



HAL
open science

Late Pleistocene mammal faunal assemblage from Cava Spagnulo (Grottaglie, Apulia, SE Italy)

B. Mecozzi, A. Chakroun, H. Bails, Dawid Adam Iurino, Raffaele Coppola,
Donato Coppola

► To cite this version:

B. Mecozzi, A. Chakroun, H. Bails, Dawid Adam Iurino, Raffaele Coppola, et al.. Late Pleistocene mammal faunal assemblage from Cava Spagnulo (Grottaglie, Apulia, SE Italy). *Alpine and Mediterranean Quaternary*, 2018, 31, pp.5 - 19. 10.26382/AMQ.2018.01 . hal-02268302

HAL Id: hal-02268302

<https://hal.science/hal-02268302>

Submitted on 20 Aug 2019

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial - ShareAlike 4.0 International License

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/329987511>

Late pleistocene mammal faunal assemblage from Cava Spagnulo (Grottaglie, Apulia, Se Italy)

Article · May 2018

DOI: 10.26382/AMQ.2018.01

CITATION

1

READS

266

6 authors, including:



Beniamino Mecozzi

Sapienza University of Rome

23 PUBLICATIONS 15 CITATIONS

[SEE PROFILE](#)



Henry Bails

Muséum National d'Histoire Naturelle (Paris) et Université Via Domitia (Perpign...

62 PUBLICATIONS 31 CITATIONS

[SEE PROFILE](#)



Dawid Adam Iurino

Sapienza University of Rome

86 PUBLICATIONS 260 CITATIONS

[SEE PROFILE](#)



Raffaele Sardella

Sapienza University of Rome

216 PUBLICATIONS 2,199 CITATIONS

[SEE PROFILE](#)

Some of the authors of this publication are also working on these related projects:



Pleistocene mammals of southern Italy [View project](#)



Digital endocasts of extinct and extant sloths [View project](#)



LATE PLEISTOCENE MAMMAL FAUNAL ASSEMBLAGE FROM CAVA SPAGNULO (GROTTAGLIE, APULIA, SE ITALY)

Beniamino Mecozzi¹⁻², **Amel Chakroun**³⁻⁴, **Henry Bails**⁵⁻⁶, **Dawid Adam Iurino**¹⁻²,
Raffaele Sardella¹⁻², **Donato Coppola**⁷

¹ Dipartimento di Scienze della Terra, Sapienza, Università di Roma, Roma, Italy

² PaleoFactory, Sapienza, Università di Roma, Roma, Italy

³ Département de géologie, Faculté des Sciences de Tunis, Universitaire Tunis El Manar, Tunis, Tunisie

⁴ Centre européen de recherches préhistoriques, UMR 6569 du CNRS, Tautavel, France

⁵ UMR 7194 du Muséum National d'Histoire Naturelle, Paris, France

⁶ Université Perpignan, Perpignan, France

⁷ Dipartimento di Scienze dell'Antichità e del Tardoantico, Università degli Studi di Bari Aldo Moro, Bari, Italy

Corresponding author: B. Mecozzi <beniamino.mecozzi@uniroma1.it>

ABSTRACT: The Quaternary sedimentary succession exposed at Cava Spagnulo, nearby the town of Grottaglie (Apulia, Southern Italy), is described for the first time. A preliminary list of the mammal remains from the upper part of the succession, has been compared with other Pleistocene Apulian sites. The identified taxa are represented by cranial and postcranial fragments and isolated teeth of bovids, cervids, equids, canids and lagomorph. In the same deposit also few Mousterian stone tools have been found. The study of the mammal assemblage and the lithic tools suggest that the upper part of the succession exposed at Cava Spagnulo could be referred to the second part of the marine isotopic stage 3.

Keywords: Fossil vertebrate, Mediterranean, Mousterian, MIS 3

1. INTRODUCTION

The Italian territory occupies a strategic position in the Mediterranean area, which represents a crossroads between North Western Europe, Central Europe, Eastern Europe and North Africa. The tectonic and volcanic activity during the Quaternary produced a heterogeneous physiography, with the presence of several natural physical barriers, such the Alps and Apennines chains. The mountain ranges represent the main ecological barriers, respectively towards continental Europe and along the peninsula, affecting the distributions of mammal fauna. Furthermore, the latitudinal extension of Italian territory causes a strong climatic gradient and produces regional differences in the climatic conditions, especially during the Late Glacial Stages (Gliozzi et al., 1997; Bedetti et al., 2001; Sala et al., 1992, Sala & Masini, 2007). During the late Quaternary, the faunal assemblages were characterised by a strong regionalism, related to the presence of different dispersal paths and local environmental conditions (Masini et al., 1990; Sala et al., 1992, Gliozzi et al., 1997; Bedetti et al., 2001; Sala & Masini, 2007).

The Apulian region is located in the Southern part of the Italian Peninsula, extending mainly along the latitudinal axis (130 km), and only 30 km along the longitudinal axis. On the basis of its peripheral position and

physiography, some authors considered the occurrence in the Apulian peninsula of a refugium area during the Late Pleistocene, due to supposed archaic nature of the vertebrate fauna (Di Stefano et al., 1994). On the contrary, other authors suggested that these mammal faunal associations could be chronologically referred to the late Middle Pleistocene (Masini et al., 1990; Sala et al., 1992).

Several vertebrate assemblages from the Middle and Late Pleistocene deposits of Apulia have been reported in previous research; these sites are mainly represented by caves and karst filling deposits (Fig. 1). In the Murge area, the middle part of Apulia, previous studies were made in the following localities: Contrada Monticelli (Mazza & Varola, 1999; Mecozzi et al., 2017), Tana delle Iene (Conti et al., 2010; 2012), Grotta della Jena (Guiscardi, 1873; Anelli, 1956, 1960; Cantelli, 1983), Grotta Sant'Angelo (Cassoli & Tagliacozzo, 2001; Casavola, 2005), Grotta della Masseria del Monte (Anelli, 1959), Santa Maria d'Agnano (Coppola, 2012), Grotta Laceduzza (Coppola, 2012). Several sites have been investigated in other area of Apulia, in particular, in the Salento Peninsula, south of Murge, coastal caves (e.g., Grotta Romanelli, Grotta delle Tre Porte) or karst filling deposits (locally known as "ventarole") near Corsi and Melpignano villages (De Giuli, 1983; Bologna et al., 1994; Rustioni et al., 1994; Sardella et al., 2005, among

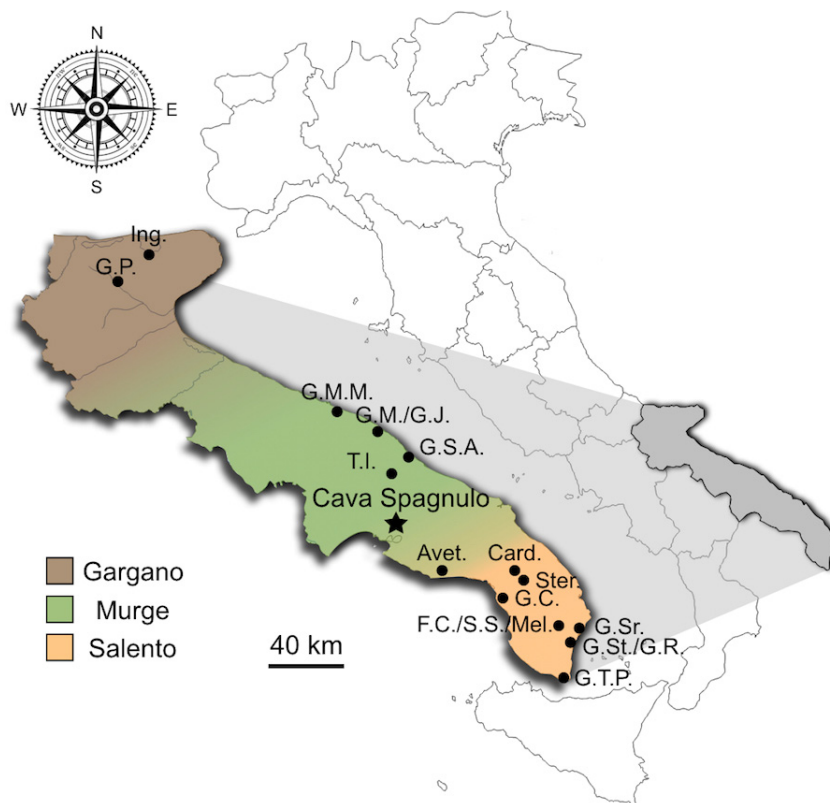


Fig. 1 - Location of Apulia (gray area) along the Italian Peninsula. The Gargano, Murge and Salento area are indicated. The asterisk indicates the position of the studied site (Cava Spagnulo), while bold point indicate other localities previously studied in Late Pleistocene deposits: Ingarano (Ing.), Grotta Paglicci (G.P.), Grotta della Masseria del Monte (G.M.M.), Grotta della Jena (G.J.), Grotta delle Mura (G.M.), Tana delle Iene (T.I.), Grotta Sant'Angelo (G.S.A.); Avetrana (Avet.), Cardamone (Card.), Sternatia (Ster.), Grotta del Cavallo (G.C.), Fondo Cattìe (F.C.), San Sidero (S.S.) and Melpignano (Mel.). Grotta del Sarcofago (G.S.R.), Grotta delle Striare (G.S.T.), Grotta Romanelli (G.R.) and Grotta delle Tre Porte (G.T.P.).

others), studied ossiferous breccias and terre rosse (red soils) constitutes the lower part of most of these deposits, followed by terre brune (brown soils) generally constitute the upper complexes of these deposits. Due to the fragmentary stratigraphic and geomorphological evidence, these deposits are mainly dated biochronologically based on the large vertebrate faunal assemblages they contain (Di Stefano et al., 1992; Bologna et al., 1994).

The scattered outcrops of ossiferous breccias are characterized by the occurrence of large mammals, such as *Palaeoloxodon antiquus*, *Stephanorhinus hemitoechus* and *Hippopotamus amphibius*, with a well-documented presence of *Dama dama*, which have been referred to the early Late Pleistocene (MIS 5c-5a) (MIS = Marine Oxygen Stage) (Di Stefano et al., 1992).

The goal of the present study is to offer the first description of the site, the list of fossil mammal remains and the artefacts collected in the Late Pleistocene deposits of Cava Spagnulo, located close to the town of Grottaglie, in the Murge area (Apulia, SE Italy). A preliminary chronological framework for the upper part of the deposit (see the asterisk in Fig. 1 for the location of the site within the Apulian region) is also proposed on the basis of the artefacts and fossil mammal remains.

2. CAVA SPAGNULO

In 1974 speleologists of the “Gruppo Speleologico Salentino” discovered the site of Cava Spagnulo (Fig. 1), previously known as Cava del Piano. The site is characterised by the presence of large mammal fossil bones associated with lithic industry of the Middle Palaeolithic (Tramonti, 1974). Tramonti (1974) claimed the presence of several mammal taxa, including proboscidean, which he referred to *Elephas* sp. No figures of the fossils or of the lithic tools were provided.

The site is located north-west of Pizzuto hill, in an abandoned quarry on the “Strada Provinciale 73”, about 1,5 km from the town of Grottaglie (Taranto, Apulia). The Pleistocene deposit of Cava Spagnulo are at 190 m a.s.l.

The outcrop, 20 m long and about 6 m thick, is exposed on a cliff of an old quarry opened in the Cretaceous limestone that constitutes the local geological bedrock. The sedimentary succession includes either marine and continental fossiliferous facies, that suggest relative sea-level changes during sedimentation.

The succession starts with a conglomerate layer, 40 cm thick (unit A), made up of calcareous cobbles (average size: 15 cm). This conglomerate grades into a chaotic boulder deposit, whose thickness ranges be-

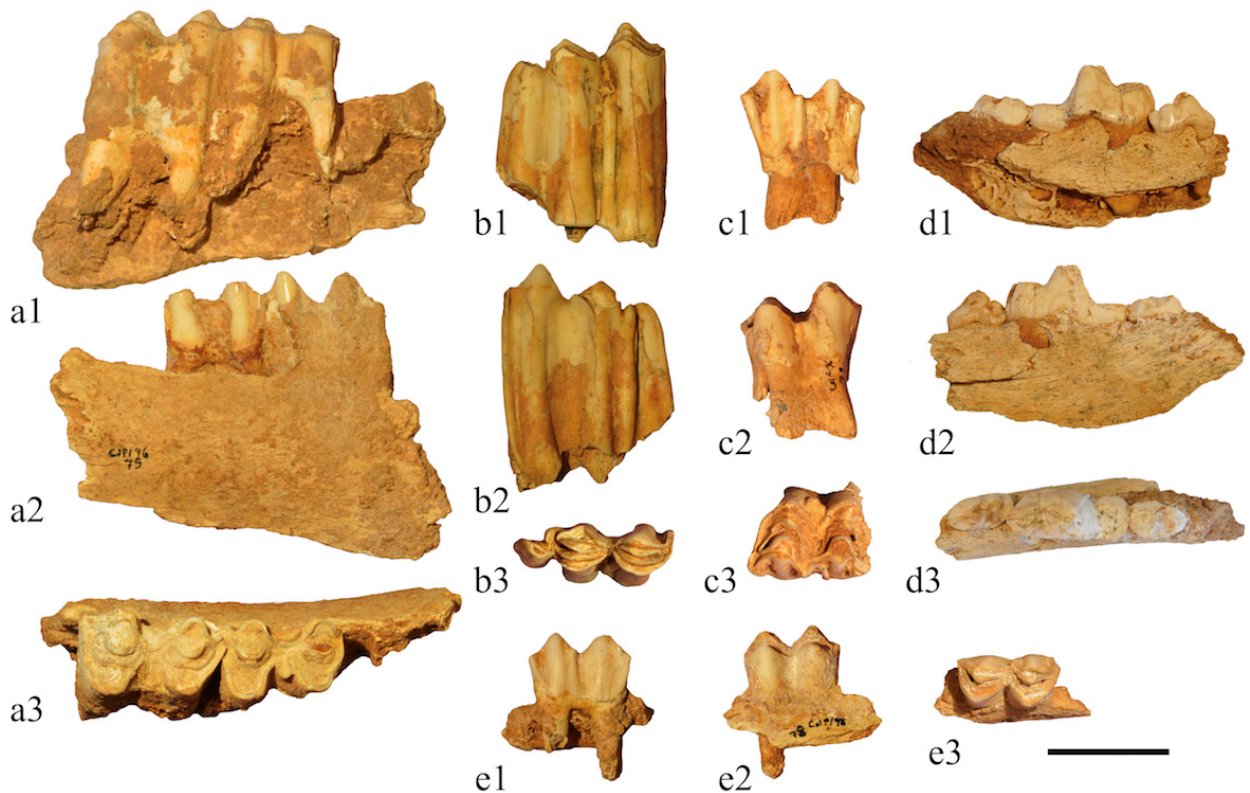


Fig. 2 - Mammal remains from layer F of Cava Spagnulo: *Bos primigenius*: a1-a3: right hemimandible (Cdp96-75); b1-b3: right lower third molar (Cdp96-77); c1-c3: left upper second molar (Cdp96-79); *Cervus elaphus*: e1-e3: right first lower molar (Cdp96-78); *Canis lupus*: d1-d3: right hemimandible (Cdp96-96). Buccal (-1), lingual (-2) and occlusal (-3) views. Scale bar 3 cm.

tween 100 and 250 cm (unit B), made up of calcareous boulders (average size of clasts: 20 cm to 30 cm). This part of the succession is covered by a discontinuous marine layer, 0-50 cm thick (unit C), lenticular and patchy, that contains a set of marine fauna belonging to Echinoidea, Gastropoda, Bivalvia (Pectinidae), Haemaphysa (Balanidae), Anthozoa, Foraminifera, and is marked by the presence of numerous specimens of *Cladocora caespitosa*.

The marine deposits are covered locally by cross-laminated sands (Unit D), from 20 to 25 cm thick. A thin calcitic crust (Unit E), from 5 to 30 cm thick, overlies Unit D.

The subsequent part of the exposed succession is made up of reddish continental deposits, represented, from the base upwards, by:

- clast-supported breccia (from 150 to 250 cm thick) (Unit F)
- matrix-supported breccia with vertebrate remains and lithic industry (from 70 to 120 cm thick) (Unit G)
- reddish clay (from 80 to 100 cm thick) (Unit H).

3. MATERIALS AND METHODS

The fossil remains described in this paper were discovered during two different field surveys, in 1974 and 1996, in the quarries of Grottaglie area. The first collection was recovered by A. Tramonti, and nowadays

the fossil materials are housed in the Technical Institute Commercial Galilei-Costa (Lecce), with the progressive catalogue number Cdp76-n. The second field survey was realised by a research team of the Department of Earth Science and Geoenvironmental, University of Bari, and the fossil remains were stored in the Museum of Preclassical culture of the southern Murge (Ostuni, Brindisi), catalogued with the progressive number Cdp96-n. According to original information about previous field activities, all the fossil materials were collected in deposits corresponding to the Unit G of the succession described in this paper.

According to von den Driesch (1976), the measurements of the studied specimens have been taken with digital callipers to the nearest 0.01 mm.

In order to evaluate the body-size variability of *Equus ferus*, we analysed *E. ferus* teeth sample from Cava Spagnulo and from several Late Pleistocene sites from Apulian Peninsula by means of log-ratio diagrams (Simpson, 1941; Simpson et al., 1960). The dental variables considered are L (length) and W (width) for the upper teeth P4, P2 and P4-M3. We chose *E. ferus* coming from the Apulian Peninsula sites that are chronologically referred to MIS 3 (Tana delle Iene, Conti et al., 2010; Fondo Cattie, Corridi, 1987; level F of Grotta del Cavallo, Sarti et al., 1998; Grotta Laceduzza) as reference species and, in addition to *E. ferus* from Cava Spagnulo, we plotted the Late Pleistocene wild horse

data from Apulian Peninsula sites distinguished by age: MIS 5 (Grotta delle 3 Porte, San Sidero, Melpignano, level H-I of Grotta del Cavallo, Sarti et al., 2002); MIS 4 (Grotta dei Giganti); MIS 2 (Santa Maria d'Agnano Riparo esterno, Grotta Paglicci, Boscato, 1994); MIS 1 (Grotta delle Mura, Bon & Boscato, 1993).

The faunal assemblage was compared with other Late Pleistocene sites of the Apulian Peninsula (Fig. 1), such as Ingarano based on literature data (Petronio et al., 1996; Petronio & Sardella, 1998; Iurino, 2014), Grotta Paglicci (Boscato, 1994), Grotta della Masseria del Monte (Anelli, 1959), Grotta delle Mura (Bon & Boscato, 1993), Grotta della Jena (Anelli, 1956), Tana delle Iene (Conti et al., 2012), Grotta Sant'Angelo (Cassoli & Tagliacozzo, 2001; Casavola, 2005); Avetrana (Petronio et al., 2008; Mecozzi & Bartolini Lucenti, 2018), Cardamone (Rustioni et al., 2003), Sternatia (Rustioni et al., 1994), Grotta del Cavallo (Sarti et al., 1998; Sarti et al., 2002, Boscato & Crezzini, 2012; Zanchetta et al., 2018), Fondo Cattiè (Corridi, 1987), Melpignano (Bologna et al., 1994), San Sidero (De Giuli, 1983; Iurino et al., 2013), Grotta del Sarcofago (Di Stefano et al., 1992), Grotta delle Striare (Malviglia, 1955; Di Stefano et al., 1992), Grotta Romanelli (Blanc, 1920; 1928; Sardella et al., 2014; 2018) and Grotta delle Tre Porte (Cardini, 1958).

We also considered morphological and morphometric data of the mammal remains stored in the following institutions: "PaleoFactory laboratory, Department of Earth Sciences, Sapienza, University of Rome" (Melpignano, San Sidero and Ingarano); "Italian Institute of Human Paleontology (IsIPU) of Anagni laboratory (Frosinone, Latium) (San Sidero, Grotta dei Giganti, Grotta delle Tre Porte); "Paleontology Museum of the Department of the Earth Science of Turin University" (Turin, Piedmont) (San Sidero); "Technical Institute Commercial Galilei-Costa (Lecce, Apulia) (Cardamone); "Museum of Preclassical civilization of the southern Murge (Ostuni, Brindisi), (Grotta Laceduzza, Santa Maria d'Agnano Riparo esterno).

In order to avoid the confusion that arise in the comparison of the literature data, the "unit G", interested by the presence of studied fossils and artefacts, will be called "level G" in the following chapters.

3.1. Measurements abbreviations

Upper and lower dentition: L, length; W, width. Long bones: Bp: breadth of proximal end; Dp: depth of proximal end; SD: smallest breadth of diaphysis; WSD; smallest width of diaphysis, Bd, breadth of distal end; Dd: depth of distal end, DSFo, depth above the olecranic fossa; BPC, breadth across the coronoid process; BFaR, breadth of radius articular surface; SDO, smallest depth of the olecranon. Scapula: BG, breadth of glenoid cavity; LG, length of glenoid cavity; GLP, greatest length of the articularis process; SLC, smallest length of the Collum scapulae. Calcaneus: L, length; W, width; H, height. Metapodial and Phalange: TL: total length; Bp: breadth of proximal end; Dp: depth of proximal end; SD: smallest breadth of diaphysis; WSD; smallest width of diaphysis; Bd, breadth of distal end; Dd: depth of distal end.

4. SYSTEMATIC PALAEOLOGY

Order ARTIODACTYLA, Owen 1848
Family BOVIDAE, (Gray, 1821)
Subfamily BOVINAE, (Gray, 1821)
Genus BOS, Linnaeus, 1758
Species *Bos primigenius*, Bojanus, 1827

Material examined: two right hemimandible fragments (Cdp96-75, Cdp96-76) (Fig. 2), one left hemimandible fragment (Cdp76-1), one right M₃ (Cdp96-77) (Fig. 2), one left M² (Cdp96-79) (Fig. 2), one third phalanx (Cdp96-112), one scaphoid (Cdp96-113), one atlas (Cdp96-122) and a sacrum (Cdp96-123) (see measurements in Table 1).

Remarks: The permanent teeth show a slight wear of the cusps and therefore were referred to adult specimens. Despite the absence of well-preserved horn remains, the morphology of the dental and postcranial elements point to *Bos primigenius*. All the fossils have large dimensions and their size is comparable with other aurochs specimens from the Late Pleistocene of the Apulian Peninsula, such as Grotta Paglicci (Boscato, 1994), Grotta delle Mura (Bon & Boscato, 1993), Avetrana (Pandolfi et al., 2013), Fondo Cattiè (Corridi, 1987), Ingarano, San Sidero and Melpignano.

Family CERVIDAE Goldfuss, 1820
Subfamily CERVINAE, Goldfuss, 1820
Genus CERVUS, Linnaeus, 1758
Species *Cervus elaphus*, Linnaeus, 1758

Material examined: one left maxillary fragment (Cdp76-2), one right M¹ (Cdp76-4), one left M² (Cdp76-5), one right (Cdp96-11, Cdp76-3) and one left (Cdp76-6) hemimandible fragments, one right M₁ (Cdp96-78) (Fig. 2), one humerus fragment (Cdp96-99), one right radius (Cdp96-102), one right tibia fragment (Cdp96-101), one left calcaneus (Cdp96-103) and one right first phalanx (Cdp96-104) (see measurements in Table 2).

Remarks: The length of the Cdp96-78 is within the range of the other Late Pleistocene samples of the Apulian Peninsula. Additional measures of the most complete postcranial elements can be found in Table 2, and their size are similar to other specimens coming from the Late Pleistocene of the Apulia Peninsula, as Grotta del Cavallo (Sarti et al., 2002), Fondo Cattiè (Corridi, 1987), Ingarano, San Sidero and Melpignano. No antlers were found.

Specimen n°	Tooth	Length	Width
Cdp96-75	m1	32.0	19.8
Cdp96-75	m2	26.3	16.2
Cdp96-77	m3	41.1	13.3
Cdp96-79	M2	28.3	21.1

Tab. 1 - Measurements of upper and lower dentition of *Bos primigenius* from Cava Spagnulo.

Specimen n°	Anatomical portion	Length	Width						
Cdp76-4	M1	27.3	16.1						
Cdp76-5	M2	23.7	17.2						
Cdp96-78	m1	24.6	14						
Cdp76-7	m2	22.3	9.2						
		Bd	Dd	SD	WSD				
Cdp96-99	Humerus	40.8	35.2	18.7	22.4				
		Bd	Dd	SD	WSD				
Cdp96-101	Tibia	40.9	32.3	28	23.2				
		Bp	Dp	SD	WSD				
CdP96-102	Radius	17	26.6	12.3	20.7				
		L	W	H					
CdP96-103	Calcaneus	84.9	30.1	29.6					
		TL	Bp	Dp	SD	WSD	Bd	Dd	
CdP96-104	I phalanx	42	14.7	18.5	11.7	13.6	13.5	12.2	

Tab. 2 - Measurements of lower dentition, humerus, tibia, radius, calcaneus and phalanx of *Cervus elaphus* from Cava Spagnulo.

Order PERISSODACTYLA, Owen 1848
 Family EQUIDAE Gray, 1821
 Subfamily EQUINAE, Steinmann & Döderlein, 1890
 Genus EQUUS, Linnaeus, 1758
 Species *Equus ferus*, Pallas, 1775

Material examined: a left maxillary fragment (Cdp76-7), two isolated incisor roots (CdP96-80, CdP96-81), one left I³ (CdP96-83), one right M² (CdP96-86), one right I₂ (CdP96-82), one right I₂ (CdP96-84), one right I₃ (CdP96-98), one left I₃ (CdP96-97), one right P₂ (CdP96-92), one left P₂ (CdP96-90), one left P₄ (CdP96-94), one left M₁ (CdP96-91, CdP96-95), one right M₂ (CdP96-87, CdP96-88), one right M₃ (CdP96-85), one left M₃ (CdP96-93) and one right hemimandible fragment with M₁ and M₂ (CdP96-89) (see measurements in Table 3) (Fig. 3).

Remarks: This species is the relatively better represented mammal in the assemblage. The sample is constituted especially by both isolated lower and upper teeth. The only post-cranial bone attributed to this taxon is a fragmented proximal epiphysis of metapodial (CdP96-100). Our metrical analysis of dentition shows that the dimensions of the Cava Spagnulo teeth (Tab. 3) are closer to other *E. ferus* specimens from the Late Pleistocene sites of Apulia Peninsula chronologically referred to MIS 4 (e.g., Grotta dei Giganti) and MIS 2 (e.g., Grotta Paglicci). The medium-sized and the morphological features allow to ascribe this material to *Equus ferus*.

Specimen n°	Tooth	Length	Width
CdP96-82	i2	14.2	11.2
CdP96-84	i2	13.5	11.4
CdP96-83	I3	13.7	12.1
CdP96-90	p2	32.6	16.3
CdP96-92	p2	32.6	16.5
CdP96-94	p4	30.4	29
CdP96-91	m1	27.2	17.7
CdP96-95	m1	26.9	16.6
CdP96-89	m1	26.9	14.9
CdP96-89	m2	27.4	17.6
CdP96-87	m2	29.8	18.5
CdP96-88	m2	29.9	18.6
CdP96-85	m3	34	14.8
CdP96-93	m3	30.2	15.2
CdP96-86	M2	30	27.5

Tab. 3 - Measurements of upper and lower dentition of *Equus ferus* from Cava Spagnulo.

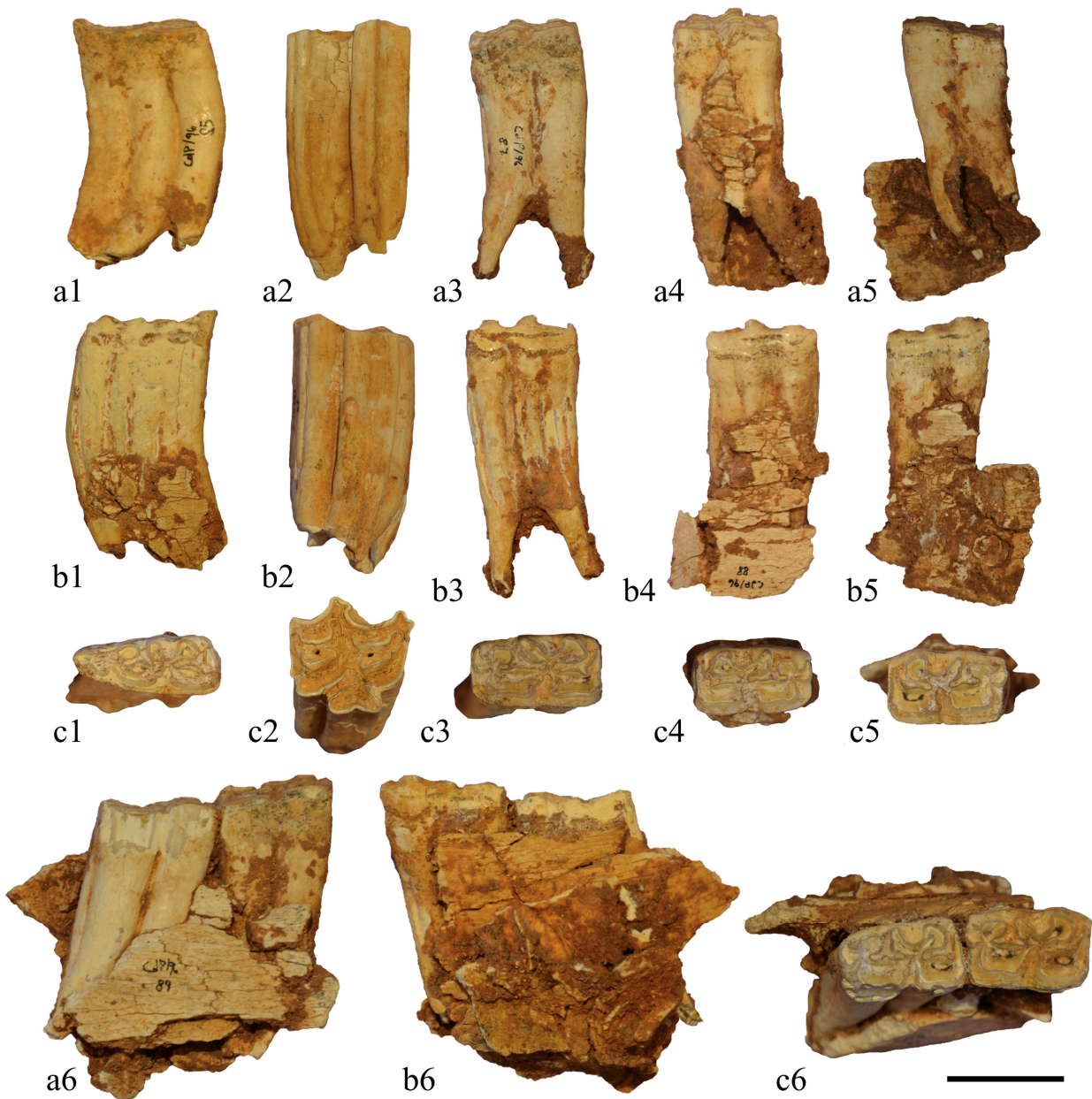


Fig. 3 - *Equus ferus* from layer F of Cava Spagnulo: a1-c1: right lower third molars (CdP96-85); a2-c2: right upper second molar (CdP96-86); a3-c3: right lower second molars (CdP96-87); a4-c4: CdP96-88 right lower second molars; a5-c5: lower left first molar (CdP96-91); a6-c6: right hemi-mandible (CdP96-89). Buccal (a), lingual (b) and occlusal (c) views. Scale bar 3 cm.

Order CARNIVORA, Bowditch, 1821
 Family CANIDAE, Fischer von Waldheim, 1817
 Subfamily CANINAE, Fischer von Waldheim, 1817
 Genus CANIS, Linnaeus, 1758
 Species *Canis lupus*, Linnaeus, 1758

Material examined: a right hemimandible fragment (CdP96-96) (Fig. 2), isolated left P⁴ (CdP96-276) and some postcranial elements such as proximal epiphysis of scapula (CdP96-111), right second metacarpal

(CdP96-110), left second metatarsal (CdP96-109), distal epiphysis of metapodial (CdP96-108) and first phalanx (CdP96-107), (see measurements in Table 4).

Remarks: CdP96-96 preserved the p4, with a protocone, a distal accessory cusp and well-marked labial cingulum; the m1 displays the protoconid higher than paraconid, and posteriorly elongated talonid forming a continuous flatter surface with the m2; the second molar is bean-squared. Taking into account the wear of the cusps and the fusion degree of the epiphyses, the bio-

Specimen n°	Anatomical portion	Length	Width						
CdP96-96	p4	15.1	7.4						
CdP96-96	m1	27.4	10.6						
CdP96-96	m2	11.5	7.9						
Cdp96- 276	p4	15.4	7.2						
		BG	LG	GLP	SLC				
CdP96-111	Scapula	22.6	26.8	37.5	30.2				
		TL	Bp	Dp	SD	WSD	Bd	Dd	
CdP96-108	Metapodial						10.6	11.3	
CdP96-109	II Metarcapal	72.6	13.3	12.4	7.7	7.3	11.2	10.8	
CdP96-110	II Metatarsal		9.1	15.7					
CdP96-107	I Phalanx	31.5	10.3	9.7	6.5	6.4	8.6	6.5	

Tab. 4 - Measurements of lower dentition, scapula, metapodial and phalanx of *Canis lupus* from Cava Spagnulo.

metric data of dental and postcranial materials the canid sample was attributed to a large adult specimen. The teeth from Cava Spagnulo are similar in size and morphology to large wolves possibly referable to glacial stage documented in the Apulian Peninsula (e.g. Cardamone, Avetrana, Mecozzi & Bartolini Lucenti, 2018).

Genus *Vulpes*, Linnaeus, 1758
Species *Vulpes vulpes*, Linnaeus, 1758

Material examined: right and left fragment (Cdp96-114, Cdp96-115) of ulna and right and left (Cdp96-116, Cdp96-130) distal epiphysis of tibia (see measurements in Table 5).

Remarks: the red fox is represented only by few postcranial remains referred to an adult specimen. The measurements taken on these postcranial elements and their morphological features fall into the body-size variability of both extant and Late Pleistocene Apulian foxes (e.g., Ingarano, Tana delle Iene).

Order LAGOMORPHA, Brandt, 1855
Family LEPORIDAE, Gray, 1821
Subfamily LEPORINAE, Trouessart, 1880
Genus *Oryctolagus*, Lilljeborg, 1873
Species *Oryctolagus cuniculus*, Linnaeus, 1758

Specimen n°	Anatomical portion	BPC	DSFo	BFaR	SDO
CdP96-114	Ulna	7.5	9.6	9.1	
CdP96-115	Ulna	7.5	10.6	6.7	5.1
		Bd	Dd		
CdP96-116	Tibia	13.4	9.3		
CdP96-130	Tibia	14.2	9.9		

Tab. 5 - Measurements of ulna and tibia of *Vulpes vulpes* from Cava Spagnulo.

Material examined: one distal epiphysis of right tibia (Cdp96-131).

Remarks: Only the fragmented tibia has been attributed to the wild rabbit. The size and the features of this specimen, such as thickness of distal epiphysis and shallow medial malleolar sulcus, are typical of the wild rabbit. The biometric measurements (Bp 8,4; Dp 5,4) show that the specimen from Cava Spagnulo falls in the size variability of both extant and Late Pleistocene rabbits.

5. ARCHAEOLOGICAL DATA

In 1996, during a field survey in Cava Spagnulo, several artefacts were discovered from the level G (Fig. 4). The scarce industry is mostly on flinty limestone, raw material very common in the deposits of the Murge region, such as Donna Lucrezia (Ceglie Messapica), Monte la Morte (Ostuni), Grotta Laceduzza (Ostuni) and Tana delle Iene (Ceglie Messapica) (Coppola, 2012). In addition to retouched tools, several flaking debris were found, indicating that the stone knapping was performed locally. Among the recovered tools, there are two scrapers and one point. The first one shows a double straight side on lamellar flake (Fig. 4 a1-a5). The second is a straight transverse scraper on large flake (Fig. 4 b1-b5). The last tool is a point platform remnant, with an asym-

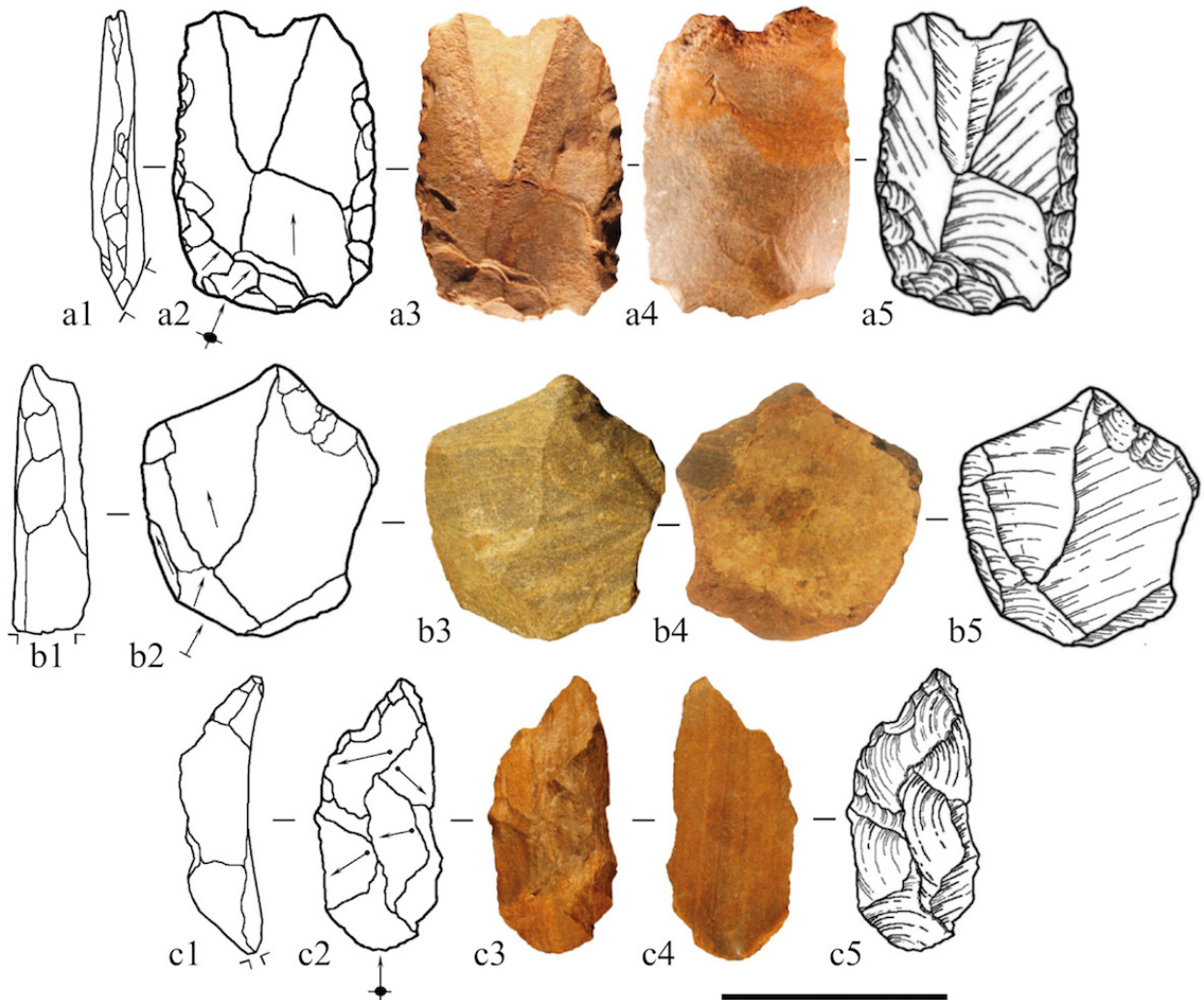


Fig. 4 - Artefacts coming from the layer G of Cava Spagnulo. a1-a5 and b1-b5: flinty limestone scrapers. c1-c5: flinty limestone point. Scale bar 3 cm.

metrical point on crested flake (Fig. 4 c1-c5). The typological analysis of the artefacts clearly provides an attribution to Mousterian faces.

6. RESULTS

The studied materials are in poor state of preservation. Most of them are partially enveloped by a reddish thin limestone crust and in some specimens with evidence of surface abrasions. The bones, which are represented only by adult specimens, were found fragmented and disarticulated. The two collections include 300 fossil remains; 52 of them have been identified and attributed to 6 different mammalian species; 248 are fragmented and not diagnostic, most of them are long bone shaft fragments. Bite marks, rodent gnaw marks and clear evidence of human butchering and exploiting activity have not been recognized on the osteological materials.

7. DISCUSSION

The faunal assemblage of Cava Spagnulo coming from the breccia level G includes the following species: *Bos primigenius*, *Cervus elaphus*, *Equus ferus*, *Canis lupus*, *Vulpes vulpes* and *Oryctolagus cuniculus*. Tramonti (1974) claimed the occurrence of elephants and hares, but no evidence of these taxa has been found in the palaeontological collections stored at Technical Institute Commercial Galilei-Costa (Lecce).

In the faunal assemblage of Cava Spagnulo, the carnivores are represented only by canids, wolves and red foxes. These species are characterised by a wide geographical distribution and ecological tolerance, which allow them to occupy several different habitats (Ungar, 2010). In the last decades, a number of studies focused on the dispersal trends and body-size variation of *Canis lupus* in relation to global climatic changes during the Middle-Late Pleistocene have been published (Argant,

2009; Brugal & Boudadi-Maligne, 2011; Bertè & Pandolfi, 2014; Sardella et al., 2014; Sansalone et al., 2015; Mecozzi & Bartolini Lucenti, 2018). A general consensus has not been reached among the specialists; therefore some of them suggested that *C. lupus* went through an increase of body size, culminating to very large wolves present during the Last Glacial Stage (Sansalone et al., 2015; Mecozzi & Bartolini Lucenti, 2018). Nowadays, the presence of a large-sized wolf in Apulian Peninsula is reported only in deposits chronologically referred to the end of MIS 3 or MIS 2, such as Grotta Paglicci (Boscato, 1994), Avetrana (Mecozzi & Bartolini Lucenti, 2018), Cardamone (Mecozzi & Bartolini Lucenti, 2018), Grotta della Masseria del Monte (Anelli, 1959) and Grotta della Jena (Guiscardini, 1873).

The set-up of an implemented database with a more detailed chronological framework of the Apulian fossiliferous sites is needed to verify the different evolutionary scenarios of *C. lupus*.

The studied faunal assemblage is mostly represented by the wild horse (*E. ferus*), whose presence suggests open forested steppes and relatively cold climatic conditions (Rustioni et al., 2003). The occurrence of a large horse characterises the Salentine faunal assemblages (Conti et al., 2010), in some cases together with the smaller *Equus hydruntinus* (Grotta delle Mura, Bon & Boscato, 1993; Grotta Paglicci, Boscato, 1994, Melpignano, Bologna et al., 1994; Sternatia, Rustioni et al., 1994; Tana delle Iene, Conti et al., 2012).

A number of studies focused on the size variability of the wild horse from the Middle-Late Pleistocene (De Giuli, 1983; Corridi, 1987; Boscato, 1994, 2004; Conti et al., 2010), leading to consider a trend from the large-sized specimens of the Middle-Late Pleistocene sites from the Italian Peninsula (e.g., Malagrotta, Torre in Pietra, Melpignano) to the small-sized specimens from the Late glacial (MIS 2) and earliest Holocene (MIS 1) from Italian Peninsula sites. In particular, Corridi (1987) suggested that body-size of the wild horse remains from Fondo Cattie (MIS 3) was smaller than that of the fossil sample coming from San Sidero (MIS 5) and Grotta Paglicci (MIS 2). Except for M1, the teeth size of wild horses chronologically referred to MIS 5 are larger than those of Apulian specimens from MIS 4 to MIS 1 (Fig. 5). The specimens from Cava Spagnulo are similar in size to those referred to MIS 4 and MIS 2. According to many authors (De Giuli, 1983; Boscato, 1994, 2004; Conti et al., 2010), the horse remains from the earliest Holocene (MIS 1) are smaller in size than those from the Late Pleistocene (Fig. 5).

The studied materials included also the European rabbit (*O. cuniculus*) and aurochs (*B. primigenius*), which had a preference for temperate conditions, but they have been reported from the palaeontological sites of the Apulian Peninsula referred to the Late Pleistocene glacial stages, with dry and cold open environment such as Avetrana (Bed8, Petronio et al., 2008), Grotta della Masseria del Monte (Anelli, 1959), Sternatia (Rustioni et al., 1994), Grotta Paglicci (Boscato, 1994) and Cardamone (Rustioni et al., 2003).

At Cava Spagnulo, also the red deer (*C. elaphus*) is poorly represented. This cervid inhabits open deciduous woodland, coniferous woodland and Mediterranean

scrub. The red deer is a very common element in the faunal association from the Late Pleistocene sites of the Apulian Peninsula, and it has been reported in both glacial and periglacial stage associations (Grotta Paglicci, Boscato, 1994; Ingarano, Petronio et al., 1996; Petronio & Sardella, 1998; Grotta della Masseria del Monte, Anelli, 1959; Grotta della Jena, Anelli, 1956, 1960; Grotta Sant'Angelo, Cassoli & Tagliacozzo, 2001; Casavola, 2005; Avetrana, Petronio et al., 2008; Fondo Cattie; Corridi, 1987; Grotta del Cavallo, Sarti et al., 1998, 2002; Melpignano, Bologna et al., 1994; San Sidero, De Giuli, 1983; Tana delle Iene, Conti et al., 2012; Cardamone, Rustioni et al., 2003; Grotta delle Tre Porte, Cardini, 1958).

Furthermore, other species typical of temperate woodland were widely diffused in the Apulia Peninsula during the Late Pleistocene (Minieri et al., 1993), such as the wild boar (*Sus scrofa*), the roe deer (*Capreolus capreolus*), the European wildcat (*Felis sylvestris*) and the Eurasian badger (*Meles meles*). These species were not found at Cava Spagnulo.

The composition of the mammal association from the level G of Cava Spagnulo differs from those reported by the ossiferous breccia from the Apulian Peninsula, especially along the southern Adriatic coastline (Blanc, 1958; Di Stefano et al., 1992). These deposits are characterized by the occurrence of large mammal fauna that included *Hippopotamus amphibius*, *Stephanorhinus hemitoechus*, *Palaeoloxodon antiquus* and middle-size cervid *Dama dama* (Tab. 6). These taxa have been considered as typical elements of warm-temperate environment of the early Late Pleistocene faunal assemblages (MIS 5c - 5a) of the Apulian sites, such as Grotta del Sarcofago, Grotta delle Striare, Grotta Romanelli and Grotta delle Tre Porte (Blanc, 1958; Di Stefano et al., 1992). The chronological attribution of these ossiferous breccias has been strongly debated among different authors (Masini et al., 1991; Sala et al., 1992), suggesting that these fossil remains of mammals could be referred to late Middle Pleistocene. The major issue was about the specific attribution of small-sized canid remains, which have been referred for a long time to Early-Middle Pleistocene Mosbach the wolf *C. mosbachensis* (Masini et al., 1991; Sala et al., 1992). Despite its reduced body-size and its peculiar morphologic characters, the wolf from Grotta Romanelli has been recently referred to *Canis lupus* (Sardella et al., 2014). However, the mammal fauna, indicating warm-temperate climate, became less frequent from the Italian Peninsula palaeontological record when cold and less humid climatic conditions established (Petronio et al., 2007), and it disappeared at the climax of the last glacial stage (MIS 2) (Rustioni et al., 2003). In particular, the last occurrences of fallow deer and narrow-nosed rhinoceros in Southern Italy are documented in the Ingarano site, referred to the MIS 3 (about 40 ka BP) (Petronio et al., 1996; Petronio & Sardella, 1998).

Albeit the small fossil sample recovered in the level G from Cava Spagnulo led us to consider the chronological attribution with caution, the faunal assemblage would appear to be characterised by the occurrence of large-sized wolf and a medium-sized wild horse. The remains of these species show different size and mor-

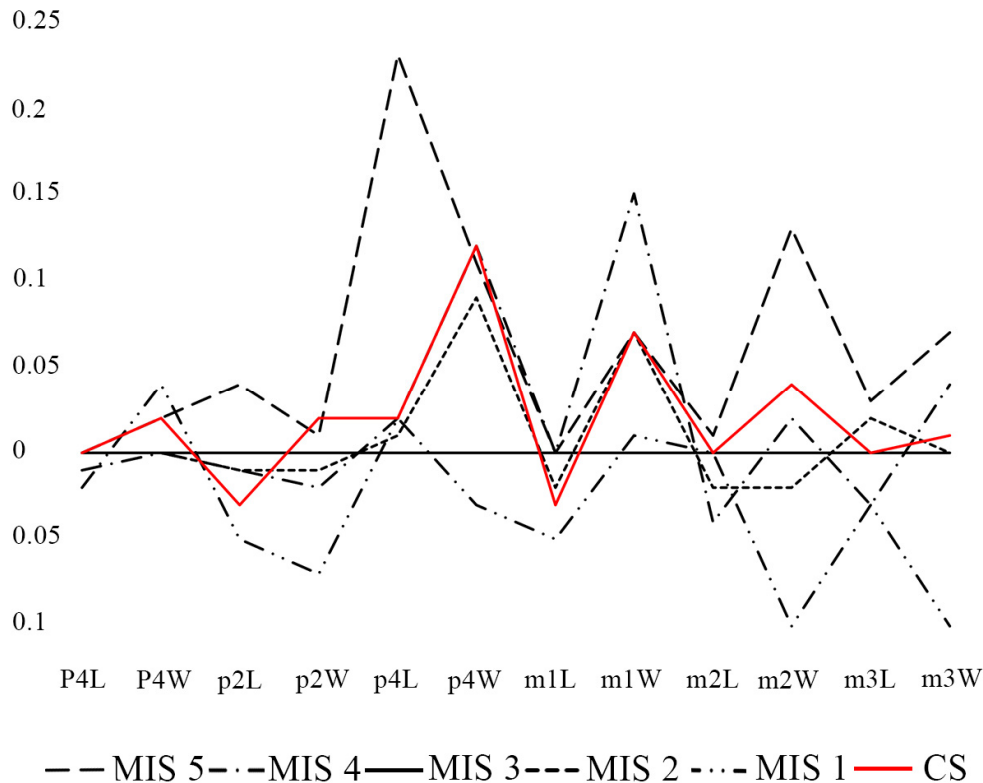


Fig. 5 - Log-ratio diagram based on selected dental variables in the studied sample of *Equus ferus* from Cava Spagnulo (CS), as well as in other Late Pleistocene specimens from Apulian Peninsula sites (MIS 5, Grotta delle Tre Porte, San Sidero, Melpignano, level H-I of Grotta del Cavallo; MIS 4, Grotta dei Giganti, Grotta Laceduzza; MIS 2, Santa Maria d'Agnano Riparo esterno, Grotta Paglicci; MIS 1; Grotta delle Mura) as compared to *Equus ferus* materials from Apulian Peninsula sites referred to MIS 3 (Tana delle Iene, Fondo Cattie, level F of Grotta del Cavallo).

phology than the specimens found in several early Late Pleistocene sites of Apulia (e.g., Grotta Romanelli, San Sidero, Melpignano). Therefore, a depositional time span referred to the early Late Pleistocene (MIS 5c-5a) can be excluded (Tab. 6). In addition, the hippo (*Hippopotamus amphibius*), the narrow-nosed rhinoceros (*Stephanorhinus hemitoechus*) and the fallow deer (*Dama dama*) were not found at Cava Spagnulo.

Many vertebrate assemblages from the Late Pleistocene deposits of Apulia area have been described in literature, but only some of them assume a significant role to reconstruct the biochronological framework of the Apulian Peninsula during the Late Pleistocene (Tab. 6).

The long and well-preserved Grotta Paglicci stratigraphic sequence included 26 archaeological levels referred to the Middle-Upper Palaeolithic (Late Pleistocene) (Palma di Cesnola, 1991, Boscato, 1994). In particular, artefacts discovered in the levels 24-22 have been attributed to the Aurignacian-Gravettian facies and, in the same levels, the mammal fauna is dominated by equids (*E. ferus* and *E. hydruntinus*) (Boscato, 1994).

The Grotta del Cavallo succession is divided in 12 levels laying on a marine terrace referred to Tyrrhenian (MIS 5) (level N). The mammal assemblage recovered in the levels H-I is dominated by *E. ferus* followed by

cervids (*C. elaphus* and *D. dama*) (Sarti et al., 2002). Most of the fossil sample discovered from the level F has been attributed to *B. primigenius* and cervids (*C. elaphus* and *D. dama*) (Sarti et al., 1998). Finally, the mammal fauna reported from the level E was dominated by *B. primigenius*, and followed by *E. ferus* and *C. elaphus* (Boscato & Crezzini, 2012).

The faunal assemblage reported from the Cardamone site indicates cold climatic conditions, including typical elements of the *Mammuthus-Coelodonta* faunal complex (*Mammuthus primigenius*, *Coelodonta antiquitatis*, *Equus ferus* and *Crocota crocuta*). Other taxa were discovered at Cardamone site, which have been referred to a more temperate autochthonous fauna (*B. primigenius*, *C. elaphus*, *L. europaeus* and *Oryctolagus cuniculus*) (Rustioni et al., 2003).

Few fossiliferous deposits were described from the Murge area. The Late Palaeolithic and Neolithic Grotta Sant'Angelo deposit was discovered in 1930 (Casavola, 2005). The stratigraphic succession consisted of red soil, in the lower part, and brown soil, in the upper part. In the faunal assemblage of the lower levels, the cervids were well represented while few specimens were attributed to equids (Cassoli & Tagliacozzo, 2001; Casavola, 2005).

A fossiliferous deposit of Grotta della Jena included

Region	Gargano Promontory		Murge					Salentine Peninsula						
	Ing.	G.P.	G.M.M.	G.J.	G.S.A.	T.I.	C.S.	Card.	G.C.		G.S.R.	G.S.T.	G.R.	G.T.P.
Sites	Levels B-E	Levels 22-24 26800 ± 300	Lower level	Lower level	Lower level	US 8	Level 6		Levels H-I	Level F	Level E		Level I	Level F
Chronological data BP	40000 ± 2000	34300 ± 800 26800 ± 300				< 60000 > 33000			> 109100±900	> 45700± 1000	> 39850± 140		> 69000	
Species														
<i>Bos primigenius</i>	X	X	X		X	X	X	X	X	X	X	X	X	X
<i>Dama dama</i>	X		X	X		X	X		X	X	X	X	X	X
<i>Cervus elaphus</i>	X	X	X	X	X	X	X	X	X	X	X	X	X	X
<i>Capreolus capreolus</i>	X		X	X	X	X			X	X	X		X	
<i>Capra ibex</i>		X		X					X					
<i>Rubicapra sp.</i>		X												
<i>Sus scrofa</i>		X	X		X	X			X	X	X	X	X	
<i>Stephanorhinus kirkerbergensis</i>												X	X	X
<i>Stephanorhinus sp.</i>	X								X			X		
<i>Coelodonta antiquitatis</i>								X					X	
<i>Hippopotamus amphibius</i>											X	X	X	X
<i>Palaeoloxodon antiquus</i>											X	X	X	X
<i>Mammuth primigenius</i>								X						
<i>Equus hydruntinus</i>	X	X			X	X				X	X	X	X	X
<i>Equus ferus</i>		X			X	X	X	X	X	X	X		X	X
<i>Canis lupus</i>	X		X	X	X	X	X	X			X	X	X	X
<i>Canis aureus</i>				X	X	X	X	X					X	
<i>Vulpes vulpes</i>	X			X		X	X	X	X	X			X	
<i>Crocuta crocuta</i>	X		X	X		X		X		X			X	X
<i>Crocuta sp.</i>											X			
<i>Ursus arctos</i>	X													
<i>Panthera pardus</i>	X													
<i>Panthera spelaea</i>														X
<i>Lynx pardinus spelaeus</i>			X											
<i>Lynx lynx</i>	X								X			X		
<i>Felis silvestris</i>	X		X		X	X				X				
<i>Meles meles</i>	X		X	X	X									
<i>Gulo gulo</i>	X													
<i>Mustela nivalis</i>					X									
<i>Oryctolagus cuniculus</i>	X		X					X				X	X	X
<i>Lepus europaeus</i>	X		X		X		X	X	X	X				
<i>Lepus sp.</i>						X				X				
<i>Lepus timidus</i>												X		

Tab. 6 - Late Pleistocene mammal taxa from selected localities of the Apulian Peninsula: 1) Ingarano (Ing.), 2) Grotta Paglicci (G.P.), 3) Grotta della Masseria del Monte (G.M.M.), 4) Grotta della Jena (G.J.), 5) Grotta Sant'Angelo (G.S.A.), 6) Tana delle Iene (T.I.), 7) Cava Spagnulo (C.S.), 8) Cardamone (Card.), 9) Grotta del Cavallo (G.C.), 10) Grotta del Sarcofago (G.S.R.), 11) Grotta delle Striare (G.S.T.), 12) Grotta Romanelli (G.R.) and 13) Grotta delle Tre Porte (GTP).

two levels separated by a thick stalagmite crust (Anelli, 1960; Cantelli, 1983). Most of the fossil sample of the mammals recovered from the red soil (lower level) has been referred to cervids (Anelli, 1960).

The site of the Grotta della Masseria del Monte site was discovered in 1942 (Anelli, 1959). The deposit included red soil in the lower part and brown soil in the upper part (Anelli, 1959). The mammal faunal discovered by lower level was dominated by cervids.

The stratigraphic succession of Tana delle lene includes 9 levels, three of which are tephra (US9, US4 and US 1) (Giaccio & Coppola, 2000). The ash levels (US9 and US4) were correlated to pyroclastic products of the Campi Flegrei, respectively dated <60000 BP and >37000 BP (Giaccio & Coppola, 2000). The upper level (US1) was correlated to Codola Plinian eruption (Giaccio et al., 2008). The faunal assemblage recovered from US8 of Tana delle lene was dominated by *D. dama*, followed by *B. primigenius* (Conti et al., 2012).

Despite the lack of the main representatives of the last glacial stage assemblage (*M. primigenius*, *C. antiq-uitatis*), the structure of the studied association is closer to that reported from several sites of the Apulian Peninsula chronologically referred to the latest interglacial and earliest last glacial stage, such as Cardamone (Rustioni et al., 2003), Grotta Paglicci (Boscato 1994, 2004), Grotta della Jena (Anelli, 1956; 1960) and Grotta della Masseria del Monte (Anelli, 1959).

Finally, the typological analysis of the tools recovered from level G enable to attribute the lithic industry to the Mousterian facies. In addition, associated to the faunal assemblage, Tramonti (1974) reported the presence of lithic artefacts referable to Middle Palaeolithic.

The small number of the artefacts prevents to make the technological characterization of the lithic complex. However, the typology of the studied tools is closer to those reported from several sites of the Murge, such as Tana delle lene (Giaccio & Coppola, 2000) and Grotta Laceduzza (Coppola, 2012).

In particular, the lithic complex from the Grotta Laceduzza was recently described (Coppola, 2012). These artefacts show close affinities to those found in the level F of the Grotta del Cavallo (MIS 3) (Coppola, 2012).

The raw material is represented by flinty limestone, typical of Murge, like the material observed in Donna Lucrezia (Ceglie Messapica, Brindisi), Grotta Laceduzza (San Michele Salentino, Brindisi), Monte la Morte (Ostuni, Brindisi) and Tana delle lene (Ceglie Messapica, Brindisi) (Coppola, 2012).

Due to the closer affinity to Grotta Laceduzza and Tana delle lene sites and their geographic position (Murge), it would be possible to hypothesize that the level G of the Cava Spagnulo could be referred to the latest interglacial part of MIS 3.

8. CONCLUSION

The description of the Pleistocene deposit exposed at Cava Spagnulo is here reported for the first time. In particular, only the upper part of the local Quaternary succession was sampled, yielding numerous frag-

mented fossil remains and some artefacts typologically referable to a Mousterian facies.

The typology and the raw material of the studied lithic complex are closer to those reported from several sites of the Murge date chronologically to MIS 3, such as Tana delle lene (Giaccio & Coppola, 2000) and Grotta Laceduzza (Coppola, 2012).

The scantiness of the fossil record suggests that such a framework needs to be verified after new field work with a more detailed stratigraphic analysis of the site.

At present, the studied faunal assemblage includes *Bos primigenius*, *Cervus elaphus*, medium-sized *Equus ferus*, relatively large-sized *Canis lupus*, *Vulpes vulpes* and *Oryctolagus cuniculus*.

Tramonti (1974) claimed the occurrence of proboscideans (*Elephas* sp.) from Cava Spagnulo, but no fossil material has been found in the studied paleontological collections, to confirm this presence. The occurrence of *Palaeoloxodon* or *Mammuthus* could be of great bio-chronological value, being related to different paleoenvironmental scenarios and chronology (see Braun & Palombo, 2012 for the discussion).

Only general taphonomical considerations can be carried on the faunal remains which show no evidence of human activity nor bite marks of carnivores or rodents. In addition, the remains show no evidence of surface alterations due to weathering.

The small number of fossil sample prevents to reconstruct the palaeoenvironmental conditions of the level G of the Cava Spagnulo. However, the pollen analysis of hyena coprolites coming from the Tana delle lene suggested open lowlands, dominated by steppe and grassland, with sporadic mesophilous and thermophilous trees for the Murge during the MIS 3 (Petrucci et al., 2005; Gatta et al., 2016). The open and dry environment with scarce forest is typical of the second part of the Late Pleistocene (MIS 3-2) in Southern Italy (Petrucci et al., 2005; Renault-Miskovsky et al., 2011; 2015; Gatta et al., 2016, Berto et al., 2017).

Finally, it would be possible to hypothesize that the level G of the Cava Spagnulo could be chronologically referred to the latest interglacial stage (MIS 3).

ACKNOWLEDGEMENTS

We wish to thank to the Soprintendenza archeologia, belle arti e paesaggio delle province di Brindisi, Lecce e Taranto.

The authors are indebted to the dott. Mariella Michiele, own of the quarry known as Cava Spagnulo and to the Ostuni municipal authorities for their support of this research.

We wish to thank A. Sposato and the two referees, P. Mazza and M. Tropeano, for the critical revision of the manuscript that greatly improved the research work.

The authors wish to thank I. Mazzini, L. Bellucci, F. Strani and J. Conti for their useful suggestions and support.

We wish to thank M. Pavia ("Museo di Paleontologia del Dipartimento di Scienze della Terra dell'Univeristà di Torino), A. Mazzotta, C. Viva (I.T.C. "Galileo-Costa"), L. Bruni, S. Grimaldi, S. Pianese Longo

(IsIPU) for granting access to fossil mammal collections from Late Pleistocene Apulian sites and the opportunity to study they.

We also acknowledge V. Stasolla, R. Marchese, V. Calderone, G. Lippolis and F. Palazzo for their valuable help in during laboratory activities.

The study has been supported by Sapienza Research grant (Ricerche universitarie 2015, Resp. R. Sardella) and Grandi Scavi 2016 (Sapienza Università di Roma, Resp. R. Sardella).

REFERENCES

- Anelli F. (1956) - Un raro reperto di stambecco nella grotta della Jena presso Castellana (Bari). Atti del 7 congresso nazionale di speleologia, 105-107.
- Anelli F. (1959) - Prime ricerche paleontologiche della grotta della Masseria del monte Conversano Murge in Bari. Le grotte d'Italia, 3, 1-34.
- Anelli F. (1960) - Eccezionale bottino di caccia nella Grotta della Jena. L'Olmo, 5(1), 3-6.
- Argant A. (2009) - Biochronologie et grands mammifères au Pléistocène moyen et supérieur en Europe occidentale: l'apport des Canidés, des Ursidés et des Carnivores en général. Quaternaire. Revue de l'Association française pour l'étude du Quaternaire, 20(4), 467-480.
- Bedetti C., Palombo M.R., Sardella R. (2001) - Last occurrences of large mammals and birds in the Late Quaternary of the Italian peninsula. The world of Elephant - International congress, Rome, 701-703.
- Berté D.F., Pandolfi L. (2014) - *Canis lupus* (Mammalia, Canidae) from the Late Pleistocene deposit of Avetrana (Taranto, Southern Italy). Rivista Italiana di Paleontologia, 120(3), 367-379.
- Berto C., Boscato P., Boschin F., Luzi E., Ronchitelli A. (2017) - Paleoenvironmental and paleoclimatic context during the Upper Palaeolithic (late Upper Pleistocene) in the Italian Peninsula. The small mammal record from Grotta Paglicci (Rignano Garganico, Foggia, Southern Italy). Quaternary Science Reviews, 168, 30-41.
- Blanc G.A. (1920) - Grotta Romanelli I. Stratigrafia dei depositi e natura e origine di essi. Archivio per l'Antropologia e la Etnologia, 50, 1-39.
- Blanc G.A. (1928) - Grotta Romanelli II. Dati ecologici e paleontologici. Archivio per l'Antropologia e la Etnologia, 58, 1-49.
- Blanc A.C. (1958) - Industria musteriana su calcare e su valve di *Meretrix chione* associata con fossili di Elefante e Rinoceronte, in nuovi giacimenti costieri del Capo di Leuca. Quaternaria, 5, 308-313.
- Bojanus L.H. (1827) - De uro nostrate eiusque sceletro commentatio scriptis et bovis primigenii sceletro auxit. Nova Acta Physico-Medica Academiae Caesareae Leopoldino-Carolinae Naturae Curiosorum, 13(2), 411-478.
- Bologna P., Di Stefano G., Manzi G., Petronio C., Sardella R., Squazzini E. (1994) - Late Pleistocene mammals from the Melpignano (LE) "Ventarole": preliminary analysis and correlations. Bollettino della Società Paleontologica Italiana, 33(2), 265-274.
- Bon M., Boscato P. (1993) - Analisi paleontologica e paleoecologica di macro e micromammiferi dei livelli romanelliani e mesolitici della Grotta delle Mura (Monopoli, Bari). Quaternaria Nova, 3, 53-104.
- Boscato P. (1994) - Grotta Paglicci: la fauna a grandi mammiferi degli strati 22-24 (Gravettiano antico-Aurignaziano). Rivista di scienze preistoriche, 46, 145-176.
- Boscato P. (2004) - I macromammiferi dell'Aurignaziano e del Gravettiano antico di Grotta Paglicci. Paglicci - L'Aurignaziano e il Gravettiano antico. Claudio Grenzi Ed., Foggia, 49-62.
- Boscato P., Crezzini J. (2012) - Middle-Upper Palaeolithic transition in Southern Italy: Uluzzian macromammals from Grotta del Cavallo (Apulia). Quaternary international, 252, 90-98.
- Bowdich T.E. (1821) - An analysis of the natural classification of Mammalia for the use of students and travellers. J. Smith, Paris, pp. 115.
- Brandt J.F. (1855) - Beiträge zur nahern Kenntniss der Säugethiere Russlands. Mem. Acad. Imp. St. Petersburg Ser, 69, 1-375.
- Braun I.M., Palombo M.R. (2012) - Mammuthus primigenius in the cave and portable art: An overview with a short account on the elephant fossil record in Southern Europe during the last glacial. Quaternary international, 276, 61-76.
- Brugal J.P., Boudadi-Maligne M. (2011) - Quaternary small to large canids in Europe: taxonomic status and biochronological contribution. Quaternary International, 243(1), 171-182.
- Cantelli C. (1983) - La Grotta della Jena (Bari): un esempio di trappola paleontologica. Le Grotte d'Italia, 11, 165-171.
- Cardini L. (1958) - Prime determinazioni delle faune dei nuovi giacimenti costieri musteriani del Capo di Leuca. Quaternaria, 5, 314-315.
- Casavola E. (2005) - Nota preliminare sui reperti faunistici provenienti dalla grotta Preisotrica di S. Angelo (Ostuni, Brindisi) saggi stratigrafici 1953. Atti Spelaion, Martina Franca, 139-147.
- Cassoli P.F., Tagliacozzo A. (2001) - La fauna della Grotta S. Angelo di Ostuni. Atti della Società per la Preistoria e Protostoria della Regione Friuli-Venezia Giulia, 12, 87-92.
- Conti N., Petronio C., Salari L. (2010) - The Late Pleistocene Equids from "Tana delle lene" (Ceglie Messapica, Brindisi, Southern Italy). Bollettino della Società Paleontologica Italiana, 49(2), 227-236.
- Conti N., Coppola D., Petronio C., Petrucci M., Sardella R., Salari L. (2012) - La fauna del Pleistocene superiore di Tana delle lene (Ceglie Messapica, Brindisi, Italia meridionale). Bollettino del Museo Civico di Storia Naturale di Verona, 36, 63-76.
- Coppola D. (2012) - Il riparo di Agnano nel paleolitico superiore: la sepoltura di Ostuni 1 ed i suoi simboli. Terra. Università di Roma Tor Vergata, Roma, pp. 368.
- Corridi C. (1987) - Faune pleistoceniche del Salento 2.

- La fauna di fondo Cattiè, Maglie, Lecce. I Quaderni del Museo Comunale di Paleontologia di Maglie, 3, 5-65.
- De Giuli C. (1983) - Le faune pleistoceniche del Salento 1. La fauna di San Sidero 3. I Quaderni del Museo Comunale di Paleontologia di Maglie, 1, 45-79.
- Di Stefano G., Petronio C., Sardella R., Savelloni V., Squazzini E. (1992) - Nuove segnalazioni di brecce ossifere nella costa fra Castro Marina e Otranto (Lecce). *Il Quaternario*, 5(1), 3-10.
- Di Stefano G., Petronio C., Sardella R. (1994) - Il significato biocronologico e paleoecologico di alcuni taxa di mammiferi del Plio-Pleistocene dell'Italia centrale. *Studi Geologici Camerti*, 459-467.
- Driesch Von den A. (1976) - A guide to the measurement of animal bones from archaeological sites: as developed by the Institut für Palaeoanatomie, Domestikationsforschung und Geschichte der Tiermedizin of the University of Munich. *Peabody Museum Bulletin*, 1, 1-137.
- Fischer von Waldheim G. (1817) - *Adversaria zoologica. Mémoires de la Société Impériale Des Naturalistes Moscou*, 5, 357-472.
- Gatta M., Sinopoli G., Giardini M., Giaccio B., Hajdas I., Pandolfi L., Bailey G., Spikins P., Rolf M., Sadori L. (2016) - Pollen from Late Pleistocene hyena (*Crocota crocuta spelaea*) coprolites: An interdisciplinary approach from two Italian sites. *Review of Palaeobotany and Palynology*, 233, 56-66.
- Giaccio B., Coppola D. (2000) - Note preliminari sul contesto stratigrafico e paleoecologico del sito "Tana delle Iene" (Ceglie Messapica, Brindisi, SE Italia). *Il Quaternario*, 13(1/2), 5-20.
- Giaccio B., Isaia R., Fedele F.G., Di Canzio E., Hoffecker J., Ronchitelli A., Sinitsyn A., Anikovich M., Lisitsyn S.N., Popov V.V. (2008) - The Campanian Ignimbrite and Codola tephra layers: two temporal/stratigraphic markers for the Early Upper Palaeolithic in southern Italy and eastern Europe. *Journal of Volcanology and Geothermal Research*, 177(1), 208-226.
- Gliozzi E., Abbazzi L., Argenti A., Azzaroli A., Caloi L., Capasso Barbato L., Di Stefano G., Esu D., Ficcarelli G., Girotti O., Kotsakis T., Masini F., Mazza P., Mezzabotta C., Palombo M.R., Petronio C., Rook L., Sala B., Sardella R., Zanalda E., Torre D. (1997) - Biochronology of selected Mammals. Molluscs and Ostracodes from the Middle Pliocene to the Late Pleistocene in Italy. The state of the art. *Rivista Italiana di Paleontologia e Stratigrafia*, 103(3), 369-388.
- Gray J.E. (1821) - On the Natural Arrangement on vertebrate animal. *London Medical Repository record*, 15, 296-310.
- Guiscardi C. (1873) - Di una grotta con ossami nella provincial di Bari. *Atti della Regia Accademia delle Scienze Fisiche e Matematiche, Napoli*, 8, 1-13.
- Goldfuss A. (1820) - *Handbuch der Zoologie*. Johann Leonard Schrag, Nürnberg, pp. 510.
- Iurino D.A., Fico R., Petrucci M., Sardella R. (2013) - A pathological Late Pleistocene canid from San Sidero (Italy): implications for social and feeding behaviour. *Naturwissenschaften*, 100(3), 235-243.
- Iurino D.A. (2014) - Body size reduction and tooth agenesis in Late Pleistocene *Meles meles* (Carnivora, Mammalia) from Ingarano (Southern Italy). *Rivista Italiana di Paleontologia e Stratigrafia (Research In Paleontology and Stratigraphy)*, 120(1), 109-118.
- Linnaeus C. (1758) - *Systema Naturae per regna tria naturae, secundum Classes, Ordines, Genera, Species, cum characteribus, differentiis, synonymis, locis. Tomus I. Laurentius Salvius, Stockholm*.
- Lilljeborg W. (1873) - *Sveriges och Norges ryggradsdjur (Vol. 2)*. W. Schultz, 551-1088.
- Malviglia C. (1955) - Ossami fossili trovati nel Grotta delle Striare (Otranto). *Natura*, 46(2), 92-95.
- Masini F., Sala B., Ambrosetti P., Azzaroli A., Ficcarelli G., Kotsakis T., Rook L., Torre D. (1991) - Mammalian faunas of selected villafranchian and galearian localities. In *INQUA SEQS, Subcommission for European Quaternary Stratigraphy, Cromer Symposium*.
- Mazza P., Varola A. (1999) - Revision of the Middle Pleistocene rhinoceros remains from Contrada Monticelli (Castellana, Bari, Southern Italy). *Il Quaternario*, 12(1), 99-104.
- Mecozzi B., Iurino D.A., Berte D.F., Sardella R. (2017) - *Canis mosbachensis* (Canidae, Mammalia) from the Middle Pleistocene of Contrada Monticelli (Putignano, Apulia, southern Italy). *Bollettino della Società Paleontologica Italiana*, 56(1), 71-78.
- Mecozzi B., Bartolini Lucenti S. (2018) - The Late Pleistocene *Canis lupus* (Canidae, Mammalia) from Avetrana (Apulia, Italy): reappraisal and new insights on the European glacial wolves. *Italian Journal of Geosciences*, 137, 138-150.
- Minieri F., Petronio C., Sardella R., Scarano M.R. (1993) - Le faune a mammiferi del Pleistocene Superiore dell'Italia peninsulare. 1° Convegno di Archeozoologia, Rovigo, 75-87.
- Owen R. (1848) - Description of teeth and portions of jaws of two extinct Anthracotherioid quadrupeds (*Hyopotamus vectianus* and *Hyop. bovinus*) discovered by the Marchioness of Hastings in the Eocene deposits on the NW coast of the Isle of Wight: with an attempt to develop Cuvier's idea of the Classification of Pachyderms by the number of their toes. *Quarterly Journal of the Geological Society of London*, 4, 103-141.
- Pallas P.S. (1775) - *Spicilegia zoologica: quibus novae imprimis et obscurae animalium species iconibus, descriptionibus atque commentariis illustrantur*. Gottlieb August Lange, Berolini, 1(1), 1-44.
- Palma di Cesnola A. (1991) - La campagna 1991 a Grotta Paglicci. *Atti del XIII convegno Nazionale di Preistoria, Protostoria e Storia della Daunia*. San Severo, 22-24 Novembre 1991.
- Pandolfi L., Petronio C., Salari L. (2013) - Catastrophic death assemblages from the Late Pleistocene of Italy: the case of Avetrana karst filling (Taranto, Southern Italy). *Rivista Italiana di Paleontologia e Stratigrafia (Research In Paleontology and Stratigraphy)*, 119(1), 109-124.

- Petronio C., Sardella R. (1998) - Remarks on the stratigraphy and biochronology of the Late Pleistocene deposit of Ingarano (Apulia, Southern Italy). *Rivista Italiana di Paleontologia e Stratigrafia*, 104(2), 287-294.
- Petronio C., Billia E., Capasso Barbato L., Di Stefano G., Mussi M., Parry S. J., Sardella R., Voltaggio M. (1996) - The Late Pleistocene fauna from Ingarano (Gargano, Italy): biochronological, palaeoecological, paleoethnological and geochronological implications. *Bollettino della Società Paleontologica italiana*, 34, 333-340.
- Petronio C., Di Canzio D.E., Salari L. (2007) - The Late Pleistocene and Holocene Mammals in Italy: new biochronological and paleoenvironmental data. *Palaeontographica Abteilung A*, 279, 147-157.
- Petronio C., Bellardini F., Arzarello M., Bedetti C., Bellucci L., Cipullo A., Di Stefano G., Pandolfi L., Pavia M., Petrucci M., Sardella R., Salari L. (2008) - The deposit of the Late Pleistocene from Avetrana (Taranto, Southern Italy): biochronology and palaeoecology. *Il Quaternario*, 21(2), 409-422.
- Petrucci M., Giardini M., Sadori L. (2005) - Analisi pollinica di coproliti di iena macchiata (*Crocuta crocuta* Erxleben) dell'ultimo glaciale della Puglia. *Informatore Botanico Italiano*, 37(1), 932-933.
- Renault-Miskovsky J., Bailis H., Marquer L., Coppola D. (2011) - Environnement vegetal et paléoclimatologie des Pouilles au Paléolithique Supérieur. *Palynologie du Gravettien et de l'Épigavettien de la grotte de Santa Maria d'Agnano (Ostuni, Brindisi, Italie)*. *Bulletin du Musée d'anthropologie préhistorique de Monaco*, 51, 75-86.
- Renault-Miskovsky J., Bailis H., Marquer L., Coppola D. (2015) - Santa Maria di Agnano (Ostuni, Brindisi, Italie). *Préhistoire et Palynologie, Paléoclimatologie et Paléoenvironnement*. *Rivista di Scienze Preistoriche*, 65, 5-28.
- Rustioni M., Mazza P., Abbazzi L., Delfino M., Rook L., Petrucci S., Vianello F. (1994) - The würmian fauna from Sternatia (Lecce, Apulia, Italy). *Bollettino della Società Paleontologica Italiana*, 33(2), 279-288.
- Rustioni M., Ferretti M. P., Mazza P., Pavia M., Varola A. (2003) - The vertebrate fauna from Cardamone (Apulia, southern Italy): an example of Mediterranean mammoth fauna. *Deinsea*, 9(1), 395-404.
- Sala B., Masini F., Ficarelli G., Rook L., Torre D. (1992) - Mammal dispersal events in the Middle and Late Pleistocene of Italy and Western Europe. *Courier Forschungsinstitut Senckenberg*, 153, 59-68.
- Sala B., Masini F. (2007) - Late Pliocene and Pleistocene small mammal chronology in the Italian peninsula. *Quaternary International*, 160, 4-16.
- Sansalone G., Bertè D.F., Maiorino L., Pandolfi L. (2015) - Evolutionary trends and stasis in carnassial teeth of European Pleistocene wolf *Canis lupus* (Mammalia, Canidae). *Quaternary Science Reviews*, 110, 36-48.
- Sardella R., Bedetti C., Bellucci L., Conti N., Coppola D., Di Canzio E., Pavia M., Petronio C., Petrucci M., Salari L. (2005) - The late pleistocene vertebrate fauna from Avetrana (Taranto, Apulia, southern Italy): preliminary report. *Geo. Alp.*, 2, 25-29.
- Sardella R., Bertè D., Iurino D.A., Cherin M., Tagliacozzo A. (2014) - The wolf from Grotta Romanelli (Apulia, Italy) and its implications in the evolutionary history of *Canis lupus* in the Late Pleistocene of Southern Italy. *Quaternary International*, 328, 179-195.
- Sardella R., Mazzini I., Giustini F., Mecozzi B., Brilli M., Iurino D. A., Lembo G., Massucci M., Muttillio B., Sigari D., Tucci S., Voltaggio M. (2018) - Grotta Romanelli (Southern Italy, Apulia): legacies and issues in excavating a key site for the Pleistocene of the Mediterranean. *Rivista Italiana di Paleontologia e Stratigrafia (Research In Paleontology and Stratigraphy)*, 124(2), 247-264.
- Sarti L., Boscato P., Lo Monaco M. (1998) - Il Musteriano finale di Grotta del Cavallo nel Salento: studio preliminare. *Origini*, 22, 45-109.
- Sarti L., Boscato P., Martini F., Spagnoletti A.P. (2002). Il Musteriano di Grotta del Cavallo-strati H e I: studio preliminare. *Rivista di Scienze Preistoriche*, 52(21), 45-109.
- Simpon G.G. (1941) - Large pleistocene felines of North America. *American Museum Novitates*, 1136, 1-27.
- Simpon G.G., Roe A., Lwontin R.C. (1960) - *Quantitative Zoology*. Harcourt Brace, New York, pp. 440.
- Steinmann G., Döderlein L. (1890) - *Elemente Der Paläontologie*. Engelmann, pp. 850.
- Tramonti A. (1974) - Grottaglie, Cava del Piano - Deposito preistorico (F° 202, I SE, Grottaglie 40°32'58 N, 4°59'22" E). *Notiziario Topografico Salentino*, 2, 134-136.
- Trouessart E.L. (1880) - On a new very small Shrew from Mayotte, *Crocidura (Pachyura) coquerelii*, Pollen and van Dam, Ms. Notes from the Leyden Museum, 2(2), 85-89.
- Ungar P.S. (2010) - *Mammal Teeth: Origin, Evolution, and Diversity*. Johns Hopkins University Press, Baltimore, pp. 303.
- Zanchetta G., Giaccio B., Bini M., Sarti, L. (2018) - Tephrostratigraphy of Grotta del Cavallo, Southern Italy: Insights on the chronology of Middle to Upper Palaeolithic transition in the Mediterranean. *Quaternary Science Reviews*, 182, 65-77.

