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LATE EARLY PLEISTOCENE MAMMAL FAUNAS OF ITALY: BIOCHRONOLOGICAL PROBLEMS*

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RIASSUNTO - *Le faune a mammiferi del tardo Pleistocene inferiore in Italia: il problema biocronologico* - Il Quaternario *Italian Journal of Quaternary Sciences,* **8**(2), 1995, 391-402 - L'analisi delle associazioni faunistiche a mammiferi del Plio/Pleistocene dell'Italia mette in evidenza come siano riconoscibili rari bioeventi che comportino un importante rinnovo delle faune, tale da coinvolgere un numero significativo di forme. Nel corso del Pleistocene superiore e al limite del Pleistocene medio si assiste, per lo più, ad un progressivo e graduale rinnovo delle associazioni sia per evoluzione in loco di forme preesistenti, sia per ricorrenti immigrazioni di forme centroeuropee o di origine orientale e africana. Queste fasi sono verosimilmente da porre in relazione con oscillazioni climatiche. I nuovi dati relativi alle temperature delle acque (superficiali e profonde dei mari e degli oceani) e alla vegetazione indicano che il clima ha subito fluttuazioni assai complesse, e che, nell'ambito dei vari cicli a carattere "caldo" e freddo", sono riconoscibili oscillazioni anche importanti sia della temperatura che dell'umidità. La risposta dei singoli *taxa* alle variazioni climatiche ed ambientali non è né uniforme né contemporanea. La lacuna di documentazione che separa due associazioni poste in sequenza biostratigrafica fa sì che più bioeventi successivi siano riconusciuti come unico fenomeno. L'ampliarsi delle conoscenze e la scoperta di nuove faune intermedie per composizione, livello evolutivo o datazioni assolute, rispetto a quelle già note, dimostra come il rinnovarsi delle associazioni sia in genere abbastanza graduale, anche se una accelerazione del fenomeno è riconoscibile in corrispondenza delle maggiori crisi climatiche. E' divenuto, pertanto, piuttosto difficile, da un punto di vista puramente biologico e di comparsa/scomparsa dei *taxa,* porre un limite netto tra "faune villafranchiane" e "faune galeriane", dal momento che alcuni elementi considerati "galeriani" compaiono diacronicamente già in varie associazioni tradizionalmente considerate "tardo-villafranchiane". Vengono quindi avanzate alcune ipotesi di lavoro, nell' intento di proporre l'avvio di discussioni che portino, almeno localmente, ad una più precisa definizione deelle "Età a Mammiferi" Villafranchiano e Galeriano.

ABSTRACT - *Late early Pleistocene mammal faunas of Italy: biochronological problems* - Il Quaternario *Italian Journal of Quaternary Sciences,* **8**(2), 1995, 391-402 - Sharp and important changes in the large mammal assemblages during the Pleistocene of the Italian Peninsula are not clearly recognisable. A progressive and gradual renewal is however recognisable either by the local evolution of preexisting forms or by recurrent immigrations from Africa, Asia or Central Europe. The main faunistic changes are actually due to an amount of distinct bioevents more or less scattered in time. The documentation gap that generally separates two assemblages in biochronological sequences is too often ignored, and induced to consider a plurality sequence of bioevents as grouped into as a single event. The renewal phases are probably related to climatic fluctuations and it is possible to notice accelerations of this phenomenon in occurrence with major climatic crises (the faunal turnover at the "Middle Pliocene" is taken into account). Bearing in mind that the response of single taxa to climatic and environmental variations is neither uniform nor synchronous, it is very difficult to put a limit between two faunistic units. At present it becomes difficult to set a limit between "Villafranchian" and "Galerian" faunas. Initial hypotheses are offered to propose the beginning of a discussion leading to a more precise definition of the Villafranchian/Galerian " Mammal Ages" transition, at least for Italian mammal fauna assemblages.

Parole chiave: Mammiferi, biocronologia, tardo Pleistocene inferiore, Italia
Key words: Mammal faunas, biochronology, late Early Pleistocene, Italy

1. INTRODUCTION

In the biochronology of large mammals, it is extremely difficult to set limits between faunal assemblages and to establish formal definitions of the boundaries between biochronological and/or biostratigraphical units on the grounds of paleontological contents and the stratigraphical context.

As pointed out by Lindsay (1990), three basic strategies are usually used to establish the age of fossil mammal assemblages: stratigraphic superposition (biostratigraphy), the stage of evolution (biochronology), and mammal dispersal events (geochronology). In the first case, it is difficult to establish a correct biostratigraphic zonation for mammal faunas because thick, continuous, and well-exposed deposits are not frequent in continental rock sequences, and sections are generally shorter and less complete than in marine sequences. In the second case, even though it was emphasized that an age determination based on stage evolution is hazardous, the establishment of the evolutionary grade of one or more taxa is generally corroborative for an age assignment of a particular assemblage, when several widely distributed lineages are known. In the third case, mammal dispersals are the most widely used biochronological events and have often been used to mark the boundaries of biochronologic units. Various factors concur to regulate the dynamics of faunal interchange, timing, and duration of dispersal events. The most significant events are those that involve several forms and, as a function of large-scale geological or climatic variations, can be observed over vast geographical areas. Climatic fluctuations, vegetation changes, or other phenomena can determine environmental variations that allow the migration of one or more mammal groups from local dispersion centers. The arrival of new immigrants is a phenom-

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enon that is repeated over and over again throughout the Plio/Pleistocene, in various sectors of Western Europe. The appearance of a species may take place in different times and ways with respect to others, though on the whole, these species will characterize a definite faunistic complex. Furthermore, there is a certain diachronism in appearance times of a specific form in single dispersion zones, especially between oriental and occidental ones; this diachronism makes it less easy to make correlations, when supportive data (such as magnetostratigraphy, absolute dating) is lacking.

Furthermore, the usual distinction of European Plio/Pleistocene mammalofauna in Faunal Units (F.U.) (in the sense of groups of local faunas of similar composition (Azzaroli, 1977; 1983a) is essentially based on the recognition of faunal renewal phases involving the disappearance of certain taxa, the appearance of new forms or a higher degree of evolution of the pre-existent ones and, therefore, on the recognition of characteristic associations of a given time span. The zonations recently reproposed by Fejfar & Henrich (1990) and Mein (1990) are grounded on similar criteria(1).

On the other hand, it is very difficult to recognize and define times and renewal modalities, so as to facilitate a biochronological scansion of mammal assemblages. The faunistic renewal process is often less clear than generally supposed. The discovery of new mammal assemblages, that are intermediate by composition, evolutionary grade, or absolute age with respect to what was previously known, shows that, during the late Pliocene and especially during the early Pleistocene, in Italy as in Western Europe, many important species occur not exactly at the same time and most faunistic renewal phases are actually due to a number of distinct bioevents which are more or less scattered in time. Well characterized faunistic complexes may be recognized, but it is impossible to highlight a precise boundary between two successive Faunal Units. It is only possible to define the time span during which a turnover is concluded.

This paper intends to emphasize such problems, in particular those relating to the biochronology of Italian associations during the Latest Villafranchian. We put forward some suggestions to commence discussions which could lead to verify if it is or not possible, in the continental environments, a precise definition and formalization of biochrons, which are characterized by an assemblage of mammals living together in a definite area and in a determinate time spans (cfr. Lindsay & Tedford, 1990).

By way of exemplification of two particular and in many ways dissimilar faunal turnovers, the classic "*Equus*-Elephant Event" (Lindsay *et al.*, 1980) and the "End Villafranchian Event" (Azzaroli, 1938b) are discussed. These events mark the transition between the Triversa and Montopoli F.U., and the transition between Villafranchian and Galerian mammal assemblages, respectively.

2. THE "*EQUUS*-ELEPHANT EVENT" AND THE QUESTION OF EARLY/MIDDLE VILLAFRANCHIAN "BOUNDARY"

The faunal turnover between Triversa and Montopoli F.U. comes about during a phase of important climatic variations involving most of the planet, and can be observed both in marine and in continental environments (cf. *inter alios* Bonadonna & Alberdi, 1987; Flinn *et al.*, 1991; Hilgen, 1991; Hooghiemstra, 1989; Horowitz, 1989; Kukla, 1991; Liu Tungsheng *et al.*, 1985; Part-ridge, 1985; Rea & Schrader, 1985; Rio *et al.*, 1990 & 1994; Shackleton *et al.*, 1984 & 1990; Sher, 1992; Suc, 1984 & 1989; Thunell *et al.*, 1990; Tonni *et al.*, 1992; Vergnaud Grazzini *et al.*, 1990; Zagwijn, 1988 & 1992a-b; Zijderveld *et al.*, 1991). Negative thermal oscillations of great intensity, larger than the former ones, occur around 2.5 Ma (stages 100-96 of Raymo *et al.*, 1989)(2). Because of the climatic deterioration, there is an overall reduction of forests, with the spreading of steppe vegetation, including *Artemisia* and *Ephedra,* in the mid-western Mediteranean area (Chaline & Farjanel, 1990; Rousseau *et al.*, 1992) and of tundra in northern Europe (Praetiglian = P III; Suc, 1964; Zagwijn, 1988). In southern Italy, the new pollen diagram of the Semaforo (Vrica) section shows rapid vegetation successions (deciduous forest, subtropical humid forest, high-altitudinal coniferous forest, open vegetation), that correspond to rapid climatic variations, similar to those illustrated in $\delta^{18}O$ records (96-90 isotopic stages, Raymo *et al.*, 1989) (Combourieu-Nebout, 1993).

The decrease in temperature and the increase in dryness, the important reduction in forest area and the resulting spread of open spaces determine, on the one hand, the disappearance of the most typical forest elements (*Ursus minimus, "Mammut" borsoni, Tapirus arvernensis, Sus minor*) and favour, on the other, two important dispersal events: the arrival in western Europe of large stenonoid equid *Equus livenzovensis* and of the archaic elephant *Mammuthus meridionalis gromovi,* not

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(1) In the revised chart of MN zones, biological events are mentioned only at the generic level: small mammals species generally have limited geographical distribution that does not allow long distance correlation. Also Steininger *et al.* (1990) point out that chronostratigraphic stages are, in general, confined regionally and mostly reflect geological history of a particular area.

(2) Recently, Rio *et al.* (1994) propose a new stage, the Gelasian, as the third upper suddivision of the Pliocene series. The Middle/Upper Pliocene boundary is coincident with the "sapropel" level which outcroups in the Monte S. Nicola section (Gela, southern Sicily), that corresponds to the Mediterranean Processional Related Sapropel 250 of Hilgen (1991) and to the Oxygen isotopic stage 103 of Raymo *et al.* (1989) (age about 2.6 Ma).

to mention *Gazella borbonica* and *Eucladoceros.* Around this time (*Mimomys polonicus* zone, *sensu* Fejfar & Heinrich, 1990, = MN 16b) the lemmings of the genus *Synaptomys,* the first representatives of completely hypsodont and ruthless arvicolids, appear in central Europe (Fejfar & Heinrich, 1990). Indeed, whether the dispersal events of *Equus* and *Mammuthus* in Europe may be predated and are exactly synchronous, is not certain: Vislobokova *et al.* (1994) point out the appearance of the *Equus* genus in layers of Kazakhistan and Transbaikalia referred to biozone MN 16a; a new mammuth species, *Mammuthus rumanus* (*nomen nudum*), is found in the faunistic complex of Carnesti (Dacian basin), for which an age of about 3 million years has been estimated (Radulescu & Samson, 1994).

Faunistic renewal is typically represented in Italy in the Montopoli association (Valdarno), representative of the homonimous unit (MN 16b; Mein, 1990) (Azzaroli *et al.*, 1988; Masini *et al.*, 1994; Torre *et al.*, 1992), paleomagnetically calibrated on the base of Matuyama, just above Gauss/Matuyama boundary (Lindsay *et al.*, 1980).

The paleoclimatic, floristic and faunistic data indicate that a series of important events came about at the time of the shift from Triversa F.U. and Montopoli F.U. This event seems to be of greater relevance with respect to what can be found in correspondence to the faunal change that marks the beninning of the Saint Vallier F.U. (Azzaroli, 1977; (Azzaroli *et al.*, 1988; Torre *et al.*, 1992). If one wants to maintain a three-part division for the associations of large mammals of the Villafranchian, setting the Early Villafranchian/Middle Villafranchian limit among the faunistic complexes referred to the Triversa and Montopoli Unit (approximately at the same time as the coming of the "Glacial Pliocene", otherwise, the beginning of the Pleistocene, as intended by various authors, cfr. Caloi & Palombo –in press– with bibliography), seems to be a possibility.

3. THE QUESTION OF VILLAFRANCHIAN/GALERIAN "BOUNDARY"

The Galerian was originally defined as an event of sharp faunal turnover and of considerable importance both in qualitative (the development of new adaptations and appearance of species with massive body structures in large bovids and cervids) and in the quantitative terms (the disappearance of over half of the late Villafranchian fauna) (Azzaroli, 1983b).

Several considerations caused the "End Villafranchian Event" to be placed in a period of time close to the Jaramillo subchron, but, though it was recognized that the faunal turnover from Late Villafranchian to Galerian did not take place at once, the transitional phase was considered of short geological duration (Azzaroli, 1983b; (Azzaroli *et al.*, 1988).

New data show that typical Galerian species, or related forms, appear early also in Italy, while Villafranchian forms persist longer than what was formerly supposed. *Canis arnensis,* for example, persists in associations of the Slivia F.U. (Masini *et al.*, 1994), which could hypothetically be correlated with the 22/24 isotopical stages. Furthermore, in the European galerian asseblages, *Homotherium latidens* is generally recorded; however, in Italian ones, Masini *et al.* (1994) report *Homotherium crenatidens* up to the Slivia assemblage. According to Sardella (1994), during the late Early Pleistocene, in Europe (*e.g.* Venta Micena and Pirro Nord) this genus is present with specimens that maintain some characteristics of *Homotherium* ex. gr. *H. crenatidens,* but that seem also to be related to *Homotherium* ex. gr. *H. latidens.* Furthermore, in the opinion of Di Stefano *et al.* (in press), *P. farnetensis* (3) may be still present in the Ponte Galeria local fauna.

Among the typical "galerian" forms, stephanorhine rhinoceroses with advanced characters were listed, intermediate between those of *S. etruscus* and *S. hemitoechus,* and for this reason considered to be close to one species or the other (Azzaroli, 1983b; Guerin, 1980). Based on recent revisions (Fortelius *et al.*, 1993; Mazza *et al.*, 1993; Sala & Fortelius, 1993), the specific identity of Galerian rhinoceroses is recognized, and were ascribed to the *S. hundsheimensis* species, typically represented in the fauna of Isernia (Molise). Small rhinoceroses, close to *S. hundsheimensis* for their cranial characteristics, occur in the latest Early Pleistocene (Scoppito, Pirro Nord, Pietrafitta, Imola, Colle Curti). According to Mazza *et al.*, (1993), these rhinoceroses could be fully grouped up into a chronologically well-defined taxon, readily identifiable because of their small size; these rhinoceroses may represent a transitional population between *S. etruscus* (Villafranchian) and *S. hundsheimensis* (Galerian) or, alternatively, be newcomers giving rise to later species.

Among equids, a form closely related to *E. altidens* appears as early as Selvella and the species is present at Pirro Nord, in a more recent assemblage where *E. sussenbornensis* could also be present (Caloi, in press). *E. altidens* is identified in Europe at Venta Micena (Alberdi & Ruiz Bustos, 1985; Marin, 1987 = *E. stenonis granatensis;* - MmQ - 2 for Agusti, 1991), in an association held to be similar to Pirro Nord one, and at Lakuti 1 (Jaramillo base, *fide* Azzaroli, 1983b). *"E. sussenbornensis"* is reported from Cueva Victoria (fide Aguirre *et al.*, 1990), in an assemblage with *Microtus (Allophaiomys) chalinei;* this fauna is doubtfully considered to be more recent than Venta Micena by Aguirre *et al.*, (1990), but older by Agusti (1991; base of MnQ - 2). *Equus* ex gr. *E. bressanus-E. sussenbornensis* is also reported from A-pollonia (Greece), in an assemblage referred to the latest

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(3) According to Di Stefanio *et al.* (in press) *"P. eurygonos"* is a good species, present from Olivola to Isernia faunal units and *"P. farnetenesis"* is a younger synonimous.

Villafranchian (Koufos *et al.*, 1992 = *E. bressanus*). A similar, if not cospecific form (= *Equus verae*) is mentioned in the "fauna of Olyor" in Alaska (age of at least 2.1 Ma) and in the Yukon Territory (Early Olyorian, 1.4 - 1.2 Ma) (Sher, 1992).

The *Megaceroides* genus appears in Italy for the first time with *M. obscurus* (Abbazi, pers. comm., 1994) at Pietrafitta and later with *M. sp.* at Pirro Nord (Azzaroli & Mazza, 1992b; Masini *et al.*, 1994). In Europe, megacerines of certain specific attribution are reported from Mosbach-1 (*M. verticornis,* Koenigswald & Tobien, 1987) and from Soleilhac (*M. solhilhacus,* Caloi & Palombo, 1980), in assemblages correlated with the Jaramillo subchron (Bruning, 1978; Thouveny & Bonifay, 1984), and also from Cueva Victoria (*Megaloceros savini:* Aguirre *et al.*, 1990; Azzaroli & Mazza, 1993).

Among the bovids, *Bison schoetensacki* and *Hemitragus bonali* are generally considered as typical "galerian" species. A bison (*Bison* sp.) is reported from Monte Peglia (Cassoli, in Guidi & Piperno, 1992) and from Mosbach-1 (Koenigswald & Tobien, 1987)⁽⁴⁾. A large-sized, short-horned bison is already reported in the Early Olyorian faunal complex, near the Jaramillo subchron (Sher, 1987). In Italy, a M_3 referred to *B. schoetensacki* was found at Cesi (Colfiorito Basin, Marche) (Ficcarelli & Silvestrini, 1991) in a horizon already correlated with that of Colle Curti, from which an evolved form of *L. vallisarni* was reported (Masini *et al.*, 1994). According to Ficcarelli (pers. comm., 1995), the Cesi assemblage falls in the Brunhes epoch and is indeed younger than the one from Colle Curti. The appearance of *B. schoetensacki* before the early Middle Pleistocene, therefore, deserves further confirmation. The presence of *Hemitragus bonali* in the late Early Pleistocene is also doubtful; for instance, *Hemitragus* sp. has been identified at Le Vallonet (Cregut-Bonnoure, 1992) and at Monte Peglia (Piperno *et al.*, 1984).

Progress in research therefore points out how faunal renewal comes about over longer timespans than was formerly supposed, and this makes it even more difficult to set an exact boundary between the Villafranchian and Galerian faunas. The Galerian "Mammal Age" therefore, lacks a formal and precise characterization, although it is quite broadly used.

In the impossibility of referring the transition be-tween faunistica complexes to a precise time, with a working hypothesis, based on currently available data, proposing several alternatives for an informal subdivision of Italian mammal faunas of the late Early Pleistocene seems to be an alternative approach. With the terms of "Villafranchian", " galerian" etc., we consider well characterized faunal complexes instead of biochrons, for which a definition of precise limits must be established. We recognize the wisdom of keeping the biochronology of macro- and micromammals separate, yet, in the formulation of said hypothesis based essentially on large mammals, it is almost inevitable to take into account data on arvicolids, which, if present, generally allow good bio-chronological calibrations.

Possible alternative solutions might be:

A) the extension of the Villafranchian as far as the limit of the Lower Pleistocene/Mid-Pleistocene (cold acme of stage 22 or 24; cfr. Caloi & Palombo, in press). In this hypothesis the basis of the local Galerian faunas is characterized by the appearance, among the large mammals, of *U. denigeri, E. antiquus, M. "trogontherii", Sus scrofa, C. elaphus acoronatus, B. schoetensacki.* However, since many of these forms appear in Western Europe (*e.g.* Soleilhac, Mosbach 1, Les Valerot, Le Vallonet)) in a period close to the Jaramillo subchron, this hypothesis seems to find support, other than in paleoclimatic data, only in the disappearance of the microtines of the subgenus *Allophaiomys.*

In this hypothesis, within the Late Villafranchian faunas two or three F.U. can be distinguished: Farneta, ?Pirro and Colle Curti. The Farneta F.U. would be char-acterized by the appearance of *M. meridionalis vestinus,* of the small rhinoceroses, of stenonian equids with slender limbs, of *P. farnetensis* and, perhaps, of *Homotherium* with more derived characters compared to the typical *H. crenatidens* (Sardella, 1994). Within this unit, two complexes can be recognized; the first essentially characterized by the lack of megacerines (Crostolo, Selvella); the second characterized by the appearance of archaic megacerines of the *M. verticornis (M. obscurus)* (Pietrafitta and Scoppito) group and, among micromammals, by the presence of *M. chalinei, M. pusillus* and not greatly evolved forms related to *M. (A.) ruffoi* (Pietrafitta). Taking into account that the characteristics of the Pirro assemblage are on the whole less advanced than those of the Colle Curti assemblage, we can consider Pirro as a distinct F.U.

The presence of *M. verticornis,* of *Bison (Eobison) degiulii* and of more advanced forms of *M.* ex gr. *M. ruffoi,* later replaced by *M. burgondiae* and *M. nutiensis,* characterizes the Colle Curti F.U. Within these units, three different kinds of associations may be identified: the first assemblages at Capena, Redicicoli (?), with *B. (Eobison) degiulii* , and of Pirro Nord in which *M.* ex gr. *M. ruffoi* closely related to the type of species (Pasa, 1947) is also present (Masini & Santini, 1991); to the second, the fauna of Colle Curti, characterized by a more restricted number of Villafranchian elements and by the occurrence of scarce remains of a microtine proached to *M. ruffoi,* but with more advanced characteristics (Masini & Santini, 1991); to the third, the association of Monte Peglia especially characterized by the occurrence of *Microtus (Allophaiomys) nutiensis* and *Microtus (Allophaiomys) burgondiae* the later probably derived from *M. ruffoi* (Masini & Santini, 1991)⁽⁵⁾.

⁽⁴⁾ According to Masini (1989) a primitive form of bison, *Bison (Eobison)* sp., is reported from Sainzelles.

⁽⁵⁾ If we choose to give more importance to evolutive degree of micromammals in the latest Villafranchian, we (cont. p.395)⟶

B) the extension of the Galerian into the late Early Pleistocene. In this case, it is difficult to choose a lower limit for the biochron. If this were set at about the same time as the Jaramillo event (*e.g.* Colle Curti assemblage) the distinction with respect to the former biochron (*e.g.* Pirro Nord assemblage) would be given, in large mammals, essentially by the disappearance of some villafranchian elements (*e.g. Lynx issiodorensis, Meganthereon cultridens, Sus strozzii, Bison degiuli*). Should the lower limit be defined by the first appearance of "galerian elements" (equids, or rhinoceroses, or megacerines), the Galerian would come to include most of the Late Villafranchian (*e.g.* until the Selvella local fauna).

C) the introduction of the Protogalerian(6), in the meaning of a biochron whose lower limit coincides with the first appearance of the already outlined "galerian forms", persisting into the early Middle Pleistocene (as such or with their descendants). The upper limit may be given by:

C_1) the disappearance of *Mimomys savini,* by the persistence of some Villafranchian elements and by the appearance, among others, of *Arvicola cantiana* (if actually present in the Isernia association), *Equus caballus, D. clactoniana, C. capreolus* as well as by *?Hyaena prisca* (7), *Panthera leo, Hippopotamus "tiberinus"* (8), *Megaloceros savini, M. solilhacus* (already mentioned in older European associations) and *Hemitragus bonali* (if not already present at Monte Peglia);

C_2) or alternatively as far as the Pliocene/Pleistocene limit, if we choose to give more importance to large mammals.

In the C_1 hypothesis, within the late Villafranchian, only the assemblages characterized by the appearence of *M. m. vestinus* and *P. farnetensis,* and by persistence of *C. etruscus* (Selvella), *S. etruscus,* and *E. stehlini* (9) as well as *E. dicranios* (not yet associated to megacerines) belong to Farneta F. U. Within the Protogalerian, four faunistic complexes (whose recognition as faunistic units would require further support in any case) could be distinguished. These are characterized by a progressive increase of "galerian" forms, while the "villafranchian" ones tend to diminish in number. The first complex, typically represented by the Pietrafitta assemblage, is essentially characterized by the appearance of *M.* ex gr. *M. (Allophaiomys) ruffoi,* small-sized rhinoceroses and a primitive *Megaceroides* (*M. boldrini*). In the second, typically represented in the Pirro Nord assemblage, *Equus* ex gr. *E. bressanus-E. sussenbornensis, M.* sp., *B. degiuli,* appear and *M.* ex gr. *M. ruffoi* is present with most advanced forms. The Colle Curti assemblage can be chosen as the type assemblage for the third faunal complex. That is characterized by the persistence of *M. m. vestinus, L. vallisarni, P. farnetensis, U. etruscus* and *C. falconeri,* whereas *B. degiuli* disappeared (Masini *et al.*, 1994). *Allophaiomys* is still present in the Colle Curti local fauna with more advanced form of *M.* ex gr. *M. ruffoi* and, later, in the Monte Peglia assemblage, with *M. (Allophaiomys) burgondiae* and *M. (Allophaiomys) nutiensis.* In the four faunal complex, typified by the Slivia assemblage, a important number of newcomers, already considered as "galerian forms" (*e.g. Ursus deningeri, Elephas antiquus, Mammuthus "trogontherii", Sus scrofa, C. elaphus acoronatus* and, perhaps, *B. schoetensacki*) appear; *Mimomys savini* is still present but a good reduction of villafranchian elements takes place; in later assemblages (galerian *s.s.* ones), the villafranchian survivors are almost lacking.

In the C_2 hypothesis the faunal complexes, typified by the Slivia assemblage, are "Galerian" and only three faunal complexes may be distinguished in the Protogalerian faunas.

D) The institution of a new biochron (Protogalerian) for late Early Pleistocene Italian faunas, characterized by the appearance and persistence of *M. (Allophaiomys)* [Biharian (*partim*) mammal age]; *M. savini - M. pusillus* and *M. savini* (*partim*) zones, *sensu* Feijfar & Heinrich, 1990). The Villafranchian *s.s.* would therefore coincides almost wholly with the MN16 and MN17 biozones (= Villanyan mammal age; *Borsodia - Villanya* superzone, Feijfar & Heinrich, 1990). In this case, the separation of the two biochrones, Villafranchian and Protogalerian, would take only slight consideration of the characterization of the large mammals, if not for further subdivisions within the biochron. Indeed, microtine from Castelfranco, the type of the *M. pliocaenicus,* is referred to the Olivola F.U. (Late Villanyan), its evolutionary level being quite close to that of *M. p. ostramosensis* of Osztramos 3 (Ma-

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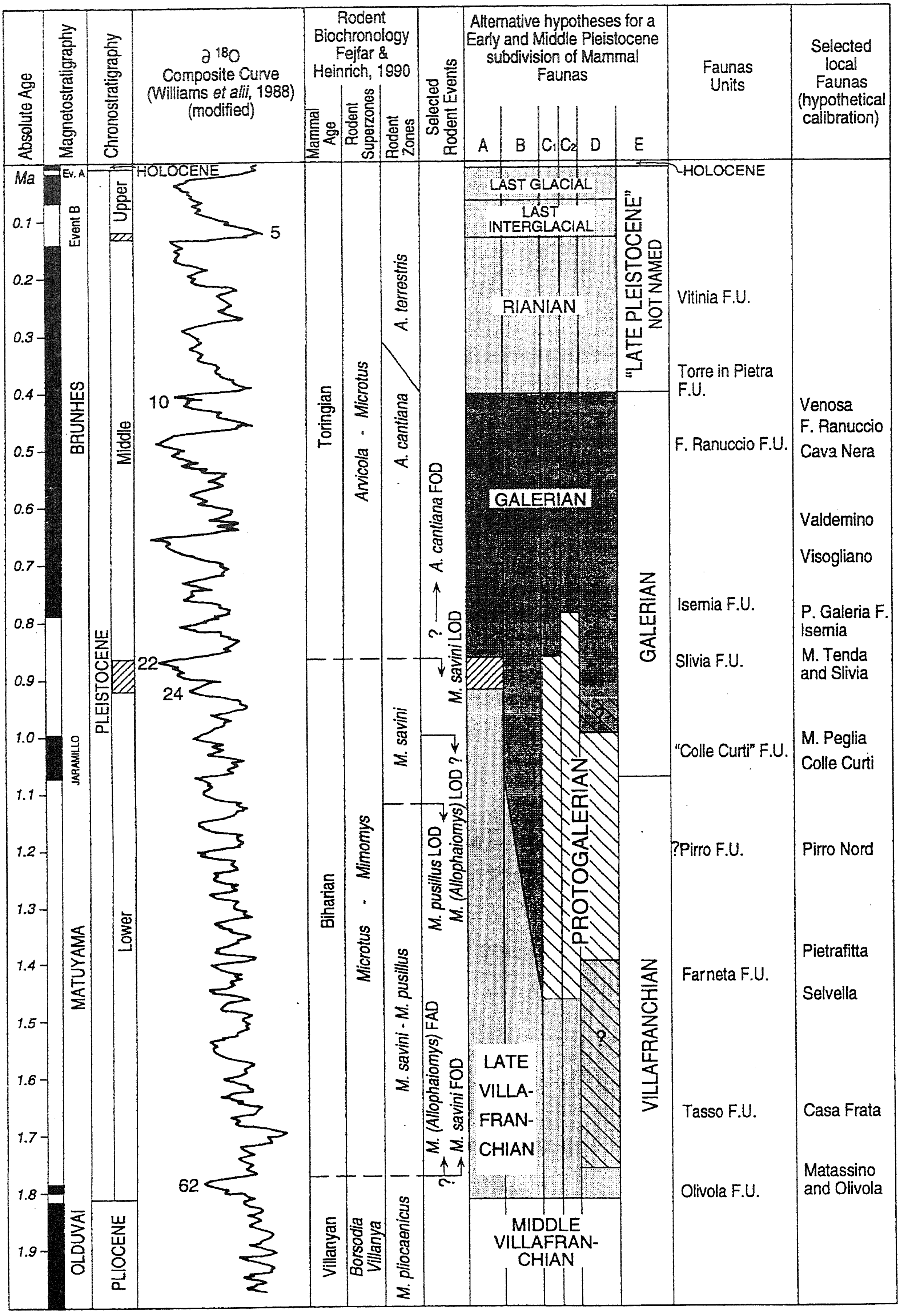
(cont.from/da p.395) may distinguish three faunistic units, of Farneta (as previously defined), of Colle Curi and of Monte Peglia, but in this last locality informations on large mammals are lacking.

(6) To distinguish the mammal faunal units from the European continental chronostratigraphic stages, Freudenthal (in Steininger *et al.*, 1990) recognizes the value of using, instead of the ending -ian (-iam, -ien) the ending -ic. Following this proposal, the correct writing is Protogaleric.

(7) Systematics and philogeny of European Pleistocene hyaenids are controversial. For some Authors, in the Middle Pleistocene *"P." perrieri* apparently reappears and is reported from several localities (L'Escale, Le Vallonet, Mosbach-2, Mauer, G.R.A.-Rome, Petralona) (Caloi & Palombo, 1986; Guerin, 1981; von Koenigswald & Tobien, 1987; Kurten & Poulianos, 1981; Turner, 1992). Other Authors disagree on this opinion and identified the large Middle Pleistocene hyaena with *Hyaena prisca* (Bonifay, 1971). The hyaena from G.R.A.-Rome (Caloi & Palombo, 1986) belong presumably to *Hyaena prisca.*

(8) *H. tiberinus* seems to characterize the early Middle Pleistocene Italian mammal faunas (Masini *et al.*, 1994). However, an almost complete skeleton, considered by Mazza (1991) as paratype of this species, was found in sandy horizons referred to upper Lower Pleistocene (Caloi *et al.*, 1980). Some Authors (cf. Petronio, in press) disagree on the specific identity of *H. tiberinus.* This form is undoubtely tied to *H. antiquus,* but shows some peculiar characters, compared with the last species. However, for a correct taxonomy, morphological and dimensional field of variation and geographical and stratigraphical range of the european Pleistocene hippos should be better defined.

(9) *Equus stehlini* is doubtfully reported from Le Vallonet (Rustioni *et al.*, 1994).


Absolute Age
Magnetostratigraphy
Chronostratigraphy
∂ 18O Composite Curve (Williams et alii, 1988) (modified)
Rodent Biochronology Fejfar & Heinrich, 1990
Mammal Age
Rodent Superzones
Rodent Zones
Selected Rodent Events
Alternative hypotheses for a Early and Middle Pleistocene subdivision of Mammal Faunas
A
B
C1
C2
D
E
Faunas Units
Selected local Faunas (hypothetical calibration)
Ma
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
1.7
1.8
1.9
Ev. A
Event B
BRUNHES
JARAMILLO
MATUYAMA
OLDUVAI
Upper
Middle
PLEISTOCENE
Lower
PLIOCENE
HOLOCENE
5
10
22
24
62
Toringian
Biharian
Villanyan
Arvicola - Microtus
Microtus - Mimomys
Borsodia Villanya
A. terrestris
A. cantiana
M. savini
M. savini - M. pusillus
M. pliocaenicus
A. cantiana FOD
M. savini LOD
M. pusillus LOD
M. (Allophaiomys) LOD ?
M. (Allophaiomys) FAD
M. savini FOD
?
LAST GLACIAL
LAST INTERGLACIAL
RIANIAN
GALERIAN
PROTOGALERIAN
LATE VILLAFRANCHIAN
MIDDLE VILLAFRANCHIAN
"LATE PLEISTOCENE" NOT NAMED
GALERIAN
VILLAFRANCHIAN
HOLOCENE
Vitinia F.U.
Torre in Pietra F.U.
F. Ranuccio F.U.
Isernia F.U.
Slivia F.U.
"Colle Curti" F.U.
?Pirro F.U.
Farneta F.U.
Tasso F.U.
Olivola F.U.
Venosa
F. Ranuccio
Cava Nera
Valdemino
Visogliano
P. Galeria F.
Isernia
M. Tenda and Slivia
M. Peglia
Colle Curti
Pirro Nord
Pietrafitta
Selvella
Casa Frata
Matassino and Olivola

sini & Torre, 1990), while *M. savini* from Case Inferno (Upper Valdarno) (Torre, 1985) is referred to the Tasso F. U. (Early Biharian). The two faunal units of Olivola and Tasso therefore must belong to the Villafranchian and Protogalerian, respectively. Although the faunistic gap between the two units is rather broad, it does not seem to be sufficient to justify such separation.

The introduction of a new age of mammals would, however, have only local relevance; a lesser fragmentation in ages would perhaps allow a broader correlation. It is therefore believed that the identification of three large faunistic complexes is possible: the first of a more archaic nature, including fauna already identified as Villafranchian, prior to the Jaramillo event; the second including fauna, for the most part renewed, of the *M. verticornis* (Galerian fauna) from the Jaramillo subchron to the decrease in temperature at the end of the Cromerian; the third including fauna with "modern" characteristics, from stage 9 to the Holocene. As concerns the latter faunistic complex, the name of Rianian, already proposed for the middle Upper Pleistocene seems to be too restrictive. It would therefore be advisable to introduce new terminology.

4. CONCLUSIONS

During the Plio/Pleistocene, in Italian peninsula, the faunal renewal (either by local evolution of pre-existing forms or by recurrent immigrations from Asia, Africa or Central Europe) is progressive and gradual in some cases; sharp turnovers are scarce. The gap in documentation generally separating two assemblages in the biochronological sequence, induces us to consider a plurality of bioevents as a single event. The main faunistic changes are actually due to a number of distinct bioevents more or less scattered in time, especially during the Pleistocene. The renewal phases are probably related to climatic fluctuations. New data relating to surface and deep water temperature of seas and oceans and to vegetation indicate that climate underwent extremely complex fluctuations, beyond what astronomical data and mere changes in the volume of glaciers confirm; within various "cold" and "warm" cycles, oscillations which are considered important both for their temperature and their degree of humidity are recognizable. The response of single taxa to climatic and environmental variations is neither uniform nor synchronous. It is possible to notice an acceleration of the renewal phenomenon only in concurrence of major climatic crises. In this condition, it is extemely difficult to refer a single faunal assemblage to a definite isotopic stage (especially lacking stratigraphical and palinological data or absolute ages) and also to put a limit between two faunistic units.

The examination of the turnover of Italian mammalofauna at the Middle Pliocene crisis and during the late Early Pleistocene confirms a certain correspondence between the renewal modality of associations and modality of variations in environmental conditions. When climatic variations seem to be more sharp and distinct and determine a significant change in environmental conditions, particularly in vegetation, dispersal bioevents of single mammal forms seem to be concentrated in time and are widespread. We have an example of this in the passage between Brunssumian and Praetiglian pollen zones of Dutch palinology (Suc, 1984; Zagwijn, 1988) and the almost corresponding faunal turnover between the Triversa and Montopoli F.U. The significant faunal renewal between the F.U. of Olivola and Tasso also comes about in a rather limited time interval, as recent paleomagnetic research shows (Torre *et al.*, 1993). This renewal seems to come about in correspondence with the passage between the Tiglian and the Eburonian.

When, after this climatic crisis and during the Early Pleistocene, the glacial/interglacial cycles are characterized by fairly uniform duration and amplitude, the renewal process occurs as subsequent events, more or less widespread in time and with differing areal extension, perhaps also as a result of local climatic factors. This seems to be the pattern of the "End Villafranchian" faunal renewal; the climatic crisis of the "Great Glacial" seems to determine the more or less final crisis of the still-surviving traditional Villafranchian forms.

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Fig. 1 - Tentative correlation chart of stratigraphic, paleomagnetic, isotopic data and mammals chronos, with hypothetical subdivisions for the Italian mammalian faunas of the late Early Pleistocene.

Correlazione schematica tra dati stratigrafici, paleomagnetici, isotopici e unità faunistiche con indicazione delle suddivisioni ipotizzate per le faune a mammiferi italiane del tardo Pleistocene inferiore.

from the Colfiorito area (Umbria-Marche Apennines). Abs., INQUA SEQS - CNR Symp. "Quaternary stratigraphy in volcanic areas", Roma, 20-22 settembre 1993, 7

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