

Preliminary data on the micro- and macromammal remains from Casa Sgherri, Lower Valdarno (Tuscany, Italy)

Federica MARCOLINI Francesco Paolo BONADONNA

Dipartimento di Scienze della Terra
Università di Pisa

Paul MAZZA

Museo di Geologia e Paleontologia
Università di Firenze

Tassos KOTSAKIS

Dipartimento di Scienze Geologiche
Università di Roma Tre

Giovanni ZANCHETTA

Dipartimento di Scienze della Terra
Università di Pisa

KEY WORDS – Mammal fauna, Palaeontology, Biochronology, Pleistocene, Lower Valdarno, Central Italy.

ABSTRACT – Preliminary data on a new mammal bearing deposit of Lower Valdarno (on the right-hand side of the Arno River) are presented here. Macromammals include: *Macaca sylvana florentina*, *Enhydriactis ardea*, *Acinonyx pardinensis*, *Sus strozzi*, *Pseudodama* sp., *Capreolus* sp., and *Leptobos* sp. The micromammals are represented by: *Glis* sp., *Mimomys pitomyoides*, *Mimomys* cf. *M. pusillus*, *Mimomys* sp. 1, *Mimomys* sp. 2, *Apodemus dominans*, *Hystrix refossa*, and *Oryctolagus* cf. *O. lacosti*. The assemblage is referable to the Middle or early Late Villafranchian and is therefore attributed to the Costa S. Giacomo or Olivola Faunal Units. This attribution confirms the most recent interpretations of the basin between Monti Pisani and Monte Albano, considering the basal portion of the fluvial deposits of the Massarella Unit as Late Pliocene.

RIASSUNTO – [Dati preliminari sui resti di micro- e macromammiferi di Casa Sgherri, Valdarno inferiore (Toscana, Italia)] – In questo lavoro vengono presentati i primi dati su un nuovo giacimento a mammiferi del Valdarno inferiore in destra orografica del fiume Arno. L'associazione a macromammiferi comprende: *Macaca sylvana florentina*, *Enhydriactis ardea*, *Acinonyx pardinensis*, *Sus strozzi*, *Pseudodama* sp., *Capreolus* sp., and *Leptobos* sp. I micromammiferi sono rappresentati da: *Glis* sp., *Mimomys pitomyoides*, *Mimomys* cf. *M. pusillus*, *Mimomys* sp. 1, *Mimomys* sp. 2, *Apodemus dominans*, *Hystrix refossa*, and *Oryctolagus* cf. *O. lacosti*. L'associazione viene inquadrata nel Villafranchiano medio o parte basale del superiore e viene quindi attribuita alla UF Costa S. Giacomo o a quella di Olivola. Questa attribuzione conferma le più recenti interpretazioni della zona compresa tra i Monti Pisani e il Monte Albano, che inquadrano nel Pliocene superiore la base dei depositi di origine fluviale dell'Unità di Massarella.

INTRODUCTION

The continental succession cropping out in the basin between Monti Pisani and Monte Albano is poorly known from both the stratigraphic and chronological points of view. Some recent works have shown a more complex stratigraphic setting than previously proposed (Trevisan *et al.*, 1971; Mazzanti, 1983; Dallan, 1988; Federici & Mazzanti, 1988; Puccinelli, 1991) and a new stratigraphic interpretation, corroborated by faunal findings, has been proposed (Caredio *et al.*, 1995; Zanchetta *et al.*, 1995; Zanchetta & Mazza, 1996; Zanchetta *et al.*, 1998).

Preliminary data on a mammal bearing deposit at Casa Sgherri, near Ponte a Cappiano (Firenze), on the right-hand side of the Arno river, are presented here.

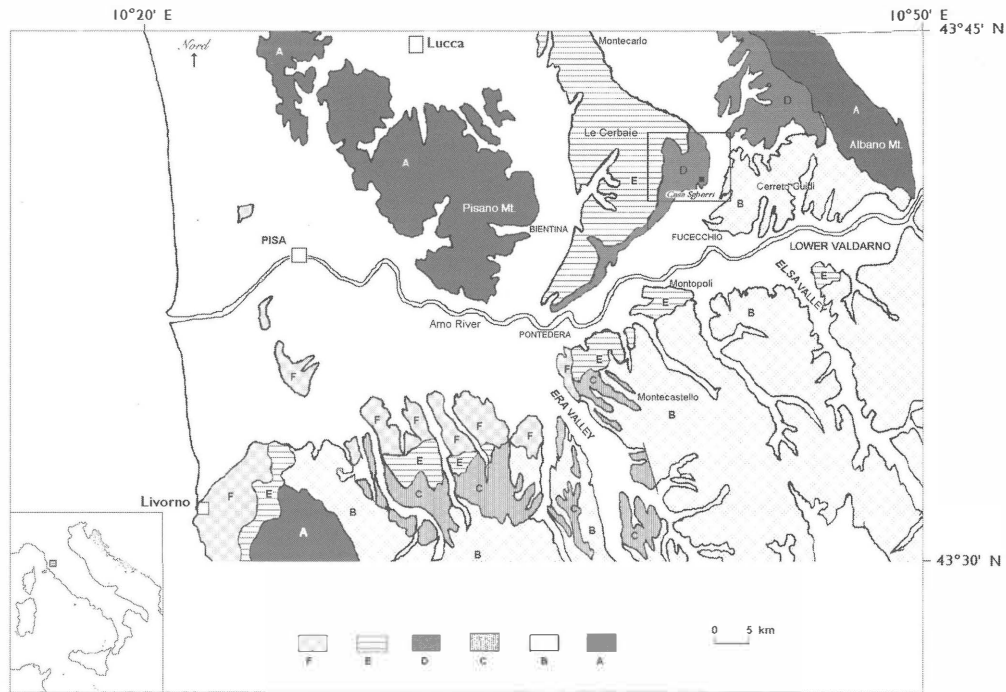
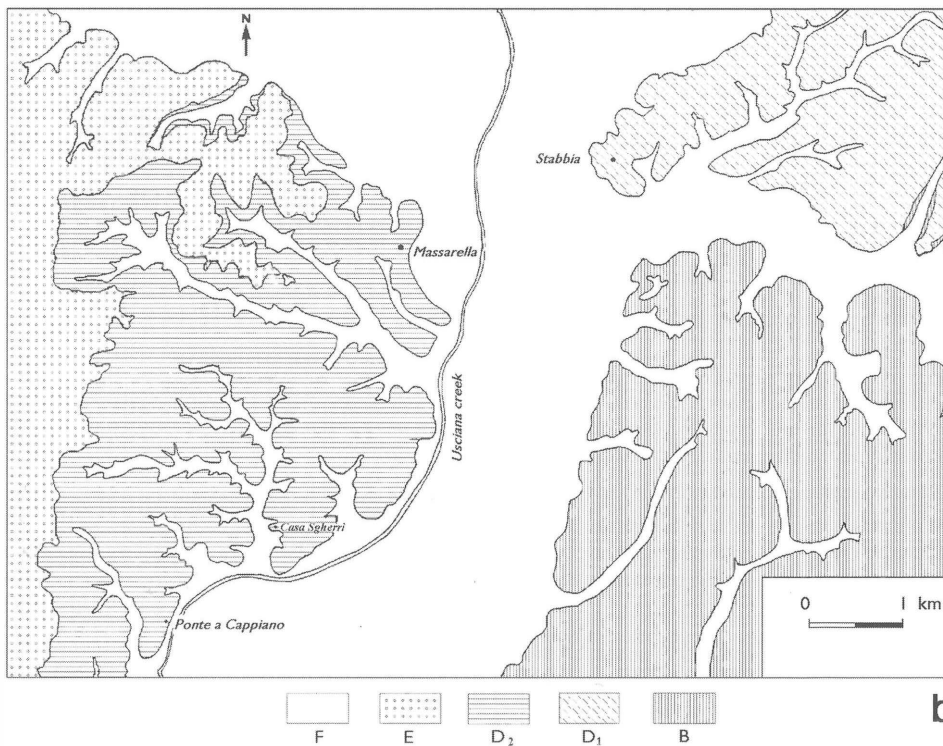
GEOLOGICAL SETTING

From a structural point of view the basin is considered the northwestward extension of the "Elsa graben" (Ghelardoni *et al.*, 1968; Bartolini *et al.*, 1982), a Neogene basin developed during post-

Tortonian disjunctive tectonic phase (Ambrosetti *et al.*, 1978). According to Ghelardoni *et al.* (1968) upper Miocene continental deposits are present in the boreholes Cerbaie-1, Certaldo-2 and Certaldo-3, in the subsurface of the Arno valley and probably represent the first deposits infilling the basin.

The marine Pliocene cycle outcrops in the Cerreto Guidi area, on the right-hand side of the Arno river (Text-fig. 1a). In proximity to Monte Albano (Trevisan *et al.*, 1971; Caredio *et al.*, 1995), these deposits consist of sands and clays with bodies of gravels of marine and transitional environment. The end of this cycle may be Middle Pliocene in age, as documented in nearby basins (Bossio *et al.*, 1981) but the data are very poor. From these deposits there are only some old indications of Early Villafranchian mammal remains (Del Campana, 1918).

A new cycle lies in unconformity on them (Text-fig. 2). The new cycle consists of continental deposits, at least in its inner parts and extends in the basin between Monti Pisani and Monte Albano. These continental deposits probably make a lateral transition to the Lower Pleistocene marine cycle, which bears northern

**a****b**

Text-fig. 1 - a: Schematic geologic map of Lower Valdarno. A) Pre-Neogene; B) Pliocene; C) Lower Pleistocene (marine deposits); D) Lower Pleistocene (continental deposits; Late Villafranchian); E) Middle Pleistocene; F) Upper Pleistocene. The square represents the area enlarged in b.

b: Schematic geologic map of the surroundings of Casa Sgherri. B) Pliocene (undifferentiated); D₁) Maestromarco Sands and Clays, Lower Pleistocene; D₂) Massarella Sands, Lower Pleistocene; E) Cerbaie Conglomerates and Gravels, Middle Pleistocene; F) Holocene alluvial deposits.

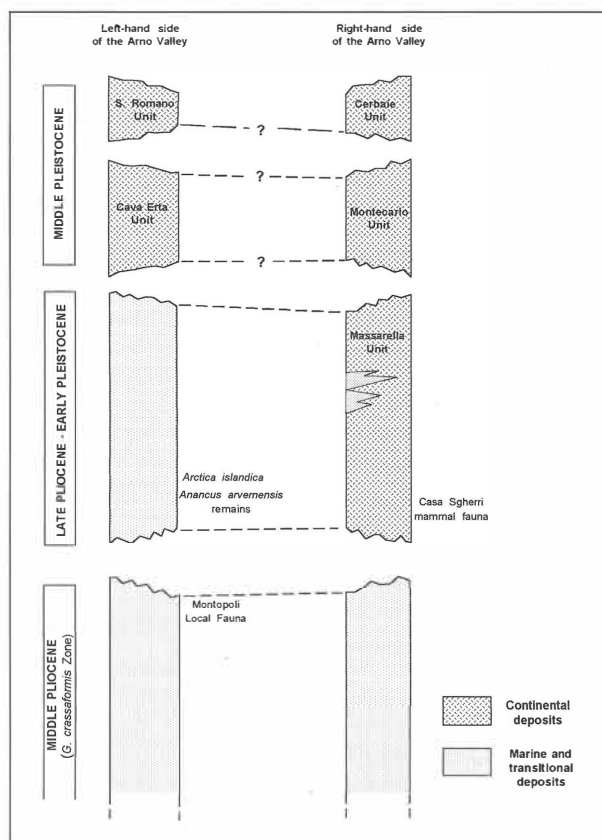
guests and largely documented up to Monte Castello, on the left-hand of the Arno River (Nencini, 1984). According to Zanchetta (1995) this transition is evident in the SW borders of Cerbaie hills where tongues of marine and brackish sediments interdigit within the continental deposits. The new cycle marks also the renewal of a sinking phase following the retreat of the Middle Pliocene sea and may begin before Early Pleistocene (Zanchetta, 1995; Zanchetta *et al.*, 1995).

Fluvial terraced and tilted deposits follow upwards. They consist of reddish sands and gravels originated by the dismantling of the Monti Pisani. According to most Authors, two different units can be distinguished on the right-hand-side, both considered Middle Pleistocene in age: the Montecarlo Gravels and Sands, the oldest one, and the Cerbaie unit (Trevisan *et al.*, 1971; Mazzanti, 1983; Federici & Mazzanti, 1988; Dallan, 1988; Puccinelli, 1991; Zanchetta, 1995). The latter is commonly correlated with the Casa Poggio ai Lecci Formation of the Arno left side (Mazzanti, 1983; Marroni *et al.*, 1990). Recent studies clearly show that the Casa Poggio ai Lecci Formation, in the area comprised between Montopoli and La Rotta, can be divided into two different units: Cava Erta Unit, the oldest, and S. Romano Unit (Gazzerro, 1997; Tani, 1997; Zanchetta *et al.*, 1998; Tani & Gazzerro, 1999).

STUDIED AREA

Two informal geological units can be encountered in the area under examination (Text-fig. 1b): they differ in lithology, facies and alteration. The oldest one, "unità di Massarella" (Zanchetta, 1991, 1995), includes the Casa Sgherri deposit and consists of fine silty sands and gravels and sometimes bears cross-bedded structures. Some authors have considered this unit as representing a Pliocene marine deposit (Ghelardoni *et al.*, 1968; Trevisan *et al.*, 1971; Dallan, 1988; Federici & Mazzanti, 1988; Marroni *et al.*, 1990; Puccinelli, 1991). New researches show that the Massarella unit is mostly of continental origin and has been interpreted as a flood plain and filled-channel deposit (Zanchetta, 1995). The Casa Sgherri level represents one of these fillings. Fresh-water mollusc assemblages and, more rarely, some land-snails have been found in some clay levels, interbedded in flood plain deposits (Zanchetta, 1995). In the western part of the area there are two brackish intercalations, heteropic with the continental part of the Massarella unit, which has been dated to the Early Pleistocene (Zanchetta, 1995; Marcolini, 1997).

The Cerbaie unit, younger than the Massarella unit, consists of polygenic, generally siliceous gravels and of sandy levels locally showing cross-beddings. The Cerbaie unit always shows an erosional surface at its bottom. This unit is not very thick and is strongly altered by pedogenic processes. It may consist of different units, distinguished in age, pedogenic alter-



Text-fig 2 - Schematic sketch of the stratigraphic relationships between the deposits ranging from Middle Pliocene to Middle Pleistocene and outcropping on the orographic left-hand side and right-hand side of the Arno River. Correlations are made between the most visible cycles. According to Lindsay *et al.* (1980), in Lower Valdarno the top of the Middle Pliocene succession is dated at about 2.5 Ma.

ation and levels of terraces (Bonadonna & Zanchetta, research in progress).

MAMMAL REMAINS

The fossiliferous layers of Casa Sgherri consist in channel-filling sands wherein fragmentary mammalian teeth, hyena coprolites and other unidentified bones fragments have been found (Table 1). The macromammals represented at the site are *Macaca sylvana florentina*, *Enhydriactis ardea*, *Acinonyx pardinensis*, *Sus strozzii*, *Pseudodama* sp., *Capreolus* sp., and *Leptobos* sp. (Plate 1). Small mammals (Text-fig. 3) include: *Glis* sp., *Mimomys pitymyoides*, *Mimomys* cf. *M. pusillus*, *Mimomys* sp. 1, *Mimomys* sp. 2, *Apodemus dominans*, *Hystrix refossa*, and *Oryctolagus* cf. *O. lacosti*.

MACROMAMMALS

Casa Sgherri sands provided only teeth and no postcranial elements. This prevented an easy identification of the species.

Order PRIMATES Linnaeus, 1758
 Family CERCOPITHECIDAE Gray, 1821
 Genus MACACA Lacépède, 1799
 MACACA SYLVANA FLORENTINA (Cocchi, 1872)
 Pl. 1, fig. 1

This primate is represented by a right P₄ and a left M₃. Both teeth conform perfectly to the holotype preserved in the Museum of Paleontology of Florence.

Macaca sylvana florentina characterises several Middle Villafranchian to Early Galerian Local Faunas of Europe (Gliozzi *et al.*, 1997). It is generally found in forest assemblages, but its remains are sometimes encountered also in fossil communities indicative of rocky landscapes. Primates are usually indicators of warm climates. Anyway *Macaca* sp. has been found in Montoussé 5 (Pyrénées, France) (Clot *et al.*, 1976a, 1976b) where it occurs with the lemming *Lemmus*. *Macaca sylvana florentina* is believed to be ancestral to the Gibraltar Macaque, the only monkey living today in Europe. Although being a monkey, the Gibraltar Macaque lacks its tail; for this reason it is sometimes called the Gibraltar "ape". At the moment it is not possible to ascertain if the Florentine Macaque also lacked the tail.

Order CARNIVORA Bowdich, 1821
 Family MUSTELIDAE Swainson, 1835
 Genus ENHYDRICTIS Major, 1902
 ENHYDRICTIS ARDEA (Bravard, 1828)
 Pl. 1, fig. 2

The only specimen referable to this species is a heavily worn right carnassial tooth that is slightly smaller than the ones kept at the Museum of Paleontology of Florence.

This lutrine carnivore was found in deposits ranging from the Early Villafranchian site of Les Etouaires to several localities of the Olivola Faunal Unit (F.U.) (Gliozzi *et al.*, 1997). Outside Italy, it was distributed

in East Anglia, France and Hungary. It is a typical forest dweller, but its remains may also be found in wood and steppe deposits. Although being a lutrine carnivore, its limbs are structured in such a way that is suggestive of an animal adapted to land.

Family FELIDAE (Gray, 1821)
 Genus ACINONYX Brookes, 1828
 ACINONYX PARDINENSIS (Croizet & Jobert, 1828)
 Pl. 1, fig. 3

The species is represented by an isolated right P₄. The tooth has a very prominent and vertically arranged protoconid, a small mesial paraconid and a low but robust metaconid and a well developed cingulum, especially along the distal margin. The arrangement and proportions of the cusps and the general size of the tooth are typical of the Villafranchian giant cheetah (Ficcarelli, 1984).

The presence of this species in Western Europe is ascertained from the Early to at least the Middle Villafranchian (Gliozzi *et al.*, 1997). It is also reported from the Late Villafranchian localities of Olivola, in the Magra Valley, and Casa Frata, in the Upper Valdarno. However its occurrence in the latter faunal assemblages is debated, since the identification of the species is not supported by material of sure taxonomic attribution, such as skulls, mandibles or teeth. The slender limb bones found there may even likely belong to *Chasmaporthetes lunensis*, a species also present at Olivola and in the Upper Valdarno.

Order ARTIODACTILA Owen, 1848
 Family SUIDAE Gray, 1821
 Genus SUS Linnaeus, 1758
 SUS STROZZII Forsyth Major, 1881 (ex Meneghini)

Two lower incisors, morphologically and dimensionally equivalent to others kept in the Museum of Florence, attest to the occurrence of this species.

Table 1: Casa Sgherri findings	P ²	M ¹	M ²	M ³	I ₁	I ₃	P ₂	P ₃	P ₄	M ₁	M ₂	M ₃
<i>Macaca sylvana florentina</i>									1			1
<i>Enhydriactis ardea</i>										1		
<i>Acinonyx pardinensis</i>									1			
<i>Sus strozzii</i>					1	1						
<i>Pseudodama</i> sp.		2	1	2				2	1	1	2	2
<i>Capreolus</i> sp.							1				1	
<i>Leptobos</i> sp.											part	
<i>Glis</i> sp.										1 lower molar		
<i>Mimomys pitomyoides</i>										1		
<i>Mimomys</i> cf. <i>M. pusillus</i>										1		
<i>Mimomys</i> sp. 1										3		
<i>Mimomys</i> sp. 2										2		
<i>Apodemus dominans</i>		2	3							5	3	
<i>Hystrix refossa</i>										1		
<i>Oryctolagus</i> cf. <i>O. lacosti</i>	1											

Tab. 1 - Casa Sgherri faunal list. Number and type of findings are indicated.

Sus strozzi is a characteristic faunal element of the late Middle-Late Villafranchian communities of many parts of Europe. It is typical of marshy woodlands (Azzaroli, 1954). It is related to *Sus verrucosus*, of the south-east of Asia, and it was generally quite larger-sized than the present day European boar, although the two species may sometimes slightly overlap in size. As compared with *S. scrofa*, *S. strozzi* had proportionally shorter limbs and somewhat wider feet.

Family CERVIDAE Gray, 1921
Genus PSEUDODAMA Azzaroli, 1992
PSEUDODAMA sp.
Pl. 1, figs. 4-5

This is the most represented faunal element of the association: two deciduous teeth, five upper molars and other fragments of upper premolars and molars, two lower incisors, four lower premolars and five lower molars.

In a recent revision Di Stefano & Petronio (1998) observed that these cervids, which Azzaroli (1992) had originally ascribed to the genus *Pseudodama*, share such a number of common traits with the Asian genus *Axis* to suggest two possibilities: the direct attribution of the Italian specimens altogether to *Axis* or their attribution to a new genus. For a number of reasons detailed in their paper, Di Stefano & Petronio (1998) preferred the latter solution and introduced the genus *Euraxis* which is meant to include the three species *E. lyra*, *E. nestii* and *E. eurygonos* (the latter in place of Azzaroli's *Pseudodama farnetensis*). Although the general lines of Di Stefano & Petronio's (1998) observations are agreed with, the two authors attribute to the new genus all the material originally called *Pseudodama*, including also the type specimen from Upper Valdarno, but then they maintained the name *Pseudodama* for the specimens from Central Europe, thus generating considerable confusion. Therefore, since this unsettled topic goes beyond the scope of the present paper, the writers prefer maintaining the name *Pseudodama* awaiting for a definitive general agreement on this question.

These cervids are typical representatives of the Villafranchian communities of Western Europe. Their ecological preferences are slightly known, but remains of *Pseudodama* are usually found in communities indicating a fairly developed wood cover.

Genus CAPREOLUS Frisch, 1775
CAPREOLUS sp.
Pl. 1, fig. 6

The only three specimens referable to this genus are a second lower premolar, a second lower molar and a not measurable fragmental molar.

The Pleistocene roe deer was decidedly larger than the present day European subspecies, but it somehow

recalls the extant Asian representatives. It appeared in the Early Galerian (Colle Curti F.U.) and it became abundant during the Middle-Late Pleistocene (Gliozzi *et al.*, 1997). The Casa Sgherri finding seems to be, at the moment, the oldest ascertained occurrence of roe deer in Europe, although recently a fossil cervid tibia, found in Messinian marine deposits in the outskirts of Collesalveti, near Pisa, was tentatively attributed to *Capreolus* sp. by Sarti *et al.* (1998).

Woods or thick bushes are the preferred environments of life of this cervid, but it may also be found in more open spaces.

Family BOVIDAE Gray, 1821
Genus LEPTOBOS Rüttimeyer, 1877
LEPTOBOS sp.

The only specimen referable to this genus is an isolated talonid of a left M_2 .

The genus seems to have originated in Asia, where species somehow linked with *L. etruscus* are reported from a number of localities (Masini & Torre, 1990). Typical element of the Villafranchian of Europe, *L. etruscus* appears in the Early Pleistocene and becomes extinct in the Middle Pleistocene (Gliozzi *et al.*, 1997). It is normally considered an open-space dweller.

MICROMAMMALS

Teeth of rodents belonging to four families were collected at the site: glirids, arvicolids, murids and hystricids. Few fragmentary teeth of a lagomorph of the family Leporidae are also present.

Order RODENTIA Bowdich, 1821
Family GLIRIDAE Thomas, 1897
Genus GLIS Brisson, 1762
GLIS sp.

A single lower molar with the occlusal surface very worn belongs to the genus *Glis*. Unfortunately, given the scantiness of the finding, a specific attribution is prevented.

Family ARVICOLIDAE Gray, 1821
Genus MIMOMYS Major, 1902
MIMOMYS PITMYOIDES Janossy & Meulen, 1975
Text-fig. 3A

One right M_1 is assigned to this species. Its morphology, with T2-T3 and T4-T5 opposite and confluent, recalls that of *Mimomys pitmyoides*, a species which first appeared at Osztramos 3 (Janossy & Meulen, 1975). In Italy it is quoted only from the karst fissure of Rivoli Veronese, which is referred to the Late Villanyan (Sala *et al.*, 1994; Gliozzi *et al.*, 1997). Tesakov (1998) considers *Mimomys pitmyoides* the type species of a distinct genus, *Pitymimo-*

mys. M. pitymyoides occurs in Montoussé 5 (Pyrénées, France) (Clot *et al.*, 1976a, 1976b) and in Bresse Valley (Auvillers, Vounas, Cassey-sur-Tille) (Chaline, 1984).

MIMOMYS cf. *M. pusillus* (Méhely, 1914)
Text-fig. 3B

Two left M_1 , one somewhat damaged, and one M^3 are assigned to *Mimomys* cf. *M. pusillus*. These teeth are morphologically similar to others found at Pietrafitta (Perugia, Central Italy) (Gentili *et al.*, 1996). In Italy this species is reported from faunal assemblages assigned to the Farneta F.U. (Masini & Torre, 1987; Gliozzi *et al.*, 1997).

MIMOMYS sp. 1
Text-fig. 3C

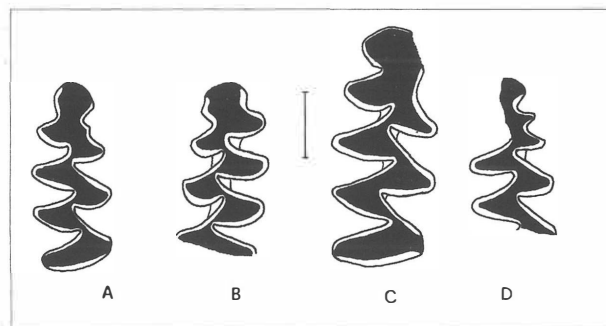
A very large right M_1 and some fragments of other teeth must be ascribed to a third species of *Mimomys*. The comparison with material of *Mimomys savini* Hinton of the collections of Bourgogne University evidenced some morphological differences. They are also larger-sized than the teeth from the type-locality (Pasquier, 1972). Marked morphological and dimensional differences also exist with another large-sized arvicolid, *Kislangia rex* (Kormos).

Some occlusal characters and the dimensions of the Casa Sgherri specimens are suggestive of *Mimomys ostramosensis* Janossy & Meulen (Janossy & Meulen, 1975; Carls & Rabeder, 1988), but the scantiness of the material prevents any attribution beyond the generic level.

MIMOMYS sp. 2
Text-fig. 3D

A fragment of a right M_1 is morphologically different from the other specimens collected at the site. The mimomyan ridge is very similar to that of *Mimomys pliocaenicus* Forsyth Major, but this character alone prevents any attribution beyond the generic level.

Family MURIDAE Illiger, 1815
Genus APODEMUS Kaup, 1829
APODEMUS DOMINANS Kretzoi, 1959



Text-fig 3 - Arvicolids from Casa Sgherri: A) *Mimomys pitymyoides* right M_1 ; B) *Mimomys pusillus* left M_1 ; C) *Mimomys* sp. 1 right M_1 ; D) *Mimomys* sp. 2 right M_1 . Scale bar represents 1 mm.

Seventeen molars are ascribed to the genus *Apodemus*. On the basis of their morphology and dimensions, the specimens can be referred to *Apodemus dominans*, a species very common in Europe from the Ruscian through the Early Biharian (Pasquier, 1974; Argenti, 1998). In Italy it occurs in some Villanyan or Early Biharian localities.

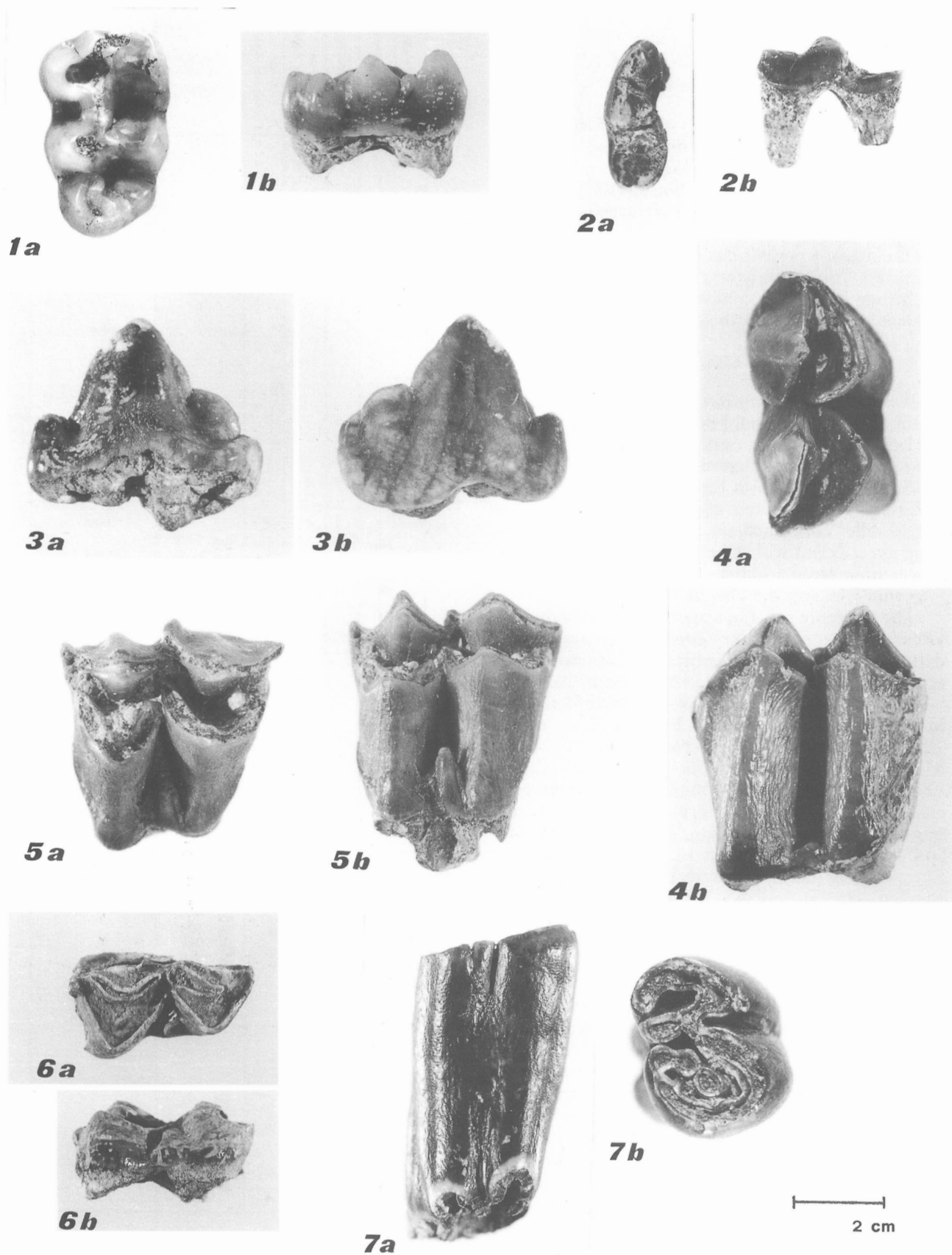
Family HYSTRICIDAE Fischer, 1817
Genus HYSTRIX Linnaeus, 1758
HYSTRIX REFOSSA Gervais, 1852
Pl. 1, fig. 7

A single right M_1 with broken roots can be referred to the genus *Hystrix*. Traditionally, the Italian Villafranchian representatives of this genus are assigned to *Hystrix etrusca* Bosco. Recently, Weers (1994) placed this species in the synonymy of *Hystrix refossa* Gervais and applied the latter name to all the Pliocene and Early Pleistocene porcupines of Europe. Azzaroli (1998) discussed the affinities and the phylogenetic position of the Upper Valdarno porcupine maintaining the name *Hystrix etrusca* without facing nomenclatorial problems.

Porcupines characterise the whole Villafranchian. They were spread out widely from Spain, France, Germany and western North Africa all the way through to southeastern Asia and as far south as the sub-Saharan areas of eastern Africa, which is approximately the same distribution they have today.

EXPLANATION OF PLATE 1

- Fig. 1 - *Macaca sylvana florentina* left M_3 . a) occlusal view; b) lingual view.
Fig. 2 - *Enhydriactis ardea* right M_1 . a) occlusal view; b) lingual view.
Fig. 3 - *Acinonyx pardinensis* right P_4 . a) lingual view; b) labial view.
Fig. 4 - *Pseudodama* sp. right M_2 . a) occlusal view; b) lingual view.
Fig. 5 - *Pseudodama* sp. right M^2 . a) occlusal view; b) lingual view.
Fig. 6 - *Capreolus* sp. right M_3 . a) occlusal view; b) lingual view.
Fig. 7 - *Hystrix refossa* left M_1 . a) occlusal view; b) lingual view.



The genus *Oryctolagus* is represented here by a single right P² (see discussion on morphology in Nocchi & Sala, 1997). It is morphologically similar to *O. lacosti* illustrated by Lopez Martinez (1977), a species of the Late Pliocene and Early Pleistocene of Europe. *Oryctolagus lacosti* was a large-sized species, more or less the size of a present-day brown hare, although its characters (broad, fairly straight lower incisors; relatively long fore-limbs, compared to *Lepus* representatives; etc.) are definitely those of a rabbit.

If the isolated *A. pardinensis* P₄ from Casa Sgherri is not reworked, it would not only represent one of the last ascertained occurrences of this species in Italy, but its presence would have important biochronological implications, as also has that of *Macaca sylvana florentina*. The Florentine macaque appears in Italy in the Middle Villafranchian. Its association with the giant cheetah and with *E. ardea* could therefore indicate a time lapse comprised between the Costa S. Giacomo F.U. and the Olivola F.U.

Mimomys pitymyoides is associated with *Macaca* sp. in Montoussé 5 (Pyrénées, France) (Clot *et al.*, 1976a, 1976b). Chaline & Farjanel (1990) assign Montoussé 5, together with Shernfeld, Neuleiningen, Osztramos 3 and Kamyk to the Lower *Mimomys pliocenicus ostramosensis* biozone, correlated to the medium-upper part of the Tiglian. *Mimomys pitymyoides* and *M. pusillus* are quoted in the same faunas in Europe at Osztramos 3 (North Hungary) (Janossy & Meulen, 1975) and in many Polish localities (Kielmiki 3B, Kadzielnia 1, Kamyk and Zabia Cave A; Nadachowski, 1998). *Mimomys pitymyoides* is associated with voles assigned to a group including *Mimomys pusillus* also at Beremend 15 (Janossy, 1990), in Bresse Valley and Pyrénées (France) (Clot *et al.*, 1976a, 1976b; Chaline, 1984) and in some localities of Russia assigned by Markova (1998) to the latest Pliocene (Psekups) or to the Early Pleistocene (Khadzhimus). The contemporary presence of the two species is therefore ascertained for faunas ranging from the late Villanyan to the earliest Biharian, which can be correlated with the Costa S. Giacomo to Olivola Faunal Units of the large mammal schemes in agreement with the Casa Sgherri large mammals biochronological information.

Absolute Age	Magnetostratigraphy	Geochronology	Large Mammal Ages	Small Mammal Ages	Calibrated local faunas	Faunal Units
0.9						
1.0	Jaramillo		Galerian early		Colle Curti	Colle Curti
1.1						
1.2						
1.3						Pirro
1.4						
1.5						Fameta
1.6						
1.7						
1.8					Tasso	Tasso
1.9	Olduvai				Matassino	Olivola
2.0						*
2.1						
2.2	Reunion				Senéze	Costa S. Giacomo
2.3						
2.4						
2.5						St. Valier
2.6					Montopoli	Montopoli
2.7						
2.8						
2.9						
3.0						
3.1						
3.2	Mammoth Kaena				Triversa	Triversa
3.3						

Text-fig. 4 - Biochronologic comparative scheme modified from Gliozzi *et al.* (1997). * indicates the probable position of Casa Sgherri fauna.

content, the basal portion of the Massarella unit must be dated to the Late Pliocene, in fairly good agreement with the recent interpretation proposed by Zanchetta (1995) and Zanchetta *et al.* (1995). Indeed, these authors suggested that the post-Middle Pliocene cycle in the Lower Valdarno is not entirely attributable to the Early Pleistocene but it could be antedated to the Late Pliocene. These preliminary data also agree with the archaic land snails assemblage found at Monte Serampoli (Zanchetta, 1995), also from deposits related to the Massarella Unit.

Small mammals remains are dominated by Arvicolidae and Muridae which represent more than 50% and more than 30% of the remains, respectively, while the other families are represented by less than 5% each. These percentages fit those indicated by Sesè (1991) for the Early Pleistocene micromammal communities. The dominance of arvicolids is suggestive of the presence of open areas and humid environmental conditions. On the other hand the high amount of murids indicates the presence of a close wooded landscape. The other faunal elements are consistent with humid environmental conditions, but furtherly suggest the occurrence of woods. *Hystrix* prefers humid, wooded environments. *Macaca sylvana florentina*, *Enhydriactis ardea* and *Sus strozzii* also attest to the occurrence of a wood cover and to the presence of water bodies. Very significant from a paleo-environmental point of view is the definite dominance, among large mammals, of *Pseudodama* remains. This deer probably had a lifestyle similar to that of the present day fallow deer and used to live in woodland areas of temperate zones. On the whole these data are concurrent to delineate a wooded and humid environment where open spaces were common, under a temperate climate.

ACKNOWLEDGEMENTS

The authors are grateful to Prof. J. Chaline of CNRS, Bourgogne University for his observations on arvicolid systematics and to Prof. G. Ficarelli and D. Torre of the University of Firenze for the discussions about carnivore systematics.

This study was financially supported by MURST 60% (F.P. Bonadonna)

REFERENCES

- AMBROSETTI, P., CARBONI, M.G., CONTI, M.A., COSTANTINI, A., ESU, D., GANDIN, A., GIROTTI, O., LAZZAROTTO, A., MAZZANTI, R., NICOSIA, U., PARISI, G. & SANDRELLI, F., 1978, Evoluzione paleogeografica e tettonica nei bacini tosco-umbro-laziali nel Pliocene e nel Pleistocene inferiore: Mem. Soc. Geol. It., 19: 573-580.
- ARGENTI, P., 1998, La biocronologia dei Roditori del Plio-Pleistocene dell'Umbria e l'evoluzione del genere *Apodemus* in Italia: Univ. Perugia, Fac. Sci. Mat. Fis. Nat., Ph.D. Thesis: 280 pp.
- AZZAROLI, A., 1954, Filogenesi e biologia di *Sus strozzii* e *Sus minor*: Palaeontogr. It., 48 (1952-53): 41-76.
- , 1992, The cervid genus *Pseudodama* n. g. in the Villafranchian of Tuscany: Palaeontogr. It., 79: 1-41, 9 pls.
- , 1998, *Hystrix etrusca* Bosco, the late Villafranchian Porcupine from the Upper Valdarno, Central Italy: Palaeontogr. It., 85: 177-198, 8 pls.
- BARTOLINI, C., BERNINI, M., CARLONI, G.C., COSTANTINI, A., FEDERICI, P.R., GASPERI, G., LAZZAROTTO, A., MARCHETTI, G., MAZZANTI, R., PAPANI, G., PRANZINI, G., RAU, A., SANDRELLI, F., VERCESI, P.L., CASTALDINI, D. & FRANCAVILLA, F., 1982, Carta neotettonica dell'Appennino settentrionale. Note illustrative: Boll. Soc. Geol. It., 101: 523-549.
- BOSSIO, A., MAZZANTI, R., MAZZEI, R., MENESINI, E., NENCINI, C., SALVATORINI, G. & UGHI, R., 1981, Nuove osservazioni sulla stratigrafia delle formazioni plioceniche e pleistoceniche di Casciana Terme. In IX Conv. Soc. Paleont. Ital. 3-8 Ott. 1981: 9-120, 11 pls.
- CAREDIO, P., ESU, D. & TESTA, G., 1995, Il margine orientale del bacino plio-pleistocenico di Lucca-Montecarlo-Vinci: evoluzione stratigrafica e tettonica: St. Geol. Camerti, Vol. Spec.: 235-253.
- CARLS, N. & RABEDER, G., 1988, Arvicolids (Rodentia, Mammalia) from the earliest Pleistocene from Schernfeld (Bavaria): Beitr. Paläont. Österr., 14: 123-237.
- CHALINE, J., 1984, La sequence des rongeurs de Bresse, en tant que référence biostratigraphique et paleoclimatique: Géol. France, 3: 251-263.
- , & FARJANEL, G., 1990, Plio-Pleistocene rodent biostratigraphy and palynology of the Bresse Basin, France, and correlations with western Europe: Boreas, 19: 69-80.
- CLOT, A., CHALINE, J., HEINTZ, E., JAMMOT, D., MOURER-CHAUVIRE, C. & RAGE, J.C., 1976a, Montoussé 5 (Hautes Pyrénées), un nouveau remplissage de fissure a faune de vertébrés du Pléistocène inférieur: Geobios, 9: 511-514.
- , —, JAMMOT, D., MOURER-CHAUVIRE, C. & RAGE, J.C., 1976b, Les poches ossifères du Pléistocène moyen et inférieur de Montoussé (Hautes-Pyrénées): Bull. Soc. Hist. Nat. Toulouse, 112: 146-161.
- DALLAN, L., 1988, Ritrovamento di *Alephis lyrix* nelle argille della serie lacustre di Montecarlo (Lucca) e considerazioni stratigrafiche sui depositi continentali dell'area tra il Monte Albano e il Monte Pisano: Atti Soc. Tosc. Sci. Nat., Mem., s. A, 95: 203-219.
- DEL CAMPANA, D., 1918, Considerazioni sulle Antilopi terziarie della Toscana: Palaeontogr. It., 24: 147-234, 5 pls.
- DI STEFANO, G. & PETRONIO, C., 1998, Origin of and relationships among the *Dama*-like cervids in Europe: N. Jb. Geol. Paläont. Abh., 207: 37-55.
- FEDERICI, P.R. & MAZZANTI, R., 1988, L'evoluzione della paleogeografia e della rete idrografica del Valdarno inferiore: Boll. Soc. Geogr. It., 5: 573-615.
- FICCARELLI, G., 1984, The Villafranchian cheetahs from Tuscany and remarks on the dispersal and evolution of the genus *Acinonyx*: Palaeont. It., 73 (1982-83-84): 94-103, 7pls.
- GAZZERRO, M., 1997, Rilevamento e stratigrafia dei depositi plio-pleistocenici nell'area Pontedera-Montopoli / Capannoli-Palaja: Univ. Pisa, Fac. Sci. Mat. Fis. Nat., Unpublished Thesis: 183 pp.
- GENTILI, S., ABBAZZI, L., MASINI, F., AMBROSETTI, P., ARGENTI, P. & TORRE, D., 1996, Voles from the Early Pleistocene of Pietrafitta (central Italy, Perugia): Acta Zool. Cracov., 39: 185-199.
- GHELARDONI, R., GIANNINI, E. & NARDI, R., 1968, Ricostruzione paleogeografica dei bacini neogenici e quaternari nella bassa valle dell'Arno sulla base dei sondaggi e rilievi sismici: Mem. Soc. Geol. It., 7: 91-106.
- GLIOZZI, E., ABBAZZI, L., AMBROSETTI, P., ARGENTI, P., AZZAROLI, A., CALOI, L., CAPASSO BARBATO, L., DI

- STEFANO, G., FICCARELLI, G., KOTSAKIS, T., MASINI, F., MAZZA, P., MEZZABOTTA, C., PALOMBO, M.R., PETRONIO, C., ROOK, L., SALA, B., SARDELLA, R., ZANALDA, E. & TORRE, D., 1997, Biochronology of selected mammals, molluscs and ostracods from the Middle Pliocene to the Late Pleistocene in Italy: *Riv. It. Paleont. Strat.*, 103: 369-388.
- JANOSSY, D., 1990, Arvicolids from the lower Pleistocene sites of Beremend 15 and Somsich-hegy 2, Hungary. *In* Fejfar, O. & Heinrich, W.D. (eds), *International Symposium on Evolution, Phylogeny and Biostratigraphy of Arvicolids*: 223-230.
- , & MEULEN, A.J., 1975, On *Mimomys* (Rodentia) from Osztromos-3, North Hungary: *Proc. Kon. Ned. Akad. Wetensch.*, s. B, 78: 381-391.
- LINDSAY, E.H., OPDYKE, N.D. & JOHNSON, N.M., 1980, Pliocene dispersal of the horse *Equus* and late Cenozoic mammalian dispersal events: *Nature*, 287: 135-137.
- LOPEZ MARTINEZ, N., 1977, Revision sistemática y biostratigráfica de los Lagomorpha (Mammalia) del Terciario y Cuaternario de España: Univ. Madrid, Fac. Sci., Ph.D. Thesis: 470 pp.
- MARCOLINI, F., 1997, Stratigrafia dei depositi continentali pleistocenici del Valdarno inferiore sulla base dei depositi a micromammiferi: Univ. Pisa, Fac. Sci. Mat. Fis. Nat., Unpublished Thesis: 155 pp.
- MARKOVA, A.K., 1998, Early Pleistocene small mammals faunas of Eastern Europe: *Med. Ned. Inst. Toegepaste Geowetensch. TNO*, 60: 313-326.
- MARRONI, M., MAZZANTI, R. & NENCINI, C., 1990, Geologia e morfologia delle Colline Pisane: *Quad. Mus. St. Nat. di Livorno*, 11 (Suppl. 1): 1-40.
- MASINI, F. & TORRE, D., 1987, Review of the Villafranchian Arvicolids of Italy: *Geol. Romana*, 26: 127-133.
- , & —, 1990, Large mammal dispersal events at the beginning of the late Villafranchian. *In* Lindsay, E.H. *et al.* (eds), *European Neogene Mammal Chronology*: 131-138.
- MAZZANTI, R., 1983, Il punto sul Quaternario della fascia costiera e dell'Arcipelago di Toscana: *Boll. Soc. Geol. It.*, 102: 419-556.
- NADACHOWSKI, A., 1998, Faunal succession of small mammal assemblages of the Pliocene-Pleistocene boundary in Poland: *Med. Ned. Inst. Toegepaste Geowetensch. TNO*, 60: 281-286.
- NENCINI, C., 1984, Il passaggio Plio-Pleistocene e i sedimenti pliocenici e pleistocenici delle colline di Monte Castello (Pisa): *Boll. Soc. Geol. It.*, 102 (1983): 391-398.
- NOCCHI, G. & SALA, B., 1997, The fossil rabbit from Valdemino cave (Borgio Verezzi, Savona) in the context of Western Europe Oryctolagini of Quaternary: *Palaeovertebrata*, 26: 167-187.
- PASQUIER, L., 1972, Étude d'une population de *Mimomys savini* Hinton 1910 (Arvicolinae, Rodentia) provenant de l'Upper Freshwater Bed (Quaternaire Ancien d'Angleterre): *Mammalia*, 36: 214-225.
- , 1974, Dynamique évolutive d'un sous-genre de Muridae, *Apodemus* (*Sylvaemus*). Étude biométrique des caractères dentaires de populations fossiles et actuelles d'Europe occidentale: Univ. Montpellier, Ph.D. Thesis: 184 pp.
- PUCCINELLI, A., 1991, Nuovi aspetti dell'evoluzione paleogeografica e tettonica al Pio-Quaternario della Piana di Lucca (Toscana): *Geogr. Fis. Din. Quat.*, 14: 171-177.
- SALA, B., MASINI, F. & TORRE, D., 1994, Villanyan arvicolids from Rivoli Veronese, a karst fissure in the Adige Valley, Northeastern Italy: *Boll. Soc. Paleont. Ital.*, 33: 3-11.
- SARTI, G., MAZZA, P. & RUSTIONI M., 1998, A Miocene cervid from the Torrente Morra sequence (Collesalveti, Livorno, Italy): *Riv. Ital. Paleont. Strat.*, 104: 215-226, 1 pl.
- SESÉ, C., 1991, Interpretación paleoclimática de las faunas de micromamíferos del Mioceno, Plioceno y Pleistoceno de la Cuenca de Guadix Baza (Granada, España): *Estudios Geol.*, 47: 73-83.
- TANI, F., 1997, Rilevamento e stratigrafia dei sedimenti plio-pleistocenici nell'area Vicarello-Collesalveti / Capannoli-Ponsacco: Univ. Pisa, Fac. Sci. Mat. Fis. Nat., Unpublished Thesis: 200 pp.
- , & GAZZERRO, M., 1999, Nuove osservazioni sui depositi plio-pleistocenici nel bacino del Torrente Cascina: *Boll. Soc. Geol. It.*, 118: 237-241.
- TESAKOV, A.S., 1998, Voles of the Tegen fauna: *Med. Ned. Inst. Toegepaste Geowetensch. TNO*, 60: 71-134.
- TREVISAN, L., BRANDI, G.P., DALLAN, L., NARDI, R., RAGGI, G., RAU, A., SQUARCI, P., TAFI, L. & TONGIORGI, M., 1971, Note illustrative alla carta geologica d'Italia alla scala 1:100.000. Foglio 105 Lucca: *Min. Ind. Com. Art. Dir. Gen. Min. Serv. Geol. It.*: 1-51.
- WEERS VAN, D.J., 1994, The porcupine *Hystrix refossa* Gervais, 1852 from the Plio-Pleistocene of Europe, with notes on other fossil and extant species of the genus *Hystrix*: *Scripta Geol.*, 106: 35-52.
- ZANCHETTA, G., 1991, Ricostruzione paleogeografica della zona tra Bientina e Fucecchio nel Quaternario: Univ. Pisa, Fac. Sci. Mat. Fis. Nat., Unpublished Thesis: 132 pp.
- , 1995, Nuove osservazioni sui depositi esposti sul fianco sudorientale delle colline delle Cerbaie (Valdarno inferiore, Toscana): *Il Quaternario*, 8: 291-304.
- , BONADONNA, F.P., ESU, D., GRASSI, R., LEONE, G. & MAZZA, P., 1998, Stratigraphic and palaeontologic aspects of Middle Pleistocene continental deposits from Lower Valdarno (Tuscany): *Boll. Soc. Geol. It.*, 117: 113-132.
- , & MAZZA, P., 1996, *Anancus arvernensis* remains from the basal portion of the *Arctica islandica* - bearing marine deposits of Lower Valdarno: *Boll. Soc. Geol. It.*, 115: 105-113.
- , PETRUCCI, S., MAZZA, P. & RUSTIONI, M., 1995, New Villafranchian finds from the Lower Valdarno: *Il Quaternario*, 8: 449-456.

(manuscript received June 15, 1999
accepted February 11, 2000)

Federica MARCOLINI

Francesco Paolo BONADONNA

Giovanni ZANCHETTA

Dipartimento di Scienze della Terra

Università di Pisa

Via S. Maria 53, 56126 Pisa, Italy

Tassos KOTSAKIS

Dipartimento di Scienze Geologiche

Università di Roma Tre

Largo San Leonardo Murialdo 1, 00146 Roma, Italy

Paul MAZZA

Museo di Geologia e Paleontologia

Università di Firenze

Via G. La Pira 4, 50121 Firenze, Italy