Supplementary Information

Size shifts in late Middle Pleistocene to Early Holocene *Sus scrofa* (Suidae, Mammalia) from Apulia (southern Italy): ecomorphological adaptations?

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Late Middle Pleistocene-Early Holocene Apulian fossil Suidae

Melpignano

The site of Melpignano, near the homonymous town, is a quarry area where several karst fissures — locally known as "ventarole"— are exposed (Fig. 1). The deposits are filled with reddish sediments (called *terre rosse*) in the lower part and brownish sediments (called *terre brune*) in the upper, both particularly rich in vertebrate fossil remains (Bologna et al., 1994). After the first description provided by Mirigliano (1941), several Institutions, as the IsIPU and the IIPP, with the support of the local Salentine Speleological group, finely investigated the fossiliferous area of Melpignano (Cardini, 1962a; De Lorentiis, 1958). Recently, the age of the lower deposit has been extended to the late Middle Pleistocene (Mecozzi et al., 2019a). The Suidae sample was recovered from the *terre rosse* of different karst cavities (Tab. 1-2, Fig. 2). Furthermore, an isolated upper tooth reported by Bologna (1992) from "Cava Nuzzo" of Melpignano was included.

Repository: MPUN: Mirigliano collection - PF: Cava Nuzzo and Cava Bianco.

San Sidero

The "ventarole" of San Sidero are located along the state road (SS16) between the towns of Corigliano d'Otranto and Maglie (Fig. 1). The first description of the deposit and its faunal assemblage was reported by Cardini (1962b). The mammal fauna from San Sidero was also studied by other authors (Iurino et al., 2015, 2013; Petrucci et al., 2012; Bedetti et al., 2004; De Giuli 1983, 1980). Similarly to the Melpignano sediments, these "ventarole" include *terre rosse* layers in the lower part and *terre brune* layers in the upper part. The Suidae sample has been collected from the *terre rosse* of Cava L (Tab. 1-2).

Repository: PF; MGP.

Avetrana

The site, located in an abandoned quarry near the town of Avetrana, was described in 2005 by a team of palaeontologists of Sapienza University of Rome. It consists of a fossiliferous karst filling deposit within the Early Pleistocene limestone known as "Calcareniti di Gravina" (Fig. 1). The rich faunal assemblage recovered from the deposit has been studied in a number of works (Salari et al., 2019; Mecozzi and Bartolini Lucenti, 2018; Petronio et al., 2008; Sardella et al., 2005; among others). The studied sample has been collected from beds 2-8 and is here subdivided according to the chronology of the layers (beds 2-7, MIS 5; bed 8, MIS 3; Tab. 1-2, Fig. 2).

Repository: MUST.

Grotta delle Striare

This site includes several caves, North-South exposed, located along the road connecting Castro to Santa Cesarea Terme (Fig. 1). This cave complex was discovered by Paolo Emilio Stasi in 1879, but geo-palaeontological surveys were carried out only in the 1950s (Maviglia, 1955; Orlandi and Cigna, 1955; Cigna and Orlandi, 1954). Some vertebrate remains were described by Di Stefano et al. (1992). Only an isolated lower tooth has been attributed to *Sus scrofa* (Tab. 1-2).

Repository: IsIPU.

Grotta delle Tre Porte

The coastal cave, located at Punta Ristola, was discovered in 1936 during a field survey of the IsIPU conducted by Gian Alberto Blanc (Blanc, 1958) (Fig. 1). The cave includes three different rooms, with two of these, Antro del Bambino and Grotta Titti, containing Pleistocene deposits. The Suidae material was recovered from level F of Antro del Bambino, associated with Mousterian (Middle Palaeolithic) lithic industry (Tab. 1-2).

Repository: IsIPU.

Grotta Mario Bernardini

Discovered in 1961, Grotta Mario Bernardini (also known as Grotta di Santa Margherita) is located along the Ionian coast of Apulia near the village of Santa Caterina (Borzatti von Löwenstern, 1971, 1970) (Fig. 1). The vertebrate fauna has never been studied in detail, although a preliminary mammal list was provided by Borzatti von Löwenstern (1971, 1970). The Suidae material has been recovered from levels B4-3 and A8, associated with Mousterian (Middle Palaeolithic) lithic industry (Tab. 1-2).
Repository: IGF.

Grotta Uluzzo C

The cave opens into the Cretaceous limestone of the Calcari di Melissano Formation at 15 m a.s.l., located in the Uluzzo Bay near the town of Nardò. (Fig. 1). The deposit and its stratigraphic sequence were described by Borzatti von Löwenstern (1966a, 1965) and Borzatti von Löwenstern and Magaldi (1969). Borzatti von Löwestern (1966a, 1965) reported a preliminary list of the fossil mammals recovered from this locality. The studied fossils have been recovered from levels G-E (Tab. 1-2). In these levels, the human presence is documented by lithic industry attributed to the Mousterian (Middle Palaeolithic).
Repository: IGF.

Grotta dei Giganti

The site is a coastal cave located between Punta Ristola and Punta Marchiello (Blanc, 1958) (Fig. 1). In the 1930s, the cave was discovered by the IsIPU during a field survey conducted by G.A. Blanc. A list of the faunal remains was reported by Blanc (1958). The radiocarbon dating attempt performed by

Alessio et al. (1978) yielded no results. The material was found in levels 3f-3c (Tab. 1-2), where artefacts referred to as Mousterian (Middle Palaeolithic) were also recovered.

Repository: ITCGC.

Grotta Laceduzza

The fossiliferous site is located on the Adriatic coast of the Apulian Peninsula, about 154 m a.s.l., near the town of San Michele Salentino (Fig. 1). The cave was discovered by the "Gruppo Speleologico Salentino Pasquale de Lorentiis" in 1970 (Coppola, 2012). A preliminary description of the mammal assemblage from the lower part of the deposit, including a rich sample of *Meles meles*, was recently carried out and few remains of *Sus scrofa* were found (Tab. 1-2) (Mecozzi et al., 2019b). In the lower part of the deposit, lithic industry referred to Mousterian (Middle Palaeolithic) was also collected (Spera, 2012).

Repository: MPCCSM.

Grotta Zinzulusa

Grotta Zinzulusa is located along the Adriatic coast of the Salentine Peninsula, near the town of Castro (Fig. 1). Francesco Antonio Del Duca, bishop of the diocese of Castro, described for the first time the cave in 1793 in a letter to Ferdinando IV, king of the Kingdom of the Two Sicilies. A century after the discovery, the Pleistocene sedimentary succession and its archaeological and palaeontological content were described by Botti (1874a). In the cave, there are several infilling successions, called Vestibolo, Antro B, Antro C, Antro D, Antro E, and Duomo (Blanc, 1962). The Suidae material was found in the Antro B, from levels B6 and B5-3 (Blanc, 1962; Cardini, 1962b) (Tab. 1-2, Fig. 2). The artefacts from level B6 were attributed to Mousterian (Middle Palaeolithic), instead those from levels B5-3 were

referred to Gravettian (Upper Palaeolithic). Nowadays, the cave is a well-known geoheritage resource and is visited annually by approximately 70,000 people (Sardella et al., 2019).

Repository: IsIPU.

Fondo Focone

The site, located near the town of Ugento (Fig. 1), was discovered in the early 1960s during a survey conducted by Decio de Lorentiis, but the first excavations in the sinkhole were performed by Luigi Cardini (Cardini, 1965). During the 1970s, the fieldwork stretched on under the direction of Eugenia Segre Naldini, who opened a trench, 3 x 3 m, called "Trincea B" (Cancellieri, 2017). Cardini (1965) reported a list of both vertebrate and archaeological content. Associated to fossil remains (Tab. 1-2), artefacts attributed to Early Epigravettian (Upper Palaeolithic) were found (Cancellieri, 2017).

Repository: IsIPU.

Santa Maria d'Agnano – esterno (SMA-esterno)

The Grotta di Santa Maria di Agnano is located near the town of Ostuni, on the north-western margin of Risieddi promontory, at about 175 m a.s.l. (Coppola, 2012) (Fig. 1). The site was discovered during the 1960s by the "Associazione Studi e Ricerche" (Studies and Research Association) (Coppola, 2012). The systematic excavation of the deposit started in 1991 and continues still today (Coppola, 2012, 1992; Vacca and Coppola, 1993; Vacca et al., 1992). The area of SMA-esterno is outside the cave, close to the present entrance (Chakroun et al., 2018; Coppola et al., 2017; Renault-Miskovsky et al., 2015; Baills, 2015; Coppola and Baills, 2008). The fossil remains come from level 8, dated 26339-25779 ^{14}C cal yr BP and from levels 6A-4C, dated 16745-16401 ^{14}C cal yr BP and 18013-17587 ^{14}C cal yr BP respectively (Tab. 1-2) (Baills, 2015; Renault-Miskovsky et al., 2011). Instead, the artefacts collected

from the level 8 were attributed to Gravettian and those from level 6A-4C to Early Epigravettian (Baills, 2015; Renault-Miskovsky et al., 2011).

Repository: MPCCSM.

Grotta Romanelli

The site, located along the Adriatic coast near the town of Castro (Fig. 1), was discovered in 1874 by Ulderigo Botti (Botti, 1874b) and in 1900 Paolo Emilio Stasi realized its remarkable importance as the first evidence of the Upper Palaeolithic in Italy. In 1914, Gian Alberto Blanc began a pioneering excavation campaign, during which the first systematic archaeological/palaeontological and stratigraphic study using scientific methods was carried out. Nowadays, Grotta Romanelli is recognized as a key site for the Mediterranean Pleistocene for its archaeological and palaeontological content and the relative stratigraphical, geomorphological and radiometric data (Sardella et al., 2019, 2018, 2014). The upper complex (level E-A) was referred to the end of Late Pleistocene and Early Holocene on the basis of radiocarbon-dated during the 1960s (Sardella et al., 2018; Alessio et al., 1965, 1964; Vogel and Waterbolk, 1963; Bella et al., 1958). In 2015, a new excavation campaign began, led by a team from Sapienza University of Rome, with the aim to provide an updated stratigraphic and chronological scheme as well as to describe the fossil remains and artefacts (Sardella et al., 2019, 2018; Giustini et al., 2018). Recently, new fossil remains were submitted for ^{14}C dating in order to confirm the chronology of the cave (Calcagnile et al., 2019). The results expand and refine the previous chronology, with a time span for the level D and B respectively from 11858 ± 85 ^{14}C yr BP to 8397 ± 45 ^{14}C yr BP (Calcagnile et al., 2019). The sample considered in this study has been found in the upper part of the deposit (level E-A) (Tab. 1-2, Fig. 2). The lithic industry found in the upper complex (level E-A) has been attributed to final Epigravettian (Upper Palaeolithic).

Repository: MUCIV; PF.

Grotta della Jena

The cave, located 2 km from the town of Castellana, was discovered in 1872 (Fig. 1). The site belongs to the well-known karst system of Pozzo Cucù, one of the greatest of the Italian Peninsula. Grotta della Jena has an historical importance, since it represents the first show cave in Apulia, and more general in Italy. The site and the faunal assemblage from the lower part of the deposit (*terre rosse*) was studied by Giuscardi (1873) and Anelli (1959, 1956). Instead, the fossil sample from the upper part of the sedimentary succession, including specimens attributed to *S. scrofa* (Tab. 1-2), was never described.
Repository: SMCC.

Grotta della Prazziche

The cave, discovered by Edoardo Borzatti von Löwenstern in 1964, is located near the town of Novaglie (Fig. 1). The succession consists of five archaeological levels: F-D, Middle Pleistocene - Mousterian; C-B, Early Holocene - final Epigravettian; A, Middle Holocene - Neolithic (Borzatti von Löwenstern, 1969, 1966b). The mammal assemblages from levels F-D and C-B were presented by Borzatti von Löwenstern (1969, 1966b). The studied sample, associated to artefacts attributed to final Epigravettian (Upper Palaeolithic), was collected from level B (Tab. 1-2).
Repository: IGF.

Biochronology

The Pliocene-Quaternary Italian large mammal biochronological scale is subdivided in mammal ages (Villafranchian, Epivillafranchian, Galerian, Aurelian), which constitute a reliable tool for correlating the geological time scale to biological events in the continental realm (Bellucci et al., 2015; Petronio et al., 2011; Gliozzi et al., 1997; Azzaroli, 1977). Transitions between mammal ages are denoted by

marked faunal renewals, related to the evolution, extinction, and dispersal of different species. During the late Middle-Late Pleistocene (Aurelian) of Italy, mammal assemblages progressively acquired modern features, associations became poor with the extinctions generally prevailed on the appearance of new taxa (Masini and Sala, 2007; Petronio et al., 2007; Gliozzi et al., 1997) (Fig. S1). Indeed, throughout the Last Interglacial (MIS 5) took place the last appearance of two of the most common and widely diffused species in the Italian Peninsula during the Middle Pleistocene: the straight-tusked elephant *Palaeoloxodon antiquus* (Falconer and Cautley, 1847), and the hippo (*Hippopotamus* ex. gr. *antiquus* Desmarest, 1822 (=*Hippopotamus tiberinus* Mazza, 1991) - *Hippopotamus amphibius* Linnaeus, 1758) (Pandolfi and Petronio, 2015; Mazza and Bertini, 2013; Braun and Palombo, 2012; Caloi et al., 1998; Caloi and Palombo, 1995; Mazza, 1995). The occurrences chronologically referred to the early Late Pleistocene (MIS 4) (Pandolfi and Petronio, 2015; Petronio and Sardella, 1998; Caloi and Palombo, 1995) are actually questionable due to their uncertain stratigraphic and geological framework, with no compelling evidence of such attributions (Braun and Palombo, 2012; Bedetti et al., 2001; Mazza, 1995). During the MIS 3 the narrow-nosed rhinoceros *Stephanorhinus hemitoechus* (Falconer, 1868) (Pandolfi et al., 2017) and the fallow deer *Dama dama* (Linnaeus, 1758) (Boscato et al., 1997) disappeared, whereas the large-sized form of *Canis lupus* spread in the Italian Peninsula (Mecozzi and Bartolini Lucenti, 2018).

The faunal impoverishment occurred during the late Middle-Late Pleistocene of Europe is the result of a strong climatic recrudescence, which caused the disappearance of species adapted to warm climatic condition and the establishment of the core of modern mammalian assemblages (Masini and Sala, 2007; Gliozzi et al., 1997). Due to the monotonous taxonomical composition and marked regionalization of these associations, biochronological scales of this time-span became difficult to define, eventually leading to no consensus for the Late Pleistocene (Masini and Sala, 2011). Body size changes in large mammals can provide new palaeobiological and palaeoecological insights and

constitute a reliable biochronological tool, since they can be observed through time on the basis of a continuous fossil documentation. The wild boar is particularly promising from this perspective, being a species prone to adapt to environmental changes with shifts in size (Albarella et al., 2009; Genov, 1999). In fact, according to our results, the size reduction of *S. scrofa* sounds likely occurred during glacial stages, MIS 4 and MIS 2, and MIS 1 (Early Holocene).

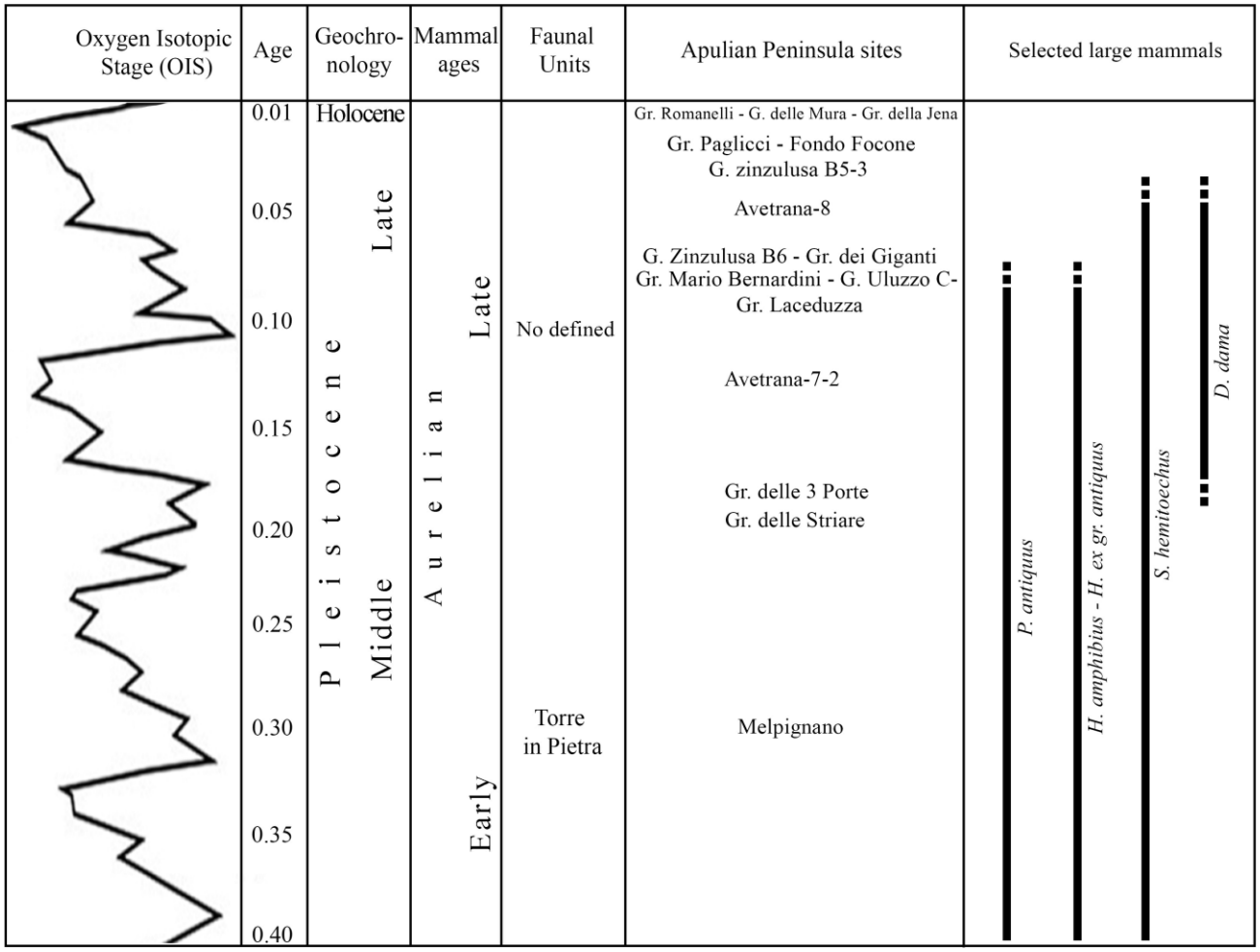

Figure S1 - Biochronological scheme of the Apulian region during the Middle Pleistocene to Early Holocene.

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