TWENTY YEARS LATER:
REFLECTIONS ON THE AURELIAN EUROPEAN LAND MAMMAL AGE

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ABSTRACT: In 1997, some Italian palaeontologists proposed a new biochronolgical assessment for selected Italian Late Pliocene-Quaternary terrestrial mammal, mollusc and ostracod species. In particular, they proposed a new Land Mammal Age (Aurelian LMA), emphasising the relevance of the taxonomical and functional turnover that characterised the post-Galerian fauna ("extinction of some Galerian forms" and the first appearance of "taxa which constitute the core of the modern mammal fauna"). During the following decades, the discovery of several Middle Pleistocene European Local Faunal Assemblages (LFAs) led to a continuous increasing of data and knowledge on the taxonomical status and the chronological range of several large mammal taxa, and new radiometric/absolute dates and magnetostratigraphical information provided substantial evidence, for a new chronological assessment of a number of European LFAs. This note aims to present a synthetic overview of the most significant new evidence and some reflections on the transition from the Galerian to the Aurelian ELMA, and the significance of the Aurelian as European Land Mammal Age.

KEYWORDS: Biochronology, biochronological units, large mammals, middle Pleistocene

1. INTRODUCTION: THE FACT OF THE MATTER

The Biochronological Units (BUs) known as Land Mammal Ages (North, NALMA, and South American, SALMA, European, ELMA, and Asian, ALMA) were initially developed in the first half of the last century in an attempt to chronologically order the North American Cenozoic mammalian assemblages (Wood et al., 1941). Since that time, LMAs have been largely, but diversely/ambiguously used by palaeontologists, and are still loosely defined. The requirements they have to fulfil, indeed, have never been discussed in any stratigraphical code (see Lindsay, 2003, pages 213, 220), and the criteria required to create a BU are vague and remain unaddressed. According to Tedford (1970, page 602), for instance, a BU (a biological entity equivalent to a discrete natural association of fossil species) could be regarded as non-overlapping and "ecologically adjusted groups of animals with specific geographical limits and chronological range", while Lindsay (2003, page 222) defined more explicitly a LMA as "a relatively short interval of geologic time that can be recognised and distinguished from earlier and later such units (in a given region or province) by a characterizing assemblage of mammals".

The first/last historical appearance (FHA/LHA) (palaeobiological events inferred on the basis of the sum of known, palaeobiological data provided by the fossil record derived from strata from the focal geographical region), the peculiar taxonomical composition and ecological structure of the mammalian fauna (which make a BU different from the earlier and later ones recorded in the same geographical area), are the key factors to consider to correctly identify a BU, whichever its chronological range should be. The known lowest and highest stratigraphical occurrence of a taxon in a given geographical area (stratigraphical datum), however, does not necessarily correspond to its first and last appearance in the time (palaeobiological datum). The finding of a taxon, regarded as a biological chrostratigraphical marker of a BU (sensu Lindsay, 2003) in stratigraphical levels significantly older/younger than those previously providing its fossil record may, for instance, substantially change the chronological extent of the BU to which it belongs, without changing its theoretical definition. This in turn implies a new assessment and definition of the BUs directly preceding/succeeding in time the focal one. In addition, increasing palaeontological and stratigraphical data might allow to better discriminating bioevents, on the one hand highlighting, the gradual transition between successive BUs, but, on the other, blurring a clear identification of the BUs. As a result, any biochronological scheme, and the definition and temporal extension of a BU, even if dependable, are open to change because depending on the available data,.

This note aims to present the main evidence suggesting to revise the definition of the Aurelian BU (as provided at the time it was proposed by Gliozzi et al., 1997) and its significance as ELMA, and some preliminary reflections on the issues related to the transition from the Galerian to the Aurelian ELMA. A more exhaustive discussion will be provided elsewhere.

2. THE AURELIAN BIOCHRONOLOGICAL UNIT: A REAPPRAISAL

The Aurelian BU was introduced in 1997 in the context of a new biochronological assessment proposed by a team of Italian palaeontologists for selected Italian Late Pliocene-Quaternary terrestrial mammal, mollusc and ostracod species (Gliozzi et al., 1997, page 372). The Italian researchers recommended the new Aurelian Land

Mammal Age (LMA) for the late Middle-Late Pleisto-cene mammalian fauna, i.e. from Marine Isotopic Stage (MIS) 10 to MIS 2, emphasising the relevance of the taxonomical and functional turnover characterising the transition from the Galerian to the post-Galerian fauna ("extinction of some Galerian forms, such as the megacerine cervids of the *Megaceroides* (recte *Praemegaceros) verticornis* group, *Megaloceros savini* and the more archaic elaphine deer", and the first ap-pearance of "taxa which constitute the core of the mod-ern mammal fauna") (Gliozzi et al., 1997, page 372). The characterisation of the new LAM was mainly based on the taxonomical composition of some Italian local faunal assemblages (LFAs) found in "deposits, which date to the late Middle Pleistocene and the Late Pleisto-cene" (Gliozzi et al., 1997, page 372).

The FHA of *Canis lupus*, *Ursus spelaeus* and *Magaloceros giganteus* (mentioned as regards to their FHA in the oldest Aurelian Faunal Unit) were the bio-events chosen by Gliozzi et al. (1997) to identify the beginning of the Aurelian BU, but what about the time of the FHA of these taxa in Europe? New evidence dates back the *C. lupus* presence to MIS 14(?) – MIS 13 (Galería GII, Atapuerca, Spain) (Rodriguez et al., 2011; Álvarez-Posada et al., 2018). A small wolf, *Canis lupus lunellensis,* was already reported from Lunel Viel (France), a site dating to about 400- 350 ka (Brugal and Boudadi-Maligne, 2011 and references therein), and the modern wolf is also recorded, together with *M. gi-ganteus*, during MIS 11 in some European LFAs, for instance, in Britain (Stewart, 2008 and references therein). The time of the lowest stratigraphical occur-rence in Europe of *U. spelaeus* cannot firmly be estab-lished due to some confusing taxonomical treatments of

some specimens (most lacking sound taxonomical diag-nostic features), likely belonging to one or the other species of the cave bear lineage known in the Middle Pleistocene: *Ursus deningeri* and its putative descen-dant *U. spelaeus*. In Schreve's opinion (Schreve, 2001, page 1694), for instance, in the "Swanscombe mammal assemblage-zone" (MIS 11) "the early Middle Pleisto-cene form *Ursus deningeri* Reichenau" was "superseded by the more advanced form *Ursus spelaeus".* The Den-inger' bear, conversely, has been reported even from significantly younger LFAs, such as Orgnac 3 levels 7-3 (France) (e.g. Sam, 2009).

The available data, moreover, indicate that some among the large mammals commonly found in the Aurelian LFAs were already present either in the post-Jaramillo Early Pleistocene (e.g. *Palaeoloxodon antiquus, Crocuta crocuta, Lynx pardinus, Sus scrofa),* or in the early Middle Pleistocene (MIS 19 - MIS 12) (e.g. *Ursus arctos, Ursus thibetanus, Vulpes vulpes, Cuon alpinus, Felis silvestris, Stephanorhinus hemi-toechus, Bos primigenius, Dama clactoniana, Bison priscus, Bos primigenius,* maybe *Rupicapra pyrenaica),* or at least during MIS 11(e.g. *Hippopotamus* ex gr. *H. amphibius*, modern roe deer *Capreolus capreolus, M. giganteus*), suggesting to predate the beginning of the Aurelian BU (Fig.1, 2).

Assuming that the hypothesis could be correct, the question arises about the time of the transition from the Galerian to the Aurelian BU.

According to Gliozzi et al. (1997, page 372), the late Galerian fauna, to which only the Fontana Ranuccio F.U. was referred, "is characterised by the total disap-pearance of typical Villafranchian taxa with the excep-tion of *Homotherium*" and by the presence of "the red
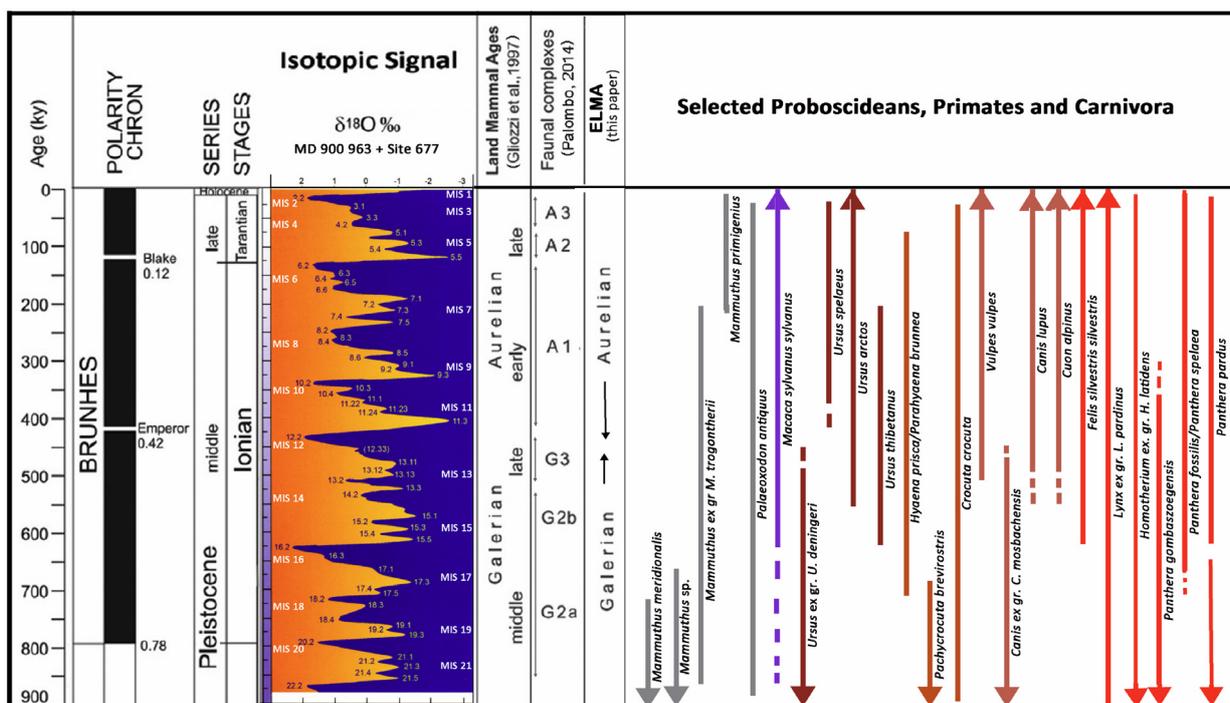

Fig. 1 - Chronological range of selected Middle and Late Pleistocene European Proboscideans, Primates, and Carnivora.
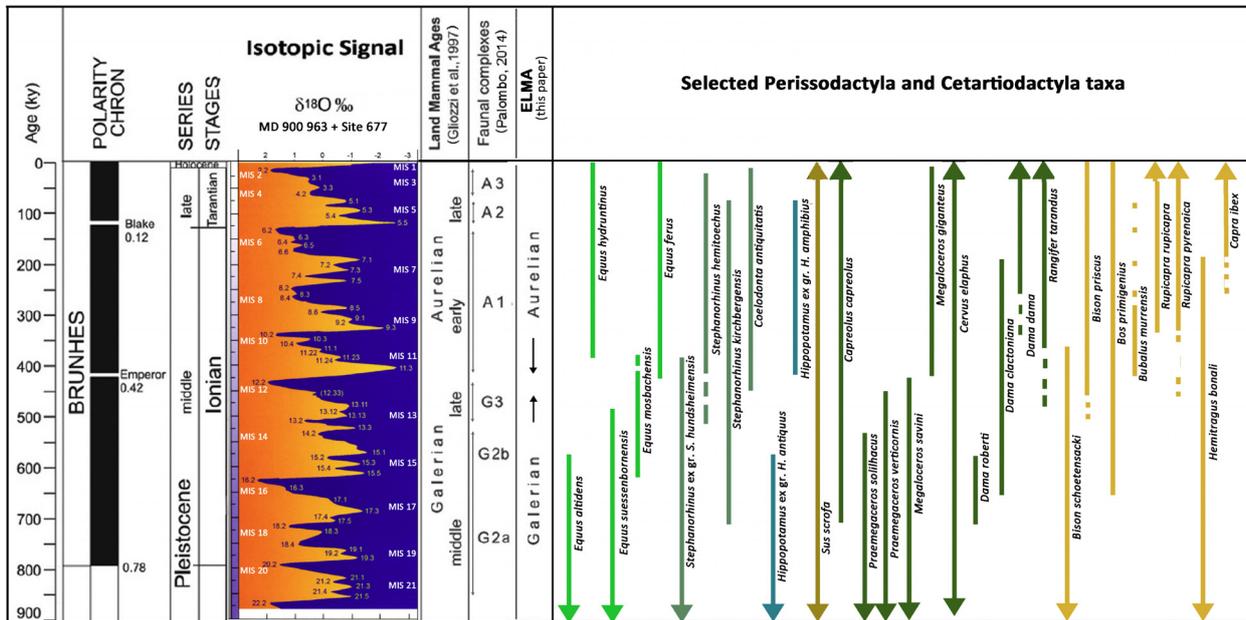
Fig. 2 - Chronological range of selected Middle and Late Pleistocene European Perissodactyla and Cetartiodactyla.

deer subspecies *Cervus elaphus eostephanoceros.* As regards to the "Villafranchian" large predators, new data indicate that the saber-toothed cat was still present during MIS 3 (Reumer et al., 2003), and *Panthera gombaszoegensis* in deposits correlated to MIS 9 or MIS 10 (Marciszak, 2014). It is worth noting, that Fontana Ranuccio LFA (Anagni Basin, central Italy), regarded by Gliozzi et al. (1997) as one of the most representative late Galerian site and epitome of the homonymous F.U., was at that time dated to 0.458 Ma (MIS 12). The age of most of the European LFAs successively correlated to the Fontana Ranuccio LFA or ascribed to the homonymous F.U. fall in the chronological range of MIS 13 and MIS 12. Recently, Pereira et al. (2018) obtained a ⁴⁰Ar/³⁹Ar age of 408±10 ka for the archaeological level (unit FR4) of Fontana Ranuccio, roughly corresponding to MIS 11 climatic optimum, in some agreement with the fauna ecological structure. According to the new date, the LFA would fall in the extended chronological range of the Aurelian BU, together with other roughly coeval LFAs from the same geographic area already regarded as "Aurelian" (e.g. Isoletta, Lademagne). Although this fact could not substantially affect the definition of the "late Galerian", the question about the significance of *C. e. eostephanoceros* as a biological chrostratigraphical marker remains unsolved. In the Gaudo San Nicola LFA, a site chronologically and geographically close to Fontana Ranuccio, indeed, Sala et al. (2014) claimed the presence of the archaic *Cervus eluphus acoronatus* subspecies, considering *C. e. eostephanoceros* a young synonymous of the former.

All in all, the available data evidence the gradual, progressive transition from a ELMA to the successive one during the late Early and Middle Pleistocene, as well as the complexity in properly detecting and defining such ELMAs.

3. REMARKS

The sum of evidence highlights the gradual modification of the structure of the mammalian palaeocommunities, leading to the configuration of the Aurelian ones (e.g. Palombo, 2017), and, in turn, the difficulty to properly define discrete LMAs succeeding each other during a short geological time. The original LMA concept, indeed, implicitly implies a long persistence in time and a wide geographical extent for each unit, given that the mean duration of a large mammal Cenozoic species is about 3 Ma (see Prothero, 2014 as regards to the North American mammals). Therefore, the shorter the time slice is, the more difficult to properly define a LMA could be. Any analysis performed on short geological time periods, for instance, may sometimes force researchers to consider taxa at a low taxonomical rank, thereby increasing the risk of disagreements in the taxonomies applied by the authors. Additional drawbacks may concern the need of a particularly detailed chronology, in contrast with a proportionally low number of LFAs with firm chronological constrains.

An alternative approach may be to focus more on the detection of "ecologically adjusted groups of animals with specific geographical limits and chronological range" than merely on FHA/LHA bioevents. Following this line of reasoning, taking into account: i) the climatic and environmental changes (e.g. the increase in summer temperatures, and average forest expansion during interglacial phases) that occurred since MIS 11; ii) its peculiarity with respect to the previous Middle Pleistocene interglacials (higher level than present-day sea related to the collapse of Greenland and West Antarctica ice sheets, greenhouse gas-driven climate warming pattern of insolation variability matching the Holocene one) (e.g. Oliveira et al., 2016 and references therein), iii) the number of FHA reported at that time (Figs. 1, 2),

iv) the Functional Diversity characterising the large mammal fauna since MIS 11 (Palombo, 2016), the hypothesis to chronologically extend the Aurelian BU to include MIS 11 seems to be the most reasonable. As a result, the definition and biochronological significance of the "late Galerian" fauna, which according to Gliozzi et al. (1997) only includes the "Fontana Ranuccio Faunal Unit", has to be reconsidered.

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