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CERVIDEA AND MOSCHIDAE (MAMMALIA, ARTIODACTYLA) FROM THE BACCINELLO V-3 ASSEMBLAGE (LATE MIOCENE, LATE TUROLIAN, GROSSETO, ITALY)

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Riassunto. Vengono descritti i resti di Cervoidea raccolti in varie località all'interno del bacino di Baccinello-Cinigiano (Italia centrale, Grosseto). Questi reperti provengono dall'orizzonte in cui è stata rinvenuta l'associazione nota come V3. Nella successione sedimentaria riconosciuta all'interno del bacino di Baccinello-Cinigiano sono state individuate 5 diverse associazioni faunistiche, che documentano altrettante fasi di popolamento durante il Miocene Superiore e Pliocene inferiore. La più antica, V0, è correlata all'unità a mammiferi Turoliano inferiore ("zona" MN11), mentre quelle chiamate V1 e V2, al Turoliano superiore ("zona" MN12). Queste due associazioni comprendono taxa caratterizzati da un marcato endemismo insulare che sono unici alla paleobioprovincia "Tosco-Sarda". L'associazione V3, riferita al Turoliano superiore ("zona" MN13), include taxa che mostrano affinità con quelli presenti nelle località europee e quindi testimonia lo stabilirsi di ampie connessioni di terre. I depositi miocenici sono ricoperti in discordanza da sedimenti marini del Pliocene inferiore, in cui sono stati rinvenuti rari resti di mammiferi riferiti all'unità Villafranchiano inferiore (zona MN16a).

La fauna di cervidi descritta nel presente lavoro comprende tre taxa: *Paracervulus* cf. *australis*, *Procapreolus* cf. *loczyi* e Cervidae indet. È stato inoltre identificato un nuovo rappresentante della famiglia Moschidae, *Tuscomeryx huerzeleri* (nov. gen., nov. sp.).

La presenza di *Paracervulus* evidenzia che questa associazione è di transizione tra le età a mammiferi Turoliano e Rusciniano. Il genere *Paracervulus* è infatti ben rappresentato in Europa occidentale nelle località rusciniane.

Abstract. Cervids and a moschid coming from various sites in the Baccinello-Cinigiano basin (Grosseto, Tuscany, Central Italy) are described. These remains have been recovered from levels correlatable with the horizon where the faunal assemblage known as V3 has been found. In the sedimentary succession within the Baccinello-Cinigiano basin, five successive faunal associations have been recognised. These assemblages document phases of population spanning the Late Miocene-Early Pliocene. The oldest assemblage, termed V0, is correlated with the MN11 "zone" (early Turolian), V1 and V2 assemblages with the MN12 "zone" (late Turolian), and V3 with the MN13 "zone" (late Turolian). Sediments bearing V3 assemblage are unconformably overlain by Lower Pliocene deposits containing remains of mammals referred to the early Villafranchian MN16a "zone".

The cervid material studied here is referred to three taxa, *Paracervulus* cf. *australis*, *Procapreolus* cf. *loczyi*, Cervidae indet., and to a new representative of the family Moschidae *Tuscomeryx huerzeleri* (nov. gen., nov. sp.). Because of the occurrence of genus *Paracervulus*, the assemblage can be referred to a phase transitional between the Turolian and Ruscinian Mammal Ages of the biochronological continental scale.

Introduction.

Mammal remains recovered from the Late Miocene deposits of the Baccinello-Cinigiano fluviolacustrine basin (Fig. 1) have been studied since the last century (Meneghini 1863; Major 1873; Weithofer 1888). Four faunal assemblages, labeled V0, V1, V2 and V3, indicating succeeding population phases were recognised in the stratigraphic sequence of this basin (Lorenz 1968; Hürzeler & Engesser 1976; Engesser 1989; Rook et al. 1996) (Fig. 2). The oldest assemblage, V0, is attributed to the early Turolian (MN11 zone, according to Mein 1990), while assemblages V1 and V2 are attributed to the late Turolian (MN12 zone) and are separated from each other by about 2 Ma (Rook et al. 1996). Fossils from the latter assemblages show marked endemic features. Besides the hominoid *Oreopithecus bambolii* (Hürzeler 1958, 1960; Harrison 1987, 1991; Rook 1993; Rook et al. 1996, Rook et al. 1999a), bovids belonging to the genera *Maremmia* and *Tyrrenotragus* have been documented (Hürzeler 1983; Thomas 1984). Faunal assemblages V1 and V2 are found only in the Tusco-Sardinian paleobioprovince (Rook et al. 1999b).

In contrast, faunal assemblage V3 shows affinities with European mainland faunas indicating that during this time interval, wide land connections with neighbouring paleobioprovinces were established. Assemblage V3 is correlated with the late Turolian MN13 zone; nevertheless, the occurrence of the hamster *Celadensia grossetana* (Rook & Torre 1995), *Tapirus* cf. *arvernensis*, and *Dicerorhinus* cf. *megarhinus* (Rook & Rustioni 1991;

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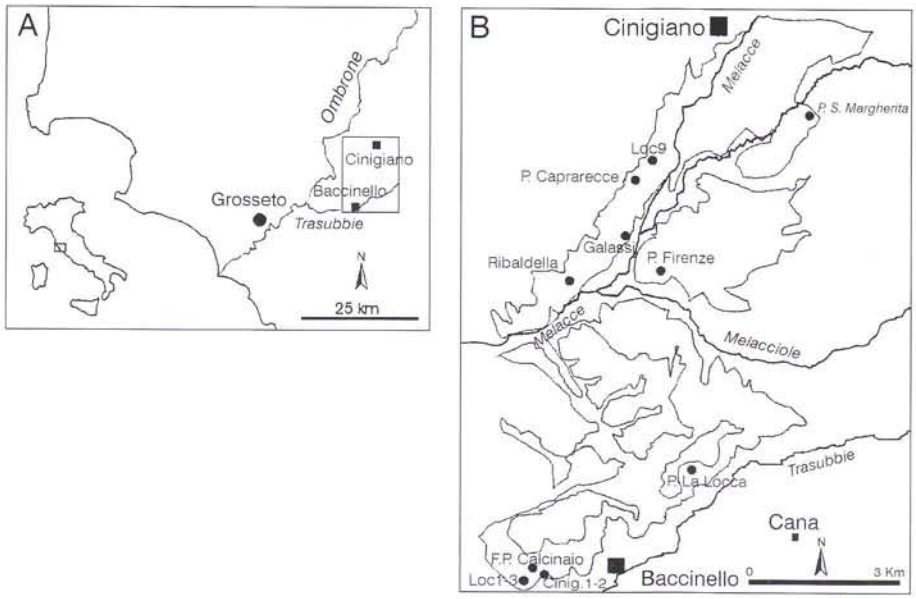


Fig. 1 - (A) Location map of Baccinello-Cinigiano basin, from Rook (1993), modified. (B) Extension of deposits bearing fossil remains of V3 assemblage and location of fossiliferous sites. From Benvenuti et al. (1997), modified.

Benvenuti et al. 1994; Rook et al. 1996), suggests that this assemblage is very close, or even transitional, to the Ruscinian Mammal Age. The fossil remains belonging to assemblage V3 come from various outcrops (Fig. 1), which may not be strictly coeval. Therefore, taxa included in this assemblage might belong to different local faunas which, on the basis of the sedimentation rate of the deposits containing assemblage V3, seem to be distributed over a time interval of about 0.5 Ma (Benvenuti et al., in press).

The sequence of the basin is unconformably overlain by marine deposits of Early Pliocene age (*Spaeroidinellopsis* zone, Bossio et al. 1991). In the surroundings of the Arcille village (10 km West of Baccinello), these sediments yielded an assemblage attributed to the early Villafranchian (MN16a zone), based on the occurrence of the arvicolid *Mimomys hajnackensis* (Masini & Torre 1990).

Systematic Palaeontology

Foreword.

The systematics of Miocene cervids is a complicated issue. The large number of taxa described in the literature reflects the great diversification of deer at this time. However, one cannot ignore that this large number of taxa may also be due to the arbitrary opinion of different authors (see for example Azanza, 1995; Azanza & Montoya, 1995).

The present report is not meant to be the final word on the systematics of the Baccinello-Cinigiano deers, but rather a first description designed to assign the specimens within an established classification.

The cervid remains from faunal assemblage V3 were never the object of detailed studies and were attributed until now to Cervidae indet. I and II in the literature (Hürzeler & Engesser 1976). More recently, Rook (1992) reported the occurrence of *?Procapreolus*.

Those specimens are attributed here to *Paracervulus* cf. *australis*, *Procapreolus* cf. *loczyi*, and Cervidae indet. The study has proved also the occurrence of Moschidae nov. gen., n. sp.

Biometric analysis on the fossil remains identifies two size groups (Fig. 3) in which the moschid and *Paracervulus/Procapreolus* fall respectively.

Repository. IGF indicates specimens stored in the Geo-Paleontological section of the Natural History Museum of the University of Florence, while other labels identify specimens stored in the Natural History Museum of Basel, unless otherwise indicated in the text.

Specimen	MDb	mdb	MDab	Mdab	hb	MDa	mda	MDp	Mdp	hb/MDab
IGF 7744v	34.20*	27.70*	36.30	27.30	108.30	32.60	21.50	30.00	19.50	2.98
IGF 7747v	0.00	0.00	0.00	0.00	0.00	26.60	15.00	-	-	-
IGF 7779v	25.6	21.6	18.40	16.30	50.0	17.90	10.90	18.80	11.5	-

Tab. 1 - Measurements of antlers of *Paracervulus* cf. *australis*. Legend: MDb= maximum diameter burr; mdb=minimum diameter burr; MDab=maximum diameter of the beam above the burr; mdab=minimum diameter of the beam above the burr; hb= height of bifurcation; MDa= maximum diameter anterior branch; mda=minimum diameter anterior branch; MDp= maximum diameter posterior branch; mdp= minimum diameter posterior branch; hb/MDab= height of bifurcation/maximum diameter of the beam above the burr* 100. * Underestimated measurements since the perlature of burr is missing.

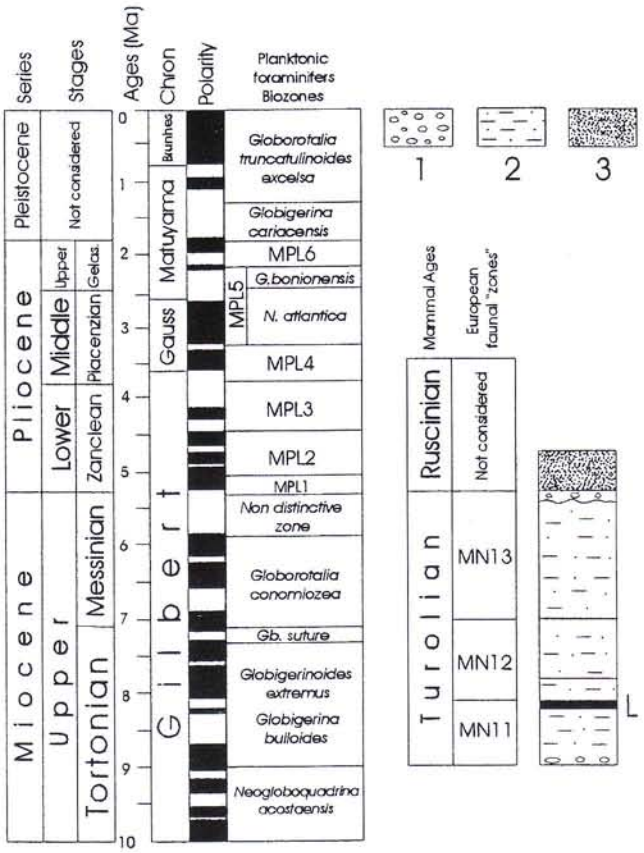


Fig. 2 - Stratigraphic succession and faunal assemblages in the Baccinello-Cinigiano basin respect to Chronostratigraphy, Biostratigraphy and European mammal Biocronology. From Benvenuti et al., (1999), modified. Legend: 1) deposits of alluvial fan; 2) fluvio-lacustrine deposits with lignites (L); 3) marine deposits of shelf.

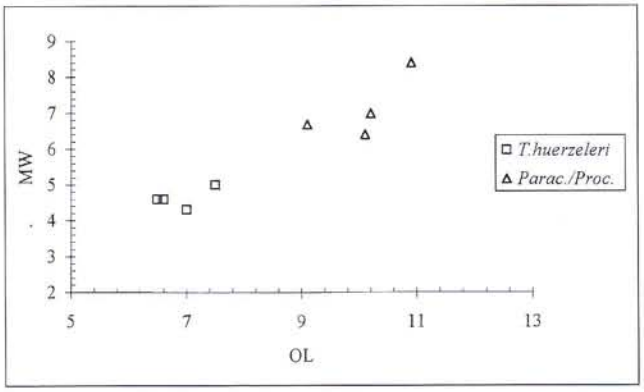


Fig. 3 - Scatter diagram of occlusal length (OL) against maximal width (MW) of fourth lower premolars of the Cervoidea recovered in the sites of Baccinello-Cinigiano Basin.

Family Cervidae Gray, 1821

Subfamily Muntiacinae Pocock, 1923

Genus *Paracervulus* Teilhard and Trassaert, 1937

Paracervulus cf. **australis** de Serres, 1832

(Plate 1; Figs. 1-3)

1	2	3	4
43	19.5	15.7	30.5

Tab. 2 - Measurements of occiput JH 117 of *Paracervulus* cf. *australis*. Legend: 1= maximum width of condyles; 2= high of foramen magnum; 3= diameter foramen magnum; 4: height of the occiput measured from its upper part to the upper border of foramen magnum.

Material. *Antlers*: IGF 7744v fragment of right shed antler, IGF 7745v, IGF 7746v fragments of basal beams, IGF 7743v distal fragment of antler, IGF 7779v fragment of left shed antler, IGF 7747v fragment of antler including the first bifurcation, IGF 7750v, IGF 7759v, IGF 7760v some not very significative fragments of beams and branches; Cing.4 fragment of left antler belonging to a juvenile specimen *Skull*: J.H.117 occiput; *Dentitions*: IGF 7743v left M1\ and M2\, Cinig.16 left M/3; Cinig.16 right M/3; *Skeleton bones*: IGF 7743v right astragalus, distal epiphyses of left radius, I phalange, proximal fragment of I phalange, distal fragment of I phalange, distal fragment of II phalange, distal fragment of II phalange, proximal fragment of II phalange, III phalange missing the tip; proximal fragment of III phalange, proximal fragment of III phalange, large and small sesamoid.

Localities (Fig. 1): Podere S. Margherita, Cinig.4 (about 0.5 km south of Ribaldella), Cinig.16 (close to Ribaldella), remains with IGF label come from unregistered sites in the surroundings of Ribaldella and Podere Firenze sites.

Description.

Antlers (Plate 1, Figs. 1, 2, 3; Tab. 1) - The beam is latero-medially flattened, with a concavity in the lateral side (Fig. 4A). In frontal view it is slightly lyre shaped. On the surface, ridges and grooves are well developed. The bifurcation is set far from the burr, and the branches, which are approximately of the same size, form an acute angle, ranging from 45° to 70°. The anterior branch tends to curve towards the inner side, its cross section is triangular at the base (Fig. 4A); the posterior branch has a quadrangular cross section. Above the bifurcation, the posterior branch is oriented slightly backwards.

The remain IGF 7743v (Plate 1, Fig. 2) is interpreted as a posterior branch of a right antler that has not yet reached its definitive morphology, as suggested by the incipient anterior ramification which occurs in a second small fragment belonging to the left antler of the same individual. The remain is a spike curved towards the inner side. The cross section of the beam is triangular because of the occurrence of a ridge extended posteriorly over the whole length of the specimen. This same morphology occurs in another remain, stored in the Natural History Museum of Basel (from Cinigiano, label Cinig. 4). In this antler the ridge occurs only in the basal part; its straight length is 170 mm.

A basal fragment of shed antler belonging to a very young individual is tentatively referred to this species (Plate 1, Fig. 3). The burr is oval in cross section;

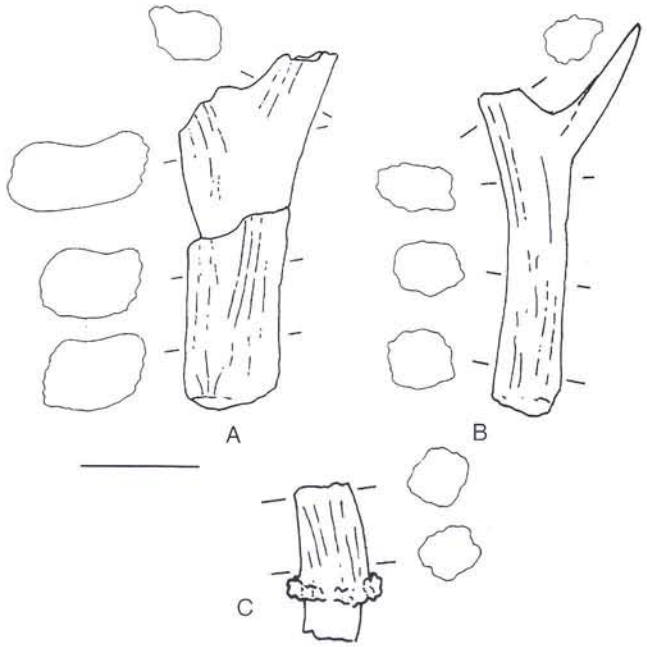


Fig. 4 - Antler of *Paracervulus* cf. *australis* A) IGF 7744v, and of *Procapreolus* cf. *loczyi* B) Cinig. 7, C) IGF7753v. Scale is 4 cm.

the beam is flattened at the bifurcation; the anterior branch is triangular at the base. Above the bifurcation, the posterior branch bends medially and is oriented backwards.

Skull (Tab. 2) - The occiput is low and wide and has a rectilinear upper profile as in the recent Muntiacine. This morphology is distinct respect to Capreolinae, both fossil (Czyzewska 1968) and Recent, in which the occiput is high. Measurements of this remain are reported in Tab 2.

Upper dentitions (Fig. 5; Tab. 3) - The description of the dentition morphology is limited to the upper molars found associated to antler IGF 7743v (Fig. 5). The degree of wear of these teeth suggests a young-adult individual. On M1/ the posterior ala of protocone is missing, while the anterior ala of hypocone is present, but it is weak. The cingulum is feebly developed on the hypocone. On M2/ alae occur in both the protocone and hypocone. The labial wall has poorly developed styles.

Lower dentitions (Fig. 6; Tab. 3) - On the basis of the considerations made on the upper molars, i.e. small size, poorly developed cingulum etc, two M/3 could belong to this taxon (Fig. 6). In these teeth ectostylids occur, and a weak Paleomeryx fold is visible.

Postcranial bones (Tabs. 4, 5) - Only the remains IGF 7743v are reliably referable to this taxon. The astragalus shows a very strong medial lip in the proximal trochlea which extends plantarly; this feature is suggestive of a deep trough in the distal articulation of the tibia, a typical trait of cursorial rear limbs. The distal fragment of radius has the following measurements. TD= 32.3 mm; APD=22.4 mm.

Comparisons.

In the antlers the bifurcation of the beam in two equivalent branches, though of different length, is typical feature of extinct Muntiacinae (Azanza 1989). In the cross section of the basal beam, the angle and height of the bifurcation and in the size, the specimens studied recall *Paracervulus* representatives from French Ruscinian localities, especially *P. australis* from Montpellier (cf. Dong 1990). A morphological character of *Paracervulus* antlers is the occurrence of a ridge on the posterior, and sometimes also in the anterior face of the beam, (see also Vislobokova 1983). This feature, which is present only on IGF 7743v is variable, however, in the remains from Montpellier (Dong 1990; personal observations on material stored in the Natural History Museum of Basel). IGF 7743v recalls the posterior branch of the antlers of *Paracervulus*, which is characterised by only one bifurcation (see neotype in Dong 1990; Vislobokova 1990).

Paracervulus dispersed in the Asiatic regions at the end of the Miocene with various species: *P. bidens*, *P. brevis*, *P. simplex*, *P. attenuatus* (Dong 1993; Vislobokova 1990; Dong & Changkang 1994). In Europe it characterises the Ruscinian faunal assemblages (see also Vislobokova 1992) and is well documented with different species in the French localities of Roussillon (Deperet 1890), Montpellier and Perpignan. As a matter of fact the most detailed descriptions were made on the populations from these localities (Dong 1990, 1996).

The occurrence of *Paracervulus* in the V3 assemblage dates its dispersal to Europe to the latest Miocene.

Specimen	ol	nl	Mw	h
IGF7743v M1/	12.0	11.3	*13	4.8
M2/	*13	12.2	-	*6
Cinig.16 M/3	17.3	18.1	8.9	7.0
Cinig.16 M/3	17.3	17.7	9.4	4.0

Tab. 3 - Measurements of teeth of *Paracervulus* cf. *australis*. * Estimated measurement. Legend: ol= occlusal length; nl= neck length; mw= maximal width; h= height.

1a	1b	1c	2a	2b	3a	3b
32.8	30.4	26.3	17.4	19.3	19.6	20

Tab. 4 - Measurements of astragalus IGF 7743v of *Paracervulus* cf. *australis*. Legend: 1a=Maximum lateral length; 1b= Maximum medial length; 1c=Minimum length; 2a=Lateral depth; 2b=Medial depth; 3a=Widht of proximal trochlea; 3b=Width of distal trochlea.

Subfamily Odocoleinae Pocock, 1923

Genus *Procapreolus* Schlosser, 1924

Procapreolus cf. **lóczyi** Pohlig, 1911

(Plate 1, Figs. 4-6)

Material. *Antlers*: IGF 7753v basal fragment of antler connected to the pedicle; IGF 7792v fragment of right shed antler broken above the bifurcation; IGF 7748v, IGF 7760v, IGF 7761v fragments belonging to one fragment of left antler corresponding to the first bifurcation; 3.10.85 fragment of right forehead with pedicle; Fosso del Pian Calcinaio Bac. 1222 fragment of left shed antler broken above the bifurcation; Fosso del Pian Calcinaio Bac. 1220 left shed antler broken above the bifurcation; Cinig. 7 right shed antler broken above the bifurcation; Cinig. 7 basal fragment of shed antler; Cinig. 7 basal fragment of antler connected with the pedicle; Cinig. 9 Fragment of antler broken at the bifurcation; 10.10.87 right shed antler broken at the bifurcation. *Dentitions*: IGF 7810v left M3/, IGF 7810v right M2/, Fosso del Pian Calcinaio JH118 right M/3-P/2, *Skull*: Fosso del Pian Calcinaio 3.10.85 right pedicle connected with the forehead.

Localities (Fig. 1): Ribaldella, Podere Caprarecce, Fosso del Pian Calcinaio, Cana 73 (unregistered locality North-West to Cana small village), Cinig. 7 (about 1.2 km north-east from Ribaldella), Cinig. 9 (about 1 km north-east from Podere Caprarecce).

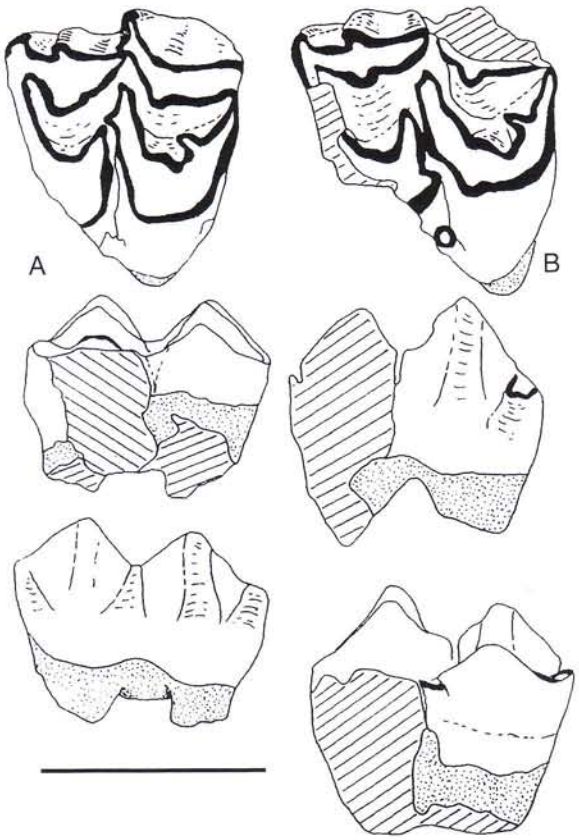


Fig. 5 - *Paracervulus* cf. *australis* IGF 7743v A) left M1\ and B) left M2\; occlusal, lingual and labial views. Scale is 1 cm.

Description.

Antlers (Tab. 6; Plate 1, Figs. 4,5) - The cross section of the antlers is square shaped at the base and is flattened in lateral-medial direction near the bifurcation where a slight concavity occurs on the lateral side. The first tine is set 68 mm to 105.2 mm far from the burr. The angle of bifurcation is about 80°. The burr is robust. The first tine is short (straight length=51-68 mm) and oriented innerwards. The beam is slightly lyre shaped: it bends towards the outer side above the first bifurcation, and then upwards; it is also inclined backwards. In some specimens a ridge occurs dorsally, approximately stretching from the bifurcation all along the remaining length of the antler. This ridge gives a triangular shape to the cross section of the beam. At this height the beam has an anti-clockwise torsion and is flattened. All the remains described here have ridges and furrows on their surfaces.

Skull (Plate 1, Fig. 6) - The pedicle 3.10.85 has the following measurements, taken at its base: TDb=25.5; APDb=20; H=32.5. In its distal part it tends to become flattened in the lateral-medial direction: TDd=23.3; APDd=24.5. The pedicle is inserted laterally on the skull and is slightly divergent relative to the sagittal suture. A ridge runs from the base of the pedicle down to the border of the orbit. A similar ridge has been also observed in some specimens referred to *Procapreolus* (Pohlig 1911; Schlosser 1924; Zdansky 1925; Korotkevich 1970).

Some dentitions in the Geo-Paleontological section of the Natural History Museum of Florence and in the Museum of Basel differ morphologically from those of *Paracervulus* cf. *australis* and recall those of *Procapreolus* (see for instance *P. ukrainicus* in Korotkevich 1970; *P. cusanus* in Heintz 1970). Therefore, they are here referred to *Procapreolus* cf. *lóczyi*.

Specimens	1a	1b	2	3	4	5	6	7
I phalange	37.5	34.2	16.9	12.7	8.6	9.4	9.9	10.6
I phalange	-	-	16.9	12.6	-	-	-	-
II phalange	-	-	16.7	11.5	-	-	-	-
II phalange	-	-	-	-	-	-	12.2	8.7
III phalange	-	-	13.5	8.3	-	-	-	-
III phalange	-	-	13.3	8.4	-	-	-	-
III phalange	-	-	13.6	8.6	-	-	-	-

Tab. 5 - Measurements of phalanges IGF 7743v of *Paracervulus* cf. *australis*. Legend: 1a= Maximum length; 1b= Dorsal length; 2= Depth of proximal articulation; 3= Width of proximal articulation; 4= Minimum depth of diaphyses; 5= Minimum width of diaphyses; 6= Depth of distal articulation; 7= Width of distal articulation.

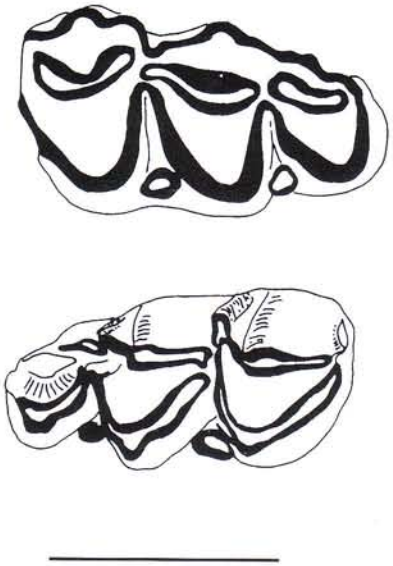


Fig. 6 - *Paracervulus* cf. *australis* Cinig. 16 left and right M/3s, occlusal views. Scale is 1 cm.

Upper Dentitions (Tab. 7, Fig. 7) - In the labial wall of upper molars the styles are strong. The cingulum occurs lingually and labially. The teeth are more brachyodont than those referred to *Paracervulus*. In the molars the posterior ala of protocone and the anterior ala of hypocone are present (Fig. 7).

Lower Dentitions (Tab. 7, Fig. 7) - The description of lower dentitions is limited to the mandible JH118. It is significantly larger than the other remains (Fig. 8). In all the molars occurs the Paleomeryx fold, it is progressively larger from M/1 to M/3. The inner wall is swollen; the ectostylids are present. On the labial wall a feeble cingulum occurs. P/4 is molarised with the metaconid fused to the paraconid; between hypoconid and protoconid a deep labial groove occurs (Fig. 7). All the premolars have a well developed anterior-lingual stylid (parastylid).

Comparisons

The antlers of *Procapreolus* cf. *lóczyi* differ from those referred to *Paracervulus* cf. *australis* in the less compressed proximal segment of the beam, the more backward inclined beam above the bifurcation, and the different cross section of both beam and first tine (Fig. 4). The first bifurcation gives rise to a true tine.

The Baccinello-Cinigiano antlers referred to *Procapreolus* have been compared with those belonging to other Late Miocene European Cervinae. *P.* cf. *lóczyi* differs from *Croizetoceros pyrenaicus*, from the Late Turolian of Spain (Azanza 1989; Azanza et al. 1989) and the Ruscinian of France (Dong 1996), for the lack of curvature, with an anterior concavity, in the proximal segment of the beam. *P.* cf. *lóczyi* also differs from *Pliocervus*, another well documented late Turolian representative, in the cross section and orientation of beams, *Pliocervus* having almost circular beams in cross section, and antlers with a strong sigmoidal bending in frontal view (Symeonidis 1973; Azanza 1995).

The rhombic cross section of the beam close to the first tine, and its torsion in the distal part, features observed in the two more complete specimens kept in Basel (Plate 1, Figs. 4,5) are characteristic of *P. lóczyi* (Pohlig 1911). In the material of *P.* cf. *lóczyi* the beam is flattened distally, suggesting the occurrence of the second bifurcation.

The bifurcation index (=height of first bifurcation/maximum diameter of beam above the burr) measured on the most complete specimens ranges from 3.06 to 3.93 (Tab. 7); these values are comparable with that (3.91) of the type of the species (Vislobokova et al. 1995).

The measures of the pedicle 3.10.85 have been compared with those of other Turolian deer (*Croizetoceros*, *Pliocervus*, Fig. 8). There is a fairly good correspondence of the values, but in *P.* cf. *lóczyi* the distal part of pedicle, close to the burr, is more flattened lateromedially (Fig. 8A,B).

Taxa	MDb	mdb	MDab	Mdab	hb	MDt	Mdt	1tl	hb/Mdab
Cinig.7	25.10	22.60	25.30	20.70	99.50	-20.00	10.00	51	3.93
Cinig. 7	24.00	23.80	24.80	18.00	0.00	0.00	0.00	-	-
Cinig. 7	27.30	23.40	24.50	17.60	0.00	0.00	0.00	-	-
IGF 7753v	35.80	*32.00	22.50	20.00	0.00	0.00	0.00	-	-
Bac. 1220	31.00	27.20	28.40	22.70	87.00	18.70	14.60	68	3.06
Bac. 1222	29.90	25.60	19.90	18.00	73.00	0.00	12.00	-	3.66
IGF 7748v	0.00	0.00	0.00	0.00	0.00	19.70	14.60	-	-
10.10.87	31.80	29.80	0.00	0.00	0.00	0.00	0.00	-	-

Tab. 6 - Measurements of antlers of *Procapreolus* cf. *lóczyi*. Legend: MDb= Maximum diameter of burr; mdb=Minimum diameter of burr; MDab= Maximum diameter of the beam above the burr; mdab= Minimum diameter of beam above the burr; hb= height of bifurcation; MDt= maximum diameter 1° tine; mdt= Minimum diameter 1° tine; 1tl= length of first tine; hb/Mdab= height of bifurcation/maximum diameter of the beam above the burr* 100. * Estimated measurement.

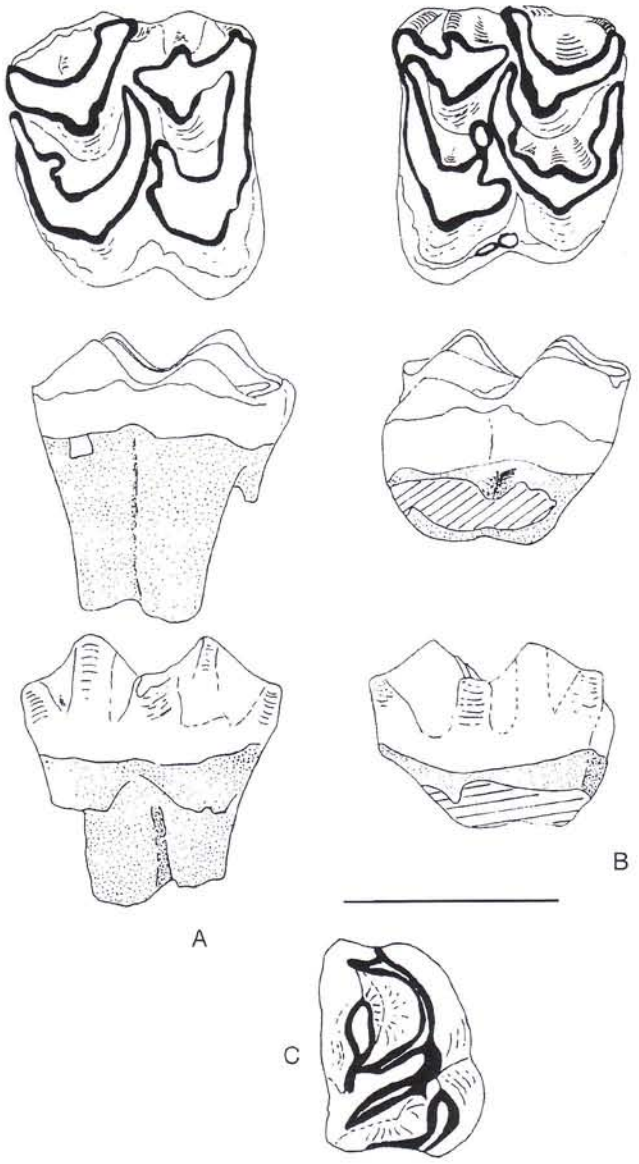


Fig. 7 - *Procapreolus* cf. *loczyi* IGF 7810v A) right M2/ and B) left M3\; occlusal, lingual and labial views. C) right fourth lower premolar belonging to the series JH118. Scale is 1 cm.

The size of the dentitions agrees with that of *P. ukrainikus*, *P. flerovi* and *P. cusanus* (Vislobokova et al. 1995); the premolar and molar ratio is also comparable (Tab. 8).

P. lóczyi is reported in Hungary (type area), and in Croatia from deposits referred to the Upper Miocene (stage Pontian, Dimitrijevic & Knezevic 1986). Its occurrence in the Baccinello-Cinigiano basin is consistent with the presence of Turolian taxa.

Specimens	ol	nl	mw	h
IGF 7810v M2\	13.7	12.9	15.3	5.5
IGF 7810v M3\	12.8	12.3	15.3	5.6
Cinig.16 M3\	13.6	13.4	15.4	6.0
Cinig.16 M1\	12.0	10.6	12.0	4.7
JH118 M/3-P/2	73.6	77.2		
M/3-M/1	45.2	47.2		
P/4-P/2	30.6	31.0		
M/3	18.4	19.1	11.4	9.5
M/2	13.8	13.1	10.6	8.4
M/1	13.0	12.6	9.9	6.1
P/4	10.9	10.7	8.4	11.1
P/3	10.6	10.6	7.7	9.4
P/2	8.1	7.6	5.5	5.6

Tab. 7 - Measurements of teeth of *Procapreolus* cf. *lóczyi*. Legend: ol= occlusal length; nl= neck length; mw= maximal width; h= height.

The genus *Procapreolus* is poorly documented in Italy. Sarti et al., (1998) described *Procapreolus* sp. from Messinian sediments in the surroundings of Pisa (Central Italy). Some fragmented remains referred to *P. cusanus* come from Middle Pliocene deposits of the Aulla-Olivola Basin (Central Italy, Abbazzi et al. 1995) and of Villafranca D'Asti in Northern Italy (Azzaroli 1977). The most recent occurrence of this genus in Italy is documented in sediments of Late Pliocene age (Middle Villafranchian) of Central Italy (Cava Toppetti site, Abbazzi et al. 1997).

Undeterminate material belonging to small sized taxon/a.

This group includes remains of antlers, skulls, dentitions and postcranial bones which can not be referred with certainty to *Paracervulus* or *Procapreolus*. By taking into account this material, the possible occurrence of other taxa of size similar to that of Paracervulus and *Procapreolus*, can not be ruled out. This supposition is suggested also by the wide dispersal of the points in the scatter diagram of Fig. 9.

Material. *Antlers*: IGF 7751v, IGF7754v, IGF 7755v, IGF 7756, IGF 7758v and from IGF 7761v to IGF 7778v small fragments of beam and tines. *Skull*: IGF 7752v left pedicle, IGF 7749 right pedicle. *Dentitions*: Cana 73 left M3/-P3/; Cinig.16 left M3/; Loc53 left M3/; Loc2 left M2/; Loc1-3 left M2/;13.8.73 left M1/; Cinig.16 right M1/; Loc1-3 left M1/; Loc1-3 r ight P4/; Loc53 left P4/; Loc53 left P4/; 1.10.93 right M/3-P/2; Cinig.16 left M/3-M/1; 4.10.84 left M/3-M/2; 3.10.93

P. cf. *lóczyi* Baccinello	*P. ukrainikus*[1]	*P. flerovi*[1]	*P. latifrons*[1]	*P. wenzensis*[1]	*P. cusanus*[2]	*P. moldavicus*[3]
67.69	65.4	65.5	66.0	63.0-74.3	65.0-72.8	67.24

Tab. 8 - Comparison of the P/M*100 ratio among various species of *Procapreolus* from Eurasiatic localities. From (1)Vislobokova et al., 1995; (2)Heintz, 1970; (3)original data from a specimen of Ruscinian *Procaproelus moldavicus* (n 59\3) stored in the Paleontological Institute of Kishinau, Moldavia (see also Croitor 1999).

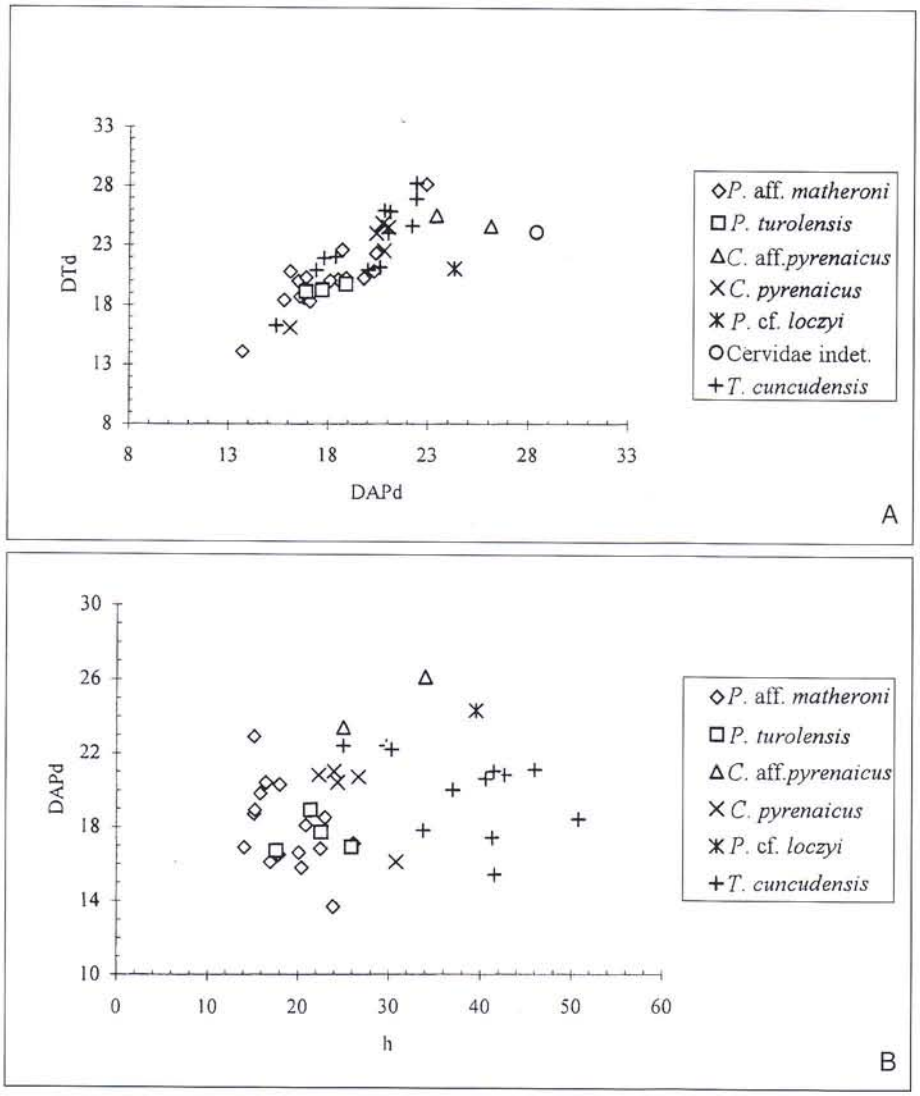


Fig. 8 - Scatter diagram of A) DTd (=transversal diameter of pedicle close to the burr) against DAPd (=antero-posterior diameter of pedicle close to the burr) and B) DAPd against h (=height) of pedicles. Data of *Pliocervus* aff. *matheroni*, *P. turolensis*, *Croizetoceros* aff. *pyrenaicus*, *C. pyrenaicus* and *Turiacemas cuncudensis* are from Azanza (1989).

left M/2-M/1; Cinig.4 left M/2-M/1; 3.10.93 right P/4-P/2; Cinig.4 right P/4; Cinig.16 right P/3. *Skeleton bones*: loc53 I and II phalanges belonging to the same individual, loc2 proximal fragment of right metacarpus, 1.8.73 distal fragment of tibia, Galassi astragalus, corpus calcanei and distal fragment of tibia belonging to the same individual, MC 1974 right and left astragalus, Scansano distal fragment of left tibia, IGF 7782v fragment of left metatarsus, IGF 7793v distal articulation of left tibia, left cubonavicular, proximal fragment of I and II phalange, IGF 7809v left cubonavicular, IGF 7781v left astragalus, IGF 7791v diaphyses of left metatarsus, IGF7806v II phalanges, IGF7807v II phalanges, IGF7896 II phalanges, IGF7804v II phalanges, IGF7794v I phalanges, IGF 7799v-7803v distal epiphyses of metatarsus, IGF 7801v distal fragment of metatarsus, IGF7798v distal fragment of metatarsus, IGF 7795v distal fragment of metatarsus, IGF 7800v distal fragment of metatarsus, IGF 7797v distal fragment of metacarpus.

Localities (Fig. 1): Cinig. 4 (about 0,5 km south of Ribaldella), Cinig. 16 (close to Ribaldella), Cana 73 (unregistered locality northwest to Cana small village), Galassi, Loc1-3, Loc53 (=Fosso del Pian Calcinaio), remains with IGF label come from unregistered localities in the surroundings of Ribaldella and Podere Firenze.

Description and comparisons

Antlers - The fragmentary state of the antlers prevents the recognition of diagnostic morphological features.

Dentitions (Tab. 9) - The Paleomeryx fold occurs in all the lower molars. According to Schlosser (1924) this character is a constantly observed feature in *P. lóczyi* while it is variable in other species of *Procapreolus*. For instance

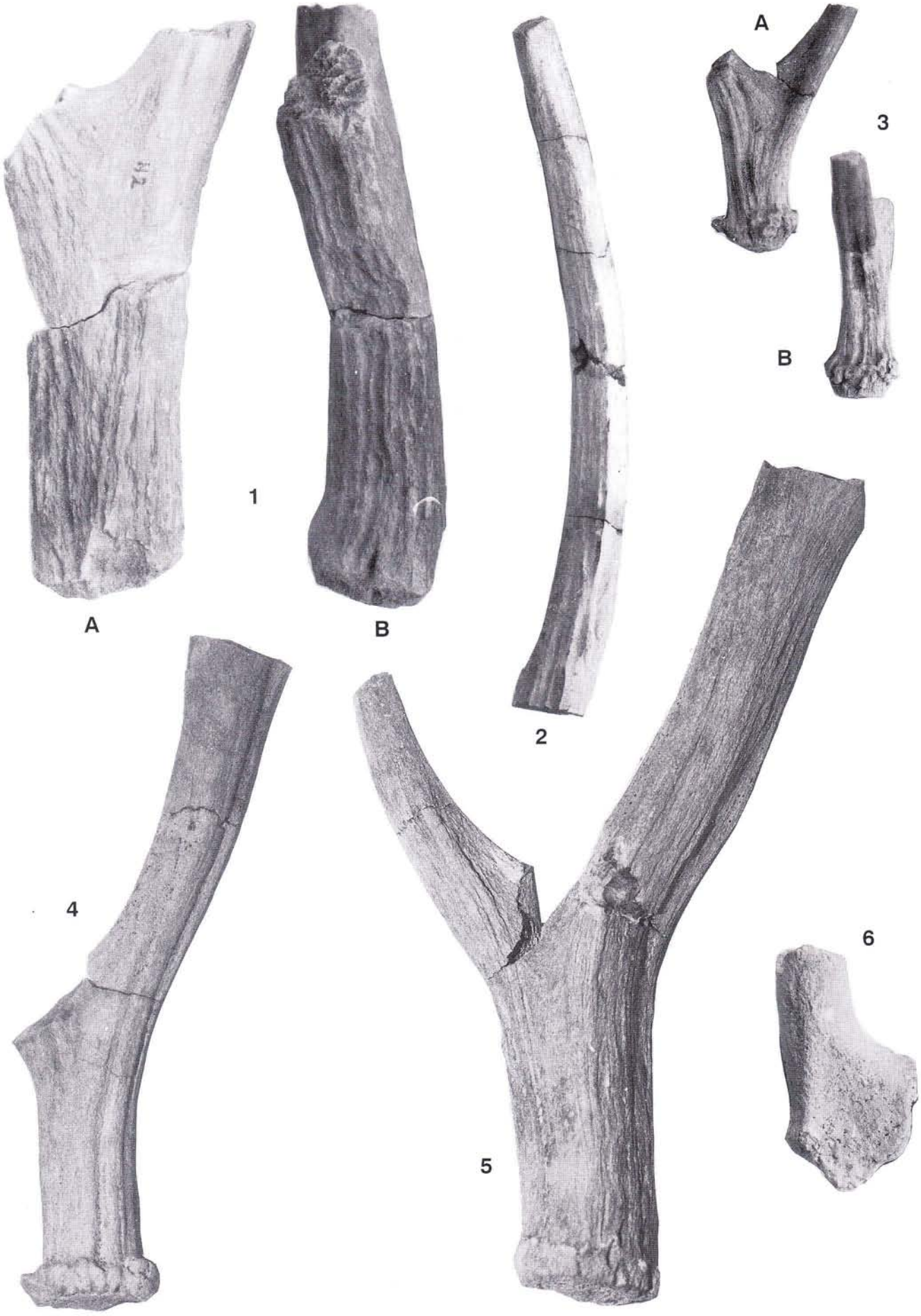
PLATE 1

Paracervulus cf. *australis*

Fig. 1 - IGF 7744v right shed antler A) internal view and B) frontal view; Fig. 2 - IGF 7743v fragment of posterior branch of right antler; Fig. 3 - IGF 7779v left shed antler A) internal view; B) frontal view. Figs. 1 and 2 are ½ of natural size; Fig. 3 is 2/3 of natural size.

Procapreolus cf. *loczyi*

Fig. 4 - Bac. 1222 left shed antler, lateral view; Fig. 5 - Bac. 1222 left shed antler, lateral view; Fig. 6 - 3.10.85 right pedicle connected to forehead. Figs. 4 and 5 9/10 of natural size; Fig. 2/3 natural size.


A
B
1
2
A
B
3
4
5
6

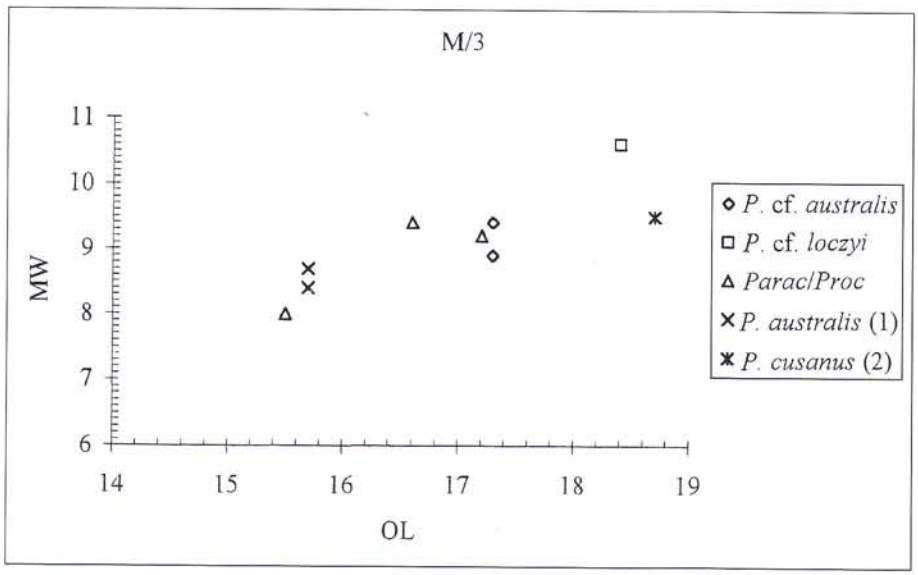


Fig. 9 - Scatter diagram of occlusal length (OL) against maximal width (MW) of M/3. (1) Data of *Paracervulus australis* are on specimens from Montpellier and Roussillon stored in the Natural History Museum of Basel; (2) Original data of *Procapreolus cusanus* (according to Croitor 1999) on the specimen n 59\3 from Lucesti stored in the Paleontological Institute of Kishinau, Moldova; Triangle close to French *P. australis* represent values of the M/3 belonging to tooth row 1.10.93.

Specimens	ol	nl	mw	h	Specimens	ol	nl	mw	h
13.8.73 M1/	12.7	11.5	15.8	5.7	3.10.93 M/2(1)	12.9	11.7	8.6	6.4
Loc53 M3/	15.0	14.3	16.3	6.5	M/1	11.3	11.2	7.9	5.5
Loc53 P4/	11.2	11.1	14.5	8.5	P/4	10.1	9.6	6.4	7.6
Loc53 P4/	9.8	9.5	12.1	9	P/3	9.9	9.0	6.1	8.2
Loc1-3 P4/	9.5	9.6	12.5	9.1	P/2	7.7	8.0	4.8	5.0
Loc1-3 M1/	13.3	13.0	16.3	5.3	4.10.84 M/3	16.6	17.7	9.4	5.4
Loc2 M2/	16.6	16.0	17.1	7.0	M/2	-	-	-	5.1
Loc1-3 M2/	15.1	14.4	17.0	5.3	Cinig.4 M/2	*14.0	12.4	10.0	5.6
Cinig.16 M/3	17.2	17.7	9.20	3.3	M/1	12.1	10.5	8.7	5.0
M/2	12.6	12.7	9.60	3.3	La Cana 73 M3\-M1\	41.1	39.9		
M/1	10.7	10.9	8.5	3.1	M3/	14.1	14.2	16.9	6.0
1.10.93 M/3-P/2	66.3	70.9			M2/	15.3	15.0	17.8	-
M/3-M/1	39.7	42.5			M1/	14.4	13.2	17.4	5.0
P/4-P/2	26.9	27.9			P4/	10.3	10.0	13.2	8.5
M/3	15.5	17.0	8.0	6.5	P3/	11.7	10.6	14.2	7.2
M/2	10.8	*11	8.7	5.0	Cinig.4 P/4	10.2.	9.7	7.0	5.2
M/1	11.0	10.2	7.0	4.4	Cinig.16 P/3	9.6	10.0	6.6	7.0
P/4	9.1	8.5	6.7	7.9					
P/3	9.2	8.0	4.8	6.7					
P/2	7.3	7.8	5.0	5.1					

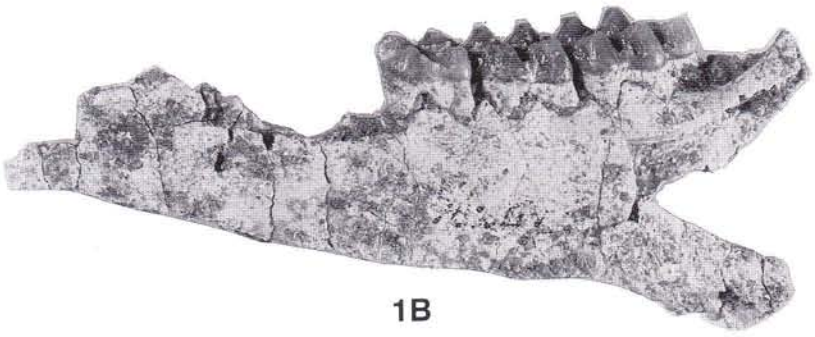
Tab. 9 - Measurements of teeth belonging to undeterminate small size taxa. (1) Series not in the mandible; * estimated measurement. Legend: ol= occlusal length; nl= neck length; mw= maximal width; h= height. r= right; l=left.

PLATE 2

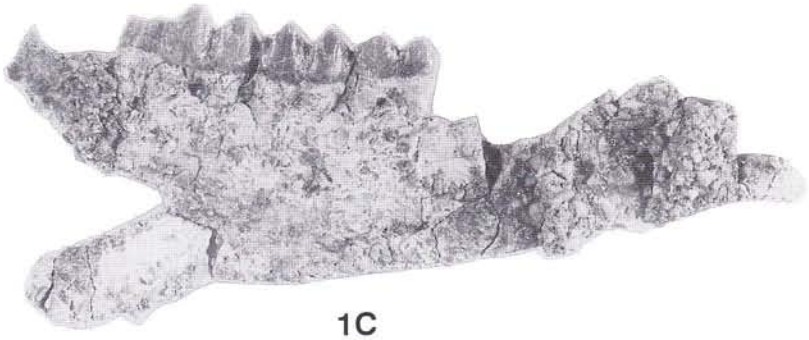
Tuscomeryx huerzeleri

Fig. 1 - IGF 7826v holotype left mandible A) occlusal, B) labial and C) lingual views; Fig. 2 - IGF 7827v left mandible A) occlusal, B) labial, C) lingual views; Fig. 3 - Bac. 1049 Upper sabre-like canine. Figs. 1A and 2A,B,C are about 3 of natural size; Figs 1B,C and Fig. 3 are 2 of natural size.

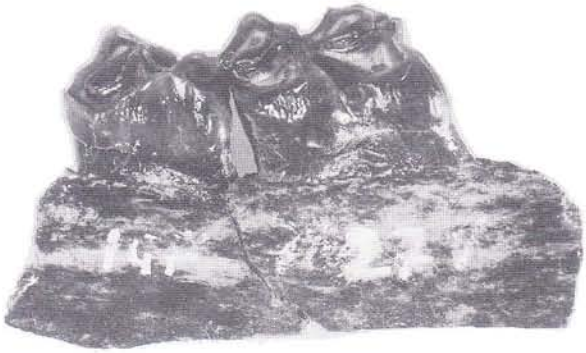
1A



1B



1C



2B

2A

3

2C

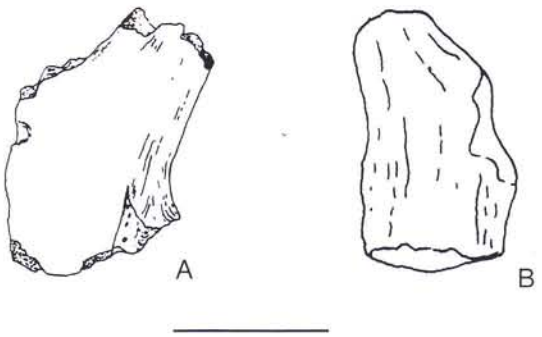


Fig. 10 - Cervidae indet. of middle size (A) IGF 7790v left pedicle and forehead (B) Bac. 1227 fragment of left shed antler. Scale is 4 cm.

it is poorly developed in *P. wenzensis* from Wezel (cf. *Czyzewska* 1960) and it is missing altogether in *P. cusanus* from western European localities (Heintz 1970). However, the Paleomeryx fold also occurs in *Paracervulus* (Azanza 1989, Dong 1990) suggesting that this character is not conclusive in separating these genera.

The P/4s show a high degree of molarisations. The P/4 in the tooth row 1.10.93 has the hypoconid strongly protruding towards the labial side. This character has been observed in *Croizetoceros ramosus* (Heintz 1970), and in some remains referred to *C.* aff. *pyrenaicus* from the locality Venta del Moro (cfr. Azanza 1989, personal observations on material stored in the Department of Geology of the Zaragoza University). The Paleomeryx fold occurs in the molars of the same tooth row and it reduces progressively from M/1 to M/3. This character too, was observed by Azanza (1989) in *C.* aff. *pyrenaicus*. In the scatter diagram of Fig. 9 the M/3 belonging to the tooth row 1.10.93, falls close to *Paracervulus australis* from French sites.

Cervidae indet. of middle size

Material *Antler*: Bac. 1227 basal fragment of left shed antler; *Skull*: IGF 7790v left pedicle connected to the forehead; *dentitions*: Loc1 fragment of upper molar, Cinig.2 fragment of lower molar.

Localities: Loc1, Cinig. 2, remains with IGF label come from unregistered localities in the surroundings of Ribaldella and Podere Firenze.

Description.

Two fragmentary teeth, a basal fragment of a left shed antler (Fig. 10A) among the material stored in the Natural History Museum of Basel, and one pedicle in the material of the Geo-Palaeontological section of the Natural History Museum of Florence (Fig. 10B), indicate the occurrence of a form approximately the size of fallow deer, therefore larger than the taxa described above. The antler has dimensions (MDb=38.0; mdb=36.0) and morphology (*i.e.* basal first tine) which recall those of some specimens referred to *Cervavitus* by Vislobokova (1983). The pedicle IGF 7790v has the following measurements close to the skull: TDb= 30.4; APDb= 24; and close to the burr TDd= 28,4; APDd= 24.1. The pedicle is broken which prevents measuring its height. Above the orbit there is a deep furrow (Fig. 10B). This specimen has been included in Fig. 8A, where its different size respect to the other plotted specimens is made evident.

The extremely poor sample of this middle sized deer prevents a more precise taxonomic definition.

Specimens	ol	nl	Mw	H
IGF 7827v l P/4	6.5	6.6	4.6	4.6
M/1	7.5	7.6	6.0	2.2
IGF 7826v M/3	11.2	10.6	5.0	3.3
M/2	8.0	8.3	5.4	2.7
M/1	6.8	6.7	5.3	2.3
18.10.76 r P/4	6.5	7.1	4.6	5.9
M/1	6.9	7.0	5.4	3.4
M/2	8.8	8.7	5.4	3.9
18.10.76 r P/3	4.9	5.0	2.2	3.0
18.10.76 l P/4	6.6	6.7	4.6	4.2
IGF 7827v r P/4	7.0	7.0	4.3	4.2
Loc1 r P/4	7.5	7.2	5.0	5.4
Cinig.1 l M/1-2	8.3	8.3	6.0	3.4
Cinig.1 r M/1-2	8.5	8.2	6.0	3.4
Loc1 M/1	8.8	7.9	6.8	1.5
IGF 7827v l M/3	12.4	12.7	5.9	3.0
18.10.76 l P4/	5.3	4.7	7.6	6.5
18.10.76 l M1/	8.1	7.1	9.3	3.0
Cinig.1 l M1-2/	8.8	7.8	10.5	3.6
18.10.76 l M2/	8.4	7.2	10.5	3.5
Cinig.1 r M2/	9.3	9.0	11.3	3.4

Tab. 10 - Measurements of teeth of *Tuscomeryx hürzeleri*. Legend: ol= occlusal length; nl= neck length; mw= maximal width; h= height.

Family Moschidae Zittel 1893

Genus *Tuscomeryx* n. gen.

Type species: *Tuscomeryx huerzeleri* n. sp.
Derivatio nominis: from "Tusci", old inhabitants of Tuscany.
Diagnosis: see that for species.

Tuscomeryx huerzeleri n. sp.

(Pl. 2; Fig. 11, 12)

Holotype: IGF 7826v fragment of horizontal ramus of left mandible with molar series.

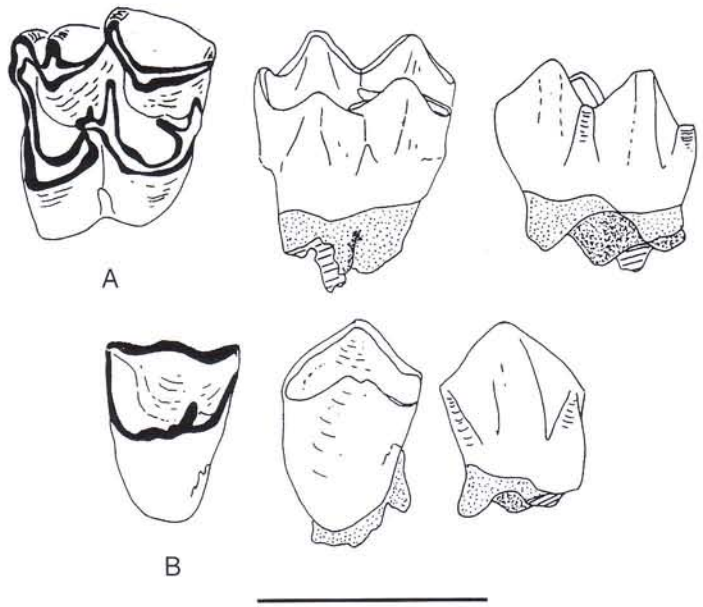


Fig. 11 - *Tuscomeryx huerzeleri* A) Bac. 1228 left M2/ or M1/ and B) Bac. 1228 left P4/; occlusal, lingual and labial views. Scale is 1 cm.

Tab. 11 - Measurements of falanges of *T. hürzeleri* (the I and II phalanges probably belong to the same individual).Legend: 1a= Maximum length; 1b= dorsal length; 2= depth of proximal articulation; 3= width of proximal articulation; 4=minimum depth of diaphyses; 5= minimum width of diaphyses; 6=depth of distal articulation; 7=width distal articulation.

Specimens	1a	1b	2	3	4	5	6	7
13.8.73 I phalange	24.7	23.4	11	8.3	6.1	-	6.5	7.3
13.8.76 II phalange	16.2	*16	*8	*8	5.8	-	6.7	5.8
Loc53 III phalange	17	15.3	8.2	7	9.3	5.3	-	-

Locus typicus: Ribaldella (Baccinello-Cinigiano basin, Grosseto).

Derivatio nominis: dedicated to Prof. Johannes Hürzeler, who devoted himself to the recovering and to the study of the fossils remains from the Baccinello-Cinigiano basin.

Age: latest Miocene, Messinian.

Diagnosis: Very small sized unantlered cervoid. The teeth are brachyodont; sabre-like upper canines occur. The lower molars bear a weak Paleomeryx fold. The third lobe of M/3 tends to be bicuspidate, at least in the first stages of wear. The upper and lower molars are characterised by inclined labial and lingual walls, respectively.

Systematics remarks. The systematics of the hornless ruminant species is very much discussed. Webb & Taylor (1980) refer to Moschina the hornless ruminants belonging to the families Moschidae and Gelocidae and to Tragulina the families Tragulidae, Hypertragulidae and Leptomericidae, while the ruminants with horns, antlers and ossicons are grouped in Eupecora. Ginsburg (1985) agrees with this scheme. Moyà-Solà (1986) contrasts this opinion including the superfamily Moscoidea (Moschidae and Palaeomerycidae) in the Eupecora group close to Cervoidea for the occurrence of the bony bridge in the distal metatarsal.

Material. *Dentitions*: Cinig. 1 right M2\; Bac.1228 left M2\-P4\, Cinig. 1 left M1-2\; Loc1 Bac. 1049 left C1\; IGF 7826v fragment of left mandible with M/3-M/1; IGF 7827v left mandible with P/4-M/1, Galassi Bac. 1228 right P/4-M/2; Galassi Bac.1228 right P/3; IGF 7827v right P/4; Galassi 18.10.76 left P/4; Loc1 left M/1; Cinig.1 right M/1-2; Cinig.1 left M/1-2; IGF 7827v left M/3; IGF 7827v fragm. of left P/2, Loc1 right P/4. *Postcranial bones*: 13.8.73 I phalange, 13.8.73 II phalange, Loc53 III phalange, 13.8.73 proximal fragment of metatarsus, Cinig. 16 corpus calcanei, IGF 7805v distal fragment of left tibia.

Localities: Podere Firenze, Ribaldella, Galassi; Podere La Locca, Cinig. 1, Fosso del Pian Calcinaio, Cinig. 16, remains with IGF label come from unregistered localities in the surroundings of Ribaldella and Podere Firenze.

Description.

Upper Dentitions (Fig. 11, Tab. 10) - In the molars the alae of the protocone, hypocone and paracone are well developed. In the labial wall, the mesostyle and parastyle are developed and protruding. Entostyles always occur.

Lower Dentitions (Fig. 12, Tab. 10) - Teeth are very brachyodont. A slightly developed Paleomeryx fold occurs in the molars, being progressively smaller from M/1 to M/3; the ectostylids are present, metaconid and entoconid are smooth, the metastylid is well developed; in M/3 the entoconid tends to be bicuspidate, at least in the upper part of the crown. The P/4 is highly molarised, the metaconid, that forms a lingual wall, is fused to the parastylid; entoconid and entostylid tend to be fused; the tooth is deeply cleft between hypoconid and protoconid. The lingual walls of molars are anterolabially postero-lingually inclined, in occlusal view.

Due to the fragmentary state of postcranial bones diagnostic characters could not be observed. The proximal fragment of metatarsus has the following measurements: TD=15.6 mm; APD= 14.4 mm; the distal fragment of tibia has: TD= 19.4 mm, APD=14.6 mm. Measurements of phalanges and calcaneus are reported in Tabs. 11,12.

Comparisons.

The moschid from Baccinello-Cinigiano Basin is comparable in size to *Moschus grandeavus* from the

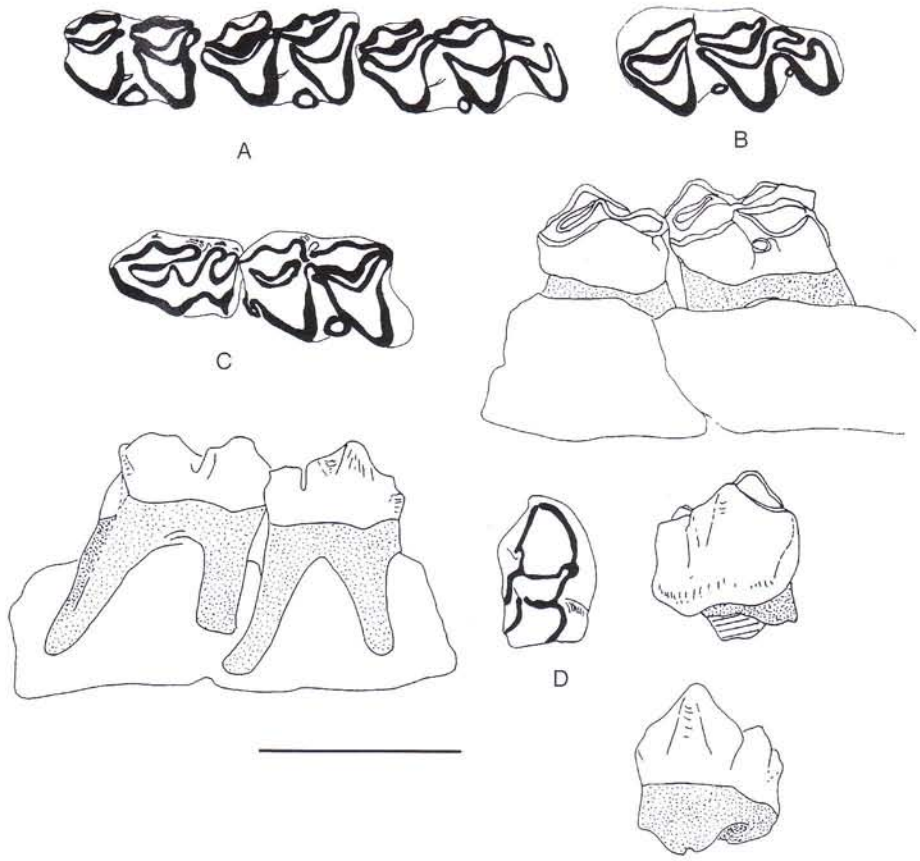


Fig. 12 - *Tuscomeryx huerzeleri* A) IGF 7826v holotype left M/3-M/1 occlusal view; B) IGF 7827v left M/3 occlusal view; C) IGF 7827v left M/1-P/4 occlusal, labial and lingual views; D) Bac. 1228 right P/4 occlusal, labial and lingual views. Scale is 1 cm.

Pliocene of Mongolia (Schlosser 1924). However this species lacks the Paleomeryx fold, which is always present in the molars of the Italian representative, and is characterised by a higher hipsodonty. The Baccinello-Cinigiano moschid was compared with a specimen of Recent *Moschus moschiferus* from Central Asia, stored in the Natural History Museum of Florence (Zoological section, La Specola, n 12056). The two moschids differ considerably, *T. huerzeleri* having a significatively higher horizontal mandibular ramus, and more developed ectostylids and more inclined and imbricate lingual walls in the cheek teeth.

Comparisons were also made with *Hispanomeryx* (Morales et al. 1981; Moyà Solà 1986), a hornless ruminant attributed to Bovoidea, fairly well represented in the Vallesian of Spain. Apart from size which is comparable (Fig. 13), the Italian and Spanish representatives differ in the teeth morphology: in the lower molars of *Hispanomeryx* the metastylid is weakly developed, the Paleomeryx fold is absent and the lingual walls of conids are aligned, in the P/4 the metaconid is not joined to paraconid.

The morphology of the Italian moschid recalls *Micromeryx* in some respects, in particular the species *M. flourensianus*. The genus *Micromeryx*, referred by Moya-Solà (1986) to Moscoidea, occurs in Western and Eastern Europe during the Middle Miocene (Gabunia 1973; Vislobokova 1983; Gentry 1990). The species *flourensianus* is well documented at La Grive (France), Steinheim (Allemagne) and in Spanish localities (i.e. Fuentidueña, Morales & Soria 1981). *Tuscomeryx huerzeleri* is larger than *Micromeryx flourensianus* (Fig. 13) and has a shorter P/4 relative to molars (Tab. 13), but has a similar outline of the conids (Fig. 14). Moreover, *M. flourensianus* has a more developed Palaeomeryx fold; this character is however consistent with the older age of this species. The species from Baccinello-Cinigiano basin could be related to *Micromeryx*, but the outlined differences justify a distinction at genus level.

1b	1c	6	7	11	12
33.4	28.4	11.8	9.9	6	11.8

Tab. 12 - Measurements of corpus calcanei (Cinig. 16) of *T. hürzeleri*. Legend: 1b= maximum plantar length of calcaneus; 1c= dorsal length of corpus calcanei; 6= height of calcanear tuberosity; 11= minimum width of corpus calcanei; 12= minimum height of corpus calcanei.

T. hürzeleri	*M. florensianus*(1)	*M. florensianus*(2)
86.6	103.7	107.8

Tab. 13 - Comparison between the fourth lower premolar and first lower molar ratio in *T. hürzeleri* and *Micromeryx flourensianus* from (1) La Grive (IGF 4181v mandible stored in the Natural History Museum of Florence, Geo-Palaeontological section) and from (2) Steinheim (left mandible n. Sth 845 stored in the Natural Museum of Basel).

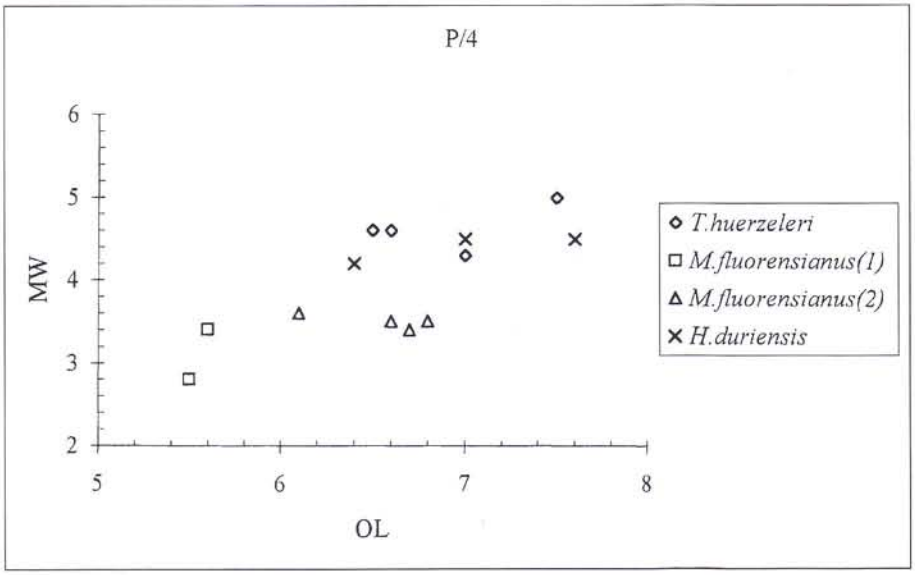


Fig. 13 - Scatter diagram of occlusal length (OL) against maximal width (MW) of fourth lower premolar. Data of *Micromeryx flourensianus* (1) are on specimens from La Grive and Steinheim stored in the Geo-Paleontological section of the Natural History Museum of Florence and in the Natural History Museum of Basel resp. , data of *M. flourensianus* (2) are from Morales & Soria (1981), data of *H. duriensis* are from Morales et al., (1981)

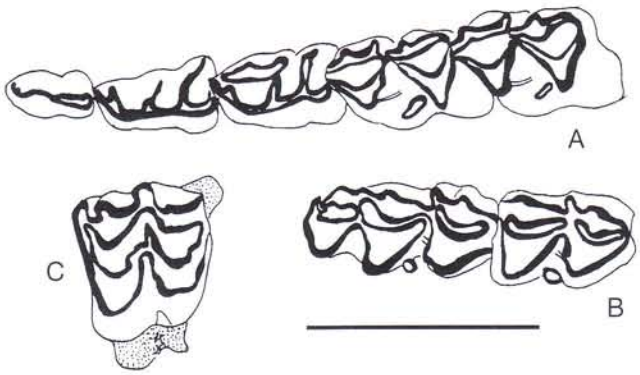


Fig. 14 - *Micromeryx flourensianus* from La Grive IGF 4181v A) left M/2-P/2; B) right M/3-M/2; C) left M1/. Scale is 1 cm.

Conclusions.

The following considerations and conclusions, in addition to those already expressed in the previous paragraphs, can be drawn:

1 - The cervid fauna from the latest Miocene deposits in the Baccinello-Cinigiano basin, though composed of fragmented remains which often hinder a certain classification, represents an important sample since it documents a population phase during the latest Miocene, which is scarcely represented in Italy. Moreover, although assemblage V3 records a time of extensive land connections, cervids do not show full analogies with other coeval European assemblages, except for the occurrence of *Procapreolus* (Vislobokova 1992; Moyà-Solà & Agustì 1990). In fact, *Croizetoceros* aff. *pyrenaicus* (Azanza et al. 1989) occurs at Venta del Moro and *Pliocervus matheronis* and *Pliocervus turolensis* (Azanza & Menendez 1990; Agusti 1999) have been reported from other Late Turolian Spanish localities. In Greece, the genus *Pliocervus* has been recorded also in the mammal assemblages attributed to MN13 (de Bonis & Koufos 1999; Azanza 1995).

2 - The boundaries between biochronological units are characterised by the progressive increase of new incomers. Indeed, the dispersal of Ruscinian taxa during the late Turolian has suggested the definition of the new unit Ventian (cf. Alberdi & Bonadonna 1991). The occurrence of *Paracervulus* at sites within the Baccinello-Cinigiano basin further confirms the opinion of other authors (see Rook et al. 1996 for references) about the transitional aspect of faunal assemblage V3.

3 - An important faunal turnover is recorded in the Baccinello-Cinigiano basin at the transition between assemblages V2 and V3. Pecora from assemblage V2 are, in fact, dominated by endemic bovids belonging to the genus *Maremmia* and to Neotragine species (e.g. *Tyrrhenotragus*), while no cervids were recovered. On the other hand, the fauna from assemblage V3 is dominated by at least three species of cervids and by a moschid, and bovids are represented only by a middle-sized form (*?Parabos* in Rook 1992). Such deer fauna suggests a landscape dominated by forests with locally bushy areas.

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