

Large Mammals from the Late Miocene of Çorakyerler, Çankırı, Turkey

Denis Geraads

CNRS, UMR 7207, Département Histoire de la Terre - CP 38, Muséum National d'Histoire Naturelle, 57 rue Cuvier, F-75231 PARIS Cedex 05, France. and Max Planck Institute for Evolutionary Anthropology, Department of Human Evolution, Deutscher Platz 6 - D-04103 Leipzig, Germany. E-mail: geraads@mnhn.fr

Abstract: I provide here a brief account of the large mammal fauna from the hominid-bearing locality of Çorakyerler near Çankırı, Turkey. It is dominated by the rhino *Acerorhinus*, an *Hipparion* close to *H. dietrichi* or *H. prostylum*, and spiral-horned antelopes, mainly *Majoreas* and *Oioceros rothi*. Antelopes of the *Pachytragus* group, other spiral-horned forms, and gazelles, are remarkably rare. There is no doubt that Çorakyerler is a Turolian site, but its faunal assemblage is unlike that of the classical Greek sites.

Key words: late Miocene, Turkey, Mammalia, hominid site

Introduction

The locality of Çorakyerler was first reported by BECKER-PLATEN *et al.* (1975), who assigned it to the Vallesian on the basis of its large mammal fauna, which included, according to their identifications: *Choerolophodon pentelici*; *Hipparion* sp. (very large); *Hipparion* sp. (medium size); *Diceros neumayri* (primitive, large form); *Chilotherium kowalevskii*; *Chilotherium samium* (large form); *Listriodon splendens*; *Listriodontinae* sp. indet. (bunolophodont); cf. *Korynochoerus* sp.; *Samotherium* sp. or *Palaeotragus* (= *Achtiaria*) *expectans*; *Palaeotraginae* sp. indet. (small form); *Oioceros* (*Samotragus*) n. sp.; *Prostrepsiceros* sp. Although not stated by these authors, the main basis for this age determination was obviously *Listriodon*, a genus unknown after the earliest Vallesian.

More recently, in 1992, Prof. Erksin Güleç from the Dil ve Tarih Coğrafya Fakültesi in Ankara invited me to take part in her research on several Middle and Upper Miocene sites that she was surveying or excavating. On my suggestion, she concentrated her activities on the site of Çorakyerler (E 33°38'10", N 40°37'), and the excavations that were conducted

there by Ayla Sevim resulted in the discovery of a fossil hominid, first reported by SEVİM *et al.* (2001) and later named *Ouranopithecus turkae* GÜLEÇ, SEVİM, PEHLEVAN and KAYA, 2007. GÜLEÇ *et al.* (2007) provided a preliminary faunal list of the large mammals, together with that of the rodents studied by ÜNAY *et al.* (2006), who tentatively assigned the locality to MN11, while noting that correlations are difficult. According to GÜLEÇ *et al.* (2007), the fossil-bearing unit consists of pale-green mottled marl that forms the lower part of a thick succession of continental red beds interfingering with shallow lake deposits.

Most of the large mammals remain unpublished, which is most unfortunate given the importance of the site, which has yielded the latest pre-human hominid so far known in Turkey. To fill this gap, I provide in the present paper a brief description of the material collected up to 2001.

Materials and Methods

The fossil material from Çorakyerler was studied in the Dil ve Tarih Coğrafya Fakültesi in Ankara, but is

now stored in the Çankırı Museum, Turkey. Lower teeth are in lower case, upper teeth in upper case. Measurements are in millimeters.

Results

Systematic paleontology

PROBOSCIDEA – *Choerolophodon pentelici*. This is a common species in the Miocene of the Eastern Mediterranean, especially Turkey, while other species of the same genus are known from the Siwalik, Kenya, and North Africa. The genus is already present in the Middle Miocene, but rare. The best specimen from Çorakyerler is a juvenile mandible that has an elongated gracile rostrum, almost in line with the corpus, a derived feature, but inclination relative to the tooth-row is difficult to appreciate in this incomplete specimen, as it is also at Kemiklitepe-D (KTD – TASSY 1994). This mandible also includes a well-preserved dp4 (Fig. 1A), of which the comparative measurements are given in Table 1.

Some authors (TASSY 1994, MARKOV 2004) recognize only one species in the late Miocene of the Aegean region, whereas others (SANDERS 2003; MARKOV 2008; KONIDARIS, KOUFOS 2012) distinguish two species, *Ch. anatolicus* (OZANSOY 1965) from the Vallesian and earliest Turolian being the ancestor of the more common Turolian *Ch. pentelici*. In any case, distinction is not easy on incomplete materials, but several attempts have been made (GAZIRY 1976; TASSY 1994, GERAADS *et al.* 2005a) to relate the size of *Choerolophodon* cheek-teeth to their geological age, but Table 1 shows that this trend towards size increase is far from obvious on dp4. On the whole, the dp4 from Çorakyerler is rather narrow, and this is hard to reconcile with a DP4 from Çorakyerler reported by GAZIRY (1976, Fig.2), which is near the upper limit of the size range of the MN9-MN12 representatives of this species (TASSY 1994 – Fig. 1), but which I have not seen. On the whole, the best fit is somewhere between the latest Vallesian, early Turolian or beginning of middle Turolian.

There are also two astragali, presumably of *Choerolophodon*, one of which is from a juvenile animal, but there is no evidence of another taxon.

RHINOCEROTIDAE – *Acerorhinus* ? n. sp. The most common rhino of Çorakyerler is represented by several more or less complete skulls, mandibles, and post-crania. In terms of biomass, it is certainly the dominant large mammal. It was assigned

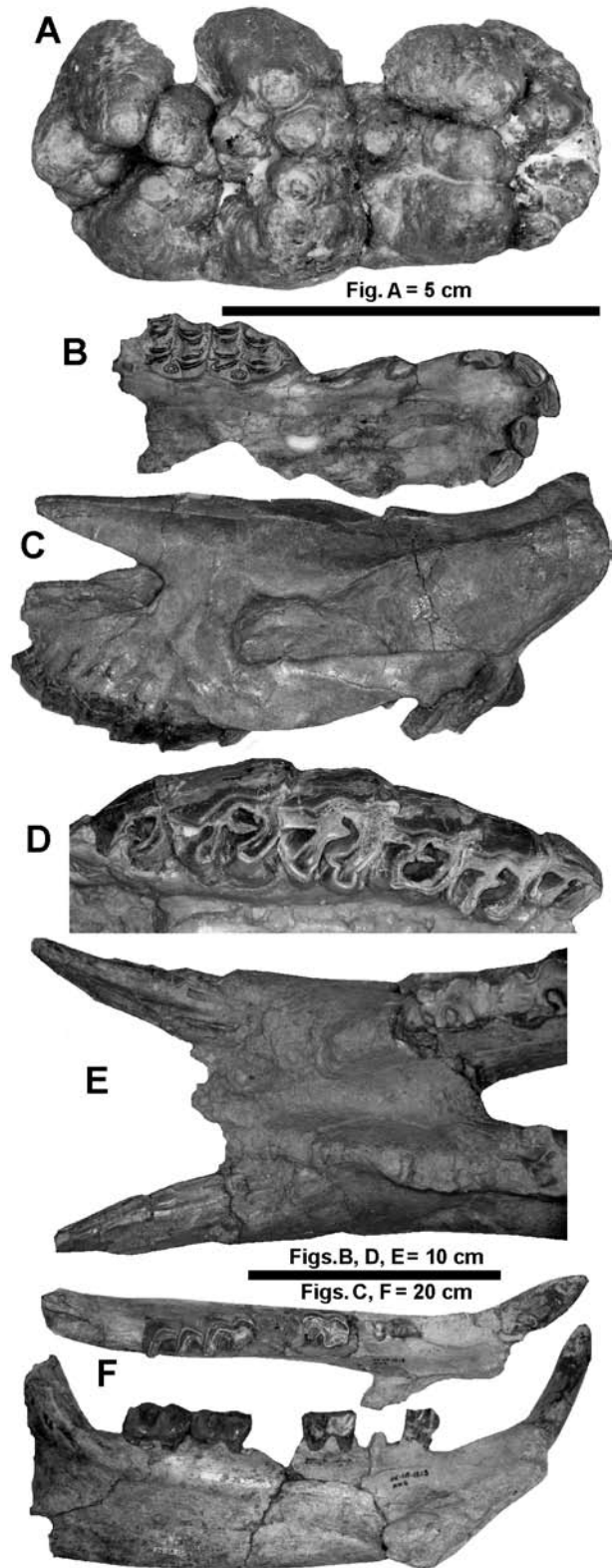


Fig. 1. A, *Choerolophodon pentelici*, dp4; B, *Hipparion* cf. *prostylum*, muzzle in ventral view; C, *Acerorhinus* n. sp., cranium; D, *Acerorhinus* n. sp., same specimen as D, upper cheek-teeth; E, *Chiloitherium* or *Acerorhinus* n. sp., mandibular symphysis; F, *Acerorhinus* n. sp., left mandible in occlusal and medial views. Scales as indicated

Table 1. Comparative measurements of *Choerolophodon* dp4s (original measurements unless otherwise indicated). Values for the Greek sites are means

	Age	Length	Width
Çorakyerler	Early/Middle Turolian	76.0	37.0
KTA (Izmir)	Middle Turolian	77.5	40.5
Maragha (NHMW)	Turolian	83.5	46.5
Maragha Ketschawa (NHMW)	Middle Turolian	76.0	46.0
Prohoma (KONIDARIS, KOUFOS 2013)	Middle Turolian	75.5	43.2
Kayadibi Kb 47 (GAZIRY 1976)	Early Turolian	73.0	40.5
Kayadibi Kb7/81 (GAZIRY 1976)	Early Turolian	68.5	38.0
KTD 66 (TASSY 1994)	Early Turolian	68.3	35.6
R. des Zouaves 1 (KONIDARIS, KOUFOS 2013)	Late Vallesian	76.4	41.9
Xirohori (KONIDARIS, KOUFOS 2013)	Late Vallesian	65.3	39.9
R. de la Pluie (KONIDARIS, KOUFOS 2013)	Late Vallesian	76.4	41.9
Sinap 14A (Izmir)	Vallesian ?	71.0	37.0
Sinap 2034 (MTA)	Vallesian ?	63.8	32.7
Sinap 1856 (MTA)	Vallesian ?	64.5	36.0

by PEHLEVAN (2006) to *Chilotherium kowalevskii*, and its tooth morphology is indeed very similar to that of this species, best known from Grebeniki in Ukraine where it is represented by numerous beautiful remains (PAVLOW 1914), but also reported from some Turkish localities (SICKENBERG *et al.* 1975). The upper premolars have a long curved protoloph that connects the transversely oriented metaloph, enclosing a central fossa blocked by a high bridge located very lingually (Fig. 1D). The crochet is strong on all upper cheek-teeth (although it vanishes with wear), and the antecrochet is long on the molars, although perhaps less so than in *C. kowalevskii*. There are, however, some significant differences with this species. At Çorakyerler, the tooth-row is distinctly more anterior, as the orbit reaches only the level of the back of M2 (in a young adult) or the front of M3 (in an older specimen), whereas it reaches M2 or M1 in *C. kowalevskii*; similarly, the bottom of the nasal notch is above P4 at Grebeniki, above M1 at Çorakyerler (Fig. 1C). The orbit is not as high as at Grebeniki (a difference with typical *Chilotherium*). Furthermore, while at Grebeniki the mandibular symphysis is broad, with very robust incisors inserted far apart as is usual in *Chilotherium* (PAVLOW 1913, pl. 5, fig. 32), the incisors are not very large at Çorakyerler, and are inserted closer to each other (Fig. 1F). They are wider apart on another, imperfectly preserved mandible (Fig. 1E), but even on this specimen the symphysis is not as distinctly broadened as in typical *Chilotherium*. It may be that this

specimen represents a different species, perhaps of a primitive *Chilotherium*, but since all upper teeth display the same features, it is more parsimonious to assume that only one species is present. As the mandibular features better match those of *Acerorhinus*, a genus based on *Aceratherium zernowi* from Sebastopol (BORISSIAK 1914) but also described by FORTELIUS *et al.* 2003 from Sinap and by GERAADS, SPASSOV (2009) from Bulgaria, the Çorakyerler form should probably be assigned to this genus, but no known species of *Acerorhinus* display the cheek-tooth morphology seen at Çorakyerler. *Acerorhinus zernowi* has simple teeth; the form from Kavakdere that FORTELIUS *et al.* (2003) described as *Acerorhinus* sp. nov. and *Acerorhinus* from Garkin have a blocked central fossa on the premolars, but the connection is much less lingual. A new species name should probably be created for the Çorakyerler rhino, which we tentatively refer to as *Acerorhinus*, but a detailed study of late Miocene Turkish rhinos and a clarification of the differences between *Acerorhinus* and primitive *Chilotherium* are badly needed.

Ceratotherium neumayri. PEHLEVAN (2006) described and illustrated some nice specimens, including a complete skull, which he assigned to this taxon. The general shape of the skull, especially that of the nasals, the rather ventrally located orbit, the lack of protocone constriction on the molars, all show that his identification is correct. The occipital crest extending caudally far behind the condyles and the forwardly located tooth-row are clear differences with

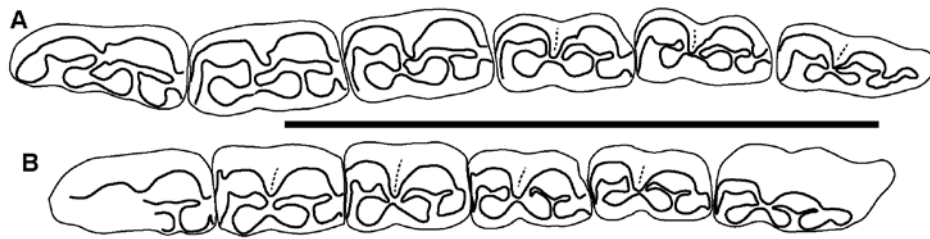


Fig. 2. **A**, “*Hipparion*” sp., sketch of the lower tooth-row CY-220; **B**, *Hipparion* cf. *prostylum*, sketch of the lower tooth-row CY-212. Scale bar = 10 cm

modern *Diceros*, a genus to which this species is sometimes erroneously referred. A juvenile maxilla (PEHLEVAN 2006, pl. 2) is also typical of this species by the lack of postfossette on DP2 and the presence of a crista on DP3.

EQUIDAE – Although not rare, the material is rather fragmentary and many specimens have undergone the plastic deformation that is so common at Çorakyerler. The rather confused state of our knowledge of late Miocene hipparions does not help in ascertaining their relationships.

Hipparion cf. *prostylum*. An incomplete, poorly preserved skull with the tooth-row and orbit shows the posterior border of an ante-orbital fossa located rather dorsally, far from the orbit (about 40 mm). Another specimen, with P2-P3 and the front teeth (Fig. 1B), is remarkable by the extremely short muzzle, the canine being located only 36 mm from P2. These features, plus the oval protocone, correspond well with the species *H. dietrichi*, known from a number of sites in the Balkano-Iranian province, most of them of early Turolian age, but apparently extending into the middle Turolian (KOUFOS 1987a & b; VLACHOU, KOUFOS 2002; KOUFOS, VLACHOU 2005; GERAADS *et al.* 2011). However, the incisor arch is more convex and the snout is slightly broader than usual in this species (L. Hristova, pers. comm.); an alternative identification would be *Hipparion prostylum*, a species defined in the Turolian of Mont Lubéron, France, and also present at Maragha. Probably of the same species are some lower tooth-rows, such as ÇO-212 (Fig. 2B; p2-p4 = 70; m1-m3 = 69; p2-m3 = 136) and ÇO-94, with heavily worn teeth (p2-p4 = 66.5; m1-m3 = 64; p2-m3 = 131.5).

Deformation and crushing of most postcranials make measurements difficult, but it is likely, although less obvious than one might have expected, that two species are represented. Table 2 shows the main measurements of the metatarsals.

These metatarsals might well be included within

Table 2. Main measurements of hipparion metatarsals (commonly used measurement numbers in brackets)

	Length (1)	W of cunei- form facet (7)	W of shaft (3)	Distal W (11)
ÇO-123	225	33	-	-
ÇO-83	236	33	31.5-	34.5
ÇO-27	240	-	-	-
ÇO-90	241	35.5	24++	31.5+
no n°	242	-	-	32
ÇO-217	242	36	28.4	34.8
ÇO-214	244	-	25.2	32.5
ÇO-206	245	c.29.5	22.5+	30-
ÇO-239	245	-	23+	30
ÇO-143	246	35.2	27.7	32.6
ÇO-162	258-	33.6	c. 27.5	c. 32.5

a single species but, surprisingly, the three metacarpals display a wider range of proportions, the smallest one being only 193 mm long with a shaft width of 22.3+, in contrast to 238 and 29.5 respectively for the largest one. This latter specimen most probably belongs to the next species.

“*Hipparion*” sp. The only specimen that definitely does not belong to the above mentioned species is a lower tooth-row ÇO-220 (Fig. 2A; p2-p4 = 80; m1-m3 = 70; p2-m3 = 154). It is larger than the previous form, the premolars are relatively longer and thicker, but the main difference is that the meta-stylid, of circular shape, is connected to the center of the ‘double boucle’ by a very long, narrow bridge, both on the molars and premolars. No other specimen shows this morphology, but it is so distinct from that of other specimens that I have little hesitation in referring this specimen to another species.

SUIDAE – *Microstonyx major*. Two skulls and several other specimens can be referred to a suid of the *M. major / erymanthius* group. Comparative measurements of the teeth (Fig. 3) show that the

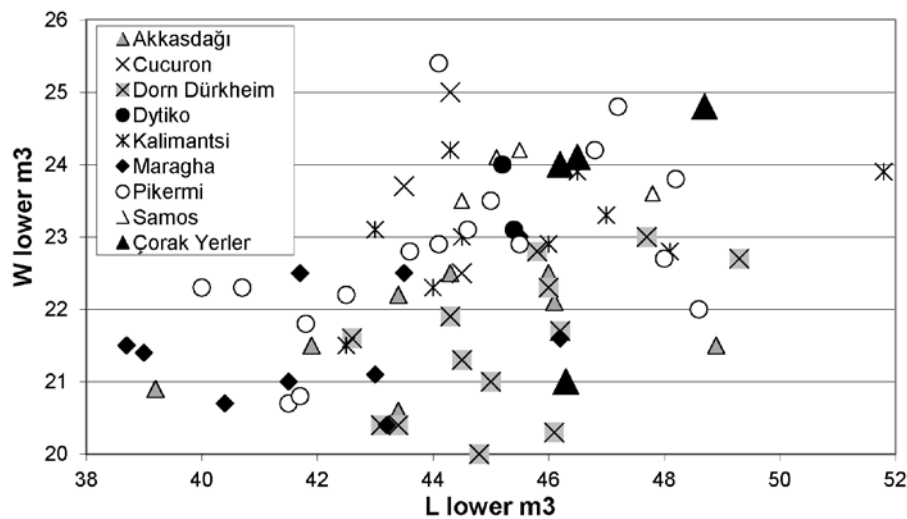


Fig. 3. L x W plot (in millimeters) of the third lower molars in some *Microstonyx major* populations. Data from BOUVRAIN, BONIS (1996); VAN DER MADE (1997); KOSTOPOULOS *et al.* (2001), LIU *et al.* (2005), SYLVESTROU, KOSTOPOULOS (2009), and original data

form from Çorakyerler is rather large. Several attempts have been made (e.g., KOSTOPOULOS *et al.* 2001; LIU *et al.* 2005) to relate the size of this species (as expressed by that of the third molars) to geological age, but the results have been disappointing. Fig. 3 shows that, although some differences can be noted (e.g., the teeth from Dorn-Dürkheim are narrow), no general trend is obvious; for instance, the variation at Pikermi virtually encompasses that of all other sites combined (GERAADS *et al.* 2011). The same is true of the development of the m3 talonid, another feature that might be expected to evolve with time. At the present time, the metric trends (if any) in this (or these) lineage(s), and the distinctive features between *M. major* and *M. erymanthius* remain obscure, and the basis for the assignment of the various populations to either species (VAN DER MADE *et al.* 2013), mysterious.

The symphysis is long and narrow, with long diastemas between i3 and c, and between c and the first premolar; it is thus very different from that of *Hippopotamodon antiquus*, a species present in the Vallesian (GERAADS *et al.* 2005a, Fig. 10J), and this lengthening of the symphysis is certainly a derived feature. VAN DER MADE *et al.* (2013) paid special attention to the evolution of the incisors in *Microstonyx*; according to them, it is marked by the lengthening of I2 (or at least increase of its L/W ratio) in connection with the reduction of i3. There are well-preserved upper and lower incisors at Çorakyerler but, unfortunately, they are much worn (indeed, more worn than the cheek-teeth). The upper I2 does not look very

long, but the lower i3s are decidedly small and short, hardly reaching farther rostrally than the base of i2. Although a definite conclusion is hard to reach, the characters of the symphysis point to an age certainly later than the Vallesian; if size increased during the Turolian, a middle Turolian age is even more likely than an early Turolian one.

Nothing suggests the occurrence of *Listriodon*, a mainly Middle Miocene Suid, previously reported from Çorakyerler (SICKENBERG *et al.* 1975), probably by mistake; as it is hard to confuse with anything else, it is likely that some mixing of collections occurred.

CERVIDAE – *Pliocervus* sp. A fragmentary antler in MTA probably belongs to this genus known from Spain, France, Greece and the Northern Black Sea, but not previously reported from Turkey.

GIRAFFIDAE – Giraffids are not rare at Çorakyerler but, as usual, they are mostly represented by teeth and postcranials. Three species are almost certainly present.

***Bohlinia* cf. *attica*.** This relative of the modern giraffe has much lengthened limbs, which allow easy identification. A metacarpal reached a length of c. 680 mm, similar to that of other *Bohlinia* specimens (review in GERAADS *et al.* 2005b). Some other limb bones probably belong to the same form. The species, or at least a close relative, is known as early as the late Vallesian (Ravin de la Pluie), until the latest Miocene at least.

***Palaeotragus* cf. *rouenii*.** Another metacarpal is similarly long and slender, but much smaller (length

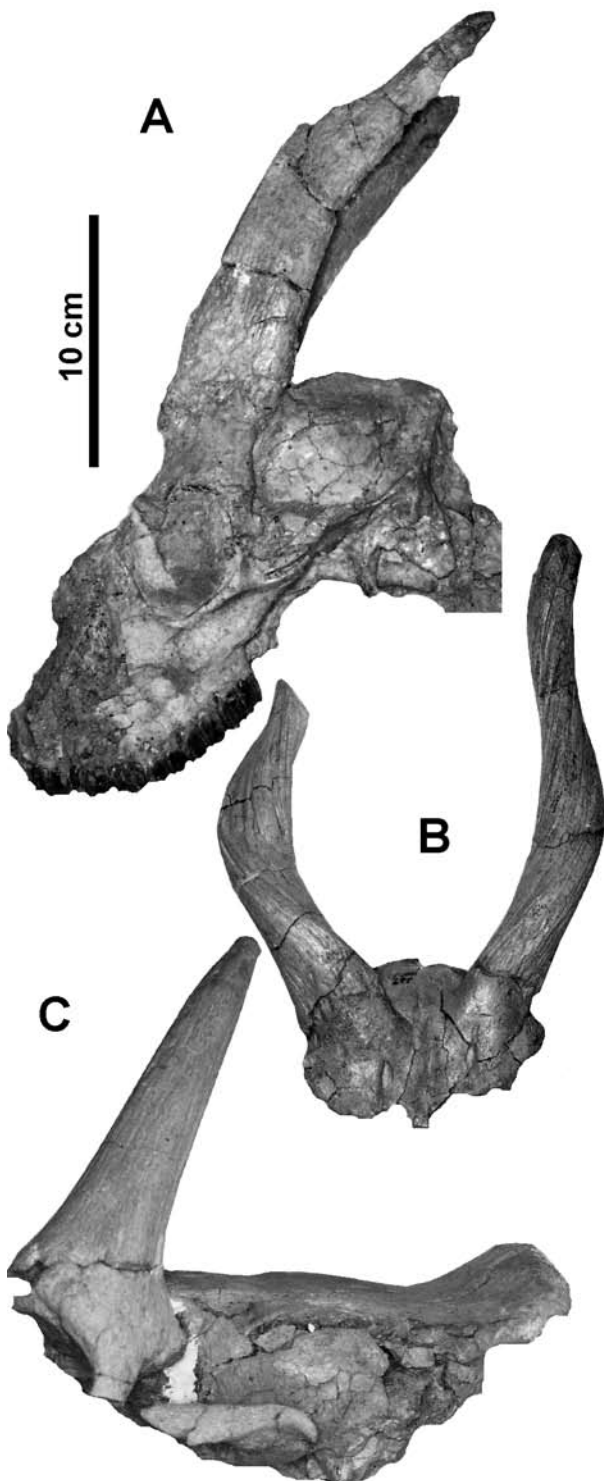


Fig. 4. **A**, *Miotragocerus* (*Pikermicerus*) sp., skull in lateral view; **B**, *Majoreas* cf. *woodwardi*, frontlet in anterior view; **C**, *Palaeotragus* cf. *quadricornis*, braincase and horn

= 450; width of shaft = 35; distal W = 58.3), and agrees closely with *P. rouenii*, a relatively common species restricted to the Turolian.

Palaeotragus cf. *quadricornis*. The rear part of a skull has a short, conical horn with a rather

square cross-section, located far from the occipital, inserted rather vertically, and located very far from its counterpart above the orbit (Fig. 4C). The occipital crest is broad and sharp. These characters are totally unlike those of the similar-sized *Bohlinia* (see, e.g., GERAADS 2009), but match those of the paleotragines; however, although anatomically similar, this specimen is much larger than *P. rouenii* from the Aegean region or *P. microdon* from China, being closer in size to the species described as *P. expectans*, *P. coelophrys* and *P. quadricornis*, which remain poorly known and are in bad need of revision (BOHLIN 1926). Thus, in spite of being the best girafid specimen from Çorakyerler, this incomplete skull provides no biochronological indication.

BOVIDAE – *Miotragocerus* (*Pikermicerus*) sp. A complete skull with the first cervical vertebrae is one of the most complete specimens from Çorakyerler (Fig. 4A) but is, unfortunately, strongly crushed transversely, preventing observation of the frontoparietal area (SPASSOV, GERAADS 2004). The small size, strongly convex lateral profile of the braincase, horn-cores closely approaching anteriorly, and long premolars relative to the molars, all support an assignment to the genus *Miotragocerus* (sensu SPASSOV, GERAADS 2004). The horns are inserted rather far from the orbits on long pedicles, they are much compressed transversely, long and slender, almost straight and parallel in the front view (but divergence and / or curvature may have been reduced by crushing), moderately curved in the lateral view, and show a strong demarcation at about 2/3 of their length, where the section changes to nearly circular; as in many late Miocene boselaphins.

Measurements: length from P2 to occipital crest = 230; length from M3 to back of condyles = 108; length of horn-core along anterior curve = 220; diameters of horn-core at base: 45.7 x 22; length of premolar row = 44.2; length of molar row = 53.8

The systematics of late Miocene boselaphins of the *Tragoptax-Miotragocerus* group, which were very common from Spain to India and Kenya in the late Miocene, is still imperfectly understood, and I prefer not to attempt a species identification, hence no biochronological conclusion; KÖHLER (1987) identified the Çorakyerler as *Tragoptax gaudryi*, but this is not entirely satisfactory, as the horn-cores are longer and more slender than usual in this species.

Tragoptax ? sp. It may be that this genus is also represented at Çorakyerler by a skull fragment

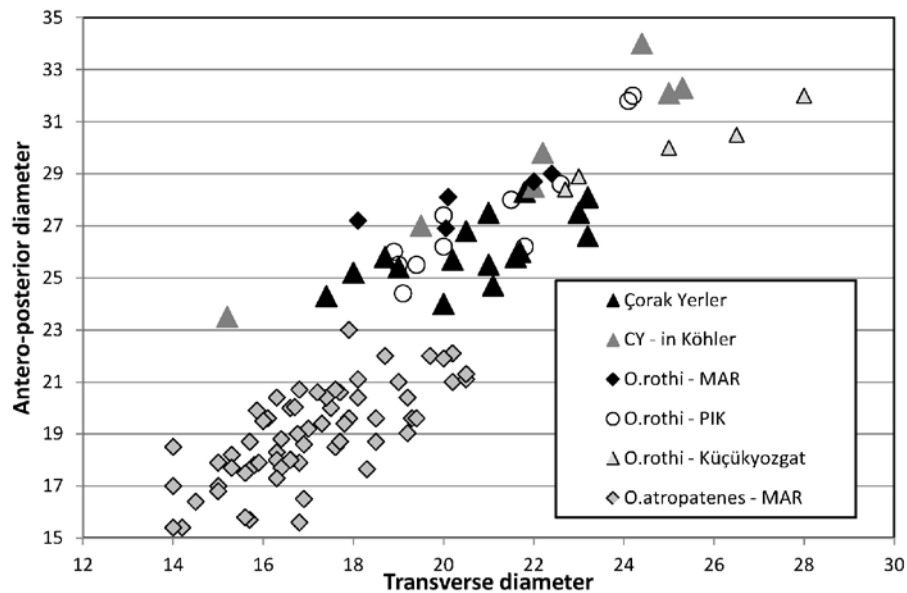


Fig. 5. Basal horn-core diameters (in millimeters) of *Oioceros* from various localities. Data from KÖHLER (1987), KOSTOPOULOS (in press), ROUSSIAKIS (2003), and original data

with the base of a horn-core of a very young individual.

cf. *Prostrepsiceros* sp. I tentatively assign a fragment of horn-core to this genus.

Criotherium ? sp. An incomplete horn-core is reminiscent of this genus, best known from Samos, but also present at Kemiklitepe-D and probably (as a different species) at Kalimantsi (GERAADS, SPASSOV 2008, and refs therein), thus wholly of Turolian age.

Majoreas cf. *woodwardi*. This is one of the most common species at Çorakyerler, together with *Oioceros rothi*. Numerous horn-cores and frontlets are known, but no specimen includes large parts of the skull. The horn-cores (Fig. 4B) are always twisted on their axis and spiraled, but variably so; some display only a weak curvature, resembling *Nisidorcas*, while others describe a clear spiral, resembling *Prostrepsiceros*; correlation with size is not perfect, but on the whole there is no doubt that spiralization increases with size. The inter-frontal suture is often fused and elevated in its posterior part. The main axis of the horn-core cross-section is strongly oblique relative to the sagittal plane; there is no anterior keel at base, but it is better expressed upwards, and may become strong at the tip. There is no posterior keel.

This form is certainly close to the Sinap form that OZANSOY (1965) called *Palaeoreas elegans*, but as it is probably not closely related to *P. lindermayeri*, type-species of this genus, I ascribe

it to *Majoreas*, a name erected by KOSTOPOULOS (2004) for *Prostrepsiceros woodwardi* PILGRIM and HOPWOOD, 1928, whose type-specimen is the Samos frontlet BMNH M4192. KOSTOPOULOS (2004) considered the latter species to be descended from *M. elegans* from Sinap. I shall follow his interpretation, although I believe that these forms differ less from *Prostrepsiceros zitteli* than he thought; definite conclusions are hard to draw, because M4192 is not well preserved, and the Sinap material very fragmentary. On the whole, however, the evolutionary stage of the Çorakyerler form suggests an age close to that of Kemiklitepe-D.

Gazella sp. ? A single, small horn-core (basal diameters: 16.1 x 14.5) might represent a gazelle, as its strong inclination backwards suggests that it suffered some dorsoventral post-mortem crushing, which might explain its apparent anteroposterior compression. It resembles *G. capricornis*, and especially the small gazelle from Kemiklitepe-D (BOUVRAIN 1994) but a species identification would be risky.

Oioceros rothi. This species is almost as common as *Majoreas*. Its type-locality is Pikermi, but it is also known in Macedonia (FYROM), Bulgaria, and other localities in central Turkey, mainly of late MN11/MN12-equivalent age (KÖHLER 1987). It is distinctly larger than *O. atropatenes*, a species known only from Maragha (KOSTOPOULOS in press, and refs therein). Fig. 5 shows that the Çorakyerler horn-cores are smaller than those from Küçükoyzgat, but I



Fig. 6. Three frontlets of *Oioceros rothi* in front view, to show variation

will not propose any interpretation of this difference, especially because the specimens from Çorakyerler measured by KÖHLER (1987) are also large.

The range of morphological variation in the horn-cores is wide (Fig. 6); it concerns the length, amount of torsion, depth of the lateral groove and strength of keel, so that the extremes might have been assigned to different taxa, but the presence of all intermediate forms prompts me to include them

all in the same species. Most specimens are twisted on their axis, only the largest ones describing a more open curve. However, as a whole, they are less widely spiraled than those from Pikermi (ROUSSIAKIS 2003), and a subspecific distinction, at least, would probably be warranted.

Protoryx sp. A fragment of horn-core and a few dental remains cannot be identified to a species. The scarcity of this group shows a clear difference when compared with other Turkish sites such as Akkasdağı, Kemiklitepe, and with Samos (BOUVRAIN 1994; KOSTOPOULOS 2005, 2009).

“Plesiaddax” inundatus. A few specimens had been reported by KÖHLER (1987) who called them *P. cf. inundatus*, but the new material is so similar to the one from Garkin that ERDBRINK (1978) named *P. inundatus* that it can be confidently assigned to the same species. The best specimens are a mandible with p2-m2 (p2-p4 = 47.8) and a mandible with m1-m3 (m1-m3 = 85). A metacarpal, probably of the same species, is remarkably long and robust (L = 315, distal W = c. 80). However, BOUVRAIN, BONIS (1984), followed by GERAADS, SPASSOV (2008) questioned the generic attribution of *P. inundatus*, noting that it is less derived than the type-species, *P. depereti* from China.

Discussion

Now that the reported occurrence of *Listriodon* (SICKENBERG *et al.* 1975, SEN *et al.* 1998) has been shown to be erroneous, the fauna from Çorakyerler looks homogeneous, and no taxon appears out of place. It is clearly a Turolian fauna, *?Acerorhinus* and *Majoreas* being perhaps the only significant taxa that might also fit an earlier age. Çorakyerler is significantly more recent than Middle Sinap or Ravin de la Pluie. Within the Turolian, most taxa suggest an age slightly earlier than Pikermi, a reference locality for MN12 in this area, and a MN13-equivalent age is very unlikely. Çorakyerler is probably earlier than Akkasdağı (SEN 2005), but the composition of the latter site is quite different, with gazelles and hipparions predominant. An interesting, as yet unsettled, question is whether Çorakyerler is earlier or later than KTD, which was considered as close to the MN11 / MN12 transition (BONIS *et al.* 1994). *?Acerorhinus* and *Majoreas* would suggest the former hypothesis, *Choerolophodon* and *Oioceros* (the latter absent from KTD) the reverse placement. The abundance

of *Oioceros* and *Majoreas*, contrasting with a dearth of other small and medium-size bovids, shows that Çorakyerler is not a classical Turolian locality. The complete lack of large carnivores and of cercopithecids is also to be noted; the latter have not been reported from Turkey.

Another hominoid-bearing locality in this area is Nikiti-1 (NKT) in Greek Macedonia (BONIS, KOUFOS 1999, and ref. therein), considered by them to be of MN10/11 age. Unfortunately, most of the material (mainly Ruminants) from this locality is in poor condition and identifications are difficult. NKT has several taxa in common with Pikermi, and three of them at least (*Microstonyx*, *Oioceros* and *Miotragocerus*) are also found at Çorakyerler. The evolutionary stage of the hipparion is the main argument, at the present time, for putting NKT earlier than Çorakyerler.

The fauna from the latest hominoid-bearing locality in continental Europe, Azmaka in Bulgaria, has not been published in detail (SPASSOV *et al.* 2012) but it differs much by the presence of *Anancus*, the different nature of the hipparions and spiral-horned antelopes and, more generally, by the greater diversity of the fauna.

Geographic and ecological factors certainly account for some of the differences in faunal composition with other sites. I tentatively refer Çorakyerler

to early MN12, bearing in mind, however, that it has very few forms in common with MN12 as defined in Spain. Its biogeographic affinities are of course best related with other Turkish sites and Samos, then with Macedonia, the Black Sea and Iran, but it shares no taxon exclusively with Southern Greece.

The bulk of the animal biomass at Çorakyerler consists of *Hipparion* s.l. (an ubiquitous genus), *Acerorhinus* (probably a grazing Rhino) and spiral-horned antelopes (common components of the Balkano-Iranian Turolian faunas, absent from Spain, and therefore probably open-country forms). Giraffids are less common than at Kemiklitepe-D, but cervids are present, although quite rare, and *Miotragocerus*, also absent from KTD, was perhaps less bound to open country than other antelopes. Suids are also more numerous than at Kemiklitepe. None of these differences is striking, but on the whole, they suggest that the environment was slightly less open; however, the great dominance of just a few species at Çorakyerler suggests a catastrophic accumulation unlike those found in most other Upper Miocene sites.

Acknowledgments: Thanks to E. GÜLEÇ for having entrusted me, a long time ago, with the study of the Çorakyerler large mammals, which I was unfortunately unable to continue. Thanks to the reviewer, N. SPASSOV, to the editor V. POPOV, and to L. HRISTOVA and G. N. MARKOV for their most useful comments on the manuscript.

References

- BOHLIN B. 1926. Die Familie Giraffidae. – *Palaeontologia Sinica*, C, 4 (1): 1-178.
- BONIS L. DE, G. BOUVRAIN 1996. Suidae du Miocène supérieur de Grèce. – *Bulletin du Muséum national d'Histoire naturelle*, 4ème sér., C 18 (1): 107-132.
- BONIS L. DE, G. BOUVRAIN, D. GERAADS, G. D. KOUFOS, S. SEN and P. TASSY 1994. Les gisements de Mammifères du Miocène supérieur de Kemiklitepe, Turquie: 11 - Biochronologie, paléoécologie et relations paléobiogéographiques. – *Bulletin du Muséum national d'Histoire naturelle*, 16: 225-240.
- BONIS L. DE, G. KOUFOS 1999. The Miocene large Mammal succession in Greece. – In: AGUSTÍ J., L. ROOK and P. ANDREWS (eds): The evolution of Neogene terrestrial ecosystems in Europe. Cambridge (Cambridge University Press): 205-237.
- BORISSIAK A. A. 1914. Mammifères fossiles de Sébastopol. – *Mémoires du Comité géologique*, 87: 105-154.
- BOUVRAIN G. 1994. Les Gisements de Mammifères du Miocène supérieur de Kemiklitepe, Turquie: 9. Bovidae. – *Bulletin du Muséum national d'Histoire naturelle*, 4ème sér., C, 16 (1): 175-209.
- BOUVRAIN G., L. DE BONIS 1985. Le genre *Samotragus* (Artiodactyla, Bovidae), une antilope du Miocène supérieur de Grèce. – *Annales de Paléontologie*, 71: 257-299.
- ERDBRINK D. P. B. 1978. Fossil Ovipovines from Garkin near Afyon, Turkey. – *Proceedings of the Koninklijke Nederlandse Akademie van Wetenschappen*, 81: 145-185.
- FORTELIUS M., K. HEISSIG, G. SARAÇ and S. SEN 2003. Rhinocerotidae (Perissodactyla). – In: FORTELIUS M., J. KAPPELMAN, S. SEN and R. L. BERNOR (Eds.): Geology and Paleontology of the Miocene Sinap Formation, Turkey. New York (Columbia University Press): 282-307.
- GAZIRY A.W. 1976. Jungtertiäre Mastodonten aus Anatolien (Türkei). – *Geologisches Jahrbuch*, B, 22: 1-143
- GERAADS D. 2009. Giraffidae (Mammalia) de la fin du Néogène de la République de Macédoine (ARYM). – *Geodiversitas*, 31 (4): 893-908.
- GERAADS D., N. SPASSOV 2008. A new species of *Criotherium* (Bovidae, Mammalia) from the late Miocene of Bulgaria. – *Hellenic Journal of Geosciences*, 43: 21-27.
- GERAADS, D., N. SPASSOV 2009. Rhinocerotidae from the late Miocene of Bulgaria. – *Palaeontographica A*, 287: 99-122.
- GERAADS D., T. KAYA, S. MAYDA 2005a. Late Miocene large mammals from Yulafli, Thrace region, Turkey, and their biogeographic implications. 2005. – *Acta Palaeontologica Polonica*, 50 (3): 523-544.
- GERAADS D., N. SPASSOV, D. KOVACHEV 2005b. Giraffidae (Artio-

- dactyla, Mammalia) from the late Miocene of Kalimantsi and Hadjidimovo, South-Western Bulgaria. – *Geologica Balcanica*, **35** (1-2): 11-18.
- GERAADS D., N. SPASSOV, L. HRISTOVA, G. N. MARKOV and T. TZANKOV 2011. Upper Miocene mammals from Strumyani, South-Western Bulgaria. – *Geodiversitas*, **33** (3): 451-484.
- GÜLEÇ E., A. SEVİM, C. PEHLEVAN and F. KAYA 2007. A new great ape from the late Miocene of Turkey. – *Anthropological Science*, **115**: 153-158.
- KÖHLER M. 1987. Boviden des türkischen Miozäns (Känozoikum und Braunkohlen der Türkei. 28). – *Paleontologia i Evolució*, **21**: 133-246.
- KONIDARIS G. E. and G. D. KOUFOS 2012. Late Miocene Proboscidea (Mammalia) from Macedonia and Samos Island, Greece: preliminary results. *Paläontologische Zeitschrift*, **87**: 121-140.
- KOSTOPOULOS D. S. 2004. Revision of some late Miocene spiral horned antelopes (Bovidae, Mammalia). – *Neues Jahrbuch für Geologie und Paläontologie Abhandlungen*, 231: 167-190.
- KOSTOPOULOS D. S. 2005. The Bovidae (Mammalia, Artiodactyla) from the late Miocene of Akkasdağı, Turkey. – *Geodiversitas*, **27** (4): 747-791.
- KOSTOPOULOS D. S. 2009. The late Miocene Mammal faunas of the Mytilinii basin, Samos Island, Greece: new collection. 14. Bovidae. – *Beiträge zur Paläontologie*, **31**: 305-349.
- KOSTOPOULOS D. S. In press. Taxonomic re-assessment and phylogenetic relationships of Miocene homonymously spiral-horned antelopes. – *Acta Palaeontologica Polonica*.
- KOSTOPOULOS D. S., N. SPASSOV and D. KOVACHEV 2001. Contribution to the study of *Microstonyx*: evidence from Bulgaria and the SE European populations. – *Geodiversitas*, **23**: 411-437.
- KOUFOS G. D. 1987a. Study of the Pikerimi Hipparions. Part I: Generalities and taxonomy. – *Bulletin du Muséum national d'Histoire naturelle*, ser. C, **9**: 197-252.
- KOUFOS G. D. 1987b. Study of the Turolian Hipparions of the lower Axios valley (Macedonia, Greece) 2. Locality "Prochoma-1" (PXM). – *Paläontologische Zeitschrift*, **61**: 339-358.
- KOUFOS G. D., T. D. VLACHOU 2005. Equidae (Mammalia, Perissodactyla) from the late Miocene of Akkasdağı, Turkey. – *Geodiversitas*, **27**: 633-705.
- LIU L., D. S. KOSTOPOULOS and M. FORTELIUS 2005. Suidae (Mammalia, Artiodactyla) from the late Miocene of Akkasdağı, Turkey. – *Geodiversitas*, **27**: 715-733.
- MARKOV G. N. 2004. The fossil proboscideans of Bulgaria and the importance of some Bulgarian finds – a brief review. – *Historia naturalis bulgarica*, **16**: 139-150.
- MARKOV G. N. 2008. The Turolian proboscideans (Mammalia) of Europe: preliminary observations. – *Historia naturalis bulgarica*, **19**: 153-178.
- OZANSOY F. 1965. Etude des gisements continentaux et des Mammifères du Cénozoïque de Turquie. – *Mémoires de la Société géologique de France*, **44**: 1-92.
- PAVLOW M. 1913. Mammifères Tertiaires de la Nouvelle Russie. 1ère Partie : Artiodactyla Perissodactyla (Aceratherium Kowalevskii n.s.). – *Nouveaux Mémoires de la Société impériale des Naturalistes de Moscou*, **17** (3):1-67.
- PAVLOW M. 1914. Mammifères tertiaires de la Nouvelle Russie. 2° partie. Aceratherium incisivum, Hipparon, Proboscidea, Carnivora. – *Nouveaux Mémoires de la Société impériale des Naturalistes de Moscou*, **17** (4): 1-78.
- PEHLEVAN C. 2006. Corakyerler (Cankırı) Rhinocerotidae (Mammalia) buluntularının değerlendirilmesi; Doktora tezi, University of Ankara, 188 p.
- ROUSSIAKIS S. 2003. *Oioceros rothii* (Wagner, 1857) from the late Miocene of Pikerimi (Greece): cranial and dental morphology, comparison with related forms. – *Geodiversitas* **25** (4): 717-735.
- SANDERS W. J. 2003. Proboscidea. In: FORTELIUS M., J. KAPPELMAN, S. SEN and R. L. BERNOR (eds.): *Geology and Paleontology of the Miocene Sinap Formation, Turkey*. New York (Columbia University Press): 202-219.
- SEN S. (ed.) 2005. *Geology, mammals and environments at Akkasdağı, late Miocene of Central Anatolia*. – *Geodiversitas* **27** (4): 513-830.
- SEN S., G. SEYİTOĞLU, L. KARADENİZLİ, N. KAZANCI, B. VAROL, H. ARAZ 1998. Mammalian biochronology of Neogene deposits and its correlation with the lithostratigraphy in the Çankırı-Çorum Basin, central Anatolia, Turkey. – *Eclogae Geologicae Helveticae* **91** (3): 307-320.
- SEVİM A., D. R. BEGUN, E. GÜLEÇ, D. GERAADS and C. PEHLEVAN 2001. A new late Miocene hominid from Turkey. AAPA 70th Annual Meeting Abstracts, *American Journal of Physical Anthropology*, **32**, suppl.: 134-135.
- SICKENBERG O. 1975. Die Gliederung des höheren Jungtertiärs und Altquartärs in der Türkei nach Vertebraten und ihre Bedeutung für die internationale Neogen-Stratigraphie. – *Geologisches Jahrbuch B*, **15**: 1-167.
- SPASSOV N., and D. GERAADS 2004. *Tragoportax* Pilgrim and *Miotragocerus* Stromer (Mammalia, Bovidae) from the Turolian of Hadjidimovo, Bulgaria, and a revision of the Late Miocene Mediterranean Boselaphini. – *Geodiversitas*, **26**: 339-370.
- SPASSOV N., D. GERAADS, L. HRISTOVA, G. N. MARKOV, G. MERCERON, T. TZANKOV, K. STOYANOV, M. BÖHME, and A. DIMITROVA 2012. A hominid tooth from Bulgaria: the last pre-human hominid of continental Europe. – *Journal of Human Evolution*, **62**: 138-145.
- SYLVESTROU I. A., D. S. KOSTOPOULOS 2006. The late Miocene vertebrate locality of Perivolaki, Thessaly, Greece. 7. Suidae. – *Palaeontographica*, **276**: 121-133.
- TASSY P. 1994. Les Gisements de Mammifères du Miocène supérieur de Kemiklitepe, Turquie: 7. Proboscidea. – *Bulletin du Muséum national d'Histoire naturelle*, 4ème sér., C, **16** (1): 143-157.
- ÜNAY E., H. DE BRUIJN and F. SUATA-ALPASLAN 2006. Rodents from the Upper Miocene Hominoid locality Corakyerler (Anatolia). – *Beiträge zur Paläontologie*, **30**: 463-467.
- VAN DER MADE J. 1997. The fossil pig from the late Miocene of Dorn-Dürkheim 1 in Germany. – *Courier Forschungsinstitut Senckenberg*, **197**: 205-230.
- VAN DER MADE J., E. GÜLEÇ and A. C. ERKMAN 2013. *Microstonyx* (Suidae, Artiodactyla) from the Upper Miocene of Hayranlı-Haliminani, Turkey. – *Turkish Journal of Zoology*, **37**: 106-122.
- VLACHOU D., G. D. KOUFOS 2009. The late Miocene Mammal faunas of the Mytilinii Basin, Samos Island, Greece: new collection. 11. Equidae. – *Beiträge zur Paläontologie*, **31**: 207-281.

Received: 05.03.2013

Accepted: 15.05.2013