Suidae, Tragulidae, Giraffidae, and Bovidae

Dimitris S. KOSTOPOULOS
University of Thessaloniki, Department of Geology, 54124 Thessaloniki (Greece)
dkostop@geo.auth.gr

Sevket SEN
CR2P UMR 7207 (MNHN, CNRS, UPMC, Sorbonne Universités),
Département Histoire de la Terre, Muséum national d'Histoire naturelle,
case postale 38, 57 rue Cuvier, F-75231 Paris cedex 05 (France)
sen@mnhn.fr

Published on 24 June 2016

urn:lsid:zoobank.org:pub:136F6810-7DB2-44A6-8D6A-229980279596

Kostopoulos D. S. & Sen S. 2016. — Suidae, Tragulidae, Giraffidae, and Bovidae, *in* Sen S. (ed.), Late Miocene mammal locality of Küçükçekmece, European Turkey. *Geodiversitas* 38 (2): 273-298. http://dx.doi.org/10.5252/g2016n2a8

ABSTRACT

The upper Miocene vertebrate locality of Küçükçekmece West, European Turkey, had provided an artiodactyl assemblage that is rich in species but poor in specimens. The present study allows revising previous artiodactyl lists provided for this site, by recognizing *Hippopotamodon* cf. *antiquus*, *Dorcatherium maliki* n. sp., *Palaeotragus* sp. (large size), *Palaeogiraffa pamiri* (Ozansoy, 1965), *Bohlinia* cf. *attica*, *Gazella* cf. *ancyrensis*, *Majoreas* cf. *elegans*, *Prostrepsiceros* sp., aff. *Protoryx* cf. *enanus*, cf. *Miotragocerus* sp., and Bovidae indet. (large size). The presence of a second suine and a cervid are poorly supported by current data but not excluded. The bulk of this artiodactyl association is also recognized in the Küçükçekmece East fossil assemblage. The Küçükçekmece tragulid is allocated to a new species of a medium sized *Dorcatherium* with bunoselenodont dentition, long premolars, tricuspid dp2 (p2) and p3, long hypoconid on dp2 and p3, simple distal fossette on p4, and presence of a lingual protocristid on the lower molars. The artiodactyl association of Küçükçekmece points to a Vallesian age, possibly between 9.6-9.4 Ma. The predominance of *Dorcatherium* and *Palaeogiraffa* among artiodactyls indicates wooded environmental conditions, whereas the taxonomic spectrum of artiodactyls reveals main influences from both Anatolia and Southern Balkans.

KEY WORDS
Vallesian,
SE Europe,
Suidae,
Tragulidae,
Giraffidae,
Bovidae,
new species.

RÉSUMÉ
Suidae, Tragulidae, Giraffidae et Bovidae.
Le Miocène supérieur de Küçükçekmece Ouest, Turquie d'Europe, a livré une association d'artiodactyles riche en espèces mais pauvre en nombre de spécimens. La présente étude permet de réviser la liste des artiodactyles précédemment décrits ou signalés de ce site, en identifiant dans le matériel de ce site les taxons suivants: *Hippopotamodon* cf. *antiquus*, *Dorcatherium maliki* n. sp., *Palaeotragus* sp. (de grande taille), *Palaeogiraffa pamiri* (Ozansoy, 1965), *Bohlinia* cf. *attica, Gazella* cf. *ancyrensis*, *Majoreas* cf. *elegans, Prostrepsiceros* sp., aff. *Protoryx* cf. *enanus*, cf. *Miotragocerus* sp., and Bovidae indet. (de grande taille). La présence d'un second suiné et d'un cervidé est possible, mais le matériel n'est pas suffisamment caractéristique pour l'affirmer. La plupart des taxons ci-dessus se trouvent également dans l'assemblage de Küçükçekmece Est. Le tragulidé de Küçükçekmece est attribué à une nouvelle espèce de taille moyenne caractérisée par sa dentition bunosélénodonte, ses prémolaires longues, dp2 (p2) et p3 tricuspides, la présence d'un long hypoconide sur dp2 et p3, d'une fossette distale simple sur p4, et d'une protocristide linguale sur les molaires inférieures. L'assemblage d'artiodactyles de Küçükçekmece indique un âge vallésien, probablement entre 9,6 à 9,4 Ma. Des ressemblances taxonomiques existent avec les faunes de mammifères de Sinap Moyen en Turquie, et dans une moindre mesure avec celles de Grèce du Nord. La prédominance des *Dorcatherium* et *Palaeogiraffa* parmi les artiodactyles indique des conditions environnementales boisées, tandis que le spectre taxonomique des artiodactyles révèle des affinités avec d'autres régions biogéographiques, principalement l'Anatolie et les Balkans.

MOTS CLÉS
Vallésien,
Europe SE,
Suidae,
Tragulidae,
Giraffidae,
Bovidae,
espèce nouvelle.

INTRODUCTION

Twenty-two kilometres west of historical Istanbul, in the eastern coasts of the Küçükçekmece Lake, a fossil vertebrate site was found in 1932 by a team of Turkish geologists prospecting the area (Sen 2016). The locality (hitherto referred to as Küçükçekmece East) is placed in the lower stratigraphic layers of the Çekmece Group that unconformably overly the marine sandstones with marl intercalations of the Çamurluhan Formation (Malik & Nafiz 1933; Rückert-Ülkümen *et al.* 1993; Sakınç *et al.* 1999; Lom *et al.* 2016). The rich fossil vertebrate assemblage described by Malik & Nafiz (1933; see also Ozansoy 1957) was originally correlated to the (late?) Sarmatian and comprises 22 species of mammals, among which a suid, a tragulid, two giraffids and five bovids (Table 1). Unfortunately, most specimens of this collection were lost during the fire that destroyed parts of the University of Istanbul in 1942, while the locality is nowadays buried below the western quarters of the city.

New material collected between 1957 and 1967 along the western shoreline of the Küçükçekmece Lake (hitherto referred to as Küçükçekmece West), formed the basis of a brief report on the site and its fauna by Nicolas (1978), who partly revised the old-fashioned list and increased the number of mammalian taxa to 44. Reported artiodactyls include now two suids, one tragulid, three giraffids and three bovids (Table 1) but none of them were described or illustrated.

The present study of the artiodactyls from Küçükçekmece is mostly based upon the Küçükçekmece West collection housed today in the Natural History Museum of Paris (MNHN). Some additional specimens from Küçükçekmece East and other individual quarries stored in the Technical University of Istanbul (ITU; some of them were part of Malik & Nafiz work) and in the Geology Museum of the Istanbul University (MIU) are also included. It worth, however, to be stressed that both Küçükçekmece East and West collections appear to come from a single fossil level within the sandy conglomerates of the Çukurçesme Formation (see Sakınç *et al.* 2007 and Lom *et al.* 2016 for local geological and stratigraphic settings).

The Küçükçekmece West material is sparse and fragmentary, and frequently suffers from the effects of extensive rolling. In most cases, however, it is complete enough to provide relatively accurate taxonomic identifications, to achieve further biochronological calibrations, and draw paleoecological interpretations. One suid, one tragulid, three giraffids and six bovid species have been identified, whereas the presence of a second suid and a cervid are uncertain (Table 1). The relations of the Küçükçekmece artiodactyl assemblage with those of contemporaneous faunas from neighboring areas are also discussed.

METHODS

The Küçükçekmece West fossil sample was studied by the first author in 2007. Specimens stored in the Istanbul Universities were studied and photographed at the same period by SS.

Dental terminology of suids generally follows Pickford (2015: fig. 1). Dental terminology of giraffids and bovids generally follows Heintz (1970: vol. II) with some additions from Geraads *et al.* (2013: fig. 1) concerning lower premolars. Dental terminology of tragulids follows Alba *et al.* (2014). It seems, however, that the term "tricuspid" is used in different ways by recent authors dealing with European tragulids (e.g., description of p2 and p3 in Hillenbrand *et al.* 2009, Alba *et al.* 2011, and Aiglstorfer *et al.* 2014). Here we consider tricuspid a p2/dp2 or a p3 in case a distinct protoconulid (mesiolingual conid) is present, whatever "bunodont" in aspect (as in Morales *et al.* 2012: figs 26-28) or not (as in Aiglstor-

TABLE 1. — List of artiodactyl taxa recorded at the Küçükçekmece West site, Turkey. Asterisks or question marks in brackets indicate the presence (*****, certain; **?**, uncertain) of the same taxon in the Küçükçekmece East fauna.

Malik & Nafiz (1933)	**Nicolas (1978)**	**This work**
		Ruminantia indet.
Sus erymanthius Roth & Wagner, 1854	*Microstonyx* cf. *antiquus*	cf. *Hippopotamodon antiquus* (?)
	Hyotherium aff. *soemmerigni*	*Propotamochoerus*? sp. (?)
Dorcatherium puyhauberti Arambourg & Piveteau, 1929	*Dorcatherium jourdani* Depéret, 1887	*Dorcatherium maliki* n. sp. (*)
Giraffa attica (Gaudry & Lartet, 1856)/ *Orasius speciosus* (Wagner, 1861)	*Bohlinia speciosa* (Wagner, 1861)	*Bohlinia* cf. *attica* (*)
	Samotherium sp.	*Palaeogiraffa pamiri* (Ozansoy, 1965) (*)
	Palaeotragus sp.	*Palaeotragus* sp. (large)
Gazella gaudryi Schlosser, 1904	*Gazella* aff. *pilgrimi*	*Gazella* cf. *ancyrensis* (*)
Helicotragus rotundicornis (Weithofer, 1888)	*Helicotragus rotundicornis*	*Majoreas* cf. *elegans* (?)
Palaeoreas lindermayeri Gaudry, 1861		
Tragocerus cf. *amaltheus*	*Tragocerus* cf. *amaltheus*	cf. *Miotragocerus* sp. (*)
		Prostrepsiceros sp. (*)
		aff. *Protoryx* cf. *enanus*
		Bovidae indet. (large)
Gazella strylodondis Pamir & Sayar, 1933		

fer *et al.* 2014: fig. 2m). We also introduce the term "lingual protocristid" in order to describe an additional molar crest that originates from the lingual wall of the protoconid and invades the anterior fossette, usually reaching the metaconid or the premetacristid near the base of the tooth. Postcranial anatomical features according to Barone (1999). All measurements are in millimetres (mm).

ABBREVIATIONS

Metrical abbreviations

HCBTD	transverse diameter at the base of the horn-core;
HCBAPD	anteroposterior diameter at the base of the horn-core;
TD	transverse diameter; APD: anteroposterior diameter;
TDP	transverse diameter at the proximal epiphysis;
APDP	anteroposterior diameter at the proximal epiphysis;
TDM	minimum transverse diameter of diaphysis;
APDM	anteroposterior diameter at the TDM point;
TDD	transverse diameter at the distal epiphysis;
APDD	anteroposterior diameter at the distal epiphysis;
L	length;
Ll	lateral length;
Lm	medial length;
W	width;
H	height;
max	maximum;
Mc	metacarpal;
Mt	metatarsal;
dex	right;
sin	left;
no No.	without catalogue number.

Institutional abbreviations

MNHN.F	Muséum national d'Histoire naturelle, Paris, collection of Palaeontology (in which specimens of the Küçükçekmece West collection are labelled as TRQ);
LGPUT	Laboratory of Geology and Paleontology, University of Thessaloniki;
ITU	Technical University of Istanbul;
MUI	Geology Museum of the University of Istanbul;
TTMEU	Tabiat Tarihi Muzesi (Natural History Museum), Ege University, Izmir (in which specimens from the Yulaflı site are labelled as CY).

SYSTEMATIC PALEONTOLOGY

Class MAMMALIA Linnaeus, 1758
Order ARTIODACTYLA Owen, 1848
Family SUIDAE Gray, 1821

Genus *Hippopotamodon* Lydekker, 1877

TYPE SPECIES. — *Hippopotamodon sivalense* Lydekker, 1877, by original designation.

***Hippopotamodon* cf. *antiquus* (Kaup, 1833)**
(Fig. 1)

MATERIAL EXAMINED AND MEASUREMENTS. — **Küçükçekmece West**: Partly preserved right ?M1 (Wmesial lobe = 22.2 mm), MNHN.F.TRQ678; fragments of molars, TRQ676, TRQ677; right i3 (L = 18.0 mm; W = 7.6 mm), TRQ682; distal fragment of right dp4 (Wdistal lobe = 14.4 mm), TRQ679; distal part of a left p2 (Wdistal = 9.2 mm), TRQ681; left p3 (L = 22.4 mm; W = 12.3 mm), TRQ675; magnum, TRQ673 (H = 28.4 mm; TDmax = 30.1 mm).

DESCRIPTION AND REMARKS

While this work was in progress, part of the studied material appeared in Pickford (2015: 84; table 21; fig. 76), without, however, a detailed description and comparison. Though poorly represented in the Küçükçekmece West sample, we believe suids from this site merit a full presentation, especially as our opinion differs from that of the latter author.

Most of the Küçükçekmece West suids belong to a large-sized suine from the extensively discussed but still unresolved taxonomic group centred on *Hippopotamodon* Lydekker, 1877 and *Microstonyx* Pilgrim, 1926 (for a detailed taxomonic history and divergent opinions see Made & Hussain 1989; Fortelius *et al.* 1996; Liu *et al.* 2004; Made *et al.* 2013; Pickford 1988, 2015). Avoiding taxonomic complications, we adopt here the point of view of Made & Hussain (1989), formally established by Pickford (2015), in recognizing synonymy between these

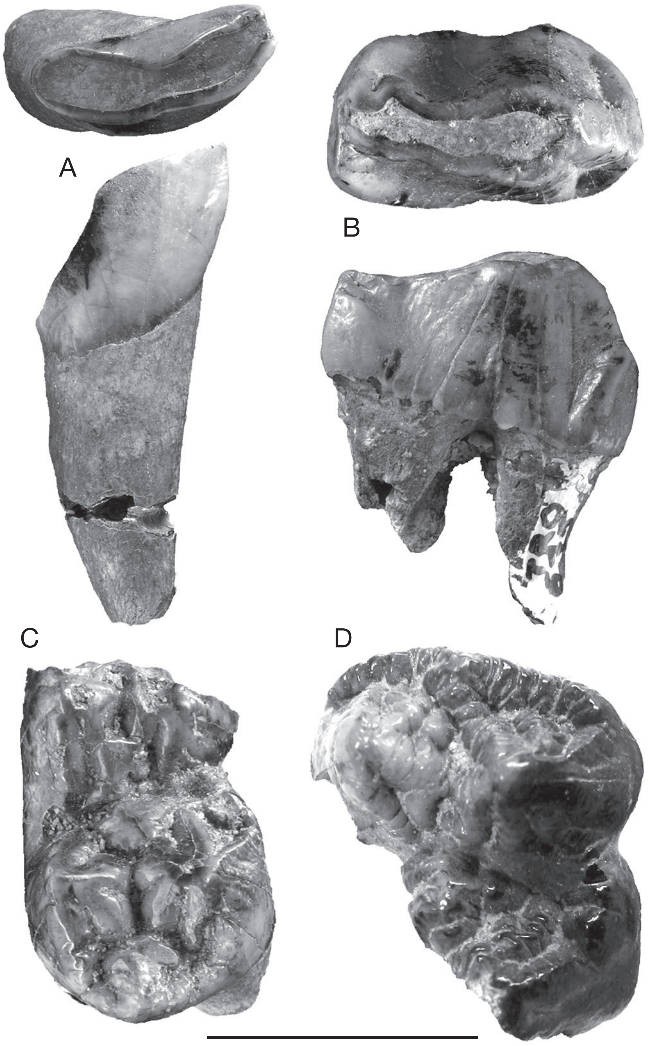

Fig. 1. — *Hippopotamodon* cf. *antiquus* from Küçükçekmece West, Turkey: **A**, i3 dex, MNHN.F.TRQ682 in occlusal (**up**) and buccal (**down**) views; **B**, p3 sin, MNHN.F.TRQ675 in occlusal (**up**) and lingual (**down**) views; **C**, distal part of dp4 dex, MNHN.F.TRQ679 in occlusal view; **D**, part of ?M1 dex, MNHN.F.TRQ678 in occlusal view. Scale bar: 2 cm.

two genera. In agreement, however, with Liu *et al.* (2004), we regard *Hippopotamodon major* (Gervais, 1848) as a polymorphic species including *Sus erymanthius* Roth & Wagner, 1854. *Dicoryphochoerus meteai* Ozansoy, 1965 from Yassiören, Turkey is considered to be a junior synonym of *H. antiquus* (Kaup, 1833) (Fortelius *et al.* 1996).

The single reasonably complete upper molar (Fig. 1D) lacks the metacone. Its length is estimated at about 24 mm. It shows a thick and complicated mesial cingulum with a rather clear central accessory cusplet. The lingual cingulum is also well expressed, especially around the hypocone, which appears multicuspid. The strong cingulum precludes an ascription to *Propotamochoerus* Pilgrim, 1925 and points to *Hippopotamodon* (Pickford 1988). Pickford (2015: table 21, fig. 76A) refers to this tooth as an M2 of *Hippopotamodon major* (distinct from *H. erymanthius* according to the same author) but if an M2 it would be placed far below the size range of this species, being even smaller than the smallest known M2 from Pikermi, Greece and within the size range of *Propotamochoerus provincialis* (Gervais, 1852). In fact, as the tooth is completely unworn and lacks dentine, it is most probably an M1 still unerupted at the time of the animal's death (van der Made pers. comm. 2015). In that case, it is metrically comparable to the largest known specimens of *H. major* (in our concept) and the smaller of *H. antiquus* (according to the size ranges provided by Made *et al.* 2013: fig. 6).

The i3, MNHN.F.TRQ682 from Küçükçekmece is quite worn (Fig. 1A; the same specimen was illustrated by Pickford 2015: fig. 76C as a left I3 with catalogue number MNHN.F.TRQ653). It is similar in occlusal length but broader than that of *H. major* from Axios valley, Greece (MNHN.F.SQL912: L = 19.5 mm, W = 5.8 mm), Perivolaki, Greece (LGPUT PER-265: L = 21.5 mm, W = 5.9 mm) and Maragheh, Iran (MNHN.F.MAR3328: L = 18.0 mm, W = 6.0 mm), though still smaller than an i3 of *H. antiquus* from Yassiören, Turkey (MNHN.F.TRQ1026: L = 21.7 mm, W = 9.5 mm). Compared to a restricted sample (n = 6) from Pikermi, Maragheh, Dorn-Dürkheim, Germany (Made 1997: pl. I, fig. 5) and Akkaşdağı, Turkey (Liu *et al.* 2005: fig. 2B, C), the Küçükçekmece West i3 exhibits a sharp occlusal angle (i.e. the angle of the occlusal surface in buccal or lingual view) like *H. antiquus* from Yassiören and in difference from the smoothly convex occlusal edge of *H. major,* indicating a different occluding pattern of upper and lower incisors between these two species. The buccal face of the Küçükçekmece i3 also bears a weak-shallow groove similar to that of *H. antiquus* from Yassiören, and unlike *H. major*.

Apart from a single specimen from Luberon, France, the distal dp4 TQR679 (Fig. 1C; Pickford 2015: fig. 76B) appears 10% wider than the broadest recorded dp4 attributed to *H. major* (n = 24; data from Made *et al.* 1992; Pickford 2015). The distal part of p2 (MNHN.F.TRQ681) is wide and bears an accessory cuspid between the main conid and the high distal cusplet (or talonid). The distal cingulum is strong and extends lingually and mostly buccally. This morphology is quite different from that of *H. major*, in which the distal cingulum of p2 is reduced and the intermediate accessory cuspid together with the talonid raises higher. The tooth width indicates a species at the very maximum extreme end of *H. major*'s size range (Wdistal < 8.2 mm in 25 out of 27 cases) and within the known range for *H. antiquus,* though data for this species are poor (Wdistal = 9.0-9.4 mm, n = 2 for Dinotheriensande/Eppelsheim according to Hünermann 1961; 9.2 mm for the Yassiören mandible MNHN.F.TRQ1026).

Although in advanced stage of wear, the single fully preserved third lower premolar (MNHN.F.TRQ675; Fig. 1B; see also Pickford 2015: fig. 76D) suggests that the main conid was strong, rising much higher than the mesial or distal cusplets, a morphology that contrasts that of *H. major*. The distal cusplet develops both lingually and bucally, instead of mostly buccally in *H. major*. The p3 of *H. antiquus* from Eppelsheim (L = 22.3 mm, W = 11.7 mm; Hünermann 1961) bears one accessory cuspid along the anterior crest, a feature present in the Küçükçekmece p3 but not in the Yassiören mandible (Fig. 2). Pickford (2015) allocates MNHN.F.TRQ675 to *H. major*, but using his own data (*idem*: table 21, fig. 77)

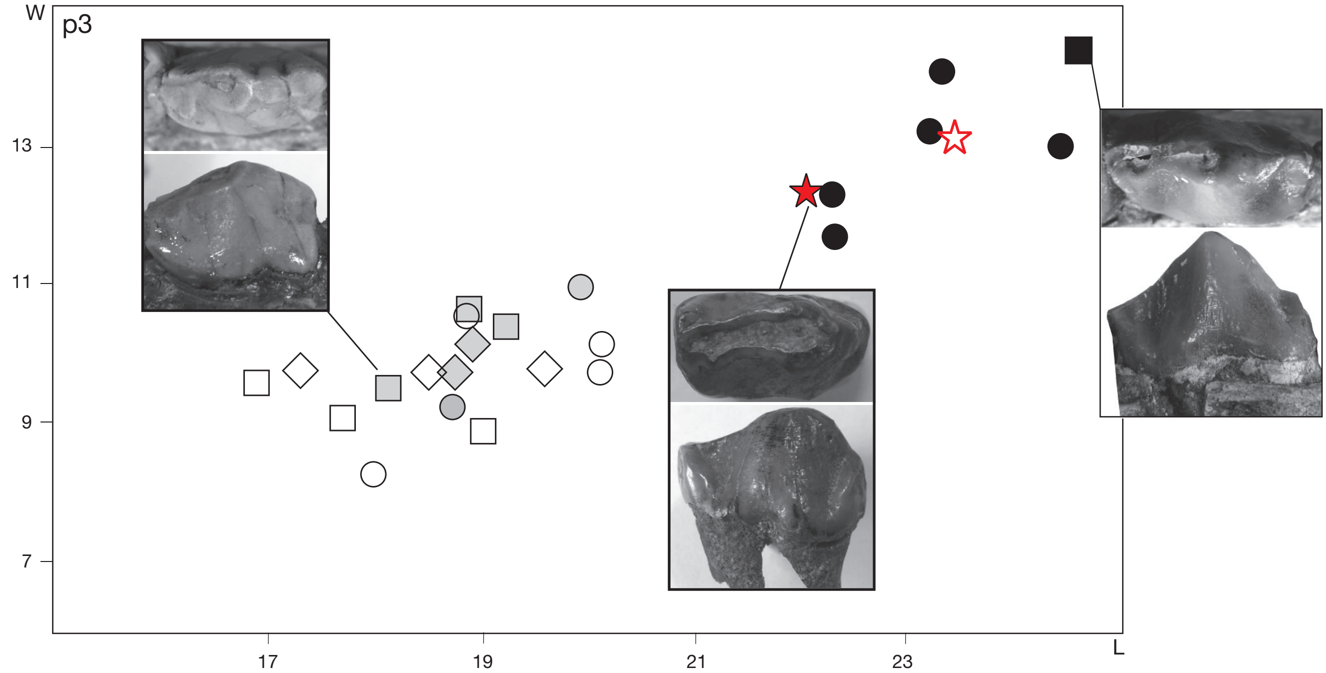

FIG. 2. — Morpho-metrical comparison of the p3s of European *Hippopotamodon* Lydekker, 1877: ★, MNHN.F.TRQ675, Küçükçekmece West, Turkey; *H. antiquus*: ●, Dinotheriensande/Eppelsheim, Germany (from Hünermann 1961; Pickford 2015); ■, Yassiören (MNHN) Turkey; ☆, Yulaflı, Turkey. *Hippopotamodon major* (Gervais, 1848): □, Pikermi, Greece; ◇, Luberon, France; ○, Samos, Greece; ◆, Dytiko, Greece; ▨, Maragheh, Iran; ●, Kalimantsi, Bulgaria (pers. data).

the specimen is metrically placed well within the size range of *H. antiquus* from Dinotheriensande, Germany together with the neighboring suid from Yulaflı, Turkey (Geraads *et al.* 2005) and far from *H. major* from Luberon (Fig. 2).

Malik & Nafiz (1933: pl. IX, fig. 2) referred to as *Microstonyx erymanthius* an astragalus (L = 67 mm) from the Küçükçekmece East site. This astragalus is slightly larger than those of *H. major* from Greece, Turkey and Spain (Made *et al.* 1992; Liu *et al.* 2005; pers. data) and it may, indeed, belong to *H. antiquus,* but comparative data are missing from the literature.

According to the results of the previous morphological and metrical comparison and in contrast to Pickford (2015), we suggest that the Küçükçekmece West large suid is better ascribed to *Hippopotamodon antiquus* than to *H. major*. Due, however, to the inadequate sample we prefer referring it to as *Hippopotamodon* cf. *antiquus*.

Genus *Propotamochoerus* Pilgrim, 1925

TYPE SPECIES. — *Propotamochoerus hysudricus* (Stehlin, 1900), by subsequent designation (Pilgrim 1925: 207; e.g., Pickford 1988: 53, 54).

Propotamochoerus? sp.

Hyotherium aff. *soemmeringi* – Nicolas 1978: 456.

MATERIAL EXAMINED AND MEASUREMENTS. — **Küçükçekmece West:** MNHN.F.TRQ683, right I1 (mesodistal L = 12.7 mm; occlusal L = 18.7 mm; W = 6.6 mm, H = 13.6 mm). Possibly ascribed: TRQ680, M1 (*c.* 19.0 mm, maximum estimated length < 25 mm).

DESCRIPTION AND REMARKS

The preserved M1 is extremely worn and thus, morphological observations are not possible. Its small size prevents certain ascription to the previous suid species. Similarly, an M2 (L = 24.0 mm, W = 19.0 mm) referred to as *Microstonyx erymanthius* by Malik & Nafiz (1933: pl. IX, figs. 1) from the Küçükçekmece East appears to be quite small and simple for *Hippopotamodon.* The I1, MNHN.F.TRQ683 is morphologically similar to that of *Propotamochoerus hysudricus* (Pickford 1988: fig. 95) and its proportions fall within the metrical range of *Propotamochoerus palaeochoerus* (Kaup, 1833) from several Vallesian sites and *Propotamochoerus* sp. from the MN11-13 of SE Europe (Hellmund 1995; Made *et al.* 1999; Geraads *et al.* 2008) but more material is certainly needed for confirmation.

Family TRAGULIDAE Milne-Edwards, 1864

Genus *Dorcatherium* Kaup & Scholl, 1934

TYPE SPECIES. — *Dorcatherium naui* Kaup & Scholl, 1834 by original designation.

Dorcatherium maliki n. sp.
(Fig. 3; Tables 2, 3)

Dorcatherium puyhauberti – Malik & Nafiz 1933: 61.

Dorcatherium jourdani – Nicolas 1978: 476.

Dorcatherium cf. *jourdani* – Geraads *et al.* 2005: 536.

Table 2. — Tooth dimensions of *Dorcatherium maliki* n. sp. from Küçükçekmece West and East, Turkey.

specimen	Tooth	L	W
MNHN.F.TRQ763 right	D4	10.7	10.8
MNHN.F.TRQ762 left	D4	11.2	9.9
MNHN.F.TRQ764 left	D4	10.8	9.4
MNHN.F.TRQ759 left	P2	12.8	7.2
ITU no No. right	P4	12.5	12.8
MNHN.F.TRQ754 right	M1	11.1	12.5
MNHN.F.TRQ755 right	M1	10.4	12.8
ITU no No.	M1	11.3	13.5
MNHN.F.TRQ753 right	M2	12.8	14.3
MNHN.F.TRQ757 left	M2	13.4	13.5
MNHN.F.TRQ751 left	M2	13.7	14.7
MNHN.F.TRQ752 left	M2	13.0	15.1
ITU379 right	M3	15.5	15.1
ITU no No. left	M3	14.7	14.9
MNHN.F.TRQ750 right	M3	14.0	17.6
MNHN.F.TRQ779 right	p2	11.3	3.7
ITU371 right	p3	14.2	4.7
ITU371 left	p3	14.6	5.0
MNHN.F.TRQ768 left	p4	12.7	4.8
MNHN.F.TRQ772 right	p4	13.7	5.3
ITU371 left	p4	13.8	5.5
ITU no No. left	p4	12.9	4.8
MNHN.F.TRQ765 right	m1	11.4	8.3
MNHN.F.TRQ748 right	m1	11.7	7.5
ITU no No.	m1	–	6.1
MNHN.F.TRQ783 right	m2	13.5	9.3
MNHN.F.TRQ767 right	m2	13.2	8.2
MNHN.F.TRQ766 left	m2	13.7	9.0
MNHN.F.TRQ782 right	m2	13.8	9.3
MNHN.F.TRQ no No. left	m2	12.7	8.4
ITU no No.	m2	12.7	8.0
MNHN.F.TRQ749 left	m3	20.7	–
MNHN.F.TRQ784 right	m3	20.1	9.3
MNHN.F.TRQ748 right	m3	18.0	(7.7)
MNHN.F.TRQ785 left	m3	–	10.7
MNHN.F.TRQ769 right	m3	–	9.5
MNHN.F.TRQ770 left	m3	–	9.8
ITU no No. right	m3	(18.6)	9.0
ITU380 left	m3	–	8.9

Holotype. — TTMEU-CY-141, partial left mandibular ramus with p4-m3, illustrated by Geraads *et al.* (2005: fig. 10I).

Formation and Locality. — Yulaflı site, 10 km NW of Çorlu in Turkish Thrace (41°12'13"N, 27°49'46"E), channel-filling sand horizons of Ergene Fm (Geraads *et al.* 2005).

Age. — Late Miocene, Vallesian.

Etymology. — Dedicated to Ahmet Malik Sayar, discoverer of the Küçükçekmece fossil site.

Diagnosis. — Medium sized *Dorcatherium* characterized by advanced selenodonty, absolutely and relatively long premolars and M3/m3; tricuspid dp2/(p2) and p3 without bulky (bunodont) protoconulid; protoconid and hypoconid of dp2 and p3 of similar lengths; simple distal fossette on p4; presence of a distinct lingual protocristid on the lower molars; long metatarsals and large astragali.

Differential diagnosis. — *Dorcatherium maliki* n. sp. is larger than *D. guntianum* von Meyer, 1846 and smaller than *D. peneckei* (Hofmann, 1893) and *D. vindebonense* von Meyer, 1846. It also differs from *D. peneckei, D. vindebonense* and from the slightly smaller *D. crassum* (Lartet, 1851) in the more advanced selenodonty. *Dorcatherium maliki* n. sp. distinguishes from *D. crassum* by the presence of a well-developed lingual cuspid on P2; the less bulky protoconulid of dp2 and p3; the longer p3 and the slightly longer and relatively narrower p4; the longer hypoconid on dp2 and p3 compared to the protoconid; the shorter *Dorcatherium*-fold on the lower molars (always much shorter than the postmetacristid); the buccallly shifted third lobe of m3; the distally larger radius with wider and shallower groove for the extensor carpi radialis and much weaker groove for the common extensor tendon of the digits; the absence of fusion between tibia and maleolus lateralis and the much narrower and more plantarily extended medial concavity of the cochlea tibia; the larger astragali with weaker angle between the axes of the proximal and distal trochlea, wider lateral condyle of the caput tali and more prominent distally medial condyle; the calcanei with weaker coracoid process, longer and narrower articular surface for the malleolar, and plantary facing articular surface for the cubonavicular; and the longer metatarsals with much wider frontal groove between the MtIII and MtIV and more unevenly placed proximal surfaces for the cubonavicular and the ectomesocuneiforme. *Dorcatherium maliki* n. sp. differs from *D. jourdani* Depéret, 1887 in having broader upper and lower molars, longer m3 compared to m2, and tricuspid dp2. *Dorcatherium maliki* n. sp. differs from *D. puyhauberti* Arambourg & Piveteau, 1929 in the longer m3 compared to m2, and the presence of cingulum all around the lingual and distal wall of the posterior lobe of upper molars. *Dorcatherium maliki* n. sp. resemble more closely *D. naui* Kaup, 1833 from which, however, it differs in the slightly larger M3/m3, the longer lower premolars, the longer hypoconid on dp2 and p3 compared to the protoconid, the strong protoconulid of dp2, the simple distal fossette of p4, and the frequent presence of a distinct lingual protocristid on the lower molars.

Studied material. — **Küçükçekmece West**: right dP4, MNHN.F.TRQ763; left dP4, TRQ762, TRQ764; left P2, TRQ759; right M1, TRQ754, TRQ755; left M2, TRQ751, 752; right M2, TRQ753, TRQ757; right M3, TRQ750; right dp2, TRQ779; right p4, TRQ772; left p4, TRQ768; partial right mandibular ramus with m1-m3, TRQ748; left m2-m3, TRQ749; right m1, TRQ765, TRQ775; right m2, TRQ783, TRQ767, TRQ782; left m2, TRQ766, TRQ771, TRQ no No. (two specimens); right m3, TRQ784, TRQ769; left m3, TRQ785, TRQ770; distal humerus, TRQ727, TRQ728; distal radius, TRQ733; distal metacarpals TRQ746, TRQ747; tibia, TRQ718; distal tibia, TRQ717, 720, 721; astragalus, TRQ706, TRQ707, TRQ708, TRQ710, TRQ711, TRQ713, TRQ714, TRQ716; calcaneum, TRQ703, TRQ704, TRQ705; metatarsal, TRQ741; distal lateral metatarsal TRQ765, Phalanx I, TRQ729, TRQ731.
Küçükçekmece East: left P4, ITU no No.; M1, ITU no No.; M3, ITU379, ITU no No.; left p3-p4 in situ, ITU371; right p3, ITU371; left p4, ITU no No.; right m1, ITU no No.; left m3, ITU380, ITU no No.; astragalus, ITU352.

Measurements. — See Tables 2 and 3.

Description

Only isolated upper teeth are preserved; among them, there are three molariform dP4 in different wear stages. They show a proportionally stronger and more mesially protruding parastyle than the permanent molars (Fig. 3G). The preparacrista ends mesially just in front of the parastyle. Both the paracone and the mesostyle are well pronounced and coniform, whereas the metacone is significantly weaker and the metastyle barely distinct. A weak crest at the distolingual wall of the paracone is present in the two less worn specimens. The postprotocrista is faint and short, weakly distinct from the long neocrista. A strong cingulum runs along the base of the mesolingual wall to the middle of the posthypocrista. A kind of basal knob or pillar develops between the lobes in two of the three available specimens.

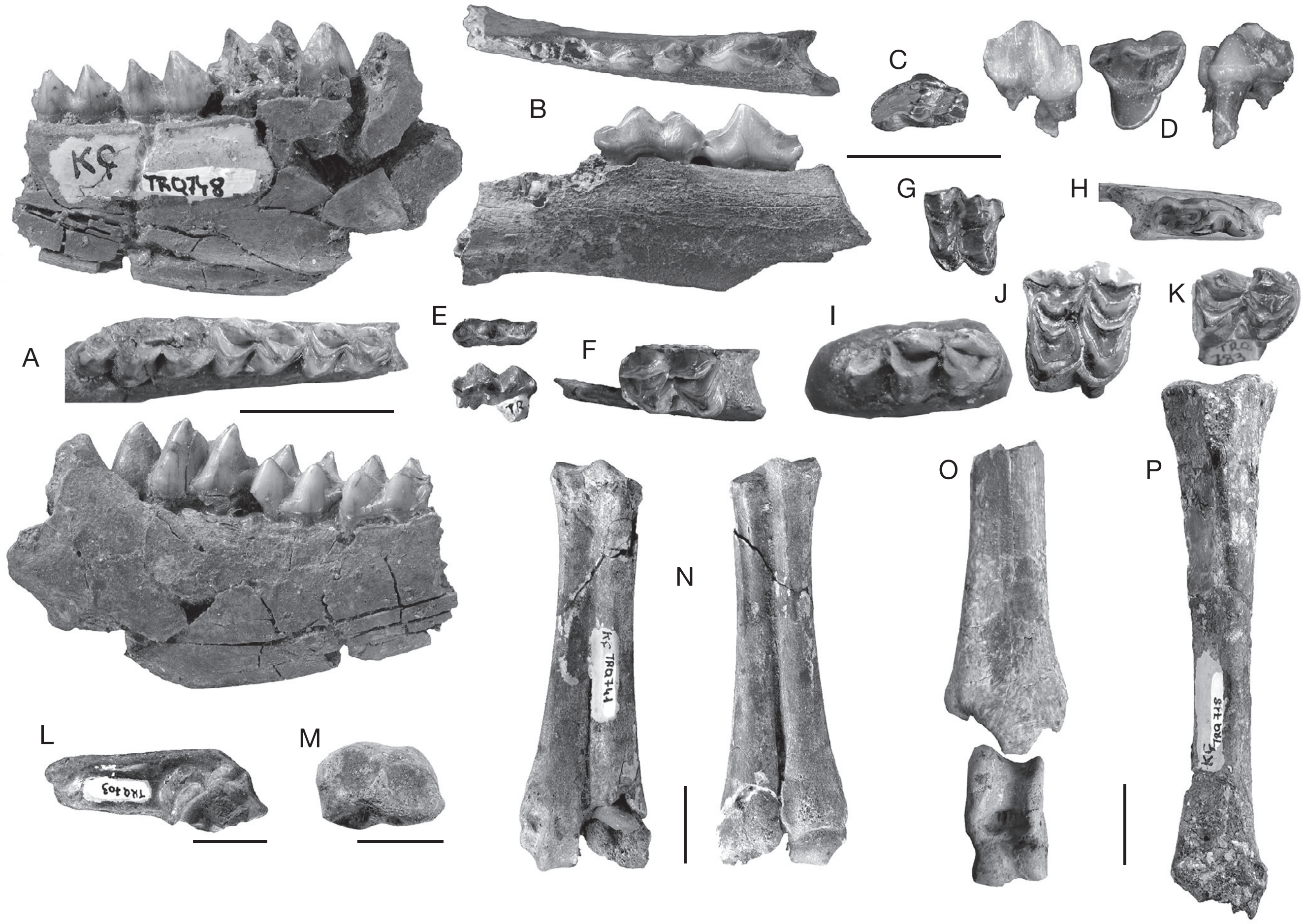

Fig. 3. — *Dorcatherium maliki* n. sp. from Küçükçekmece West, Turkey: **A**, m1-m3 dex, MNHN.F.TRQ748 in lingual (**up**), occlusal (**middle**), and buccal (**down**) views; **B**, p3-p4 sin, ITU371 in occlusal (**reversed-up**) and buccal (**down**) views; **C**, P2 sin, MNHN.F.TRQ759 in occlusal view; **D**, P4 sin, ITU no No. in buccal (**left**), occlusal (**middle**), and lingual (**right**) views; **E**, dp2 dex, MNHN.F.TRQ779 in occlusal (**up**) and buccal (**down**) view; **F**, m2 sin, MNHN.F.TRQ766 in occlusal view; **G**, dP4 dex, MNHN.F.TRQ763 in occlusal view; **H**, p4 sin, MNHN.F.TRQ768 in occlusal view; **I**, m3 dex, MNHN.F.TRQ784 in occlusal view; **J**, M2 sin, MNHN.F.TRQ751 in occlusal view; **K**, m2 dex, MNHN.F.TRQ783 in occlusal view; **L**, calcaneum, MNHN.F.TRQ703 in medial view; **M**, distal radius, MNHN.F.TRQ733 in distal view; **N**, metatarsal III+IV, MNHN.F.TRQ741 in plantar (**left**) and dorsal (**right**) view; **O**, distal tibia and talus, MNHN.F.TRQ716, TRQ717 in dorsal view; **P**, tibia, MNHN.F.TRQ718 in dorsal view. Scale bars: 2 cm.

The tri-rooted P2 (Fig. 1C) is much longer than wide with well-developed lingual (protocone) and buccal (paracone) cuspids and a distinct distolingual cingulum. Mesially, the tooth bears a strong buccal style and a well-developed lingual cuspid.

The single P4 (Fig. 1D) is three-rooted and has strong paracone and protocone. The protocone shows well-expressed selenodonty and its height reaches almost 2/3 of the paracone height. The preparacrista is long, leading to a well-developed parastyle that projects mostly mesially. The postparacrista is equally long but less sloping down and leads to a weakly developed metastyle that bears a blunt distobuccal cingulum. The preprotocrista reaches marginally the parastyle. The postprotocrista turns buccally, terminating in between the paracone and the metastyle, and closing the fossette. The distolingual cingulum is strong rising up to the distal surface of the protocone, which is also surrounded by a well-developed cingulum.

The preserved upper molars show advanced selenodonty though in moderate to advanced wear stage, and thus little informative (Fig. 3J). The prehypocrista is significantly longer than the neocrista and reaches the lingual wall of the postparacrista. In two molars at least, there is evidence of a very weak postprotocrista. The para- and mesostyle are strong and the paracone has well-convex lingual and buccal ribs. The cingulum is strong all along the lingual wall of the molars and mostly on the mesial lobe (Fig. 3J).

Discriminating between isolated dp2, p2 and p3 is quite difficult in case all appear tricuspid. We assume, however, the isolated and tricuspid MNHN.F.TRQ779 (Fig. 3E) is a dp2 as its roots are more divergent than in permanent premolars and the talonid is high (Geraads, Aiglstorfer & Rössner pers. comm. 2016). A similar tricuspid dp2 from Küçükçekmece East is also illustrated by Malik & Nafiz (1933: pl. XI, fig. 2). Both the dp2 and p3 (Fig. 3B, E) are very similar in morphology: tricuspid, long, and buccolingually compressed, though the p3 width reaches distally the minimum values for the p4. The protoconid is as long but slightly higher than the hypoconid, whereas the protoconulid is shorter than the other two, low, directs mesio-lingually, and though well developed it is not bulky unlike *D. crassum* (Lartet, 1851). The prehypocristid of both dp2 and p3 is shorter than the preprotocristid. Two sharp distal cristids branch from both the protoconid and the hypoconid. One is running along the mesio-distal axis of the tooth (postprotocristid and posthypocristid, respectively) and is long and slightly convex. The other is much shorter (about half of the length of the buccal cristids) and directs distolingually. Distally, the posthypocristid joins near the base the weakly developed but clear distolingual cingulum and, together with the distolingual cristid of the hypoconid, they define a subrounded distolingual valley. A weak basal lingual cingulum also connects the protoconulid with the protoconid.

The p4 (Fig. 3B, H) is slightly broader than the p3. The protoconid (mesiobuccal conid) dominates at the center of the tooth. The preprotoconulid is undistinguished from the preprotocristid even at initial wear stages. Their contact is marked by the deep and abrupt buccal clefts of the wide and open lingually anterior valley. An incipient preparacristid is present in two out of four specimens. Two cristids branch on the posterior part of the protoconid: the lingual one is almost parallel to the mesiolingual axis of the tooth and reaches the distolingual corner, and the distal one fuses with the hypoconid. The hypoconid is well convex buccally-distobuccally, more so than the protoconid. A narrow posthypocristid directs vertically compared to the mesiodistal axis of the tooth reaching the distolingual corner. The long and rather narrow posterior fossette (fossetid) of the tooth is almost fully enclosed but remains narrowly open at the distolingual corner till advanced wear stage. In one specimen (MNHN.F.TRQ772) an additional isolated tubercle appears in the mesial-most corner of the posterior fossette. Short mesiolingual and distolingual cingula are developed.

The lower molars (Fig. 3A, F, K) are rather narrow and relatively high (height represent 70-80% of the maximum length). The length of the lower molar row is 41.8 mm in MNHN.F.TRQ748 (Fig. 3A). The distal lobe of m1 and m2 is slightly broader than the mesial one. The m1 and m2 (Fig. 3A, F, K) have well-developed Σ-structure. The *Dorcatherium*-fold is always short representing about half of the postmetacristid length. The postprotocristid and the *Tragulus*-fold are equally developed. In some specimens the postmetacristid passes over the postprotocristid, reaching the terminal point of the *Tragulus*-fold. *Zhailimeryx*-fold is weak to absent. In most specimens (6 out of 8 in initial to mid wear stage) the postentocristid is double, formed by a long and thin lingual and a very short buccal cristid. The posthypocristid is longer than the postentocristid and turns lingually, closing the posterior fossette. The lingual wall of the protoconid shows an additional crest (called lingual protocristid) invading the anterior fossette and reaching the base of the premetacristid; though always present, its development varies from weak (knob-like) to important (*c.* half of the preprotocristid length). A small ectostylid is usually present on m2 but very weak to absent on m1. The mesial cingulum is strong, especially mesiolingually; the buccal cingulum is less marked. The morphology of the two mesial lobes of the m3 is identical to that of m1-m2 (Fig. 3A, I). The posthypocristid is divided distally into a long internal and a very short external cristid. The former reaches lingually the postentocristid, closing the distal fossette, whereas the latter connects the prehypoconulid-cristid with wear. The posthypoconulid-cristid is rather short leading to a small entoconulid. The prehypoconulid-cristid extends lingually reaching the short postentoconulid-cristid, and closing the back fossette of the m3. The third lobe is oval in occlusal view and directs toward the buccal side, deviating from the main axis of the tooth (Fig. 3I). There is no ectostylid but a low cingulum appears buccally between the lobes and especially between the second and third lobe.

REMARKS

Recent advances on European Miocene tragulids partly solved longstanding taxonomic confusion and allowed recognizing two possible lineages with distinct morphometric features (Hillenbrand *et al.* 2009; Rössner 2010; Alba *et al.* 2011, 2014; Sánchez *et al.* 2011; Morales *et al.* 2012; Rössner & Heissig 2013; Aiglstorfer *et al.* 2014). Nevertheless, the SE European record remains little known and still out of the discussed frame.

Malik & Nafiz (1933: pl. XI, fig. 2; pl. XI, fig. 3; pl. XI, figs 4, 5; pl. X, figs 3, 4) described from Küçükçekmece East a right mandible with dp2-dp4, a part of a left mandible with p4-m3, an isolated m2, one m3 and two metatarsals as *Dorcatherium puyhauberti* Arambourg & Piveteau, 1929. This material is morphologically and dimensionally identical with the one described here, representing a single species. Geraads *et al.* (2005) also described from the nearby site of Yulaflı three partially preserved lower toothrows, and a metatarsal III+IV without distal ends, indicating strong similarities between the Yulaflı and the Küçükçekmece tragulids. As Nicolas (1978) before them, Geraads *et al.* (2005) refer samples from both fossil sites to *Dorcatherium jourdani* Depéret, 1887, which taxonomic validity is presently questioned (e.g., Morales *et al.* 2012; Aiglstorfer *et al.* 2014).

The occlusal length of the lower molar row is 41 mm in the specimen illustrated by Malik & Nafiz (1933), 42 mm in two samples from Yulaflı (Geraads *et al.* 2005; though maximum molar row length may reach 44.40 mm; S. Mayda pers. comm. 2015) and 41.8 mm for the specimen studied here. Similarly with the Küçükçekmece tragulid, the Yulaflı specimens show advanced selenodonty, long p4 with simplified distal valley, large m3 with similar structure of the third lobe, comparable development of *Dorcatherium* and *Tragulus* folds, weak buccal postentocristid, weak cingula and basal pillars (entostylids), and presence of a distinct lingual protocristid. Hence, we suggest tragulids from these two neighboring and roughly contemporaneous sites represent a single *Dorcatherium* species, in agreement with Geraads *et al.* (2005). The Küçükçekmece-Yulaflı species is twice as large as the living *Moschiola meminna* (Erxleben, 1777) and about 30% larger than the dentally more similar *Hyemoschus aquaticus* (Ogilby, 1841). Using body mass equations proposed by Janis (1990), the average weight of the Küçükçekmece–Yulaflı species, based on the length of the M2, m2 and m1-m3 row, is estimated at 31.4 kg, ranging between 24.8 and 38.5 kg (n = 13). According to the body weight data provided by Alba *et al.* (2011) the Küçükçekmece-Yulaflı tragulid is comparable in size to *D. naui* Kaup, 1833 from Can Petit, Ballestar and Los Valles de Fuentidueña, Spain.

TABLE 3. — Postcranial dimensions of *Dorcatherium maliki* n. sp. from Küçükçekmece West, Turkey. *, transverse diameter of the trochlea; **, TD and APD at the level of sustentaculum talii. Abbreviations: see Material and methods.

Specimen	L		TDP	APDP	TDM	TDD	APDD
MNHN.F.TRQ727 Humerus	–		–	–	–	(26)	19.0
MNHN.F.TRQ728 Humerus	–		–	–	–	26.0	17.0
MNHN.F.TRQ733 Radius	–		–	–	–	29.3	19.9
MNHN.F.TRQ746 Mc	–		–	–	–	11.6*	11.3
MNHN.F.TRQ747 Mc	–		–	–	–	10.7*	10.8
MNHN.F.TRQ718 Tibia	*c.* 140		–	–	–	23.8	21.2
MNHN.F.TRQ717 Tibia	–		–	–	–	29.3	23.5
MNHN.F.TRQ720 Tibia	–		–	–	–	23.2	18.3
MNHN.F.TRQ721 Tibia	–		–	–	–	23.4	17.8
MNHN.F.TRQ704 Calcaneum	60.8		17.6**	21.4**	–	–	–
MNHN.F.TRQ703 Calcaneum	60.5		17.3**	22.5**	–	–	–
MNHN.F.TRQ705 Calcaneum	–		17.1**	–	–	–	–
	Ll	**Lm**					
MNHN.F.TRQ706 Astragalus	32.5	30.0	16.7	–	–	–	16.9
MNHN.F.TRQ707 Astragalus	32.9	29.3	16.2	–	–	–	17.0
MNHN.F.TRQ708 Astragalus	–	29.0		–	–	–	17.3
MNHN.F.TRQ710 Astragalus	29.0	26.0	14.3	–	–	–	15.2
MNHN.F.TRQ711 Astragalus	33.5	30.9	17.5	–	–	–	17.4
MNHN.F.TRQ713 Astragalus	–	29.7		–	–	–	17.5
MNHN.F.TRQ714 Astragalus	28.6			–	–	–	
MNHN.F.TRQ716 Astragalus	38.2	33.7	19.6	–	–	–	20.0
ITU352 Astragalus	39.3	35.8		–	–	–	21.5
MNHN.F.TRQ741 MtIII-IV	>106.0		24.3	21.8	21.3	34.0	16.6
MNHN.F.TRQ765 MtIII-IV	–		–	–	–	15.3*	15.8
MNHN.F.TRQ731 Phx I central	27.9		12.5	–	–	8.9	–
MNHN.F.TRQ729 Phx I lateral	21.4		10.9	–	–	8.3	–
MNHN.F.TRQ737 Phx IIIcentral	25.4		12.6	–	–	–	–
MNHN.F.TRQ736 Phx III lateral	23.9		9.9	–	–	–	–
MNHN.F.TRQ735 Phx III lateral	20.0		8.3	–	–	–	–

Upper and lower molar proportions of the Küçükçekmece and Yulaflı sample occupy an area in between the maximum observed values for *Dorcatherium naui* and the minimum for *D. vindebonense* von Meyer, 1846 (Fig. 4). Compared to the studied species, *D. guntianum* von Meyer, 1846 is too small to be further considered (Fig. 4; metrical comparison based on data provided by Rössner & Heissig 2013; Alba *et al.* 2011, 2014). The little known *D. jourdani* from Croix Rousse, France is also smaller than the Küçükçekmece-Yulaflı species, showing slightly shorter and constantly narrower upper and lower molars and shorter m3 (Fig. 4; metrical comparison based on data provided by Rössner & Heissig 2013). According the restricted available data, *D. puyhauberti* from Vathylakkos, Axios Valley, Greece, is characterized by smaller upper molars and much shorter m3 (Fig. 4), though the rest of its lower molars are placed within the normal range of *D. naui* and close to those of the studied species. The index "length m3/length m2 %" is 126.9 in MNHN.F.SLQ788 of *D. puyhauberti* and 135 in CR68 of *D. jourdani* instead of 146.5-148.7 in Küçükçekmece (n = 2), 142.1-143.9 in Yulaflı (n = 2), 146.1-163.5 in *D. naui* from Eppelsheim, Germany (n = 3), and 145.8-172.3 in *D. crassum* from Sansan, France (n = 3) (metrical data from Rössner & Heissig 2013).

By their size, the three dP4 from Küçükçekmece are placed close to the values recorded for *D. jourdani* from Croix Rousse and *D. naui* from several West European sites (metrical data from Alba *et al.* 2011; Morales *et al.* 2012; Rössner & Heissig 2013; Aiglstorfer *et al.* 2014) (Fig. 4). The p3 is as long as that of *D. vindebonense* but proportionally narrower (Fig. 4). The sample of the adequately represented p4 from Küçükçekmece (n = 4) plus Yulaflı (n = 2) shows a great overlapping with that of *D. naui* from several Central and West European sites, though with a tendency to be longer (Fig. 4). The single preserved dp2 from Küçükçekmece West (Table 2) is placed within the range of *D. crassum* from Sansan and Els Casots (L = 10.5-11.6 mm, n = 7; metrical data from Rössner & Heissig 2013 and Alba *et al.* 2014), being significantly longer than a single known dp2 of *D. naui* from Gratkorn (L = 8.9 mm; Aiglstorfer *et al.* 2014).

The advanced hypsodonty and selenodonty of the studied species clearly differentiate it morphologically from both *D. crassum* and *D. vindebonense*. Like *D. naui* and *D. jourdani* the Küçükçekmece-Yulaflı species is characterized by upper molars with less bulky styles, a short *Dorcatherium*-fold, a buccally shifted third lobe of m3, and weak mesiobuccal conid on the p3 (Sánchez *et al.* 2011; Morales *et al.* 2012; Aiglstorfer *et al.* 2014; not all features known for *D. jourdani*). In difference, however, from *D. naui* and *D. jourdani* (Depéret 1887: pl. XIII, fig. 38) the Küçükçekmece sample shows a tricuspid dp2 like that of *D. crassum* (Morales *et al.* 2012: figs 29-31), though without bulky protoconulid and with longer hypoconid in comparison with the protoconid. As the p2 and dp2 of European *Dorcatherium* species show the same condition (namely, tricuspidy or bicuspidity: Morales *et al.* 2012; Aiglstorfer *et al.* 2014), the tricuspidy of the Küçükçekmece dp2 leads us to assume that this taxon had a tricuspid p2 as well, in contrast again to *D. naui*. Unlike *D. crassum* from Sansan, France and Sandelzhausen, Germany (Rössner 2010), *D. naui* from Can Mata, Spain and Gratkorn, Austria (Alba *et al.* 2011; Aiglstorfer *et al.* 2014) and *D. jourdani* from Croix Rousse, the p3 from Küçükçekmece shows a more mesiodistally developed hypoconid compared to the protoconid. The Küçükçekmece-Yulaflı p4 differs from that of *D. crassum* in the well-individualized protoconulid and the long posterior fossette, which is simpler than in the specimens of *D. naui* from Gratkorn and *D. guntianum* from Wannenwaldtobel 2 (Sach 1999; Aiglstorfer *et al.* 2014: fig. 5) and rather closer to the Abocator de Can Mata and Eppelsheim morphotypes of *D. naui*. A lingual protocristid, occasionally seen in an incipient stage of development in West European populations of *D. naui*, becomes more frequent and distinct in the Küçükçekmece and Yulaflı lower molars. In a lesser degree, the same feature occurs in three out of the six preserved lower molars of *D. puyhauberti* from Vathylakkos, Greece (MNHN; pers. obs.). A tendency similar to the supposedly typical character of the latter species (i.e. an extremely long postmetacristid, marginally reaching the *Tragulus*-fold; Geraads *et al.* 2005) is also seen on the m1 of MNHN.F.TRQ748 (Fig. 3A) and in two additional isolated lower molars (MNHN.F.TRQ765, ITU no No.) from Küçükçekmece. Nevertheless, *D. puyhauberti* from Vathylakkos has significanty smaller M2, M3 and m3 (Fig. 4), and reduced cingulum on the posterior lobe of the upper molars compared to the Küçükçekmece tragulid. A well preserved half-mandible from Strumyani, Bulgaria referred to *D.* cf. *puyhauberti* by Geraads *et al.* (2011), also shows shorter p3, p4 and m3 compared to the Küçükçekmece-Yulaflı species.

A comparison of the postcranial elements is not really feasible as – apart for *D. crassum* from Sansan (Morales *et al.* 2012) – most species are insufficiently known. Additionally, the best-represented postcranials from Sansan (astragali, n = 36; calcanei, n = 15; metatarsals, n = 9; Morales *et al.* 2012: table 2) indicate that differences between minimum and maximum measured values may exceed 20%, indicating large intraspecific variation. The distal humeri from Küçükçekmece (Table 3) are comparable in size to a single specimen of *D. crassum* from Sansan and close to *D. naui* from Eppelsheim and Atzelsdorf (Kaup 1832; Hillenbrand *et al.* 2009; Morales *et al.* 2012). The distal radius from Küçükçekmece (MNHN.F.TRQ733, Table 3) appears significantly larger than specimens from Sansan (n = 6) and a single specimen of *D. jourdani* from Croix Rousse reported by Depéret (1887). It additionally differs from *D. crassum* in the wider and shallower groove for the extensor carpi radialis and the much weaker groove for the common extensor tendon of the digits (Fig. 3M, compared to Morales *et al.* 2012: figs 37, 41). In these features it looks similar to the Atzelsdorf distal radius of *D. naui* (Hillenbrand *et al.* 2009: pl. 1, fig.13). The single complete tibia from Küçükçekmece (MNHN.F.TRQ718, Fig. 3P), which however belongs to a young adult individual, appears similar in length to that from Croix Rousse and quite shorter than that from Sansan (Morales *et al.* 2012: tab. 2 but Depéret 1887: 225 reported a tibia of *D. crassum* with comparable length to the Küçükçekmece one). As in *D. naui* and unlike *D. crassum* (Aiglstorfer *et al.* 2014) the Küçükçekmece tibia shows no fusion with maleolus lateralis and a much narrower and more plantarily extended medial concavity of the cochlea tibiae (Fig. 3O, P). The size range of the Küçükçekmece astragali (n = 7) appears much greater than that of *D. crassum* from Sansan. The size variability of the astragali (v' = 31.5; *sensu* Freudenthal & Cuenca-Bescós 1984) is, however, less than the intaspecific size variability estimated from the body weight of the species based on dental data alone (v' = 43.1), precluding second thoughts on the homogeneity of the material. Excluding two small astragali (MNHN.F.TRQ710, TRQ714) that possibly represent young individuals, the rest of the studied sample indicates large dimensions (Fig. 4), marginally overlapping with the Sansan size range of *D. crassum*. MNHN.F.TRQ706, TRQ707, TRQ708 and TRQ711 have similar size to the larger specimens of *D. naui* from Atzelsdorf and the single astragalus from Gratkorn (Fig. 4), whereas MNHN.F.TRQ716 and TRQ732 are as large as a single astragalus from the Vallesian fauna from Kastellios Hills in Crete Island refered to as cf. *Dorcabune anthracotheroides* by Made (1996). As the astragali of *D. naui* from Gratkorn and Atzelsdorf (Hillenbrand *et al.* 2009: pl. 1, fig. 12; Aiglstorfer *et al.* 2014: fig. 2s) and in difference from *D. crassum* from Sansan (Morales *et al.* 2012: figs 63-64), the Küçükçekmece astragali (Fig. 3O) show weaker angle between the axes of the proximal and distal trochlea, whereas the lateral condyle of the caput tali is wider and the medial condyle more prominent distally in dorsal view. By their size, the two complete calcanei from the Küçükçekmece (Table 3; Fig. 3L) are well within the size range of the Sansan sample (Morales *et al.* 2012). Nevertheless, the coracoid process is weaker, the articular surface for the maleolar is longer and narrower, and the articular surface for the cubonavicular faces plantary instead of medially in *D. crassum* (Morales *et al.* 2012: figs 58-59). The Küçükçekmece metatarsals (including those described by Malik & Nafiz [1933]) appear slightly more robust and certainly longer than those of *D. crassum* from Sansan (L < 100, n = 9; Morales *et al.* 2012, instead of >106, n = 3 in Küçükçekmece). They also differ in the much wider frontal groove between the MtIII and MtIV (Fig. 3N), and the more unevenly placed proximal surfaces for the cubonavicular and the ectomesocuneiforme. Unfortunately no complete metatarsals of *D. naui* or *D. jourdani* are known to us for a further comparison.

To sum up, the Küçükçekmece-Yulaflı tragulid shows great general morphometric resemblance to the West and Central European *D. naui*, from which, however, it differs in the slightly larger size (M3/m3, astragali), longer lower premolars, and the expression of some dental features. Among them, the most important are: (1) the presence of tricuspid dp2 (and possibly p2); (2) the stronger mesiodistal development of the hypoconid on the dp2 and p3; (3) the rather simple posterior fossette of the p4; and (4) the common presence of a dintinct lingual protocristid on the lower molars. In character (2) the Thracian tragulid recalls *D. guntianum* from Wannenwald-

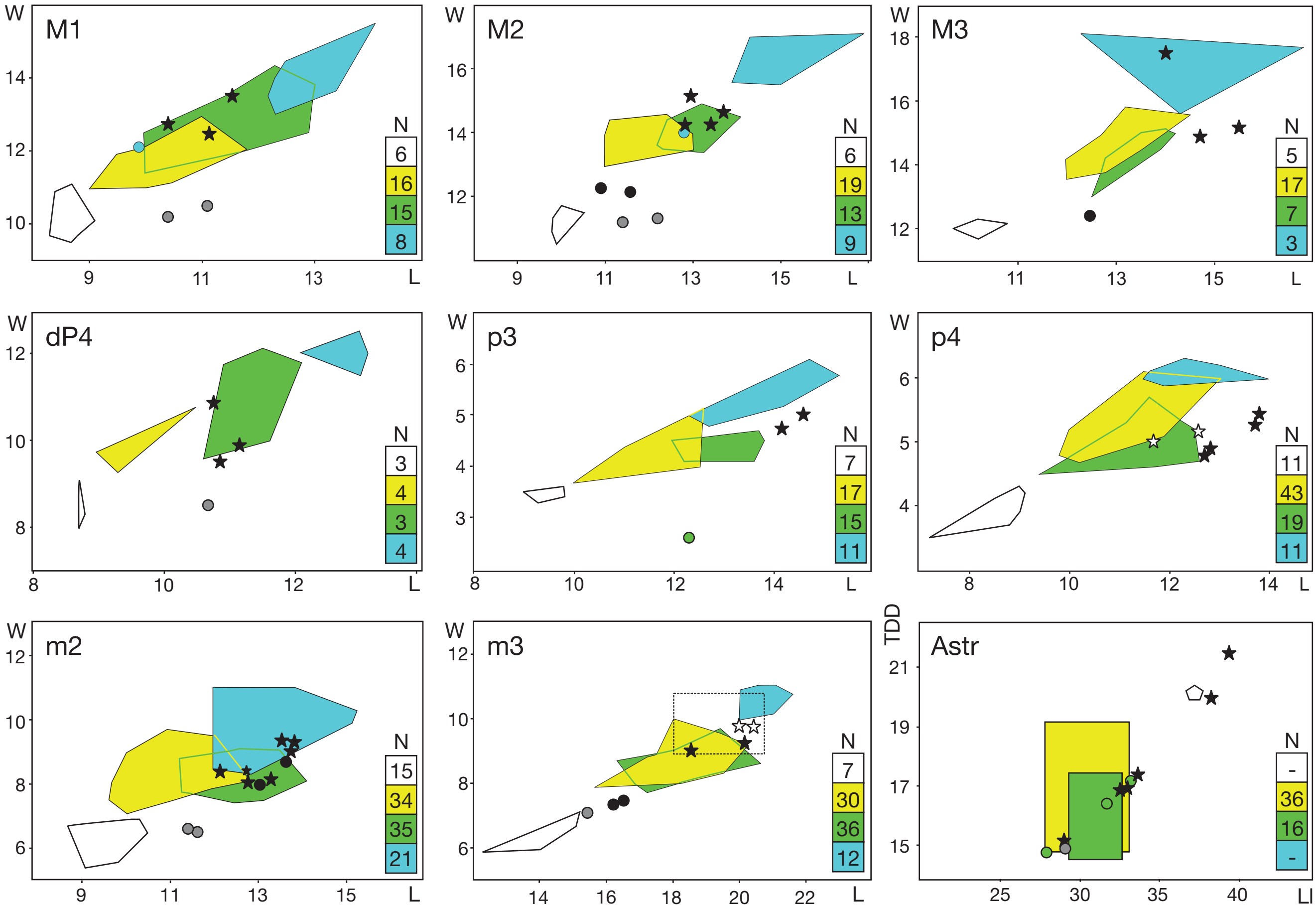

Fig. 4. — Metrical comparison of several European *Dorcatherium* Kaup, 1833 species. Scatters adopted and modified from Alba *et al.* (2011: fig. 4A) for DP4 and Alba *et al.* (2014: fig. 7) for M1, M2, M3, p3, p4, m2, m3, adding data from Rössner (2010), and Aiglstorfer *et al.* (2014), as well as personal data on *D. puyhauberti* Arambourg & Piveteau, 1929 from Axios valley, Greece (based on MNHN collection). Data sources for astragali from Morales & Soria (1981), Hillenbrand *et al.* (2009), Morales *et al.* (2012) and Aiglstorfer *et al.* (2014). Coloured areas represent convex hulls of original distributions with outliers per species indicated with the same coloured circles. For astragalus, boxes represent minimum-maximum size range. The number of records per species (**N**) is given in the similar coloured boxes associated with each distribution. **White area**, *D. guntianum* von Meyer, 1846; **yellow area**, *D. crassum* (Lartet, 1851); **green area**, *D. naui* Kaup & Scholl, 1834; **blue area**, *D. vindebonense* von Meyer, 1846. Symbols: ●, *D. jourdani* Depéret, 1887; ●, *D. puyhauberti* Arambourg & Piveteau, 1929; ★, Küçükçekmece tragulid; ☆, Yulaflı tragulid; ⬠, Kastellios tragulid, Crete Island. The dashed box on m3 indicates minimum-maximum range for Küçükçekmece.

tober 2, Germany (Sach 1999) and *D. naui* from Abocador de Can Mata, Spain (Alba *et al.* 2011), both representing earlier members of the European "selenodont phylogenetic lineage" (*sensu* Rössner & Heissig 2013). Characters (3) and (4) are not unique to the studied form and their variation in different chrono-spatial populations of the genus is still unknown. Character (1) excludes, however, *D. naui* as a possible affiliation and in combination with the rest of the observed features (i.e. advanced selenodonty, large M3/m3, long premolars, long hypoconid compared to the protoconid on dp2, p3, and common presence of a distinct lingual protoctistid on lower molars) justify, in our opinion, the foundation of a new species, namely *Dorcatherium maliki* n. sp. The discontinuous geographic distribution between *D. naui* at the northwest and the Thracian taxon to the south-east (see Geraads *et al.* 2005: fig. 14) would also support such a decision. Phylogenetic relations between *D. maliki* n. sp. and the later *D. puyhauberti* can also be alleged on the basis of some secondary dental features, but more material of both species is necessary to test this hypothesis.

Family Giraffidae Gray, 1821

Genus *Palaeotragus* Gaudry, 1861

Type species. — *Palaeotragus rouenii* Gaudry, 1861, by original designation.

Palaeotragus sp. (large)
(Fig. 5A-G; Tables 4, 5, 6)

Camelopardalis attica – Malik & Nafiz 1933: 52.

Palaeotragus sp. – Nicolas 1978: 456

Material examined and measurements. — **Küçükçekmece West**: left m3, MNHN.F.TRQ439 (L = 39.8 mm, W = 20.7 mm); right m1-(part of) m3, TRQ368 (m1: L = *c.* 26.8 mm; m2: L = 30.8 mm, W = 20.6 mm); part of lower molar, TRQ434; distal humerus, TRQ444 (TDM = 52.0 mm; TDD = 106.5 mm); juvenile radius, TRQ445 (L>510.0 mm; TDP = 100.7 mm; TDM = 54.7 mm; DTD = *c.* 92 mm); proximal radius, TRQ449 (TDP = 110 mm; APDP = 57.7 mm); juvenile metacarpal

TABLE 4. — Metapodial dimensions of *Palaeotragus* sp. and *Palaeogiraffa pamiri* (Ozansoy, 1965) from Küçükçekmece West, Turkey. Abbreviation: **j**, juvenile. Other abbreviations: see Material and methods.

Metapodials		**L**	**TDP**	**APDP**	**TDM**	**APDM**	**TDD**	**APDD**
Palaeotragus sp.								
Mc	MNHN.F.TRQ438 j	>320	70.9	44.6	26.4	29.1	–	–
Mt	MNHN.F.TRQ536	–	57.2	62.8	–	–	–	–
	MNHN.F.TRQ540	–	–	–	–	–	(65)	39.3
Palaeogiraffa pamiri								
Mc	MNHN.F.TRQ479 j	>400	86.6	59.9	45.0	43.0	–	–
	MNHN.F.TRQ538	–	91.6	56.7	–	–	89.0	56.5
	MNHN.F.TRQ541	–	–	–	–	–	–	44.4
Mt	MNHN.F.TRQ533 j	>435	50.7	63.7	39.2	42.0	–	–
	MNHN.F.TRQ539	–	–	–	–	–	69+	(44)
	MNHN.F.TRQ543	–	–	–	–	–	68.4	46.0
	MNHN.F.TRQ535	–	71.6	71.3	–	–	–	–
	MNHN.F.TRQ537	–	–	–	41.6	41.0	–	46.7
	MNHN.F.TRQ534	–	66.3	74.1	–	–	–	–
	ITU365	–	–	–	–	–	78	–

TABLE 5. — Astragalus dimensions of *Palaeotragus* sp. and *Palaeogiraffa pamiri* (Ozansoy, 1965) from Küçükçekmece West, Turkey.

Astragalus	**Ll**	**Lm**	**TDP**	**TDD**
Palaeotragus sp.				
MNHN.F.TRQ522	82.0	75.7	55.6	52.2
MNHN.F.TRQ526	81.8	73.3	49.6	50.6
MNHN.F.TRQ525	90.3	81.2	–	51.7
MNHN.F.TRQ521	86.2	78.6	54.0	50.9
Palaeogiraffa pamiri				
MNHN.F.TRQ524	85.3	75.3	58.5	57.1
MNHN.F.TRQ523	93.0	83.8	62.5	56.3
MNHN.F.TRQ520	92.5	80.5	55.0	58.9

TRQ438; distal femur, TRQ487 (TDD = 96.7 mm); tibia, TRQ502 (L = 510.0 mm; TDM = 54.0 mm; TDD = 82.0 mm); distal tibia, TRQ508, TRQ509 (TDD = 78.0; 79.0 mm); calcaneum, TRQ515 (L = 156.0 mm), TRQ516 (L = 175.0 mm; TD at sustentaculum tali = 52.4; APD at coracoids process = 70.6); part of calcaneum, TRQ517, TRQ518; cubonavicular, TRQ530 (TDmax = 67.0 mm; APDmax = 61.0 mm); astragalus, TRQ521, 522, 525, 526; proximal part of metatarsal, TRQ536; distal part of metatarsal, TRQ540; first phalanx, TRQ555, TRQ557, TRQ563, TRQ564, TRQ567, TRQ604, TRQ616; second phalanx, TRQ568, TRQ569, TRQ571, TRQ572, TRQ578; third phalanx, TRQ597 (L = 73.4 mm; H = 43.3 mm).

ADDITIONAL MEASUREMENTS. — See Tables 4, 5, 6.

DESCRIPTION AND REMARKS

A few dental and some fragmentary postcranial elements represent a small to medium sized giraffid (Fig. 5). The lower molars have very banal giraffid morphology with the crescents being slowly fused with wear. The protoconid and the hypoconid are slightly constricted buccally (Fig. 5A). The metaconid is smoothly convex and the rib of the entoconid projects weakly on the lingual wall. There is no basal pillar on the first two lower molars but it does exist on the third one. The parastylid and the metastylid are present on m3, which also bears a weak entostylid in the upper part of the crown (Fig. 5B). The third lobe of m3 is strong and sub-square shaped in occlusal view.

The lower molars and especially the m3 morphology of the Küçükçekmece West species differs significantly from the similar-sized *Bohlinia* Matthew, 1929 in showing less strong lingual ribs, less obliquely set lingual crescents, narrower protoconid and hypoconid, more elliptical third lobe, and a posthypocristid that does not reach the lingual wall (Fig. 5B). The morphological characters of the available teeth and postcranials (Figs 5, 6) match better the Palaeotragini Pilgrim, 1911. Dimensionally the Küçükçekmece West small giraffid is larger than *Palaeotragus rouenii* Gaudry, 1861 from Pikermi, Samos (Greece) and other Turolian SE European sites and smaller than *Samotherium* Forsyth-Major, 1888 from Samos, Vathylakkos (Greece) and Maragheh (Iran).

The m3 dimensions fit pretty well those of *Palaeotragus coelophrys* (Rodler & Weithofer, 1890) from Maragheh, *Achtiaria expectans* Borissiak, 1914 from Sebastopol, Ukraine, *Palaeotragus hoffstetteri* Ozansoy, 1965 from Yassiören, Turkey, and *P.* cf. *coelophrys* from China (Borissiak 1914; Bohlin 1926; Ozansoy 1965). They are also close to the dimensions of *Palaeotragus* from Pentalophos, and Ravin de la Pluie, Axios valley, Greece and Loc. 49 of Middle Sinap, Turkey (Geraads 1978; Gentry 2003; pers. obs.). Nevertheless, the taxonomy of the late Miocene large *Palaeotragus* is highly confused, and – as pointed by Geraads (2013) – in bad need of revision. The hypsodonty index (height/length) for the m3 MNHN.F.TRQ439 is 49, quite less than in *P. coelophrys* from Maragheh (63; MNHN.F.MAR669) and closer to the value obtained for the Pentalophos species (54; LGPUT PNT328). The same index is 36 for the somewhat worn specimen from Loc. 49 (spec. 91704) of Middle Sinap (Gentry 2003). Additionally, the Maragheh *P. coelophrys* shows more intense lingual ribs and stronger parastylid and metastylid than the Küçükçekmece West m3, which in these features looks, again, more similar to the Pentalophos and Loc. 49 species.

Apart from astragali, and first and second phalanges the preserved postcranials are too fragmentary to be fully compared, and most of them belong to immature indi-

Fig. 5. — *Palaeotragus* sp. (large sized) and *Bohlinia* cf. *attica* from Küçükçekmece West, Turkey. *Palaeotragus* sp.: **A**, m1-m3(part) dex, MNHN.F.TRQ368 in occlusal view; **B**, m3 sin, MNHN.F.TRQ439 in occlusal view; **C**, distal femur, MNHN.F.TRQ487 in medial view; **D**, astragalus, MNHN.F.TRQ521 in plantar view; **E**, calcaneum, MNHN.F.TRQ515 in dorso-medial view; **F**, first phalanx, MNHN.F.TRQ555 in dorsal view; **G**, juvenile metacarpal, MNHN.F.TRQ438 in dorsal view. *Bohlinia* cf. *attica*: **H**, ossicone, MNHN.F.TRQ417 in lateral view (**up**) and natural basal cross section (**down**). Scale bars: 2 cm.

viduals (Fig. 5D-G). The astragalus from Küçükçekmece West (Fig. 6) is larger than that of *P. rouenii* and narrower distally than that of *S. boissieri* Forsyth-Major, 1888 from Samos, approaching more closely specimens referred to as *P. coelophrys* or *P. hoffstetteri*. Metacarpals and metatarsals from Küçükçekmece West appear dimensionally close to those of *P. coelophrys* from Maragheh and *Palaeotragus* from Middle Sinap (Loc 72 and Loc 49; Gentry 2003), although available data are statistically insufficient. Malik & Nafiz (1933: pl. IX, figs 3, 4) described a lower m1 and a talus as *Camelopardalis attica*; both, however, can be better taken as *Palaeotragus* sp.

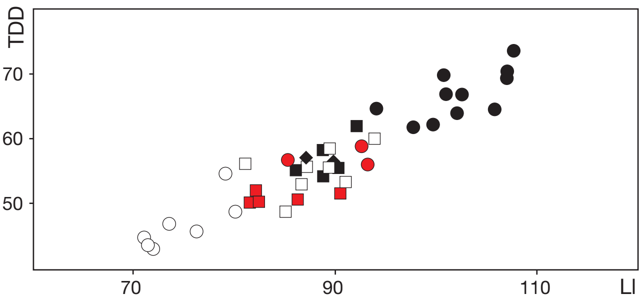

Fig. 6. — Metrical comparison of astragali of several late Miocene giraffids: 🟥, *Palaeotragus* from Küçükçekmece West; 🔴, *Palaeogiraffa* from Küçükçekmece West; ●, *Samotherium major* Bohlin, 1926; ■, *Samotherium boissieri* Forsyth-Major, 1888; ○, *Palaeotragus rouenii* Gaudry, 1861; □, *Palaeotragus* Gaudry, 1861 specimens referred to as *P. coelophrys* (Rodler & Weithofer, 1890); ◇, *P. hoffstetteri* Ozansoy, 1965.

Palaeogiraffa Bonis & Bouvrain, 2003

Type species. — *Palaeogiraffa macedoniae* (Geraads, 1989), by subsequent designation (Bonis & Bouvrain 2003: 10).

Palaeogiraffa pamiri (Ozansoy, 1965)
(Fig. 7; Tables 4, 5, 6, 7)

Samotherium sp. – Nicolas 1978: 456.

Material examined and measurements. — **Küçükçekmece West:** Buccal wall of P3/4 MNHN.F.TRQ423; part of right maxilla with M2-M3, TRQ421; left M1, TRQ425; right M2 TRQ422; right M1/2, TRQ428, TRQ424; left M1/2, TRQ429, TRQ426; part of right mandibular ramus with p4-m3, TRQ431; part of left mandibular ramus with p4-m3, TRQ432; part of right mandibular ramus with m1-m3, TRQ430; right m1, TRQ437; left m1, TRQ433; part of lower molars TRQ435, TRQ436; distal humerus, TRQ443

Table 6. — First and second phalanx dimensions of *Palaeotragus* sp. and *Palaeogiraffa pamiri* (Ozansoy, 1965) from Küçükçekmece West, Turkey (plus an additional specimen from Küçükçekmece East in ITU).

	L	TDP	APDP	TDD	APDD
1st Phalanx					
Palaeotragus sp.					
MNHN.F.TRQ555	90.9	37.0	41.7	29.4	24.4
MNHN.F.TRQ557	82.3	34.8	40.4	31.0	26.1
MNHN.F.TRQ564		36.0	42.2		
MNHN.F.TRQ567		36.2	40		
MNHN.F.TRQ563		31.4	38.7		
MNHN.F.TRQ616				27.7	23.0
MNHN.F.TRQ604		36.6	40.5		
Palaeogiraffa pamiri					
MNHN.F.TRQ556	90.2	40.3	45.3	33.4	28.7
MNHN.F.TRQ558	98.7	45.8	46.9	36.0	29.6
MNHN.F.TRQ560	88.0	40.9	42.5	32.0	27.0
MNHN.F.TRQ561	96.1	42.9	47.0	37.0	30.6
MNHN.F.TRQ562		42.6	43.5		
MNHN.F.TRQ565		37.8	44.3		
MNHN.F.TRQ566		42.1	45.3		
2nd Phalanx					
Palaeotragus sp.					
MNHN.F.TRQ568	53.3	30.4	34.0	23.7	
MNHN.F.TRQ569	48.0	29.9	34.2	26.0	
MNHN.F.TRQ571	50.7	27.8	34.5	24.5	
MNHN.F.TRQ572	48.5	28.9	34.8	24.4	
MNHN.F.TRQ578	52.2	32.3	34.0	27.0	
Palaeogiraffa pamiri					
MNHN.F.TRQ376	55.7	33.1	40.7	28.9	
MNHN.F.TRQ573		34.0	42.0		
MNHN.F.TRQ575		35.5	41.2	30.1	
MNHN.F.TRQ577	53.0	32.9	39.0	33.1	
MNHN.F.TRQ583	55.0	36.5	40.0	34.6	
MNHN.F.TRQ585	*c.* 54	34.7	37.9	30.9	
MNHN.F.TRQ586	55.0	*c.* 32	*c.* 42	*c.* 29	
MNHN.F.TRQ588	54.5	36.2	43.1	31.7	
MNHN.F.TRQ589			*c.* 43	*c.* 36	
MNHN.F.TRQ590	53.0	35.7	40.9		
MNHN.F.TRQ591	52.0	33.8	37.6	29.0	
ITU no No.	56.0	36.0		30.7	

(TDD = 119.0 mm); proximal radius, TRQ481 (TDP = *c.* 99 mm; TDM = 67.0 mm); distal radius, TRQ446 (TDM = 67.5 mm; TDD = 99.8 mm); part of ulna, TRQ450 (H olecranon = 150.0 mm); metacarpal, TRQ479; proximal metacarpal, TRQ538; distal metacarpal, TRQ541; distal femur, TRQ441; cubonavicular, TRQ527 (TDmax = 74.0 mm; APDmax = *c.* 70 mm), TRQ529 (TDmax = 72.7 mm; APDmax = 75.2 mm); astragalus, TRQ520, TRQ523, TRQ524; calcaneum, TRQ513 (L = 187.0 mm; TD at sustentaculum tali = 56.9; APD at coracoids process = 81.8 mm), TRQ512 (L = 186.5 mm; TD at sustentaculum tali = 61.6; APD at coracoids process = 83.3 mm); metatarsal, TRQ435; proximal metatarsal, TRQ535; distal metatarsal, TRQ539, TRQ543; first phalanx, TRQ556, 558, 560, 561, 562, 565, 566; second phalanx, TRQ376, TRQ573, TRQ575, TRQ577, TRQ581, TRQ583, TRQ585, TRQ586, TRQ588, TRQ589, TRQ590, TRQ591; third phalanx, TRQ594 (L = 84.2 mm; H = 47.7 mm).
Küçükçekmece East: astragalus, ITU no No. (×2); second phalanx, ITU no No.

Additional measurements. — See Tables 4, 5, 6 and 7.

Description

The upper molars have strong styles, crescents fusing late in wear and no basal pillars. The mesostyle is placed behind the junction point of the fossettes (Fig. 7B, C). The posterior flange of the protocone (postprotocrista) is short and curves inwards. A weak cingulum is always present on the mesial face of the molars and in some specimens around the lingual wall of the mesial lobe. An enamel islet is occasionally present to the rear of the distal fossa. The molariform p4 is as high as the m2. In the little worn specimen MNHN.F.TRQ431 (Fig. 7A), the protoconid is already fused with the hypoconid (feature referred sometimes as continuous eocristid), the talonid has a continuous lingual wall due to the mesiodistally expanded metaconid, and the entoconid is oblique comparatively to the main axis of the tooth. The mesial fossette (mesosinusid *sensu* Geraads *et al.* 2013: fig. 1) is delimited posteriorly by a short transverse cristid (*sensu* Geraads *et al.* 2013: fig. 1) that does not reach the lingual wall. In more advanced stage of wear (MNHN.F.TRQ432; Fig. 7C) the protoconid and the hypoconid rest marginally fused and the distal flange of the metaconid (postmetacristid *sensu* Geraads *et al.* 2013: fig. 1) covers the half of the oblique entoconid. The lower molars (Fig. 7A, C, E) are narrow comparatively to their length. A weak mesial (goat) fold and a large basal pillar are usually present on m1 but both obliterate towards m3. The parastylid is weak and the metastylid quite strong. The third lobe of the m3 is elliptical, formed by a single semilunar cuspid (Fig. 7A, C, E).

Remarks

The material represents a medium-sized giraffid with moderately slender metapodials, close dimensionally to the well-known samotheres from the Turolian of the Balkano-Iranian province (especially *Samotherium boissieri* from Samos and *S. neumayri* (Rodler & Weithofer, 1890) from Maragheh). Nevertheless, the large premolars (judging from the size of p4 compared to m1), the large talonid in comparison with the trigonid on p4 and its continuous eocristid, the weak and symmetrical paracone rib on the upper molars and the assignment of the mesostyle to the distal lobe, and the presence of a fairly strong ectostylid on m1 prevent attributing the Küçükçekmece large giraffid to *Samotherium* (and palaeotragines in general) and indicate relations with sivatheriines (Hamilton 1978; Geraads 1986; Montoya & Morales 1991). The studied form differs from the Turolian *Helladotherium* Gaudry, 1860/*Bramatherium* Falconer, 1845 (see discussion in Geraads & Güleç 1999 about their possible synonymy) and the Pleistocene *Sivatherium* Cautley & Falconer, 1835 in the significantly smaller size and the much slenderer metapodials. The Küçükçekmece species agrees in size and morphology with *Decennatherium* Crusafont, 1952, *Birgerbohlinia* Crusafont, 1952 and *Palaeogiraffa* Bonis & Bouvrain 2003, even though Solounias (2007) recently proposed removing the first two genera from sivatheriines. Teeth dimensions of both *Birgerbohlinia* and *Decennatherium* from Spain are about 20% larger than the Küçükçekmece ones, whereas the p4 of the former taxon shows no continuous eocristid (Alcalá & Montoya 1994: fig. 4d). Furthermore, the limb proportions of the Küçükçekmece species are significantly different from those of the Span-

Fig. 7. — *Palaeogiraffa pamiri* (Ozansoy, 1965) from Küçükçekmece West, Turkey: **A**, right mandible, MNHN.F.TRQ431 in occlusal (**up**, reversed) and lingual (**down**) views; **B**, M1 sin, MNHN.F.TRQ425 in occlusal view; **C**, M2-M3 dex, MNHN.F.TRQ421 in occlusal view; **D**, left mandible, MNHN.F.TRQ432 in buccal view; **E**, m1-m3 dex, MNHN.F.TRQ430 in occlusal view; **F**, distal humerus, MNHN.F.TRQ441 in dorsal view; **G**, astragalus, MNHN.F.TRQ524 in plantar view; **H**, calcaneum, MNHN.F.TRQ513 in medial view; **I**, juvenile metacarpal, MNHN.F.TRQ479 in proximal and dorsal view. Scale bars: 2 cm.

ish forms; the metacarpals appear to be longer than those of *Birgerbohlinia schaubi* Crusafont, 1952 and wider that those of *Decennatherium pachecoi* Crusafont, 1952; the metatarsals are as long as those of *D. pachecoi* but as wide as those of *B. schaubi,* and the astragali are shorter than those of *B. schaubi* and wider distally than in *D. pachecoi* (Crusafont 1952; Montoya & Morales 1991).

Geraads (1979, 1989) recorded in the Vallesian faunas of the Axios valley, N. Greece, two species provisionally ascribed to *Decennatherium*: *D.*? cf. *pachecoi* from Ravin de la Pluie and *D.*? *macedoniae* Geraads, 1989 from Pentalophos, emphasizing, however, that these two species could belong to a different sub-generic group than the Spanish *D. pachecoi* and *B. schaubi*. He also suggested relationships between *Samotherium pamiri* Ozansoy, 1965 from Yassiören and the Pentalophos species. More recently, Bonis & Bouvrain (2003) created for this group of Eastern Mediterranean Vallesian giraffids the genus *Palaeogiraffa*, recognizing three species: *P. macedoniae* (Geraads, 1989) in Pentalophos, *P. pamiri* (Ozansoy, 1965) in Yassiören and Xirochori (Axios valley, Greece) and *P. major* Bonis & Bouvrain, 2003 in Ravin de la Pluie. At the same time Gentry (2003) described as *Decennatherium macedoniae* some more material from Loc. 4 of Middle Sinap and Geraads *et al.* (2005) referred to as ?*Palaeogiraffa* cf. *macedoniae* several postcranials from the Vallesian fauna of Yulaflı in European Turkey. The last authors also claimed that referring all these eastern forms to the same genus is uncertain since resemblances mostly rest upon primitive dental features, and they consequently suggested retaining *Palaeogiraffa* for the Pentalophos species only.

Table 7. — Teeth dimensions of *Palaeogiraffa pamiri* (Ozansoy, 1965) from Küçükçekmece West, Turkey.

	M1/2		M1		M2		M3		M2-M3
	L	W	L	W	L	W	L	W	L
MNHN.F.TRQ421	–	–	–	–	*c.* 41	–	–	–	*c.* 76.0
MNHN.F.TRQ422	–	–	–	–	36.7	38.2	–	–	–
MNHN.F.TRQ425	–	–	36.7	31.2	–	–	–	–	–
MNHN.F.TRQ428	37.8	–	–	–	–	–	–	–	–
MNHN.F.TRQ424	37.6	–	–	–	–	–	–	–	–
MNHN.F.TRQ429	–	35.4	–	–	–	–	–	–	–
	p4		**m1**		**m2**		**m3**		**m1-m3**
	L	W	L	W	L	W	L	W	L
MNHN.F.TRQ431	(30)	19.6	36.8	21.3	38.5	24.7	47.5	24.8	122.6
MNHN.F.TRQ430	–	–	33.6	22.6	35.2	23.2	41.9	20.5	112.2
MNHN.F.TRQ432	29.3	19.1	32.2	21.8	33.7	22.1	46.3	23.5	109.4
MNHN.F.TRQ437	–	–	36.3	24.4	–	–	–	–	–
MNHN.F.TRQ433	–	–	(31)	23.2	–	–	–	–	–

Direct comparison of the Küçükçekmece West species with the Eastern Mediterranean ones shows that it is slightly smaller than the Ravin de la Pluie giraffid and similar in size to both the Xirochori and Pentalophos species. Unlike most other giraffids except of the Spanish *Decennatherium* (Morales & Soria 1981; Alcalá & Montoya 1994), the presence of a continuous eocristid on the p4 is a significant resemblance between the Küçükçekmece West and the Pentalophos giraffe, and a strong evidence for their common generic assignment. In contrast, however, to *P. macedoniae* from Pentalophos, the upper molars of the Küçükçekmece giraffid bear a hypoconal islet and have stronger buccal and lingual cingula, the p4 has a longer and obliquely set entoconid, and the lower molars have stronger mesiobuccal cingulum. Most of these features appear in the Xirochori, Yassiören and Loc. 4 of Middle Sinap giraffids (Ozansoy 1965; Bonis & Bouvrain 2003; Gentry 2003), validating – in our opinion – their distinction from the Pentalophos species.

The Küçükçekmece West preserved postcranials (Fig. 7F-I) appear slightly longer but more robust than those of *Palaeotragus* from the same site (Fig. 6). Geraads *et al.* (2005) recorded at Yulaflı three complete metacarpals. Although a direct comparison with the Küçükçekmece West material is not possible because of the incompatibility of the available specimens, it seems that the size and proportions of both the Yulaflı and the Küçükçekmece West metapodials are close to those of *P. macedoniae* from Pentalophos. The Küçükçekmece distal humerus MNHN.F.TRQ443 (Fig. 7F) and the preserved parts of radii (MNHN.F.TRQ481, TRQ446) are also dimensionally and morphologically similar to those of *P. macedoniae* described by Geraads (1989).

Genus *Bohlinia* Matthew, 1929

Type species. — *Bohlinia attica* (Gaudry & Lartet, 1856), by subsequent designation (Bohlin 1926: 123; Matthew 1929: 546).

Bohlinia cf. *attica* (Gaudry & Lartet, 1856)
(Fig. 5H)

Material and measurements. — **Küçükçekmece West**: part of ossicone, MNHN.F.TRQ417; calcaneum, TRQ514 (L = 192.0 mm; APD at the coracoids process = 73.5 mm); posterior? first phalanx, TRQ559 (L = 104.5 mm; TDP = 41.1 mm; APDP = 44.3 mm; TDD = 36.7 mm); second phalanx, TRQ584 (TDP = *c.* 39.6 mm; TDD = 38.6 mm), TRQ587 (L = 58.0 mm; TDP = 37.4 mm; TDD = 34.6 mm), TRQ589 (L = 59.6 mm; TDP = 36.0 mm; TDD = 32.8 mm); third phalanx, TRQ596 (L = 93.0 mm; H = 52.0 mm).
Küçükçekmece East: astragalus, ITU no No. (Lmedial = 84 mm; TDD = 64.4 mm); distal metatarsal ITU no No. (TDD = 79.5 mm; APDD = 49.5 mm).

Description and Remarks

Malik & Nafiz (1933: 54) referred to as "*Orasius speciosus*" an isolated molar from the Küçükçekmece East site but this tooth was never illustrated. Nicolas (1978) also reported *Bohlinia* in the Küçükçekmece West sample without, however, more details. A fragment of a robust ossicone (preserved length at about 140 mm) with sub-squarish to cylindrical cross-section (Fig. 5H) and a few elongated and slender postcranials might indeed belong to *Bohlinia attica*. The ossicone MNHN.F.TRQ417 is extremely dense with a restricted central porous zone (Fig. 5H), reminiscing that of modern giraffe, whereas its surface is decorated by moderately wide and deep longitudinal grooves and sparsely distributed small and low knobs. In comparison with *Palaeogiraffa* from the same site, the calcaneum MNHN.F.TRQ514 is slightly longer but with much narrower and relatively more elongated body. Similarly, the first phalanx MNHN.F.TRQ559 is barely longer but slenderer and the astragalus (ITU no No.) wider.

Family Bovidae Gray, 1821

Genus *Gazella* Blainville, 1816

Type species. — *Gazella dorcas* (Linnaeus, 1758), by subsequent designation (opinion 108 of the ICZN) of Blainville (1816).

Gazella cf. *ancyrensis* Tekkaya, 1973
(Fig. 8)

Gazella gaudryi – Malik & Nafiz 1933: 63.

Gazella aff. *pilgrimi* – Nicolas 1978: 456.

MATERIAL AND MEASUREMENTS. — **Küçükçekmece West**: right horn-core MNHN.F.TRQ628 (L = *c.* 60 mm, HCBTD = 16.0 mm, HCBAPD = 16.4 mm). Küçükçekmece East: right horn-core ITU 351 (HCBTD = 17.4 mm, HCBAPD = 18.4 mm); horn-core ITU no No. (HCBTD = 18.0 mm, HCBAPD = 18.2 mm); rolled horn core ITU no No. (HCBTD = 17.1 mm, HCBAPD = 20.9 mm); part of left mandible with m1-m3, ITU 370 (m1: L = 9.1 mm, W = 5.0; m2: L = 9.4 mm, W = 5.2; Lm1-m3 = 30.6 mm).

DESCRIPTION AND REMARKS

The preserved horn-cores are short, straight or faintly curved backwards and circular in cross section with a well-marked posterior longitudinal furrow (Fig. 8A, B). The pedicles are high anteriorly compared to the horn-core length. The postcornual groove is round and moderately deep and the supraorbital foramens open into oval depressions. The lower molars lack mesial folds or basal pillars and their lingual wall is slightly undulated (Fig. 8C). The hypoconid is angular and both the hypoconid and the protoconid direct distally. The third lobe of m3 is single-cuspid, round and large relatively to the tooth size.

Malik & Nafiz (1933) referred several teeth and horn-cores from Küçükçekmece East to the genus *Gazella* but as this material has been lost, a direct comparison is not possible. Nonetheless, a left horn-core illustrated by these authors under the binomen *G. gaudryi* Schlosser, 1904 (Malik & Nafiz 1933: pl. XII, fig. 1) looks identical with those described here. The general morphological and metrical characters of the Küçükçekmece West gazelle is strongly reminiscent of *Gazella ancyrensis* Tekkaya, 1973 from the MN9 assemblage of Yassiören, Middle Sinap, Turkey. The relatively high pedicles, the weak medio-lateral compression, the short horn-cores with small diameters (Fig. 9) and the near absence of curvature are distinctive features of *G. ancyrensis* and usual characters of early *Gazella* (or *Gazella*-like; e.g., Bouvrain 1997: 9; Gentry 2003: 361) populations recovered from several Vallesian to early Turolian mammal assemblages of SE Europe and beyond (Tekkaya 1973; Köhler 1987; Bouvrain 1997; Gentry 2003; Kostopoulos & Bernor 2011).

Genus *Prostrepsiceros* Forsyth-Major, 1891

TYPE SPECIES. — *Pr. houtumschindleri* (Rodler & Weithofer, 1890) by subsequent designation of Forsyth-Major (1891: 609).

Prostrepsiceros sp.
(Fig. 10)

MATERIAL EXAMINED AND MEASUREMENTS. — **Küçükçekmece West**: left horn-core, MNHN.F.TRQ639 (HCBTD = 18.8 mm; HCBAPD = 24.9 mm); part of left horn-core, TRQ640 (HCBAPD = 25.7 mm). Provisionally attributed: part of right mandibular ramus with p4-m3, TRQ412 (p4: L = 8.5 mm, W = 5.0 mm; m1: L = 9.2 mm, W = 6.7 mm; m2: L = 11.2 mm, W = 8.4 mm; m3: L = 16.2 mm, W = 8.2 mm)

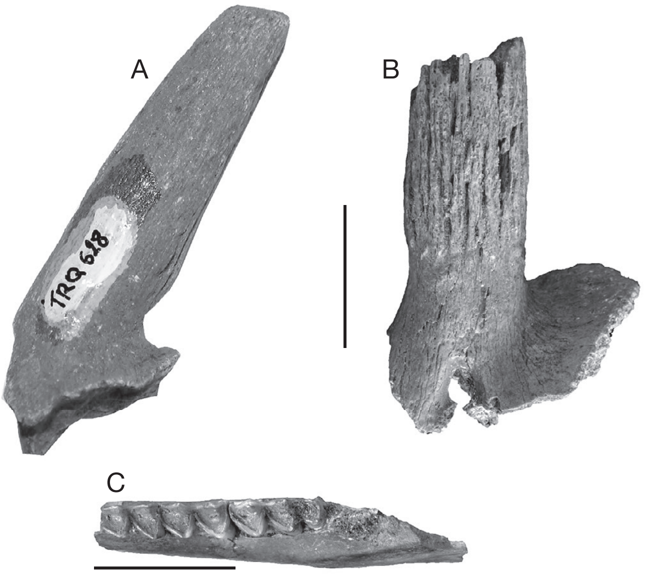

FIG. 8. — *Gazella* cf. *ancyrensis* from Küçükçekmece West, Turkey: **A**, left horn-core, MNHN.F.TRQ628 in lateral view; **B**, right horn-core, ITU351 in frontal view; **C**, left mandible, ITU370 in occlusal view. Scale bar: 2 cm.

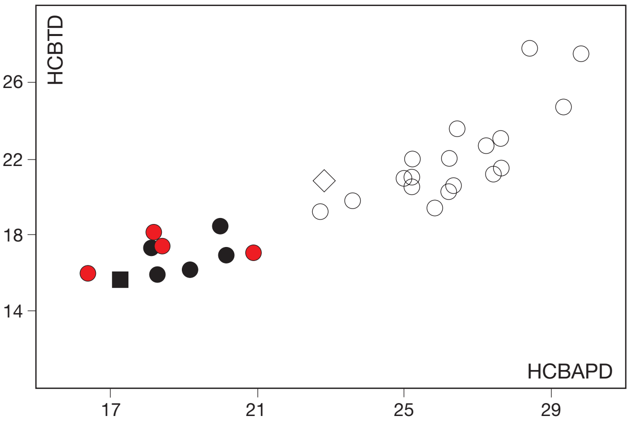

FIG. 9. — Comparison of the horn-core basal dimensions of several early *Gazella* populations with *G. capricornis* (Wagner, 1848) from Pikermi. ●, Küçükçekmece West sample; ●, *Gazella* from Pentalophos, Axios valley, Greece (pers. data); ■, type of *Gazella ancyrensis* Tekkaya, 1973 from Yassiören, Turkey (Tekkaya 1973); ◇, *Gazella* Blainville, 1816 from Loc 72, Middle Sinap, Turkey (Gentry 2003); ○, Pikermian gazelle (pers. data).

Küçükçekmece East: part of right horn-core, ITU no No. (HCBTD = 28.4 mm; HCBAPD = 29.6 mm);
Rami Sand Quarry: part of horn-core, ITU no No. (HCBTD = 23.8 mm; HCBAPD = 25.9 mm).

DESCRIPTION AND REMARKS

The most complete but strongly weathered specimen MNHN.F.TRQ639 (Fig. 11A) indicates a small heteronymous spiral-horned antelope with short, fast tapering horn-cores (preserved length along the anterior face *c.* 100 mm). In lateral view, the horn-core is smoothly curved posteriorly and then quickly re-curved upwards. It is placed above the orbit and bears traces of an anterior furrow. The torsion is loose and the spiralling closed. The supraorbital foramen opens into a pit, close to the base of

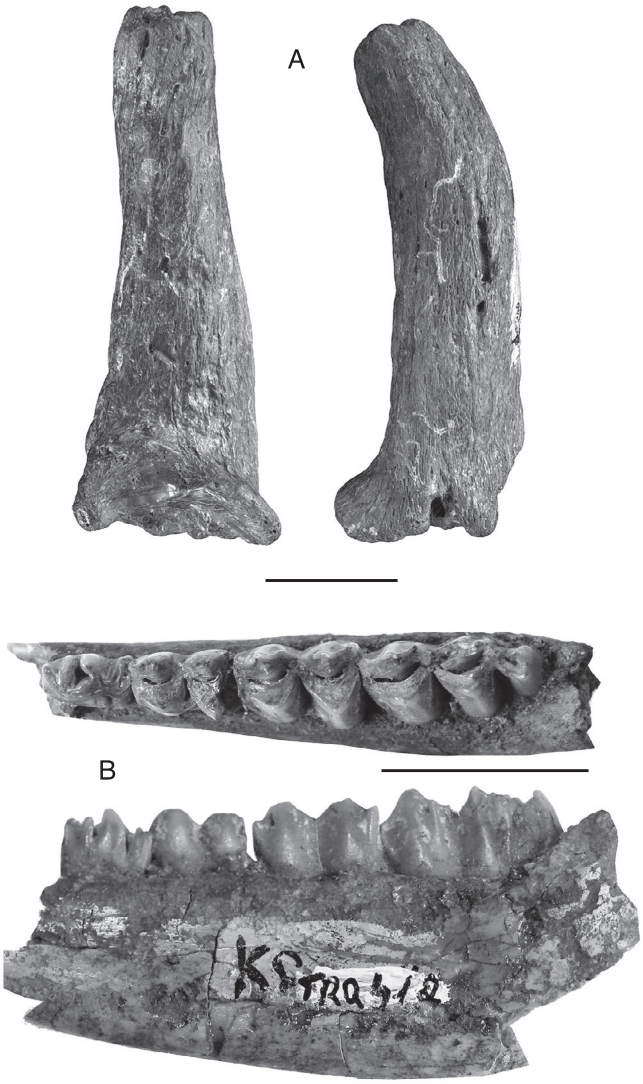

Fig. 10. — *Prostrepsiceros* sp. from Küçükçekmece West, Turkey: **A**, left horn-core, MNHN.F.TRQ639 in frontal (**left**) and medial (**right**) views; **B**, right mandible, MNHN.F.TRQ412 in occlusal (**up**) and lingual (**down**) views. Scale bars: 2 cm.

the pedicel (Fig. 11A). MNHN.F.TRQ640 is a part of a horn-core just above the pedicel. Although somewhat larger, it shows the same morphological features as the previous specimen; additionally a furrow is clear along its anterior face. Horn-core specimens from Küçükçekmece East and Rami Sand Quarry are similar in size and morphology to those from Küçükçekmece West.

A single mandibular fragment (MNHN.F.TRQ412; Fig. 11B) could be attributed to this species. The paraconid of the p4 directs distally and the metaconid mesially, so the valley between them tends to be closed though it remains narrowly open until late stage of wear. The hypoconid of the p4 is well developed. The lower molars show a weak mesial fold and a short and thin basal pillar. The metastylid is weak. The entostylid is as strong as the parastylid. The buccal end of the hypoconid is angular.

Among numerous late Miocene heteronymously spiral-horned antelopes, *Prostrepsiceros rotundicornis* (Weithofer, 1888) from Pikermi and Chomateres (MN12, Greece), *Prostrepsiceros fraasi* (Andree, 1926) from Maragheh and Samos (MN11-12, Greece) and *Sinapodorcas incarinatus* Bouvrain, Sen & Thomas, 1994 from Yassiören, and Loc. 91 of Middle Sinap (MN9-10, Turkey) show keel-less and helicoidally spiralled horn-cores with heteronymous torsion, similarly to the Küçükçekmece species (Bouvrain *et al.* 1994; Gentry 2003; Kostopoulos 2005). The spiralling is, however, much more open in *Pr. fraasi* and *S. incarinatus,* placing the Küçükçekmece form morphologically closer to *Pr. rotundicornis.*

Pr. rotundicornis is exclusively known from Turolian faunas of the Greco-Iranian province but Gentry (2003) attributes to this species a right horn-core from the late Vallesian Locality 63 of Middle Sinap. This early form differs from the typical Pikermi species in its smaller size and the shorter and faster tapering horn-cores that are less divergent, more inclined backwards and less obliquely inserted on the frontals (Gentry 2003). In these features the Loc. 63 species clearly approaches the Küçükçekmece one, which, however, lacks (but also possibly due to weathering) evidences of a keel descending to a posterolateral insertion. Both the Küçükçekmece and Loc. 63 samples show a parasagittal long diameter of the horn-core, distinct from the more oblique diameter seen in the Turolian representatives *Pr. rotundicornis.*

Basal horn-core dimensions of the Küçükçekmece and Loc. 63 specimens are placed in between those of *Pr. rotundicornis* from Pikermi and the latest Vallesian *Pr. syridisi* Kostopoulos & Koufos, 1996 from Nikiti-1 (Greece; e.g., Koufos *et al.* 2016 for a recent review). Similarly with the studied sample, the horn-cores of *Pr. syridisi* show anteroposteriorly trending great basal axis, tight spiralling, no anterior and a blunt posterior keel, but the horn-cores are certainly longer, and their mediolateral compression stronger (compression index is 71-83, n = 10 in Nikiti-1 versus 75.5-96, n = 3 in Küçükçekmece, and 85, n = 1 in Loc 63). As the material is very poor for definite conclusions, we suggest referring both the Küçükçekmece and Loc. 63 forms to as *Prostrepsiceros* sp.

Genus *Majoreas* Kostopoulos, 2004

Type species. — *Majoreas woodwardi* (Pilgrim & Hopwood, 1928) by subsequent designation (Kostopoulos 2004: 184).

Majoreas* cf. *elegans (Ozansoy, 1965)
(Fig. 11; Table 8)

Helicotragus rotundicornis – Malik & Nafiz 1933: 55. — Nicolas 1978: 456.

Palaeoreas lindermayeri – Malik & Nafiz 1933: 59.

Material examined. — **Küçükçekmece West**: basal part of right horn-core MNHN.F.TRQ636, TRQ635, TRQ637, TRQ632; basal part of left horn-core TRQ627, TRQ638; distal part of

TABLE 8. — Horn-core dimensions of *Majoreas* cf. *elegans* from Küçükçekmece West, Turkey (plus one specimen from Rami Sand Quarry referred to as cf. *Majoreas*).

		HCBTD (1)	HCBAPD (2)	Index (1)/(2)*100
MNHN.F.TRQ636	right	23.1	30.1	76.7
MNHN.F.TRQ627	left	–	30.3	–
MNHN.F.TRQ638	left	–	–	–
MNHN.F.TRQ635	right	23.3	29.8	78.2
MNHN.F.TRQ637	right	(19)	(30)	(63)
MNHN.F.TRQ632	right	25.4	35.0	72.5
Rami Sand Quarry no No.	?	26.7	32.3	82.6

horn-core TRQ634, TRQ644. Provisionally attributed: right M3, TRQ407 (L = 10.3 mm, W = 9.1 mm); m1/2 TRQ406 (L = 14.7 mm, W = 8.6 mm).

Küçükçekmece East: provisionally attributed part of mandibular ramus with p3-m2, ITU369 (p2: Lalveolar = 7.2 mm; p3: L = 9.4 mm, W = 5.7 mm; p4: L = 10.3 mm, W = 6.1 mm; m1: L = 10.9 mm, W = 7.5 mm; m2: L = -, W = 8.5 mm).

Rami Sand Quarry: ITU350; basal part of a right horn-core.

MEASUREMENTS. — See Table 8.

DESCRIPTION AND REMARKS

A group of partially preserved horn-cores in MNHN represents another heteronymous spiral horned antelope in the Küçükçekmece West fauna (Fig. 11B-D; Table 8). The postcornual groove is large and deep. The pedicel is higher than in *Prostrepsiceros* sp. from the same locality. The horn-cores are placed above the orbits. They have a sharp anterior keel descending anteromedially, and they show a rather strong mediolateral compression (63.3-78% at the base, n = 6) probably increasing toward the apexes (Fig. 11D). Spiralling is weakly developed but axial torsion is quite strong. The greater diameter at the horn-core base is trending anteroposteriorly. The specimen referred by Malik & Nafiz (1933: pl IX, fig. 5) to as *Helicotragus rotundicornis* (Weithofer, 1888) should also be ascribed to this species.

Teeth dimensions are about 20% larger than those of *Prostrepsiceros* sp. from the same locality. The p3 is simple with well-developed paraconid and hypoconid, and distally directed metaconid (Fig. 11E). The p4 is quite similar to that of *Prostrepsiceros* sp. but with less developed paraconid, deeper distal valley and more vertically placed metaconid. Mesial fold and basal pillar are present on the lower molars, which also show a rounded hypoconid.

The morphological and metrical characters of the Küçükçekmece West horn-cores, such as the weak spiralling, the fairly strong torsion, the sharp anterior keel descending anteromedially, the strong mediolateral compression and the large and deep postcornual grooves set them apart from *Palaeoreas* Gaudry, 1861, *Prostrepsiceros* and *Nisidorcas* Bouvrain, 1979, recalling *Palaeoreas elegans* Ozansoy 1965 from Yassiören, Turkey. Kostopoulos (2004) revised *"Palaeoreas" elegans* and *Prostrepsiceros woodwardi* Pilgrim & Hopwood, 1928, suggesting their inclusion into a separate genus *Majoreas*. As far, *Majoreas elegans* is poorly known from the Vallesian localities Yassiören and Loc. 49 of Middle Sinap, Turkey (Ozansoy 1965; Köhler 1987; Gentry 2003), whereas *M. woodwardi* is known from the early Turolian faunas of Samos, Halmyropotamos, Kemiklitepe D, Çorakyerler and Garkin (Kostopoulos 2004; Geraads 2013). The basal horn-core dimensions of the Küçükçekmece West species (Fig. 12) appear smaller on the average than those of Samos and Kemiklitepe D, close to the specimens of *M. elegans* from the type locality and within the range of the Çorakyerler sample. There is probably some morphological progression from Middle Sinap to Çorakyerler to Samos/Kemiklitepe D (see also Gentry 2003: 349) with an overall increase in size, a medial shift of the insertion point of the anterior keel, an increase of spiralling and a frontal rise. As the Küçükçekmece species fits better the more primitive condition of this taxonomic group both in size (Fig. 12) and morphology, it is referred to as *Majoreas* cf. *elegans*.

The single horn-core from the Rami Sand Quarry (Fig. 11A) displays again a strong anterior keel but it is slightly tighter twisted in its preserved basal part and less compressed mediolaterally that the MNHN sample (Table 8), making its inclusion into the same taxon more friable.

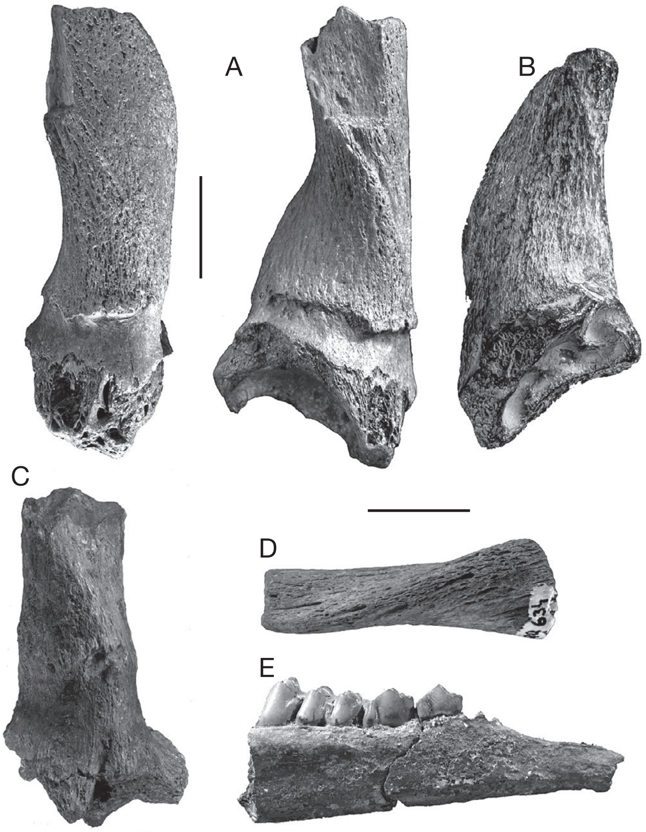

FIG. 11. — **A**, cf. *Majoreas* from Rami Sand Quarry; **B**-**E**, *Majoreas* cf. *elegans* from Küçükçekmece West, Turkey. **A**, proximal horn-core, ITU350 dex in frontal (**left**) and lateral (**right**) views; **B**, proximal horn-core, MNHN.F.TRQ637 dex in medial view; **C**, proximal horn-core, MNHN.F.TRQ636 dex in frontal view; **D**, distal horn-core, MNHN.F.TRQ634 dex in frontal view; **E**, p3-m2, ITU369 in buccal view. Scale bars: 2 cm.

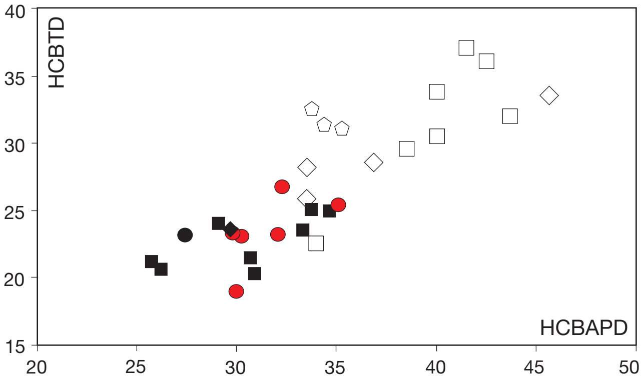

Fig. 12. — Comparison of the basal horn-core dimensions of several *Majoreas* Kostopoulos, 2004 populations. ●, Küçükçekmece West sample; □, Samos, Greece; ◇, Kemiklitepe D, Turkey; ⬠, Middle Sinap, Turkey; ■, Çorakyerler, Turkey; two specimens of *M. elegans*: namely MTA Museum Ankara, #1921 (●) and no numbered specimen in MNHN (◆). Data from Ozansoy (1965), Kostopoulos (2004), Gentry (2003), Geraads (2013).

Genus indet. aff. *Protoryx* Major, 1891

aff. *Protoryx* cf. *enanus* Köhler, 1987
(Fig. 13)

Material and measurements. — **Küçükçekmece West**: basal part of right horn-core MNHN.F.TRQ631 (HCBDT = 24.5 mm, HCBAPD = 37.7 mm); distal part of left horn-core TRQ629; part of horn-core TRQ626. Provisionally attributed: left M2 TRQ410 (L = 15.3 mm, W = 12.5 mm); right M3 TRQ409 (L = 15.9 mm); right m1/2 TRQ412 (L = 15.8 mm, W = *c.* 9.5 mm); right m3 TRQ413 (L = 22.1 mm, W = 10.2 mm).

Description and remarks

This poorly known medium-sized bovid with simple "gazelle-like" horn-cores is characterized by hollowed frontals, though the sinuses do not invade the pedicels (Fig. 13A, B). The postcornual groove is narrow and deep. The frontals are slightly depressed at their posterior part and the interfrontal suture is crest-like (Fig. 13A). The pedicels seem to be short. The greater axis of the horn-core base is parasagittal. The lateral face of the horn-core is flat whereas the medial one is strongly convex. There are no keels. Judging from the specimen MNHN.F.TRQ629 (Fig. 13B), the horn-cores slightly curve backwards at their distal parts.

A few isolated molars could be ascribed to this species on a size basis. The molars are not very hypsodont with the hypsodonty index estimated at about 110 for an unworn m1/2 and 75 for a slightly worn m3. The upper molars show strong styles, angular protocone and hypocone, well-developed paracone and low basal pillar (Fig. 13C). The lower molars have not mesial fold, the parastylid is strong, the hypoconid and the protoconid are angular, and the metaconid is well protruding lingually. A low basal pillar is present in all lower molars. The third lobe of m3 is single-cuspid with concave lingual wall (Fig. 13D).

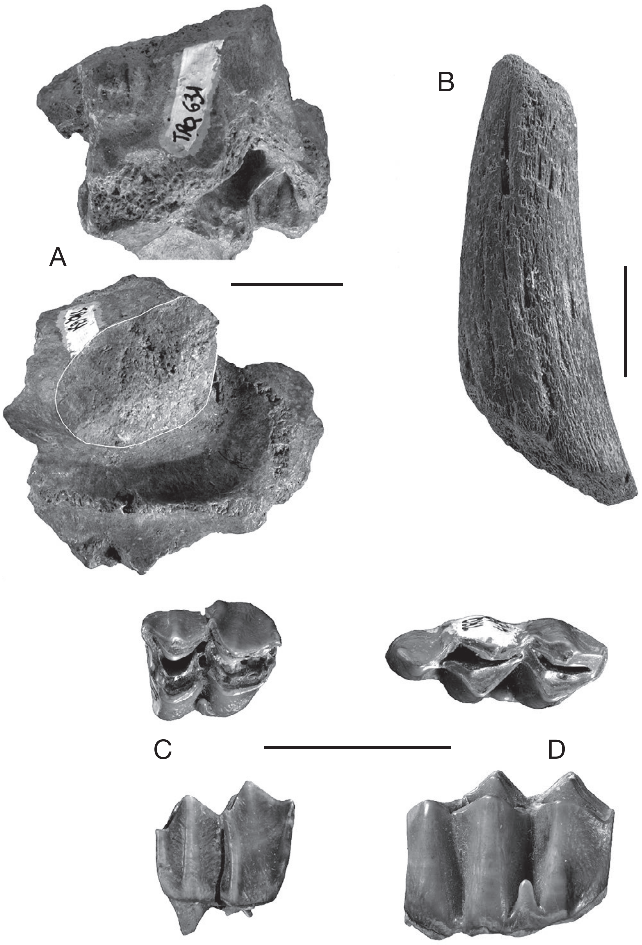

Fig. 13. — Aff. *Protoryx* cf. *enanus* from Küçükçekmece West, Turkey: **A**, proximal horn-core, MNHN.F.TRQ631 dex in lateral (**left**) and dorsomedial (**right**) views; **B**, distal horn-core, MNHN.F.TRQ629 sin in lateral view; **C**, M2 sin, MNHN.F.TRQ410 in occlusal (**up**) and buccal (**down**; reversed) views; **D**, m3 dex, MNHN.F.TRQ413 in occlusal (**up**) and buccal (**down**) views. Scale bars: 2 cm.

The horn-core and frontal morphology suggest relationships with early caprine-like bovids and their relatives. The Küçükçekmece West species is significantly smaller than the Turolian *Skoufotragus* Kostopoulos, 2009, *Protoryx* Forsyth-Major, 1891 and *Sporadotragus* Kretzoi, 1968 species (Fig. 14). It is also smaller than the Astaracian-Vallesian (MN 8-9) "*Protoryx*" *solignaci* Robinson, 1972 from Tunisia and Turkey (Fig. 14), which additionally differs in the stronger mediolateral compression of the horn-cores, the presence of a sharp anterior keel in the upper part, the hollowed pedicels and the shallow and small postcornual fossa (Gentry 2000). The same features differentiate the Küçükçekmece West species from *Protoryx* sp. from Pentalophos, Greece (Bouvrain 1997; though the fossil assembly of this taxon needs a revision) (Fig. 14). The roughly contemporaneous *Aragoral mudejar* Alcalá and Morales, 1997 from the Vallesian of Spain also differs from the Küçükçekmece species in its larger size, completely pneumatized pedicels and keeled horn-cores (Alcalá & Morales 1997).

The overall size, the rather short pedicels without sinuses, the slightly raised and hollowed frontals, the absence of keels and the oval cross-section of the Küçükçekmece West horn-cores match *Protoryx enanus* Köhler, 1987, known only from the MN 7 mammal assemblages of Çatakbağyaka and Sofça (Turkey). According to Bouvrain (1997) and Gentry (2000) the absence of sinuses in the pedicels leaves doubts about the generic attribution of this species to *Protoryx*. Actually, the set of morphological features seen in "*Protoryx*" *enanus* and the Küçükçekmece species indicates stronger relationships with the middle Miocene *Tethytragus* Azanza & Morales, 1994 than with *Protoryx/Skoufotragus,* and a revision is needed.

The scarcity of MN7-MN10 data cannot allow further comparison. Nevertheless, Bouvrain *et al.* (1994) mentioned the presence of a "form close to a small *Protoryx*" in the MN9 assemblage of Yassiören (material not located), whereas Gentry (2003) referred to as *Protoryx solignaci* several fragmentary teeth from Loc. 104 (MN8), 94 and 4 (MN9) of Middle Sinap. To what extend these two references may be related to the poorly known *Capra bohlini* Ozansoy, 1965 from Lower and Middle Sinap is not yet clear. Though comparable in size, the Küçükçekmece West horn-cores differ from those of *"C". bohlini* in the stronger mediolateral compression (64.9 in MNHN.F.TRQ631 vs 79-90 in 5 specimens of *"C" bohlini* in MNHN), the absence of torsion, and the more parasagittal orientation of their great basal axis. Avoiding nomenclature implications, we suggest referring the Küçükçekmece West species to as aff. *Protoryx* cf. *enanus*, pending for more data.

cf. *Miotragocerus* sp.
(Fig. 15)

Tragocerus amaltheus – Malik & Nafiz 1933: 57.

Tragocerus cf. *amaltheus* – Nicolas 1978: 456.

MATERIAL AND MEASUREMENTS. — **Küçükçekmece West**: ?distal part of horn-core, MNHN.F.TRQ624, TRQ630; part of left M3 TRQ402 (L = *c.* 22.2 mm, Wp = 18.6 mm); left m1 TRQ403 (L = 17.6 mm, W = 11.1 mm).
Küçükçekmece East: part of right maxilla with P4-M3, ITU359 (P4: L = 12.4 mm, W = 15.3 mm; M1: L = 19.7 mm, W = 18.5 mm; M2: L = 20.7 mm, W = 19.7 mm; M3: L = 20.4 mm, W = 18.8 mm); left M2 ITU no No. (L = 20.5 mm, W = 18.0 mm); part of left mandibular ramus with p3-m1 ITU355 (p3: L = 14.2 mm, W = 7.8 mm; p4: L = 15.2 mm, W = 9.2 mm; m1: L = 17.8 mm, W = 11.5 mm); left p3, ITU377 (L = 14.6 mm, W = 8.4 mm); left m3, MUI22-55 (L = 27.7 mm, W = 11.8 mm, H = 16.6 mm).

DESCRIPTION AND REMARKS

The absence of complete toothrows and other cranial material makes difficult the identification of the Küçükçekmece large bovid, even at genus level. The morphological (Fig. 15) and metrical characters suggest a small boselaphin, similar in size to *Miotragocerus pannoniae* (Kretzoi, 1941) from Höwenegg and *M. valenciennesi* (Gaudry, 1861) from Pikermi. The strong development of the paraconid on p3 and p4 (stronger than the parastylid; Fig. 15B) and its distal curvature, the mesially curved metaconid of the p4, the rather large molars comparatively to the premolars and the rounded hypocone (-id) and protocone (-id) on the molars indicate, however, a different dental pattern than in *Miotragocerus* Stromer, 1928 (Fuss *et al.* 2015; pers. obs.). Similar large size and p3 and p4 pattern appear in several boselaphin specimens from the early Turolian of the Axios valley, Greece, currently referred to as ?*Miotragocerus* sp. (e.g., Kostopoulos 2016). Nevertheless, the Küçükçekmece species seems to have much more brachydont molars; the hypsodonty index is *c.* 60 for one m3 (MUI22-55) and *c.* 78 for an m1 (ITU355) versus *c.* 100 for Axios valley material.

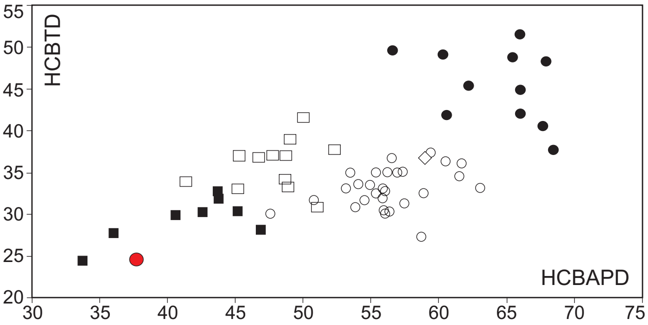

FIG. 14. — Comparison of basal horn-core dimensions of several middle-late Miocene caprine-like bovids. ●, Küçükçekmece West sample; ■, aff. *Protoryx enanus*, Turkey; ○, "*Protoryx*" *solignaci* (Robinson, 1972) from Turkey; ●, *Skoufotragus* Kostopoulos, 2009 from Samos; □, *Sporadotragus* Kretzoi, 1968 from several sites; ◇, aff. *Protoryx* from Pentalophos, Axios valley, Greece. Data from Köhler (1987), Kostopoulos (2009), and pers. data.

Malik & Nafiz (1933: 57, pl. IX, fig. 6; pl. X, figs 1, 2) presumably attributed to *Tragocerus amaltheus* Roth & Wagner, 1854 a few toothrows and a metacarpal from Küçükçekmece East. The teeth are comparable in size and morphology to those described here but the distal epiphysis of the illustrated metacarpal seems to be too extended transversally compared to its length for a boselaphin. Boselaphins are already present in the area from the Vallesian onwards (Bouvrain 1997; Gentry 2003) but the taxonomic status of their earlier representatives remains doubtful.

BOVID POSTCRANIALS

The Küçükçekmece West collection includes several bovid postcranials representing four size classes. By its small size, a part of tibia (MNHN.F.TRQ415) may be ascribed to the Gazella species from this site. A robust astragalus (MNHN.F.TRQ384) represents a large bovid that does not seem to match by size any of the previously described taxa. It is referred to as Bovidae indet. and may be at about 20-25% larger than the Küçükçekmece boselaphin. Two more sets of postcranials represent medium to large sized bovids and could be ascribed to aff. Protoryx cf. enanus and cf. Miotragocerus sp., respectively (Table 9).

Ruminantia indet.

MNHN.F.TRQ633 is a part of a frontal appendage. Its size is comparable to that of the horn-cores of *G. ancyrensis* (mean dimensions of the horn-core are HCBAPD = 18.5 mm and HCBTD = 17.3 mm) but the cross-section is characteristically square-shaped. It appears slightly curved without reducing diameters towards the preserved ends, and a shallow furrow runs along one of its surfaces. It is highly spongy internally with increasing size of porous from

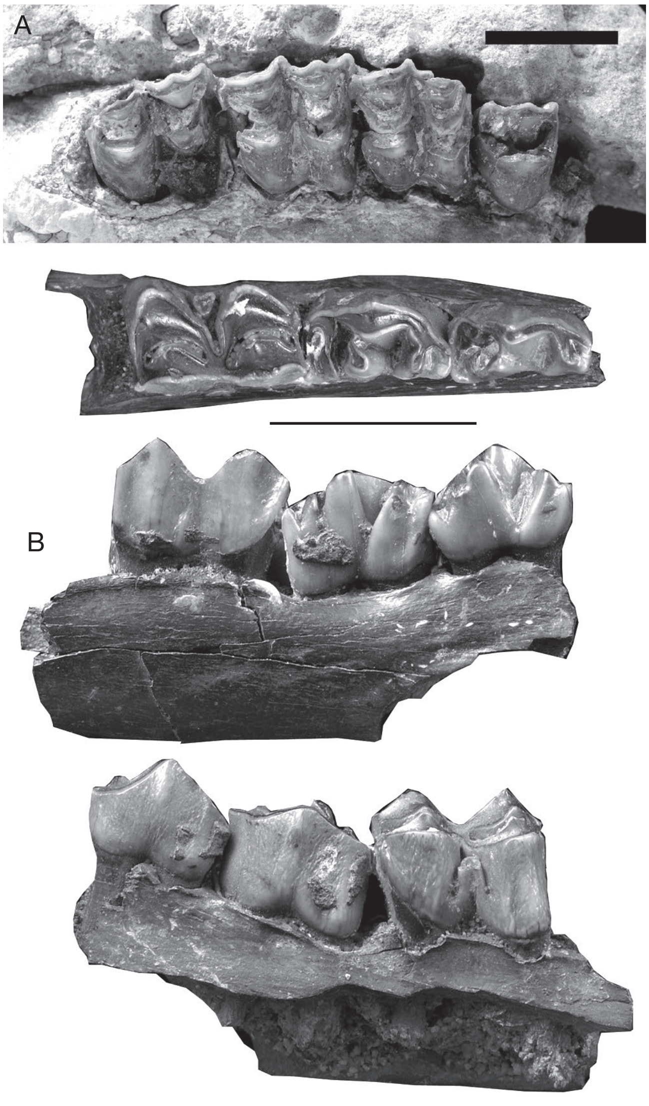

Fig. 15. — cf. *Miotragocerus* from Küçükçekmece East, Turkey: **A**, upper toothrow P4-M3 dex, ITU359 in occlusal view; **B**, p3-m1 sin, ITU355 in occlusal (**up**), lingual (**middle**) and buccal (**down**) views. Scale bars 2 cm.

the periphery towards the centre. None of the known late Miocene bovid taxa fits this morphology according to our knowledge, and we cannot exclude the possibility that it may, in fact, represent an antler fragment.

DISCUSSION

The study of the Küçükçekmece artiodactyl assemblage allows extendedly revising its faunal list and reveals the presence of 12-13 taxa in Küçükçekmece West (MNHN collection, Table 1), six of them also recorded in the Küçükçekmece East (ITU, MIU collections and material illustrated by Malik & Nafiz 1933; Table 1). Confirming stratigraphic observations (Lom *et al.* 2016 and pers. comm. 2015), we do not detect any significant taxonomic difference between the Küçükçekmece West and East artiodactyl assemblages that seem to represent a single palaeocommunity. Extensive rolling, weathering and fragmentation together with preferential preservation of large and/or young individuals, teeth and small compact bones (i.e. phalanges, astragals etc.), indicate strong taphonomic bias that may significantly alter the recorded taxonomic spectrum and the relative abundances of particular taxa.

The co-occurrence of *Hippopotamodon* cf. *antiquus, Palaeogiraffa pamiri, Gazella* cf. *ancyrensis,* and *Majoreas* cf. *elegans* and their association with a large *Palaeotragus*, a primitive *Prostrepsiceros*, and a primitive caprine-like bovid, certainly point to a Vallesian age. The artiodactyl association of Küçükçekmece exhibits the greatest taxonomic resemblance with the Vallesian assemblage of Yassiören (Ozansoy 1965), as well as with Middle Sinap faunas (Loc4, 49, 63) ranging in age from 10.6 to 9.1 Ma (Gentry 2003; Kappelman *et al.* 2003). Küçükçekmece also shares in common *Hippopotamodon antiquus*, *Dorcatherium maliki* n. sp., and *Palaeogiraffa* with the fauna of Yulaflı nearby, dated indirectly between 9.4-9.3 Ma (Geraads *et al.* 2005). A similar age of these two faunas is also supported by stratigraphic data. According to Sakınç *et al.* (2007) the mammal bearing strata of the Çekmece Group (i.e. the Çukurçesme Fm., in which Küçükçekmece East and West are included) are in lateral transition and close geographic proximity with the pertified woods-bearing beds of the Ergene Formation, where the Yulaflı fauna is included (Geraads *et al.* 2005).

The giraffid combination of *Bohlinia*, large *Palaeotragus* and *Palaeogiraffa* recorded at Küçükçekmece, is rather typical of the Vallesian mammal faunas of N. Greece. Furthermore, the Küçükçekmece *Palaeogiraffa* appears dentally closer to the species from Xirochori (Axios valley Greece), dated magnetochronologically at 9.6 Ma (Sen *et al.* 2000; Koufos 2006), than either the older Pentalophos or the younger Ravin de la Pluie (*c.* 9.3 Ma; Sen *et al.* 2000) species. Apart from a similar gazelle species, the well-known Pentalophos fauna, possibly of the MN9/MN10 transition, lacks tragulids and *Hippopotamodon*, whereas the bovids from this site appear quite different than those from Küçükçekmece. Although a precise biochronological placement is not possible by the artiodactyls alone, we can tentatively infer an early late Vallesian age (9.6-9.4 Ma) for the Küçükçekmece faunal assemblage.

The abundance of *Dorcatherium* (25% of the total number of identified artiodactyl specimens, TNIAS: 212) is considered to reflect wet, forested habitats (Rössner 2007; Aiglstorfer *et al.* 2014; Alba *et al.* 2014). This conclusion seems in agreement with the strong presence of giraffids in the site (46.5% of TNIAS), half of them (26% of TNIAS) represented by *P. pamiri,* a species with clear browsing dental mesowear pattern (pers. observations; *P. macedoniae* from Pentalophos is also registered as a leaf browser according to microwear data by G. Merceron, pers. comm. 2016). Though bovids correspond to a lesser proportion of the TNIAS (22%), they appear highly divers with six taxa at least. Half of the bovids occurring in Küçükçekmece (*Gazella, Majoreas,* aff. *Protoryx*) show clear Anatolian affinities, while others such as *Prostrepsiceros* are widespread in the

TABLE 9. — Postcranial dimensions of Bovidae from Küçükçekmece West, Turkey.

	Specimen	L/ LI	TDM	TDD	APDD
Gazella					
Tibia	MNHN.F.TRQ415	>125	8.8	14.1	10.5
aff. *P.* cf. *enanus*					
Humerus	MNHN.F.TRQ370	–	–	34.3	–
	MNHN.F.TRQ372	–	–	32.4	31.8
	MNHN.F.TRQ371	–	–	37.6	–
Metacarpal	MNHN.F.TRQ390	–	–	30.7	21.5
Tibia	MNHN.F.TRQ376	–	–	32.9	28.0
Astragalus	MNHN.F.TRQ388	37.6	–	23.4	–
	MNHN.F.TRQ385	40.6	–	24.0	–
	MNHN.F.TRQ377	–	–	23.6	–
cf. *Miotragocerus*					
Humerus	ITU no No.	–	–	39.9	37.4
Tibia	ITU no No.	–	–	34.4	27.5
	ITU346	–	–	36.6	29.6
Calcaneum	ITU no No.	62.6	–	–	–
Astragalus	MNHN.F.TRQ833	46.3	–	31.3	–
	ITU no No.	42.8	–	–	–
Bovidae indet.					
Astragalus	MNHN.F.TRQ384	57.3		38.6	

entire Balkano-Anatolian region. The same is true for the giraffid *Palaeogiraffa,* whereas large *Palaeotragus* as well as *Hippopotamodon* seem to have a much wider geographic domain. *Bohlinia,* on the other hand, shows a more restricted, roughly Balkan, occupation area. Despite the wide Upper Miocene geographical spread of *Dorcatherium* from Georgia to Spain, its distribution appears discontinuous with a clear and rather isolated peri-Aegean cluster. Northern influences in the Küçükçekmece artiodactyl assemblage may be reflected on the presence of cf. *Miotragocerus* and, in any case, they are well demonstrated by other taxonomic groups (carnivores [Peigné 2016], proboscideans [Tassy 2016], equids [Koufos & Sen 2016]; see relevant chapters in this volume).

As discussed in detail by Geraads *et al.* (2005: 540) the *Dorcatherium*-dominated artiodactyl association seen at Küçükçekmece appears to have a strong signal during Vallesian along Thrace-Dardanelles, in sharp contrast with the faunal spectrum on either side of this region (i.e. the southern Balkans and Anatolia), from were tragulids are absent. Whether, however, this corridor represents a particular province along the present day east Aegean coasts as suggested by Geraads *et al.* (2005) or simply a local belt of denser canopy along the newly established Paratethys-Aegean connection (Sakınç *et al.* 1999) is not clear to us. In difference from Geraads *et al.* (2005: 540), the present study shows, for instance, that dolichopodial giraffids and a well-diversified bovid assemblage (comparable in species richness to contemporaneous faunas from Middle Sinap or Axios valley) were present at that time in this area, even if rare and badly documented (but how much of the lacking evidence is due to the particular taphonomic dynamics in an unusual assemblage biased towards large animals and bringing together land and sea mammals?). On the other hand, and given the postcranial similarity between *D. maliki* n. sp., *D. naui* and *Hyaemoschus aquaticus* (see present description and Aiglstorfer *et al.* 2014 for a recent review on *D. naui*), the extremely high concentration of tragulids in the Vallesian faunas of this region could associated with their particular coastal habitat and hydrophilous ecological niche (Rössner 2007), conditions that seem to meet the complicated early Upper Miocene palaeogeography around nowadays Istanbul (Sakınç *et al.* 2007). Though we basically agree with Geraads *et al.* (2005) in that some barrier must have been act in the area during Vallesian, its origin, nature, extend and role need to be further investigated.

Acknowledgements

Part of the present study was realized with the financial support of a Synthesis grant (FR-TAF-1979) to DK. Thanks are due to P. Tassy (MNHN, Paris), C. Sagne (MNHN, Paris), M. Sakınç (ITU, Istanbul) and Izver Özkar Öngen (IU) for providing access to collections and facilities. We are also grateful to D. Alba (Institut Català de Paleontologia Miquel Crusafont, Barcelone), D. Geraads (MNHN, Paris), S. Mayda (Ege University, Izmir), J. Morales (Consejo Superior de Investigaciones Cientificas, Madrid), G. Rössner (Bayerische Staatssammlung für Paläontologie und Geologie, Munich), I. Sánchez (Museo Nacional de Ciencias Naturales, Madrid), M. Aiglstorfer (Staatliches Museum für Naturkunde Stuttgart), and G. Merceron (iPHEP, Université de Poitiers) for providing us with photos, bibliography and valuable opinions. Most of the photographies come out from the professional camera of Philippe Loubry, who also helped with the study of the Istanbul material, complemented by Ozan Erdal (ITU) for those who missed us. Both D. Geraads and J. Morales are deeply thanked for their constructive criticism.

REFERENCES

Aiglstorfer M., Rössner G. E. & Böhme M. 2014. — *Dorcatherium naui* and pecoran ruminants from the late Middle Miocene Gratkorn locality (Austria). *Palaeobiodiversity and Palaeoenvironments* 94: 83-123. http://dx.doi.org/10.1007/s12549-013-0141-9

Alba D. M., Moyà-Solà S., Robles J. M., Casanovas-Vilar I., Rotgers Ch., Carmona R. & Galindo J. 2011. — Middle Miocene tragulid remains from Abocador de Can Mata: the earliest record of *Dorcatherium naui* from Western Europe. *Geobios* 44: 135-150. http://dx.doi.org/10.1016/j.geobios.2010.10.003

Alba D. M., DeMiguel D., Morales J., Sanchez I. M. & Moyà-Solà S. 2014. — New remains of *Dorcatherium crassum* (Artiodactyla: Tragulidae) from the Early Miocene (MN4) of Els Casots (Subirats, Vallès-Penedès basin). *Comptes Rendus Paleovol* 13: 73-86. http://dx.doi.org/10.1016/j.crpv.2013.09.003

Alcalá L. & Morales J. 1997. — A primitive caprine from the upper Vallesian of La Roma 2 (Alfambra, Teruel, Aragón, Spain). *Comptes Rendus de l'Académie des Sciences de Paris* 324: 947-953.

Alcalá L. & Montoya P. 1994. — Los jirafidos del Neogeno de la fosa de Teruel. *Estudios Geologicos* 50: 127-137.

Barone R. 1999. — Anatomie comparée des mammifères domestiques. Tome 1-Ostéologie. Vigot, Paris.

Bohlin B. 1926. — Die Familie Giraffidae. *Palaeontologica Sinica* ser. C 4(1): 1-178.

Borissiak A. A. 1914. — Mammifères fossiles de Sébastopol. *Mémoires du Comité géologique de Saint-Pétersbourg* 87: 105-154.

Bonis L. de & Bouvrain G. 2003. — Nouveaux Giraffidae du Miocène supérieur de Macédoine (Grèce), *in* Petculescu A. & Stiuca E. (eds), *Advances in Vertebrate Paleontology "Hen to Panta"*. Romanian Academy, Bucharest: 5-16.

Bouvrain G. 1997. — Les bovidés du Miocène supérieur de Pentalophos (Macédoine, Grèce). *Münchener Geowissenschaftliche Abhandlungen* (A) 34A : 5-22.

Bouvrain G., Sen S. & Thomas H. 1994. — Un nouveau genre d'antilope dans le Miocène supérieur du Sinap Tepe en Turquie. *Revue de Paléobiologie* 13: 375-380.

Crusafont PairÓ M. 1952. — Los jiráfidos fósiles d'España. *Memorias y Comunicaciones del Instituto Geológico Barcelona* 8: 1-239.

Depéret C. 1887. — Recherches sur la succession des faunes de vertébrés miocènes de la vallée du Rhône. *Archives du Muséum d'Histoire naturelle de Lyon* 4: 45-313.

Fortelius M., Made J. van der & Bernor R. L. 1996. — Middle and late Miocene Suoidea of central Europe and the eastern Mediterranean: evolution, biogeography and paleoecology, *in* Bernor R. L., Fahlbush V. & Mittmann, H. V. (eds), *The Evolution of Western Eurasian Neogene Mammal Faunas*. Columbia University Press, New York: 348-379.

Freudenthal M. & Cuenca-Bescós G. 1984. — Size variation of fossil rodent population. *Scripta Geologica* 76: 1-28.

Fuss J., Prieto J. & Böhme M. 2015. — Revision of the boselaphin bovid *Miotragocerus monacensis* Stromer, 1928 (Mammalia, Bovidae) at the middle to late Miocene transition in Central Europe. *Neues Jahrbuch für Geologie und Paläontologie Abh.* 276: 229-265. http://dx.doi.org/10.1127/njgpa/2015/0481

Gentry A. W. 2000. — Caprinae and Hippotragini (Mammalia, Bovidae) in the upper Miocene, *in* Vrba E. S. & Schaller G. B. (eds), *Antelopes, Deer, and Relatives: Fossil Record, Behavioural Ecology, Systematics and Conservation*. Yale University Press, New Haven: 65-83.

Gentry A. W. 2003. — Ruminantia (Artiodactyla), *in* Fortelius M., Kappelman J., Sen S. & Bernor R. L. (eds), *Geology and Paleontology of the Miocene Sinap Formation, Turkey*. Columbia University Press, New York: 332-379.

Geraads G. 1978. — Les Palaeotraginae (Giraffidae, Mammalia) du Miocène supérieur de la région de Thessalonique (Grèce). *Géologie Méditerranéenne* 5: 269-276.

Geraads D. 1979. — Les Giraffinae (Artiodactyla, Mammalia) du Miocène supérieur de la région de Thessalonique (Grèce). *Bulletin du Muséum national d'Histoire naturelle* 4ᵉ série, C 4: 377-389.

Geraads D. 1986. — Remarques sur la systématique et phylogénie des Giraffidae (Artiodactyla, Mammalia). *Geobios* 19: 465-477.

Geraads D. 1989. — Un nouveau giraffidé du Miocène supérieur de Macédoine (Grèce). *Bulletin du Muséum national d'Histoire naturelle* 4ᵉ série, C 11: 189-199.

Geraads D. 2013. — Large mammals from the late Miocene of Çorakyerler, Çankırı, Turkey. *Acta Zoologica Bulgarica* 65 (3): 381-390.

Geraads D. & Güleç E. 1999. — A *Bramatherium* skull (Giraffidae, Mammalia) from the late Miocene of Kavakdere (Central Turkey). Biogeographic and phylogenetic implications. *Bulletin of the Mineral Research and Exploration* 121: 51-56.

Geraads D., Kaya T. & Mayda S. 2005. — Late Miocene large mammals from Yulaflı, Thrace region, Turkey, and their biogeographic implications. *Acta Palaeontologia Polonica* 50: 523-544.

Geraads D., Spassov N. & Garevski R. 2008. — New specimens of *Propotamochoerus* (Suidae, Mammalia) from the late Miocene of the Balkans. *Neues Jahrbuch für Geologie und Paläontologie Abh.* 248: 103-113.

Geraads D., Spassov N., Hristova L., Markov G. N. & Tzankov T. 2011. — Upper Miocene mammals from Strumyani, South-Western Bulgaria. *Geodiversitas* 33 (3): 451-484. http://dx.doi.org/10.5252/g2011n3a3

Geraads D., Reed K. & Bobe R. 2013. — Pliocene Giraffidae (Mammalia) from the Hadar Formation of Hadar and Ledi-Geraru, Lower Awash, Ethiopia. *Journal Vertebrate Paleontology* 33 (2): 470-481. http://dx.doi.org/10.1080/02724634.2013.723657

Hamilton W. R. 1978. — Fossil giraffes from the Miocene of Africa and a revision of the phylogeny of Giraffoidea. *Philosophical Transactions of the Royal Society* (B) 283: 165-229.

Heintz E. 1970. — *Les Cervidés villafranchiens de France et d'Espagne. Volumes 1 & 2.* Muséum national d'Histoire naturelle, Paris, 206 p. (Mémoires du Muséum national d'Histoire naturelle, Sér. C – Sciences de la Terre (1950-1992) ; 22).

Hellmund M. 1995. — The vertebrate locality Maramena (Macedonia, Greece) at the Turolian-Ruscinian boundary (Neogene). 13. Suidae (Artiodactyla, Mammalia). *Münchner Geowissenschaftlische Abhaldungen* (A) 28: 143-156.

Hillenbrand V., Göhlich U. B. & Rössner G. 2009. — The early Vallesian vertebrates of Atzelsdorf (Late Miocene, Austria) 7. Ruminantia. *Annalen des Naturhistorisches Museum in Wien* 111A: 519-556.

Hünermann K. A. 1961. — Die Suidae (Mammalia, Artiodactyla) aus den Dinotheriensanden (Unterpliozän+Pont) Rheinhessens (Artiodactyla, Mammalia). *Schweizerische Palaeontologische Abhandlung* 86: 1-96.

Janis C. M. 1990. — Correlation of cranial and dental variables with body size in ungulates and macropodoids, *in* Damuth J. & McFaden B. (eds), *Body Size in Mammalian Paleobiology Estimations and Biological Implications*. Cambridge University Press, Cambridge: 225-300.

Kappelman J., Duncan A., Feshea M., Lunkka J.-P., Ekart D., Mcdowell F., Ryan T. & Swisher III C. C. 2003. — Chronology of the Sinap Formation, *in* Fortelius M., Kappelman J., Sen S. & Bernor R. L. (eds), *Geology and Palaeontology of the Miocene Sinap Formation, Turkey*. Columbia University Press, New York: 41-66.

Kaup J. J. 1833. — [No title] *Neues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde* 1833: 327.

Köhler M. 1987. — Boviden des turkischen Miozäns (Känozoicum und Braunkohlen der Turkei 28). *Paleontologia i Evolucio* 21: 133-246.

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 Akkaşdağı, Turkey, *in* Sen S. (ed.), Geology, mammals and environments at Akkaşdağı, late Miocene of Central Anatolia. *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: 345-389.

Kostopoulos D. S. 2016. — Artiodactyla, *in* Koufos G. D. & Kostopoulos D. S. (eds), Palaeontology of the Upper Miocene vertebrate localities of Nikiti (Chalkidiki Peninsula, Macedonia, Greece). *Geobios* 49 (1-2): 119-134. http://dx.doi.org/10.1016/j.geobios.2016.01.011

Kostopoulos D. S. & Bernor R. L. 2011. — The Maragheh bovids (Mammalia, Artiodactyla): systematic revision and biostratigraphic-zoogeographic interpretation. *Geodiversitas* 33 (4): 649-708. http://dx.doi.org/10.5252/g2011n4a6

Koufos G. D. 2006. — The Neogene mammal localities of Greece: faunas, chronology and biostratigraphy. *Hellenic Journal of Geosciences* 41 (1): 183-214.

Koufos G. D. & Sen S. 2016. — Equidae, *in* Sen S. (ed.), Late Miocene mammal locality of Küçükçekmece, European Turkey. *Geodiversitas* 38 (2): 225-243 (this volume). http://dx.doi.org/10.5252/g2016n2a5

Koufos G. D., Kostopoulos D. S. & Vlachou Th. 2016. — Revision of the Nikiti 1 (NKT) fauna with description of new material, *in* Koufos G. D. & Kostopoulos D. S. (eds), Palaeontology of the Upper Miocene vertebrate localities of Nikiti (Chalkidiki Peninsula, Macedonia, Greece). *Geobios* 49 (1-2): 11-22. http://dx.doi.org/10.1016/j.geobios.2016.01.006

Liu L., Kostopoulos D. S. & Fortelius M. 2004. — Late Miocene *Microstonyx* remains (Suidae, Mammalia) from Northern China. *Geobios* 37: 49-64.

Liu L., Kostopoulos D. S. & Fortelius M. 2005. — Suidae (Mammalia, Artiodactyla) from the late Miocene of Akkasdagı, Turkey, *in* Sen S. (ed.), Geology, mammals and environments at Akkaşdağı, late Miocene of Central Anatolia. *Geodiversitas* 27 (4): 715-733.

Lom N., Ülgen S. C., Sakinç M. & Şengör A. M. C. 2016. — Geology and stratigraphy of Istanbul region, *in* Sen S. (ed.), Late Miocene mammal locality of Küçükçekmece, European Turkey. *Geodiversitas* 38 (2): 175-195. http://dx.doi.org/10.5252/g2016n2a3

Made J. van der 1996. — Pre-Pleistocene Land Mammals from Crete, *in* Reese D. S. (ed.), *Pleistocene and Holocene Fauna of Crete and Its First Settlers*. Prehistory Press, Madison: 69-79.

Made J. van der 1997. — The fossil pig from the late Miocene of Dorn-Durkheim 1 in Germany. *Courier Forschungs-Institut Senckenberg* 197: 205-230.

Made J. van der & Hussain S. T. 1989. — *Microstonyx major* (Suidae, Artiodactyla) from Nagri. *Estudios Geológicos* 45: 409-416.

Made J. van der, Montoya P. & Alcalá L. 1992. — *Microstonyx* (Suidae, Mammalia) from the upper Miocene of Spain. *Geobios* 25: 395-413.

Made J. van der, Krakhmalnaya T. & Kubiak H. 1999. — The pig *Propotamochoerus* from the upper Miocene of Grytsiv, Ukraine. *Estudios Geológicos* 55: 283-292.

Made J. van der, Savaş Güleç E. & Erkman A. C. 2013. — *Microstonyx* (Suidae, Artiodactyla) from the Upper Miocene of Hayranlı-Haliminhanı, Turkey. *Turkish Journal of Zoology* 37: 106-122. http://dx.doi.org/10.3906/zoo-1202-4

Malik A. & Nafiz H. 1933. — Vertébrés fossiles de Küçükçekmece. *Publication de l'Institut de Géologie de l'Université d'Istanbul* 8: 1-119.

Montoya J. & Morales J. 1991. — *Birgerbohlinia schaubi* Crusafont, 1952 (Giraffidae, Mammalia) del Turoliense inferior de Crevillente-2 (Alicante, España). Filogenia e historia biogeografica de la subfamilia Sivatheriinae. *Bulletin du Muséum national d'Histoire naturelle, Paris* 4e série, C, 13: 177-200.

Morales J. & Soria D. 1981. — Los artiodáctilos de los Valles de Fuentidueña (Segovia). *Estudios Geológicos* 37: 477-501.

Morales J., Sanchez I. M. & Quiralte V. 2012. — Les Tragulidae (Artiodactyla) de Sansan, *in* Peigné S. & Sen S. (eds), *Mammifères de Sansan*. Muséum national d'Histoire naturelle, Paris: 225-247 (Mémoires du Muséum national d'Histoire naturelle; 203).

Nicolas J. 1978. — Un nouveau gisement de vertébrés dans le Chérsonien : Kutchuk-Tchekmedje Ouest (Thrace turque). *Comptes rendus de l'Académie de Sciences* 287D: 455-458.

Ozansoy F. 1957. — Faunes de mammifères du Tertiaire de Turquie et leurs révisions stratigraphiques. *Bulletin of the Mineral Research and Exploration Institute of Turkey* 49: 29-48.

Ozansoy F. 1965. — Étude des gisements continentaux et des mammifères du Cénozoïque de Turquie. *Mémoire de la Société géologique de France* 102: 1-92.

Peigné S. 2016. — Carnivora, *in* Sen S. (ed.), Late Miocene mammal locality of Küçükçekmece, European Turkey. *Geodiversitas* 38 (2): 197-224 (this volume). http://dx.doi.org/10.5252/g2016n2a4

Pickford M. 1988. — Revision of the Miocene Suidae of the Indian subcontinent. *Münchener Geowissenschaftliche Abhandlungen, Reihe A, Geologie und Paläontologie* 12: 1-91.

Pickford M. 2015. — *Late Miocene Suidae from Eurasia: the* Hippopotamodon *and* Microstonyx *Problem Revised.* Münchener Geowissenschaftliche Abhandlungen, vol. 42: 1-126.

Rössner G. E. 2007. — Family Tragulidae, *in* Prothero D. R. & Foss S. E. (eds), *The Evolution of Artiodactyls*. Johns Hopkins University Press, Baltimore: 213-220

Rössner G. E. 2010. — Systematics of Ruminantia (Artiodactyla, Mammalia) from the Miocene of Sandelzhausen (southern Germany, Northern Alpine Foreland Basin). *Paläontologische Zeitschrift* 84: 123-162.

Rössner G. E. & Heissig K. 2013. — New records of *Dorcatherium guntianum* (Tragulidae), stratigraphical framework, and diphyletic origin of Miocene European tragulids. *Swiss Journal of Geoscience* 106: 335-347.

Rückert-Ülkümen N., Kaya O. & Hottenrott M. 1993. — Neue Beiträge zur Tertiär-Stratigraphie und Otolithen fauna der Umgebung von Istanbul (Küçükçekmece- und Büyükçekmece See), Türkei. *Mitteilungen der Bayerischen Staatssammlung für Paläontologie und Historische Geologie* 33: 51-89.

Sach V. J. 1999. — Litho- und biostratigraphische Untersuchungen in der Oberen Süßwassermolasse des Landkreises Biberach a. d. Riß (Oberschwaben). *Stuttgarter Beiträge zur Naturkunde* B 276: 1-167.

Sakinç M., Yaltirak C. & Oktay F. Y. 1999. — Palaeogeographical evolution of the Thrace Neogene basin and the Tethys-Paratethys relations at northwestern Turkey (Thrace). *Palaeogeography, Palaeoclimatology, Palaeoecology* 153: 17-40.

Sakinç M., Yaltirak C. & Perk A. 2007. — İstanbul'un silisleşmiş ağaçları: paleoflora, paleocoğrafya ve paleoiklim [Silicified threes of Istanbul: paleoflora, paleogeography and paleoclimate]. İstanbul'un Jeolojisi III Sempozyumu, İTÜ, İstanbul, 7-9 December 2007: 10-14.

Sánchez I. M., Quiralte V., & Morales J. 2011. — Solving an old dispute: anatomical differences between the European Miocene chevrotains *Dorcatherium crassum* (Lartet, 1839) and *Dorcatherium naui* Kaup & Scholl, 1834 (Mammalia, Ruminantia, Tragulidae). *Paleontologia i Evolucio*, mem. Esp. 5: 343-347.

Sen S. 2016. — Historical background, *in* Sen S. (ed.), Late Miocene mammal locality of Küçükçekmece, European Turkey. *Geodiversitas* 38 (2): 153-173 (this volume). http://dx.doi.org/10.5252/g2016n2a2

Sen S., Koufos G. D., Kondopoulou D. & de Bonis L. 2000. — Magnetostratigraphy of the late Miocene continental deposits of the lower Axios valley, Macedonia, Greece, *in* Koufos G. D. & Ioakim Ch. (eds), *Mediterranean Neogene Cyclostratigraphy in Marinecontinental Deposits. Bulletin of the Geological Society of Greece*, special publ. vol. 9: 197-206.

SOLOUNIAS N. 2007. — Family Giraffidae, *in* PROTHERO D. R. & FOSS S. E., *The Evolution of Artiodactyls*. The John Hopkins University Press, Baltimore: 257-277.

TASSY P. 2016. — Proboscidea, *in* Sen S. (ed.), Late Miocene mammal locality of Küçükçekmece, European Turkey. *Geodiversitas* 38 (2): 261-271 (this volume). http://dx.doi.org/10.5252/g2016n2a7

TEKKAYA I. 1973. — Une nouvelle espèce de *Gazella* de Sinap moyen. *Bulletin of the Mineral Research and Exploration Institute of Turkey* 80: 118-143.

Submitted on 9 July 2015;
accepted on 16 February 2016;
published on 24 June 2016.