of the camp, where the local production of geometric arrowheads on blade/bladelet with the *microburin technique* seems to have been a regular activity in support of a hunting expedition. Observing this fact in the light of site location at the beginning of the Atlantic, namely in a high-altitude district rich in water sources and natural shelters, next to the ecotonal upper tree belt and crossed by strategical alpine routes (as nowadays), it is clear that Mesolithic hunter-gatherers settled in Pian de La Lóra during the good season, expanding their hunting-ground in phase with the annual upward migration of some gregarious ungulate species. This functional interpretation is shared with the close Mondeval de Sora VF1 site and many other coeval finds lately discovered in the same region (Alciati *et al.* 1992; Fontana & Pasi 2002; Fontana 2006).

Although site specialization can be easily understood, it does not seem to be as extreme as commonly seen in other Mesolithic high-altitude open-air stations. As seen above, along with armatures and microburins, other tools like end-scrapers and retouched blades/bladelets are in fact well represented in the lithic finds, fostering the idea that various support activities were carried out at the camp, like butchering or arrow crafting/repairing. In this case, the episode of occupation would result less ephemeral than usually thought but, following the research methods successfully applied at the Late Mesolithic alpine site of Laghetti del Crestoso (Bovegno, Brescia) (Baroni & Biagi, 1997), only use-wear analysis of the whole toolkit could solve the question.

So, where did those hunters come from? It's hard to say, but good hints are coming from the preliminary analysis of raw material used for lithic production. In fact, there are no traces of rock quartz in the whole assemblage, while good quality flint from the eastern Venetian Prealps and the Piave alluvial plain is the most represented. This indicates that either site inhabitants crossed those sectors along the year or they had an exchange relationship with groups who had direct access to southern flint outcrops. Both hypotheses are supported by dozens of Late Mesolithic sites already known from the Venetian prealpine/foothills belt to the plain "spring line", including the Montello area (Gerhardinger 1984-1985; Broglio & Paolillo 1989; Fontana *et al*. 2002; Cesco-Frare & Mondini *op. cit.*). By the way, raw material was collected as nodules or pebbles, probably from secondary deposits, and carried out in such a shape up to Pian de La Lora, as suggested by the presence of decortication waste among chipped artefacts.

Human presence in Val Civetta during the Early Atlantic has therefore to be analysed as a part of a much broader logistic system, reasonably extended from the Piave alluvial plain to the Dolomitic district (Grimaldi 2005) (Fig. 5). Within this system, conceivable as a wide tribal territory, all the Late Mesolithic finds suggest the existence of efficient social networks and non-random routes across seasonal supply areas and buffer zones. Besides, scientific results from Pian de La Lóra and the growing number of trapezoidal armatures collected in the surrounding region call into question the common idea of an unavoidable disertion of the Alps at this cultural stage, due to an increasing mountain forestation and consequent evolution of hunting strategies. As a matter of fact, latest archeological evidence from the Venetian Dolomites proves that Late Mesolithic bands

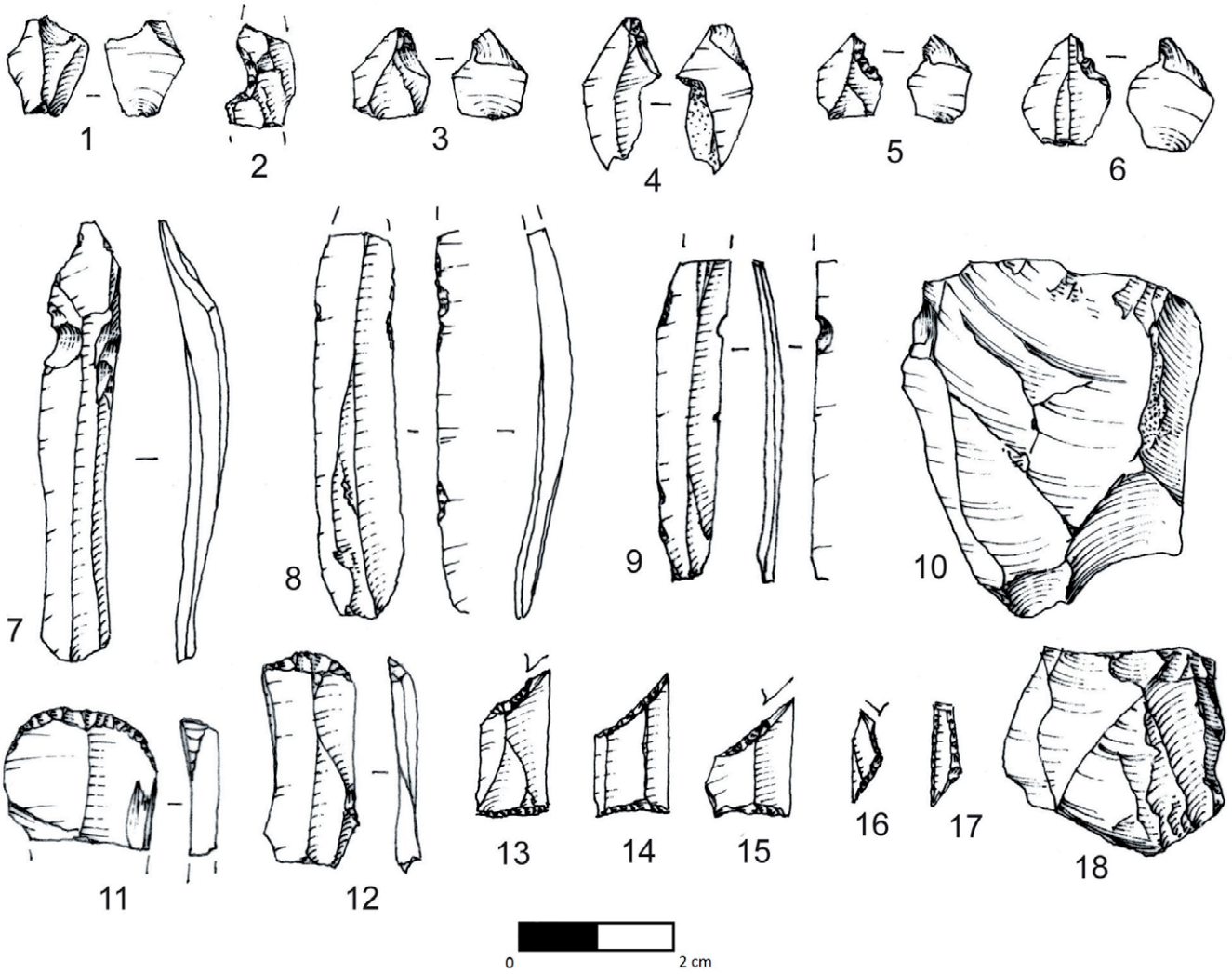

Fig. 4 - Samples from the lithic collection discovered during 2007 excavations: microburins (1, 3-6), bladelets fractured at the notch (2), retouched blades (7-9), end-scrapers (10-11), trapezoidal armatures (12-15), triangular armatures (16-17), cores (10, 18) (drawn by Almerigogna G. & Franco C., from Franco 2008). / Alcuni esempi delle industrie litiche rinvenute nella stagione di scavo 2007: microbulini (1, 3-6), incavi adiacenti a frattura (2), lame ritoccate (7-9), grattatoi (10-11), armature trapezoidali (12-15), armature triangolari (16-17), nuclei (10 e 18) (disegni di Almerigogna G. & Franco C., da Franco 2008).

still regularly exploited high-altitude hunting-grounds at the end of the VIII millennium uncal BP, moreover settling a territory where, at this point of field researches, lithic asseblages clearly attributable to Preboreal/Boreal hunters seem to be uncommon (Franco 2011). Nevertheless, many are the unsolved questions about the Late Mesolithic of North-Eastern Italy, where the archaeological visibility of hunter-gatherers societies seems to fade long before a stable settlement of Neolithic communities in the landscape (Biagi 2001, 2003). In such a context, Pian de La Lóra site fosters new reflections on this key phase, allowing to believe that other Mesolithic camp-sites are just waiting to be discovered in the examined area.

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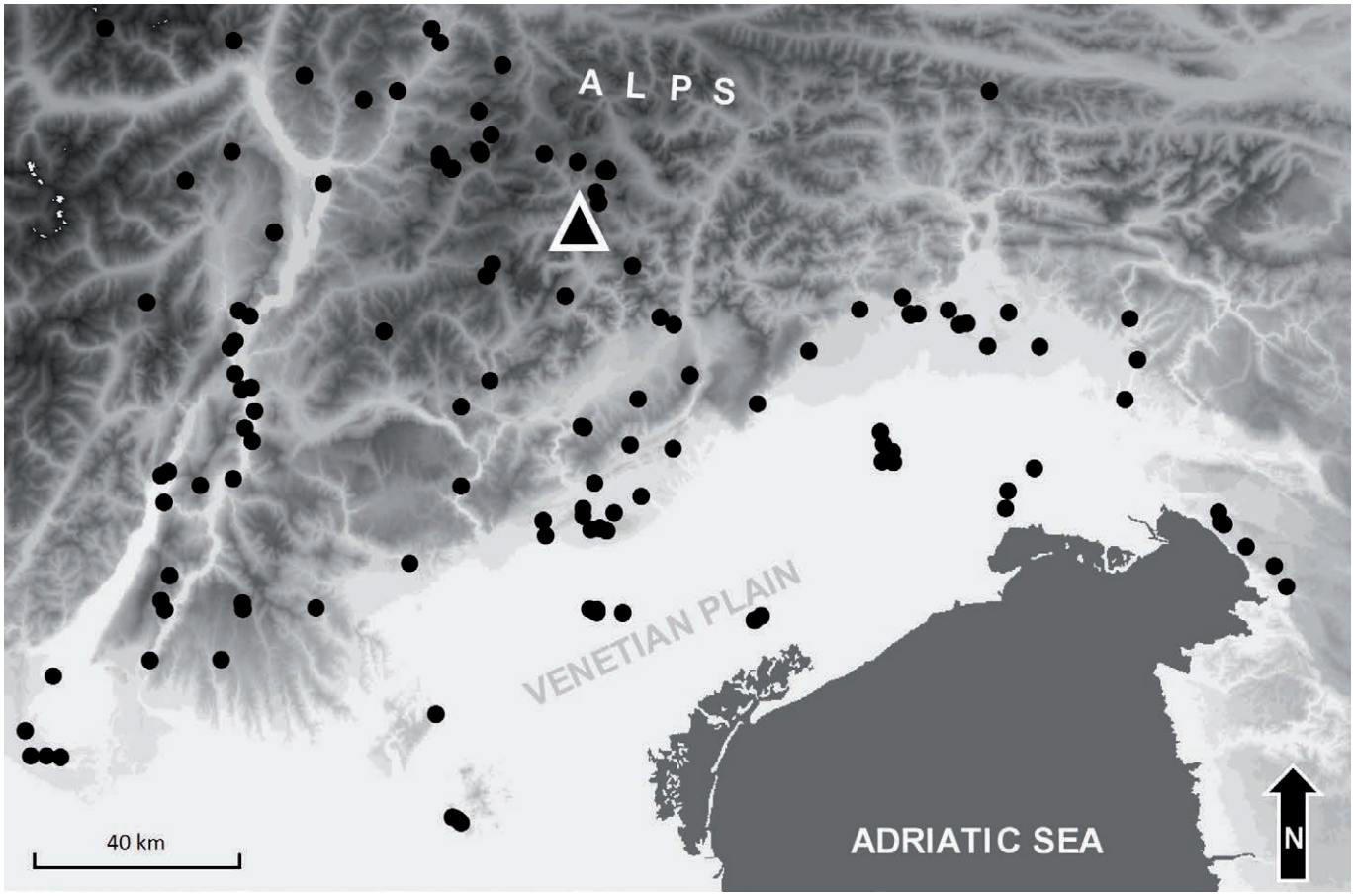

Fig. 5 *- Pian de la Lóra (triangle) in the context of the Late Mesolithic sites in North-Eastern Italy (dots) (graphics by the author). / Localizzazione di Pian de La Lóra (triangolo) nel contesto dei siti del Mesolitico Recente dell'Italia nord-orientale (cerchi) (elaborazione grafica dell'autore).*

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Article

Mesolithic findings from the area of the engraved boulders at Cemmo (Lombardia, Italia)

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Key words

- Mesolithic
- Sauveterrian
- lithic industries
- Lombardy
- Italy

Parole chiave

- Mesolitico
- Sauveterriano
- industrie litiche
- Lombardia
- Italia

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Summary

During the recent excavations carried out by the Soprintendenza per i Beni Archeologici della Lombardia close to the famous engraved boulders of Cemmo (Capo di Ponte, Brescia), an archaeological deposit was unearthed. The cultural sequence spans from the Early Mesolithic to the Copper Age. Among the lithic materials a Sauveterrian production has been identified. Mesolithic artefacts were found not only in primary deposition layers but also in other disturbed stratigraphic units containing intrusive Neo-Eneolithic artefacts.

Riassunto

Recenti ricerche nell'area dei massi incisi a Cemmo (Capo di Ponte, Brescia) effettuate dalla Soprintendenza per i Beni Archeologici della Lombardia hanno messo in luce lembi di deposito antropico sul quale poggiano i massi stessi. La sequenza culturale del deposito archeologico indagato si estende dal Mesolitico all'età del Rame. Tra i materiali litici è stata individuata una produzione di tipo sauveterriano che è stato possibile esaminare sia in porzioni di deposito in posto sia in altre contenenti materiali intrusivi neo-eneolitici.

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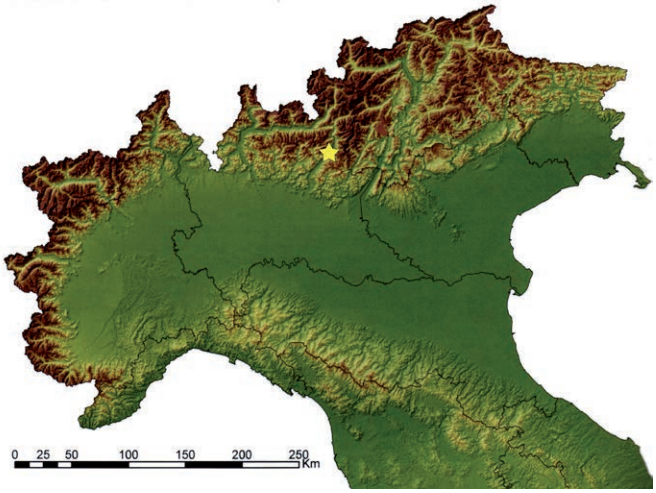

Fig. 1 *- Cemmo (Lombardy, Italy). Site location. / Localizzazione del sito.*

Introduction

The famous "Massi di Cemmo", two engraved boulders dating back to the Copper Age, are located in the little valley of Pian delle Greppe, North of Capo di Ponte (Brescia), around 400 metres a.s.l. (Figg. 1, 2, 3). Recent archaeological researches performed in the area around the boulders have brought to light an anthropogenic deposit on which the rocks themselves lie. This deposit has been the focus of a stratigraphic excavation by the Soprintendenza per i Beni archeologici della Lombardia. The cultural sequence of the archaeological deposits extends from Early Mesolithic to Copper Age (Poggiani Keller 1999-2000; 2009).

The lithic assemblage

Several *in situ* stratigraphic units underlying the Neolithic and Eneolithic layers have yielded lithic artefacts related to the Sauveterrian *facies*. Due to its paucity this Mesolithic assemblage is described here in its techno-typological and stylistic characteristics, which cannot be traced back to a typological structure (*sensu* Laplace).

The group *in situ* is composed of 35 retouched pieces, 3 cores, 19 microburins, 226 *débitage* products (prevalently *debris*, secondarily unretouched blanks, rejuvenation blades, cores shaping and maintenance blanks). A hypermicrolithic crescent, a centripetal core (Fig. 4, n. 7) and few hypermicrolithic microburins (Fig. 4, nn. 5-6) were found in secondary position.

Raw material, technology

Some of the few useful finds for a diagnosis of the sources of the raw materials (most of the artefacts have a heavy white patina) are made of high quality flints that, by macroscopic observations, seem to refer to Lombardy formations (Maiolica, Selcifero Lombardo, Medolo) whose closest known outcrops are found in the reliefs located South of Lake Iseo (Baroni & Biagi 1997) and South-East of Lake Garda (Barfield 1990). To these formations might refer some blanks extracted from small nodules and blocks gathered in areas not distant from the primary outcrops. Few items might be related to the Veneto-Trentino platform formations.

In brief, with the reserve due to the nature of the sample and the lack of specific studies about flint source availability in the areas surrounding the site, we hypothesize that a part of the exploited flints come from areas more than 40 kilometres from Cemmo.

Technological features

The reduction sequences are oriented to the production of hypermicro and microbladelets for the manufacturing of armatures of less than 10 mm in width. The rare larger laminar blanks (length over 35 mm) and the microflakes are used to make common tools. The main reduction scheme is recognizable in some bladelets and in a small core, connected to the same technical system: direct percussion, basic preparation of the striking platform, abrasion of the core overhang (Fig. 4, nn. 1-4, 8). To the same scheme can also be attributed a thick *tablette* from a *semitournant* core related to an initial phase of the core exploitation.

Retouched artefacts

The retouched assemblage (here described following Laplace's typology 1964) is represented by 7 armatures and 28 common tools. The size of common tools is micro (length 16-25 mm) and small (up to 50 mm); the hypermicro (up to 15 mm) items are very rare. The armatures are equally micro and hypermicro in size.

Fig. 2 *- Cemmo. The archaeological area of the engraved boulders (Archive of Paletnologia - Università di Firenze). / L'area archeologica dei massi incisi. (Archivio fotografico di Paletnologia - Università di Firenze).*

Fig. 3 *- Cemmo. The engraved boulders in the excavation area where the Mesolithic layers were found (Archive of Paletnologia - Università di Firenze). / I massi incisi nell'area dove sono stati intercettati gli strati mesolitici (Archivio fotografico di Paletnologia- Università di Firenze).*

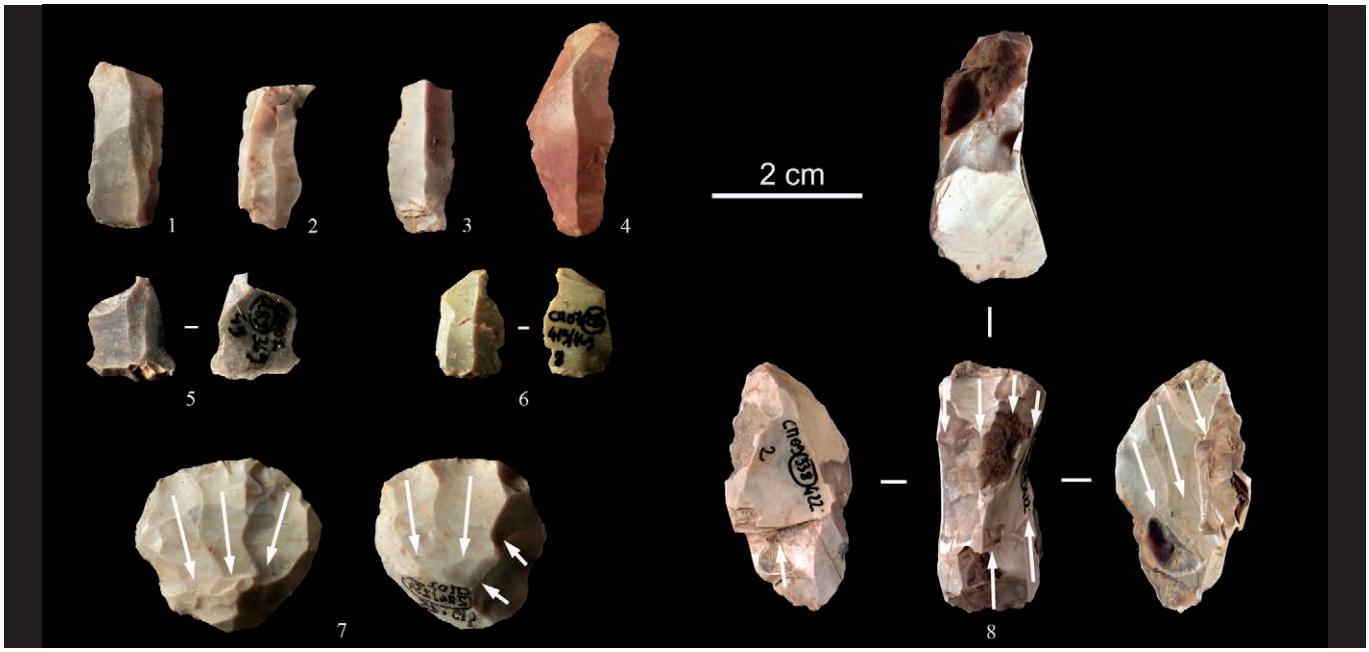

Fig. 4 - Cemmo. Sauveterrian lithic industry: 1-4 plein débitage bladelets; 5-6 microburins; 7-8 cores. (Photo D. Lo Vetro). / Industria litica sauveterriana: 1-4 lamelle di pieno débitage; 5-6 microbulini; 7-8 nuclei (Foto D. Lo Vetro).

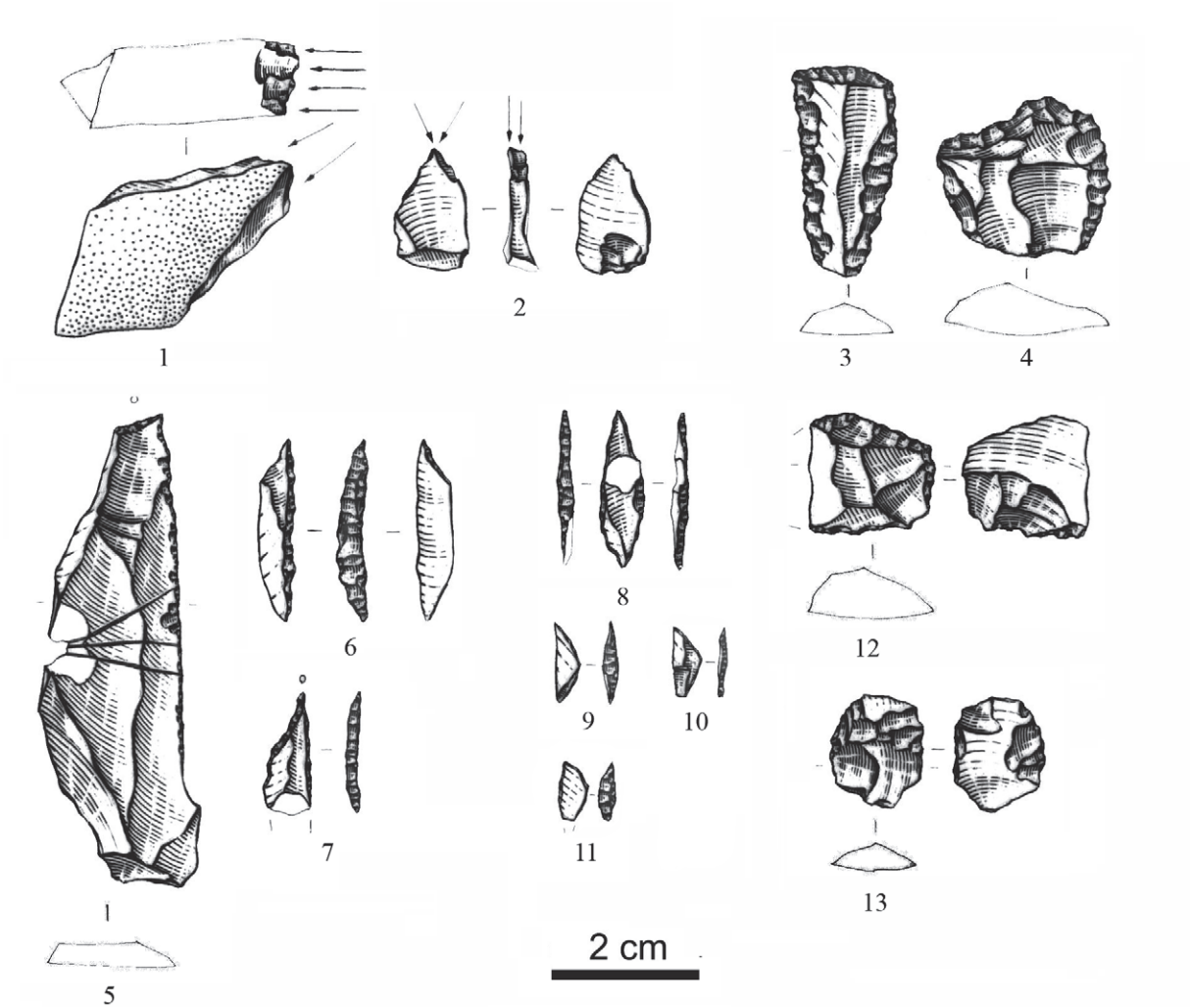

Fig. 5 - Cemmo. Sauveterrian lithic industry: 1-2-burins; 3-4 end-scrapers; 5-7 borers; 8-double backed point; 9-10 triangles; 11- crescent; 12-transversal scraper; 13- splintered piece (drawnings by L. Baglioni). / Industria litica Sauveterriana: 1 e 2-bulini; 3 e 4 grattatoi; 5-7 becchi; 8- punta a dorso bilaterale; 9-10 triangoli; 11- segmento di cerchio; 12- raschiatoio trasversale; 13- pezzo scagliato (disegni L. Baglioni).

Armatures

The typical double backed point (Sauveterre) is lacking; the geometric armatures are represented by crescents and triangles always carefully made. The armatures are listed below:

- convex double backed point (PD4), symmetric, made on a wide microbladelet (Fig. 5, n. 8)
- total unilateral rectilinear backed blade (LD2) on a narrow ipermicrobladelet
- partially retouched wide, microlithic crescent (Gm1)
- two crescents (Gm1) obtained from two narrow ipermicrobladelets (Fig. 5, n. 11)
- scalene triangle (Gm3) on a wide microbladelet (Fig. 5, n. 10)
- scalene triangle (Gm3) on a narrow ipermicrobladelet (Fig. 5, n. 9)

Common tools

The burins category consist of 3 items: one Simple axial burin (B2), one single angle burin (B3) and one probable retouched burin with oblique facet (B7). These burins are not accurate and made on flake (Fig. 5, nn. 1-2). The two end-scrapers consist of a item on a blade (G2), with rectilinear scraping edge, and a short item (G4), on a wide flake with a very irregular asymmetrical scraping edge (Fig. 5, nn. 3-4). Two of the three borers are made on microbladelets (Fig. 5, nn. 6-7); these items are very similar, in shape and size, to the armatures.

The other tools share the partial and rough shaping, as well as a more or less peripheral retouch; this is the case of the blade-scrapers (8 items, all asymmetrical: six with inframarginal retouch, two with marginal retouch) and the flake-scrapers (5 items), as for two fragments of a blade/flake-scraper, for the two abrupt retouched flakes, for the two denticulates (a scraper and an end-scraper) and for the splintered piece (Fig. 5, 13). Among the common tools significant is a transversal scraper (*Skrobacz*) whose morphology tends to subtectiform end-scraper (Fig. 5, n. 12).

The Mesolithic assemblages of Cemmo generically fit the Northern Mesolithic complexes of Sauveterrian facies, the evidence of which is also attested in Valcamonica at Cividate Camuno site (Martini *et al.* this volume).

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Article

Mesolithic frequentation at Cividate Camuno - Via Palazzo (Brescia - Italy)

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Key words

- Mesolithic
- Sauveterrian
- Italian pre-Alpine region
- lithic industry
- use-wear analysis

Summary

Researches carried out between 1987 and 1995 during the restoration of a Roman domus in Via Palazzo, in the old town centre of Cividate Camuno, in Valle Camonica (Brescia - Italy), discovered the presence of underlying prehistoric levels dating back to the Upper Palaeolithic, Mesolithic, Middle-Late Neolithic and Bell Beaker culture. The authors present the results of the typological study and use-wear analysis of the Sauveterrian lithic assemblage (SU 282).

Parole chiave

- Mesolitico
- Sauveterriano
- area prealpina
- industria litica
- analisi delle tracce d'uso

Riassunto

Le indagini archeologiche condotte tra il 1987 e il 1995 contestualmente ai lavori di restauro di una domus romana in Via Palazzo nel centro storico di Cividate Camuno, in Valle Camonica (Brescia), hanno messo in luce una importante sequenza stratigrafica che comprende livelli del Paleolitico superiore, Mesolitico, Neolitico medio-finale ed Eneolitico (Cultura del Vaso Campaniforme). Gli Autori presentano i risultati dello studio tipologico e quello sulle tracce d'uso compiuti sull'industria litica proveniente dal livello di frequentazione del Mesolitico di facies sauveterriana (US 282).

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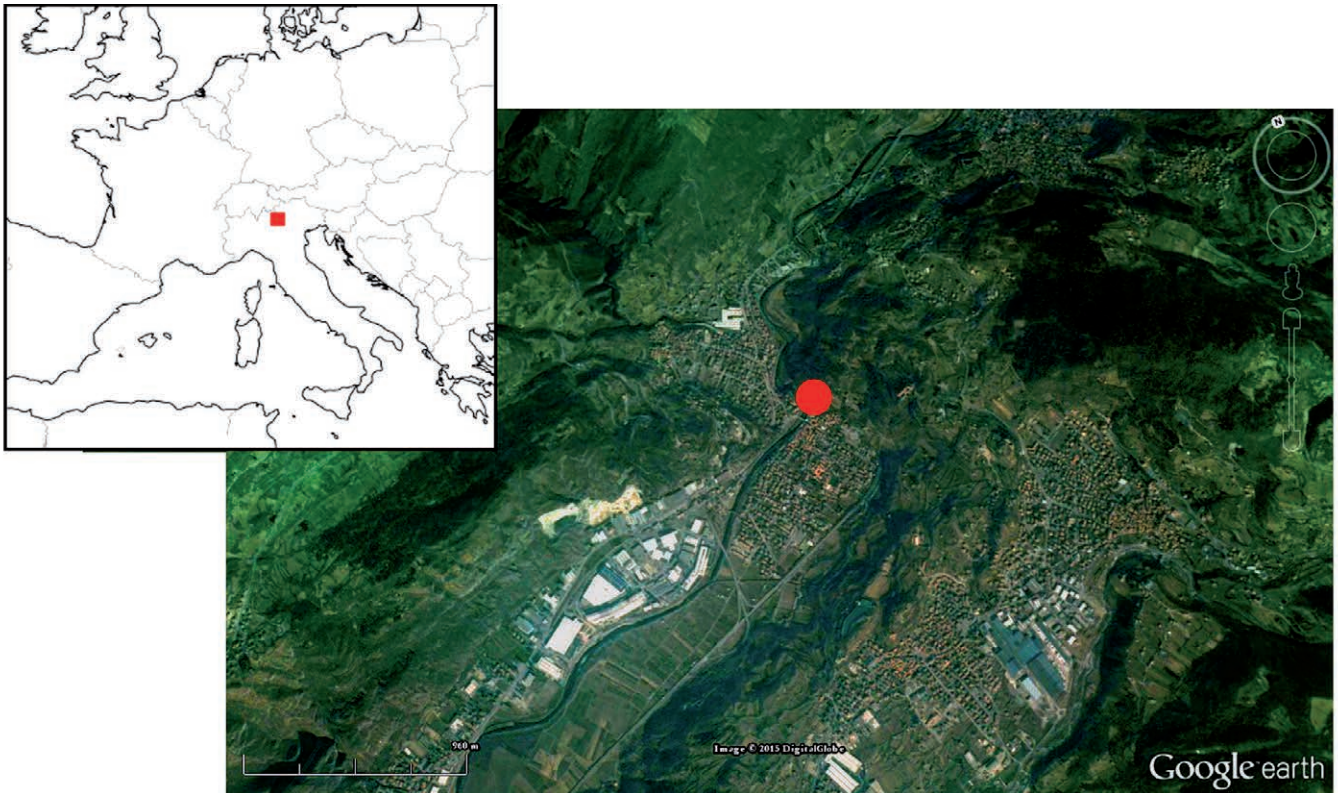

Fig. 1 - Geographical framework of the Cividate Camuno site. Satellite photo from Google Earth. / Localizzazione geografica del sito di Cividate Camuno. Foto satellitare da Google Earth.

Fig. 2 - Cividate Camuno. General view of the excavation area (photo Soprintendenza per i Beni archeologici della Lombardia). / Veduta generale dell'area di scavo (foto Soprintendenza per i Beni archeologici della Lombardia).

Introduction

The Mesolithic settlement of Cividate Camuno (middle Valle Camonica - Brescia), came to light in 1987 during investigations carried out at the same time as the restoration of a Roman *domus* in Via Palazzo, the historic centre of Cividate Camuno (Fig. 1). The site is located near the left bank of the river Oglio, at the base of a cliff which stands as an isolated rock in the plain (Fig. 2). It is a valley bottom site (as the not so far Cemmo site, see Martini *et al.* this volume) which adds itself to the contemporary evidence found in neighbouring mountain areas (see Paolo Biagi's research, Biagi *et al.* 1994). Archaeological research has revealed different levels of human presence: Upper Palaeolithic and Mesolithic phases, a Middle-Late Neolithic phase and a Copper Age level, that of the Bell Beaker culture. The excavation was directed by the Soprintendenza Archeologica della Lombardia in three campaigns: 1988, 1992 and 1995 (Poggiani Keller 1990, 1996, 1999, 2003). We mention the presence of a Palaeolithic structure (5.60 m diameter) dated to 13,805 ± 440 BP (Baglioni & Martini 2009).

In 1992 a Mesolithic level of frequentation (SU 282) was investigated (Fig. 3), south of the Palaeolithic structure. The level, extending over a sub-triangular area of 5 m^2 (Fig. 4), did not show clear structural elements and has been partly compromised by Historical Age structures. The associated faunal remains were quite scarce (Fusco, 1990). The radiometric chronology: 8,820 ± 112 BP (GX-18843 AMS/1993, Geo. Lab. Krueger Int., Cambridge, Massachusetts), 8,235-7,612 cal BC (2 σ).

The lithic industry

The lithic industry includes 1,245 elements, among which 310 retouched tools (313 Laplace's primary types), 27 cores,

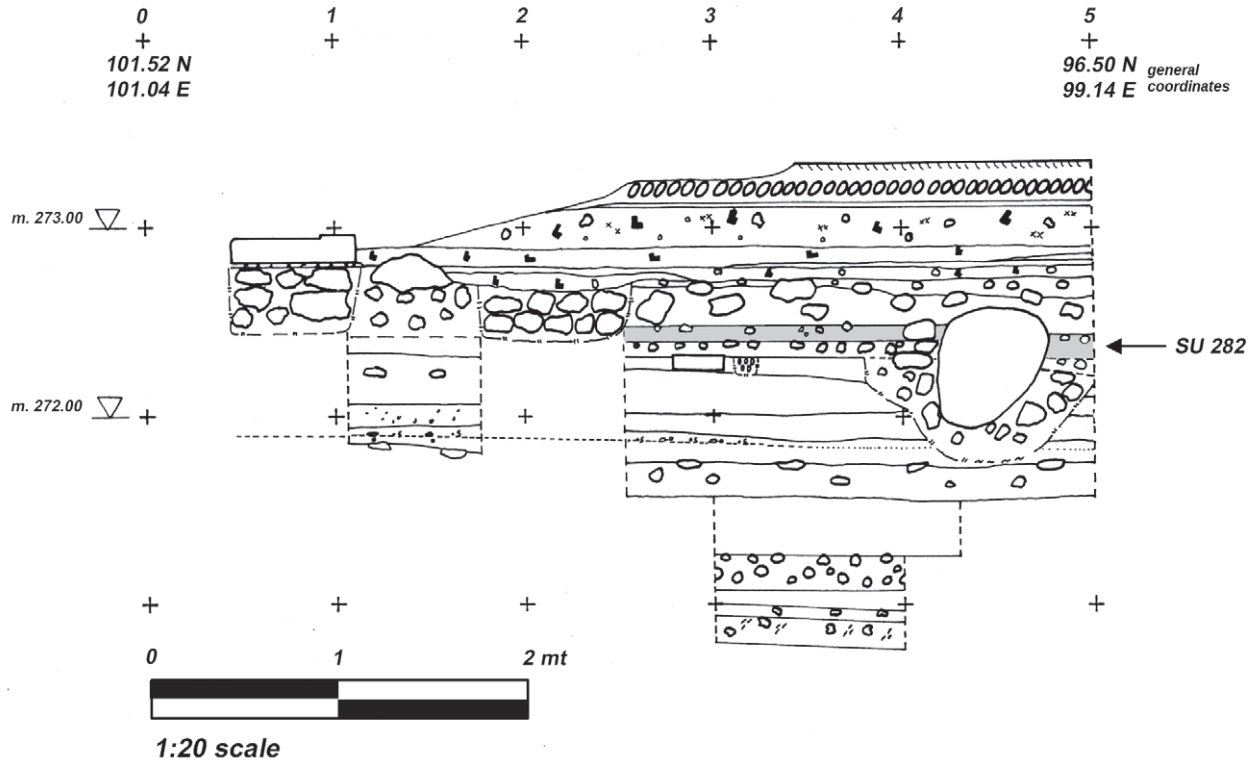

Fig. 3 - Cividate Camuno. Stratigraphy with the Mesolithic layer - SU 282 (drawing Soprintendenza per i Beni archeologici della Lombardia). / Stratigrafia del deposito con il livello mesolitico - US 282 (disegno Soprintendenza per i Beni archeologici della Lombardia).

Fig. 4 - Planimetry of the Mesolithic layer - SU 282 (drawing Soprintendenza per i Beni archeologici della Lombardia). / Planimetria del livello mesolitico - US 282 (disegno Soprintendenza per i Beni archeologici della Lombardia).

603 un-retouched pieces and 305 microburins[1]. It shows structural and techno-morphological characteristics related to the Northern Mesolithic-Sauveterrian facies complexes, with elements connected to other groups of the Middle-Recent Sauveterrian phase and peculiarities which are described here below.

Typological analysis

Burins: structurally not important (Tab. 1), they are characterized by unelaborated subtypes (Fig. 5, 1).

End-Scrapers: are few, but rank third in the total industry. They have mostly short and large morphologies (G3 and G4 *sensu* Laplace 1964; X and XI classes *sensu* Broglio & Kozlowski 1983) (Fig. 5, 2 and 4-5), also with convergent edges at the base; we note the presence of one ogival hyper-microlithic example (XVI class *sensu* Broglio & Kozlowski 1983) (Fig. 5, 3). The roof-shaped, shoulder or nose-ended scraper morphologies, characteristic of the Sauveterrian Alpine aspects, are absent. Micro and hyper-microlithic sizes are prevalent.

Truncations: there is a high incidence of Truncations (these artefacts represent the abrupt retouched tools), with a prevalence of oblique types made on flakes or bladelets; sizes are very small (Fig. 6, 50-60). Hyper-microlithic, carefully made truncations characterized by regular, sub-triangular or sub-quadrangular shapes are significant (Fig. 6, 53-57). They should be considered as armature types. We note among the oblique truncations a few specimens of large elements that could be considered as armatures (truncation/point *sensu* Broglio & Kozlowski 1983) (Fig. 6, 50-52).

Backed Points: they are obtained from hypermicro- or microbladelets and occasionally from flakes (Fig. 6, 1-13). The totally backed type prevails, with bilateral subtypes (Fig. 6, 4-13) more numerous than unilateral ones (Fig. 6, 1-3). The long bipoint or monopoint cfr. *Sauveterre*, narrow or very narrow (widths between 2,7 and 3,9 mm) is predominant (Fig. 6, 4-5, 8-12). There are also triangular-shaped, small-sized elements, with large bases (Fig. 6, 6-7).

Backed Blade: these are rare specimens, all with deep retouch (LD2 *sensu* Laplace 1964). They have a very diversified morphology, with sub-parallel or convergent edges, either wide or narrow. A common feature is the partial retouch.

Backed and Truncated Tools: they consist largely of examples with obtuse truncation (DT4 *sensu* Laplace 1964) and convergent edges/triangular morphology (scalene), with only one backed, regular or irregular shape (Fig. 6, 14-18).

Geometrics: the group is characterized by hypermicrolithic triangular armatures (Fig. 6, 26-49), primarily scalenes (27 cases) (Fig. 6, 26-38) and secondarily isosceles (13 cases) (Fig. 6, 39-49. Among the scalenes the long form is more numerous than the short form, and the long form with long base prevails; only one element has 3 retouched edges (Fig. 6, 38). Among the isosceles the short form prevails; only one element has 3 retouched edges (Fig. 6, 49). Irrelevant is the number of crescents (short and long) (Fig. 6, 19-22), with the second edge retouched, and trapezoidal segments, all short (Fig. 6, 23-25).

Substratum: within the Substratum *sensu* Laplace, 1964 which is structurally important, the *flake scrapers* prevail, often partially and marginally retouched. There are some hyper-microlithic elements with semi-backed retouch (Fig. 5, 12-13). The *blade scrapers* have mostly marginal retouch (Fig. 5, 6-7). Usually the morphology is asymmetric or with subparallel edges; exceptional are the more regular or symmetrical morphologies. Among the *Abrupts*, structurally unimportant appear the hyper-microlithic armatures (length <10 mm), in quadrangular regular shape, with transversal retouch, rectilinear and also oblique (Fig. 6, 61-65). About the *Denticulates* (Fig. 5, 8-11), slightly significant, we note a partial and rough denticulation with less invasive retouch (Fig. 5, 8).

Tab. 1 - Cividate Camuno SU 282. Typological Structure (sensu Laplace 1964). / US 282. Struttura tipologica (sensu Laplace 1964).

Typological groups	nr.	%
Burins	***6***	***1.91***
End-scrapers	***12***	***3.83***
Abrupt retouched tools	***168***	***53.7***
Truncations	58	18.65
Borers	8	2.55
Backed points	26	8.3
Backed blades	5	1.59
Backed truncated tools	7	2.23
Geometrics	48	15.33
Indeterminate baked tools	16	5.11
Flat retouched tools	***1***	***0.31***
Substratum	***114***	***36.43***
Points	1	0.31
Blade scrapers	24	7.66
Flake scrapers	34	10.86
Indeterminated scrapers	5	1.59
Abrupts	22	7.02
Denticulates	28	8.94
Splintered tools	***6***	***1.91***
Fr.Simple mode	***3***	***0.95***
Fr. Abrupt mode	***3***	***0.95***
Total	***313***	***100%***

Use-Wear analysis

A detailed use-wear analysis of the lithic assemblage from the Mesolithic layer (SU 282) of the Cividate Camuno site has been carried out; this study had the objective of assessing the type of productive activities carried out at the site and, in turn, contribute to the understanding of how the different typological groups were employed[2]. A total of 552 elements has been selected for the analysis, including all the unretouched and retouched tools, except *debris*, indeterminate waste materials and heavily burned materials. For what concerns microburins, a sample of 29 implements has been included. The remaining part of the sample is composed of 47 core trimming elements, 9 burin spalls, 263 flakes, 177 bladelets and 27 cores or core-fragments. As a result of the microscopic observation, a totality of 117 used tools has been identified, corresponding to 118 active zones. A resume of the results is provided in Tab. 2 and Tab. 3.

The outcome of the analysis indicates that all the inferred activities are related to hunting and game slaughtering and processing. Projectile tools represent the largest group among the used tools

1 The technological study and the analysis of microburins and cores are still in progress.

2 The analysis has been carried out at the Laboratorio di Archeometria of the Museo e Istituto Fiorentino di Preistoria, following the standard procedure of the use-wear analysis (see Marreiros et al. 2014). A Nikon SMZ-2T stereoscopic microscope (5x-40x) has been employed for the analysis of the macro-traces, while a reflected-light microscope Olympus BX51 (50x-500x) has been used for the observation of the microscopic features.

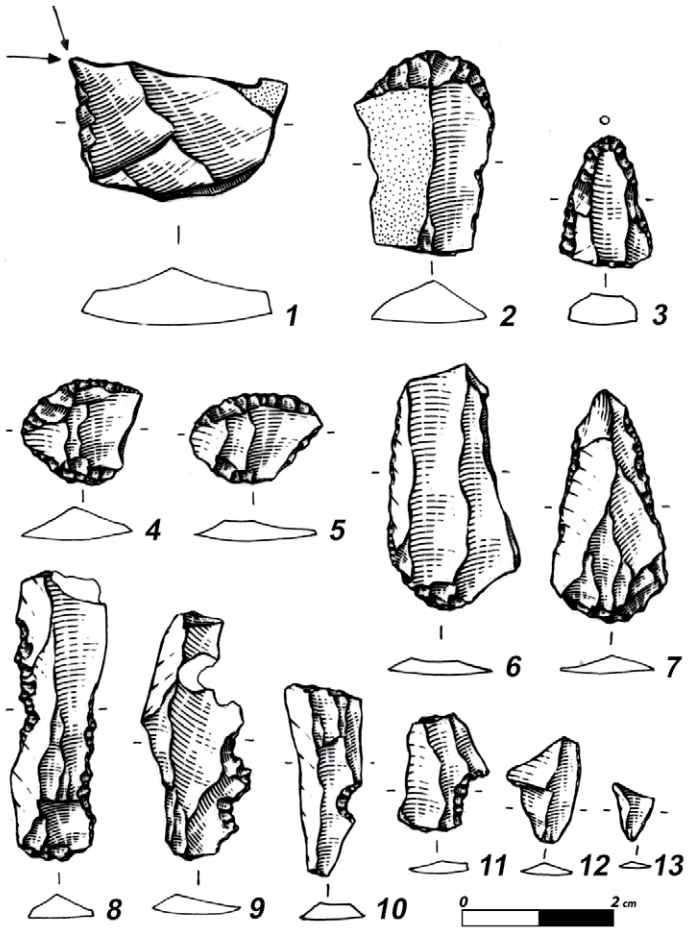

Fig. 5 *- Cividate Camuno, SU 282. 1 Burin; 2-5 End-scrapers; 6-7 Blade scrapers; 8-11 Denticulates; 12-13 Flake scrapers (drawings 1:1 by L. Baglioni). / US 282. 1 Bulino; 2-5 Grattatoi; 6-7 Raschiatoi lunghi; 8-11 Denticolati; 12-13 Raschiatoi corti (disegni di L. Baglioni, scala 1:1).*

(44,9%), followed by tools used for hide-processing (16,1%) and tools used butchering (12,2%), while traces associated to bone/antler (4,2%) and vegetal materials (1,7%) are more scarcely represented. It must be remarked that butchering tools should be considered under-represented in the analysed assemblage, being the preservation of their use-wears more complicated; indeed, a relevant part of the indeterminate materials (20,3%) can be probably associated with butchering processes. The other way around, crafting activities are almost absent in the assemblage; the few traces associated with the work of bone/antler, wood or dry-hide are scarcely developed, probably produced by brief maintenance tasks and not of prolonged and intense craft activities.

From a techno-typological point of view, there are several aspects that should be remarked. Among the backed tools, which amount to 102 elements, *Backed Points* (18 cases; 15,3%) and *Geometrics* (16 case; 13,6%) are the types more systematically used as projectiles (see Tab. 3). However, the ratio of used implements is probably higher than the value here expressed; experimentally it has been proved that only a reduced percentage (between 20% - 40%) of projectile tips develop diagnostic impact marks (Fischer *et al.* 1984; Domingo 2005; Lo Vetro *et al.* 2009; Pétillon *et al.* 2011). Impact marks are represented by tiny bending/step, spin-off and/or burin-like fractures, often in reciprocal association on the same tool. Fracture dimensions averagely oscillate between 1-2 mm, but considering the hyper-microlithic dimensions of the tools it appears a reasonable wear pattern. When impact traces are present, their directionality and distribution indicates that both geometric and backed tools were mainly used as tips, probably hafted on the extremity of the arrow shaft (7, a-b). Also several truncations (T1 and T3 *sensu* Laplace 1964) have been used as projectile tools, especially the hyper-microlithic elements. Nevertheless, in this case they are mainly employed as side elements, probably hafted parallel to the shaft (Fig. 7, c). This data seems to suggest the use of weapons with different design, possibly including composite projectiles.

Finally, for what concerns the other typological classes, blade and flake scrapers are mainly used for butchering (Fig. 7, h-1); denticulates (Fig.6, g) and burins are mainly used for working hard indeterminate and bone/antler materials (in the case of the burins the active zone is not the dihedral angle but the newly formed dorsal ridge) (Fig. 7, f), while end-scrapers are associated with the scraping of hide (Fig. 7, d-e), in particular for the first stages of hide working, such as the skinning and fleshing phases, related to the removing of animal fat, muscles and all adipose tissues.

In conclusion, gathered data points out toward an interpretation of Cividate Camuno as a temporary or secondary camp where the main activities were represented by the production and maintenance of the weaponry and the first processing of games; as a result it could be hypothesized the existence of intermediate sites between the so-called residential sites and the hunting stations or

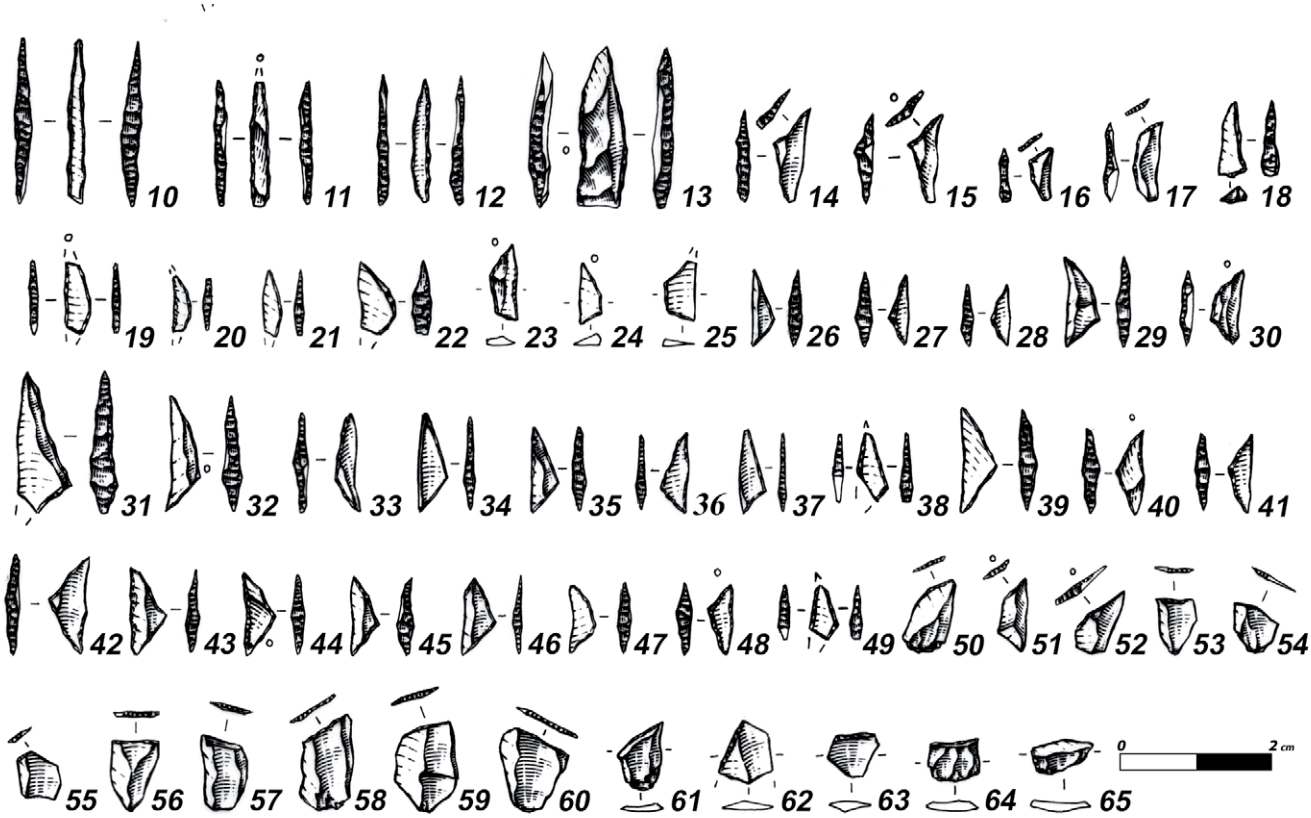

Fig. 6 - Cividate Camuno, SU 282. 1-13 Backed point; 14-18 Truncated backed tools; 19-25 Segments; 26-49 Triangular armatures; 50-60 Truncations; 61-65 Abrupts (drawings 1:1 by L. Baglioni). / US 282. 1-13 Punte a dorso; 14-18 Dorsi troncati; 19-25 Segmenti; 26-49 Triangoli; 50-60 Troncature; 61-65 Erti indifferenziati (disegni di L. Baglioni, scala 1:1).

Tab. 2 - Count (Σ) and relative percentages (%) of active zones (AUAs) for each typological groups. Typological categories from Laplace (1964). / Somma (Σ) e relative percentuali (%) del numero di zone attive (AUAs) per ciascun gruppo tipologico (sensu Laplace 1964).

Typological groups	AUAs (Σ)	AUAs (%)
Abrupt retouched tools	58	49.2
Backed truncated tools	4	3.4
Backed points	16	13.6
Backed blades	1	0.8
Geometrics	18	15.3
Indeterminate baked tools	4	3.4
Truncations	15	12.7
Abrupts	3	2.5
Burins	4	3.4
Borers	5	4.2
Denticulates	4	3.4
Splintered tools	1	0.8
End-scrapers	10	8.5
Blade scrapers	12	10.2
Flake scrapers	9	7.6
Unretouched tools	12	10.2
Total	***118***	***100%***

Tab. 3 - Count (Σ) and relative percentages (%) of active zones (AUAs) for each class of worked material. BU: butchering actvities; HA: hard animal materials (bone/antler); HI: hide; HI-DR: dry hide; HI-FR: fresh hide; HI-INDET: hide indeterminated; INDET: indeterminate material of various hardness; HH: hard indeterminate; MM: medium hardness; SF: Soft indeterminate; PY: projectile tool; VG: vegetal material (plant/wood). / Somma (Σ) e relative percentuali (%) del numero di zone attive (AUAs) per ciascuna classe di materiali lavorati. BU: Tracce di macellazione; HA: Materiali duri di origine animale (ossa/corno); HI: pelle; HI-DR: pelle secca; HI-FR: pelle fresca; HI-INDET: pelle in stato indeterminato; INDET: materiali indeterminati di diversa durezza; HH: materiali duri indeterminati; MM: materiali di media durezza; SF: materiali poco resistenti; PY: tracce d'impatto; VG: materiali di origine vegetale (piante/legno).

Activities	AUAs (Σ)	AUAs (%)
BU	15	12.7
HA	5	4.2
HI	19	16.1
HI-DR	3	2.5
HI-FR	10	8.5
HI-INDET	6	5.1
INDET	24	20.3
HH	15	12.7
MM	5	4.2
SF	4	3.4
PY	53	44.9
VG	2	1.7
Total	***118***	***100%***

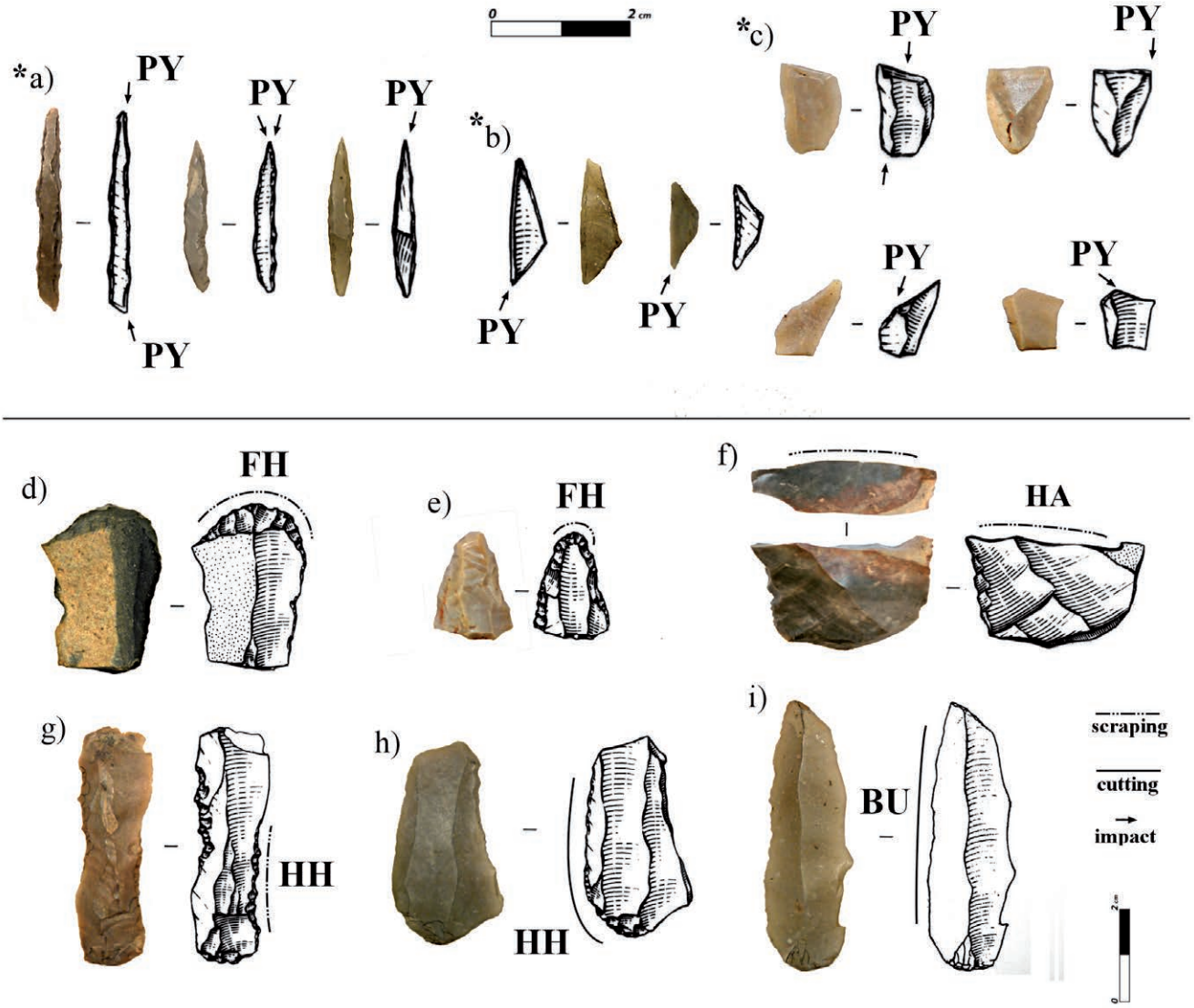

Fig. 7 - Cividate Camuno, SU 282. Selection of tools with use-wear traces. Microliths: a) Backed points; b) Geometrics; c) Truncations. Common tools: d-e) End-scrapers; f) Burin; g) Denticulate; h-i) Blade scrapers. PY: Projectile impact traces; FH: Fresh hide working traces; HA: Hard animal traces (bone/antler); HH: Hard indeterminate material traces; BU: Butchering traces. / US 282. Selezione di strumenti con tracce d'usura. Armature: a) Punte a dorso; b) Geometrici; c) Troncature. Strumenti comuni: d-e) Grattatoi; f) Bulini; g) Denticolati; h-i) Raschiatoi su lama. PY: Tracce da impatto; FH: Pelle fresca; HA: Materiali duri di origine animale (ossa/corno); HH: Materiali duri indeterminati; BU: Tracce di macellazione.

encampments (Broglio & Lanzinger 1990; Broglio 1995). Still, the scarcity of Early Mesolithic sites in the Lombardia region makes it difficult to prove such an idea. Future works, including a broader sample of comparison sites, will explore this possibility.

Discussion and conclusions

The lithic group of Cividate Camuno fits among the Northern Mesolithic-Sauveterrian facies complexes, with elements connected to other lithic complexes of the Middle-Recent Sauveterrian phase and some peculiarities. Nevertheless, a chrono-cultural attribution on a structural basis, should considers as well the lithic series of the north-eastern Alps from different types of environments (valley bottoms, low altitudes, hills, mountain streams).

The Cividate Camuno's lithic industry reveals original structural and stylistic peculiarities (*sensu* Laplace 1964) (Tab.1):

- very low percentage of End-Scrapers (3,8%);
- high incidence of Truncations(18,6%);
- high incidence of *Substratum* (36,4%);
- very low percentage of armatures (32,6%);
- original elaborations of hyper-microlithic armatures on flakes (truncations and abrupt retouched tools).

The most important element of the structural level is the significance of Cividate Camuno's *Substratum* in relation to armatures: this parameter allows us to emphasize the originality of our site with respect to the Northern Sauveterrian; it shares this originality for the moment with Galgenbühel/Dos De La Forca (Wierer 2007, 2008), another valley bottom site located at 225 m a.s.l., as well as with the AC5 level of Romagnano Loc (Broglio & Kozlowski 1983). This aspect, for the moment, has no plausible explanation.

The careful analysis of the structural setting using not only primary and secondary types of Laplace but also typological parameters of Broglio and Kozlowski (1983), allows us to highlight the original elements of the Cividate Camuno site which, combined with stylistic and quantitative parameters, let us insert the

industry into a productive Sauveterrian system, in the Middle or Recent Sauveterrian phases, as illustrated by North-Eastern Italian sequences.

The analysis of the individual types of microliths (*sensu* Broglio & Kozlowski 1983) allows us to make some observations:

- the low index of triangular armatures (in relation to the total number of microliths), around 44%, could refer to the moment of development of these microliths that at Romagnano Loc concludes the Middle Sauveterrian sequence (AC4 - AC1 layers). We note analogies with Gaban Shelter (Kozlowski & Dalmeri 2000), FC+30 layer (51,6%) and FB+29 layer (57,5%). These percentages deviate clearly from what we know about the early phase of the Middle Sauveterrian (AC8/9 - AC5 layers in Romagnano Loc: percentages between 21,6% for AC8/9 layers and 35,3% for AC5 layer);
- the relationship between short and long scalene triangles in favour of the long (0,6%) may indicate the late stage of the Middle Sauveterrian in concomitance with the beginning of the lengthening process of scalene microliths (Romagnano Loc, AC6 layer: 0,6% - AC5 layer: 0,7%); this process will reach full development in the Recent phase (Romagnano Loc, AC1 layer: 0,3%; Gaban Shelter, FC+30 layer: 0,1% - FB+29 layer: 0,1%);
- the extremely low percentage of long scalene triangles with short bases (2,2%) indicates the early Middle Sauveterrian, before the beginning of the evolution of these armatures that characterize at Romagnano Loc the evolved Middle Sauveterrian (AC6 - AC5 layers) with maximum development in the Recent phase (AC1 layer: 51,6%);
- the low percentage of the triangular armatures with three retouched edges (4,4%) seems completely anomalous for the Middle Sauveterrian. These have however a low average percentage in the Middle Sauveterrian (starting with Romagnano Loc, AC8/9 layers: 7,7%) and high percentages in the Recent phase (Romagnano Loc, AC2 layer: 37,7% - AC1 layer: 46,8%; Gaban Shelter, FC+30 layer: 34,8% - FB+29 layer: 38,8%);
- the low incidence of bilateral backed points (13,7%) may indicate the Middle-Recent Sauveterrian passage (Romagnano Loc, AC3 Layer: 12%; Gaban Shelter, FC+30 layer: 12,5% - FB+29 layer: 6,3%);
- the high development of long bilateral backed points (86%) compared to the short ones (14,3%) indicates the Middle-Recent Sauveterrian passage (Romagnano Loc AC4 layer: 89,4% versus 10,6% - AC3 layer: 86,4% versus 13,6%); in the Recent Sauveterrian we note a decrease in the long ones (Romagnano Loc, AC1 and AC2 layers and Gaban Shelter, FB+29 layer);
- the low percentage of crescents (5,9%) refers to the Middle-Recent Sauveterrian passage (Romagnano Loc, AC2 layer: 7,3% - AC1 layer: 6,9%).

The structural and stylistic data do not resolve the problem of chrono-cultural attribution between the Middle and Recent Sauveterrian. According to the chronological sequences of Romagnano Loc and Gaban Shelter, the radiometric date of Cividate Camuno is coherent with the attribution to the transition between the two Sauveterrian phases[3].

3 R. Poggiani Keller organized and coordinated the archaeological excavation with the collaboration of F. Magri, L. Baglioni and F. Martini analyzed the lithic industry and N. Mazzucco is the author of the use-wear analysis.

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Article

New data on the Mesolithic from the Alpine foreland: the Montebelluna and Montello area, North-Eastern Italy

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Key words

- Montebelluna
- Montello
- Sauveterrian
- Castelnovian

Parole chiave

- Montebelluna
- Montello
- Sauveterriano
- Castelnoviano

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Summary

Recent researches on the prehistory of Montebelluna and Montello area have provided new data on the Mesolithic population of the Venetian Plain. Lithic assemblages have been identified after review of the archaeological materials stored at the Museum of Natural History and Archaeology of Montebelluna and new findings have been made from the field surveys carried out between 2009 and 2011. The most important result was the identification for the first time of some flint cores and tools related to the ancient Mesolithic, whereas the recent Mesolithic was already known in the area. The Mesolithic findings from the territory of Montebelluna can been placed into the broader context of anthropogenic population of the Eastern Italian Alps; particularly, the significant peopling of Montello and Montebelluna Hill suggests the strategic importance of this area in postglacial times, due to geographic and economic factors such as the favorable topographic position, the proximity to the Piave river, the geographical location close to the foothills of the Alps in a point of easy access to the mountain sector and, at least, the availability of nearby sources of lithic raw material.

Riassunto

Recenti ricerche sulla preistoria del territorio di Montebelluna e del Montello hanno fornito nuovi dati sul popolamento mesolitico della Pianura veneta. A seguito della revisione dei materiali da vecchi recuperi conservati presso il Museo di Storia Naturale e Archeologia di Montebelluna sono stati individuati nuovi complessi inediti di industrie litiche provenienti dal territorio; inoltre sono state fatte nuove scoperte a seguito delle ricognizioni di superficie effettuate tra il 2009 e il 2011. Per la prima volta sono stati individuati alcuni nuclei e strumenti in selce attribuibili al Mesolitico antico, mentre il Mesolitico recente era già noto in quest'area. Le evidenze mesolitiche del territorio di Montebelluna possono essere interpretate nel più ampio contesto del popolamento delle Alpi italiane orientali; in particolare, il consistente popolamento del Montello e della Collina di Montebelluna suggerisce l'importanza strategica di questo territorio nel periodo postglaciale, dovuta a fattori sia geografici che economici, quali la favorevole posizione geografica, la prossimità al Fiume Piave, la vicinanza alla fascia collinare prealpina in un punto di facile accesso al comparto montano e, infine, la disponibilità a poca distanza di fonti di approvvigionamento della selce.

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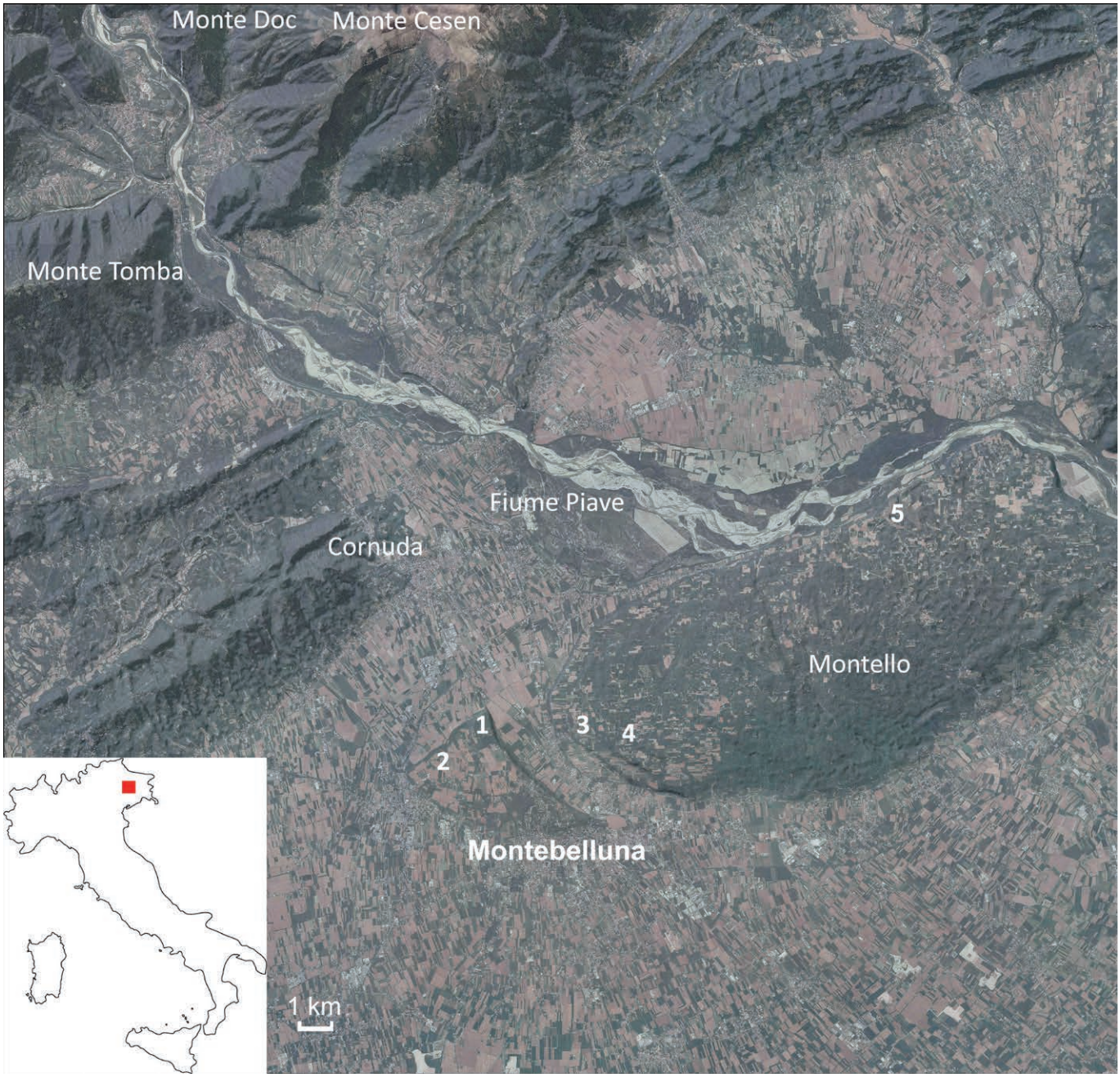

Fig. 1 *- Study area with the location of Montebelluna and Montello at the beginning of the upper Piave Valley. Mesolithic sites: 1, Capo di Monte; 2, Caerano San Marco-Le Rive; 3, Le Campagnole; 4, Panerola; 5, Presa 10 surroundings. / Area di studio con il posizionamento di Montebelluna e del Montello allo sbocco della Valle del Piave. Siti mesolitici: 1, Capo di Monte; 2, Caerano San Marco-Le Rive; 3, Le Campagnole; 4, Panerola; 5, Area della Presa 10.*

Introduction

Recent researches on the prehistory of Montebelluna and Montello area have provided new data on the Mesolithic population of the Venetian Plain.

The study area is located in the Treviso district, in the eastern part of Veneto region. It lies in the Venetian Plain at the outlet of the Piave River valley. Here the river borders the northern edge of the Montello which is a hill of approximately elliptical shape (370 m a.s.l.) and maximum length of about 13 km; its major axis is ENE-WSW oriented. This hill slopes gently to the south, where it connects with the plain through a smooth slope and slightly tilted, whose foot lies the town of Montebelluna. As regards the Montello area, the following places have been considered: Le Campagnole, Panerola, Presa 10 surroundings (Fig. 1, nn. 3-5).

The landscape of this region is also dominated by the hill of Montebelluna (also named Montelletto), a small elevation (200 m a.s.l.) roughly triangular in shape. This hill was originally connected to the western side of Montello, from which it is now separated by a narrow ancient river valley (Solco di Biadene). As regards the Montebelluna area, the following places have been considered: Capo di Monte and Caerano San Marco-Le Rive (Fig. 1, nn. 1, 2).

Thanks to the Archeogeo Project (AA.VV. 2012), lithic assemblages have been identified after the review of the archaeological materials stored at the Museum of Natural History and Archaeology of Montebelluna and new findings have been made from the field

surveys carried out between 2009 and 2011.

This study was first based on a large collection of unpublished flint artifacts from field surveys carried out during '70s and '80s. This analysis either confirmed the peopling of the area during the recent Mesolithic (Broglio & Paolillo 1989; Paolillo 2004) and provided new evidence about the ancient Mesolithic. Since the former collection suggested the presence of significant concentrations of lithic artifacts in certain areas of the Montebelluna municipality, such as the hill of Montebelluna and the western side of Montello, new field surveys have been carried out in that localities between 2007 and 2010, within the Archeogeo Project. Unfortunately, the surveys highlighted that the whole area was heavily damaged by intensive ploughing since '60s. Plough damage affected most of the prehistoric deposits, as indicated by mixed artifacts from different periods, with the consequent loss of pedological and stratigraphic data relating to the original contexts. Thanks to the new field researches, anyway, more Mesolithic flint artifacts have been collected. These materials, together with the artefacts from the old collections, allow for greater detail in defining the Mesolithic human presence in the Montebelluna area.

Findings attributed to the Sauveterrian

The review of lithic materials from old collections enabled the identification of some artifacts most probably attributed to the Sauveterrian: noteworthy is a fragment of a "Sauveterre" point (Fig. 2, 3) that finds comparisons with the lithic armatures of other sites dated or attributed to Sauveterrian, such as Romagnano III in Adige Valley (Flor *et al.* in press, Fontana *et al*. in press), Colbricon (Bagolini & Dalmeri 1987), Plan de Frea (Alessio *et al.* 1994) and Mondeval de Sora (Fontana & Vullo 2000) in the Dolomites, Cima XII on Sette Comuni Plateau (Broglio *et al.* 2006) and Casera Davià (Peresani & Angelini 2002) on Cansiglio Plateau. Besides, two truncated points and numerous microburins, indicators of microliths production, have been identified. Unfortunately, the lack of triangles, segments, and backed and truncated bladelets does not allow to specify the chronological phase of this frequentation. With regard to cores, some small prismatic (Fig. 2, 2) and carenoid (Fig. 2, 1) specimens intensely exploited through the alternation of several knapping surfaces have been attributed to the Sauveterrian. Moreover, few cores with an oval shape (Figg. 2, 4; 2, 11) were characterized by the exploitation of both opposite surfaces through unipolar production sequences. This latter morphology, aimed at obtaining bladelets and laminar flakes, finds accurate comparisons with some specimens from Cima XII on the Sette Comuni Plateau (Broglio *et al.* 2006).

Findings attributed to the Castelnovian

Certainly attributable to the Castelnovian are many trapezes characterized by short forms, scalene, with a concave base (Figg. 2, 7-10; 3, 3; 3, 5-8; 3, 12-15) or less frequently with a rectilinear one (Fig. 2, 12), and a residual piquant-trihedral edge on the opposite extremity. These types are well documented in the Mesolithic sequences of the Adige Valley (Broglio 1992) and in many other sites in north-eastern Italy dated to the Castelnovian. Challenging is the ascription to this cultural complex of several cores with a subconical or pyramidal shape (Fig. 3, 4), characterized by regular ridges and emphasized counter-bulbs, related to the use of pressure as knapping technique. This technique, indeed, is employed in Northern Italy both during the Castelnovian and the Early Neolithic. Strict comparisons, anyway, come from the Castelnovian industries of Trentino (Dalmeri *et al.* 2008; Flor *et al.* in press) and Emilia (Ferrari 2011).

Raw material provisioning

The flints knapped in the Montebelluna area belong to several varieties mostly related to the Cretaceous sequence of the Venetian and Trentino platform. The primary sources closer to the site are the Maiolica and Scaglia Rossa limestones on the Tomba, Monfenera and Cesen mountains and those of the Scaglia Variegata Alpina on Doc mount (about 15-20 km from the Montebelluna area) (Fig. 1). The analysis, carried out only macroscopically, took into account different features like the color, texture and consistence of the flint. The study of the cortical elements has shown as the main provisioning area does not correspond to primary sources but rather to Montello conglomerate.

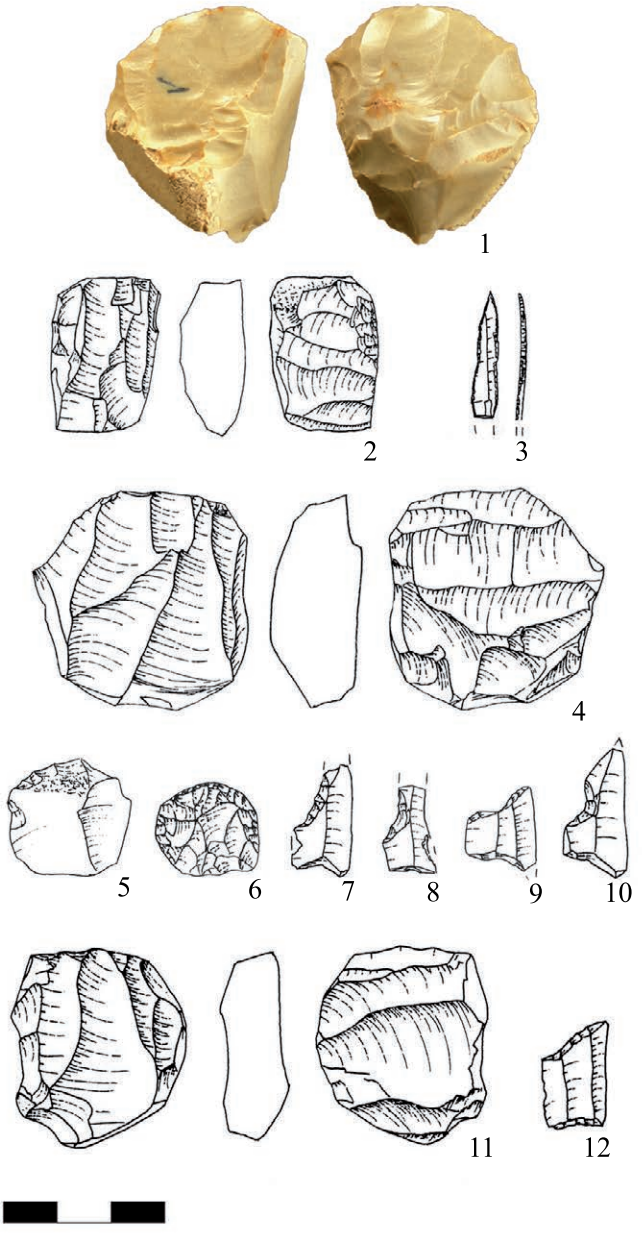

Fig. 2 *- Sauveterrian (1-4, 11) and Castelnovian (5-10, 12) findings from Capo di Monte and Caerano San Marco-Le Rive: 1,2,4,11 cores, 3 "Sauveterre" point, 5,6 end-scrapers, 7,8,9,10,12 trapezes (drawn by E. Gilli, photo R. Duches; scale 2:3). / Reperti sauveterriani e castelnoviani da Capo di Monte e Caerano San Marco-Le Rive: 1,2,4,11 nuclei, 3 punta di "Sauveterre", 5,6 grattatoi, 7,8,9,10,12 trapezi (disegni E. Gilli, foto R. Duches; scala 2:3).*

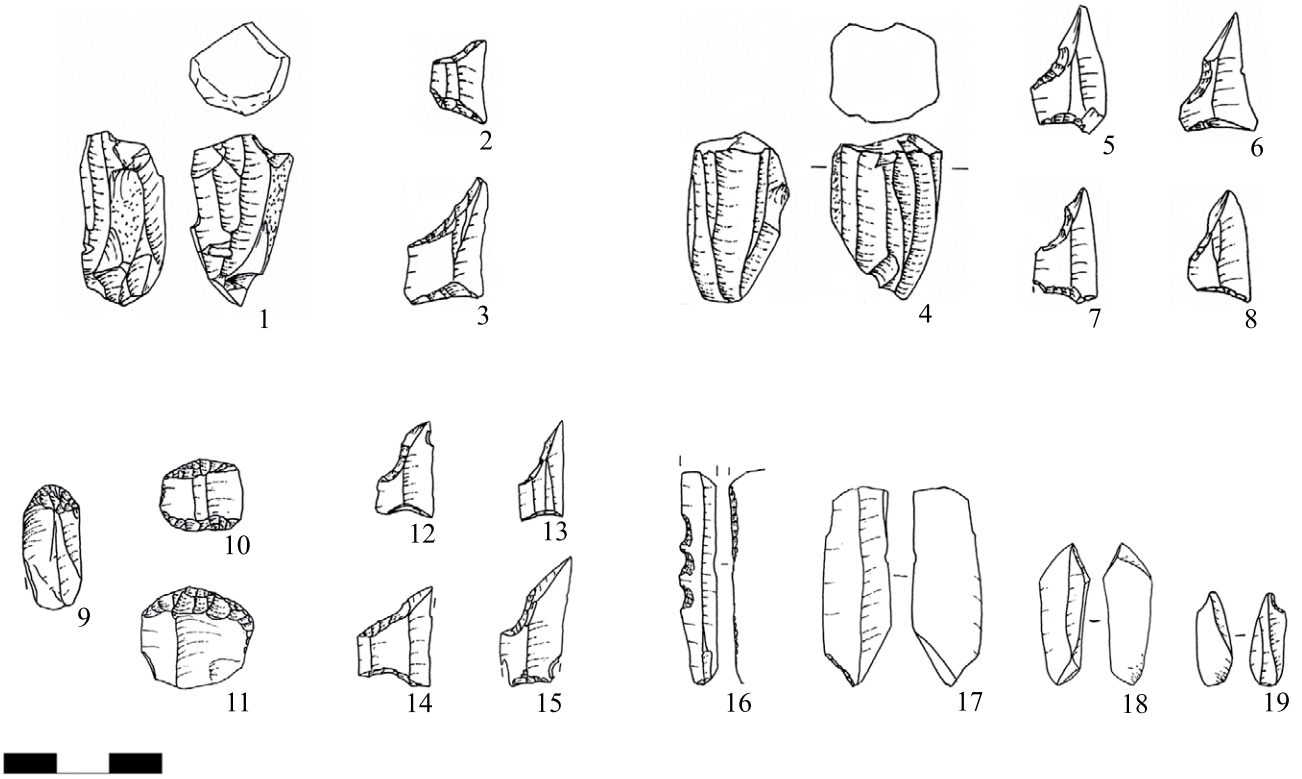

Fig. 3 *- Sauveterrian (1) and Castelnovian (2-19) findings from Le Campagnole (1-3), Panerola (4-8) and Montello - Presa 10 surroundings (9-19): 1,4 cores, 2-3 5-8 12-15 trapezes, 9-11 end-scrapers, 16 notched blade, 17-19 microburins (drawn by E. Gilli, photo R. Duches; scale 2:3). / Reperti sauveterriani (1) e castelnoviani (2-19) da Le Campagnole (1-3), Panerola (4-8) e Montello Presa 10 (9-19): 1,4 nuclei, 2-3 5-8 12-15 trapezi, 9-11 grattatoi, 16 lama denticolata, 17-19 microbulini (disegni di E. Gilli, scala 2:3)*

Fig. 4 *- Panerola. View of the site (photo P. Beltrame 2012). / Panerola. Panoramica del sito (foto di P. Beltrame 2012)*

Discussion

The findings from the territory of Montebelluna can be placed into the broader context of the Mesolithic population of the Eastern Italian Alps; particularly, the significant peopling of Montello and Montebelluna Hill suggests the strategic importance of this area in postglacial times, due to geographic and economic factors such as the favorable topographic position, the proximity to the Piave river, the geographical location close to the foothills of the Alps (Fig. 1) in a point of easy access to the mountain sector and, the availability of nearby sources of raw material. The scarcity of Sauveterrian artifacts support the hypothesis of an occasional human presence in this area during the early Mesolithic. The abundance of Castelnovian finds in almost all the territory of Montebelluna, instead, suggests a strong frequentation of this area in the second part of the Mesolithic.

The topographic position related to the presence of several trapezes and exhausted bladelets cores, advocates an interpretation of these sites such as seasonal residential camps, comparable to those of Romagnano Loc III and Pradestel (Flor *et al.* in press; Fontana *et al*. in press, Dalmeri *et al.* 2008). The information on the Mesolithic peopling of the Treviso area derived from other significant findings in the hills (Broglio & Paolillo 1989; Paolillo 2004), along the Venetian karst springs and around the lagoon. These sites are probably part of a wide settlement pattern characterized by a well attested human presence in the Venetian Plain, strictly related to wetlands, waterways and karst springs. An economy based on hunting, fishing and gathering shellfish, can be assumed according to the zooarchaeological data from the Adige valley sites (Boscato & Sala 1980; Crezzini *et al.* 2014; Wierer & Boscato 2006). The availability of nearby sources of lithic raw material and the variety of ecosystems defined by the Piave river and the Treviso Prealps, must have affected significantly the prolonged stay of the Castelnovian hunter-gatherers in these territories.

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Article

Looking for the Mesolithic in the Venetian Plain: first results from the Sile river springs (North-Eastern Italy)

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Key words

- Mesolithic
- Venetian plain
- lithic scatters
- Sile river
- springs area

Parole chiave

- Mesolitico
- Pianura veneta
- industrie litiche di superficie
- fiume Sile
- area delle risorgive

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Summary

During the '80s of the last century the activity of local amateurs led to the identification and collection of several thousand lithic artefacts mostly referred to the Mesolithic in the area of the Sile river springs (Veneto, North-Eastern Italy). Although representing one of the rare evidence of occupation of alluvial plains by Mesolithic groups in the Italian peninsula, for several years such discoveries have been completely forgotten. Starting from 2012 a new research project aimed at the diachronic reconstruction of prehistoric settlement dynamics related to environmental changes has been undertaken over this area. The preliminary data indicate an intense occupation near the springs of the river Sile by the Mesolithic groups during the ancient and middle Holocene, in close connection to the peculiar features of this wetland area which possibly represented the focus of rich biotopes suitable for subsistence.

Riassunto

Durante gli anni '80 del secolo scorso le attività di ricerca di alcuni appassionati hanno portato all'identificazione e alla raccolta di diverse migliaia di manufatti litici, prevalentemente riferibili al Mesolitico, nell'area delle Sorgenti del Sile (Veneto, Italia nord-orientale). Nonostante nella penisola italiana questi ritrovamenti rappresentino una delle poche evidenze d'occupazione della pianura da parte dei gruppi mesolitici, per molti anni non sono stati adeguatamente considerati e valorizzati. A partire dal 2012 è stato intrapreso un nuovo progetto di ricerca finalizzato alla ricostruzione diacronica delle dinamiche insediative di questa area in connessione all'evoluzione ambientale. I dati preliminari indicano un'intensa occupazione della zona delle sorgenti del Sile durante l'Olocene antico e medio, che può essere connessa alle caratteristiche peculiari di quest'area, probabilmente fulcro di ricchi biotopi favorevoli alle attività di sussistenza dei gruppi preistorici.

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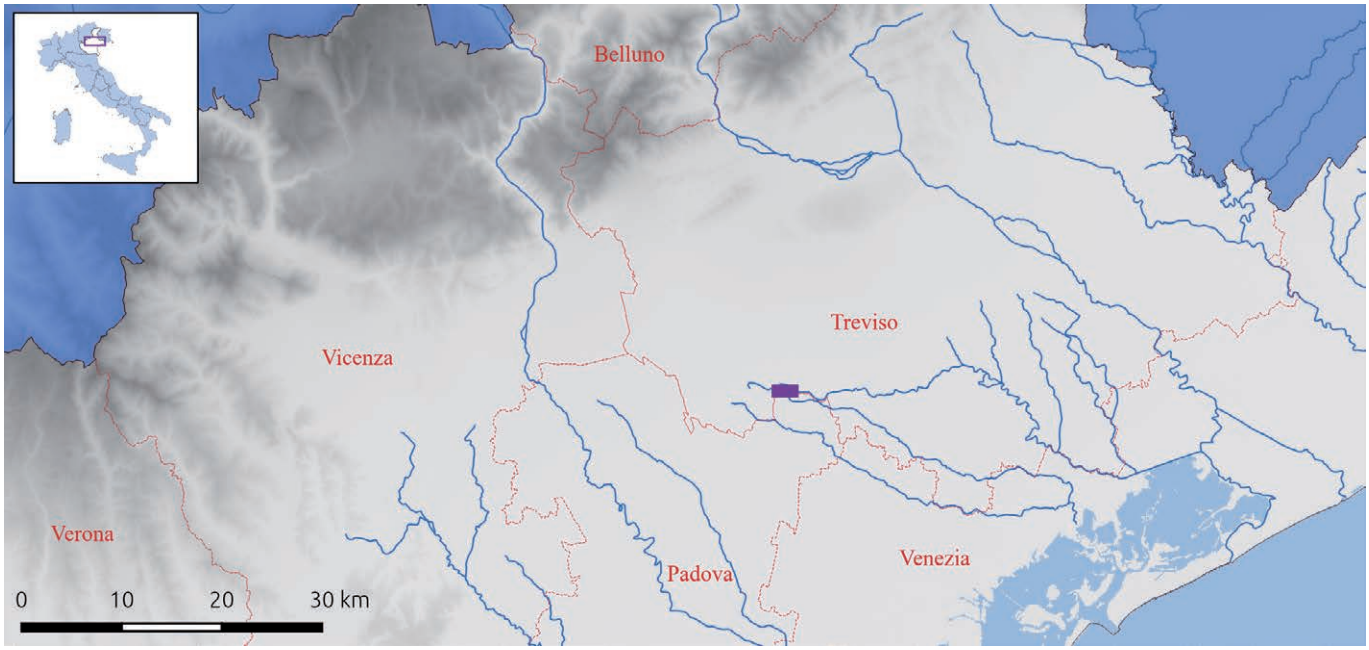

Fig. 1 - Location of the project area. / Localizzazione dell'area delle ricerche.

Introduction

Since its identification in the early 1970s the Mesolithic of North-Eastern Italy has mostly been related to mountainous environments (Broglio 1971). After the first discoveries in the Adige valley bottom and at the Colbricon lakes, near San Martino di Castrozza, a massive evidence referring to this period was collected during the following decades in Trentino - Alto Adige (Broglio 1992, Dalmeri & Pedrotti 1994, Kompatscher & Hrozny Kompatscher 2007) and the Belluno Dolomites (Alciati *et al.* 2004, Fontana & Pasi 2002, Fontana *et al.* 2009).

In the same years other discoveries were carried out in the Northern Adriatic plain between the lower Piave valley and the Venetian mainland (Paolillo 1988, Broglio & Paolillo 1989, Broglio *et al.* 1987, Gerhardinger 1984, 1984/1985). The attribution of most complexes collected from this area, exclusively represented by surface lithic scatters, to the Castelnovian contributed to the reconstruction of a diachronic settlement model for North-Eastern Italy according to which Sauveterrian groups would have mainly focused on the exploitation of the upland sector of the region while Castelnovian ones would have shifted towards the plain as a consequence of environmental changes occurred during the Atlantic period (Bagolini & Broglio 1985, Broglio & Paolillo 1989, Broglio *et al.* 1987).

In spite of the high potential offered by these sites for the reconstruction of the territorial organization of the last hunter-gatherers, after these first steps the problem of the lowland Mesolithic was rapidly dismissed as well as any academic research activity. Only recently a systematic research project has started in one of the most promising areas of the Venetian plain, that of the Sile river springs between the provinces of Treviso and Padova (Vedelago and Piombino Dese municipalities). Here the presence of a rich Mesolithic record is known since the early 1980s when local amateurs identified and collected thousands of lithic artefacts all along the upper course of the river Sile, possibly favoured by the progressive increase of plough depth during agricultural activities (Gerhardinger 1984).This paper presents the first preliminary results of this project which is focused on the investigation of the role of plain areas for the subsistence of the Mesolithic groups in Northern Italy. The project is articulated into different steps, namely: a) the definition of the palaeo-environmental setting and the geomorphological evolution of the area; b) the systematic collection of the abundant lithic scatters still coming to light from plough fields; c) the opening of trenches aimed at highlighting possible undamaged *in situ* deposits; d) the diachronic reconstruction of prehistoric settlement dynamics in the area in connection to environmental changes.

The Geomorphological Context

The study area is located in the central part of the Venetian plain (North-Eastern Italy) (Fig.1). The spring line of the river Sile locally marks the transition between the so-called "high" and "low" sectors of the alluvial plain. The former is characterised by coarse, gravel-rich sediments and presents a well-developed soil with reddish argillic horizons. These sediments characterise the southernmost part of the Montebelluna megafan, deposited by the river Piave before the Last Glacial Maximum (LGM) when it used to flow to the west of the Montello Hill (Mozzi 2005, Fontana *et al.* 2008). The latter consists of finer alluvial sediments (sandy channel belts, often forming alluvial ridges, and silty-clay overbank fines) which belong to the megafan of the river Brenta dated to the LGM period. Between the two lies an elongated depressed area where the un-

Fig. 2 - An active spring of the Sile area (photo D. Visentin). / Un fontanile attivo nell'area del Sile (foto D. Visentin)

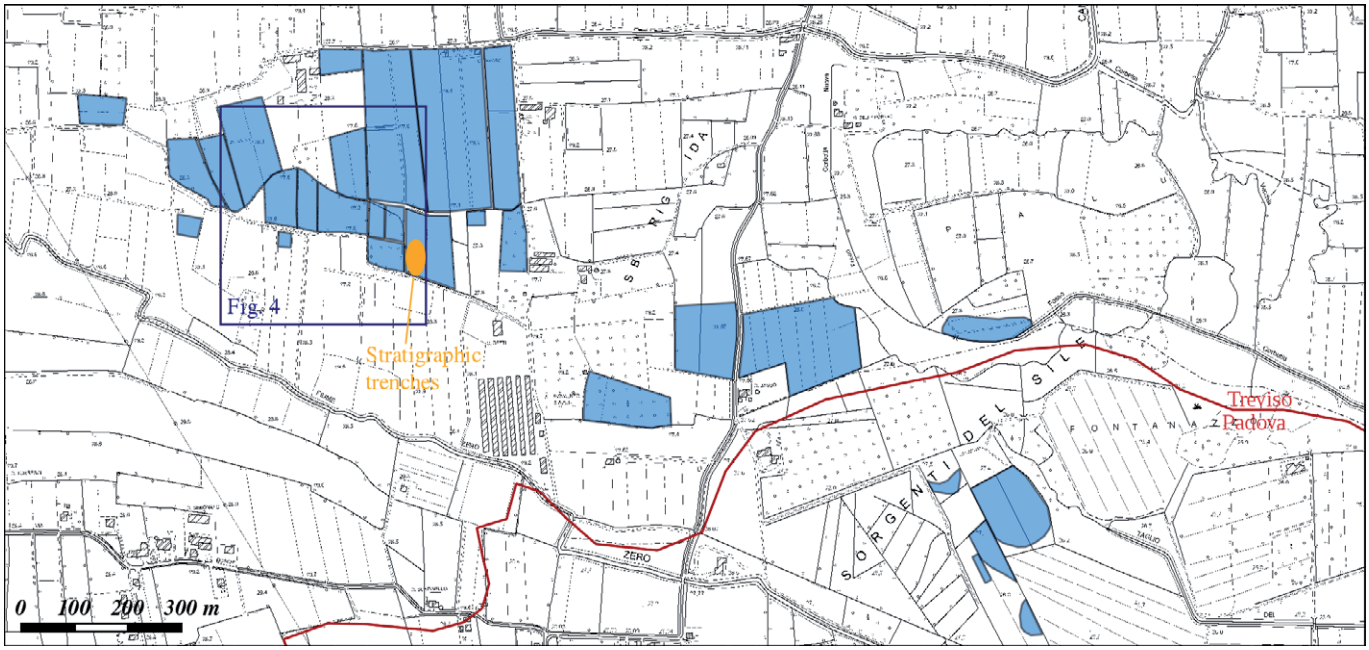

Fig. 3 - The project area and position of the stratigraphic trenches. Fields that yielded lithic artefacts are indicated in blue. / L'area oggetto delle ricerche e la posizione dei saggi stratigrafici. Gli appezzamenti che hanno restituito i reperti sono evidenziati in blu.

derground water table is at surface level and numerous springs—the so called *fontanili* or *fontanazzi*—arise (Fig. 2). In detail, the geomorphology of the spring zone is characterized by the presence of minor swales and alluvial ridges (Mozzi 1990-91, Mozzi 1998). The latter appear as slightly raised sandy areas with moderately well-drained yellowish soils. The outcropping of the water table in the depressions leads to the formation of swampy areas characterized by peat deposition. Land reclamation since the 1950s has dramatically reduced these wetlands, whose former extent can now be traced in the fields as it is highlighted by the presence of dark, organic-rich soils resulting from peat degradation.

Preminary Field Survey Results

Systematic survey campaigns in the spring area of the river Sile started in 2012. The methodology applied consists of mapping this wide area in order to locate all lithic scatters and collecting the artefacts coming to light. From the main *corpus* of sites—discovered in the past years—survey activity is moving to the neighbouring fields, as soon as agricultural practices turn them available for inspection. In the fields where a significant cluster of artefacts is identified, the collection proceeds by applying a 5 meters grid in order to enhance the spatial resolution of the dataset and allow analysis on the distribution of the evidence.

Up to present day the mapping activity is still at a preliminary stage, considering that the area interested by Mesolithic findings exceeds 200 hectares and a great part of it is still to be systematically covered (Fig. 3). Nonetheless it is already possible to identify a clear correspondence between the distribution of lithic scatters and the small sandy ridges attested in the area (Fig. 4) (Mozzi 1990/1991). Being the higher and thus less humid areas, these ridges have probably represented the places chosen for settlement.

At the same time a techno-economical and typological analysis is being carried out on the assemblages collected: a total of more than 6000 artefacts coming from 9 fields (6.3 ha ca.) has been analysed so far. As regards the preservation state, artefacts are generally characterised by thick patinas. On the other hand edge damage due to plough activity is quite varied: some elements appear almost complete while others are heavily scarred. Among this sample of artefacts 332 cores, 362 retouched blanks and 123 microburins have been recognised attesting a relatively high presence of modified blanks (8% ca.). While the high number of cores could be due to their larger dimensions—that allow an easier identification in the fields—the same cannot be said for tools. Armatures, which are present in the assemblage, may be much underestimated due to their

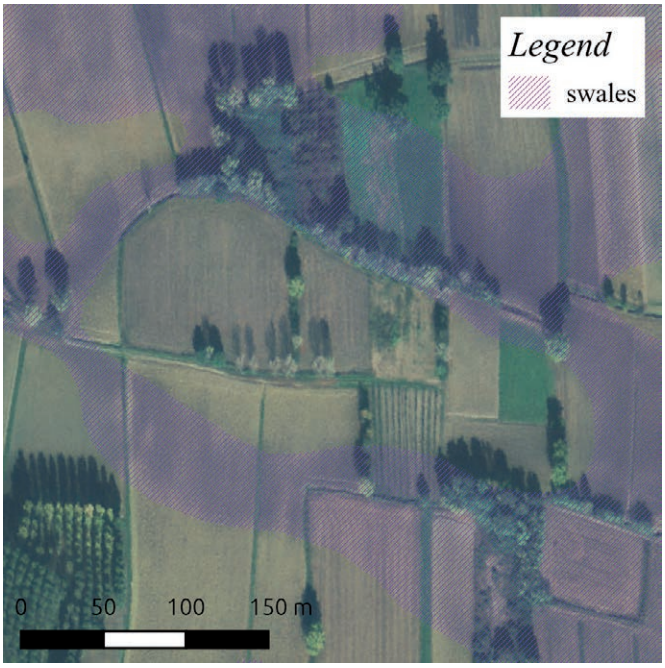

Fig. 4 - Aerial photo showing some palaeochannels with peaty infilling that enclose better-drained areas. In the central zone a few thousands Mesolithic artefacts have been collected. / Foto aerea raffigurante alcuni paleocanali con riempimenti torbosi che circondano aree meglio drenate. Nella zona centrale sono state raccolte alcune migliaia di manufatti.

generally small dimensions.

The preliminary typological analysis has allowed a cultural attribution of the assemblages. The Mesolithic evidence—both Sauveterrian and Castelnovian—is undoubtedly the most attested although it is not the only one. In the easternmost part some cores and tools seem to indicate that human occupation of the area began at the end of the Pleistocene (Late Epigravettian). Furthermore other groups of artefacts reflect a more recent prehistoric chronology.

First Evidence From The Stratigraphic Trenches

Three stratigraphic trenches have been opened in the westernmost sector of the investigated area with the purpose of verifying the sedimentary sequence and identifying possible undamaged *in situ* deposits. The first trench has been dug in correspondence with an area superficially characterised by sandy sediments (Fig. 5). The other two were dug respectively a few meters to the South and to the East of the first trench, where the surface deposits appeared darker and richer in organic substances. The depths of the trenches have varied between 50 and 115 centimetres. A few artefacts have been identified in all the three trenches but only within the ploughed layer (S.U. 1). The underneath layer is represented by silty-sandy to clay-silty sediments, partially pedogenised, deposited by the river Brenta during the LGM. The top of this layer appeared clearly truncated supporting the hypothesis that the archaeological context in this area has been largely destroyed by the mechanical action of the ploughs.

Concluding Remarks

The wide area of the Sile river springs where the lithic scatters are coming to light represents the richest and most extensive concentration of Mesolithic sites so far known in the Italian peninsula. This intensive occupation of the Sile springs and river banks during the lower and middle Holocene can be related to the presence of rich biotopes suitable for the subsistence of the last hunter-gatherers and attests the occupation of alluvial plain areas by Mesolithic groups.

In spite of the massive evidence coming from surface lithic scatters, this area still lacks stratigraphic data that would be very useful in order to fully explain the reasons that led to the formation of such clusters of human settlement during the first part of the Holocene, as well as the evolution of peopling through time. As from the previously mentioned trenches, it appears that during the last 40 years the western sector of the area, being generally dryer than the eastern one and more fit for agricultural purposes, has been largely affected by human practices and so most of its rich assemblages have probably been damaged. On the other hand the eastern sector, and in particular the area where some springs are still active, could reveal a much more favourable situation. The presence of preserved plots of land has been ascertained during the last field campaign, although the fortunate presence of sites in this area still needs to be verified by systematically digging stratigraphic trenches.

Data from this area constitute a good starting point to re-evaluate the role of lowlands for the settlement and subsistence of Early

Fig. 5 *- Stratigraphic section of one of the trenches opened in the western sector of the investigated area highlighting the ploughed layer cutting the lower LGM deposit (photo D. Visentin). / Sezione stratigrafica di uno dei saggi aperti nel settore occidentale dell'area indagata che mette in evidenza come il livello arativo tagli i sottostanti depositi dell'UMG (foto D. Visentin).*

(Sauveterrian) and Late (Castelnovian) Mesolithic groups. These data also pose the question of the relationship, in terms of territorial organisation, with the best known and abundant record documented in the valleys and highlands of the Eastern sector of the Southern Alps and pre-Alps.

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Article

First evidence of human peopling in the southern Po plain after the LGM: the early Sauveterrian site of Collecchio (Parma, Northern Italy).

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Key words

- Early Mesolithic
- Preboreal
- southern Po Plain
- organic remains
- lithic artefacts

Parole chiave

- Mesolitico antico
- Preboreale
- pianura del Po meridionale
- resti organici
- manufatti litici

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Summary

According to the current archaeological evidence human peopling in the Southern Po Plain after the LGM was delayed with respect to other areas of northern-central Italy. Although a rather rich set of sites is recorded from the plain to the main Apennines watershed, true reference points are still lacking. Within this context, Collecchio (Parma, Northern Italy) represents a key-site, attesting that stable settlement in the region began at least in the mid part of the Preboreal. This site, which is also the richest Early Mesolithic (Sauveterrian) deposit to have been extensively excavated in the southern Po Plain, has yielded a varied record of archaeological remains including organic residues and an abundant lithic assemblage that were following a multidisciplinary approach.

Riassunto

Le evidenze attualmente disponibili mostrano che il ripopolamento umano della Pianura Padana meridionale alla fine dell'UMG risulta essere piuttosto ritardato rispetto ad altre aree dell'Italia centro-settentrionale. Seppur sia attestato un cospicuo numero di siti fra la pianura e lo spartiacque appenninico, mancano effettivi punti di riferimento per quanto concerne la cronologia della prima rioccupazione dell'area. In questo contesto Collecchio (Parma, Italia settentrionale) rappresenta un sito-chiave che dimostra come, già durante la parte centrale del Preboreale sia presente un insediamento stabile della regione. Questo sito, che rappresenta il più ricco deposito del Mesolitico antico (Sauveterriano) scavato in estensione nella Pianura Padana meridionale, ha restituito una discreta varietà di reperti organici, oltre ad un abbondante insieme litico che sono stati analizzati con un approccio multidisciplinare.

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Introduction

Data on the post-glacial occupation of north-central Italy seem to reflect regional variations which derive from the mosaic of environments characterizing this area. At the same time, it should be taken into account that the reconstruction of human peopling is strongly biased by the differential preservation and visibility of the archaeological record and the intensity of research in the different territories. The best known area is the north-eastern sector of Italy, particularly the south-eastern Alps where a settlement model has been proposed starting from the rich record brought to light in the Adige basin (Broglio 1980; Cusinato *et al.* 2003; Fontana 2011; Fontana *et al.* 2011). Here human re-occupation had a considerable impulse starting from the first part of the Late Glacial and the temperate interstadial and became particularly intense in the early Holocene. The same can be affirmed for the north-western Tuscan area, where evidence brought to light in the Serchio valley attests for a Late Glacial peopling of this sector of the Apennines with a continuity of occupation throughout the first part of the Holocene (Kozlowski *et al.* 2003; Tozzi 2000).

The southern Po plain and northern Apennines area has yielded a very poor and uncertain Late Glacial record (Ghiretti 2003) while evidence on the early Holocene occupation is much richer. Nonetheless the latter still lacks reference points especially for the definition of a chronological framework in relation to environmental conditions, resource exploitation strategies and settlement dynamics (Biagi *et al.* 1980; Fontana *et al.* 2013; Fontana & Visentin 2016). Within this context Collecchio represents a key-site, having yielded the most ancient radiocarbon dates and being the richest Early Mesolithic settlement that has been extensively excavated with the recovery of a rich record of archaeological remains including organic residues (charcoal, malacofauna, macrofaunal and carpological remains) and a rich lithic assemblage. The multidisciplinary approach used for the analysis of this evidence has, therefore, allowed gaining a broader view on human occupation of this area.

The regional setting

The Po Plain has undergone a complex geomorphological evolution during the late Cenozoic. This is especially true for its southern margin, where different geomorphological features and sedimentary systems (piedmont fans vs. alluvial plain) come into contact. The fans that were mainly formed during Middle and Upper Pleistocene times were sometimes covered by loess deposits and characterized by several phases of soil formation throughout the Quaternary (see, e.g. Cremaschi 1987; Busacca & Cremaschi 1998). During the Holocene, they were partly affected by sedimentary activity and mostly interested by soil formation processes, which were more marked in the mid part of this period (Cremaschi 1990). Particularly, the sediments of the present-day alluvial plain have recorded an environmental shift at the Late Glacial to early Holocene transition with the deposition of several layers of fine-grained sediments made of sandy-clayey deposits at the base and indicating alternating phases characterized respectively by dry and wet conditions (Cremaschi 1985; Cremaschi et al. 1990; Cremonini 1987). In the highlands of the Apennines, researches carried out on some deposits located at altitudes between 1600 and 1800 meters in the Reggio Emilia area have shown the persistence of conditions of low vegetal cover and erosion phenomena up to the beginning of the Atlantic period (Biagi *et al.* 1980).

The most recent synthesis on the evolution of the vegetal landscape in the plain during the early Holocene indicates the presence of woodlands mostly composed of pine trees (mainly Scottish Pine), followed by silver fir and spruce during the Preboreal, while from the Boreal onwards a spread of deciduous mixed-oak forests is documented accompanied by the presence of abundant lime trees. In the hilly areas of the Apennines mixed broadleaf forested environments were present throughout the first part of the Holocene with refuge areas for chestnut and walnut in the Preboreal and Boreal, while in the mountain sector conifers, particularly *Pinus* (accompanied by abundant *Abies*), appear as the best represented species since the Preboreal (Accorsi *et al.* 1996).

In this region early Mesolithic (Sauveterrian) human occupation is documented only by a few deposits in the plain and by a higher number of sites in the highlands. The lowland sites are geographically distributed west to east, from Piacenza to Bologna and they have been extensively investigated between 1983 and 2001 (Fig. 1). All the sites in the area of Bologna are located on alluvial fans along the banks of the streams that cross the Apennines (I.N.F.S. at the confluence of the Idice and the Quaderna fans, Casalecchio and Cava Due Portoni on the Reno fan) while the only site of the Piacenza area (Le Mose) is situated in the lowermost part of the plain near the confluence between the Nure and the river Po (Fontana and Cremona 2008; Fontana *et al.* 2009a, b). Only for the latter a radiocarbon chronology is available with the two dates of 9220 ± 50 BP, 8560-8300 cal BC (Poz-13344 for S.U. 507, Pl. 19 S, 2σ) and 8250 ± 50 BP, 7460-7130 cal BC (Poz-13343 for S.U. 507 - Locus 7,2σ) (Fontana *et al*. 2009b), even though the first and most ancient one does not appear to be directly associated to any archaeological evidence. Based on the characteristics of the lithic assemblages, the site of I.N.F.S. can be considered as more ancient than Le Mose, Cava Due Portoni and Casalecchio (Boreal?), possibly of early Preboreal age (Fontana *et al.* 2009a; Fontana & Visentin 2016). According to this evidence, plain sites were part of a wider settlement system extending at least from the river Po, to the north, to the main Apennines watershed to the south and including also the sites located on the hilly terraced surfaces that bound the main Apennines valleys (at altitudes varying between 150 and 800 m a.s.l.) and mid-highlands stations placed at altitudes between 1100 and 1800 m a.s.l. along the main inter-valleys systems and the Tusco-Emilian watershed (Biagi *et al.* 1980; Fontana *et al.* 2009c; 2013; in press; Fontana & Visentin 2016; Ghiretti & Guerreschi 1988). Almost all of these sites only comprise lithic scatters and just one has been the object of an excavation in 1970s and has yielded a radiocarbon chronology. Occupation at Monte Bagioletto Alto, located in the high Apennines of Reggio Emilia, can be placed between the Late Boreal and the first part of the Atlantic phase spanning from 7447 to 6390 cal BC (8260 ± 60 BP, B/N 2839; 7630 ± 120 BP, I-12, 520)(Cremaschi *et al.* 1984).

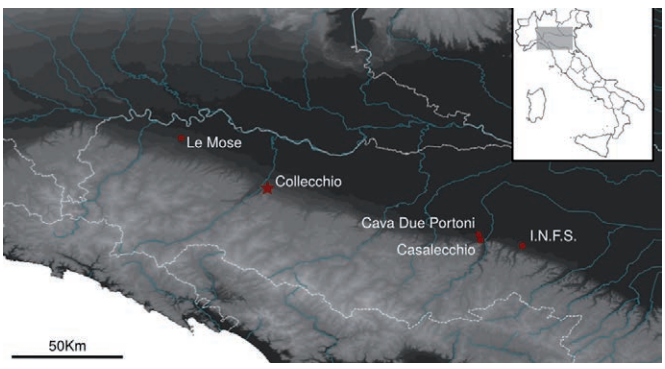

Fig. 1 *- Map of the southern Po Plain showing the location of Collecchio and of the other Sauveterrian sites of the Emilian plain (elaboration by D. Visentin). / Mappa della Pianura Padana meridionale con la posizione di Collecchio e degli altri siti sauveterriani della pianura emiliana (elaborazione D. Visentin)*

The site of Collecchio: geographical, environmental and chronological context

The site of Collecchio is located at the far edge of the alluvial fan of the river Taro (44.75709 °N,10.21208 °E, WGS84), a right tributary of the river Po, approximately where the Taro fan deposits dip beneath the younger fine alluvial deposits of the Po Plain, at an altitude of 106 m a.s.l. The Taro fan is regarded as a giant alluvial fan because of its large size and its thickness. Its evolution during the Pleistocene was mostly controlled by tectonics and climate constrains (Bedulli & Valloni 2004).

The site was discovered in 1992 during development works of the town road network. The Early Mesolithic layer (S.U. 77) was identified in December 1994 under a level containing evidence of a middle Neolithic occupation (Fig. 2). All excavated sediments were water-screened and sorted in order to optimize the collection of lithic artefacts and organic remains. More than seven thousand lithic artefacts along with burnt bone fragments, seeds, charcoal, shells and burnt clay-chips were brought to light. All finds have been assigned to a spatial system based on a 33 centimetres square grid.

Site stratification was analysed in the field for an extension of several hundred meters along the trenches opened during road works. Analysis of the lateral variations of layers and stratigraphic correlation led to define a stratigraphic succession reaching a total thickness of ca. 3.5 m and observed over the whole explored area of the site (see stratigraphic column, Fig. 3), despite slight lateral variations.

The site succession can be divided into four main geoarchaeological complexes, from top to bottom:

Complex 1. The top complex (horizons Ap and C in Fig. 3) is made up of silty, massive, light yellowish brown, alluvial sediment that thickens eastwards; the topsoil which developed on this material consists of a dark, apedal, moderately organic, homogeneous Ap horizon; the base of the complex is an angular unconformity cutting the underlying complex;

Complex 2. This (2B and 2C in Fig. 3) comprises a buried soil developed from coarse alluvial sediments; the buried soil is truncated and shows a poorly developed cambic 2B horizon, brown, clayey silt, with a moderate blocky structure (locally, this horizon shows argic properties, with slight evidence of clay migration and redder colour); underneath it, polygenetic, rounded to well-rounded, alluvial gravel are found; the Neolithic evidence recorded at the site is embedded in the upper part of the B horizon;

Complex 3. Discontinuous intercalations of fine, silty, alluvial sediment, with no evidence of soil formation (3C in Fig. 3);

Fig. 2 *- The site of Collecchio during excavation (photo by Archeosistemi). / Il sito di Collecchio durante lo scavo (foto Archeosistemi).*

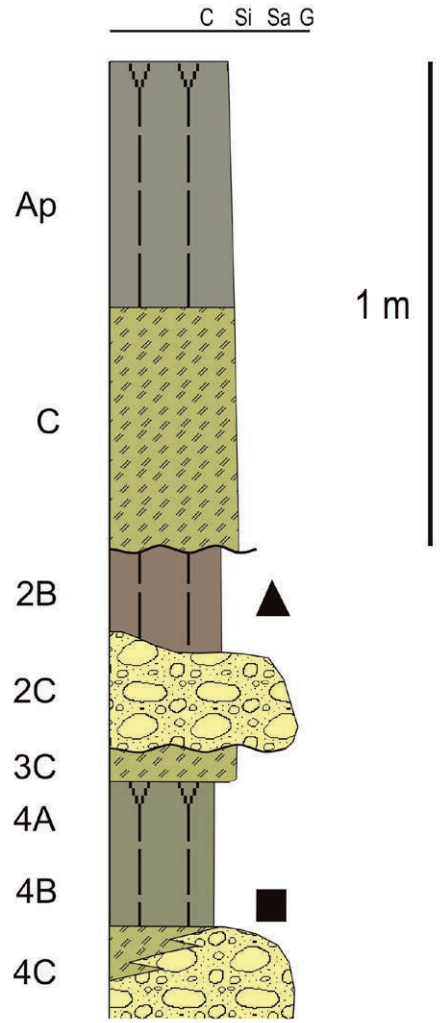

Fig. 3 *- Schematic stratigraphic column of Collecchio. Key: letters and numbers to the left of the column refer to soil horizons (see text for explanation); the solid triangle and the square respectively report the positions of Neolithic and Mesolithic archaeological finds and features; C – clay; Si – silt; Sa – sand; G – gravel (Drawing by D.E. Angelucci). / Colonna stratigrafica schematica di Collecchio. Legenda: lettere e numeri sulla sinistra si riferiscono agli orizzonti del suolo (si veda il testo per spiegazioni); il triangolo e il quadrato indicano rispettivamente la posizione dei reperti e delle strutture neolitiche e mesolitiche; C – argilla; Si – limo; Sa – sabbia; G – ghiaia (disegno D.E. Angelucci).*

Complex 4. A thick buried soil is preserved in the lowermost complex of the stratigraphic succession (4A, 4B and 4C in Fig. 3); this soil is articulated as follows: 4A horizon, organic, dark brown clay with prismatic structure and clear vertic fissures; 4B horizon, dark brown clay, with blocky structure and common slicken sides; 4BC horizon, transitional to the underlying 4C horizon, which is laterally variable and is silty, massive light yellowish brown alluvial sediment featuring lenticular bodies of rounded to well-rounded polygenetic gravel; the Mesolithic record is stratigraphically located at the base of the buried soil.

The complexes 2, 3 and 4 dip westwards with a low angle, while complex 1 is sub-horizontal.

Archaeological record at the site is embedded in buried soil profiles found inside the alluvial sediment of the Taro fan and sealed by the younger fine deposit of the Po alluvial plain. The complexes 2, 3

and 4 are related to the alluvial fan of the river Taro; distinct phases of alluvial activity are documented alternating with stable phases. Complex 4 represents a first cycle of alluvial sedimentary action, with coarse deposit attesting to medium-high energy and a subsequent soil formation phase leading to the development of the buried vertisol (horizons 4A, 4B and 4BC). The Sauveterrian assemblages-and the dating obtained from the early Mesolithic layers, which falls within the Preboreal zone-belong to the alluvial sediment of horizon 4C and are older than the development of the buried vertisol. This indicates that soil formation may date to the Boreal, while alluvial aggradation can be attributed to the early Preboreal or to the late upper Pleistocene. Early Mesolithic hunter-gatherers probably settled the site at the beginning of the stable phase during which the vertic soil would later develop. Two other phases of alluvial activity are documented, respectively, by complexes 3 and 2. The latter is sealed by a buried soil featuring Neolithic archaeological evidence, which can be approximately dated to the Atlantic period. The Atlantic soil formation phase is well documented in the Po plain and Neolithic evidence is often related to mid-Holocene soil profiles (Cremaschi 1987; Cremaschi 1990). The subsequent erosion of the buried soil and the ingression of fine alluvial deposit belonging to the Po sedimentary system (complex 1) are post-Atlantic in age.

Radiometric dates

Two radiocarbon accelerator mass spectrometry (AMS) dates are available for the Mesolithic deposits: 9251 – 8814 cal BC (9643 ± 70 BP, LTL6147A, burnt hazelnut, 2σ, -17.0 ± 0.4 $\delta^{13}C$) and 9119 – 8564 cal BC (9442 ± 60 BP, LTL12390A, wood charcoal, 2σ, -31.9 ± 0.5 $\delta^{13}C$). Samples calibration has been carried out with OxCal Ver. 4.2.4 software based on atmospheric data (Reimer *et al.* 2013). Both dates refer to the middle part of the Preboreal zone. In this context the site of Collecchio represents the first undeniable evidence of re-occupation of the southern Po Plain after the Last Glacial Maximum.

Malacofaunal remains

Several snail shells were retrieved from archaeological excavation and were determined. They can be referred to three species of terrestrial pulmonate gastropods: *Chondrula tridens* (O.F. Müller, 1774), *Cernuella* cf. *cisalpina* (Rossmassler, 1837) and *Cepaea* cf. *nemoralis* (Linnaeus, 1758).

Chondrula tridens (O.F. Müller, 1774)

Dimensions: height = 9-12 mm; diameter = 4-4.5mm (Kerney & Cameron 2006).

Snail with dextral shell, cylindrical-conical shape, with 7-8 weakly convex laps; strongly thickened and reflected peristome; aperture with three major teeth, one columellar, one parietal and one palatal. It prefers calcareous and dry environments but can also be easily found in meadows and rocky areas. It is rare at altitudes over 700 m above sea level (Kerney and Cameron 2006).

The shells analysed and identified as belonging to this species are extremely damaged. The identification was possible thanks to the presence of numerous fragments of the peristome of the shell, which is fundamental for its identification.

Cernuella cf. *cisalpina* (Rossmassler, 1837)

Dimensions: height = 5-9 mm; diameter = 7-12 mm (Giusti & Castagnolo 1982).

Snail with dextral shell, subglobose shape, with 5-6 convex whorls separated by deep sutures, yellowish-white colour, with continuous brown bands or divided by irregular spots; external surface with thick and rough growth lines; sub-circular aperture; lightly reflected peristome (Giusti & Castagnolo 1982). It can be easily found along the borders of herbaceous spontaneous vegetation of cropland (Ferreri 1994) and in meadows (Cossignani & Cossignani 1995).

The shells analysed and identified as belonging to this species are extremely damaged; therefore species determination is not certain because of the polymorphism within the genus *Cernuella* (Manganelli *et al.* 1995).

Cepaea cf. *nemoralis* (Linnaeus, 1758)

Snail with dextral shell, medium to large size, globose shape, more or less depressed, with 5 convex whorls; reflected, thickened and brown-blackish peristome (Lazzari 2007); external surface with more or less marked and irregular growth lines (Kerney & Cameron 2006). This species is characterized by a large polychromy of the shell (Lazzari 2007). This snail is widespread in the forests, particularly those of deciduous trees and evergreen sclerophyllous where it lives in the meadows and dunes.

The shells analysed and identified as belonging to this species are extremely damaged. The determination was based on the size and ornamentation of the shell and on the peristome. The peristome is either missing or appears discolored in the samples; therefore it is not possible to provide a determination to species level because of the presence of a species with white peristome (*Cepaea hortensis*) within this kind. Since *C. hortensis* is a species not reported in the Italian territory as opposed to *C. nemoralis* (Manganelli *et al.* 1995), it can be affirmed with reasonable certainty that the shells belong to the latter species. Both *Cepaea* cf. *nemoralis* and *Cernuella* cf. *cisalpina* are still living edible gastropods.

Charcoal and carpological analysis

Anthracological and carpological findings have been studied with a stereomicroscope and a reflected light microscope. In total 583 charcoals and 33 remains of seeds were examined (Table 1). Charcoal fragments are generally well preserved, although their dimensions are reduced, usually being smaller than a few millimetres. Edges are quite irregular, thus attesting an *in loco* deposition, without further displacement due to water and weathering.

498 charcoal fragments have been determined and 19 *taxa* have been identified. The dominant species are *Castanea sativa* (n. 103 + 118 probable remains) and *Populus* (n. 31) or *Populus-Salix* (n. 139). *Quercus* deciduous is also well represented with 65 charcoal fragments, 41 of which can be attributed to *Quercus* sect. *robur* and 27 to *Quercus* cf. *robur*. The other species are not so well represented: *Fraxinus oxycarpa* (n. 10), *Fraxinus* cf. (n. 1), *Ostrya carpinifolia* (n. 7), *Ostrya* cf. (n. 8), *Frangula alnus* (n. 6), *Crataegus* cf. (n. 4), *Viburnum* cf. (n. 2), *Acer* cf. *campestre* (n. 1), *Juglans* cf. (n. 1), *Abies* cf. (n. 1) and *Pinus* cf. (n. 1).

The carpological analysis has allowed identifying 33 fragments of *Corylus avellana* that can be referred to a total of 9-10 hazelnuts.

According to the analysis of charcoal remains, the arboreal component is dominated by deciduous broadleaves and especially by chestnut, poplar-willow-a species typical of hygrophilous woods-and other *taxa* which are characteristic of the mixed oak-wood (*Quercetum)*, such as oak, hornbeam, ash, maple and thorn tree (Accorsi *et al.* 1996). Chestnut is a species that has survived the Last Glacial Maximum in the Po Plain on hilly refuge areas together with walnut, mainly as a spontaneous component of mixed deciduous broadleaves wood (Accorsi *et al.* 2000a). Different studies have highlighted that this species was widespread in the hilly lands since the Preboreal (Bandini Mazzanti *et al.* 2000). The presence of the poplar-willow can be attributed to the location of the site on the Taro river alluvial fan. Actually, this hygrophilous species lives along the rivers shores, particularly on their middle-hilly and final sectors, where floods are more frequent.

The use of chestnut, poplar-willow and oak wood as combustible is probably due to their presence in the proximity of the site. This is particularly clear for chestnut-a species typical of wooded hilly and low mountain environments-that has always been used for various purposes. Its origin remains uncertain but some studies confirm that

Tab. 1 - Collecchio, taxa identified by charcoal analysis; nomenclature according to Pignatti 1982. / Collecchio, taxa identificati tramite l'analisi antracologica; nomencaltura in accordo a Pignatti 1982.

Family	*Taxa*	Tot.	%
Aceraceae	*Acer* cf. *campestre*	1	0.2%
Caprifoliaceae	*Viburnum*	2	0.3%
Corylaceae	*Ostrya carpinifolia* Scop.	7	1.2%
	Ostrya cf.	8	1.4%
Fagaceae	*Castanea sativa* Miller	191	32.7%
	Castanea cf.	30	5.2%
	Quercus cf. *robur*	27	4.6%
	Quercus sect. robur	14	2.4%
	Quercus deciduous	24	4,1%
Juglandaceae	*Juglans* cf.	1	0.2%
Oleaceae	*Fraxinus oxycarpa* Bieb.	10	1.7%
	Fraxinus	1	0.2%
Pinaceae	*Abies* cf.	1	0.2%
	Pinus cf.	1	0.2%
Rhamnaceae	*Frangula alnus* Miller	6	1.0%
Rosaceae	*Crataegus* cf.	4	0.7%
Salicaceae	*Populus*	31	5.3%
	Populus/Salix	139	23.9%
Undetermined		85	14.5%
Total		**583**	**100%**
Trees		473	81.1%
Shrubs		25	4.3%
Deciduous broadleaf		496	85.1%
Quercetum		100	17,1%
Edible fruits		287	49.2%
Conifer		2	0.4%
Hygrophilous plants		170	29.2%

Castanea sativa was an indigenous north Italian species (Paganelli & Miola 1991; Krebs *et al.* 2004).

Concerning the characteristics of the selected woods, chestnut is compact, elastic and not very heavy, indicated as fuel only if appositely dried; the wood of poplar-willow is useful only during the first phases of fire-lightening because of its rapid combustion. The only species represented at Collecchio which is ideal for combustion and heat preservation is oak wood. We can thus hypothesize that different species were adopted for lightening-up the fire, such as poplar, together with small branches of other species, while during its maintenance chestnut and oak wood were preferred.

Faunal remains

The faunal remains coming from the site of Collecchio (totally 2295 elements or fragments) are mainly composed of small bone fragments (below 1 cm length) strongly modified by burning (black colored and calcinated fragments). The identified specimens are therefore very scarce (25) and belong to wild boar (17), hare (4), fox (1) and wild cat (3). It is not possible to estimate the Minimum Number of Individuals because of the high degree of fragmentation, but the remains of wild boar can be attributed to a young individual on the basis of the presence of unfused bones and one unerupted first molar. The majority of the 27 elements identified on anatomical basis refers to the distal part of limbs (phalanges, carpal and tarsal bones). Only three of them belong to different parts of the skeleton: a molar of *Vulpes vulpes*, one of *Sus scrofa* and a coxal bone of *Lepus europeaus*.

The lithic assemblage

Raw material provisioning

A large spectrum of lithologies has been flaked at Collecchio. The first group includes silicified cherts and radiolarites from different sedimentary formations (Triassic to Miocene) and the second one fine crystalline Cretaceous limestones and Miocene marls and sandstones/siltstones. They all belong to the stratigraphic sequences of the Northern Apennines. This region is characterized by a very complex geological stratigraphy including a large variety of rocks. The raw materials exploited at Collecchio refer to deep marine and fore-land basins (flysch) formations. They have been grouped on the basis of their lithology, age and texture. For each group both the geological formation (Fm) and the geographic provenance have been investigated. Identification has been carried out by comparing archaeological to geological samples collected through extensive surveys on the territory. An attribution to different paleogeographic domains has thus been possible:

Umbro-Tuscan units (Calcari Selciferi, Scisti Diasprigni and Maiolica); Triassic–Cretaceous age.

Ligurid ophiolitic units (Radiolarites, cherts of the Calpionella Limestones, cherts and limestones of the Palombini Shales); Jurassic-Cretaceous age.

Ligurid Flysch units (Monte Sporno Flysch); Paleocene-Eocene age.

Epiligurid units (silified marls and siltstones from the Antognola and Contignaco formations); Oligocene-Miocene age.

As attested by external surfaces, raw material provisioning at Collecchio mostly took place within the alluvial and slope deposits of the main northern Apennine valleys (Taro, Baganza and Enza). A few artefacts are characterized by well rounded edges attesting a strong river transportation but more frequently edges are sub-angular which is a morphology associated with either gravitational or hill slope sediment transportation. Particularly, cherts were mostly extracted from the residual soils situated at the base of the outcrops as it is suggested by the presence of deep patinas with iron and manganese oxides.

The lithologies described are present in the site with different proportions and seem to have been sorted according to their textural properties and knapping suitability. The group of cherts (particularly the Cretaceous ones) is the best represented (58.4%) but red radiolarites are also abundant (20.8%). A peculiar aspect is the exploitation of partially silified lithologies such as the limestones of the Palombini Shales (5.0%) and Cherty Limestones Formations (1.3%) and spiculitic limestones (5.2%) together with a coarser siltstone (9.3%) from the Antognola Formation.

It is interesting to note that the Plio–Pleistocene silicified marine pebbles included in the Sabbie Gialle Formation have not been used at Collecchio although they crop out all along the lower Apennines and were abundantly exploited by the Mesolithic groups attested further east in the Bologna area. Allochthonous raw materials such as the Alpine or pre-Alpine cherts are also not attested.

The reconstruction of the provisioning territory suggests that groups' mobility was included within an area spanning from the foothill to the mid Apennines, following the main drainage systems and

spacing between the Trebbia, to the west, and the Baganza valley, to the east, on the Emilian side of the Apennines (Fig. 4).

Technological analysis

The lithic assemblage consists of 7697 artefacts, 2785 of which have been considered as diagnostic for technological analysis. Blanks less than 1 cm in length have been counted (825) and sorted by lithology; *debris* and undetermined fragments smaller than 2 cm have been divided on the basis of presence (1500) or absence (2587) of heat alteration.

Overall the lithic assemblage shows a good preservation state: more than 50% of the artefacts entered in the database are entire and the percentage of items attesting edge damage, presence of patina and/or other mechanical/chemical post-depositional alterations is rather low (15%). These data confirm the rapid burial of the archaeological deposit after abandonment of the site by the Mesolithic groups as also suggested by the characteristics of the sedimentological context and the results of spatial analysis (Visentin & Fontana 2016).

For technological analysis the different lithologies identified have been grouped into three main classes according to their technical properties and knapping suitability. The best quality one (A) is represented by the finest cherts and radiolarites, the second one (B) by more or less silicified limestones, spiculitic cherts and radiolarites and the third one (C) by low silicified coarse marly siltstones.

A refitting program has also been carried out which has resulted in the highest rate of refittings for a Mesolithic site in the Italian peninsula. It amounts to 13% of the analysed pieces, with a total number of 329 items, divided into 122 complexes composed of two or more elements. The highest number of artefacts involved in a single refitting complex is 12. Three types of refitting have been identified: reduction sequences, breaks and modifications (Cziesla 1990). Those related to reduction are representative of all the stages: from the initializing phase to the abandonment of cores (Figs. 5, 6). Many complexes are formed by a series of partially cortical flakes, while others-missing just the first cortical flakes-include almost all the products up to the abandonment of cores, thus confirming that all these operations took place on site. Also a few retouched pieces have been refitted and positioned into the refitted complexes.

Two main reduction sequences have been identified by the technological analysis of diagnostic lithic artefacts and refitting complexes. The first one is adapted to the finest cherts while mid-quality radiolarites and limestones and the other one to siltstone.

The first reduction sequence is aimed at the production of bladelets, small lamellar flakes and flakes. The dimensional values of bladelets and lamellar flakes range from 10 to 40 mm in length and from 5 to 15 mm in width. Raw blocks are represented by nodules and nodule fragments, mostly showing a naturally suitable shape and in particular natural fractures characterized by thick patinas which appear good to be used directly as striking platforms. The use of thick cortical flakes as supports for knapping is also quite common.

The most frequent types of cores are burin-like (Visentin et al. 2014) and prismatic ones. The two of them account for almost 60% of the first class of raw materials (finest cherts) and almost 80% of the second one (mid-quality radiolarites and limestones). Other types are represented by polyhedric and pyramidal cores which are mostly found in the class of finest chert that also includes a couple of peripheric cores. Within this reduction sequence blanks selection for transformation by retouch is not very marked although some general trends can be identified. For the production of microliths, (micro) bladelets and small flakes belonging to the finest quality group (A) were preferably chosen while blanks used for tools belong to the two groups (A and B) with a same percentage.

The second reduction sequence aims at the production of large partially cortical and natural backed flakes through the exploitation of siltstone blocks. The dimensional range of the products is quite wide

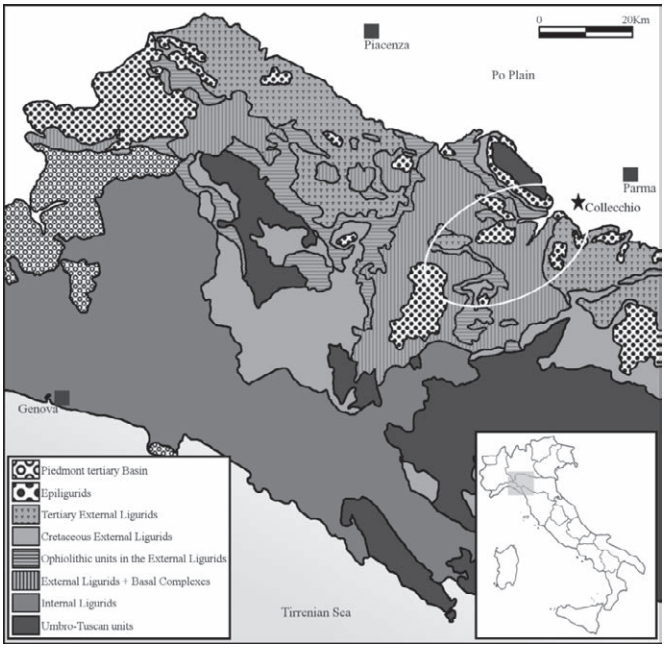

Fig. 4 *- Provisioning territory proposed for the site of Collecchio (modified from Elter & Marroni 1991). / Territorio di approvvigionamento proposto per il sito di Collecchio (modificato da Elter & Marroni 1991).*

ranging between 20 and 70 mm in both length and width. There are no cores in the archaeological assemblage which can be referred to this reduction sequence. No shaping out of the blocks is attested but cortical flakes are pragmatically struck off the core followed by the removal of some series of partially cortical flakes which are the main product of this reduction sequence. Flakes are usually plunged and characterized by cortex both on the butt, on one of the two edges and on the distal end.

The excavation has also yielded a flat cobble used as a stone-hammer and a few fragments and flakes belonging to the same raw material (coarse sandstone) that have been interpreted as fragments of hammers.

Typological analysis

The lithic assemblage includes 224 retouched blanks and 11 wastes of backed tool manufacturing among which 3 microburins, 4 fractured notches and 4 Krukowski microburins (Table 2, Figs. 7, 8). Tools dominate over microliths (143 vs. 81) and burins constitute the best represented type.

Among burins (50) “simple” types are the best represented-with removals starting from a flat natural surface-followed by those characterized by a transversal truncation and a lateral removal. On the other hand, end-scrapers are poorly represented. Among the remaining tools the best represented ones are truncated bladelets (19), denticulates (19) and backed flakes (16), followed by scrapers (13), blade scrapers (3) and splintered pieces (2). The 4 multiple tools include, two burins opposed to denticulate tools, a burin opposed to an end-scraper and a fragmented backed element opposed to a denticulate.

As far as armatures are concerned, the assemblage has yielded 13 backed points, 12 geometric microliths, 8 backed and truncated bladelets and 3 backed bladelets. Three backed points belong to *Sauveterre* types, characterized by double backed sides and points. The geometric types are represented almost entirely by crescents, while just one scalene triangle is attested. The use of the microburin technique is documented by the presence of 3 microburins and by 4 microliths bearing a *piquant triédre* at one of the extremities.

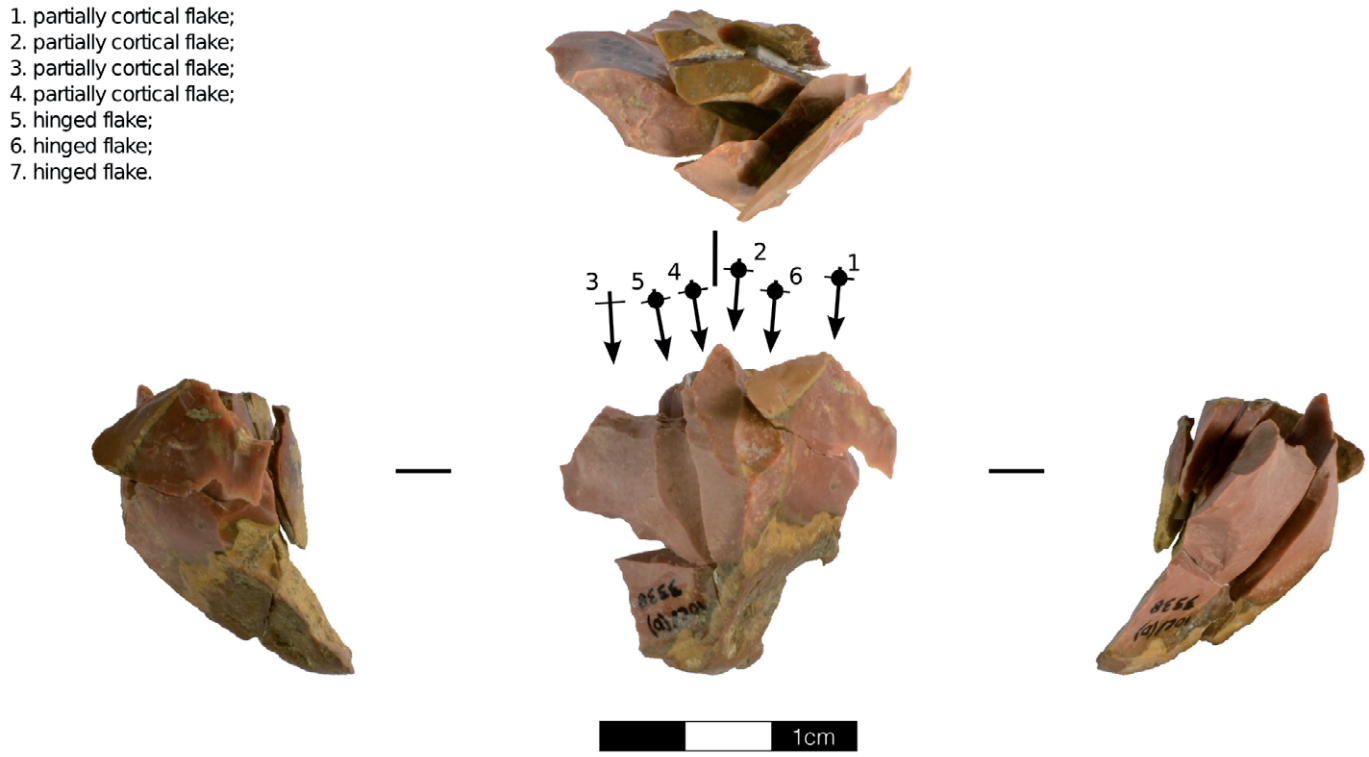

Fig. 5 - Refitting assemblage attesting unidirectional exploitation of a core. Debitage products are symbolized by a crossed arrow; a solid circle indicates the presence of the butt (photo by D. Visentin). / Rimontaggio attestante uno sfruttamento unidirezionale del nucleo. I prodotti di débitage sono indicati da una freccia incrociata; un cerchio pieno indica la presenza del tallone (foto D. Visentin).

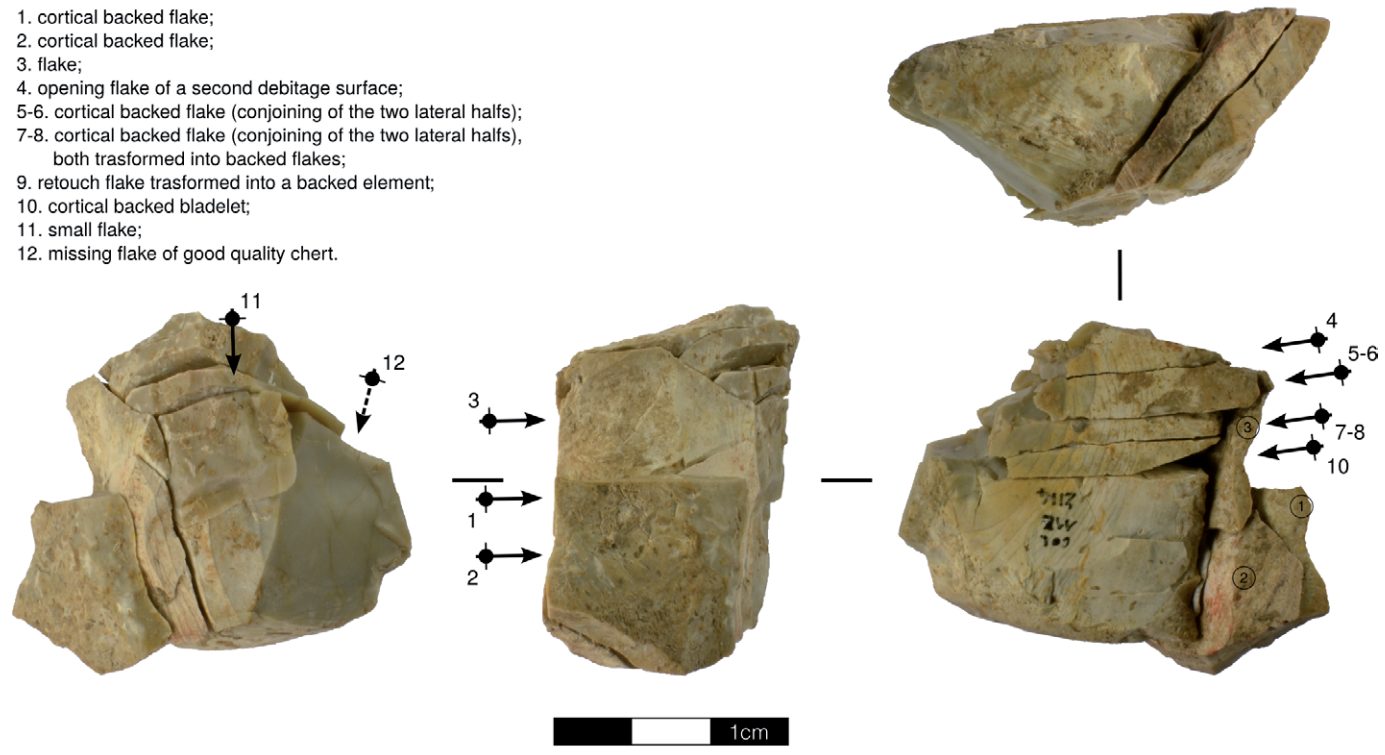

Fig. 6 - Refitting assemblage attesting orthogonal reorientation. Debitage products are symbolized by a crossed arrow; a solid circle indicates the presence of the butt (photo by D. Visentin). / Rimontaggio attestante riorientamenti ortogonali. I prodotti di débitage sono indicati da una freccia incrociata; un cerchio pieno indica la presenza del tallone (foto D. Visentin).

Use-wear analysis

Use-wear analysis has been carried out through an integrated approach (Moss 1983; Vaughan 1985; Plisson 1985; Beyries 1987; Christensen 1996; Lemorini 2000; Pawlik 2011). This methodology is based on both low (Odell 1981; Tringham et al. 1974) and high power approaches (Keeley 1980). A stereomicroscope Seben Incognita III (20x-80x) has been used for the low magnification analysis and a metallographic microscope Leica DMLM (100x, 200x) for the high magnification one.

An experimental collection composed of about 300 artefacts obtained from the most represented raw materials and particularly from radiolarite and siltstone has been created. The analysis of this experimental series has shown that the formation of use-wear traces on radiolarite blanks is comparable to the one obtained on the chert artefacts. Contrarily, siltstone artefacts show a different pattern. At a low magnification the analysis of edges shows marked and widespread use-wear traces that lead to a rapid dulling of the blanks, thus attesting their lower efficiency compared to the chert and radiolarite ones. The irregular surfaces that characterize these blanks have not allowed any profitable analysis with a metallographic microscope. In particular no diagnostic features for identification and description of micro-polishes could be detected.

The recognition of the hardness of the worked materials has been carried out according to Odell's classification (1981) integrated by the experimental collection, while both experimental results and bibliographic references have been used to identify micro-polishes (Beyries 1987; Fischer *et al.* 1984; Gassin 1996; Moss 1983; Plisson 1985; Rots 2002).

235 retouched artefacts have been selected for analysis along with 236 unretouched blanks featuring the following characteristics: presence of functional edges, absence of fractures and post-depositional alteration, absence of traces due to field and laboratory damage, absence of thermal alteration. After analysis 51 retouched and 54 unretouched blanks have revealed the presence of use-wear traces (Table 3).

Among retouched artefacts the best represented group is that of burins. 9 out of 55 have allowed identifying the presence of use-wear traces; transversal actions on a hard material dominate. In two cases these could be identified as due to wood processing (Fig. 9).

The position of traces suggests that the main functional edges were either the lateral dihedral formed by the burin facet or the truncation while no evidence was identified on the tips (trihedral). Sometimes use-wear traces were recognized on the natural edges of the blanks recording the same use as that shown by the burin dihedral. Use-wear traces on some burin spalls were also recorded and testify the rejuvenation of the functional edge after the first utilization (n. 12). Microscopic analysis attests that burins have been used with a unidirectional transversal action. Only in a few cases (n. 3) unmodified edges have been used on soft/mid-soft materials; in one of these, worked material has been identified as animal tissue, with a bidirectional longitudinal movement. In one case, functional continuity before and after the removal of a burin spall was documented thanks to refitting. Similar use-wear traces were in fact identified both on the truncation removed with the burin spall and on the dihedral obtained by its removal (Fig. 10). A hypothesis can be advanced on the dynamics of use of these tools which involves two stages: at first the natural edges of the blanks or the truncations were used on different materials; then by removing one or more burin spalls, dihedrals were obtained and used for working hard materials.

As far as the other tool types are concerned, 2 among 7 end-scrapers have yielded traces interpreted as due to hide-working. The same traces were identified on a backed retouched flake which also showed use-wear connected to hafting, i.e. some bright spots located at the centre of the tool (cf. Rots 2002).

Three other backed retouched flakes have traces which in two cases are due to working on hard materials with a transversal action and in the other on animal soft tissues-using an unmodified edge.

***Tab. 2** - Collecchio, typological structure of the lithic assemblage. / Collecchio, struttura tipologica dell'insieme litico.*

RETOUCHED BLANKS	TOT.	%
Tools	**143**	**63.8%**
Burins	50	22.3%
End-scrapers	6	2.7%
Truncated bladelets	19	8.5%
Backed flakes	16	7.1%
Scrapers	13	5.8%
Blade scrapers	3	1.3%
Denticulates	19	8.5%
Splintered pieces	2	0.9%
Composite tools	4	1.8%
Retouched fragments	11	4.9%
Microliths	**81**	**36.2%**
Backed points	14	6.3%
Backed bladelets	3	1.3%
Backed and truncated bladelets	4	1.8%
Crescents	11	4.9%
Scalene triangles	1	0.4%
Backed fragments	48	21.4%
Total	**224**	**100%**

The same activity-working of mid-hard materials with unidirectional transversal movements-is attested also by three truncated bladelets. The location of traces on the latter suggests that this activity was carried out by using the lateral natural edge as already proposed for other European Mesolithic sites (Philibert 2002). Scrapers and denticulates also reflect transversal actions mainly on hard materials, more rarely on mid-soft ones. Only one blade-scraper has yielded use-wear traces which are connected to the cutting of mid-soft materials. By a functional viewpoint the use-wear pattern recorded on the latter can be assimilated to that of most unretouched blanks (cf. *infra*).

The presence of use-wear traces on a splintered piece has shown its use on a soft material with a rotary action.

About 20% of the microliths (16 elements among 81) are characterized by impact fractures which confirm their role as projectile implements (points or barbs). Fractures are present on some undetermined/fragmented backed artefacts (n. 10), 4 crescents, 1 backed and truncated bladelet and 1 triangle. On 3 of them some traces of a longitudinal action on soft animal tissues have also been identified enabling us to assume that they were recycled as implements on composite cutting tools. The same traces are present on 2 backed points and 1 backed and truncated bladelet not affected by impact fractures. Finally 2 of the 3 backed bladelets show use-wear traces on their unmodified edges which indicate a transversal unidirectional action on hard/mid-hard materials while one backed fragment attests working of the same material with longitudinal movements.

Unretouched blanks show a high variability of actions-longitudinal and transversal movements-and worked materials-hard/mid-hard and soft. The analysis of blanks with use-wear traces in relation to the phase of the reduction sequence has shown that production and production/maintenance blanks have been used for working soft and mid-soft materials with longitudinal movements while a greater variety of blanks, including partially cortical flakes and maintenance flakes, have been used for working mid-hard and hard materials with transversal movements.

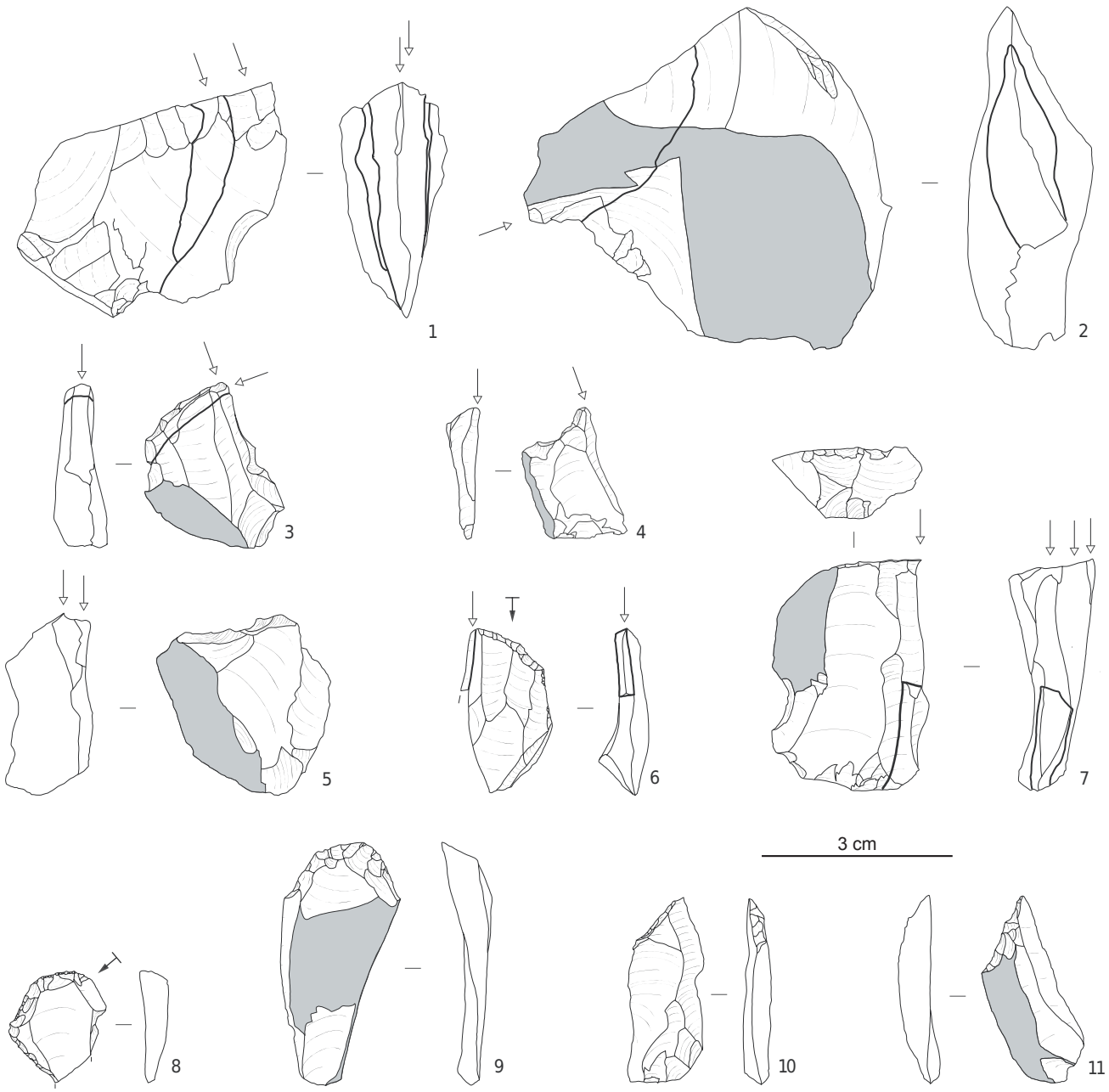

Fig. 7 *- Collecchio, lithic industry: 1-2, 6-7. burins and corresponding burin spalls; 3. burin with rejuvenation; 4-5. burins; 8-9. endscrapers; 10-11. oblique truncated bladelets (drawings by S. Ferrari). / Collecchio, industria litica: 1-2, 6-7. bulini e rispettivi ritagli di bulino; 3. bulino con ravvivamenti; 4-5. bulini; 8-9. grattatoi; 10-11. troncature oblique (disegni S. Ferrari).*

Discussion

Due to preservation condition of the archaeological record, the reconstruction of the Early Holocene palaeonvironmental background in the southern Po plain has mostly been based on sedimentary and palynological data (cfr. *supra*). Within this context Collecchio is the only lowland site having yielded a variety of remains which, although not abundant, allow integrating with new data the poor evidence available for this area. Particularly, charcoal remains indicate that the area surrounding the site was characterized by an arboreal vegetal cover of deciduous broadleaves dominated by chestnut, *Populus-Salix,* oak and other species of the mixed *quercetum* wood while the three land shell species attested highlight the presence of both dry and sunny places without arboreal vegetation (*Chondrula tridens* and *Cernuella* cf. *Cisalpine)* and of woods formed by deciduous trees and/or evergreen sclerophyll ones (*Cepaea* cf. *nemoralis*). Also the composition of the faunal assemblage which includes wild boar, hare, fox and wild cat, points to the presence of both open environments and forests near humid areas. Faunal remains are attested also at the other plain sites but determination is available so far only I.N.F.S. where some teeth of *Sus scrofa* and some antler fragments of an unidentified *Cervidae* are reported (Farabegoli *et al.* 1994). By contrast in the Apennines highland sector where the only available evidence comes from the site of Monte Bagioletto in the Reggio Emilia area (1750 m a.s.l.), charcoal remains indicate a forest dominated by *Abies* associated to *Fraxinus sp.* and *Ulmus/ Laburnum* (Cremaschi *et al.* 1984).

A richer record is available for the technical systems adopted

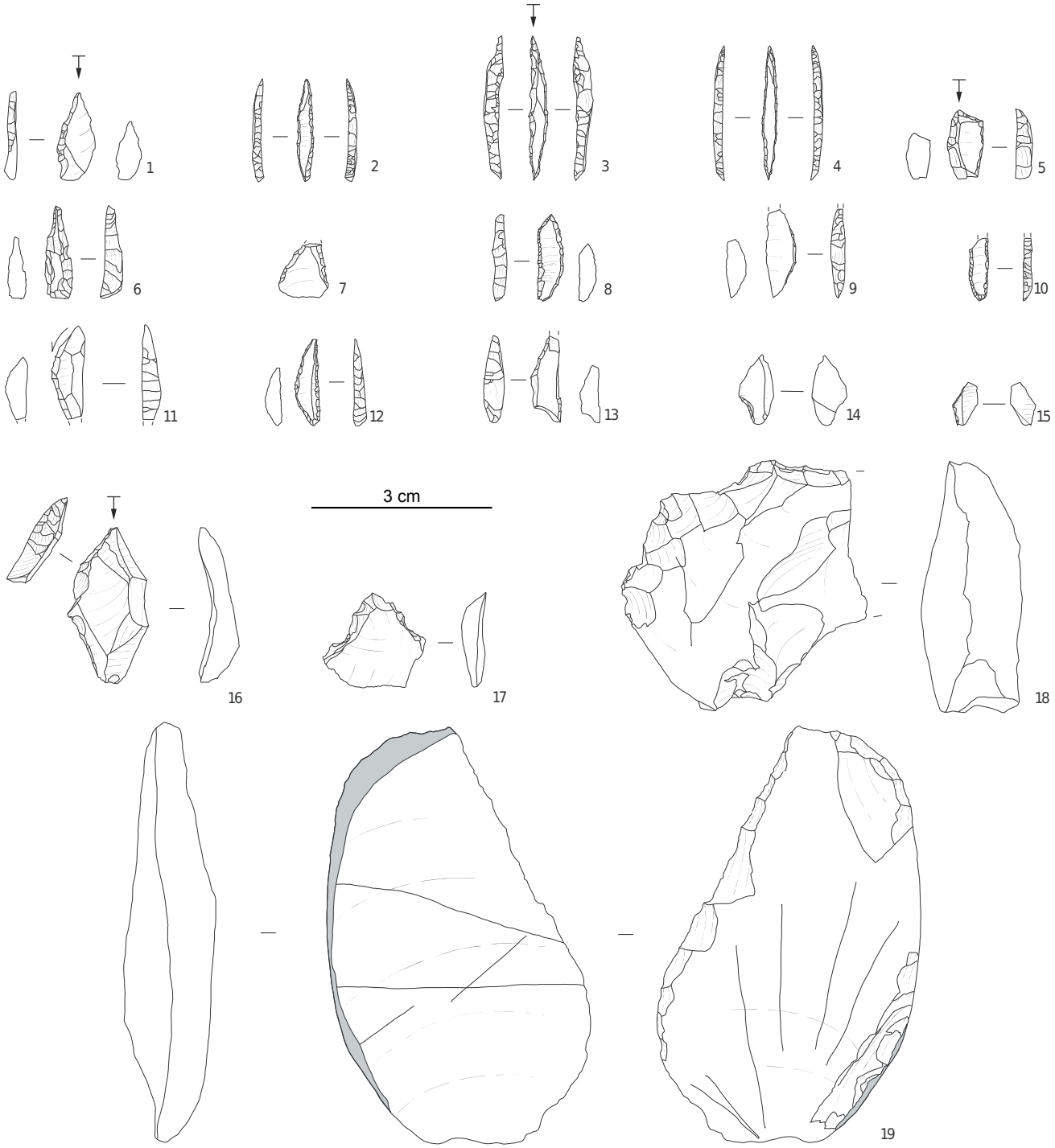

***Fig. 8** - Collecchio, lithic industry: 1. backed point; 2-4. double backed points; 5. backed and truncated bladelet; 6. backed and truncated point; 7. backed fragment; 8-12. crescents; 13. scalene triangle with impact fracture; 14. microburin; 15. Krukowski microburin; 16. partially backed point; 17-18. denticulated endscrapers; 19. backed flake (Drawings by S. Ferrari). / Collecchio, industria litica: 1. punta a dorso; 2-4. punte a doppio dorso; 5. lamella a dorso e troncatura; 6. punta a dorso e troncatura; 7. frammenti a dorso; 8-12. segmenti; 13. triangolo scaleno con frattura da impatto; 14. microbulino; 15. microbulino Krukowski; 16. punta a dorso parziale; 17-18. grattatoi denticolati; 19. scheggia a ritocco erto (disegni S. Ferrari).*

by the early Mesolithic groups settled in the area (Fontana & Visentin 2016). Some common features in lithic raw materials exploitation are observable between the different sites of this lowland territory, namely INFS, Casalecchio and Cava Due Portoni in the Bologna area and Le Mose, near Piacenza (Fontana *et al.* 2009a; Fontana and Cremona 2008). For all of them the documented range of lithologies reflects provisioning systems established along the main drainage systems, with north-east to south-west displacements. This aspect is confirmed by the composition of the lithic assemblages of the mountain deposits scattered along the northern side of the Tusco-Emilian Apennines (Biagi *et al.* 1980) while only at one of the plain sites (Cava Due Portoni) the presence of a few implements made on extra-regional raw materials (possibly a radiolarite from the Parma/Piacenza area and cherts from the Southern Alps) has been

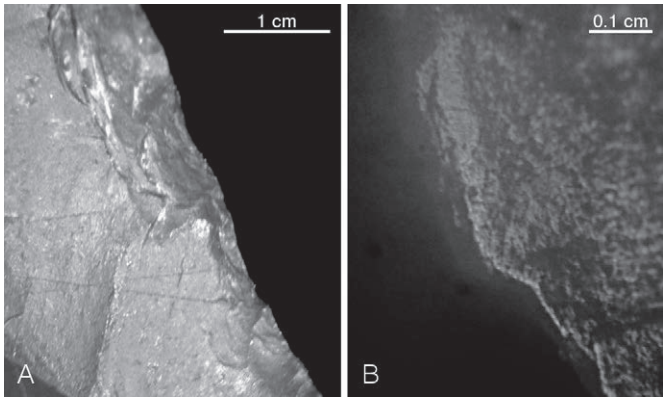

Fig. 9 - Micro-traces interpretable as working of wood with a transversal action identified on the truncation of a burin (Photo by G.L.F. Berruti, A. magnification 65x, B. magnification 100x). / Micro-tracce sulla troncatura di un bulino riferibili alla lavorazione del legno con un'azione trasversale (Foto G.L.F. Berruti, A. ingrandimento 65x, B. ingrandimento 100x)

identified, attesting mobility and/or contacts over longer distances (Cremaschi *et al.* 1990; Fontana *et al.* 2009a; 2009b; Fontana & Cremona 2008; Fontana & Visentin 2016).

The types and quality of exploited raw materials attest to the coexistence of higher and lower quality lithologies at Collecchio as well as at the sites of the Bologna area (Fontana *et al.* 2009a; Fontana and Cremona 2008). Nonetheless, separated reduction sequences specifically adapted to the different lithologies are only present at Collecchio and INFS. At the latter fine flints from small marine pebbles of the "Sabbie Gialle" formation are aimed at a lamellar production for the preparation of microliths whereas the coarser siltstone (locally named "ftanite"), available as large size river blocks, is mostly knapped in order to obtain large laminar flakes which were transformed into a variety of tools (Farabegoli *et al.* 1994; Fontana & Guerreschi 2009).

At all plain sites tool kits are dominated by microliths with the exception of Collecchio where tools, namely burins, are the most represented. It is also interesting to point out that at INFS and Collecchio triangles are absent and microliths mainly represented by crescents and Sauveterre points, an aspect which could reflect the close chronology of the two sites, possibly older than the others where triangles especially of the scalene type are well documented. This hypothesis is reinforced by the discrete presence of backed and truncated bladelets at the two sites but needs to be confirmed by radiometric dating that are still missing for I.N.F.S.

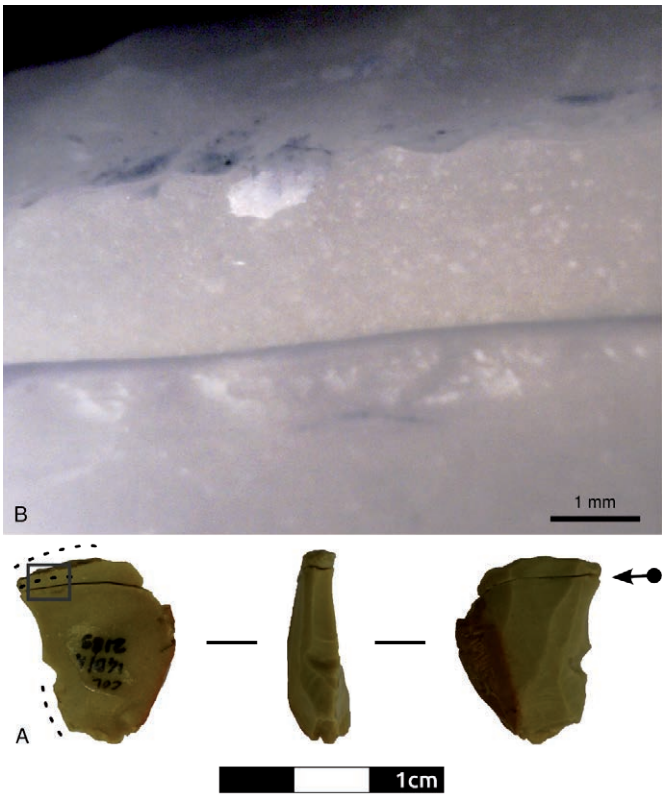

Fig. 10 - Refitting of a burin with its transversal burin spall (A) and detail showing use-wear traces on both of them (Photo A by D. Visentin and B by G.L.F. Berruti). / Rimontaggio di un bulino con il suo ritaglio trasversale (A) e dettaglio sulle trace d'uso presenti su entrambi (foto A D. Visentin e B G.L.F. Berruti)

As far as functional analysis is concerned there are no sites for comparison in the region and only two in Northern Italy (Mondeval de Sora, 2150 m a.s.l., in the Belluno Dolomites, and Casera Lissandri 17, 1070 m a.s.l., on the Cansiglio Plateau) both dominated by hunting activities and practices connected to the exploitation of animal carcasses (Fontana *et al.* 2009c; Peresani *et al.* 2009; Visentin et al. 2016).

Conclusions

According to two available radiometric dates and considering the dubious Late Palaeolithic record for the area, Collecchio repre-

Tab. 3 - Collecchio, actions and worked materials identified by use-wear analysis, divided according to the lithology of the blank (Ch – cherts; Rd – radiolarites; Lm/SC – limestones and spiculitic cherts; Sl – siltstone). / Collecchio, azioni e materiali lavorati identificati tramite l'analisi funzionale, divisi in base alla litologia dei supporti (Ch – selci; Rd – radiolarite; Lm/SC – calcari e selci spicolitiche; Sl – siltite).

	Retouched blanks	Row blanks	Z.U.	Transversal action	Longitudinal action	Mixed action	Rotatory action	Undet. action	Hafting	Impact fracture	Hard material	Mid-hard material	Mid-soft material	Soft material	Undet. material	Wood	Soft animal tissue	Bone	Hide
Ch	42	28	64	34	19	3		7	1	16	17	6	12	10	10	1	5		3
Rd	6	21	30	15	12		1	2		1	7	4	3	2	3	4	6	1	
Lm/SC	3	2	5	5							5								
Sl		3	3		2			1			1		2						

sents the most ancient dated site of the southern Po Plain after the end of the LGM. In contrast with data documented both for the southern Alps and the Tuscan Apennines, where re-colonization after the LGM can be traced back to the Late Glacial, Collecchio attests that the first settlement of the Southern Po Plain by the last prehistoric hunter-gatherers started at least in the early Preboreal. This late settlement may represent a consequence of biased preservation of the archaeological record or reflect the real state of occupation of the area. In both cases, it is likely that environmental circumstances have played an important role either by avoiding visibility and/or causing destruction of former traces or by discouraging human occupation in the phases that preceded the Holocene. At any rate, starting from the Early Preboreal the hilly terraced areas of the Northern Apennines, where Collecchio is located, were favourable to human settlement, as it is well attested by palaeo-environmental data.

Concerning the subsistence of groups, besides the presence of faunal remains, which refer to a rather wide range of species, some hazelnuts represent the first evidence of the collection of spontaneous fruits by Early Mesolithic groups in the southern sector of the Po plain. The occurrence of edible land shells (*Cepaea* cf. *nemoralis* and *Cernuella* cf. *Cisalpine*) is also interesting although the lack of concentration areas for the latter, unfortunately, does not allow advancing any hypothesis on their possible role in the diet of the Mesolithic groups of Collecchio. At a more general level, being at the contact between two distinct landscape units, the prehistoric inhabitants settled in the area could exploit the resources offered by two different environments: the alluvial fan to the south (and the Taro valley further south) and the alluvial plain of the Po to the north, with its sizable biomass.

The results obtained from this multidisciplinary study indicate that the settlement model recognized for the Mesolithic of the Southern Po plain area had already developed since the mid Preboreal and was based on the exploitation of the resources offered by the local Apennines drainage systems. In particular, analysis of lithic raw materials from Collecchio suggests displacements between the foothill and the mid-high Apennines, covering an area spanning from the Trebbia valley (Piacenza) to the west to the Baganza valley (Parma) to the east. These data match with information coming from researches carried out in the mountain territories of the Emilian Apennines which, although in most cases lacking a radiocarbon chronology, indicate an intense exploitation of these areas by the Sauveterrian groups (Biagi *et al*. 1980; Fontana *et al.* 2013; Ghiretti & Fontana in press; Cipriani *et al.* 2001).

Within this system the site of Collecchio, located at the far edge of the alluvial fan of the river Taro, a right tributary of the river Po, could represent a seasonal base camp of mid-term duration, oriented towards different subsistence activities as attested by the prevailing role of tools and especially of burins over microliths (Visentin et al. 2014). This aspect together with evidence of several traces of transversal actions on hard materials (particularly wood) both on burins and on other categories of tools (truncations, flakes with an abrupt retouch, scrapers and denticulates) and unmodified blanks makes Collecchio a unique site in the Italian context for the early Mesolithic. Its functional role seems therefore complementary to that of most of the other known deposits of the Po plain area (I.N.F.S., Casalecchio, some loci at Le Mose) which show features that are more typical of short-term hunting stands (Fontana *et al.* 2009b; Visentin & Fontana 2016).

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Articolo

Paesaggio vegetale e ambiente nel sito mesolitico rinvenuto in localitá Le Mose (Piacenza, Nord Italia) ricostruito attraverso le indagini palinologiche e microantracologiche

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Parole chiave

- Le Mose
- Piacenza
- Mesolitico
- analisi polliniche
- paesaggio
- microcarboni

Key word

- Le Mose
- Piacenza
- Mesolithic
- Pollen analyses
- landscape
- micro-anthracological remains

Riassunto

Il presente lavoro intende ricostruire il paesaggio vegetale e le relazioni fra uomo e ambiente nel sito mesolitico di Le Mose (Piacenza, Nord Italia) sulla base di studi archeopalinologici e micro-antracologici.

Summary

The aim of this study is to reconstruct the vegetal landscape and the man-environment relationship on the basis of archaeopalynological and microanthracological studies carried out in the site of Le Mose (Piacenza, Northern Italy) in the course of the Mesolithic.

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Introduzione

L'archeologia del paesaggio è una tematica sempre più ricorrente negli studi archeologici degli ultimi decenni in quanto collega l'uomo all'ambiente in cui vive e associa due ambiti che diventano praticamente inscindibili l'uno dall'altro. Ricostruire il nostro passato significa dunque scrivere la storia dell'uomo interfacciata al contesto ambientale nel quale ha vissuto che, nel corso del tempo, risulta essere sempre più condizionato dalle attività e dagli interventi antropici. Un contributo importante per la ricostruzione del contesto vegetazionale e ambientale è oggi dato dall'archeobotanica. Nonostante gli importanti cambiamenti ambientali che hanno interessato la prima parte dell'Olocene, portando gli ultimi cacciatori-raccoglitori ad attuare nuove strategie di sussistenza che implicavano lo sfruttamento di un'ampia gamma di risorse, includendo la caccia di grandi e piccoli mammiferi, la pesca, l'uccellagione, la raccolta di molluschi, uova e prodotti vegetali, gli studi archeobotanici relativi al Mesolitico sono ad oggi ancora piuttosto esigui.

Questo lavoro intende fornire nuove informazioni sulla frequentazione mesolitica dell'area emiliana, con particolare attenzione alla componente ambientale e alle piante impiegate nella vita quotidiana, presentando i risultati degli studi archeopalinologici e microantracologici condotti recentemente in località Le Mose (Piacenza).

***Fig. 1** - Il sito mesolitico di Le Mose (PC)./The Mesolithic site of Le Mose (PC).*

Il sito di Le Mose

A partire dal 1998 fino al 2003, sotto la direzione scientifica della dott.ssa M. Bernabò Brea della Soprintendenza per i Beni Archeologici dell'Emilia Romagna (Bernabò Brea *et al.* 2005), in località Le Mose (53 m s.l.m.), presso una vasta area alla periferia sud-orientale di Piacenza destinata ad insediamenti produttivi, sono stati individuati livelli di frequentazione di età mesolitica (Fig. 1) e neolitica, oltre a limitate presenze riferite all'età del Rame, del Ferro e all'età romana. Il territorio indagato archeologicamente è ubicato all'interno del bacino del torrente Nure, a circa 3 km a ovest dell'attuale corso e a 4 km a sud del fiume Po; si tratta quindi di un'area che da sempre è stata interessata da deposizioni di natura prevalentemente alluvionale.

Materiali e metodi

Il campionamento palinologico si è concentrato sui livelli e aree/strutture pertinenti cronologicamente al Mesolitico ritenute più importanti e significative ai fini della ricostruzione dell'ambiente vegetale. Tra i numerosi campioni pollinici prelevati ne sono stati selezionati 10 da sottoporre ad analisi presso il Laboratorio di Palinologia e Archeobotanica del C.A.A. Giorgio Nicoli nella sede operativa di San Giovanni in Persiceto (BO). Per la preparazione dei campioni pollinici è stato usato il metodo elaborato dall'Istituto di Scienze della Terra dell'Università di Vrije (Lowe *et alii* 1996) che prevede il trattamento con tetrasodiopirofosfato 1%, setacciatura con filtri di nylon, HCl 10%, acetolisi di Erdtman, arricchimento mediante flottazione con liquido pesante (sodiometatungstatoidrato), HF 40%, etanolo, allestimento di vetrini fissi con gelatina glicerinata. L'osservazione dei campioni è stata effettuata al microscopio ottico a 1.000x contando e determinando un numero statisticamente significativo di granuli pollinici e spore di Pteridofite. La determinazione dei granuli è basata sulla Palinoteca del nostro laboratorio e sui correnti atlanti/chiavi polliniche in aggiunta ad una vasta miscellanea morfopalinologica specifica in tema. Per il calcolo delle concentrazioni polliniche (p/g = n. granuli pollinici per grammo di materiale) sono state preventivamente aggiunte ai campioni pastiglie di spore di *Lycopodium* (Berglund, Ralska-Jasiewiczowa 1986). La nomenclatura tassonomica fa riferimento a Pignatti (1982) e Zangheri (1976). Il conteggio dei microcarboni è stato effettuato sugli stessi vetrini analizzati per l'analisi pollinica e segue il metodo di misurazione e conteggio di Clark (1982) con alcune modifiche. Per tutti i campioni analizzati sono stati redatti spettri pollinici generali su base percentuale in aggiunta a varie sommatorie relative a Gruppi Pollinici significativi utili per l'interpretazione dei risultati riassunti in grafici di sintesi (Fig. 2a, 2b, 2c). E' inoltre stato redatto un grafico complessivo relativo alla presenza dei microcarboni (Fig. 3).

Risultati e discussione

Vengono di seguito presentati i risultati delle analisi palinologiche e microantracologiche effettuate per ricostruire l'evoluzione del paesaggio vegetale nei vari momenti cronologici indagati. In particolare, l'indagine palinologica fornisce informazioni sul paesaggio vegetale e sulla sua evoluzione durante la prima parte dell'Olocene, con un *focus* sulla vegetazione naturale che circondava il sito, mentre l'analisi dei microcarboni consente di dettagliare eventi collegati a fuochi/incendi locali ed extralocali. L'evoluzione del paesaggio viene suddivisa in 3 fasi cronologiche che coincidono con altrettante fasi vegetazionali; in particolare le prime due sono riferibili al Preboreale e la terza al Boreale.

FASE I = il paesaggio vegetale denota una copertura costituita in gran parte da arboree (A+ar+L: 65,9%, 27 *taxa*), presenti nelle zone circostanti il sito: dominano le Conifere (Cf: 57,8%, 7 *taxa*) con vari Pini (*Pinus* cf. *cembra*/Pino cembro cf., *Pinus* cf. *mugo*/Pino mugo cf., *Pinus* cf. *nigra*/Pino nero cf., *Pinus* cf. *sylvestris*/Pino silvestre cf.) e Abeti

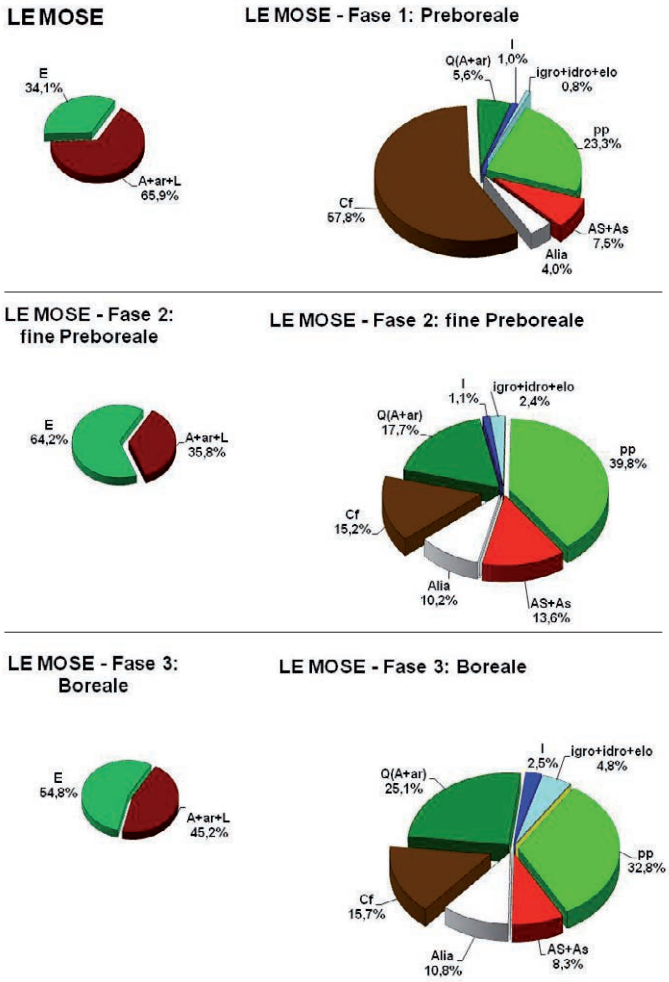

Fig. 2 - Grafici di sintesi dei principali raggruppamenti emersi dagli spettri pollinici generali redatti su base percentuale: a) grafici di sintesi della Fase 1, b) grafici di sintesi della Fase 2, c) grafici di sintesi della Fase 3. Legenda dei grafici: Legnose (A+ar+L), Erbacee (E), Conifere (Cf), Querceto Q(A+ar), Igrofite legnose (I), igrofite+idrofite+elofite erbacee (igro+idro+elo), Indicatori Antropici Spontanei Totali (AS+As), Indicatori di prato (pp), Alia. / Graphic showing main pollen groups from percentage pollen spectra: a) Phase 1; b) Phase 2; c) Phase 3. Selected sums: Oak wood (A+ar+L), Herbs (E), Conifers (Cf), Quercetum = Q(A+ar), Hygrophilous (woody plants = I), Hygrophilous+hydrophilous+helophilous plants (herbs = igro+idro+elo), Anthopogenic Indicators (woody plants + herbs = AS+As), Pasture/meadow Indicators (pp), Alia.

(*Abies alba*/Abete bianco, *Picea excelsa*/Abete rosso), accompagnati da diverse Latifoglie Decidue (LD: 7,5%, 18 *taxa*) con specie tipiche del *Quercetum* (Q=A+ar: 5,6%, 12 *taxa*) fra cui *Quercus* cf. *cerris*/Cerro cf., *Quercus* cf. *pubescens*/Roverella cf., *Quercus* cf. *robur*/Farnia cf., *Carpinus betulus*/Carpino comune, *Ostrya carpinifolia-C. orientalis*/Carpino nero - C. orientale, *Fraxinus excelsior* tipo/Frassino comune tipo, *Fraxinus ornus*/Orniello, *Tilia cordata*/Tiglio selvatico, *Tilia platyphyllos*/Tiglio nostrano e *Corylus avellana*/Nocciolo comune.

Discreta la presenza delle Erbacee (E: 34,1%, 33 *taxa*) con dominanza di *Cichorioideae, Asteroideae* e *Gramineae* spontanee. Questi dati suggeriscono un ambiente boscato con ampie radure di media dimensione in corrispondenza del sito indagato (pp: 23,3%, 5 *taxa*). La concentrazione degli Indicatori Antropici, collegati alla possibile presenza/attività dell'uomo nell'area, risulta essere la più bassa della serie pollinica (AS+As: 7,5%, 11 *taxa*); sono documentate diverse *Chenopodiaceae*/Chenopodiacee, *Artemisia vulgaris* tipo/assenzio selvatico tipo, *Aster* tipo/astro tipo, fiordaliso (*Centaurea cyanus*/fiordaliso vero, *Centaurea nigra* tipo/fiordaliso scuro tipo), *Cirsium*/cardo, *Cichorium* cf. *intybus*/cicoria cf. comune, *Rumex acetosa* tipo/romice acetosa tipo, *Linaria* tipo/linajola tipo, *Solanum nigrum* tipo/morella comune tipo, ecc. Questi bassi valori potrebbero indicare una presenza occasionale/naturale di queste piante, non strettamente collegata all'uomo e alle sue attività.

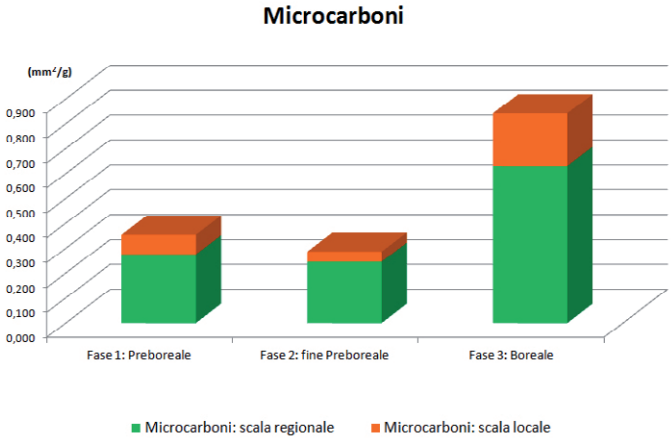

Fig. 3 - Grafico di sintesi dei microcarboni. / Graphic showing the microanthracological remains.

Sono inoltre documentati alcuni *taxa* legnosi spontanei con frutti eduli (Fe: 4,1%, 7 *taxa*) fra cui Nocciolo, varie Querce e *Sorbus*/Sorbo, piante che potevano fornire frutti spontanei con valenza alimentare e che quindi potevano essere raccolti e impiegati nella dieta alimentare.

Le piante di ambiente umido sono presenti con basse percentuali (I+igro+idro+elo: 1,8%, 7 *taxa*): fra le arboree sono documentati vari Ontani (compreso *Alnus* cf. *viridis*/Ontano verde cf., forse proveniente da zone di quota) e *Salix*/Salice; fra le specie erbacee si segnalano *Butomus umbellatus*/giunco fiorito, *Sagittaria sagittifolia* tipo/sagittaria comune tipo, *Cirsium palustre* tipo/cardo di palude tipo e diverse *Cyperaceae*/Ciperacee.

La curva della concentrazione dei microcarboni rileva una buona presenza di incendi a carattere regionale (0,275 mm²/g), mentre a livello locale i valori sono piuttosto bassi (0,079 mm²/g), attestando che l'area in questa fase era scarsamente frequentata dall'uomo.

I rilevanti valori di Conifere e la bassa presenza di specie di ambiente umido indicano una fase climatica ancora abbastanza fredda e secca, con limitate precipitazioni piovose; confrontando il contesto vegetazionale con i dati in letteratura, è plausibile inserire questa prima fase nel Preboreale (8.200 – 6.800 a.C.).

FASE II = il paesaggio vegetazionale risulta notevolmente modificato rispetto alla fase precedente a causa di una diminuzione complessiva delle Legnose (A+ar+L: 35,8%, 29 *taxa*) a favore di un'espansione considerevole delle erbacee (E: 64,2%, 29 *taxa*). In particolare diminuiscono le Conifere (Cf: 15,2%, 6 *taxa*), che iniziano a scomparire dalle zone di pianura per espandersi nelle aree collinari e montane, mentre in contemporanea si assiste all'espansione del querceto mesofilo (Q: 17,7%, 15 *taxa*). L'ambiente risulta complessivamente più aperto rispetto alla fase precedente e costituito da maggiori spazi prativi (pp: 39,8%, 4 *taxa*), nonostante i boschi di Conifere e di latifoglie decidue continuino comunque ad essere elementi importanti del paesaggio.

Le piante tipiche di ambienti umidi subiscono un aumento (I+igro+idro+elo: 3,5%, 7 *taxa*): incrementano gli Ontani (*Alnus* cf. *glutinosa*/Ontano comune cf., Ontano verde cf.) e i Salici, oltre a numerose specie erbacee (carici, giunco fiorito, cardo di palude tipo, ecc.), suggerendo la presenza di limitate zone umide non lontane dal sito. Gli Indicatori Antropici spontanei (AS+As: 13,6%, 10 *taxa*) incrementano rispetto alla fase precedente e ciò potrebbe indicare una prima possibile frequentazione umana del sito, nonostante il dato non sia confermato dalla curva di concentrazione dei microcarboni che, al contrario, si attesta su valori leggermente più bassi rispetto alla fase precedente (concentrazione regionale: 0,245 mm²/g; concentrazione

locale: 0,020 mm²/g). Da segnalare è il buon incremento delle piante produttrici di frutti eduli (Fe: 13,9%, 7 *taxa*) rispetto alla fase precedente. Dal punto di vista climatico, la netta diminuzione delle Conifere e l'aumento del bosco deciduo potrebbero suggerire un sostanziale miglioramento climatico, caratterizzato da temperature più alte, anche se persiste un ambiente abbastanza secco e con limitate precipitazioni piovose; il quadro vegetazionale emerso dalle indagini polliniche collocherebbe questa fase indicativamente alla fine del Preboreale.

FASE III = datazioni radiometriche effettuate presso il Poznan Radiocarbon Laboratory datano lo strato US 507 = 7, corrispondente alla paleosuperficie mesolitica, al 9.220 ± 50 BP (8.560 - 8.300 cal. BC) (Poz-13344 - Plinto 19 S) e all'8.250 ± 50 BP (7.460 - 7.130 cal BC) (Poz-13343 - area selci VII). Durante questa fase, l'ambiente è caratterizzato da ampie aree aperte (E: 54,8%); la componente arborea, inferiore al 50% (A+ar+L: 45,2%, 42 *taxa*), è caratterizzata da Latifoglie Decidue (LD: 29,1%,29 *taxa*) con specie tipiche del querceto (Q: 25,1%, 15 *taxa*). Da segnalare la comparsa di *Quercus ilex*/Leccio, specie tipica di ambiente mediterraneo che esige temperature abbastanza elevate per vegetare e rilevanti valori di *Tilia* (5,4%) che suggeriscono una maggior diffusione delle specie tipiche del bosco mesofilo. Rimangono sullo sfondo del paesaggio le Conifere, con valori simili a quelli della fase precedente (Cf: 15,7%, 8 *taxa*). Interessante la comparsa di *Juniperus* tipo/Ginepro comune. Si registra inoltre un aumento delle piante collegate agli ambienti umidi (I+igro+idro+elo: 7,3%, 20 *taxa*), in particolare di quelle arboree con Ontani, Salice e *Populus*/Pioppo, mentre le specie erbacee riportano una lista floristica più diversificata (giunco fiorito, *Callitriche*/gamberaja, cardo di palude tipo, *Carex* tipo/carice tipo, *Schoenus* tipo/giunco nero tipo, Ciperacee, *Hydrocharis morsus-ranae*/morso di rana, *Lemna*/lenticchia d'acqua, *Nuphar lutea*/ninfea gialla, *Nymphaea* cf. *alba*/ninfea comune cf., *Thalictrum flavum* tipo/pigamo giallo tipo, *Sparganium emersum* tipo/coltellaccio a foglia stretta tipo, *Sparganium erectum* tipo/coltellaccio maggiore tipo, *Valeriana dioica*/valeriana palustre). Rilevanti sono anche i valori percentuali delle *Pteridophyta* (P: 19,2%, 8 *taxa*), a testimonianza di una maggior diffusione di aree tendenzialmente umide nelle zone circostanti. Le Erbacee rappresentano il raggruppamento dominante in questa fase e riportano valori percentuali elevati (E: 54,8%, 72 *taxa*) con una buona presenza di specie tipiche delle praterie (pp: 32,8%, 8 *taxa*). Gli Indicatori Antropici spontanei (AS+As: 8,3%, 23 *taxa*) raggiungono valori discreti: da segnalare il rinvenimento di uno stame di *Cannabis*, pianta a cui viene generalmente attribuito un significato sinantropico, ma che nel presente contesto, accompagnata a granuli pollinici di *Artemisia* e a varie *Chenopodiaceae*, suggerisce l'appartenenza a piante selvatiche (Mercuri *et al.*, 2002). Altrettanto importante è il rinvenimento di alcuni granuli pollinici che, per parametri morfo-biometrici, rientrano nel gruppo dell'*Hordeum*/orzo gruppo e in quello dell'*Avena-Triticum gruppo*/avena-grano gruppo: *tuttavia,* considerando il contesto e le caratteristiche morfometriche dei granuli rinvenuti si possono considerare specie spontanee incluse nei due gruppi (Behre, 2007). Le piante produttrici di frutti eduli (Fe: 16,1%, 13 *taxa*) hanno valori sempre più elevati e qualitativamente risultano più diversificate rispetto alle fasi precedenti: sono presenti granuli pollinici di *Sambucus nigra*/Sambuco comune, *Sambucus* cf. *racemosa*/Sambuco rosso cf., *Cornus mas*/Corniolo maschio, Castagno comune, varie Querce, *Juglans regia*/Noce comune e Nocciolo, quest'ultimo attestato con discreti valori percentuali (7,7%). Complessivamente la curva dei microcarboni (concentrazione regionale: 0,604 mm²/g; concentrazione locale: 0,195 mm²/g) raggiunge in questa fase i valori più elevati della serie studiata, soprattutto a livello regionale, indice di una buona presenza antropica nell'area.

Considerando il calo delle Conifere rispetto alle fasi precedenti, la comparsa del Leccio unitamente ad elevati valori di Nocciolo e Tiglio, si può ipotizzare per questa fase un ulteriore miglioramento climatico in senso temperato/fresco, con una percentuale di umidità leggermente più elevata, dovuta a precipitazioni piovose probabilmente più consistenti. Questi dati, nonostante la prima datazione al radiocarbonio cada nel Preboreale, collocherebbero questa fase nel Boreale, in accordo con la seconda datazione al radiocarbonio.

Considerazioni conclusive

Le indagini palinologiche e microantracologiche effettuate nel sito rinvenuto in località Le Mose, a sud-est di Piacenza, hanno consentito di ricostruire l'evoluzione del paesaggio vegetale e dell'ambiente in un arco cronologico che va dal Preboreale al Boreale. In particolare, nel Boreale si verifica una drastica riduzione della componente arborea a carico soprattutto delle Conifere, che si contraggono significativamente passando dal 57,8% al 15,7% a causa di un miglioramento climatico che porterà queste piante progressivamente a scomparire dalle zone di pianura per espandersi in aree collinari e montane. Le Conifere, infatti, sono progressivamente sostituite dal bosco di latifoglie decidue (che passano dal 5,6% al 25,1%) e, contemporaneamente, incrementano anche gli spazi aperti dominati da specie erbacee (che passano dal 34,1% al 54,8%). Tali spazi aperti potevano essere poi facilmente occupati dall'uomo per stabilirvi i primi insediamenti. Dai boschi circostanti l'uomo poteva poi non solo approvvigionarsi di legname per i suoi fabbisogni ma anche raccogliere i numerosi frutti eduli che potevano essere consumati nella dieta alimentare.

Anche le specie tipiche di zone umide, dalle fasi precedenti la frequentazione al pieno Mesolitico, registrano un aumento e passano da 1,8% a 7,3% e testimoniano una maggior presenza di ambienti stagnanti attorno al sito. Gli Indicatori Antropici Spontanei (che passano da 7,5% a 13,6% e poi a 8,3%), che rappresentano le specie strettamente collegate alla presenza dell'uomo nell'area e in particolare al calpestio, riportano valori percentuali non particolarmente elevati, quasi a testimoniare che l'area sia stata occupata per un breve periodo. La curva dei microcarboni raggiunge invece buoni livelli nel Boreale, testimoniando fuochi regionali e locali abbastanza frequenti.

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Article

The paradoxical pattern of the Mesolithic evidence in Liguria: piecing together the puzzle

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Key words

- Settlement
- Mesolithic
- Northern Italy
- Liguria

Parole chiave

- Insediamento
- Mesolitico
- Nord Italia
- Liguria

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Summary

Several open-air Mesolithic sites are known, mainly located on the rugged eastern bank. All of them are surface collections of chipped artefacts doubtfully attributed, only on techno-typological grounds, to the Sauveterrian or to the Castelnovian. However none of them provided any biostratigraphical context; therefore archaeobotanical and archaezoological data are completely missing, as well as any C14 dating. Conversely, any Mesolithic industry is lacking in the few sites where some lower Holocene/early Atlantic environment insights and C14 datings are available. The strong gap between dates and cultural evidence underlines a patchy and paradoxical regional pattern.

Riassunto

Sono note diverse stazioni mesolitiche di superficie, prevalentemente concentrate in Liguria orientale, le quali hanno restituito manufatti attribuibili, in modo dubitativo e solo su base tecno-tipologica, al Sauveterriano e al Castelnoviano. Non sono noti siti mesolitici stratificati e datati, contenenti chiare evidenze culturali. Le uniche datazioni attribuibili a questa fase provengono da depositi di interesse archeologico-ambientale, privi di manufatti caratteristici. La dicotomia tra datazioni ed evidenze culturali rende quindi la situazione ligure lacunosa e paradossale.

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Introduction - A challenging matter

Liguria is a long arc-shaped chain of mountains, facing the Mediterranean to the South and the Po Plain to the North. Several open-air Mesolithic sites are known, mainly located on the rugged eastern bank (Franco 2011; Maggi & Negrino 1992) (Fig. 1). All of them are surface collections of chipped artefacts of Sauveterrian or Castelnovian typology. However none of them provided any biostratigraphical context; therefore archaeobotanical and archaezoological data are completely missing, as well as any C14 dating. Conversely, a few sites yielded some environment archaeological insights without any association to industry. A few caves located in the west bank have provided the only stratigraphical occurrence of tools C14 dating to the Mesolithic (Alessio *et al.* 1967, 1968). However, ironically, such artefacts are of final Epigravettian typology and the suggestion of the continuation of a Palaeolithic way of life up to almost the VII millennium cal BC is hardly tenable. New lucky excavations and detailed investigations are requested, in order to sort out the assessment of the Mesolithic of a region that knew the earliest neolithisation of Northern Italy (Binder & Maggi 2001; Binder *et al.* 2008; Branch *et al.* 2014).

The archaeological evidence

Our knowledge about the Ligurian Mesolithic is still rather fragmented, both for the scarcity of good archaeological contexts and for the lack of thorough studies and researches (Fig. 1; Tab. 1).

Flint artefacts, including geometrics, attributable to the passage from final Upper Palaeolithic to the Sauveterrian, have been found at La Mortola, close to the sea and not far from Balzi Rossi caves (Ventimiglia, Imperia)(Baroni & Biagi 1991), from the open-air site of Ortovero, in the inland of Albenga (Savona)(Negrino *et al.* 2015) and at Colla di San Giacomo, a mountain pass near Finale Ligure (Savona) (Franco 2011: p. 274; Arobba & Vicino 2013). Like-sauveterrian finds have been also discovered in open-air sites located in the Apennine range to the east of Genoa, on the mountains but also on river terraces at the bottom of the valleys.

Late Mesolithic evidence (Castelnovian) is apparently more common. The interesting site of Pian del Re, near Imperia, is still unpublished (even if problematic, because a mixing of different chronological aspects, from the Epigravettian period to the Neolithic one: Didier Binder pers. com.). Another site related to this period is Prate delle Ranghe, in the high Vara valley, located on a wide mid-slope terrace (Varese Ligure, La Spezia)(Ghiretti & Guerreschi 1988; Negrino 2002: note 23, p. 360); the presence of a buried layer with charcoals, could provide in the future a direct date for the Ligurian Castelnovian. In fact, none of the Ligurian Mesolithic sites have been yet dated.

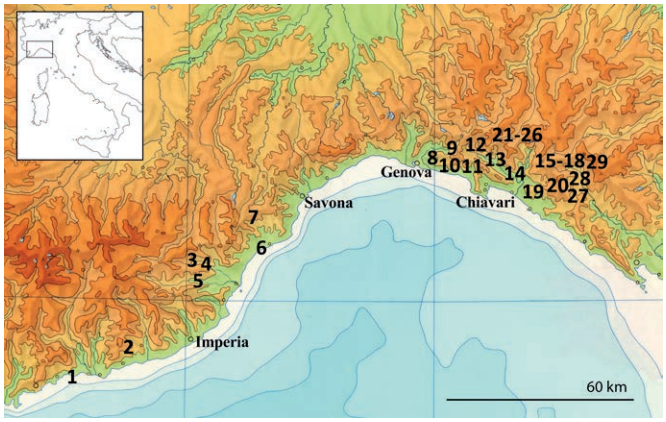

Fig. 1 *- Map of Liguria with the localities mentioned in the text. / Ubicazione delle località citate nel testo.*

With the exception of the sites of La Mortola and Pian del Re, in Western Liguria, where the armatures like triangles and trapezes are quite abundant, the others known sites are very poor in this kind of artefacts (Baffico *et al.* 1983, 1984; Colella & Maggi 1987; Del Lucchese & Salonio 1987; Maggi & Nebiacolombo 1987; Odetti 1987; Odetti & Starnini 1987; Salonio 1987; Starnini & Menni 1992; Starnini & Rembado, 1992; Starnini & Tiscornia 1987), in sharp contrast with what happens in other areas, such as in Trentino, but also in the surrounding regions (Provence, Emilia and Tuscany)(Brochier 1982; Franco 2011; Tomasso *et al.* 2014; Walsh K. *et al.* 2007); the high presence of non retouched blanks and the rarity of geometrics tools is an intriguing subject (Maggi & Negrino 1992). Even the chronological attributions, in the absence of secure stratigraphic contexts, remain largely hypothetical, particularly those relating to the Sauveterrian; in some Italian Castelnovian sites, in fact, trapezes are often associates to geometrics of older typology, like triangles (see discussion in Franco 2011).

The levels of the Arene Candide cave (Finale Ligure, Savona) immediately underlying the Early Neolithic units, yielded few not diagnostical artefacts, although two radiometric dates made on charcoals belong to the lower Holocene and early Atlantic (Beta-109618: 7640±60 uncal BP - C13[-27,5], 6604-6403 cal BC[1]; Beta-109619: 9090±60 uncal BP – C13[-27,1], 8527-8222 cal BC). This evidence suggests the sporadic use of the cave during this phase (Guerri 1976; Maggi 1997; Tiné 1976, 1999).

A coring from Pozza dell'Orso (Monte Caucaso, Neirone) in the Genoese Apennine, provided evidence of a buried soil, that dates to 6082-5922 cal BC (Beta-177066: 7150±40 uncal BP). A few flakes of flint and jasper collected on the surface suggest this is a possible Castelnovian site suitable for excavation.

Radiometric dates attributed to the Early Holocene also come from some bio-stratigraphic contexts devoid of industries. At Grotta del Bandito, in Lagorara Valley (Maissana, La Spezia), some charcoals gathered from a deep colluvial level date to 8271-7371 cal BP (Beta-60703: 8670±180 uncal BP)(Campana *et al.* 2002).

Very interesting is what can be observed at the Mogge di Ertola peat bog (Rezzoaglio, Genova). Here several dates of Mesolithic age (from 8912±100 uncal BP - 8291-7739 cal BC till 7190 ±60 uncal BP – 6216-5931 cal BC) were obtained from basal peat & debris-flow layers, possibly related to deforestation by fire of the surrounding slopes (Cevasco *et al.* 2013). This is suggested by a peak of micro-charcoals, by a significant reduction of the white fir forest and by other fluctuation in the pollen sequence. A similar, wider, concentration of micro-charcoals also occurs in the Roman levels, where the anthropic impact is clearly shown by several soils and vegetational markers, including the definitive replacement of the white fir by the beech. Therefore, for comparison, it can be argued that the environmental modifications, including the formation of a small lake, observed in the levels C14 dated to the Mesolithic could also be due to human activities, possibly related to the management of environmental resources. .

The conventional radiometric measurements, made in the Sixties of the last century, from the Stefanin cave, in the inland of Albenga (Savona), of Mesolithic date but associated with Epigravettian artefacts, are questionable (Alessio *et al.* 1967; Leale Anfossi 1972). At Arma dello Stefanin, which dates have been obtained from several charcoals, the refitting of the lithic artefacts showed mixing among the strata. However an AMS date (8895+270 uncal BP, 8786-7382 cal BP) from new "control" excavation carried out in the eighties, still looks too young against the associated Late Epigravettian lithic typology (Barker *et al.* 1990; Biagi 1991; Biagi & Maggi 1984; Biagi *et al.* 1987). Therefore the question of a local cultural delay is somehow open, although hardly tenable. The dated level is sealed by a

1 Calibration at 95.4% confidence interval (OxCal 4.2, IntCal 13: Reimer *et al.* 2013).

***Tab. 1** - Ligurian sites with Mesolithic artifacts or dated to lower Holocene/early Atlantic. Calibration at 95.4% confidence interval (OxCal 4.2, IntCal 13: Reimer et al. 2013). / Siti liguri che hanno restituito manufatti mesolitici o che sono stati datati all'Olocene antico o all'inizio dell'Atlantico. Calibrazione al 95.4% di probabilità (OxCal 4.2, IntCal 13: Reimer et al. 2013).*

	NAME OF THE SITE	PROVINCE	ALTITUDE (ASL)	TYPOLOGY OF THE SITE	LITHIC ARTIFACTS	RADIOCARBON DATES	CULTURAL ATTRIBUTION
1	**Punta della Mortola - Ventimiglia**	IM	10	Open-air site (reworked deposit)	Geometrics	-	**Epigravettian/ Sauveterrian**
2	**Pian del Re - Perinaldo**	IM	850	Open-air site	Geometrics	-	**Castelnovian**
3	**Arma dello Stefanin - Aquila d'Arroscia**	SV	450	Cave (stratified deposit)	(Late Epigravettian?)	GX-16959: 8895±270 BP charcoal (8786-7382 cal B) Bln-3567: 8710 ±70 BP charcoal (8165-7586 cal BP) GIF-7210: 8300±900 BP charcoal (10165-5621 cal BP)	***Lower Holocene***
4	**Arma di Nasino**	SV	250	Rock shelter (stratified deposit)	(Late Epigravettian?)	Beta-76823/CAMS-16559: 7870±60 BP bone collagene (7029-6596 cal BP)	***Early Atlantic***
5	**Ortovero**	SV	60	Open-air site (stratified deposit)	Not diagnostic	-	**Epigravettian/ Sauveterrian**
6	**Caverna delle Arene Candide - Finale Ligure**	SV	90	Cave (stratified deposit)	Not diagnostic	Beta-109619: 9090±60 BP charcoal (8527-8222 cal BP) Beta-109618: 7640±60 BP charcoal (6604-6403 cal BP)	***Lower Holocene and early Atlantic***
7	**Colla di San Giacomo - Finale Ligure**	SV	790	Open-air site	Geometrics	-	**Sauveterrian**
8	**Passo Giuche - Monte Bastia - Genova**	GE	750	Open-air site	Geometrics	-	**Castelnovian**
9	**Monte Traso - Bargagli**	GE	850	Open-air site	Geometrics	-	**Sauveterrian**
10	**Nasoni / Monte Rotondo -Bogliasco**	GE	750	Open-air site	Geometrics	-	**Castelnovian**
11	**Monte Uccellato - Sori**	GE	780	Open-air site	End-scraper and retouched blades	-	**Mesolithic?**
12	**Pozza dell'Orso - Monte Caucaso - Neirone**	GE	1150	Open-air site (stratified deposit - coring)	Not diagnostic	Beta-177066: 7150±40 BP charcoal (6082-5922 cal BP)	**Castelnovian**
13	**Ferrada di Moconesi**	GE	120	Open-air site (stratified deposit)	Geometrics	-	**Sauveterrian**
14	**Cian dei Tenenti - Calvari**	GE	50	Open-air site (stratified deposit - coring)	No artifacts	Beta-118952: 9430±40 BP charred material (8811-8617 cal BP)	***Lower Holocene***
15	**Bosco delle Lame - Borzonasca**	GE	1500	Open-air site	Geometrics	-	**Castelnovian**
16	**Colmo Rondio - Borzonasca**	GE	1170	Open-air site	Geometrics	-	**Sauveterrian and Castelnovian**
17	**Malga Perlezzi - Borzonasca**	GE	1650	Open-air site	Geometrics	-	**Sauveterrian**
18	**Prato Mollo - Borzonasca**	GE	1500	Open-air site	Geometrics	-	**Sauveterrian and Castelnovian**
19	**Nido del Merlo - Ne**	GE	700	Open-air site	Geometrics	-	**Sauveterrian**
20	**Passo della Camilla - Ne**	GE	720	Open-air site	Geometrics	-	**Sauveterrian and Castelnovian**
21	**Passo dello Zovallo - S. Stefano d'Aveto**	GE	1400	Open-air site	Geometrics	-	**Castelnovian**

Tab. 1 - continued / continua

	NAME OF THE SITE	PROVINCE	ALTITUDE (ASL)	TYPOLOGY OF THE SITE	LITHIC ARTIFACTS	RADIOCARBON DATES	CULTURAL ATTRIBUTION
22	**Groppo Rosso - S. Stefano d'Aveto**	GE	1595	Open-air site	Geometrics	-	**Castelnovian**
23	**Prato della Cipolla - S. Stefano d'Aveto**	GE	1600	Open-air site	Geometrics	-	**Castelnovian**
24	**Mogge di Ertola - Rezzoaglio**	GE	1115	Open-air site (stratified deposit - peat bog)	No artifacts	LTL-547A: 8912±100 BP charcoal (8291-7739 cal BP) LTL-1220A: 7190±60 BP peat (6216-5931 cal BP)	***Lower Holocene and early Atlantic***
25	**Passo Esola - Rovegno**	GE	1300	Open-air site	Geometrics	-	**Castelnovian**
26	**Pian Brogione - Rovegno**	GE	1150	Open-air site	Geometrics	-	**Castelnovian**
27	**Località U Péou - Torza - Maissana**	SP	500	Open-air site	Geometrics	-	**Castelnovian**
28	**Grotta del Bandito - Maissana**	SP	920	Cave (stratified deposit)	No artifacts	Beta-60703: 8670±180 BP charcoal (8271-7371 cal BP)	***Lower Holocene***
29	**Prate delle Ranghe - Varese Ligure**	SP	805	Open-air site (stratified deposit)	Geometrics	-	**Castelnovian**

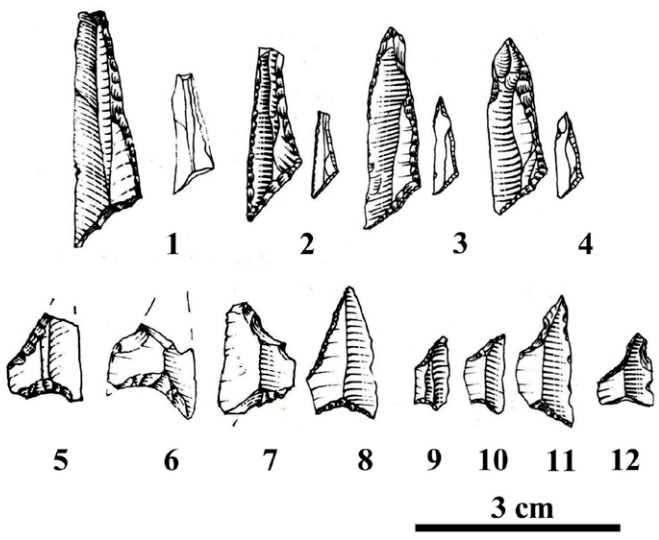

***Fig. 2** - Mesolithic artifacts: triangles (1-4) and trapezes (5-12). Ferrada di Moconesi (1); Nido del Merlo (2); Prato Mollo (3-4, 12); Passo Giuche, Monte Bastia (5); località U Péou, Torza (6); Prate delle Ranghe (7); Colmo Rondio (8); Prato della Cipolla (9); Bosco delle Lame (10-11). / Manufatti mesolitici: triangoli (1-4) e trapezi (5-12). Ferrada di Moconesi (1); Nido del Merlo (2); Prato Mollo (3-4, 12); Passo Giuche, Monte Bastia (5); località U Péou, Torza (6); Prate delle Ranghe (7); Colmo Rondio (8); Prato della Cipolla (9); Bosco delle Lame (10-11).*

***Fig. 3** - The Mesolithic site of Prato Mollo (Borzonasca, Genova). / Il sito mesolitico di Prato Mollo (Borzonasca, Genova).*

floorstone layer, containing charcoals. Thus It could be argued that, as occurs in Arene Candide cave, these charcoals might be related to occasional presence of Mesolithic people, so scanty not to leave amount of artefacts of archaeological relevance.

Solving the enigma

The archaeological framework is therefore paradoxical, since it provides contradictory evidence. Thus, in order to undertake an updated discussion of this historical riddle it is necessary to face the following steps:

- proceed with the study of unpublished sites;

- carry on new surveys and new excavations in caves, shelters and open-air sites;
- do new radiocarbon dates.

This is the only way to build in a scientifically valid manner the behavioural of the Mesolithic communities in an area where the earliest neolithisation of Northern Italy occurred, in order to get a coherent historical pattern out of the paradox.

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Article

Use-wear analysis of a Mesolithic assemblage: the Mourre de Sève rock shelter (Sorgues-Vaucluse)

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Key words

- South France
- Mesolithic
- Use wear
- Castelnovian
- Sauveterrian

Parole chiave

- Sud della Francia
- Mesolitico
- Tracce d'uso
- Castelnoviano
- Sauveterriano

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Summary

This research concerns the characterisation of the economy of a Mesolithic settlement from Southern France. The Mourre de Sève site is a rock shelter located close to the Rhône and Ouvèze confluence and it represents the exploitation of a riverine environment by hunter-gatherers. The latest excavations, in 1994 and 1997, dated the site using AMS to the Sauveterrian and the Castelnovian periods. The Castelnovian lithic industry from the top levels of the site constitutes one of the few blade and trapeze complexes of the region between the Alps and the Pyrenees. In this article we discuss the results of use-wear analysis carried on the lithic artefacts from the recent excavations. The results of this analysis are linked to multidisciplinary studies of the archaeological material to characterize the economy of the site. The findings suggest continuity in economy type from the Sauveterrian to the Castelnovian occupations.

Riassunto

Questa ricerca concerne la caratterizzazione dell'economia di un sito mesolitico nel sud della Francia. Mourre de Sève è un riparo sotto roccia collocato non lontano dalla confluenza dei fiumi Rhône e Ouvèze e rappresenta l'occupazione di un ambiente umido da parte di cacciatori raccoglitori. Gli scavi più recenti, svolti tra il 1994 e il 1997, hanno datato il sito (AMS) ai periodi Sauveterriano e Castelnoviano. L'industria mesolitica, dei livelli più alti della stratigrafia, rappresenta uno dei pochi esempi di industrie a lame e trapezi della regione situata tra le Alpi e i Pirenei. In questo articolo saranno presentati i risultati delle analisi funzionali svolte sui materiali litici rinvenuti durante gli scavi recenti. Al fine di caratterizzare l'economia del sito, i risultati della nostra ricerca sono stati confrontati con quelli di analisi multi disciplinari condotte sul resto dei materiali. L'esito delle nostre analisi sembra suggerire una continuità nel tipo di economia dalle occupazioni sauveterriane a quelle castelnoviane.

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Introduction

This paper present the result of use-wear analysis carried out at the site of Mourre de Sève (Sorgues-Vaucluse). The site is composed of several Mesolithic occupations, which show similarity in lithic production and homogeneity in environmental exploitation, from the Sauveterrian to the Castelnovian period. The aim of this research is to better understand the technical system and function of the site during Mesolithic through a functional analysis of stone tools.

Study area

The Mourre de Sève (Sorgues, Vaucluse) rock shelter is located close to the confluence of Rhône-Ouvèze Rivers in the Comtat plain region of Southern France (Fig. 1). The site is located under an overhanging cliff at 80 m a.s.l., and faces north. During Mesolithic period this area was characterized by a riverine environment and was situated in the meso-mediterranean vegetation belt, with the predominance of *Quercus cf* forests.

The stratigraphy

During the first excavation, in the 1950's, several occupations dating to the Mesolithic and Neolithic were discovered (Paccard & Marcq 1993). Limited field notes were found about the site stratigraphy from this excavation, and the data was published in 1993 (Paccard & Marcq). The latest excavations (Binder 1994 and 1997), in 1994 and 1997, revealed different Mesolithic occupations and they found a small undisturbed area between E2 and E3 squares (Fig. 2). The deposit of this area cut a Miocene molasses layer next to a big block fallen from the cliff. In this part of the site, it was possible to recognize and to date, by AMS analysis, three Castelnovian occupations between 6650 and 6200 cal BC. The basal level contained some Sauveterrian remains, probably mixed with Castelnovian artifacts, which is dated between 7540 and 7420 cal BC. (Binder & Sénépart 2004).

Outside of this area, the sediment contained Neolithic and Mesolithic artefacts. However, the sediment was disturbed, making it impossible to distinguish any discrete occupations. For this reason, the functional analysis was applied mostly on lithic artefacts coming from the E2 and E3 squares.

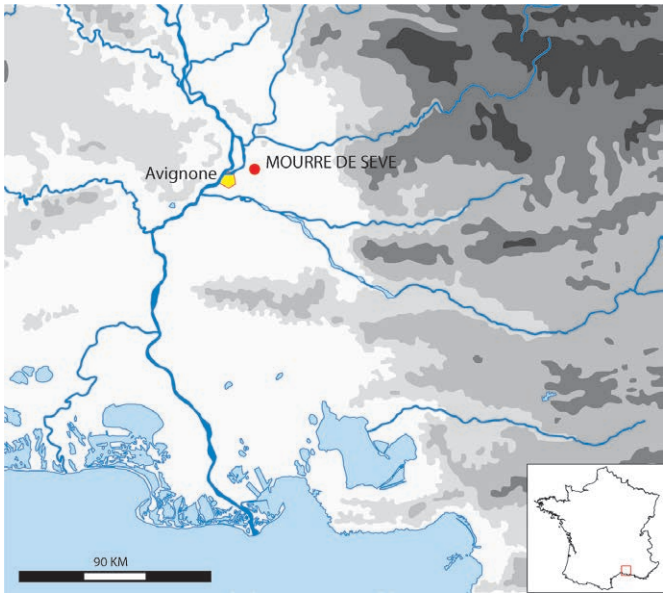

Fig. 1 *-The Mourre de Sève location in the Rhône Valley / Localizzazione geografica del sito di Mourre de Sève nella valle del Rodano.*

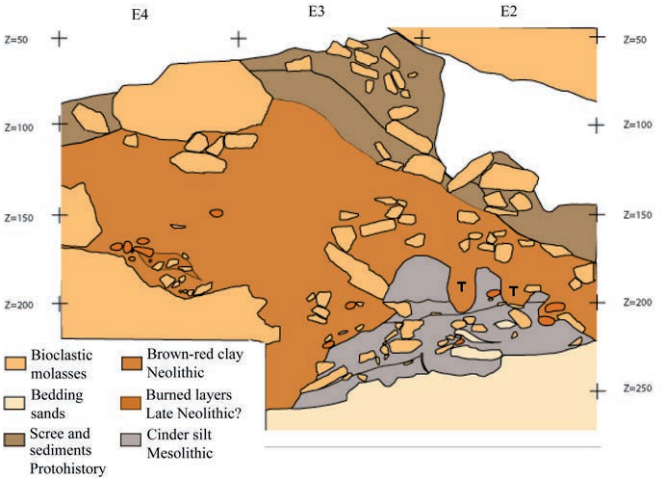

Fig. 2 *-Stratigraphic profile of E2 and E3 squares of the Mourre de Sève site. The large blocks fallen from the cliff are visible in the stratigraphy and two burrows are referred by a "T" in the section of E2 square (Binder & Sénépart 2004). / Sezione stratigrafica dei quadrati E2 e E3 del sito di Mourre de Sève. I grandi blocchi caduti dalla falesia sono visibili nella stratigrafia. La presenza di due tane sono segnalate dalla lettera "T" nella sezione del quadrato E2 (Binder & Sénépart 2004)*

Environment and economy

The anthracological analysis run by S. Thiébault (Binder & Sénépart 2004) showed the presence of a forested environment during the Mesolithic period. *Quercus cf. pubescens*, *Acer sp.*, *Ulmus sp*. and *Rosaceae sp.* characterized the forest and the presence of *Populus sp.* and *Salix sp.* indicated a riverine environment nearby the site.

Few faunal remains were recovered during the recent excavation (Binder 1994). A small sample of bones of wild boar (n=1), deer (n=3) and roe deer (n=6) showed evidence for hunting activities. The scarceness of mammal remains is contrasted with the high number of fish and turtle (*Emys orbicularis*) remains recovered from the site. The former was represented by fish of varying sizes and in particular by a large quantity of eel remains, all of them headless. Fishing was a very common activity during the Mesolithic and evidence can be found at other sites from the Provence and Languedoc region, including the Sauveterrian site of Fontbrégoua (Salernes) (Courtin 1975), the Castelnovian site of La Font de Pigeons (Châteauneuf-les-Martigues) (Courtin *et al.* 1985) and at the Mesolithic site of La Baume de Montclus (Binder & Sénépart 2004, Rozoy 1978). As well, turtles were a common part hunter-gatherers' diet from these regions, as witnessed at the sites of de Chinchon

Tab. 1 *-Comparison between the tools type and the number of cores coming from the two excavations. / Confronto tra gli strumenti e i nuclei provenienti dai due scavi.*

EXCAVATION	BLADES	END-SCRAPERS	NOTCHED BLADES	CORES
Marcq	High index of blades, but not calculated	14	5	13
Binder (E2-E3 squares)	44,4%	1	3	1

Tab. 2 -Number and types of projectiles coming from Marcq's excavation (Mesolithic levels) and Binder's excavations (E2 and E3 squares and the disturbed areas). / Quantità e tipologia delle armature provenienti dallo scavo di Marcq (livelli mesolitici) e dagli scavi di Binder (quadrati E2 e E3 e zone rimaneggiate).

EXCAVATION	BACKED BLADELET	TRAPEZE	SEGMENT	POINT	TRIANGLE	TOTAL
Marcq	-	19	1	-	-	20
Binder E2-E3 squares	11	3	-	1	1	16
Binder (disturbed areas)	5	13	-	-	2	20
Total	16	35	1	1	3	56

Tab. 3 -Number of analysed blanks for each occupation. / Numero dei supporti analizzati per ogni occupazione.

OCCUPATIONS	BLANK WITHOUT USE-WEAR	NON-DIAGNOSTIC	PROJECTILES	USED BLANKS	TOTAL
Castelnovian	103	11	10	8	132
Sauveterrian	38	8	6	5	57
Total	141	19	16	13	189

and Fontbrégoua (Royer *et al.* 2009). The analysis of turtle plastrons and the carapaces showed evidence of burnings, suggesting the turtles were cooked (*ibid.*).

The anthracological and archaeozoological analysis showed continuity in the environmental characteristics and exploitation throughout the Sauveterrian and Castelnovian levels. In fact, the faunal remains and their quantity were constant during all occupations. The same continuity was found in some features of the lithic industries.

Lithic industry

Several raw materials were used for lithic production during the Mesolithic, the most common was a Cretaceous (Bedoulian) honey flint and a Tertiary flint (Sannoisien). Raw material sources are found approximately 30 km from the rock shelter (Binder 1998). During the Castelnovian occupations, the main products made from the honey flint are regular bladelets produced by pressure flaking (Binder *et al.* 2012) and were used primarily for the production of geometrics. When present, the proximal parts of these blanks have pressure removals features: developed and well-delimited bulbs and well-expressed tearing-out lip. The blades are prismatic and regular, between 2 and 5 mm thick and 10 mm width. Aside this kind of *débitage*, other laminar blanks were produced by soft hammer percussion.

The lithic industry coming from Marcq's excavation has the same raw materials characteristics, methods of *débitage* and shape of the blanks. The over representation of plain *débitage* blades reveals a selection of blanks, which were used mostly for the production of geometrics.

Only one core comes from E2 and E3 squares, from Castelnovian layers. It is a prismatic core made from Bedoulian flint, bearing negatives of small flakes.

Sauveterrian and Castelnovian industries have a small number of tools (Tab. 1). Among the material analysed in this research, only one end-scraper is present. The rest of the tools are composed by blades, bladelets, and elongated flakes with retouch or irregular scarring on the edges. In this group of artefacts there are three notched blades[1]. The "Montbani" blades, so-called by Rozoy (1967), are supposed to be a typical element from the late Mesolithic lithic industry of France, North of Italy, Spain and even from Upper Capsian of the Maghreb (Gassin *et al*. 2013). The notched blades of Mourre de Sève have one notch (Fig. 3 n.1), or multiple notches (Fig.3 n.7), created by a semi-abrupt retouch. All notched blades have some fractures (on the distal or/and proximal part), but they do not affect the notches.

The projectiles group is composed of geometrics and hypermicroliths. The former are emblematic of Castelnovian deposits, while the latter are typical of *microlamellaire* Sauveterrian complexes. Their presence all along the Mesolithic stratigraphy (Tab. 2) characterizes this industry (Binder 1994). The same association of Sauveterrian hypermicroliths and Castelnovian industries is present at Châteauneuf (Binder & Courtin 1987). The recovery of these two projectile types at Mourre de Sève confirms that their association is not the result of mixed industries, but that they regularly occur together (Binder 2000). The absence of these tools from Marcq's excavation could have resulted from the use of a large screen size to sieve deposits (Binder 1994).

The production of geometrics occurs at the site evidenced by the high percentage of microburins in the assemblage (Binder & Sénépart 2004). Symmetrical and asymmetrical trapezes come from the Mesolithic levels of the entire site. Finally, techno-typological analysis (Binder 1994; Binder & Sénépart 2004) confirms the Mesolithic production of projectiles in the disturbed areas of the site (Tab.2).

The technological characteristics of the Castelnovian assemblage place the Mourre de Sève series within the Rhodanian aspects of the Castelnovian (Binder 2000). This industry is characterized by: production of prismatic and regular blades made by pressure, notched blades, use of non-retouched blades and flakes, several type of projectiles (triangles and trapezes) and flat and inverse retouch on small truncations.

Methods

The analysis employs Semenov's method (Semenov, 1964) using a stereomicroscope (Olympus SZH magnification from x0.74 to x64) (Tringham 1974) illuminated by a fibre-optic light source and an illuminated reflective light microscope (Leica DMLM magnification from

1 Two notched blades come from the Sauveterrian layers and one comes from the Castelnovian layers.

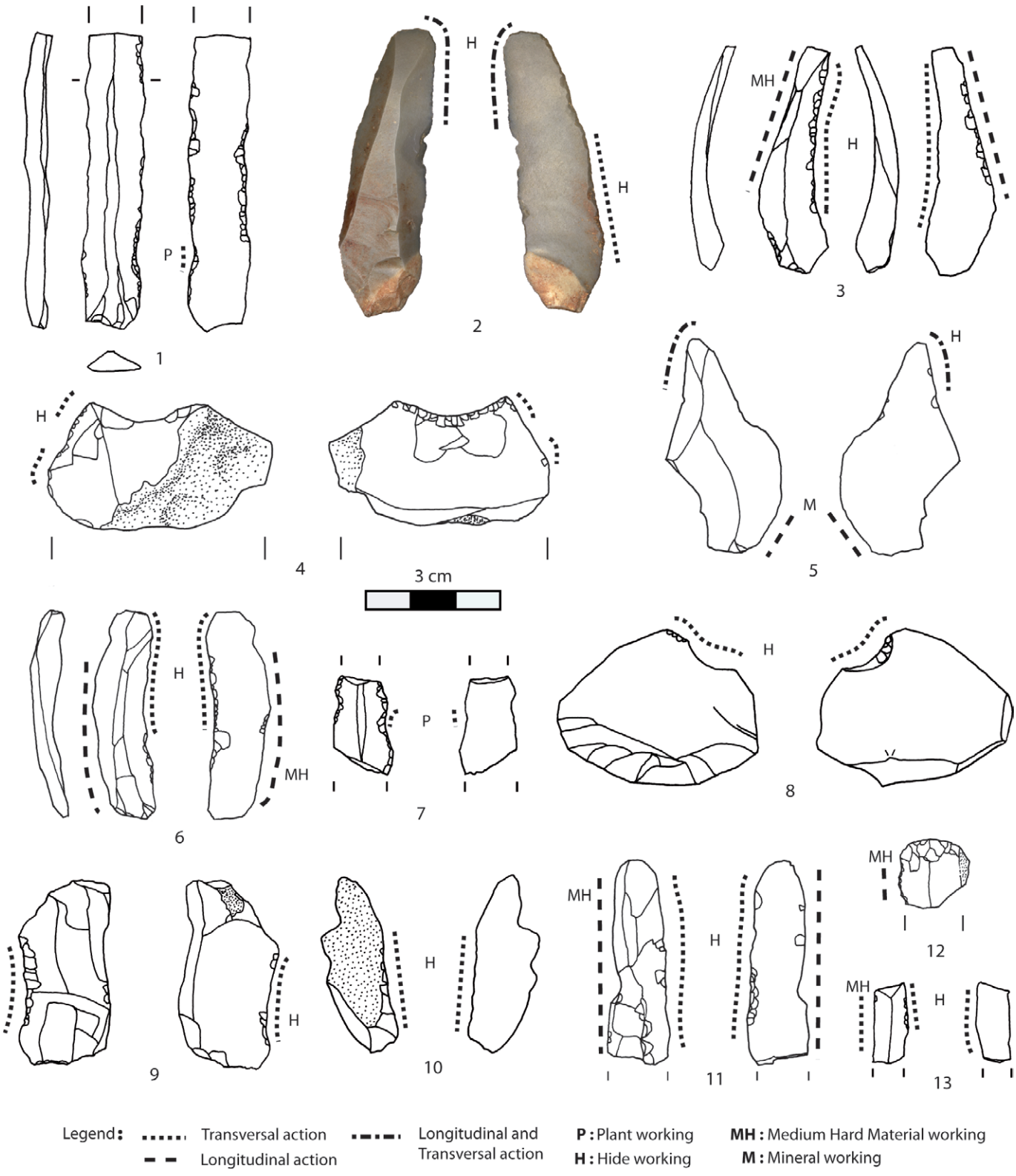

Fig. 3 *-Tools from Sauveterrian (n° 1,2,3,4 and 13) and Castelnovian levels (n° 5, 6, 7, 8, 9, 10, 11, 12) displaying use-wear. Drawings (1, 3, 6, 7, 11, 12) D. Binder and (4, 5, 8, 9, 10, 13) C. De Stefanis. / Strumenti con trace d'uso provenienti dagli strati Sauveterriani (n° 1,2,3,4 e 13) e Castelnoviani (n° 5, 6, 7, 8, 9, 10, 11, 12). Disegni (1, 3, 6, 7, 11, 12) D. Binder e (4, 5, 8, 9, 10, 13) C. De Stefanis.*

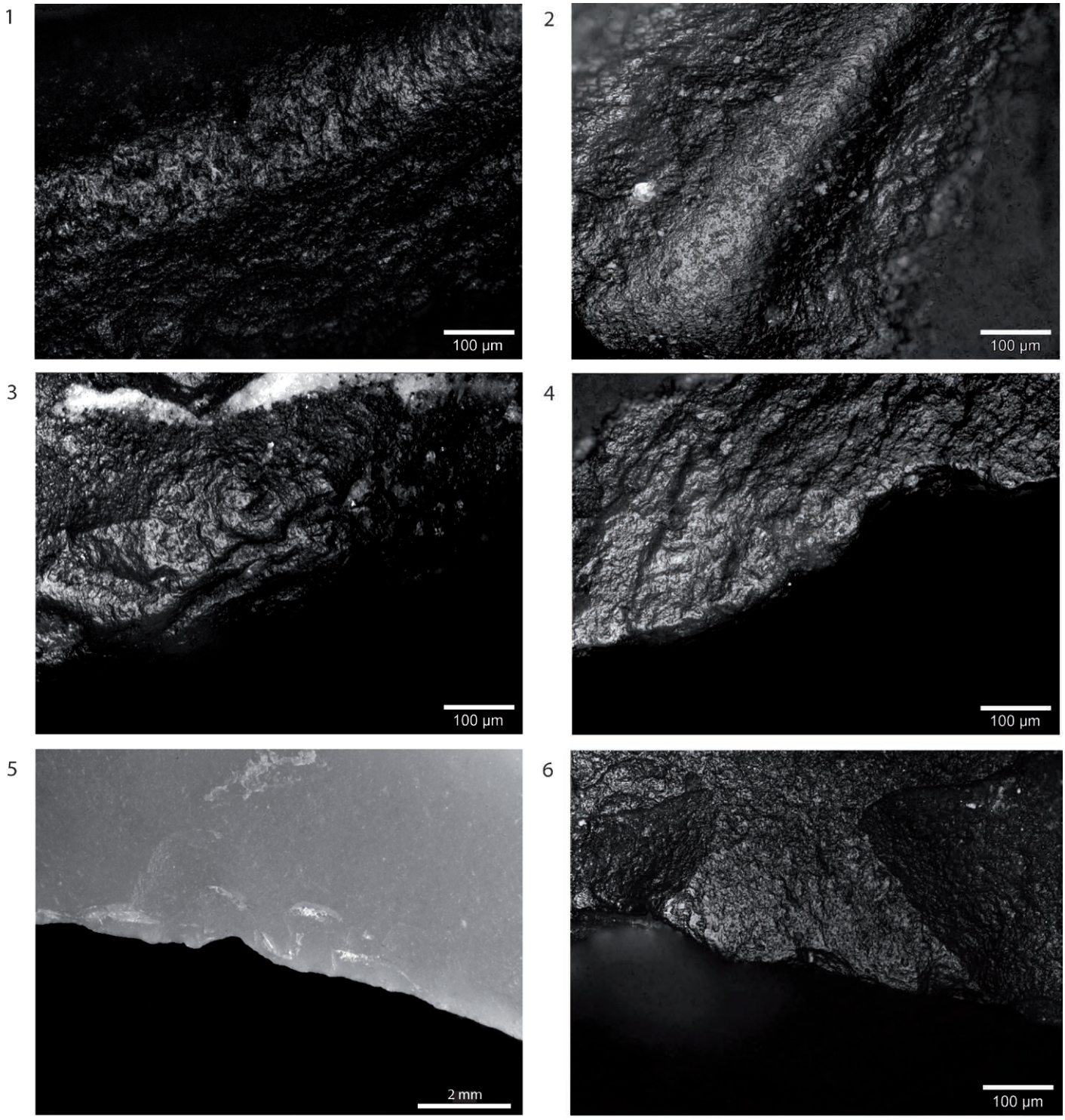

Fig. 4 *-Hide working: 1) Working on dry hide: transversal and longitudinal coarse striations cover a low linked dull polish. 2) Higher linked polish than the former with thin transversal striations and a high degree of edge rounding. Photos n. 3 (proximal left edge of the tool n. 2 Fig. 3) and 4 (UA on the tool n.3 Fig. 3) show two UA scraping on a damper hide and showing a highly linked and less pitted polish, with thin striations. The photo n. 3 shows a higher degree of rounding. 5) Quadrangular feathered and stepped scars, perpendicular to the edge, show a transversal action on a medium hard material. 6) Domed polish, with rare and fine striations, shows a transversal action on wood. The polish is interrupted by micro stepped scars. / Lavoro sulla pelle: 1) grosse strie trasversali e longitudinali coprono una politura opaca a trama larga. 2) Politura a trama più stretta della prima, con strie fini e forte smussamento dei bordi. 3) Le foto 3 (bordo sinistro prossimale del disegno Fig. 3.2) e 4 (UA sullo strumento in Fig. 3.3) mostrano due UA che hanno raschiato una pelle più umida e mostrano una politura a trama più stretta, con meno buchi e strie fini. La foto n. 3 presenta una più alto grado di smussamento. 5) Sbrecciature quadrangolari a terminazione "feather" e "step", perpendicolari al bordo mostrano un'azione trasversale su un material medio duro. 6) Politura "domed", con strie rare e fini, mostra un'azione trasversale su legno. La politura è interrotta da micro sbrecciature.*

Tab. 4 *-Tasks and worked materials by used area (UA). / Attività e materiali lavorati per zona d'utilizzo (UA).*

OCCUPATIONS	HIDE			PLANT SCRAPING	MINERAL CUTTING	MEDIUM HARD MATERIAL CUTTING	MEDIUM MATERIAL		TOTAL UA
	SCRAPING	CUTTING	MIX				LONGITUDINAL	TRANSVERSAL	
Castelnovian	5	1	1	1	1	1		1	11
Sauveterrian	4		1	1			1	1	8
Total UA	**9**	**1**	**2**	**2**	**1**	**1**	**1**	**2**	**19**

Tab. 5 *-The characteristics of use-wear of hide working identified on the Sauveterrian lithic industry of Mourre de Sève: 1-Tool Fig.3.2, right distal edge, 2-Tool Fig.3.2, left proximal edge, 3-Tool Fig.3.4, distal edge, 4-Tool Fig.3.3, right edge, 5-Tool Fig.3.13, right edge. / Caratteristiche delle tracce d'uso legate al lavoro della pelle nell'industria litica sauveterriana di Mourre de Sève : 1-Strumento Fig.3.2, bordo distale destro, 2-Strumento Fig.3.2, bordo sinistro prossimale, 3-strumento Fig.3.4, bordo distale, 4-strumento Fig.3.3, bordo destro, 5-strumento Fig.3.13, bordo destro.*

UA	ACTION	CONTACT ANGLE	HUMIDITY OF THE HIDE	ABRASIVE	ROUNDING	DEGREE OF ROUNDING
1	Scraping and cutting	< 40 °	Medium low	Coarse and fine	Flattened	High
2	Scraping	> 45 °	Medium high	Fine	-	High
3	Scraping	30°-60 °	Medium	Fine	Rounded	High
4	Scraping	30°-40°	High	Fine	Flattened	Low
5	Scraping	-	-	Fine	Rounded	Medium

x100 to x200) (Keeley 1980). The interpretation of the use-wear is based on comparisons between the artefacts and experimental collections. Each artefact was cleaned with soap and warm water, and with alcohol before the microscopic analysis. For this study, all lithic artefacts (N=189) from undisturbed areas of the site were chosen (the E2 and E3 squares) (Tab. 3).

The complete lithic assemblage from this area was studied to obtain a representative sample of the Sauveterrian and Castelnovian sequence of the site. By studying the range of tools and blanks at the site it allows us to better understand the dynamics of the choices made when using tools, without letting oneself being influenced by our modern thinking. In this way, we can give the same attention to every kind of blanks throughout the *cha*îne *opératoire,* during the analysis.

Finally, the study of impact traces on projectiles inspected all the bladelets and geometrics coming from the earliest (Marcq 1950's) and the latest (Binder 1994 and 1997) excavations (Tab. 2). The techno-typological analysis of these tools (Binder 1994 and 1997; Binder & Sénépart 2004; Paccard & Marcq 1993) showed their homogeneity and it linked most of them to the Mesolithic industry. Increasing our projectiles sample with these artefacts will help us to better understand their use and hafting.

Results

In the analysed sample, 7 % of the blanks shows evidence of use-wear (Tab. 3). The 65 % percentage of blanks show post-depositional alterations[2], and 19 artefacts are considered non diagnostic because they display too many alterations (Baesemann 1986; Mansur-Franchomme 1986; Semenov 1964; Stapert 1976; Vaughan 1981). The presence of post-depositional alterations could have erased the use-wear of the softest materials (e.g. meat). No traces linked to the butchering activities were found, despite the presence of faunal and fish remains.

In spite of the high percent of post-depositional alterations, the functional analysis allowed us to identify several different tasks on hide, vegetal, and minerals.

The Sauveterrian level

The Sauveterrian layer contains 57 lithic artefacts. Six are projectiles and none displays use or impact wear. The rest of the blanks are composed by flakes or blades/bladelets and among them five tools shows use-wear on eight used areas (UA): one related to wood working, five to hide processing and two to activities on medium-hard material (Tab. 4 and Fig. 3).

The use-wear analysis showed that hide working is the most represented task during this occupation. Four different blanks with five UA are used (a cortical flakes, two regular blades and a twisted blade). Three UA out of five are un-retouched (Fig.3 n. 2, 4 and 13). The shape of their used edges does not show the same characteristics and the edge angles varies between 35 ° and 85 °. All the UA show a weak or medium degree of wear development and none is resharpened.

It is possible to distinguish several stages of humidity of the hide, thanks to the degree of linkage of the polishes and their brightness (Vaughan 1985). Scraping is the most common action used with hide working. It is identified on 4 UA, and only one edge shows a double action (longitudinal and transversal) (Tab.5). Two of these UA display a dull and rough polish linked to the hide working. The first UA conserve a higher linked polish than the former, with thin striations, a high degree of rounding and a pitted aspect (Fig. 3 n. 4 and Fig.4 n. 2). According to these features, it is linked to a softening task on a medium dry hide. The former UA shows a double action on dry hide on the distal right edge, which has coarser striations and a low linked and dull polish (Fig. 3 n. 2 and Fig. 4 n. 1). On the same tool, another UA is located on the opposite edge. This edge worked a damper hide, which created a highly linked and less pitted polish,

2 Trampling, thermal damages, solution phenomena and Glossy appearance.

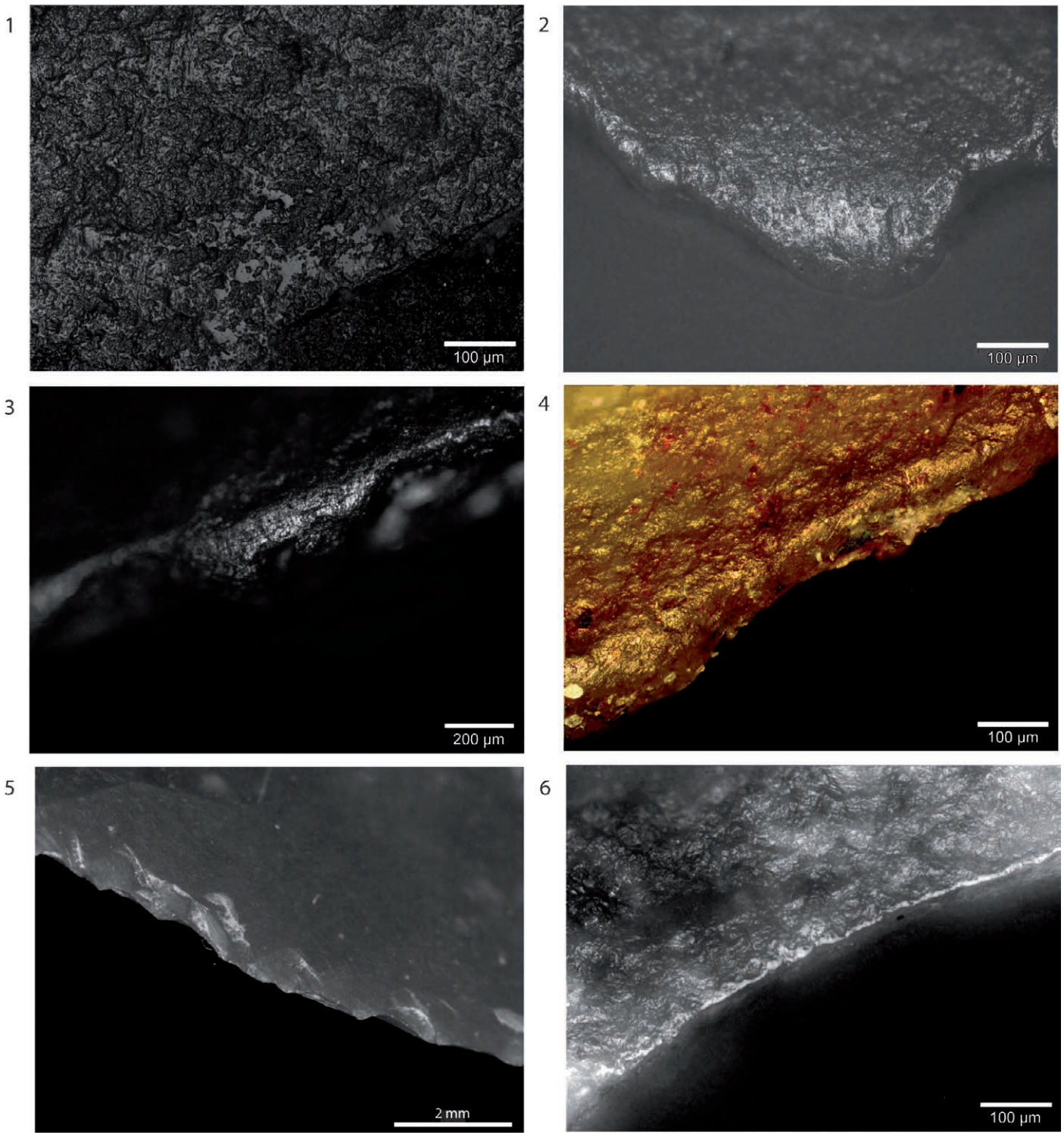

Fig. 5 *-1) The end limit of the retouch cuts the dull, rough and pitted polish of the hide. Some spots of a flat and shiny alteration cover the hide polish. Photos 2) and 3) show a dull and pitted polish, with a rough aspect and numerous striations. A flat rounding is visible on photo n. 3, and a rounding on photo n. 2. 4) Soft mineral working. A rounded edge displays a linked polish covered by numerous longitudinal striations of different dimensions and coarseness. 5) Quadrangular scars, with step terminations and oblique directions, produced by the contact with a medium-hard material. 6) Domed polish with slight transversal undulations and fine striations shows the transversal motion on soft wood. / Limite del ritocco che ha interrotto la politura della pelle. Alcune macchie di una politura d'alterazione piatta e brillante coprono le tracce della pelle. Foto 2) e 3) mostrano una politura opaca e bucherellata, con un aspetto rugoso e numerose strie. Uno smussamento piatto è visibile sulla foto n. 3, e uno smussamento arrotondato sulla foto n. 2. 4) Lavoro su un minerale tenero. Un bordo smussato mostra una politura a trama unita coperta da numerose strie di diverse dimensioni. 5) Sbrecciature quadrangolari, a terminazione "step" e direzione obliqua, prodotte dal contatto con un materiale medio-duro. 6) Politura "domed" con leggere ondulazioni trasversali e strie fini testimoniano un gesto trasversale su un legno morbido.*

with thin striations (Fig. 4 n. 3 and n. 4). This side of the tool has red colorant residues, which covers the dorsal and the ventral surfaces (Fig. 3 n. 2). If this UA was linked to a transversal action on a red mineral material it would have left coarser striations on the edge. For these reasons it is not possible to link the presence of red colorant to a mineral working. At the same time no glue residues are found and chemical analysis cannot link the red residues to the presence of mastic.

The work of a medium hardness material is represented by a longitudinal and a transversal action on two different UA located on two tools, which also display hide polish (Fig. 3 n. 3 and 13, and Fig. 4 n. 5). Both areas show only macro-wears, which consist of quadrangular feathered and stepped scars. On one UA they are oriented perpendicular to the edge indicating transversal action and on the other UA they are oblique suggesting longitudinal motion.

The last task recorded within Sauveterrian occupation is a transversal activity on wood, located on a notch of a blade (Fig.3 n.1). The ventral face is the contact surface and it worked with an angle of about 45°. On this face, some quadrangular hinged and stepped scars indicate contact with a flexible and medium hard material. A domed polish with rare and fine striations suggests contact with a medium hard plant, like wood (Fig. 4 n. 6). The rest of the blank do not have other used areas but, the surface shows a lot of alterations, which could have removed the use-wear.

The Castelnovian levels

The Castelnovian lithic industry counts 132 artefacts, among them nine displays traces of hide, plant, mineral, medium material and a medium hard material working (11 UA) (Tab. 4). Seven projectiles come from these levels and three have diagnostic impact wear.

Hide working (Tab. 6) is represented by seven UA on six tools (Fig. 3), with a non-standardized shape. Furthermore, the used edges have different morphologies and most of their edges (five UA) are retouched to create angles between 55° and 90°. The majority of the used edges have a slight or medium rounding and only one is resharpened (Fig. 3.6 and Fig. 5 n. 1). According to the use-wear features, the worked hides were dry or medium dry. Indeed, the edges displays a dull and pitted polish with a rough aspect and numerous striations (Fig. 5 n. 2 and 3). If still visible through the rounding, the macro-traces have a bending initiation and a step and hinge terminations caused by the contact with a medium hard and flexible material. Among the scraping actions it is possible to distinguish two groups of tools. The first is composed by the tools which worked with a contact angle between 45° and 80°. Most of the tools edges shows a high degree of rounding and the presence of coarse striations caused by an abrasive material. In the second group, the most part of the contact angles are between 30° and 45°, and the edges displays a slightly developed flat rounding and a thin abrasive striation.

Among the tools used on hide processing, two show a second use. One of them is a medium material which produced scars and a slight rounding on the edge of a blade (Fig. 3 n.6). The other tool bears another UA which was used for a longitudinal motion on a soft mineral (Fig. 3 n. 5). The edge displays a slight rounding, which covers the marginal macro-traces, and a red mineral residue on part of the edge and spots on the inner surface. A linked micro polish covers the marginal part of the edge. The polish is characterized by numerous longitudinal striations of different dimensions and coarseness (Fig. 5 n. 4).

Only the distal fragment of an end-scraper comes from E2 and E3 squares of the site and no use-wear is found on its scraper edge (Fig. 3 n. 12). However, the endscraper has macro-wear produced by contact with a medium-hard material (Fig. 5 n. 5) on the left edge.

In the Castelnovian levels, a notched blade shows the only wear linked to plant working (Fig. 3 n.7). A domed polish is localized on the distal ventral bevel of the notch. Slight undulations and fine striations show the transversal motion, with the ventral face as the contact surface (Fig. 5 n. 6). According to the localization and the characteristics of the use-wears, this UA scraped a soft wood with a high working angle.

Projectiles

The use-wear analysis on projectiles concerns 56 artefacts (Tab. 7 and 8): 20 hyper-microliths and 36 trapezes. Without experimental experience on this particular task, we base the functional analysis on the result of other projectile experiments (Chesnaux 2014 and 2006; Crombé 2001; Fischer *et al.* 1984; Philibert 2002; Plisson 1986; Gassin 1991). Some experiments on trampling alteration on microliths (Chesnaux *op. cit.*) demonstrated that these phenomena could produce fractures similar to the impact traces, and according to the dimensions of the armatures, these scars could have several lengths. For these reasons and the small size of the projectiles analyzed, this study defines diagnostic impact fractures (DIF) as, fractures longer than 2 mm with either a burin like fracture, "*en charnière*" fractures, bending

Tab. 6 *-Characteristics of use-wear of hide working identified on the Castelnovian lithic industry of Mourre de Sève : 1-Artefact Fig.3.8, distal edge, 2-Artefact Fig.3.9, left edge, 3-Artefact Fig.3.5, left distal edge, 4-Artefact Fig.3.6, right edge, 5-Artefact Fig.3.11, right edge, 6-Artefact Fig.3.11, left edge, 7-Artefact Fig.3.10, right edge. / Caratteristiche delle tracce d'uso legato al lavoro della pelle nell'industria litica castelnoviana di Mourre de Sève: 1-Strumento Fig.3.8, bordo distale, 2-Strumento Fig.3.9, bordo sinistro, 3-Strumento Fig.3.5, bordo distale sinistro, 4-Strumento Fig.3.6, bordo destro,5-Strumento Fig.3.11, bordo destroy, 6-Strumento Fig.3.11, bordo sinistro, 7-Strumento Fig.3.10, bordo destro.*

UA	ACTION	CONTACT ANGLE	HUMIDITY OF THE HIDE	ABRASIVE	ROUNDING	DEGREE OF ROUNDING
1	Scraping	45°-60°	Medium	Fine	Rounded	Low
2	Scraping	45°-60°	-	Coarse	Rounded	High
3	Scraping and cutting	60°-80°	Dry	Coarse	Flat	High
4	Scraping	30°-40°	Medium	Fine	Flat	Low
5	Scraping	30°-45°	Dry	Corse	Flat	Low
6	Cutting	-	Medium	Fine	-	Low
7	Scraping	30°-40°	-	Fine	Flat	High

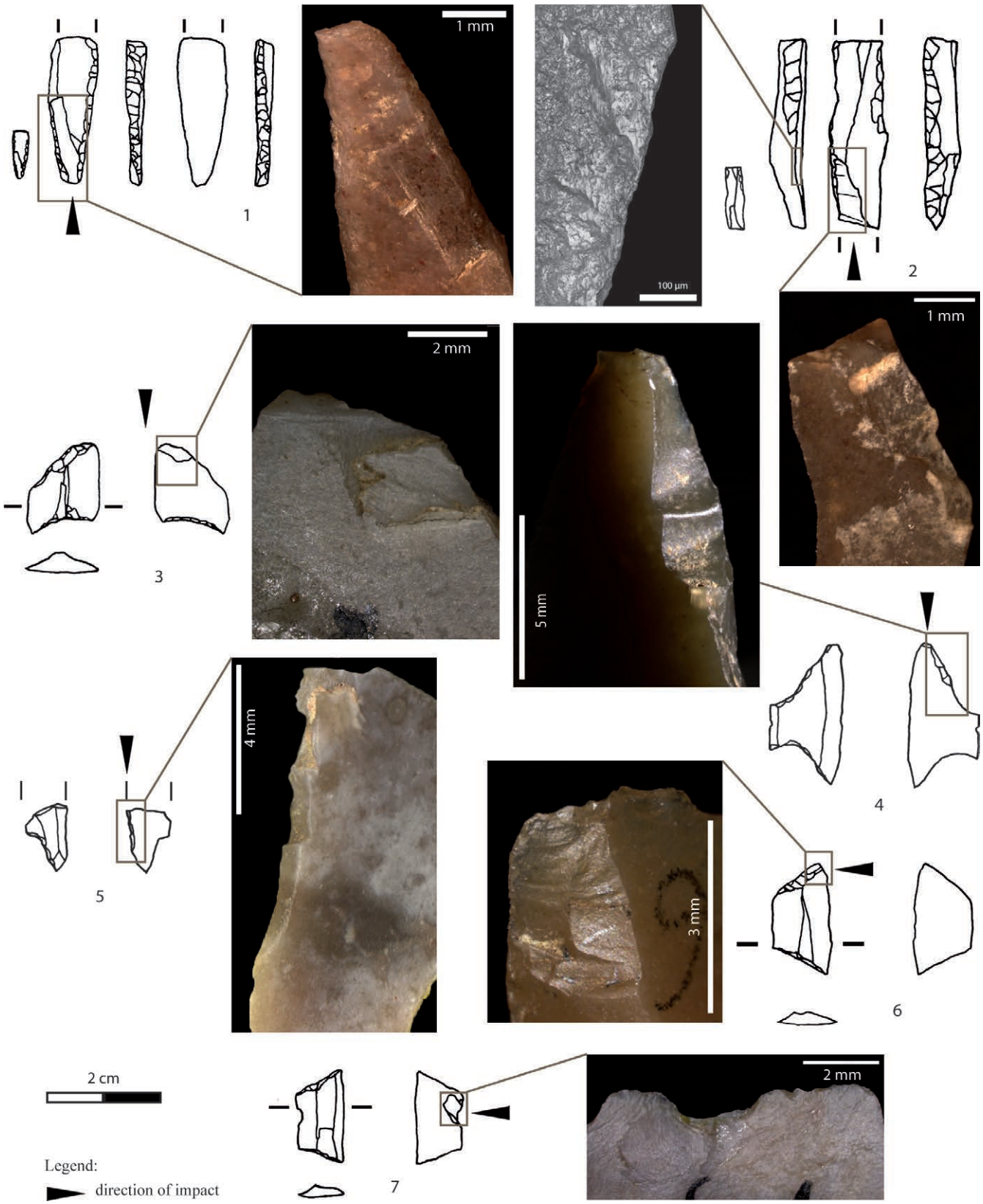

Fig. 6 *-Projectiles with DIF and MLIT of Mourre de Sève. 1) Axial bending step fracture. 2) DIF "en charniere" and MLIT on the ventral face of the bladelet. 3) Axial bending step fracture on the large point. 4) DIF "en charniere" on the large point. 5) "En charniere" fracture on the unretouched edge of a trapeze fragment. 6) Cone fractures coming from the large base to the small one, covering part of the truncation. 7) Cone and bending with hinge and step terminations fractures on the unretouched edge of the trapeze. Drawings (1, 2, 3, 6, 7) D. Binder and (4, 5) C. De Stefanis. / Armature con DIF e MLIT del sito di Mourre de Sève. 1) Frattura assiale "bending step". 2) DIF "en charniere" e MLIT sulla faccia ventrale della lamella. 3) Frattura assiale "bending step" sulla punta. 5) Frattura "en charniere" su un lato non ritocatto del frammento di trapezio. 6) Frattua a "cone" proveniente dalla grande base e diretta verso la piccola base del trapezio, copre parte della troncatura. 7) Fratture "cone" e "bending" a terminazioni "hinge" e "step" sul lato non ritoccato del trapezio. Disegni (1, 2, 3, 6, 7) D. Binder e (4, 5) C. De Stefanis.*

Tab. 7 -Results of the functional analysis on microliths of Mourre de Sève. Each microlith type is presented with a number: 1-unilaterally baked bladelet, 2-bilaterally backed bladelet, 3-micro-triangle, 4-point "de Chaville". / Risultati delle analisi funzionali sui microliti di Mourre de Sève. Ogni numero corrisponde a una tipologia di microlite: 1-lamella a dorso, 2-lamella a doppio dorso, 3-micro triangoli, 4-punta della Chaville.

EXCAVATION	TYPE	PRESERVED PART	DIF	MLIT
Binder	1	Mesial	x	x
(E2-E3 squares)	2	Intact		
	2	Proximal	x	
	2	Distal		
	2	Distal		
	2	Mesial		
	3	Meso-Distal		
	4	Intact		
	2	Distal		
	1	Mesial		
	1	Mesial		
	2	Distal		
	2	Meso-Proximal		
Binder (Perturbed Areas)	1	Mesial		
	2	Distal		
	3	Distal		
	2	Proximal		
	2	Distal		
	3	Meso-Distal		
	1	Proximal		

or cone fracture with a feather, step or hinge termination, the associated spin-off and microscopic linear impact trace (MLIT).

The hyper-microlith group was composed by baked bladelets, points, and micro-triangles. This set showed DIF only on two backed bladelets (Tab. 7).

According to the terminology proposed by Fisher, Vemming and Rasmussen (1984), one DIF is a step bending fracture 5 mm long (Fig. 6 n.1) and the other one is an "*en charnière*" fracture 3 mm long (Fig. 6 n. 2) (Plisson & Geneste 1986). The latter also displays a MLIT on the edge, caused by the contact with a hard material (Fig. 6 n. 2). Among the rest of microliths, 16 (80 %) show a distal or/and proximal fracture (Tab. 7). Although the high percentage of breakage, these fractures are snap terminating bending fractures, without diagnostic impact features, and the low number of the sample is not enough representative for statistical analysis.

Among the trapezes, the analysis do not find MLITs, but five projectiles display fractures longer than 2 mm (Tab. 8). According to the position of these fractures on the projectiles, it is possible to suggest the use of two different axial points. The first type is represented by two asymmetrical trapezes with a large straight truncation and a small concave truncation, and a fragment of trapeze with a concave truncation (Fig. 6. n. 3-5 and Tab. 8 tools n° 1, and 23-24). They exhibit an axial fracture on the large point as a bending type fracture, and an "*en charnière*" type fracture (between 5 and 8 mm long). According to the direction and the position of the DIF, these trapezes were hafted with their bigger point as the tip of the arrow. The other type of axial point is recognized on a symmetrical trapeze (Fig. 6 n. 6 and Tab.8 tools n 31). It shows some cone fractures coming from the large base to the small one, covering part of the truncation (Fig. 6 n 6). In this case, the trapezes were hafted as transverse arrowhead, with the big base at the tip of the arrow. On the small base of the projectile there are snap fractures, which could be caused by the recoil on the shaft.

As shown in table 8, most of trapezes have snap fractures on the points and several scars on the bases, all less than 2 mm length. Experiments on this type of projectiles, as transversal arrowhead (Gassin 1991), showed that breakages and scars on the bases of trapezes could be produced by impact. In our archaeological sample this kind of fractures are present on 10 trapezes, but only one of them displays fractures longer than 2 mm and could be considered a DIF (Fig. 6 n 7).

Discussion and conclusions

The use-wear analysis carried on lithic industry of E2 and E3 squares confirms continuity in economy type from the Sauveterrian to the Castelnovian occupations. These complexes shows the predominance of irregular blanks used as tools: blades or flakes, with several edge morphologies (47 % of UA were retouched), and cortex remains (Fig. 3).

Most of the used edges are still sharp and only one displays resharpening (Fig. 5). Their low exploitation confirms a constant supply of flint.

The majority of UA show use-wear on hide working (63 %) throughout the occupations. The variation in hide humidity and the contact angle indicates several stages of hide processing (Tab 5 and 6). At the same time, the presence of cutting activities means that the hide is also transformed on the site into other items such as clothing. Although hide working is the most represented activity, no specialized hide working tools are present among the analyzed sample. For these activities irregular flakes and blades are used, with no evidence for hafting and mostly with low development of rounding and traces. The only end-scraper in our sample does not display hide polish and the 14 coming from Marcq's excavation are not analyzed. This difference of end-scrapers numbers could be linked to a spatial organization of the craft or to several occupations with different functions and activities. Unfortunately we have not enough data to understand the reasons of this spatial distribution.

In both occupations, the plant working is evidenced by two notched blades (Fig. 3 n° 1 and 7). The bevel of the notches shows a transversal activity on wood, which suggests a specialized craft for the transformation of this material. Their presence during Castelnovian and Sauveterrian occupations could suggest that these kind of tools are not specific only for Capsian and Castelnovian periods.

The hunting activities are indicated by the presence of DIF and MLIT on six projectiles (10 %). Four geometrics displays impact traces showing 2 types of arrow tips. The first is an asymmetrical trapeze with a large straight truncation and a small concave truncation used as a transverse arrowhead, with the large point as the tip of the arrow. The second is a symmetrical trapeze hafted as transverse arrowhead, with the large base at the tip of the arrow. Two backed bladelets show DIF and MLIT, but it is not possible to define their position on the shaft (point or barb). The sample analyzed here presents high variability in arrowhead type and possible hafting, but additional use-wear studies are needed to understand if this variability could be related to the hunted prey, the type of bows used, or to cultural factors.

The absence of butchering tasks is surprising, especially compared to the presence of numerous faunal remains. This lack of traces could be attributed to the high presence of alterations on stone tools, which could have removed some use-wear traces or confused their interpretations (Van Gijn 1986). For eel processing, the inhabitants of the site could be butchering off-site. In fact, among the remains of this species, no heads were found and it is probable that this kind of prey was processed on the fishing site.

Tab. 8 *-Summary of fractures on the trapezes of Mourre de Sève. The numbers in the first column identify each artefact. The provenance of different excavations is pointed out by an "M" as Marcq excavation, "B1" as Binder excavation of E2/E3 squares and as a "B2" as Binder excavation of perturbed areas. The typology of trapezes is indicated by the follow numbers: Fragment of trapeze=1, Segment=2, Trapeze with displaced base=3, Asymmetric trapeze=4, Symmetric trapeze=5. The presence or absence of fractures is showed in the rest of the table, specifying the length of breakage on the points and their morphology on the bases. / Riassunto delle fratture presenti sui trapezi di Mourre de Sève. I numeri nella prima colonna identificano ogni pezzo. La provenienza dai diversi scavi è precisata attraverso una "M" per lo scavo Marcq, con "B1" per gli scavi Binder dei quadrati E2/E3 e "B2" per gli scavi Binder delle zone rimaneggiate. La tipologia dei trapezi è indicata dai seguenti numeri: Frammento di trapezio=1, Segmento=2, Trapezio a troncature oblique=3, Trapezio asimmetrico=4, Trapezio simmetrico=5. Nel resto della tabella è riassunta la presenza o assenza di fratture, specificando la lunghezza delle fratture sulle punte e la loro morfologia sulle basi.*

N°	EXCAVATION	TIPOLOGY	INTACT	FRACTURE ON ONE OF THE POINTS					BIG BASE	SMALL BASE
				IMPACT BURINATION	EN CHARNIERE	SNAP	BENDING	CONE		
1	B2	1			> 7 mm	x				
2	M	2	x							
3	B2	3							Marginal cone	
4	M	3							Snap	
5	M	3	x							
6	M	3				x			Snap	
7	B2	4								
8	B2	4				x				
9	B2	4				x				
10	B2	4				x		< 1 mm		
11	M	4								Snap
12	M	4				x				
13	M	4				x				
14	M	4	x							
15	M	4				x				
16	M	4	x							
17	M	4						< 2 mm	Snap	
18	B1	4				x				
19	B2	4				x			Marginal bending	
20	B2	4								
21	B2	4				x				
22	M	4				x				
23	M	4					2,5 mm			
24	B2	4			8 mm					
25	B2	4				x				
26	B2	4	x							
27	B1	5				x				
28	B1	5	x							
29	B2	5	-	-	-	-	-	-	-	-
30	M	5		< 2 mm			< 2 mm			
31	M	5						3 mm		Snap
32	M	5								Cone/Bending
33	M	5				x				
34	M	5				x				
35	M	5							Bending	
36	M	5						< 2 mm		Snap

In summary, the function and the economy of the site does not change during several Mesolithic occupations. The same kinds of raw material and blanks are chosen to be used: irregular flakes and blades for domestic activities and unspecialized crafts, and the regular blades to produce geometrics and notched blades. The sample shows a low variability of activities and worked materials. Among them, hide is the most represented, however only expedient tools are used for this task. The use-wear study, combined to other multidisciplinary analysis, suggests a non-specialized function of the Mourre de Sève site, with brief occupations, due to the small assemblage size. The site seems to be linked to a network of the sites targeted towards the exploitation of different environmental resources with the region (fish and faunal resources, a forested environment, and lithic raw materials). To confirm this hypothesis additional use-wear research on other Mesolithic sites of the region will be needed.

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Article

Insights into the Late Mesolithic toolkit: use-wear analysis of the notched blades. Case-studies from the Iberian Peninsula

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Key words

- Late Mesolithic
- Notched Blades
- Use-Wear Analysis
- Iberian Peninsula

Parole chiave

- Mesolitico recente
- Lame a incavi e denticolate
- Analisi funzionale
- Penisola Iberica

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Summary

During the last decades we have gained a considerable amount of data about the Mesolithic lithic toolkit in the Western Mediterranean. A large set of instruments probably existed for a variety of purposes: foraging practices (both hunting and fishing), food processing, crafting activities, etc. Disposable tools, scarcely elaborated, coexisted with formal and more complex instruments, often composed of multiple parts and realized on a variety of raw-materials (e.g. stone, shell or bone inserts; bone or wood hafts, etc.). In this paper we will consider one particular type of tool that appears in the Western Mediterranean starting from the Seventh-Sixth millennia BC: the notched and denticulated blades. We will consider and interpret from a functional viewpoint materials from five different Late Mesolithic contexts: the Cocina Cave and Vallmayor IX in the NE of the Peninsula, Artusia rock-shelters in Navarre and Atxoste and Mendandia rock-shelters in the Basque country.

Riassunto

Durante l'ultimo decennio, la nostra conoscenza dello strumentario litico Mesolitico nel Mediterraneo Occidentale si è considerabilmente arricchita. Sappiamo che esistevano una varietà di strumenti utilizzati per scopi diversi: l'ottenimento di alimenti (sia attraverso la caccia, che la pesca), l'elaborazione di tali alimenti, la produzione di artefatti, etc. Strumenti di natura speditiva, scarsamente elaborati, coesisterono con strumenti formali, più complessi, spesso costituiti di più parti e di materie prime diverse (es. inserti in pietra, conchiglia, osso, manici in legno od osso, etc.). In questo articolo ci concentriamo su un particolare tipo di strumento che compare nel Mediterraneo Occidentale tra il VII-VI millennio a.C.: le lame a incavi e denticolate. Consideriamo i materiali provenienti da cinque diverse siti del Mesolitico recente: la Grotta Cocina e il sito di Vallmayor IX nel nord-est della Penisola Iberica, il riparo sottoroccia di Artusia in Navarra e i siti di Atxoste e Mendandia nei Paesi Baschi e ne proponiamo un'interpretazione funzionale.

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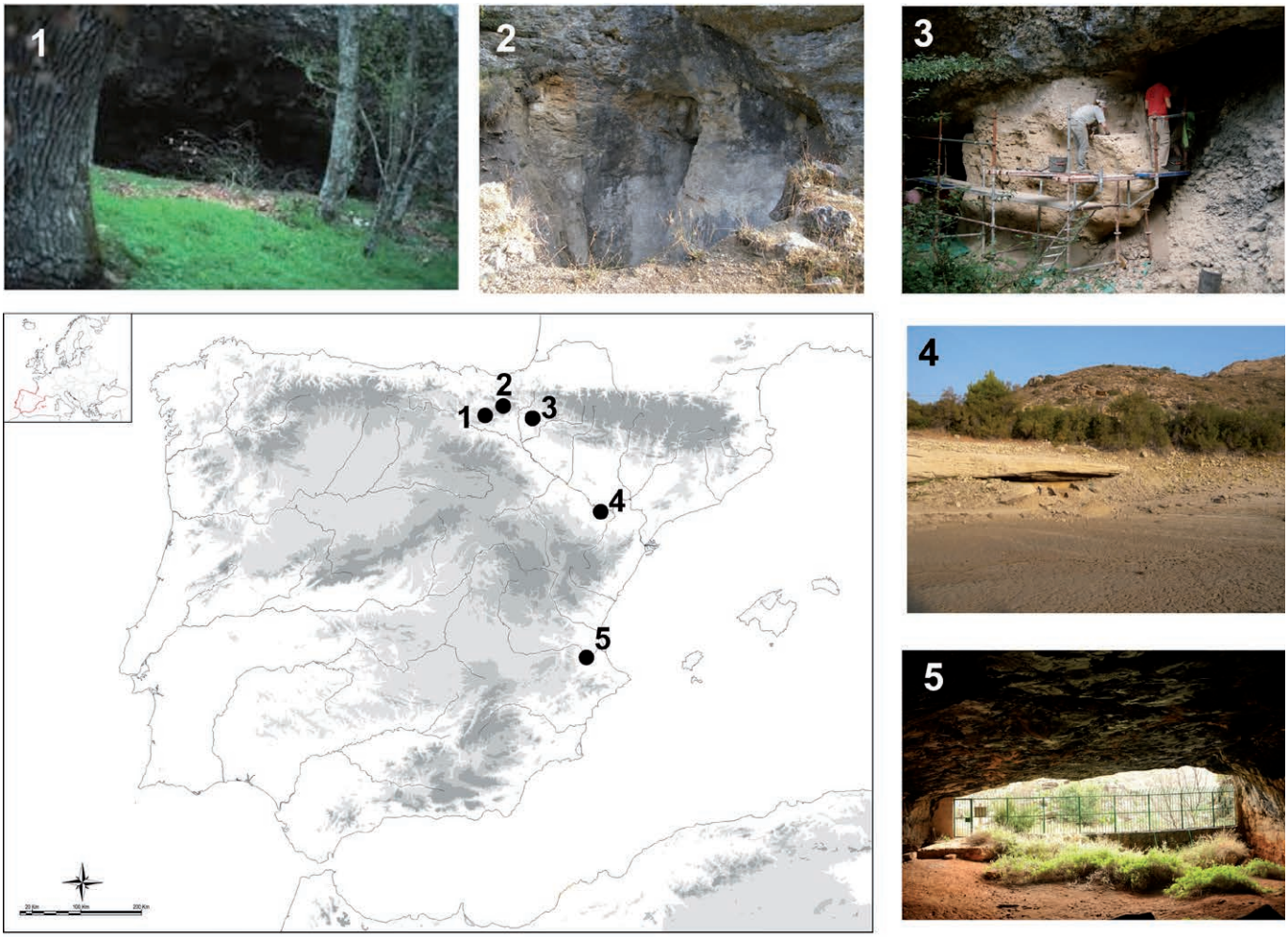

Fig. 1 - Sites location and overview. 1) Mendandia; 2) Atxoste; 3) Artusia; 4) Vallmayor XI; 5) Cocina Cave. / Posizione e panoramica dei siti. 1) Mendandia; 2) Atxoste; 3) Artusia; 4) Vallmayor XI; 5) Grotta della Cocina.

Introduction

Our knowledge of the Mesolithic craftsmanship has increasingly grown during the last decades. The period is considered a time of technological innovation characterized by a variety of sophisticated equipment, including bow and arrow, fishing gears (such as nets, traps, hooks) and seagoing craft such as canoes (see for example Pickard & Bonsall 2007; Lozovski *et al.* 2013). Altogether this set of artefacts implied the development of fresh knowledge, know-how and tools; in turn, such transformations in technology were associated with broader social and economic changes involving mobility patterns, groups size and site location, duration and seasonality of the occupations, subsistence strategies, symbolic and burial behaviours, etc. (Zvelebil 2009; Jordan & Cummings 2014; Warren 2014).

Nevertheless, from an archaeological point of view, it is not always simple to highlight such diversity in technology and crafting techniques. Most of the Mesolithic crafting processes involved perishable materials, such as wood, vegetal fibres, animal skins, etc., which are only rarely conserved in the archaeological contexts. In this sense, the application of traceological analysis on both coarse and flaked stone tools has represented an important instrument for detecting craft and processing activities that otherwise would have not been emerged from the archaeological record. For example, the study of the use-wear patterns has demonstrated that vegetal materials, both ligneous and non-ligneous plants, covered an important role within the Mesolithic crafting system (Clarke 2009; Gijn 2010; Guéret 2013, Guéret *et al.* 2013 among others). Bone and antler tools were intensively produced and used as well (Gijn 2007; Osipowicz 2007; Maigrot *et al.* 2014; Bergsvik & David 2015). A broad variety of crafting tools probably existed; disposable, scarcely elaborated elements coexisted with formal and more complex instruments, often composed of multiple parts and realized on an assortment of materials (i.e. stone, shell or bone inserts; bone or wood hafts, etc.).

Recent researches on the Late Mesolithic complexes in Europe and North Africa have shown that not only hunting weapons (i.e. triangles and trapezes industries) were geographically distributed over large areas, but also some crafting tools were characterized by certain homogeneity from a technological and functional point of view in almost the entire Western Mediterranean (Gassin *et al.* 2014). Notched blades, removed by pressure or indirect percussion, became one of the characteristic elements of the flaked stone assemblage starting from the 9-8th millennium BP depending on the geographical area (Perrin *et al.* 2009). In the absence of any functional study, different hypotheses were proposed to explain the production and use of these notched blades: blank tools used to scrape wooden sticks in order to shape arrow shafts, the notches created by the work itself (Rozoy 1978); tasks correlated with an intensification of plant processing (Rahmani & Lubell 2012), etc.

In this work we will consider the notched or denticulated blades from five different Late Mesolithic contexts of the Iberian Peninsula (Fig. 1). The traceological analysis of those elements is presented and discussed in the light of experimental works recently performed (Gassin *et al.* 2013; Guéret et al 2013; Gassin *et al.* 2014).

Methods of analysis

Traceology has today a well-established method shared by most of the analysts. During the last forty years, the traceological approach to the study of the lithic industries has been defined and updated by the works of several authors. Since the pioneer works of Semenov, new techniques and methodologies have been introduced constantly. For a detailed state of the art, one can look at the recent synthesis of Marreiros *et al.* (2015). Nevertheless, apart from the methodological improvements that occur along with the appearance of new techniques and analytical tools, one can fundamentally divide the traceological work into three main steps:

I. A first evaluation of the conservation of the archaeological material is done through stereoscopic microscopy. A sample of artefacts is observed, in order to identify the presence of eventual post-depositional alterations and, thus, to evaluate the feasibility of the analysis;

II. Once defined the state of conservation of the assemblage, a detailed analysis of each single artefact is undertaken. The first step of the analysis involves the employment of stereoscopic microscope. The analysis of edges and surfaces is directed to the identification of possible active zones (PUAs - Possibly Used Areas) (Gijn 1989). Moreover, the macroscopic observations allow a first level of inference; it is already possible to formulate hypotheses about the hardness of the worked materials (i.e. soft, medium, hard) and about the type of movement performed (i.e. longitudinal, transversal, circular, impact, etc.). The analysis of macro-traces is also important for the recognition of possible hafted parts, transportation traces, post-depositional and post-excavation modifications, etc. Several works of reference are available for the so called 'macro-traces' among which: Tringham *et al.* (1974), Odell & Odell-Vereecken (1980), Gonz ález & Ib áñez (1994). The categories considered in this study have been mainly taken from these works, classifying the macro-traces on the basis of semi-qualitative variables.

III. When possible used areas (PUAs) or other modified zones are detected, artefacts have been submitted to a detailed microscopic analysis through the employment of reflected-light microscopy (Olympus BH2, 50X-400X). The objective of this analysis is, first of all, to prove the nature of the previously identified PUAs. If PUAs are actually used we call it AUAs (Actually Used areas) (Gijn 1989). Once the consistency of the traces has been proved, the analysis is directed toward the interpretation of the micro-features through the observation of their characteristics. For the definition of the semi-qualitative variables employed for micro-wears classification one can refer to several works among which Gijn (1989), González & Ib áñez (1994) and Gassin (1996).

The number of tools analysed in this work amounts to 89 elements. All the notched blades showing traces of use have been analysed both macro- and microscopically. Wears identified in the archaeological specimens have been compared with the experimental samples. Indeed, fresh experimental data has been obtained during a collective blind test performed in Barcelona in October of 2012, allowing greater care to be taken with our interpretations (Gassin *et al.* 2014).

Archaeological contexts and studied materials

Atxoste

Atxoste site is located in the Puerto de Azáceta, near the village of Vírgala Mayor. It is a limestone rock-shelter with south orientation with a south orientation, located a few meters away from the Berrón River (Alday 1996). Near Atxoste, in a range of one kilometre of distance, there are other two Mesolithic sites: Kanpanoste (Cava 2004) and Kanpanoste Goikoa (Alday 1998). All of those sites are located in a strategic position for territorial control, connecting the lower valleys with the highlands and the mountain ridges.

Atxoste stratigraphy goes from the Upper Palaeolithic to the Early Neolithic. Analysed tools belong to layers IV and IIIb2, both belonging to the Geometric Mesolithic horizon. The former, which is superposed to the Notched and Denticulated horizon, is dated around the half of the 8th millennium BP (GrA-13469: 7480±50 and GrA-13418: 7340±50). The latter, superposed to the layer IV without any clear stratigraphic break, is dated to the end of the beginning of the 7th millennium BP (GrA-13458: 7140±50 and GrA-13415: 6940±40 (Alday 2002, 2005; Alday & Cava 2009).

The number of analysed tools amount to 13 tools, three of which are characterized by a truly denticulated edge, while the remaining shows a single notch. Both voluntary retouched notches and involuntary fractures are present. Average dimensions are comprised between 32-26 x 29-18 x 3-4 mm.

Mendandia

Mendandia is a medium-sized rock-shelter located in the Oquina-Sáseta area (Treviño) at *ca.* 740 m a.s.l. (Alday 2006). The site shows several common features with the other Mesolithic settlements of the Basque region: a rock-shelter near permanent water-sources, located in a strategic overview position. Like Atxoste site, Mendandia rock-shelter is interpreted as a temporary camp, part of a larger network of complementary sites, recurrently occupied by groups of nomadic hunter-gatherers (Alday 2002, 2005, 2009; Montes & Alday 2012).

Site stratigraphy ranges from Late Mesolithic to Early Neolithic. Analysed tools belong to the Geometric Mesolithic level (layer III - GrN-22743: 7620±50 BP) and to the so-called Notched and Denticulated Mesolithic (layer IV - GrN-22745: 7780±40 BP (Alday 2006).

The number of analysed tools amounts to 12 notched blades, eight of which present exclusively one notch, while the remaining four are characterized by a truly denticulated edge. Average dimensions are comprised between 44-38 x 34-23 x 3-4 mm.

Artusia

Artusia rock-shelter is located in the municipality of Unzué, in the Navarra region. The rockshelter opens near the 'Arroyo de Artusia' creek, a seasonal affluent of the Zidacos River. The site is located in one of the narrow sectors of the valley, partially protected by conglomerate deposit. However, only part of the prehistoric deposit has been preserved against the erosive processes. During the years 2009-2010 excavation campaigns have been carried out revealing a stratigraphic series which ranges from the Upper Paleolithic to the Mesolithic (Rojo *et al.* 2012). Both Geometric Mesolithic and Nothced and Denticulated Mesolithic layers have been detected.

The number of analysed tools amounts to 15 notched blades, eight of which present exclusively one notch, while the remaining four are characterized by a truly denticulated edge. Average dimensions are comprised between 32-21 x 15-9 x 4-2 mm.

Valmayor XI

Valmayor is a rock-shelter located in the Mequinenza municipality (Zaragoza). The site opens in the Mequinenza gorge, near the creek's mouth. Currently, the site is covered by the waters almost all year round, except during very dry seasons. This is the case of the summer of the 2011, when the first and the last excavation campaign has been carried out at the site (Rojo *et al.* 2012).

Site stratigraphy goes from Geometric Mesolithic to Early Neolithic levels. An intermediate layer between Mesolithic and Neolithic horizons has been detected. It represents an intermediate stage, where a Mesolithic assemblage is mixed with few ceramic fragments, even if it is not clear whether such commingling is the result of a

stratigraphic, post-depositional factor or of human behaviours.

The number of analysed notched blades amounts to 16 implements, two from the Geometric Mesolithic horizon (U.S. 21), six from the intermediate horizons (U.S. 6 & 14) and eight form a superficial layer (U.S. 0). Their dimension is comprised between 66-50 x 16-27 x 5-3 mm. Notches are often characterized by overlapping fractures, likely a consequence of the edge-use and not of a voluntary retouch; however retouched notches have been observed as well.

Cocina

Cocina Cave is located in the Valencia region, in the ravine known as 'Barranco de la Ventana', one of the last mountains before the plain of the Jucar River. It represents one of the most important sites for the chrono-cultural sequence of the Iberian Mesolithic. The site was discovered and excavated during the 1940s by L. Pericot (1945) and later (in the 1970s) by J. Fortea (1973). After the publication of Fortea's book about the Epipalaeolithic complexes on the Mediterranean Coast of the Peninsula Iberia, Cocina Cave has reached an international relevance in relation with the characterization of the last Mesolithic assemblages of the Western Mediterranean (Geometric Mesolithic).

Recently, the first radiocarbon dates for the Mesolithic levels of Cocina have been obtained. Results indicate that the Mesolithic period began about 8500 cal BP and lasted until 7700 cal BP.

The number of analysed notched tools amounts to 33 implements. Their dimensions are comprised between 45-37 x 11-9 x 4-3 mm. The retouch is generally made by pressure, from the ventral toward the dorsal face. Except for one element, which is realized on a flake, all the remaining tools are on laminar blanks. The majority of tools (n. 18) is characterized by a succession of notches, thus forming a denticulated edge, while the remaining part is composed of one-notched tools.

Results & Discussion

Of the totality of analysed notched blades more than 60% show traces of use (n. 56). Moreover, several blades of this assemblage were characterized by more than one area of use (AUA), with 22 items which show a double active zone and 3 items characterized by three active zones. Therefore, the final number of activities recognized amounts to 83 areas of use.

Our analysis highlighted certain homogeneity among the analysed materials, both on a technological and functional level. Used blanks are mainly blades with one or more notches produced on the dorsal face of the tool. Flakes are only marginally employed to produce such type of tools, at least during the chronologies considered in this study.

The used zone is always the concave part of the notch. Most of the notches can be considered intentionally made; indeed, a scraping motion with the ventral face as a rake face would produce quite a similar notch, but with a different distribution of the use polishes; indeed in this case the bevel would be on the dorsal (retouched) face and not on the ventral one. The other way around, a positive rake with a scraping motion would produce a scarring which only partially matches the patterns observed on archaeological tools. Therefore, we think that the notches are the result of a voluntary retouch, creating a very short concave active zone with a robust straight-angled edge (Fig. 2, a). Only in the case of denticulated edges with very short and continuous notches we can imagine that the edge-fractures have been produced by the scraping action itself.

Also the cinematic of the tool appears almost identical in all the observed implements. A major variability has been observed among the worked materials. Indeed, the notches appear to be used for scraping a variety of materials, from soft vegetal and animal substances, to woody plants or hard-animal material such as bone and antler. The polish is always asymmetric, with a bevel on the ventral face, characterized by a compact domed polish, while, on the retouched dorsal face, the polish is sometimes weaker, sometimes compact and shiny. This asymmetry results from a negative rake-cutting of different materials. The end-flank is always the ventral face; the dorsal face is the rake face, with a rake angle near 90°.

From a functional point of view, it is often difficult to establish the exact nature of the worked material, because of the overlaps between use-wear traces. Some notches bear on the dorsal face a bright, smooth polish and on the ventral face either an invasive pitted and striated polish or a smooth polish with few striations (Fig. 2, b). Those tools are often associated with woodworking activities or soft plant scraping. On other notches, polish on the ventral face is limited to a band along the very edge of the tool, creating a domed bevel, often with some striations (Fig. 2, c). These tools are generally associated with the work of very hard animal materials such as bone/antler. In those cases, on the retouched dorsal face, the polish is usually not much developed. Finally, some notches show a rather rough polish on the ventral face, with striations and micro-fractures (Fig. 2, d). In those cases, traces show a major variability, from dry-wood to hide working.

The most common use, on the basis of the analysed sample, is associated with bone working (24.10%), followed by hide-working (19.28%) and woodworking (10.84%), at least among the determined materials. Hard indeterminate materials represent the 19.26%, while indeterminate materials represent the 15.66% of the AUAs (Fig. 3). In general, different uses are associated with most of the analysed sites (always in the case that a sufficient sample of materials has been analysed) (Tab. 1).

Finally, we have to remark that such tools are generally characterized by a scarce development of the use-wears. Edge exploitation is never very intense and we do not generally observe resharpening retouches made in order to prolong the tool use-life. This pattern could indicate that such tools were mainly employed for brief tasks, possibly related to very specific phases of wood/bone/hide artefacts manufacturing and/or maintenance. Therefore, despite notched blades appears quite homogeneous and standardized objects on a technological level, from a functional point of view they can be defined as disposable tools, being generally used briefly to carry out a variety of crafting tasks.

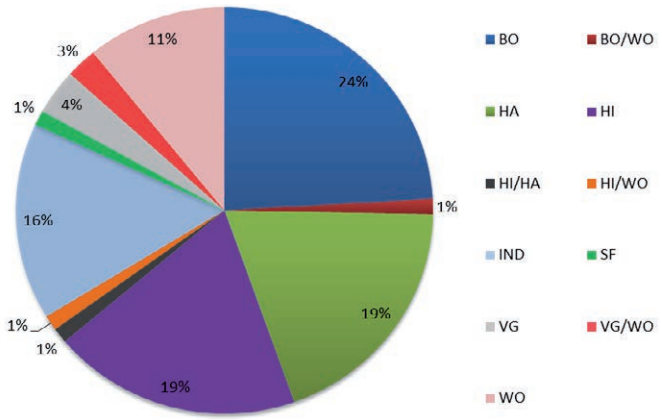

Fig. 3 - Percentage of AUAs for each class of worked material inferred. BO: Bone; BO/WO: Bone or hard wood; HA: Indeterminate hard material; HI: Hide (both fresh and dry hides); HI/HA: Hide or another Hard material; HI/WO: Hide or Soft wood; IND: Indeterminate material; SF: Indeterminate soft material; VG: Soft vegetal substance; VG/WO: Plant or wood; WO: Hard wood. / Percentuali di AUAs (Zone Usate) per ciascuna delle classi di materiali lavorati in base alla nostra interpretazione. BO: Osso; BO/WO: Osso o Legno; HA: Materiale resistente di natura indeterminata; HI: Pelle (sia fresca che secca); HI/HA: Pelle o un altro materiale resistente; HI/WO: Pelle o Piante legnose; IND: Materiale indeterminato; SF: Materiale indeterminato poco resistente; VG: Piante; VG/WO: Piante o legno; WO: Legno.

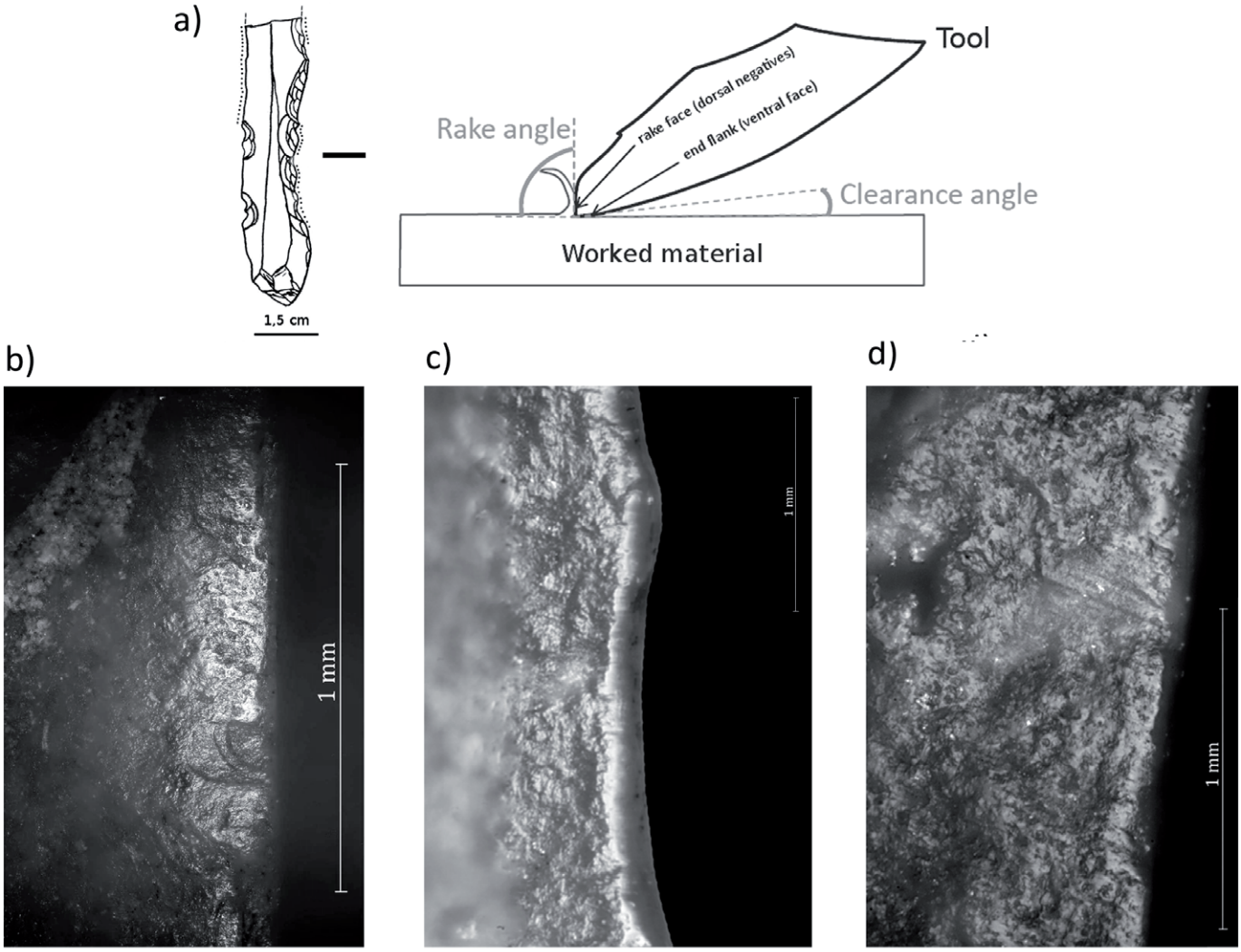

Fig. 2 - a) Schematic representation of the mode of use of the notched blades; b) Pitted-smooth polish with few striations (50X), probably resulting from wood working - Atxoste site; c) domed bevel, with some striations (100X), probably resulting from bone scraping - Cocina cave; d) rather flat bevel on the ventral face, with striations and micro-fractures (100X), probably resulting from vegetal (plant or wood) scraping - Artusia rock-shelter. / a) Rappresentazione schematica del modo d'utilizzo delle lame a incavi; b) Politura smussata con presenza di crateri e poche strie (50X), probabilmente prodotta dalla lavorazione del legno - riparo Atxoste; c) politura su angolo dall'aspetto arrotondato con presenza di strie (100X), probabilmente prodotta dalla lavorazione dell'osso - Grotta della Cocina; d) politura su angolo piuttosto piatta sulla faccia ventrale, con numerose strie e microfratture del bordo (100X), probabilmente prodotta dalla lavorazione di sostanze vegetali (piante o legno) - riparo Artusia.

Tab. 1 - Sum and Percentage of AUAs for each class of worked material inferred per each site. Indeterminate or doubtful AUAs have been excluded. BO: Bone; HA: Indeterminate had material; HI: Hide (both fresh and dry hides); SF: Indeterminate soft material; VG: Soft vegetal substance; WO: Hard wood. / Somma e Percentuali di AUAs (Zone Usate) per ciascuna delle classi di materiali lavorati per ciascuna sito. BO: Osso; HA: Materiale resistente di natura indeterminata; HI: Pelle (sia fresca che secca); SF: Materiale indeterminato poco resistente; VG: Piante; WO: Legno.

Sites	BO		HA		HI		SF		VG		WO	
	Σ	%	Σ	%	Σ	%	Σ	%	Σ	%	Σ	%
Artusia	-	-	-	-	3	*50,0*	-	-		*0,0*	3	*50,0*
Atxoste	1	*6,7*	2	*13,3*	7	*46,7*	-	-	1	*6,7*	4	*26,7*
Cocina	18	*58,1*	10	*32,3*	-	-	-	-	1	*3,2*	2	*6,5*
Mendandia	1	*11,1*	2	*22,2*	3	*33,3*	-	-	1	*11,1*	2	*22,2*
Valmayor XI	-	-	2	*33,3*	3	*50,0*	1	*16,7*	-	-	-	-
Tot	**20**	*29,9*	**16**	*23,9*	**16**	*23,9*	**1**	*1,5*	**3**	*4,5*	**11**	*16,4*

Conclusions

On the basis of the results of our analyses, we can consider notched blades a multi-tasking tool employed in a variety of crafting/manufacturing processes on different materials. The recurrent choice of regular blades and the scarcity or absence of notched flakes or flakes with naturally straight angle edges used to scrape the same range of materials, seem to point toward a well-established technical tradition. Nevertheless, making notches to scrape different materials does not need a high level of know-how, and could have invented independently in several places and times. Therefore, do Late Mesolithic notched blades represent a convergent behaviour in response to similar technical/economic needs? Or do they represent a shared tradition, which imply the existence of similar forms of artefact production and utilization among different groups?

Still, our data is not sufficient to hypothesize the presence of some technical heritage or a traditional way of doing things between Mesolithic groups. However, it is to remark that direct notches on regular blades represent one of the dominant tools of the Late Mesolithic industries of the Western Mediterranean; thus they represent the material outcome of a systematic behaviour, not an occasional or isolated practice. In the future, enlarging the sample of analysed sites, we will maybe prove the existence of 'formal' tools among Late Mesolithic communities, contributing to the debate about the transfer of ideas, technological know-how and traditions during Prehistory.

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Article

The mesolithic at Mura cave

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Key words

- Grotta delle Mura
- Mesolithic
- Sauveterrian
- typology
- lithic technology
- reduction sequence

Parole chiave

- Grotta delle Mura
- Mesolitico
- Sauveterriano
- tipologia
- tecnologia litica
- catene operative

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Summary

Mura Cave is located along the shoreline of the southern part of the suburban area of Monopoli (Bari, Italy). The archaeological excavation was focused on a 21 square area and the stratigraphic sequence ranged from Mousterian to ancient Neolithic. The project aim was to analyze the Mesolithic phase (Layer 2), which was located between two other layers, one related to the final Epigravettian and the other related to the Neolithic. Some pebble mobiliary art and bone artifacts were found. There was a rich lithic industry, comprising 5000 unretouched artifacts, 1100 retouched tools and 34 cores. The lithic technology was typical Sauveterrian, essentially structured on prismatic and discoidal cores. The typological analyses revealed a Sauveterrian structure mixed with some Epigravettian local features.

Riassunto

Il sito di Grotta delle Mura è situato lungo la costa all'interno del reticolo urbano della cittadina di Monopoli (Bari). Le ricerche archeologiche interessano un'area 21 metri quadri ed una sequenza stratigrafica estesa tra il Musteriano ed il Neolitico antico. Quì è presentato lo studio relativo alla fase di frequentazione mesolitica (strato 2), successiva ad un livello (strato 3) relazionabile all'Epigravettiano romanelliano, ed uno superiore neolitico. Dallo strato provengo alcuni reperti di arte mobiliare, industria su osso, reperti faunistici ed una notevole quantità di industria litica. Questa ultima si compone da circa 5000 supporti non ritoccati, 1100 strumenti ritoccati e 34 nuclei. La tecnologia litica risulta essere sauveterriana, basata essenzialmente sullo sfruttamento di piccoli nuclei prismatici e discoidali, mentre in leggero contrasto le strutture tipologiche delineano un contesto mesolitico dove i caratteri epigravettiani tipici dell'areale geografico sud-adriatico non sono ancora svaniti.

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The site

An introduction

Grotta delle Mura is situated along the shoreline of a suburban area of the small town of Monopoli (Bari, Italy) (Fig. 1). The site has been the subject of archaeological investigation since 1950, thanks to Professor Franco Anelli (1952)(Cornaggia Castiglioni 1960; Calattini 1986a). The present excavation extended to 20 m2, is subdivided into three different areas: A, B and C (Fig. 2). The stratigraphic succession consisted principally of seven layers, chronologically extending from the middle Paleolithic to the Neolithic (Calattini 2005) (Fig. 3):

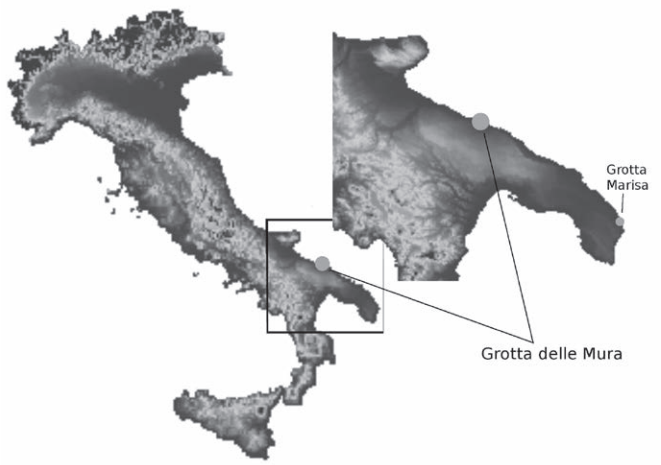

Fig. 1 *- Geographic location of Grotta delle Mura. / Posizione geografica di Grotta delle Mura.*

- Clay soil without archaeological artifacts (Layer A).
- Ancient Neolithic (Layer 1) (Calattini and Greco 2000) .
- Sauveterrian Mesolithic (8240 +/-120 BP) (Layer 2 and US 124) .
- Final Epigravettian (Romanelliano) (10540 +/- 140BP, 10850 +/- 100 BP)(Layer 3 and US 125-129) (Calattini 2005).
- Evoluted Epigravettian (US 141).
- Ancient Epigravettian (15860 +/- 80 BP) (Layer 4 and US 142-143).
- Mousterian (44530 +/- 2040 BP)(Layer 5).

The aim of this work is largely related to Layer 2, for which three articles have been published previously; the first two publications were short notes related to area A (Calattini 1996a, 1996b) and the third publication a typological study of the lithic assemblage from Area B (Calattini and Morabito 2006). Layer 2 had a maximum thickness of 60 cm and an area of 12 m2. During the excavation it was subdivided into 15 sub-levels of different thickness as a result of the friability of the sediment, which was harder in the lower part (levels 15–8) and softer in the upper parts (levels 7–1). No convincing structures were found. We obtained two radiometric dates for Layer 2, one from the upper part of the layer and the other from the lower part; they are, respectively, 8290+/50BP (Utc1417) and 8240+/-120 BP (Utc 780).1 Analysis of the macro- and micro-fauna suggested a humid, temperate climate, characterized, respectively, by the predominance of Bos primigenius and the rare presence of equidae (Bon, Boscato 2003) and the presence of Heliomys and Crocidura. The upper part of the layer indicated an increasing of forest coverage. There is also an abundant malacological fauna, with predominantly ter-

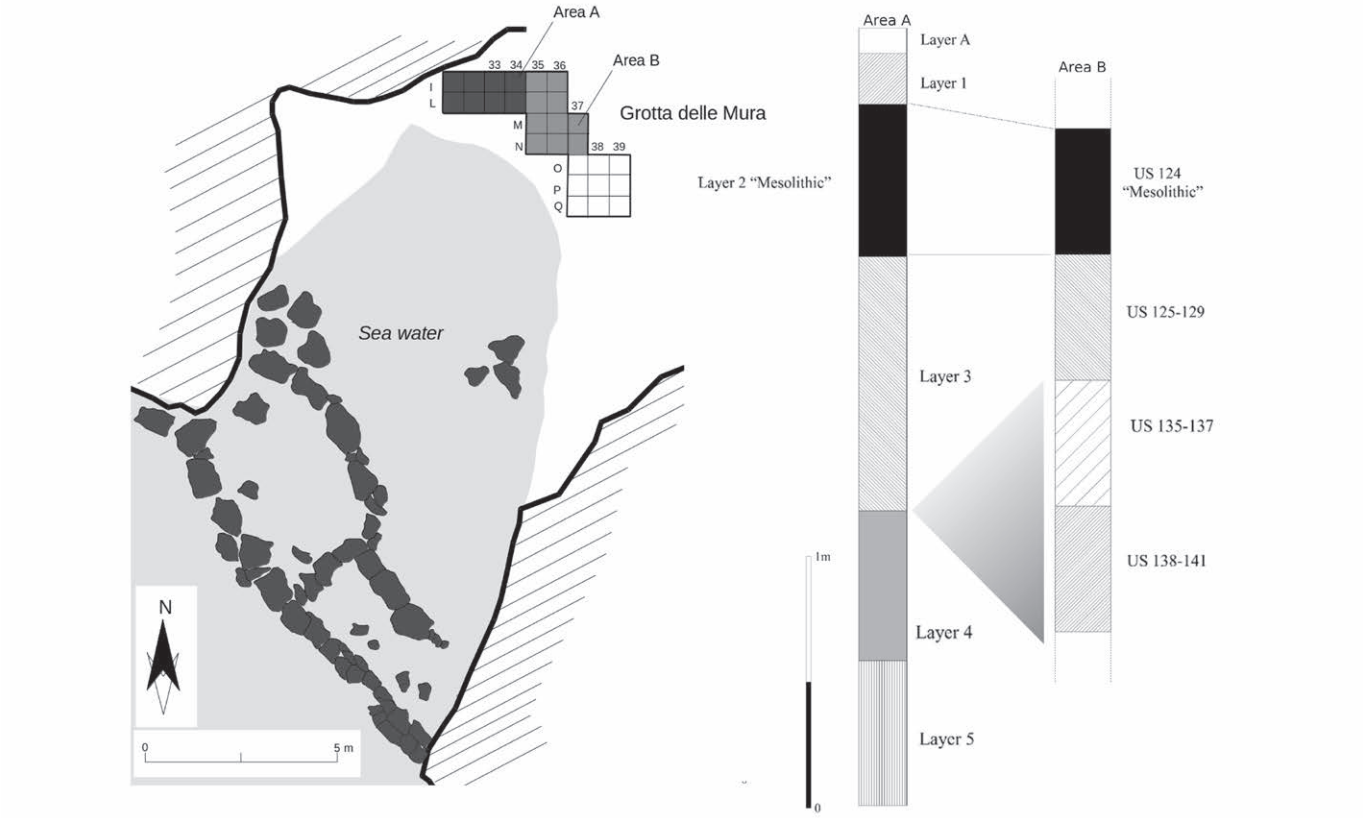

Fig. 2 *- Archaeological context of Area A and B and logs of stratigraphic successions of Area A and B. / Mappa del sito e schema stratigrafico dell'area A e B.*

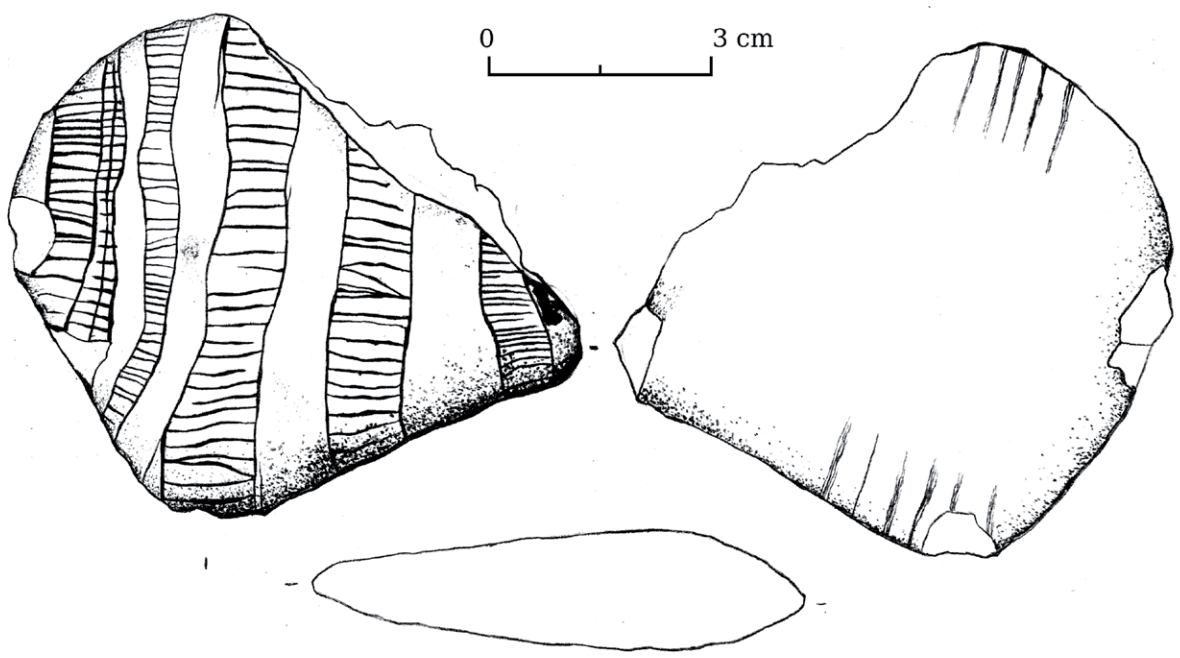

Fig. 3 - Engraved stone from Layer 2. (Drawing by C. Tessaro). / Ciottolo inciso proveniente dallo strato 2. (Dis. di C. Tessaro).

restrial but also maritime species present. The terrestrial species are principally Eubania vermiculata and Rumina decollata, and the maritime species Patella caerulea and Monodonta turbinata. All the evidence suggests the climate was tending towards the temperate phase of the Boreal period.

Mobiliary art and bone working

Several pieces of mobiliary art were found in Layer 2, three of which are linear engraved pebbles defined by a particular scale line pattern. One pebble is engraved on both sides and another only over one face. The first pebble is 50 mm in length, 45 mm in width and 15 mm thick; it is decorated on both faces and on one of the edges. On the first side, the decorative syntax consistes of three more or less parallel bundles, with two deep external strokes filled by thinner lines, perpendicular to the outline. On the edge, simple sub-parallel lines could be seen, while on the second side of the pebble there is an association of parallel lines and, possibly, a chevron pattern, which is only partially visible. The second pebble, a calcarenite pebble, has a length of 45 mm, width of 40 mm and thickness of 25 mm; one side has the same decorative syntax as the first pebble, i.e. bundles with two external lines filled by thinner strokes. The third limestone pebble (Fig. 3) has a length of 70 mm, width of 65 mm and thickness of 17 mm, and shows traces of exposure to heat. Engravings are present on both sides; on the first side, there are five bundles like the ones described above, while on the other side there are only simple parallel strokes. It is important to note that all the engraved pebbles found in this layer were intentionally broken ab antiquo; this phenomenon has been observed before, at Grotta delle Veneri di Parabita (Apulia) and interpreted as ritual activity (Cremonesi 1987, pp. 35–46). Evidences of bone working are scarce, comprising a spatula made from an animal vertebra and two awls of different size and shape. Two bone pendants were also found, made from deer atrophic canines (Fig. 4).

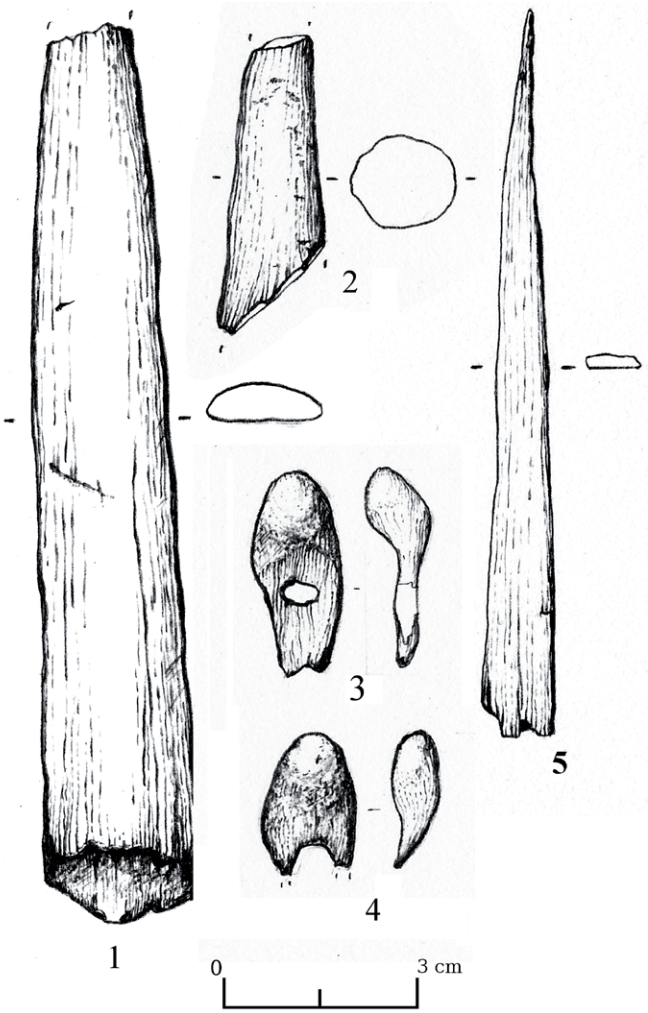

Fig. 4 - Bone industry – layer 2. Awls (1, 2 e 5), pendants (3 and 4). (Drawings by C. Tessaro). / Industria su osso relativa allo strato 2. Punteruoli (1, 2 e 5), pendagli (3 e 4). (Dis. di C. Tessaro).

Tab. 1 - Basic composition of the assemblage. / Composizione dell'insieme litico.

	CORES		FLAKES		BLADES		RETOUCHED T.		DEBRIS		TOT.
	N	%	N	%	N	%	N	%	N	%	N
Layer 2 (7-1)	15	0.2	59	0.8	97	1.3	485	6.7	6602	91.5	7258
Layer 2 (15-8)	19	0.3	158	2.8	286	5.1	670	12.0	4429	79.6	5562
Total Layer 2	34	0.3	217	1.7	383	6.5	1150	9.0	11031	86.3	12820

Tab. 2 - Shaping blanks (total 58). / Supporti di relativi alla messa in forma dei nuclei (tot. 58).

CLASSES	15-8	7-1
Opening blades	1.7%	8.2%
Opening flakes	30.6%	32.7%
Crested blades	15.5%	0.0%
Partial crested blades	10.3%	20.4%
Generic cortical flakes	6.7%	30.6%
Tot.	**29**	**28**

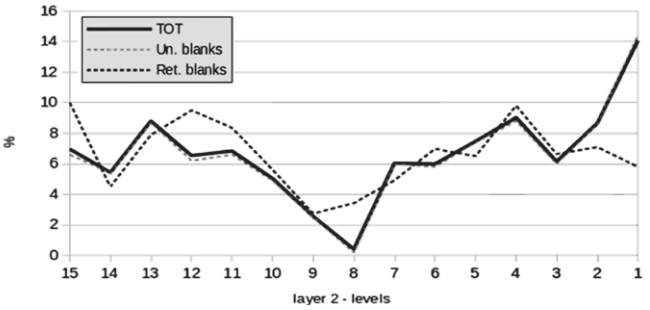

Fig. 5 - Lithic artifact vertical distribution in layer 2. / Distribuzione dei reperti litici per tagli nello strato 2.

Tab. 3 - Production/Maintenance blanks in Layer 2. / Supporti relativi alla fase di messa in forma/produzione (strato 2).

CLASSES	LAYER 2
Opening platf.	0.7%
Surbaissé	2.1%
Rejuvenation	2.81%
Demi-tablette	1.41%
Neo-crested blade	1.0%
Tablette	0.7%
Cortical backed flake	2.1%
Backed flake	1.4%
Flake	69.5%
Backed blade on edge	5.9%
Cortical backed blade	2.1%
Backed blade	10.0%
Tot.	**289**

Lithic industry

Analysis of the lithic assemblage was carried out following the stratigraphic division of Layer 2 into 15 sub-levels. The artifacts come from the whole excavated area. Quantitatively, the lithic industry is very rich, comprising 12820 artifacts made up of 34 cores, 217 flakes, 383 blades, 1155 retouched tools and 11,031 debris2 fragments. These data with a preliminary comparison of the debitage products define a depth quantitative gap between the categories of the lithic set, surely a consequence of high degree of reduction by retouch (Tab. 1). The unique exploited raw material are a good quality flint. The analysis of the cortical surfaces shows that a type of flint presumably was collected locally, in this case they are small pebbles, in the other one slabs/block coming probably from the Gargano area. The microburin technique is present: 47 elements in total, 26 for levels 15-8 and 21 for levels 7-1. They are generally ordinary types of microburins, the Krukowski type is quite rare, only four. The use of this technique is quite common at Grotta delle Mura, with a ratio armatures/microburins equal to 5.23 (levels 15-8) and 7.0 (levels 7-1).

In order to verify the hypothetical subdivision of Layer 2, we considered the vertical distribution of the frequency of artefacts in each level and we confirmed the division of the layer into two distinct sets, one comprising levels 15–8, with a peak frequency in in level 13, and the other one comprising levels 7–1, with a peak in level 1 (Fig. 5).

Technology

Because of the high degree of blank modification,3 the absence of lithic artefacts related to a peculiar phase of the chaine operatoires and, in consequence the complete absence of refitting, an accurate analysis of morpho-techno-metrical features of the cores and unretouched blanks was carried out. This gave us sufficient data to interpret the reduction sequence.

The first phase of the debitage, the shaping of the cores, is only indicated by a very small number of artifacts (a total of 57 for the whole of Layer 2) (Tab. 2). The principal categories are generic flakes, related to the making of striking platforms, and some half-cortical blades, related to the working of small pre-shaped blocks of flint. In the upper part of the layer (levels 7–1) there is an increase in generic cortical flakes, a consequence of more intensive management of small flint pebbles, confirmed with analysis of the cortical surfaces. This kind of raw material, identified from the remaining cortex, increased from 9% in levels 15–8 to 50% in levels 7–1 of artifacts. What must be emphasized are the low frequencies of half cortical flakes (0.1%–0.2%), corresponding to the opening of new knapping surfaces on pre-used cores. It seems that the first phase of shaping the raw material is completely absent at this site.

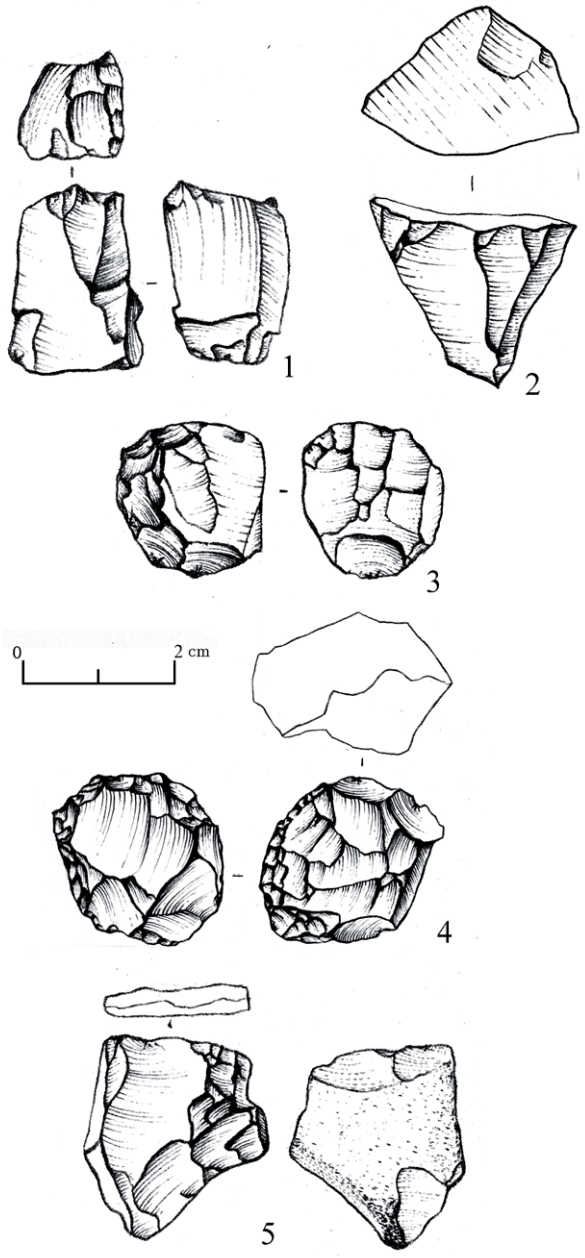

Fig. 6 - Cores of layer 2: class III (1-2), class VII (3), class V (5), class VII (4).(Drawings by C. Tessaro). / Nuclei dello strato 2: classe III (1-2), classe VII (3), classe V (5), classe VII (4). (Dis. di C. Tessaro).

In the blank production phase, only lamellar blanks, or ones for which the intended function is certain, are included for analysis. Regarding the orientation of removal, blanks with unidirectional removal dominated throughout the sequence (94.3%–93.91%), while the number of blanks showing oblique and convergent/oblique removal remained constantly low or absent (around 0.1%–0.9%). The double ventral definition is essentially related to blanks that resulted from the management of flake/discoidal cores (2.25%–3%). The analysis also includes a category of artifacts comprising generic blanks or technical blanks, generally related to production/management processes. The generic flakes are more frequent throughout Layer 2, backed blanks or centering blades are very rare, as are flakes showing lateral and transverse convexity; crested blade and neo-crested blades are also very rare (Tab. 3).

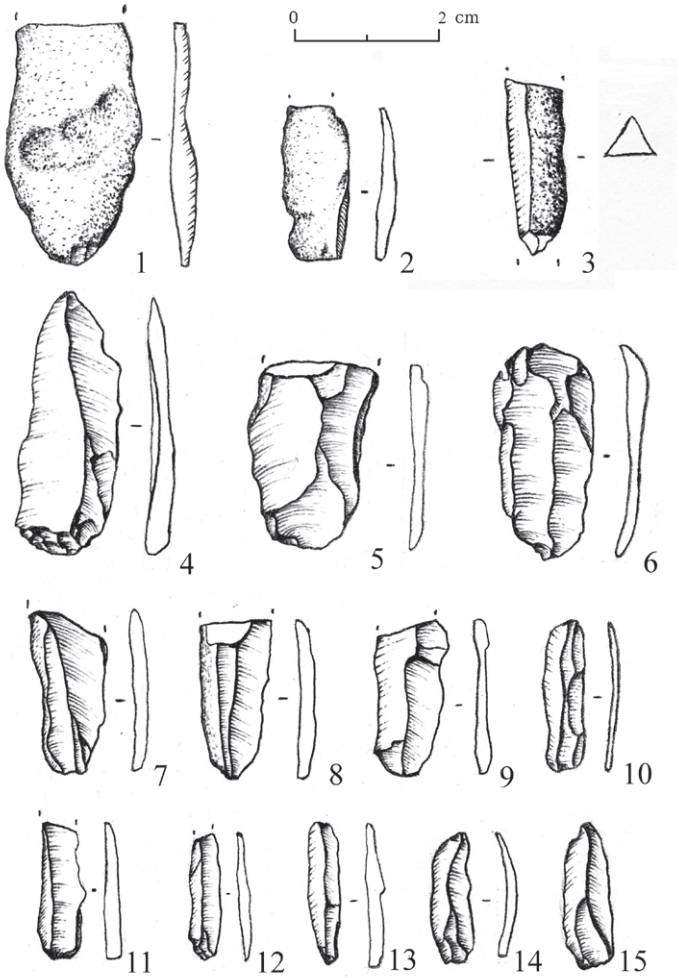

Fig. 7 - Unretouched lamellar blanks. Cortical (1-2), on natural edge - half cortical (3), bladelets (4-5), micro-bladelets (7-9) and iper-micro-bladelets (10-15). (Drawings by C. Tessaro). / Supporti lamellari non ritoccati. Corticali (1,2), semi corticali (3), lamelle (4,5), micro-lamelle (7 – 9), iper-micro-lamelle (10 – 15). (Disegni di C. Tessaro).

Cores

There are not many cores in Layer 2 (Fig. 6), with a total of just 34, and the same types are generally present in the lower levels as in the upper levels of the layer. It is present also a reuse of an exhausted polihedrical core such an hammer, the maximum dimension is 35 mm. The following typological subdivision is based on the proposed classification for Romagnano III (Broglio & Kozlowski 1983).

- Pre-cores (class I): absent from all levels.
- Sub-conic bladelet cores with one stricking platform (class II): six here in levels 15–8 but only one in the upper levels. All the artifacts are very small, being between 10 and 26 mm in length. The morphology of the artifacts is not standardized, principally because of the selection of different raw materials. The types selected are generally small blocks of flint, slabs, small pebbles or thick cortical flakes. Some cores showed a re-orientation of the debitage surfaces, with a sequence of detachment usually semi-tournant, or facial, with two or four lamellar negatives.
- Subconical bladelets cores (class III): not many, only one in the lower part of the layer and two in the upper part. Like the other types, they are also small, usually obtained from thick cortical flakes. The lamellar detachment always started from non-prepared knapping surfaces, but the use tended to be more intense, with a sequence of rejuvenation of the knapping surface, and usually

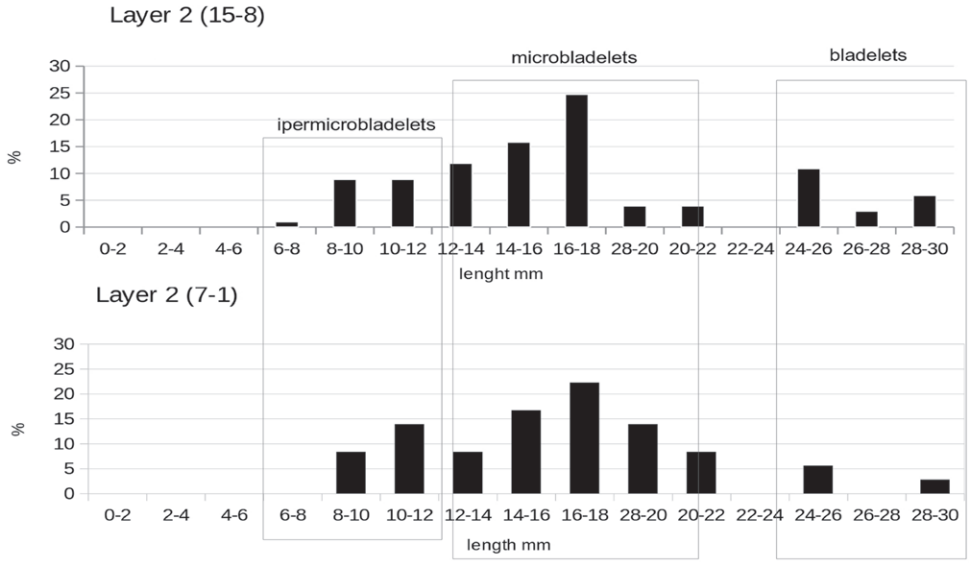

Fig. 8 - Charts of frequency of unretouched lamellar blanks by length. / Grafici relativi alle frequenze della lunghezza dei supporti lamellari non ritoccati.

with the start of a new one on the opposite, transverse part of the core. The abandoned surface is always related to exhaustion of the useful volume of the artifacts from the lamellar debitage. We generally found intensive exploitation of the knapping surface that tended to transform the stricking platform in a line.

- Bladelet cores with two striking platforms (class IV): one element from the level 7-1 with maximum dimension of 67 mm. The two stricking platform are oppose and they are characterized by lamellar detachment, and like all the other cores the exploitation is unipolar (the bipolar knapping is not synchronized). The volumetric exploitation is very intensive.
- Discoidal cores (class V): there are two discoidal cores for microlithic flakes, one in the lower part and the other in the upper part of the layer. Both seems to be derived from a thick cortical flake. The debitage consisted of a series of three to five detachments of very short blanks on the ventral part of the flake, with a stricking platform only partially elaborated.
- On-flake cores (class VI): eight cores are characterized by a poligonal/polihedrical shape, all come from the lower part of Layer 2. They are very small, and the volume completely exhausted, with planes of debitage apparent in every kind of orientation, with the detachment of little, écaille thin flakes.
- Pièces écaillées (class VII): There are only six, and in general their techno-morphological aspects are similar to those of type V. They are very small, with intensive knapping usually on the transverse profile, or all over the perimeter, clearly as a consequence of bipolar percussion on an anvil.
- Elements not clearly identifiable: the volume of seven elements had been exploited to the point that it was impossible to identify the debitage scheme clearly, other than to relate them with one of the previous core classes. All these cores are fragments, three in levels 15-8 and four in levels 7-1.

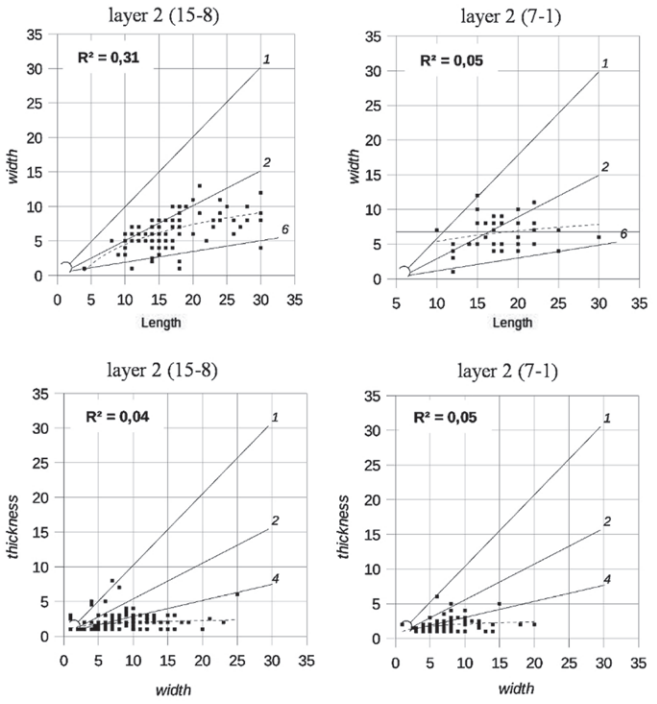

Fig. 9 - Unretouched lamellar blanks correlation graphs (length and width). / Grafici di correlazione relativi alla lunghezza/larghezza dei supporti lamellari.

The lamellar debitage is related only to class II and III cores. For these, the debitage are from the unprepared stricking platform on thick flakes (with cortex present as well), or from small blocks/slabs or flint pebbles. Even though the debitage are very intensive, the sequence of the detachment is short (usually just three to four blanks) and usually facial or semi-tournant. Very frequently there are re-orientation of the core exploitation, with the opening of new debitage surfaces. The discoidal cores related exclusively to the production of flakes/microflakes, usually based on the exploitation of thick flakes. The debitage started with a rough preparation of the stricking platform, and proceeded with the detachment of no more than four blanks, in unipolar, bipolar or centripetal directions.

Typometry of the unretouched blanks

The typometrical analysis was conducted with the aim of defining the debitage. The analysis presented here is concerned only with the unretouched artifacts; the analysis of the blanks did not take into account their specific roles in the reduction sequence, cause it is impossible always to understanding it. Measurements were taken with the help of the minimal rectangle method (Laplace 1977), described separately for the blades, flakes and retouched tools. The lithic assemblage is characterized by an high degree of microlithics, related principally to the unretouched blanks. The artifacts in general are between 6 and 44 mm long, less than 33 mm wide, and less than 20

mm thick. The average and median values are similar, and the standard deviation relatively low, indicating a good morphological standardization of production process, in particular in lower part (levels 15–8). The index length/width statistics of the blades/bladelets mean that the assemblage could be divided into three subsets: iper-micro-bladelets, micro-bladelets and bladelets (Fig. 7–8). In the iper-micro-bladelets class, the blanks are smaller than in the others, with lengths less than 12 mm. The micro-bladelets are between 12 and 22 mm in length, and the bladelets between 24 and 30 mm. The categories are the same in both parts of Layer 2. The correlation of width and thickness confirm previous observations, that there is some morphological standardization of the longitudinal profile of blanks in levels 15–8 and

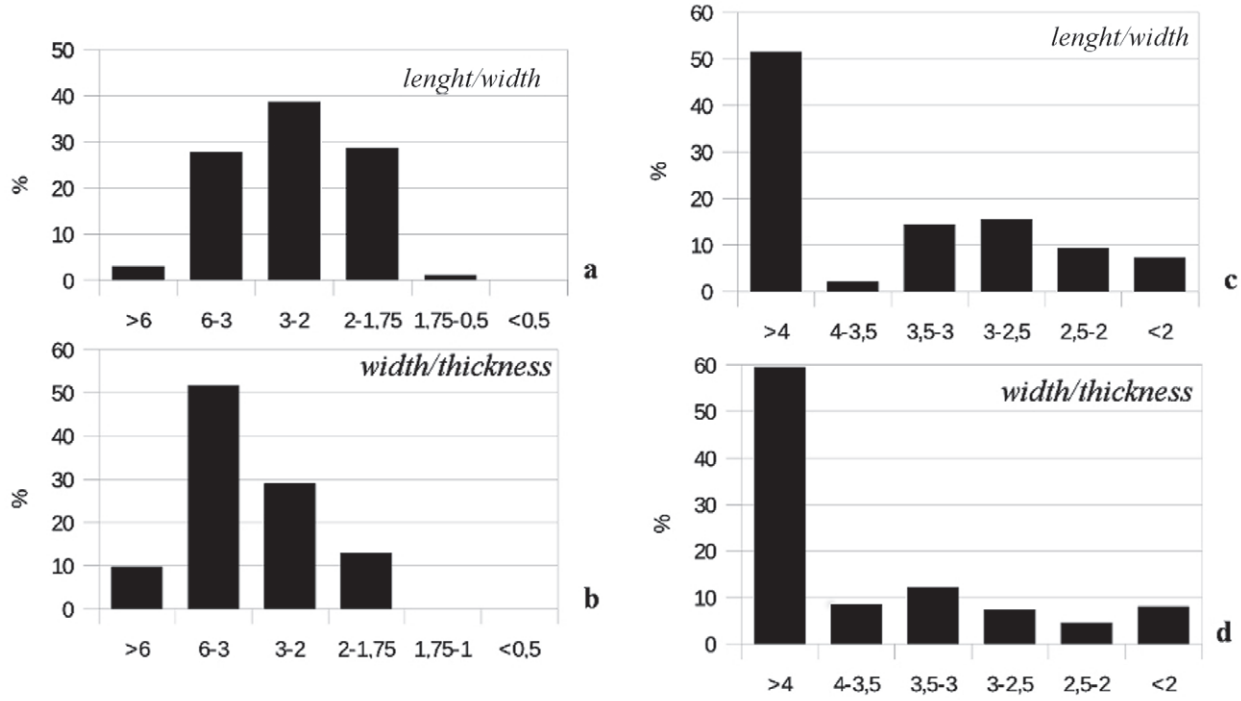

Fig. 10 - Load chart of measure of unretouched lamellar blanks (length/width and width/thickness). / Grafici relativi alla correlazione della larghezza e spessore dei supporti lamellari.

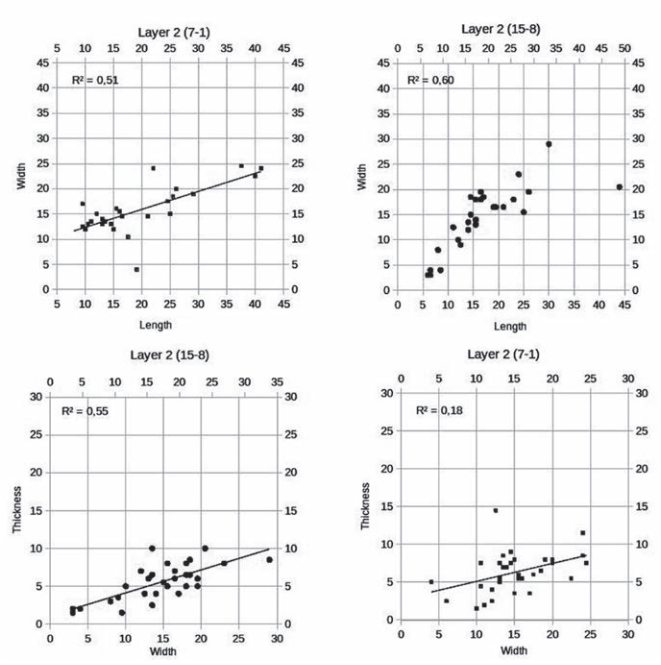

Fig. 11 - End-scrapers correlation graphs. / Grafici di dispersione relativi alla tipometria dei grattatoi.

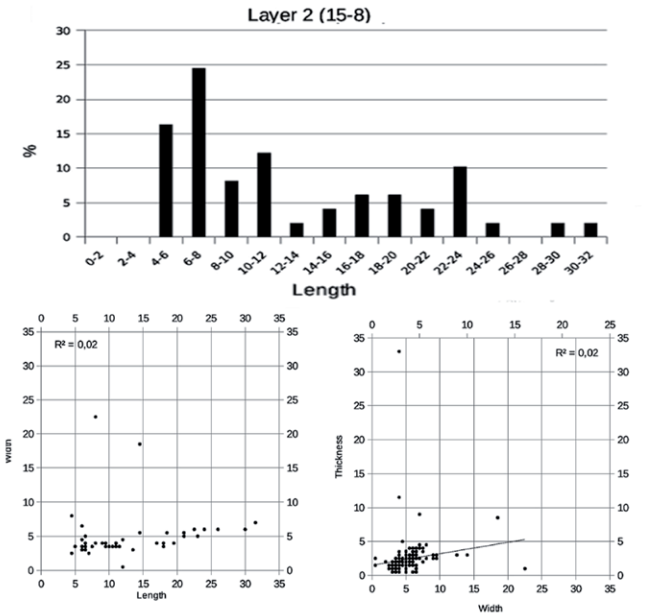

Fig. 12 - Armatures correlation graphs and histograms related to length and width (mm), levels 15 – 8. / Grafici relativi alla tipometria delle armature, tagli 15 – 8.

levels 7–1 (Fig. 9 – 10). In general the shape is usually straight, and the length index (length/width) is on average 3; the bladelets rarely have values higher than 6. The shape of the transversal/longitudinal profile of the blanks are not very standardized, and the blades tended to be irregular or curved. A major trend in standardization could be seen in levels 7–1, with a very low correlation coefficient (0.05).

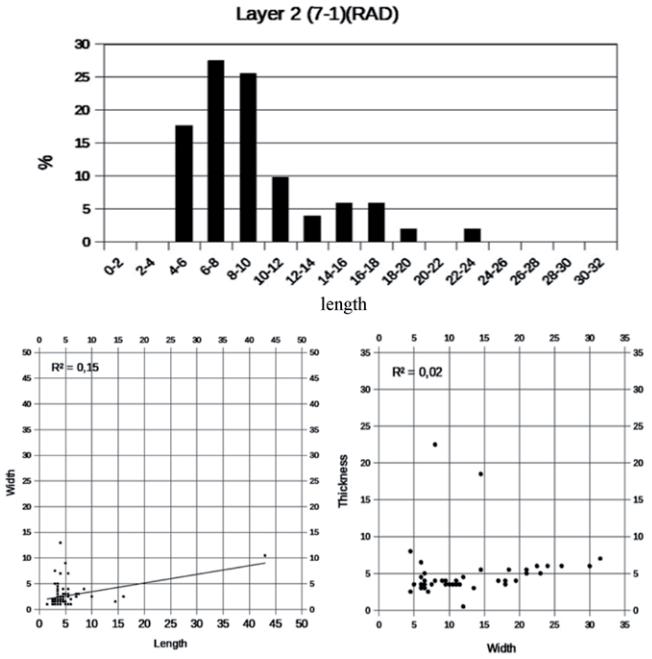

Fig. 13 - Armatures correlation graphs and histograms related to length and width (mm), levels 7 – 1. / Grafici relativi alla tipometria delle armature, tagli 7 – 1.

Retouched tools

Typometry of the retouched artifacts

The typometrical analysis of retouched tools was conducted in order to try and clarify the particular choices for the final artifacts. A strong trend in microlithics is constant across the retouched tools, specifically 50% microlithic and 30% iper-microlithic blades. In general we have 30%–35% blades and 60%–70% flakes, and a consistent number of carenated tools. The common tools have a very low metric standardization, clearly related to the generic morphological variability, and in relation to a uniform choice of tools relative to each phase of the reduction sequence. The values for length are between 4 and 41 mm in levels 15–8, and 3 and 77.5 mm in levels 7–1, with an average of 18.2 and 21.2 mm, respectively. If we only consider the typological group of end-scrapers, the maximum dimension is between 3 and 29 and 8 and 41 mm, respectively, with a corresponding average value of 14.6 and 18.8 mm. In both parts of the layer, regarding the relationship between width and thickness, the trend is similar, with a medium carenage index of about 2.5 mm and a maximum length that rarely exceeded 10 mm, even though the measurements seem to underline a major standardization of shapes concerning the transverse profile, with a correlation coefficient of 0.54 for levels 15–8 compared with a very low 0.17 for the upper levels. Regarding the relationship between length and width, the assemblages are more differentiated. The longitudinal profiles are much more defined, with a value of R2 greater than 5, and from level 15 to 1 there is a clear, specific morphological trend towards making straighter end-scrapers. The tools in levels 15–8 are shorter, with a length/width ratio usually about 1, and a rounded or sub-rounded morphology (G5 sensu Laplace). In the second group, the longitudinal profiles are straighter, and two distinct groups are present (fig. 11): one with a length/width index of about 1 (there are Romanellian types present) and the other one with a length/width ≥1,5 relative to end-scrapers made on blades (Fig. 12–13).

For armatures the selection of unretouched blanks is only concerned with the micro-bladelet sets, apart from three tools. The measure-

Tab. 4 - Typological groups (sensu Laplace) from Layer 2. / Gruppi tipologici (sensu Laplace), strato 2.

TYPOLOGICAL GROUPS	Layer2			
	15-8		7-1	
	n	%	n	%
(B) Burins	21	3.4	13	3.0
(G) End-scrapers	44	7.1	34	8.0
(T) Truncated tools	51	8.3	29	6.8
(Bc) Becs	4	0.6	1	0.2
(PD) Backed points	45	7.3	47	11.0
(LD) Backed blades	33	5.3	43	10.1
(DT) Backed blades and truncation	29	4.7	16	3.8
(Gm) Geometrics	40	6.5	30	7.0
(PD/LD/DT) fragments	103	16.3	51	11.9
(P) Points	10	1.6	6	1.4
(L) Blades	39	6.3	28	6.6
(R) Scrapers	106	17	57	13.3
(P/L/R) fragments	22	3.5	24	5.6
(A) Abrupts	10	1.6	12	9.8
(D) Denticulated	20	3.2	26	6.1
(E) Ecailles	43	6.9	28	6.6
Tot.	620	-	427	-

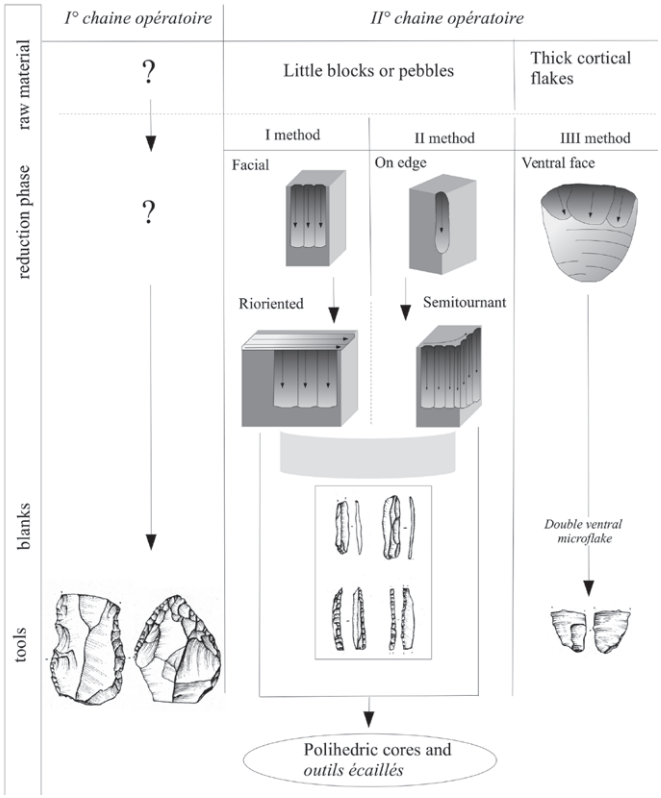

Fig. 14 - Reduction sequences of layer 2. / Schema riassuntivo della catena operativa relativo alla strato 2.

ments range between 4.5 and 31.5 mm for levels 15–8, and 4.5 and 24 mm for levels 7–1, with an average of 13 and 10 mm, respectively. Even though the typometrical gap between the two assemblages is significant, 200 elements from the lower sequence and 88 from the higher sequence, we presume the morphometrical differences between the sequences of Layer 2 are true. In levels 15–8 the values create a plurimodal curve with three peaks (at 6–8 mm, 10–12 mm and 22–24 mm). For levels 7–1, the graph is simpler, with a bimodal curve and a first peak at 10 mm and a second peak at 17–18 mm. The longitudinal profile of the tools also change throughout Layer 2. In levels 15–8 the correlation between length and width showed a fairly linear distribution and a very low index of correlation (0.01). In levels 7–1 the dimensions of the tools cluster around 5 mm in length and 2–3 mm in width. The values of this index tends to decrease constantly with levels 7-1, and the tools are less straight and wider. Another differential gradient between the two assemblages are indicated by the transverse morphology of tools (the width/thickness correlation). In levels 15–8 careening is quite high, around 1, in contrast to the morphology of tools in levels 7–1, which are much smaller, with a sparse and unclustered distribution of values shown in correlation graphs. We are not able to identify any clear standardization in general for armatures from a morphometrical point of view.

Typology

The typology is based on Laplace (1964) (Tab. 4), but also taking into account Broglio and Kozlowky (1983). The frequency of tools based on the essential element structure (sensu Laplace) are similar in both subsets. The general composition of the assemblage indicated a prevalence of backed pieces (RAD) and of the substratum (SUB). The burins and end-scrapers had a very low frequency. The general distribution of the primary type is similar in both subsets; only the absolute values showed variation. The burins are always less frequent than the end-scrapers, but we still noticed some differences in typological composition. In the lower part of the layer, in the burin group, the retouched types are always less frequent than the simple types, but the index is inverted in the upper part. It is important to emphasize that within the typological group of end-scrapers the short shapes are much more numerous (length/width ≤1,5) and the rounded scrapers increased in levels 7–1 (IR 9.1–17.6). The steeped retouched tools (RAD), like the truncated pieces, backed blades and points and geometric tools, are the best represented, and this class is characterized by a high frequency of truncation, principally orthogonal (IR 16.7–13.14). The backed points, most numerous in the upper part of Layer 2 (10.6%), are generally exclusively made by a total retouch (PD4); those with a bilateral total retouch (sauveterre) are present equally in both parts of the layer. The backed points are always microlithics, with the exception of one piece that came from the upper part of the layer (50 mm in length). The frequencies of the backed blades are similar to those of the backed points, but we have to emphasize the evidence of a general reduction in the absolute values of these kinds of tools in the more recent levels of the layer. The same tendency is also present with the backed and truncated pieces (DT). In this group, the orthogonal shapes are the most common, as for the truncated pieces. The geometric tools (Gm) has a very important role in the cultural attribution of Layer 2. They showed an increase in frequency in levels 7–1 (IR Gm 12.2–13.8). The triangle is the most common geometric tool, followed by segments (Gm1), which are more common in levels 15–8. Within the triangles we recorded a predominance of the scalene type (Gm3/Gm4 1.5–1.3) in both sets. Also within this type shorter shapes are clearly much more frequent than longer shapes; the rare long-type triangle is only found within the scalene type. The substratum has frequencies too much elevated (40.3%). From a quantitative point of view, the best represented tools are the short scrapers (17.0%–12.0%) followed by the écailles tools and the longer scrapers (blades); points are very rare. We did not notice any particular variation concerning the frequencies of tools classified in the substratum.

Reduction sequences

The reconstruction of the chaine operatoires and the identification of the objectives of the debitage, and the process of selection, retouching and use of the lithic assemblage, was possible because of the integration of technological, morphological and typometrical analyses of retouched and unretouched artifacts. The results identities two principal reduction sequences and three further processes that are usually interrelated (Fig. 13). In general the type of lithic artifact production present at Grotta delle Mura fits perfectly with what has been defined as the pragmatic style of debitage, namely a lithic assemblage characterized by a low degree of standardization of unretouched blanks (lamellar or not) accompanied by intensive retouch activity and microburin technique (Fontana & Guerreschi 2009; Flor et al. 2011). Two chaines operatoires are present, albeit not represented in detail in every step. The first reduction sequence is only evidenced at the site by the presence of finished retouched tools; it is based on the production of lamellar blanks with a length of more than 60 mm and relatively thick. The element seems to be present at the site as finished tools, and then abandoned. From a typological point of view they are elements of the substratum, such as points, blade and scrapers (sensu Laplace). The second reduction sequence is represented at every step and show three types of production process. The first two processes start with small blocks/slab of good-quality flint, more common in levels 7–1 as pebbles. The objective was to obtain small lamellar, micro-lamellar and iper-micro-lamellar blanks. The first process involved an initial, rather simple, exploitation of the core volume, with a sequence of three or four detachments, starting with bladelets with a natural dihedral profile, without any particular preparation of the core surface (crested blade). The debitage continues with a re-orientation of the core surfaces useful for the knapping activity. The second process shows a more intensive initial exploitation of the core volume,

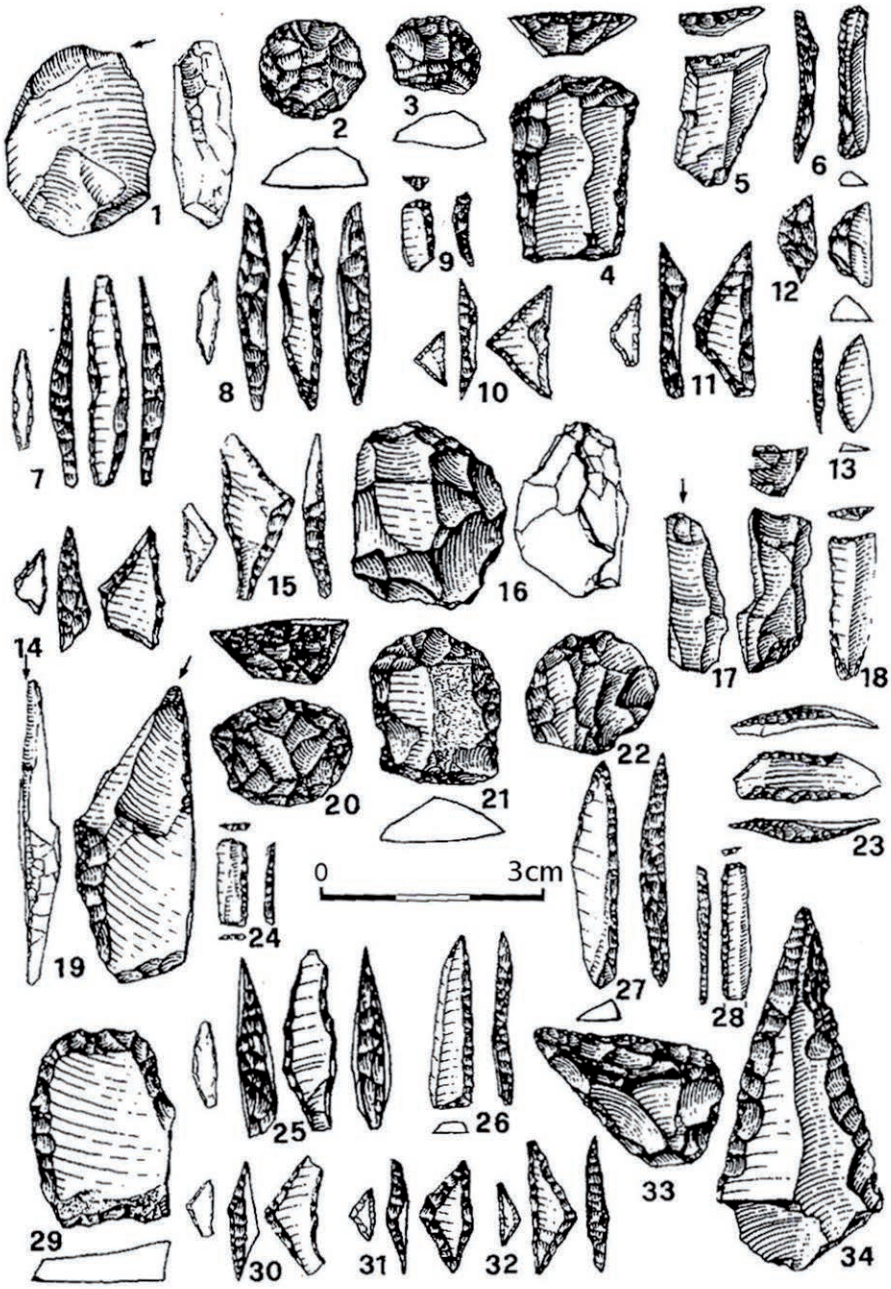

Fig. 15 *- Retouched tools of layer 2. Burins (1,17,19), end-scrapers (2-4, 20-22), truncated pieces (5,18), backed tools (DT, PD and LD)(6-9, 24-28), geometrics (10-15, 30-32), point (34), scrapers (19, 23, 33), core (16) (Drawings by G. Fabbri). / Strumenti, strato 2 di Grotta delle Mura. Bulini (1, 17, 19), grattatoi (2 – 4, 20 – 22), Troncature (5, 18), punte a dorso, lame a dorso, dorsi e troncatura (6 – 9, 24 – 28), geometrici (10 – 15, 30 – 32), punta (34), raschiatoi (19, 23 e 33), nucleo (16) (Disegni di G. Fabbri).*

starting with a facial sequence, and later, sometimes, following a sequence of lamellar detachment using a semi-tournant method. The volumetric exploitation tends to reach a limit with both methods, and the continuous re-orientation of the knapping surfaces tends to transform the morphology of the core by the end of the reduction sequence to a polyhedral shape or to an ecailles–cores . The end of the reduction sequence results in the production of microlithic blanks, rarely with a lamellar morphology. The third process, in contrast, is dedicated to the exploitation of flakes, usually cortical flakes and always thick, useful for the production of very thin, small flakes (maximum dimension usually around 15–20 mm), from the ventral face of the flake core. The sequence of debitage can be centripetal or bipolar, usually very short (three flakes), not very intensive, without any clear preparation of core morphology, just a rapid rectification of the debitage plane contraposed to the platform or lateral to it.

Conclusion

The Italian context indicates a Mesolithic regionalisation, both in the Sauveterrian period and in the Castelnovian. Lithic industries from the South-central part of the Italian peninsula can be strongly differentiated from the typical Sauveterrian Alpine. The Central Italy (Isola Santa, Levane-Bandella) (Kozlowski et. al. 2003; Magi 2008) is characterized by a very low presence of backed knives, no tectiform end-scrapers, some present the shape of scalene triangles with

Tab. 5 - Typological comparison between Grotta delle Mura and Marisa (sensu Broglio & Kozlowski). / Comparazione degli indici tipologici (sensu Broglio & Kozlowski) tra Grotta delle Mura e Grotta Marisa.

COMMON TOOLS	GR. DELLE MURA			MARISA
	15-8	7-1	TOT.	
(A) End-scrapers	13.8 %	17.3 %	15.2 %	31.9 %
(B) Retouched flakes	33.3 %	29.1 %	31.7 %	31.3 %
(C) Burins	6.6 %	6.6 %	6.0 %	2.1 %
(D) Truncated tools	16.0 %	14.8 %	15.6 %	2.7 %
(E) Retouched blades	12.3 %	14.3 %	13.0 %	15.8 %
(F) Becs	1.3 %	0.5 %	1.0 %	1.9 %
(G) Backed knives	-	-	-	-
(H) Points	3.1 %	3.1 %	3.1 %	1.2 %
(J) Ecailles	13.5 %	14.3 %	13.8 %	13.1 %
(O) Backed points	30.3 %	49.7 %	54.8 %	32.7 %
(P) Segments	1.5 %	5.4 %	3.5 %	2.0 %
(Q) Backed truncated	11.8 %	19.7 %	15.9 %	4.0 %
(R) Triangles	20.6 %	21.8 %	21.2 %	41.6 %
(S) P. Sauveterre	5.9 %	3.4 %	4.6 %	17.3 %
(T) Trapezoids	-	-	-	-
Common tools	318	196	514	250
Armatures	136	147	283	202
Tot.	454	343	767	452

short base and Montclus type. In southern Italy, there are different realities simultaneously, such as a local Mesolithic sauveterrianized (Grotta Marisa, Grotta delle Mura), the Epi-romanellian (Grotta del Cavallo) and the Mesolitico indifferenziato of Grotta della Serratura (Martini 1993: Martini 1996).

This study was carried out to confirm the correlation of Layer 2 of Grotta delle Mura with the sauveterrianized mesolithic of south Italy. From a typological point of view (Tab. 5) the lithic assemblage does not seem to show any significant variation in structure in the lower and upper parts of the layer, with the exclusion of the index for retouched burins/simple burins and the increase in rounded and short types of end-scrapers in levels 7–1. It is important to take into account the typical Sauveterrian technology that characterizes this lithic industry (discoidal cores, pragmatic reduction sequence, microlithics, etc.). A focus for retouched tools has a strong legacy within the Epigravettian culture (final Epigravettian) and is also demonstrated here (Romanellian end-scrapers, backed and truncated pieces, etc.). This kind of relationship is also documented by the mobiliary art objects present at the site, which show a strong relationship with the Epi-Romanellian context. The permanence of the Epigravettian cultural tradition has been highlighted in one study (Calattini 1996b) and was recently reconsidered by another (Kozlowski 2009). These aspects make Layer 2 a peculiar cultural reality of the Mesolithic.

The only site where it is possible to make an in-depth comparison with Grotta delle Mura (because of its geographical proximity) is Grotta Marisa, in south Apulia (Lecce) (Astuti et al. 2005). There are many cultural and paleo-environmental points of contact. The most important are the mobiliary art decorative patterns and an almost perfect correlation of the typological analyses of the lithic assemblages. However, it is also at this level that some important divergences occur, and they give us cause to consider the hypothesis of two different chronological contexts. Within the common tools (Broglio & Kozlowski 1983) at Grotta delle Mura there is a lower frequency of end-scrapers and burins, and within the armatures there is a higher quantity of backed points and backed-truncated pieces (Tab. 5). Despite the lack of radiometric data at Grotta Marisa, and assuming the Sauveterrian presents a progressive acquisition model, the much higher presence of Epigravettian elements at Mura cave could be considered from a chronological point of view to indicate a more ancient Mesolithic occurrence.

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Article

The Mesolithic occupation at Grotta della Cala (Marina di Camerota - Salerno - Italy). A preliminary assessment

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Key words

- Mesolithic
- Sauveterrian
- Southern Italy
- palaeoenvironment

Parole chiave

- Mesolitico
- Sauveterriano
- Italia meridionale
- paleoambiente

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Summary

The Holocene human occupation of Grotta della Cala is attested only within the sonamed "internal series" (and not in the "Atrio series") and starts with Mesolithic layer 7, dating back to the time span between 7579 and 6687 (cal BC). This layer, which was excavated by Paolo Gambassini in 2004, is possibly the same as layer F investigated by Palma di Cesnola in the sixties, and is directly superimposed onto stalagmite α sealing the Pleistocene stratigraphical sequence. Layer 7 produced a lot of large and middle sized mammal remains. It also yielded a lot of malacofauna, both of terrestrial and, above all, marine types, as well as a number of chipped stone artefacts, a painted pebble, and a grindstone used for ochre processing. Outcomes from archaeozoological, malacological and anthracological studies have provided a detailed framework of the surrounding landscape and of the subsistence strategies adopted by the Mesolithic groups at Grotta della Cala during the Boreal.

Riassunto

L'occupazione olocenica della Grotta della Cala è stata individuata solamente nella cosiddetta "serie interna" (e non nella "serie atriale") ed inizia con lo strato Mesolitico 7 datato tra 7579 e 6687 (cal BC). Questo strato, scavato da Paolo Gambassini nel 2004, è molto probabilmente in rapporto di uguaglianza con lo strato F indagato da Palma di Cesnola negli anni sessanta dello scorso secolo ed è direttamente sovrapposto ad una stalagmite che sigilla la sequenza stratigrafica pleistocenica. Lo strato 7 ha fornito numerosi resti di macro e meso mammiferi. Ha restituito abbondante malacofauna, sia di specie terrestri che marine, così come industria litica, un ciottolo dipinto e una macina usata per la lavorazione dell'ocra. I risultati degli studi archeozoologici, malacologici e antracologici hanno fornito un quadro dettagliato del paesaggio circostante e delle strategie di sussistenza adottate dai gruppi mesolitici che hanno occupato la Grotta della Cala in una fase del periodo Boreale.

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Introduction

The cave

Grotta della Cala opens east of the village of Marina di Camerota, very close to the present coastline, at the foot of a wide hilly-mountainous complex characterized by short tablelands 250-500 m a.s.l. and furrowed by a main valley (Vallone dell'Isca) (Fig. 1). Amongst the numerous prehistoric sites located along the Cilento coast, this cave contains one of the widest and most detailed anthropic deposits. In fact it was inhabited almost continuously from the final Middle Palaeolithic to the Copper Age.

The cave (Fig. 2) has two main rooms with the first being the largest one. About halfway the cavity forms a bottleneck, a sort of natural door, beyond which the second room (squares D-M 20-33) opens (except for a small test trench no excavations were carried out in this second room) . To make things easier the investigated area was divided into the so-called "atrio series" (squares B-Q 3-11), "Palma di Cesnola's trench" (squares D-H 12-16) and "internal series" (squares D-L 16-20), corrisponding to different excavation seasons.

The stratigraphical sequence starts with a marine strongly cemented conglomerate possibly attributable to MIS 5. A roughly 3 m thick continental series abounding in anthropic remains overlies the eroded top of this conglomerate. The earliest evidence of human occupation, situated in the lower part of the continental deposit, is represented by a set of intercalating stalagmite and gravel layers belonging to the Mousterian. The Middle Palaeolithic horizon is sealed by a thick concretion (β) which constitutes the base of the Upper Palaeolithic sequence (Fig. 3). In the atrio series (that is not included in Fig. 3) β is covered by the Uluzzian and the Aurignacian layers (Benini *et al.* 1997), followed by a number of layers of the Early Gravettian (Boscato *et al.* 1997), of the Gravettian with Noailles-type Burins (Palma di Cesnola 1993) and of the Evolved and Final Epigravettian (there is no evidence for the Early Epigravettian). Another stalagmitic episode (α), separating the Pleisotocene deposit from the Holocene one, is superimposed onto the final Epigravettian. The Holocene occupation is limited to the internal area and includes Mesolithic (str. 7), Neolithic (str. 5) and Eneolithic (strs. 4-3) layers (Gambassini 2003).

Early investigations at Grotta della Cala were undertaken in 1966-71 by Arturo Palma di Cesnola of the University of Siena in the inner part of the cavity where a trench of around 12 square meters was dug reaching the bottom of the anthropic deposit (Palma di Cesnola 1969, 1971). The excavations of the atrio series was initiated in 1974 by P. Gambassini e A. Ronchitelli, of the same University, in collaboration with the Office for the Archaeological Heritage of Salerno, Avellino, Benevento and Caserta. Research went on until 2004 and, from 1994, also involved the internal series, with the holocenic layers, right next to Palma di Cesnola's trench. Investigations at the site have been resumed in 2014.

Fig. 1 *- Grotta della Cala - Location of the cave east of the village of Marina di Camerota. / Localizzazione della grotta ad est dell'abitato di Marina di Camerota.*

Layer 7

Within the internal series Mesolithic layer 7 occupies the same stratigraphical position as layer F in Palma di Cesnola's trench (squares D-H 11-16). It directly lies on stalagmitic layer α and is separated in patches from the overlying deposit by another, much thinner and more discontinuous, stalagmitic layer which corresponds to layer α' covering layer F in Palma di Cesnola's trench (Bartolomei *et al.* 1975).

Layer 7 is on average 15 cm thick and is formed by calcareous clasts with sharp edges mixed with iron-grey fine sand. In squares E16-E17 a very thin (maximum thickness 3 cm) silty lens less than one square m wide, called str.6, was identified between layers 5 (Neolithic) and 7. This lens yielded few lithic artefacts including a Sauveterre point and a trapezoidal microlith (Gambassini 2003).

During the fieldwork carried out from 1994 to 2004 a surface of 12 m^2 (squares C-F 15-20) was investigated from the edge of Palma di Cesnola's trench towards the inner part of the cave up to the point where layer 7 finishes against the rising of stalagmite α. Right close to the north - western margin of Palma di Cesnola's trench, there is the bottleneck leading into the second room (see above). This

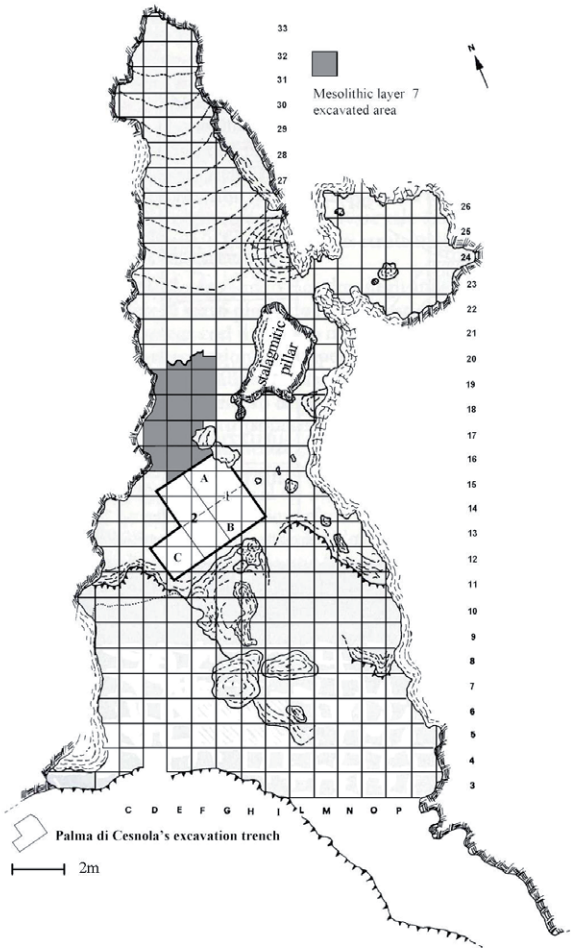

Fig. 2 *- Grotta della Cala - Plan of the cave (drawing by Andrea Benini and Paolo Boscato). In grey the 1994-2004 excavation area. / Planimetria della grotta (disegno di Andrea Benini e Paolo Boscato). In grigio l'area di scavo 1994-2004.*

passage is divided into two separate entrances of different width due to a stalagmitic pillar in between (Fig. 2). This created a sort of obligatory way-in where each layer was clearly marked by its own trampling surface. In this area (D-F 16-20) (Fig. 4) layer 7 was more or less uniformly characterized by large amounts of charcoal and burned stones. A sub-circular fireplace, 50 cm in diameter, was discovered near the wall, in square D17. Next to the fireplace (astride squares E16 and E17) there was a large stone, wedged, with a lot of smaller stones, along its whole perimeter, which was interpreted as a possible seat. A number of objects were retrieved not far from these structures: from E17 an elongated sandstone pebble whose use-wear trace pattern (a couple of roundish depressions on both faces) is very similar to that occurring on the ethnographic anvils/hammers called *quebra-cocô* and used for cracking nuts, acorns and suchlike (de Beaune 1989) (Fig. 5: 1); from D18, a limestone grindstone, showing a slightly concave face wholly covered with red ochre, and a painted pebble (Fig. 6) located right next to it (Gambassini 2003); from the same square a valve of *Ostrea edulis* (Fig. 8: 6) decorated with incised lines on its interior face.

Two 14C dates were obtained for layer 7, from charcoal samples, at the Beta Analytic Laboratory of Miami: Beta 74162 8370±80 BP and Beta 123856 8060±100 BP. These dates were calibrated using OxCal 4.2 (Bronk Ramsey & Lee 2013) and IntCal13 (Reimer *et al*. 2013), and result in an age range of 7579 to 7189 and 7314 to 6687 cal BC at 95,4% of probability. These results did not confirm the previous date of 10390 ± 180 BP obtained on charcoal from layer F at the 14C laboratory of Florence (F109) (Palma di Cesnola 1993). Since we consider this latter date quite unreliable as it was performed several years ago, this inconsistency will be disentangled only by performing a new set of dates of layer F and revisiting its whole material.

The lithic assemblage

In layer 7 a few hundreds of pieces were collected including about eighty retouched artefacts, numerous cores and a wealthy set of "macro-artefacts", namely the grindstone and the anvil described above, some percussors and several knapped stones and pebbles (Fig. 5: 2).

As their study is still in progress, only preliminary outcomes concerning the techno-typological analysis of cores and retouched tools are illustrated.

The most common raw materials are flint and radiolarite collected as small sized pebbles and water-rolled slabs in the Pleistocene alluvial and marine formations which can be found on the coast near Marina di Camerota. Rock quality is variable and several pieces exhibit cracks and/or impurities which make them difficult to be wrought. However, this characteristic favoured the natural edges and striking platforms necessary, thus reducing the core preparation time (Wierer 2008).

Production was based on two main operational sequences, which were performed independently from each other. The first one, whose cores are absent, produced blanks of larger dimensions (both flakes and blades) mostly devoted to the manufacturing of "common tools". The second system starts from raw blocks of smaller dimensions and is addressed towards the accomplishment of micro and hyper-micro bladelets and micro and hyper-micro flakes. Cores belonging to this second process are well documented. These are very small in size. Their maximum length rarely exceeds 30 mm. Striking platforms are mostly plain, obtained through the removal of a single thick cortical flake at one of the ends of the pebbles. Otherwise, when slabs or small blocks, stemming from the fracturing of larger blocks along cracks, are involved, they can be natural. The shaping out of the core is generally quite approximate. The opening of the knapping surface was predominantly due to the use of natural edges or convexities. However this procedure was rarely carried out also pre-forming the core with a unilaterally prepared crest. Production was almost exclusively unidirectional. Attempts of core re-orientation with the opening of opposite or orthogonal striking platforms, can be sporadically observed only during the final exploitation phase, after which cores were abandoned. Discarding was generally connected to the occurrence of hinged removals. Most of the original raw material blocks consisted of sub-circular or elongated pebbles. From these, two different blank types could be obtained, by definite choice. The first one, short and wide, was exploited to detach

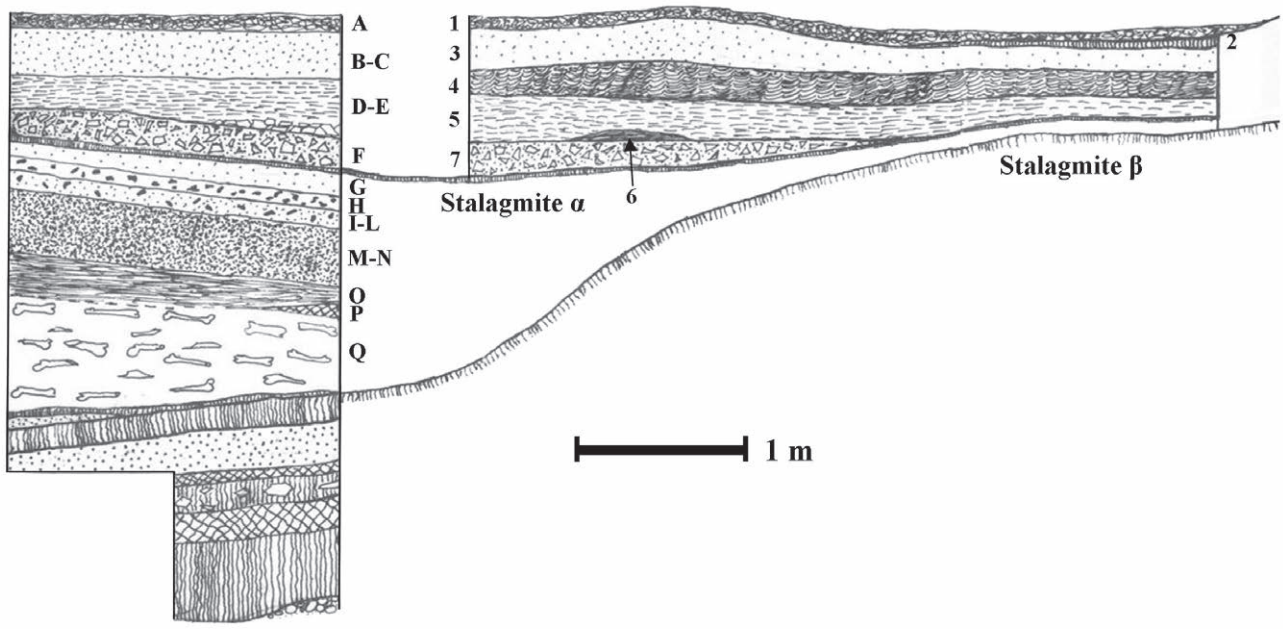

Fig. 3 - Grotta della Cala - Stratigraphic sequence of Palma di Cesnola's trench (excavation fieldwork 1966-71) (on the left) and of the internal series (excavation fieldwork 1994-2004) (on the right) (drawing by Paolo Gambassini). / Sequenza stratigrafica della trincea Palma di Cesnola (scavi 1966-71) (a sinistra) e della serie interna (scavi 1994-2004) (a destra) (disegno di Paolo Gambassini).

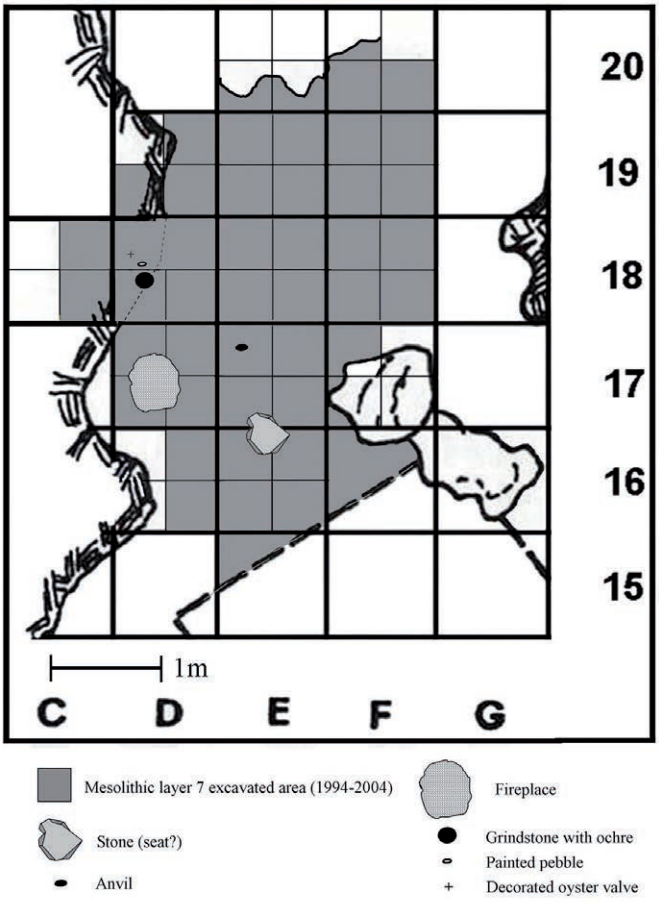

Fig. 4 *- Grotta della Cala - Spatial distribution of structures and some objects of layer 7, squares D-E 16-18. / Distribuzione spaziale delle strutture e di alcuni oggetti dello strato 7, quadrati D-E 16-18.*

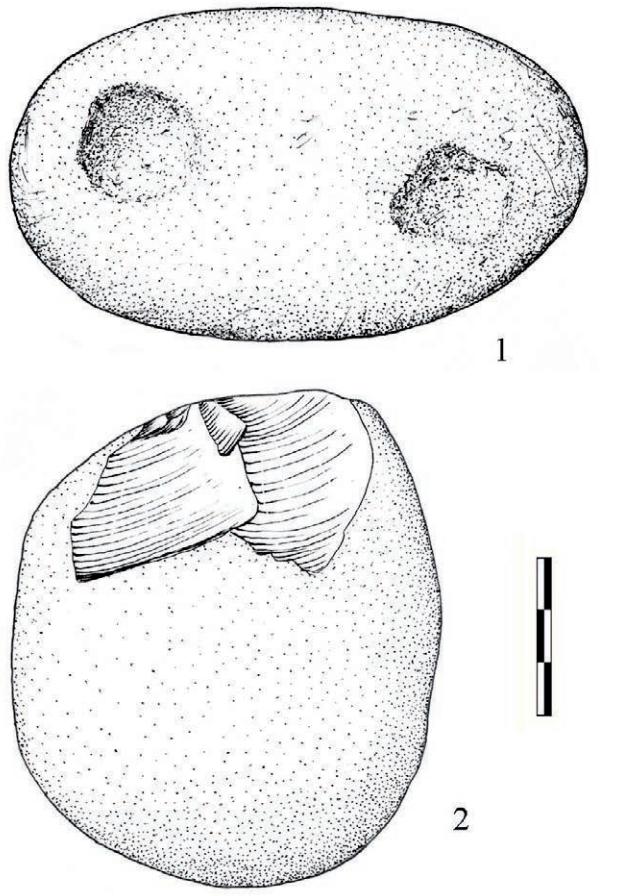

Fig. 5 *- Grotta della Cala - n. 1 anvil/hammer; n. 2 knapped pebble (drawings by Adriana Moroni). / n.1 incudine/martello; n. 2 ciottolo scheggiato (disegni di Adriana Moroni).*

laminar small flakes and/or bladelets within 20 mm in length (Fig. 7: 1, 4); the second one, more slender, was exclusively intended for the production of longer bladelets (Fig. 7: 2). In the former case blanks were obtained both by "uncapping" or halving sub-circular pebbles (striking platform represented by a scar or a ventral face) and "recycling" portions (the shortest ones) discarded while building striking platform of elongated pebbles (striking platform represented by a ventral face). Given the lack of core tablets, the possible stemming of the first type from the progressive shortening of larger cores is very unlikely. Exploitation was initially facial and turned later into *semitournan*t thanks to the creation of a lateral edge through the removal of a flake on the side of the core. Usually cores were abandoned at this stage of the process, even though core reduction could go on until a pyramidal *tournant* morphology was achieved. A less widespread strategy, aimed at the production of micro and hyper-micro bladelets as well, employed small blocks stemming from the breaking of slabs or pebbles. Starting from natural striking platforms, pre-existing or intentionally built edges were used for the production of a limited series of bladelets. A third system, only sporadically attested, involved the use of thick flakes as cores which could be exploited both on their dorsal and ventral face, often by means of bi-polar knapping, for the production of very short series of blanks (sometimes a single item).

"Common tools" (i.e. non backed implements - Broglio & Kozlowski 1983) were often achieved from by-products like cortical flakes and blades, crests, blanks bearing hinged removals on their dorsal face and thick blanks resulting from the correction of the laminar surface. However several blades and bladelets of "*plein débit-*

Fig. 6 *- Grotta della Cala - Different views of the painted pebble found in layer 7 (photo by Stefano Ricci). / Differenti vedute del ciottolo dipinto trovato nello strato 7 (foto di Stefano Ricci).*

age" were also chosen for the manufacturing of side-scrapers and end-scrapers. These systematically display fractures at one or both ends. As noted above, dimensions of many of the so-called common tools are incompatible with the size of cores found in layer 7.

Side-scrapers and denticulates (mainly scrapers but also notches) are the predominant groups, followed by end-scrapers and splintered pieces. End-scrapers are represented by both short and long types (Fig. 7: 3, 6). These latter are always on quite thick blades

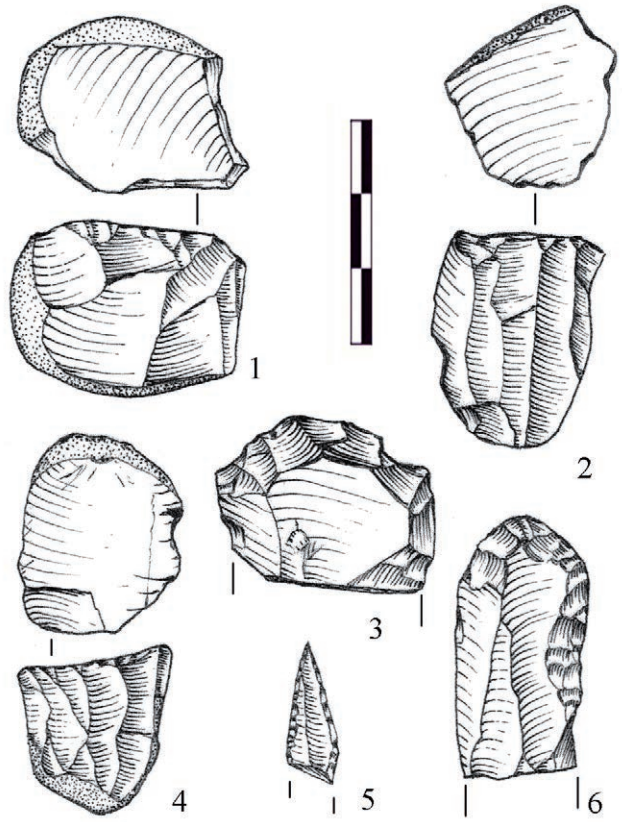

Fig. 7 *- Grotta della Cala - ns. 1, 2, 4 cores; ns. 3, 6 end-scrapers; n. 5 Sauveterre point (drawings by Adriana Moroni)./ Nn. 1, 2, 4 nuclei; nn. 3, 6 grattatoi; n. 5 punta di Sauveterre (disegni di Adriana Moroni).*

broken (intentionally?) at their proximal extremity and tend to be ogival in shape (akin to types 18 and 19 in Broglio & Kozlowski 1983). Short types feature notches which occur on one or both sides of the front and form a sort of wide nose (akin to types 61 and 63 in Broglio & Kozlowski 1983). Truncated pieces (n. 2) and beaks (n. 1) are minimally represented and burins are absent. Several artefacts show modifications formed by marginal retouches, which may be interpreted as macro-wear, and a couple of tools (an end-scraper and a splintered piece) bear tiny traces of a dark residue (glue?).

In addition to the *Sauveterre* point and the trapezoidal microlith from layer 6, microlithic implements are composed of few backed blades and backed pieces with truncation, one bilateral backed point (*Sauveterre* point) (Fig. 7: 5) and some unidentifiable fragments. Neither microburins or *piquant-triedre*-like fractures were retrieved.

Exploitation of faunal resources

Within the economic strategies implemented by the Mesolithic groups of Grotta della Cala, macro and meso mammals, birds, fishes and molluscs played a role of different weight. Remains of medium and large sized mammals are, most probably, to be wholly connected to the anthropic exploitation, whilst fishes and birds (the study of which is still in progress) might have partially been the prey of strigiforms and other raptors, which occasionally frequented the cave. The wide microteriofauna sample from layer 7 (still to be quantified and analyzed) may constitute, in fact, a sign for the presence of boli of strigiforms. Taphonomic examination of fish and macromammal remains, although useful for detecting traces due to man and animal predation, is unlikely going to provide quantitative data about the anthropic exploitation of these two groups.

In this framework medium and large mammals provided the most sizeable biomass exploited as food by Mesolithic populations of Grotta della Cala. The red deer is the dominant species followed by the wild boar and the roe deer.

Macro and meso mammals

The examined sample, recovered using 1mm sieves, is composed of 491 identified remains, among which 400 belong to ungulates (Tab.1). The majority of these remains is well preserved, as bone surfaces are not affected by specific alterations. Exfoliations are minimally present and only few materials (from squares E18 III and F19 II) are covered by concretions. High fragmentation of bones, partially due to consumption of marrow, involved also small sized elements. Out of the 33 recovered phalanxes of red deer and roe deer (recessive phalanxes excluded), only 3 are still intact. Traces of lithic tools have been detected on several skeletal elements and, on first observation, no marks of carnivore gnawing have been recognized. Consequently we may assume that the analyzed bone sample was exclusively connected to anthropic activities.

Cranial parts, mainly isolated teeth, are the most numerous anatomical elements. These parts reach 45,5% of the identified material among ungulates and 29,7% among lagomorphs and carnivores (Tab. 2). Limb bones are 47% of the identified elements within ungulates and 61,5% among lagomorphs and carnivores. Vertebrae and ribs as well as scapular and pelvis belt bones are scarcely present. As far as larger size prey are concerned, this distribution of skeletal elements may indicate that limbs and skulls were selected to be brought into the cave. Conversely skeletal parts not involved in the consumption of marrow/brain were probably abandoned at the killing sites. However two factors, which may lead to largely underestimating the quantity of identifiable elements, must be taken into account: 1) difficulties in identifying skeletal parts like ribs and vertebrae to species level 2) their bad condition of preservation. The lack of parts of the axial skeleton belonging to small species, namely hare, fox, wild cat and mustelids is most probably due to these reasons as it seems realistic that carcases of these animals were brought entire into the cave. A study of the unidentifiable material and taphonomic analyses carried out on the whole sample will provide new data and clarification.

Ungulates encompass three well documented species (wild boar, red deer and roe deer) and three species only sporadically attested (chamois, ibex and auroch). The quantitative gap between these two groups is as clear-cut as is the difference between their ecological habitats. The first ones are typical of woody environments; the ideal habitat of the auroch is the forest steppe; the ibex and the chamois are rocky environment species.

The wild boar (*Sus scrofa*) (147 identified elements) is the second species in numerical presence. Analysis of dental elements allowed us to calculate a minimum number of 8 individuals, including four juveniles, three adults and one senile. Nearly one third of the elements (deciduous teeth and cranial and post-cranial bones showing unfused parts) (32% - NISP = 47) belong to immature specimens. In particular one 4-5 month old individual, two 8 to 10 months and one 12 to 14 months have been recorded (Bull 1982; Bridault *et al.* 2000; Rowley-Conwy 2001). Unfortunately there are few data in this regard. Moreover, although they can provide some information about the killing seasons (spring, summer end and autumn) (Heptner *et al.* 1989, Apollonio 2003), different seasonal occupation phases of the cave cannot be ruled out. Butchering traces have been identified on a tibia and on a rib. Measures taken on some skeletal elements indicate that these Mesolithic wild boars were larger in size than the present Italian populations.

As said above, more frequent anatomical parts are isolated teeth and limb bones. However, in the case of the wild boar, seven vertebrae (two cervical and five thoracic) have been identified. Evidently, at least once in a while, Mesolithic hunters used to bring the whole carcases of this ungulate into the cave.

The red deer (*Cervus elaphus*) is the dominant species (identified specimens NISP = 176) and it provided the bulk of the meat supply. A minimum number of 7 individuals have been recognized (1 juvenile and 6 adults) (Mariezkurrena 1983) from dental remains and bones with unfused epiphises. Frequency of young and sub-adult individuals (9% - NISP = 16) is clearly lower if compared with the wild boar and there are no data on killing seasons. A fragment of shed antler due to a natural loss was probably found lying around and picked up as it cannot belong to a killed animal. The recovered parts encompass, although largely varied in quantity, all skeletal body parts. Among limb bones, phalanxes and sesamoids (NISP = 32) are very numerous. Phalanxes were systematically broken for marrow extraction. The identified vertebrae are 2 cervical and 1 thoracic. Mandible fragments (NISP = 8) and lower teeth are much more numerous than maxillary fragments (NISP = 1) and upper teeth. Except for incisors and canines, occurring exclusively on the mandibles, there are 31 lower jugal teeth while there are 15 upper ones.

The roe deer (*Capreolus capreolus*) is the third species in numerical presence (NISP = 70). The percentage of bones and teeth of juveniles (2 individuals) are similar to those recorded for the red deer (8,6% - NISP = 6). Skeletal parts of adults, particularly some teeth, indicate a minimum number of 3 individuals. A frontal bone with antler fragment is attributable to an adult male killed in the period between May and October (Perco 2003). A metatarsal dyaphisis displays clear cut-marks left by lithic implements. As is the case for the wild boar, the size of Mesolithic roe deer was larger than that of the present Italian specimens. The three other species of ungulates recovered in layer 7, the auroch (*Bos primigenius*), the ibex (*Capra ibex*) and the chamois (*Rupicapra* sp.), are represented by a very low number of bone fragments. The scarcity of these animals is also characteristic of the Gravettian and Epigravettian series of Grotta della Cala (Sala 1983), possibly due to the orographic conditions unsuitable to their diffusion. The occasional killing of these species occurred, perhaps, on the outskirts of the main hunting territory characterized by woods both in the hilly tablelands overlying the cavity and in the plain in front of it.

Medium sized prey (lagomorphs and carnivores) were regarded as a resource both for food and hide. An in depth taphonomic analysis will provide more information about this activity.

The hare (*Lepus europaeus/corsicanus*) is present with at least two individuals (18 remains), a juvenile and an adult. Neither cranial elements nor isolated teeth were found.

The fox (*Vulpes vulpes*) is the most representative carnivore (48 identified elements). A juvenile (three remains) and two adults (isolated teeth) have been recognized. Although fox remains are referable to the whole skeleton, its cranial parts are the most frequent. The distal articulation of a radium is pathological.

Only four remains belong to Mustelids (*Martes martes* and *Meles meles*).

A minimum number of three individuals, two adults and a sub-adult, are attributable to the wild cat (*Felis silvestris*) (19 remains). Also for this species cranial parts and isolated teeth are the most recorded elements. A single fragment (a proximal piece of radium) belonging to an adult lynx (*Lynx lynx*) was recovered.

Molluscs

Molluscan materials recovered in layer 7 include 2036 more or less complete shells and an indeterminate number of fragments belonging to 32-35 different species of molluscs (27-30 gastropods and 5 bivalves: Tab. 3).

The dominant species is the gastropod *Osilinus turbinatus*, represented by more than 800 shells, in most cases complete. The gastropod *Patella caerulea* (360 specimens) and the bivalve *Cerastoderma glaucum* (represented by more than 300 valves belonging to at least 157 specimens) follow in order of abundance. The other species are composed of a lower number of specimens, varying from one to 98 (Tab. 3).

Gastropods include around 20 marine and 9 land species while there are only five marine bivalve species. On the whole, almost all the marine gastropods found in this site belong to species associated with rocky bottoms and superficial water from supralittoral and mediolittoral to infralittoral zones (*Littorina neritoides*, *Patella* spp., *Osilinus* spp., *Gibbula* spp., *Phorcus* spp., *Stramonita haemastoma*, *Hexaplex trunculus*, *Columbella rustica*, *Bolma rugosa*). Regarding bivalves, *Ostrea edulis* comes from the same environment, while the other species (*Glycymeris violacescens*, *Acanthocardia tuberculata* and *Donax venustus*) are basically linked to sandy substrates of the infralittoral zone. Other species linked to soft bottoms are present at the site, but they are more typical of muddy substrates at greater depths (such as gastropod *Galeodea echinophora*) or shallow brackish water (such as gastropod *Cyclope neritea* and bivalve *Cerastoderma glaucum*, which are often found in lagoons or near estuaries). Finally, *Truncatella subcylindrica* is mainly linked to beached plant material and coarse foreshore gravel (D'Angelo & Gargiullo 1978; Margalef 1985).

Land gastropods include eight snails and a slug, some of which can be considered generalists (*Pomatias elegans*, *Oxychilus* cf. *draparnaudi*, *Limax* sp.) while others tend to be linked to specific habitats, such as forests (*Chilostoma planospira*), grasslands (*Rumina decollata*, *Cernuella* sp.), sites with scattered and discontinuous vegetation (*Siciliaria* sp. and *Helix* sp.) or rocky outcrops (*Marmorana* sp.) (Kerney *et al*. 1983; Welter-Schultes 2012).

Many of the marine molluscs were surely collected for food. Most of the species from rocky bottoms (*Patella* spp., *Osilinus* spp., *Stramonita haemastoma*, *Hexaplex trunculus*, *Ostrea edulis*) may have been abundant and easily accessible just below the tide line or even above it (Margalef 1985). Conversely, molluscs living in soft bottoms (*Glycymeris violacescens*, *Acanthocardia tuberculata*, *Cerastoderma glaucum* and *Galeodea echinophora*) could have been collected fresh or still alive on the foreshore after coastal storms.

It cannot be ruled out that some of these molluscs were collected from beaches for aesthetic reasons even in the absence of edible soft parts (no use-wear analysis has been performed yet). For instance, some fragments of bivalve shells show incisions (two valves of *Ostrea edulis*: Fig.8: 6), residues of red pigment (one valve of *Cerastoderma glaucum*: Fig.8: 4) or intentional piercings in the umbo attesting their use for necklaces and other ornaments (three valves of *Acanthocardia*

Tab. 1 *- Grotta della Cala - Vertebrate remains from layer 7. / I resti di vertebrati dello strato 7.*

	NISP	% NISP	MNI
Sus scrofa	147	29,9	8
Bos primigenius	2	0,4	2
Capra ibex	2	0,4	1
Rupicapra sp.	3	0,6	2
Cervus elaphus	176	35,8	7
Capreolus capreolus	70	14,2	5
Tot. Ungulates	**400**		
Lepus europaeus/corsicanus	18	3,6	2
Vulpes vulpes	49	10	5
Martes martes	3	0,6	1
Meles meles	1	0,2	1
Felis silvestris	19	3,9	3
Lynx lynx	1	0,2	1
Tot.	**491**		
Testudo sp	37		
Aves (NSP)	161		
Pisces (NSP)	79		

tuberculata and three of *Glycymeris violacescens* Fig.8: 5). Gastropods like *Columbella rustica* and *Cyclope neritea* (Fig. 8: 1,3) were certainly used for this purpose, as all the recovered specimens (35 and 10, respectively) show one or two man-made piercings. A shell of *Natica* sp. displays a circular hole and traces of a red colouring substance (ochre?) (Fig. 8: 2).

The occurrence in the cave of *Truncatella subcylindrica* and *Littorina neritoides* is more difficult to explain: they might have been introduced with other materials, since these gastropods are too small to suggest intentional collection and human exploitation for any purpose.

Finally, empty shells of terrestrial molluscs from surrounding environments may have been deposited in the cave by rainwater. The only exceptions could be *Oxychilus* cf. *draparnaudi* (a regular inhabitant of subterranean environments potentially living at the site; Kerney *et al.* 1983; Welter-Schultes 2012) and *Helix* sp., an edible snail (Negra & Lipparini 2003) that may have been collected intentionally for food.

The plant environment as shown by charcoal data

In order to reconstruct the natural environment also archaeobotanical investigations were carried out on charcoal from layer 7.

Charcoal (charred wood) surely represents a valuable source

Tab. 2 *- Grotta della Cala - Ungulates, carnivores and lagomorphs: skeletal elements from layer 7. / Elementi scheletrici di ungulati, carnivori e lagomorfi rinvenuti nello strato 7.*

	Sus scrofa	*Bos primigenius*	*Capra ibex*	*Rupicapra sp*	*Cervus elaphus*	*Capreolus capreolus*	*Lepus europaeus - cors.*	*Vulpes vulpes*	*Martes martes*	*Meles meles*	*Felis silvestris*	*Lynx lynx*
antler					5	1						
maxilla	3				1	1		1			1	
mandible	7				8						3	
cranium	14				5	1		2			1	
deciduous teeth	12			1	6	2						
upper permanent teeth	10		2		10	7		4			2	
lower permanent teeth	19			1	30	7		11			1	
teeth unident.	5	1			21	2		1				
vertebrae	7				3	2		4			3	
sternum					1							
ribs	3											
scapula	5					2	1	1				
humerus	5				1	3	2				1	
radius	2				4	1	3	4				1
ulna					2	1	1					
radius-ulna					1							
carpals	4			1	8			3	1			
metacarpals	2				5	6		3				
pelvis	3				1	3	3	3		1		
femur	3				3	1		2				
patella					1							
tibia	5				7	7	2				2	
fibula	1											
malleolar bone						1						
tarsals	5				9	4	4	4	1		1	
metatarsals	4				5	9	1				1	
metapodial	8	1			7	2						
phalanx I	7				12	3	1	3	1		2	
phalanx II	7				12	3		2			1	
phalanx III	6				4	1		1				
sesamoids					4							
Total	**147**	**2**	**2**	**3**	**176**	**70**	**18**	**49**	**3**	**1**	**19**	**1**

of information to improve knowledge both on forest species as well as on vegetation dynamics in relation both to climate changes and human impact. In particular, charcoal (*sensu* Chabal *et al.* 1999) resulting from long-term burning activities and processes, can be considered representative of local vegetation and well suitable for palaeoecological studies (Chabal *et al*. 1999; Heinz & Thiébault 1998; Figueiral & Mosbrugger 2000; Asouti & Austin 2005).

Sediment samples collected during the excavations were sieved *in situ* by water through a sieving column. All charcoal fragments from 1, 2 and 4 mm mesh size were sorted under a dissection microscope.

200 charcoal fragments were analysed using a reflected light microscope (100 - 1000X). Taxonomic determination was carried out on the basis of the reference collection of the Vegetation History and Wood Anatomy Laboratory of University Federico II of Naples and wood anatomy atlases (Greguss 1955, 1959; Schweingruber 1990). Charcoal data agree with the faunal reconstruction; indeed they attest the presence of a wooded landscape. Namely the charcoal assemblage (Fig. 9) testifies to the presence of a winter deciduous forest dominated by *Quercus pubescens* which is the best represented taxon, followed by other broadleaves mesophilous taxa such as *Acer*, *Ulmus*, *Carpinus* and/or *Ostrya carpinifolia*. This situation of maximum expansion of deciduous forest is recorded in most areas of the western Mediterranean by both pollen and charcoal data from the early to middle Holocene and is interpreted as evidence of a *climate optimum* phase, (e.g. Vernet 1974; Vernet & Thiébault 1987; Heinz & Barbaza 1998; Heinz & Thiébault 1998; de Beaulieu *et al*. 2005; Drescher-Schneider *et al*. 2007; Sadori *et al*. 2008). In the study area high level of precipitation during the early Holocene is confirmed by stable isotopes of land snail shells from the close Grotta della Serratura (Colonese *et al.* 2010). In particular the presence of *Laurus nobilis* and *Arbutus unedo* is notable and can be considered an evidence of laurophyllous vegetation, typical indicators of warm-humid climates (Quézel & Médail 2003).

Concluding remarks

The attribution to Early Mesolithic Sauveterrian groups of layer 7 anthropic occupation relies on the results of ^{14}C dating and on the general characteristics of the lithic assemblage.

Calibrated chronology (between 7579 and 6687 cal. BC) places layer 7 in the Boreal phase (Orombelli & Ravazzi 1996). During this period sea-level was 20-35 m lower than nowadays (Lambeck *et al.* 2011) and the coastline should be located a few hundred metres from the site. Therefore, a flat and not very extended land-belt was present in front of the cavity.

Outcomes from the different approaches discussed above have provided a detailed framework of the landscape surrounding Grotta della Cala during the early Holocene (Boreal) and have shown that Mesolithic groups were very well integrated with the environment as they were able to exploit as best they could all the available ecological niches.

Exploitation of faunal resources was based on a wide spectrum of vertebrates like ungulates, lagomorphs, carnivores, testudinata as well as upon fish, birds and molluscs. Ungulates were primarily represented by forest *taxa* namely red deer, wild boar and roe deer which constituted 80% of the killed meso and macro-mammals. Remains of *caprinae* and aurochs are rare. Skulls and limbs are the most represented skeletal parts. Small prey hunting was addressed especially towards fox, cat and hare. Fowling and fishing were practiced too, although to a less extent.

At Grotta della Cala the whole Early Gravettian to Final Epigravettian period features a constant and high presence of red deer which, among hunted ungulates, is between 59% and 90% (Sala 1983, Boscato *et al.* 1997). From layer H (Final Epigravettian 12.350±200 BP, 12.030±120 BP, 12.020±210 uncal BP) (Palma di Cesnola 1993) onwards (Mesolithic layer included) an important change in faunal association is recorded, given the higher numbers of wild boar and

Tab. 3 *- Grotta della Cala - Molluscs from layer 7. Taxonomy and nomenclature according to Oliverio (2008) for marine and brackish gastropods, Welter-Schultes (2012) for land gastropods and Schiaparelli (2008) for marine and brackish bivalves. Number of valves recovered for bivalves is between brackets. / Molluschi rinvenuti nello strato 7. Tassonomia e nomenclatura secondo Oliverio (2008) per i gasteropodi marini e salmastri, Welter-Schultes (2012) per i gasteropodi terrestri e Schiaparelli (2008) per i bivalvi marini e salmastri. Per i bivalvi il numero di valve rinvenute è tra parentesi.*

Marine (M) and brackish (B) gastropods		
M	*Patella caerulea*	362
M	*Patella* cf. *ulyssiponensis*	84
M	*Patella ferruginea*	4
M	*Patella rustica*	3
M	*Patella* sp.	86
M	*Bolma rugosa*	3
M	*Osilinus articulatus*	30
M	*Osilinus turbinatus*	817
M	*Gibbula divaricata*	7
M	*Phorcus mutabilis*?	38
M	*Phorcus richardi*	6
M	Trochidae gen. et sp. indet.	46
M	*Truncatella subcylindrica*	1
M	*Littorina neritoides*	3
M	*Natica* sp.	2
M	*Galeodea echinophora*	1
M	*Hexaplex trunculus*	2
M	*Stramonita haemastoma*	5
B	*Cyclope neritea*	10
M	*Columbella rustica*	35
Land (T) gastropods		
T	*Pomatias elegans*	1
T	*Rumina decollata*	1
T	*Siciliaria* sp.	2
T	*Limax* sp.	13
T	*Oxychilus* cf. *draparnaudi*	5
T	*Cernuella* sp.	1
T	*Chilostoma planospira*	2
T	*Marmorana* sp.	10
T	*Helix* sp.	98
T	Gastropod gen. et sp. indet.	1
Marine (M) and brackish (B) bivalves		
M	*Donax* cf. *venustus*	1 (1)
M	*Glycymeris violacescens*	3 (4)
M	*Ostrea edulis*	21 (21)
B	*Cerastoderma glaucum*	157 (303)
M	*Acanthocardia tuberculata*	7 (11)
		2036

roe deer. This is probably due to the humid and mild phase starting with the Alleröd interstadial, when open wood (the ideal habitat of red deer - Mattioli 2003) was possibly integrated or replaced by broadleaf complexes abounding in underwood, more suitable for the roe deer and the wild boar (Apollonio 2003, Perco 2003). Better trophic conditions may account for the larger size of these ungulates (see above).

At Grotta della Serratura, located a few hundred metres from Grotta della Cala, a very similar faunal change is recorded within the Final Epigravettian (layers 8c-8a) (Hellemans *et al.* 1993).

Comparison between these Cilento sites and the coeval layers of Grotta delle Mura (Monopoli - Bari), located on the Adriatic Apulian coast, a very arid region, gives some interesting insights. At Grotta

***Fig. 8** - Grotta della Cala - Shells with piercings, incisions or residues of red pigment: shells of* Columbella rustica, Cyclope neritea *and* Natica *sp. (ns. 1-3); fragment of a left valve of* Cerastoderma glaucum *with residues of red pigment (n. 4); right valve of* Acanthocardia tuberculata *with piercing (n. 5) and right valve of* Ostrea edulis *with incisions (n. 6). / Conchiglie con fori, incisioni, o residui di pigmento rosso: conchiglie di* Columbella rustica, Cyclope neritea *e* Natica *sp. (nn. 1-3); frammento di valva sinistra di* Cerastoderma glaucum *con residui di pigmento rosso (n. 4); valva destra di* Acanthocardia tuberculata *con foro (n. 5) e valva destra di* Ostrea edulis *con incisioni (n. 6).*

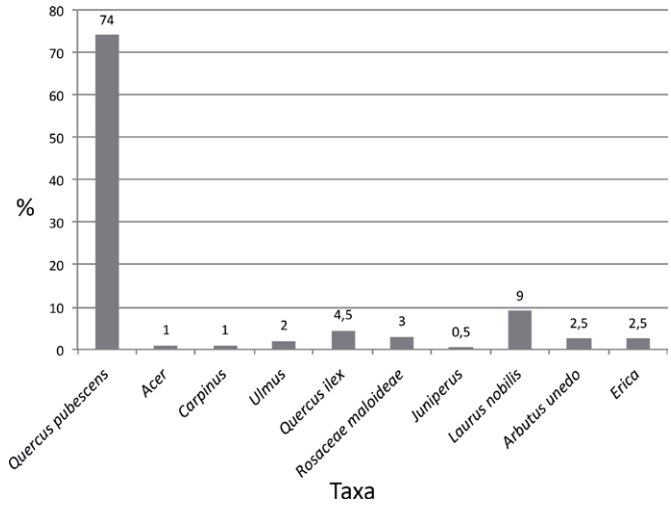

***Fig. 9** - Grotta della Cala - Percentages of identified charcoal fragments in the layer 7. Percentages were calculated from a total of 200 analysed charcoals. / Percentuali dei carboni identificati nello strato 7, calcolati su un totale di 200 frammenti.*

delle Mura open environment ungulates like the auroch (forest steppe) and the horse dominate the faunal association. The Pre-boreal to Boreal climatic improvement is attested by the progressive increasing of the auroch reaching 68% of ungulates in Mesolithic layer 2 (Bon & Boscato 1993, 1996).

People from these two areas of Southern Italy, divided by the Apennine Chain, although being at the same latitude and in the course of the same climatic phase, developed their food procurement strategies by exploiting completely different environments.

The charcoal assemblage from layer 7 shows the presence of a deciduous forest dominated by *Q. pubescens* mixed with *Acer* and *Carpinus*, while maquis vegetation, which presently characterizes this coastal sector, was nearly absent. These data are consistent with those from the zooarchaeological analysis, that is with the wide occurrence of forest taxa.

Layer 7 also yielded a lot of malacofauna composed of both of the terrestrial and, above all, marine species. Most of these species could easily be gathered without any implement help, except for *Patella* which would require *ad hoc* un-sticking tools. Even though mollusc gathering was mainly aimed at satisfying food necessity, a certain number of shells from layer 7 (principally *Cyclope neritea* and *Columbella rustica*) were clearly used as ornaments, given the occurrence of intentional piercings and colouring substances on their surfaces.

The preliminary study of the lithic assemblage has highlighted techno-typological features which are usually considered as distinctive of the Sauveterrian. Reduction sequences express a flexible production concept both by exploiting and adapting to the morphological characteristics of raw material according to a "pragmatic" approach (Walzak 1998; Fontana & Cremona 2008). Blank selection mirrors the dichotomy (see Wierer 2008; Fontana & Cremona 2008) between bladelets/small flakes for microliths on the one hand, and larger products (often by-products from a different operational chain) for "common tools" on the other. Microliths comprise two Sauveterre points and an important component of the tool-kit is embodied by macro-artefacts.

Since the study of the lithic assemblage from layer 7 is still widely incomplete (not only referring to the techno-typological analysis, but also to the use wear and residue traces) and also material from layer F should be wholly revisited, it is too early to put forward hypotheses about the function of the site during the Mesolithic occupation. Nevertheless, it is worth noting the anomaly currently featured by the low number of armatures and end-scrapers. Actually both these categories are usually much more numerous in Sauveterrian sites, reaching, even 50-70% of the retouched component and 40% of non-backed tools respectively.

If these data are confirmed by the revision of the lithic assemblage from layer F (layer 7 and F together cover an investigated area of about 24 square metres) two hypotheses might be taken into consideration: 1) microliths were moved elsewhere as either armatures or finished weapons, 2) microliths concentrated in the atrium of the cave, the area where Mesolithic and part of the Epigravettian deposits were eroded by the Holocenic sea ingression (Bartolomei *et al*. 1975).

In this view the activity area discovered in squares D-E 16-18 deserves special attention. In this area both implements for the processing of colouring substances (grindstone) like ochre and, possibly, food (anvil/hammer), and decorated objects (painted pebble and incised oyster) were retrieved in the close proximity of a fireplace, along with a series of pierced shells scattered around. This evidence does entail that the inner part of the cave was used as a place for symbolic and, perhaps, ritual practices (did they also involve processing/consumption of specific food?). The co-existence of a number of objects devoted to the symbolic/magic sphere with other elements mostly connected to day-to-day requirements (knapped cores and implements, faunal remains) may result from the different use of the same area in different times. However it is more likely that the atrium of the cave, wider and full of light, could have been the most suitable place for daily activities. This might account for the low number of armatures and, more in general, of tools recovered in the internal series.

Authors' contributions

Adriana Moroni carried out the study of the lithic assemblage and conceived the article together with Paolo Gambassini and Paolo Boscato who also performed the faunal analysis. Gaetano Di Pasquale and Emilia Allevato performed palaeobotanic investigations. Andrea Benocci, Leonardo Favilli and Giuseppe Manganelli carried out mollusc analysis. Fabrizio Di Bella collaborated as an undergraduate student to the study of lithic, faunal and malacofauna remains. Conclusions were discussed among all the authors.

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Article

The Mesolithic levels of Grotta del Santuario della Madonna at Praia a Mare (Cosenza, Italy): new excavations, chronological data and techno-typological features of the lithic assemblages

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Key words

- Calabria
- Cave
- hearths
- shell middens
- Early Mesolithic
- Undifferentiated Epipalaeolithic

Parole chiave

- Calabria
- Grotta
- focolari
- chiocciolai
- Mesolitico antico
- Epipaleolitico Indifferenziato

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Summary

The cave opens on a cliff at about 500 m from the modern coastline. The excavations discovered an impressive archaeological deposit, evidencing human frequentation from the Upper Palaeolithic to the Middle Ages. Since 2002 new excavations adjacent to the old trench were carried out. In the new excavations, evidences of the latest Mesolithic frequentations had been disturbed by Neolithic structures. The underlying Mesolithic layers are characterized by the presence of well-organized hearth structures, shell middens, lithic industry and bone remains of wild mammals, tortoises and malacofauna. The data on the lithic production indicate the presence of an Early Mesolithic assemblage, with very low microlithic component known as Undifferentiated Epipalaeolithic. The new dates, frame the middle Mesolithic levels between 7040 and 7310 cal. BC and the lower ones, with the hearths and the shell midden, between 7830 and 8430 cal. BC.

Riassunto

La grotta si apre su una falesia a circa 500 metri dalla costa attuale. Gli scavi hanno messo in luce un imponente deposito archeologico, che evidenzia una frequentazione umana dal Paleolitico superiore al Medioevo. Sono stati effettuati nuovi scavi adiacenti alla vecchia trincea. I nuovi scavi hanno evidenziato che i livelli con le ultime frequentazioni mesolitiche sono stati disturbati dalle successive strutture neolitiche. Gli strati mesolitici sottostanti sono caratterizzati dalla presenza di strutture e focolari ben organizzati, "chiocciolai", industria litica e resti ossei di mammiferi selvatici, tartarughe e malacofauna. I dati della produzione litica indicano la presenza di una industria del Mesolitico antico, con bassissima componente microlitica, nota come Epipaleolitico indifferenziato. Le nuove, inquadrano i livelli mesolitici intermedi tra il 7040 e il 7310 a.C. e quelli inferiori con i focolari e il chiocciolaio tra 7830 e 8430 a.C.

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Fig. 1 *- Grotta del Santuario della Madonna (southern Italy) location of the cave, panoramic views of the cliffs (photo I. Fiore). / Localizzazione del sito, vista panoramica della falesia (foto I. Fiore)*

Introduction

This paper presents the results of AMS 14C dating carried out on charcoal samples selected from the Mesolithic levels in an excavated area at the Grotta del Santuario della Madonna. In addition, the results of the techno-typological study of the lithic industry will be described. All the artifacts have been studied and classified in order to reconstruct the reduction processes, as well as the raw material procurement strategy and the typological features.

The cave, a single large room (2000 m^2 surface and 15 m high), opens on a cliff at about 500 m from the modern coastline (Fig. 1) The excavations carried out by the Istituto Italiano di Paleontologia Umana of Rome (1957-1970) have highlighted an impressive archaeological deposit, over 8 m thick, with several layers related to human occupation of the cave, from the late phases of the Palaeolithic to the Middle Ages (Cardini 1972). In fact, Grotta del Santuario della Madonna has been one of the key sites traditionally used, since the 1960s/70s, for the reconstruction of the different chrono-cultural phases in the prehistory of Southern Italy (AAVV 2000; Tagliacozzo 2000; Tagliacozzo and Fiore 2003; Fiore et al 2004a-b). Starting in 2002 the Soprintendenza al Museo Nazionale Preistorico Etnografico "L. Pigorini" carried out new excavations adjacent to the old trench, close to the NW wall of the cave (Fig. 2). Such new excavations (test trench 4x5 m) involved the upper and the middle layers of the stratigraphic sequence, corresponding to about 5.5 m of anthropic deposit referred to the Holocene period, down to the Mesolithic occupation (Fugazzola et al 2004; 2005; 2007; Tiné 2006; Scarciglia 2009).

The aim of this study is to provide an accurate chronology of the Mesolithic levels of Grotta della Madonna and to describe the main techno-typological features of the lithic industry, for a more accurate definition of the Mesolithic in South-Central Italy.

Study area

The stratigraphy of the studied area is shown in Figure 3.

Under the first layer, immediately below the surface and covered by a modern cemetery, 4 main horizons can be recognized in the new stratigraphic sequence (Cardini 1972; Calcagnile *et al.* 2010):

Horizon II. The upper levels belong to the Middle Bronze Age Apennine Culture (Middle Bronze Age, phase 3, 11th–12th centuries BC) and Proto- Apennine Culture (Middle Bronze Age, phases 1–2, 12th–14th centuries BC), showing clear anthropic palaeo-surfaces. These layers are followed by Late Chalcolithic–Early Bronze Age thin levels (Laterza culture pottery). Archaeological remains suggest an intense anthropic frequentation of the cave.

Horizon III. This is formed by thin strata showing a peculiar twofold, black and- white, mode of soil deposition. The small amount of pottery recovered belongs to the Early Chalcolithic (Piano Conte style, second half of 4th to first half of 3rd millennium BC) and Late Neolithic (Spatarella-Diana style, end of 5th to beginning of 6th millennium BC). Archaeological remains show clearly the low intensity of human frequentation of the cave.

Horizon IVA. This horizon is characterized by a yellowish clay formation with few pottery sherds belonging to the Late Neolithic (Diana style) or to the evolved phases of the Middle Neolithic (Serra d'Alto style). This stratum clearly indicates a hiatus in the human occupation of the cave.

Horizon IVB. The bottom Neolithic level contains a large amount of the typical Bande Rosse pottery from earliest phases of the Middle Neolithic in southern Italy (second half of the 6th millennium BC). Several hearths and drainage structures recovered in this stratum suggest a residential use of the cave by Neolithic people.

Horizon V. Mesolithic. The upper Mesolithic level has been partially disturbed by the installation of Middle Neolithic structures (pits and post holes with rare pottery). The underlying Mesolithic layers are characterized by the presence of hearth structures, shell mid-

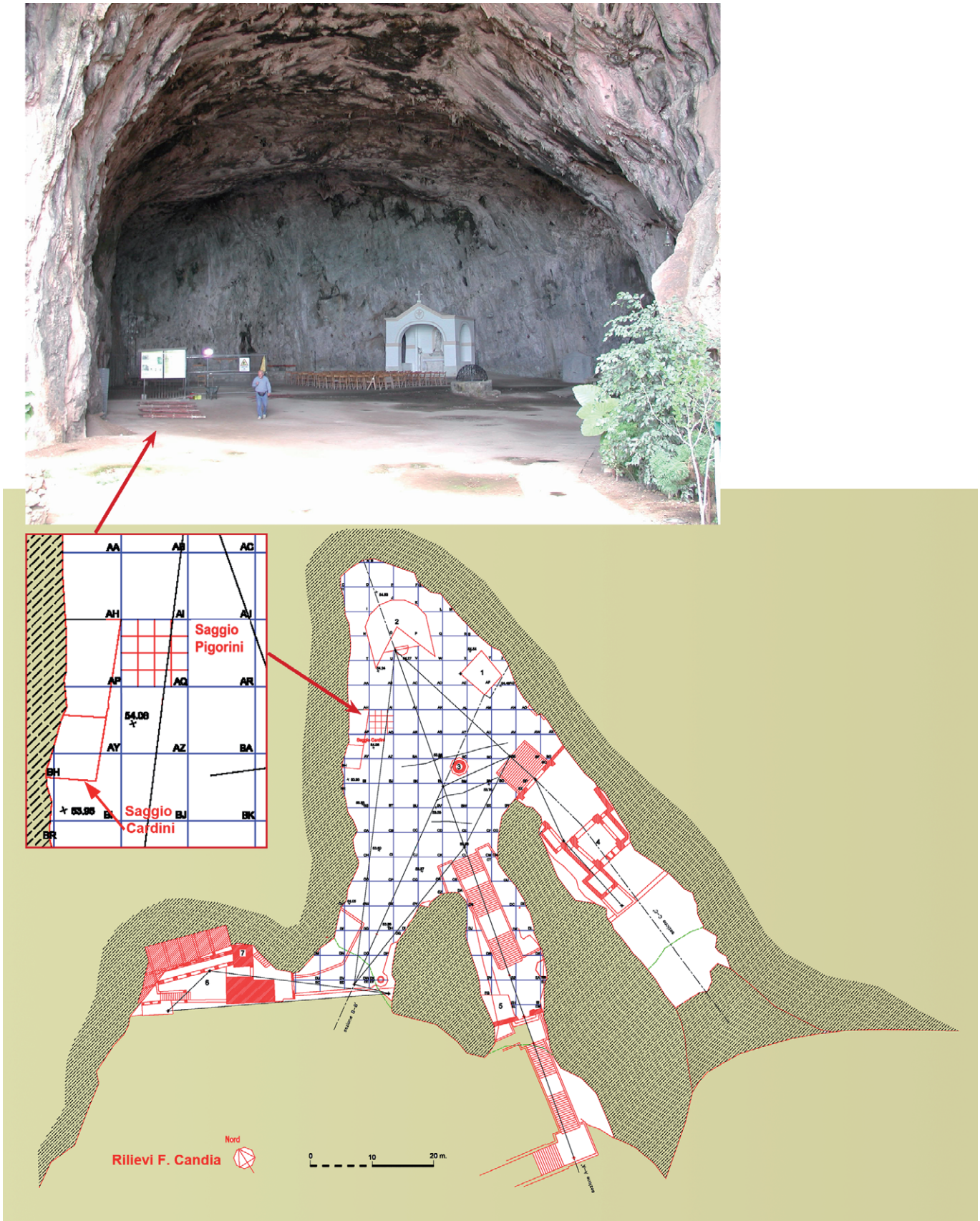
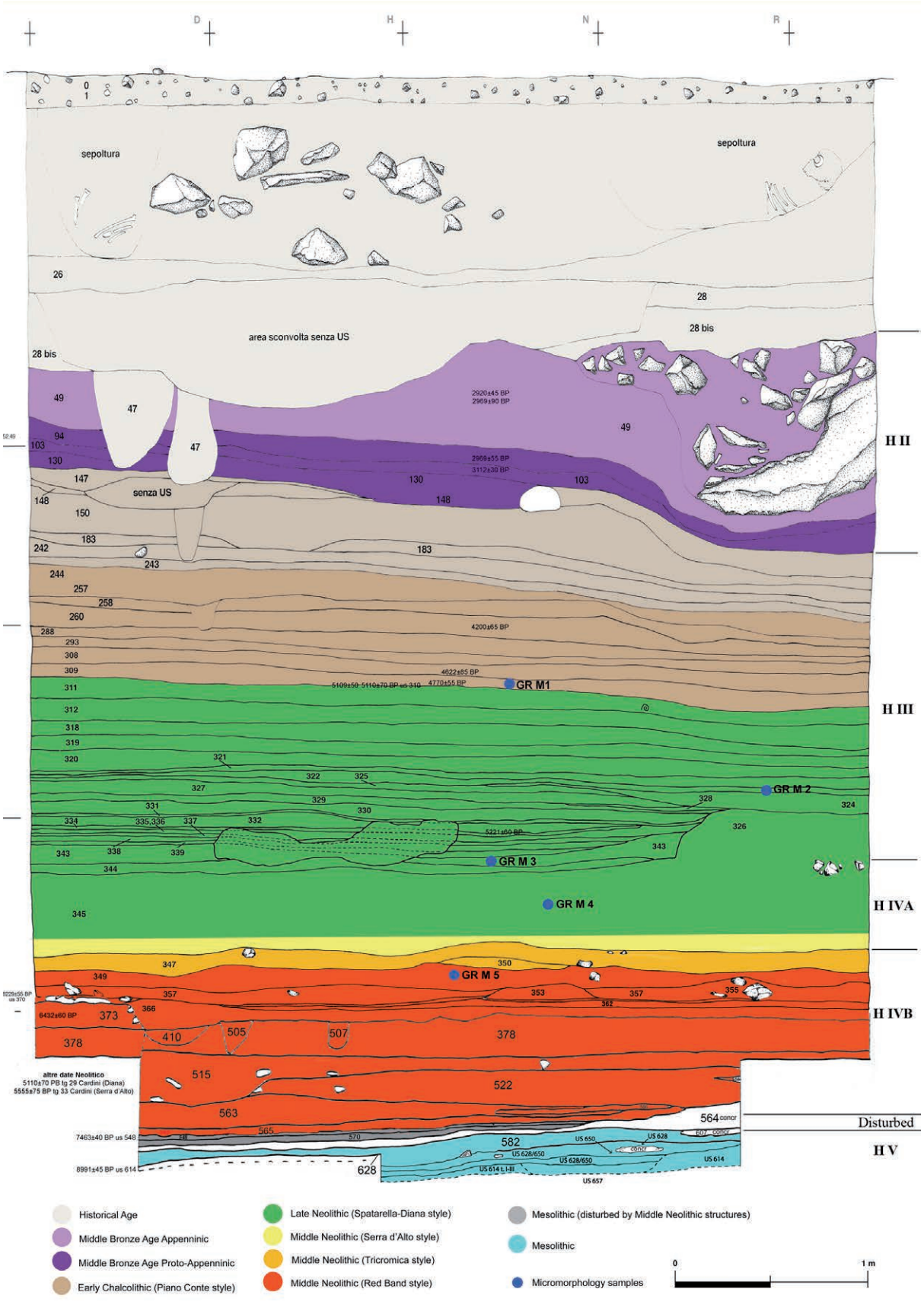


Fig. 2 - *Grotta del Santuario della Madonna: view of the interior of the cave (photo V. Tinè), general planimetry of the cave (drawing F. Candia) and detail of the excavation trench. / Vista dell'interno della grotta (foto V. Tinè), planimetria generale della grotta (rilievo F. Candia) e dettaglio del saggio di scavo.*



Grotta del Santuario della Madonna di Praia a Mare. Sezione C-D (Tinè 2006, modificata E. Natali, I. Fiore)

Fig. 3 - Grotta del Santuario della Madonna: new stratigraphical sequence. Five main phases has been recognized under the first layer dated to the modern age. / Nuova sequenza stratigrafica. Sotto il primo strato di età moderna, sono stati riconosciuti 5 orizzonti principali.

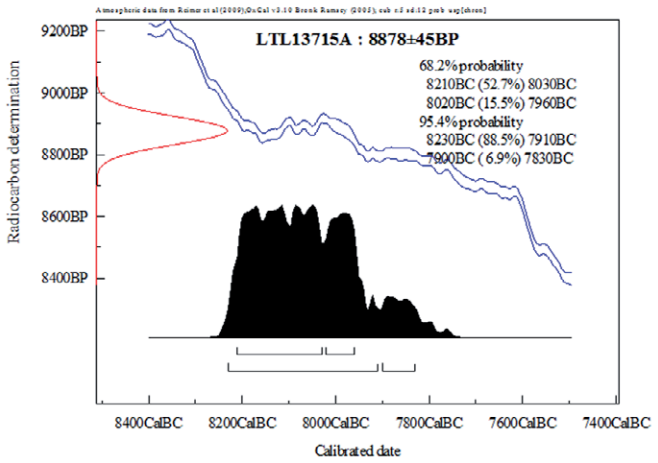


Fig. 4 - Grotta del Santuario della Madonna: calibration curve of the radiocarbon measurements from the sample LTL13715A (feature 657). / Calibrazione della data convenzionale al radiocarbonio del campione LTL13715A proveniente dall'US 657.

dens, lithic industry, bone remains and abundant malacofauna. Archaeological remains suggest an intense anthropic frequentation of the cave.

Methods

Short-lived samples, identified by palaeo-botanical analysis, were selected for AMS 14Cdating analyses, which were carried out at the CEDAD (Centre for Dating and Diagnostics) of the University of Salento (Calcagnile *et al.* 2004, 2010).

The samples were prepared by standard chemical processing employed for plant remains, essentially consisting in alternate acid-alkali-acid (AAA) washes and were aimed at the removal of contaminants (D'Elia *et al.* 2004). Conversion of the purified sample material to carbon dioxide was done by combustion at 900 °C in sealed quartz tubes. The extracted carbon dioxide was then converted into graphite by catalytic reduction using H2 as reducing agent and iron powder as catalyst.

The quantity of graphite extracted from the samples resulted to be adequate for an accurate experimental determination of the age. 14C measurements were carried out at the CEDAD on its 3MV HVEE 4130HC Tandetron accelerator (Calcagnile *et al.* 2005). IAEA-C6 (sucrose) and IAEAC4 (sub-fossil wood) standards were used for normalization and background correction, respectively.

The conventional radiocarbon date has been corrected for the effects of isotopic fractionation by measuring the $\delta^{13}C$ term, carried out directly with the accelerator and for the background of the measurement.

Samples of known concentration of Oxalic Acid provided by the NIST (National Institute of Standard and Technology) have been employed as a control for the quality of the results. For the determination of the experimental error in the radiocarbon date, both the scattering of the data around the mean value and the statistical error deriving from the counting of the ^{14}C have been taken into account. The radiocarbon dating for the samples was then calibrated in calendar years using the software OxCal Ver. 3.10 based on atmospheric data (Reimer *et al.* 2004; Fig. 4).

The study of the lithic production was carried out following the stratigraphic sequence and the relationships between the layers belonging to the same occupation phase. For this reason, according to the stratigraphic sequence, the lithic materials were grouped into tree main phases. All the artefacts have been studied and classified in order to reconstruct for each phase the reduction processes as well as the raw material procurement strategy and the typological features.

Results

Stratigraphic sequence, dwelling structures and AMS 14C dating

The charcoal samples that allowed the new dates have been collected from different Mesolithic levels and structures evidenced during the 2010 and 2011 excavations (Tab. 1). A sample from the Mesolithic levels (Stratigraphic Unit 1025) had been already dated (Calcagnile *et al.* 2010) in 2006 during the works for the re-establishment of the old trench excavated by Cardini. Such sample (LTL3578A) provided the following results: 8963±60 BP (uncalibrated 14C age) and 8274–8181 (38.4%); 8113–8090 (7.7%); 8076–8061 (4.6%); 8043–7994 (17.5%) (Calibrated time ranges for each sample were obtained using the OxCal model). Previously (Cardini 1972) two other dates of the middle-basal levels (cuts 45-46) of layer I (Mesolithic) of the Cardini excavations were known: the first one was obtained on charcoal (R-187: 8735±80 BP uncal), the second one on burnt bones (R-188: 9070±80 BP uncal).

The new stratigraphic record and the related C14 dates allow us to detect three main phases of Mesolithic occupation. In the following paragraphs the levels yielding the charcoal samples that allowed the new dates will be briefly illustrated starting from the top

Tab. 1 - Grotta del Santuario della Madonna: AMS 14C dating, the samples are listed together with their locations within the strata. / AMS 14C dating, elenco dei campioni con la provenienza stratigrafica.

CODE	CEDAD CODE	RADIOCARBON AGE (BP)	δ13C (‰)	CALIBRATED DATE (2σ CONFIDENCE LEVEL)
GRM 2010 US548 TGI	LTL13713A	7463 ± 40	-22.8 ± 0.4	6420BC (95.4%) 6240BC
GRM 2011 US637 TGII	LTL13714A	8135 ± 45	-23.6 ± 0.3	7310BC (13.6%) 7210BC
				7200BC (81.8%) 7040BC
GRM 2010 US612	LTL13712A	8782 ± 45	-27.8 ± 0.5	8200BC (95.4%) 7600BC
GRM 2011 US614 TGIII	LTL13716A	8991 ± 45	-31.4 ± 0.3	8300BC (72.2%) 8160BC
				8120BC (23.2%) 7970BC
GRM 2011 US657 TGIII	LTL13715A	8878 ± 45	-30.4 ± 0.2	8230BC (88.5%) 7910BC
				7900BC (6.9%) 7830BC
GRM 2011 US657 TGI-II	LTL13717A	9076 ± 45	-25.1 ± 0.7	8430BC (3.0%) 8370BC
				8350BC (92.4%) 8220BC

of the Mesolithic sequence; furthermore, a synthesis of the data on the faunal remains recovered in these levels will be also provided[1].

The upper levels (phase 3)

SU 548 represents a residue of the most recent level of Mesolithic frequentation of the cave. It is a silty level with small charcoal fragments, lithic industry and wild mammal bones, partially disturbed by Middle Neolithic structures (Fig. 5). The only 14C date obtained so far for this level (7463 ± 40 BP, 6420 – 6240BC cal) is surprisingly more recent than the other dates known for the Mesolithic in Southern Italy and almost overlaps with the earliest dates of the Initial Neolithic in the Southeast (from around 6200 cal BC; Pessina Tiné 2008). Given the presence in these levels of post holes and Neolithic sherds from the overlying levels, this date may be the result of a contamination from these later phases or may represent a charcoal, residue of firing episodes from outside the cave, accidentally incorporated by colluviation into the filling (as ascertained in several layers by micro morphological analysis; Scarciglia *et al.* 2008). In any case, more dating of these higher levels of the Mesolithic frequentation of the site are planned in order to clarify their possible extension.

The medium levels (phase 2)

SU 582 is a level of Mesolithic frequentation with presence of combustion areas, lithic industry and wild mammal bones (with wild boar and red deer more frequent than roe deer). Several mammal specimens show butchery marks; some percussion cones, suggesting bone fracturing, occurred close to the hearth. Rare bird remains are also present: dove *(Columba livia/oenas*), common raven (*Corvus cf. corax*) and crag martin (cf. Ptyonoprogne rupestris). The dove ulna presents scrape marks on the dorsal face, while the radius of the common raven shows some combustion traces localized on the extremity. These traces may indicate the exploitation of the bone as raw material or be related to the procurement of feathers, rather than to butchery/consumption (Fiore *et al.* this volume). Fish remains are rare and the malacofauna is scarce, with few limpets and some land gastropods. There are also rare bone tools and some pierced shells of rustic dove snail (*Columbella rustica*).

SU 612 (in SU 582) represents the lower level, formed by stones and charcoal-rich soil, of a hearth consisting in a shallow pit filled with charcoal-rich and cineritic sediments (LTL13712A: 8782 ± 45 BP, 8200 – 7600BC cal, Tab. 1).

The lower levels (phase 1)

SU 637 is the fill of a circular pit (SU 638) excavated in the Mesolithic palaeo-surface SU 628

Such fill, silty and friable with small stones and dispersed charcoal, contained mammal bones malacofauna and lithic industry (Fiore *et al.* this volume). The 14C date obtained for this structure (LTL13714A : 8135 ± 45 BP uncal, 7310 –7210BC cal; 7200-7040BC cal, Tab. 1) is not consistent with its stratigraphic position.

The first depositional level of the pit seems to evidence a selection of faunal elements. In fact, besides ungulate remains, there are a wolf mandible, a complete distal posterior limb of a badger and several shells of limpets and top snails. Among the ungulates, the remains of wild boar (NISP 18) are prevalent, red deer is scarcer (NISP 7) and roe deer is rare (NISP 3). Many specimens are characterized by localized burning traces, while butchery marks are represented by cuts and impacts.

The wolf (*Canis lupus*) is represented by a right hemi-mandible belonging to an adult-senile individual, probably a male, considering the large size. The most evident traces of human handling are those referred to the fracturing for the extraction of the canine, that is actually absent and to the stone tool cut marks located on the lateral face below the condyle, referable to the disarticulation of the mandible from the cranium.

The left posterior distal limb of the badger (*Meles meles*) was recovered in anatomical articulation. The completeness of the limb end and the way it was recovered suggest the intentional deposition of the paw still with part of the soft tissues and the pelt. It probably represented an ornament or an amulet rather than the residue of a pelt since sometimes the paws remain attached to it (Fiore *et al.* this volume).

Birds are represented by 3 undetermined fragments. An ulna diaphysis of a large sized bird shows stone tool cut marks that may be interpreted as related to the procurement of raw material rather than to simple butchery. Furthermore, in pit SU 638 there are large portions of carapace and plastron of both pond and terrestrial tortoises. Limpet shells are abundant, while top snails and terrestrial gastropods are rarer. A *Monodonta* specimen presents dark marks located on one half of the shell. Some limpet shells show clear-cut fracture edges that could have been produced by the use of these shells as side or end scrapers. Rare remains of fish, sea urchin and hard animal tissue artifacts are also present.

In the occupation level SU 614 (LTL13716A: 8991 ± 45 BP uncal, 8300 – 8160BC cal; 8120-7970BC cal, Tab. 1) there is a wide combustion area (USs 641-642-657). The hearth (SU 641) is made of two layers of medium-small stones, containing granular sediment, as well as numerous small charcoal fragments and burnt bones (Fig. 6). Adjacent to the hearth there is an area (SU 642) of brown-reddish granular clay, with small and medium stones, rich in charcoal, fauna (in particular large portions of tortoise carapace and plastron, some of them in anatomical connection and limpets) and lithic industry. Around the hearth there is an area (SU 657), rich in charcoal, with a concentration of food debris, in particular malacofauna (terrestrial and marine) and large portions of tortoise carapace and plastron, with rare mammal bones and some burned stones in the center. Unfortunately both the hearth and the adjacent area continue under the trench wall and therefore it was not possible to investigate them completely (Fiore *et al.* this volume).

The three different areas that form the combustion structure seem to be characterized by the presence of different animal spe-

Fig. 5 *- Grotta del Santuario della Madonna: the Mesolithic level disturbed by Middle Neolithic features (pits and post-holes) (photo I. Fiore). / Livello mesolitico disturbato da strutture del Neolitico Medio (fosse e buche di palo) (foto I. Fiore).*

1 The Mesolithic layers are characterized by the presence of well-organized hearth structures, shell middens, lithic industry, bone remains of wild mammals and tortoises and abundant malacofauna. For the analytical description of the levels and the structures as well as of the faunal composition, the lithic assemblage and the archaeological interpretation of the structures see Fiore *et al.* 2016 in this volume.

***Fig. 6** - Grotta del Santuario della Madonna: there the Mesolithic layers produced evidence of several well-organized fire-places and a shell midden (photo I. Fiore). / Gli strati del Mesolitico sono caratterizzati, nell'area indagata, dalla presenza di focolari ben organizzati e da un chiocciolaio (foto I. Fiore).*

cies. SU 641 yielded almost exclusively tortoises, both pond and terrestrial ones, with localized combustion traces. There are also numerous fragments of terrestrial gastropods and rare limpet shells. Wild boar and red deer remains are extremely rare. Fishes are represented by 4 elements.

In SU 642 abundant remains of malacofauna are present; these include mainly limpets, with less frequent top snails and terrestrial gastropods. There are also rare remains of red and roe deer, wild boar and tortoise. The two rustic dove snail shells are pierced.

In SU 657 there is a high concentration of terrestrial gastropod fragments, numerous limpet shells and more rare top snails (LTL13717A: 9076 ± 45BP uncal, 8430 –8370BC cal; 8350-8220BC cal. LTL13715A: 8878 ± 45 BC uncal; 8230-7910BC cal; 7900-7830BC cal, Tab. 1). Abundant remains of tortoises, mainly the pond one, are also present, frequently with clear cooking traces. Many large portions of tortoise are preserved and sometimes the limb long bones are still articulated. There are rare remains of ungulates: red deer, wild boar and roe deer. In addition, there is a fragment of badger skull with cut marks. Fish and bird remains are extremely rare. There is also a *Glycimeris* pierced shell.

Overall, the combustion structure appears as a true and typical Mesolithic shell midden, resulting from several repeated occupations of the same place, with accumulation, around a hearth, of food debris mainly related to gathering (terrestrial and marine mollusks, tortoises) rather than hunting activities (Fiore *et al.* this volume).

The lithic assemblages

Raw material

In the whole Mesolithic sequence of Grotta della Madonna the lithic assemblages are made mainly on local raw materials, as pebbles of variable shape and size, that were gathered locally in secondary deposits (marine shore and river beds). Recent researches on the raw material procurement during the Upper Paleolithic in the Calabro-Campanian region (Martini et al 2003; Martini *et al.* 2007, Lo Vetro *et al.* 2011, Romagnoli *et al.* 2016) provided useful information about the lithic resource availability also for the area surrounding Grotta della Madonna[2]. Although the study on raw materials is still in progress and more detailed petrographic analyses are expected, we can plausibly assume that most of the rocks exploited at the site may be referred to pebbles collected in secondary deposits not far from the cave (Noce river basin and mouth, shoreline) originating from the Triassic-Jurassic formations (Lagonegro Units) located in the mountainous areas north east of the site, up to 30 km away as the crow flies (Massiccio del Sirino). These outcrops yielded mainly red, green and gray good quality radiolarites and dark to gray transparent flints, which are very abundant in the Mesolithic assemblages of Grotta della Madonna. Radiolarites and flint pebbles had not been accurately selected by the cave occupants, in fact several items (flakes, cores, small block fragments, debris) show natural surfaces or fissures and are referable to pebbles affected by internal fractures (Fig. 7, nos. 2, 16; Fig 8, nos. 6, 9, 10). Few flint and radiolarite blanks bearing residual natural surfaces, may suggest an occasional gathering also from the detritus. A considerable amount of corticated blanks comes from pebbles of low quality chert, dark brown to gray in color, with medium-grained matte texture and very smooth surfaces. The origin of a high quality transparent flint whose exploitation is evidenced by some items, is still unknown.

Radiolarites, especially the red ones, were the most frequently knapped rocks during the whole Mesolithic sequence. Among the formal tools these lithotypes occur in all typological categories of the assemblages. Flint is also abundant, this raw material consists of a wide variety of lithotypes among which semitransparent, black and light to dark gray colored ones are prevalent. Flint too covers a broad range of typologies and this rock seems to be preferred in the backed tool production. At a subordinate place there is the low quality chert, exclusively used to make scrapers, notches and denticulates, coarsely retouched, and to obtain wide flakes used without retouch.

The very few obsidian items (3 from phase 3 and 1 from phase 1) are intrusive, due to the installation of Middle Neolithic structures that partially disturbed the underlying levels.

Lithic assemblages composition

In all the sequence lithic artefacts are scarce and only in the first two phases they are enough to accomplish a statistically reliable techno-typological study. However, a comparison of the assemblage composition in the three phases indicates a similar ratio in the percentages of the different technological categories (Tabs. 2-3). The large amount of unretouched flakes compared to the paucity of laminar blanks is constant throughout the sequence and clearly evidences a flake-oriented production. The percentage of the retouched blanks indicates a moderate degree of transformation of the blanks, while the high percentages of waste products, such as debris and hyper-microflakes, are reasonably due to the knapping activity performed in the excavated area, whereas the low number of shaping and maintenance blanks is probably related to the low technical investment characterizing the assemblages.

Reduction methods and raw material economy

All along the Mesolithic sequence pebble exploitation is essentially aimed at the production of crude and unstandardized flakes by direct hard percussion. Two main *chaînes opératoires* have been reconstructed:

a) exploitation of radiolarite and flint pebbles by means of unidirectional and multidirectional methods with a low degree of predetermination (Fig. 7, nos. 1-2; Fig. 8, n. 10), in order to obtain mainly squat and asymmetric flakes and, secondly, irregular laminar flakes. Items attributable to shaping and surface maintenance of the cores are sporadic. Blanks frequently bear more or less broad portions of the cortical surface. The blank size is variable, mainly ranging from

2 The lithic samples collected during the above mentioned researches, stored at the Museo e Istituto fiorentino di Preistoria, were used as comparative material.

***Tab. 2** - Grotta del Santuario della Madonna: Composition of the lithic assemblages. / Composizione delle industrie litiche.*

TECHNOLOGICAL CATEGORIES/US	PHASE 1									
	641-642-657	637	650, 628, 625, 623, 620, 618		616		614		TOT	
	N	N	N	%	N	%	N	%	N	%
Flakes	16	9	75	21,9	44	19,6	100	30,9	244	25,1
Laminar flakes	-	2	4	1,2	5	2,2	8	2,5	19	2,0
Blades/bladelets	-	2	10	2,9	6	2,7	2	0,6	20	2,1
shaping/maintenance blanks	1	5	26	7,6	10	4,4	10	3,1	52	5,4
Undeterminable fragments	1	1	38	11,1	39	17,3	55	17,0	134	13,8
Debris and flakes < 1cm	14	12	161	46,9	104	46,2	112	34,6	403	41,5
Retouched blanks	7	7	24	7,0	17	7,6	34	10,5	89	9,2
Cores	1	3	4	1,2	-	-	1	0,3	9	0,9
Raw material blocks	-	-	1	0,3	-	-	-	-	1	0,1
Total	**40**	**41**	**342**		**225**		**324**		**971**	

TECHNOLOGICAL CATEGORIES/US	PHASE 2						PHASE 3					
	617-619, 615,612,607,602		582		TOT		564	570	548		TOT	
	N	%	N	%	N	%	N	N	N	%	N	%
Flakes	43	30,5	288	38,0	331	36,8	13	4	36	18,2	53	18,7
Laminar flakes	-	-	3	0,4	3	0,3	0	0	3	1,5	3	1,1
Blades/bladelets	1	0,7	15	2,0	16	1,8	1	1	10	5,1	12	4,2
shaping/maintenance blanks	4	2,8	18	2,4	22	2,4	5	0	6	3,0	11	3,9
Undeterminable fragments	6	4,3	26	3,4	32	3,6	7	5	22	11,1	34	12,0
Debris and flakes < 1cm	73	51,8	350	46,2	423	47,1	24	18	108	54,5	150	53,0
Retouched blanks	11	7,8	54	7,1	65	7,2	5	0	9	4,5	14	4,9
Cores	2	1,4	4	0,5	6	0,7	1	1	4	2,0	6	2,1
Raw material blocks	1	0,7	-	-	1	0,1	-	-	-	-	-	
Total	**141**		**758**		**899**		**56**	**29**	**198**		**283**	

micro (up to 25 mm) to small (26-50 mm)[3]. The flake production is unimodal, micro-flakes are obtained by means of intensive exploitation of the cores (Fig. 7, n. 2), although the occasional use of smaller pebbles or blocks to obtain micro- and hyper-microflakes cannot be excluded. Very few laminar blanks may be referred to this *chaîne opératoire*: also in this case they are asymmetrical, irregular in shape (Fig. 7, nos. 9-10; Fig. 8, nos. 6, 23) and not standardized; therefore they may be considered as an occasional outcome of a reduction system not aimed at the laminar production.

b) exploitation of low-quality chert, in form of oblong pebbles with ovoid cross-section, to obtain coarse cortical and semi-cortical large flakes to be used without further modifications (Fig. 7, n. 27; Fig 8, n. 8) or after being roughly retouched (scrapers, notches and denticulates) (Fig. 7, nos. 17, 24;). The average size of the blanks is generally larger than that of the other raw materials, with length ranging mainly from small (26-50 mm) to medium (51-100 mm). Several blanks have a cortical butt, plain, wide and inclined (sometimes less than 75°), a cortical back and a sharp edge on the opposite side (Fig. 8, n. 25). The technical procedures adopted for the blank production are rather rudimentary and do not meet any criteria of predetermination. The pebbles were reduced without preliminary shaping, exploiting a naturally flat side of the pebble; their knapping continued without surface maintenance.

Very few micro-bladelets, mainly made of good quality flint, may suggest the occasional adoption of a lamellar reduction method; however, the general rarity of laminar blanks and the lack of blade cores and other technological elements clearly referable to a laminar method, make it difficult to recognize a reduction scheme expressly aimed at bladelet production. The slight increase in blade/bladelet percentage in phase 3 (from ca.2% to ca.4%) may be due, in part, to

3 The dimensional parameters are referred to the typometric classification by G. Laplace (1968).

Tab. 3 *- Grotta del Santuario della Madonna: Typological structures (according to Laplace's 1964 analytical typology) / Strutture tipologiche (secondo la tipologia analitica di Laplace 1964).*

TIPIPOLOGY/US	PHASE 1							PHASE 2				PHASE 3		
	641, 642, 657	637	628, 625, 623, 620, 618	616	614	TOT	%	617-619, 615, 612, 607, 602	582	TOT	%	564	548	TOT
Burins	1	2	-	-	-	3	3,2	-	-	-	-	1	-	1
End-scrapers	-	-	2	1	6	9	9,6	1	7	8	12,1	-	3	3
short end-scrapers	-	-	*2*	*1*	*4*	*7*	*7,4*	*1*	*7*	*8*	*12,1*	-	*3*	*3*
nose end-scrapers	-	-	-	-	*1*	*1*	*1,1*	-	-	-	-	-	-	-
carinated short end scrapers	-	-	-	-	*1*	*1*	*1,1*	-	-	-	-	-	-	-
Truncations	-	1	-	-	-	1	1,1	-	2	2	3,0	-	1	1
Borers	-	-	4	-	2	6	6,4	1	3	4	6,1	2	1	3
Backed tools	-	-	1	3	-	4	4,3	2	8	10	15,2	-	-	-
backed points (double backed items)	-	-	-	*2(2)*	-	*2 (2)*	*2,1 (2,1)*	*2*	*3(1)*	*5(1)*	*7,6 (1,5)*	-	-	-
backed blades	-	-	-	-	-	-	-	-	*3*	*3*	*4,5*	-	-	-
Fragmets of backed tool	-	-	*1*	*1*	-	*2*	*2,1*	-	*2*	*1*	*1,5*	-	-	-
Geometrics	-	-	-	-	1	1	1,1	-	-	-	-	-	-	-
crscents	-	-	-	-	*1*	*1*	*1,1*	-	-	-	-	-	-	-
Blade scrapers	-	-	-	-	-	-	-	-	2	2	3,0	-	-	-
Flake scrapers	-	4	8	5	5	22	23,4	2	6	8	12,1	1	-	1
Abrupts	-	-	1	1	1	3	3,2	-	-	-	-	-	-	-
Denticulates	3	1	9	4	17	34	36,2	4	18	22	33,3	2	2	4
notches	-	*1*	*1*	*3*	*4*	*9*	*9,6*	*2*	*5*	*7*	*10,6*	*2*	-	*2*
denticulated scrapers	*3*	-	*7*	*1*	*10*	*21*	*22,3*	*1*	*11*	*12*	*18,2*	-	*2*	*2*
denticulated end-scrapers	-	-	-	-	*2*	*2*	*2,1*	-	*2*	*2*	*3,0*	-	-	-
fragments of denticulate	-	-	*1*	-	*1*	*2*	*2,1*	*1*	-	*1*	*1,5*	-	-	-
undeterminable retouched fragments	1	-	-	2	2	5	5,3	-	4	4	6,1	-	1	1
Splintered pieces	2	-	2	1	1	6	6,4	1	5	6	9,1	-	1	1
Tot	**7**	**8**	**27**	**17**	**35**	**94**		**11**	**55**	**66**		**8**	**14**	**22**

intrusive items from the above middle Neolithic levels, as in the case of the above mentioned few obsidian pieces.

Transformed blanks and typological features

Regardless of the raw material, blanks were transformed mainly to obtain common tools such as denticulates (notches and denticulate-scrapers are prevalent) and flake-scrapers (often with marginal and partial retouch)[4]. The retouch is generally not accurate, sometimes inverse (Fig. 7, nos. 10, 17, 19, 20, 21, 23; Fig. 8, nos. 22, 26); in notches and denticulates it appears frequently as a single, wide and deep detachment aimed at obtaining active edges with marked denticulation. In some cases deep adjacent notches are intended for making a short pin (Fig. 7, n. 21; Fig. 8, n. 26); sometimes a similar result is obtained by a notch adjacent to a concave unretouched margin (Fig. 7, n.19; Fig. 8, n. 28). In other cases unilateral denticulate retouch is aimed at making a point whose result is similar to a borer or perforator (Fig. 7, nos. 22, 23; Fig. 8, nos. 21, 23). Rare small pebbles are retouched as little choppers (Fig. 7, n. 25). As far as the scrapers are concerned, the retouch is usually marginal or little invasive and partial (Fig. 7, nos. 16-17).

Thick and irregular blanks were roughly transformed to make also other types of tools such as burins (especially simple and unelaborate ones), splintered pieces (Fig. 7, n. 26) and borers (Fig. 8 nos. 4-5, 20). Rare laminar flakes or irregular blades were used to make borers and truncations (Fig. 7, nos. 9-10).

Specialized tools consist of short end-scrapers, backed tools and a geometric (one crescent). Short end-scrapers include items with or without lateral retouch; some of them tend to have a circular forms, while others are nail-shaped. The scraping edge is more or less convex. In some cases the retouch involves one or both sides. Size is exclusively hyper-micro (up to 15 mm) and micro (up to 25 mm) (Fig. 7, nos. 3-7; Fig. 8, nos. 1-2, 11-14). Backed tools consist mainly of points and secondly of blades and undeterminable fragments (Fig. 7, nos. 11-14; Fig. 8, nos. 15-19). Backed tools are both hyper-micro and micro in size and width ranges from 2 to 8 mm (2-4 mm items prevail). Among the backed points three double backed ones are present (Fig. 7, n. 11-12; Fig. 8, n. 16).

4 Retouched tools are described following the analytic typology by G. Laplace (1964),

Fig. 7 *- Grotta del Santuario della Madonna: lithic artifacts from phase 1. 1-2. cores; 3-6. hypermicro-short end-scrapers; 7. carinated micro- short end-scraper; 8. micro-nose end-scraper; 9. truncation; 10. borer; 11-12. double backed points, 13. backed blade; 14. fragment of backed tool; 15. crescent; 16-17. scrapers (n. 17 with inverse retouch); 18-19. notches (n. 19 with inverse retouch); 20-25. denticulated scrapers (nos. 20, 21 and 23 with inverse retouch, n. 25 on small pebble); 26. splintered piece; 27. unretouched flake with edge-removals produced by use (photo D. Lo Vetro). / Industria litica della fase 1. 1-2. nuclei; 3-6. grattatoi corti ipermicrolitici; 7. grattatoio carenato frontale microlitico; 8. grattatoio a muso microlitico; 9. troncatura; 10. becco; 11-12- punte a dorso bilaterali, 13. lama a dorso; 14. frammento di strumento a dorso; 15. segmento di cerchio; 16-17. raschiatoi (n. 17 a ritocco inverso); 18-19. incavi (n. 19 a ritocco inverso); 20-25. raschiatoi denticolati (nn. 20 e 23 a ritocco inverso, n. 25 su piccolo ciottolo); 26. pezzo scagliato; 27. scheggia non ritoccata con sbrecciature d'uso sui margini (foto D. Lo Vetro).*

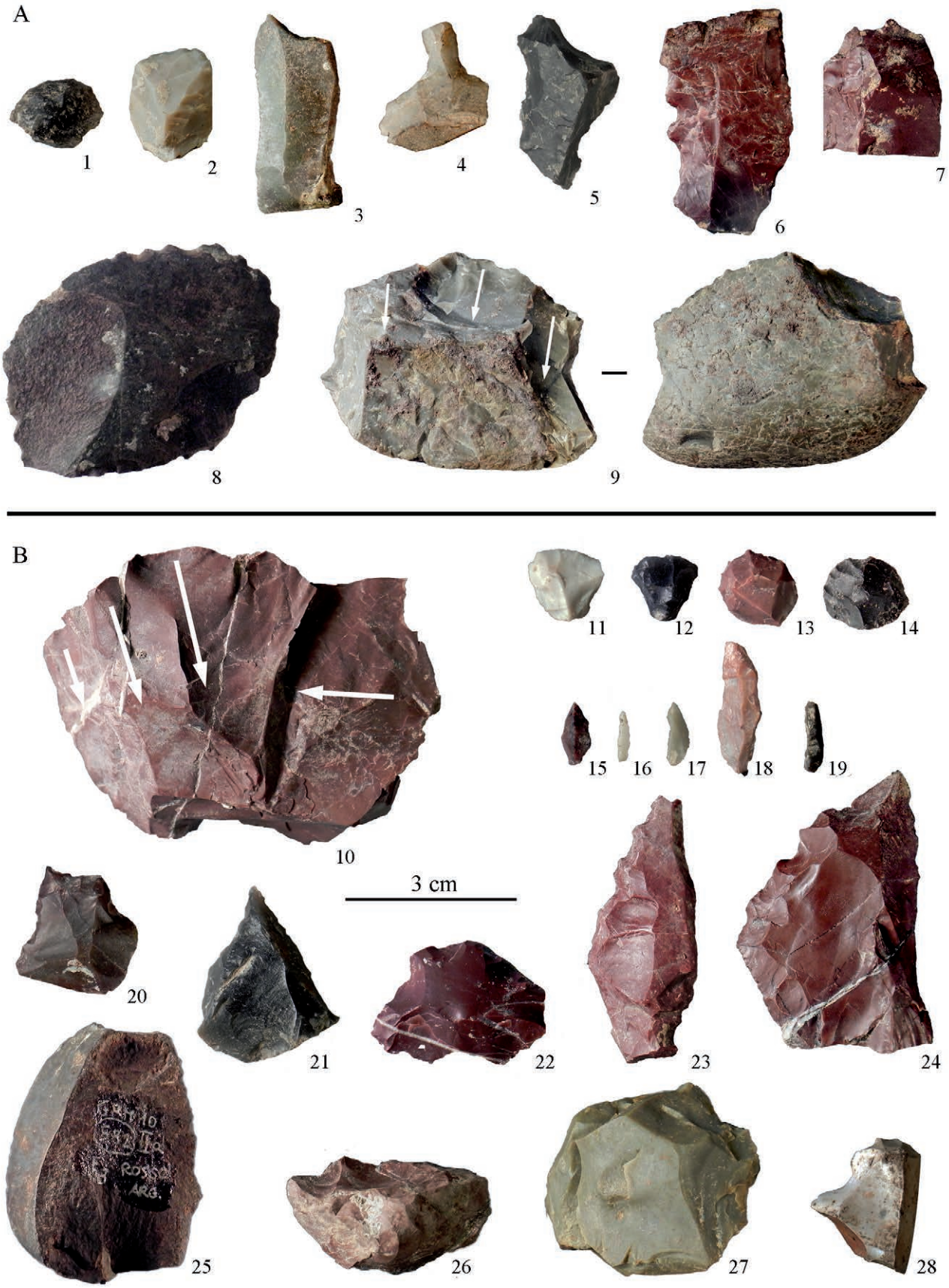


Fig. 8 *- Grotta del Santuario della Madonna: lithic artifacts from phase 2 (B) and 3 (A). 1-2- hypermicro- and micro- short end-scrapers; 3- truncation; 4-5- borers; 6-7- denticulate scrapers; 8- unretouched flake with edge-removals produced by use; 9- core on pebble cap; 10- core; 11-14- hypermicro- short end-scrapers; 15- partial backed point; 16-18- total backed points (n. 16 double backed); 19- backed bladelet; 20- borer; 21- notch; 22-24, 26- denticulate scrapers (nos. 22 and 26 with inverse retouch); 25- unretouched flake; 27 and 28- denticulate end-scrapers (photo D. Lo Vetro). / Industria litica delle fasi 2 (B) e 3(A). 1-2 grattatoi corti micro e ipermicrolitici; 3- troncatura; 4-5- becchi; 6-7- raschiatoi denticolati; 8- scheggia non ritoccata con sbrecciature d'uso sui margini; 9- nucleo su calotta di ciottolo; 10- nucleo a schegge; 11-14- grattatoi corti ipermicrolitici; 15- punta a dorso parziale; 16-18- punte a dorso totale (n. 16 a dorso bilaterale); 19- lamella a dorso; 20- becco; 21- incavo; 22-24, 26- raschiatoi denticolati (nn. 22 e 26 a ritocco inverso); 25- scheggia non ritoccata 27-28- grattatoi denticolati (foto D. Lo Vetro).*

The blanks used for the production of short end-scraper and backed tools are in part compatible with the reduction systems described above for the common tools. In fact, except for those rare backed tools made on regular micro-lamellar blanks, these specialized tools are made on unstandardized micro-flakes, whose selection is based on a morpho-dimensional criterion. Short end-scrapers are made on thick micro- and hyper-microblanks ready to be easily regularized by semi-abrupt simple retouch. As regards backed tools and the geometric one, the degree of transformation is so high that it is not always possible to recognize the shape of the original blank; rare items are made on micro-bladelets (Fig. 7, n. 10; Fig. 8, n. 19), while other few specimens are made on unstandardized tiny micro-flakes (Fig. 8 n. 17).

Discussion and Conclusions

The new excavations (2002-2011) at Grotta del Santuario della Madonna confirm the absence of human frequentation during the Impressed Ware Early Neolithic period, because the Middle Neolithic levels are directly in contact with the underlying Mesolithic ones. The evidences of the latest Mesolithic frequentations have been heavily disturbed by the installation of Middle Neolithic structures (pits and post holes with rare pottery, obsidian and domestic fauna remains). The underlying Mesolithic layers (without Neolithic disturbances) are characterized, in the investigated area, by the presence of several combustion structures (simple *cuvettes*, organized hearths with deposition of stones, cooking surfaces), a shell midden, lithic industry and bone remains of wild mammals (mainly wild boar and red deer), tortoises and abundant malacofauna, mostly limpets and top snails (Fiore et al, this volume). The presence of numerous combustion structures within such limited excavation area appears particularly interesting. Furthermore, it should be emphasized that in the short report about the 1957-1970 excavations, Cardini (1972) did not mention the presence of hearths in the Mesolithic levels he investigated (that are adjacent to the new excavations). In addition, in the stratigraphy of Fig. 5 on page 41, associated to the report, no hearths are graphically reported; these are instead indicated as numerous in the underlying Epigravettian levels and in the above Neolithic ones. It is difficult to interpret such different spatial organization within a distance of few meters. However, it should be noted that the old excavations had been carried out in direct contact with the wall of the cave and therefore such area may had been used for other functions, as also the presence of a child burial seems to suggest. The only grave good in this burial was a pierced *Cardium* on the chest of the child (Cardini 1972). As a further support to the hypothesis of a non-residential function for the area excavated by Cardini, there is also the finding, close to the burial, of a pebble painted with a male anthropomorphic outline.

Considering the differences in spatial organization as well as in the quantity of animal remains recovered and in the ratios among species, the different structures discovered in the new excavations seem to have played a different role. Among the remains of medium-large sized mammals, there are rare specimens of carnivores (wolf and badger) and more frequent wild ungulates among which wild boar is prevalent, followed by red deer and, less abundant, roe deer. Complete ungulate carcasses were brought back to the cave and butchery, disarticulation and marrow extraction activities occurred close to the cooking areas.

The species identified and their ratios reflect more or less the faunal data from the Mesolithic levels excavated by L. Cardini (Cardini 1972, Fiore *et al.* 2004). However, it should be emphasized that in the investigated structures there is a complete absence of bovids (aurochs, ibex and chamois) and also a lower number of carnivore species, compared to the area excavated by Cardini.

Rare bird remains have been recognized; these include the dove, the common raven and the crag martin, all birds frequenting caves or cliffs. Nevertheless, the presence of anthropic traces may be interpreted as evidence for the exploitation of birds. The Testudinata are present with two species: *Emys* cf. *E. orbicularis* (aquatic) and *Testudo hermanni* (terrestrial). Among their remains there are mainly fragments of carapace and plastron, but also limb long bones. Notwithstanding the proximity to the coast, fish remains are rare. Terrestrial gastropods are the most abundant mollusks (in particular *Helix* sp.). Among the marine mollusks there are numerous *Patella* sp. and top snail shells (*Phorcus turbinatus*). Rustic dove snail (*Columbella rustica*) shells are rare, often pierced and used as ornament.

For the association between the wolf mandible and the complete badger paw, the structure 637/638 represents an *unicum* in the scenario of the Italian Mesolithic. The presence of selected bone remains in the basal fill of the pit may indicate a propitiatory or ritual use. The structure USs 641-642 and 657, may exemplify a real and typical Mesolithic shell midden, produced by several occupations repeated over time in the same place, with accumulation of food refuses resulting from gathering activities.

As far as the subsistence activity is concerned, the wide range of animal species exploited documents a good knowledge of the territory and the resources that were systematically exploited by the Mesolithic hunter-gatherers.

The new dates of the Mesolithic levels and structures, unearthed during the new excavations, fit perfectly with the old dates (uncal. BP) of the middle-basal levels (Cardini 1972) and indicate an intense frequentation of the cave between the end of the 10th and the entire 9th millennium BP.

A strong homogeneity in the lithic assemblages of the three phases is clear in all aspects (raw materials, technical systems, typological structure and stylistic physiognomy of the formal tools). Except for the upper phase, whose sample is numerically too small for a reliable statistical evaluation, it is possible to note a variation between the first and second phase in the percentages of some techno-typological categories; nevertheless, such variation does not appear to be particularly significant (Tabs. 2 and 3). The most important change seems to be the increase in the percentage of backed tools, however, considering the low number of retouched tools, especially in phase 2, the statistical interpretation, in this case, should be considered with caution.

Absolute chronology and lithic assemblages of the Mesolithic sequence investigated in the new excavations at the Grotta del Santuario della Madonna, confirm the presence at the site of a Mesolithic stone assemblage with very few microliths, characterized by a low technical investment, as already recognized by Cardini (Cardini 1972).

The techno-typological features (in particular: crude lithic technology, production of unstandardized and asymmetric broad blanks, coarse retouched tools, especially notches, denticulates and scrapers) allow referring these lithic assemblages of the Mesolithic sequence of Grotta della Madonna to the *Undifferentiated Epipalaeolithic facies* (*sensu* Martini 1993) with a significant presence, although quantitatively limited, of specialized typologies, such as hyper-micro backed tools, a crescent and micro short end-scrapers, that in some peninsular areas strongly marked the coeval armature-rich assemblages such as the Sauveterrian and the Epiromanellian.

The presence of this *facies* at Grotta della Madonna had already been suggested (Martini 1993) on the basis of the few data published about the post-Paleolithic assemblages found by Cardini during his researches in the 60s of the last century (Cardini 1972). However, the lithic industries recovered during the new investigations allow to better define and detail the economic and techno-typological features along the Mesolithic sequence also in order to compare these assemblages with similar industries found in other Mesolithic sites in Central and Southern Italy and in its main islands.

The *Undifferentiated Epipaleolithic* is one of the Mesolithic *facies* appearing during the Early Holocene in some areas of Central and Southern Italy, in Sicily and in Sardinia-Corsica, interpreted as the likely

Tab. 4 *- Radiocarbon dates of layers with Undifferentiated Epipalaeolithic assemblages from Riparo Blanc and Grotta della Serratura. / Datazioni radiometriche dei livelli con industrie litiche dell'Epipaleolitico Indifferenziato di Riparo Blanc e Grotta della Serratura.*

SITE	LAYER	LAB CODE	AGE (BP)	2σ CALIBRATED DATE
Riparo Blanc	upper level	R-341	8565±80	7811-7474 BC
Grotta della Serratura	layer 5	Bln-3568	9700±60	9288-8843 BC

outcome of techno-typological trends already in progress at the end of the final Epigravettian. This *facies* does not seem to be present North of the Latium region (Martini 1993; Lo Vetro & Martini 2012 and 2016; Martini & Tozzi 2012; , Lo Vetro *et al*. in this volume).

The available radiocarbon dates of the *Undifferentiated Epipaleolithic,* span from the last quarter of the 10th to the half of 8th millennium cal. BC; only in Sardinia this *facies* seems to persist almost until the end of the 7th mill. cal BC. The calibrated absolute chronology of the *Undifferentiated Epipaleolithic* partially overlaps with that of the armature-based assemblages (Sauveterrian-like). Both *facies* occur sometimes in the same region (Campania, Calabria[5] and Sicily) and, in two cases, at the same site: Grotta della Serratura (Southern Campania: Martini 1993) and Perriere Sottano (Eastern Sicily: Aranguren & Revedin 1998); at these sites the two *facies* occur in distinct and superimposed levels. The cultural framework of the Mesolithic in Southern Italy includes also the Epiromanellian, a *facies* restricted to southern Apulia (Salento), characterized by the high amount of micro and hypermicro circular end-scrapers associated with abundant backed tools. The chronology of the Epiromanellian is still based on stratigraphic evidence because of the lack of radiocarbon dates (Martini & Tozzi 1996).

Unlike the other Mesolithic *facies*, whose technology is mainly aimed at microbladelet and microflake production for making backed tools and geometrics, employing quite repetitive reduction methods, the *Undifferentiated Epipaleolithic* assemblages are characterized by an expedient technology resulting in a macrolithic and unstandardized production of broad (sometimes thick) and asymmetric flakes. The retouched toolkit consists of a large amount of common tools, in particular notches, denticulates and scrapers, often made with a rough retouch, sometimes inverse. Borers and splintered pieces are generally frequent, while backed bladelets and geometric microliths are very few or absent.

The main key sites for these facies are: Riparo Blanc – lower levels (Southern Latium) (Taschini 1964 and 1968), Grotta della Serratura layers 5-4 (Southern Campania) (Martini 1993), Su Coloru, Porto Leccio and Sa Coa de Sa Multa (Sardinia) (see Martini & Tozzi 2012 also for the detailed references), Perriere Sottano-lower level (Sicily) (Aranguren & Revedin 1998).

The Mesolithic industries from Grotta della Madonna show some evident similarities with those of Riparo Blanc–lower levels and Grotta della Serratura-layers 5-4. According to the available radiocarbon dates, the first two phases of the Mesolithic frequentation of Grotta della Madonna are chronologically placed between the other two sites (Tab. 4) although the absolute chronology of SU 657 (phase 2) is much closer to that of Riparo Blanc.

As regards the lithic productions at these three sites some comparisons may be proposed:

1) regarding the technological features and the raw material economy a comparison is provisionally possible only on the basis of the few data inferred from the available publications. All the three sites seem to share a main common technological scheme aimed at the coarse production of unstandardized flakes through the exploitation of pebbles (also of poor quality chert) collected not far from the site. The *chaînes opératoires* are marked by a general low investment that seems to involve raw material procurement, core reduction and blank transformation.

2) The typological structures (*sensu* Laplace) are quite similar in all the three industries: the common tool category has high percentages mainly due to the high frequencies of notches, denticulates and scrapers. Similarities are stronger between Grotta della Madonna and Riapro Blanc: the moderate presence of micro short end-scrapers, as well as the very low percentages of burins and truncations and the moderate quantity of splintered pieces. The typological structure of the assemblages of Grotta della Serratura are less similar. The presence of rare microliths (2.1% in total) is significant (a hypemicro backed point, a backed bladelet and a crescent), however the percentage is lower than the already small amount at Grotta della Madonna (5.4% in phase 1 and 15.2% in phase 2). As stated above, at Grotta della Madonna the non-occasional presence of armatures represents a peculiarity among the assemblages of the *Undifferentiated Epipaleolithic*. At Riparo Blanc armatures seem to be absent in the *in situ* deposit, even though Taschini (1964) underlines the presence of a marginal retouched microbladelet ("Dufour-like" according to Taschini). Six microliths, including a double-backed point, were found in the disturbed areas at the top of the Pleistocene deposit underlying the Mesolithic level, but the relationship with the *Undifferentiated Epipaleolithic* assemblage cannot be proved (on this topic see also Martini 1993 & Broglio 1971).

3) As regards the stylistic features, besides a general poor accuracy in tool manufacture, other specific characters, shared by most of the *Undifferentiated Epipaleolithic* assemblages, should be pointed out: marked denticulation made by single blow removals; denticulates with deep adjacent notches on the same edge forming a short pin (whose result is a sort of borer); frequent inverse retouches; marginal and partial retouch in scrapers, occurrence of sporadic very small retouched pebbles. In particular, precise comparisons between Grotta della Madonna and Riparo Blanc may be emphasized as regards the morpho-dimensional and stylistic features of the short end-scrapers that are present with sub-circular and nail-shaped types, micro and hypermicro in size.

The occurrence, during the Early Holocene, of non-laminar industries with a low technical investment and poor in microliths is also attested in several regions of the Mediterranean basin from the Iberian peninsula to Cyprus (e.g., Martini 1993; Perlès 1990, 1999, 2003; Alday 2006; Mihailovic 2009). It involves lithic assemblages that cannot be traced back to a common matrix, but are indicative of a widespread trend in lithic productions that has its roots in the different local Paleolithic substrates (Martini 2002). Although similar patterns of resource exploitation can be sometimes identified (Perlès 2003) and several of these "macrolithic" assemblages have been found in coastal sites with evidence of more or less abundant marine resource consumption, the emergence of these assemblages cannot be explained only by functional and/or economic issues, related to marine resource (molluscs in particular) exploitation, as suggested by some scholars (e.g., Bietti 1984; Perlès 2003; Kozłowski 2005; Alhaique & Bietti 2007; Franco 2011). At Grotta della Serratura, for example, where the *Undifferentiated Epipalaeolithic* overlies the Sauveterrian, no changes in the economic system have been noted; in both *facies* subsistence is based on hunting medium-large mammals

5 As regards the Sauveterrian in Calabria see Marini *et al.* in this volume about the new evidences of the Mesolithic industries at Riparo del Romito.

supplemented by the exploitation of marine resources. The substantial difference in the lithic industries cannot be therefore attributed to a shift in the economic strategies, but to other factors including technological behaviors referable to different cultural backgrounds. Regarding this issue, other examples outside Italy can be mentioned: in Spain, notch and denticulate industries (called Muescas y Denticolatos), similar to those of the Italian *Undifferentiated Epipaleolithic*, occur at the same time of microlith-based assemblages (e.g., Alday 2006); in this case too functional hypotheses are not sufficient to explain the coexistence of different Mesolithic stone assemblages in the same region. As in Italy, also in Spain the archaeological record from carefully excavated sites offers a more articulated picture with different Mesolithic techno-complexes, whose emergence might be due to a multiplicity of factors among which distinct cultural identities should also be contemplated.

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Article

Grotta del Santuario della Madonna at Praia a Mare (Cosenza, Italy): ritual pits and combustion structures. Spatial organization, fauna and lithic industries of the Mesolithic levels (2008-2011 excavations)

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Key words

- Grotta del Santuario della Madonna at Praia a Mare
- Calabria
- Heart
- Pit ritual
- Animal remains
- lithic industry

Parole chiave

- Grotta del Santuario della Madonna a Praia a Mare
- Calabria
- Focolare
- Fossa rituale
- Resti animali
- Industria litica

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Summary

This paper presents the results of the study of the Mesolithic structures recovered during the 2008-2011 field seasons. These include a combustion structure and several small post-holes in SU 582, a pit (SU 638) and a hearth (SUs 641-652) with adjacent charcoal-rich area (SU 657). The structures differ in morphology and content, although all of them yielded animal bone remains, malacofauna and tortoise shells. However, the quantity of bone remains and the ratio among species as well as the fragmentation of the specimens are considerably variable. Such variables characterize the structures evidencing their different functions. Considering as a whole the remains it contained (including a wolf hemi-mandible and posterior distal limb of a badger), the pit SU 638 has been interpreted as a "ritual pit" or, in any case, a pit used in propitiatory rituals. Among the lithic industry any selection of particular tools occours in the structures. The lithic assemblage, is referable to the Undifferentiated Epipalaeolithic an Early Holocene facies spread in South-Central Italy, Sicily and Sardinia-Corsica, between the 10th and the 8th millennium cal. BC.

Riassunto

Si presentano i dati relativi allo studio delle strutture mesolitiche rinvenute nelle campagne di scavo 2008-2011. Si tratta di una struttura di combustione e di una serie di piccole buche di palo in SU 582, di una fossa (SU 638) e di un focolare (SU 641-652) con annessa un'area carboniosa (SU 657). Le strutture sono diverse per morfologia e per contenuto, anche se in tutte sono stati rinvenuti resti ossei animali, malacofauna e gusci di tartarughe. La quantità dei resti ossei e i rapporti tra le specie variano sensibilmente, così come la frammentazione dei resti. Queste variabili caratterizzano le strutture mettendo in evidenza le loro differenti finalità. La fossa SU 638, per l'insieme dei reperti in essa contenuti (tra i quali un'emimandibola di lupo e una zampa posteriore di tasso), viene interpretata come una"fossa rituale" o comunque adibita a riti propiziatori. Lo studio dell'industria litica non rivela selezioni di particolari strumenti litici nelle strutture. L'insieme litico è riferibile all'Epipaleolitico indifferenziato, una facies diffusa nel Centro-Sud Italia, Sicilia e Sardegna-Corsica, tra il X e l'VIII millennio cal. BC.

Redazione: Giampaolo Dalmeri

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Fiore I., Lo Vetro D., Pino Uria B., Tagliacozzo A., 2016 - Grotta del Santuario della Madonna at Praia a Mare (Cosenza, Italy): ritual pits and combustion structures. Spatial organization, fauna and lithic industries of the Mesolithic levels (2008-2011 excavations). *Preistoria Alpina*, 48: 199-214.

Introduction

This article presents the results of the most recent investigations carried out by the Soprintendenza al Museo Nazionale Preistorico Etnografico L. Pigorini in the Mesolithic levels of Grotta del Santuario della Madonna at Praia a Mare (Cosenza, Italy). The history of the researches, the stratigraphy of the cave and the results of AMS 14C dating are reported in Tagliacozzo *et al*. (this volume). The most recent levels of the Mesolithic occupation appear to be partially disturbed by the installation of Middle Neolithic structures. The presence of Neolithic pits and post holes appears less evident starting from SU 548 and disappears in the underlying SU 582 (see stratigraphic section in Fig. 3, Tagliacozzo *et al*. 2016 this volume).

The most significant Mesolithic palaeosurfaces and structures discovered during the excavations, as well as the preliminary considerations regarding the faunal remains and the associated lithic industries, will be described in detail (Tabs 1-3). SU 582 is characterized by the presence of a complex combustion structure and by a series of small sized post holes. The combustion structures continue in the underlying levels (SUs 614, 628). One pit (SU 638/637, ca. 7200 cal BC) is deeply depressed; it has an oval shape in the upper part becoming more round in the lower portion, and contained faunal remains (red deer, roe deer, wild boar, a complete distal limb of a badger and a wolf hemi-mandible). Another hearth consists of a central circular part (SU 641), made of two superimposed levels of stones with abundant charcoal and burned bones. Around the hearth there is a well-defined charcoal-rich area (SU 657, ca 7900-8400 cal BC), a real shell midden, rich in malacofauna remains (terrestrial and marine) as well as fragments of tortoise carapace, plastron and bones, some of them still in anatomical connection.

Method

The taxonomic and skeletal identifications made in this study are based on the reference collections of the Laboratorio di Bioarcheologia of the Museo Nazionale Preistorico-Etnografico "L. Pigorini" (Rome, Italy). Microscopic analyses of the bone surfaces were carried out using a Nikon 1000 stereomicroscope with a 20x-220x magnification range.

In order to identify the nature of the surface alterations on the bones, and to distinguish human traces from those produced by animals, trampling abrasion, etc., reference was made to the well-established taphonomic literature (Binford 1981; Brain 1981; Potts and Shipman 1981; Shipman 1981; Shipman and Rose 1984; Blumenshine & Selvaggio 1988; Capaldo & Blumenshine 1994; Lyman 1994; Blumenshine 1995; Fisher 1995). The degree of combustion was evaluated employing the methodology developed by Stiner *et al*. (1995). The study of the bone industry has followed Legrand & Sidéra (2007).

Sex and age at death were determined in order to reconstruct exploitation strategies of the different species (Aitken 1974; Mariezkurrena 1983). Measurements were taken following von den Driesch (1976). In order to evaluate species abundance, the following indexes were used: number of identified specimens (NISP) (Grayson 1984), minimum number of elements (MNE) (Binford 1981; Klein & Cruz-Uribe 1984; Stiner 1994), and the estimate of the minimum number of individuals (MNI) (Bökönyi 1970).

The study of the lithic production was carried out following the stratigraphic sequence. All the artifacts have been studied and classified in order to reconstruct the core reduction sequences, the raw material procurement strategy and the typological features.

Results

Palaeosurface SU 582

SU 582, excavated 9 m^2 - depth 6/9 cm, represents the most recent preserved palaeosurface related to the Mesolithic frequentation (Fig. 1). It is characterized by archaeological material in horizontal deposition (limpets, top snails, lithic industry, and bones) and by the presence of a complex combustion structure (SUs 602-615), a more simple hearth (SU 604) and some post holes (SUs 592-594-596-598). Such post holes are of small size (diameter variable between 6 and 9 cm) and seem to follow a regular outline. One of them (SU 594) was coated with red-orange clay. The hearth of the complex combustion structure is a shallow pit (SU 602 ; L 20 cm, W 20 cm, D 10 cm ca.), filled by two different levels: a lower one made of stones and charcoal-rich soil (SU 612) and an upper one with more charcoal-rich and cineritic sediment (SU 603). In continuity with the hearth there is a cooking surface, slightly depressed (SU 615; L 50 cm, W 30 cm), made of medium-small stones with traces of exposure to fire and residues of ash and charcoal. Close to the hearth, spots of sediment very rich in charcoal have also been discovered (SUs 617 and 619), representing residues of the cooking activity.

SU 612 8782 ± 45 BP (uncalibrated 14C date); 8200-7600 BC (Calibrated using the OxCal model).

Lithic assemblage

The lithic assemblage from SU 582 and related structures (ca. 900 artifacts.) includes mainly unmodified knapping debris (ca. 47% of the total assemblage) and asymmetric squat flakes (ca. 37%) made from pebbles (radiolarite, flint and siliceous limestone) that were collected locally on the shore and in riverbeds. Regardless of the raw material, the shape and the size of the blanks is not standardized. Blades and bladelets are very few (less than 2%). Five cores for flake production (Fig. 2, n. 1), almost all made on little pebbles, are also present.

Sixty five retouched tools (ca. 7% of the total assemblage) are present, most of them are common tools such as denticulates and scrapers made on broad flakes (Fig. 2, n. 11-18), sometimes with inverse retouch (Fig. 2, n. 13, 16). Borers (Fig. 2, n.11), truncations and splintered pieces also occur. Specialized tools consist of hyper-micro- (up to 15 mm) and micro- (16-25 mm) short end-scrapers (some of them sub-circular) (Fig. 2, n. 2-5) and hyper-micro- and micro-backed-tools (Fig. 2, n. 6-10), among which a double backed point (a non-canonical Sauveterre point) occurs (Fig. 2, 7). The lack of blade cores and other technological elements related to a specific technological lamellar scheme might suggest that these micro-backed tools were brought to the site as finished products.

The presence of microlithic backed tools is reasonably related to hunting, while it is likely that scrapers, denticulates and borers were used to perform other domestic activities. Some unretouched flakes show clear micro-removals along one edge suggesting the use of these crude blanks.

Fauna

The hearth area and the charcoal-rich ones immediately adjacent to it, yielded 114 faunal remains; 71 (62% ca.) of them were unidentifiable: mainly small flakes that were burnt or showed traces of exposure to fire (Tabs 1-3). Mammals are represented by 17 remains of wild ungulates: wild boar and red deer are more frequent than roe deer, while carnivores are absent. Wild boar remains may be referred to 3 individuals: 2 juveniles (for the presence, among the others, of a fragment of lower deciduous canine and a newly erupted lower P3) and an adult. Those of red and roe deer may be referred to a single adult individual each. The presence of an upper M2 of roe deer allowed to assess an age of 3 - 5 years. Ungulates are represented by very rare cranial elements and loose teeth, rare long bone

diaphyses, and more frequent distal limb bones. Several specimens show butchery marks, especially fracturing; some percussion cones are also present suggesting that bone fracturing occurred close to the hearth. Rare bird remains are also present; 2 fragments of a right ulna shaft and a right distal humerus have been attributed to a medium sized Columbiformes, *Columba livia/oenas*. Two other remains belong to Passeriformes of different size: a left radius shaft of a large Corvidae, common raven (*Corvus* cf. *corax*), and a right humerus

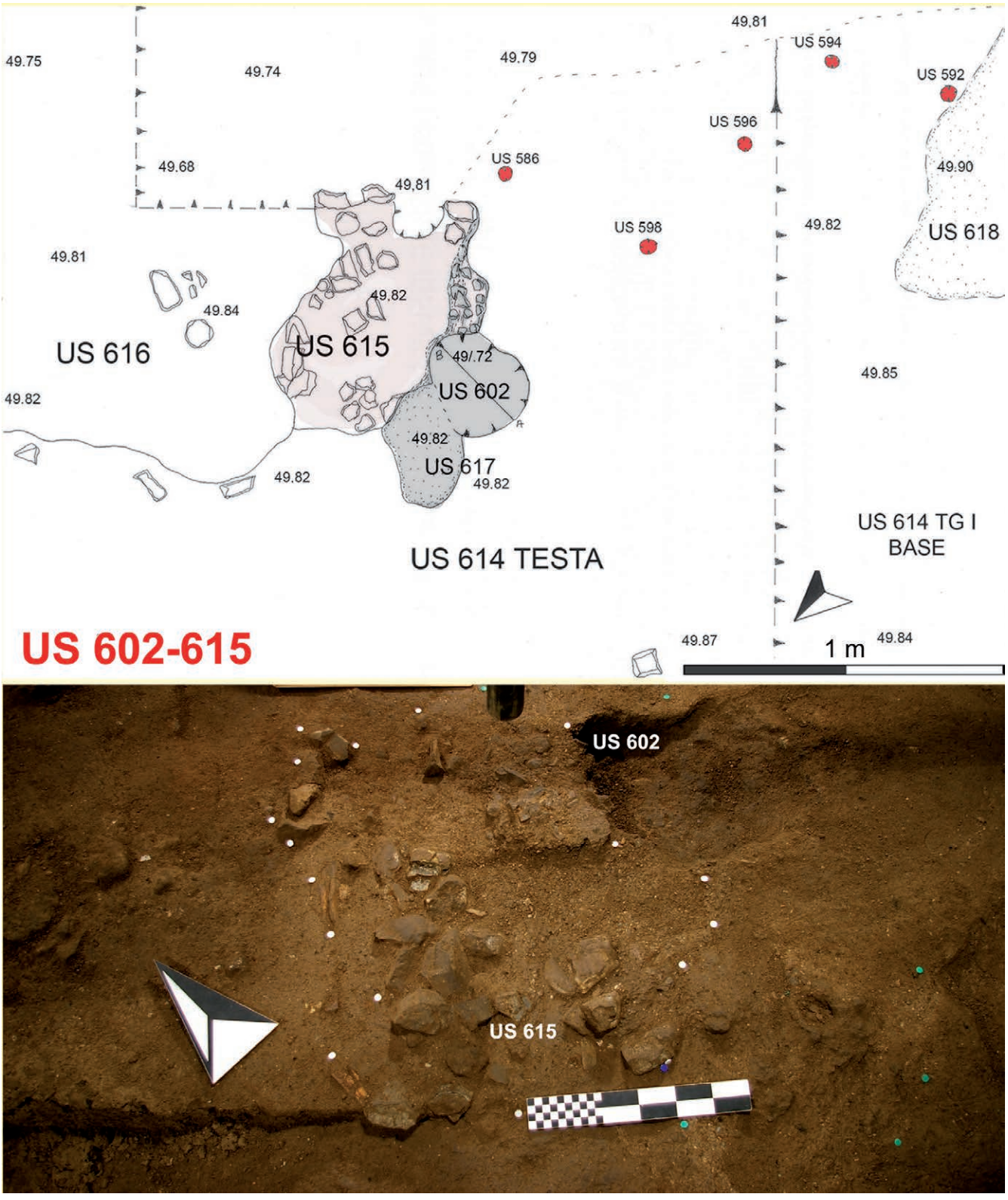

Fig. 1 *- Grotta del Santuario della Madonna – Palaeosurface SU 582 : combustion structure (SUs 602-615), level rich in ash and charcoal with post holes (SUs 592-594-596-598). / Livello US 582 : struttura di combustione (USs 602-615), livello ricco di cenere e carbone (US 617) e buche di palo (USs 592-594-596-598).*

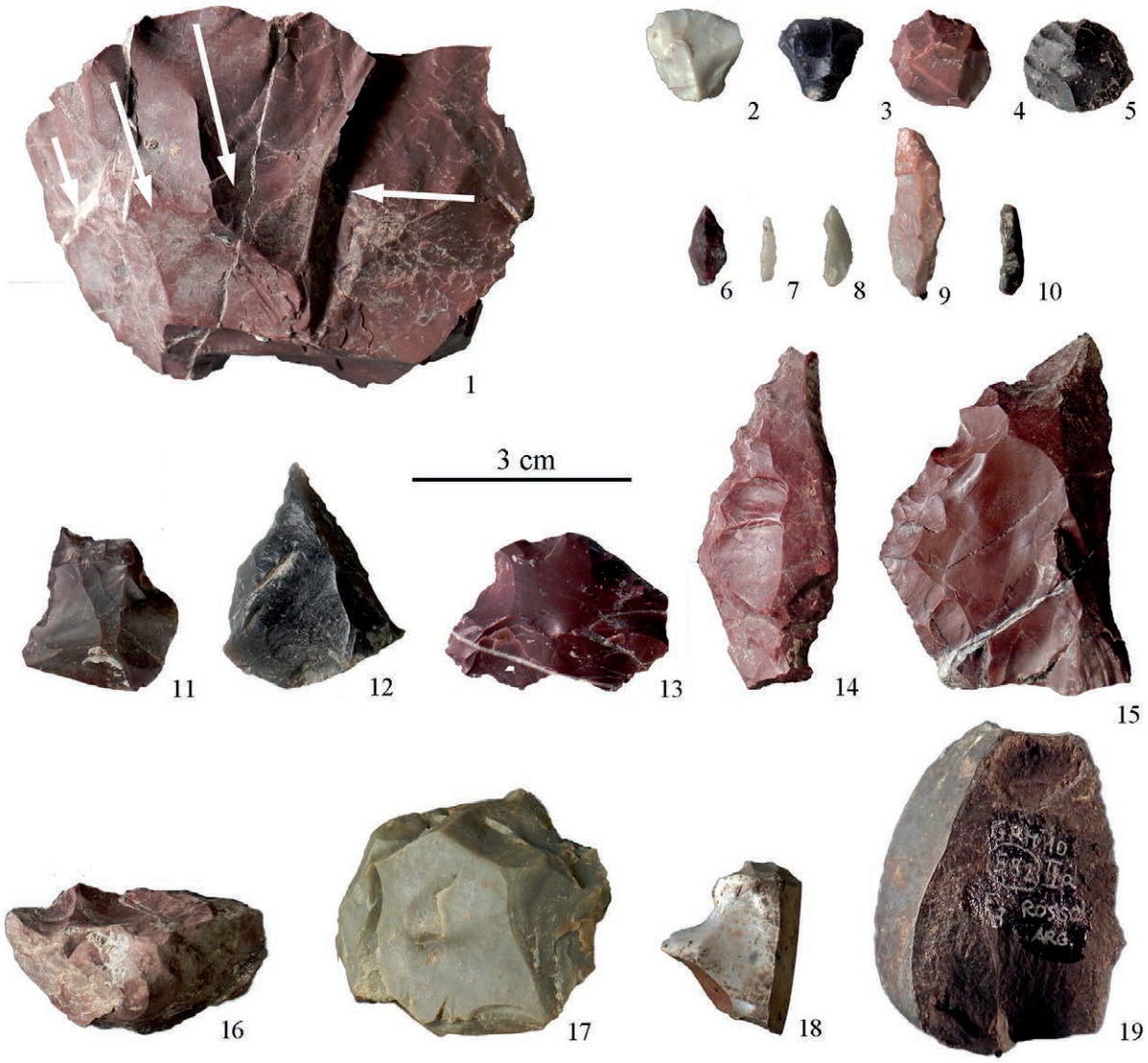

Fig. 2 *- Grotta del Santuario della Madonna – Lithic artifacts from palaeosurface SU 582 and related structures. 1, core; 2-5, micro short end-scrapers; 6, partial backed point; 7-9, total backed points (n. 7 double backed); 10, backed bladelet; 11, borer; 12, notch; 13-16, denticulated scrapers (n. 13 and 16 with inverse retouch); 17-18, denticulated end-scrapers; 19, unretouched flake. / Industria litica dalla paleosuperficie US 582 e relative strutture. 1, nucleo a schegge; 2-5, grattatoi corti microlitici; 6, punta a dorso parziale; 7-9, punte a dorso totale (n. 7 a dorso bilaterale); 10, lamella a dorso; 11, becco; 12, incavo; 13-16, raschiatoi denticolati (nn. 13 e 16 a ritocco inverso); 17-18, grattatoi denticolati; 19, scheggia non ritoccata.*

of a small sized Passeriformes of the Hirundinidae family, crag martin (cf. *Ptyonoprogne rupestris*). The dove ulna displays scrape marks on the dorsal face (Fig. 3), some of them are long and longitudinal, others are short and oblique to the *Papillae remigales.* Only the diaphyseal portion of the radius of the common raven is preserved with fractured and burned ends; combustion affects all the fracture edges for a few millimeters; some feeble superficial striae referable to a lithic tool have also been identified. The traces on the two bird diaphyses may indicate the exploitation of the bone as raw material rather than butchery/consumption. The scrape marks on the ulna may have a double interpretation and be related also to the procurement of feathers. Fish remains are rare and the malacofauna is scarce with few limpets and some land gastropods. On the edges of some limpets traces of old removals have been detected, probably related to their gathering.

Hard animal tissue artifacts

An anterior portion of the diaphysis of a red deer tibia displays fracture edges that cannot be just related to simple fragmentation produced during butchery. The specimen shows a species of tang ending with a rectilinear base, while the opposite end affects the whole width of the tibia. On the edge of such end and on one of the lateral edges, that was intentionally thinned, use wear traces have also been detected, traces of cutting of soft material remains (study in progress).

Tab. 1 - Grotta del Santuario della Madonna - Number of animal remains from the different SUs. / Numero di resti animali provenienti dalle diverse USs.

TAXA	US 617 /619	US 612 /602	US 615	US 637	US 641	US 642	US 643	US 652	US 657	Total Remains	
	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	NISP	%
Mammals											
Wolf (*Canis lupus*)				1						1	*0,1*
Badger (*Meles meles*)				21					1	22	*1,2*
Carnivore				2	1	1				4	*0,2*
Wild boar (*Sus scrofa*)	4	1	2	18	4	5			13	47	*2,5*
Red deer (*Cervus elaphus*)	1	1	4	7	1	5	1		17	37	*2,0*
Roe deer (*Capreolus capreolus*)	1	1	1	3		4			2	12	*0,6*
Cervid	1									1	*0,1*
Total NISP	**7**	**3**	**7**	**52**	**6**	**15**	**1**		**33**	**124**	***6,5***
Micromammals	3			30	17	21	12	3	25	111	*5,9*
Total Mammals	**10**	**3**	**7**	**82**	**23**	**36**	**13**	**3**	**58**	**235**	***12,4***
Testudines											
Pond tortoise (*Emys cf. orbicularis*)				8	10	10	2		96	126	*6,6*
Hermann's tortoise (*Testudo hermanni*)				5	6	6			27	44	*2,3*
Testudines	2			10	10	4	3		61	90	*4,7*
Total Testudines	**2**			**23**	**26**	**20**	**5**		**184**	**260**	***13,7***
Others											
Vertebrate											
Aves	3	1		3					1	8	*0,4*
Anphibia/Reptilia				1						1	*0,1*
Pisces				5	4				2	11	*0,6*
Invertebrate											
Echinoidea (sea-urchin)				2						2	*0,1*
Total others	**3**	**1**		**11**	**4**				**3**	**22**	***1,2***
Mollusca											
Columbella rustica	3					2				5	*0,3*
Monodonta sp.				19	1	6	1		19	46	*2,4*
Patella sp.	10			77	14	106	6		151	364	*19,2*
Glycymeris sp.									1	1	*0,1*
Terrestrial Gastropoda	5			79	64	53	10		277	488	*25,8*
Total Mollusca	**18**			**175**	**79**	**167**	**17**		**448**	**904**	***47,7***
Total Identified	**33**	**4**	**7**	**291**	**132**	**223**	**35**	**3**	**693**	**1421**	***75,0***
Unidentified											
Large mammal - cranial				2			2		1	5	*0,3*
Large mammal - axial				2					3	5	*0,3*
Large mammal - appendicular		1		3	1	3			7	15	*0,8*
Medium mammal - cranial				1	1				2	4	*0,2*
Medium mammal - axial		1		25		2			15	43	*2,3*
Medium mammal - appendicular				24	5	3	1		13	46	*2,4*
Unidentifiable	45	24		82	16	61	24		104	356	*18,8*
Total Unidentified	**45**	**26**		**139**	**23**	**69**	**27**		**145**	**474**	**25,0**
Total Remains	**78**	**30**	**7**	**430**	**155**	**292**	**62**	**3**	**838**	**1895**	**100,0**

Tab. 2 - Grotta del Santuario della Madonna - Number of animal remains (Identified and Unidentified) and minimum number of individuals grouped by structure. / Numero di resti animali (determinati e indeterminati) e numero minimo di individui raggruppati per struttura.

TAXA	STRUCTURES IN US 582		US 637		USS 641-652		US 657	
	NISP	%	NISP	%	NISP	%	NISP	%
Mammals								
Wolf (*Canis lupus*)			1	*0,23*				
Badger (*Meles meles*)			21	*4,88*			1	*0,12*
Carnivore			2	*0,47*	2	*0,39*		
Wild boar (*Sus scrofa*)	7	*6,14*	18	*4,19*	9	*1,76*	13	*1,55*
Red deer (*Cervus elaphus*)	6	*5,26*	7	*1,63*	7	*1,37*	17	*2,03*
Roe deer (*Capreolus capreolus*)	3	*2,63*	3	*0,70*	4	*0,78*	2	*0,24*
Cervid	1	*0,88*						
Total NISP	**17**	***14,91***	**52**	***12,09***	**22**	***4,30***	**33**	***3,94***
Micromammals	3	*2,63*	30	*6,98*	53	*10,35*	25	*2,98*
Total Mammals	**20**	***17,54***	**82**	***19,07***	**75**	***14,65***	**58**	***6,92***
Testudines								
Pond tortoise (*Emys cf. orbicularis*)			8	*1,86*	22	*4,30*	96	*11,46*
Hermann's tortoise (*Testudo hermanni*)			5	*1,16*	12	*2,34*	27	*3,22*
Testudines	2	*1,75*	10	*2,33*	17	*3,32*	61	*7,28*
Total Testudines	**2**	***1,75***	**23**	***5,35***	**51**	***9,96***	**184**	***21,96***
Others								
Vertebrate								
Aves	4	*3,51*	3	*0,70*			1	*0,12*
Anphibia/Reptilia			1	*0,23*				
Pisces			5	*1,16*	4	*0,78*	2	*0,24*
Invertebrate								
Echinoidea (sea-urchin)			2	*0,47*				
Total Others	3	*2,63*	**11**	*2,56*	4	*0,78*	**3**	*0,36*
Mollusca								
Columbella rustica	3	*2,63*			2	*0,39*		
Monodonta sp.			19	*4,42*	8	*1,56*	19	*2,27*
Patella sp.	10	*8,77*	77	*17,91*	126	*24,61*	151	*18,02*
Glycymeris sp.							1	*0,12*
Terrestrial Gastropoda	5	*4,39*	79	*18,37*	127	*24,80*	277	*33,05*
Total Mollusca	**18**	***15,79***	**175**	***40,70***	**263**	***51,37***	**448**	***53,46***
Total Identified	**43**	***37,72***	**291**	***67,67***	**393**	***76,76***	**693**	***82,70***
Unidentified								
Large mammal - cranial			2	*0,47*	2	*0,39*	1	*0,12*
Large mammal - axial			2	*0,47*			3	*0,36*
Large mammal - appendicular	1	*0,88*	3	*0,70*	4	*0,78*	7	*0,84*
Medium mammal - cranial			1	*0,23*	1	*0,20*	2	*0,24*
Medium mammal - axial	1	*0,88*	25	*5,81*	2	*0,39*	15	*1,79*
Medium mammal - appendicular			24	*5,58*	9	*1,76*	13	*1,55*
Unidentifiable	69	*60,53*	82	*19,07*	101	*19,73*	104	*12,41*
Total Unidentified	**71**	***62,28***	**139**	***32,33***	**119**	***23,24***	**145**	***17,30***
Total Remains	**114**	***100,00***	**430**	***100,00***	**512**	***100,00***	**838**	***100,00***

Tab. 3 - Grotta del Santuario della Madonna - Number of identified animal remains and minimum number of individuals grouped by structure. / Numero di resti animali determinati e numero minimo di individui raggruppati per struttura.

TAXA	STRUCTURES IN US 582			US 637			USS 641-652			US 657		
	NISP	%	MNI	NISP	%	MNI	NISP	%	MNI	NISP	%	MNI
Wolf (*Canis lupus*)				1	*0,40*	1						
Badger (*Meles meles*)				21	*8,40*	1				1	*0,15*	1
Carnivore				2	*0,80*		2	*0,60*	1			
Wild boar (*Sus scrofa*)	7	*18,92*	3	18	*7,20*	2	9	*2,68*	2	13	*1,95*	2
Red deer (*Cervus elaphus*)	6	*16,22*	1	7	*2,80*	1	7	*2,08*	2	17	*2,56*	1
Roe deer (*Capreolus capreolus*)	3	*8,11*	1	3	*1,20*	1	4	*1,19*	1	2	*0,30*	1
Cervid	1	*2,70*										
Total Mammals	**17**	***45,95***	***5***	**52**	***20,80***	***6***	**22**	***6,55***	***6***	**33**	***4,96***	***5***
Pond tortoise (*Emys cf. orbicularis*)				8	*3,20*	2	22	*6,55*	4	96	*14,44*	7
Hermann's tortoise (*Testudo hermanni*)				5	*2,00*	1	12	*3,57*	4	27	*4,06*	3
Testudines	2	*5,41*	1	10	*4,00*		17	*5,06*		61	*9,17*	
Total Testudines	**2**	***5,41***	**1**	**23**	***9,20***	**3**	**51**	***15,18***	**8**	**184**	***27,67***	**10**
Columbella rustica	3	*8,11*	3				2	*0,60*	2			
Monodonta sp.				19	*7,60*	12	8	*2,38*	8	19	*2,86*	10
Patella sp.	10	*27,03*	6	77	*30,80*	55	126	*37,50*	70	151	*22,71*	90
Glycymeris sp.										1	*0,15*	1
Terrestrial Gastropoda	5	*13,51*	2	79	*31,60*	7	127	*37,80*	15	277	*41,65*	27
Total Mollusca	**18**	***48,65***	***8,00***	**175**	***70,00***	**74**	**263**	***78,27***	**95**	**448**	***67,37***	**128**
Totale Remains	**37**	***100***	**14**	**250**	***100,00***		**336**	***100,00***		**665**	***100,00***	

A rib fragment belonging to a medium sized animal shows a pointed and rounded end.

Three pierced shells of rustic dove snails (*Columbella rustica*) have been recovered. One of them, particularly well preserved, allows to observe the working traces produced for making the hole, initially by pressure followed by widening, and to detect use wear traces on part of the edge (Fig. 4, 5, a, b). The other two rustic dove shells appear fragile, whitish and with pulverulent surface; such deterioration may have been due to exposition to a heat source. The holes were found on the largest coil and have a quadrangular shape.

Such artifacts are often considered as ornaments, for jewels or for decorating clothes, but it is also possible that they had a more utilitarian purpose, for example as buttons.

Pit SU 638

Particularly distinctive is the pit (SU 638; L 58 cm; W 56 cm, D 7/9 cm) excavated in the palaeosurface SU 628, this unit has been investigated for 3,5 m^{2}ca.(depth 4/6 cm) (Fig. 5). Such pit has initially an oval shape that becomes more round towards its base. The filling (SU 637R) is made of silty sediment with abundant medium-small stones and contains abundant faunal remains and lithic industry. The excavation was carried out by artificial cuts and particularly significant is the content of cut III/IV, corresponding to the first depositional level, where there seems to be a selection of faunal elements. In fact, in addition to remains of red deer and wild boar, there are a wolf mandible, a complete distal posterior limb of a badger, and several shells of limpets and top snails (Tabs 1-3).

SU 637 TGII: 8135 ± 45 BP (uncalibrated 14C date); 7200-7040 and 7310-7210 BC (Calibrated using the OxCal model).

Fig. 3 - Grotta del Santuario della Madonna – 1, dove ulna with scrape marks on the dorsal face: 2, detail of the striae. / 1, ulna di colomba con tracce da raschiamento sulla faccia dorsale; 2, dettaglio delle strie.

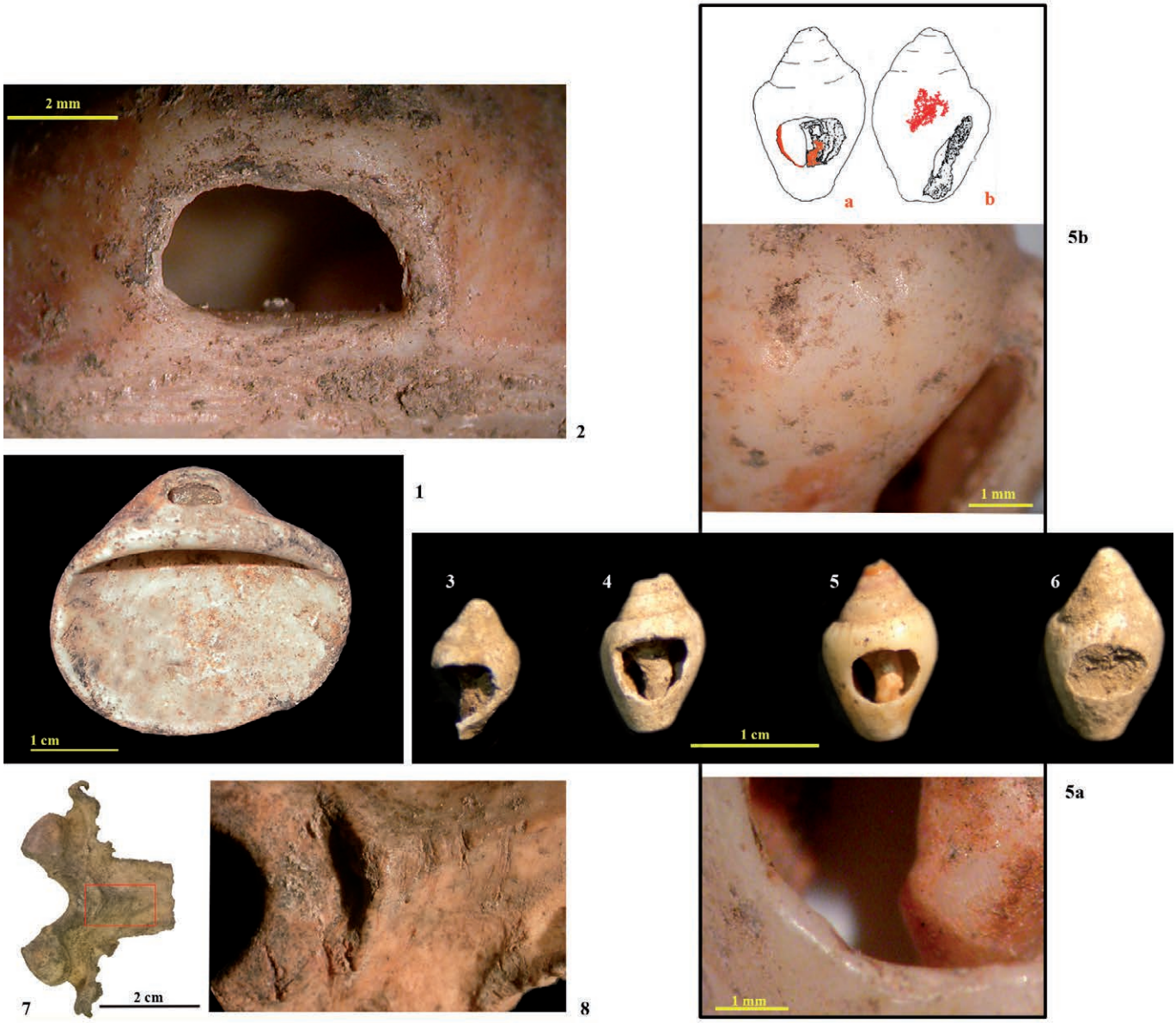

Fig. 4 - Grotta del Santuario della Madonna – 1, Pierced Glycimeris sp. shell; 2, detail of the hole; 3-6, pierced shells of rustic dove snails; 5 a-b, detail of use-wear traces on shell n. 5, a (red) localization of use-wear traces on the hole and detail, b (red) rounding and polishing due to use on the back of the shell and detail; 7, fragment of badger skull with cut marks; 8, detail of cut marks. / 1, Glycimeris sp. forata ; 2, dettaglio del foro; 3-6, conchiglie forate di columbella; 5 a -b, dettaglio delle tracce di usura sulla conchiglia n. 5, a (rosso) localizzazione delle tracce d'usura nel foro e ingrandimento al microscopio, b (rosso) localizzazione delle tracce di arrotondamenti dovute all'uso nella parte posteriore della conchiglia e ingrandimento al microscopio; 7, frammento di cranio di tasso con tracce di macellazione; 8, dettaglio dei tagli di macellazione.

Lithic assemblage from pit SU 638

The filling (SU 637) of the pit SU 638 yielded scanty lithic material (41 items) for the most part consisting of some unretouched coarse flakes and debris. Among the formal tools there are a multiple burin on flake, a truncation on irregular blade, four scrapers and a notch, all made on broad and asymmetric flakes. Two residual cores (flint) and a flake core made on a little radiolarite pebble are also present.

The raw material and the techno-typological features of the lithic assemblage from pit SU 638 are comparable with those of SU 582 and do not show any peculiar feature that would suggest a selection in the lithic material deposition.

Fauna

Over 430 specimens have been collected (Tabs. 1-3). Twenty-eight remains belong to ungulates, mainly wild boar (NISP 18); red deer is scarcer (NISP 7) and roe deer is rare (NISP 3). There are remains of an adult wild boar (fused distal metatarsal), of a young-adult one with an age of 12-18 months (maxilla with M1, unfused vertebral discs, and unfused acetabulum) as well as of a single adult individual each for red and roe deer.

The wild boar is represented by two remains of maxilla and mandible, 8 fragments of ribs and vertebrae, 2 pelvis portions, two fragments of ulna, one of fibula and 4 belonging to distal limb bones.

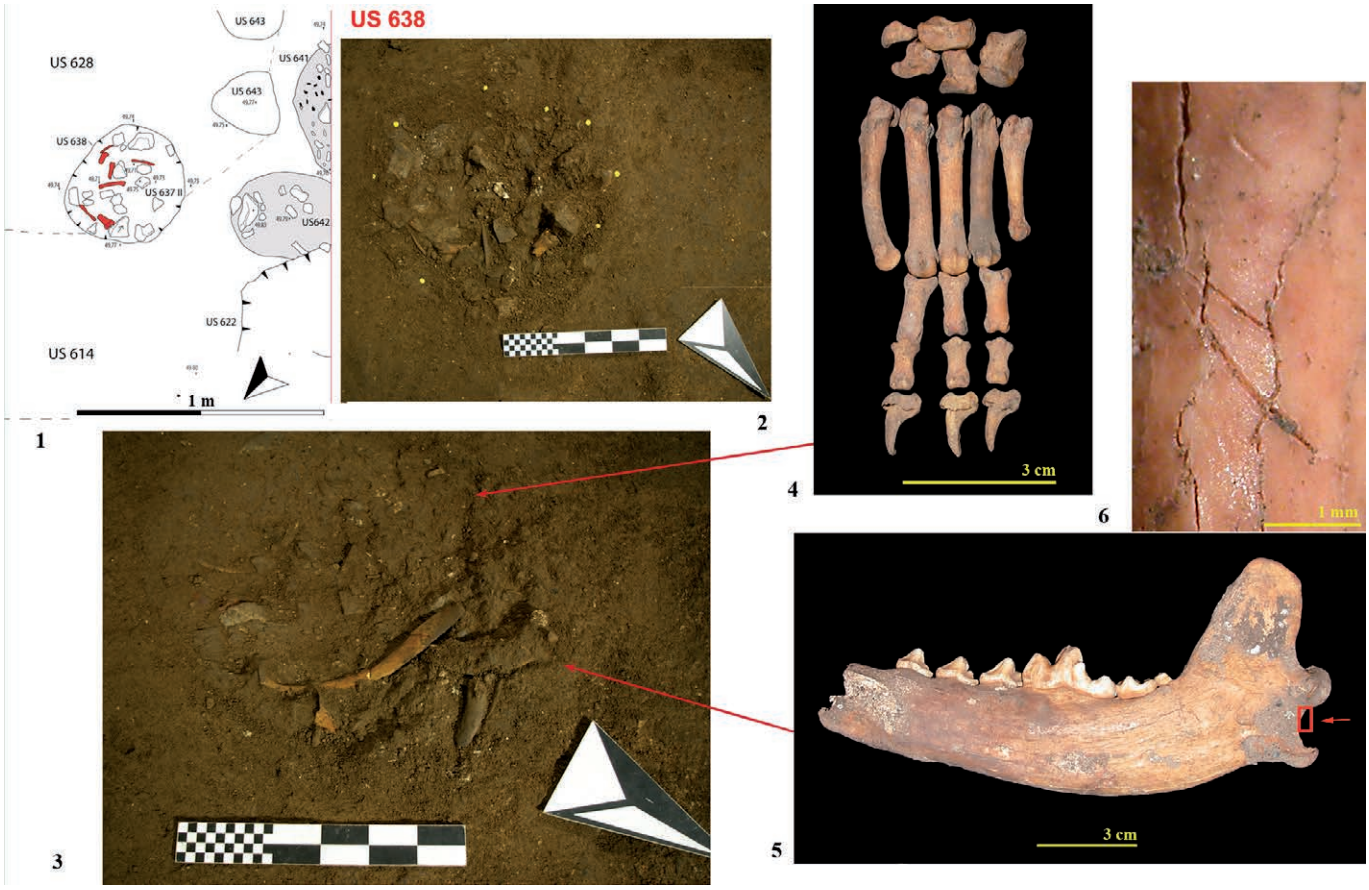

Fig. 5 *- Grotta del Santuario della Madonna – 1-3, pit SU 638; 4, left posterior distal limb of badger; 5, right hemi-mandible of an adult-senile wolf; 6, detail of the cuts on the hemi-mandible, referable to its disarticulation from the cranium. / 1-3, fossa US 638; 4, zampa posteriore sinistra di tasso; 5, emimandibola destra di lupo adulto senile; 6 dettaglio dei tagli sull'emimandibola riferibili a disarticolazione dal cranio.*

The elements are referable to both the right and left side of the animal and among the wild boar sized unidentifiable remains there are frequent fragments of long bone diaphyses and of trunk elements. Red deer is present with rare remains of maxilla with peeling traces, fragments of distal limb bones and some ribs, one of them complete. Roe deer is documented only by a distal metacarpal, a pelvis and an antler fragment.

Many specimens display localized burning traces. Butchering marks are represented by artificial cuts and impacts, several fragments display the distinctive traces of green bone fracture, and peeling traces, while gnaw marks have been detected on the roe deer pelvis.

Furthermore, in pit SU 638 there are also the remains of two carnivores: the wolf, with a complete right mandible, and the badger, with a whole left posterior distal limb. Two other remains of indeterminate medium-small sized carnivore, a caudal vertebra and a fragment of third phalanx, have been recovered close to the edge of the pit.

Birds are represented by 3 undetermined fragments. An ulna diaphysis of a large sized bird shows a longitudinal stone tool cut mark, a clear distal fracture and a triangular pointed end. Such features may be interpreted as related to the procurement of raw material rather than to simple butchery.

Furthermore, in pit SU 638 there are large portions of carapace and plastron of both pond and terrestrial tortoises, referable to at least 3 individuals.

Shells of limpets are abundant (MNI 55), while top snails (MNI 12) and terrestrial gastropods (MNI 7) are more rare. A *Monodonta* specimen presents dark marks located on one half of the shell; unfortunately the fragment is fractured just in the part with the traces. On one side of the fracture some longitudinal lines are preserved; these intersect each other forming a grid; on the other side only few oblique lines are preserved (Fig. 6). Specific analyses are in progress in order to define the nature of the traces identified on this specimen.

Some limpet shells display lateral removals on the edge produced during the gathering activity. The presence of three shells showing clear-cut fracture edges and rectilinear outline should also be emphasized; such modifications could have been produced by the use of these shells as side or end scrapers; future researches will help to clarify this aspect.

It is also worth mentioning the presence of fish and sea urchin remains.

Wolf

The right hemi-mandible belonged to an adult-senile wolf (*Canis lupus*), probably a male individual considering the large size (Fig. 5, nn. 5-6). The surfaces of the specimen are covered by concretion and show longitudinal cracking suggesting a long exposure to weathering agents before burial. The element is almost complete and preserves the whole ascending ramus while in the mandibular branch only the anterior symphysis is missing, damaged in ancient times. The P2-M3 dental series is preserved, but the distal portion of the last tooth is broken. The P1 is absent, but its alveolus is completely preserved, while the alveolus of the canine is incomplete and filled with sediments and concretions. Therefore, it is not possible to exclude that the symphysis was intentionally fractured in the past just to extract the canine, that is actually absent. The element, considering the general dimensions, shows a body of the mandible that is particularly robust and massive, especially for its thickness.

Some measurements of the specimen are reported (in mm). Between parentheses the numbering system used by von den Driesch (1976).

Height of the mandible behind M1 (19): h 30.22 - Thickness of the mandible behind M1: 15.30;

M1: L 28.71 - B 10.9;

Length of the premolar row P1-P4, measured along the alveoli (11): L 49.43;

Length of the molar row M1-M3, measured along the alveoli (10): L 44.30;

Length of the cheek- tooth row P1-M3, measured along the alveoli (8): L 92.80;

Height of the vertical ramus (18): 65.8;

Length from the condyle process to the aboral border of the canine alveolus (4) 148.52;

Length from the indentation between the condyle process and the angular process to the aboral border of the canine alveolus (5): 132.26.

From a comparison of this mandible with others referable to the Evolved and Final Epigravettian of South-Central Italy, the specimen resulted to be similar in size to one from the "Terre Brune" of Grotta Romanelli (Lecce) and smaller than the two from Palidoro (Rome). The length of the lower M1 falls within the average range of modern boreal wolf. The most evident traces of human handling are those referred to the fracturing for the extraction of the canine and to the stone tool cut marks located on the lateral face below the condyle, referable to the disarticulation of the mandible from the cranium. A light burning trace affects the anterior portion of the mandible, from the alveolus of the canine to M1 on both faces.

Badger

The left posterior distal limb of the badger (*Meles meles*) includes 21 remains of metatarsals, phalanges, and sesamoids and was recovered in anatomical connection (Fig. 5, n. 4). It is almost complete, cut at the level of the distal tibia, and preserves the two rows of the tarsals and the metatarsals, while some phalanges are absent. There are no evident traces of human modifications with the exception of a light combustion and slight wear affecting the proximal metatarsals. The completeness of the limb end and the way it was recovered suggest the intentional deposition of the paw still with part of the soft tissues and the pelt. The badger is a plantigrade, and the limbs are long, large and with long and robust claws used for digging and defense. The anterior portion is covered by a blackish fur, while the plantar side is hairless and shows a large central pad, corresponding to the metatarsals, and five smaller ones of the digits. The paw recovered had a size of about 6 -7 cm. It probably represented an ornament or an amulet rather than the residue of a pelt since sometimes the paws remain attached to it. This hypothesis is supported both by the combustion traces localized on the proximal metatarsals and by the wear detected on the same elements. Such modification may indicate the will to clean and preserve the object (combustion) and its persistent manipulation (wear) that affected mainly the part of the bones that were not covered anymore by the skin, once the paw was severed from the rest of the limb.

Hard animal tissue artifacts

A medium ungulate shaft fragment displays at one end micro-retouches produced by use and a series of notches in the medullary portion related to bone tool manufacturing (Fig. 7). It presents use wear traces both at its end and on one edge. A roe deer antler tine portion shows some rounding traces at the end, but it is not sure if these are related to actual use by humans or to natural causes.

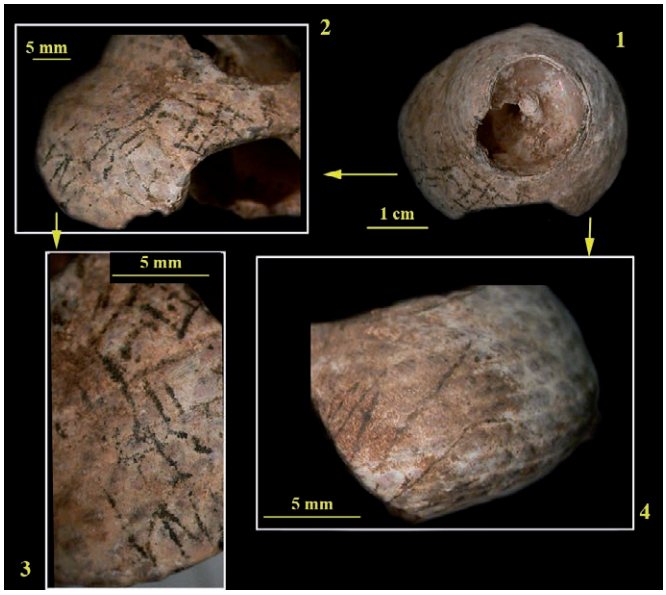

Fig. 6 *- Grotta del Santuario della Madonna – 1, fragment of Monodonta shell with dark marks; 2-4, details of the dark marks. / 1, frammento di Monodonta sp. con linee di colore scuro; 2-4, dettaglio delle linee.*

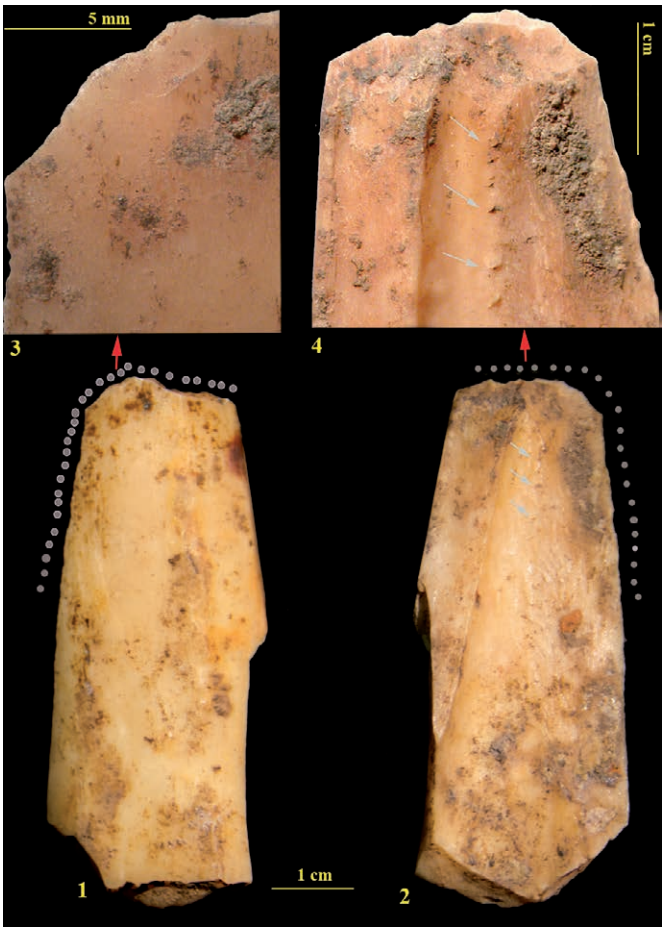

Fig. 7 *- Grotta del Santuario della Madonna – 1-2, shaft fragment with micro-retouches at one end and a series of notches on the medullary face. Use wear traces are present both at its end and on one edge; 3, detail of use-wear traces; 4, detail of notches. / 1-2, frammento di diafisi con microritocchi su un'estremità e una serie di tacche nella porzione midollare, presenta tracce di uso su un'estremità e su uno dei margini; 3, dettaglio delle tracce d'uso 4, dettaglio delle tacche.*

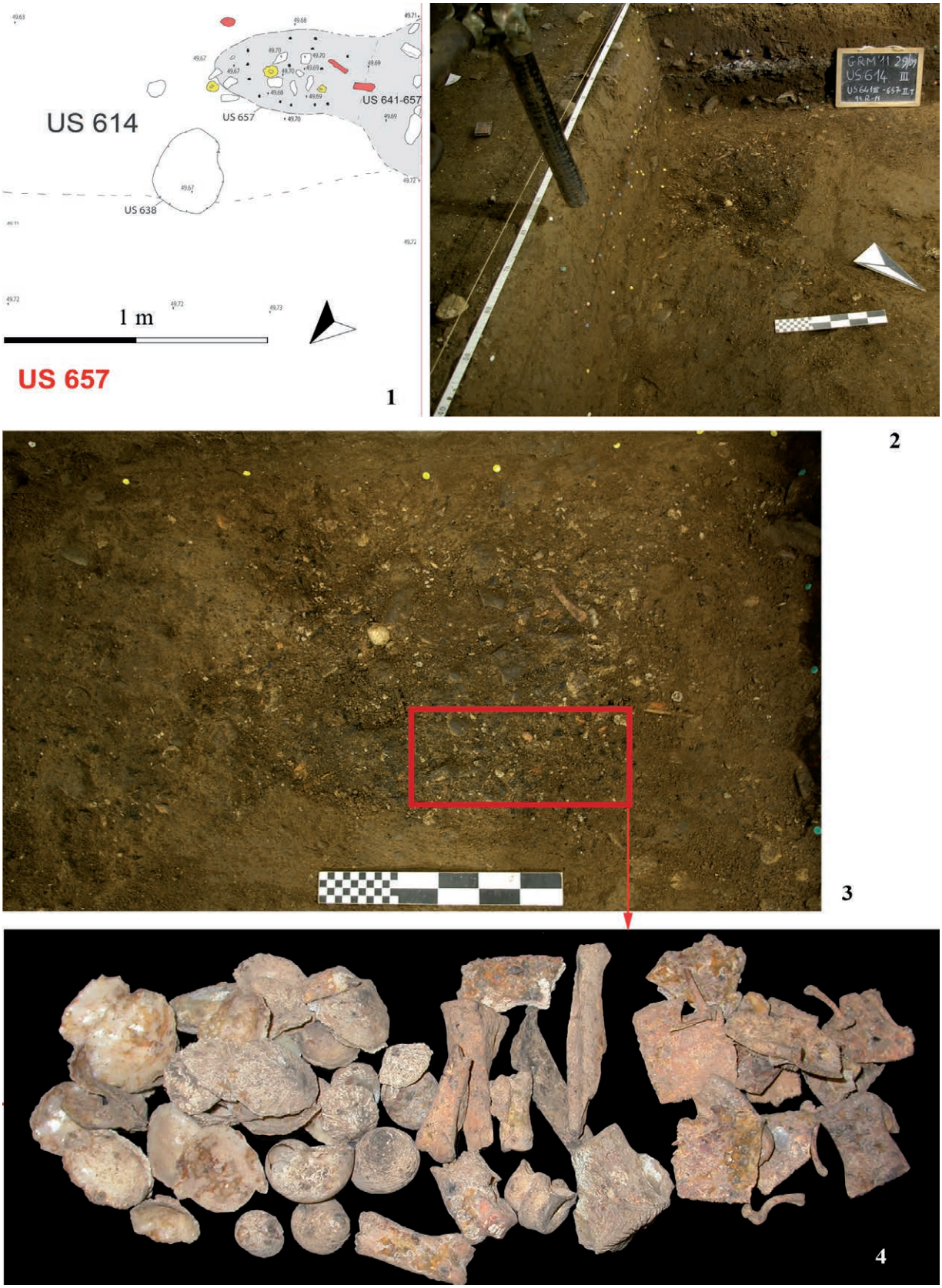

Fig. 8 *- Grotta del Santuario della Madonna – 1-3, Shell midden SU 657; 4, high concentration of terrestrial gastropod fragments and limpet shells, abundant remains of tortoises, rare remains of ungulates. The bones from the area marked with red rectangle. / 1-3, Chiocciolaio US 657; 4, alta concentrazione di gasteropodi terrestri e patelle, abbondanti resti di tartaruga, rari resti di ungulati. Resti ossei proveniente dall'area del rettangolo rosso.*

For the uniqueness of the species identified and of the anatomical elements (in particular the association between the wolf hemi-mandible and the badger paw that is unknown in other Mesolithic structures) the remains recovered at the base of the pit may represent an intentional deposition for a specific purpose and not just discarded food debris.

Structure SUs 641-642-657

In the occupation level SU 614,excavated 9 m^2 ca - depth 15-18 cm (IV cuts), there is a wide combustion area (SUs 641-642-657), identified on the basis of the characteristics of the sediment and the concentration of materials. The hearth is represented by SU 641 made of two layers of medium-small stones, containing granular sediment, produced by exposure to fire, as well as numerous small charcoal fragments and burnt bones. Adjacent to the hearth there is an area (SU 642) of brown-reddish granular clay, with small and medium stones, rich in charcoal, fauna (in particular large portions of tortoise carapace and plastron, some of them in anatomical connection, and limpets), and lithic industry. Unfortunately both the hearth and its adjacent area continue under the trench wall, outside the excavated area, and therefore it was not possible to investigate them completely. SU 643 and SU 652 are sub-units that have been associated to SUs 641-642 (L 200 cm, W 57 cm, D 6/8 cm). In the portion of the deposit that was possible to observe, there is an area around the hearth (SU 657, L 68 cm, W 40 cm, D 6/8 cm), made of clayey-carbonaceous sediment, that is rich in charcoal, and has a concentration of food debris in particular malacofauna (terrestrial and marine) as well as large portions of tortoise carapace and plastron, with rare mammal bones and some burned stones in the center.

SU 657 TGI–II 9076 ± 45 BP (uncalibrated 14C date); 8350-8220 BC (Calibrated using the OxCal model). SU 657 TGIII 8878 ± 45 (uncalibrated 14C date); 8230-7910 BC (Calibrated using the OxCal model)

Lithic assemblage from structure SU 641-642-657

A total of forty lithic items comes from this combustion area. Debris and unretouched flakes are prevalent, only seven formal tools (a burin, 3 denticulates, 2 splintered pieces and an undeterminable retouched fragment) and one residual core were found. In this structure the lithic assemblage shows the same techno-typological features of the other SUs and there is no peculiarity which may suggest a specific selection of the artifacts.

Fauna

The different stratigraphic units forming the combustion structure have been analyzed separately (Tabs 1-4), but, considering both the proximity of the different areas and the low number of specimens in each unit, they have been combined in order to allow general considerations. The three different areas that form the combustion structure seem to be characterized by the presence of different animal species.

SU 641: 155 faunal remains have been recovered: almost exclusively tortoises, both pond and terrestrial ones, with localized combustion traces. The remains are referred to only 3 individuals: one terrestrial and two pond tortoises. There are numerous fragments of terrestrial gastropods, that are difficult to correlate to a precise MNI because of the high fragmentation, and rare limpet shells corresponding to about ten individuals. Wild boar (NISP 4) and red deer (NISP 1) remains are extremely rare and distal limb elements are almost exclusively present, although among the unidentifiable remains there are rare fragments of long bone diaphyses. Fishes are represented by 4 elements.

SU 642: 292 faunal remains have been recovered: abundant remains of malacofauna (NISP 167), mainly limpets (NISP 106), less frequent top snails (NISP 6) and terrestrial gastropods (NISP 53). There are rare remains of red and roe deer, wild boar and tortoise; an element belonging to a small indeterminate carnivore is also present.

The two SUs 643 and 652 are characterized by the presence of rare faunal remains (Tab. 1).

On the whole the hearth yielded 512 faunal remains, over half of them are mollusks (Tab. 2), the remains of ungulates are rare (20 specimens) representing 2 wild boars (a juvenile and an adult male), 2 adult red deer and one adult roe deer. Carnivores are represented by a caudal vertebra and a fragment of 3rd phalanx. The unidentifiable specimens include small undeterminable flakes, some of them burnt. The tortoises are represented by 8 individuals (4 pond and 4 terrestrial tortoises); mollusks include at least 95 individuals: limpets are very abundant with 70 individuals, while top snails and terrestrial gastropods are less frequent. The two rustic dove snail shells are pierced.

SU 657: there is a high concentration of terrestrial gastropod fragments (NISP 277), so much fragmented that the estimate of the minimum number of individuals is 27; numerous limpet shells, corresponding to 151 fragments for a total of 90 individuals, and more rare top snails, with 19 fragments belonging to 10 individuals, were also recovered. Abundant remains of tortoises (NISP 181), frequently with clear cooking traces, have been identified. The pond tortoise prevails with 96 fragments corresponding to 7 individuals, many of them in large portions with the limb long bones still articulated; the terrestrial tortoise is more rare with 27 fragments and 3 individuals.

There are rare remains of ungulates (NISP 33). This is the only structure where the red deer remains (NISP 17) identified are prevalent over wild boar ones (NISP 13), however, if we consider the individuals, wild boar is represented by two animals (a juvenile and an adult) while red and roe deer only by a single adult each. Wild boar is represented only by distal limb bones (especially metapodials and phalanges). Among the red deer specimens distal limb bones are prevalent as well, but also the other limb elements are present. Roe

Tab. 4 *- Grotta del Santuario della Madonna - Number of animal remains and minimum number of individuals grouped by classes and structure. / Numero di resti animali e numero minimo di individui raggruppati in classi e per struttura.*

TAXA	US 582		US 637		USS 641-652		US 657	
	NISP	MNI	NISP	MNI	NISP	MNI	NISP	MNI
Total Mammals	17	*5*	52	*6*	22	*6*	33	*5*
Total Testudines	2	1	23	3	51	8	184	10
Total Mollusca	18	*8*	175	74	263	95	448	128
Total Remains	37	14	250	83	336	109	665	143
TAXA %	%	%	%	%	%	%	%	%
Total Mammals	45,9	35,7	20,8	7,2	6,5	5,5	5,0	3,5
Total Testudines	5,4	7,1	9,2	3,6	15,2	7,3	27,7	7,0
Total Mollusca	48,6	57,1	70,0	89,2	78,3	87,2	67,4	89,5

deer is present with a metatarsal portion and a phalanx fragment. Some elements with butchering marks (striae and impact), mainly red deer specimens, rare percussion cones and frequent fragments with localized combustion traces have also been identified.

Furthermore, there is a fragment of badger skull with cut marks (Fig. 4, n. 7-8).

Among the unidentifiable mammal bones those of medium sized animals are prevalent, while fragments belonging to larger sized mammals are more rare. Small indeterminable flakes are frequent, most of them burnt. Fish and bird remains are extremely rare.

Hard animal tissue artifacts

There are a distal end of a very thin awl on an indeterminate long bone shaft and another awl made on a metatarsal shaft of roe deer with only the point modified. There are also two pierced shells: one of rustic dove snail (SU 642) and one of *Glycimeris* (SU 657, Fig. 4, n. 1-2).

On the whole the combustion structure appears as a true and typical Mesolithic shell midden, a place with accumulation, around a hearth, of food debris mainly related to gathering (terrestrial and marine mollusks, tortoises) rather than hunting activities (not whole animals were consumed, but among the ungulate remains metatarsals and phalanges are prevalent: portions with low content of edible parts). Unfortunately only a small portion of the area could be investigated, therefore it is not possible to establish for sure if the remains represent the residues of several occupations by a small group of people or of a single "banquet". However, considering the number of tortoises recovered, at least 17, within an area that represents only a small portion of the shell midden, it is more likely that this is the resulting from several repeated occupations of the same place.

Discussion

The faunal remains from the different structures include a total of 1894 specimens; for about 73% of them it was possible to define genus and species. This very high number of identified specimens is due to the abundance of mollusks, some of them extremely fragmented (Tab. 1).

The structures are characterized by the presence of a different quantity of faunal remains varying from 114 (6%) in SUs 582 to 838 (44% ca.) in SU 657 (Tabs. 1-4, Fig. 9) Furthermore, among the structures it is possible to detect differences in the animal species composition as well as in their quantitative ratios.

Medium-large sized mammals are represented by 124 specimens; there are rare remains of carnivores (wolf and badger) and more frequent wild ungulates among which wild boar is prevalent with 47 remains, followed by red deer with 37 and, less abundant, roe deer with 12 specimens. The MNI estimate confirms the data obtained from the number of remains: wild boar is always prevalent with at least 9 individuals followed by red and roe deer with, respectively, 5 and 4 individuals (Tab. 1). The age estimate was based mainly on the degree of epiphysis fusion in long bones, because teeth were very rare. Wild boars are represented mainly by young/young-adult individuals (MNI 5), among which a 12-18 months old one, documented by a maxilla, provides also an indication of the season of capture: between the end of the spring and the beginning of autumn. Adults, with an age over 3-4 years, are less represented (MNI 4); among them at least one male individual was identified, besides a fragment of lower canine, also on the basis of the large size of some distal metapodials. Red deer remains belong mainly to adults, as indicated by the degree of fusion of metapodials and phalanges. However, there is at least one young-adult individual, less than 3 years old, as indicated by a fragment of proximal femur that is just fusing. Roe deer is represented only by adult animals; among them there is one 3-5 years old individual identified from a not very worn upper left M1 (SU 615).

The carnivores, represented by wolf and badger, are present with rare remains referable to adult animals. The association between the wolf mandible and the complete badger paw in structure 637/638 represents an *unicum* in the scenario of the Italian Mesolithic. Furthermore, in this pit the remains have been found arranged in a coherent and not chaotic way as it would be in a simple dump of food residues; this is supported also by the position of the metapodials and the ribs of the ungulates. It is therefore possible to hypothesize an intentional deposition of selected remains of carnivores and ungulates that were considered of particular interest.

The badger is present also in the shell midden (SU 657), with a posterior portion of the skull with stone tool cut marks referable to butchery. Other incomplete fragments, from SUs 641-642, are referred to a medium sized indeterminate carnivore (Tabs 1-3).

The indeterminate remains that allowed at least an attribution to animal size and anatomical portion are 118 and are mainly referable to medium sized mammals (wild boar and red deer). The unidentifiable items are 474 and include mainly long bone shaft fragments, some of which are burnt.

Although the investigated structures yielded relatively few mammal remains, the species identified and their ratios reflect more or less the faunal data from the Mesolithic levels of the excavations by L. Cardini (Cardini 1972, Fiore *et al*. 2004). In fact there are the three most hunted ungulate species (wild boar, red deer, roe deer). However, it is noteworthy - in the faunal association from the structures - the complete absence of bovids (aurochs, ibex and chamois) that are instead present, although with rare specimens, in the area excavated by Cardini. Finally it is possible to note also a decrease in the number of carnivore species in these contexts; in fact both wild cat and other mustelids are absent.

The presence of abundant micromammals, still under investigation, may evidence the existence of raptor roosts along the walls of the cave. However, no raptor remains have been identified in the fauna from the structures. Nevertheless, the presence of raptorial birds is intensely documented in the Mesolithic layers of the excavations by Cardini. In fact the remains of at least 6 species of diurnal raptors (Accipitriformes and Falconiformes) have been identified; some of these, such as the Northern goshawk (*Accipiter gentilis*) and the Common buzzard (*Buteo buteo*) frequent rock walls, cliffs and cavities (Gala *et al*. in this volume).

Rare bird remains have been recognized; these include a medium sized Columbiformes, *Columba livia/oenas* that, even now, is present in the cave with numerous individuals; the common raven (*Corvus* cf. *corax*) a largest Corvidae (between 55 and 70 cm long and with a wingspan that may almost reach 1.30 m) living in coastal areas with cliffs where it nests; a small sized Passeriformes of the Hirundinidae family, the crag martin (cf. *Ptyonoprogne rupestris*), that builds its nest in rocky cliffs, in caves or under an overhanging rock. These remains, being of birds frequenting caves or cliffs, may therefore belong to birds that died of natural causes. However, both the dove ulna and the raven radius display anthropic traces that, rather than being produced during butchery or for meat consumption, may instead be interpreted as evidence for the exploitation of the bone as raw material or be related to the procurement of feathers.

The Testudinata are present with two species *Emys* cf. *E. orbicularis* (aquatic) and *Testudo hermanni* (terrestrial). For the presence in Sicily of the species *Emys trinacris* (Fritz *et al*. 2005), as regards the specific attribution of *E. orbicularis*, we preferred to use the name *E*. cf. *E. orbicularis*, although it is unlikely that in the sample analyzed there are remains belonging to the endemic Sicilian species (Pino Uria, Tagliacozzo 2008). A total of 260 remains has been identified; these include mainly fragments of carapace and plastron, but also limb long bones. Large portions of plastron with combustion traces have been recovered.

Notwithstanding the proximity to the coast, fish remains are rare and very rare are the amphibian specimens.

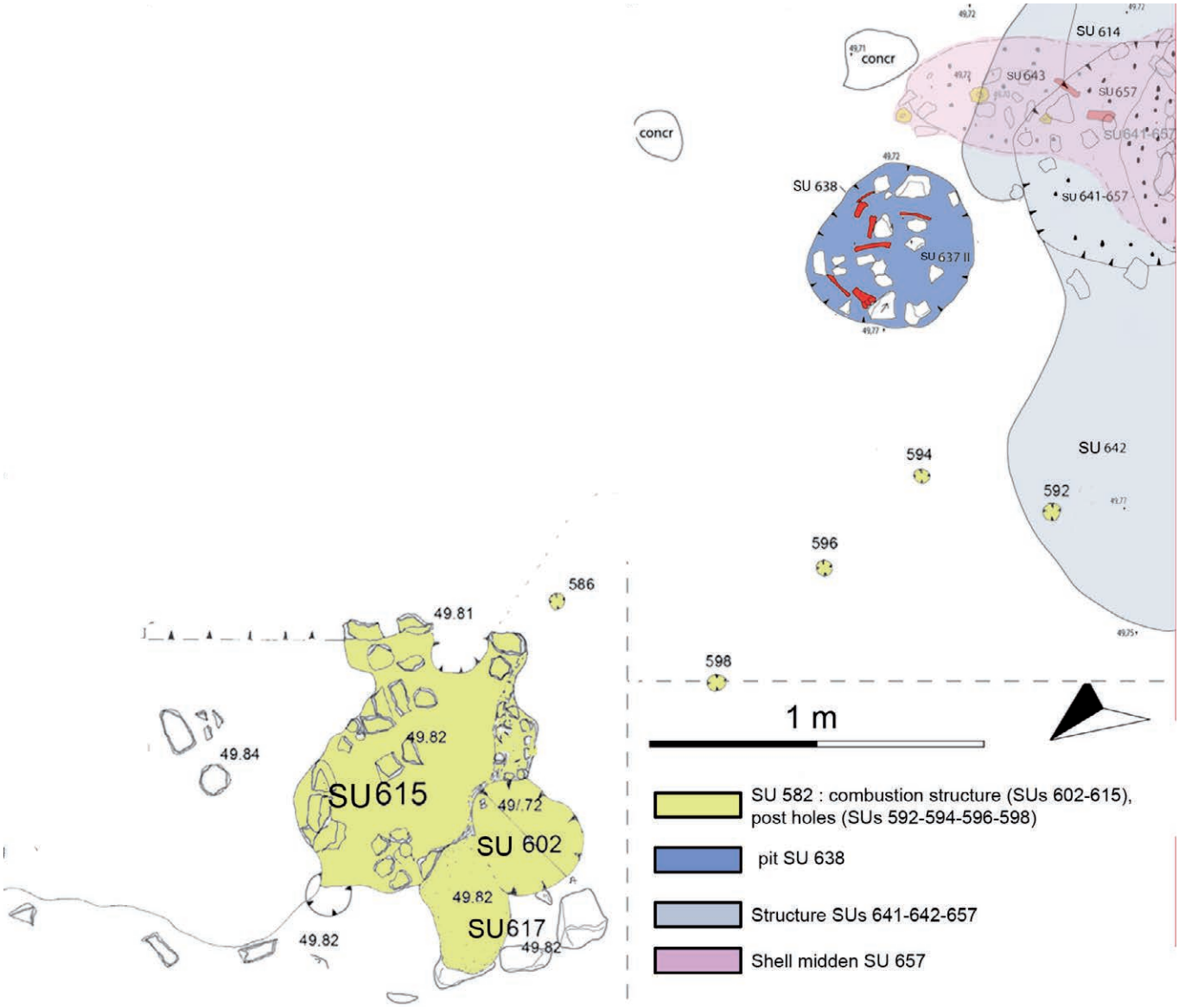

Fig. 9 *- Grotta del Santuario della Madonna – Plan of the structures identified on the investigated area. Stratigraphic relationships are not respected (from the bottom SU 657, SUs 641-642-657, SU 637/638, SU 582 level with SUs 602-615 and post holes). / Planimetria delle strutture identificate sull'area indagata. I rapporti stratigrafici non sono rispettati (dal basso US 657, USs 641-642-657, US 637, livello US 582 con USs 602-615 e buche di palo).*

Complete or fragmented mollusk shells represent 47% (NISP 904) of the faunal assemblage; such specimens are still being analyzed, but preliminary results will be synthesized here. Terrestrial gastropods are the most abundant mollusks (in particular *Helix* sp.); complete shells are very rare, while fragments, even very small ones, are numerous; this makes the estimate of the MNI very difficult (NISP 488 MNI 40/50?).

Among the marine Gastropods, there are many complete or large portions of shells of *Patella* sp. (NISP 364 - MNI 221?). These are referable mainly to P*. caerulea* and *P. aspera* and their dimensions are medium-small. Many shells display an edge with old fractures probably produced when a tool was used as a lever for removing the shell from the rocks during gathering. Other rare specimens show also rounded and possibly worn edges and it is not possible to exclude that some of them may have been used as tools. The shells of top snail Phorcus turbinatus (*Osilinus turbinatus = Monodonta turbinata*) are less frequent. Specimens with a broken top have been recovered; such fractures are old and probably were produced to extract the mollusk. Rustic dove snail (*Columbella rustica*) shells are rare, often pierced and used as ornament. Finally there are also some remains of echinoderms: spines of sea urchins.

The different structures reveal peculiarities on the basis of the quantity of remains, the species identified and the ratios among them (Tabs. 2, 3). Mollusks are always prevalent with the exception of the "structures in SU 582" where mammals are slightly more abundant. Mollusks are prevalent in pit SU 637, followed by mammals and rare tortoise fragments. The area of the hearths 642 - 652 and of the shell midden SU 657 are characterized by abundant mollusks and a good percentage of tortoises, while mammals are less represented. Considering the different distribution of the mammal species, carnivores were recovered in the ritual pit US 637/638 and in the shell midden 657 with particularly significant remains of wolf and badger, while in structure 641-652 there are a caudal vertebra and a fragment of 3rd phalanx of an indeterminate carnivore. The three ungulates are instead present in all the structures, with wild boar always prevalent with the exception of the shell midden where red deer is just a little bit more abundant.

Neither the number of remains nor the number of individuals are

representative of the importance of the different animals in the diet. In fact, although there are almost 300 mollusks compared to 22 tortoise individuals and 18 ungulates, these latter provide a quantity of meat and food noticeably higher than tortoises and mollusks, without taking into account the other products (hides, tendons, bones) that may be obtained from them. The accumulations of mollusks and tortoises, especially those around the shell midden, seem to represent, in any case, different and repeated short occupations during which most of the food was the resulting from gathering rather than hunting.

Conclusions

The study of the palaeosurfaces of the Mesolithic frequentation at Grotta del Santuario della Madonna at Praia a Mare evidenced the presence of several combustion structures (simple *cuvettes*, organized hearths with deposition of stones, cooking surfaces). The different structures seem to have played a different role considering the differences in spatial organization as well as and in the quantity of animal remains recovered and the ratios among species. In contrast, it was not possible to detect peculiar features in the structure and composition of the scarce lithic industry associated with them.

The structures in SU 582 (USs 602-603-612 and 615) represent a cooking area with stones reddened by fire, repeatedly used, and probably often cleaned. This hearth area displays higher frequency of mammal bones, although extremely fragmented and of small size, and rare malacofauna. The hearths 641-642 and 657, that show significant presence of tortoises and malacofauna with scarce mammal remains, may represent for the different position and faunal composition, a set of different episodes. But, more probably, they may reflect a real and typical Mesolithic shell midden, produced by several occupations repeated in the same place and with accumulation of food refuses resulting from gathering activities.

Particularly interesting is the pit SU 637/638 that, for the presence of selected bone remains in the basal fill, may indicate a propitiatory or ritual use, before it was filled with other material and food debris.

Overall the investigated area represents a zone of repeated and short frequentations, as suggested by the relatively low number of bone and lithic remains. The presence of distal limb elements suggests that the complete ungulate carcasses were brought back to the cave and the presence of rare percussion cones shows that butchery, disarticulation and marrow extraction activities that occurred close to the cooking areas were reduced. The almost complete absence of cranial remains and loose teeth may indicate that most of the ungulate butchery activities occurred either in another area of the cave or outside it.

Bone tools are rare, often just diaphyseal fragments barely modified and showing clear modifications only on the functional portion. It is not possible to exclude that some limpets had been used as scrapers because some shells display rounded edges that cannot be explained just as modifications produced during shell gathering or related to post depositional phenomena that were not detected on other specimens. Ornaments obtained from shells of *Columbella* and *Glycimeris* are also numerous.

The lithic assemblages from the Mesolithic structures of Grotta della Madonna (see also Tagliacozzo *et al*. this volume) do not show any peculiar feature that would suggest a selection in the deposition of the lithic material. On the whole, they may be referred to the Mesolithic *facies* known as Undifferentiated Epipaleolithic (Martini 1993) documented in some sites of Central and Southern Italy, Sicily and Corsica-Sardinia, between the last quarter of the 10th and the last quarter of the 7th millennium cal. BC (Lo Vetro & Martini 2016). This *facies* has been interpreted as the likely outcome of techno-typological trends that were already in progress at the end of the final Epigravettian in South-Central Italy. Its lithic production is characterized by: a) an expedient technology, based on local raw material exploitation using hard direct percussion; b) a high frequency of common tools (mainly notches, denticulates and scrapers), made on unstandardized flakes, roughly retouched; c) a very low amount of microliths (backed tools and geometrics).

In general, as far as the subsistence activity is concerned, the wide range of animal species exploited (ungulates, birds, terrestrial and pond tortoises, fish, marine and land mollusks) documents an excellent knowledge of the territory and of the variety of resources that it may have offered; resources that were systematically exploited by the hunter-gatherers living at Grotta della Madonna.

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Article

The raptors in the Mesolithic at the Grotta del Santuario della Madonna at Praia a Mare (Cosenza, Italy)

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Key words

- Calabria
- Southern Italy
- Falconiformes
- Strigiformes
- taphonomy
- human-raptor relationship

Parole chiave

- Calabria
- Italia meridionale
- Falconiformes
- Strigiformes
- tafonomia
- rapporto uomo-rapaci.

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Summary

Grotta del Santuario della Madonna at Praia a Mare, located in Northern Calabria, was continuously occupied from the Upper Paleolithic until the Middle Ages. Over 1,200 bird bones belonging to 50 species were found in the Mesolithic layer I. The rocky species are prevalent, mainly because of the high frequency of rock dove. Woodland and aquatic birds are also well represented. One of the features of this avian assemblage is the abundance of raptor remains (Falconiformes and Strigiformes). Previous taphonomic analyses on Paleolithic and Mesolithic aquatic bird bones (including also some diurnal raptors) evidenced many anthropic marks produced during carcass dismemberment and meat cooking for consumption. In order to continue and improve the study of the Mesolithic bird exploitation in this cave, further taphonomic investigations have been carried out on the raptor bones. The presence of a large number of anthropic traces (cut marks, impacts, polishes, peelings, arrachement, fractures, burning) allows hypothesizing that some of these birds were included in the diet of Mesolithic hunters-gatherers; furthermore, they were also captured in order to use the bones and the feathers for ornamental and/or symbolic purposes.

Riassunto

Grotta del Santuario della Madonna di Praia a Mare, localizzata nella Calabria settentrionale, è stata occupata continuativamente dal Paleolitico superiore fino al Medio Evo. Oltre 1.200 ossa appartenenti a 50 specie di uccelli provengono dal livello I del Mesolitico. Le specie che frequentano le pareti rocciose e falesie sono predominanti soprattutto per l'alto numero di resti di piccione selvatico. Gli uccelli dei boschi e acquatici sono ben rappresentati. Una delle caratteristiche del complesso ornitico è la presenza di molte specie di rapaci (Falconiformes e Strigiformes). Precedenti analisi tafonomiche condotte sulle ossa degli uccelli acquatici dagli strati paleolitici e mesolitici (tra i quali anche alcuni rapaci diurni) hanno evidenziato molte tracce antropiche prodotte durante il depezzamento della carcassa e la cottura della carne per consumarla. Al fine di continuare ed approfondire lo studio delle modalità di sfruttamento degli uccelli del Mesolitico di questa grotta sono state effettuate ulteriori indagini tafonomiche sulle ossa dei rapaci. La presenza di un gran numero di tracce antropiche (strie, impatti, politure, peeling, arrachement, fratture, combustioni) permette di ipotizzare che alcuni di questi uccelli siano stati inclusi nella dieta dei cacciatori-raccoglitori mesolitici oltre ad esser stati catturati per utilizzarne le ossa e le piume a scopo ornamentale e/o simbolico.

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Introduction

Since ancient times until the present days, raptors have always affected human imagination. Consider, for example, the role played in mythologies and in many religions of early civilizations in the Old World (Egyptians, Greeks, Romans), but also among the native Americans and the Incas. A symbolic value, strictly related to the myth of the foundation of the *Urbs*, was even assigned to the vulture remains recovered in the sacrificial deposit of the *Niger Lapis* in the area of the *Comitium* in the Roman Forum (Blanc & Blanc 1958). Human-raptor relationship presents numerous facets, that are difficult to understand only at a material level; however, some ethnographic examples show varied and complex uses of these animals by modern populations that may provide important clues for the archaeozoological interpretation. For example, specific vulture organs or portions were used for therapeutic purposes in Africa and in Israel, while in India and in Pakistan their meat was consumed (Dendaletche 1988). During the last few years, some archaeozoological researches tried to identify the earliest evidences of interactions between raptors and hunters-gatherers in order to understand the way these birds were acquired and exploited. In Italy and in Europe, the earliest evidences of anthropic traces on raptor bones date back to the Middle Paleolithic (and therefore *H. neanderthalensis*) and reveal human behaviors that may have also had a symbolic character. In fact the traces are localized on particular anatomical portions: wing and talon (Fiore *et al.* 2004a; Peresani *et al.* 2011; Morin & Laroulandie 2012; Romandini *et al.* 2014). The interest in the raptor wings is documented also in the early Gravettian of Grotta Paglicci where stone tool cut marks have been detected on humeri of cinereous vulture (*Aegypius monachus*) and kestrel (*Falco tinnunculus*) (Tagliacozzo & Gala 2004). It is only in the final Epigravettian, at Grotta Romanelli, that we find the largest number of information on the butchery and cooking techniques used for eagles, hawks, and owls; however, their exploitation only for alimentary purposes is not sure. In fact anthropic traces may indicate the use of these birds also for other purposes (procurement of feathers and down?) (Cassoli & Tagliacozzo 1997; Cassoli *et al.* 2003; Gala & Tagliacozzo 2010).

At Grotta della Madonna, one of the most important sites in Southern Italy, there are numerous raptor bones, in both the Upper Paleolithic and the Mesolithic levels. Therefore a research project was launched in order to clarify the way raptor carcasses were exploited.

This paper presents the results of the analyses carried out on the bones of 11 species of diurnal and nocturnal raptors found in the Mesolithic level of this large cave (about 40x50 m wide and 15 m high) opening on a cliff at about 500 m from the modern coastline (Fig. 1). The excavations, carried out by the Istituto Italiano di Paleontologia Umana of Rome (1957 - 1970), revealed an impressive archaeological deposit, over 8 m thick, characterized by several layers

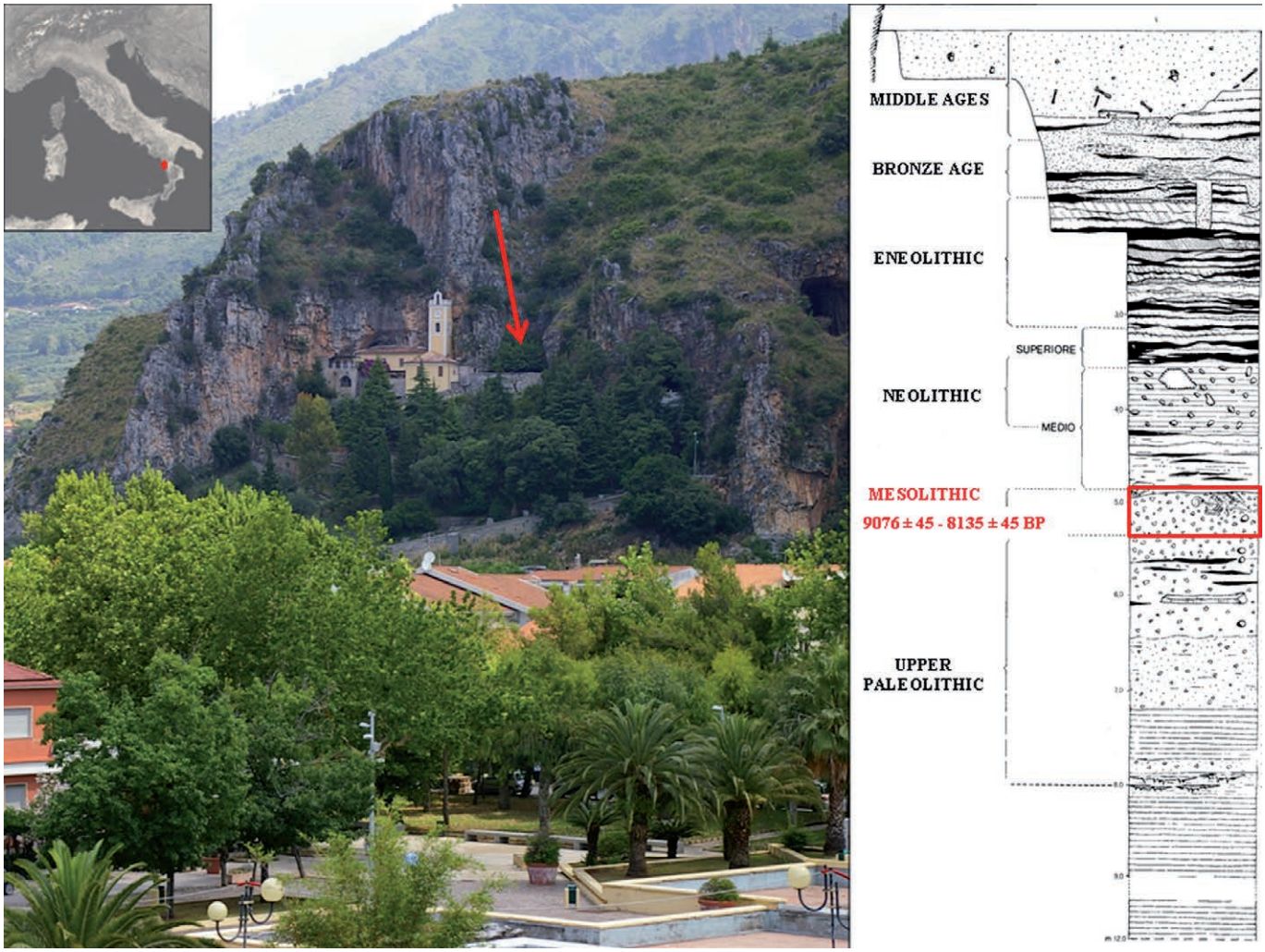

Fig. 1 *- Location of Grotta della Madonna in the southern Italian Peninsula; cave view (photo I. Fiore) and stratigraphic profile with Mesolithic layer I (cuts 42-47) based on Cardini 1972. / Localizzazione di Grotta della Madonna nella penisola italiana; vista della grotta (foto I. Fiore) e sezione stratigrafica con il livello I Mesolitico (tagli 42-47) da Cardini 1972.*

related to the human occupation of the cave, from the late phases of the Upper Paleolithic until the Middle Ages (Blanc & Cardini 1957, 1961; Cardini 1972). The Upper Paleolithic level "L" with final Epigravettian industry provided dates by 14C between 12,100±150 and 9,020±125 BP (Alessio *et al.* 1966, 1967).

Starting in 2002 the Soprintendenza al Museo Nazionale Preistorico Etnografico L. Pigorini carried out new excavations (test trench 4x5 m) corresponding to about 5.5 m of anthropic deposit of the Holocene period, down to the Mesolithic frequentation.

The new excavations provided new chronological data for the site, applying the radiocarbon method (AMS) to different Mesolithic cuts and structures. The new dates (from 8,350-8,220 cal. BC to 7,200- 7,040 cal. BC) indicate an intense frequentation of the cave between the end of the 10th and the entire 9th millennium BP (see Tagliacozzo *et al*. this volume). The data obtained from the lithic production indicate the presence of an Early Mesolithic assemblage, with very low microlithic component, similar to other industries from Central and Southern Italy, known as Undifferentiated Epipaleolithic.

The bone remains analyzed in this study come from the Mesolithic layer I (cuts 42-47) of the excavations by Cardini. The faunal sample includes over 12,000 remains, about 7,000 of which could be identified. Mammal bones are the most frequent, followed by birds, testudinates, amphibians and fishes. Among the mammals, wild boar is the most frequently hunted species, followed by cervids (red and roe deer). Small mammals (hare and dormouse) and carnivores are also present. The analysis of the bone remains showed the presence of several butchering marks and combustion traces, indicating the capture and the consumption of a wide range of animal species (Fiore *et al.* 2004b, 2004c).

Method

The raptor bones analyzed in this paper had been previously selected by P. F. Cassoli who also identified most of the bird assemblage. The revision of the materials was carried out using the osteological collections of the Laboratorio di Paleontologia del Quaternario e Archeozoologia of the Museo Nazionale Preistorico Etnografico "L. Pigorini" and of the Istituto Italiano di Paleontologia Umana.

The remains were quantified employing the most common methods: NISP (Number of Identified Specimens) and MNI (Minimum Number of Individuals); this latter has been calculated by cut. The Minimum Number of Element (MNE) was not calculated because there were only few specimens for each species, distributed in different cuts, therefore the MNE overlapped with the NISP. Measurements have been taken following von den Driesch (1976). The taxonomic sequence and the nomenclature are based on "La lista CISO-COI degli uccelli italiani" (Fracasso *et al.* 2009). The anatomical terms follow Baumel & Witmer (1993) and the data regarding the present distribution, behavior and ecology have been obtained mainly from Brichetti (2002). Microscopic analyses of the bird bone surfaces were carried out using a Nikon 1000 stereomicroscope with a magnification range of 15x-35x. For each bone pre- and post-depositional modifications have been described according to criteria established in the taphonomic literature for mammals and particularly for birds (Binford 1981; Lyman 1994; Fisher 1995; Cassoli & Tagliacozzo 1997; Laroulandie 2000; Serjeantson 2009). The category "impact mark" includes traces of different nature produced by percussion fracturing. For assigning some traces of dubious interpretation a "Homo/Other" category has been created.

Results

Over 1,200 bird bones belonging to 50 different species were found in the Mesolithic layer I (Tab. 1). The rocky species are prevalent, mainly because of the high frequency of rock dove (*Columba livia*). Gruiformes and Passeriformes are also well represented. The proximity of a large delta allowed the capture of several aquatic birds, particularly the coot (*Fulica atra*) and many species of Anseriformes, including the mallard (*Anas platyrhynchos*) which is the prevalent species among them. The analysis of water bird bone remains evidenced many anthropic marks (cuts, impacts, scrapings and localized burnings) suggesting that these birds were exploited for human consumption (Gala & Tagliacozzo 2004).

Raptors of Grotta della Madonna

One of the features of the Paleo-Mesolithic avian assemblage of Grotta della Madonna is the large number of remains and the abundance of species belonging to diurnal and nocturnal raptors (Tab. 1). In the Paleolithic level there were remains of 10 species of Accipitridae and 3 species of Falconidae among the diurnal raptors, and 5 species of Strigidae among the nocturnal birds of prey, both representing about the 4% of the NISP of the total sample. In the Mesolithic level a significant decrease in the number of species of diurnal raptors was observed: only 5 species of Accipitridae and 1 of Falconidae were recorded; while the number of species of Strigiformes remained unchanged, although the species composition varied (1 of Tytonidae and 4 of Strigidae). In this level the raptors (NISP 27) represent more than 2% of the total avian assemblage.

In the Mesolithic level it was possible to observe the absence, among the Accipitridae, of the honey buzzard (*Pernis apivorus*), of the marsh harrier (*Circus aeruginosus*), of the hen harrier (*C. cyaneus*), of the sparrowhawk (*Accipiter nisus*), and particularly of the cinereous vulture (*Aegypius monachus*). Among the Falconidae, the lesser kestrel (*Falco naumanni*) and the hobby (*F. subbuteo*) are missing. As far as the nocturnal raptors are concerned, the short-eared owl (*Asio flammeus*) was not found, replaced by the barn owl (*Tyto alba*) that is absent in the Paleolithic level.

Distribution and behavior of raptors in the Mesolithic level at Grotta della Madonna

Falconiformes
Accipitridae

White-tailed eagle (*Haliaeetus albicilla*). Right distal humerus.

This species is found in northern Europe and Asia, may reach a length of 70-90 cm and a wingspan of 200-240 cm. It is common on the seacoast, especially in wooded areas, in wetlands and estuaries. It feeds on fish and several mammals and occasionally eats carrions. Currently, the Mediterranean population is almost extinct.

Pallid harrier (*Circus macrourus*). Right distal radius.

This migratory bird breeds in southeastern Europe and central Asia, and winters in the Mediterranean area. It is a medium-sized raptor, has a wingspan of 95-110 cm and a length of 40-48 cm. It is present mostly in open plains, marshes and heathlands.

Goshawk (*Accipiter gentilis*). Left incomplete coracoid and left medio-proximal femur.

This sedentary species is a medium-sized bird of prey, has a wingspan of 135-165 cm and a length of 48-62 cm. It hunts mainly squirrels, hares, small mammals and various birds. The prey is attacked and killed using the talons. The carcasses are eaten on the ground or on the lower branches of the trees. It is present mainly in woodlands, but may also adapt to Mediterranean scrub areas.

Buzzard (*Buteo buteo*). Left distal radius.

The range of this species covers most of Europe. It is a medium-sized raptor measuring between 51 and 57 cm in length and with a wingspan of 113-128 cm. It lives in forests and wooded areas, but usually hunts in open areas, eating small mammals and sometimes carrions. It nests in trees, but also on rock walls.

Tab. 1 *- Grotta della Madonna. Number of Identified Specimens (NISP) of birds from the Upper Paleolithic (Layer L) and the Mesolithic (Layer I). / Numero resti (NR) degli uccelli del Paleolitico superiore (Livello L) e Mesolitico (Livello I).*

TAXA	UPPER PALEOLITHIC (LEVEL L)		MESOLITHIC (LEVEL I)							
	TOTAL		CUTS						TOTAL	
	NISP	%	47	46	45	44	43	42	NISP	%
Anseriformes Anatidae										
Cygnus cygnus	18	0,24								
Anser fabalis	3	0,04								
Anser albifrons	24	0,32		1					1	0,1
Anser anser	3	0,04								
Tadorna tadorna	4	0,05	1						1	0,1
Anas penelope	5	0,07		1					1	0,1
Anas strepera	8	0,11								
Anas platyrhynchos	265	3,55	11	2	4		1		18	1,5
Anas acuta	38	0,51		1			1	2	4	0,3
Anas querquedula	3	0,04								
Netta rufina	16	0,21								
Aythya ferina	88	1,18	4	1		2	1		8	0,6
Aythya nyroca	22	0,30		1		1			2	0,2
Aythya fuligula	76	1,02	6	4	3		1		14	1,1
Somateria mollissima	3	0,04								
Bucephala clangula	3	0,04								
Mergus serrator	7	0,09	1						1	0,1
Mergus merganser	7	0,09								
Tot. Anseriformes	**593**	**7,95**	**23**	**11**	**7**	**3**	**4**	**2**	**50**	**4,0**
Galliformes Tetraonidae										
Lagopus mutus	1	0,01								
Tetrao tetrix	1	0,01								
Phasianidae										
Alectoris graeca	8	0,11								
Perdix perdix	19	0,25								
Coturnix coturnix	6	0,08		1	6	10	8	4	29	2,3
Tot. Galliformes	**35**	**0,47**		**1**	**6**	**10**	**8**	**4**	**29**	**2,3**
Gaviiformes Gaviidae										
Gavia stellata	5	0,07								
Gavia arctica	15	0,20	2						2	0,2
Tot. Gaviiformes	**20**	**0,27**	**2**						**2**	**0,2**
Procellariiformes Procellariidae										
Calonectris diomedea	3	0,04								
Podiceps cristatus	13	0,17	1	1	1				3	0,2
Podiceps nigricollis	8	0,11				2			2	0,2
Tot. Procellariiformes	**24**	**0,32**	**1**	**1**	**1**	**2**			**5**	**0,4**
Pelecaniformes Phalacrocoracidae										
Phalacrocorax carbo	**4**	**0,05**	**1**					**1**	**2**	**0,2**

Tab. 1 - *Continued. / Continua.*

TAXA	UPPER PALEOLITHIC (LEVEL L)		MESOLITHIC (LEVEL I)							
	TOTAL		CUTS						TOTAL	
	NISP	%	47	46	45	44	43	42	NISP	%
Ciconiiformes Ardeidae										
Botaurus stellaris	**11**	**0,15**		**1**					**1**	**0,1**
Podicipediformes Podicipedidae										
Tachybaptus ruficollis	**12**	**0,16**		**1**		**1**	**1**		**3**	**0,2**
Falconiformes Accipitridae										
Pernis apivorus	1	0,01								
Haliaeetus albicilla	1	0,01			1				1	0,1
Aegypius monachus	6	0,08								
Circus aeruginosus	3	0,04								
Circus cyaneus	22	0,30								
Circus macrourus	4	0,05				1			1	0,1
Accipiter gentilis	9	0,12			1		1		2	0,2
Accipiter nisus	1	0,01								
Buteo buteo	7	0,09		1					1	0,1
Aquila chrysaetos	71	0,95					1		1	0,1
Falconidae										
Falco naumanni	3	0,04								
Falco tinnunculus	3	0,04			1	1			2	0,2
Falco subbuteo	3	0,04								
Tot. Falconiformes	**134**	**1,80**		**1**	**3**	**2**	**2**		**8**	**0,6**
Gruiformes Rallidae										
Rallus aquaticus	1	0,01								
Crex crex	2	0,03								
Gallinula chloropus	2	0,03	1				1		2	0,2
Fulica atra	273	3,66	41	31	14	17	9	2	114	9,2
Gruidae										
Grus grus	30	0,40			1				1	0,1
Otididae										
Tetrax tetrax	685	9,19	5						5	0,4
Otis tarda	25	0,34								
Tot. Gruiformes	**1018**	**13,66**	**47**	**31**	**15**	**17**	**10**	**2**	**122**	**9,9**
Charadriiformes Scolopacidae										
Scolopax rusticola	8	0,11								
Laridae										
Larus canus	1	0,01								
Tot. Charadriiformes	**9**	**0,12**								
Pterocliformes Pteroclidae										
Pterocles orientalis	**1**	**0,01**								
Columbiformes Columbidae										
Columba livia	4569	61,29	219	200	166	134	45	33	797	64,4
Columba oenas	382	5,12	14	16	11	10	2		53	4,3
Columba palumbus	47	0,63	6	6	3	5		2	22	1,8
Streptopelia turtur	4	0,05		1			1		2	0,2
Tot. Columbiformes	**5002**	**67,10**	**239**	**223**	**180**	**149**	**48**	**35**	**874**	**70,7**

Tab. 1 - *Continued. / Continua.*

TAXA	UPPER PALEOLITHIC (LEVEL L)		MESOLITHIC (LEVEL I)							
	TOTAL		CUTS						TOTAL	
	NISP	%	47	46	45	44	43	42	NISP	%
Cuculiformes Cuculidae										
Cuculus canorus					**1**				**1**	**0,1**
Strigiformes Tytonidae										
Tyto alba					1		1		2	0,2
Strigidae										
Otus scops	1	0,01			3		1		4	0,3
Bubo bubo	11	0,15	1		1	1			3	0,2
Athene noctua	13	0,17		1	1				2	0,2
Strix aluco	100	1,34	2	4		1		1	8	0,6
Strix sp.	25	0,34								
Asio flammeus	2	0,03								
Tot. Strigiformes	**152**	**2,04**	**3**	**5**	**6**	**2**	**2**	**1**	**19**	**1,5**
Coraciiformes Coraciidae										
Coracias garrulus	**1**	**0,01**	**1**					**1**	**2**	**0,2**
Piciformes Picidae										
Picus viridis	**5**	**0,07**								
Passeriformes Alaudidae										
Melanocoripha calandra	3	0,04								
Hirundinidae										
Ptyonoprogne rupestris	23	0,31	3	2		2	1	2	10	0,8
Turdidae										
Turdus merula	114	1,53	12	10		6	10	4	42	3,4
Turdus pilaris	23	0,31			7	4	3	1	15	1,2
Turdus iliacus	61	0,82	5	7		4	4		20	1,6
Turdus viscivorus	24	0,32		2		3	4		9	0,7
Oriolidae										
Oriolus oriolus	1	0,01		1					1	0,1
Corvidae										
Garrulus glandarius	38	0,51	4	1	2	2	2	2	13	1,1
Pyrrhocorax graculus	38	0,51								
Pyrrhocorax pyrrhocorax	6	0,08								
Corvus monedula	8	0,11								
Corvus frugilegus	12	0,16	1						1	0,1
Corvus corone	37	0,50								
Corvus corax	39	0,52	1						1	0,1
Fringillidae										
Fringilla coelebs	7	0,09		3		2		1	6	0,5
Emberizidae										
Miliaria calandra								1	1	0,1
Tot. Passeriformes	**434**	**5,82**	**26**	**26**	**9**	**23**	**24**	**11**	**119**	**9,6**
TOTAL	**7455**	**100**	**343**	**301**	**228**	**209**	**99**	**57**	**1237**	**100**

Golden eagle (*Aquila chrysaetos*). Incomplete pelvis.

This species is currently widespread in the mountainous areas throughout Eurasia. It is a large bird of prey with a length of 75-88 cm and a wingspan of 204-220 cm. It nests in cliffs, but frequents a wide range of open spaces or with sparse trees, where it mostly hunts mammals (rodents and lagomorphs) and birds (Galliformes) and, in winter, it also feeds on carrions.

Falconidae

Kestrel (*Falco tinnunculus*). Left coracoid and right distal ulna.

This is one of the most common small sized raptor in Europe, it measures 32-35 cm from head to tail and has 71-80 cm of wingspan. It tolerates a wide range of habitats, mainly rock faces, and hunts mice, other rodents, small birds and insects in open country.

Strigiformes

Tytonidae

Barn owl (*Tyto alba*). Right ulna and right carpometacarpus.

This species is widespread over all continents, it is mostly non-migratory, nocturnal or crepuscular. Its length is 33-35 cm with a wingspan of 83-93 cm. It is present in open country areas and hunts voles, mice, moles, but also amphibians and insects, mainly at the edge of the woods.

Strigidae

Scops owl (*Otus scops*). Left distal humerus, left carpometacarpus, left proximal carpometacarpus and left tarsometatarsus.

After the Eurasian pygmy owl (*Glaucidium passerinum*) this is the smallest European nocturnal raptor: length 19-20 cm, wingspan 53-63 cm. It is a migratory bird that winters in wooded or shrubby savannahs in sub-Saharan Africa. Some southern Italy populations, however, are non-migratory. It nests in caves, in rock cavities or in tree holes. It hunts mainly insects, to a lesser extent, birds and toads, and only rarely small mammals. It prefers open habitats, sometimes arid.

Eagle-owl (*Bubo bubo*). Right ulna shaft and 2 foot phalanges.

This is the largest owl species with a wingspan of 160-188 cm and a length of 60-75 cm. It nests in the trunks of trees or in rock crevices and lives mainly in rocky terrain forests. It hunts, at sunrise and sunset, mostly small mammals (rodents and lagomorphs), but also fox-sized preys. It kills also other birds, including other raptors and Galliformes.

Little owl (*Athene noctua*). 2 right distal humeri.

This species is widespread throughout the Northern Hemisphere; in Italy it is a very common bird. It is a typical nocturnal bird of prey and may be active also at sunrise and sunset. It is about 21-23 cm long and has a wingspan of 54-58 cm. It nests in small cavities between the rocks or in trees. It feeds on small vertebrates and large insects. It prefers poorly tree-lined hilly areas, but may adapt to different environments.

Tawny owl (*Strix aluco*). Left quadratum, right coracoid shaft, left medio-distal coracoid, left distal humerus, left radius shaft, incomplete pelvis, left medio-proximal femur, right tarsometatarsus shaft

This is a medium-sized owl (length 37-39 cm, wingspan 94-104 cm) widespread throughout Italy. It is closely related to forest habitat, but it also adapts to open environments and breeds in cavities of different type both on isolated trees and on rocky faces. It is specifically nocturnal, but it is also active at sunset when caring for its offspring. It feeds mainly on small mammals, but also birds, amphibians and invertebrates.

Raptor bones in the Mesolithic level at Grotta della Madonna

The raptors are represented by a minimum number of specimens varying from 1 (for 4 species), up to 8 remains (tawny owl) for an estimated total of 22 individuals (Tab. 2). Adult specimens predominate in the assemblage, but 2 juvenile bones of golden eagle and tawny owl were also identified (7%).

The sex of one individual of tawny owl was determined from the medullary bone in a radius shaft; this is therefore a female who died during the hatching period that lasts up to 29 days, once a year, between March and June.

The skeletal element distribution (Tab. 3 and appendix) shows more wing bones (humerus, ulna and radius) and coracoids. The number of leg bones is very low, in fact there are only 1 femur of goshawk, 1 femur of tawny owl, 2 tarsometatarsi of scops owl and tawny owl and 2 foot phalanges of eagle-owl. This latter bird is represented also by an ulna, and since the three bones come from different Mesolithic cuts, it was not possible to attribute them to a single individual. In any case it is undeniable that these are all particular elements belonging to the wing and to the distal limbs. No other posterior phalanges have been found in the Mesolithic raptor sample.

Taphonomic analyses

Most of the long bones are fragmented (NISP 22) and only some of them are complete (NISP 5).

The bone specimens are well preserved and only in a few cases are eroded by soil, root action or affected by abrasion (30%) (Tab. 4). The taphonomic analysis evidenced several types of traces, some of them (8 bones, 33%) surely referable to humans (cut marks, impact marks, polishes, peelings, *arrachement*). In addition many combustion traces have been detected on 19 bones (79% of the modified remains); in some cases they cover the whole surface (2 NISP) or a large portion of the bone (5 NISP), in others they are localizes mainly on the long bone epiphyses (12 NISP).

Other traces are instead of more difficult attribution (gnawing

Tab. 2 *- Grotta della Madonna. Number of Identified Specimens (NISP) and Minimum Number of Individuals (MNI) of raptors from the Mesolithic (Layer I). / Numero resti (NR) e Numero Minimo degli Individui (NMI) dei rapaci del Mesolitico (Livello I).*

MESOLITHIC (LEVEL I) / *TAXA*	NISP	%	MNI	%
FALCONIFORMES				
Accipitridae				
White-tailed eagle (*Haliaeetus albicilla*)	1	*3,70*	1	*4,55*
Pallid harrier (*Circus macrourus*)	1	*3,70*	1	*4,55*
Goshawk (*Accipiter gentilis*)	2	*7,41*	2	*9,09*
Buzzard (*Buteo buteo*)	1	*3,70*	1	*4,55*
Golden eagle (*Aquila chrysaetos*)	1	*3,70*	1	*4,55*
Falconidae				
Kestrel (*Falco tinnunculus*)	2	*7,41*	2	*9,09*
STRIGIFORMES				
Tytonidae				
Barn owl (*Tyto alba*)	2	*7,41*	2	*9,09*
Strigidae				
Scops owl (*Otus scops*)	4	*14,81*	2	*9,09*
Eagle-owl (*Bubo bubo*)	3	*11,11*	3	*13,64*
Little owl (*Athene noctua*)	2	*7,41*	2	*9,09*
Tawny owl (*Strix aluco*)	8	*29,63*	5	*22,73*
TOTAL	***27***	***100***	***22***	***100***

Tab. 3 *- Grotta della Madonna. Skeletal part representation of raptor remains. Head: CRA (skull, mandible, maxilla, quadrate). Axial: VER (Vertebra), RIB, STE (Sternum), PEL (Pelvis, synsacrum, notarium). Shoulder girdle: FUR (Furcula), COR (Coracoid), SCA (Scapula). Wing: HUM (Humerus), ULN (Ulna), RAD (Radius), CAR (Carpometacarpus) CRP (Carpal), W.P (Wing Phalanx). Hindlimb: FEM (Femur), TIB (Tibiotarsus), FIB (Fibula), TAR (Tarsometatarsus), MET (Metatarsal), F.P (Foot Phalanx). / Rappresentazione scheletrica dei rapaci. CRA (cranio, mandibola, mascella, osso quadrato). VER (Vertebra), RIB (Costa), STE (Sternum), PEL (Pelvis, synsacrum, notarium). FUR (Furcula), COR (Coracoide), SCA (Scapola). HUM (Omero), ULN (Ulna), RAD (Radio), CAR (Carpometacarpo) CRP (Carpale), W.P (Falange alare). FEM (Femore), TIB (Tibiotarso), FIB (Fibula), TAR (Tarsometatarso), MET (Metatarsale), F.P (Falange posteriore).*

	HEAD	AXIAL				SHOULDER GIRDLE			WING						HINDLIMB						TOTAL	
TAXA	CRA	VER	RIB	STE	PEL	FUR	COR	SCA	HUM	ULN	RAD	CAR	CRP	W.P	FEM	TIB	FIB	TAR	MET	F.P	NISP	%
White-tailed eagle (*Haliaeetus albicilla*)									1												**1**	***3,7***
Golden eagle (*Aquila chrysaetos*)					1																**1**	***3,7***
Eagle-owl (*Bubo bubo*)										1										2	**3**	***11,1***
Total large sized raptors					**1**				**1**											**2**	**5**	***18,5***
Pallid harrier (*Circus macrourus*)											1										**1**	***3,7***
Goshawk (*Accipiter gentilis*)							1								1						**2**	***7,4***
Buzzard (*Buteo buteo*)											1										**1**	***3,7***
Barn owl (*Tyto alba*)										1		1									**2**	***7,4***
Tawny owl (*Strix aluco*)	1				1		2		1		1				1			1			**8**	***29,6***
Total medium sized raptors	**1**				**1**		**3**		**1**	**1**	**3**	**1**			**2**			**1**			14	***51,9***
Kestrel (*Falco tinnuculus*)							1			1											**2**	***7,4***
Scops owl (*Otus scops*)									1			2						1			**4**	***14,8***
Little owl (*Athene noctua*)									2												**2**	***7,4***
Total small sized raptors							**1**		**3**	**1**		**2**						**1**			**8**	***29,6***
TOTAL RAPTORS	**1**				**2**		**4**		**5**	**2**	**3**	**3**			**2**			**2**		**2**	***27***	***100***
% TOTAL RAPTORS	***3,7***				***7,4***		***14,8***		***18,5***	***7,4***	***11,1***	***11,1***			***7,4***			***7,4***		***7,4***		

and fresh bone fractures). As regards tooth marks (gnawing), these were observed on 13 bones (54 % of the modified remains): coracoids, wing elements (humerus, ulna, radius, carpometacarpus) and pelvis. Punctures (on 11 bones, 85 % of the gnawed remains) and scoring (on 6 bones, 46 % of the gnawed remains) are the most abundant, but crenulated edges (on 4 bones, 31 % of the gnawed remains) were also recorded. Except for 2 cases (coracoid of tawny owl and carpometacarpus of barn owl) all the other gnawed bones showed other kinds of human damage on the same specimen, cut mark (3 NISP), peeling (6 NISP), *arrachement* (1 NISP), fracture (5 NISP) and localized burning (8 NISP).

Among the large raptors, at least 3 groups of cut marks, 2 impact marks and 2 peeling traces are present on the two faces of the distal humerus of a white-tailed eagle. Two sub-parallel *striae* transverse to the bone axis are visible on the distal diaphysis (Fig. 2.3), while many transverse cuts, deep, more or less short and rectilinear, are present close to the *processus supracondilaris dorsalis* (Fig. 2.6). The fracture edge shows signs of polish, peeling and possible functional removals (Fig. 2.4-5). Furthermore, a combustion trace is also evident on the *condylus dorsalis*. It is therefore possible that the different actions, with and without a lithic tool, were aimed at the disarticulation of the humerus from the forearm, in order to consume the meat that was covering it. Another purpose was to use the bone since this specimen probably represent an expedient tool.

Striae of variable size and orientation are located above the *foramen ilium ischiadicum* of the pelvis of a young individual of golden eagle: two long, deep and longitudinal *striae*, one of which is interrupted, and two other groups of short, repeated and transverse marks (Fig. 3.2-3). This area is affected also by combustion traces and crenulated edges, while on the *ileum* there are at least 5 punctures (Fig. 3.4). Other single short, deep and transverse cuts on the synsacrum are associated to peeling on the same face of the bone (Fig. 4). The different butchering activities were aimed at the disarticulation of the pelvis from the femur, probably before cooking and consumption .

Traces of lithic tool divided into two groups of short, superficial

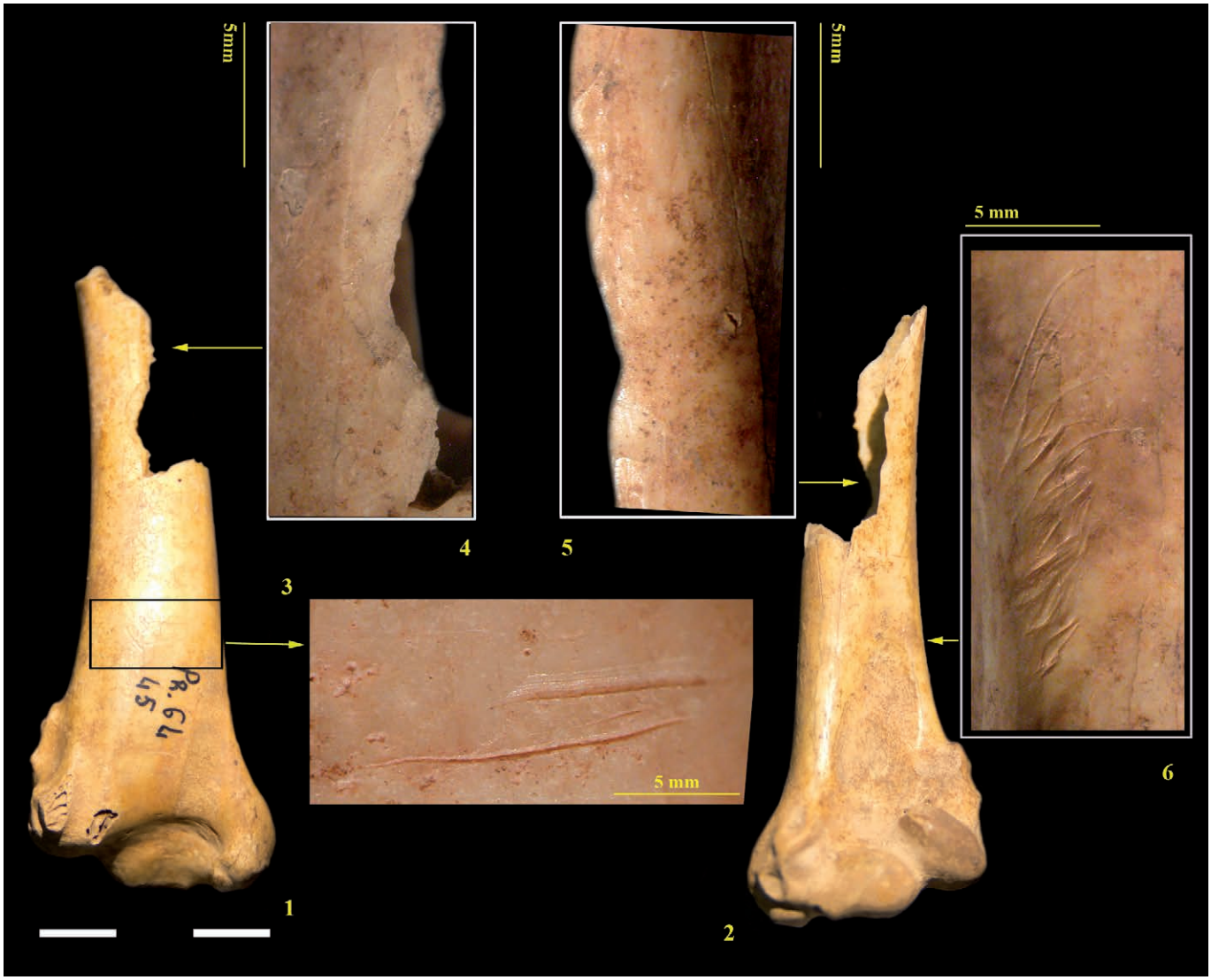

Fig. 2 *- 1-2 Distal humerus of white-tailed eagle (Haliaeetus albicilla), caudal and cranial views. 3 Cut marks. 4-5 Detail of impact mark and fracture edge with signs of polish and removals. 6 Detail of cut marks. / 1-2 Omero distale di aquila di mare (Haliaeetus albicilla) viste caudale e craniale. 3 Strie da strumento litico. 4-5 Particolari dell'impatto e del margine di frattura con tracce di politure e distacchi. 6 Particolare dei tagli.*

and transverse marks have been observed on the diaphysis of the ulna of the eagle-owl. On the distal diaphysis there are *arrachement,* peeling and crenulated edge, while on the proximal end there are a fresh bone fracture and a combustion trace. On the whole the observed traces suggest that human exploitation may be related to disarticulation and filleting of the wing, as well as to cooking and consumption.

A fresh bone fracture is also visible on the proximal end of an eagle owl talon, while combustion traces cover the whole surface of a medio-distal posterior phalanx. The burning traces are in general relatively light, but become more intense close to the proximal fracture edge suggesting a localized combustion.

As far as the medium sized birds are concerned, among the diurnal birds of prey the distal radii of buzzard and pallid harrier from two different Mesolithic cuts, (46 and 44) present fresh bone fractures. In the case of the buzzard radius, there are also other macro- and micro- traces (cut mark, impact, polish, peeling) (Fig. 5). Three groups of *striae*, mostly short, deep, repeated and oblique, depart from the dorsal face and continue to the ventral face; an impact is present on the diaphysis; a localized combustion trace was detected on the dorsal face of the distal portion of the diaphysis; peeling traces were found on the dorsal face of the distal end. Furthermore, the bone diaphysis is affected by a puncture on the cranial face. All these modifications on such a small fragment evidence a particular interest in a portion that may have been used as a tool; such interpretation is also supported by the polished appearance of the bone and by the rounded tip. However, it seems, as in the case of the humerus of white-tailed eagle, that this pointed object represents an expedient tool.

Human modifications are also visible on the coracoid and on the femur of two individuals of goshawk from two different cuts. The whole surface of the coracoid is burnt and presents also a proximal peeling and bi-lateral gnaw marks (puncture, scores and crenulated edge) on the distal portion over the *processus lateralis*.

On the femur, combustion traces are more evident on the proximal portion (the prolonged exposure to fire or coals produced also a break) where there is also a wide fracture edge, but are localized also on the distal portion of the bone, always close to an intentional fracture. It is therefore possible to hypothesize that for this bird no lithic tools were employed, but small portions were disarticulated, such as the coracoid from the shoulder girdle or the femur form the pelvis and the tibiotarsus, probably after cooking (as indicated by the

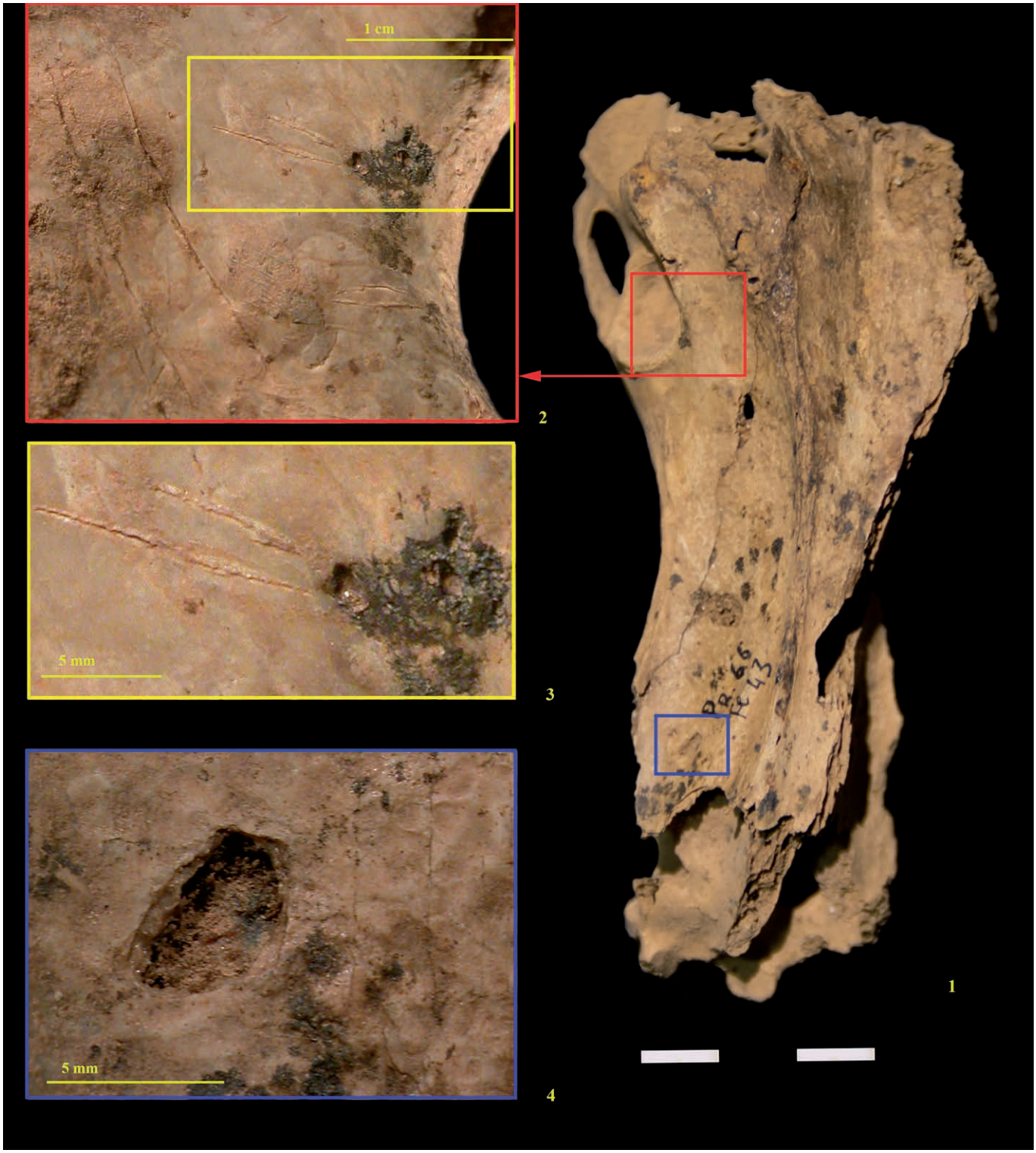

Fig. 3 - 1 Pelvis of golden eagle (Aquila chrysaetos), lateral view. 2-3 Cut marks. 4 Puncture. / 1 Pelvis di aquila reale (Aquila chrysaetos) vista laterale. 2-3 Strie da strumento litico. 4 Puncture.

traces on the femur) and then consumed (as suggested by gnawing on the distal coracoid).

The biological agent that gnawed the carpometacarpus of barn owl producing 2 bilateral punctures on the *processus extensorius* is not clear.

Of the 8 bones of tawny owl, only the caudal face of the proximal diaphysis of the femur shows many marks suggesting the use of a lithic tool: 2 long *striae*, superficial and transverse were identified below the trochanter, and further down many other *striae*, shorter, repeated and oblique, but also transverse to the bone axis, are present (Fig. 6). The distal portion of the same specimen had been removed and a fresh bone fracture is present on the diaphysis.

The distal portion of the humerus is fractured as well, however it presents, besides a slight burning trace on the diaphysis, a hole close to the *condylus dorsalis* and evidences of gnawing on the caudal face. Such gnawing traces present features that are different from

those produced by carnivores and other animals, and may therefore be probably attributed to human chewing.

Other gnaw marks are visible on the proximal portion of a coracoid of a young individual and a clear puncture is evident on the *lamina infracristalis ilii,* close to the acetabular cavity of the pelvis (see eagle pelvis).

On the pelvis there are also several combustion traces of variable intensity and extension on the 4 faces of the bone and peeling traces on the *crista iliaca obliqua*.

Other very intense traces of burning have been observed on the two ends of a coracoid, without the epiphyses, while a bending fracture, associated to peeling, has been identified also on the proximal diaphysis of a completely burnt tarsometatarsus.

Among the small sized raptors, the coracoid of a kestrel shows scores on dorsal and ventral faces of both ends of the bone, a puncture on the distal end and a slight proximal combustion.

The ulna of the other individual shows a fracture and scores on the diaphysis and a burned *condylus dorsalis ulnae*. It is difficult to attribute these traces to a specific predator, but it is possible to note that the gnawing on the distal end of the coracoid is comparable to the one on the goshawk coracoid.

Other bilateral punctures are visible on the distal humerus of a scops owl, presenting also a fracture and a slight burning on the *condylus dorsalis*.

A light punctiform burning trace is present on the dorsal face of the proximal diaphysis of a tarsometatarsus of the same species.

A widespread, but more intense, combustion was observed on the distal end on an almost complete carpometacarpus of scops owl that, in the same area, presents also some scores, transverse to the long axis of the bone. Other traces of peeling are visible on the proximal end below the *processus extensorius* that is partially absent (removed?).

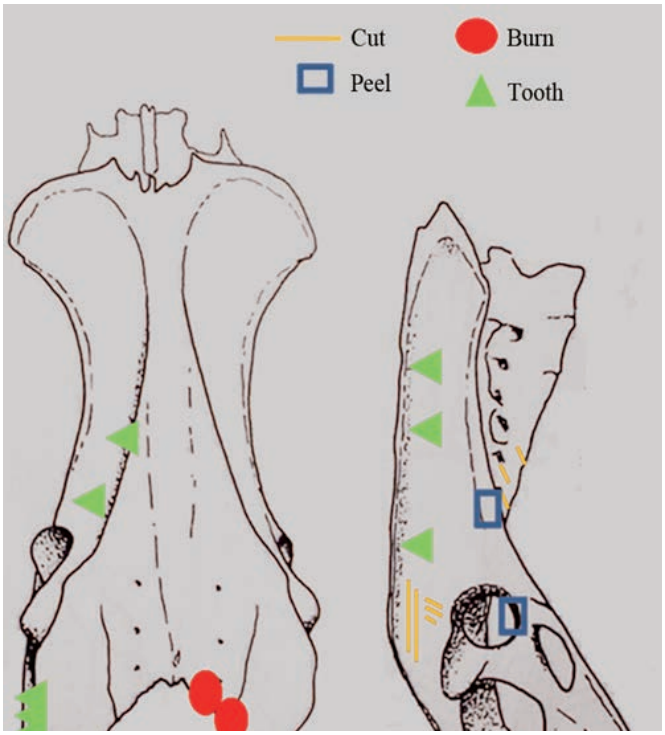

***Fig. 4** - Summary of the anthropic traces identified on Pelvis of golden eagle (Aquila chrysaetos) (drawing modified from Cohen Serjeantson 1996). / Riepilogo delle tracce antropiche individuate sul pelvis di aquila reale (Aquila chrysaetos) (disegno modificato da Cohen Serjeantson 1996).*

***Tab. 4** - Grotta della Madonna. Modifications on raptor remains. Some bones show several types of modifications. CUT: cut-marks. Imp: impact marks. POL: polish; PEEL: peeling. ARRACH: arrachement. FRA: fresh bone fracture. Burn: burning traces. TOOTH: tooth marks. E/R/T: Erosive action/Root/Trampling. / Modificazioni delle ossa dei rapaci. Alcuni reperti presentano vari tipi di modificazioni. CUT: cut-marks. Imp: impatti. POL: politure; PEEL: peeling. ARRACH: arrachement. FRA: fratture da osso fresco. BURN: combustioni. TOOTH: rosicature. E/R/T: tracce di erosione/Radici/Abrasioni.*

	TOTAL WITH MODIFICATION		HUMAN MODIFICATION					HUMAN/OTHER			OTHER
TAXA	NISP	%	CUT	IMP	POL	PEEL	ARRACH	FRA	BURN	TOOTH	E/R/T
White-tailed eagle (*Haliaeetus albicilla*)	1	*4,2*	1	1	1	1			1		3
Golden eagle (*Aquila chrysaetos*)	1	*4,2*	1			1			1	1	
Eagle-owl (*Bubo bubo*)	3	*12,5*	1			1	1	3	3	1	1
Total large sized raptors	**5**	***20,8***	**3**	**1**	**1**	**3**	**1**	**3**	**5**	**2**	**4**
Pallid harrier (*Circus macrourus*)	1	*4,2*						1			
Goshawk (*Accipiter gentilis*)	2	*8,3*				1		1	2	1	
Buzzard (*Buteo buteo*)	1	*4,2*	1	1	1	1			1	1	1
Barn owl (*Tyto alba*)	1	*4,2*								1	2
Tawny owl (*Strix aluco*)	6	*25,0*	1			2		3	5	3	
Total medium sized raptors	**11**	***45,8***	**2**	**1**	**1**	**4**		**5**	**8**	**6**	**3**
Kestrel (*Falco tinnunculus*)	2	*8,3*						1	2	2	
Scops owl (*Otus scops*)	4	*16,7*				1		2	3	2	
Little owl (*Athene noctua*)	2	*8,3*						2	1	1	
Total small sized raptors	**8**	***33,3***				**1**		**5**	**6**	5	
TOTAL RAPTORS	**24**	***100***	**5**	**2**	**2**	**8**	**1**	**13**	**19**	**13**	**7**
% TOTAL RAPTORS			***20,8***	***8,3***	***8,3***	***33,3***	***4,2***	***54,2***	***79,2***	***54,2***	***29,2***

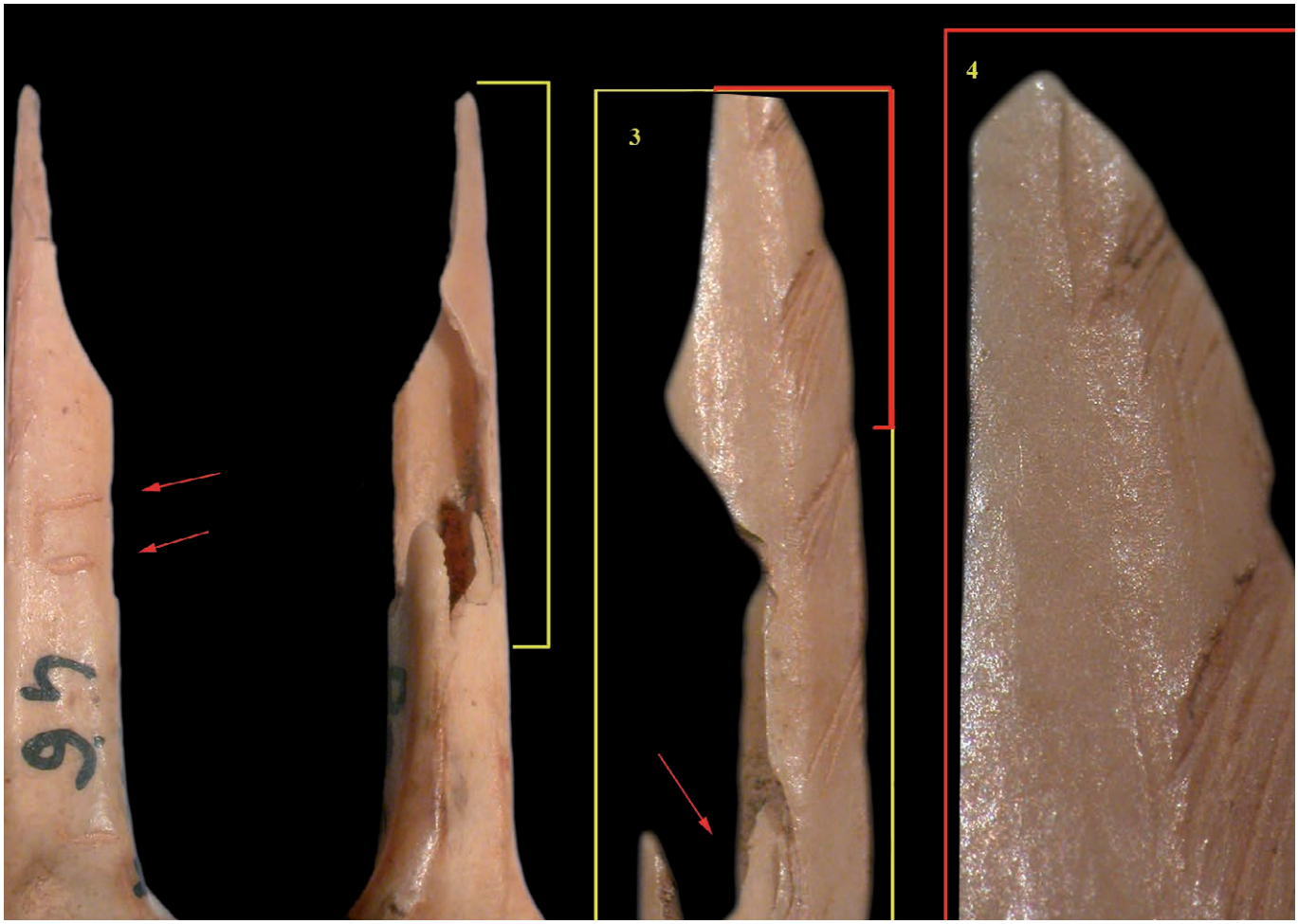

Fig. 5 - 1-2 Distal radius of buzzard (Buteo buteo), dorsal and ventral views. 3 Group of cut marks on the edge of the bone, impact mark, fracture and edge with signs of polish. 4 Detail of cut marks and rounded tip. / 1-2 Radio distale di poiana (Buteo buteo) viste dorsale e ventrale. 3 Gruppo di strie da strumento litico sul margine dell'osso, impatto, frattura e margine con tracce di politure. 4 Particolare dei tagli e della punta arrotondata.

A fracture is evident on the diaphysis of another proximal carpometacarpus, but, considering the small dimensions and the absence of other traces, it is very difficult to suggest an interpretation. On the other 3 specimens of scops owl it is possible to note that the localized combustion traces are in 2 cases associated to gnawing and there are no criteria to exclude that humans contributed to the accumulation of these remains.

Similarly the fractures on the 2 distal humeri of little owl, placed at different cuts along the diaphysis and the presence of a bilateral gnaw mark on the longest fragment and of a puncture on the caudal face do not provide further clues. However, it is true that only two humeri belonging to two different individuals, but of the same side (right) and of the same portion (distal), have been attributed to this bird; they also present the same fracture typology as well as punctures in the same position on the caudal face. Therefore, although with some doubts, it is possible to hypothesize some kind of intentionality in the actions and attribute such awareness to humans.

Discussion and conclusions

The majority of raptor remains in the Mesolithic level of Grotta della Madonna suggests the presence nearby of woodlands and forests, but also of large clearings where these birds could hunt. The cliff where the cave is located and the cave itself may have been used for nesting by some of the species identified in the sample (buzzard, golden eagle scops owl, little owl).

The presence of bones of small vertebrates (that are in small number) may indicate the use of some areas of the cave as a roost, thus explaining the accumulation of pellets.

The taphonomic analysis did not reveal digested bones, therefore it is possible to exclude the capture of small birds of prey by larger raptors. On the examined bones there were no sure traces related to carnivore action, except dubious gnaw marks on two bones of barn owl and tawny owl. The other 11 gnawed bones represent 46% of all the modified bones, and since they all present other kinds of human damage, it is not possible to exclude that most of these specimens were altered by human chew marks. These mostly occurred on humerus (3), coracoid (2), ulna (2), pelvis (2), carpometacarpus (1) and radius (1). Comparing the punctures with experimental traces produced during the consumption of a hare, analogies in size (about 5 mm) and shape (ovoid but with one rectangular edge and crushing of cortical bone) have been observed with at least one of the punctures on the pelvis of golden eagle.

Although part of the bird remains may not be of anthropic origin, for example, the juvenile elements of tawny owl, that are birds nesting in the cave, probably represent animals that died of natural causes, it is possible that humans may have been the main agent for the introduction of raptor carcasses in the cave. The identification of human modifications (cut marks, impact marks, polishes, peelings and *arrachement*) on large (white-tailed eagle, golden eagle, eagle-owl) and medium sized raptors (buzzard, tawny owl) may con-

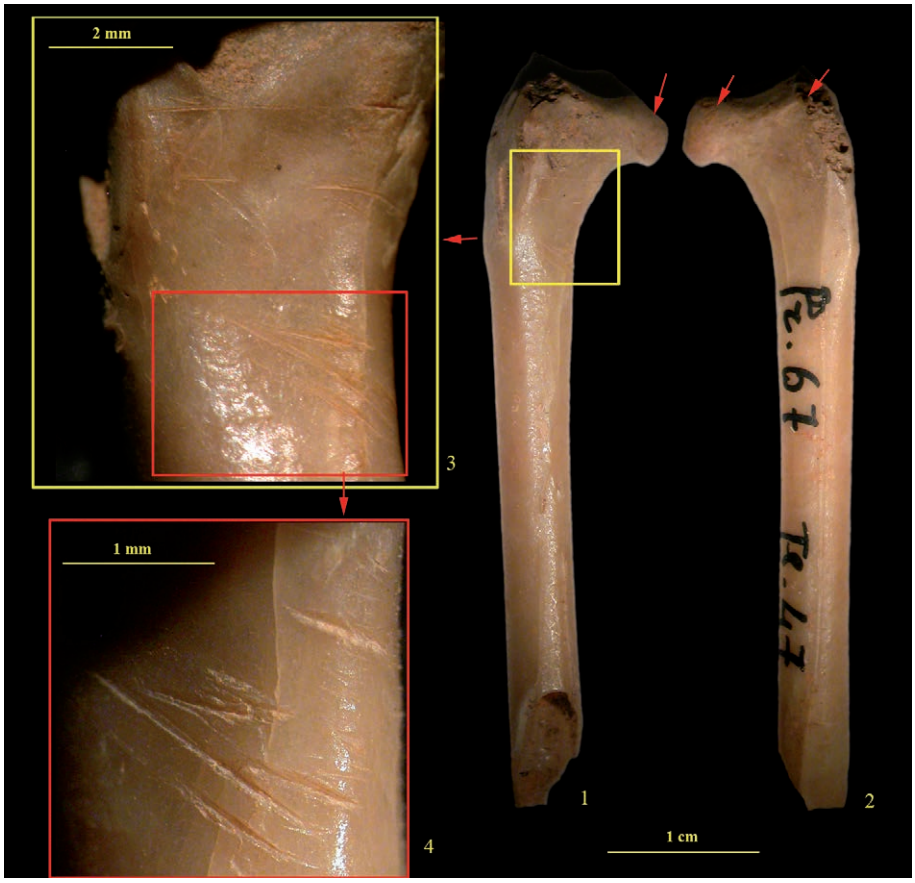

Fig. 6 - 1-2 Proximal femur of tawny owl (Strix aluco), caudal and cranial views. 3 Group of cut marks. 4 Detail. / 1-2 Femore prossimale di allocco (Strix aluco), viste caudale e craniale. 3 Gruppo di strie da strumento litico. 4 Particolare.

firm this hypothesis. Mainly traces referable to carcass portioning have been identified: disarticulation of the wings from the shoulder girdle (coracoid of goshawk), of wing portions (humerus of white-tailed eagle, scops owl, tawny owl and little owl, radius of buzzard and perhaps pallid harrier, ulna of eagle-owl and kestrel, carpometacarpus of scops owl), of the femur from the pelvis (golden eagle and tawny owl). Filleting traces have been evidenced on the ulna of eagle-owl; a particular interest in wings is indicated by the impacts and the signs of polish on the humerus of white-tailed eagle and the radius of buzzard.

In addition, localized combustion traces on long bone epiphyses, coracoid, pelvis and foot phalanges of diurnal (white-tailed eagle, goshawk, kestrel) and nocturnal (scops owl, tawny owl and eagle-owl) birds of prey, indicate the intentional division of the carcasses into small portions. It is possible that all these traces may reflect the consumption of some raptors.

However, the analysis of the anatomical regions highlights the complete absence of skulls, vertebrae and, above all, bones of the pectoral girdle (sternum, furcula, scapula) that provide the largest amount of edible meat in birds. In contrast, the wing bones appear to be particularly abundant (humerus, ulna, radius and carpometacarpus), suggesting a particular interest in this part of the body or, most likely, in the raptor remiges, possibly for ornamental purposes. Such interest, however, has already been described in the case of Middle Paleolithic sites in several European countries (Peresani *et al.* 2011).

In the second step of the research project the taphonomic study of the raptor remains from the Upper Paleolithic layer L of this cave will be completed and the results of the two layers will be compared providing a more comprehensive description of the human-raptor relationship over a period of 4000 years.

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Appendix *- Measurements (in mm) of raptor bones after Von den Driesch (1976): GL (greatest length), Bd (breadth distal end), Bp (breadth proximal end), Dp (proximal depth), Dd (distal depth), Dip (diameter of the proximal end), Did (diameter of the distal end), DiA (Diameter of the acetabulum), LV (Length along the vertebrae), Sc (smallest breadth of the corpus). Ad= adult; juv = juvenile /* ***Appendice*** *- Misure (in mm) delle ossa dei rapaci da Von den Driesch (1976): GL (lunghezza massima), Bd (larghezza distale), Bp (larghezza prossimale), Dp (spessore prossimale), Dd (spessore distale), Dip (diametro prossimale), Did (diametro distale), DiA (diametro dell'acetabulum), LV (lunghezza vertebrae), Sc (larghezza minima del corpo dell'osso). Ad= adulto; juv = giovanile.saetos)*

TAXA	ELEMENT	MEASUREMENT	AGE
White-tailed eagle (*Haliaeetus albicilla*)	Right distal humerus	Bd = 30.8	Ad
Pallid harrier (*Circus macrourus*)	Right distal radius	Bd = 6.4	Ad
Buzzard (*Buteo buteo*)	Left distal radius	Bd = 8.3	Ad
Golden eagle (*Aquila chrysaetos*)	Incomplete pelvis	LV = 11.2; DiA=16.6	Ad
Kestrel (*Falco tinnunculus*)	right distal ulna	Did = 5.9	Ad
Barn owl (*Tyto alba*)	Right ulna	GL = 93.9 Bp = 7.8 Dp = 8.1 Sc = 3.8 Did = 7	Ad
Barn owl (*Tyto alba*)	Right carpometacarpus	GL = 43.6 Bp = 9.2 Did = 7.1	Ad
Scops owl (*Otus scops*)	Left distal humerus	Bd = 7.8	Ad
Scops owl (*Otus scops*)	Left carpometacarpus	GL = 23.8;	Ad
Scops owl (*Otus scops*)	Left proximal carpometacarpus	Bp = 5.9	Ad
Scops owl (*Otus scops*)	Left tarsometatarsus	GL = 26.4 Bp = 5.6 Sc = 3 Bd = 5.7	Ad
Little owl (*Athene noctua*)	Right distal humerus	Bd = 9.1	Juv
Little owl (*Athene noctua*)	Right distal humerus	Bd = 9.9	Ad

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Article

New insight on the Romito shelter (Calabria, southern Italy): the lithic production of the Mesolithic levels

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Key words

- Mesolithic
- Sauveterrian
- lithic industries
- Calabria
- Italy

Parole chiave

- Mesolitico
- Sauveterriano
- industrie litiche
- Calabria
- Italia.

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Summary

Romito shelter (Papasidero, Cosenza), set forward the cave of the same name, has been explored in the 1960s by P. Graziosi. During his archaeological research, Graziosi opened a large trench parallel to the rocky wall, between the two well-known engraved boulders below the shelter. Graziosi brought to light a stratigraphic sequence containing several phases related to the Upper Paleolithic and the Neolithic. During the recent archaeological research carried out by the University of Florence, new excavations in the shelter were undertaken. The new excavations, performed close to the 1960s trench, revealed a pre-Neolithic sequence that testifies the human presence at Romito also during the Early Holocene. The stratigraphic sequence contains some Mesolithic paleosurfaces overlaying an Upper Paleolithic deposit. Mesolithic stone assemblages are placed within the context of the Sauveterrian-like armature complex of the low Tyrrhenian region.

Riassunto

Il Riparo del Romito, antistante l'omonima grotta, è stato oggetto di ricerche archeologiche negli anni '960 da parte di P. Graziosi che aprì una grande trincea di scavo parallela alla parete rocciosa del riparo, in un'area compresa tra i due celebri massi incisi. Graziosi mise in luce una sequenza stratigrafica comprendente fasi di frequentazione riferibili al Paleolitico finale e al Neolitico. Nel corso delle recenti ricerche, a partire dalla campagna del 2011, sono state riprese le indagini nel riparo. I nuovi scavi a ridosso della trincea Graziosi hanno messo in luce una sequenza preneolitica, che amplia le conoscenze correlate alle ricerche di P. Graziosi. La serie stratigrafica, scandita da alcune paleosuperfici, talora con impianti strutturati di combustione, contiene alcuni livelli con industrie litiche ascrivibili al Mesolitico antico. L'attribuzione crono-culturale è al Sauveterriano e la produzione litica viene inserita nell'ambito dei contesti ad armature del basso versante tirrenico.

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Fig. 1 - Riparo del Romito. Site location. / Localizzazione del sito.

Introduction

Grotta del Romito is located in the Lao Valley, Northern Calabria (275 m asl) ca. 12 km from the Tyrrhenian Sea (Fig. 1). The area is fairly mountainous, with nearby peaks overpassing 2000 m. The site is at the foot of a rock cliff and is composed by a rock shelter and a cave. The western part of the cave and the rock shelter were connected during the Palaeolithic and Mesolithic to form a large living space.

During the latest archaeological researches at Grotta del Romito (since 2000), as part of a new research and valorisation project linked to Paolo Graziosi's first excavations in the 1960's (Martini *et al.* 2004; Martini & Lo Vetro 2011), excavations in the external deposit of the rockshelter (Fig. 2) have brought to light, beneath the Neolithic layers, a Sauveterrian sequence which lies above Final Epigravettian layers (Fig. 3) (Lopez Garcia *et al*. 2014). This Early Holocene phase was not detected during Graziosi's researches and the lithic assemblages from the rockshelter are almost unpublished (Boscato *et al*. 1996).

The Mesolithic industries

The study of lithic assemblages from some layers of the Mesolithic deposit (levels 3, 3A, 3B, 3C, 3D, 4-spits 1 and 2) allowed obtaining some preliminary results. The lithic industries are grouped as follows:

- upper level 3 (3, 3A, 3B): 108 retouched tools
- lower level 3 (3C, 3D): 99 retouched tools 9.747±65 uncal. BP
- upper level 4 (4-spits 1 e 2): 176 retouched tools

Underneath, the stratigraphic sequence includes Sauveterrian layers that follow the Epigravettian presence (level 5: ^{14}C uncal. between 10.547±65 BP and 11.574±65 BP).

Fig. 2 - Riparo del Romito. View of the rock shelter (Archive of Paletnologia - Università di Firenze). / Veduta (Archivio fotografico di Paletnologia - Università di Firenze).

Raw material, technology

Petrographic analysis (Romagnoli *et al.* 2016) on both geological and archaeological samples indicates the use of three main lithological groups:

1. red and green radiolarites coming from Monte Sirino that were collected in form of pebbles at the Noce river deposits (15-20 km as the crow flies from the cave);
2. black flint, that were collected in the Lao river deposits, near the cave;
3. grey chert, some of which probably originating in the Monte Sirino area and mainly collected in detritus and in riverbeds.

Preliminary data from the technological study show no substantial differences in raw material procurement and exploitation along the Mesolithic sequence. Radiolarites are always predominant even if in the earliest phase a greater variability of raw material is attested (level 4).

All along the Sauveterrian sequence the main *chaîne opératoire* is almost the same. The lithic production is based on intense exploitation of small pebbles and blocks and, sometimes, large flakes, mainly aimed at producing micro- and hypermicrobladelets, lamellar flakes and wide micro- and hypermicroflakes, all suitable for geometric microliths (crescents and triangles) and backed tools production.

Standardized core reduction methods are performed in order to obtain the greatest possible number of products from each core: unidirectional methods, both frontal and on-edge (Fig. 4, n. 3; Fig. 5 nn. 1-2), are often replaced at the end of the reduction sequence by bidirectional schemes to completely exploit the cores (most of the cores are abandoned at about 15-25 mm in size) (Fig. 4, n. 1). Few very small centripetal cores for hypermicro and microflakes production seem to belong to this final stage of exploitation (Fig. 4, n. 2; Fig. 5, n. 3).

Structural features and typology

Typological analysis of retouched tools was made according to G. Laplace's Analytical Typology (Laplace 1964). For each phase the main typological and structural features are as follows:

- upper level 4 (spit 1 and 2) (Fig. 6, C): strong predominance of armatures (87% ca.), common tools category is scarce (12% ca.).The armatures are represented by crescents (23% ca.), total-backed points (15% ca.) and triangles (scalene and isosceles: 8% ca.); backed blades (6% ca.) and truncated backed tools (4% ca.) are scarcer. The backed tools fragments amount to 21% ca. The common tools mostly consist of truncations, especially oblique; each of the other typological groups does not surpass 2%.
- lower level 3 (3C-3D) (Fig. 6, B): decrease of armatures (68% ca.). The most characteristic types are: crescents (17% ca.), total-backed points (10% ca.) and triangles (6% ca.). All groups of the common tools category (30% ca.) increase slightly, except the truncations.
- upper level 3 (3, 3A, 3B) (Fig. 6, A): structural stability of the armatures (67% ca.).The crescents (13% ca.) continue to characterize the assemblage, associated with total-backed points (7% ca.), both types decrease as the triangles increase (8% ca.).The common tools category (33% ca.) maintain a structure homogeneous with that of the previous phase.

The three Sauveterrian phases identified at Romito show a quite standardized structural and stylistic physiognomy characterized by:

- very strong indexes of armatures, slightly decreasing along the sequence (from 87,5% to 67%);
- increase of common tools (from 12,5% to 33%);
- armatures mainly composed of crescents and triangles;
- scarce backed points and blades, truncated backed blades, all decrease along the sequence;
- presence of bilateral backed points (Sauveterre-like), never numerous and in decrease;
- presence of total-backed points often with convex edge, similar to crescents;
- scalene triangles decrease (from 6,8% to 3,7%) while isosceles increase (from 1,1% to 4,6%);

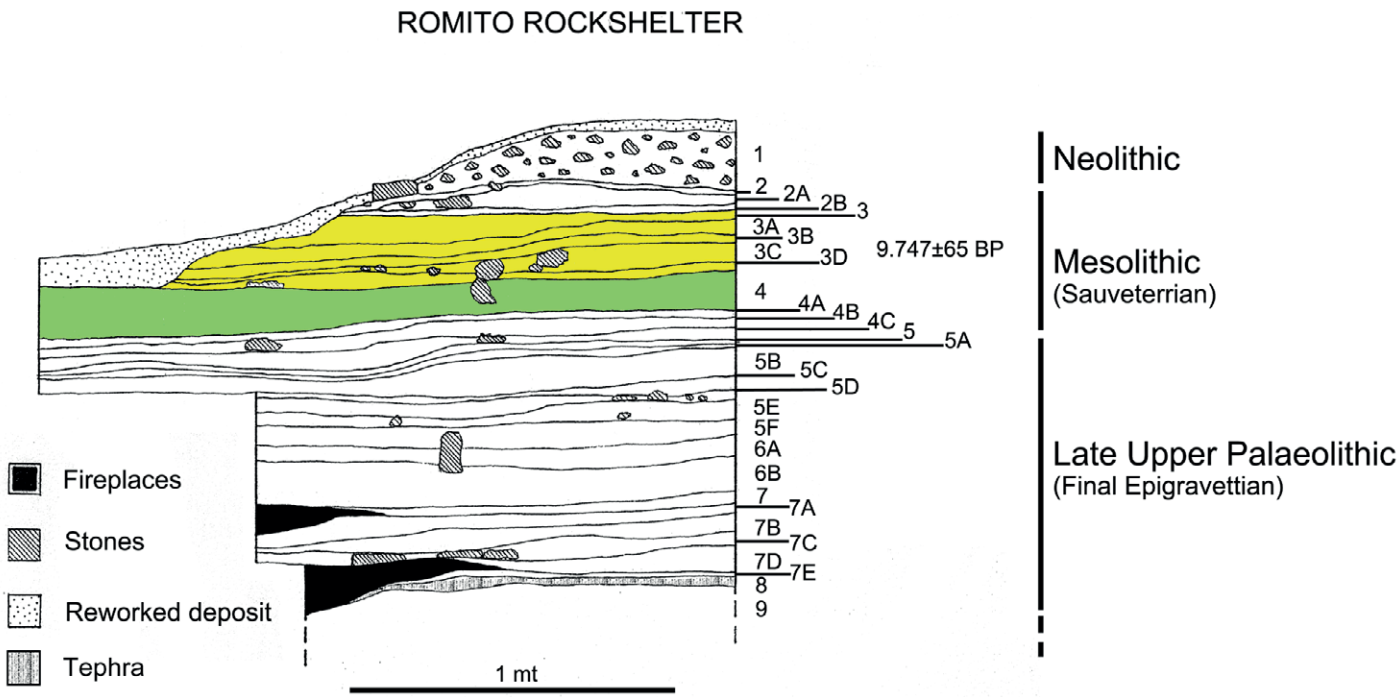

Fig. 3 *- Riparo del Romito. Stratigraphic sequence. / Sequenza stratigrafica.*

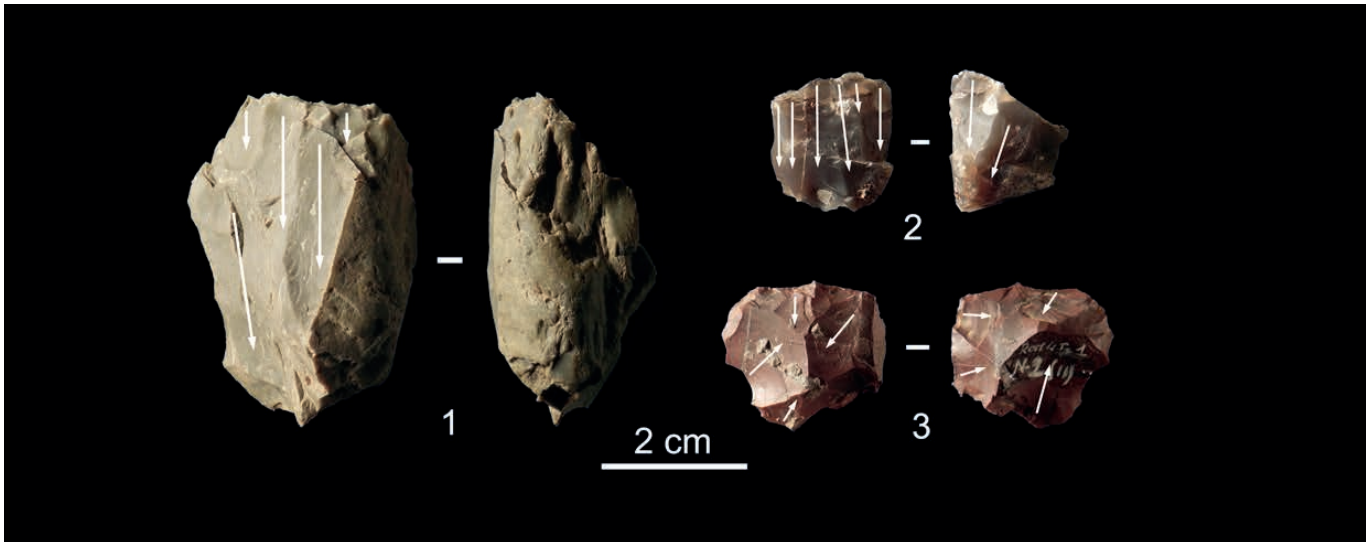

Fig. 4 - Riparo del Romito. Cores from layer 3 (Photo D. Lo Vetro). / Nuclei dallo strato 3 (Foto D. Lo Vetro).

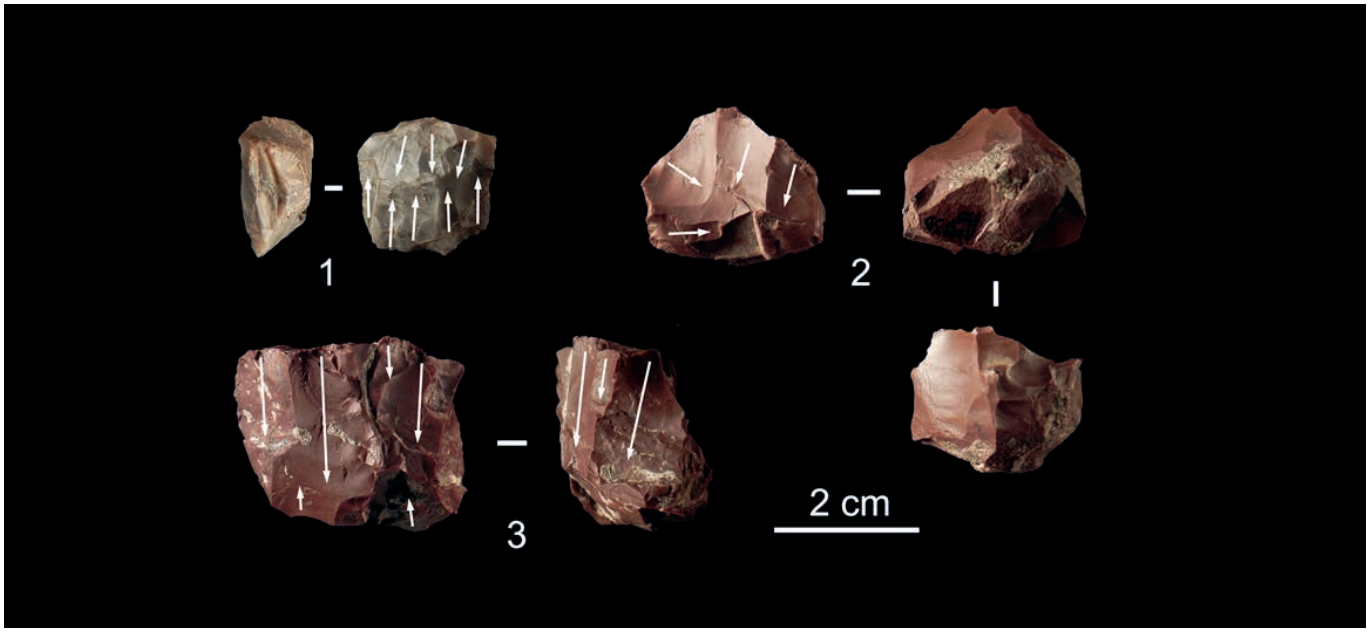

Fig. 5 - Riparo del Romito. Cores from layer 4 (Photo D. Lo Vetro). / Nuclei dallo strato 4 (Foto D. Lo Vetro).

- size of the armatures is mostly hypermicrolithic (up to 15mm);
- only in level 4 few armatures, stylistically similar to the Epigravettian types in morphology and typometry, are present (9.1% of the armatures: total backed points, backed blades, double truncated backed blades, crescents and a few fragments of indeterminate backed tools).

Relationship with the local Final Epigravettian lithic production

At the current state of research on the Late Upper Palaeolithic-Mesolithic Romito sequence, the problem remains open as to the possible phyletic link between the Sauveterrian of layers 4-3 and the local Epigravettian tradition (Martini *et al.* 2003 and 2007; Lo Vetro & Martini 2016). Between the two macro-phases both similarities, suggesting a direct derivation, and differences that have yet to be evaluated, can be observed.

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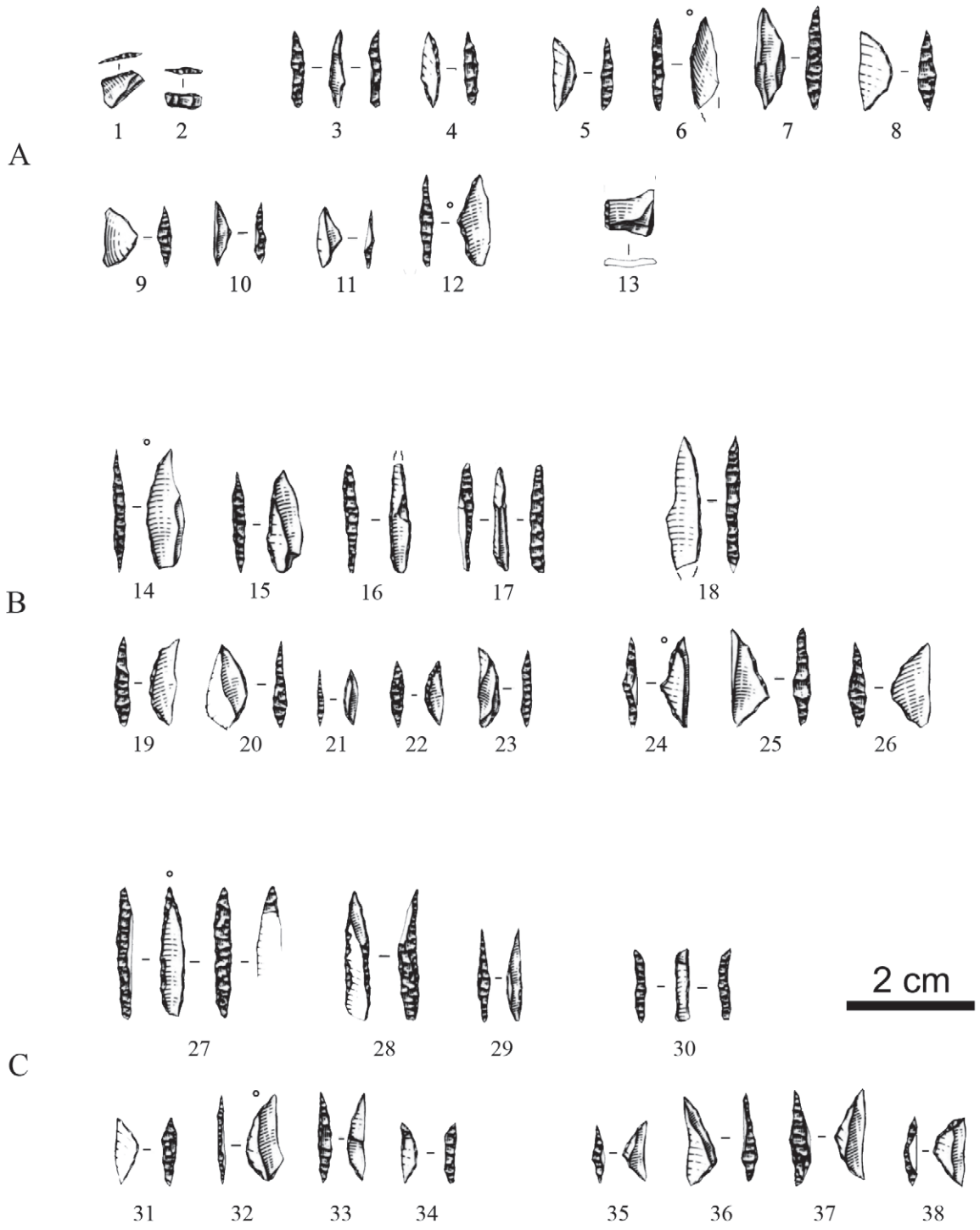

Fig. 6 *- Riparo del Romito. Sauveterrian lithic industry. A (Level 3 Top): 1 e 2-truncations; 3-4 total backed points; 5-8 crescents; 9-12 triangles; 13 abrupte. B (Level 3 Bottom): 14-17 total backed points; 18-total backed blade; 19-23 crescents; 24-26 triangles. C (Level 4 Top): 27-29 total backed points; 30-total backed blade; 31-34 crescents; 35-38 triangles (drawings by L. Baglioni). / Industria litica sauveterriana. A (Livello 3 Superiore): 1 e 2-troncature; 3-4 punte a dorso totale; 5-8 segmenti di cerchio; 9-12 triangoli; 13 scheggia a ritocco erto. B (Livello 3 Inferiore): 14-17 punte a dorso totale; 18-lama a dorso totale; 19-23 segmenti di cerchio; 24-26 triangoli. C (Livello 4 Sup.): 27-29 punte a dorso totale; 30-lama a dorso totale; 31-34 segmenti di cerchio; 35-38 triangoli (disegni L. Baglioni).*

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Article

The Mesolithic occupation at Isolidda (San Vito Lo Capo), Sicily

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Key words

- Sicily
- Mesolithic
- lithic assemblages
- coastal resource exploitation

Parole chiave

- Sicilia
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- industrie litiche
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Summary

'Gruppo dell'Isolidda' is a complex of five caves along a rocky cliff on the eastern side of the promontory of San Vito Lo Capo in NW Sicily. In 2004 archaeological excavations in the slope below the caves revealed a stratified deposit, partially in secondary position, containing levels with Late Epigravettian and Mesolithic stone tool assemblages. Early Mesolithic assemblages, characterized by backed microliths, were distributed in two contiguous layers (SU 21 and SU 25), the lowest of which (SU 21) also contained Epigravettian tools, probably due to sediment reworking. Three AMS dates on *Phorcus turbinatus* shells (~9520-9000 cal. BP) are chronologically compatible with the Early Mesolithic materials and suggest that the bulk of the deposit accumulated then. A third level, lying above the previous ones, contained artefacts associated to the Late Mesolithic or Early Neolithic. Faunal remains included abundant shells of intertidal molluscs, along with few fragmented bones of terrestrial herbivores. Oxygen isotope analyses on shell carbonates of *Phorcus turbinatus* show that, around 9520-9000 cal. BP, marine molluscs were exploited year-round, albeit more often in autumn and winter.

Riassunto

Il "Gruppo dell'Isolidda" è un complesso di cinque cavità che si aprono lungo il versante orientale del promontorio di San Vito Lo Capo (Trapani). Nel 2004 un sondaggio praticato nel pendio che si estende davanti alle grotte, ha messo in luce un deposito pluristratificato, parzialmente in giacitura secondaria, con livelli riferibili all'Epigravettiano finale, al Mesolitico e probabilmente al Neolitico antico. Le industrie del Mesolitico antico, caratterizzate da armature ipermicrolitiche, sono distribuite in due strati sovrapposti (USS 21 e 25); in quello più antico (US 21) si registra una commistione con elementi epigravettiani, probabilmente frutto di un rimaneggiamento in antico. Un terzo livello, soprastante ai precedenti, potrebbe essere riferibile ad un aspetto mesolitico a trapezi o al Neolitico antico. Le faune sono rappresentate soprattutto da abbondanti resti di molluschi marini mentre sono molto scarsi i resti di erbivori. Le analisi isotopiche effettuate su conchiglie di *Phorcus turbinatus*, dimostrano che, intorno a 9520-9000 cal. BP, la raccolta dei molluschi marini avveniva durante tutto l'anno, ma soprattutto in autunno ed in inverno.

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The site and its setting

'Gruppo dell'Isolidda' is a complex of five caves that opens 70-60 m above sea level along a coastal rocky cliff on the eastern side of the promontory of San Vito Lo Capo (Trapani) (Fig. 1).

The caves were probably all part of a single larger cave, which is now partially collapsed.

The first archaeological investigations at this site took place in the 1920s, when Raymond Vaufrey found Upper Palaeolithic industries at Grotta Racchio (Vaufrey 1928), the easternmost of the five caves. In the early 1960s, Giovanni Mannino discovered rock art in this same cave (Mannino 1962).

In 2004 a research team from the University of Florence, in partnership with the Museo e Istituto Fiorentino di Preistoria, undertook multidisciplinary investigations at the site (Martini *et al*. 2012a; Baglioni *et al.* 2012). Three trenches were opened to verify the presence of archeological deposits.

A trench of around 8 square metres, excavated on the slope below the cave complex, revealed a stratified deposit under the modern topsoil (SU 20), partly in secondary position, consisting of three main stratigraphic units (SU 24, 25 and 21), each excavated in artificial spits of about five centimeters (Fig. 1, E-F). No structures or evident paleosurfaces were detected, as it is likely that the stratigraphic sequence accumulated following distinct colluvial episodes, which transported sediments from just outside the caves further downslope. Despite these formation processes, the deposits have distinguishable levels and constitute a rather coherent sequence. This can be explained by hypothesizing that the colluvial events were chronologically discrete and that colluviation down the slope occurred soon after their primary deposition.

The archaeological sequence contained stone tool industries dating back to the Late Pleistocene (Late Epigravettian) and Early Holocene (Mesolithic and Early Neolithic) (Tab. 1). The lowermost levels (SU21-spits 17 lower, 18 and 19) contained only Epigravettian industries, while the levels above them (SU21-spits 17 and 16, SU25 spit 16 upper) contained a mixture of Upper Palaeolithic and Early Mesolithic industries. SU25- spit 15 contained the bulk of the Early

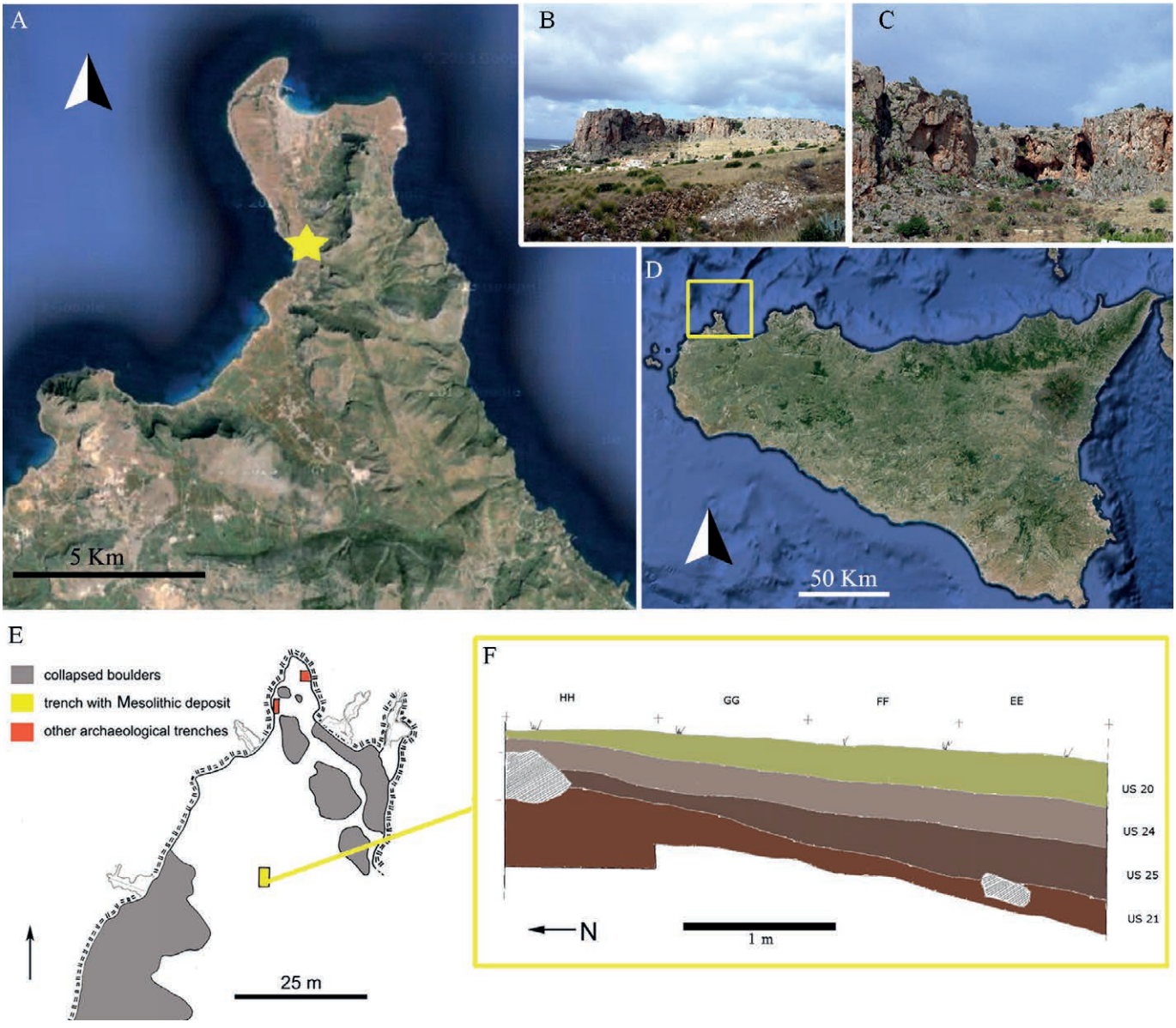

Fig. 1 *- Gruppo dell'Isolidda. A-D- the site and its location; E- plan of the site and position of trench n. 2. excavated on the slope below the caves; F- stratigraphic sequence drawn from the section east of trench n. 2. / A-D- il sito; E- pianta del sito e posizione della trincea 2 aperta sul pendio sottostante le cavità; F- sequenza stratigrafica della sezione est della trincea 2*

***Tab. 1** - Gruppo dell'Isolidda. Stratigraphic scheme and chrono-cultural sequence. The radiocarbon dates were calibrated with the OxCal 4.2 software (Bronk Ramsey & Lee 2013), using the Marine13 curve (Reimer* et al*. 2013). The reservoir correction of the calibrated ages is based on the estimate of the reservoir effect by Siani et al. (2000) for Sicily (ΔR = 71±50 ^{14}C yrs). / Schema stratigrafico e sequenza crono-culturale. Le date radiometriche sono state calibrate con il software OxCal 4.2 (Bronk Ramsey & Lee 2013), usando la curva Marine13 (Reimer* et al. *2013). La correzione dell'effetto reservoir delle date calibrate è basata sulla stima del "reservoir effect" elaborata da Siani et al. (2000) per la Sicilia (ΔR = 71±50 ^{14}C yrs).*

LAYER	SPIT	MAIN DIAGNOSTIC ARTEFACTS AND SUBSISTENCE REMAINS	CULTURAL ATTRIBUTION OF STONE TOOL INDUSTRIES	AMS CHRONOLOGY (^{14}C BP)
SU 24	14	Ipermicro and micro trapezes Very few obsidian flakes Very few indeterminable pottery sherds Few marine mollusc shells	Late Mesolithic or Early Neolithic	-
SU 25	15 upper	Few ipermicro and micro lithic armatures Two ipermicro trapezes Very few obsidian flakes Marine mollusc shells	Early Mesolithic with intrusive Late Mesolithic or Early Neolithic elements	-
SU 25	15 lower	Ipermicro and micro lithic armatures Small centripetal and facial cores Marine mollusc shells Rare terrestrial mammal remains	Early Mesolithic	(OxA-18069) 8685±40 (9430-9080 yrs cal BP; 2σ)
SU 25	16 upper	Ipermicro and micro lithic armatures Small centripetal and facial cores Upper Palaeolithic stone elements Abundant marine mollusc shells Engraved *Columbella rustica* shell Rare terrestrial mammal remains	Late Epigravettian and Early Mesolithic	(OxA-18070) 8620±45 (9380-9000 yrs cal BP; 2σ)
SU 21	16 lower	Ipermicro and micro lithic armatures Small centripetal and facial cores Upper Palaeolithic stone tools and cores Marine mollusc shells Rare terrestrial mammal remains	Late Epigravettian and Early Mesolithic	-
SU 21	17 upper	Upper Palaeolithic stone tools and cores Some Mesolithic stone elements Marine mollusc shells Few terrestrial mammal remains	Late Epigravettian and Early Mesolithic	(OxA-18071) 8785±45 (9520-9220 yrs cal BP; 2σ)
SU 21	17 lower	Upper Palaeolithic stone industry Few marine mollusc shells	Late Epigravettian	-
SU 21	18 and 19	Upper Palaeolithic stone industry	Late Epigravettian	-

Mesolithic stone tools found in the archaeological deposit; SU25-spit 15 lower yielded exclusively Early Mesolithic industries, while in the level above it (SU25-spit 15 upper) two trapezes and a rare intrusive obsidian flakes were recovered, probably coming from the overlying layer (SU 24). SU 24 was characterized by the occurrence of trapezes dating back to the Late Mesolithic or Early Neolithic.

AMS radiocarbon dating

AMS radiocarbon dating was undertaken at the Oxford Radiocarbon Accelerator Unit on three shells of the marine mollusc *Phorcus turbinatus* from the two lowermost stratigraphic units. The dates all fall within the Early Holocene and are consistent with the archaeological stratigraphy and the Early Mesolithic stone tool assemblages. The calibrated ages of the dates on the shells from SU 21-spit 17 upper (OxA-18071), SU 25-spit 16 upper (OxA-18070) and SU 25-spit 15 lower (OxA-18069) overlap and suggest that the bulk of the deposit accumulated during the Mesolithic (~9520-9000 yrs cal. BP) (Tab. 1)

Mesolithic stone tool assemblages

The archaeological deposit of trench 2 contained over 7000 lithic items, including almost 1200 retouched tools and 100 cores, attributable to the period spanning from the Late Epigravettian to the Early Neolithic. As mentioned above (see section 1 and Tab. 1), with the exception of the lowest spits of SU21 (spits 19-18 and 17 lower), Mesolithic lithics have been found throughout the archaeological sequence, often mixed with finds of other periods. The retouched lithic tools and cores that can be ascribed almost exclusively to the Early Mesolithic are those from SU25-spit 15, although this assemblage also contains a few intrusive artefacts from the layer above (spit 15 upper).

Of the whole stone tool assemblage recovered at Isolidda, only the Mesolithic finds will be discussed here, in our account of the main techno-typological features of the assemblage and of the most significant lithic artefacts.

The Mesolithic stone tool assemblages (Fig. 2) are made on good quality flint, locally collected mainly in secondary deposits (shores and riverbeds), in the form of pebbles and cobbles (Collina 2006 and 2012).

In SU 21-spits 17 upper and 16 lower (Fig. 2, E and D) and SU 25-spits 16 upper and 15 lower (Fig 2, C and B) an intensive exploitation of cores, through both facial (unidirectional and bidirectional) and centripetal reduction schemes, attests a production aimed at obtaining ipermicro (up to 15mm)- and micro (16-25mm)-blanks (bladelets, laminar flakes, flakes) for making armatures. In these levels, among the retouched artefacts, unilateral backed points (some of which are curved) and short triangles, are present. These items might be assignable to one of the local Mesolithic facies defined as "Epigravettian-tradition facies" (Lo Vetro & Martini 2012 and 2016). Several artefacts are also compatible with the local Sauveterrian-like facies, such as: an ipermicro double-baked point, ipermicro short triangular backed points, "tectiform" (roof-shaped) end-scrapers, and very small facial and centripetal cores. These items are comparable with those from Perriere Sottano (Aranguren & Revedin 1998) and Grotta d'Oriente (Martini *et al*. 2012b). A nosed end-scraper with two lateral notches from SU 25-spit 16 upper (Fig. 2, n. 25) is comparable to the items from the Early Mesolithic levels of Grotta dell'Uzzo (Piperno 1985; Guerreschi & Fontana 2012).

SU 24 (Fig. 2, A) yielded a dozen of ipermicro trapezes, some of which made on very regular pressure flaking bladelets, comparable to the Late Mesolithic (Castelnovian) and Early Neolithic items from Grotta dell'Uzzo (Collina 2012). Pressure flaking is also attested by the occurrence of few symmetric and thin bladelets among which there are some microburins.

Mesolithic subsistence strategies and seasonality of mollusc exploitation

Subsistence strategies at the site involved the exploitation of large mammals and intertidal molluscs. Large mammal exploitation was mainly oriented towards *Cervus elaphus* and *Sus scrofa*. Intertidal molluscs were collected on nearby rocky shores and are mainly represented by *Phorcus turbinatus* and different species of Patellidae. A peak in the minimum number of individuals (MNI) is observed in SU 25, although intertidal molluscs occur throughout the sequence, with no substantial changes in species composition (Shannon index) (Fig. 3).

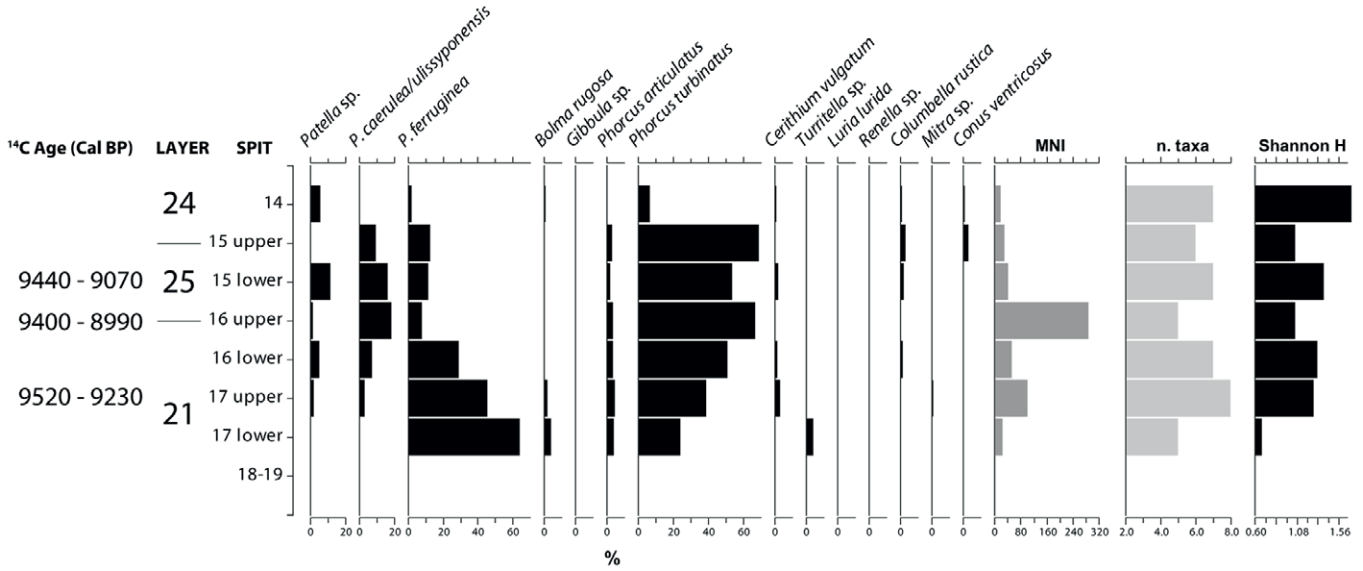

Fig. 3 - Gruppo dell'Isolidda. Trench 2. Marine molluscs. The minimum numbers of individuals (MNI), the number of taxa and the Shannon index are also reported on the right. / Trincea 2. Molluschi marini. Sulla parte destra dell'istogramma sono riportati il numero minimo degli individui, (MNI), il numero dei taxa e l'indice Shannon.

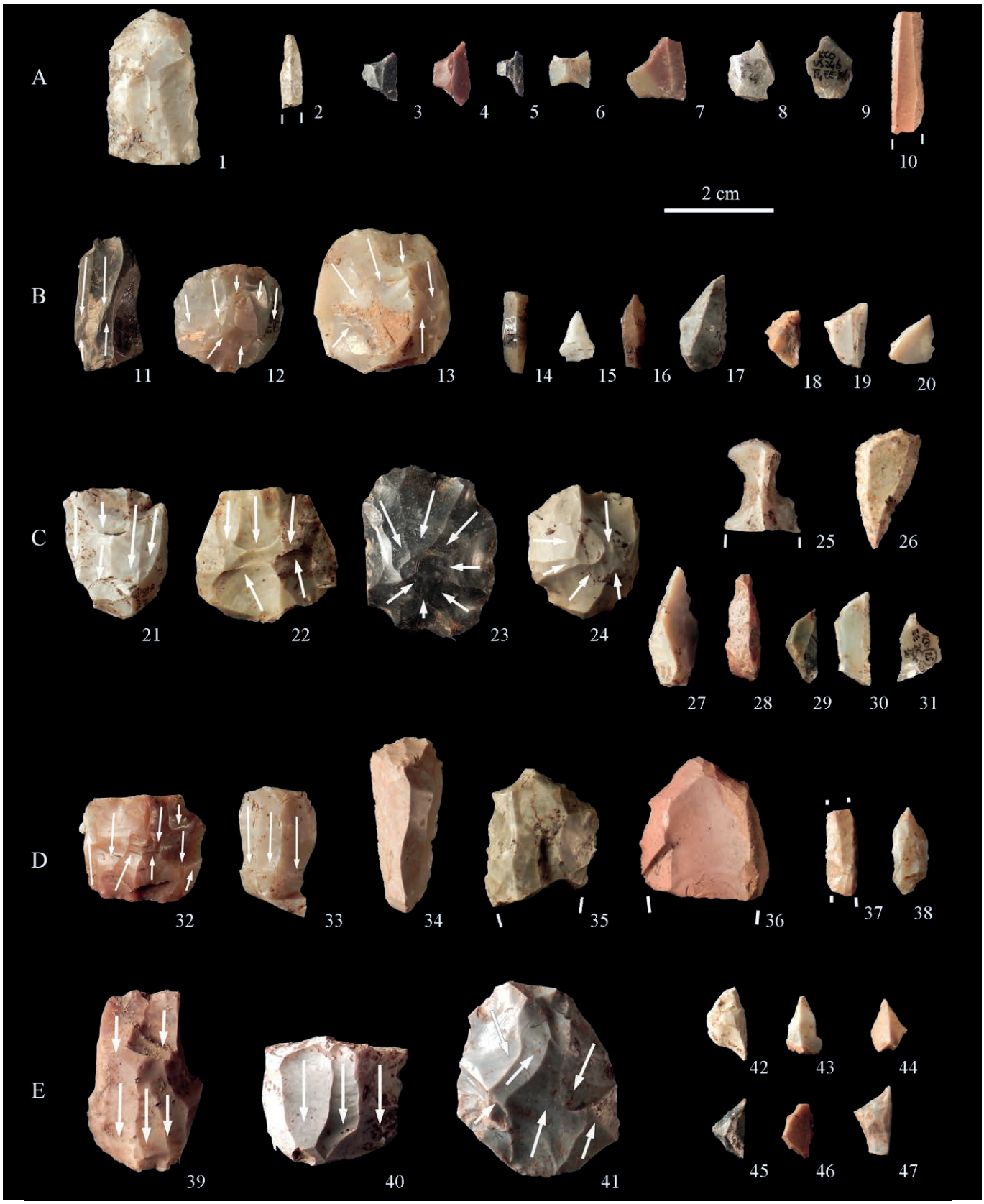

Fig. 2 *- Gruppo dell'Isolidda. Mesolithic stone artefacts from trench 2. A: from SU 24, 1- tectiform (roof-shaped) long end-scraper, 2- backed point, 3-7- trapezes, 8-9- microburins, 10- pressure knapped bladelet; B: from SU 25-spit 15 lower, 11- facial reduction method core, 12-13- centripetal reduction method cores, 14- truncated bladelet, 15-17- backed points, 18-20- triangles; C: from SU 25-spit 16 upper, 21-22- facial reduction method cores, 23-24- centripetal reduction method cores, 25- long end-scraper, nosed end-scraper, 27-28- backed points, 29- triangle, 30- trapeze, 31- microburin; D: from SU 21-spit 16 lower, 32-33- facial reduction method cores, 34- long end-scraper, 35-36- tectiform (roof-shaped) end-scrapers, 37- backed point, 38- fragment of backed tool; E: from SU 21-spit 17 upper, 39-40- facial reduction method cores, 41- centripetal reduction method core, 42-44- backed points, 45-47- triangles (photo D. Lo Vetro). / Manufatti litici mesolitici dalla trincea 2. A: da US 24, 1- grattatoio frontale lungo, 2- punta a dorso, 3-7- trapezi, 8-9- microbulini, 10- lamella a pressione; B: da US 25-taglio 15 inferiore, 11- nucleo a sfruttamento frontale, 12-13- nuclei a sfruttamento centripeto, 14- troncatura, 15-17- punte a dorso, 18-20- triangoli; C: da US 25-taglio 16 superiore, 21-22- nuclei a sfruttamento frontale, 23-24- nuclei a sfruttamento centripeto, 25- grattatoio frontale lungo, grattatoio a muso evidenziato, 27-28- punte a dorso, 29- triangolo, 30- trapezio, 31- microbulino; D: da US 21-taglio 16 inferiore, 32-33- nuclei a sfruttamento frontale, 34- grattatoio frontale lungo, 35-36- grattatoi frontali tettiformi, 37- punta a dorso, 38- frammento di dorso; E: da US 21-taglio 17 superiore, 39-40- nuclei a sfruttamento frontale, 41- nucleo a sfruttamento centripeto, 42-44- punte a dorso, 45-47- triangoli (foto D. Lo Vetro).*

Shells of *Patella ferruginea* dominated the marine mollusc remains in SU 21 (Fig. 4), which is associated with lithic assemblages typical of the Late Epigravettian and Early Mesolithic. It is also worth noting that this species underwent a substantial decrease in size from SU 21 (60.6±5.3 mm) to SU 25 (46.6±10 mm). As *P. ferruginea* living in protected areas today (51.9±1.9 mm) are larger than those recovered in SU 25, it is can be hypothesized that during the Early Holocene this species was subject to either environmental changes or anthropogenic pressures. *Phorcus turbinatus* was the most intensively collected species during the accumulation of SU 25. Most of the shells are partially broken or had their apex removed likely for the extraction of the molluscan flesh.

Oxygen isotope analyses

To investigate the seasonality of site occupation, we undertook oxygen isotope analyses on 28 shells of the intertidal gastropod *Phorcus turbinatus* according to established methodologies (Mannino *et al*. 2007, 2008; Colonese *et al.* 2009). Molluscs were exploited in every season, but mainly in autumn and winter, with few summer and rare spring collections. This suggests that hunter-gatherers were at the site regularly, although with the evidence at hand it is hard to establish whether this was a result of frequent short visits or more prolonged year-round occupation (Fig. 5).

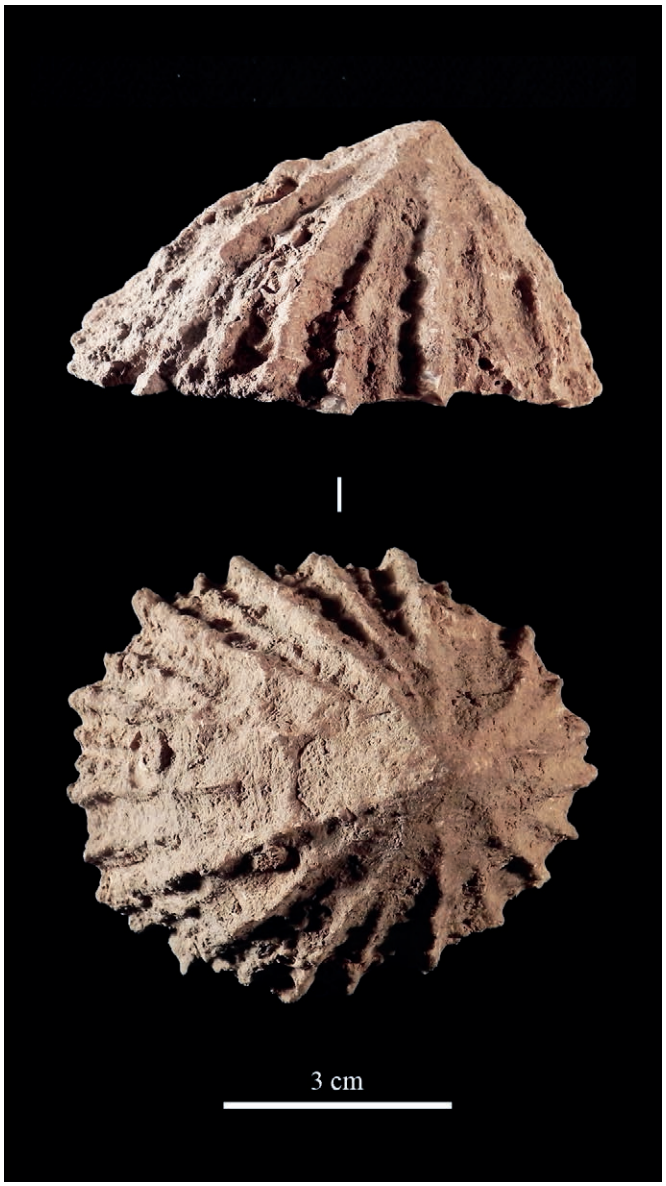

Fig. 4 *- Gruppo dell'Isolidda. Trench 2.* Patella ferruginea *from SU 21-spit 17 upper. / Trincea 2.* Patella ferruginea *da SU 21-taglio 17 superiore.*

Modified marine shells: personal ornaments

Marine shells were modified and likely used as personal ornaments by the occupants of the site, as attested by perforated shells of *Columbella rustica* retrieved mainly from SU 25 (spits 15 and 16), and SU 24. One shell of *Columbella rustica* (SU 25-spit 16 upper) had several parallel incisions on the body whorl (Fig. 6; Martini *et al*. 2012a). Use-wear traces suggest that this shell was suspended or attached to clothing. This is a remarkable find since it bears very similar ornamentations to worked shells of *Columbella rustica* from other Mesolithic sites in Sicily: Grotta dell'Uzzo (two specimens, Tagliacozzo 1993), Perriere Sottano (one specimen, Aranguren & Revedin 1998) and Grotta d'Oriente (one specimen, Cilli *et al.* 2012). The latter shell is associated either to the Late Mesolithic of Castelnovian tradition or to the Early Neolithic (Martini *et al.* 2012b). Taken together, this evidence suggests that there was an established shell ornament tradition shared by Mesolithic groups living across Sicily.

Conclusions

The site of Isolidda was occupied from the end of the Upper Palaeolithic to the Early Neolithic, similarly to many cave sites in NW Sicily. However, the main occupation phase coincided with the Early Mesolithic (upper spits of SU 21 and SU 25) when hunter-gatherers exploited terrestrial mammals and marine molluscs, the latter also for ornamental purposes. In these levels, although Mesolithic and Late Epigravettian lithic artefacts are partly mixed, due to site for-

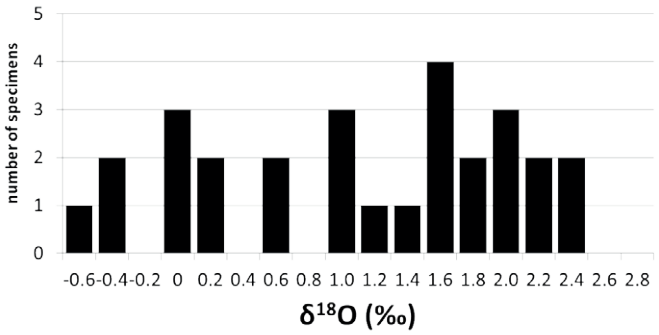

Fig. 5 *- Gruppo dell'Isolidda. Trench 2. Oxygen isotope values of edge samples drilled from 28 shells of* Phorcus turbinatus *recovered in SU 21-spit 17 upper, SU 25-spit 16 upper and SU 25-spit 15 lower. The x-axis represents the overall yearly oxygen isotope range recorded on specimens from the site of Isolidda, with the highest values corresponding to the coldest temperatures and the lowest values to the warmest. Intervals in the x-axis are equivalent to around 1.0°C in sea surface temperature ($\delta^{18}O$ = 0.23‰). / Trincea 2. Valori degli isotopi dell'ossigeno dai campioni prelevati al bordo di crescita di 28 conchiglie di Phorcus turbinatus rinvenute nelle US 21-taglio 17 superiore, US 25-taglio 16 superiore ed US 25-taglio 15 inferiore. Sull'asse delle ascisse è rappresentato il range annuale dei valori degli isotopi dell'ossigeno registrato su alcuni esemplari dell'Isolidda, con i valori isotopici più elevati corrispondenti alle temperature dell'acqua del mare più basse e quelli più bassi alle temperature più alte. Gli intervalli riportati sull'asse delle ascisse corrispondono a circa 1.0°C nella temperatura di superficie dell'acqua del mare ($\delta^{18}O$ = 0.23‰).*

***Fig. 6** - Gruppo dell'Isolidda. Trench 2. Shell of* Columbella rustica *with several parallel incisions on the body whorl (after Martini,* et al. *2012a). / Trincea 2.* Columbella rustica *con incisioni parallele (da Martini* et al*. 2012a).*

mation processes, it is possible to recognize stone tool assemblages showing techno-typological features comparable to those from other Early Mesolithic Sicilian sites. Some items might be referred to the local Sauveterrian-like facies, others to the so-called "Epigravettian-tradition facies". A more recent phase is attested in SU 24, in which some elements (trapezes, pressure flaking bladelets) may be referred to a Late Mesolithic (Castelnovian) or Early Neolithic occupation.

The Mesolithic occupants of Isolidda were culturally very close to groups living across Sicily in the early Holocene, as testified by their lithic industries and worked shells, which imply common symbolic repertoires.

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Article

A contribution to landscape reconstruction in the basin of Mondeval de Sora (Belluno Dolomites, N-E Italy): preliminary analysis of an anthracological sample from the Mesolithic layers of site VF1, sectors I and III

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Key words

- Vegetation landscape
- anthracology
- South-Eastern Alps
- Mesolithic
- palaeoenvironment

Parole chiave

- vegetazione
- antracologia
- Alpi sud-orientali
- Mesolitico
- paleoambiente

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Summary

We studied the Early and early-Mid Holocene landscape at the site of Mondeval de Sora, VF1 (Belluno, N-E Italy), preserving one of the best archaeological records of the Dolomites for this time span. Charcoal analyses are related to sectors I and III located under a dolomite boulder at an altitude of 2,150 m a.s.l. Samples were systematically picked up through wet sieving all over the stratigraphic sequence during archaeological excavations. For our analysis we sub-sampled 414 charcoals from the estimated total number of ca. 300.000. The analyzed charcoal come from levels dating to the Sauveterrian and the Castelnovian. They are mainly constituted of larch/spruce, followed by pine, probably mugo pine, and by cembran pine. Broadleaves are rare and represented by green alder. The larch, is more represented than spruce confirming its ability to occupy higher altitudes. Cembran pine, is less represented with respect to larch and spruce.

Riassunto

Nella presente ricerca è stato studiato il paesaggio durante l'Olocene antico e medio iniziale del sito di Mondeval de Sora, VF1 (Belluno, N-E Italia), che preserva uno dei migliori record archeologici delle Dolomiti per questo lasso di tempo. Le analisi dei carboni sono relative ai settori I e III situati sotto un masso dolomitico a un'altitudine di 2.150 m s.l.m. I campioni sono stati raccolti in modo sistematico attraverso setacciatura a umido lungo tutta la sequenza stratigrafica durante gli scavi archeologici. Per le analisi è stato effettuato un sotto-campionamento di 414 carboni dal numero totale stimato di ca. 300.000. I carboni analizzati provengono dai livelli risalenti al Sauveterriano e al Castelnoviano. I carboni sono principalmente costituiti da larice / abete rosso, seguita da pino, probabilmente pino mugo, e pino cembro. Le latifoglie sono rare e rappresentate da ontano verde. Il larice è più rappresentato dell'abete rosso, a conferma della sua capacità di occupare quote più elevate. Il pino cembro, è meno rappresentato rispetto al larice e all'abete rosso.

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Introduction

Land use and exploitation strategies at high altitudes in the South-Eastern Alps by the last groups of hunter-gatherers have been already addressed and developed using a wide repertoire of complementary approaches (e.g. Cusinato and Bassetti 2007, Peresani *et al.* 2009, Fontana *et al.* 2009 a, b, 2011). Models of vertical nomadism characterized by a seasonal shift from valley-bottom winter camps to the high altitude settlements during the favorable season have been proposed and, more recently, also a system based on a circular nomadism (Broglio 1992, Grimaldi 2005). Lastly, it has also been suggested that the current record for the early Mesolithic of north-eastern Italy indicates a much more complex system than previously envisaged, as evidenced by the varied location of the known sites (Fontana *et al*. 2011; Fontana and Visentin in press).

The study of organic materials from a Mesolithic site, particularly macroscopic plant remains and pollens, besides helping the reconstruction of the surrounding environment, can point out the modalities of supply of key resources, such as wood used as fuel, as well as fruits and seeds (e.g. Kubiak-Martens 1996, Mason and Hather 2002, Regnell 2012) and therefore give an important contribution to the reconstruction of natural resource exploitation.

Among the numerous Mesolithic sites known in the southern slope of the Alps and especially in its central-eastern side only a few have yielded organic remains, both animal and vegetal. This aspect especially concerns high-altitude camps whereas valley-bottom rock-shelter sites present a more varied range of findings (Broglio 1992, Fontana *et al.* 2011). Within this context the mountain camp-site of Mondeval de Sora represents a real exception with its excellent preservation conditions which can be connected to its location under a dolomite boulder that has protected archaeological layers from erosion and favored preservation. Therefore the Mesolithic layers from this site have yielded large quantities of charcoal remains with good preservation also during the following occupation of the site, up to present times. Such evidence represents a unique opportunity to investigate aspects concerned with the exploitation of wood resources at high altitudes in the Dolomites by the last groups of hunter-gatherers.

The site

The basin of Mondeval de Sora (San Vito di Cadore, Belluno) is located in the Belluno Dolomites (NE Italy), in the upper part of Fiorentina Valley, a tributary of the river Piave, with altitudes ranging between 2,100 and 2,360 m a.s.l (Fig. 1).

The basin is surrounded by a jagged ridge of Dolomia Principale and San Cassiano Formation, while the substrate is formed by rocks of the Wengen Group: volcanic turbidites, tufaceous sandstones, conglomerates and marly limestones (Frescura and Zinato 2010). During the Last Glacial Maximum the basin was occupied by two small confluent glaciers. The one to the W had a mainly erosive action, with minor deposition consisting almost exclusively of dolomitic erratic boulders while the one to the E deposited massive moraines and some moraine bars that originated a small proglacial lake now disappeared (Alciati *et al.* 1992).

In the basin of Mondeval two main wet environments are still attested called Laghetto delle Baste and Busa dei Ciavai. Nowadays the basin of Mondeval de Sora is covered by herbaceous formations while arboreal species lack, except for some rare *Larix decidua* reduced to shrub. Due to human impact, especially referable to pastures, the timberline is nowadays located at an altitude of 1,850 - 2,050 m, i.e. lower than the site.

Vegetation of pastures is mainly characterized by *Sesleria* and *Festuca* coenoses while where grazing is more intense *Poion alpinae* is favoured. Herbaceous formations in the wet environments are composed especially of *Arabis soyeri, Cardamine amara, Juncus triglumis* and *Carex frigida*. Geobotanical surveys conducted in the area of Croda da Lago, about 2 km away from Mondeval, indicate that at altitudes higher than 1,950 m *Picea abies* is scarcely present compared to *Pinus cembra* and especially to *Larix decidua*, which is the most widespread species up to 2,200 m (Soraruf and Carrer, 2007). In this area the timberline is attested at 2,100 m and the tree-line at 2,200 m.

Site VF1 of Mondeval de Sora (San Vito di Cadore, Belluno) is located at 2,150 m under an erratic boulder (Fig.2). Two sectors have been investigated respectively facing S (sector I) and N (sector III). Both of them have yielded complex stratigraphic sequences indicating human frequentation with repeated interruptions from the Early Mesolithic to recent times.

In sector I the stratigraphic sequence (Fig. 3 A) shows different phases of settlement dating back to the Mesolithic, the Bronze Age and the historical period (Alciati *et al.* 1992). The Mesolithic is represented by a Sauveterrian sequence located in the southern part of the shelter and a well-preserved Castelnovian burial (SU 4B) accompanied by some disturbed Castelnovian layers (SUs 100 and 25) also present in the southern part of the site but in the portion closer to the rock wall. In the northern area the Mesolithic layers are absent since they have been completely erased by the following occupation of the site. The Sauveterrian sequence consists of a series of dwel-

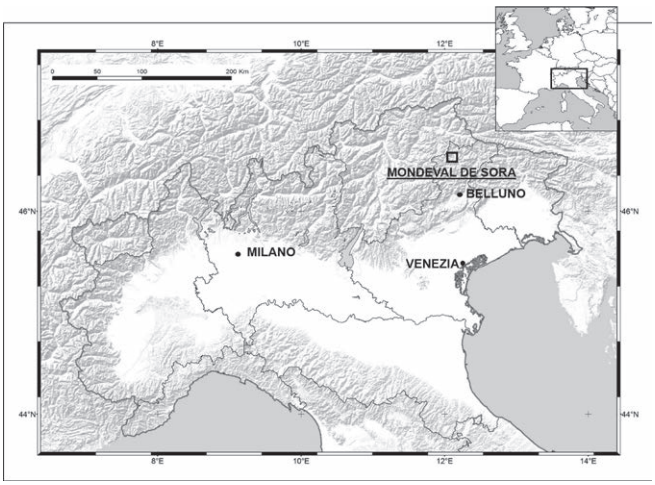

Fig. 1 *- Location of the site of Mondeval de Sora in NE Italy and in Europe. / Posizione del sito di Mondeval de Sora in Italia Settentrionale e in Europa.*

Fig. 2 *- The basin of Mondeval de Sora: left in the background the erratic boulder with the prehistoric site. / Il bacino di Mondeval de Sora: a sinistra sullo sfondo il masso erratico con il sito preistorico.*

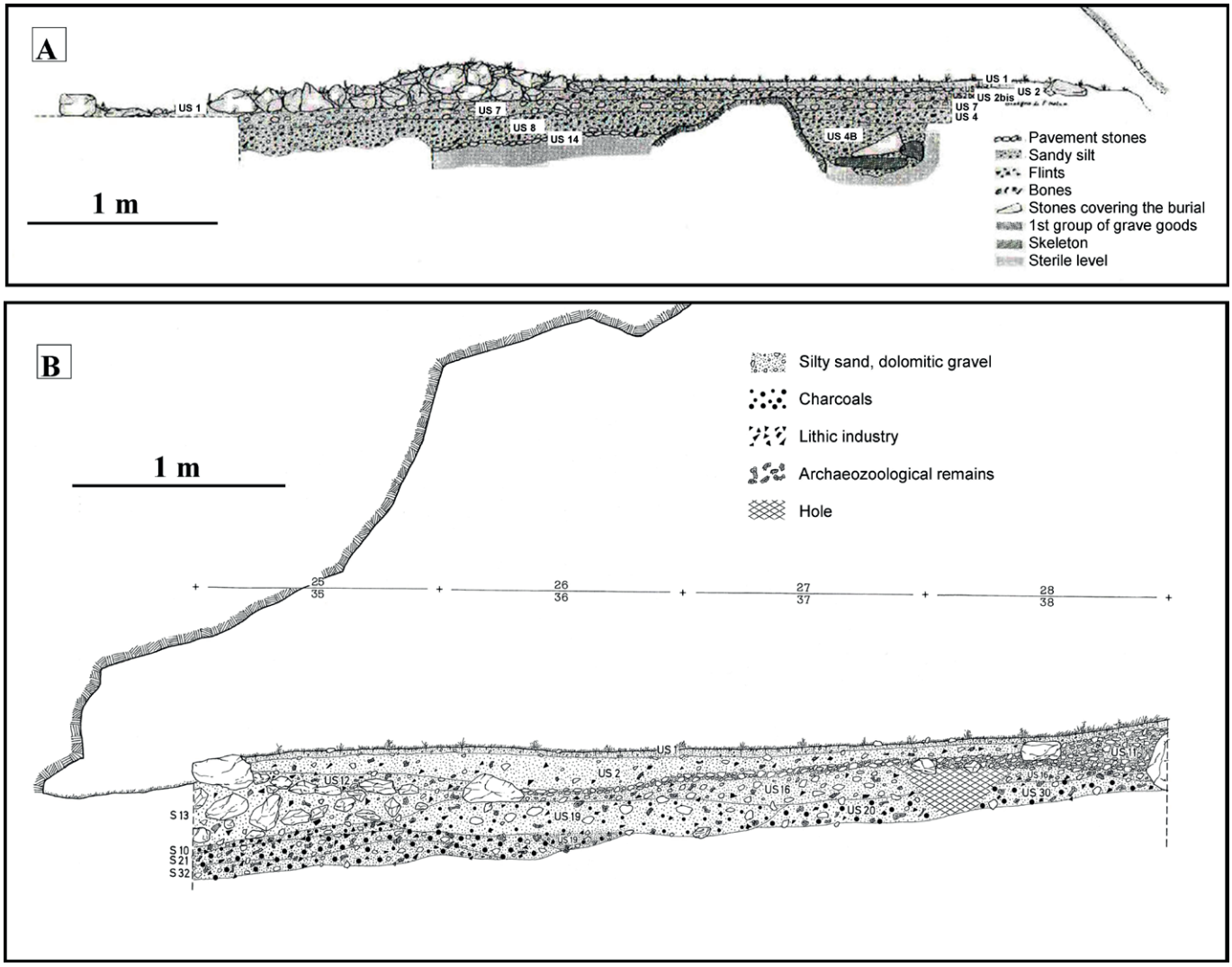

Fig. 3 - Stratigraphic sequences from sectors I (A) and III (B) of site VF1 of Mondeval de Sora. The numbers above and below the bar refer to the square grid system used during fieldworks. / Sequenze stratigrafiche dei settori I (A) e III (B) del sito VF1 di Mondeval de Sora. I numeri sopra e sotto le barre si riferiscono alla griglia quadrata utilizzata durante il lavoro di campo.

ling structures (a paved area made of small tufa slabs - SU 14 and an accumulation of dolomite blocks surrounding it - SU 33, within which a fireplace could be distinguished - SU 32) and some anthropogenic soils that covered them (SUs 7, 8, 31) and that were extremely rich of lithic waste, tools and armatures along with organic remains, mainly charcoals and bones. Two radiocarbon dates are available for the Sauveterrian sequence (GX-21788: S.U. 8 and GX-21793: S.U. 7II) (Tab. 1). Both have a wide standard deviation for which no definite explanation exists, although archaeological data indicate that the corresponding layers (with SU 7II overlying SU 8) must have formed as a result of multiple seasonal occupations. As far as the Castelnovian burial is concerned, one AMS radiocarbon date carried out on a bone from the skeleton (OxA-7468) has yielded a date of 7,425±55 BP (6,428-6,212 cal BC). This date fits only one of the two dates obtained from the charcoal samples collected in the sediment filling of the burial pit (SU 4B, R-1939). The other one (SU4B, R-1937) is older and possibly comes from a charcoal deriving from an older occupation layer dismantled during the excavation of the burial pit (Alciati *et al.* 1992, Fontana *et al.* in press). During archaeological excavations levels referred to the Bronze Age and historical periods have been also identified (Alciati *et al.* 1992, Fontana and Guerreschi 1998, Asolati *et al.* 2005, Fontana *et al.* 2009 a). Preliminary anthracological analyses have been carried out also on these levels (Colombo 2014), although in the present paper we will focus only on the palaeobotanical data referred to the Mesolithic.

Sector III (Fig. 3 B) has also yielded a complex stratigraphic sequence documenting different occupation phases: Early Mesolithic (SUs 10, 20, 21, 30, 32), Bronze Age, Roman and post-Roman period (Fontana *et al.* 2009 b, 2015) (Tab. 1). Particularly, a combustion structure has been attributed to the Bronze Age on the base of the potsherds typology (SU 19) while two SUs (11 and 16) have been dated to the Roman period based on the presence of two coins (Asolati *et al.* 2005). Only two radiocarbon dates are available for this sequence, both referring to the Sauveterrian (SUs 32 and 10; Tab. 1) in accordance with the characteristics of the lithic assemblages recovered from these layers (Valletta *et al*., in press). No evident dwelling structures were identified within this Mesolithic sequence which was interrupted in the external part of the shelter by levels that formed during the following occupation.

Materials and methods

Charcoals were integrally picked up with naked eyes during the archaeological excavation from wet sieving of the sediments with a mesh size of 2 mm. This procedure was applied to recover all the

***Tab. 1** - Mondeval de Sora. Radiocarbon dates obtained from charcoals of the Stratigraphic Units of Sectors I and III (R = Rome, Italy; GX = Geochron Laboratories, USA). / Mondeval de Sora. Datazioni radiocarboniche ottenute da carboni delle Unità Stratigrafiche dei Settori I e III (R = Roma, Italia; GX = Geochron Laboratories, USA).*

CODE	SECTOR	SU	YEARS BP	CALIBRATED DATE (±1σ) BC	CALIBRATED DATE (±2σ) BC
R-1939	I	4B	7,330±50	6,235-6,100	6,355-6,065
R-1937	I	4B	8,380±70	7,530-7,355	7,580-7,195
GX-21797	III	10	8,445 ± 50	7,570-7,495	7,590-7,370
GX-21793	I	7	8,260±175	7,485-7,080	7,600-6,755
GX-27748	III	32	9,160 ± 90	8,525–8285	8,615–8,245
GX-21788	I	8	9,185±240	8,780-7,995	9,155-7,750

findings from the different Stratigraphic Units using diverse size grids (mainly 33x33cm, but also 20x20cm and 10x10 cm). Due to the extremely high density of the archaeological evidence recording of the position of the single findings with a coordinate system was not possible. Considering an approximate number of 50 fragments contained in 5000 paper bags a total number of ca. 250.000- 300.000 charcoal fragments has been estimated divided into different squares and Stratigraphic Units. The ratio between the volume of washed sediment and the quantity of charcoals sampled with naked eyes was not recorded during the excavations. Samples arrived at the Laboratorio di Archeobiologia dei Musei Civici di Como accurately divided.

960 charcoal fragments coming from layers dating back to the Mesolithic (Sauveterrian and Castelnovian), the Bronze Age and to historical times were analyzed (Colombo 2014). Palaeobotanical data related to the Mesolithic were obtained from the analysis of 414 charcoals from 12 Stratigraphic Units. For sector I 250 fragments from 7 Stratigraphic Units were analyzed; for sector III 164 fragments from 5 Stratigraphic Units (Tab. 2). We selected SUs that could be related to the stratigraphic/chronological sequences derived either from radiocarbon dates or artifacts typology.

Charcoals were analyzed at reflected light microscope by the observation of the three fundamental fractures, at 50, 200 and 400 x magnitude. As exposed below, 6 *taxa* were identified allowing reconstructing the features of tree and shrub vegetation in the basin of Mondeval de Sora during the Mesolithic. Carpological remains were recognized and extracted from charcoal samples and analyzed at the stereomiscroscope at 8 -100 x magnitude. Reference collections of the Laboratorio di Archeobiologia were used both for charcoal and carpological remains identification.

Results

Charcoal determination

The 6 *taxa* are: *Larix/Picea* (larch/spruce), *Larix* (larch), *Picea* (spruce), *Pinus mugo/sylvestris* (mugo pine/scots pine), *Pinus cembra* (cembra pine), *Pinus* sp. (pine), *Alnus viridis* (green alder).

Difficulties in the distinction between *Larix* and *Picea* are known in the literature (Greguss 1955, Sárkány and Stieber 1955, Schweingruber 1982, Schweingruber 1990, Bartholin 1979, Anagost *et al.* 1994, Talon *et al.* 1998, Marguerie *et al.* 2000; Ali *et al.* 2005). In order of importance and recurrence, the characteristics that distinguish *Larix decidua* are the sharp transition between earlywood and latewood in traversal section (fig. 4A), the presence of biseriate bordered pits in radial section and the asymmetry of resin canals in tangential section; sometimes these pits are difficult to see because of the narrowness of the growth rings and particularly of the latewood. Whenever these characters were not clearly observable we preferred to mark charcoals as *Larix/Picea*. However, palaeobotanical considerations (Ravazzi 2002, Drescher-Schneider 2008) and ecological (Andreis *et al*. 2009) corroborate the hypothesis that charcoals can be mainly attributed to larch. Nowadays the larch reaches 2100 m a.s.l. and prefers fresh soils rich in bases, silts and/or clay; it is an heliophilous plant which favors bright and dry places (Oberdorfer 1979, Soraruf and Carrer 2007). It could form associations with cembran pine and spruce. Spruce needs natural wet soils, both soft and coarse; it is a pioneer species and spreads especially in pure woods or sometimes with *Fagus* and *Ulmus*, up to 900 m a.s.l. (Oberdorfer 1979).

In addition to regular analyses, we analyzed some charcoals of SU 32 Q. 6/3 in sector I (see Tab. 1) in order to test the possibility to discriminate *Larix* and *Picea* based on the characteristics of these woods reported in literature (e.g. Anagost *et al.* 1994, Talon 1998 *et al.*, Marguerie *et al.* 2000). Most charcoals fragments are branches with very narrow growth rings (e.g. 42 rings in 8 mm); consequently not all the important characters could be observed. Other fragments allowed recognizing the most important features although only seldom we could identify the characteristics reported in literature. For example, because of the combustion the epithelial cells of the vertical resin canals were badly observable and thickenings in tracheids were not visible. However, the most important characteristics let us conclude that in this sample most charcoals can be attributed to *Larix*.

Another problem in charcoal determination concerns the impossibility to distinguish *Pinus mugo* from *Pinus sylvestris* since both are characterized by pinoid large pits and transversal tracheid tooth-shaped walls. Considering the ecological needs of these species it is possible to affirm that they are mainly attributable to *Pinus mugo*. Generally, the scots pine does not reach altitudes higher than 1,800 m while *Pinus mugo* reaches 2,700 m a.s.l. (Pignatti 1982).

The peculiarity of *Pinus cembra* is the presence of smooth-walled transversal tracheids in the rays in radial section (Fig. 4B). The smooth transition between earlywood and latewood is less reliable for species determination (Schweingruber 1982). It spreads along

Tab. 2 - Charcoal frequencies in the Mesolithic layers from site VF1, sector I and sector III. / Frequenze dei carboni nei livelli mesolitici dal sito VF1, settore I e III settore.

Sector I *Taxa*	Q	50	38,40,54	Tot.		68	52-7	Tot.		83/17-20	85/7	Tot.		54	Tot.	100/7	100	Tot.		85	Tot.	70	85	85-100	Tot.		Tot.	
	US	**4B**	**4B**	N	%	7	7	N	%	**8**	**8**	N	%	**14**	%	**31**	**31**	N	%	**32**	%	**33**	**33**	**33**	N	%		
		N	N			N	N			N	N			N		N	N			N		N	N	N			N	**%**
Larix decidua	larch		1	1	2,7	7		7	17,5	6	3	9	23,1	1	2,6		1	1	2,7								19	**7,6**
Larix/Picea	larch/spruce	12	5	17	45,9	10		10	25,0	14	13	27	69,2	9	23,7	17	16	33	89,2	21	60		6	6	12	40	129	**51,6**
Picea abies	spruce													1	2,6	1		1	2,7								2	**0,8**
Pinus mugo/sylvestris	mugo/scots pine	5	6	11	29,7	1		1	2,5		3	3	7,7	12	31,6		1	1	2,7	14	40	8	4	4	16	53,3	58	**23,2**
Pinus cembra	cembra pine	1		1	2,7	1	20,0	21	52,5					12	31,6		1	1	2,7			2			2	6,7	37	**14,8**
Alnus viridis	green alder		5	5	13,5																						5	**2**
		18	19	37	100	20	20	40	100	20	19	39	100	38	100	18	19	37	100	35	100	10	10	10	30	100	250	**100**

Sector III *Taxa*	Q	15	16	Tot.		6	16	Tot.		28	Tot.	37	27	Tot.		25	Tot.		Tot.	
	US	**10**	**10**	N	%	**32**	**32**	N	%	**30**		**20**	**20**	N	%	**21**	N	%		
		N	N			N	N			N	%	N	N			N			N	**%**
Larix decidua	larch	3	4	7	21,2	7	4	11	34,4	10	30,3	2	7	9	26,5	4	4	12,1	41	**25**
Larix/Picea	larch/spruce	11	7	18	54,5	10	9	19	59,4	16	48,5	17	6	23	67,6	25	25	75,8	101	**61,6**
Picea abies	spruce									1	3,0		2	2	5,9				3	**1,8**
Pinus mugo/sylvestris	mugo/scots pine	4	3	7	21,2	1	1	2	6,3	1	3,0					4	4	12,1	14	**8,5**
Alnus viridis	green alder									5	15,2								5	**3**
		19	14	33	100	18	14	32	100	33	100	19	15	34	100	33	33	100	164	**100**

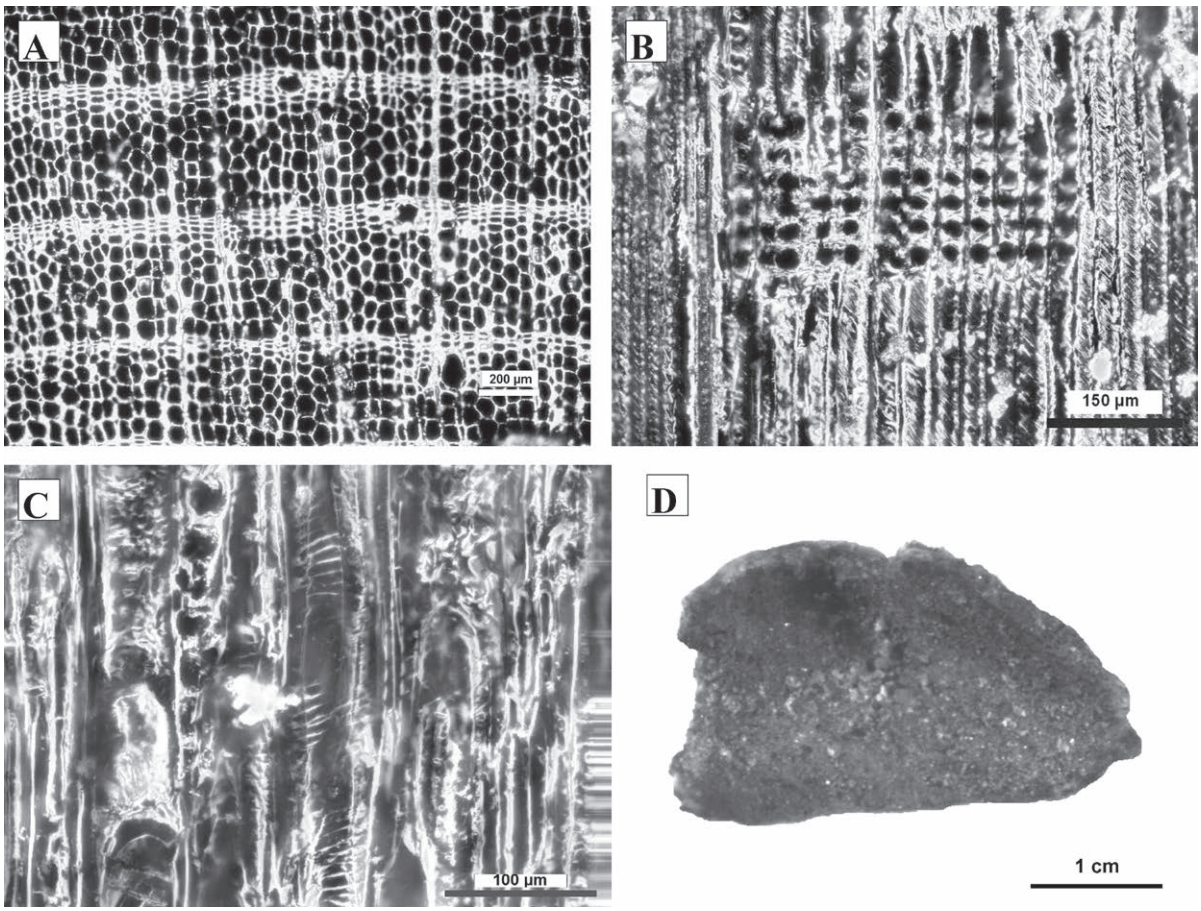

Fig. 4 - Charcoal remains (taken at the reflected light microscope) and carpological remains (taken at the stereomicroscope). A. Transversal section of Larix (larch) showing the sharp transition between earlywood and late wood. Bar = 200 µm. B. Tangential section of Pinus cembra (cembran pine) showing smooth-walled, transversal tracheids in the rays. Bar = 150 µm. C. Radial section of Alnus viridis (green alder) showing scalariform perforations. Bar = 100 µm. D. Pinus cf. cembra seed testa. Bar = 1cm. / Immagini di carboni (scattate al microscopio a luce riflessa) e resti paleocarpologici (scattate al microscopio ottico stereoscopico). A. Sezione trasversale di Larix (larice) che mostra la netta transizione tra legno primaticcio e legno tardivo. Barra = 200 µm. B. Sezione tangenziale di Pinus cembra (pino cembro) che mostra le tracheidi trasversali con pareti lisce nei raggi. Barra = 150 µm. C. Sezione radiale di Alnus viridis (ontano verde) che mostra le perforazioni scalariformi. Barra = 100 µm. D. Testa di seme di Pinus cf. cembra. Barra = 1 cm.

the upper limit of tree-line up to ca. 1,950 m, especially on acid soils with raw humus in cold climate. It is a slow growing heliophilous plant, very resistant to bad weather (Oberdorfer 1979).

As to the genus *Alnus*, the transversal section of the species *viridis* presents a clearly lower pore number with respect to the species *glutinosa* and it is widespread and not semi-ring porous. *Alnus viridis* presents typical scalariform perforations in radial section (Fig. 4 C). *Alnus glutinosa* and *A. incana* reach respectively altitudes of 1,200 m and 1,300 m, while *A. viridis* reaches 2,300 m (Pignatti 1982).

Charcoal and carpological remains related to the Mesolithic layers of VF1, sectors I and III

During the Mesolithic *Picea abies* is very scarce (0.8% in sector I; 1.8% in sector III) and *Larix* prevails, especially in sector III (7.6% in sector I; 25.0% in sector III), also in the uncertain form *Larix/Picea* (50.4% in sector I; 61.2% in sector III). *Pinus mugo* is present in both sectors (23.2% in sector I; 8.5% in sector III), while *Pinus cembra* is fairly abundant in sector I (14.8%) and absent in sector III (Tab. 2). The presence of *Alnus viridis* during the Mesolithic is sporadic and limited to two SUs (4 B and 30, respectively in sector I 2.0%, I and in sector III 3.0%).

Carpological remains are represented by a fragment of larch strobilus (SU 31, sector I), a stalk of alder infructescence (SU 8, sector I) and a cf. *Pinus cembra* seed testa (SU 8, sector I; Fig. 4D).

Discussion

During the Sauveterrian, at the higher limit of the subalpine belt, the presence of *Larix decidua*, *Picea abies*, *Pinus cembra*, *Pinus mugo* and some broadleaves is attested. After the Early Mesolithic we observe no evidence of the gradual expansion since ca. 7,000 BC of *Picea abies* that appears in the pollen diagrams of the Eastern Alps (Oeggl and Wahlmüller 1992, Kofler 1992, Drescher-Schneider 2008, Festi *et al.* 2014), Central Alps (Pini 2002, Gobet *et al.* 2003) and the Alps as a whole (Tinner and Vescovi 2007).

Larix decidua seems to be more represented than *Picea abies*

confirming its ability to occupy higher altitudes, while the latter is currently present at altitudes not exceeding 1,800 m (Soraruf and Carrer 2007) also in the area of Mondeval. It is not to be completely excluded that *Larix decidua* was selected because of its effective higher heating value (Ilarioni 2007).

Even the values of *Pinus cembra*, a species now spread in Italy between 1,400 and 2,300 m (Pignatti 1982) are coherent with the analyses carried out on pollen and plant macrofossils (*Pinus cembra* needles) at Hirschbichl, Austria located at 2,140 m a.s.l. where this species is present since 9,370 +/- 170 years ago (Oeggl and Wahlmüller 1992).

The presence of *Alnus viridis* may have been favored by the fact that this species is less sensitive to fire passages with respect to the other plants found among charcoals (Gobet *et al.* 2003), as it is well documented also in the area of the Trentino Dolomites (Kofler 1992). Namely pollen curves show a strong increase of this species around 9,000 BP, followed by its reduction about one millennium later (Oeggl and Wahlmüller 1992, Filippi *et al*. 2005). However, we neither have data about vegetation evolution in the area through pollen series, nor about the fires frequency from pedoanthracological studies. Actually, fire passages favor especially *Alnus viridis* and, among the species documented at Mondeval *Larix decidua, Pinus mugo, Pinus cembra* and *Picea abies*.

According to pollen data from the South-Eastern Alps, reforestation started very quickly after the Lateglacial, bringing the limit of the forests up to 2,100 m not later than 10,800 yrs cal BP. In the high zones of the subalpine belt the forest was dominated by *Pinus cembra* and *Larix decidua* since about 8,000 years ago, as indicated by the pollen diagrams from the southern area of the Eastern Alps (Oeggl and Wahlmüller, 1992; Drescher-Schneider, 2008). Based on pollen and plant macrofossils in the Tyrolean Alps, forests reached the maximum spread approximately 5,200 uncal BP (Oeggl and Wahlmüller 1992).

With the support of palynological analysis carried out at Alpe Fedèra located 2,5 Km northeast of Mondeval at ca. 2,050 m a.s.l. (Soldati *et al.* 1997), it is possible to hypothesize the presence of woods mainly composed of conifers in the basin of Mondeval during the Mesolithic (between 9,155-7,750 BC and 6,355-6,065 BC 2σ cal), while during the following phases especially in historical times, when the area was exploited for pastoral purposes, the fuel had probably to be searched a few hundred meters below the site. However, this evidence seems to be in contrast with the palynological analysis of the filling of the Castelnovian grave, where the herbs percentage exceeds 91% (Cattani 1992).

A few anthracological comparisons in the Eastern Italian Alps are available for the Mesolithic sites of Colbricon at 2,100 m a.s.l. (Foresta Demaniale di Paneveggio - Trento) and Plan de Frea IV at 1,930 m a.s.l. (Val Gardena - Bolzano) (Bagolini *et al*. 1975: pp. 29-32, Angelucci *et al.* 2001: p. 100). In the first site *Pinus montana* and *Pinus cembra* are very common while *Picea/Larix* is rarer and one finding of *Rhododendron* sp. is recorded. In the second site *Larix decidua*, *Pinus cembra*, *Pinus sylvestris/mugo* and *Juniperus* sp. were collected. This study shows that *Larix/Picea* and *Pinus mugo/sylvestris* appear constantly among the identified *taxa*, in greater percentages than all other species.

The tree line in the Eastern Alps during the Mesolithic was at the same altitude of Mondeval or even higher. Therefore, it is possible that the area was mostly covered by open larch parkland and with diversified areas, such as woods of *Alnus viridis,* also on the basis of the superficial hydrography and of the geolithology. The presence of other species, not necessarily associated one another, such as *Pinus mugo* and other conifers, can be explained by the existence nowadays of a mosaic of tree formations around the basin or even inside; this mosaic is partly preserved also nowadays on the slopes at the edge of Mondeval basin .

The only carpological remains that were found are constituted by one fragment of *Larix decidua* strobilus and one *Alnus viridis* stalk, both woody and inedible plant organs, and by one millimetric fragment of *Pinus* cf. *cembra* seed testa. Other findings of *Pinus cembra* seed are not known for the Mesolithic of the Alps, except for the one of Staller Pass (Kompatscher *et al*. 2016, in press), while they are a bit more frequent in the Middle Neolithic of the French Alps (Martin *et al.* 2008, Martin 2012: p.127) and in the Middle - Late Neolithic of Lake Constance area (Hosch and Jacomet 2004, Jacomet 2009). This absence could be explained by a combination of phenotypic factors of the species, symbiosis with vertebrates and resource accessibility. Theoretically this resource would be represented by huge productions per hectare, in the case of pure forests of *Pinus cembra* as in the North of Eurasia (Formosoff 1933), with high values also in the Alps (Zong *et al.* 2010). Two months after flowering, in September, *Pinus cembra* cones are ripe with still closed leathery scales that rarely fall to the ground without the intervention of vertebrates, especially the nutcracker (*Nucifraga caryocatactes*) and the eurasiatic squirrel (*Sciurus vulgaris*) (Abs 2004, Zong *et al.* 2010). The pine cones fall and open in the following spring and the collection of seeds from the litter under the trees by animals takes place between April and November. The presence of the squirrel during the Mesolithic at Mondeval is supported by palaeontological remains (Berto *et al.* this volume).

A good ethnographic documentation referred to the nineteenth and early twentieth century confirms the autumn collection of pine seeds “when the scales of the cones have lost the resin and the seeds are brown”, but also of the immature cones from the tree to directly consume the seeds. In turn, the cones fall by the spring of the second year from fructification (Bürgi and Stuber 2003: p. 368). At the altitude of Mondeval the collection period of closed mature cones would be between September and November and the one of pine seeds fallen to the ground from April to May. But in the latter case the collection would be compromised by the strong competition of nutcrackers and squirrels. For example, a single nutcracker can gather and hide under the ground up to 60.000 pine seeds that will constitute its reserves only for the winter. Both seasonal data based on the analysis of the faunal assemblage from the Mesolithic layers (Fontana *et al.* 2009) and the altitude at which the site is located indicate that occupation could occur between the late spring and the beginning of autumn.

Conclusions

The anthracological association of *Picea abies, Larix decidua, Pinus cembra* and *Pinus mugo* (*P. sylvestris/mugo*), with the probable prevalence of *Larix decidua* and *Pinus mugo,* identified at the site of Mondeval de Sora (VF1) during the Mesolithic (especially in the Sauveterrian) testifies the spread of these arboreal formations at high altitudes during this time span. Such species started to diffuse in the early Holocene along the tree-line zone of the south-eastern Alps with variations due to the local geolithology. Such associations are consistent with those of uncharred macroscopic remains found in the Eastern Alps such as at Hirschbichl - Austria (Oeggl and Walmüller 1992), 50 km N of Mondeval, while they differ from those of the esalpic region where broadleaves such as *Laburnum alpinum* and *Sorbus* sp. appear, such as at Laghetti del Crestoso (Brescia – Italy), about 100 kilometers S-W of Mondeval (Nisbet 1997).

Based on the scarcity of carpological remains, it is not possible to draw any conclusion about the choice and the use of plant food resources by the Mesolithic groups that occupied the site of Mondeval de Sora. The question remains open on whether and how, during the summer camps at high altitude, a collection of edible species to be stored or eaten fresh was practiced, which did not leave any substantial traces among the carbonized remains.

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- Le tabelle e le figure (grafici, fotografie, disegni) dovranno essere verticali e composte nel modo seguente:
- la base dovrà essere di 1 colonna (8 cm) o 2 colonne (17 cm), l'altezza massima di 24 cm
- utilizzare il carattere Times New Roman in corpo leggibile (almeno corpo 8)
- utilizzare simboli e caratteri speciali derivanti da Word (in caso contrario allegare i file con il font usato)
- non riportare un titolo
- per le tabelle, utilizzare la formattazione automatica "semplice 1" di Word con bordi sottili
- per i grafici, non riportare il bordo esterno.

Tabelle e figure vanno numerate progressivamente con numeri arabi. L'Autore indicherà la posizione suggerita sul margine sinistro nella copia cartacea del dattiloscritto. Nel testo, le tabelle e le figure vanno citate per esteso con inizia le minuscola se fuori parentesi (per es.: ...come mostrato in Figura 1) oppure in forma abbreviata con iniziale maiuscola se in parentesi. Per es.: (Figura 1) o (Figure 1, 2).
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Juan Cabanilles J., 1990 - Substrat épipaléolithique et néolithisation en Espagne: apport des industries lithiques à l'identification des traditions culturelles. In: Cahen D. & Otte M. (eds), *Actes du Colloque de Liège*, 1988, "Rubané et Cardial", ERAUL, 39: 417-435.
Bazzanella M., Moser L., Mottes F. & Nicolis F., 1998 - The Neolithic levels of the Mezzocorona-Borgonuovo site (Trento): preliminary data. Preistoria Alpina, 34: 213-226.

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