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## THE SECTION OF TORRE PICCHIO (TERNI, UMBRIA, CENTRAL ITALY): A VILLAFRANCHIAN SITE RICH IN VERTEBRATES, MOLLUSCS, OSTRACODS AND PLANTS.

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*Abstract.* Fluvial deposits of the S. Maria di Ciciliano Formation crop out near Montecastrilli (Terni), in the southwestern branch of the Tiberino Basin. Many specimens of plants ("mummified" woods, fruits and seeds), freshwater molluscs, ostracods, vertebrate bones and coprolites were collected at Torre Picchio.

This small outcrop contains a fairly rich record of fruits and seeds, among which about 50 species were identified; the most frequent invariably belong to submerged, floating and emergent aquatic herbs, possibly because these were buried not far from their place of growth, thus representing the ancient local vegetation. The fruits and seeds of woody plants, including several exotic elements, were transported from neighbouring areas and indicate a palaeoclimate similar to the present day, though slightly wetter.

Among molluscs, three distinct assemblages were found, indicating fluvial, swampy and lacustrine environment, respectively. They contain taxa of biochronological interest, most of them typical of Early Pleistocene deposits (Late Villafranchian), but making their first appearance in the Late Pliocene (Middle Villafranchian). One species, *Margaritifera (Pseudunio) auricularia*, represents the oldest record everywhere, since it was known, so far, only from the Middle Pleistocene upwards. As palaeoenvironmental indicators, the ostracods complete the informations given by molluscs.

Vertebrates are represented by large and small mammals, rare

birds, reptiles, amphibians and some fishes. A great number of coprolites was collected as well. The mammal assemblage shows affinities with the Costa S. Giacomo and Olivola F.U. (Middle and Late Villafranchian, Late Pliocene). *Mimomys medasensis*, an Iberocitane element, is signaled for the first time in Italy.

From the geological point of view, the S. Maria di Ciciliano Fm. is interfingering with the marine Chiani-Tevere Fm., which is mostly Santernian in age and lies unconformably on the Middle Pliocene cycle. Only in some areas representing a structural low, the continuous transition between the lower portion of this unit and Late Pliocene deposits may be observed before the heteropic episodes. This fact suggests some inconsistencies between chronostratigraphy and biochronology in the examined area because some taxa indicate a latest Pliocene age. A heterochrony in the extinction of some species of plants and animals is suggested as a possible solution to the problem.

*Riassunto.* Nei pressi di Montecastrilli (Terni), nel ramo sud-occidentale del Bacino Tiberino, affiorano depositi fluviali della Formazione di S. Maria di Ciciliano. In località Torre Picchio ne è esposta una sezione di circa 3 m di spessore che, negli ultimi anni, è stata oggetto di uno scavo paleontologico sistematico. Nonostante la limitata estensione dell'affioramento è stato raccolto un gran numero di fossili: macroresti vegetali (legni, frutti e semi "mummificati"), molluschi continentali, ostracodi, ossa di vertebrati e moltissimi coproliti.

I dati riguardanti i resti vegetali (frutti e semi) hanno consentito di identificare circa cinquanta specie di piante erbacee e arboree;

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fra le erbacee risultano dominanti le elofite e le macrofite acquatiche, i cui resti sono stati sepolti in prossimità del luogo di crescita. I resti di piante arboree, fra cui abbondano gli elementi esotici, sono stati trasportati da aree limitrofe al sito di deposizione e permettono di ricostruire un paleoclima temperato simile all'attuale, ma leggermente più umido. Le associazioni macrofloristiche indicherebbero in linea di massima il Pliocene terminale ma è plausibile anche un'età Pleistocenica inferiore.

Fra i molluschi sono state riconosciute tre diverse associazioni di ambiente rispettivamente fluviale, di palude e lacustre. Esse contengono taxa di significato biocronologico, la maggior parte dei quali caratterizza depositi del Pleistocene inferiore (Villafranchiano superiore) pur avendo fatto la loro prima comparsa nel Pliocene superiore (Villafranchiano medio). Una specie, *Margaritifera (Pseudunio) auricularia*, rappresenta la citazione più antica in assoluto, poiché era stata sinora rinvenuta solo a partire dal Pleistocene medio. Gli ostracodi suggeriscono condizioni ambientali che completano quelle fornite dai molluschi.

I vertebrati sono rappresentati da ossa e coproliti. L'associazione a mammiferi presenta una composizione affine alle unità faunistiche di Costa S. Giacomo e Olivola (Villafranchiano medio e superiore, Pliocene superiore). Il roditore *Mimomys medasensis*, segnalato per la prima volta in Italia, indica la presenza di un elemento iberocicciano nell'associazione.

Spunti di discussione ed approfondimento sui rapporti fra cronostratigrafia e biocronologia nell'area in questione vengono suggeriti dal fatto che la Formazione di S. Maria di Ciciliano è eteropica a quella marina del Chiani-Tevere: questa è prevalentemente santerniana e discordante sul ciclo medio-pliocenico, mentre soltanto in alcune zone di basso strutturale ed al di sotto della fascia di eteropia essa passa inferiormente con continuità al Pliocene superiore. D'altra parte alcuni taxa sia di piante che di animali indicherebbero un'età pliocenica terminale. Un'eterocronia nella scomparsa di alcune specie di piante e animali è suggerita come possibile soluzione del problema.

## Foreword

The Tiberino Basin is the largest intramontane basin of the Apennine where non marine sedimentation took place from the Pliocene to the Holocene. The geology and paleontology of this basin have been investigated since the 18th century. Modern studies give an updated picture of the stratigraphy and palaeontology of its southwestern branch, where the sedimentary successions widely crop out. The stratigraphy was described, among others, by Conti & Girotti (1978), Ambrosetti et al. (1989, 1995a, 1995b), Basilici (1995, 1997), Abbazzi et al. (1997). The palaeontology of molluscs, ostracods, vertebrates and plants was studied, among others, by Ambrosetti (1972), Esu & Girotti (1975), Ambrosetti et al. (1995a, 1995b), Ciangherotti et al. (1998), Esu et al. (1991, 2001), Pontini & Bertini (2000). These studies deal mainly with Pliocene and early Pleistocene deposits, among which three lithostratigraphic units are considered in this paper because of their important role in deciphering the chronological position of the faunas under study:

1. The Fosso Bianco Formation, a lacustrine unit, Middle Pliocene - Late Pliocene in age.
2. The S. Maria di Ciciliano Formation, which lies unconformably above the Fosso Bianco Formation. It consists of sediments deposited in a fluvial environment

characterised by different facies: meandering channel deposits with trough cross stratification, lake and swamp deposits, and paleosols. Based on the molluscs and mammals, this formation was referred to the Early Pleistocene.

3. The Chiani-Tevere Formation, a marine unit cropping out widely along the Middle Tiber Valley and interfingering laterally with the S. Maria di Ciciliano Formation. The Chiani-Tevere Formation is mostly Early Pleistocene, with only few sites of Gelasian age in the lowermost part of the stratigraphic column. The total thickness exceeds 300 m and it is heteropic with the S. Maria di Ciciliano Formation in the portion of Santernian age (Mancini et al. in prep.).

In the surroundings of the Montecastrilli village (Terni, Umbria, Central Italy), in the southwestern branch of the Tiberino Basin, fluvial and fluvio-lacustrine sediments referable to the S. Maria di Ciciliano Formation (Basilici 1995, 1997) widely crop out (Fig. 1). An excavation survey in cooperation with the Soprintendenza Archeologica per l'Umbria was started in 1996 at Torre Picchio, a site located 6 km from Montecastrilli. The excavations were carried out along a natural section which yielded some well preserved fossil bones. The fossils are stored, at present, in the Palaeontological Museum located in the former S. Tommaso Church in Terni, but the mollusc fauna which is kept in the coll. Esu-Girotti, Museum of Paleontology, University of Rome "La Sapienza" (M.P.U.R.-7).

The fossiliferous body is located on the northern side of a hill, at around 300 m a.s.l. and is exposed along a 3 m thick and 15 m<sup>2</sup> wide section. It yielded a good number of micromammal and non-marine mollusc remains, several isolated elements of large mammal bones, fish teeth, fragments of amphibians, reptiles and birds; macrofloristic remains (woods, seeds and fruits) and coprolites were collected as well. Several species of ostracods, mainly found in clayey and peaty levels, were recognised.

All the fossil material, together with the sedimentology and the stratigraphy of the section, was studied in a multidisciplinary approach in order to collect data for paleocological interpretations and, above all, to determine the age of the Torre Picchio fossiliferous site. As it will be shown later, the biochronological data of some mammals (indicating a Late Pliocene age) are in conflict with the chronostratigraphic position of the deposit, which is held as Early Pleistocene in age, because of the heteropic transition between the S. Maria di Ciciliano Formation and the Chiani-Tevere Formation. (NB. in the European nomenclature the term "heteropy" is referred to different facies or lithostratigraphic units, which are synchronous and adjacent; two formations are called "heteropy" when such conditions are documented: Bosellini & Rossi 1974).

Therefore, an interesting contribution to a possi-

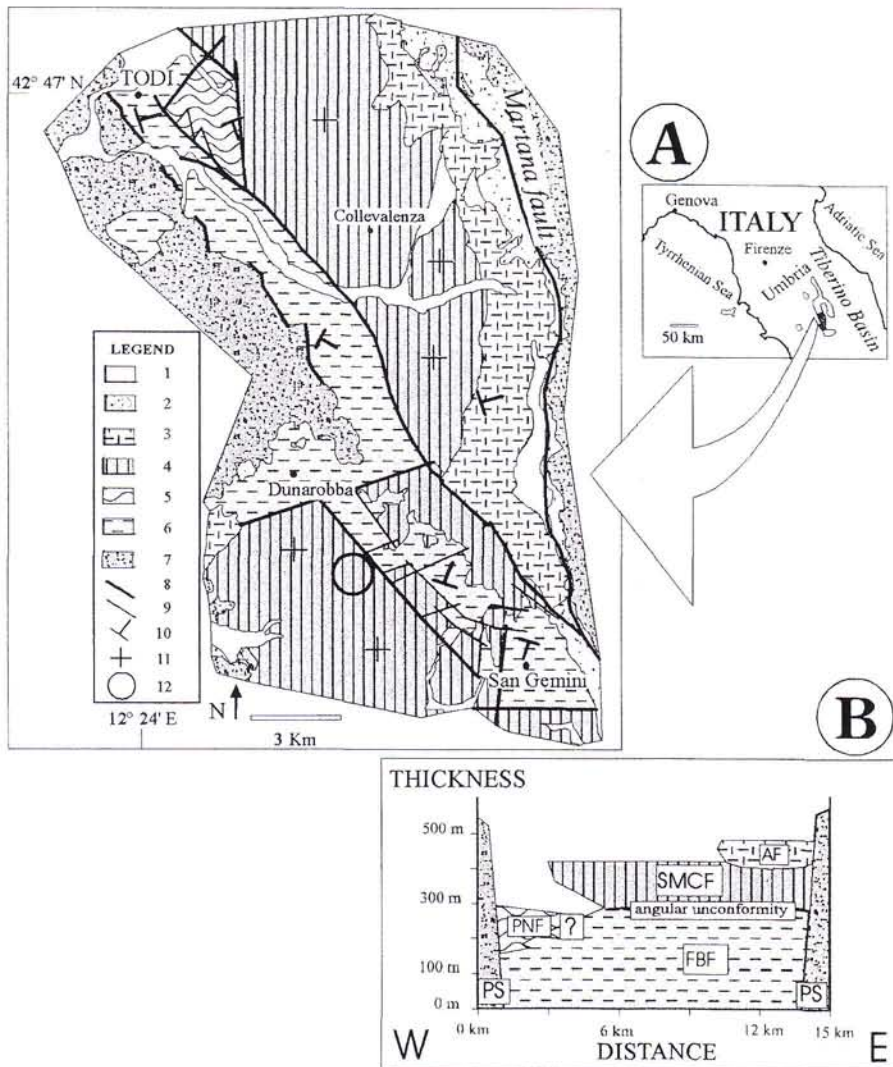


Fig. 1 - A: location of the Torre Picchio section in the Tiberino Basin; legend: 1, recent alluvial; 2, alluvial fan and talus deposits (late Pleistocene); 3, Acquasparta Formation (Early Pleistocene); 4, S. Maria di Ciciliano Formation (Early Pleistocene); 5, Ponte Naia Formation (Late Pliocene); 6, Fosso Bianco Formation (Middle-Late Pliocene); 7, pre-Pliocene substratum; 8, 9, faults (principal and secondary); 10, inclined strata; 11, horizontal strata, 12, location of the Torre Picchio section. B: schematic stratigraphic framework of the southwestern branch of the Tiberino Basin (from Basilici 1997).

ble reassessment of the biochronological framework at the Plio-Pleistocene transition is given.

O. Girotti depicted the stratigraphical framework and, in collaboration with D. Esu, studied the molluscs; E. Squazzini carried out the field work phases and the preparation of the fossils; E. Martinetto studied the palaeobotanical remains; E. Gliozzi studied the ostracods and, together with L. Capasso Barbato and T. Kotsakis, the micromammals; T. Kotsakis studied also the amphibians and reptiles; C. Petronio and R. Sardella analysed the macromammal remains. The conclusions presented in this paper are the result of a collaborative work.

### The Torre Picchio section

The Torre Picchio (TP) section consists of a little outcrop of sandy, clayey and silty sediments belonging to a body of a few hundreds cubic meters, which slid down from an escarpment along which the S. Maria di Ciciliano Formation is exposed. Without doubt the detached portion of sediments coincides with the in situ

deposits and therefore the fossils of TP belong to the formation mentioned above. Detritus covers the in situ fossiliferous horizon and the fossil remains were unearthed only from the mentioned outcrop that collapsed for a few meters from its former position without disturbing its strata.

The lithological log of Fig. 2 illustrates the facies associations of the S. Maria di Ciciliano Formation as shown in the stratotype section (Basilici 1992). The Torre Picchio outcrop can be located on the upper part (at about 30 m) of this section, at the transition from the second sandy body to the paleosol.

The TP section is characterised (from bottom to top) by two meters of coarse sands followed at the top by one meter of silts and clays. The sandy body, ascribed to a meandering channel deposit, is yellow, cross-stratified, with levels or lenses of clayey pebbles, fine sand, silt and clay. Oxidised crusts and fossil wood stumps are common features. Above it, the first silty 35 cm are brownish in colour, showing evident root traces and thus are considered as a paleosol developed in a swampy environment; the last 70 cm consisting of grey clays are referable to a lacustrine environment.

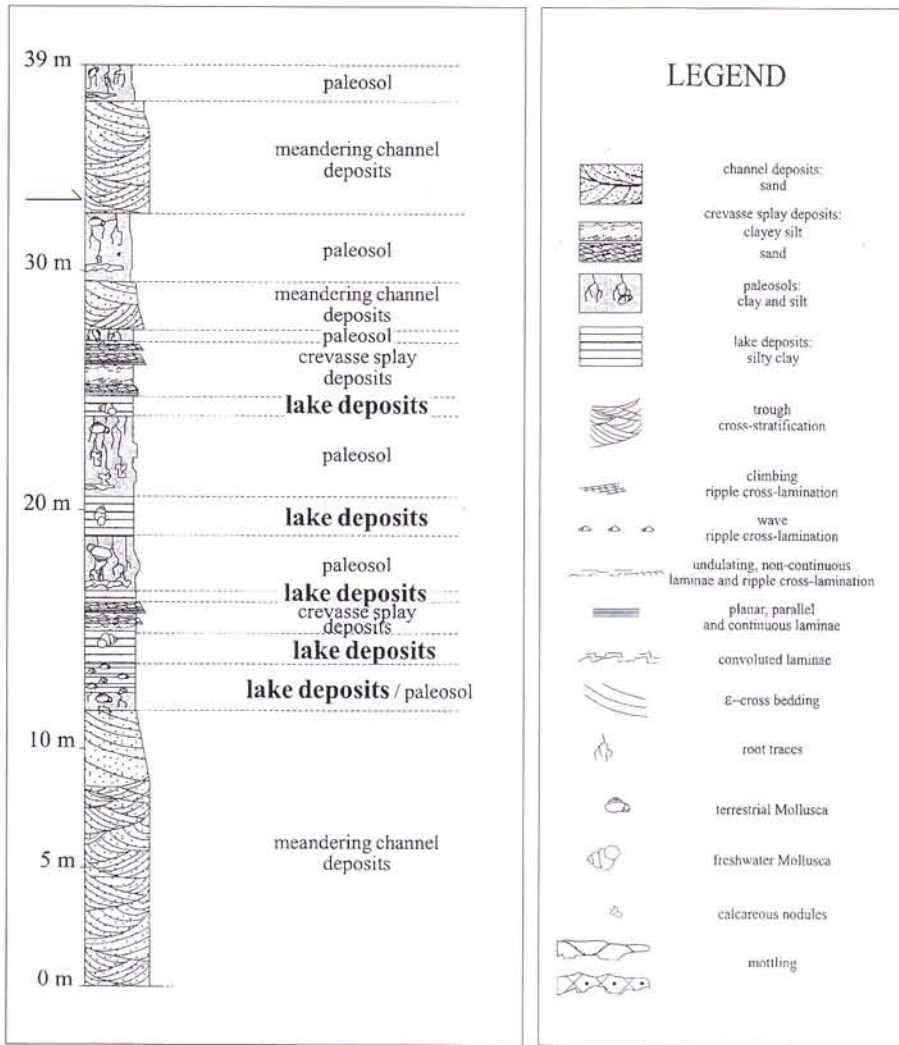


Fig. 2 - Lithostratigraphy of the S. Maria di Ciciliano Formation (drawing by Basilici unpubl.). Location of the Torre Picchio section (arrow).

quent invariably belong to herbaceous aquatic macrophytes (Tab. 1), possibly because these were buried not far from their place of growth. These fossils likely represent the ancient local vegetation, that would have consisted of the submerged *Ceratophyllum*, *Myriophyllum* and *Ranunculus* cf. *R. aquatilis*, the water lilies *Nuphar* (Pl. 1, fig. 11) and *Nymphaea*, the small-sized floating fern *Azolla* and emergent herbs such as *Alisma*, *Carex* cf. *C. pseudocyperus*, *Decodon*, *Oenanthe*, *Ranunculus sceleratus* (Pl. 1, fig. 13), *R. flammula*, *Scirpus* cf. *S. tabernaemontani*. The ecological requirements of the species listed above point to standing or slowly flowing waters in eutrophic conditions.

Additionally, the TP sediment samples proved to contain a fairly rich assemblage of

The fossils remains were collected mainly from the coarse sandy body, i.e. almost all the vertebrates, the coprolites, few species of molluscs (very abundant), the ostracods, the wood, fruits and seeds. On the contrary, the upper fine sediments yielded extremely scarce vertebrates, a few ostracods and abundant molluscs and plant remains.

### Plants

Three samples of muddy sand containing "mummified" plant macrofossils were collected in 1998 from different layers of the TP section to perform palaeocarpological analyses. The sediments were dried and later broken down by immersion in a solution of 5% hydrogen peroxide, which also permitted to concentrate the fruits and seeds through preferential floatation. The suspended material was sieved with a final mesh size of 0.3 mm, while a mesh size of 1.5 mm was adopted for the remaining residue.

All samples proved to contain a rather rich record of "mummified" fruits and seeds, even if the most fre-

woody plant remains (Tab. 1), considering their rather small volume. These remains, mostly represented by fruits or seeds, were probably produced partly by the terrestrial vegetation standing around the deposition site, and partly by plants growing further away. Based on the ecological requirements and the abundance of their fruits/seeds, we may suggest that the following species formed a local riparian wood: *Alnus* sp., *Pterocarya* cf. *P. limburgensis*, *Liquidambar* sp., *Vitis* cf. *V. silvestris* and possibly also *Ficus* cf. *F. carica*, *Ilex* cf. *I. protogaea* and *Zelkova* sp. The remaining woody plants probably grew in mesic woods located upstream in the ancient river basin, so their fruits/seeds may have experienced a longer transport before being incorporated into the sediment. As a whole the rather diversified assemblage of arboreal plants points to a deciduous broad-leaved forest as the type of regional vegetation. The occurrence of three *Picea* needles in sample PIO requires particular attention, because this coniferous tree is mostly considered an element of altitudinal vegetation growing under cool-temperate climatic conditions (e.g. Bertoldi 1990; Pontini & Bertini 2000). The scarce number of these remains permits to formulate

two hypotheses about their origin: 1) the *Picea* needles were transported from a higher vegetation belt, while the lower altitudes were covered by a deciduous broad-leaved forest; 2) *Picea* grew in the lower altitudinal belt, as an accessory element of the deciduous broad-leaved forest. The Late Pliocene record from northwestern Europe and northern Italy gives support to the second hypothesis, since it proves that spruces of Himalayan affinity (e.g. *Picea florschuetzii* Van der Hammen) grew in the lowlands together with exotic Angiosperms such as *Actinidia*, *Eucommia*, *Magnolia*, *Menispermum*, *Phyllocladon*, *Pterocarya*, *Symplocos* sect. *Palura*, etc. (Van der Hammen 1951; Cavallo & Martinetto in press).

#### Palaeobiogeography

Most of the genera and species identified so far in the TP site are rather common in the late Cenozoic of the Western European Palaeofloristic Region (Mai & Walther 1988), thus confirming its extension southwards to Umbria, as mentioned in Martinetto (2000). A few notable exceptions are represented by ?*Fagaropsis* sp. and *Ficus* cf. *F. carica* (Pl. 1, figs. 12a, b and 15). The first seems to be a new species, known only in central and northwestern Italy (where it was identified incorrectly as *Myrtus palaeocommunis* Friis: Mai 1995), with Miocene relatives in eastern France and southern Austria (Gregor 1984; Meller et al. 1999). The second taxon is known also in the Pliocene of northwestern Italy, and its relation with the living Mediterranean fig tree (*F. carica*) is not well assessed, since it could also be related to the eastern European fossil species *F. europaea* Negru (1972). All of the fossil specimens need a detailed revision and a careful comparison with those of the modern *F. carica*. Additional elements not known in the rest of Europe may be represented by ?*Nigella* sp. and by three still unidentified species (*Carpolithes* spp.).

#### Palaeoclimatic significance

An analysis regarding the climatic tolerance of the nearest living relatives of the TP fossil plants suggests that they can only coexist in a mid-temperate climate. The absence of indicators of very warm-temperate climate (e.g. *Cinnamomum*, *Symplocos* sect. *Symplocos*) and the presence of *Picea* and *Abies* needles suggests to set the highest admissible limit of MAT (Mean Annual Temperature) around 13°C, and to focus the analysis on the lower value. For this purpose the occurrences of *Vitis*, *Pyracantha*, *Pterocarya*, *Liriodendron*, *Liquidambar*, *Ilex* and *Ficus* are particularly useful, since these genera mostly grow wild where the MAT is higher than 11°C. Therefore the ancient MAT was likely around 12±1°C, i.e. close to modern temperatures in the same region.

A group of mesic taxa, that require high soil moisture (*Liriodendron*, *Magnolia*, *Taxus*) in the growing season, indicates that precipitation was higher than at pre-

Species and habitus	Family	Sample			Inventory	
		P10	P11	P12		Part
<b>Woody plants</b>						
<i>Acer</i> sp.	Aceraceae	1			fr.	P10 B3A
<i>Alnus</i> sp.	Betulaceae		5		am.	P11 A9Q
<i>Cornus</i> ( <i>Swida</i> ) sp.	Cornaceae	2			en.	P10 B3A
<i>Corylus avellana</i> L.	Betulaceae		8		fr.	P11 A9Q
<i>Fagaropsis</i> ? sp.	Rutaceae		16	23	s.	P11 A9Q
<i>Ficus</i> cf. <i>carica</i> L.	Moraceae			3	s.	P12 A9R
<i>Ilex</i> cf. <i>aquifolium</i> L.	Aquifoliaceae	1			s.	P10 B3A
<i>Ilex</i> cf. <i>protogea</i> Mai *	Aquifoliaceae		15	8	s.	P11 A9Q
<i>Juglans bergomensis</i> (Balsamo-Crivelli) Massal.*	Juglandaceae	coll.	Squazzini		en.	
<i>Liquidambar</i> sp.	Hamamelidaceae		7	6	fh.	P11 A9Q
<i>Liriodendron geminata</i> Kirchheimer *	Magnoliaceae	2			s.	P10 B3A
<i>Magnolia cor</i> Ludwig *	Magnoliaceae			1	s.	P12 A9R
<i>Picea</i> cf. <i>rotundae-squamosa</i> (Ludwig) Mai & Walther *	Pinaceae	3			l.	P10 B3A
<i>Prunus</i> sp.	Rosaceae		1		en.	P11 A9Q
<i>Pterocarya</i> cf. <i>limburgensis</i> Reid *	Juglandaceae	6	6	1	en.	P11 A9Q
<i>Pyracantha</i> sp.	Rosaceae	14	3	7	en.	P10 B3A
<i>Quercus</i> sp.	Fagaceae	1		1	cu.	P10 B3A
<i>Styrax</i> sp.	Styracaceae		2		s.	P11 A9Q
<i>Taxus</i> cf. <i>baccata</i> L.	Taxaceae	1			s.	P10 B3A
<i>Vitis</i> cf. <i>sylvestris</i> Gmelin	Vitaceae	10	23	5	s.	P10 B3A
<i>Zelkova</i> sp.	Ulmaceae		12	6	fr.	P11 A9Q
<b>Herbaceous wetland plants</b>						
<i>Alisma</i> sp.	Alismataceae		1		fr.	P11 A9Q
<i>Carex</i> cf. <i>pseudocyperus</i> L.	Cyperaceae			1	fr.	P12 A9R
<i>Cyperus</i> sp.	Cyperaceae	1			fr.	P10 B3A
<i>Decodon</i> cf. <i>gibbosus</i> (Reid) Nikitin *	Lythraceae		f	2	s.	P11 A9Q
<i>Oenanthe aquatica</i> (L.) Poiret	Apiaceae		f	4	fr.	P12 A9R
<i>Oenanthe</i> cf. <i>lachenalii</i> Gmelin	Apiaceae		5	3	fr.	P12 A9R
<i>Ranunculus sceleratus</i> L.	Ranunculaceae		f	12	fr.	P12 A9R
<i>Ranunculus flammula</i> L.	Ranunculaceae	2			fr.	P10 B3A
<i>Scirpus</i> cf. <i>tabernaemontani</i>	Cyperaceae	1		1	fr.	P10 B3A
<i>Sparganium</i> cf. <i>neglectum</i> Beeby	Sparganiaceae	1	3		en.	P10 B3A
<i>Typha</i> sp.	Typhaceae		4		s.	P11 A9Q
<b>Aquatic plants</b>						
<i>Azolla</i> cf. <i>filiculoides</i> Lam.	Azollaceae	f	ff		ms.	P11 A9Q
<i>Ceratophyllum demersum</i> L.	Ceratophyllaceae		6	3	fr.	P11 A9Q
<i>Ludwigia</i> cf. <i>palustris</i> L.	Onagraceae		2	2	s.	P12 A9R
<i>Myriophyllum</i> sp.	Myriophyllaceae		1	3	en.	P12 A9R
<i>Nipar</i> cf. <i>canaliculatum</i> Reid *	Nymphaeaceae		f	34	s.	P12 A9R
<i>Nymphaea</i> sp.	Nymphaeaceae			1	s.	P12 A9R
<i>Ranunculus</i> cf. <i>aquatilis</i> L.	Ranunculaceae	1			fr.	P10 B3A
<i>Stratiotes</i> sp.	Hydrocharitaceae	1			s.	P10 B3A
<b>Other herbaceous plants</b>						
<i>Ajuga</i> cf. <i>reptans</i> L.	Lamiaceae	1			en.	P10 B3A
<i>Boehmeria</i> sp.	Urticaceae	2			fr.	
<i>Carpolithes</i> spp.	?		7	f?		P12 A9R
Chenopodiaceae indet.	Chenopodiaceae			1	s.	P12 A9R
<i>Hypericum</i> sp.	Hypericaceae	1			s.	P10 B3A
<i>Lobelia pliocenica</i> (Dorofeev) Mai *				1	s.	P12 A9R
<i>Melissa elegans</i> Reid *	Lamiaceae	1			fr.	P10 B3A
<i>Nigella</i> ? sp.	Ranunculaceae	1			s.	P10 B3A
<i>Physalis</i> sp.	Solanaceae		1	2	s.	P12 A9R
<i>Pilea</i> sp.	Urticaceae			1	fr.	P12 A9R
Polygonaceae indet.	Polygonaceae			1	fr.	P12 A9R
<i>Rubus</i> sp.	Rosaceae	2			en.	P10 B3A
<i>Rumex</i> sp.	Polygonaceae			1	fr.	P12 A9R
<i>Selaginella magdae</i> Knobloch *	Selaginellaceae	2			ms.	P10 B3A

Tab. 1 - List of fruits and seeds found in 3 samples of the Torre Picchio section. The numbers are referred to the abundance of specimens. Extinct species are marked with an asterisk. am.: amentum, cu.: cupule, en.: endocarp, f: frequent; fh.: fruiting head, fr.: fruit, l.: leaf, ms.: megaspore, s.: seed.

sent and there was no marked summer drought, as further confirmed by the absence of Mediterranean xerophytes.

These climatic conditions can be inserted in a broader climatic trend that is going to be reconstructed in central Italy on the basis of pollen diagrams (Pontini & Bertini 2000) and plant macrofossil data. In fact, in the Umbria region itself, some rich fossil sites with rich macrofloras, which are surely older than TP, are known in the Fosso Bianco and Ponte Naja formations (Martinetto, unpubl. data), assigned to the Middle-Late and Late Pliocene, respectively. All these floras indicate warmer conditions in comparison with TP, since they

include such thermophile evergreen elements as *Eurya*, *Symplocos* sect. *Symplocos* and *Toddalia*. Another rather rich fruit and seed flora was sampled in the Santa Maria di Ciciliano Formation at Villa San Faustino, in a succession assigned to the early Pleistocene by Ambrosetti et al. (1995a). This last flora is particularly rich in conifers and seems to represent a moderately cool-temperate phase, when the slopes of the Tiberino Basin were probably covered by mixed coniferous and deciduous broad-leaved forest.

#### Biochronological notes

The TP carpological taxa mostly show a long stratigraphic range in Europe. However the attention has to be focused on a few taxa that may contribute to the definition of the time interval in which the age of TP could fall. First of all, *Lobelia pliocenica* is presently known only for the Pliocene of Russia and northern Germany; secondly, *Selaginella magdae*, *Boehmeria*, *Liquidambar* and *Liriodendron geminata* disappear from central Europe, and seemingly also from northern Italy, at the end of the Pliocene. Also *Magnolia cor* is thought to disappear from transalpine Europe at the end of the Pliocene, but in northern Italy its range extends to the Early Pleistocene (Martinetto 1999). On the other hand *Oenanthe aquatica*, *O.* cf. *O. lachenalii*, *Carex* cf. *C. pseudocyperus* and *Azolla filiculoides* are young elements in the Neogene floras, which make their first appearance in the Pliocene, and in the case of *A. filiculoides* even in the latest Pliocene. Other interesting occurrences are those of several extinct or exotic taxa, i.e. ?*Fagaropsis* sp., *Ilex* cf. *I. protogea*, *Melissa elegans*, *Decodon* cf. *D. gibbosus*, *Pterocarya* cf. *P. limburgensis*, *Zelkova* sp.; their abundance indicates a floral context markedly different from that found in the study area today, a feature usually diagnostic of floras which predate the middle Pleistocene. In conclusion, the fruit and seed assemblage gives more indications of a Late Pliocene age. However, an Early Pleistocene age would not be surprising for two reasons: 1) recent studies showed that the time of extinction of several species do not coincide in northern-central Italy and in transalpine Europe (Martinetto 1999); 2) just a few sites provided fairly rich fruit and seed flora in peninsular Italy, so that an accurate local biochronological scheme for this type of fossil floras is not available at present. The comparison with pollen data is certainly useful, but not conclusive because of the many taphonomically induced differences in the micro- and macrofossil record of terrestrial plants.

#### Molluscs

The fossiliferous sediments yielded several species of non-marine molluscs belonging to aquatic and terre-

strial gastropods and large bivalves.

Three distinct assemblages were found in the lower sandy layer, in the following swampy paleosol and in the uppermost lacustrine clays, respectively. First, the fauna was examined from a palaeoecological point of view. For this purpose the results of previous works about non marine extinct and extant taxa of the Tiberino Basin (Ambrosetti et al. 1995a; Ciangherotti et al. 1995) were used. These are based on the qualitative and quantitative method adopted for Quaternary European assemblages by different authors, including Lozek (1964) and Puisségur (1976). Then, remarks on the extinct species or species no longer living in Central Italy are presented and the palaeobiogeography and palaeoecology of the recorded species is addressed.

#### Palaeoecological aspects

The following molluscs are recorded from the sandy level:

*Melanopsis affinis* Férussac,  
*Parmacella* (*Parmacella*) sp.,  
*Eobania vermicularia vermicularia* (Michelotti),  
*Margaritifera* (*Pseudunio*) *auricularia* (Spengler),  
*Corbicula fluminalis* (Müller).

The lithofacies (coarse sand) of this assemblage likely reflects a fluvial environment, supported in particular by the bivalves *M. auricularia* and *C. fluminalis*, which colonize large rivers even today. The genus *Melanopsis* is adapted to running waters too; the other two gastropod species are terrestrial pulmonates that likely lived near the riverbank in bushy surroundings.

The following molluscs are recorded from the silty pedogenic level:

*Valvata* (*Cincinna*) *piscinalis* (Müller),  
*Valvata* (*Valvata*) *crustata* Müller,  
*Belgrandia* sp.,  
*Prososthenia* sp.,  
*Bithynia leachi* (Sheppard) with many opercula,  
*Bithynia tentaculata* (Linnaeus),  
*Micromelania* (*Goniochilus*) *zitteli* (Schwartz von Mohrenstern),  
*Emmericia umbra* De Stefani,  
*Lymnaea stagnalis* (Müller),  
*Planorbis planorbis* (Linnaeus),  
Helicidae indet.,  
*Anodonta* sp.,  
*Corbicula fluminalis* (Müller),  
*Pisidium* sp.

This is an assemblage of freshwater prosobranchs, pulmonates and bivalves characterising a marshy to swampy environment, with influxes of slow running waters. Most of the species listed require a vegetated bottom. *M. (G.) zitteli*, *E. umbra* and *C. fluminalis*, which require more oxygenated waters, are extremely scarce and probably not autochthonous. The abundance of plant remains in the sediments confirms the palaeoecology of the assemblage.

From the uppermost clays the following taxa were identified:

*Valvata piscinalis*,

*Bithynia leachi* with numerous opercula.

A lacustrine environment is suitable for these species.

Remarks on extinct species or species no longer living in Central Italy.

*M. (G.) zitteli* is an extinct species with eastern affinities and of ipo-oligohaline environment. In Italy it is typical of the Tiberino basin from Late Pliocene to Early Pleistocene and there are no records outside this basin (Esu & Girotti 1975; Ambrosetti et al. 1995b).

*E. umbra* is a widespread species from Central Italy, ranging from Messinian to Early Pleistocene, in intramontane basins of Tuscany, Umbria and Latium (Esu et al. 2001). Living species of *Emmericia* prefer clear and well-oxygenated waters rich in calcium carbonate such as springs and rivers.

*M. affinis* appears since the middle Villafranchian, together with a few other species (Ciangherotti et al. 1998) that become very abundant in upper Villafranchian deposits. To date this fossil species is known to be found exclusively in Central Italy. Living species of *Melanopsis* prefer warm waters up to thermal temperatures: they are widespread in southernmost Europe, North Africa and Near East (Esu & Girotti 1975).

*P. (Parmacella)* sp. is a terrestrial pulmonate no longer living in Italy, where it is known as a very rare fossil from the Late Pliocene to Early Pleistocene of Central Italy (Tuscany, Umbria) (Manganelli & Giusti 1993; Zanchetta 1995; Ciangherotti & Esu 2000). Recently it was recorded in the S. Maria di Ciciliano Formation from Monticelli (Umbria) (personal unpubl. data). At present it is widespread in warmer areas of the Mediterranean basin.

*E. v. vermicularia* (Pl. 2, fig. 3) is well known in literature but it was illustrated only by Sacco (1897). It is recorded from the Middle Pliocene of Piedmont (Sacco, 1884, 1897; Wenz 1923-30) and the early Pleistocene of Sabina (Latium) (Tuccimei 1889; Wenz 1923-30; Esu et al. 1993). We collected also some specimens from the Upper Pliocene deposits of the Ponte Naja Formation near Todi, Umbria. Additional specimens, which were collected in 1869 by G. Bellucci near Martinello (Perugia, Umbria), are kept in the collections of the Archaeological Museum of Perugia. Up to now this species were not found in younger deposits.

*C. fluminalis* (Pl. 2, fig.7), ranging from the Pliocene upwards, is a cosmopolitan species of the Palaeoartic domain still living outside Europe in large rivers and lakes; extinct in Italy after the middle Pleistocene (Gliozzi et al. 1997), it is well represented in the Plio-Pleistocene of the Tiberino basin, mainly in fluvatile sediments but also in lacustrine deposits (Esu & Girotti 1975). Recently it was recorded in Plio-Plei-

stocene sediments of Lower Valdarno (Caredio et al. 1995) and Middle Pliocene deposits of Val d'Elsa (Benvenuti pers. com.).

*M. (P.) auricularia* (Pl. 2, fig.1-2) is a fluvial species still living outside of Central Italy in the Po River and in Spanish, French and North-West African rivers (Fechter & Falkner 1990; Gittenberger et al. 1998). In the Quaternary it is recorded in Italy from middle and upper Pleistocene alluvial deposits of the Tiber Valley (Malatesta 1964). Its presence at TP represents the oldest known record for *M. (P.) auricularia*, whereas the youngest fossil specimens come from various Holocene sites in northern Europe.

#### Chronostratigraphic position

Among the bivalves, the presence of *M. auricularia* is of special interest, because it was never found in deposits older than middle Pleistocene: TP is so far the oldest record for this species. *C. fluminalis* ranges from Middle Pliocene to Early Pleistocene in the Villafranchian basins of Central Italy, where it is associated with the extinct gastropods *M. (G.) zitteli*, *E. umbra*, *M. affinis*, *P. (Parmacella)*, *E. v. vermicularia*. Among these gastropods none survive beyond the Early Pleistocene and each is present in Pliocene deposits, where they are widespread. Moreover, *M. zitteli* and *M. affinis* make their first appearance in Central Italy in Late Pliocene sediments (Ambrosetti et al. 1995b; Gliozzi et al. 1997; Ciangherotti et al. 1998): in fact, these species occur also in the upper part (Late Pliocene) of the Fosso Bianco Formation and in the Dunarobba fossil forest area (Ambrosetti et al. 1995b), where they are associated with terrestrial pulmonates that became extinct at the end of the Pliocene. Therefore, a latest Pliocene or earliest Pleistocene age can be suggested for the mollusc fauna from the Torre Picchio section.

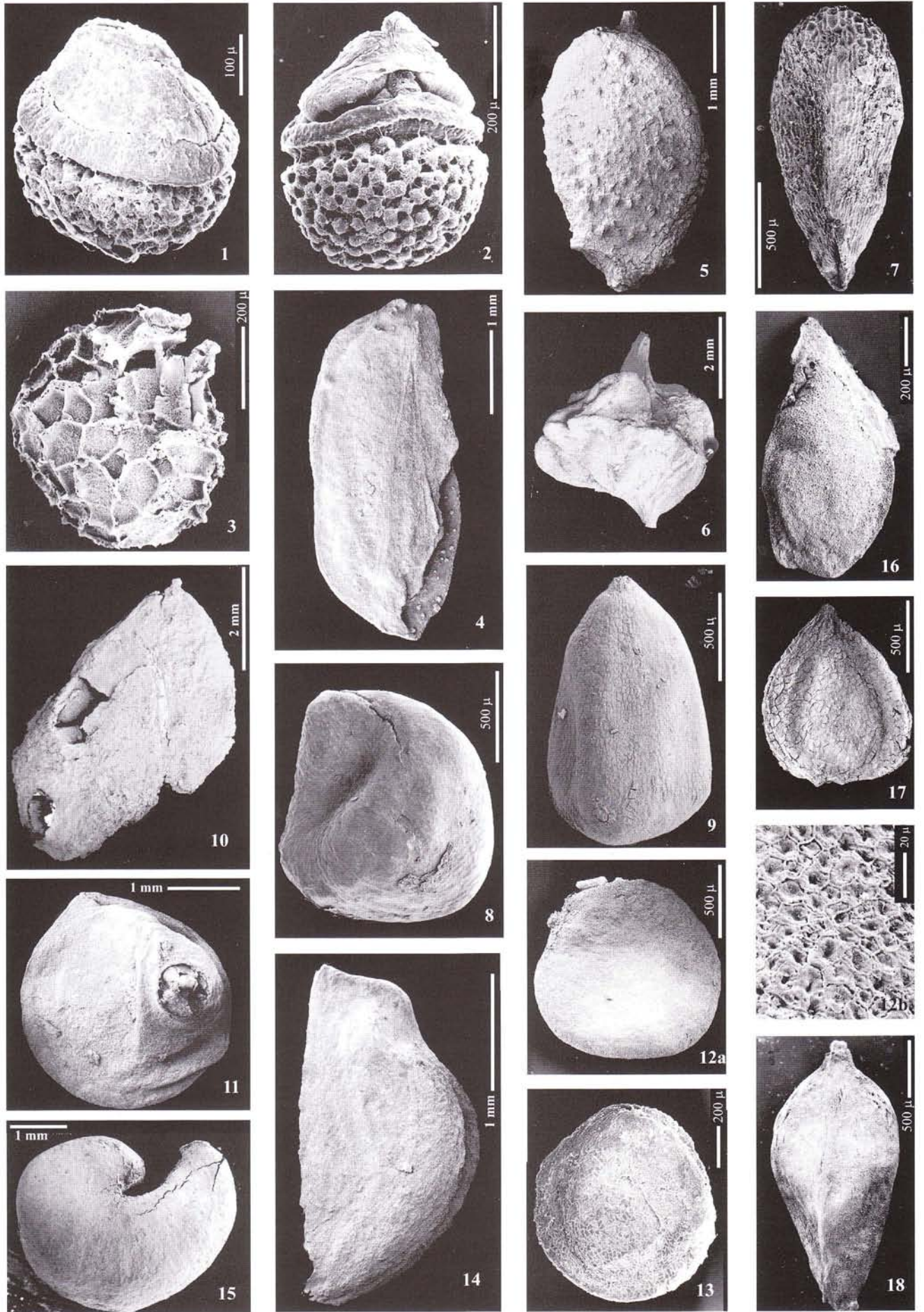
#### Ostracods

The TP section was investigated in detail for ostracod analyses by means of 11 samples collected every 25 cm. The following six ostracod species were found: *Cyprideis torosa* (Jones), *Ilyocypris gibba* (Ramdhor), *Candona neglecta* Sars, *Fabaeformiscandona levanderi* (Hirschmann), *Fabaeformiscandona fabaeformis* (Fischer) and scarce instars of *Pseudocandona* sp.

*F. fabaeformis* and *F. levanderi* are signaled for the first time in the Tiberino basin, but are already known in central Italy from the upper Pliocene-lower Pleistocene deposits of the Rieti basin (Barberi et al. 1995). All the other species were collected previously from the Santa Maria di Ciciliano Formation of the Tiberino basin (Di Napoli Alliata 1962; Ambrosetti et al. 1989).

Each species collected shows low to very low frequencies, but is represented generally by both adults and





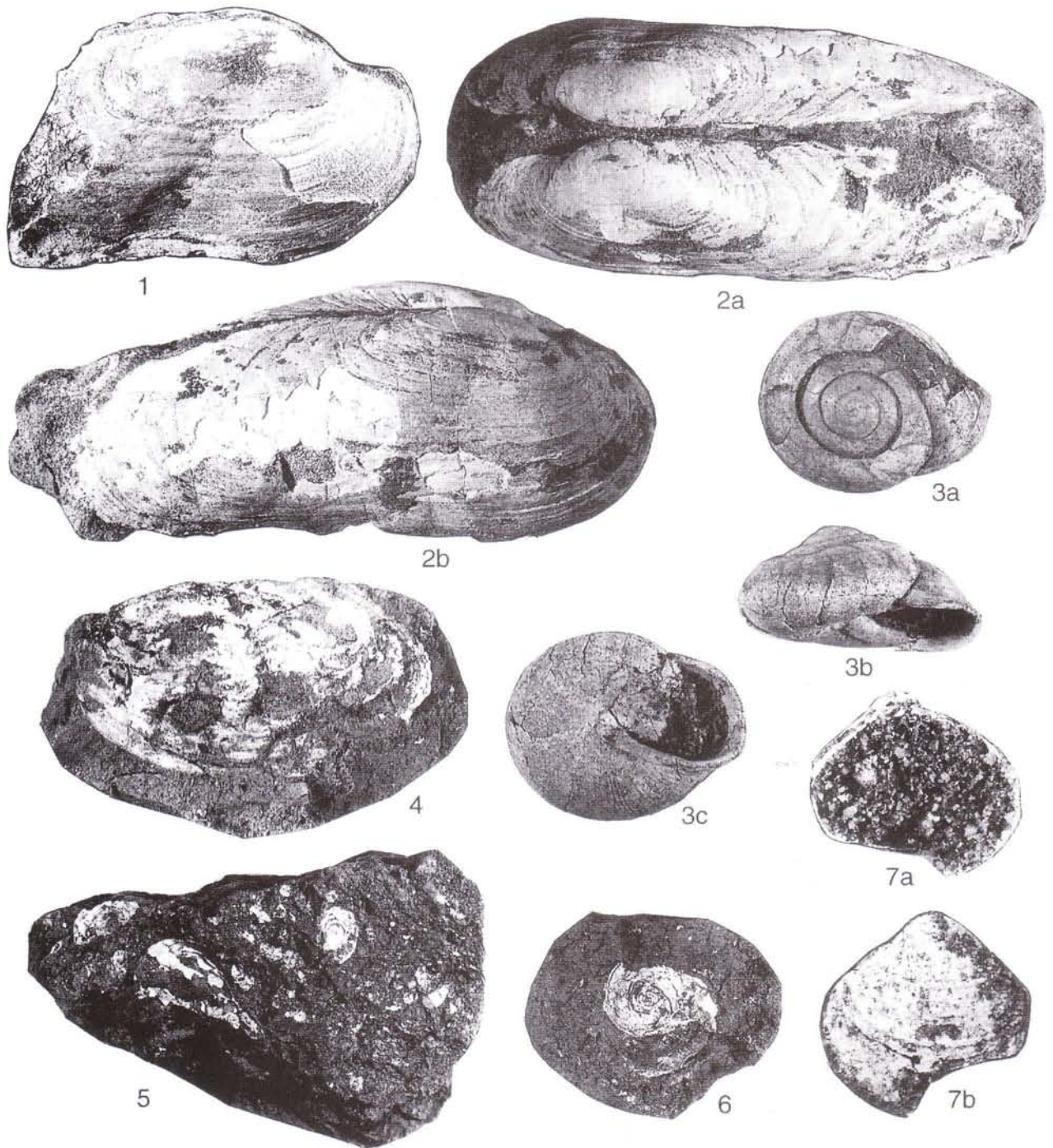


Plate 1

Fig. 1 - *Azolla filiculoides* Lam. Megaspores: upper-oblique view. Fig. 2 - *Azolla filiculoides* Lam. Megaspores: lateral view. Fig. 3 - *Selaginella magdae* Knobloch: megaspore. Fig. 4 - *Ilex* cf. *I. protogea* Mai: seed in ventral view. Fig. 5 - *Ceratophyllum* sp.: fruit in lateral view. Fig. 6 - *Pterocarya* cf. *P. limburgensis* Reid & Reid: fruit in lateral view. Fig. 7 - *Melissa elegans* Reid: fruit in ventral view. Fig. 8, 9 - *Decodon* cf. *D. gibbosus* (Reid) Nikitin: 8) fruit in lateral-ventral view with incipient dehiscence along the apical margin; 9) fruit in lateral view. Fig. 10 - *Liriodendron geminata* Kirchheimer: couple of seeds. Fig. 11 - *Nuphar* cf. *N. canaliculatum* Reid & Reid: seed in apical view. Fig. 12a, b - *Ficus* cf. *F. carica* L.: endocarp in lateral view and detail of its external surface. Fig. 13 - *Ranunculus sceleratus* L.: fruit in lateral view. Fig. 14 - *Pyracantha* sp.: endocarp in lateral view. Fig. 15 - *Fagaropsis?* sp.: seed in lateral view. Fig. 16, 17 - *Boehmeria* sp.: achenes in lateral view, respectively with scanty remains of the wing and with complete wing. Fig. 18 - *Scirpus tabernaemontani* Gmelin: achene in lateral view.

Plate 2

Figs. 1 - 2a, b - *Margaritifera (Pseudunio) auricularia* (Spengler), from the sandy level. Fig. 1, M.P.U.R.-7- 1479/1; x 0.8. Fig. 2a, b, M.P.U.R.-7- 1481/1; x 0.8. Fig. 3 a, b, c - *Eobania vermicularia vermicularia* (Michelotti), from the sandy level. M.P.U.R.-7-1480/1; x 0.9. Fig. 4 - *Anodonta* sp., from the silty pedogenic level. M.P.U.R.-7-1482/1; x 1. Fig. 5 - Freshwater mollusc assemblage from the silty pedogenic level. Fragmentary little gastropod shells, Planorbids and bivalves are visible. M.P.U.R.-7-1483/1; x 0.9. Fig. 6 - *Planorbis planorbis* (Linnaeus), from the silty pedogenic level. M.P.U.R.-7- 1484/1; x 1. Fig. 7 - *Corbicula fluminalis* (Müller), from the sandy level. M.P.U.R.-7-1485/1; x 2.25. All the material is kept in the coll. Esu-Girotti, Museum of Paleontology, University of Rome "La Sapienza" (M.P.U.R.-7).

last instars, indicating only a moderate displacement (Whatley 1988). Moreover, these species are not homogeneously distributed in all samples.

At the base of the TP section, both coarse (TP11a) and finest muddy sands (sample TP11b) were sampled: the first are barren of ostracods, while in the latter a poor ostracod assemblage is represented by scarce valves of *F. fabaeformis*, *C. neglecta* (juv.) and *Pseudocandona* sp. (juv.). They are all freshwater taxa typical of shallow permanent or temporary aquatic environments, which tolerate also low salinities (oligohaline).

In the middle sandy and coarser portion of the succession, samples TP 10-TP6 are barren of ostracods and record only the presence of displaced *Bithynia* opercula and some pharyngeal fish teeth. In this portion the samples are very rich in vegetal remains (wood, seeds).

Sample TP5, taken upwards in grey clays, records only the presence of *C. torosa* characterised by noded adult valves. This species is a very euryhaline temporary and permanent water dweller. Many studies have addressed its capability to show ecophenotypical morphs linked to the salinity variations. In particular, according to Carbonel (1988) and Van Harten (1996) noded specimens occur when salinity decreases below 8‰ and the environment is characterised by the sedimentation of terrigenous deposits. Recently, Van Harten (2000) suggested that nodding could be induced also by other factors, such as pH and CO<sub>2</sub> content. On the contrary, according to Kruit (1955), nodding could develop also in hyperhaline environments. Even if *C. torosa* is present in sample TP5 with a very low frequency, this species indicates a permanent or temporary saline water body. Due to the monospecificity of the assemblage, it is not possible to define if the TP waters were oligo- or hyperhaline. However, the comparison with the ostracod assemblages collected in the nearby Villa S. Faustino section, still part of the Santa Maria di Ciciliano Formation (Ambrosetti et al. 1995a) points to an oligohaline environment.

Towards the top of the TP section, the clayey samples TP4-TP3 are again barren of ostracods and very rich in lignite (maybe the environmental conditions were too acid for ostracods), while the muddy and peaty samples TP2-TP1 are characterised by abundant, but oligotypical ostracod assemblages made by *C. neglecta* (dominant), *F. levanderi* and *I. gibba*. This assemblage records the restoration of a shallow, permanent or temporary, fresh-water body.

## Vertebrates

Vertebrates are represented by large and small mammals, rare birds, reptiles, amphibians and some fishes.

The following taxa were found:

Pisces indet., Anura indet., *Emys orbicularis* (Linnaeus), *Mauremys* sp., Testudinata indet. (?*Trionyx* sp.), Ciconiidae, Accipitridae, *Canis* sp., ?*Baranogale* sp., *Homotherium* sp., ?*Mammuthus meridionalis* (Nesti), *Equus* cf. *E. stenonis* Cocchi, *Stephanorhinus* cf. *S. etruscus* (Falconer), *Sus strozzii* Meneghini, *Eucladoceros dicranios* (Nesti) vel *ctenoides* (Nesti), *Axis nestii* (Major), Cervidae gen. et sp. indet., *Leptobos* cf. *L. etruscus* (Falconer), Bovidae gen. et sp. indet. (medium sized antelope), Bovidae gen. et sp. indet., *Castor* sp., *Mimomys medasensis* Michaux, *Prolagus* sp., *Oryctolagus* cf. *O. lacosti* (Pomel).

## Amphibians

Anura indet. A distal half of a large tibia-fibula belonging to an anuran of the size of a toad is the only fragment collected in TP. Any classification, even at family level, is impossible.

## Reptiles

All the reptile remains collected at TP belong to turtles.

*Emys orbicularis*. One fragmentary nuchal, two neurals, one suprapygal, several costals (fragmentary), many peripherals, three epiplastra (one fragmentary), one entoplastron, four big fragments of hyoplastra, one fragment of hypoplastron and three xiphiplastra belong to the common European pond turtle, *Emys orbicularis*. This species is characterised by a weakly developed epiplastral tubercle, the presence of a gentle xiphiplastral notch and a smooth and slightly grooved hinge line between the hyoplastra and hypoplastra. The peripherals, unlike in the genus *Mauremys*, are interested by deep grooves of the dermal shield (boundary of supra-marginal and marginal scutes). All these characters are present in the fossils. Some bones indicate the presence of specimens that are almost as large as the largest living individuals (about 35 to 40 cm long).

Remains of this emydid are very common in Europe until the Pliocene (Młynarski 1980). In Italy it is present also in sediments of the Upper Valdarno (Tuscany) (Kotsakis 1980) now ascribed to the Late Pliocene. In the Tiberino basin abundant fossils of this species were collected in the Pietrafitta lignite quarry (Farneta F.U.) (Kotsakis & Gregori 1985). *E. orbicularis* is very common today in the Italian peninsula and in the larger islands; it occurs usually in permanent low-energy fresh-water environments with abundant aquatic vegetation (Hollman 1998).

*Mauremys* sp. A left xiphiplastron with a deep xiphiplastral notch and the groove between the femoral and anal shields almost parallel to the anterior border of the xiphiplastron indicates the presence of a member of the genus *Mauremys*, the stripe-neck terrapins.

The genus *Mauremys* is present in the Pliocene deposits of Upper Valdarno with *Mauremys gaudryi* etr-

*usca* Portis (see Kotsakis 1980). During the Pleistocene it is present in a few localities of Peninsular Italy and in Sardinia (Caloi et al. 1981; Kotsakis 1981; Delfino & Bailon 2000). The genus *Mauremys* is living in southern Europe, but with a wide gap between Spain and former Yugoslavia. The species of this genus occur in almost every type of available aquatic habitat (Hollman 1998).

Testudinata indet. (? *Trionyx* sp.) A very big scapula with the processus acromialis is also present. It is very similar to the corresponding bone of living *Trionyx* and to the scapula illustrated by Bachmayer (1966), discovered in the late Miocene site of Schwechat (Wien, Austria) and assigned to *Trionyx* sp. *Trionyx* cf. *T. pliopedemontanus* Sacco is present in the Pliocene of Upper Valdarno (Kotsakis 1980), but at this moment the attribution of this single bone is uncertain.

#### Birds

Birds are represented by a carpometacarpus referable to a Ciconiidae and a tarsus metatarsus of an Accipitridae. The detailed taxonomical analysis of these fossils is still in progress (det. by C. Bedetti and M. Pavia).

#### Mammals

*Canis* sp. A fragmentary P<sup>3</sup> and a distal part of a metapodial bone can be referred to this genus on the basis of their size and shape. The tooth and bone sizes fall in the average of the data of *Canis arnensis* Del Campana from different localities of Upper Valdarno (Torre 1967), while the coeval *Canis etruscus* Major is larger and shows stouter metapodials.

Azzaroli (1983) considered the first occurrence of *C. etruscus* in Italy as one of the biological events which characterised the faunal renewal of the late Villafranchian (the wolf event). In recent times, Rook & Torre (1996) referred to *Canis* cf. *C. etruscus* some fossils from the middle Villafranchian fauna of Costa S. Giacomo, while a very similar canid occurs in the almost coeval deposit of Senéze (France).

The first occurrence of *C. arnensis* seems to be at Poggio Rosso (Upper Valdarno), in a fauna with transitional features between Olivola and Tasso F.U.s (Napoleone et al. 2001). This taxon survives until the Farneta F.U., while *Canis* aff. *C. arnensis* (advanced form) is still occurring in the Galerian faunas (Rook & Torre 1996; Gliozzi et al. 1997).

?*Baranogale* sp. The occurrence of a mustelid is indicated by a lower carnassial and a second phalanx. Unfortunately the crown of M<sub>1</sub> is heavily worn out and no morphological considerations are allowed. The size of the tooth is intermediate between the range of the Italian Villafranchian species referable to the larger *Pannonictis nestii* (Martelli) (Olivola-Farneta F.U.) and *Enhydriactis ardea* (Bravard) (early-late Villafranchian) (Rook 1995; Gliozzi et al. 1997), and the smaller European zorillas *Vormela* and *Baranogale* (Spassov 2001). The specimen from TP can be compared in size to *Bara-*

*nogale* cf. *B. helbingi* Kormos from the middle Villafranchian Greek locality of Dafnero (Koufos & Kostopoulos 1997), but only new findings will allow further detailed taxonomical considerations.

*Homotherium* sp. The occurrence of a large felid is recorded by a first phalanx, with evidences of fluvial transport. The curved diaphysis is typical of the felids and its large size is more indicative of the sabretoothed cat *Homotherium* rather than *Panthera*. The earliest occurrence of *Homotherium* in Italy is recorded at Pieve Fosciana (Tuscany), in a faunal assemblage referable to the Triversa F.U.; this sabretoothed cat is a quite common element of the late Villafranchian faunas and disappears in the Middle Pleistocene (Sardella 1994).

?*Mammuthus meridionalis*. Some fragmentary enamels of molars belong to an Elephantidae. The thickness and morphology of the teeth fragments seem to fit those of the genus *Mammuthus*, but the remains are too scanty to allow a sure taxonomic classification.

*Equus* cf. *E. stenonis*. The occurrence of stenooid horses is testified by some fragmentary cheek-teeth with short and asymmetric protocones (Fig. 3 g) and fragmentary bones.

*Stephanorhinus* cf. *S. etruscus*. The etruscan rhino is represented by a mandible of a juvenile specimen and a third metatarsal (Fig. 4 c, d). The teeth are brachyodont and the horizontal branch of the mandible is short. Even if we take into account the young age of the specimen, it is similar in shape to the specimen from Capitone (Tr) (Ambrosetti 1972). The third metatarsal is very long and slight and shows total length-transversal diameters indexes that fit well with the biometrical parameters of *Stephanorhinus etruscus* (cf. Fortelius et al. 1993). This species is recorded in Italy in the middle and late Villafranchian (Gliozzi et al. 1997).

*Sus strozzii*. This suid is represented by fragmentary remains. The most significant element (Fig. 3 h) is a complete M<sub>3</sub> showing a bunodonty and a strong thickness of the enamel typical of the species (Azzaroli 1955). Also the biometrical parameters fit well with those of *Sus strozzii* specimens from Upper Valdarno.

*Eucladoceros dicranios* vel *ctenoides*. Remains of a large cervid referable to the genus *Eucladoceros* were collected. Some fragmentary molars, a calcaneum (Fig. 3 f) and an astragalus show dimensions and morphology similar to those of the species *Eucladoceros ctenoides* and *E. dicranios*. The absence of the antlers does not allow a more defined taxonomical classification. Both species are typical of the late Villafranchian faunas of Italy (Olivola and Tasso F.U.) (Gliozzi et al. 1997).

*Axis nestii*. This species, recently revised by Di Stefano & Petronio (1998, in press), is the best represented at TP (Fig. 3 a, b, c, d). The morphological and biometrical features of the collected bones fall in the intraspecific variability range of this taxon (Di Stefano & Petronio 1998). In particular, some basal parts of the antlers were recorded. They show the first tine lightly

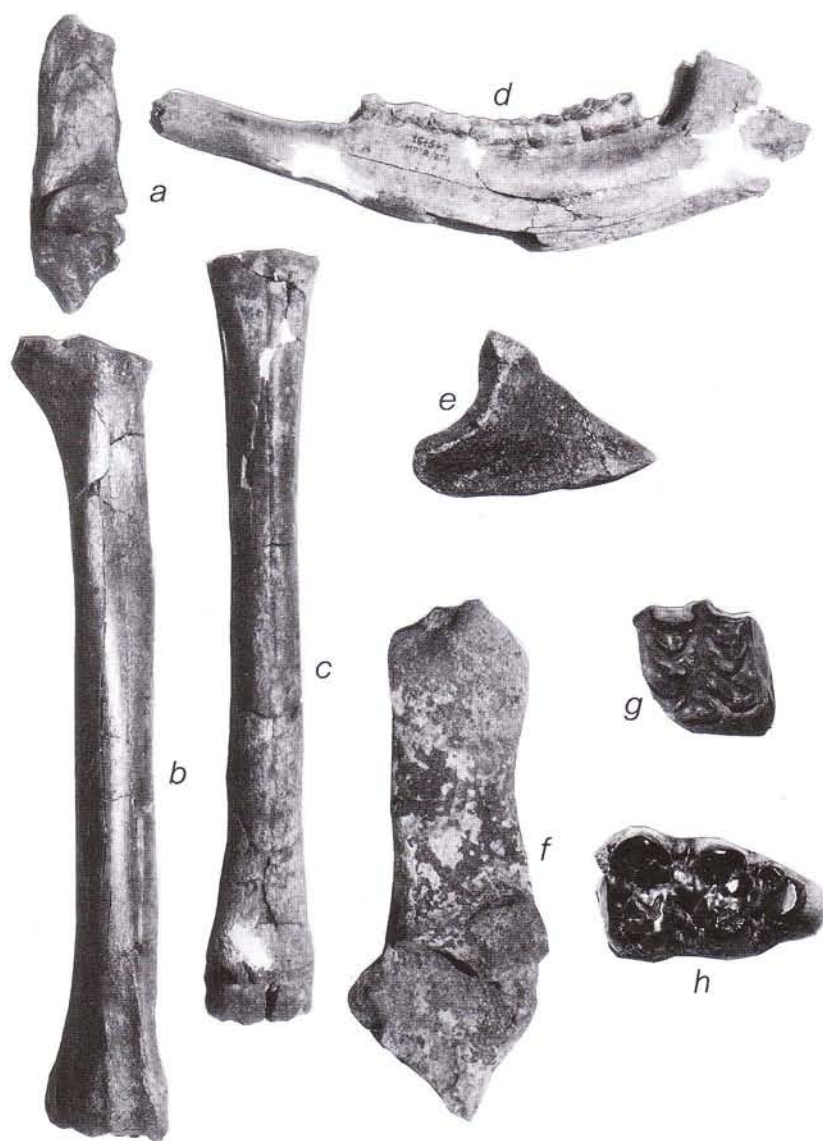


Fig. 3 - *Axis nestii*: Torre Picchio (Umbria, Central Italy). a, calcaneum in internal view; b, radius in anterior view; c, metacarpal in anterior view; d, mandible in labial view. Bovoidea gen. et sp. indet.: e, third phalanx in external view. *Eucladoceros dicranios* vel *ctenoides*: f, calcaneum in internal view. *Equus stenonis*: g, M<sup>1</sup> in occlusal view. *Sus strozzi*: h, M<sup>3</sup> in occlusal view. a - e) x 0.45; f) x 0.56; g - h) x 0.78.

distanced by the rosetta and oriented with an acute angle, as in the other specimens of *Axis nestii* (Di Stefano & Petronio 1998).

Premolars and molars show a less derived morphology in comparison with *Axis eurygonos* (Azzaroli), which characterises the Farneta F.U. and is still present in the Galerian faunas. Also the size and morphology of the postcranial bones can be considered for the taxonomical definition. The TP specimens have radius and metatarsals with proportions (total length-transversal length) similar to those of *A. nestii* specimens considered by Di Stefano & Petronio (1998), substantially differing from the "rusoid" European forms.

Cervidae gen. et sp. indet. Several fragmentary bones can be generically referred to this family.

*Leptobos* cf. *L. etruscus*. This bovid is represented by a great number of bones. Following Masini (1988), the morphology of the skull and the shape of the horn cores are very important features in the taxonomy of leptobovines. These skeleton parts are missing in the TP samples and, taking into account also the marked

intraspecific variability and the marked sexual dimorphism, the biometrical data of the limb bones (Fig. 4 a, b) have to be considered with caution.

The specimens from TP show some affinities with the late Villafranchian *Leptobos etruscus* (i.e. the shape of the molars and metapodials); the taxonomical attribution is suggested by the analysis of the scattergram diagrams for metatarsal bones (Fig. 5), (maximum length/transversal distal diameter). This bovid characterised the Olivola and Tasso F.U.

Bovoidea gen. et sp. indet. (medium sized, ?*Gallogoral*). A third phalanx (Fig. 3, e) shows morphological features referable to those of Bovoidea sensu lato. It is slender, antero-posteriorly shortened, with a plantar surface similar in shape to those of bovines. The occurrence of medium sized antelopes (i.e. *Procamptoceras*, *Gazellospira*) characterised the Late Pliocene faunas (Guerin 1965). The last occurrence of these taxa is recorded in the Olivola F.U. (Gliozzi et al. 1997).

Bovidae gen. et sp. indet. The taxonomical attribution of several fragmentary bones is impossible in this group.

*Castor* sp. A single right M<sup>2</sup> (7.60 x 8.11 mm) and a small phalanx belong to the genus *Castor*. The molar crests are almost unfolded while the striids are relatively long. The first character is present in the living *Castor fiber* Linnaeus whilst the second is more common in the Villafranchian beavers (Kretzoi 1977) but the material is very scanty and we prefer a classification at generic level. The genus *Castor* is common in mammal Villafranchian assemblages of Italy.

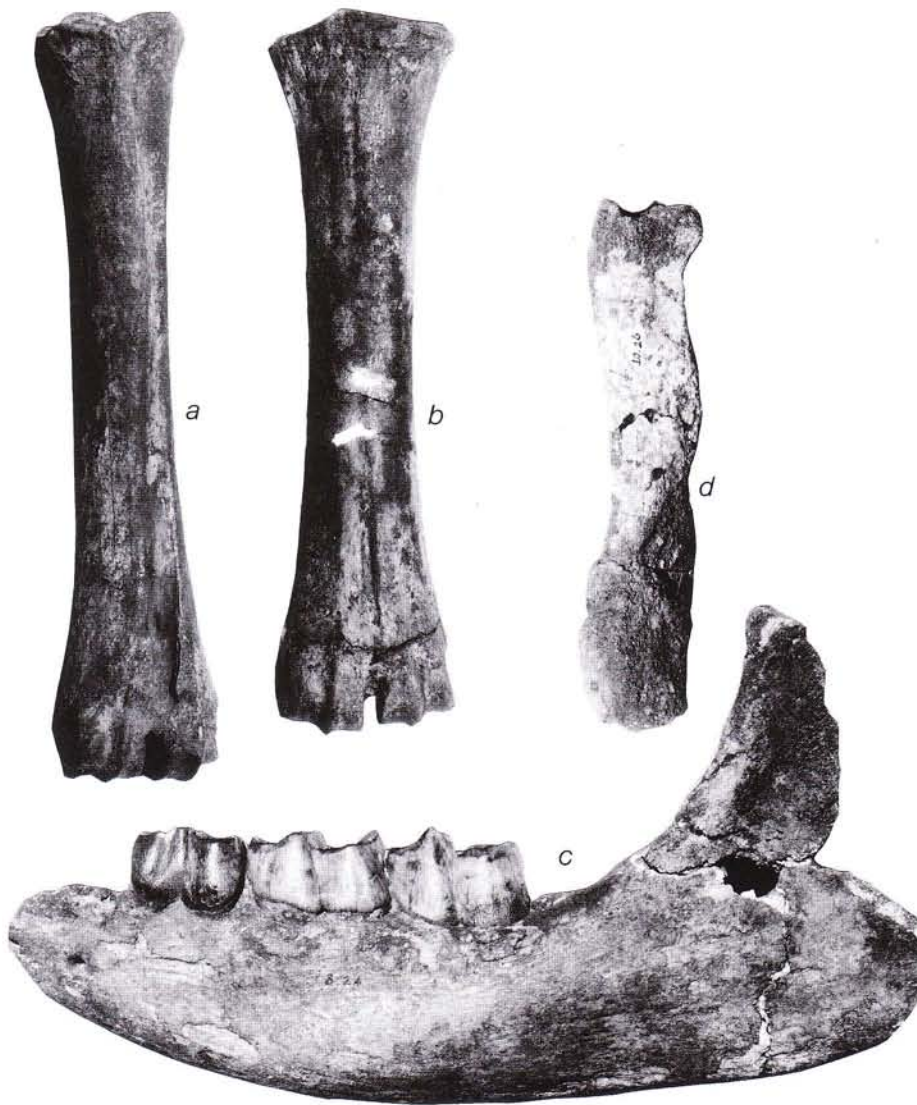


Fig. 4 - *Leptobos* cf. *L. etruscus*: Torre Picchio (Umbria, Central Italy). a, metatarsal in anterior view; b, metacarpal in anterior view. *Stephanorhinus* cfr. *S. etruscus*: c, mandible in labial view; d, third metatarsal in anterior view; a, b) x 0.39; c) x 0.70; d) x 0.45.

*gus*. The fossils of this genus collected in the Italian mainland are under revision. For this reason we prefer to classify the remains of TP only at a generic level.

A rich population of *Prolagus* was collected from a fissure filling in Montagnola Senese (Tuscany) (Fondi 1970, 1972); at first assigned to the "Cromerian", this fauna is now considered as late Villanyian (or earliest Biharian) (Maul et al. 1998). Scanty remains of *Prolagus* are reported from Upper Valdarno deposits of

the same age (Rook & Masini 1990) and from the early Villanyian of Arondelli (Piedmont) and Arcille (Tuscany) (Berzi 1967; Hürzeler & Engesser 1976). More recent records of this genus are reported from the Western Mediterranean area (in Sardinia till the XVIII century), but not from mainland Italy (Lopez Martinez 1977).

*Oryctolagus* cf. *O. lacosti* (Fig. 6 c). The remains of leporids are fewer than those of the ochotonids (see Appendix) and all are very similar to *Oryctolagus lacosti*, the Villafranchian rabbit, and are clearly different from *Oryctolagus laynensis* Lopez Martinez or *Oryctolagus burgi* Nocchi & Sala (cf. Lopez Martinez 1977; Nocchi & Sala 1997a, b). However, the material is rather poor and we prefer an attribution to *Oryctolagus* cf. *O. lacosti*.

The Villafranchian rabbit is present in Italy in many assemblages of late Villanyian or early Biharian age (Kotsakis et al. in press). The Villafranchian remains, assigned by many authors to extinct hare species (*Lepus etruscus* Bosco, *Lepus valdarnensis* Weithoffer), are considered as synonyms of *O. lacosti* (see Lopez Martinez 1977).

*Mimomys medasensis* (Fig. 6 a). All rodent remains collected at this site belong to a single species, a big arvicolid of the genus *Mimomys* (see Appendix). The dimensions of  $M_1$  (3.16-3.80 mm) correspond to species like *Mimomys savini* Hinton, *Mimomys pliocaenicus* (Major), *Mimomys ostramosensis* Janossy & Meulen and *M. medasensis*. The presence of enamel islets also in adults of advanced age excludes *M. savini* and *M. ostramosensis*. On the other hand the linea sinuosa is identical to that of *M. medasensis*, illustrated by Michaux (1971) and Esteban Aenlle & Lopez Martinez (1987).

*M. medasensis* is a species collected in some Late Villanyian sites of the Iberian peninsula (Michaux 1971; Esteban Aenlle & Lopez Martinez 1987; Agustí 1990). Torre Picchio is the first site outside Spain where this arvicolid was discovered. It is one of the rather rare Ibero-citanic elements arriving from time to time in the Italian peninsula (at different times) (Kotsakis et al. in press).

*Prolagus* sp. (Fig. 6 b). Several remains (see Appendix) belong to an ochotonid of the genus *Prola-*

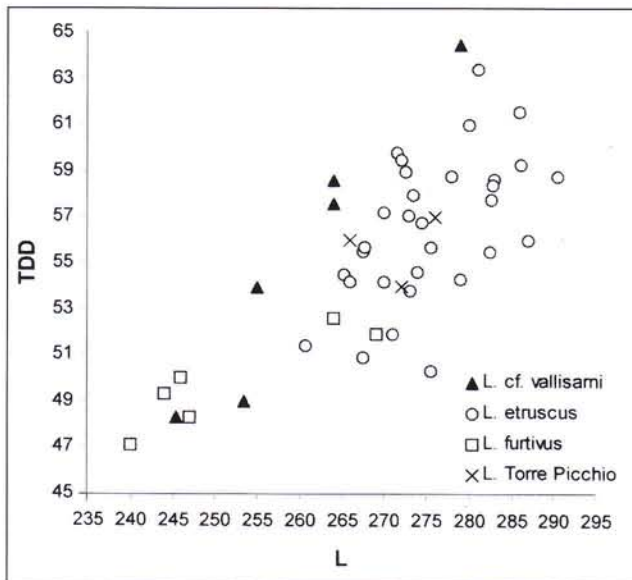


Fig. 5 - Metatarsal Length/Transversal distal diameter ratio of different *Leptobos* species.

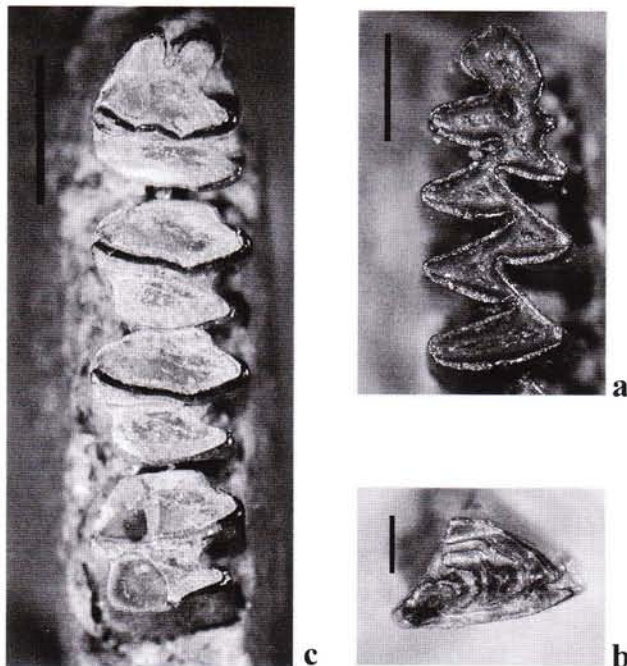


Fig. 6 - a: *Mimomys medasensis*: Torre Picchio (Umbria, Central Italy); right  $M_1$ , occlusal view. Scale 1 mm. b: *Prolagus* sp.: Torre Picchio (Umbria, Central Italy); right  $P^3$ , occlusal view. Scale 1mm. c: *Oryctolagus* cfr. *O. lacosti*: Torre Picchio (Umbria, Central Italy); right mandibular ramus with  $P_3$ - $M_2$ , occlusal view. Scale 3 mm.

#### Biochronological remarks on the vertebrates

The TP vertebrate assemblage includes several species, some of those rare or recorded in Italy for the first time. The occurrence of *Mimomys medasensis*, ?*Baranogale* sp. and ?*Gallogoral*, typical elements of Late Pliocene faunas, with taxa characterising late Villafanchian assemblages, can be explained in different ways. The data collected on the middle and late Villafanchian faunas need to be increased, and only a

detailed work of sampling and analysis will enable to fill this gap. Inferences about the biochronology of the TP fauna suggest two possibilities: 1) to assign a Late Pliocene age to the fossiliferous deposit, with the first occurrence of species that will be very common during the early Pleistocene times (e.g. *Axis nestii*, *Leptobos etruscus*, etc.) or 2) to consider peninsular Italy as a refuge area, in which some vertebrates, molluscs and plants that originated in the Pliocene survived in the Early Pleistocene.

#### Conclusions

The non marine Santa Maria di Ciciliano Formation, to which the TP section belongs, is heteropic to the marine Chiani-Tevere Formation, which is mostly of Santernian age: in fact, the Late Pliocene was recognised only in a few sites, such as Valle Ricca (Carboni et al. 1993), near Nazzano (Di Bella 1999; Mancini et al. in prep.) and the Lugnano section (Borzi et al. 1998). All these sites are located in the middle Tiber Valley in the so-called Tiber Graben (Borzi et al. 1998), where the Santernian strata of the Chiani-Tevere Formation (characterised by the *Bulimina elegans marginata* Biozone and by significant taxa such as *Bulimina etnea*, *Globigerina calabra* and *Globigerina* aff. *G. calida calida*) lie conformably onto the Upper Pliocene. Di Bella (1999) gives a good picture of the biostratigraphic evidences of the Santernian sediments in the middle Tiber Valley.

The heteropy between the non marine S. Maria di Ciciliano Formation and the marine Chiani-Tevere occurs where the latter is already of Early Pleistocene age.

In more detail, the Apennine relief of the Amerini Mts. separates the marine from the non marine basin. However, near S. Pellegrino a saddle in the Amerini Mts. caused a topographic link, which induced a well recognisable interfingering between the sediments of these formations, as recorded by both rocks and fossils, i.e. brackish sediments and molluscs in the Santa Maria di Ciciliano Formation and non marine deposits (fluvial sediments, travertines and lignitiferous clays) with fresh-water molluscs and mammals in the Chiani-Tevere Formation (Ambrosetti et al. 1989; Esu & Girotti 1991; Cavinato et al. 1999).

It is noteworthy that such interfingering occurs at the top of the marine succession, well above the Plio-Pleistocene boundary and near evident shorelines, which are cut into the Apennine relief (Girotti & Piccardi 1994). Moreover, the fluvial Santa Maria di Ciciliano Formation is separated by an angular unconformity from the underlying Upper Pliocene strata of the lacustrine Fosso Bianco Formation (Conti & Girotti 1978; Ambrosetti et al. 1989, 1995a): the TP section falls in the upper part of the stratigraphic column of the fluvial unit (Fig. 2).

An age attribution for the TP section other than Early Pleistocene is therefore problematic, both from the geologic and the stratigraphic point of view.

The TP palaeobotanical remains can be considered relevant because they are in association with several other palaeontological records, thus permitting a thorough reconstruction of Plio-Pleistocene biota and environmental conditions in central Italy. This aspect is more important than any consideration on the richness of the TP carpoflora, which is certainly biased by the poor development of palaeocarpological research in this area. In fact the present knowledge permits to state that most outcrops of Pliocene-Early Pleistocene sediments in the Tiberino Basin contain a good record of fossil fruits and seeds, so that the extension of carpological studies would produce much new information.

Nevertheless, TP provides an interesting picture of the palaeoflora at the Plio-Pleistocene transition, with its mixture of extinct (*Liriodendron geminata*, *Lobelia pliocenica*, *Magnolia cor*, *Melissa elegans*, etc.) and still living species (*Corylus avellana*, *Ceratophyllum demersum*, *Oenanthe aquatica*, *Ranunculus flammula*, etc.). This implies a marked difference between the Plio-Pleistocene and modern central Italian plant communities. Such a difference can be partly attributed to slightly wetter palaeoclimatic conditions, which permitted such genera as *Lobelia* and *Taxus* to grow in the Umbrian lowlands, and partly related to the drastic post-Pliocene plant extinction in southern Europe, caused by the frequent oscillations in temperature and moisture. The fruits and seeds assemblage is therefore indicative of an age ranging from Late Pliocene to Early Pleistocene.

The molluscs indicate the same time range, the assemblages being however more widespread in Early Pleistocene sediments. On the contrary, in the vertebrate assemblage the occurrence of quite rare elements such as *Miomys medasensis*, ?*Baranogale* sp. and ?*Gallogoral* sp. suggests a Late Pliocene age. A possible explanation for such a contradictory data is to consider peninsular Italy as a refuge area. Among the vertebrates there are some cases of typical Neogene taxa, extinct elsewhere at that time, present in central Italy during the Early Pleistocene. For example the discoglossid *Latonia*, a genus with a good fossil record in the European Neogene, disappears from Europe during the Early Pleistocene with the exception of the site of Pietrafitta (Umbria, Central Italy). An assemblage of vertebrates and non-marine molluscs belonging to the Farneta F.U. was collected from this site (Esu et al. 1991).

In conclusion we observe a contradiction between biochronological and stratigraphical data. One explanation, consistent with the current data, is to admit a heterochrony in the disappearances of some taxa and their survival in the Italian peninsula for longer time. In any case the vertebrate assemblage of TP is clearly older than the Tasso F.U. and the contradiction mentioned above will be possibly resolved when the existing gaps in

the Villafranchian biochronological framework are filled and when more magnetostratigraphic data from non marine successions become available, since the attribution of the Olivola F.U. to the latest Late Pliocene is assessed mainly on palaeomagnetic analysis.

The palaeoecological observations on the first mollusc assemblage indicates a fluvial environment for the lower, sandy, two thirds of the section. A brief episode of oligohaline waters is evidenced by ostracods in a clayey layer at the top of this first part of the succession. This is followed by a swampy and marshy environment, indicated by the second mollusc assemblage collected in the clays of a swampy paleosol. At the top of the succession ostracods and molluscs collected in the clays indicate a lacustrine environment. The flora is composed of water plants of standing or slowly flowing eutrophic waters, riparian plants and more distant mesic woods indicating a deciduous broad-leaved forest. The whole flora indicates a mean annual temperature of  $12 \pm 1^\circ\text{C}$  very similar to present day values.

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## Appendix

Taxonomic notes on a few carpological species

*Azolla filiculoides* Lamarck (Pl.1, fig. 1, 2)

The megaspores of *Azolla* are very abundant, especially in sample PI1, and their peculiar morphology makes identification very easy. Megaspores of this type have been long known to be present in the late Cenozoic of Europe and have been assigned mostly to the still-living species *Azolla filiculoides*. However, several Russian authors, starting from Nikitin (1938), decided to assign the specimens from Eastern Europe to a separate fossil species, i.e. *A. interglacialica* Nikitin. Mai & Walther (1988) pointed out that the putative differential characters of *A. interglacialica* were observed also in recent *Azolla filiculoides* material, so there is no reason to maintain two species. The biogeographic history of *Azolla filiculoides* is quite interesting: it first appears in the Pliocene of Northeastern Europe and only in the latest Pliocene spreads to Northwestern Europe. Its occurrence at TP demonstrates that it also penetrated rather early into southern Europe. In the Early and Middle Pleistocene it is widespread in the interglacials (i.e. Holsteinian), having been recovered in Britain as well as in western Siberia. In the Late Eemian this species definitively disappeared from Europe and persisted only in North America. In the past centuries it has been re-introduced by man into Europe, and the fact that it can easily grow in the wild suggests a good adaptation to the modern climatic conditions. Standing waters in eutrophic conditions represent its favourite habitat.

*Selaginella magdae* Knobloch (Pl.1, fig. 3)

This type of spherical, distinctly reticulate, megaspores is rather common in the Cenozoic deposits of Europe. They are often referred to the group of *S. pliocenica* Dorofeev, which is found in the Miocene and Pliocene, mainly in Eastern Europe. Knobloch (1986) and Mai (1999) differentiated several species within this group, even if the diagnosis of such species is often based on one or a few specimens and the entity of intraspecific variation is not discussed. The two megaspores from TP can be assigned to *Selaginella magdae* Knobloch based on the widely reticulate ornamentation, with thin muri and granulate lumina. This species is only known from the Miocene of the Czech Republic (Knobloch 1986) and from the Pliocene of northwestern Italy (Martinetto 1995), therefore its occurrence at TP may be of some biochronological relevance.

*Ceratophyllum demersum* Linnaeus (Pl.1, fig. 4)

Fruits of *Ceratophyllum* are very common in Late Cenozoic assemblages of freshwater macrophytes. The remains of TP agree very well with the modern *C. demersum*, and only one specimen shows a peculiar morphotype with distinct warts on the lateral sides (Pl.1, fig.5), a feature which is attributed to intraspecific variation. This species indicates standing or slowly flowing waters in eutrophic conditions.

*Ilex* cf. *I. protozea* Mai (Pl.1, fig. 5)

The seeds of *Ilex* found in samples PI1 and PI2 surely belong to a species that is either extinct or no more present in Europe. The seeds are rather variable: those with only a few ribs are very similar to those of *Ilex protozea* Mai, a species known in the Miocene and Pliocene of Germany (Mai & Walther 1988). Other specimens show more abundant ribs and resemble *Ilex cantalensis* Reid from the Late Miocene of France (Reid 1920). Furthermore, some seeds of TP resemble another fossil species, *Ilex fortunensis* Van der Burgh (1978) from the Early Pliocene of the Rheinisch Basin. The description and illustration of these three fossil species do not allow the identification of the TP material, thus a direct examination of the type material will be necessary.

*Melissa elegans* Reid (Pl. 1, fig. 7)

The single fossil specimen is very similar in shape to modern nutlets of *M. officinalis* L.; the ornamentation is quite different, especially for the broadly reticulate pattern at the rounded apex of the fruit, which is

characteristic of *Melissa elegans*, a species known in the Pliocene and Early Pleistocene from Britain to northern Italy (Mai 1995; Martinetto in press). It is most probably an extinct species with connections to the modern East Asian species (Mädler 1939).

*Pterocarya* cf. *P. limburgensis* Reid & Reid (Pl.1, fig. 6)

The easily identified endocarps of *Pterocarya* are very compressed in the TP section, creating some problems when comparing recent and fossil material. However, apart from the strong deformation, most specimens of sample PI0 perfectly match analogous material assigned to *P. limburgensis* Reid & Reid (collected at Tegelen, in the Late Pliocene of Limburg, type locality of the species - coll. DSTT), a very common species in the Pliocene and early Pleistocene of northern Italy (Martinetto 1999).

According to Tralau (1963, p. 15) the fruits of *P. limburgensis* are very variable and "more or less comparable" to those of three recent species: *P. hupehensis* Skan., *P. rhoifolia* Sieb & Zucc. and *P. pterocarpa* (Michx.) Kunth. (= *P. fraxinifolia* (Lam.) Spach). This means that it is difficult to decide, based on fruit morphology, when the "fossil" species name *P. limburgensis* has to be abandoned in favour of the name of the modern Caucasian species, *P. fraxinifolia* (Lam.) Spach, which is thought to occur in central Italy during the Middle Pleistocene (Follieri 1958).

In addition, it was noticed that the fruits from sample PI1 show the predominance of a rather peculiar morphotype, which is rare or absent in both *P. limburgensis* and *P. fraxinifolia*: the size is smaller, the base is mainly acute and continues in a short stalk; finally, the equatorial zone of most specimens is marked by an irregular ridge (Pl. 1, fig. 6) and/or a series of warts or even spines. The role of this morphotype in the taxonomical assessment of the juglandaceous endocarps from TP still needs to be carefully evaluated.

*Liriodendron geminata* Kirchheimer (Pl.1, fig. 10)

Two seed couplets show the typical shape and ornamentation of *L. geminata*, a fossil species with seed characters distinct from those of the recent species (Mai & Walther 1988), which grow in North America and East Asia. In central Europe *L. geminata* is thought to disappear definitively at the end of the Pliocene (Mai & Walther 1988; Westerhoff et al. 1998), while the most recent occurrence in Italy is recorded at the Buronzo site in Piedmont, thought to be of Late Pliocene or Early Pleistocene age (Martinetto 1999). It is very likely that this species may last longer in Italy, as suggested by the occurrence of *Liriodendron* pollen in Early Pleistocene deposits (Bertoldi 1990).

*Decodon* cf. *D. gibbosus* (Reid) Nikitin (Pl.1, fig. 8, 9)

These typical thick-walled seeds are characterised by an expanded dorsal side; however, when they are dorsoventrally compressed this character is no longer evident and they resemble *D. globosus* (Reid) Nikitin. The type material of both species originates from the French site of Point-de-Gail (Reid 1920), now assigned to the Late Miocene. The group of species allied to *D. gibbosus* is common in the Miocene and Pliocene, and it rarely occurs also in the early and middle Pleistocene (Mai & Walther 1988). The nearest living relative is *Decodon verticillatus* (L.) Gmelin, a herbaceous plant that grows in dump places of Eastern North America.

*Boehmeria* sp. (Pl. 1, fig. 16, 17)

Two fruitlets from sample PI1 can be assigned to the urticaceous genus *Boehmeria* based on the narrow wing which borders the lateral margins and the apex of the narrowly ovate achene. The specimen illustrated (Pl. 1, fig. 16, 17) has lost most of the wing, with only a small fragment preserved at the top of the left side. Most likely these remains represent a herbaceous plant, and indeed an exotic element, since the living relatives grow either in America or East Asia. These specimens differ from *B. lithuanica* Dorofeev, rather common in the Pliocene of northern Italy (Martinetto 1999), for the marked asymmetry of the achene; however it is difficult to assess their specific position, since Dorofeev (1982) described several poorly differentiated fossil species in Eastern Europe.

*Scirpus tabernaemontani* Gmelin (Pl. 1, fig. 18)

The dimensions, the slender outline and the well-developed beak at the apex of the nutlet are useful to differentiate the fruits of this species from similar taxa within the subgenus *Schoenoplectus*. At present *S. tabernaemontani* is found mainly along the coasts, where it tolerates brackish conditions; however, it can also grow in dump places and freshwater basins far from the sea (Pignatti 1982).

### Vertebrate remains (measurements in mm)

#### Amphibia

Anura indet.

TP/sn/A 1. One fragmentary tibia-fibula.

#### Reptilia

*Emys orbicularis*

TP/sn/R 1-34. One fragmentary nuchal, two neurals, one suprapygial, several costals (fragmentary), many peripherals, three epiplastra (one fragmentary), one entoplastron, four big fragments of hyoplastra, one fragment of hypoplastron and three xiphiplastra.

*Mauremys* sp.

TP/sn/R 35. A left xiphiplastron with a deep xiphiplastral notch and the groove between the femoral and anal shields almost parallel to the anterior border of the xiphiplastron.

? *Trionyx* sp.

TP/sn/R 36. A very big scapula with the processus acromialis.

#### Aves

Ciconiidae

TP sn. Carpometacarpus.

Accipitridae

TP sn. Tarsusmetatarsus

#### Mammalia

*Canis* sp.

10.28a Fragment of metapodial; 10.56 fragment of P<sub>3</sub>.

?*Baranogale* sp.

M/1 (L: 9.5; B: 3.7); second phalanx.

*Homotherium* sp.

Fragment of first phalanx; fragment of femur.

?*Mammuthus meridionalis*.

Fragment of molar; fragment of molar; 11.18 fragment of molar; fragment of molar.

*Equus* cf. *E. stenonis*

10.57 Proximal epiphysis of metatarsus; fragment of ilaeum with acetabulum; fragment of P<sub>4</sub>; fragment of P<sub>3</sub>; fragment of premolar; fragment of molar; fragment of D<sub>3</sub>.

*Stephanorhinus* cf. *S. etruscus*

8.24 Right juvenile emimandible with P<sub>3</sub> (L: 20.0; B: 11.5), P<sub>4</sub> (L: 31.0; B: 16.8), M<sub>1</sub> (L: 39.0; B: 18.5), M<sub>2</sub> (L: 40.0; B: 21.5). metapodial (L: 159; PTD: 36; MTD: 26).

*Sus strozzii*

Incisor; fragment of molar; fragment of a lower canine; M<sub>3</sub> (L: 41; B: 23).

*Eucladoceros dicranios* vel *ctenoides*

Calcaneum (L: 125.5; PTD: 35.5; APPD: 48.0); astragalus (L: 68.0; mL: 63.5; mB: 38.0); 9.4 fragment of juvenile emimandible; 10.25 M1 (L: 22; B: 25); fragment of metatarsus; M<sub>1</sub> (L: 27.8; B: 21.5).

Cervidae gen. sp. indet.

Juvenile atlas; juvenile lumbar vertebra; fragment of thoracic vertebra; fragment of scapula; fragment of scapula; caudal vertebra; fragment of

ephistropheus; 8.14 lumbar vertebra; rotula; sesamoid; 9.3 fragment of beam; fragment of scapula; fragment of second phalanx; fragment of carpal bone; fragment of juvenile calcaneus; fragment of cervical vertebra; fragment of acetabulum; fragment of P<sub>3</sub>; fragment of cervical vertebra; fragment of beam; fragment of beam; fragment of beam; rotula; fragment of P<sub>3</sub>, P<sub>4</sub>, M<sub>1</sub>; fragment of M<sub>2</sub>; fragment of incisor; fragment of P<sub>2</sub>.

*Axis* sp.

6.3 First phalanx; 8.11 third phalanx; fragment of tibia; calcaneus (L: 86.5; PTD: 18; APDD: 23); first phalanx; first phalanx; first phalanx; fragment of metatarsus (L: 237; PTD: 25.5; MTD: 17); fragment of tibia; fragment of antler; fragment of metacarpus; fragment of tibia.

*Axis nestii*

Radius - L: 239.5; PTD: 43.0; APPD: 23.1; MTD: 26.2; MAPD: 20.5; DTD: 36.5; APDD: 30.0; fragment of emimandible with M<sub>2</sub> (L: 18.5; B: 11.6) and M<sub>3</sub> (L:25.5; B:11.35); M<sub>1</sub> (L: 16.3; B: 9.5); fragment of M<sub>1</sub>; fragment of M<sub>2</sub>; fragment of M<sub>3</sub> (L: 23.0; B: 11.5); lower incisor; M<sub>2</sub> (L: 19.5; B: 11.0); P<sup>4</sup> (L: 10.0; B: 14.0); P<sup>4</sup> (L: 10.5; B: 14.8); M<sub>2</sub> (L: 17.0; B: 14.0); P<sub>4</sub> (L: 11; B: 13); M/1 (L: 15.5; B: 11); M/2 (L: 18; B: 12); M/1 (L: 18; B: 11); M<sub>3</sub> (L: 22.5; B: 10); M/3 (L: 23; B: 10.8); metatarsus (L: 257; PTD: 28.8; APPD: 32.5; MTD: 20; DTD: 31; APDD: 20); metacarpus (L: 225; PTD: 33; APPD: 22.6; MTD: 20.2; DTD: 32; APDD: 19.5); mandible with P<sub>2</sub> (L: 8.8; B: 4.3); P<sub>3</sub> (L: 10.8; B: 7.7); P<sub>4</sub> (L: 12.5; B: 7.8); M<sub>1</sub> (L: 15.1; B: 12); M<sub>2</sub> (L: 15.9; B: 12.7); M<sub>3</sub> (L: 21.5; B: 11.2); M1/ (L: 18; B: 15); M2/ (L: 17; B: 16.5); M<sub>3</sub> (L: 21.5; B: 10.8); P<sub>4</sub> (L: 14.8; B: 10).

Bovoidea indet. (medium size)

Fragment of skull with horn core.

Bovoidea (medium sized antelope)

7.3 Third phalanx.

Bovidae gen. sp. indet. (large size)

Fragment of molar; fragment of M<sup>3</sup>.

*Leptobos* sp.

Distal epiphysis of tibia (DTD: 61; APDD: 46.5); distal epiphysis of humerus (DTD: 81.5; APDD: 78.5); fragment of radius; M<sub>2</sub> (L: 27; B: 22); fragment of M<sub>2</sub>; 10.11 P<sup>3</sup> (L: 15.5; B: 20); 10.12 M<sup>2</sup> (L:27; B: 23.5); M<sup>1</sup> (L: 27.5; B: 20); M<sub>1</sub> (L: 27; B: 13.5); M<sub>1</sub> (L: 26; B: 15.5); P<sub>2</sub> (L: 12; B: 9); 10.18 M<sub>1</sub> (L: 30; B: 30.5); 10.19 fragment of molar; 10.20 fragment of M<sup>3</sup>; M<sub>1</sub> (L: 23; B: 14); M<sub>2</sub> (L: 26; B: 19.5); M<sub>2</sub> (L: 27.5; B: 23.5); P<sub>4</sub> (L: 17.5; B: 18); P<sub>3</sub> (L: 20; B: 10.5); M<sub>2</sub> (L: 21; B: 15); fragment of first phalanx.

*Leptobos* cf. *L. etruscus*

Metacarpus (L: 246; PTD: 60; APDD: 38; MTD: 38.5; DTD: 62; APDD: 33.5); metacarpus (L: 242; PTD: 61; APDD: 39.5; MTD: 36; DTD: 60; APDD: 37.5); metatarsus (L: 276; PTD: 51; APDD: 53; MTD: 37.5; DTD: 57; APDD: 35.6); metatarsus (L: 272; PTD: 53; APDD: 52; MTD: 34; DTD: 54; APDD: 35); metatarsus (L: 266; PTD: 52.3; APDD: 52.5; MTD: 32.5; DTD: 56; APDD: 33); 10.4 first phalanx (L: 67.5; PTD: 32; APDD: 35; DTD: 29; APDD: 28.5); 10.5 second phalanx (L: 47; PTD: 31.5; APDD: 37; DTD: 29; APDD: 33.5); 10.6 tibia (L: 420; PTD: 91; APDD: 99; MTD: 46; DTD: 66; APDD: 51.5); femur (L: 415; PTD: 144; DTD: 104; APDD: 103); fragment of mandibula with P<sub>4</sub> (L: 20; B: 12.5); M<sub>1</sub> (L: 24; B: 14.5); M<sub>2</sub> (L: 27; B: 14.6).

*Castor fiber*

TP/MM 86. 1 right M<sup>2</sup>; 1 phalanx.

*Mimomys medasensis*

TP/sn/MM 1-35. 15 M<sup>1</sup>, 2 M<sup>2</sup>, 4 M<sup>3</sup>, 10 M<sub>1</sub>, 3 M<sub>2</sub>, 1 M<sub>3</sub>, 4 mandibular fragments (one complete with M<sub>1</sub>-M<sub>3</sub>, one with M<sub>1</sub>-M<sub>2</sub> and two bearing only M<sub>1</sub>).

*Prolagus* sp.

TP/sn/MM 36-72. 1 anterior portion of a skull with P<sup>2</sup>-M<sup>3</sup>; 1 fragment of palate with P<sup>3</sup>; 3 fragments of mandibles with molars; 1 fragment of incisive; 5 P<sub>2</sub>; 5 P<sub>3</sub>; 3 P<sub>3</sub> (one fragmentary); 18 fourth premolars and molars or fragments of molars.

*Oryctolagus* cf. *O. lacosti*

TP/sn/MM 73-85. 1 mandibular fragment with P<sub>3</sub>-M<sub>3</sub>; 1 fragment of incisive; 3 P<sub>3</sub>; 8 molars.

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