

Research Article

The Uluzzian Beyond the Known. From the Research History to the Basis That Define the Very Nature of This Techno-Complex

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Abstract

A study issued in 2011 has established the modern character of the two deciduous teeth found in 1964 at Grotta del Cavallo thus diametrically changing reference parameters for the attribution of the makers of the Uluzzian. Nevertheless, some scholars still argue for a Neandertal authorship of this techno-complex involving possible post-depositional disturbances affecting the deposit from which the teeth were retrieved. In cultural terms the Uluzzian is commonly considered to be a transitional industry mostly on the basis of some inferred characteristics such as a chiefly flake-based production a small amount of Upper Palaeolithic-like tools and a combination of Middle and Upper Palaeolithic elements both in the toolkit and in the technical systems. The purpose of this study is twofold clarifying the Uluzzian part of the stratigraphic sequence of Grotta Del Cavallo and providing new data aimed at shedding light on the true character of the Uluzzian techno-complex. In the first part of this paper we provide a thorough re-examination of the history of research carried out by A. Palma di Cesnola and P. Gambassini in the Uluzzian layers of Grotta Del Cavallo in the years between 1961 and 1986, ultimately rebutting the allegations raised about the integrity of the Uluzzian deposit containing the teeth. In the second part of the paper we provide updated information on the human remains and the preliminary results of the study on the lithic assemblage from the earliest Uluzzian layer and on backed pieces from the whole Uluzzian sequence of Grotta Del Cavallo.

We conclude that the early Uluzzians demonstrate original technological behaviour and innovations devoid of any features deriving or directly linked with the late Mousterian of Southern Italy. The notion that the Uluzzian of Grotta del Cavallo may represent a developmental stage rooted in the preceding Mousterian is no longer valid.

Introduction

The Uluzzian has been assigned recently [1] along with a number of other techno-complexes (Châtelperronian, Szeletian and Lincombian-Ranisian-Jerzmanowician) to the heterogeneous group of the so-called “Transitional assemblages” [2]. These cultural entities cover a time span of ca. ten millennia (48-39 KY) corresponding in Europe to the Middle to Upper Paleolithic transition and display variable geographical distribution and technotypological characteristics. One of the crucial points affecting this particular period is the scarcity and often the complete lack of human remains associated with the archaeological record. It follows that in most cases, there is great uncertainty about the makers of these assemblages.

Presently the Uluzzian is represented in a small number of sites all distributed in Peninsular Italy (Figure 1) and Peloponnese in Greece. In Italy it occurs both in open-air (Mostly surface) sites where it is often mixed with materials from different periods and in the stratigraphic sequences of a small number of cave sites. In this latter case the Uluzzian layers always lay on top of a late Mousterian occupation with a sedimentological hiatus in between and without interstratifications.



Figure 1: Locations of the Uluzzian findings in Italy. Star: Grotta del Cavallo. List of indicated sites: Porcari (1); San Leonardo (2); San Romano (3); Podere Colline (4); Val di Cava (5); Casa ai Pini (6); Salviano (7); Maroccone (8); Indicatore (9); Villa Ladronaia (10); Val Berretta (11); Poggio Calvello (12); Grotta la Fabbrica (13); Santa Lucia I (14); Colle Rotondo (15) (personal communication by M. Pennacchioni); Tornola (16); Atella (17); 23-27 (personal communication by M. Pennacchioni); 28 (personal communication by M. Pennacchioni); 29 (personal communication by M. Pennacchioni).

(17); Grotta di Castelcivita (18); Foresta Umbra (19); Falce del Viaggio (20); Grotta della Cala (21); Torre Testa (22); Grotta del Cavallo (23); Grotta di Uluzzo (24); Grotta di Serra Cicora (25); Grotta Mario Bernardini (26); Grotta di Uluzzo C/Cosma (27); Grotta delle Veneri di Parabita (28); San Pietro a Maida (29); Grotta di Fumane (30). The question mark (?) for Grotta di Fumane points out that, based on our interpretation, the attribution of the layers A3 and A4 to the Uluzzian is questionable. Sea level 70 m below the present-day coastline Modified [3]

The story of this techno-complex starts in 1963 in the Uluzzo (Asphodel) Bay at Grotta Del Cavallo (Apulia) when on July 10th in the course of the first excavation field season at this cave Arturo Palma di Cesnola came across a curved backed tool crescent-like in shape. Due to the presence of curved backed artefacts and to its stratigraphic position the newly-discovered assemblage was immediately identified as the Italian counterpart of the French Châtelperronian even if Palma di Cesnola never failed to stress in his publications the differences between the two techno-complexes. Thus, after the discovery of Neandertal human remains at Arcy-sur-Cure and at Saint Césaire [4-5] the Uluzzian was more or less formally considered as the product of Neandertals. Grotta Del Cavallo is up to now the only Uluzzian site that has yielded identifiable human remains. However, studies carried out on the morphological and morphometric characteristics of these findings two deciduous molars found in layer EIII in 1964 (i.e. Cavallo B and Cavallo C) [6-10] were not able to identify their taxonomical attribution with certainty. Hence the Uluzzian was interpreted over the years as evidence of the Neandertal trend towards the acquisition of cognitive skills analogous to those expressed by modern humans. This assumption was overturned by Benazzi et al. [11] who were able to establish the modern nature of the two teeth using cutting edge methodologies. Some years later Zilhão et al. [12] questioned the integrity of the 1963-64 stratigraphic sequence at Grotta Del Cavallo and claimed that the teeth found inside the Uluzzian layers were intrusive owing to post-depositional disturbances affecting the site. These claims were at times accompanied by inferences which are incompatible with a careful review of the reports Palma di Cesnola published at the end of each excavation field season [13-16]. In addition, the Uluzzian has often been described on the grounds of some characteristics occurring in sites in which the presence of the Uluzzian "Proper" (That is the Uluzzian defined as such in the type site of Grotta del Cavallo) is questionable [1,17]. Such misinterpretations of the evidence have contributed to creating confusion around the character of this techno-complex. So far 1963-66 excavation reports as well as first descriptions of the Uluzzian lithic assemblage produced by Palma di Cesnola are hardly known outside Italy. At the same time the Uluzzian so far has been mainly analysed and described from a typological view-

point to date apart from the bone industry [18] only very preliminary results from technological and functional studies carried out using modern methodologies are available [19-20] and the study of other categories of archaeological materials (Pigments, ornaments) have only been marginally tackled. The lack of a comprehensive picture of the Uluzzian diachronic and cultural evolution makes it difficult to detect the presence/absence of connections between this techno-complex and the preceding (And coeval) late Mousterian and limits detailed investigations into possible relationships with European and non-European Initial Upper Palaeolithic/transitional assemblages. An additional problem inherent in the archaeological record must be taken into account the Uluzzian is found in a small number of sites which are mostly single-phase sites. In recent years, systematic field research at the main Uluzzian sites (Such as Grotta Della Cala, Grotta di Castelcivita, Grotta Uluzzo C, Grotta di Serra Cicora and Grotta Mario Bernardini) has been resumed and a full systematic revision of the Uluzzian materials from Grotta del Cavallo including new investigations at this site is planned for the near future.

The present paper is therefore conceived as the first of a series of contributions devoted to the Uluzzian with the aim of clarifying the nature of this intriguing cultural entity and as a consequence of the human group responsible for its making. The paper makes inferences on the characteristics of the Uluzzian behaviour in the context of the transitional scenario including an inquiry on its relations to the late Mousterian in southern Italy. In particular it focuses on Grotta del Cavallo which plays a crucial role in the ongoing debate and includes: 1) a thorough re-examination of the research history at Grotta del Cavallo based on all the documents currently available (i.e. excavation reports, field notes, drawings, publications) ultimately clarifying the uncertainty about post-depositional disturbances for this archaeological site 2) new data on aspects of the Uluzzian collection of Grotta del Cavallo (i.e. lithics from layer EIII backed pieces from the whole sequence human remains) presently housed at the University of Siena. The remaining Uluzzian materials of Grotta del Cavallo including those located at the Soprintendenza Archeologia Belle Arti e Paesaggio per le Province di Brindisi, Lecce e Taranto (among which the thousands of "Waste" products from Palma di Cesnola's 1963-64 excavations) will be the object of future study.

Research History

Grotta del Cavallo called also Grotta delle Giumente (Mares) or Uluzzo A opens into the rocky coast of the Uluzzo Tower bay around 15 m a.s.l. Its entrance which is more than 5 m wide and about 2.5 m high faces NW (Figure 2).



Figure 2: Grotta Del Cavallo entrance in 1964 (Photo from Palma di Cesnola's archives).

The cavity is formed by a single chamber roughly circular in shape with a diameter of approximately 9 m. The vault is 3 m ca. above the present floor. This cave contains a stratigraphic sequence of pivotal interest as its 7-m thick deposit encompasses a long time interval including the local Middle Palaeolithic evolution (Layers N-G) which closes with the late Mousterian (Layer F) the subsequent Middle-to-Upper Palaeolithic transition (Layers E, D) sealed at its top by a volcanic horizon (Layer C) and after a long chronological gap the final Upper Palaeolithic (Layer B Romanellian) and the Holocene occupations (Layer A) [21-22]. Grotta del Cavallo is not only the site where the Uluzzian was

recognized and described for the first time but it currently remains the main site in which this techno-complex can be followed in its chrono-cultural evolution.

In order to reconstruct the complicated and sometimes troubled story of this key Palaeolithic site the following sources have been used: a) publications that Palma di Cesnola regularly produced every year after each excavation field season which can be considered excavation reports to all intents and purposes [13-16,23-29] b) Palma di Cesnola's personal Excavation Field Notes (EFNs) (Acquired by the authors only recently) c) publications issued after 1978 mainly composed of brief excavation reports [30-33]. What is presented below is the fruit of the data cross-reading from published material and Palma di Cesnola's personal notes.

Palma di Cesnola's investigations at Grotta del Cavallo started in July 1961 with his colleague from the University of Florence Edoardo Borzatti von Löwenstern. They took advantage of the excavation field season of the Italian Institute of Prehistory and Protohistory at Grotta del Fico (Santa Maria al Bagno) to launch a survey in the caves located in the Uluzzo bay few km south of Santa Caterina di Nardò. On this occasion Cesnola opened a small test trench (Trench X) (Figure 3, no. 4) along the NE wall of Grotta del Cavallo which at that time he named Grotta A or Grotta di Uluzzo A (EFNs 21/06/1963) [13,23]. This trench, not more than 1 m deep "Showed the presence of a sandy deposit dark brown in its upper part with flint bladelets Neolithic potshards and later accompanied by a lot of marine and terrestrial mollusc shells lighter brown in its lower part with Upper Palaeolithic industry and several faunal remains mainly from *Equus caballus*" [13]. With this initial test, therefore the excavator went through the Holocene deposit and part of the Epigravettian layer B. The first excavation season was carried out from the 20th June to the 12th July 1963 in collaboration with the Italian Institute of Human Palaeontology of Rome and mainly involved the Holocene and the Epigravettian layers. Before starting excavation "The ground appeared mostly intact except for some looters' "Rummaging" traces adjacent to the walls fortunately of minor entity" [13]. In this year a trench (The so-called "Principal Trench" hereafter PT) 2.5-3 x 3.5 m ca. wide was opened which from the NE wall extended towards the middle of the cavity. The PT final size was reached by consecutive enlargements starting from the 1961 test trench (X). Initially a small trench (Trench A - EFNs 22 and 24/06/1963) was added at right angles to the test trench X. Later a new trench (Trench B₁) was opened from trench A (EFNs 24/06/1963) (Figure 3, no. 4).

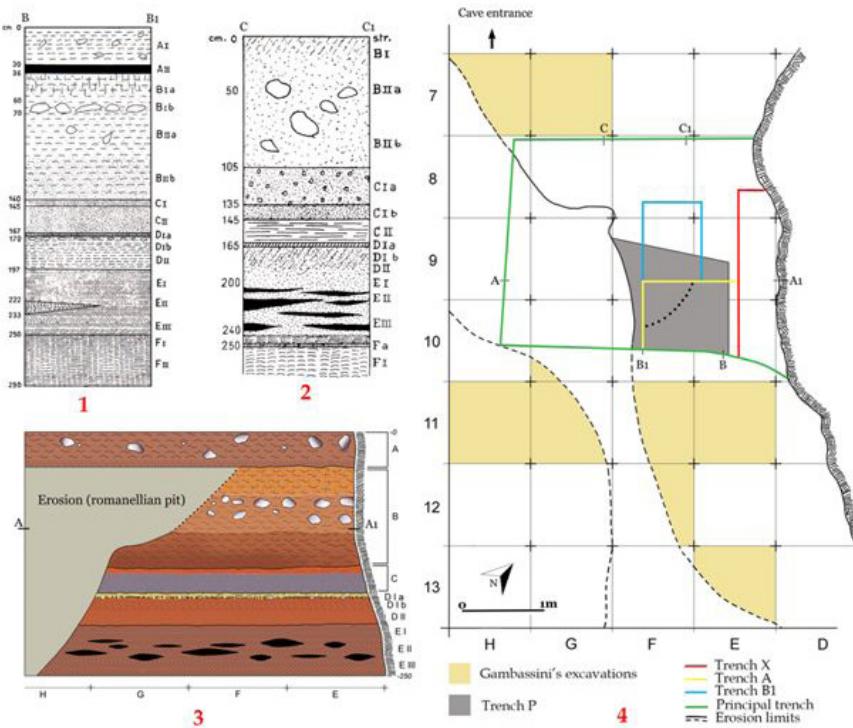


Figure 3(1-4): Stratigraphic sequence and planimetry of Grotta del Cavallo. Schematic SE stratigraphic profile of trench P (Fieldwork season 1963) (1); schematic NW stratigraphic profile of the Principal Trench (fieldwork season 1964) (2); schematic stratigraphic profile of the Principal Trench (Palma di Cesnola's excavations) with the pit due to the erosional event, reconstructed on the basis of published data and fieldwork notes (3); planimetry of the excavation area relating to 1961-1986 field seasons with trenches X, A, B₁, P, the Principal Trench and the squares excavated by P. Gambassini in the years from 1979 to 1986 (4). Trench X was opened as a test in 1961; trench A and B₁ were opened two days apart from each other at the beginning of the 1963 field season. The continuous line marks the boundary of the “Pit” identified by Palma di Cesnola. The dotted line represents the erosion limits which have been reconstructed on the grounds of Gambassini's observations carried out in the years after 1979.

The PT (Figure 3, no. 4) was divided into sectors which were excavated separately and were brought down to different depths. Layer E was investigated only in one sector (Trench P) (EFNs 11/07/1963) located close to the PT SE wall and about 1 square m wide this was pushed to 2.9 m down from the trampling floor [13] (Figure 3, no. 4). In trench P the whole layer E (Uluzzian) was excavated (Divided into layers EII-I and EIII) and layer F (Late Mousterian) was tested down to 40 cm (EFNs 10-12/07/63 and 10/07/64) [13]. The discovery of a “Human milk tooth” is reported from layer DI [13]. This tooth is not in the list of the materials under study at the University of Siena. During this season layer E was therefore reached at the end of the excavation period (EFNs 9-10/07/1963) and investigated over a limited area of the PT where layer EII-I turned out to be rich in stratified hearths.

The second season was carried out on behalf of the Italian Institute of Prehistory and Protohistory of Florence (As also for the 1965-66 excavation seasons) and took place from the 9th to the 31st July 1964 when the whole PT was brought down to layer F and excavation into the Mousterian deposit went on to layer I over an area 2 x 1 m wide. Most of the Uluzzian material was

thus recovered in 1964. The deciduous teeth Cavallo B and C were found in this year in the earliest (Archaic) Uluzzian layer (EIII) publication relating to this field season reports “The retrieval in EIII of a few human teeth among which an infant molar (presently under study at the Institute of Anthropology of Florence) showing” according to the author “A pronounced tubercolo of Carabelli.” [14]. Furthermore we know that “ladent Baété récoltée dans le premier foyer uluzzian lequel se superpose directement au dernier sol moustérien F. La dent C, bien qu’appartenant au même horizon culturel provient d’un point situé environ 15-20 cm plus haut.” [6] In 1976 it was said that these teeth came from spits 7 (Cavallo B) and 5 (Cavallo C) of layer E III [7]. The discovery of Cavallo B in the earliest Uluzzian hearth namely at the base of layer EIII in direct contact with layer F red soil is confirmed also by the EFNs (15/07/1964). In recent literature [8] Cavallo C has erroneously been assigned to layer EII-I due to this first slip the same mistake was later repeated [11].

Although the 1963-66 excavations at Grotta del Cavallo were conceived merely as a test trench [34] it is worth highlighting that Palma di Cesnola as carried out his research in the observance of

stratigraphy following lithostratigraphic macro-units (Layers A, B, C etc.) these were divided into layers (EI, EII, EIII etc.) and then if necessary into sub-layers (B1a, B1b, C1a etc.) in order to stress minor sedimentological variations. A further division rigorously internal to single layers/sub-layers was artificial spits approximately 10 cm thick. The sediment was sieved by 2 x 2 mesh water screening. During the third excavation season (August-September 1965) the trench previously opened in the Mousterian deposit was enlarged and deepened down to more than 5 m [15].

The fourth season was carried out in July 1966 [16] and was mainly devoted to further widening the PT and to exploring the Mousterian series down to the marine beach N (O in the more recent publications, see) [22]. During the widening of PT other two human teeth here named Cavallo E and F were found in the reworked deposit (EFNs 1966) (The so-called “Romanellian pit” described in paragraph of post-depositional disturbance). Owing to the enlargement of the excavation surface the overlying layers, including the Uluzzian ones were gone through again. In this year charcoal samples for dating were collected from the hearths found in EIII and EII [16]. Analyses were performed at the Istituto di Geochimica di Roma but given that epoch’s limited dating tools it was only possible to obtain the terminus ante quem of >31000 BP (R-352) for the EII-I horizon [35]. From 1964 Paolo Gambassini started collaborating with Palma di Cesnola at Grotta del Cavallo and years later he was delegated to resume research in the Uluzzian layers of this site. After a long interval (1967-76) in which the Cavallo deposit was seriously damaged by looters in September 1977, Palma di Cesnola returned to the cave in order to close the entrance with a gate (EFNs 1977) [27] and to remove the reworked deposit. The following years (September 1978, June 1979 and November 1980) [28,30-31] were nearly in toto devoted to restoring the cave infill by clearing the intact layers from looters’ dumps and to building a grid and the planimetry of the cave. In 1979 a piece (60 x 40 cm) of Uluzzian (Mainly layers EIII and EII-I) which had fortunately been left intact was excavated in squares G7 and H7. From then onwards Palma di Cesnola was kept busy by the excavations at Grotta Paglicci (Gargano) and Paolo Gambassini, Lucia Sarti and Fabio Martini took over the responsibility of research at Grotta Del Cavallo for the Uluzzian the Mousterian and the Epigravettian respectively [36]. Gambassini continued therefore investigations in the Uluzzian layers in collaboration with Annamaria Ronchitelli until 1986 when once the available area had been excavated he had to stop while waiting for F. Martini to bring forward excavations in the overlying Epigravettian layers. Gambassini’s intervention encompassed squares E11, E13, F11, F12, G5, G7, G10, G11, H7, and H11 (Figure 3, no. 4). In his role as a geologist he also worked on the deposit formation processes. Each square meter was subdivided into four sectors I, II, III and IV 50 cm per side. These numbers must not be mistaken for the roman numbers used by Palma di Cesnola to name layers (e.g. EI, EII, EIII etc.). Layers and sub-layers were excavated with spits 5 or 10 cm

thick (Using Arab numerals) obviously maintaining stratigraphic differences. Lithic materials from Palma di Cesnola’s excavations amount to more than 2400 pieces (As well as thousands of “Waste materials and debris”) [34,37] which were ink-labelled according to their stratigraphic provenance by Palma di Cesnola himself. Lithic material from Gambassini’s excavations amounts to thousands of pieces. Except for few artefacts (Mostly showing uncertain stratigraphic provenance) and the bulk of “Waste products and debris” from Palma di Cesnola’s excavations (Which are currently stored at the depot of the Soprintendenza Archeologia, Belle Arti e Paesaggio per le Province di Brindisi, Lecce e Taranto) from 2009 onward everything is legally housed at the University of Siena as part of a research project aiming to completely revise the Uluzzian materials using cutting-edge methodologies.

After a long period of being forgotten, the attribution of Cavallo B and Cavallo C to modern humans [11] triggered a renewal of interest towards the Uluzzian. In recent years papers have been issued on its chronology [38] and on its hypothetical origin [39]. In addition, some very preliminary publications have been produced on the technological and functional characteristics of the Uluzzian of Grotta del Cavallo [19-20] and a doctoral thesis has been written on the use-wear traces of a number of splintered and backed pieces [40] from the same site. Finally, exhaustive studies have been performed on the faunal remains retrieved from layer EIII spit 5 (Gambassini’s excavations) [41] and on the bone industry [18].

Stratigraphic sequence

The stratigraphic sequence brought to light at Grotta del Cavallo by Palma di Cesnola in 1963-64 is the following (From the top downwards) [13-14] (Figure 3, nos. 1-2):

- Layer AI (0-30 cm): brown silty sand rich in limestone large angular stones with hearth remnants and recent remains.
- Layer AII (30-36 cm): darker brown silty sand containing several scattered charcoals and hearth ashes both AI and AII yielded mixed lithic and faunal materials limit between AII and the underlying layer B1a clear and horizontal.
- Layer B1a (36-60 cm): partially cemented reddish brown silty sand occurring in most of the excavation area; presence of gaps and pits filled with more recent materials.
- Layer B1b (60-70 cm): brownish silty sand rich in large stones forming a horizontal level which marks the transition to BII.
- Layer BII (70-140 cm): brown sand becoming darker and darker downwards containing sparse stones very clear limit with CI this layer was subdivided into 7 spits (Named BIIa the upper 2 and BIIb the lower 5) very rich in lithics and faunal remains but poor in burned materials.
- Layer C: this unit remarkably increased in thickness towards

the entrance of the cave for the presence of layer C1a absent in the SE part of the PT it was divided into.

- Layer C1a (105-135 cm): reddish sand mixed with medium to small angular stones few lithics and bone fragments probably due to infiltrations of materials from BII.
- Layer C1b (135-145 cm): reddish loose sand of aeolian origin composed of light glassy volcanic elements and rounded siliceous grains, sterile.
- Layer CII (145-165): slightly cemented silvery grey sand regularly laminated of volcanic origin, sterile, limit with DI clear and undulating this layer was more recently identified as Campanian Ignimbrite [42].
- Layer D (167-197 cm): the lower part (DII) was kept separated from the overlying DI as this latter especially its upper part was liable to having some kind of disturbance in some sectors not only layer C was in fact absent but DI took on especially close to the NE rock wall a much darker tonality less easily distinguishable from BII unit D was divided into.
- Layer D1a (167-170 cm) (spit 1): rather hard reddish stalagmite crust.
- Layer D1b (170-180 cm) (spit 2): little cemented reddish brown silty sand sealed by a layer containing medium size stones in close contact with the overlying stalagmite crust, Upper Uluzzian.
- Layer DII (180-197 cm) (spits 3-4): reddish brown silty sand but looser and more rich in clay if compared with the previous one, Upper Uluzzian.
- Layer E1 (197-220 cm) (Spits 1-3): dark brown silty sand with several hearths given the absence of a clear-cut limit between layers DII and E1 in the 1964 excavations an artificially built transitional level (E-D) (A sort of buffer spit) probably containing a mixing from both layers was introduced [34,37].
- Layer EII (220-230 cm) (Spit 4): the same silty sand as the previous layer but darker and very rich in burned bones scattered charcoals and ashes at times cemented especially in the NW area of the PT presence of a thick series of hearths with a lot of ash charcoal and burned bones as well as several lenses of reddish baked soil, Evolved Uluzzian.
- Layer EIII (230-250 cm) (Spits 5-7): dark brown silty sand in the PT SE area presence of a pit (25 cm wide and more than 10 cm deep) filled with charcoal and burned bones penetrating the underlying layer F1 (EFNs 11/07/1963) [13] differently from the PT SE area in the NW area this layer was characterized by thick stratified intact fireplaces almost everywhere [14] (Gambassini's personal communication) Archaic Uluzzian.
- Layer F1 (250-260 cm): cemented reddish silty sand with Mousterian lithics in the NW cut this layer was covered by a thin lens of greenish volcanic sand (Fa).

Post-depositional disturbances

As in the largest part of prehistoric deposits also stratigraphy of Grotta Del Cavallo was affected by a number of post-depositional disturbances occurring both ab antiquo and in more recent periods. In 1963-64 before looters' catastrophic damaging this problem is reported by Palma di Cesnola especially for the upper part of the sequence: "Continuity of layers AII, B1a e B1b appeared to be distinctly interrupted by pits filled with reworked sediment which in one case reached a depth of more than 1 m. Concretion corresponding to B1a was well-represented although discontinuously on a large part of the Principal Trench. Lower down volcanic sands CI-II was visible especially towards the middle part of the cave while close to the NE wall soil BII came into direct contact with DI and only some isolated and partially "Digested" bits of the red and grey aeolian sediment were preserved" [13]. As for layer A is concerned a "Mouse burrow" (EFNs 24/06/63) is reported while layer B had been partially damaged by a "Fox burrow" where two skulls of this animal were retrieved (EFNs 27/06/63 and 1/07/63). Rodent burrows also occurred between layers CII and DII (EFNs 22/07/64) as well as in layer E spit 1 (EFNs 23/07/64) and spits 6-7 (EFNs 27/07/64). Amongst ab antiquo post-depositional disturbances there must be included also reworking carried out by the Earliest Uluzzians (EIII) in the upper part of layer F (Also in the form of deeply dug features), mentioned by Palma di Cesnola (EFNs 11/07/1963 and 28/07/64) [13,14] and resulting from Gambassini's observations.

However, what is above all clear from the initial pages of the 1963 field notes, relating to the excavation of layers located at the top of the sequence is the presence of a pit also called "Cavity" (Actually an erosional event - see below) which was identified in the SW corner of the excavation area (Namely towards the middle of the cave) in trench A before the opening of trench B₁ (Figure 3, nos. 3-4). Owing to this situation Palma di Cesnola was driven to divide trench A in half ("Conditions of the soil at the SW end advise one to cut the small trench in half" and again "At the SW corner beware still pit") (EFNs 24/06/63) and to separately excavate the two halves in order to avoid possible mixing. Moreover, the excavation area was further widened in the direction of the cave entrance with trench B₁ so as to better understand the nature of this pit. From then onwards the pit and the undisturbed layers were separately dug (EFNs 27/06/1963; 10-17/07/1964) rigorously keeping the materials distinct. Official information about the presence of such a pit was given for the first time in 1964 "These observations seem to confirm for layer C the value of sterile diaphragm between the Romanellian and the underlying Uluzzian layers. However, such a diaphragm appeared in the southern corner of the trench gone through by a dig of indeterminable epoch which probably extended over the whole middle part of the cave the pit which left clearly visible volcanic layers in its cut had affected also a considerable portion of layers D and E down below with its bottom arriving

near the trench SW wall few cm from the Mousterian red soil F. In the brown sediment, from time to time incoherent or slightly cemented which along with numerous blocks formed the filling of the cavity Early Upper Palaeolithic artefacts mixed with others of the Romanellian type were recovered without however observing neither modern nor Neolithic items. In all the other sectors of the excavation area layer C resulted in being regularly and nearly horizontally stratified under the Romanellian brown sands, except for a slight inflection close to the NE wall of the cave" [14]. In 1966 the excavator was able to go on delimiting the boundaries of what is called in the report of that year "Wide pocket ("Sacca") already observed in the previous years" containing a mixing of materials from layers B, D and E. In this case Palma di Cesnola hypothesized an intentional dig Romanellian in age. [16] The pit is again cited in 1972 when complex stratigraphic context of layer B displaying pits down to 1 m deep (With Neolithic pottery therein) and reworking of unknown origin, was reasserted. The pit is described as "Slightly flared with an irregularly curved or fringed edge" [26].

In 1978-79 [27-30] while clearing away the reworked sediment due to looters' activity a tunnel opening in the rear wall of the cave (SW wall) was brought to light. This discovery allowed the excavators to identify the "Pit" as the effect of an erosional event probably related to major episodes of water runoff from the inside of the cave (Personal communication by P. Gambassini). Gambassini's hypothesis was later on confirmed by further excavations [33]. Owing to the looters' disruption detection of the pit original morphology and dimensions was impossible [33] save for the portion of boundary drawn by Palma di Cesnola in 1963-64.

Chronology

For several decades the Uluzzian of Grotta del Cavallo lacked reliable radiometric determinations and the entire archaeological sequence was associated with a single infinite radiocarbon date obtained in the late 1960s (RM-352: >31000) [35]. The sample comprised a piece of charcoal recovered from Layers E II-I excavated in 1966. A series of more recently obtained radiocarbon results reported by Ronchitelli et al. [43] and Kuhn et al. [44] belong to a group of 10 determinations made on burnt bone from layer E III [45]. However, given the unreliable nature of this material this series can only serve as a minimum estimate of the real age of layer E III.

This lack of chronometric control meant that understanding important aspects of the Uluzzian at its type site such as initial

appearance, evolution, expansion and demise/replacement of its makers remained unattainable goals. From 2006 onwards, a renewed chronology project focusing on the Middle to Upper Palaeolithic transition in Europe [46-50] incorporated Grotta del Cavallo as one of the sites under investigation. The lack of charcoal available for dating and the absence of collagen in several faunal bones tested meant that alternative material was sought for dating the Uluzzian layers of Cavallo. This material comprised of eight marine shells from which we obtained ten radiocarbon determinations (2 samples were dated twice). The results were initially reported by Douka [46] and Benazzi et al. [11] and they were further elaborated in a recent publication [38].

These radiocarbon dates are consistent with respect to stratigraphic position. The youngest (OxA-19254) comes from the first spit of the uppermost Uluzzian layer D spit 1 (= D Ib) excavated in 1984 and dates to ~ 35 ka BP/ ~ 40 ka cal BP. This layer was sealed by layer C identified as CI tephra hence this result is consistent with the age accepted for the CI eruption and slightly predates it. The lowermost directly-dated shell (OxA-19242) dates to 40 ka BP/44 ka cal BP. It does not come from the basal spit of E but is roughly equivalent to the lowermost part of E II-I of Palma di Cesnola's stratigraphy hence it provides a terminus ante quem for the appearance of shell beads in the Evolved Uluzzian layers of Cavallo.

More recently 2 new dates from a single sample of mixed charcoals collected from the Mousterian layer FII of Cavallo were obtained (Fi0822: $39,300 \pm 1900$ and Fi0824: $42,000 \pm 2400$ BP, weighted average $40,600 \pm 1500$ BP) [51]. Regretfully these were treated with a method (ABA) insufficient for decontaminating Palaeolithic-age charcoal hence they should be only considered minimum wages for the age of that layer.

Notwithstanding in a new Bayesian model, we incorporated all previously published dates (OxA- codes) as well as the new 2 determinations (Fi- codes) (Figure 4). The new model shows high degree of agreement and identifies only 1 outlier (OxA-19257). The boundary for the transition from the end of the Mousterian to the start of the Uluzzian layers is placed at 46-42.8 ka cal BP (95.4%) or 44.5-43.1 ka cal BP (68.2%). Given that there is an unconformity at the top of the Mousterian layers (Depositional hiatus/erosion) and given that E III is not directly dated while the ages of F II are minimum ages only we may conclude that this boundary could shift towards slightly earlier age with the addition of more chronological data from the aforementioned layers.

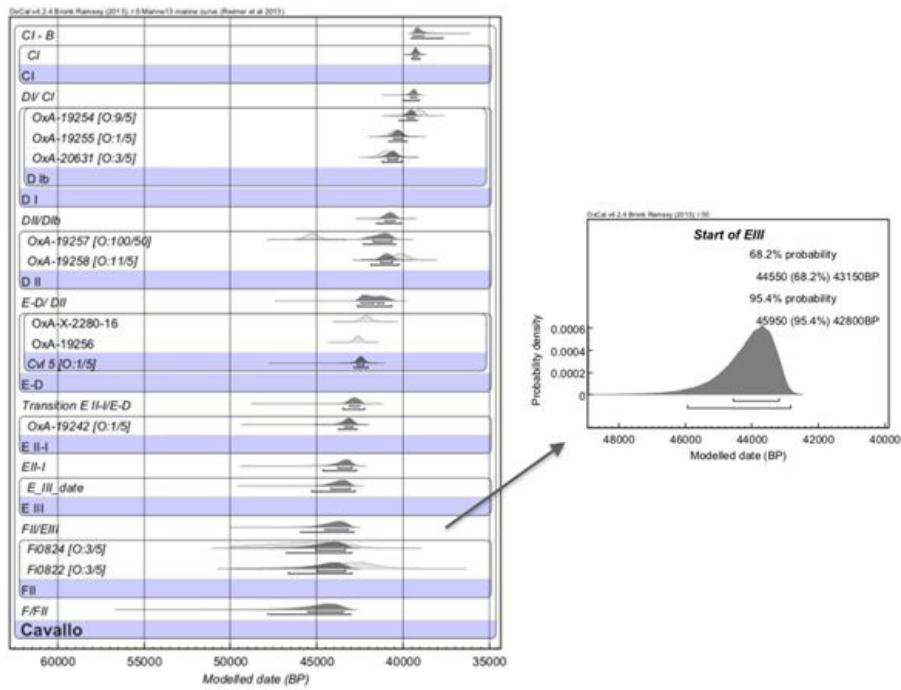


Figure 4: Bayesian model of the Cavallo radiocarbon determinations. The OxA-codes are marine shell dates [11,38] whereas the Fi-codes are dates on ABA-treated charcoal. The model displays high degree of agreement and only 1 date (OxA-19257) is identified as outlier. The transition from the late Mousterian to the start of the Uluzzian is calculated to be ~44.5-43.1 ka cal BP (1s) and 45.9-42.8 ka cal BP (2s). The probability distribution function for the FII/EIII start boundary is shown in detail on the right-hand site.

Based on this new model for Cavallo as well as the synthetic data reported in Douka et al. [38] for other sites, the Uluzzian appears to have been in the Uluzzo Bay and in the rest of Italy by 39- 40 ka BP or ~45 thousand years ago. Its termination is placed ~40/39 ka cal BP shortly before the time of the Campanian Ignimbrite eruption [42].

New data on the archaeological and anthropological materials

As mentioned above the characteristics of the Uluzzian techno-complex of Grotta del Cavallo are so far almost exclusively known via the studies published by Palma di Cesnola in the years closely following the fieldwork of 1963 and 1964 at this site (The most detailed reports can be found in *Rivista di Scienze Preistoriche*) [34,37]. In accordance with the methodological approach of his time Cesnola primarily described stone artefacts from a typological standpoint. Within this “Static” notion of lithic production greater prominence was given to retouched implements while technological and functional aspects were considered to be of lesser importance. It is clear that due to the limitations posed by such approach the advances in lithic studies regarding methodological/technological aspects as well as the discovery of further Uluzzian sites this data need to be revisited.

This is particularly important for the renewed study of the knapped assemblages from a technological and functional viewpoint. The study of the other categories of materials such as ornaments, anvils and pigments using cutting-edge methodologies is of paramount importance as well. We present here some new results deriving from the revision of the lithic material from layer EIII fieldwork of 1963 and 1964 (Where and when the teeth were found), and of the whole corpus of backed tools (Layers EIII, EII-I, E-D and D (Palma di Cesnola’s and Gambassini’s excavations).

All the human remains from Grotta del Cavallo (Figure 5) except specimens Cavallo E and Cavallo F have already been the subject of thorough morphological and morphometrical reassessment based on state-of-the art methods. Cavallo A a lower left second deciduous molar unearthed from layer L and Cavallo D a lower right first deciduous incisor from layer FIII were classified as Neandertals [51-52]. Cavallo B and Cavallo C retrieved in an area corresponding to squares E8 sectors I-II, E9 sector II, F8, F9 sectors II-III and G8 which had not been affected by erosional processes (See the paragraph on post-depositional disturbances and the discussion for more details) were recently classified as modern humans [11] a result confirmed by other studies [53-54]. To complete the investigation of the human remains of Grotta del Cavallo in this contribution we provide the first taxonomic

discrimination of the specimens Cavallo E and Cavallo F and the morphological description of a specimen hereafter called tooth X. This latter was confused for a human deciduous tooth albeit never published in detail but presented at the 16th Congresso degli Antropologi Italiani, Genoa, Italy [9] and cited by Riel Salvatore [10]. We also note that Palma di Cesnola mentioned both in his 1963 personal archive and published 1963 report a further human tooth which was retrieved during the 1963 excavation from layer DI. This specimen does not appear in any following publication and is not among the human / faunal material housed in Siena hence it is likely the tooth turned out to be “Non-human” exactly as the aforementioned tooth X.

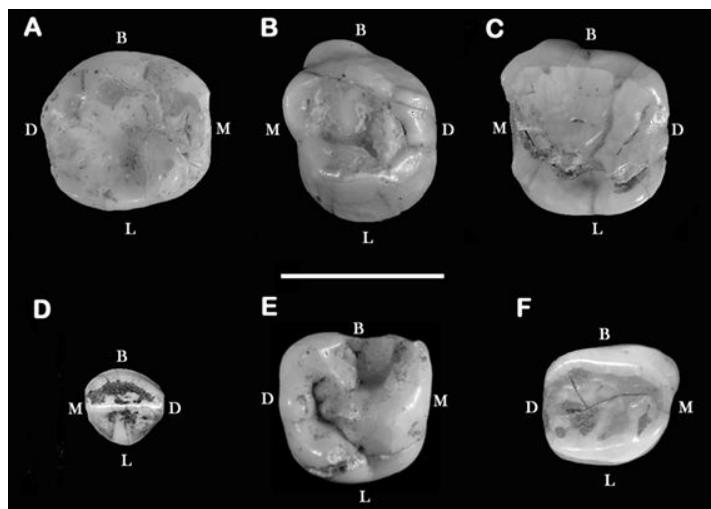


Figure 5(A-F): Occlusal view of the deciduous teeth of Grotta del Cavallo. Cavallo A, Neandertal left dm_2 (A); Cavallo B, *Homo sapiens* left dm^1 (B); Cavallo C, *Homo sapiens* left dm^2 (C); Cavallo D, Neandertal right I_1 (D); Cavallo E, *Homo sapiens* right dm^2 (E); Cavallo F, *Homo sapiens* left dm_1 (F). B=buccal, D=distal, L=lingual, M=mesial. Scale bar, 1cm.

Materials and Methods

Lithics

The lithic sample from layer EIII housed at the University of Siena consists of 1089 pieces. These were studied from a technological viewpoint [55-60] with the aim of reconstructing in this preliminary phase of the study the main production processes carried out by the earliest Uluzzians and identifying distinctive attributes of their toolkit. As first step artefacts were classed into five broad categories cores, flakes (Length/width < 2), blades (Length/width ≥ 2), indeterminate pieces (Fragmented, altered pieces etc.) and retouched pieces. A study on the cores was performed taking into consideration the origin and morphology of the blanks as well as the kind of volumetric concept and the exploitation system. The type and location of the striking platform the characteristics of removals and the possible reasons why the core was discarded were further evaluated. Products were examined according to

the extent and localization of cortical parts, their morphological attributes (Profile, symmetry and cross-section) the characteristics of dorsal scars, butts, bulbs and ventral faces in order to identify as far as possible the reduction sequence they belonged to. Finally, the occurrence of retouch and of possible alteration features (Chemical, post-depositional, thermal) was also taken into consideration. A raw material revision was performed on the lithic component obtained from siliceous lithotypes (Mostly pebbles) along with a preliminary attempt of refitting which gave one successful result. In this case artefacts were sorted on the grounds of their macroscopic features such as colour and thickness of cortex, texture, colour, inclusions and opacity of the raw material.

A more detailed study was conducted on backed pieces. These were analysed on the basis of the procedures used in their manufacturing the original blanks their dimensions (Maximum length, breadth and thickness were measured) and proportions (Length/breadth and breadth/thickness have been considered) the backing process. The working edge (The one opposite the back) angle of each piece was also measured. The obtained data were intertwined in order to identify potentially recurring characters and to reconstruct as far as possible the techno-functional life of each artefact.

The traceological analysis on backed pieces was carried out by means of both the Low Power Approach (LPA) [61-63] and the High-Power Approach (HPA) [64-66]. Traces were observed by means of a Hirox KH-7700 3D digital microscope using two different optics a MX-G 5040Z body equipped with an AD-5040Lows and an AD-5040HS lens working at low magnification (20x-50x) used to observe the macro-traces (Fractures, edge damage, diagnostic impact fractures) and a MXG-10C body and an OL-140II lens (140x- 480x) used to analyze the micro use-wear (Polishes, abrasions and striations). This instrument enables the generation of a 3D model of the observed surface through the overlapping of several planes (Up to 120) taken at different focus levels allowing versatile observation in three dimensions. A fully-focused image can be created from a small number of pictures facilitating observation of the used surfaces at high magnifications [67,68].

Human Remains

High-resolution micro-CT images of Cavallo E, Cavallo F and tooth X were obtained with a XAL-T microtomographic system (Institute of Clinical Physiology, Pisa, Italy) [69] using the following scan parameters 50 kV, 0.7 m A with a 2mm Al filters. Each tooth was scanned at the highest magnification factor (M=2.6) for ca. 45 min and a volumetric dataset has been then reconstructed with a cubic voxel size of 18.3 μ m via cone-beam filtered back-projection with standard ramp filter applying corrections for ring artefacts and beam hardening. Attention has been paid on accurate geometrical calibration of the scanner prior to each scan session. The image stacks were segmented with a semiautomatic approach

in Avizo 7.0 (Visualization Sciences Group Inc.) to reconstruct three-dimensional (3D) digital models of the teeth which were then used for the morphological description of the external surface and the Enamel-Dentine Junction (EDJ) surface and for morphometric analysis. Terminology for the morphological description follows Scott and Turner [70]. Non-metric traits were evaluated according to standards outlined by the Arizona State University Dental Anthropology System ASUDAS [71]. Occlusal wear stage was assessed based on Molnar [72]. Age of death for Cavallo E was estimated combining different observations such as stages of tooth formation dental eruption and root resorption using the sequences provided by Moorrees [73] and AlQahtani and colleagues [74] for recent *Homo sapiens*. The Mesio-Distal (MD) and Bucco-Lingual (BL) crown diameters of Cavallo E and Cavallo F were compared with a sample of Neandertal (N) Upper Palaeolithic *H. sapiens* (UPHS) and Recent *H. sapiens* (RHS) teeth collected from the scientific literature [75-82]. Besides measuring the crown diameters, for Cavallo E crown outline analysis was carried out. Since the tooth is fractured buccally (See Figure 6A and morphological description below) several steps were required to obtain the shape variables. First it was not possible to exploit the orientation protocols based on the cervical line (i.e. [11, 83]). Therefore, the digital model of Cavallo E was imported in Rapidform XOR2 (INUS Technology, Inc, Seoul, Korea), virtually oriented to maximize the occlusal surface area in superior view (XY-plane) and rotated around the z-axis so that the lingual side was parallel to the x-axis. The incomplete crown outline of Cavallo E was then projected onto the xy-plane (Figure 6 A). Second to reconstruct the outline without biasing the final outcome two restorations were proposed based on the mean shape of the Upper Palaeolithic *Homo sapiens* (UPHS) and Neandertal samples used by Bailey et al. [53] respectively (Figure 6 B-C)

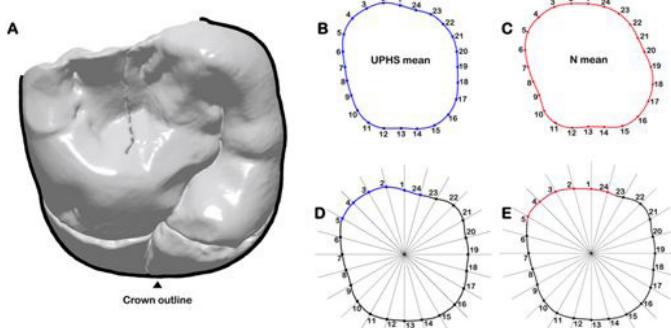


Figure 6(A-E): The human remains Cavallo E. The incomplete crown outline of Cavallo E projected onto the xy-plane (A); mean shape of the Upper Palaeolithic *Homo sapiens* (UPHS mean) crown outline samples (B); mean shape of the Neandertals (N mean) crown outline samples (C); the restoration of the crown outline shape of Cavallo E based on the mean shape of the Upper Palaeolithic *Homo sapiens* (UPHS) samples (D); the restoration of the crown outline shape of Cavallo E based on the mean

shape of Neandertal (N) samples (E).

Owing to the lack of real landmarks that can guide the deformation of the UPHS and Neandertal means onto the outline of Cavallo E the formers were digitally translated and uniformly scaled onto the latter in Rhino 4.0 beta CAD environment (Robert McNeel and Associates, Seattle WA) till the best match was found. Then the portion of the mean outlines in correspondence with the missing area was used to obtain two versions of Cavallo E, namely Cavallo E based on UPHS (i.e., Cav-E UPHS) and Cavallo E based on Neandertals (i.e., Cav-E N) (Figure 6D-E). Both outlines were centered superimposing the centroids of their area according to the comparative sample used by Bailey and colleagues [53] represented by 24 pseudolandmarks obtained by equiangularly spaced radial vectors out of the centroid, and scaled to unit centroid size [11,52]. Finally, the shape variables of Cav-E UPHS and Cav-E N were projected into the shape-space obtained from a Principal Component Analysis (PCA) of the comparative sample used by Bailey et al [53]. The data was processed and analyzed through software routines written in R [84].

Results

New insights from the lithic assemblage of layer EIII

The most common rock lithotype (Approximately 80%) exploited by the Uluzzians of layer EIII is greyish laminated limestone showing different degrees of silicification. It was available from local Mesozoic outcrops [34] as also attested for the Mousterian levels of the same site [22,85]. Natural surfaces present on the artefacts show that this raw material was collected from primary outcrops as layers varying from approximately 50 mm to 5 mm in thickness. Such layers naturally cleave according to parallel planes. Thin layers are generally less silicified. Palma di Cesnola refers to thicker layers as “Liste” (Slabs) whereas he introduced the term “Lastrina” to indicate thinner layers (15-5 mm) and cortical parts of more silicified thick layers or thin portions of them defined by cleavages [34]. This raw material is often of poor quality and relatively difficult for knapping. Secondarily a series of different siliceous raw materials are present which appear to have been mostly collected as small pebbles (As clearly indicated by cortex where present). They include fine-grained flint and radiolarite medium to coarse grained flint medium to coarse grained siliceous limestone and medium-grained quartzite.

Besides the use of debitage production characteristic of the lithic assemblage from layer EIII is the considerable amount of lastrina (Which constitute 76.8% of retouched pieces) (Table 1) directly employed as blanks for retouched tools without any previous debitage modification. These two procedures are for two completely different purposes. End-scrapers and side-scrapers are above all on lastrina while debitage is mostly associated with the production of blades and microlithic items in general.

Layer EIII 1963-1964		
	N	%
Bipolar core	365	-
Bipolar blade-bladelet	74	-
Bipolar flake-flakelet	19	-
Tot. bipolar	458	67
Freehand core	33	-
Freehand blade-bladelet	28	-
Tot. freehand	105	15.4
Indet. blade-bladelet	23	3.4
Indet. flake-flakelet	44	6.4
Total blade-bladelet	125	-
Total flake-flakelet	107	-
Other	53	7.7
Retouched artefact	106	-
Tot. debitage	683	-
Tot. retouched on lastrina	357	-
Indeterminate on lastrina	36	-
Tot. retouched on thermal flake	13	-
Total assemblage	1089	-

Table 1: Counts of layer EIII lithics (Excavation seasons 1963 and 1964) currently housed at the University of Siena. Frequency distribution of the examined categories. Indeterminate blade and flake categories contain specimens which cannot be attributed to specific reduction systems.

Two techniques were employed in the knapping operations: direct freehand percussion [57] and bipolar knapping on anvil the latter largely predominant (67% of the whole sample) (Table 1). Cores are always of small size since their maximum dimension does not exceed 60 mm. However, the occurrence of a number of large flakes from raw materials other than limestone slabs indicates that a minor part of the production was probably implemented elsewhere. In addition, very rare unilateral crests and *tablettes* on fine-grained flint denote the sporadic use of more elaborated technological systems. Except for backed pieces which are dealt with separately in the ensuing paragraph formal tools on knapped

blanks are not very numerous. These are mostly composed of side-scrapers (Figure 7, nos. 13/17) and end-scrapers (Figure 7, no. 6) as well as by some denticulates and a few (3 pieces) marginally backed small blades irregular in profile (Unlike classic Dufour bladelets) two of which from bipolar reduction (Figure 7, nos. 1/3).

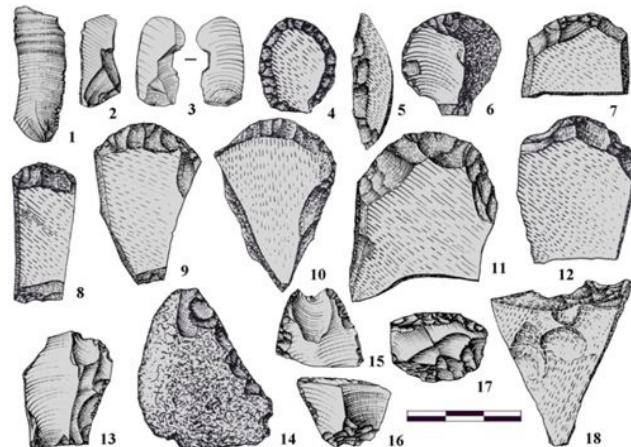


Figure 7(1-18): Layer EIII. Retouched tools. Marginally backed small blades (1-3); pseudo-lunate on lastrina (5); end-scrapers on lastrina (4, 7-12); end-scraper on flake (6); scrapers on flake (13-17); denticulate on lastrina (18). Modified after [34] (1, 2, 4-18). Tools 6, 8 and 9 are intentionally modified on the extremity opposed to the frontal edge.

Among cores we also considered specimens bearing single or few short scaled test removals and a moderate quantity of unexploited slabs/lastrine showing adjustments of the edges which are consistent with a sort of rough crest preparation.

In cores exploited by direct freehand percussion, debitage (Figure 8, nos. 3/6) is very simple as it encompasses none or only a minimal (Presence of few partial crested items) preparation of the volume to be flaked. Striking platforms are generally natural. Save for some exceptions knapping is unifacial (Both unidirectional and bidirectional) and is carried out along the maximum dimension of the blank. Reduction sequences aimed at the achievement of few blades (Figure 8, nos. 1-2) or flakes per core are brief and interrupted by hinged removals more often than not. A core shows an additional use as a hammerstone.

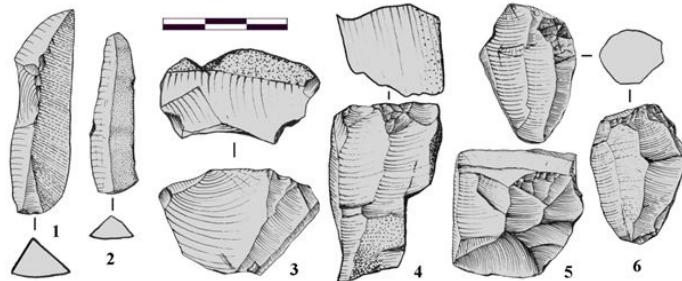


Figure 8(1-6): Cores and products from layer EIII. Cores (3-6) and products (1,2) from direct freehand percussion. Drawings by A Moroni.

As already repeatedly put forward by Palma di Cesnola and other authors involved in the study of the Uluzzian [17,38,86-88] a major feature marking the identity of this techno-complex is the overwhelming occurrence of artefacts displaying evidence of a particular stone knapping behaviour, the bipolar flaking on anvil, and commonly classified as splintered pieces (The French *pièces esquillées* or *écaillées*). Since the beginning of his study Palma di Cesnola carefully refrained from including splintered pieces into the formal tool count “Amongst cores most are of the bipolar type these show different morphologies probably owing to the different degree of their exploitation. Sometimes two flat striking platforms at opposite poles of the piece can be observed in other cases only one striking platform is preserved while on the opposite end a splintered thin edge is present. However, the most abundant category of bipolar cores has thin splintered edges at both ends this type therefore can be placed amongst the so-called *pièces écaillées*. The scarcity of typical cores showing a visible striking platform compared with the large amount of *pièces écaillées* can perhaps indicate that cores were usually exploited up to their extreme dimensional limits. However, a doubt arises that the aim of this working was not to obtain splinters at times really tiny but was the remnant itself or *pièce écaillée* which would have had in this way a specific function in itself” [34]. In its commonly accepted meaning bipolar reduction can be described as a percussion technique in which lithic raw material is manually held on a mineral anvil and vertically or tangentially struck with a hammer (Usually hard) [57-58,89-93]. This entails obtaining relatively uncontrolled removals that vary in technological features. Moreover, contrary to the other debitage techniques a single bipolar blow can concomitantly produce more than one product either from the same edge or from the two opposite ends [92-94]. In several contexts bipolar reduction comes into play as an ancillary technique either in cobble- splitting at the beginning of a reduction sequence or when the core becomes too small to be knapped otherwise. Its exclusive use on specific raw materials has also been noticed [95]. In our

case there is no selection in the exploitation of different raw materials and direct freehand debitage and bipolar knapping appear to have been unrelated processes as in both categories several pieces display remnants of the original surfaces attesting the small size of the initial core mass.

Layer EIII yielded both specimens universally recognized as cores and quadrilateral pieces chisel-like in profile which in the literature are often classified as tools (Splintered pieces) on the grounds of their edge morphology and/or inferred function. Initial results of the study carried out on technological and morpho-metrical attributes of this bipolar component bear witness to the lack of a clear separation among differently-shaped artefacts. Conversely these objects display as shown below recurring traits suggesting the possibility of a common technological pattern. While waiting for more in-depth studies substantiated by a complete set of experimental tests and use-wear and residue analyses (In our schedule for the immediate future) we are inclined to interpret most of the bipolar evidence from layer EIII as cores belonging to reduction processes aimed at the production of blanks.

EIII bipolar flaking strategies are oriented towards the achievement of elongated products of small to hyper-micro-lithic dimensions. Fractions of slabs/lastrine small pebbles and flakes the original ventral faces of which are sometimes still discernible were indifferently exploited. Pebbles were first split into segments resulting from an initial bipolar blow each of these segments (Flenniken’s “Split cobble cores”) [96] was used independently as shown by a small refit between two cores stemming from the same pebble (Figure 9, no. 8).

Bipolar cores can be clustered into two main groups

- Cores starting from elongated blank (Figure 9, nos.1-2-10). In the case of slabs these blanks are parallelepipeds with two cortical sides. Negative removals are represented, for the most part by small blades bladelets and micro bladelets. Intensive exploitation extended on both faces and sides can generate an elongated narrow morphology (Resembling often a sort of small stick) showing at least one striking platform reduced to a point ogival in shape. Slabs used in this category of cores are thin and narrow as their width which corresponds to the limestone layer thickness only exceptionally exceeds 15 mm. The reduction process starts from the natural edge of the slab and always follows the direction of the layer surface.
- Cores starting from roughly square-shaped blank (Figure 9, nos. 5-9-15). In this case removals are both small blades/bladelets/micro bladelets and small flakes/flakelets/micro flakelets. Flakes always come from the plan faces of the core.

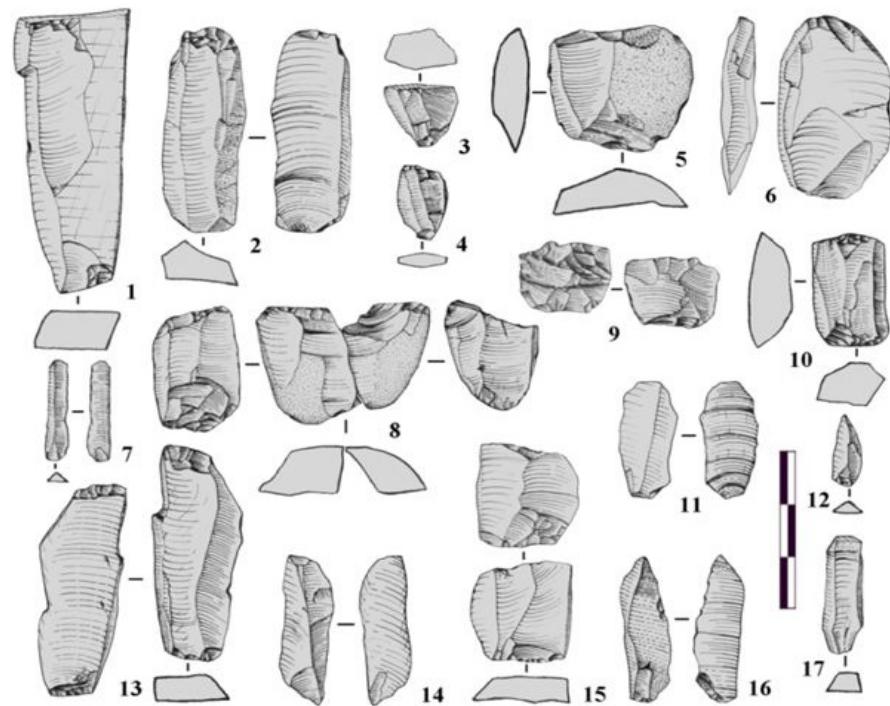


Figure 9 (1-17): Bipolar cores and products from layer EIII. Bipolar cores (1-6, 8-10, 15) and products (7, 11-14, 16, 17) from bipolar knapping. Refitting between two portions of a pebble which were individually exploited as cores after the splitting of the pebble (8) Drawings by A. Moroni.

In both groups the spent cores having instead of the striking platform one or two opposite ridges crushed and buttered by splintering are numerous. A minor part of bipolar cores displays different evidence. Some quadrangular or triangular lastrine bear blade removals developing along the longest natural edges without invading the faces in plan view. Another system employs triangular fractions of slabs/lastrine to achieve elongated blanks using the triangle top as striking starting point. Finally, there are some cores chiefly oriented towards blade production showing few bipolar removals randomly distributed.

Interestingly despite the “Uncontrolled” character of bipolar reduction conditions for the achievement of blades or more in general elongated products are provided by a standard exploitation modus operandi in which a key factor is the occurrence on the core of lateral steep edges naturally present (Slabs and pebble segments) [58] (Figure 8) or intentionally created (Flakes). Plan removals tend to maintain this prerogative as they always develop parallel to these edges. Only at the very end of the process in completely exhausted morphologies (Usually of very small size) also lateral edges are invaded and obliterated by splintering. The entire process causes a progressive relatively proportional reduction of the core which basically retains its original profile although diminishing in size. Therefore, even if bipolar products are scarcely controlled in shape and thickness the use of repeating patterns of technical expedients allowed prehistoric craftsmen to partially influence if not predetermine proportions of the wished products.

Although potentially more productive than hand-held cores [97] in the case under study bipolar cores turned out to be unsuitable for extended reduction sequences owing to their intrinsic characteristics (Primarily the already small size of blanks). This might account for their vast quantity in the EIII sample.

Given the lack of any former preparation of the core the morphometric attributes of bipolar products are closely related to the potentialities inherent in the core blank natural morphology. Products resulting from bipolar reduction show (As in other authors’ descriptions) [58,90,92,98-99] “Sheared bulbs of percussion” [58] butts shattered or reduced to a point or a line and longitudinal profile of the ventral face generally rectilinear (Figure 9, nos. 7-11/14-16-17). The ventral and the dorsal faces are not always easily distinguishable from each other in addition the ventral face of some products exhibits “Very pronounced ripple marks” (Figures 7, no. 1 and 9, no. 11) [100] (Face d’éclatement vibrée) [101] which are due to the intensity of the strike and indicate a percussion angle of 90° [98]. Thick and quadrilateral in cross-section blades [58] (Figure 8c) are also present (Figure 9, no. 17).

In layer EIII specimens on lastrina represent 36.1% of the whole assemblage and 76.8% of retouched tools. Their use decreases from EIII to EII-I to D where they nearly disappear [34, 37]. This is a very particular system of making tools induced by the characteristics of raw material which is exclusive of the sites located in the same area of Grotta Del Cavallo. Tools were directly

achieved from lastrina naturally fragmented or shaped by intentional breaking. Their 90° backed sides were then transformed by retouching them in order to obtain cutting edges.

End-scrapers are the most numerous and characteristic tools (42.7%) they are mainly represented by specimens with semi-circular fronts (Figure 7, nos. 7/10) (Table 2). Only in 30 pieces does the retouch extend from the front to the adjacent edges (Figure 7, no. 4). Even if end-scrapers are quite varied in size, they are all rather short (Only 12 items display a more elongated profile) (Figure 7, no. 8). It is also possible that this feature was deliberately pursued, since 18 pieces exhibit a clearly intentional shortening at the end opposite to the front (Figure 7, no. 8).

Lateral fractures are generally sub-parallel with the exception of 20 specimens in which fractures converge to form a point opposite to the end-scaper (Figure 7, no. 10). Some pieces with “Flattened” fronts are in an intermediate position between end- and side-scrapers.

Layer EIII 1963-1964		
	N	%
Front end-scrapers	129	
Nose end-scrapers	22	
Crenulated end-scrapers	6	
End-scrapers fragments	11	
Total end-scrapers	168	42.7
Convex side-scrapers	85	
Straight side-scrapers	38	
Concave side-scrapers	1	
Side-scrapers fragments	11	
Total side-scrapers	135	34.4
Denticulates	37	9.4
Pseudo-lunates	17	4.3
Indeterminate	36	9.2
Total	393	

Table 2: Counts of layer EIII artefacts on lastrina (Excavation seasons 1963 and 1964) currently housed at the University of Siena.

Within the rest of the assemblage (Side-scrapers and denticulates) it is really difficult to identify which pieces are finished tools fragments or by-products without having performed an appropriate experimental activity and a targeted technological study. However, we note also amongst side-scrapers and denticulates the occurrence of convergent fractures shaping the sides adjacent to the retouched edge (Figure 7, no. 18). A noteworthy recurring type on lastrina already described by Cesnola [37] is what we have provisionally labelled “Pseudo-lunate” (Figure 7, no. 5). This is indeed lunate-like in shape even if it is characterized unlike true lunates by a fracture forming a curved back on the one side and by

a retouched cutting edge on the other. Several pieces on lastrina retain residues of red pigment. The analysis of their localization integrated with a use-wear study will provide information about the possibility that tools on lastrina or some of them were hafted.

Backed pieces

Crescent-shaped backed tools (Also referred to as lunates or segments) are considered together with the bipolar technique the hallmark of the Uluzzian (Figure 10). Such tools actually occur in all the Italian assemblages belonging to this techno-complex, but they are really numerous only at Grotta del Cavallo [88,102-103]. Palma di Cesnola’s and Gambassini’s excavations yielded more than 146 backed tools (Considering both finished and in fieri objects -146 is the amount of specimens housed at the University of Siena) embodied for the greatest part by lunates. This allowed their quantitatively reliable study the preliminary results of which are presented herein.

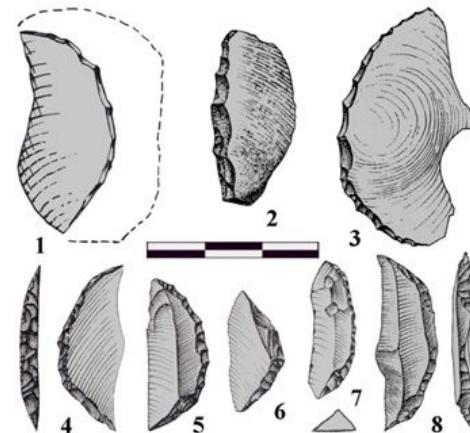


Figure 10(1-8): Backed pieces. Schematic reconstruction (1) of the most common method (type A) used in lunate manufacturing: the back was obtained by reducing one of the longest edges of the blank until reaching its maximum thickness (around the middle of the blank) usually, at the end of the backing process, the butt resulted in being entirely removed and only about 2/3-1/2 of the bulb was preserved. Backed piece interpreted as an in fieri lunate from layer EIII (2); lunate on thermal flake from layer EIII (3); lunates (type A) from layer EII-I (4-6); lunates (type B) from layers EIII (7) and DII (8). Modified after Palma di Cesnola (8), [13,34,37] (2, 3), (4-6). Drawings by A. Moroni (1,7).

Backed pieces are not evenly distributed amongst the three main stratigraphic partitions their percentage is lower in EIII increases in EII-I and decreases again in D [34,37] (34, 60, 30 and 22 pieces of the examined sample from layer EIII, layer EII-I, layer E-D and layer D respectively). This category contains several irregular and roughly retouched specimens in addition to a greater part of more or less carefully made items including rare quasi trapezoidal or triangular implements (Which can be conceptually incorporated among lunates). Evidence resulting from the analysis of their technological features attests that various kinds of blanks

(Bladelets, flakes and lastrine) obtained from different production systems [20] were used on the condition that they had a sufficient degree of thickness. The production phase had therefore a subordinate role as tool shaping chiefly relied upon the transformation process (Retouching) [20].

In the cases in which the original blanks (109 pieces) can be identified, these are more often blades (L/W ratio ≥ 2) (53%) especially in layers EII-I and D represented by small frequently thick blades (Maximum length $> 20 \leq 40$ mm) and exceptionally by bladelets (Maximum length ≤ 20 mm). The blade/flake ratio, globally 1.1, is in favour of flakes (0.6) in the lowest layer EIII (Table 3). Some blanks show clear features attesting their provenance from bipolar cores. The angle of the edge opposite the back ranges between 20° and 40° (Table 4).

Layers	Length (mm)	Breath (mm)	Thickness (mm)	Length/Breath	Breath/Thickness
EIII	29.25 ± 5.76	14.74 ± 3.54	5.09 ± 1.94	2.01 ± 0.38	3.16 ± 0.99
	(n = 28)	(n = 31)	(n = 32)	(n = 28)	(n = 31)
EII-I	25.13 ± 5.59	11.2 ± 2.64	4.1 ± 1.27	2.26 ± 0.48	2.86 ± 0.8
	(n = 45)	(n = 51)	(n = 52)	(n = 45)	(n = 51)
E-D	24.2 ± 4.75	11.07 ± 3.35	4.07 ± 1.28	2.31 ± 0.46	2.94 ± 1.11
	(n = 25)	(n = 30)	(n = 30)	(n = 25)	(n = 30)
D	26.5 ± 3.63	10.9 ± 2.17	4.29 ± 1.49	2.43 ± 0.49	2.81 ± 1.34
	(n = 18)	(n = 20)	(n = 21)	(n = 18)	(n = 20)

Table 3: Dimensions (In mm) and length/breath and breath/thickness ratios (Means \pm standard deviation) by layer, calculated on backed pieces with complete length (Tot.116) breath (Tot.132) and thickness (Tot.135).

Working edge angle	EIII		EII-I		E-D		D		Total	
	n	%	n	%	n	%	n	%	n	%
20°	8	24.2	14	26.9	9	30	4	23.5	35	26.5
30°	14	42.4	25	48	14	46.6	8	47	61	46.2
40°	11	33.3	12	23	7	23.3	5	29.4	35	26.5
50°			1	1.9					1	0.7
Total	33		52		30		17		132	

Table 4: Values of the working edge angles of backed pieces by layer.

In layer EIII some thermal flakes stemming from lastrina were used as blanks (Figure 10, no. 3). It is possible that heating was an effective fracturing stratagem intentionally applied to this particular kind of raw material in order to quickly extract blanks.

For most of the lunates the back was obtained by reducing one of the longest edges of the blank (whether flake or blade) until reaching its maximum thickness (Around the middle of the blank) (Type A) (Figure 10, nos. 1-4/6). Usually at the end of the backing process the butt resulted in being entirely removed and only about 2/3 - 1/2 of the bulb was preserved. Some pieces with straight backs formed by retouch starting from the dorsal face are most probably to be considered unfinished specimens (Figure 10, no. 2). Another system (Type B) mainly attested from EII-I upwards involve blanks formed by small blades often triangular in cross-section only the ends were deeply modified by retouching whereas the edge in between was slightly transformed or left unaltered (Figure 10, nos. 7-8). None of the segments obtained in this

last way show signs of impact damage. Independently from the chosen procedure the aim was to preserve as much cutting edge as possible even at the expense of its regularity and to make the back coincide with the thickest part of the blank. Therefore, the length of the cutting edge (Which never presents any kind of intentional modification) corresponds in most cases, to the original edge of the blank. The back thickness is highly variable (From 2 to 10 mm). The abrupt retouch was produced in many cases exclusively on the dorsal face (64 pieces) more rarely on the ventral one (15 pieces). Tools shaped using bipolar abrupt retouch alone are few (11 pieces) since this procedure was more often used only in the middle and proximal portions of the back, namely where the blank was thicker.

A possible use of backed pieces of Cavallo in composite implements is substantiated by the occurrence (On 28 items) of residues of red ochre often concentrated on or/and near the backed edges (Figure 11, no. 4). However, although type B appears to be

quite standardized the majority of these pieces display a certain degree of morpho-metric variability due to their size profile and curvature of the backed side especially during the early phase (EIII). What is not clear yet is whether these differences or some of these differences (And then which ones?) had a real practical value (With regard to their use in different devices or to their different positions in the same implement) as there are archaeological examples like the case of the skeleton discovered with several backed microliths in a sand dune in Narrabeen (Sidney) [104-105] where artefacts different in shape and size were probably hafted together.

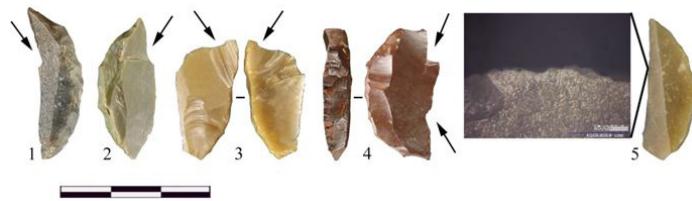


Figure 11(1-5): Selection of backed pieces with impact scars and use-wear traces from Grotta del Cavallo. Burin-like fracture (1); spin-off fracture ≥ 6 mm with step termination (2); bi-facial spin-off fracture (3); burin like fracture and impact notch (4); polishes localized on the un-retouched edge interpreted as due to scraping vegetal material (5). (Photos by Stefano Ricci).

The analysis of micro and macro use-wear traces of the Uluzzian lunates of Grotta del Cavallo has confirmed the functionally flexible nature of this specific tool (Figure 11). Observations have been carried out on 40% of the sample but the entire set of backed pieces has been examined in order to detect macro-fractures due to their possible use in hunting weapons. Sixty % of the analysed items exhibit no use-wear traces or unclear traces. Up to now no experimental work has been directly conducted by the authors. Analytic results have been compared with data made available by current literature regarding this subject [106-112]. We are well aware of the risks connected to misinterpretations of impact scars when an archaeological study is not accompanied by a controlled experimental activity [113]. However, our main goal in this preliminary phase is to probe all the potentialities displayed by the Uluzzian lunates. Therefore, we discuss herein only a general overview of fractures consistent with impact scars considered more diagnostic postponing to a later project their final study which will also include an experimental program. As similar fracture types are absent in the rest of the industry we are inclined to refuse at the time of writing a taphonomic origin such as trampling.

Specimens showing impact scars are thicker than the average taking into consideration both the absolute value (Mean 4.8 vs 3.8) and the width/thickness ratio (Mean 2.3 vs 3) they also present a higher working edge angle (Mean 33.6° vs 29°). Impact

fractures are mostly of the burin-like type (Figure 11, no. 1) often associated with spin-offs. To a lesser extent step terminating bending fractures also in this case associated with spin-off fractures and spin-offs > 6 mm [109] have been detected (Figure 11, nos. 2-3).

Occasionally segments with impact burination or spin-off fractures exhibit semi-circular notches (Figure 11, no. 4) on their cutting edges consistent with those occurring on archaeological examples from Sibudu Cave and other Howiesons Poort South-African sites as well as with impact fractures experimentally reproduced [109] (Figure 6). There are also specimens displaying bipolar scars frequently associated with impact burination. These might be the result of an impact as is the case of type a2m in Goldstein and Shaffer [112] (Figures 6 and 11). Microscopic linear impact traces were not observed on the analysed sample. A different use as possible insets mounted in cutting implements is suggested by the use-wear traces occurring on the edge opposite the back of some pieces (Figure 11, no. 5). Traces mostly consist of scars and edge rounding. Polishes are scarcely developed. These artefacts were used above all for cutting and scraping soft and semi-hard materials at times detectable as vegetal material or animal tissue.

The Human and Non-Human Remains

Cavallo E

Upper right second deciduous molar (Rdm2) which lacks the mesiobuccal portion of the crown (Thus affecting the integrity of the paracone) and most of both mesial and distal roots (Figures 12 A and 6 A). The tooth shows several fractures which are clearly visible on the EDJ (Figure 13 A). It is slightly worn equal to the wear stage 2. Despite the fractures and missing portions four principal cusps a Cusp 5 (ASUDAS grade 4) two mesial accessory tubercles (MAT) accessory crests and a small depression near the protocone identifiable with the Carabelli's trait (Grade 4) are still visible both on the external surface and on the EDJ (Figure 13 A). The hypocone is relatively small giving to the crown a sub-square shape as typically observed in modern human dm2s (See also crown outline analysis below [11,53]). An interproximal facet is visible on the medial side (Length=1.5 mm; height=1.2 mm). The lingual root is preserved but still developing (Equal to stage Rc of Moorrees) [73] thus suggesting an age at death between 2 and 3 years old which is in agreement with the wear stage. The tooth crown has a MD diameter of 8.4 mm (Minimum estimation due to interproximal wear) while the BL diameter ranges between 8.6 mm (Crown outline reconstructed by Neandertal) and 8.8 mm (Crown outline reconstructed by UP modern human). At the cervix the MD diameter is 6.6 mm. As shown in Table 5 the crown diameters of Cavallo E are small and fall (In particular for the BL crown diameter) in the RHS range of variability.

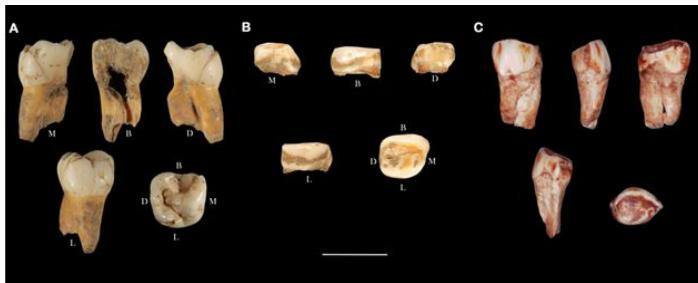


Figure 12(A-C): Human remains from Grotta del Cavallo. The specimen Cavallo E (A); the specimen Cavallo F (B); the specimen tooth X (C). B=Buccal, D=Distal, L=Lingual, M=Mesial. Scale bar, 1cm.

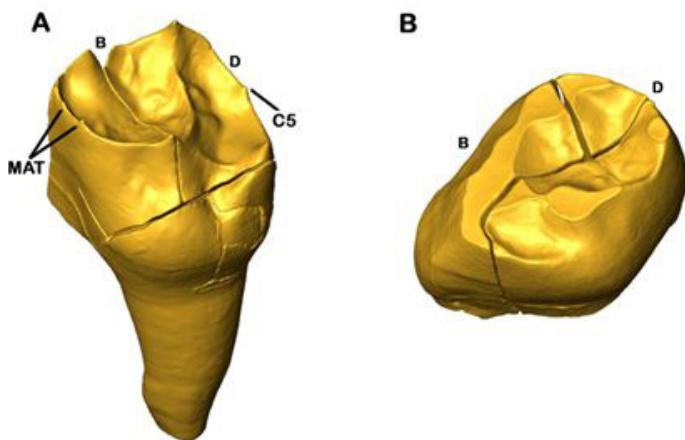


Figure 13(A-B): The Enamel-dentine Junction (EDJ) of Cavallo E and Cavallo F. Digital reconstruction of the EDJ of the specimen Cavallo E (A): C5=Cusp 5, MAT=mesial accessory tubercles; digital reconstruction of the EDJ of the specimen Cavallo F (B): B=Buccal, D=Distal.

	Rdm ²		Ldm ₁		
	BL (mm)	MD (mm)	BL (mm)	MD (mm)	
	m ± s (n)				
Grotta del Cavallo	8.6 (CAV-E N)-8.8(CAV-E UPHS)		8.4	6.5	8
N	10.3 ± 0.4 (13) ^a	9.22 ± 0.56 (13) ^a	7.56 ± 0.47 (24) ^c	8.83 ± 0.44 (24) ^c	
UPHS	10.5 ± 0.5 (15) ^a	9.5 ± 0.62 (15) ^a	7.23 ± 0.76 (11) ^d	8.13 ± 0.75 (11) ^d	
RHS European-male (UK) ^b	9.38 ± 0.84 (50)	9.42 ± 0.28 (50)	7.03 ± 0.49 (50)	8.16 ± 0.49 (50)	
RHS European-female (UK) ^b	9.18 ± 0.49 (50)	9.14 ± 0.14 (50)	6.99 0.63		

(50)	8.13 ± 1.27 (50)			
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Table 5: Buccolingual (BL) and Mesiodistal (MD) crown diameters (In mm) of Cavallo E (Rdm²) and Cavallo F (Ldm₁) compared to a reference sample composed of Neandertals (N), Upper Paleolithic *H. sapiens* (UPHS), recent *H. sapiens* (RHS). m=mean; s=standard deviation. Number of individuals in brackets [76-80] CAV-E N: the specimen Cavallo E reconstructed by the Neandertal mean; CAV-E-UPHS: the specimen Cavallo E reconstructed by the Upper Paleolithic *H. sapiens* mean.

The two crown outlines reconstructed for Cavallo E (i.e., Cav-E UPHS and Cav-E N) were projected into the shape-space PCA previously computed by Bailey and colleagues [53] for Neandertal and *Homo sapiens* dm²s (Figure 14). The two reconstructions plot nearby pointing out that the reference used for the reconstruction of the mesiobuccal missing portion (Either Upper Palaeolithic *Homo sapiens* or Neandertals) does not affect the final outcome. Most importantly both outlines plot within the range of variability of RHS and UPHS confirming that Cavallo E belongs to modern humans.

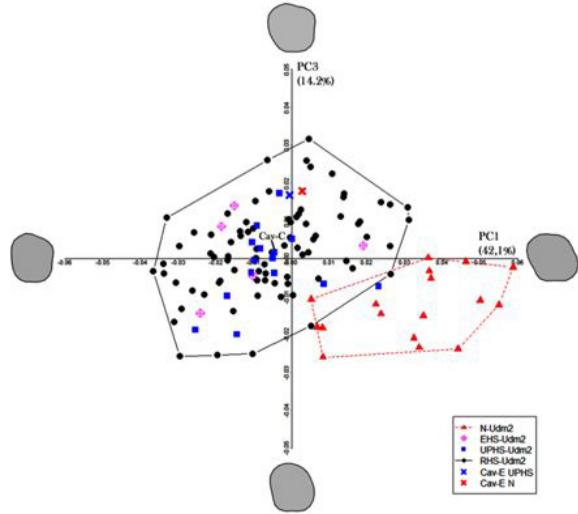


Figure 14: Shape-space PCA plot of the two Rdm² crown outlines of Cavallo E restored by the Neandertal mean (Cav-E N) and the UPHS mean (Cav-E UPHS). The deformed mean crown outline in the direction of the PCA is drawn at the extremity of each axis. N-Udm2=Neandertal; EHS-Udm2=Early Homo sapiens; UPHS-Udm2=Upper Palaeolithic Homo sapiens; RHS-Udm2=Recent Homo sapiens.

Cavallo F

Lower left first deciduous molar (Ldm₁) (Figure 12 B) with a complete heavily worn crown (Wear stage 5). Two large fractures the first mesio-distally directed and the second departing from the previous one and directed bucco-distally separate the crown in three main fragments which are clearly visible on the EDJ (Figure 13 B). The root is almost totally reabsorbed thus suggesting an age

of 11-12 years old. Due to the advanced stage of wear the cusps are not identifiable on the external surface but on the EDJ the remnant of four cusps can be recognized (Figure 13 B). From the occlusal view the crown outline has an asymmetric shape in the mesiobuccal aspect due to the well-expressed tubercle of Zuckerkandl a cervical tubercle at the mesiobuccal crown margin. Such asymmetry is usually observed in modern human dm1s which is generally different from the oval Neandertal dm1s [114]. Both interproximal wear facets are visible even though the mesial one smaller than the distal one (Length=4.4 mm, height=3.2 mm) is partially covered by deposit of calculus (Thus preventing the measurement of the length) (height=1.4 mm) ultimately suggesting the tooth was lost after the lower left deciduous canine. The tooth crown has a MD diameter of 8 mm (Minimum estimation due to interproximal wear) and a BL diameter of 6.5 mm while at the cervix the MD diameter is 7.6 mm and the BL diameter is 5.5 mm. Overall, as shown in Table 5, the crown diameters are small and fall in the UPHS and RHS range of variability.

Tooth X

Heavily worn tooth retrieved from layer EIII, square G11 (Gambassini's excavations) of Grotta del Cavallo (Figure 12 C). The irregular morphology of the tooth with a crown mesiodistally elongated a moderately convex buccal side and a single root buccolingually flattened does not find any parallel in the human dentition, both deciduous and permanent. The advanced wear stage has removed all the morphological features on the external surface even preventing the identification of the tooth class. A digital reconstruction of the EDJ and of the internal dental architecture (Figure 15) shows that the pulp chamber is completely filled with secondary dentin a process that in humans may be observed in permanent dentition. A cement layer covers parts of the crown (Figure 15) as happens in hypodont teeth like in some ungulate species and not in human ones.

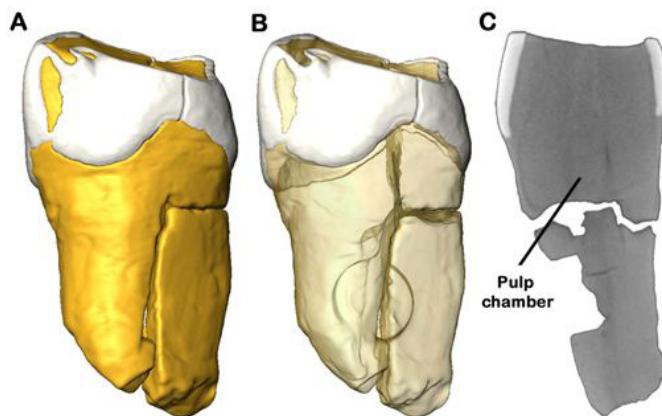


Figure 15: The specimen tooth X. 3D digital model of the specimen tooth X (A): a cement layer covers parts of the crown; a digital transparent reconstruction of the specimen tooth X (B): in the internal dental

architecture the pulp chamber is not visible; the hole in the root is where a sample was taken for DNA analysis; sagittal section of tooth X micro-CT (C): the pulp chamber is completely filled with secondary dentin.

The size is too small for a human permanent tooth as the crown has a MD diameter of 8.1 mm and a BL diameter of 5.1 mm. Among the deciduous dentition the BL diameter is comparable with the anterior deciduous teeth [115-116] while for the MD diameters the tooth is similar to the lower first deciduous molars [114]. However, lower first deciduous molars have two roots which are not flattened buccolingually. To summarize even though the taxonomic attribution of the specimen tooth X remains uncertain based on the above mentioned considerations we exclude its attribution to humans.

Discussion

On the integrity of the Uluzzian deposit of Grotta Del Cavallo

Del Cavallo

The stratigraphic issue is no doubt of crucial importance as it concerns the integrity of the deposit that yielded (In 1964) Cavallo B and C the only identifiable human remains which can be hitherto ascribed to the Uluzzian techno-complex. It was therefore inevitable that we carried out meticulous work following Palma di Cesnola's research program step by step. The critical cross-reading of the information contained in his publications and in his personal field-work notes allowed us to extract a number of meaningful data whose key points can be summarized as follows:

- The so-called "Pit" (Actually an erosional event) which can be considered the main ab antiquo post-depositional disturbance was identified as an intrusive event and therefore excavated separately by Palma di Cesnola since the beginning of the first excavation season in 1963 (Exactly on the 5th day).
- In the same year the Uluzzian layers and especially unit E were reached and excavated only in a restricted area (Trench P) of the principal trench, located close to the SE cut. Cavallo B and Cavallo C as well as the largest part of the Uluzzian material were recovered in the *in-situ* deposit (Corresponding to squares E8 sectors I-II, E9 sector II, F8, F9 sectors II-III and G8) (Figure 3, no. 4) in 1964 when the part of the principal trench located towards the entrance of the cave was excavated Cavallo B was found inside the earliest hearth in layer EIII by scraping the Mousterian red soil F which had partly been cut by the Uluzzian combustion feature.
- In addition to the "Pit" other post-depositional problems even of minor entity (e.g. rodents' burrows) were regularly reported by the excavator both in his publications and in his excavation field notes there is no reason to think that Cesnola was not able to identify or worse that he omitted a possible mixing in the case of the two teeth to the contrary Palma di Cesnola

never mentioned for neither of the teeth the possibility that their presence in the Uluzzian layers could be due to post-depositional mixing.

- Unit C which formed a thick boundary between unit's B and D was regularly present in the excavated area. This unit remarkably increased in thickness (From 30 to 60 cm) towards the entrance of the cave (Figure 3, nos. 1-2) thus forming a partition even thicker in the area where the teeth were recovered only in the deposit closest to the rock wall (Figure 3) unit C appeared to be heavily reduced in thickness as a consequence unit B had come here into direct contact with D this is the reason why the lower part (DII) of D was kept separated by the excavator from the overlying DI in order to avoid mixing.

In addition to the arguments discussed above and based on direct evidence there are other good reasons to support the integrity of the deposit where Cavallo B and C were retrieved. After careful study of the lithic materials from layer EIII (Excavation seasons 1963 and 1964) we are able to state that within the hundreds of pieces examined none can be considered intrusive (i.e. Epigravettian). The two teeth were found at different points and at different depths from each other had they been intrusive one would need to imply that Palma di Cesnola made the same mistake (i.e. failing to identify a stratigraphic problem) twice and only in the case of the human remains. To rephrase Mellars [117] this is an "Impossible coincidence".

The Human Remains

In order to shed light on the alleged uncertainty about the human fossil record of Grotta del Cavallo (i.e. human teeth mentioned by Palma di Cesnola in some preliminary reports, but that do not appear in any further study [12] in this contribution we have provided a clear overview of the human remains from Grotta del Cavallo) including the study of two unpublished human teeth Cavallo E (Rdm^2) and Cavallo F (Ldm_1) (Figure 3). Both teeth are attributed to modern humans but unfortunately, they cannot be associated to any specific cultural phase being retrieved from reworked deposit potentially spanning from the Uluzzian to the Romanellian. Overall the taxonomical reassessment of Cavallo B and Cavallo C (i.e., modern humans) [11] the taxonomical assessment of Cavallo E and Cavallo F (i.e., modern humans) as well as the non-human attribution of Tooth X suggest that in Grotta del Cavallo there are no Neandertal teeth in the deposit above the Mousterian levels.

Examining the Uluzzian from a Behavioural Perspective

In current studies the general characteristics of the Uluzzian techno-complex have been mainly borrowed from Palma di Cesnola's more recent synthetical work [86,118] on the Uluzzian of Central-Southern Italy. On the basis of this, the Uluzzian has been

generally described as a lithic assemblage displaying a very limited presence of blades and chiefly oriented towards flake production. A small amount of Upper Palaeolithic-like tools (Among which backed pieces) and a combination of Middle and Upper Palaeolithic items (Even more than in the Châtelperronian) both in the toolkit and in the technical systems (Discoid/centripetal cores) are also considered typical traits of this cultural entity [1,17]. These assertions are indeed only partial "Remakes" of what Cesnola had underlined since the beginning of his research in the Uluzzo bay: "Horizon EIII could have followed the last Mousterian settlements shortly afterwards. The Mousterian tradition of side-scrappers on lastrina is here clearly recognizable". [14] "In its structure the archaic Uluzzian appears indeed as an assemblage still little typified in which some typological elements of the leptolithic kind are included in a broad homogeneous substratum which is mostly Mousteroid" [34] and finally "The Uluzzian is an essentially flake-based industry which is comparable from a general point of view to the Châtelperronian complexes of Western Europe of which it may represent only a particular Mediterranean version" [34]. Limiting our considerations to layer EIII which represents on the basis of the current chronological data the more archaic expression of the Uluzzian in peninsular Italy the preliminary re-analysis of the lithic assemblage by means of an integrated technological approach paved the way for alternative interpretations of the available data. First of all, previous syntheses (Including) [39] on the Uluzzian of Grotta del Cavallo never took into account (Except for) [10,119] the role of bipolar reduction as the basic technical system in terms of blank production thus underestimating the bulk of small-micro-hypermicro-lithic generally unmodified artefacts often consisting of elongated items and their presumably specific functions in the Uluzzian toolkit. An argument along similar lines can be made for the numerous tools on lastrina. This class of artefacts is the main cause for both the inferred similarities with the underlying Mousterian and the assumed flake-based character of the lithic set. Tools on lastrina are most of the times flake-like in size and according to Palma di Cesnola, they were classified as such. It should also be noted that from the typological perspective of that time "Flake-based" or "Blade-based" definitions were above all concerned with the blanks used in the retouched component these were considered the only desired products while un-retouched specimens were essentially relegated within discarded materials. In fact, when we take into consideration the whole set of retouched and un-retouched debitage products of the examined sample (Thus excluding tools on lastrina) the frequency of flakes and blades come out to be more or less equally proportioned (Blades = 53.8%). The previous arguments provide a general picture of the earliest Uluzzians unlike the one commonly assumed. In particular one need to question whether defining a lithic assemblage as "Flake-based" or "Blade-based" still makes sense especially when we deal with post-Middle Palaeolithic cultural entities. In the lithic world of *Homo sapiens* not only flakes and blades alone had different

techno-functional roles. The larger/smaller artefact dichotomy could be even more meaningful in that these two categories were most probably devoted to different activities (e.g. domestic/hunting activities) and were often produced by independent reduction processes. Differences in the frequency of each category are not necessarily due to cultural constraints they can be connected to the functional role of the site under study and/or to the different spatial distribution of artefacts occurring inside the site itself as well as to taphonomic reasons.

A similar signal is displayed by the EIII lithic assemblage. This consists of both larger-size-tools like end-scrapers and side-scrapers most of which on lastrina and smaller-size-tools (That include backed pieces) presumably used in composite devices. This understanding begs several questions concerning the range of possible implements involved which can be only addressed using further methodological approaches (Use-wear techno-functional residue) in addition to the techno-typological study.

Bipolar Technique

The functional status of bipolar artefacts is still an open question broadly debated among scholars (For a wider discussion on this topic see [91,95,120]. The problem revolves around whether pieces resulting from bipolar knapping were almost entirely more or less exhausted cores or whether they represented instead distinct functional categories. There are authors who agree with the former hypothesis [58,89-91,121-124], even if some admit the possibility that bipolar spent cores could be recycled as tools for a variety of tasks [97,121,124]. According to others core reduced pieces and splintered pieces are distinct categories aimed at distinct purposes and, despite them partially morphologically overlapping they can be easily separated on the grounds of specific features [125-126].

Use-wear and residue analyses have emphasised the occurrence of traces on the edges (Often the non-splintered ones) of splintered pieces due to the working of medium or hard materials (Like wood and bone) [40,124,127] demonstrating that these objects whatever their origin could have been used occasionally as tools.

The possible use of splintered items as intermediate pieces (Wedges) for splitting or grooving wood antler and bone has been put forward by many scholars [120,126,128-131] and this hypothesis has also been the object of experimental tests [132-134]. However experimental results on the efficiency of these objects as wedges are controversial (For an overview of this problem see [91,97,120]. In lithic studies function and functioning constitute specific issues which may not have much to do with production processes and morphology in that similar artefacts may have different uses (And vice versa) depending on their socio-cultural chronological and geographical context. For these reasons each instance requires to be weighed individually [134]. This is also the case of the splintered/bipolar phenomenon whose spatiotemporal

diffusion [94] does not allow for a generalization. In this view we consider the results of our study on the lithic assemblage from layer EIII closely related to the Uluzzian context here examined.

Despite its “R strategy” connotation bipolar reduction proved to be an eclectic modus operandi which enables the knapper to obtain with little effort small elongated products particularly suitable to be hafted as they are scarcely curved and lacking in butts and bulbs. Additionally, it has been efficiently demonstrated [40,124,127] that exhausted cores (alias splintered pieces) were used for several activities. Our challenge is now to understand if we are dealing with something like an opportunistic recycling of few/several pieces or with a planned chaîne opératoire resulting in the final achievement of specific tool morphologies. Whichever the answer is further experimental and use-wear studies are needed to make this point clearer.

In general, bipolar knapping is considered an “Expedient” low-cost technique [135-139] in that it can be a means of maximizing resources as it is the only effective method of making full use of small and/or unmanageable raw materials [58,90,97] as a consequence it can also represent a response to raw material shortage [140]. According to archaeological ethnographic and experimental accounts [10,89,120,128,135,141] bipolar “Waste” products are suitable to be used “As is” for many purposes. In particular there is evidence of the use of unmodified small flakes as inserts in wood, bone and antler hafts [142-143]. Very small flakes (Mean length, width and thickness of 10.5 mm, 7.5 mm and 1.7 mm respectively) assembled in split wood handles are reported by Flenniken [96] from the Hoko River prehistoric site in Washington state. In Australia bipolar small flakes are mounted on composite knives and spear points (The so-called “Death Spears”) with the aid of adhesives [128] and in New Guinea similar artefacts occur in hafted implements [89]. The possible use of unaltered bipolar inserts in cutting tools has also been confirmed by experimental and use-wear trace studies [143]. In other words emerging evidence suggests the potential occurrence in the Uluzzian assemblages of a micro-lithic and unmodified tool component hitherto not taken into consideration which can be disclosed only by means of functional analyses.

Interpreting artefacts on lastrina

The systematic exploitation of lastrine in a very singular way is symptomatic of a very low technical investment as it does not entail any action connected to debitage operations. We assume that this approach could be conceptually classified like bipolar reduction as an expedient procedure (In fact it could be defined as the expedient system par excellence) in the sense that it may represent an effective response to raw material constraints and to time and energy availability. Unlike bipolar technique lastrina were exploited for the production of the larger size component of the industry which was presumably devoted to specific tasks. The use of a number of thermoclastic elements often from lastrina in

the manufacturing of lunates (And of other tools) can probably be included in the same behavioural concept either these specimens were intentionally obtained or only opportunistically used.

Backed pieces

Several projects focusing on use-wear traces, micro-residue and macro-fracture formation dynamics many of which were conducted on African Howiesons Poort backed tools have emphasized the concrete possibility that these objects were hafted, by means of the back as single or multiple inserts in composite implements (Knives and Weapons) [106,108,110-112,144-145]. Such an assumption is corroborated by ethnographic and archaeological instances [104,105,145-147]. In this perspective the lunate turns out to be a versatile tool which adapts to different multitask devices. The fact that each specimen is easily replaceable without any consequence for the rest of the implement is an advantage of this technology. Several pieces from Cavallo retain residues of red ochre often concentrated on or/and near the backed edges. Different applications of ochre its antibacterial function and its effectiveness as an additive of wax and resin in adhesives used to glue stone artefacts to hafts have been discussed in numerous studies. In particular direct evidence of the use of ochre in adhesive compounds found on the back of geometric "Microliths" has been reported for the South African MSA [107,148-151]. At Grotta del Cavallo the occurrence of ochre spots particularly on the back of the segments is in accordance with the evidence resulting from use-wear analysis. However only separate research focusing narrowly on the chemical composition of residues will provide the final word.

Our preliminary review of backed pieces from Grotta del Cavallo has contributed to highlighting the complexity inherent in the study of this particular tool-type. Although preliminary results from use-wear analysis foreshadow the occurrence of at least two broad categories of artefacts (The former aimed at arming hunting weapons and the second assembled in cutting or scraping implements) the general lack of standardization which is also stressed by the use of different blanks (Bladelets, flakes and lastrine) constitutes an obstacle for the identification of more definite functional roles. In addition, another important aspect emerged the heterogeneous composition of backed pieces which include artefacts at different stages of their techno-functional life (Unfinished, not used, used, repaired and discarded) whose role in the whole sequence is not always clearly detectable. For now, a constructive first step has been to provide evidence that the Uluzzian lunates could function successfully in composite tools including weaponry. Predictably the amount of lunates pertaining to stone-tipped weapons is probably underestimated as several pieces were surely shattered and scattered during hunting and damaged tools brought back to the campsite would have been a small percentage. Moreover, it has been observed that many pieces used in experimental weapons developed fractures considered non-

diagnostic [109] whereas others remained intact especially when hafted as barbs [111].

Evidently the work to do is still long as it involves an array of analytical approaches combining techno-functional studies and comparative use-wear and residue analyses with experimental activity in order to reconstruct the techno-functional life of each artefact and to identify potentially recurring features pertaining to definite functional categories. A further question which must be deeply investigated is the relation existing between backed pieces and unmodified microlithic items and their respective functional roles as possible elements in composite devices.

Uluzzians vs Mousterians

For an understanding of the Uluzzian it is of paramount importance that we define the nature of its relationship with the underlying Mousterian. The latest Middle Palaeolithic of Grotta del Cavallo is represented by layer F which has been attributed to MIS3 (47.900-42.100 cal BP 95%) [51]. F contains three archaeological layers (FIII, FII, FI from bottom to top) among which FIII was further subdivided into sub-layers (FIIIe, IIIId, IIIIc, IIIIb, IIIIa). All the layers/sub-layers were clustered into three main units on techno-typological grounds (FIIIe -IIIId, IIIIc-IIIId, IIIIa-FII-FI). If compared with the previous ones, the more recent unit (IIIId-FII-FI) is characterized by the adoption of the discoid method (Instead of the Levallois one) which dominates the production during the whole phase and by the appearance of low percentages of bipolar items (A maximum of 11.6% in layer FI) [22,152]. The use of lastrine reaches 2.8 % and 5.6 % in FII-I and IIIId respectively [153]. In stratigraphic terms there is a sharp break between the earliest Uluzzian occupation (EIII) and the most recent Mousterians (Layers FII-I) this is documented by the presence of a thin volcanic sterile layer (Fa) [14] followed by a gap in sedimentation marked by important dripping episodes (Gambassini's observations).

It should be of interest to note that a similar hiatus is also recorded in the other Uluzzian sites of peninsular Italy [39]. To estimate this phenomenon scale studies and possibly age models on sedimentation marked by important dripping episodes.

As mentioned above among, the major features which are still commonly considered typical of the Uluzzian there is the occurrence of "Clear" elements of Mousterian tradition. Yet even Palma di Cesnola despite his firm belief in a local evolution of the Uluzzian had indeed to admit the difficulty in finding a direct ancestor of this techno-complex within the Middle Palaeolithic evidence of Southern Italy [118]. Also in the years immediately following the discovery of the Uluzzian the "Filiation hypothesis" was only generically approached by Cesnola as it rested ultimately on the so called "Archaic" features of the EIII lithic assemblage especially due to convex and transverse scrapers mainly on lastrina that he considered reminiscent of the types occurring in layer F.

Based on an updated reading compelling evidence suggests that a radical behavioural change took place at Grotta del Cavallo between the late Mousterian and the earliest Uluzzian. This change is reflected by several factors operating in concert. Layers FII-I and EIII share similar ungulate associations which are dominated by aurochs red deer and horse possibly attesting to the same cool arid climatic phase characterized by the widespread occurrence of grassland and forest steppe [39,41]. Nevertheless, these two assemblages exhibit clearly distinct modalities in the exploitation of skeletal parts. In FII-I postcranial bone associations are typical of the Middle Palaeolithic assemblages found in the Apulia region abundance of diaphysis fragments of long bones and little to no presence of epiphyses and carpal and tarsal bones as well as of falanges and sesamoids. The faunal sample from layer EIII, spit 5 of Grotta del Cavallo (Gambassini's excavations) revealed on the contrary an exploitation pattern wholly in line with the Upper Palaeolithic record with numerous fragmented phalanges and epiphyses and much higher percentages of carpal and tarsal bones [41]. Contrary to what is generally thought neither the production processes nor the toolkit of layer EIII display any evident link with the Mousterian. Moreover, the frequency and variety of Upper Paleolithic types is important as proved by the number of end-scrapers (22, 3%) [34,37] and backed pieces such values are incompatible with any Middle Palaeolithic Italian industry [154-155]. The use of lastrine which represents a prominent part of the earliest Uluzzian technical attitude, was really marginal in FII-I. The same can be noted for the blade component which is completely absent in FIIa, FII and FI (conversely it is attested in FIIe and FIIId) [152]. Finally, and, perhaps most importantly the sharp break in blank production, which is based in layer EIII almost exclusively on expedient systems (Bipolar on lastrina and on thermal flake) despite the fact that there were no significant changes in the use of raw material with respect to the latest Mousterians. It has been correctly observed [156] that bipolar flaking is indeed a technique not a method as the term "Method refers to any carefully thought out sequence of interrelated actions each of which is carried out according to one or more techniques" [60]. From a conceptual standpoint this fact places bipolar reduction as well as the other expedient strategies (Namely the use of lastrine and thermal flakes) in an antithetical position to highly predetermined methods such as the Levallois and the discoid ones. As has already been argued [20] this entails a very low technical investment in terms of time and energy dedicated to blank production by the Uluzzians (Unlike the Mousterian).

Low-cost technologies and behavior. Which nexus?

In sum the use of low-cost production strategies could be defined as the "Leitmotiv" of the Uluzzian for this trend is also characteristic with all due changes of the evolved and the final phases of this techno-complex both at Grotta del Cavallo and in the other Uluzzian sites of Central-Southern Italy. Our challenge is

now detecting what this implies in behavioural terms.

Bipolar stone-working is considered by many to be an expedient technique for conserving time and/or energy [137,157-158] which comes into play under particular subsistence (Energy gathering) circumstances and specific constraints according to a delicate and complex balancing between costs and benefits [138,157,159]. Both the systematic use of lastrine and the occasional exploitation of thermal flakes are part of the same energetic-efficiency scheme. In behavioural terms this choice acquires therefore a broader significance involving the socio-economic context given that it allowed prehistoric people to preserve their own time and energy budget not only during knapping operations but also in the procurement (Pursuit and transport) of more suitable lithotypes thus diminishing risks due to long periods away from the campsite as well as in the apprenticeship time dedicated to young artisans. A further purely speculative hypothesis put forward by some [160-161] is that the use of bipolar technique could have been a matter of different skills and age connected for instance to children training or even a matter of gender (For a wider discussion) [124]. A similar pattern would be most likely expected in contexts where other production systems prevail, and bipolar reduction is attested to a lesser degree. Conversely when the use of expedient technologies embodies the very essence of the lithic production being so rooted as is the case in the Uluzzian in the socio-economic tissue of a human group more holistic explanations must be taken into account. It has been demonstrated for instance that bipolar knapping is not always exclusively connected to the use of small and/or intractable raw materials and vice versa small and/or poor quality raw materials appear to be not always associated with this technique [98]. The adoption of such a method can thus foreshadow also reasons which are beyond simple material costs or time/environmental constraints. In the case of layer EIII the abundance of slabs/lastrine with natural striking platforms and ridges should have encouraged the use of freehand direct percussion. The overwhelming occurrence of bipolar technique leads us to suppose that also some persisting tradition might have had its weight in this technological choice. In the last analysis interplay among different factors operating in concert (Availability and quality of raw materials, territory expertise, socio-economic requirements and cultural tradition) is the most probable explanation for the Uluzzian technological behaviour of layer EIII. Bipolar flaking has been reported in several MSA complexes of eastern-southern Africa and is considered a typical trait of the LSA of these regions (For a wider dissertation) [162]. At Mumba Rockshelter in Tanzania Eren et al. [159] tried to explain the considerable use of bipolar reduction in Bed V (Which dates between 56.9 ± 4.8 and 49.1 ± 4.3 ka cal BP) by analysing several factors which could have stimulated an increased territoriality namely "The resource defence strategy in which foragers occupy certain areas more or less exclusively by means of repulsion through overt defence or through social interactions" [159]. An increase in territoriality

(i.e. reduced mobility) can occur as an adaptive response to an array of factors like climatic changes [163] population increase competition among groups in terms of resource procurement and limited territory-expertise. In Eren et al.'s opinion this phenomenon might have triggered a spectrum of possible effects among which are increase in time costs and subsistence risks as well as an improvement of the toolkit by developing more portable easily repairable implements and weapons. As the main characteristics of a weapon must be efficiency and reliability these required a certain amount of energy and time for composite tool manufacture (Tool design, hafts, clues, ballistics etc.). The only way therefore to save time was the shortening of the production phase by introducing least-cost technological systems.

A similar model might also fit the Uluzzian of Southern Italy as this techno-complex developed during a period of climatic variability [38, 41, 164] and demographic changes in a geographic area populated by behaviourally different human groups possibly coexisting in the same territories for a reasonable time span (About 3000 years) [48]. Although it is highly speculative it could be mentioned that in the area of Grotta del Cavallo several sites (Grotta di Uluzzo, Grotta-Riparo di Uluzzo C, Grotta di Serra Cicora, Grotta Mario Bernardini) [165] are concentrated in a very restricted territory which could have represented a sort of enclave.

Which label for the Uluzzian?

Some final remarks are concerned with a paper recently issued on the site of Grotta di Fumane in Veneto [17]. This cave deposit yielded an archaeological sequence spanning from the late Middle Palaeolithic and the early Upper Palaeolithic. Layers A4-A3 which are interstratified between a Levallois Mousterian (Layers A6-A5) and the Proto-Aurignacian (Layers A2-A1) are thought to be emblematic of the Early Uluzzian in Northern Italy and of its connection with the final Mousterian. Layer A5 occupation took place prior to 43.6-43.0 KY cal BP while the arrival of the first Aurignacians (Layer A2) dates after 41.2-40.4 KY cal BP [17,166]. The assemblages from layers A4-A3 both contain a clearly Mousterian component (Less abundant in A3) and are characterized by reduction strategies primarily oriented towards the production of flakes denoting a significant divergence from the underlying Levallois blade complex (Layers A6-A5). In layer A4 there is still a predominance of the Levallois method although the unipolar modality (Typical of layers A6-A5) was replaced by the centripetal one. Bipolar technique makes its appearance in this layer (3.8% considering both cores and products). Blade/bladelets and blade cores have a very subordinate role (3.8% of the total assemblage).

In layer A3 recurrent centripetal flaking characterized by a low degree of predetermination is the most exploited technical procedure. Bipolar reduction is here slightly more important (7.4%) than in layer A4 as is the blade/bladelet component (6.0%). Among

tools a single end-scraper on cortical flake marginally retouched is also reported [17] (Figure 9, no. 6). Based on what has emerged from the revision of layer EIII it is evident that Fumane exhibits a really different pattern. Leaving aside the evidence displayed by the A4-A3 strongly Mousterian imprint (Which is absent in layer EIII) it should be emphasized that the roles of bipolar reduction and of laminar volumetric exploitation are always substantially marginal. Actually, the incidence of bipolar and laminar items at Fumane is patently closer to the variability reported for some latest Mousterian contexts of Southern Italy. For instance, bipolar reduction makes its emergence in layer F of Grotta del Cavallo with frequencies reaching as high as 11.6% in FI a blade-bladelet volumetric system is significantly present in sub-layer FIIIe of the same cave [85] and is attested in other Middle Palaeolithic sites of Peninsular Italy [17,167-168]. Thus, the following assertion that: "The splintered pieces are the key element that characterizes the more pronounced shift in the transition from the final Mousterian unit A5-A6 to the Uluzzian layer A4 although these are very scarce compared to all other tool types and are associated with a tool kit still traditionally Mousterian" [17] is correct however it does not demonstrate that layer A4 is not Mousterian and least of all that it may be Uluzzian. Likewise, the occurrence of often roughly-made end-scrappers and more in general of sporadic leptolithic-like tools is not unusual in the Italian final Middle Palaeolithic [155] (See e.g. the few end-scrappers attested in layer FIII at Grotta del Cavallo and the specimens from SU1 of Riparo L'Oscurusciuto) (Figure 5 nos. 9-10) [14,153,167-169].

Judging from figures (Figure 5, nos. 1-5 and Figure 9, nos. 1-5) and descriptions [17] backed pieces recovered in layers A4-A3 seem to display atypical characteristics related both to their general morphology (Proportions, profile irregularity, back delineation and morphology) and to the fashion in which they were manufactured (Blank type, backing procedure) relative to their Uluzzian counterparts. As a matter of fact, the presence of backed pieces has sporadically been reported in late Mousterian contexts. Both the straight and curved variants are attested in a few surface sites in Tuscany where Palma di Cesnola pursuing his idea of continuity with the latest Mousterian had identified a possible cradle for the Uluzzian [118]. The occurrence of backed artefacts in late Middle Palaeolithic assemblages is not an Italian feature alone well-known is the case of the Mousterian of Acheulean tradition type B considered by Peyrony and by Bordes [170-171] the ancestor of the Chatelperronian because of its typical backed-knives this theory challenged by Bordes and Teyssandier [172] has been recently re-proposed by Ruebens et al. [173] and Roussel et al. [174]. All things considered we could argue that Fumane does not look like an Uluzzian complex or at least it does not look like a "Classic" Uluzzian complex in that it is sufficiently divergent from the picture reconstructed at Grotta del Cavallo which remains at any rate the eponymous site. Whether it is worth preserving this "Purist" vision or otherwise enlarging the Uluzzian concept to a

broader spectrum of distinctive traits will be an integral part of scientific debate in projects devoted to the study of the Uluzzian in the near future.

Conclusions

Based on a careful revision of Palma di Cesnola's unpublished field notes and publications as well as on Gambassini's observations we demonstrated that there are no valid reasons for casting doubts on the integrity of the deposit of Grotta del Cavallo (contra) [12] in which the two-modern human deciduous teeth (Cavallo B and Cavallo C) were retrieved. Post-depositional disturbances especially the so-called "Romanellian pit" were identified and separately investigated by Cesnola at the beginning of his excavations at Cavallo in 1963. Cavallo B and Cavallo C were recovered in 1964 in layer EIII from an undisturbed deposit during the excavation of the NW part of the test trench opened by Cesnola. This is confirmed by one of us (P. G.) who took part in the excavation at Cavallo [14]. In addition, there is clear evidence that Cavallo B was found at the base of the earliest Uluzzian hearth.

Concomitantly this contribution has been devoted to a preliminary reassessment of the Uluzzian of Grotta del Cavallo, examined from a behavioural perspective, mainly resting, in this phase of the research on the initial results provided by the technological study of the lithic assemblage from the earliest Uluzzian occupation (Layer EIII) and by the analyses of backed pieces from the whole sequence. Owing to various elements the Uluzzian in layer EIII can be depicted as a true "Upper Palaeolithic" assemblage devoid of any features displaying a possible connection with the preceding (And coeval) late Mousterian of Southern Italy. The lithic industry from layer EIII is characterized by an important mostly un-retouched small blade/bladelet component derived mainly from bipolar reduction. Among formal tools end-scrapers and backed elements (Including three marginally backed small blades) which are mainly composed of lunates have a key role. However, the most distinctive feature is the vast use of low-cost production strategies especially exemplified by bipolar technique but also consisting of the direct use of "Lastrine" and thermal flakes which allowed the knappers to significantly reduce time dedicated to debitage activities. This concept appears to be strongly rooted in the Uluzzian technology as it persists during the evolved and the final Uluzzian at Grotta del Cavallo and is a recurring trait of the other Uluzzian sites on the Italian Peninsula [34,37,88]. The use of bipolar technique as the main production system entails that an important part of the Uluzzian toolkit might be composed of micro-artefacts presumably used "As is" in composite devices. This behaviour has no parallel in the European record of the period at issue and embodies a well-defined caesura with the Mousterian world of Southern Italy [154-155] where the production phase appears to be in terms of lithics the most challenging technical investment. In the light of these observations we question the attribution of the Uluzzian or at least of the classic facies of this

techno-complex identified in the eponymous site to the group of the "Transitional assemblages" [1]. This label implies the idea that "These industries display some Middle Palaeolithic reminiscence" and/or that they "Resulted from a local evolution of the late MP groups" [1].

The systematic use of expedient production strategies in the lithic assemblage of layer EIII led us to assume that the Uluzzians might have developed a reduced residential mobility as a means of resource-defence under particular environmental and demographic conditions in which different human groups could occupy the same territories. This notion may account for the exploitation of essentially local lithic raw materials and for the occurrence of several sites in a very restricted geographic area.

The backed segment is a tool of original morphology typical (Along with bipolar technique) of the Uluzzian which does not display parallels in other archaic Upper Palaeolithic complexes of Europe. In a previous paper [39] some of us (A.M., P.B. and A.R.) had argued for an African origin of the Uluzzian also basing it on the occurrence of these tools and on their specific attributes. Recently published studies [162,175] have highlighted that bipolar technique (Generally associated with segments) is broadly widespread in South Africa/eastern Africa MSA and MSA/LSA transitional assemblages and is considered a distinctive trait of the African LSA. A weak point of the Uluzzian "Out of Africa" hypothesis is the wide geographic lacuna existing along the assumed dispersal routes between the nearest area of African evidence and the Uluzzian sites in Europe. We are well aware that this is an essential still unsolved question. Nevertheless, the Uluzzian shares with the African complexes and in particular with Mumba Rockshelter's so-called transitional assemblage from Bed V (Which dates between 56.9 ± 4.8 and 49.1 ± 4.3 ka cal BP) undeniable behavioural similarities. These are not easy to justify under a simple convergence pattern. To date the notion of an African cradle for the Uluzzian remains, in the opinion of some of us (A.M. P.B. and A.R.) the most parsimonious hypothesis accounting for the sudden emergence of a techno-complex endowed with such specific characteristics.

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