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Gli effetti delle variazioni climatiche pleistoceniche sulla dinamica
dei popolamenti animali e vegetali nella Penisola italiana

Biogeography of Early and Early Middle Pleistocene Mammalian Faunas of Italy

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SUMMARY

The stratigraphical distribution of Early and Middle Peistocene mammalian fossils in Italy is described in detail. The author stresses the occurrence of two major climatic events, the first between 3.1 and 2.5 M.y. ago, the second at 1.0-0.9 M.y. The distribution of Italian continental faunas before and after the second event are described in detail. There is a definite lag from continental faunas turnovers and temperature changes of sea waters. Faunas which preceded and followed the second temperature drop in ocean waters are described in detail.

The Pleistocene begins at oxygen isotope stage 62, near the top of the Olduvai palaeomagnetic event, about 1.8 M.y. ago (Fig. 1). This date coincides with the arrival in large number of the so called "Northern Guests" in the Mediterranean, although older, scattered occurrences of these guests have been observed in Italy. When this boundary was officially defined, in the International Geological Congress of London, 1948, the arrival of cold climate indicators in the middle latitudes appeared to be a relevant event in the history of our planet. Subsequent studies have shown that it coincided with a minor sea retreat and negative climatic oscillation: the oxygen isotope curve of oceans does not evidence any definite climatic change at this time.

Greater variations in ocean temperatures took place earlier and later. The isotope curve evidences a progressive decline in water temperatures between 3.1 and 2.5 M.y., isotope periods KM2 and 100. Around 2.5 M.y. the "Acquatraversan event" of Ambrosetti et al. (1972) was characterised by a marked sea retreat and a major faunal revolution, both in oceans and continents. Another, more marked temperature fall is recorded in the same curve at cold period 22, shortly after 0.9 M.y. ago, the "Cassian event" of Ambrosetti et al. (1972), also characterized by a sea level fall. At this time the pattern of oscillations of ocean temperatures changed

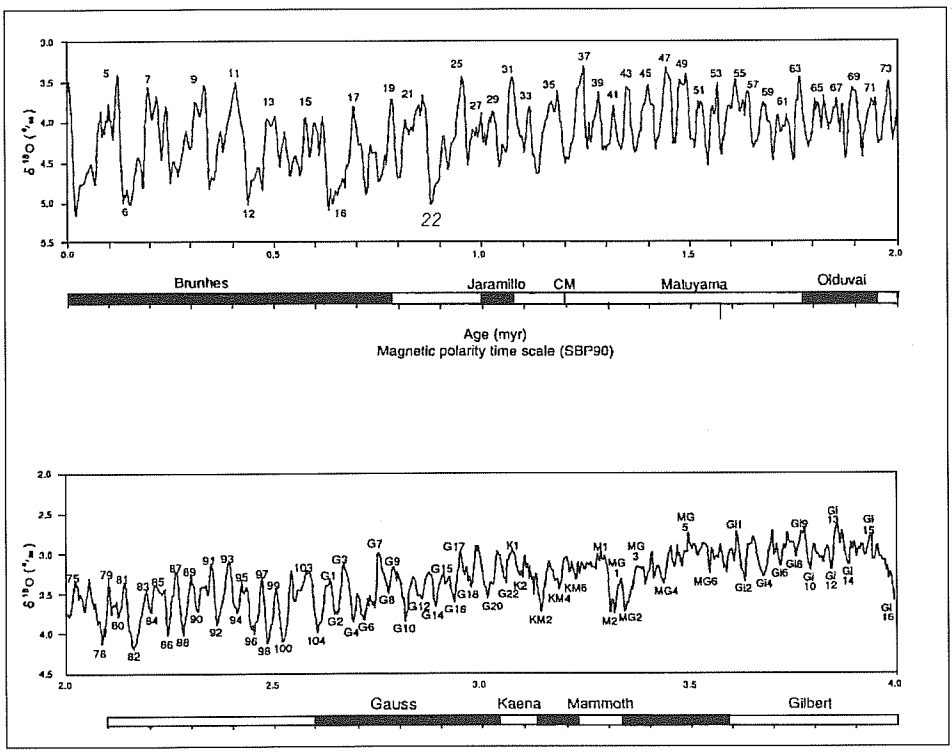

Fig. 1 - Palaeomagnetic field and oxygen isotope curve of the last 4 M.y. (Middle Pliocene to Holocene), after Shackleton, 1995.

sigificantly. Between 3.1 and 1.3 M.y. it oscillated with periods of around 41 kyr; from 1.2 to 0.9 kyr the duration of oscillations gradually changed and after 0.9 kyr settled with rithms of 100 kyr, and oscillation amplitude increased considerably (De Menocal and Bloemendal, 1995; Shackleton, 1995; Vrba, 1995).

The older temperature fall deeply influenced marine faunas (Kennet et al., 1971) and also continental faunas and vegetation, the transition from the warm Reuverian to the cooler Praetiglian in pollen stratigraphy (Zagwijn, 1974), the Elephant-*Equus* event of Lindsay and Opdyke (1980) in continental mammalian faunas; it marked the transition from the Triversa to the Montopoli faunas of larger mammals (Azzaroli, 1977). The second major shift, shortly after 0.9 M.y., did not influence deeply marine faunas but on the continents the story was different. Cold elements characterizing the Galerian stage of Western Europe (Tiraspolian of Eastern Europe, Olyorian of North-Eastem Siberia) began to appear among terrestrial mammals. This happened in Siberia between 1.4 and 1.2 M.y. ago (Sher, 1987); in the middle latitudes the faunal revolution began shortly before 1 M.y.: the typically Galerian fauna of Colle Curti in the mountains of Central Italy (Masini et al., 1994) has been calibrated with the Jaramillo episode

(1.07-0.99 M.y.: Coltorti et al., in press) and a similar date has been proposed for the fauna of Solilhac in the French Central Massif (Thouveny and Bonifay, 1984). This was the "end-Villafranchian event" (Azzaroli, 1983). The vegetation witnessed similar changes around the same time, in Europe and in Asia, as far as Japan (Azzaroli, 1995; Azzaroli et al., 1988). There was therefore a definite lag between climatic changes, and presumably athmospheric temperatures on the continents and ocean water cooling.

Late Villafranchian faunas were entirely made of extinct taxa. With the Galerian, viz. Tiraspolian and Olyorian, the fauna of terrestrial mammals acquired its modern character; cervids of gigantic size, recently extinct, and heavy, massive bovids that still live in our faunas made their first appearance at this date.

The early Pleistocene of continental Italy may be divided into five faunal units. The oldest unit was called Olivola by Azzaroli (1977), from a fauna in the hills of NW Tuscany, but recent discoveries have shown that this site probably is of very late Pliocene age. A rich fauna was recently retrieved from Poggio Rosso near Matassino in the Upper Valdarno and has been calibrated with the Olduvai palaeomagnetic event. Its fauna is similar to the fauna of Olivola, but contains in addition at least two species that do not occur in it: *Canis arnensis* and *Equus stehlini.* This complex is followed by four faunal units: Tasso, from a site in the Upper Valdarno, Tuscany; Farneta, from an Abbey in the valley of the Chiana river South of Arezzo, eastern Tuscany; Pirro, from a set of karst fillings in Mesozoic limestones in Northern Puglia, South Eastern Italy; Colle Curti, from a village in the high Apennines near the watershed between Umbria and Marche, central Italy. The former four units belong to the Villafranchian of continental stratigraphy, the fifth marks the beginning of the Galerian, which extends into the early Middle Pleistocene.

Palaeomagnetic investigations also showed that the lowermost part of the Upper Valdarno sequence, Montevarchi Lake, is of late Pliocene age: it falls in the lower part of the Olduvai episode and into the uderlying reversely magnetized early Matuyama. This may explain the occurrence, in this lake, of some species which characterize the Pliocene: *Anancus arvernensis, Leptobos merlai, Pachycrocuta perrieri.*

The fauna of the next stage of the early Pleistocene, the Tasso f.u. of Azzaroli (1977), takes its name from a village in the Upper Valdarno basin, in the vicinity of which it is richly represented. It is believed that the largest part of the Upper Valdarno fauna may possibly belong to this time interval; local faunas at Le Ville, Case Inferno, Casa Frata belong to this stage. The association is similar to that of Poggio Rosso but has been enriched by several new elements: *Leptobos vallisarni, Hippopotamus antiquus, Canis (Xenocyon) falconeri.* The cervids *Eucladoceros dicranios dicranios* and *E. ctenoides,* which are more derived than their relative *E. dicranios olivolanus* present at Olivola, may possibly come from this horizon, and this also seems to be the case for *Pseudodama nestii eurygonos.* Other species

presumably belonging to this level are *Mimomys pliocaenicus, Mimmys savini* and *Microtus (Allophaiomys) pliocaenicus* (Torre, 1985).

The following stage is called the Farneta f.u. from a medieval Abbey in the low hills that flank to the East the Chiana river, South of Arezzo, in eastern Tuscany. Fossils were collected in a rather wide area of fluvial sands ranging from Farneta Abbey in the North to the vicinity of Chiusi to the South in Tuscany and to Petrignano, Pozzuolo and as far as the Selvella farmhouse east of Gioiella village in westernmost Umbria. The fauna is characterized by the occurrence of *Archidiskodon meridionalis vestinus,* a derived subspecies of large size with a deep, anteroposteriorly compressed skull and powerful tusks. Other typical species of the fauna are *Pseudodama farnetensis,* similar to the Valdarno species but with widely divergent antlers (Azzaroli, 1992) and *Megaceroides obscurus,* which marks the evolutionary transition from the typically Villafranchian genus *Eucladoceros* to the genus *Megaceroides* (Azzaroli and Mazza, 1993, Abbazzi, 1995). The rest of the fauna, rich in individuals but not much varied, includes several species which also occur in the Upper Valdarno: *Equus stenonis, E. stehlini, Leptobos etruscus, L. vallisarni, Canis etruscus* etc.

The rich fauna of the Pietrafitta lignite mine in Umbria (Ambrosetti et al., 1987) belongs to the same unit. It is more varied than the fauna of Farneta but has not yet been fully described. Several articulated skeletons of *Archidiskodon meridionalis vestinus* were collected in the lignite. Other fossils are *Megaceroides obscurus,* a rather small rhinoceros recalling in its features the much larger, Galerian *Stephanorhinus hundsheimensis,* macaque, beaver, various rodents etc.

Faunas of this stage are fairly common in central, and also in Northern Italy. Possibly the fauna, or at least a part of the fauna of Leffe, Bergamo province, Northern Italy (Vialli, 1956), which has yielded remains of a derived elephant of the *meridionalis* group, belongs to this unit. So does the fauna from the lignites and lacustrine deposits of the Mugello basin in Northern Tuscany, with *Archidiskodon meridionalis vestinus, Leptobos* sp. (large), a rhinoceros recalling the features of the species from Pietrafitta; a palate and jaw of *Archidiskodon meridionalis vestinus* from Péccioli in the Lower Valdarno, West of Florence; a skull of the same subspecies from Oriolo near Faenza, at the Southern margin of the Po plain, and the perfectly preserved skeleton from Scoppito, West of L'Aquila in Abruzzo (Maccagno, 1962), the holotype of this subspecies (its subspecific name is derived from the *Vestini,* a tribe that populated the area at the time of the Roman republic).

The fourth unit of the early Pleistocene has been called Pirro Nord (Masini et al., in press), from a locality in Northern Puglia region, near San Severo, province of Foggia. Fossils were collected from karst fillings in local Mesozoic limestones (De Giuli et al., 1986). The most characteristic element of this fauna is *Eobison,* a genus of intermediate morphology between *Leptobos* and *Bison,* represented by

a skull with a bulging forehead, a jaw and two rather short and massive metacarpals. The fauna, collected in viarious sinkholes, is rich. Besides *Eobison* it includes a rhinoceros (probably *Stephanorhinus),* a rather slender limbed variety of *Equus stenonis,* a *Pseudodana* more derived than *P. farnetensis, Megaceoides* sp., *Sus* sp., *Archidiskodon* sp., *Megantereon* cf. *cultridens, Homotherium crenatidens, Pachycrocuta brevirostris, Canis arnensis, C. falconeri, Vulpes* cf. *alopecoides, Ursus etruscus, Hystrix* cf. *etrusca* and several small mammals, among which *Pitimys arvaloides, Microtus (Allophaiomys) pliocaenicus, Apodemus flavicollis, Hypolagus* cf. *pachygnathus, Lepus* cf. *etruscus, Miniopterus* sp., *Myotis* cf. *blithy, Rhinolophus* cf. *euryale, Talpa minor* etc.

The following Colle Curti unit in the Colfiorito area of the Umbro-Marchean Apennines falls in the Jaramillo palaeomagnetic episode (Coltorti et al., in press) and characterizes the beginning of the great Galerian faunal revolution. It marks the final stage of the marine early Pleistocene. The fauna, which is still under study, is poor but significant. It is characterized by the occurrence of *Megaceroides verticornis* and also includes *Stephanorhinus* cf. *hundsheimensis, Pseudodama* cf. *farnetensis, Canis arnensis, Canis* cf. *falconeri, Ursus* cf. *etruscus, Microtus (Allophaiomys)* ex gr. *pliocaenicus* and a large size variant of *Hippopotamus antiquus* (Ficcarelli et al., 1990, Masini et al., 1994, Mazza, 1995).

Other Galerian faunas, with ages comprised between the latest early Pleistocene and the beginning of the middle Pleistocene occur in the Tiber delta at Ponte Galeria – the site whence this unit takes its name – with *Megaceroides verticornis,* possibly *Megaloceros savini, Bison* cf. *schoetensacki* and *Elephas* sp. (Ambrosetti, 1967) and at La Maglianella, with *Hippopotamus tiberinus* (Mazza, 1991). Other sites occur in the Farneta area, above the Villafranchian fluviatile formation, in minutely pebbly beds with an ochraceous matrix at the cemetery of Borgonuovo, with *Elephas antiquus, Hippopotamus* sp., *Megaceroides verticornis* and *Equus ferus,* and farther South, at Petrignano and Pozzuolo, with *Megaceroides verticornis.* Scattered Galerian elements also occur in the Upper Valdarno. The most significant specimen is a horncore of *Bison schoetensacki* from Persignano (Azzaroli, 1984). Another site with Galerian fossils is Monte Oliveto near San Gimignano, Siena province, with *Equus ferus, Elephas antiquus* and a Galerian megacerid, probably *Megaceroides verticornis* (Berzi, 1972).

In Northern Italy a Galerian fossil is *Stephanorhinus hundsheimensis,* found in the Stirone river, Parma province (Cigala Fulgosi, 1976, described as *Dicerorhinus hemitoechus).* Another Galerian fossil is a horneless braincase of *Cervalces latifrons* from Fornace di Rànica, Bergamo province, in the foothills of the Alps (Azzaroli, 1979).

Most of the Villafranchian fauna became extinct at the end of this period but several of its elements gave origin through evolutionary changes to species

characteristic of later ages. *Letobos vallisarni* may have given origin, through *Eobison,* to the middle Pleistocene *Bison schoetensacki; Hippopotamus antiquus* probably evolved into *H. tiberinus; Equus stenonis* gave origin in the late Villafranchian to *E. stehlini* and to *E. bressanus,* and through the latter to the Galerian *E. süssenbornensis. Stephanorhinus etruscus* may possibly have evolved, through intermediate stages represented at Pietrafitta and in the Mugello basin, into *S. hundsheimensis,* fairly well represented in the middle Pleistocene of Italy. *Cervalces,* represented in Italy only by a braincase of the middle Pleistocene *C. latifrons,* had its origin in the Villafranchian *C. gallicus,* well represented in central France and Eastem England. Canids are represented in the Villafranchian of China by the same species that lived in Italy; *C. etruscus* seems to have given origin to *C. mosbachensis* and, through the latter, to *C. lupus,* while the small *C. arnensis* was possibly related to African jackals (Torre, 1967).

INSULAR FAUNAS

Several islands around Italy were populated by mammals immigrated from the mainland. Many islands were colonized in the middle and late Pleistocene but some of them had a more complex history.

The earliest endemic faunas of Sicily were found in karst fillings in Monte Pellegrino, in the outskirts of Palermo. They are represented by small mammals, all however somewhat larger than their continental relatives: a mustelid, *Pellegrinia arzilla,* a leporid, *Hypolagus* sp., a murid, *Apodemus maximus,* two glirids, a ctenodactylid, an insectivore of the genus *Episoriculus.* The occurrence of a ctenodactylid, which belongs to a family endemic to Africa, is remarkable as it implies a territorial connection of Sicily to the African continent, presumably during the Messinian dessiccation of the Mediterranean. This fauna is presently under study.

The rest of the Sicilian fauna belongs to the later Pleistocene. Most of it is represented by an association of red deer derived from the continental *Cervus elaphus,* a hippo presumably related to *Hippopotamus amphibius,* an elephant, *Elephas mnaidriensis,* related to the continental *Elephas antiquus* and a large glirid, *Leithia melitensis.* A similar fauna also occurs at Malta, which must have had a durable connection with Sicily during the middle-late Pleistocene. Elephants and hippos are about 200 ky old, according to measurements made on aminoacid racemization of their teeth (Bada et al., 1991). There is however an elephant of much smaller size, and much older age than *Elephas mnaidriensis: Elephas falconeri.* The male is about 1 mt. tall at the shoulder. Its age, also determined through aminoacid racemization, is about 400 ky. Its affinities are not clear, the skull does not show relationships to the continental *E. antiquus.* The provenance of this elephant is still a query.

Sardinia and Corsica also had a varied history, independent from Sicily. In the early Miocene Sardinia was populated by rodents, including a Ctenodactylid, and insectivores presumably immigrated from the Balearics, at a time when the Corso-Sardinian massif had not yet begun its counter-clockwise rotation which brought it into its present position (De Bruijn and Rümke, 1974; Azzaroli, 1990, 1993).

A second colonization took place during the Messinian dessiccation, but no Messinian fossils have been found in the islands. Their descendants, of Pliocene or early Pleistocene age, are preserved in deposits at Capo Figari in NE Sardinia and in other sites: *Macaca majori, Prolagus figaro, Tyrrhenoglis majori, Rhagamys minor, Nesiotites corsicanus, Talpa tyrrhenica, Enhydrictis galictoides, Sus nanus* and *Nesogoral melonii* (Azzaroli, 1946; Ficcarelli and Torre, 1967; Gliozzi and Malatesta, 1980; Van der Made, 1988).

A new immigration took place at the transition from early to middle Pleistocene, in all likelihood during the Cassian sea level fall. The older fauna was wiped out, with the exceptions of *Rhagamys,* represented now by the species *R. orthodon,* and *Prolagus,* represented by *P. corsicanus.* Immigrants were an elephant, *Mammuthis* (or *Archidiskodon?) lamarmorai* (Malatesta, 1954, Ambrosetti, 1972), the giant deer *Megaceroides,* which in the course of the Pleistocene gave origin to a variety of dwarf forms in Sardinia and Corsica (Azzaroli, 1961), the vole *Microtus (Tyrrhenicola) henseli,* closely related to the continental *Microtus (Allophaiomys) pliocaenicus* (Mezzabotta et al., 1995) and *Canis (Cynotherium) sardous* (Malatesta, 1970), presumably derived from a late Villafranchian canid of the continent.

PALAEOGEOGRAPHY

Early Pleistocene faunas occur mainly in Central Italy and there are only restricted records of them in the North (Leffe, Oriolo) and in the South (Pirro). Nearly all the mammalian fauna of central Europe is represented in the Peninsula, although at that time its territory was less extended than it is at present. The topographically restricted occurrence of late Villafranchian faunas is mainly due to the distribution of continental deposits, which are rare in the Alpine region, moderately rich in the margin of the Apennines, richer on their Tyrrhenian slope and in the adjoining areas to the West and again more restricted in the South, where the Pirro fauna was collected in sinkholes in the local Mesozoic limestone, while most fossil bearing sites in the central and southern parts of the peninsula belong to younger ages.

The palaeogeography of the Corso-Sardinian massif has been discussed by Azzaroli and Guazzone (1979) and by Azzaroli (1990 and in press). During the early Tertiary these islands, jointly with the Balearics, formed the Southern margin of Western Europe. In the Oligocene the Balearics still had some connection with Europe and at least temporarily with Northern Africa. Thus a mixed fauna of

European and African elements migrated to Sardinia, where it is documented in the early Miocene. During the later Miocene and Pliocene the Balearics became detached from the continent, Corsica and Sardinia rotated counter-clockwise and eventually reached their present position in the Pliocene or Pleistocene. They were united to the European continent during the Messinian dessiccation, were isolated in the Pliocene and earliest Pleistocene, and had a temporary connection with Tuscany through northern Corsica at the Villafranchian-Galerian transition during the Cassian marine low stand.

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