

## CONSIDERATIONS ON AN INTEGRATED BIOCHRONOLOGICAL SCALE OF ITALIAN QUATERNARY CONTINENTAL MAMMALS

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**ABSTRACT:** ABSTRACT: Masini F. & Sala B., *Considerations on an integrated biochronological scale of Italian Quaternary continental mammals.*

The paper of MASINI and SALA (2007) regarding an integrated approach on the stratigraphic distribution patterns of large and small mammals in the late Pliocene and Pleistocene of the Italian peninsula is analysed, showing the weak and strong points. New data are presented on the mammal biochronology of the Late Pleistocene

**RIASSUNTO:** Masini F. & Sala B., *Considerazioni su una scala biocronologica integrata dei mammiferi continentali quaternari in Italia. Viene analizzato il lavoro di MASINI e SALA (2007) sull'approccio integrato della distribuzione dei grandi e piccoli mammiferi dell'Italia continentale del tardo Pliocene e del Pleistocene, tenendo conto della nuova definizione del Quaternario, mettendo in risalto i punti di forza e quelli deboli della scala proposta. Vengono inoltre aggiunti nuovi dati sulla biocronologia a mammiferi del Pleistocene Superiore.*

Keywords: Biochronology, Mammals, Quaternary, Italian peninsula.

Parole chiave: Biocronologia, Mammiferi, Quaternario, Italia continentale.

Despite the marginal geographical position of the Italian peninsula in the Eurasian continent, Italian Quaternary deposits have yielded a good succession of well diversified fossil mammal assemblages. The effect of the Quaternary climatic changes on faunal associations was moderate due to the gentle effect of the sea. However, there are important differences between the Ligurian - Tyrrhenian coast and the Adriatic coast, which interrelate with the significant latitudinal extension and complex geomorphological setting of the peninsula (SALA 2002; SALA and MARCHETTI 2006). This diverse geographical situation allowed some species to use specially protected areas as refuges during very cold climatic phases.

Mammalian biochronology has a certain tradition in Italy thanks to the pioneering works of AZZAROLI (1977). Villafranchian and Galerian large mammal ages, mainly defined on the Italian succession of large mammal faunas, are of common use in Italy as well as in some other European countries. However, the so called Holarctic biochronological scale based on small mammal faunas, mostly Arvicolidids, is most widespread for the Plio - Pleistocene of Europe and the former Soviet Union. This contribution is a revision of an updated version of the biochronology proposed by MASINI and SALA (2007), SALA and MASINI (2007), in which large and small mammals scales are correlated (the references of the sites here cited are referred to the former paper). The adopted large mammal biochronology is that pioneered by AZZAROLI (1977), and further developed mainly by Italian students; the small mammal scale is that of FEJFAR and HEINRICH (1990). Correlation presents some

difficulties, as only few deposits of the Early Pleistocene and part of the Middle Pleistocene have valid documentation of mammals of both classes of size. The complexity of the correlations is also influenced by many taphonomic factors and by different approaches to the study of the two groups of mammals (e.g. SALA 1983; PALOMBO 2004; MASINI and ABBAZZI 2004). The adopted chronostratigraphical frame is that of GIBBARD et al (2005-2007) according to GIBBARD and HEAD (2009) and GIBBARD et al (2009) definitions.

Recently, Palombo (2009) focuses on the differences between biochronology and biostratigraphy, and bases her chronological framework on large mammals, reporting advantages and deficiencies. The use of large mammals data does not allow, for example, to recognize the age of Valdemino faunal assemblage (lower layers), which is included, for the small mammals, in the lower Toringian for the occurrence of *Arvicola mosbachensis* and the lack of *Mimomys savini*, while it is incorrectly referred to the Slivia FU by Palombo 2009. This author does not accept the Saint Vallier FU because not well documented in Italy and encloses the faunal remains of this Unit in Costa S. Giacomo FU.

The base of the Quaternary period corresponds to the beginning of the Middle Villafranchian (Montopoli Faunal Unit = FU) large Mammal Age, and roughly to the end of the Early Villanyian small Mammal Age. The deposit of Montopoli (Pisa), which occurs at the Gauss-Matuyama transition (LINDSAY et al. 1980), however, is not preceded by adequate documentation of the faunal transition from Early Villafranchian and only yielded large mammal remains. Other sites of this FU (Bocchi-

gnano, Rieti; Vinci, Pisa; Montecarlo, Firenze; Anagni, Frosinone) contain scant assemblages. The second part of the Middle Villafranchian is documented by sporadic finds, possibly representing the St. Vallier FU (e.g. Castel Viscardo, Orvieto) and by the fauna of the Costa San Giacomo FU. The rich micro-teriofaunas of Rivoli Veronese (Verona) and Montagnola Senese (Siena) well document the occurrence of the Late Villafranchian in Italy and correlate with the latest part of the Middle Villafranchian, even though the lack of significant large mammal finds in these localities does not allow a direct correlation.

The transition to the Olivola FU (early Late Villafranchian) is quite gradual, as it is that to the next Tasso FU. Monte La Mesa (Verona) yielded a very rich small mammal fauna, referable to the early part of the Early Biharian, and likely correlated to the Tasso FU. The scant remains of large mammals at Monte la Mesa, however, again highlight the correlation problems mentioned above. The magnetostratigraphic correlations of the faunas of this part of Villafranchian are based almost exclusively on findings in the Upper Valdarno basin, where the sediments containing fauna of Tasso (Arezzo) refers to the top of the sub-magnetochrone Olduvai and thus are placed at the base of the second part of Early Pleistocene (Calabrian). The FU of Farneta and Pirro include Early Biharian micro-fauna (Pietrafitta, Cava Pirro - Dell'Erba, Soave Cava Sud) found together with rich Late Villafranchian large mammal assemblages, thus giving a direct correlation between the two biochronological scales. A calibration for these two faunal units is lacking, but the evolutionary stages of some taxa (*Allophaiomys*) allow to propose a dating around 1.5 and 1.3 Ma respectively.

The Colle Curti (Macerata), Castagnone (Alessandria) and Monte Peglia (Perugia) localities are attributed to the sub-magnetochron Jaramillo. They contain large mammals of the beginning of the Galerian age (Colle Curti FU) and small mammals of late Early Biharian. The following Early Galerian Slivia FU yielded typical Late Biharian microfaunas, where *Microtus (Allophaiomys)* is absent and *Mimomys savini* is associated to more advanced species of *Microtus*. The small mammal fauna of Rifreddo (Potenza) belongs to the same FU and is correlated to the lower part of Brunhes Chron. Documentation becomes richer during the Middle Galerian. The most important sites are Isernia La Pineta (Isernia), Valdemino Cave (Savona), Visogliano (Trieste), deeper layers, and Venosa-Notarchirico (Taranto). The Middle Galerian coincides with the beginning of Toringian, characterised by the substitution of *Mimomys savini* by *Arvicola mosbachensis*. This transition is linked to climate change, with the appearance of more arid environments, at least seasonally, determining greater differences between "cold" and "warm" faunas within the glacial-interglacial cycles. Palaeomagnetic and radiometric dating are available at Isernia and Notarchirico.

The climatic and faunal changes lead to the Late Galerian fauna, represented by the Fontana Ranuccio FU. The small mammal faunas, e.g. Boscochiesanuova (Verona), Loara and Commenda (Vicenza) (BARTOLOMEI 1969, 1980) belong to the Early Toringian, while large mammal faunas are difficult to be placed chronologically, since they poorly differ from the previous ones. The increase in climatic differences between warm and

cold periods, the beginning of a marked regionalism, the similarity of the faunas, especially during warm periods, and the lack of "absolute" dating introduce some uncertainties when assigning the chronology of the deposits.

The spread of faunas with cold affinities (e.g. the occurrence of the modern wolf, the boreal lynx and the ibex) indicates the beginning of the Aurelian Mammal Age (or post-Galerian). We are approaching to the end of the Middle Pleistocene, and the increased documentation, the regional differences, the intensity of climatic oscillations require finer chronological detail. From this moment on, the utility of the Faunal Unit falls short, in favour of Marine Isotope Stages (MIS) which scan the chronology of the major climatic fluctuations very well.

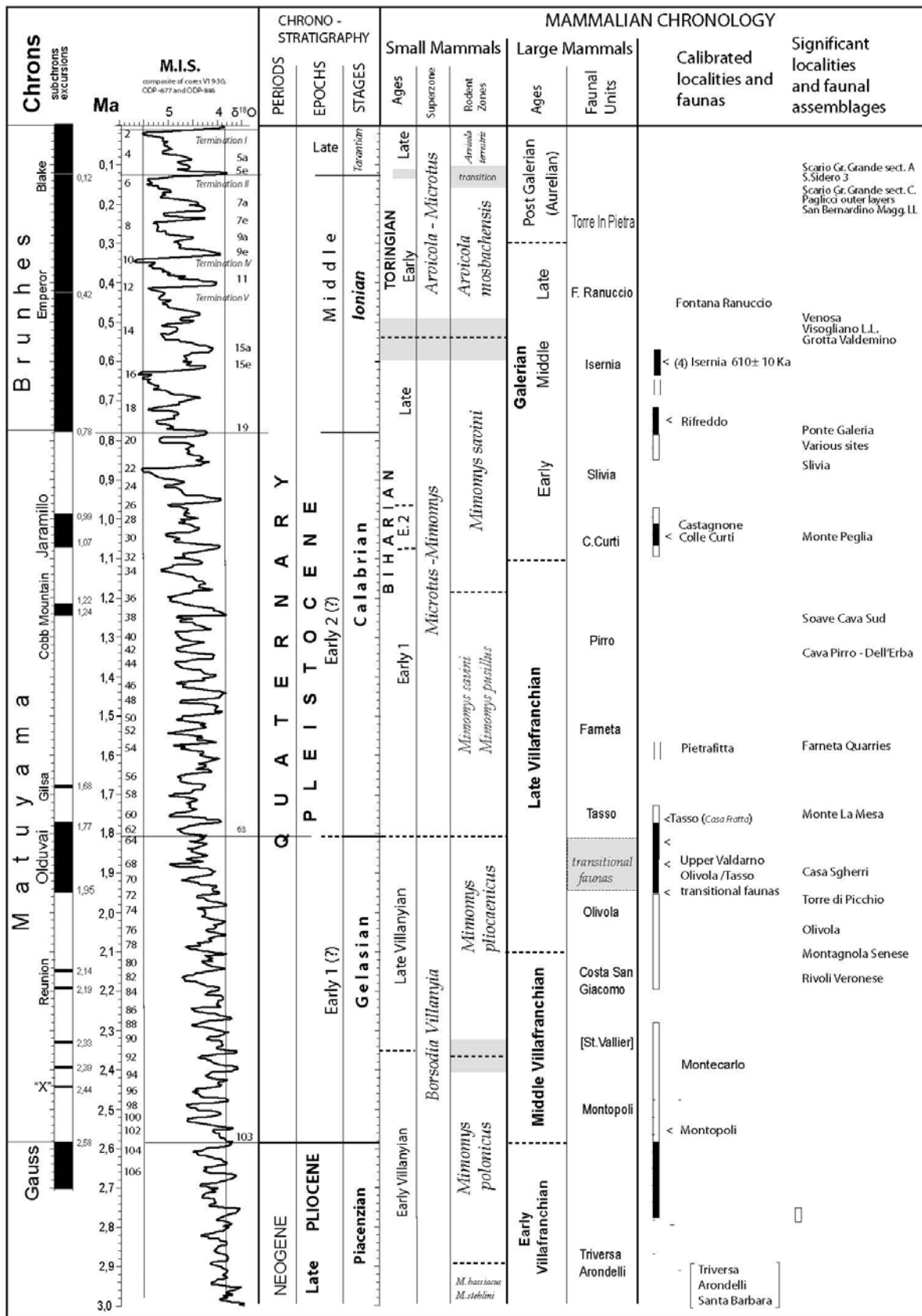
Sites with transitional faunas and those referred to the beginning of the Aurelian yielded mammals of warm environments. Most important ones are in Latium (Rianno, Castel di Guido, Malagrotta, Polledrara of Cecanibbio), where the arrival of a *Bubalus* of Asian origin is reported, thus indicating one or more "hot" climatic oscillations. *Bubalus* arrives twice in Germany, during the Steinheim Interglacial (Holstenian), and later during the Eemian (KOENIGSWALD 1986). The faunal association from Steinheim includes mammals such as *Bubalus murrensis*, *Palaeoloxodon antiquus*, *Bos primigenius*, *Megaloceros giganteus*, *Stephanorhinus kirchbergensis* (CZARNETZKI 1983) that are also found in Latium faunal assemblages; likely the latter faunas should be referred to MIS 7. PALOMBO *et al.* (2004), however, according to their interpretation of the sequence stratigraphy of the Roman basin, suggest a correlation with MIS 9 for Torre in Pietra 1, Monte delle Gioie, Sedia del Diavolo, Polledrara of Cecanibbio and Castel di Guido, and with MIS 7 for Vitiña, Quartaccio and Torre in Pietra 2.

The cold faunas are affected minor uncertainty. The sequences of Poggio cave and of Grotta Grande - Sector C. of Scario (Salerno), the outer levels of Paglicci cave (Foggia) and San Bernardino cave (Vicenza) and the R and S layers of Broion cave (Vicenza) contain faunas dominated by first cold mountain goats arriving in the Italian peninsula, *Capra ibex*, and are referred to MIS 6. The transition between early and late Toringian is somewhat blurred in the Italian Peninsula due to the possible co-occurrence of two species of *Arvicola*.

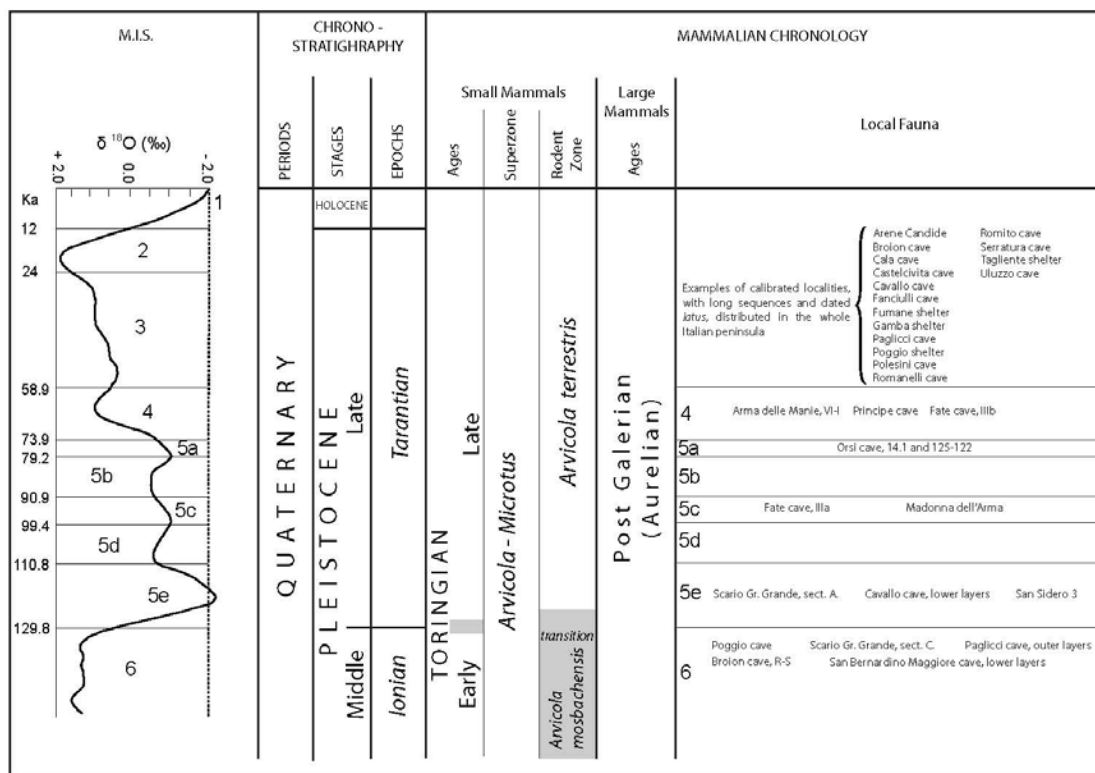
Recently, Petronio *et al.* (2007) proposed two new Faunal Units for the Late Aurelian but, as reported above, especially for the regional differences during this period, we are unfavourable to the use of faunal units for assemblages younger than MIS 7 and we do not accept this proposal. Moreover, the use in biochronology of the occurrence of not easy recognizable subspecies, such as *Dama dama dama*, and of mammals which are very rare in Italy, such as *Coelodonta antiquitatis*, to define a FU is not applicable.

In MASINI and SALA (2007) the late Pleistocene was scantily reported and commented, so we provide here with new data.

The last interglacial (Eemian, MIS 5e), which marks the beginning of the Late Pleistocene, is documented by the sediments of some coastal caves containing remains of large vertebrates and recently yielded the remains of small mammals, e.g. the deepest levels of Cavallo cave (Lecce). There are, however, some temperate faunas ascribed to a generic MIS 5, e.g. San Sidero 3 (Lecce) and Grotta Grande of Scario S.A. (Salerno).



Tab. 1: Integrated stratigraphic scheme for the Quaternary large and small mammalian record of the Italian peninsula.  
 Schema stratigrafico integrato del Quaternario per il record dei grandi e piccoli mammiferi della penisola italiana



Tab. 2: Integrated stratigraphic scheme for the MIS 6-1 large and small mammalian record of the Italian peninsula. Schema stratigrafico integrato del MIS 6-1 per il record dei grandi e piccoli mammiferi della penisola italiana

The IIIrd level of Caverna delle Fate (Savona) is assigned by PSATHI (2003) to MIS 5, but QUILÈS (2003), using the P<sup>4</sup> morphometric index of *Ursus spelaeus* (RABEDER 1999), infer an age of 90 ka, roughly corresponding to MIS 5c or 5a. The faunal assemblage from Madonna dell'Arma and from the lower levels of Grotta del Principe (Imperia), considered coeval, are referred to MIS 5c or 5a (VALENSI 2009). In two papers on large (RUBINATO 2009) and small mammals (BERTO 2009) from Caverna degli Orsi (Trieste) the stratigraphic units 14.1 of the sector A and 125-122 of the sector B are ascribed to the temperate oscillation of MIS 5a.

During the MIS 5, in Italy, and probably also in all the Europe, *Palaeoloxodon antiquus* and *Hippopotamus* are still quoted, but not during MIS 4, probably due to the first climatic rigours of the Last Glacial (Wurmian). *Dama dama*, abundant in MIS 5e, becomes rarer in MIS 5c-a but it is present also e.g. at Caverna degli Orsi, in the North-East, where the environment was less temperate than in other parts of the peninsula, in plane or at the foot of the mountains.

The levels IIIb of Caverna delle Fate, the upper levels of Grotta del Principe, the levels IV-1 of Arma delle Manie (Savona) are assigned to MIS 4 (VALENSI 2009). Some other sequences of caves and shelters with Mousterian industries and rich of faunas are ascribed to this stage, e.g. upper layers of Ghiacciaia cave (Verona) (SALA 1990). Many other sites bear long sequences with Mousterian industries but dating are scarce.

After 50 ka, the <sup>14</sup>C radiometric dating are of assistance for the chronology and recently also TL dating and U/Th-ESR combined dating are used above all in prehistoric sites. An example is supplied by PERESANI *et al.*

(2008), in which Uluzzian levels of Fumane cave and others sites in the Eastern Italian Pre-Alps, Slovenia and Croatia are quoted with those methodologies to MIS 3 (layers I of Broion cave, Rio Secco cave, layers B through E1 and E1/E2 of Munjina Pečina, level G3 of Vidinja cave and others). Other prehistoric localities are attributed to MIS 3, e.g. Mezzena shelter (Verona) (GIUNTI *et al.* 2008).

Later, with the appearance of the Upper Palaeolithic industries and their undoubted chronological value, the dated layers are very numerous. If the referral to isotopic stage is adopted, the sub-stage should be specified, because the minor climatic oscillations occurring within a stage are reflected in changes in faunal associations. The geographic location of the site must also be considered with the highest regard, because of the occurrence of regional faunal differences and since even small changes in altitude or topography of the area determined important differences in the assemblages of both micro- and macro-mammals.

The sequence of the Castelcivita Cave records the Mousterian - Late Paleolithic transition; the rich faunal assemblages (MASINI & ABBAZZI, 1997) are well representative of the mammalian populations of the middle to late part of MIS 3 (substages MIS 3,12 to MIS 3,01, sensu PISIAS *et al.* 1984; PATERNE *et al.* 1986) at the Tyrrhenian side of the Peninsula (NAPOLIONE *et al.* 1997). In the MIS 3 some mammals are present for the last time, e.g. *Dama dama* in the Aurignacian levels of the Cala cave (BENINI *et al.* 1997), *Mammuthus primigenius* and *Megaloceros giganteus* at Settepolesini di Bondeno (Ferrara) (GALLINI and SALA 2001).

MIS 2 is well documented in Italian peninsula and some papers furnish information on faunal assemblages

of the Last Glacial Maximum (SALA 2004 and references in it) or of the Late Glacial (SALA 2007 and references in it) of numerous sites of the whole Italian peninsula. Among the carnivores, the occurrence of *Crocuta spelaea* is noted for the last time in the Ancient epigravettian layers of Paglicci cave (BOSCATO and PALMA DI CESNOLA 2000).

The mammal faunas of the ancient Holocene also are well known and come from Mesolithic and Neolithic sites. In the Holocene the reduction of biodiversity is only partially compensated by the arrive of *Martes foina*, *Micromys minutus*, *Mus domesticus* and later of *Rattus rattus*, *Rattus norvegicus*; very recently *Apodemus agrarius*, *Erinaceus concolor* and *Canis aureus* begin to spread in the north-eastern of Italy.

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