

## Grotta del Cavallo (Apulia – Southern Italy). The Uluzzian in the mirror

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- the history of research in the Uluzzian layers of Grotta del Cavallo based on excavation field notes and publications;
- a synthesis of the main arguments attesting to the integrity of the Uluzzian deposit of Grotta del Cavallo;
- the chronological background of the Uluzzian techno-complex.

### Research History

In order to provide a reliable picture of the complicated and sometimes troubled story of the cave site of Cavallo 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 (Palma di Cesnola, 1961, 1963; Palma di Cesnola & De Borzatti, 1963; Palma di Cesnola, 1964a, b, 1965a, 1966a, b, 1972, 1978); b) Palma di Cesnola's personal Excavation Field Notes (EFNs) (Fig. 1), acquired by the authors only recently; c) publications issued after 1978 mainly composed of brief excavation reports (Gambassini & Palma di Cesnola, 1979; Gambassini, 1980; Gambassini et al., 1984; Sarti & Martini, 2008). What is presented below is the result 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 north of Santa Caterina di Nardò. On this occasion Cesnola opened a small test trench (trench X) (Fig. 2, n. 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) (Palma di Cesnola, 1961, 1963). 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 pot shards and, later, accompanied by numerous marine and terrestrial mollusc shells, lighter brown in its lower part, with Upper Palaeolithic industry and several faunal remains mainly from *Equus caballus*" (Palma di Cesnola, 1963, pp. 41-42). 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" (Palma di Cesnola, 1963, p. 42). In this year, a trench (the so-called "Principal Trench"

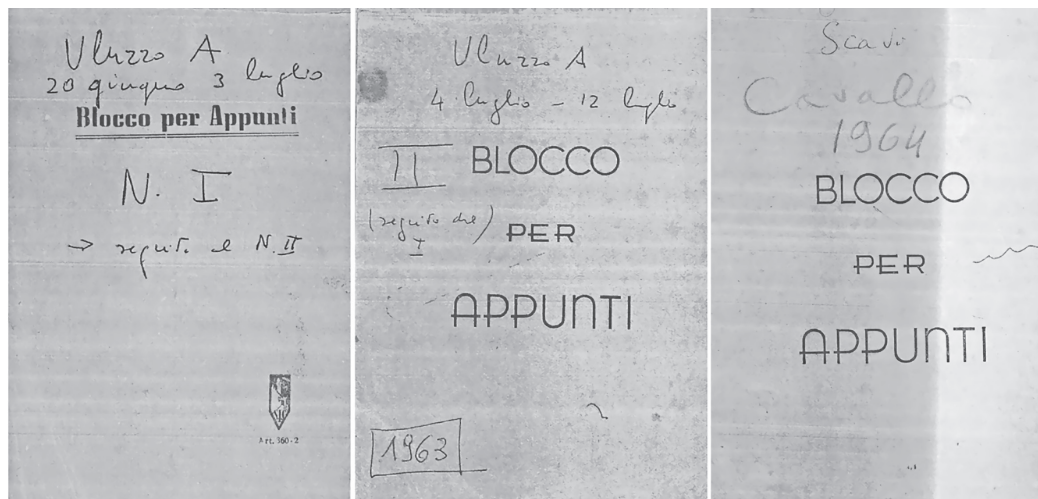


Fig. SM1. Covers of Palma di Cesnola's excavation field notes 1963-64.

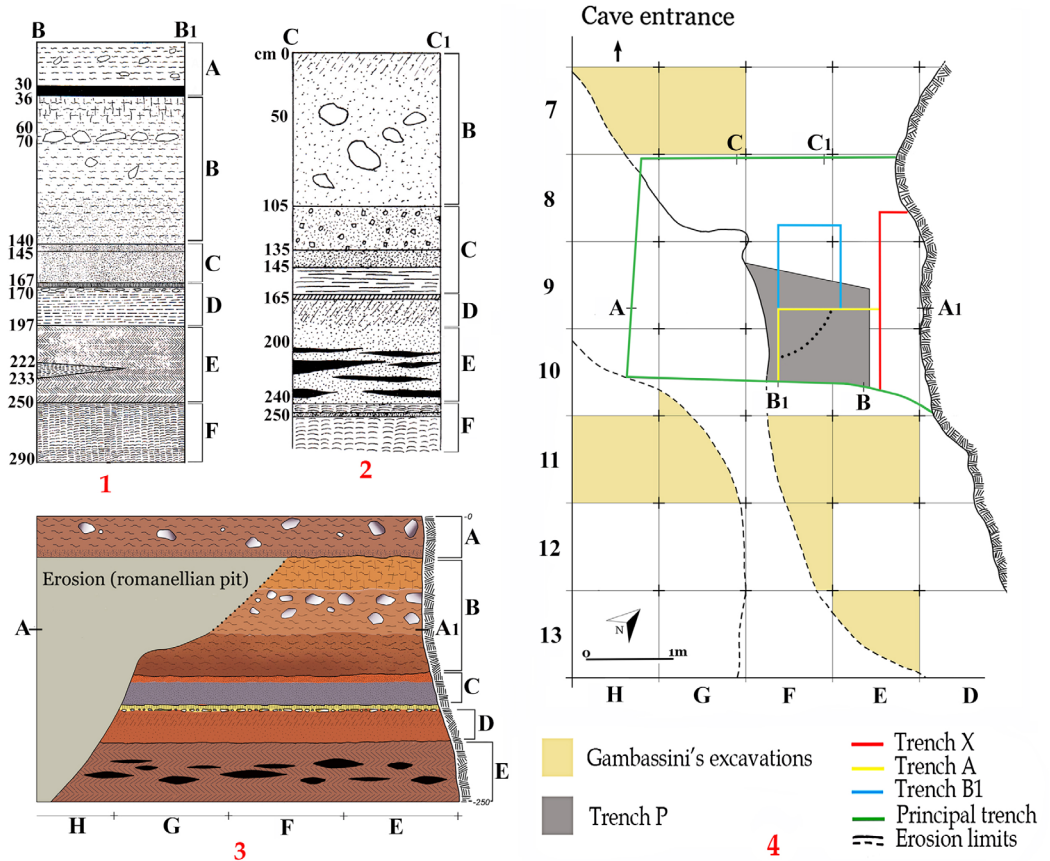
hereafter PT) 2.5-3 x 3.5 m ca. wide was opened which, from the NE wall, extended towards the middle of the cavity. The PT final size was reached by consecutive enlargements starting from the 1961 test trench (X). Initially a small trench (trench A - EFNs 22 and 24/06/1963) was added at right angles to the test trench X. Later a new trench (trench B1) was opened from trench A (EFNs 24/06/1963) (Fig. 2, n. 4).

The PT 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 (Palma di Cesnola, 1963, p. 43). 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) (Palma di Cesnola, 1963). The discovery of a "human milk tooth" is reported from layer DI (Palma di Cesnola, 1963, p. 54). 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 tooth X. This latter was found later on, during

Gambassini's excavations (1985-86), and was initially confused for a human deciduous tooth. Albeit never published in detail, it was presented at the 16th Congresso degli Antropologi Italiani, Genoa, Italy by Gambassini in 2005 and cited by Riel Salvatore (Riel-Salvatore, 2009, p. 388).

During 1963 field-work, 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." (Palma di Cesnola,



**Fig. SM2.** 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 modified after Palma di Cesnola 1964a) (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.

1964a, p. 27). Furthermore we know that "...la dent B a été récoltée dans le premier foyer uluz-zian, 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." (Palma di Cesnola & Messeri, 1967, p. 251). In 1976 it was

said that these teeth came from spits 7 (Cavallo B) and 5 (Cavallo C) of layer E III (Messeri & Palma di Cesnola, 1976, p. 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 (Churchill &

Smith, 2000) Cavallo C has erroneously been assigned to layer EII-I; due to this first slip the same mistake was later repeated (Benazzi et al., 2011).

Although the 1963-66 excavations at Grotta del Cavallo were conceived merely as a test trench (Palma di Cesnola, 1965b, p. 36), it is worth highlighting that Palma di Cesnola 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 (BIa, BIb, CIa etc.) in order to stress minor sedimentological variations. A further division rigorously internal to single layers/sub-layers was artificial spits maximum 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 (Palma di Cesnola, 1965a).

The fourth season was carried out in July 1966 (Palma di Cesnola, 1966a) 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 Romagnoli *et al.*, 2016). During this widening, teeth Cavallo E and F, were found in the reworked deposit (EFNs 1966) (the so-called “Romanellian pit” described below in “post-depositional disturbances”). 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 time span of ten years (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) (Palma di Cesnola, 1978, p. 417) and to remove the reworked deposit. The following years (September 1978, June 1979 and November 1980) (Gambassini & Palma di Cesnola, 1979; Palma di Cesnola, 1979; Gambassini, 1980) were nearly *in toto* devoted to restoring the cave infill,

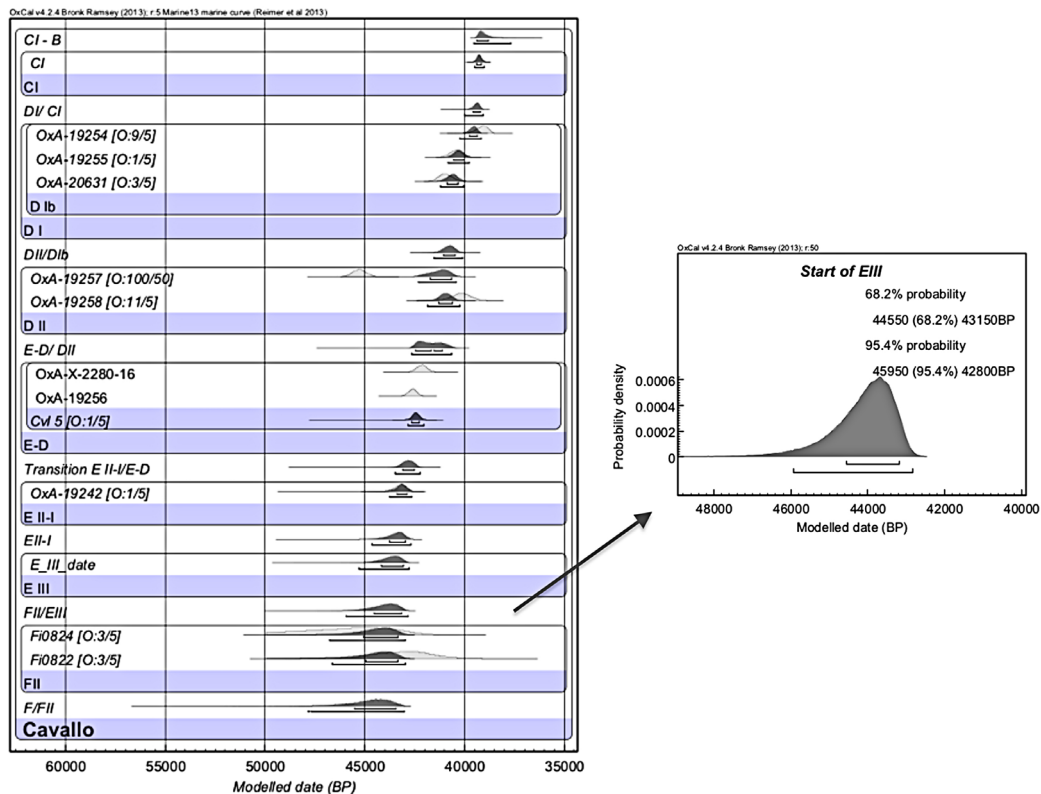
by clearing the intact layers from looters’ dumps, and to building a grid and the planimetry of the cave. In 1979 a piece (60 x 40 cm) of Uluzzian which had fortunately been left intact, was excavated in squares G7 and H7. From then onwards Palma di Cesnola was kept busy by the excavations at Grotta 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 (Sarti, 1987-1988). Gambassini continued, therefore, investigations in the Uluzzian layers (squares E11, E13, F11, F12, G5, G7, G10, G11, H7, H11 – Fig. 2, n. 4) 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. In his role as a geologist Gambassini 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”) (Palma di Cesnola, 1965b, p. 36, 1966c, p. 3), 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.

### Stratigraphy

The stratigraphic sequence brought to light at Grotta del Cavallo by Palma di Cesnola in 1963-64 is the following (from the top downwards) (Palma di Cesnola 1963, 1964a) (Fig. 3, ns. 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 BIa clear and horizontal;
- layer BIa (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 BIb (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 CIa absent in the SE part of the PT; it was divided into:
  - layer CIa (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 CIb (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 silty grey sand regularly laminated of volcanic origin; sterile; limit with DI clear and undulating; this layer was more recently identified as Campanian Ignimbrite (Giacio et al., 2017; Zanchetta et al., 2018);
- - 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 DIa (167-170 cm) (spit 1): rather hard reddish stalagmite crust;
  - layer DIb (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 EI (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 EI, 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 (Palma di Cesnola, 1965b, pp. 35-36, 1966c, p.19);
  - 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 FI (EFNs 11/07/63; Palma di Cesnola, 1963, p. 45); differently from the PT SE area in the NW area this layer was characterized by thick stratified intact fireplaces almost



**Fig. SM3.** Bayesian model of the Cavallo radiocarbon determinations (OxCal, version 4.3). The OxA-codes are marine shell dates (Benazzi et al., 2011; Douka et al., 2014) whereas the Fi-codes are dates on ABA-treated charcoal. The model displays high degree of agreement and only one 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.

everywhere (Palma di Cesnola, 1964a, p. 26; Gambassini's observations); Archaic Uluzzian;

- layer FI (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). Recently layer Fa was attributed to tephra Y-6 (Green Tuff of Pantelleria Island) dated to  $45.5 \pm 1.0$  ka (Zanchetta et al., 2018).
- In 1969 a layer (Fs) positioned between EIII and Fa was described in the following way: "crushed stone with scarce industry of the archaic Uluzzian" (Palma di Cesnola 1969,

p. 342). This sediment, rich in clasts, indicates deposition by rockfall processes from the ceiling of the cave and can be considered equivalent to the erosional dripping episode discovered during Gambassini's excavations 1981 (Gambassini's observations).

#### 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, BIa e BIb 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 BIa was well-represented, although discontinuously, on a large part of the Principal Trench. Lower down volcanic sands CI-II were 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” (Palma di Cesnola, 1963, p. 45-46). 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) (Palma di Cesnola, 1963, p. 45, 1964a, p. 38) and resulting from Gambassini’s observations.

However, what is 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 (Fig. 2, ns. 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” (Palma di Cesnola, 1964a, p. 25). 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 (Palma di Cesnola, 1966a, p. 290). 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” (Palma di Cesnola, 1972, p. 53).

In 1978-79 (Palma di Cesnola, 1978, p. 417, 1979, p. 288; Gambassini & Palma di Cesnola, 1979, p. 289), 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 P. Gambassini 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. Gambassini’s hypothesis was, later on, confirmed by further excavations. Owing to the looters’ disruption, detection of the pit original morphology and dimensions was impossible (Sarti & Martini, 2008, p. 421), save for the portion of boundary drawn by Palma di Cesnola in 1963-64.

*About the integrity of the deposit of Grotta 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 technocomplex. 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:

- post-depositional disturbances (including the so-called “Romanellian pit”) were identified as intrusive events and, therefore, excavated separately, 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 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) (Fig. 2, n. 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;

- unit C which formed a thick boundary between units 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 (Fig. 2, ns. 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 unit C appeared to be heavily reduced in thickness or absent; 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 above arguments 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 (2005) this is an “impossible coincidence”.

Another argument strengthening this thesis is provided by the overview presented in this contribution about the human remains from Grotta del Cavallo including the study of the two unpublished human teeth, Cavallo E (Rdm2) and Cavallo F (Ldm1). 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) [Benazzi et al., 2011], 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 (according to Palma di



Cesnola the so called “Romanellian pit” had not affected the Mousterian deposit).

## 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) (Palma di Cesnola, 1969). 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. (2009) and Kuhn et al. (2010) belong to a group of 10 determinations made on burnt bone from layer E III (Riel-Salvatore, 2007). 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 (Douka, 2011; Higham, 2011; Wood et al., 2012; Wood et al., 2013; Higham et al., 2014) 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 (two samples were dated twice). The results were initially reported by Douka (2011) and Benazzi et al. (2011) and they were further elaborated in a more recent publication (Douka et al., 2014).

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 pre-dates 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 two new dates from a single sample of mixed charcoals collected from the Mousterian layer FII of Cavallo were obtained (Fi0822: 39,300 ±1900 and Fi0824: 42,000 ±2400 BP, weighted average 40,600 ±1500 BP) (Fabbri et al., 2016). Regrettably these were treated with a method (ABA) insufficient for decontaminating Palaeolithic-age charcoal, hence they should be only considered minimum ages 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 two determinations (Fi- codes) (Fig. 3). The new model shows high degree of agreement, and identifies only one 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) 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.

Based on this new model for Cavallo, as well as the synthetic data reported in Douka et al. (2014) 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 (confirmed by the aforementioned date of layer Fa published by Zanchetta et al. 2018). Its termination is placed ~40/39 ka cal BP, shortly before the time of the Campanian Ignimbrite eruption (Giaccio et al., 2017).

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