Il Quaternario
Italian Journal of Quaternary Sciences
***23**(2), 2010 - 257-262*

MAMMAL FOSSIL RECORD, DEPOSITIONAL SETTING, AND SEQUENCE STRATIGRAPHY IN THE MIDDLE-UPPER PLEISTOCENE OF ROMAN BASIN

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ABSTRACT: Palombo M.R. & Milli S., *Mammal fossil record, depositional setting, and sequence stratigraphy in the Middle-Upper Pleistocene of Roman Basin*. (IT ISSN 0394-3356, 2010)
In the Roman Basin, and particularly in the Ponte Galeria area, Quaternary vertebrate remains are preserved both in continental and marine sedimentary successions. The facies and sequence stratigraphical analyses carried out in the last twenty years on such deposits led to a detailed local chronostratigraphical framework which fixes some physical and temporal limits to the fist/last local appearances of some mammalian taxa. This contributes to a better definition of faunal complexe, characterizing the biochronological setting proposed for the Quaternary large mammal faunas of the Italian peninsula.

Riassunto: Palombo M.R. & Milli S., Record fossile a mammiferi, assetto deposizionale e stratigrafia sequenziale della successione del Pleistocene medio-superiore del Bacino Romano. *(IT ISSN 0394-3356, 2010)*
Nel Bacino Romano, ed in particolare nell'area di Ponte Galeria, resti di vertebrati quaternari sono presenti in successioni sedimentarie sia continentali sia marine. L'analisi di facies e stratigrafico- sequenziale condotta su tali depositi nel corso degli ultimi venti anni ha portato ad un dettagliato inquadramento cronostratigrafico dei depositi e ha consentito di fissare limiti temporali per la prima comparsa di alcuni taxa, in particolare grandi mammiferi fra cui specie non ancora segnalate nel resto della penisola, contribuendo così ad una migliore caratterizzazione dello schema biochronologico proposto per le faune a grandi mammiferi del Quaternario della penisola italiana.

Key words: Large Mammals, Biochronology, Sequence Stratigraphy, Pleistocene, Roman Basin.

Parole chiave: Grandi Mammiferi, Biocronologia, Stratigrafia sequenziale, Pleistocene, Bacino Romano.

1. INTRODUCTION

The sedimentary cyclicity characterizing the Quaternary stratigraphical record represents an outstanding example on how climate and glacio-eustatic signals could affect the stratigraphical setting of sedimentary successions. The Quaternary sedimentary record of the Roman Basin hightlights this climate-driven cyclicity by a continuous modification of landscape and of depositional environments. Moreover, the peculiar environmental conditions and the paleogeographical setting of the Latium area during the Middle-Late Pleistocene (Fig. 1) promoted the diffusion of a rich mammal fauna and their postmortem preservation in deposits of different sedimentary environments. The latters mainly range from transgressive fluvial and fluvio-palustrine deposits, filling incised valleys (TST), to highstand barrier island–lagoon deposits (HST) (Milli *et al*., 2008).

2. GEOLOGICAL AND SEQUENCE-STRATIGRAPHICAL SETTING

The investigated area is located along the Latium Tyrrhenian margin that has undergone extensional tectonic processes since the Late Miocene, in connection with the opening of the Tyrrhenian basin, and intense volcanic activity that reached a climax in the Middle-Late Pleistocene.

During the Pleistocene the geological and palaeogeographical evolution was controlled by the close interaction among three main processes: the glacio-eustatic sea-level fluctuations related to Quaternary climatic changes, the volcanic activity, and the tectonic uplift of the Latium Tyrrhenian margin. Starting by the pioneering work by Conato *et al*. (1980), the Pleistocene succession mainly cropping out in the Ponte Galeria area was subdivided into informal lithostratigraphic units named, from the oldest to the youngest, Monte Mario Formation (Lower Pleistocene, 'Calabrian'), and Ponte Galeria, S. Cosimato, Aurelia, and Vitinia Formations ranging in age from the latest Early Pleistocene to the late Middle Pleistocene ('Ionian') (Fig. 2). In the last years, the stratigraphic resolution of sedimentary successions has notably improved due to development of sequence stratigraphic concepts. Thanks to this methodology, the spatial-temporal relationships between terrestrial and marine depositional systems in relation to sea-level changes have been better defined. Basing on a detailed facies and physical stratigraphic analysis of the Pleistocene/Holocene sedimentary succession, Milli (1992, 1994,1997, 2006) refined the stratigraphy of the

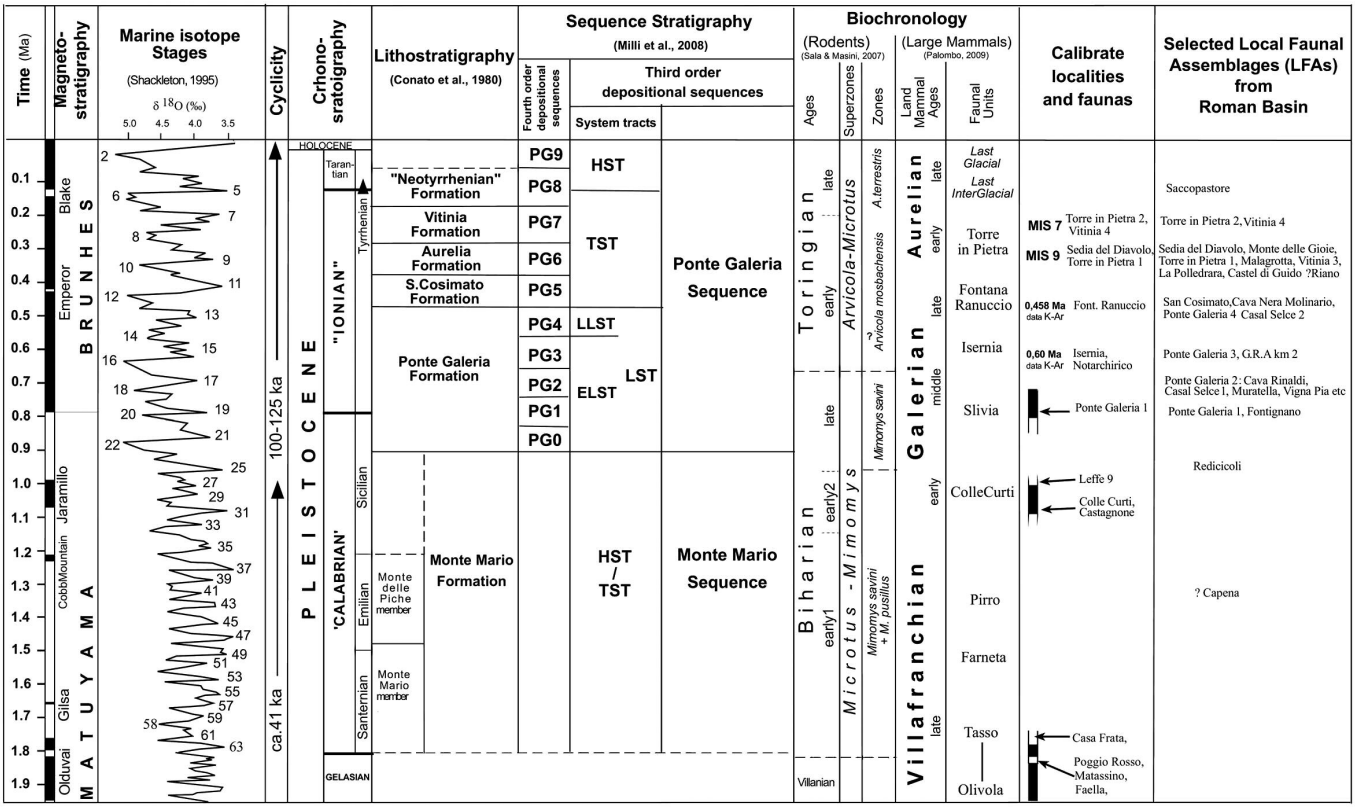

Fig. 1 - Integrate chronostratigraphy and sequence stratigraphy of the Pleistocene deposits of the Roman basin and biochronological setting of Italian mammal faunas.

area defining several fourth-order sequences, stacking to form two composite third-order sequences named Monte Mario Sequence (MMS) and Ponte Galeria Sequence (PGS) (Fig. 1). Most of the mammal remains are contained in the PGS. The PGS extends for about 30 km, in NW-SE direction, along the Latium coastline; in the area between Roma and the coastline its thickness varies from 10-15 m to 100-110 m, depending on the intensity of the erosional phases connected with cyclic, recurrent lowerings of relative sea level. The PGS consists of ten 4th-order sequences with an approximate period of 100,000 years (Fig. 1); the boundaries of these high-frequency sequences are expressed by sharp erosional surfaces, recording basin- and downward shifts of facies, subaerial exposure and by paleosols in the interfluve areas, which put in contact sediments belonging to different depositional systems (MILLI *et al.*, 2008 and references therein).

The fourth-order depositional sequences are characterised by a seaward stack, which is opposite to the trend that the PGS would have had if controlled by glacio-eustasy alone. This trend is though to be the result of the close interaction between high frequency sea-level fluctuations related to glacio-eustasy and the tectonic uplift, which comprises also a local volcanically-induced component, particularly strong during the late Quaternary time, that affected the LatiumTyrrhenian margin during the Middle-Late Pleistocene. In particular the lower four 4th-order sequences (PG0 to PG3) stack to form the early LST, which developed during a period of relative sea-level fall producing a series of prograding and downstepping wedges-shaped high-frequency sequences. Stratigraphical relationships between PG4 and the underlying sequences enable us to assign it to the late LST, whereas sequences from PG5 to part of PG8 can be ascribed to the TST, and the sequence PG9 entirely to the HST (Fig. 1) (MILLI *et al.*, 2008).

3. MAMMALIAN REMAINS FROM THE PONTE GALERIA SEQUENCE: BIOCHRONOLOGICAL FRAMEWORK

In the Rome urban area, a molar tooth of *Mammuthus meridionalis* has been found in the marine sands of the MMS, attributed to the Lower Pleistocene (Santernian), while in the in the area between Rome and the Latium coastline, most of the mammalian remains come from both continental and marine sediments of the PGS (Fig. 1,3). Particularly, in the Ponte Galeria area, the richest Local Faunal Assemblages (LFAs) come from the PG2, PG3 and PG4 4th-order sequences, developed during a period of long term (i.e. related to the 3rd order cyclicity) average sea-level fall and initial rise. Fossil bones have been found in transgressive fluvial and fluvio-palustrine deposits filling incised valleys (TST) and in highstand barrier island-lagoon deposits (HST) of the 4th order sequences (see MILLI & PALOMBO, 2005; MILLI *et al.*, 2008). Remains from PG2 to PG4 sequences represent the “classic Italian Galerian fauna” (see AMBROSETTI, 1967; AMBROSETTI *et al.*, 1972) ascribed to the middle Galerian Land Mammal Age (LMA) (GLIOZZI *et al.*, 1997; PALOMBO, 2009). Few teeth of “cold”

small mammals (*Prolagurus pannonicus* and *Predicrostonyx* sp., Ponte Galeria 1 LFA) have been retrieved from the lacustrine lagoonal deposits of PG1 sequence (Fontignano, *Helicella* clay), which recent paleomagnetic data have attributed to an inverse polarity (see KOTSAKIS *et al.*, 1992; MARRA *et al*., 1998). These data, together with stratigraphic and sedimentological data, (see, MILLI, 1997) indicate that these sediments were deposited during a cold climate phase (MIS 20); they have been also attributed to the Late Lowstand Systems Tracts of the PG1 sequence (MILLI, 1997).

In the beach sand and gravel deposits underlying the *Venerupis senescens* clays (HST of sequence PG2, whose age roughly ranges from 0.72 to 0.68 Ma) the first local appearance (FLA) of *Crocuta crocuta, Mammuthus trogontherii, Megaloceros savini*, and *Hemibos galerianus* represents also the lowest occurrences of these taxa in the Italian peninsula (Fig. 3). Among other taxa retrieved from these deposits, *Equus altidens* first appeared in Italy during the latest Villafranchian, *Stephanorhinus hundsheimensis* and *Praemegaceros verticornis* are first recorded shortly before and at the beginning of the Jaramillo subchrons, whilst *Palaeoloxodon antiquus, Cervus elaphus acoronatus* and *Bison schoetensacki* appeared in the latest Early Pleistocene (PALOMBO, 2009 and references therein). The appearance of spotted hyaena would suggest that this LFA (Ponte Galeria 3 LFA, PALOMBO, 2004, 2009) would be younger than the Slivia LFA (Northeastern Italy), where *Pachycrocuta brevirostris* is still present. But, is this enough to support the Petronio and Sardella's hypothesis (PETRONIO & SARDELLA, 1999) according to which Slivia LFA and Ponte Galeria 2 LFA belong to two distinct Faunal Units? Taking into account the doubtful identification of some main herbivores of the Slivia local fauna, as well as the scanty knowledge of small mammals belonging to Ponte Galeria 2 LFA, the possibility that Slivia and Ponte Galeria LFAs belong to the same FU cannot be ruled out (see PALOMBO, 2004, 2009). Moreover, much more data need to clarify the dynamics of *C. crocuta/P. brevirostris* replacement in the Western Mediterranean, where *P. brevirostris* and *C. crocuta* seem to have been both present across the Early/Middle Pleistocene boundary. For instance, in the Iberian peninsula *P. brevirostris* is recorded during the latest Pleistocene at Vallparadís (Terrassa, Catalonia) in deposits correlated with MIS 21 (MADURELL-MALAPEIRA *et al*., 2010), while *C. crocuta* is present, just before the Matuyama/Bruhnes boundary transition, in the TD6 level from Gran Dolina (Atapuerca, North Spain) (CUENCA-BESCOS & GARCIA, 2007).

The LAF (Ponte Galeria 3) from the HST beach deposits and the lacustrine-palustrine deposits of PG3 sequence (about 600-550 ka) (Fig.1,3), counts several vertebrates remains (birds, amphibians and reptiles, small and large mammals), among which the vole *Arvicola mosbachensis* (MILLI & PALOMBO, 2005; SARDELLA *et al*., 2006) confidently confirms that the LFA can be ascribed, together with the almost coeval Isernia La

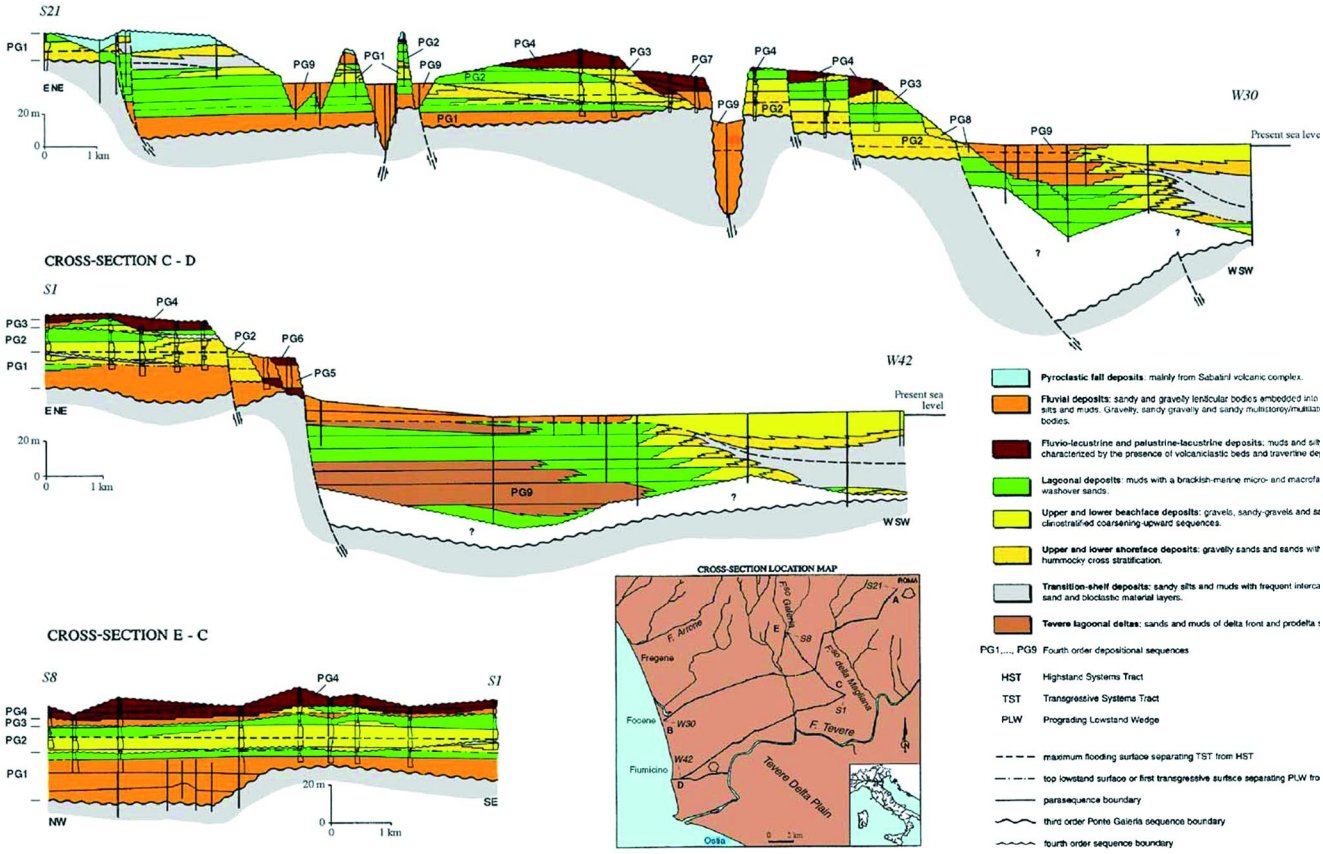

Fig. 2 – High-resolution strathigraphical cross-section and depositional setting of the third-order Ponte Galeria Sequence (PGS) between the town of Rome and the Latium coastline (modified after MILLI, 1997).

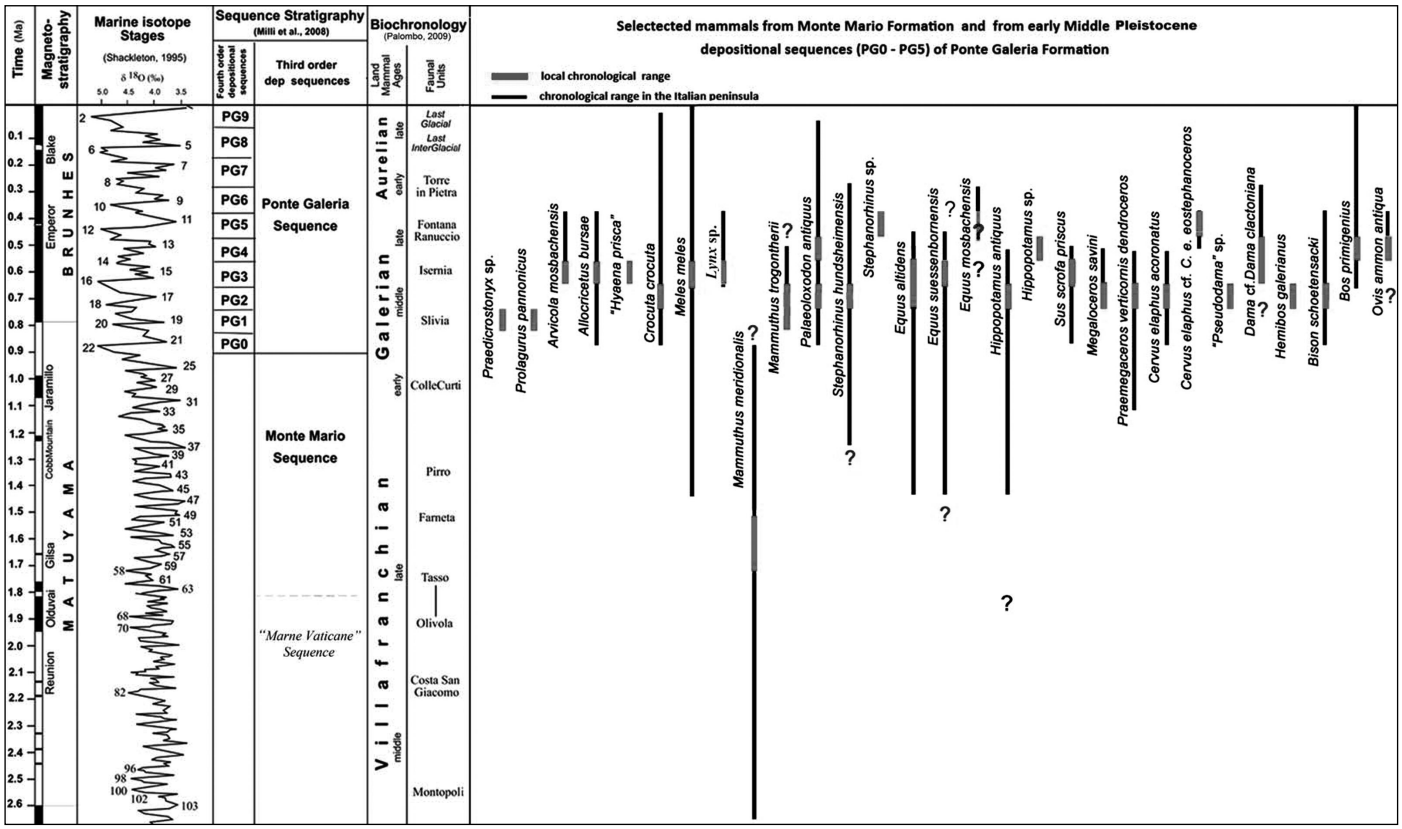

Fig. 3 - Biochronology of selected large mammals found in the Monte Mario and Ponte Galeria third-order sequences (Roman Basin).

Pineta LFA (Central Italy) (COLTORTI *et al*., 2005, and references therein) to the oldest Toringian fauna recorded in Italy to date (SALA & MASINI, 2007) (Fig. 1,3). The Ponte Galeria 3 LFA is fairly rich and diversified, including together with *Allocricetus bursae*, a primate (*Macaca sylvanus*), a few carnivores such as *Meles meles, Lynx* sp., a hyaena whose taxonomical identification is still matter of debate, (*''Hyaena prisca''* = *Pliohyaena perrieri* according to TURNER *et al*. 2008), as well as large (*Stephanorhinus* cf. *S. hundsheimensis, Equus altidens, Equus suessenbornensis, Hippopotamus* ex gr. *H. antiquus, Bison* cf. *B. schoetensacki)* and middle-sized herbivores (*Sus scrofa priscus, "Pseudodama"* sp., *Cervus elaphus acoronatus*) (CALOI & PALOMBO, 1986; PETRONIO & SARDELLA, 2001; MILLI & PALOMBO, 2005).

In deposits of about 500 ka belonging to the HST of the PG4 sequence, some vertebrate remains (Testudinata, some bones of a disarticulated skeleton of *Palaeoloxodon antiquus, Hippopotamus* sp., *Dama* sp., and *Bos primigenius*) have been found at the Casal Selce quarry (Casal Selce 2 LFA) (MILLI *et al*., 2005). These deposits are represented by fluvial braided sandy deposits at the base, passing upward to lagoonal mud and silty-sands and muds of palustrine-lacustrine environment (MILLI, 1997). The deposits are characterized by a high component of volcaniclastic material (ranging in age between 500 and 485 ka, see KARNER & RENNE, 1998; KARNER & MARRA, 1998), which was emplaced through fall events (MILLI *et al*., 2008). The LFA could be ascribed to the late Galerian Fontana Ranuccio FU, as well as the sporadic remains of late Galerian taxa that have been uncovered in sediments interbedded with the Sabatini volcaniclastic deposits (Tufo Giallo della via Tiberina or Tufi Stratificati Varicolori di Sacrofano) (e.g., *Cervus elaphus eostephanoceros, Hippopptamus* ex gr. *H. amphibius*).

New studies carried out on the incomplete skull of *Ovis ammon antiqua* reported by PORTIS (1917) as hypothetically retrieved from deposits overlaying the "Pozzolane grigie" in the Magliana area, enable us to clarify that the argali skull is at least younger than the beginning of the volcanic activity in the study area and to hypothesize that it was possibly found in the TST/HST lacustrine-lagoonal deposits of the PG4 sequence (see ROZZI *et al*., in press for a discussion). Accordingly, the incomplete skull of *Ovis ammon antiqua* should be referred to the Fontana Ranuccio FU and regarded as penecontemporaneous with or slight older than the argali from Visogliano (Northeaster Italy), the only other specimen of such a rare species thus far recorded in Italy (ABBAZZI *et al*., 2000; FALGUERES *et al*., 2008).

LFAs belonging to Aurelia Formation/PG6 and Vitinia Formation/PG7 (Fig. 1) sequence are characterized by the association of *Palaeoloxodon antiquus* with large *Bos primigenius*, accompanied by cervids (*Dama clactoniana, Dama dama tiberina, Cervus elaphus, Capreolus capreolus* and *Megaloceros giganteus*), while *Equus ferus* may be present, at times in abundance, and *Equus hydruntinus* sporadically occurs. Rhinoceroses (*Stephanorhinus hemitoechus, S. hundsheimensis* and S. *kirchbergensis*), hippopotamus, wild boar and middle- sized carnivores (*Canis lupus, Vulpes*

vulpes) are often present, while the large (*Ursus spelaeus, Panthera spelaea, Panthera pardus*) and small (Mustelidae) carnivores are poorly documented (Palombo *et al*., 2003 and references therein; Milli *et al.*, 2008). These LFAs can be referred to the early Aurelian LMA (Torre in Pietra FU) (see Palombo *et al*., 2004; Palombo, 2009 for a discussion).

4. REMARKS

In the Roman Basin, the vertebrate remains collected from the high-frequency depositional sequences should be ascribed to faunal complexes with a temporal range comparable to the range of the high-frequency sequences. Although the possibility of exhumation exists, the type of fossil remains, their mode of preservation, and the characters of the depositional environments suggest that faunal remains have the same age of the deposits within which they are contained. Accordingly, the sequence-stratigraphic framework as well as the radiometric and palaeomagnetic data (see Milli, 1997; Karner *et al*., 2001; Marra *et al*., 2008 and references therein) enable us to constrain the age of the LFAs, to better calibrate bioevents both with the geochronology and oxygen isotope signals, and to improve our knowledge on local highest occurrences/last appearances of mammal taxa in the Italian peninsula.

ACKNOWLEDGMENTS

The authors thank the anonymous reviewers for their comments to the manuscript.

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Ms. ricevuto il 4 agosto 2010
Testo definitivo ricevuto il 18 novembre 2010

Ms. received: August 4, 2010
Final text received: November 18, 2010