

## NEW VILLAFRANCHIAN FINDS FROM THE LOWER VALDARNO (TUSCANY, CENTRAL ITALY)\*

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**RIASSUNTO** - Nuovi ritrovamenti di età villafranchiana nel basso Valdarno (Toscana, Italia centrale) - Il Quaternario Italian Journal of Quaternary Sciences, 8(2), 1995, 449-456 - I depositi del graben del fiume Elsa e del suo prolungamento nord-occidentale, rappresentato dal bacino compreso fra Montealbano, a est, ed i Monti Pisani, a ovest, sono attraversati dal fiume Arno che separa nettamente un dominio meridionale, caratterizzato soprattutto da sedimenti marini plio-pleistocenici, da un dominio meridionale, prevalentemente caratterizzato da depositi continentali. Nel corso di recenti rilevamenti delle sequenze continentali, sono stati rinvenuti resti di mammiferi del Villafranchiano (medio?) superiore (2.5 ÷ 1 Ma circa). Questi hanno fornito una notevole informazione sulla stratigrafia dell'area di studio. Nell'area di Vinci conglomerati di conoidi deltizia, sovrapposti con discordanza sui depositi del ciclo medio pliocenico (datati circa 2.5 Ma sulla base di dati paleomagnetici) hanno fornito resti di *Sus* cf. *strozzi*, di un rappresentante di grande taglia di *Equus stenonis* cf. *vireti* e coproliti di ienide. Nell'area compresa fra Lamporecchio e Stabbia, i conglomerati sono coperti da sedimenti che hanno prodotto numerosi individui di *Viviparus* cf. *ampullaceus* ed un dente di *Castor plicidens*. Coevi a quest'ultimi sono i depositi che giacciono sotto le ghiaie medio-pleistoceniche che affiorano lungo la scarpata meridionale e sud-orientale delle Colline delle Cerbaie. Osservazioni geologiche e paleontologiche hanno dimostrato che questi sedimenti non appartengono alle successioni marine plioceniche, come ritenuto in precedenza, ma sono depositi prevalentemente continentali e possono essere riferiti con discreta sicurezza al Villafranchiano superiore (1.7 ÷ 1.0 Ma circa). Se confermato da ulteriori dati, i resti fossili di Vinci sono particolarmente significativi, poiché suggeriscono la presenza di depositi del Villafranchiano medio (circa 2.5-2.2 Ma) che possono riempire buona parte dello *hiatus* ritenuto separare la fine del ciclo pliocenico, segnato dai famosi mammiferi continentali di Montopoli, dal rinnovato tettonismo responsabile della formazione del nuovo bacino continentale. Infine, la presenza di *Hippopotamus* cf. *tiberinus* a S. Regolo, sulla sinistra d'Arno, suggerisce la possibile presenza di depositi tardo villafranchiani o galeriani (1.0 ÷ 0.5 Ma circa) finora mai segnalati.

**ABSTRACT** - New Villafranchian finds from the Lower Valdarno (Tuscany, central Italy) - Il Quaternario Italian Journal of Quaternary Sciences, 8(2), 1995, 449-456 - The deposits of the Elsa river Graben and its northwestern extension - namely the basin between Montealbano, to the East, and the Pisani Mountains, to the West - are cut through by the Arno river, which sharply separates a southern domain prevalently characterized by Plio-Pleistocene marine sediments, from a northern one, mostly characterized by continental deposits. During recent field surveys of the continental sequences, (Middle?) Late Villafranchian (from about 2.5 to about 1 Ma) terrestrial mammal remains were found, which yielded substantial stratigraphical information on the study area. Fan delta conglomerates, disconformably overlying the deposits of the Middle Pliocene cycle (dated to about 2.5 Ma on the basis of paleomagnetic evidence) in the area near the small town of Vinci, provided remains of *Sus* cf. *strozzi*, of a large-sized *Equus stenonis* cf. *vireti* and hyenid's coprolites. In the area between Lamporecchio and Stabbia, the conglomerates are overlain by sediments that yielded several *Viviparus* cf. *ampullaceus* specimens and a tooth of *Castor plicidens*. Coeval to the latter sediments are the deposits underlying Mid-Pleistocene gravels along the southern and southeastern cliffs of the Cerbaie Hills. Geological and paleontological observations have shown that these sediments do not belong to the Pliocene marine sequences as previously believed, but are prevalently continental deposits which are likely to be referred to the Upper Villafranchian (about 1.7-1.0 Ma). If confirmed by further evidence, the fossil mammals from Vinci are particularly significant because they suggest the presence of Middle Villafranchian deposits (about 2.5-2.2 Ma) which may well fill in the hiatus that is believed to separate the end of the Pliocene cycle - marked by the renowned continental mammals from Montopoli - from the new tectonic phase responsible for the formation of the new continental basin. Eventually, the occurrence of *Hippopotamus* cf. *tiberinus* at San Regolo, on the left side of the Arno river, would indicate the presence of Late Villafranchian or Galerian deposits (about 1.0 ÷ 0.5 Ma) which had never been reported up to now.

Key words: *Mollusca*, *Mammalia*, Plio-Pleistocene, Lower Valdarno, central Italy

Parole chiave: *Mollusca*, *Mammalia*, Plio-Pleistocene, basso Valdarno, Italia centrale

### 1. INTRODUCTION

The Lower Valdarno is renowned for the rich collections of fossil mammal remains found in littoral deposits locally representing the regressive part of the Pliocene

cycle. On the contrary, stratigraphic and faunal characters of the continental deposits outcropping between Monte Albano to the East and the Pisani Mountains to the West, are far less known. These sediments are correlated with the Upper Villafranchian mostly for strati-

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graphical reasons, because they transgressively overlie the local Pliocene levels at Monte Albano and because of the occurrence of "cold" palinofloras in some clay quarries (Trevisan *et al.*, 1971; Ricciardi, 1952).

Isolated remains of *Equus stehlini* have repeatedly been found in deposits overlying Pliocene marine sequences outcropping on the right side of the Arno river along the hillsides of Cerreto Guidi (Bartolini & Pranzini, 1979). These remains are of uncertain stratigraphic provenance. Recently a fragmentary metacarpal bone referred to *Alephis lyrix* was found in lacustrine clays of a now inoperative quarry in the surroundings of Lappato (Lucca) (Dallan, 1988) along the northern margin of the basin. This find suggests the possible presence of Lower Pliocene (Ruscian) continental deposits in the area.

Recent surveys threw new light on the stratigraphic and sedimentologic aspects of the Lower Valdarno continental deposits. The results of these preliminary researches are illustrated here.

## 2. GEOLOGICAL SETTING

The study area is included between Monte Albano and Monti Pisani (Fig. 1). This part of the Lower Valdarno basin is the northwestern extension of the "Val d'Elsa" graben which was formed during the Late Miocene (Ghelardoni *et al.*, 1968; Bartolini & Pranzini, 1979; Bossio *et al.*, 1981a; Bartolini *et al.*, 1982). The Upper Miocene deposits do not outcrop, but they were explored by some deep drillings (Ghelardoni *et al.*, 1968). On the other hand, the deposits referable to the Pliocene cycle outcrop extensively along the hills of Cerreto Guidi, on the right-hand side of the Arno river. The biostratigraphy of this area has not been revisited in recent times. On the contrary, there is a rich literature of studies on the hills around Pisa and, more in general, on the deposits on the left-hand side of the Arno river (Valleri *et al.*, 1990; Maroni *et al.*, 1990; Nencini, 1983; Bossio *et al.*, 1981b; Benvenuti & Dominici, 1992). According to these studies the Pliocene cycle ends during the Middle Pliocene (about 2.5 Ma) as a consequence of extensional tectonics and of the inversion of the movement causing the emergence of northwestern Tuscany. Resumed extensional tectonics led to a limited marine ingression in Early Pleistocene times. On the left side of the Arno river basin, this new marine cycle is marked by *Arctica islandica*-bearing sands and clays and the so-called "Nugola Vecchia" sands. This marine cycle is documented up to Monte Castello or slightly beyond (Nencini, 1983; Marroni *et al.*, 1990; Bigazzi *et al.*, 1993) and is referable to the Santernian-Emilian. The continental deposits referred to in this paper mostly developed during this phase. They were followed by the deposition of gravels outcropping on the Cerbaie Hills and by the terraced deposits around Lucca and on the left side of the Arno river, which can be correlated with the "Casa Poggio ai Lecci" Formation of Middle

Pleistocene age (Giannelli *et al.*, 1981; Mazzanti, 1983; Federici & Mazzanti, 1988; Marroni *et al.*, 1990; Lazzarotto *et al.*, 1990). The Montecarlo-Cerbaie ridge probably formed in successive phases during that time, and divided the basin into two smaller basins—Bientina and Fucecchio—filled with Upper Pleistocene-Holocene deposits (Magaldi *et al.*, 1983; Federici, 1987). The Montecarlo-Cerbaie ridge cuts through the continental deposits and makes problematic the direct connection of the several outcropping fragments, especially the oldest ones, with one another.

From a strictly stratigraphic point of view, the lowest deposits along the flanks of Monte Albano which are represented by gravels alternated with coarse-grained sands are attributed to the post-Pliocene cycle. Gravels are prevalently formed by variously elaborated arenaceous elements (*Macigno*) from Monte Albano. Finer-grained sediments, such as silt and bluish clayey sand with plant elements, are rarer. All these sediments are fan or fan-delta deposits, laterally passing to the lacustrine and fluvio-lacustrine deposits described below (Zanchetta, 1991; Zanchetta, in press). Westwards, on the hills of Lamporecchio and Stabbia, lacustrine facies outcrop in the "Mastro Marco" clay pit and on the bottom of some small valleys. In the extensively outcropping upper portion, detrital supplies of alternated sand, clay, silt and fine-grained thin-bedded sand, tend to prevail. Ferruginous concretionary or reddened crusts are evidence of a subaerial exposure.

Along the southern and southeastern cliffs of the Cerbaie Hills, the Middle Pleistocene gravel sheets overlie deposits that have long been attributed to the Pliocene marine cycle. Recent surveys have shown that these deposits are prevalently continental and probably belong to the post-Pliocene continental cycle. The deposits consist of sand alternated with thin-bedded silt and clay levels containing abundant fresh-water mollusks. Two intercalated thick conglomerate levels are locally used as reference horizons. Particularly interesting is the occurrence of two thin brackish marine intercalations in the middle-upper part of the sequence. Northwards, up to the villages of Porcari, Gagnano and Montecarlo, lacustrine and fluvio-lacustrine deposits, mostly represented by grey or blue clays with local intercalations of sands and conglomerates, extensively outcrop again. In the Montecarlo area, these deposits are overlain by thick sandy conglomerate sheets ("Montecarlo" Conglomerates and Sands) containing a rich amount of siliceous elements partly derived from the *Verrucano* of Monte Pisano. Although the nature of the contact between the lacustrine formation and the conglomerate sheet has not yet been precisely identified, a sharp erosional surface seems to separate the two units. Sands and clays, outcropping at the foot of the hills surrounding Lucca, underlie terraced deposits correlatable with the "Poggio ai Lecci" Formation and thus probably with the "Montecarlo" Conglomerates. Along the Montecarlo-Cerbaie ridge the continental deposits to the North and those outcropping along the south-

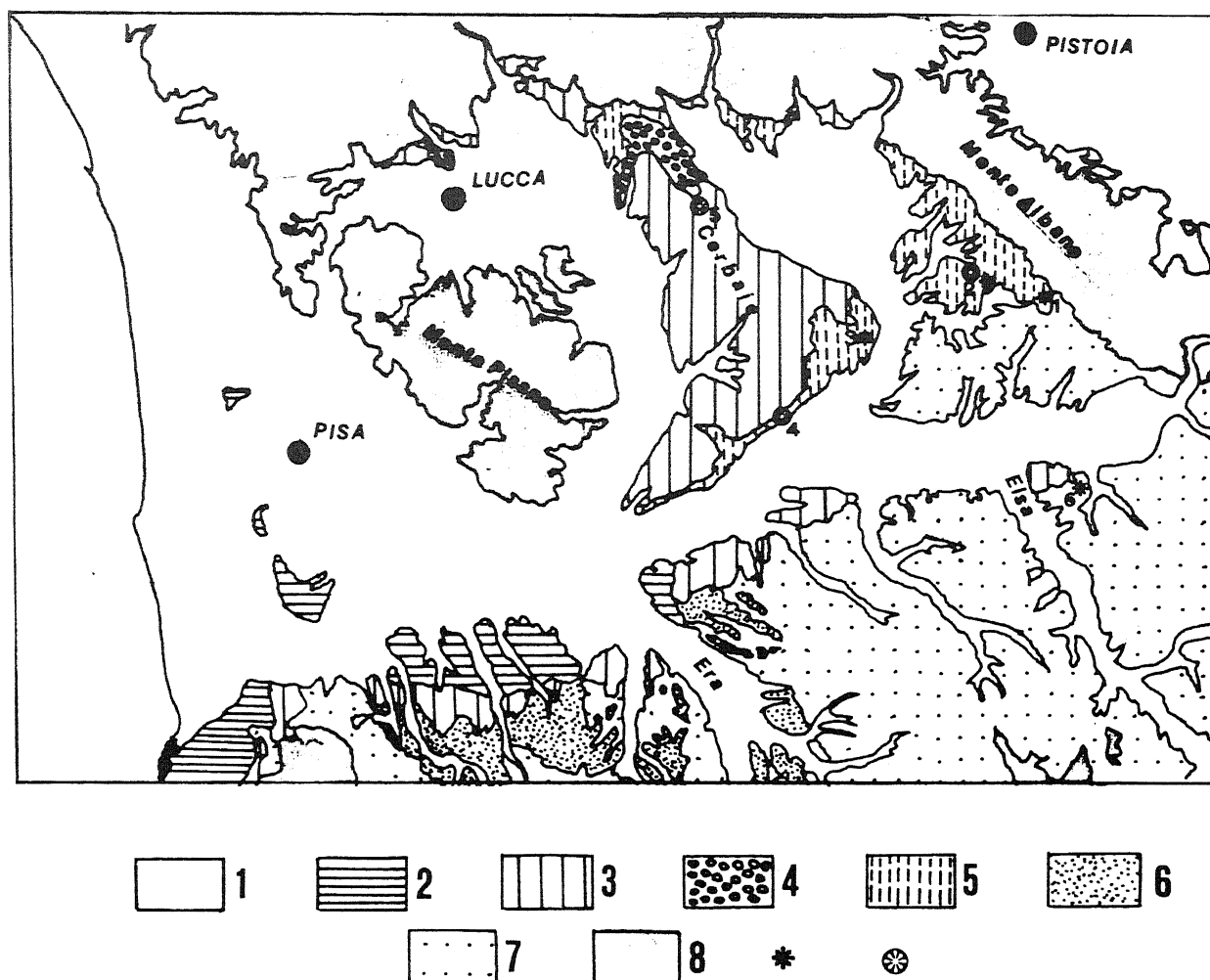


Fig. 1 - Schematic geological map of the Lower Valdarno. 1 = Holocene deposits; 2 = Upper Pleistocene deposits; 3 = Middle Pleistocene deposits; 4 = "Montecarlo" Sands and Conglomerates (Lower-Middle Pleistocene); 5 = Villafranchian deposits; 6 = Lower Pleistocene marine deposits; 7 = Pliocene marine deposits; 8 = Pre-Neogene deposits. Black asterisk = fossil mammals; white asterisk = continental mollusks.

*Carta geologica schematica del Valdarno Inferiore: 1 = depositi olocenici; 2 = depositi del Pleistocene superiore; 3 = depositi del Pleistocene medio; 4 = Sabbie e Conglomerati di Montecarlo; 5 = depositi villafranchiani; 6 = depositi marini del Pleistocene inferiore; 7 = depositi pliocenici marini; 8 = depositi preneogenici. Asterisco nero = mammiferi fossili; asterisco bianco = molluschi continentali.*

eastern flank of the Cerbaie Hills are "sutured" by gravel levels dated to the Middle Pleistocene, which too are correlated with the "Casa Poggio ai Lecci" Formation (Mazzanti, 1983; Federici & Mazzanti, 1988). This prevents to establish direct relations between these deposits, although evidence from drillings attest to a substantial lateral continuity of the continental deposits underlying the gravel sheets.

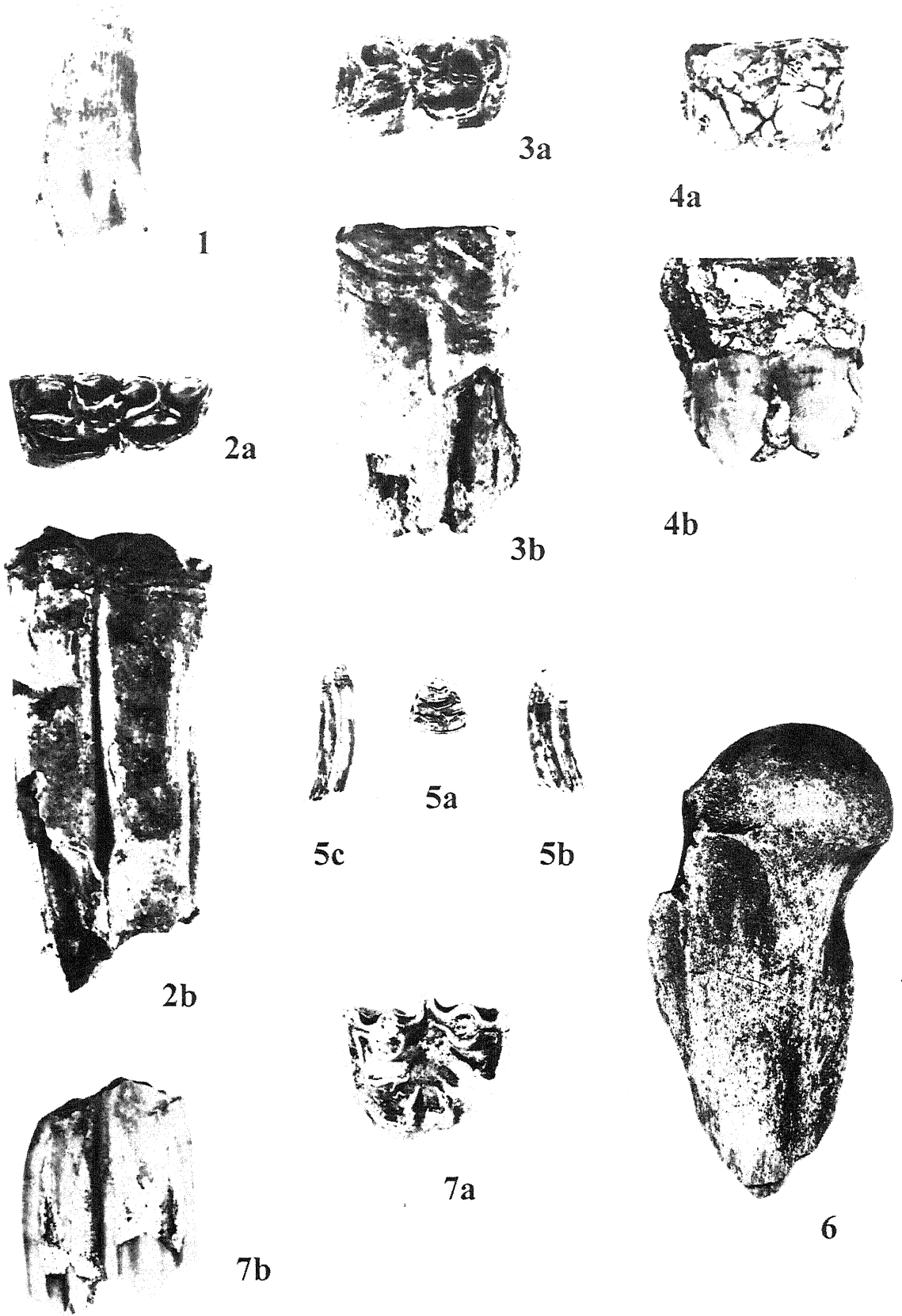
### 3. CONTINENTAL MAMMALS

The most famous site of Lower Villafranchian age in the Lower Valdarno is *Uccellatoio di Montopoli*. Other finds correlatable with Montopoli come from Pliocene littoral deposits near Cerreto Guidi. As mentioned above, these deposits are unconformably overlain by transgressive fan deposits. In the surroundings of Vinci, the lower level of these fan deposits yielded three teeth of a large-

sized *Equus stenonis* (a left I<sup>3</sup>, a right P<sub>2</sub> and left P<sub>3</sub> or P<sub>4</sub>; Fig. 2, 1-3b), formerly referred to *Equus stenonis cf. vireti* by Bonadonna & Alberdi (1987), a left M<sup>2</sup> of *Sus cf. strozzii* (Fig. 2, 4a-b), a fragment of lower cheek tooth of *Stephanorhinus* sp. and several hyenid's coprolites. A *Castor plicidens* left P<sub>4</sub> (Fig. 2, 5a-c) was found in the middle-upper part of the fluvio-lacustrine deposits near Stabbia, in levels overlying *Viviparus cf. ampullaceus*-bearing greyish lacustrine clays outcropping in the Mastromarco clay pit.

Along the south-western escarpment of LeCerbaie, at Casa Maniera, near Torre, fluvial deposits provided a proximal fragment of a right femur of *Stephanorhinus cf. etruscus* (Fig. 2, n°6), two cheek teeth fragments of *Equus cf. stenonis*, a fragmental tooth of *Sus cf. strozzii* and a left M<sup>3</sup> of *Leptobos cf. etruscus* (Fig. 2, 7a-b).

In earlier times, local amateurs had found remains of *Equus cf. stenonis*, *Leptobos* sp. and *Archidiskodon meridio-*



*nalis* (?) and several hyænid's coprolites in the surroundings of "Villa Tricolle", a locality near Torre, and a *Homotherium* sp. canine near "Ponte a Cappiano" (A. Azzaroli, pers. comm., 1990).

Recently, Mazza (1994) reported on the occurrence of a right tibia of *Hippopotamus* cf. *tiberinus* from San Regolo, which furtherly attests to the occurrence of Late Villafranchian or Galerian assemblages in the Lower Valdarno.

Some of the specimens quoted above are described in detail below. Measurements are in millimeters.

### 3.1 Vinci

#### *Equus stenorhis*

Left 3rd upper incisor. Antero-posterior diameter: 11.7; transversal diameter: 22.3.

Right 2nd lower premolar. Length: 35.5; breadth: 16.

Left 3rd or 4th lower premolar. Length: 32; breadth: 17.9.

The incisor is heavily worn. It belongs to a particularly large-sized adult individual, perhaps an about 10 years old specimen. The enamel is particularly thick. The infundibula is isolated, well open and shallow.

The premolars bear morphological characters comparable with the *E. stenorhis* specimens from the Upper Valdarno.

#### *Sus* cf. *strozzii*

Left 2nd upper molar. Length: 28.8?; breadth: 19.6.

The talon is not preserved. The tooth is slightly worn. It lacks a buccal cingulum and has a very weak mesial cingulum that bears two small cuspules. A robust pillar-like entostyle occurs between the protocone and the hypocone. This large-sized tooth resembles those of the Upper Valdarno *Sus strozzii* in morphology and size.

### 3.2 Stabbia

#### *Castor plicidens*

Left 4th upper premolar. Length: 9.4; breadth: 10.3; height: 24.2.



Fig. 2 - (1-3) *Equus stenorhis* from Vinci: (1) left I<sup>3</sup>, labial view, about natural size; (2a, b) right P<sub>2</sub>, occlusal and labial view, about natural size; (3a, b) left P<sub>3</sub> or P<sub>4</sub>, occlusal and labial view, about natural size. (4a, b) *Sus* cf. *strozzii* from Vinci: left M<sup>2</sup>, occlusal and lingual view, about natural size. (5a-c) *Castor plicidens* from Stabbia: left P<sup>4</sup>, occlusal, lingual and labial view, about natural size. (6) *Stephanorhinus* cf. *etruscus* from Casa Maniera: fragmental right femur, cranial view, about 1/2 natural size. (7a, b) *Leptobos* cf. *etruscus* from Casa Maniera: left M<sup>3</sup>, occlusal and lingual view, about natural size.

(1-3) *Equus stenorhis* da Vinci: (1) I<sup>3</sup> sinistro, norma labiale, circa dimensioni naturali; (2a, b) P<sub>2</sub> destro, norma occlusale e labiale, circa dimensioni naturali; (3a, b) P<sub>3</sub> o P<sub>4</sub> sinistro, norma occlusale e labiale, circa dimensioni naturali. (4a, b) *Sus* cf. *strozzii* da Vinci: M<sup>2</sup> sinistro, norma occlusale e linguale, circa dimensioni naturali. (5a-c) *Castor plicidens* da Stabbia: P<sup>4</sup> sinistro, norma occlusale, linguale e labiale, circa dimensioni naturali. (6) *Stephanorhinus* cf. *etruscus* da Casa Maniera: femore destro frammentario, norma craniale, circa 1/2 dimensioni naturali. (7a, b) *Leptobos* cf. *etruscus* da Casa Maniera: M<sup>3</sup> sinistro, norma occlusale e linguale, circa dimensioni naturali.

The tooth is quite well preserved and belongs to a fairly large individual. The size, proportions and morphology of this specimen fall in the fields of variability of the Villafranchian beaver.

### 3.3 Casa Manera (Torre)

#### *Stephanorhinus* cf. *etruscus*

Fragment of the proximal end of right femur. Antero-posterior diameter of the *Caput Femoris*: 68.3; transversal diameter: 7.1.

The specimen belongs to a middle- small-sized representative. The *Caput Femoris* is roundish and not very large. The lesser trochanter is slightly developed. The structure of the bone and the proportions and dimensions of the articular head are like those of the Upper Valdarno *Stephanorhinus etruscus* specimens.

#### *Leptobos* cf. *etruscus*

Left 3rd upper molar. Length: 29.6; breadth: 22.7.

The tooth is fairly worn down. It bears well developed and prominent styles; in buccal view the parastyle bends markedly backwards towards the roots of the tooth. The anterior ala of the protocone is distinctly convex, while the posterior ala of the hypocone is flatter. The entostyle is robust, quite elongate and moderately worn. It is bounded by slightly incised grooves. Residues of a thick cement veneer are present. These characters, added to the dimensions and proportions of the tooth, make the specimen tentatively referable to the Etruscan narrow-nosed ox.

## 4. CONTINENTAL MOLLUSKS

Several beds containing fresh-water and continental mollusks have been found in the course of surveys. In some cases these fossils contributed significant stratigraphical information. Only the most important taxa are described here, because at the moment an exhaustive study of the invertebrate assemblages has not yet been carried out.

The clay pit of Cava Pucci, at the foot of the Montecarlo Hill, yielded a particularly interesting mollusk assemblage characterized by *Melanopsis affinis*, *Prosostenia oblonga*, *Emmerica umbra*, *Belgrandia* sp. and *Neritina* cf. *groyanus*. This assemblage correlates with the Late Villafranchian of Central Italy (Esu & Girotti, 1974; Esu, 1982; Esu & Girotti, 1991). The presence of *Viviparus* cf. *ampullaceus* in the area of Stabbia-Lamporecchio-Vinci is suggestive of the occurrence of deposits correlatable with the Late Villafranchian. Rich mollusk assemblages were found in deposits outcropping along the southern flank of LeCerberaie; in particular, at Monte Serampoli two clay levels yielded a rich collection of *Viviparus* cf. *ampullaceus*, *Negulus villafranchianus*, *Gastrocopta* (*Vertigopsis*) *dehmi*, *Leiostyla gottschicki*, *Parmacella* sp. This assemblage contains archaic elements, such as *N. villafranchianus*, *G. (V.) dehmi*, *L. gott-*

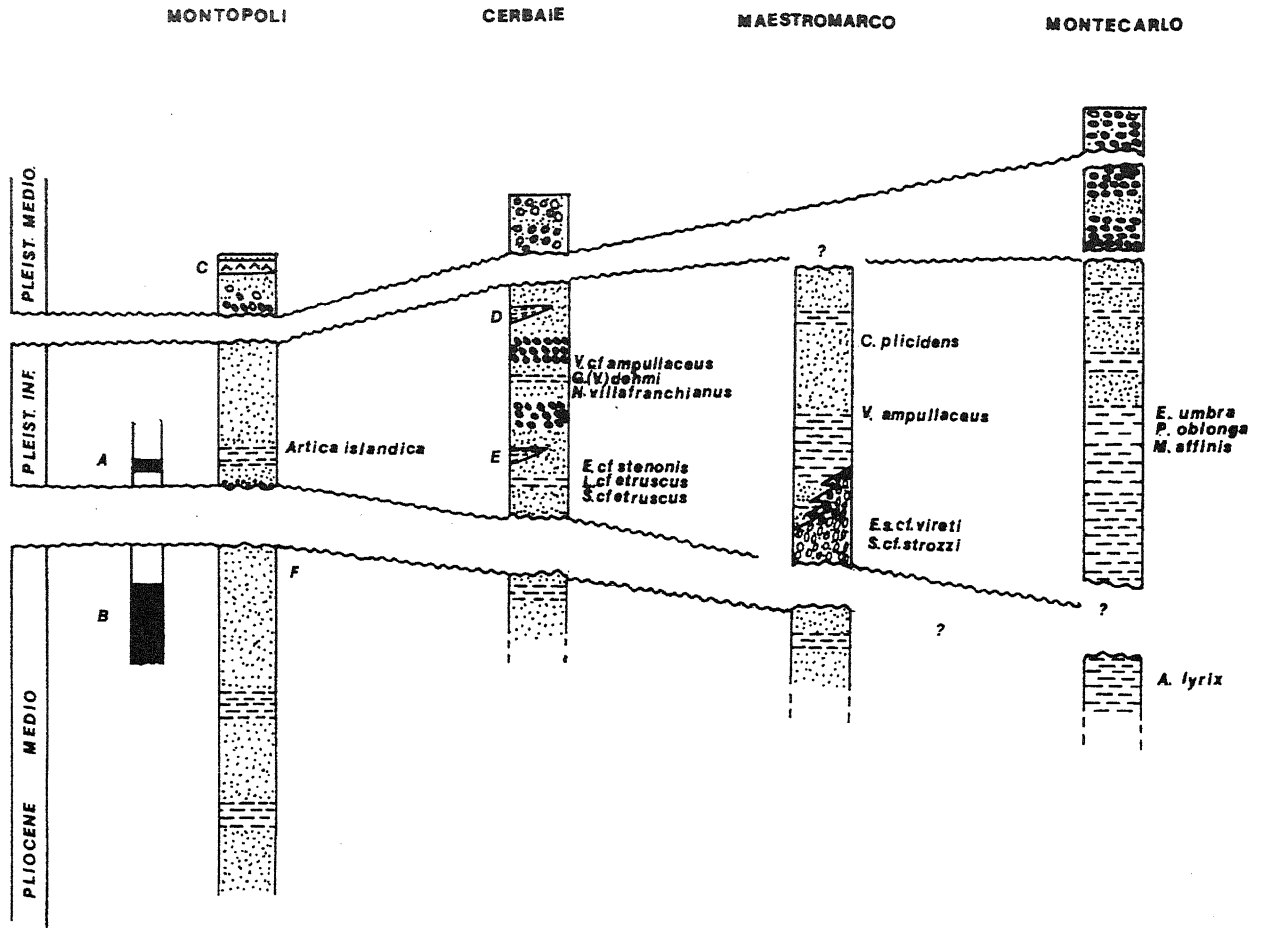


Fig. 3 - Correlation between continental deposits of selected sequences on the right and left side of the Arno river. Paleomagnetic data: A: Ambrosetti *et al.* (1975); B: Lindsay *et al.* (1980); C: Montopoli ash deposit; this is dated  $0.59 \pm 0.08$  Ma after Aria *et al.* (1980) and  $0.62 \pm 0.07$  after Bonadonna F.P. in Marroni *et al.* (1990); D-E: brackish marine intercalations within the villafranchian deposits of LeCerbaie; F: mammalian faunas from Montopoli.

Correlazione dei depositi continentali di sezioni scelte della destra e sinistra d'Arno. Dati paleomagnetici: A: Ambrosetti *et al.* (1975); B: Lindsay *et al.* (1980); C: Cinerite di Montopoli: datata  $0.59 \pm 0.08$  Ma secondo Aria *et al.* (1980) e  $0.62 \pm 0.07$  secondo Bonadonna F.P. in Marroni *et al.* (1990); D-E: intercalazioni salmastre marine nei depositi villafranchiani delle Cerbaie; F: faune a mammiferi di Montopoli.

*schicki*, which are generally reported from Middle Pliocene deposits. Also other levels sporadically provided *Viviparus cf. ampullaceus* specimens, or trivial assemblages of shallow water lacustrine environments. Some levels have yielded only continental mollusks, such as *Pomatia elegans*, *Cepaea* sp. and *Zonites* sp., found at Monte Serampoli in oxidized clayey sands included between the two grey clay levels englobing the mollusks quoted above.

## 5. FINAL CONSIDERATIONS

On the basis of the data collected, we can say that the fossil mammal remains from Vinci and Stabbia-Lamporecchio stratigraphically postdate those found in the Pliocene littoral deposits, which can be referred to the Lower Villafranchian and can be accommodated in the Montopoli Faunal Unit. The large-sized *Equus stenorhis* and *Sus cf. strozzii* from Vinci may possibly attest to the occurrence of Middle Villafranchian assemblages (St.

Vallier Faunal Unit); this find might even be one of the oldest occurrences of boar. The hiatus between the end of the Pliocene cycle and the beginning of the following continental cycle seems to be linked to resumed extensional tectonics and may therefore be modest.

*Castor plicidens* and *Viviparus cf. ampullaceus*, in deposits overlying those containing *E. stenorhis* are suggestive of an attribution to the Late Villafranchian. This seems indirectly confirmed by the occurrence of *Equus stehlini* at Cerreto Guidi, which however does not date the base, but the top of the continental cycle.

The interpretation of the Cerbaie deposits is more problematic. The presence of *Viviparus cf. ampullaceus* is suggestive of an attribution to the Upper Villafranchian, which is consistent with the occurrence of *Stephanorhinus cf. etruscus*, *Leptobos cf. etruscus* and *Sus cf. strozzii*. However other mollusks found in the same levels, such as *Negulus villafranchianus*, *Gastrocopta (Vertigopsis) dehmi* and *Leiostyla gottschicki*, are typical Middle Pliocene elements (Esu & Girotti, 1991). Stratigraphical evidence

suggests that these deposits probably formed the east-ern margin of the Upper Villafranchian outcrops and that the brackish marine levels could represent the transition to the Lower Pleistocene marine deposits which occur on the left side of the Arno river. This hypothesis should be verified.

Although outside of the study area, the right tibia of *Hippopotamus cf. tiberinus* from San Regolo—it too on the left side of the Arno river—attests to the possible occurrence of Upper Villafranchian or Galerian deposits unknown until now. The specimen may come from deposits of the Middle Pleistocene continental cycle which is altogether correlated with the “Casa Poggio ai Lecci” Formation (Mazzanti, 1983). The present writers found fossil mammal remains also in the sediments of this latter formation in the area of Montopoli. From the study area to the left side of the Arno river, Upper Villafranchian and “basal” Middle Pleistocene sequences seem to be wanting or are insufficiently documented at present (Bigazzi *et al.*, 1993), leaving aside the uncertainly dated Montecarlo-Gragnano-Porcari conglomerates.

The scheme shown in Figure 3 summarizes the field observations and the paleontologic evidence described and discussed above. The scheme is completed with paleomagnetic data and numerical datings on the Montopoli ash deposits drawn from the literature.

## REFERENCES

- Ambrosetti P., Arias C., Bigazzi G., Bonadonna F.P., De Giuli C., Girotti O., Kukla G., Iaccarino S., Malatesta A., Mazzanti R., Radicati Di Brozzolo & Trevisan L., 1975 - *Guide Book, Meeting of the INQUA Subcommission on the Mediterranean and Black Sea Shoreline*. Pisa-Perugia-Tarquinia 1975.
- Arias C., Bigazzi G. & Bonadonna F.P., 1979 - *Studio cronologico e paleomagnetico di alcune serie sedimentarie dell'Italia appenninica*. Contributi Preliminari alla Carta Neotettonica d'Italia, Publ. 356, P.F.Geodinamica, 1441-1448, Roma.
- Azzaroli A., 1982 - *Remarques sur les subdivisions chronologiques du Villafranchien*. Actes du Colloque “Le Villafranchien Méditerranéen”, Lille 9-10 Decem., 1, 7-14.
- Azzaroli A., De Giuli C., Ficarelli G. & Torre D., 1982 - *Table of the stratigraphic distribution of continental mammalian faunas in Italy from the Pliocene to the early middle Pleistocene*. Geog. Fis. Dinam. Quat., 5, 55-58.
- 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.
- Bartolini C. & Pranzini G., 1979 - *Dati preliminari sulla neotettonica dei fogli 97 (S. Marcello Pistoiese), 105 (Lucca) e 106 (Firenze)*. Contributi Preliminari alla Realizzazione della Carta Neotettonica d'Italia, P.F.Geodinamica Publ. 251, 481-523.
- Benvenuti M. & Dominici S., 1992 - *Facies analysis, paleoecology and sequence stratigraphy in a Pliocene siliciclastic succession, San Miniato (Pisa, Italy)*. Boll. Soc. Paleont. Ital., 31, 241-259.
- Bigazzi G., Bonadonna F.P., Cioni R., Leone G., Sbrana A. & Zanchetta G., 1993 - *Nuovi dati geochimici, petrologici e geocronologici su alcune cineriti plio-pleistoceniche del Lazio e della Toscana*. Mem. Serv. Geol. Naz., in press.
- Bonadonna F.P. & Alberdi M.T., 1987 - *Equus stenorhis COCCHI as a biostratigraphical marker, in the Neogene-Quaternary of the Western Mediterranean basin: consequence on Galerian-Villafranchian chronostratigraphy*. Quaternary Science Reviews, 6, 55-66.
- Bossio A., Giannelli L., Mazzanti R., Mazzei R. & Salvatorini G., 1981 - *Gli strati alti del Messiniano, il passaggio Miocene e l'ascezione di Nugola nelle colline NE dei Monti Livornesi*. Atti, IX Convegno Soc. Paleontol. It., 3-8 October, Pisa, 91-120.
- Bossio A., Mazzanti R., Mazzei R., Menesini E., Nencini C., Salvatorini G. & Ughi R., 1981b - *Nuove osservazioni sulla stratigrafia delle formazioni plioceniche e pleistoceniche di Casciana Terme*. Atti, IX Convegno Soc. Paleontol. It., 3-8 October, Pisa.
- 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., Serie A, 74, 570-578.
- Esu D., 1982 - *Les mollusques continentaux du Villafranchien de l'Italie: indications biostratigraphiques et paléoclimatiques*. Actes Colloque “Le Villafranchien Méditerranéen”, 1, 71-81, Lille.
- Esu D. & Girotti O., 1974 - *La malacofauna continentale del Plio-Pleistocene dell'Italia centrale I: paleontologia*. Geol. Rom., 13, 203-293.
- Esu D. & Girotti O., 1991 - *Late Pliocene and Pleistocene assemblages of continental molluscs in Italy. A survey*. Il Quaternario, 4(1a), 137-150.
- Federici P.R., 1987 - *Il territorio del Bientina: dalla geologia alla storia*. In: *Il Padule di Bientina; aspetti naturalistici ed economici*. Pacini Ed., Pisa, 23-54.
- Federici P.R. & Mazzanti R., 1988 - *L'evoluzione della paleogeografia e della rete idrografica del Valdarno Inferiore*. Boll. Soc. Geol. It., serie XI, 5, 573-615.
- Giannelli L., Mazzanti R., Mazzei R. & Salvatorini G., 1981 - *Breve quadro stratigrafico e paleogeografico del Neogene e del Quaternario del Valdarno Inferiore, delle Val di Fine e della Val di Cecina*. IX Conv. Soc. Paleontol. It., 9-20.
- Ghelardoni R., Giannini E. & Nardi R., 1968 - *Ricostruzione paleogeografica dei bacini neogenici e quaternari della bassa valle dell'Arno sulla base dei sondaggi e dei rilievi sismici*. Mem. Soc. Geol. It., 7, 91-106.
- Lazzarotto A., Mazzanti R. & Nencini C., 1990 - *Geologia*

- e morfologia dei comuni di Livorno e Collesalveti*. Suppl. n. 2 Quad. Mus. Stor. Nat. Livorno, **11**, 1-85.
- Magaldi D., Bidini D., Calzolari C. & Rodolfi G., 1983 - *Geomorfologia, suoli e valutazioni del territorio tra la piana di Lucca e il Padule di Fucecchio*. Annali Ist. Sperim. St. Difesa del Suolo, **14**, 21-108.
- Marroni M., Mazzanti R. & Nencini C., 1990 - *Geologia e morfologia delle Colline Pisane*. Quad. Mus. St. Nat. Livorno, Suppl. n.1, **11**, 1-59.
- Mazza P., 1994 - *On the occurrence of Hippopotamus at S. Regolo, Lower Valdarno*. Il Quaternario, **7**, Roma.
- Mazzanti R., 1983 - *Il punto sul Quaternario della fascia costiera e dell'Arcipelago di Toscana*. Boll. Soc. Geol. It., **102**, 419-556.
- Nencini C., 1983 - *Il passaggio Plio-Pleistocene e i sedimenti pliocenici delle Colline di Montecastello (Pisa)*. Boll. Soc. Geol. It., **102**, 391-398.
- Ricciardi E., 1952 - *Studio geologico del Quaternario della regione di Altopascio-Montecarlo in Lucchesia*. Unpublished dissertation, University of Pisa.
- Trevisan L., Brandi G.P., Dallan L., Nardi R., Raggi G., Rau A., Squarci P., Taffi L. & Tongiorgi M., 1971 - *Note illustrative della Carta Geologica d'Italia. Foglio 105 Lucca*. Min. Ind. Comm. Ar. Serv. Geol. It., 1-51.
- Valleri G., Bertoldi R. & Bertini A., 1990 - *Studio delle associazioni a foraminiferi e a pollini di Ponte a Elsa (Valdarno Inferiore, Toscana)*. Boll. Soc. Paleontol. It., **29**(3), 321-333.
- Zanchetta G., 1991 - *Ricostruzione paleogeografica nel Quaternario tra Bientina e Fucecchio*. Unpubl. dissertation, Fac. Scie. Mat., Fis. e Nat., University of Pisa.
- Zanchetta G. (in press) - *Larciano: Quadro geologico e ambientale*. In: *Larciano - Archeologia e Territorio*, Milanese Patera (Ed).

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