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Fossil remains of Villafranchian mammals from Frattaguida (Parrano, Terni, central Italy)

Carmelo Petronio & Leonardo Salari*

Dipartimento di Scienze della Terra, "Sapienza" Università di Roma, Piazzale Aldo Moro 5, I-00185 Roma, Italy
** Corresponding author: Leonardo Salari, E-mail: leonardosalari@virgilio.it*

Abstract
The mammal fossil remains collected on the top of a hill, near the Church of Santa Maria della Neve, in the village of Frattaguida (Parrano, south-western Umbria) are described. The bone remains show a peculiar feature of fossilization due to crystals of calcite that have replaced the bone marrow. Several taxa, such as *Canis* cf. *C. arnensis*, *Mammuthus* sp., *Stephanorhinus* sp., *Equus stenonis*, *E. stehlini*, *Axis nestii*, *Eucladoceros ctenoides* vel *dicranios* and *Leptobos* sp., were identified. The remains of *E. stehlini* represent a rare Italian occurrence of this small Villafranchian equid outside Tuscany. The concomitant occurrences of *E. stehlini* and *A. nestii* have permit to attribute the mammal assemblage to the Tasso Faunal Unit. This result agrees with previous geomorphological, morphoneotectonic and hydrographic observations on the Pornello-Frattaguida basin, specifying its chronology, and with the palaeogeographic evolution of south-western Umbria.

Keywords
Early Pleistocene, South-western Umbria, Mammal assemblages, Biochronology, Lacustrine basins.

Riassunto
I resti fossili di mammiferi villafranchiani di Frattaguida (Parrano, Terni, Italia centrale).- Sono descritti i resti fossili di mammiferi raccolti sulla sommità di una collina, nei pressi della Chiesa di Santa Maria della Neve, nel paese di Frattaguida (Parrano, Umbria sud-occidentale). I resti ossei mostrano una peculiare caratteristica di fossilizzazione dovuta a cristalli di calcite che hanno sostituito il midollo osseo. Sono stati identificati diversi taxa, come *Canis* cf. *C. arnensis*, *Mammuthus* sp., *Stephanorhinus* sp., *Equus stenonis*, *E. stehlini*, *Axis nestii*, *Eucladoceros ctenoides* vel *dicranios* e *Leptobos* sp.. I resti di *E. stehlini* rappresentano in Italia una rara presenza di questo piccolo equide villafranchiano al di fuori della Toscana. La concomitante presenza di *E. stehlini* e *A. nestii* hanno permesso di attribuire l'associazione a mammiferi all'Unità Faunistica Tasso. Ciò concorda con precedenti osservazioni geomorfologiche, morfotettoniche e idrografiche sul bacino di Pornello-Frattaguida, precisandone la cronologia, e con l'evoluzione paleogeografica dell'Umbria sud-occidentale.

Parole chiave
Pleistocene inferiore, Umbria sud-occidentale, Associazioni a mammiferi, Biocronologia, Bacini lacustri.

1. INTRODUCTION

The fossil remains examined in this note were collected in the last years on the surface from the top of a hill, called Monte delle Ossa (local toponym, literally: Mount of bones), near the Church of Santa Maria della Neve, in the village of Frattaguida (Fig. 1), a few kilometres from the San Venanzo volcano, in the Municipality territory of Parrano (Terni, south-western Umbria). In the field where the fossil remains were collected, silty-sandy sediments clearly prevail; there are also sporadic intercalations of small and medium-sized conglomerates and flattened arenaceous pebbles.

In Umbria, there are various fluvio-marsh and fluvio-lacustrine deposits, from the Tavernelle basin (Perugia, western Umbria) to the sediments in the surroundings of Orvieto (Terni, southern Umbria). In most of them, many mammalian faunas referred to the early Pleistocene, late Villafranchian, mostly from Olivola to Farneta Faunal Units (FUs), approximately between 1.8 and 1.6 Ma, have been found (Sardella *et al.*, 1995; Petronio *et al.*, 2002; Argenti, 2004; Cherin *et al.*, 2019a; see Figs 1 and 6). The Frattaguida area, in fact, is included between the coastal marine sediments of the earliest Pleistocene of the Tiber Valley near Fabro (Terni) to the West, and those inland lacustrine of the Villafranchian of the south-

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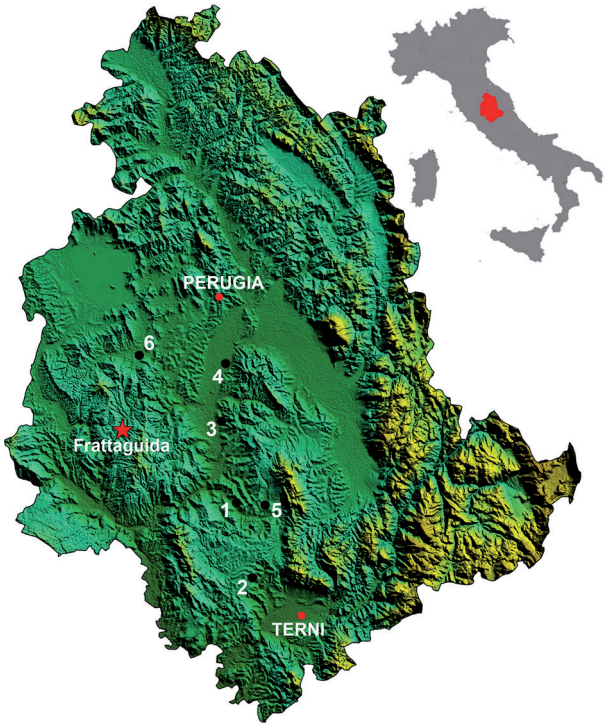

Fig. 1: Geographical localization of the Frattaguida (Umbria, central Italy) site (red star) and other Villafranchian fossiliferous deposits mentioned in the text (black circle). 1: Cava Toppetti; 2: Torre Picchio; 3: Pantalla; 4: Podere San Lorenzo; 5: Colle Sant'Andrea and Villa San Faustino; 6: Pietrafitta.

western part of the Tiberino Basin to the East (Conti & Girotti, 1977; Ambrosetti *et al.*, 1987, 1995; Cattuto *et al.*, 1988; Basilici, 1997).

Cattuto *et al.* (1988) have studied the geomorphological, morphoneotectonic and hydrographic characteristics of the area between Paglia and Tiber rivers, in the Municipalities of Pornello, San Venanzo and Parrano. For the tectonic and stratigraphic data, please refer to Cattuto *et al.* (1988), in which, in summary, numerous faults dating late Pliocene and early Pleistocene were detected, which caused several tectonic lowering. This caused an inversion of the flow of the paleo-Nestòre river and the formation of the Tavernelle lacustrine basin, in the North of area. A fault, corresponding to the Migliari creek, interrupted the flow of the paleo-Fersinone river and produced the formation of the Pornello-Frattaguida lacustrine basin, to South (Cattuto *et al.*, 1988). Both the lacustrine basins were filled with sediments mainly silty-sandy during the early Pleistocene, Villafranchian (Jacobacci *et al.*, 1970; Cattuto *et al.*, 1988).

From the highest part of these fluvial-lacustrine deposits, near the so-called Monte delle Ossa, Verri (1885) and Clerici (1896) reported "*Bos*, *Cervus*, *Equus* and *Meganthereon*" fossil remains and Jacobacci *et al.* (1970) added "*Elephas meridionalis*" remains. Finally, Argenti (2004) lists *Megantereon cultridens*, *Equus* sp., *Canis* sp., *Elephas* sp., *Stephanorhinus* cf. *S. etruscus*, *Equus stenonis*, *Cervus* sp., *Bos* sp., and an indeterminate antelope, and refers them generically to the early Pleistocene.

The aim of this work is to describe the fossil remains recently collected from Frattaguida and to discuss their biochronological implications, attempting to attribute a precise chronological interval to the mammal fossil assemblage recovered.

2. MATERIALS AND METHODS

The fossil material is housed at the "Museo Vulcanologico" in the Municipality of San Venanzo (Terni, Umbria).

The fossil remains are mostly whitish in colour and often encrusted with fine-grained yellowish sandstone, probably remainder of fluvio-lacustrine deposits. A peculiar common feature of all the bone remains is that the bone marrow has been replaced by macro- and micro-crystals of calcite (Fig. 2A), probably precipitated in lacustrine environments for subsequent evaporation of solutions rich in calcium carbonate.

The bone remains are reworked, mostly fragmented and consist mainly of diaphysis of long bones and therefore not easily identifiable in their morphology. No carnivore gnaw-marks were observed. The fossil remains were compared with osteological material, both recent and fossil, including the entire skeletons of *Stephanorhinus etruscus* from Capitone (southern Umbria) and *Bison (Eobison) degiuli* from Capena (Latium), stored in the Department of Earth Sciences of "Sapienza" University of Rome.

The study is aimed only at the few teeth, at the distal and proximal epiphyses of long bones, and the very rare complete bones, mostly belonging to equids, bovids and cervids. The fossil remains recognized at least at the genus level, have been provisionally numbered from FG1 to FG62. The measurements were taken with a standard calliper and expressed in mm following the methodology introduced by Driesch (1976), except for the Equids, taken according to Eisenmann (1980, 1986). Dental terminology is: I: upper incisors; C: upper canine; P: upper premolars; M: upper molars; lower teeth are denoted by lowercase letters.

3. RESULTS

The fossil remains collected in the surrounding of the Church of Santa Maria della Neve, in the village of Frattaguida, include the following taxa.

Class Mammalia Linnaeus, 1758
Order Carnivora Bowdich, 1821
Family Canidae Fisher von Waldheim, 1817
Genus *Canis* Linnaeus, 1758

***Canis* cf. *C. arnensis* Del Campana, 1913**

A distal portion of femur of canid was found (Fig. 2B). For a secure taxonomic attribution of this fragment of femur, any morphological description would be insufficient. The only data that can be ascertained are the size (distal transverse diameter: 30.1 mm; distal antero-posterior diameter: 31.4 mm), larger than the fox and smaller than the wolf, that could bring it closer to *Canis arnensis*, a late Villafranchian medium-sized canid. The relatively small size should allow us to separate this jackal-like species from the almost coeval *C. etruscus*, the Etruscan wolf, of greater dimensions (Torre, 1967; Cherin *et al.*, 2014; Bartolini Lucenti & Rook, 2016, 2018).

Order Proboscidea Illiger, 1811
Family Elephantidae Gray, 1821
Genus *Mammuthus* Brookes, 1828

***Mammuthus* sp.**

A large fragment of sternum and some fragments of ribs can be referred to this genus of Proboscidea, the only present in the late Villafranchian of Italy.

Order Perissodactyla Owen, 1848
Family Rhinocerotidae Gray, 1821
Genus *Stephanorhinus* Kretzoi, 1942

***Stephanorhinus* sp.**

A central fragment of mandible in which only the roots of two teeth are visible is referred to this genus. Mandibular height and thickness are similar to those of *Stephanorhinus etruscus* from Capitone, southern Umbria (Ambrosetti, 1972), but this datum would be insufficient for a specific attribution.

Family Equidae Gray, 1821
Genus *Equus* Linnaeus, 1758

***Equus stenonis* Cocchi, 1867**

Three upper molars in good condition and several proximal and distal fragments of long bones are attributed to this species. The upper molars, probably of the same individual, show flat lingual profile, the pli caballin is small and barely visible, the protocone is asymmetric and relatively short and there is a low number (6-7) of enamel plications (Fig. 2C-D). These morphological

Fig. 2: Frattaguida (Umbria, central Italy), early Pleistocene, late Villafranchian: A) section of indeterminate long bone with calcite crystals; *Canis* cf. *C. arnensis*: B) distal portion of femur: 1) lateral view, 2) anterior view; *Equus stenonis*: C) upper M3 and D) upper M1/2 (presumably of the same individual) in occlusal view, E) distal portion of tibia in anterior view; *Equus stehlini*: F) distal portion of tibia in anterior view, G) third metacarpus; 1) anterior view, 2) posterior view; *Axis nestii*: H) mandibular fragment with m3 in lingual view, I) proximal portion of metacarpus in posterior view; *Eucladoceros ctenoides* vel *dicranios*: L) proximal portion of radius in anterior view, M) distal portion of radius in anterior view; *Leptobos* sp.: N) distal portion of radius in anterior view, O) distal view of articular surface of tibia. Scale bars: 5 cm.

characteristics, together with the dimensions (Tab. 1), allow to attribute these teeth to *Equus stenonis* (see Azzaroli, 1965; De Giuli, 1972; Eisenmann, 1980, 2004; Caloi, 1994; Rustioni *et al.*, 1995; Koufos & Vlachou, 1997; Alberdi *et al.*, 1998; Athanassiou, 2001).

Among the fragments of long bones, the comparison of the dimensions of proximal and distal epiphyses with the same measurements of several Villafranchian horses (Koufos & Vlachou, 1997; Alberdi *et al.*, 1998; Athanassiou, 2001; Alberdi & Palombo, 2013; Cherin *et al.*, 2019a) allows the attribution to this species of two proximal epiphyses of third metacarpus, a distal portion

Table 1: Frattaguida (Umbria, central Italy), early Pleistocene, late Villafranchian: measurements (mm) of the fossil remains of equids taken according to Eisenmann (1980, 1986). Upper teeth: OL: occlusal length, OB: occlusal breadth, PL: protocone length, H: height, PI: protocone index; Radius: 7: distal breadth, 8: distal articular breadth, 9: greatest distal articular depth, 10: breadth of radial condyle, 11: breadth of ulnar condyle; Metacarpus III: 1: greatest length, 2: lateral length, 3: breadth in middle of shaft, 4: depth in middle of shaft, 5: proximal breadth, 6: proximal depth, 7: diameter of articular facet for os magnum (carpale III), 8: diameter of articular facet for unciform (carpale IV), 9: diameter of articular facet for trapezoid (carpale II), 10: distal supra-articular breadth, 11: distal articular breadth, 12: depth of sagittal crest, 13: smaller depth of the medial condyle, 14: greatest depth of the medial condyle; Tibia: 3: breadth in middle of shaft, 4: depth in middle of shaft, 7: distal depth, distal breadth; Metatarsus III: 1: greatest length, 2: lateral length, 3: breadth in middle of shaft, 4: depth in middle of shaft, 5: proximal breadth, 6: proximal depth, 7: diameter of articular facet for large cuneiform (tarsale III), 8: diameter of articular facet for cuboid (tarsale IV), 9: diameter of articular facet for small cuneiform (tarsale II), 10: distal supra-articular breadth, 11: distal articular breadth, 12: depth of sagittal crest, 13: smaller depth of the medial condyle, 14: greatest depth of the medial condyle.

Upper teeth		OL	OB	PL	H	PI									
FG19	M12	25.3	25.5	10.6	38.8	41.9									*E. stenonis*
FG20	M3	27.2	24.1	10.8	42.4	39.7									*E. stenonis*
FG21	M3	29.8	27.7	11.4	24.6	38.2									*E. stenonis*
Radius	7	8	9	10	11										
FG28	72.3	63.8	36.5	24.4	15.4										*E. stenonis*
FG29	66.8	59.4	33.0	21.2	14.2										*E. stehlini*
Mc III	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
FG4					53.8		42.1	21.4							*E. stenonis*
FG7					60.1										*E. stenonis*
FG1	206.7	202.8	34.8	25.2	49.7	32.4	42.5	15.6		44.7	44.9	33.5	26.2	28.3	*E. stehlini*
FG2					47.1	30.3	40.0	14.9							*E. stehlini*
FG3					47.4	32.3	42.2	15.6							*E. stehlini*
FG5					46.4	33.7	40.8	16.1	3.4						*E. stehlini*
FG6					47.6			12.2							*E. stehlini*
FG8											42.7				*E. stehlini*
FG9										47.1	44.2	31.4	25.2		*E. stehlini*
Tibia	3	4	7	8											
FG24			47.8	72.6											*E. stenonis*
FG27			48.3	72.8											*E. stenonis*
FG25	46.3	32.6	51.2	75.2											*E. stenonis*
FG23			40.3												*E. stehlini*
FG26			43.7	64.1											*E. stehlini*
Mt III	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
FG13					50.8	41.4	46.2	11.3	10.8						*E. stenonis*
FG12					46.6	40.0	46.6	11.2	10.4						*E. stehlini*
FG15					46.4	40.1	41.6	11.2							*E. stehlini*
FG16					44.4	44.3	42.2								*E. stehlini*
FG14						40.2		12.2							*Equus* sp.
FG17						40.1									*Equus* sp.
FG18										42.2		30.5	24.8		*Equus* sp.

of radius, three distal epiphyses of tibia and a proximal portion of third metatarsus (Tabs 1 and 2; Fig. 3). Finally, besides the biometric data, also the morphology of the distal epiphysis of the tibia (Fig. 2E), which presents massive and rounded profiles on both the external and internal sides, is part of the features of Stenon' horse.

Equus stehlini Azzaroli, 1965

The only entire long bone recovered in Frattaguida is a third metacarpus of horse (Fig. 2G). The bone is small, relatively thin and with internal and external profiles, proximal and distal epiphyses very similar to those of *Equus stehlini* (see Azzaroli, 1965; Alberdi *et al.*, 1998; Alberdi & Palombo, 2013).

Comparison with the average values of the maximum length and the distal transverse diameter of Villafranchian horses, i.e. *E. livenzovensis*, *E. stenonis*, *E. stehlini*, *E. altidens* and *E. suessenbornensis* (see Alberdi *et al.*, 1998; Alberdi & Palombo, 2013) shows that the measurements (Tab. 1) and ratios of this metacarpus are closer to the *E. stehlini* values than those of any other species considered (Tab. 2; Fig. 4). It can be noted that the metacarpus of *E. stehlini* from Frattaguida is slightly smaller and stronger than the average values of the species.

The comparison of the dimensions of metapodials with the same measurements of several Villafranchian horses (Koufos & Vlachou, 1997; Alberdi *et al.*, 1998; Athanassiou, 2001; Alberdi & Palombo, 2013; Cherin *et al.*, 2019a) allows the attribution to this species of four proximal and two distal portions of third metacarpus and three proximal epiphyses of third metatarsus (Tabs 1 and 2; Fig. 3B and D). Furthermore, also a distal fragment of radius and two of tibia significantly smaller than those of *E. stenonis* (Tab. 1; Figs 3A and C) can also be attributed to *E. stehlini*.

As regards the distal epiphysis of the tibia (Fig. 2F), it can be noted that it is relatively slender, with very thin inner and outer edges, almost sharp, and thus completely different from the robust and rounded profiles of the same bone in *E. stenonis*.

Equus sp.

Less than ten fragments that show no significant morphological or morphometric data are attributed to horse only at the genus level (see Tab. 1).

Order Artiodactyla Owen, 1848
Family Cervidae Goldfuss, 1820
Genus *Axis* Hamilton Smith, 1827

Axis nestii (Azzaroli, 1947)

A mandible fragment with m2 (L.= 19.8 mm, B.= 11.2 mm) and two mandibular fragments with m3 (Fig. 2H) at different wear stages, along with some proximal and distal epiphyses of limb bones and few fragments of metapodial bones (Fig. 2I), are referred to *Axis nestii*. Although there are no antler remains, that is the safest morphological element for taxonomic attributions (Di Stefano & Petronio, 1998, 2002), the above bones and teeth are attributed to the species with sufficient reasonable certainty. Indeed, the third molars (L.= 23.8-24.1 mm, B.= 10.4-11.2 mm) show a robust interlobar stylus and an equally strong basal cingulum, and the third lobe is not very developed: these morphological features are typical of the archaic forms of *Axis* with respect to *A. eurygonos*. Furthermore, between the postcranial bones, transverse and antero-posterior diameters of proximal and distal epiphyses of radius and metatarsus (Tab. 3) allow separating them both from those of *A. lyra* and *A. eurygonos* (see Di Stefano & Petronio, 1998).

Genus *Eucladoceros* Falconer, 1868

Eucladoceros ctenoides (Nesti, 1841) vel *E. dicranios* (Nesti, 1841)

This medium-large sized cervid is present with a proximal and a distal epiphysis of radius (Fig. 2L-M). Even in this case, considering the absence of antler and the fragmentation of the two fossil remains, it is possible to recognize with certainty only the genus.

Table 2 : Selected measurements of Villafranchian horses related to the Figures 3B, 3D and 4. Metacarpus III: 1: greatest length, 5: proximal breadth, 7: diameter of articular facet for os magnum (carpale III), 10: distal supra-articular breadth; Metatarsus III: 5: proximal breadth, 7: diameter of articular facet for large cuneiform (tarsale III); s.d.: standard deviation; data from Alberdi *et al*. (1998) and Alberdi & Palombo (2013).

Species/ measurement	Metacarpus III								Metatarsus III			
	1		5		7		10		5		7	
	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.	mean	s.d.
E. livenzovensis	267.9	8.92	55.8	2.48	46.0	2.85	50.8	3.18	54.4	3.25	48.8	2.57
E. stenonis	241.2	7.81	51.7	3.18	42.4	2.95	48.5	2.91	50.3	3.46	46.1	3.14
E. stehlini	212.8	7.12	46.7	3.21	39.2	2.62	44.5	3.21	45.2	1.38	40.6	2.46
E. suessenbornensis	274.6	8.81	60.4	2.47	49.0	2.39	56.5	1.40	50.4	3.27	46.3	4.25
E. altidens	240.3	7.48	49.7	2.91	41.1	2.14	46.1	2.14	46.5	2.21	42.6	1.84

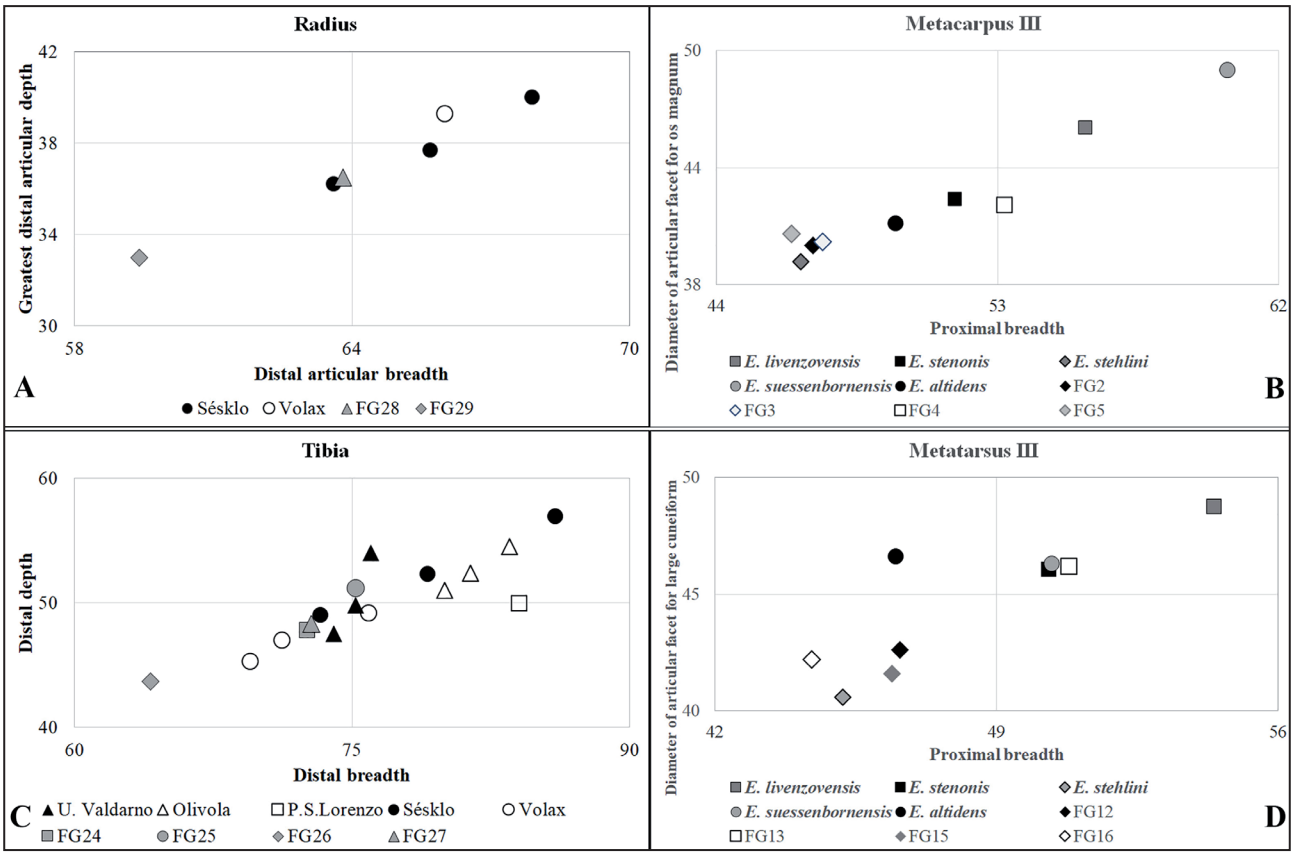

Fig. 3: A) Scattergram of greatest distal articular depth versus distal articular breadth of horse radii from Frattaguida compared with the values of *Equus stenonis* from Séskio and Volax (Greece); B) scattergram of diameter of articular facet for the os magnum versus the proximal breadth of metacarpal bones of horses from Frattaguida compared with the average values of Villafranchian horses; C) scattergram of distal depth versus distal breadth of horse tibiae from Frattaguida compared with the values of *E. stenonis* from Upper Valdarno, Olivola, Podere San Lorenzo (Italy), Séskio and Volax (Greece); D) scattergram of diameter of articular facet for large cuneiform versus the proximal breadth of metatarsal bones of horses from Frattaguida compared with the average values of Villafranchian horses. *E. stenonis* from Upper Valdarno, Olivola and Podere San Lorenzo by Cherin *et al*. (2019a), from Volax by Koufos & Vlachou, (1997), from Séskio by Athanassiou (2001); average values of *E. livenzovensis*, *E. stenonis*, *E. stehlini* and *E. suessenbornensis* by Alberdi *et al*. (1998), those of *E. altidens* by Alberdi & Palombo (2013).

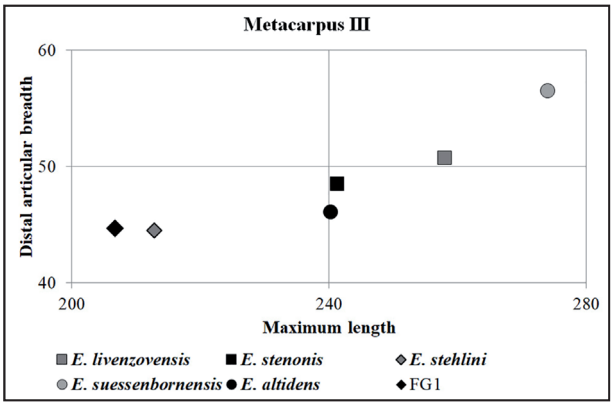

Fig 4: Scattergram of distal transverse diameter versus maximum length of Metarcarpus III of horse from Frattaguida compared with the average values of Villafranchian horses. Data of *E. livenzovensis*, *E. stenonis*, *E. stehlini* and *E. suessenbornensis* by Alberdi *et al*. (1998), those of *E. altidens* by Alberdi & Palombo (2013).

To attempt a more precise attribution, the measurements of the transverse and antero-posterior diameters, both proximal and distal (Tab. 3), were compared with the corresponding measures (Azzaroli & Mazza, 1992; Vos *et al.*, 1995) of Villafranchian *Eucladoceros*. The two diagrams (Fig. 5) show that, both in size and in ratios, Frattaguida radius fragments are quite close to both the Dutch ones (*E. ctenoides*) and the Olivola ones (*E. dicranios olivolanus*). Therefore, they were prudently attributed to *Eucladoceros ctenoides* vel *dicranios*, as was done for the *Eucladoceros* fossils from Torre Picchio (south-western Umbria) (Girotti *et al.*, 2003). Finally, according to Azzaroli & Mazza (1992), the constant presence of two dimensional groups in the *Eucladoceros* from Tuscan sites would be due to sexual dimorphism rather than the improbable contemporary presence of two species or the biologically impossible presence of two subspecies. Therefore, it is plausible that the radius portions from Frattaguida, of small size, could have belonged to a female individual.

Table 3: Frattaguida (Umbria, central Italy), early Pleistocene, late Villafranchian: measurements (mm) of the fossil remains of artiodactyls taken according to Driesch (1976). Humerus, Radius, Metacarpus (Mc), Tibia and Metatarsus (Mt): PTD: proximal transverse diameter, PAPD: proximal antero-posterior diameter, MTD: middle transverse diameter, MAPD: middle antero-posterior diameter, DTD: distal transverse diameter, DAPD: distal antero-posterior diameter.

	PTD	PAPD	MTD	MAPD	DTD	DAPD
Axis nestii						
Radius						
FG34	41.7	23.8				
FG35					35.2	22.8
FG36					35.5	26.2
Mc						
FG37	30.4	22.6				
Tibia						
FG38	49.3	52.9				
Mt						
FG39	28.6	32.8				
FG40			16.5	23.4		
Eucladoceros ctenoides* vel *dicranios						
Radius						
FG59	59.2	32.8				
FG60					49.3	30.6
***Leptobos* sp.**						
Humerus						
FG46					74.4	73.2
Radius						
FG47	70.2					
FG48	77.8	39.8				
FG49	77.2	42.2				
FG50	74.3	39.6				
FG51					73.4	47.6
FG52					60.2	37.3
Mc						
FG53	51.3	33.2				
FG54		33.7				
FG55	59.4					
Tibia						
FG56	102.3					
FG57	84.8					
FG58						56.8

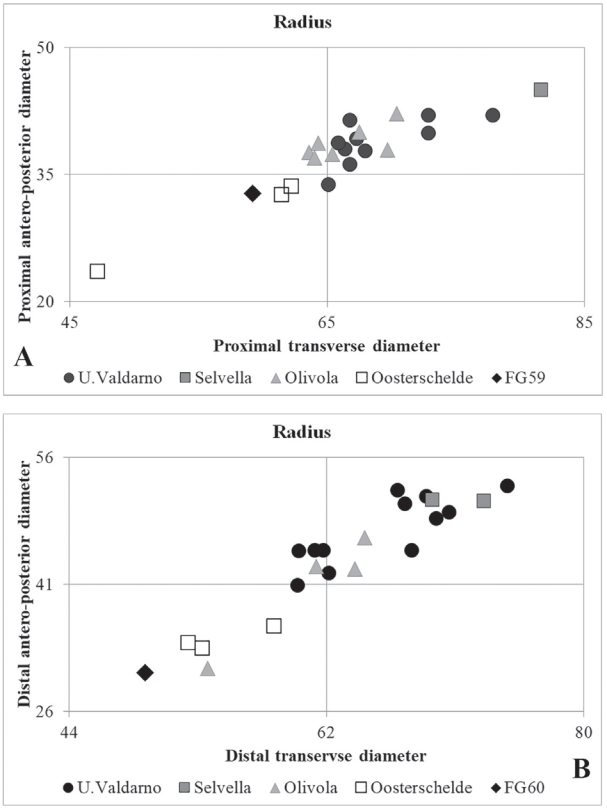

Fig. 5: A) Scattergram of antero-posterior diameter versus transverse diameter of proximal radius of large-sized cervid from Frattaguida compared with Villafranchian *Eucladoceros*; B) Scattergram of antero-posterior diameter versus transverse diameter of distal radius of large-sized cervid from Frattaguida compared with Villafranchian *Eucladoceros* (see text). Upper Valdarno, Selvella and Olivola by Azzaroli & Mazza (1992), Oosterschelde by Vos *et al*. (1995).

Family Bovidae Gray, 1821
Genus *Leptobos* Rütimeyer, 1878

***Leptobos* sp.**

Morphological comparisons between several fragments of humerus, radius (Fig. 2N), metacarpus, tibia and metatarsus from Frattaguida and the corresponding anatomical elements of leptobovines and *Bison (Eobison) degiuli*, allow the attribution to the genus *Leptobos*. The measurements of proximal and distal epiphyses (Tab. 3), compared with several osteometric data (Merla, 1949; Masini, 1989; Gentili & Masini, 2005; Cherin *et al.*, 2019b), do not allow a clear separation of these fossil remains of *Leptobos* at species level.

However, the distal epiphysis of tibia (Fig. 2O), and in particular the caudal margin of the articulation with the talus with a decidedly open angle and the contour of the articulation surface with the fibula, is closer to that of *L. etruscus* than to *L. merlai* (see Cherin *et al.*, 2019b, fig. 13). Several authors (e.g., Masini *et al.*, 2013; Cherin *et al.*, 2019b) divide the European species into two groups or lineages: the first includes *L. stenometopon*, *L. merlai* and *L. furtivus*, the second *L. etruscus* and *L. vallisarni*, morphologically similar and possibly strictly related. Thus, with all possible caution, the morphological features of the tibia allow to attribute the specimens from Frattaguida to the second lineage.

4. BIOCHRONOLOGIC CONSIDERATIONS

Any biochronologic conclusion that allows to identify a possible time interval relating to the mammal fossil assemblage from Frattaguida site must take into account that the bone remains collected belong to a few species identified with certainty. Indeed, only the small cervid, *Axis nestii*, and the equids, *Equus stenonis* and *E. stehlini*, were identified to species level. A few bone fragments for which it was difficult to make any comparison with similar species represent all the other taxa.

In particular, the small size of the *Canis* femur fragment that allow it to be compared to the Villafranchian *C. arnensis* do not completely remove the doubts about the possible attribution of the same bone to the almost contemporary *C. etruscus* from Valdarno, even if the size of the latter is slightly larger. However, the last occurrences of both *C. etruscus* and *C. arnensis* in Italy occur in the Tasso FU (Cherin *et al.*, 2014; Bartolini Lucenti & Rook, 2016, 2018).

The large fossil fragments of Elephantidae attributed to the genus *Mammuthus* could belong to *M. meridionalis* that occurs over a long time interval including between the middle Villafranchian and the early Galerian (Palombo & Ferretti, 2005; Marra *et al.*, 2014). The same can be said for the mandibular fragment of rhinoceros, in which the structure of the lower molars cannot be observed and the dimensions of the height and thickness of the mandible do not give any certainty about a possible attribution to *Stephanorhinus etruscus*. Etruscan rhino is a Villafranchian species that persisted in the Italian peninsula until the end of the early Pleistocene (Pandolfi *et al.*, 2017). Bovid fossil remains were also referred to the genus level. The large and slender taxa of the genus *Leptobos* occur during the early to late Villafranchian, replaced by the small *Bison (Eobison) degiuli* in the latest Villafranchian, Pirro FU (Petronio *et al.*, 2011; Masini *et al.*, 2013). The species morphologically close to the Frattaguida specimens, *L. etruscus* and *L. vallisarni*, were relatively commons in the late Villafranchian mammal assemblages of Italy, the first in Olivola and Tasso FUs, the second in Tasso and Farneta FUs (Masini *et al.*, 2013; Cherin *et al.*, 2019b).

The scant remains of large cervid were attributed to *Eucladoceros ctenoides* vel *dicranios*. Both *E. ctenoides* and *E. dicranios* were found in several Italian fossil deposits referred to Olivola and Tasso FUs (Girotti *et al.*, 2003; Rook & Martínez-Navarro, 2010; Petronio *et al.*, 2011), with *E. dicranios olivolanus* typical cronosubspecies of Tasso FU (Gliozzi *et al.*, 1997). Even the remains of small cervid *Axis nestii*, identified with confidence, allow to significantly restrict the time interval of the mammal fossil assemblage to Olivola and Tasso FUs (Gliozzi *et al.*, 1997; Petronio *et al.*, 2011). Indeed, it is believed that this species is derived from the archaic *A. lyra* and it was later replaced by *A. eurygonos*, a species that occurs in Italian deposits for a long time interval, from Farneta FU to the whole Galerian (Di Stefano & Petronio, 2002; Petronio *et al.*, 2011).

As for equids, *E. stenoni*s and *E. stehlini* were both identified with confidence. For biochronological purposes, *E. stenonis* has an excessively long timespan in the Italian peninsula ranging from the middle Villafranchian to the whole late Villafranchian (Gliozzi *et al.*, 1997; Petronio *et al.*, 2011) or to part of the same late Villafranchian, until the Tasso FU (Rook & Martínez-Navarro, 2010; Alberdi & Palombo, 2013). Conversely, *E. stehlini* has a very short biochronological life, limited to a short stretch of the late Villafranchian between Tasso and Farneta FUs (Gliozzi *et al.*, 1997; Rook & Martínez-Navarro, 2010; Petronio *et al.*, 2011). However, according to a recent revision of stenonoid horses from Italy, its occurrence in local faunas referred to Farneta FU needs to be confirmed, due to the uncertainty about the actual chronostratigraphic position of most the Tuscany material belonging to old collections (Alberdi & Palombo, 2013).

Therefore, in consideration of the taxa identified and their biochronologic data, it seems possible to give a precise chronological interval to the Villafranchian mammal assemblage from Frattaguida limited to the Tasso FU.

5. CONCLUSIONS

Several taxa, such as *Canis* cf. *C. arnensis*, *Mammuthus* sp., *Stephanorhinus* sp., *Equus stenonis*, *E. stehlini*, *Axis nestii*, *Eucladoceros ctenoides* vel *dicranios* and *Leptobos* sp., were identified among the mammal fossil remains collected from the top of a hill, near the Church of Santa Maria della Neve, in the village of Frattaguida (Parrano, south-western Umbria). It can be noted that *E. stehlini* was identified through a complete metacarpus and that the fossil remains from Frattaguida represent a rare Italian record of this small Villafranchian equid outside Tuscany (see Alberdi *et al.*, 1998; Alberdi & Palombo, 2013).

The concomitant occurrences of *E. stehlini* and *A. nestii*, in particular, have made it possible to attribute this late Villafranchian mammal assemblage to the Tasso FU. This agrees with other faunal findings collected in the neighbouring areas, such as the *Meganthereon cultridens* remains (Argenti, 2004). Furthermore, this result seems to be in agreement with the geomorphological, morphoneotectonic and hydrographic observations on the Pornello-Frattaguida lacustrine basin by Cattuto *et al*. (1988) and permits to also better specify the age of filling of the lacustrine basin (or at least this area of Pornello-Frattaguida basin) to the late early Pleistocene, late Villafranchian, Tasso FU, about 1.7 Ma ago (Fig. 6). This conclusive datum fits well into the paleogeography of south-western Umbria (Ambrosetti *et al.*, 1987, 1995; Basilici, 1997; Girotti *et al.*, 2003; Argenti, 2004) in which there were, in addition to the Frattaguida-Pornello basin, several other Villafranchian fluvio-marsh and

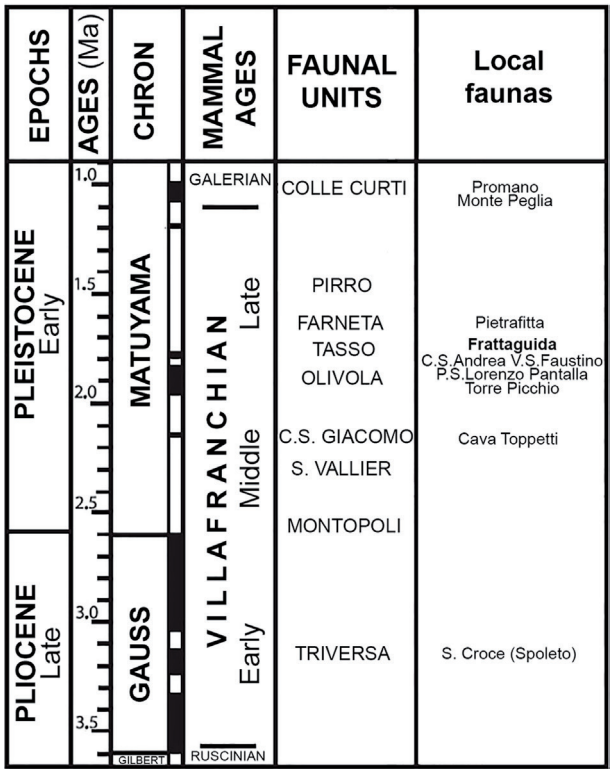

Fig. 6: Biochronologic position of Frattaguida mammal assemblage, the local faunas mentioned in the text and other selected mammal assemblages from Umbria (Italy).

fluvio-lacustrine basins, such as the Tavernelle basin, to North, and the central-southern part of the much larger Tiberino Basin, to East. These basins have been the subject of recent studies (Girotti *et al.*, 2003; Martinetto *et al.*, 2014; Cherin *et al.*, 2016, 2019a, *inter alios*) and have also returned abundant faunal remains which, depending on the taxa reported, testify to a time interval between the middle and late Villafranchian, from Coste S. Giacomo to Farneta FUs.

The main sites of this area are schematically summarized in the Figures 1 and 6. The oldest local fauna is Cava Toppetti (Abbazzi *et al.*, 1997; Petronio *et al.*, 2011) in which *Stephanorhinus etruscus* and, above all, *Equus livenzovenzis* and *Axis lyra* indicate a biochronologic position included in Coste S. Giacomo FU. The most recent mammal assemblage is Pietrafitta, attributed to Farneta FU (Argenti, 2004; Petronio *et al.*, 2011) essentially for the occurrence of *Praemegaceros obscurus*. Among the other sites depicted in Figure 1, Pantalla and Torre Picchio were correlated with Olivola FU, and Podere San Lorenzo with Olivola/Tasso FUs, due they contain taxa such as *C. etruscus*, *M. meridionalis*, *E. stenonis*, *S. etruscus*, *Sus strozzii*, *A. nestii*, *E. dicranios* vel *ctenoides*, *L. etruscus*, among other (Gentili *et al.*, 1997; Girotti *et al.*, 2003; Cherin *et al.*, 2016, 2019a) compatibles with both the FUs. The faunal remains from Colle Sant'Andrea and Villa San Faustino, recovered from the same sandy deposits of the Santa Maria di Ciciliano formation (Ambrosetti *et al.*, 1995; Sardella *et al.*, 1995; Petronio *et al.*, 2002), for the occurrence of *Leptobos* cf. *L. vallisarni* and *A. nestii* were referred to Tasso FU, almost coevals to the Frattaguida mammal assemblage.

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