Mammalian remains from a new site near the classical locality of Pikermi (Attica, Greece)

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Abstract

We describe the first results on the fossil mammalian fauna recovered during the first excavation season at the new site "Pikermi Valley-1". The fauna comprises two hipparionine species (*H. mediterraneum*, *H. brachypus*), a giraffid (*Bohlinia attica*), five bovids (*Palaeoreas lindermayeri*, *Protragelaphus skouzesi*, *Tragoportax amalthea*, *Gazella* sp., Bovidae indet.) and two carnivores (? *Adcrocuta eximia*, Felidae indet.). The composition of the fauna suggests a Turolian age.

Keywords: Pikermi, Late Miocene, Turolian, Mammalia

Introduction

In 2008 the major of Pikermi Mr. A. Adamopoulos started collaboration with the first author trying to raise funds for founding a local Museum, protect the fossiliferous sites and organize a presentation of the fossils *in situ*, a project pending since at least 1901, when the demand for a local museum was expressed in a newspaper article. Geological prospecting carried out in the same year by a University of Athens team, in order to locate sites for the purposes of the project, resulted in the discovery of the new fossiliferous locality "Pikermi Valley-1" (PV-1). The new site is situated in the ravine of the stream Megálo Réma (locally known as Valanáris), 500 m east-southeast of the alleged location of the classical Pikermi locality and about 1700 m southwest of Chomateri (Fig. 1). The findings come from a single fossiliferous horizon on the northern bank of the stream, slightly above the present water level.

The first excavation season (June 15 – July 15, 2009), sponsored by the Municipality of Pikermi (University of Athens Project Research Account 70/3/9494), revealed a promising fossil mammal assemblage.

The specimens in the assemblage were rather sparse, particularly when compared to the tight accumulation observed in the classical Pikermi locality (observation based on fossiliferous blocks stored in several museums), or at "Chomateri" (also referred to as "Kisdari") locality, excavated mainly from 1978 to 1982. Most long bones exhibited a NE–SW orientation, which probably was the direction of the palaeocurrent (Fig. 2).

Material and Methods

The excavated sample consists of more than 200 specimens; the identifiable ones are described below. All material is stored in the Museum of Palaeontology and Geology, University of Athens, and was prepared in its laboratory using mechanical methods (hand and pneumatic tools). The biometric study of the equids followed the methodology of Eisenmann et al. (1988), while the artiodactyl specimens were measured according to the suggestions of Heintz (1970). All measurements are in mm. The upper and lower teeth positions are given using upper and lower case letters respectively (e.g. M1 and m1).

Systematics

Perissodactyla OWEN, 1848

Equidae GRAY, 1821

Hipparion DE CHRISTOL, 1832

The hipparionine material (Figs 3–5,Table 1) consists of a few mainly isolated teeth and some postcranial elements. The best preserved teeth belong to aged individuals. The upper teeth exhibit numerous enamel plications at the fossettes, simple pli caballin and rather shallow, Vshaped hypoconal groove. The very worn lower premolars have a shallow ectoflexid that does not penetrate the isthmus, rounded metaconid and metastylid, separated by a shallow linguaflexid. In a very worn lower molar the linguaflexid and ectoflexid are in contact. The flexids show practically no plications. A fresh isolated lower molar has a hypsodonty index of 47 (calculated following Eisenmann et al. 1988).

The best preserved postcranial elements are four complete metapodials (two MC III and two MT III). They are long and slender. In the third metacarpals, the slenderness index (3/1) is 12.3% and 12.1%; another similar index (11/1) is calculated to be 15.1% and about 16.6%. The corresponding indices of the two third metatarsals are 10.1%, about 10.1%, 12.4% and 12.6% respectively. The above specimens are plotted inside the cluster of the small sized Pikermi hipparions provided by Dermitzakis (1976, figs 6-7). Based on their morphology, dimensions and proportions, these metapodials are referred to the species *Hipparion mediterraneum* (ROTH & WAGNER, 1854).

A fragmentary left calcaneus (PV1/53) presents large distal maximal breadth (measurement "7" of Eisenmann et al. 1988), measuring 51.0 mm. It can be referred to *Hipparion brachypus* HENSEL, 1862, since it is plotted to the cluster of the large sized Pikermi hipparions provided by Theodorou (1997) and corresponds in size to the larger values provided by Koufos (1987a) for this species.

There are two tibias, both missing their proximal ends. One of these (PV1/4) is more slender and has similar dimensions with the *H. mediterraneum* Pikermi sample studied by Koufos (1987a, 1987b). The other one (PV1/1) is larger and more robust. Compared to the data provided by Koufos (1987b, fig. C-18) it is plotted inside the *H. brachypus* sample.

Two complete proximal phalanges III (possibly pedal) also present similar size differences, one of them (PV1/57) being significantly more robust than the other (PV1/12), and could belong to different hipparionine species. The dimensions of the robust one plot inside the range of the *H. brachypus* sample (Koufos 1987b, fig. C-18).

Artiodactyla OWEN, 1848

Giraffidae GRAY, 1821

Bohlinia MATTHEW, 1929

Bohlinia attica (GAUDRY & LARTET, 1856)

The giraffids are represented in the new material by only one specimen (PV1/72), a right radius-ulna missing its proximal part (Fig. 6). Its preserved length measures about 68 cm, the greatest width of the distal end 107 mm, and the medio-lateral diameter of the diaphysis about 63 mm. The crest that defines the lateral margin of the lunar facet is more curved and oblique than in the extant giraffe. The specimen is referable to *B. attica* based on its morphological and metrical characters (Gaudry 1862-1867; Bohlin 1926; Geraads 1974; Geraads 1979).

Bovidae GRAY, 1821

The Bovidae material comprises dental and cranial remains, and few postcranial elements. The dental and cranial remains indicate the presence of four taxa.

Palaeoreas GAUDRY, 1861

Palaeoreas lindermayeri (WAGNER, 1848)

The material referred to this species comprises a frontlet (PV1/42) and a right mandible (PV1/25). The frontlet (Fig. 7) is badly damaged and distorted by compression. The horn-cores are in a poor state of preservation, but present an anterior and a posterior keel. The former is blunt and descends anteriorly. The latter, preserved at the distal part of the left horn-core, is acute. Only the anteroposterior basal diameter of the left horn-core can be provided, that measures about 48 mm. The postcornual fossae are large and deep. Between the horn-cores, the frontal region is strongly elevated above the level of the supraorbital margins and strongly bent, even if the latter is probably exaggerated by distortion. The supraorbital foramens open into deep frontal depressions and communicate with the orbital fossae. The distance between the lateral borders of the frontal depressions measures about 35 mm.

The mandible (Fig. 8) is completely preserved (Lp=25.2, Lp3-p4=19.2, Lm=41.6, Lpm=66.2, Lp3-m3=60.2). The mandibular ramus is only slightly deeper below m3 than below p2, and the premolar series is large in relation to the molar one (Lp/Lm=60.6%, Lp3-p4/Lm1-m3=46.2%). The p3 and p4 are elongated, and the p3 is long in relation to p4 (Lp3/Lp4=90.4%). On p3 the metaconid is small. On the labial wall, the groove in front of the hypoconid is faint. The p4 is generally similar to p3. The paraconid is well separated from the parastylid. The metaconid is columnar and the 2nd and 3rd valleys of the tooth are open. The base of the 2nd valley bears a small tubercle. The groove in front of the hypoconid is marked. The molars bear moderately developed pli caprin. The ectostylids are moderately developed on m1, m2, less in m3. The specimen is metrically similar to *P. lindermayeri* from Pikermi (Fig. 9).

Both specimens exhibit all characters of *P. lindermayeri* (Bouvrain 1980; Bouvrain 1992; Geraads et al. 2003) and are referred to this species.

Protragelaphus DAMES, 1883

Protragelaphus skouzesi DAMES, 1883

A frontlet with both horn-cores (PV1/69; Fig. 10) can be referred to *P. skouzesi*. This specimen could belong to a not fully grown individual since its horn-cores' surface is porous. The horn-cores are moderately separated (about 27.5 mm) and diverge from the sagittal plane by an angle of about 30°, and they are slightly compressed mediolaterally at their bases (DAP×DT=(44.0)×35.8 mm, left horn-core). The horn-core axis is almost straight, the torsion follows a close spiraling, and there is no anterior keel. The posterior keel can be traced in two revolutions. The left horn-core is almost completely preserved and measures about 210 mm in length (in straight line). There are postcornual fossae. The intercornual region is on a higher level than the supraorbital margins. The parietofrontal suture is open. The interfrontal suture cannot be traced since the specimen is damaged along it. The supraorbital foramens are small, not sunken in frontal depressions, and open about 27 mm below the horn-cores' bases. The frontlet PV1/69 is quite similar to other specimens referred to *P. skouzesi*, though, its horn-cores are slightly less robust compared to already known Pikermi specimens (Fig. 11; Roussiakis 2009).

A left mandible (Fig. 12; PV1/68; Lp3-p4=20.8, Lm=48.9, Lp3-m3=68.0) can also be attributed to *P. skouzesi*. The premolars are short in relation to the molars (Lp3-p4/Lm=42.5%). The p3 is rather triangular and clearly smaller than the p4 (Lp3/Lp4=84.1%). The metaconid is oblique and extends distolingually, closing the distal part of the lingual wall of the tooth. The 2nd valley remains open, while there is no groove in front of the hypoconid on the labial wall of the tooth. The p4 is similar to p3, but the metaconid forms a mesiodistally directed wall that also constricts the 2nd valley of the tooth. The groove in front of the hypoconid is moderately marked. On the molars, the ectostylids are rather strong on m1 and m2, less on m3. There is a faint pli caprin on m1 and m2. The lower dentition of *P. skouzesi* is not definitely known. Pilgrim and Hopwood (1928, pl. 9, fig. 3), followed by Gentry (1971, pl. 6), referred some mandibular rami from Pikermi to *P. skouzesi*, while Mecquenem (1925, pl. 6, fig. 1) referred to this species a mandibular ramus from Maragha. In addition, to the same species might belong two mandibular rami from Pikermi stored in AMPG: one of this, PA1842/91, was referred to *P. skouzesi* by Roussiakis (1996), while the other (Π89/740) was recently located in the AMPG Pikermi collections. On these specimens the Lp3-p4/Lm ratio ranges from 40.3% to 45.1% and the metaconid of p4 tends to be fused with the paraconid. This tendency is also exhibited by PV1/68 that appears comparable in size and proportions to the Pikermi specimens referred to *P. skouzesi* but slightly smaller compared to the Maragha specimen (Fig. 9).

Tragoportax PILGRIM, 1937

Tragoportax amalthea (ROTH & WAGNER, 1854)

We refer to *T. amalthea* a left mandibular ramus (PV1/38; Fig. 13), with the complete dentition preserved (Lp=45.7, Lp3-p4=32.3, Lm=60.7, Lp3-m3=91.0, Lpm=104.3). The mental foramen opens about 40 mm in front of p2. The premolar series is elongated (Lp/Lm=75.3%, Lp3-p4/Lm=53.2%). On p3, the 2nd valley is widely open while the 3rd one is narrow. The paraconid is transverse to the mesiodistal axis of the tooth and rather bulbous towards its base. The metaconid is distolingually directed. The groove in front of the hypoconid is faint. On p4, the 2nd and 3rd valleys are narrow due to the mesiodistally directed T-shaped metaconid. The paraconid is well separated from the parastylid and directs distolingually. The groove in front of the hypoconid is strong. A trace of pli caprin is observed on m1. The ectostylid is well developed on m1, but decreases towards m3. The m1 and m2 bear a lingual basal pillar between the paraconid and metaconid; this is faint on m3. Metrically PV1/38 is comparable to the larger Pikermi specimens of *Miotragocerus valenciennesi* and the smaller of *T. amalthea* (Fig. 14). However, the rather wide p3 and the T-shaped metaconid of p4 are typical characters of *Tragoportax* (Spassov and Geraads 2004; Kostopoulos 2005), so we refer this specimen to *T. amalthea*.

Gazella sp.

An isolated but damaged horn-core (PV1/70; Fig. 15) with preserved length of about 85 mm (in straight line) can be referred to *Gazella* sp. The surface of the horn-core is deeply grooved. The lateral surface is flatter than the medial, and the posterior surface appears gently curved in lateral view. The base of the horn-core is badly broken and no measurements can be provided. However, 2 cm above the base the cross section of the horncore is subelliptical (DAP×DT=24.0×21.4 mm) while about 7 cm above the base is more circular (L×W=17.1×16.6 mm). The general characters of this specimen show similarities to *Gazella capricornis* (WAGNER, 1848), but a specific determination cannot be established because of the scantiness of the available material.

Bovidae indet.

A right maxilla fragment (PV1/36; Fig. 16) preserving the complete dentition (LP=38.7, LM=48.1, LP3-P4=25.4, LPM=80.4) is characterized by the long premolar series in relation to the molars (LP/LM=80.5%, LP3-P4/LM=52.8%). P2 is elongated (L×W=14.0×10.1). Its parastyle is thin, while the paracone rib is thick, labially projected and rather mesially situated. The protocone projects lingually slightly more than the hypocone. It is separated from the latter by a deep lingual groove located opposite the paracone rib. P3 is only slightly larger in length than in width (L×W=13.9×12.8). The parastyle and paracone rib are strong. The metastyle is stronger and projects labially more than the parastyle and paracone rib. Lingually it is strongly bilobated, as P2, but the hypocone projects lingually much more than the protocone. P4 is larger transversely than mesiodistally (L×W=11.6×13.6). The parastyle, paracone rib and metastyle are moderately developed. The hypocone bears a hypoconal spur that forms a hypoconal islet. The upper molars are characterized by the strong parastyle, paracone rib and mesostyle, while the metacone rib and the metastyle (apart from M3) are weak. A hypoconal islet is present on M2 and a free hypoconal spur on M3. A central islet is not observed. A slightly developed entostyle is present on M1. It is faint on M2 and absent on M3.

A left mandibular ramus with p3-m3 (Fig. 17; PV1/17; Lp3-m3=77.8, Lp3-p4=28.2, Lm=51.1) agrees dimensionally, proportionally and morphologically to the above described upper toothrow. The p3 and p4 are elongated in relation to the molar series (Lp3-p4/Lm=55.2%). The toothrow length is estimated to 85 mm and the premolar length to 35 mm. The p3 is elongated relative to its width (L×W=19.4×7.1). The paraconid is independent from the parastylid and does not project lingually. The metaconid is distolingually directed but does not fuse with the entoconid. A faint groove is present in front of the hypoconid. The p4 is similar to p3 but the metaconid appears stronger. The m1 and m2 bear a weakly developed pli caprin. The parastylid and metastylid are weak on all molars. A moderated developed ectostylid is present on m1; it is faint on m2 and absent on m3.

The maxilla PV1/36 exhibits similarities to a specimen from Maragha referred to *Prostrepsiceros houtumschindleri* (RODLER & WEITHOFER, 1890) by Mecquenem (1925, pl. 5, fig. 5) on its relative long premolar series and elongated and bilobated P2, but it is larger in size. The mandible PV1/17 is very similar to NHML M13007 from Pikermi, referred by Gentry (1971), with reservation, to *Prostrepsiceros rotundicornis* (WEITHOFER, 1888), but the latter is smaller (Lp3-m3=65.8), presents stronger pli caprin and a deep groove in front of the hypoconid. PV1/17 also exhibits similarities to *P. rotundicornis* from Akkaşdağı that ranges in length from 68.8 to 75.1 mm (Kostopoulos 2005).

Carnivora BOWDICH, 1821

Hyaenidae GRAY, 1821

? *Adcrocuta eximia* (ROTH & WAGNER, 1854)

Hyaenids are represented by a right P2 and a right upper canine (PV1/49, PV1/22). The canine (L×W=17.3×13.5 mm) presents a moderately developed mesiolingual crest as well a distal one. The P2 (L×W=16.2×11.1 mm) is rectangular in outline. It presents two accessory cusps: a strong distal one on the long axis of the tooth, and a smaller one situated mesiolingually. Both specimens can be provisionally referred to *Adcrocuta eximia*.

Felidae FISCHER DE WALDHEIM, 1817

Felidae indet.

The proximal half of a proximal phalange (PV1/71; preserved length=29.6 mm, DTprox×DAPprox = 17.9×16.2 mm) has typical felid morphology. Its dimensions indicate a rather large felid, larger than *Metailurus parvulus* (HENSEL, 1862) (Roussiakis et al. 2006).

Discussion

Pikermi constitutes one of the oldest known and most famous localities of the Eurasian Late Miocene, and it is typical locality for many Turolian taxa. The recently discovered PV-1 locality, though very promising, has not yet yielded a large number of specimens and taxa; however, all findings come from a single horizon. A direct stratigraphic correlation with the classical Pikermi or the Chomateri localities is not possible at the moment.

The Pikermi fauna is generally considered as chronologically homogenous, though the early authors already noticed that the fossils occur in at least two stratigraphic levels. This was first observed by Gaudry (1855; 1862-1867), who mentioned the presence of two fossiliferous horizons. Later on, Woodward (1901) referred to two or locally three horizons, which is well documented in a photograph published by Abel (1922; Fig. 132). The stratigraphic problem at the classical site has raised considerations on the exact faunal content of each level. With respect to this question Theodorou and Nicolaides (1988) and Theodorou (1997) commented on the occurrence of one or two hipparionine species in various Pikermi samples, discussing the possibility that the presence of two species indicates a mixed sample. This was based on the observation that some authors have published statistical data of pikermian hipparionine samples comprising only one size group (Theodorou and Nicolaides 1988) However, the newly excavated material from PV-1 —though statistically inadequate— provides evidence for the co-existence of two hipparionine species, at least for a period of time. Roussiakis (2002) reached to the same conclusion concerning the classical site. Nevertheless, to conclude on this very important question we need adequate statistical samples for all Pikermi horizons.

Conclusion

The material excavated during the first field season documents the presence of the following taxa in PV-1: *Hipparion mediterraneum*, *Hipparion brachypus*, *Bohlinia attica*, *Palaeoreas lindermayeri*, *Protragelaphus skouzesi*, *Tragoportax amalthea*, *Gazella* sp., Bovidae indet., ? *Adcrocuta eximia* and Felidae indet.

In spite of the limited number of available specimens, PV-1 presents close taxonomic similarity with the classical Pikermi fauna, as all taxa determined to the species level are common between the two sites. This allows us to date the new site in the Turolian. A more precise dating requires more material, and/or a direct stratigraphic correlation to the classical site.

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FIGURE CAPTIONS

Figure 1: Geographical distribution of the Pikermi sites: 1, classical locality; 2, Chomateri or Kisdari; 3, Pikermi Valley-1. Graphical scale: 500 m. Pikermi is located 20 km east-northeast of Athens, Greece. Satellite image © 2009 Digital Globe / Google.

Figure 2: Pikermi Valley-1: partly excavated bones *in situ*.

Figure 3: *Hipparion mediterraneum*. Left third metacarpals (PV1/5, PV1/15), dorsal view. Graphical scale in cm.

Figure 4: *Hipparion mediterraneum*. Left third metatarsals; PV1/8, lateral view; PV1/40, dorsal view. Graphical scale in cm.

Figure 5: *Hipparion* sp. Proximal phalanges III (PV1/12, PV1/57), dorsal view. Graphical scale in cm.

Figure 6: *Bohlinia attica*. Right radius-ulna (PV1/72), anterior view. Graphical scale: 10 cm.

Figure 7: *Palaeoreas lindermayeri*. Frontlet (PV1/42), anterior view. Graphical scale in cm.

Figure 8: *Palaeoreas lindermayeri*. Right mandible (PV1/25); a) occlusal view, b) lingual view. Graphical scale in cm.

Figure 9: Comparison of *P. lindermayeri* and *P. skouzesi* from PV-1 with specimens from Pikermi and Maragha. Based on personal data.

Figure 10: *Protragelaphus skouzesi*. Frontlet (PV1/69); a) anterior view, b) anterolateral view. Graphical scale in cm.

Figure 11: Comparison of the basal horn-core dimensions (DT *vs* DAP) of *P. skouzesi* from PV-1 with *Protragelaphus*, *Ouzocerus* and *Helladorcas* species from various localities. Data according to Bouvrain (1978, 1997), Geraads and Güleç (1999), and Roussiakis (2009). PNT: Pentalophos-1, RZ1: Ravin des Zouaves-1.

Figure 12: *Protragelaphus skouzesi*. Left mandible (PV1/68); a) occlusal view, b) lingual view. Graphical scale in cm.

Figure 13: *Tragoportax amalthea*. Left mandible (PV1/38); a) occlusal view, b) lingual view. Graphical scale in cm.

Figure 14: Premolar *versus* molar length (lower dentition) in *Tragoportax* and *Miotragocerus* from various localities. Based on personal data, Kostopoulos (2005, 2009, pers. com.), Spassov and Geraads (2004) and Bouvrain (2001).

Figure 15: *Gazella* sp. Right horn-core (PV1/70), medial view. Graphical scale in cm.

Figure 16: Bovidae indet. Right upper toothrow (PV1/36); a) labial view, b) occlusal view. Graphical scale in cm.

Figure 17: Bovidae indet. Left mandible (PV1/17); a) occlusal view, b) lingual view. Graphical scale in cm.

Table 1: Long bone measurements of *Hipparion mediterraneum* from PV-1. Measurement methodology according to Eisenmann et al. 1988. The measurements in parentheses are inaccurate.

	Metacarpal III		**Metatarsal III**		**Tibia**		**Prox. Phalanx III**	
	PV1/5	**PV1/15**	**PV1/8**	**PV1/40**	**PV1/1**	**PV1/4**	**PV1/12**	**PV1/57**
1	204.4	202.5	259.5	253.3	—	—	61.8	63.7
2	196.8	196.3	251.7	245.1	—	—	56.9	58.2
3	25.2	24.5	26.1	(25.6)	40.6	38.5	24.2	27.6
4	21.1	22.7	28.7	(27.1)	29.1	27.0	35.5	39.2
5	32.6	33.9	38.9	39.1	—	—	27.2	31.0
6	24.2	23.9	28.0	—	—	—	29.1	32.7
7	28.5	29.2	36.7	(35.6)	66.7	59.2	29.0	32.2
8	—	8.8	10.3	—	44.5	41.2	18.3	22.1
9	—	3.4	8.1	—	—	—	19.1	20.3
10	31.0	34.5	35.9	36.9				
11	30.8	(33.7)	(32.2)	32.0				
12	25.3	26.3	30.3	28.5				
13	21.4	22.4	22.8	22.1				
14	21.9	23.8	26.9	25.6				
11/1	15.1	(16.6)	(12.4)	12.6				

Fig. 1

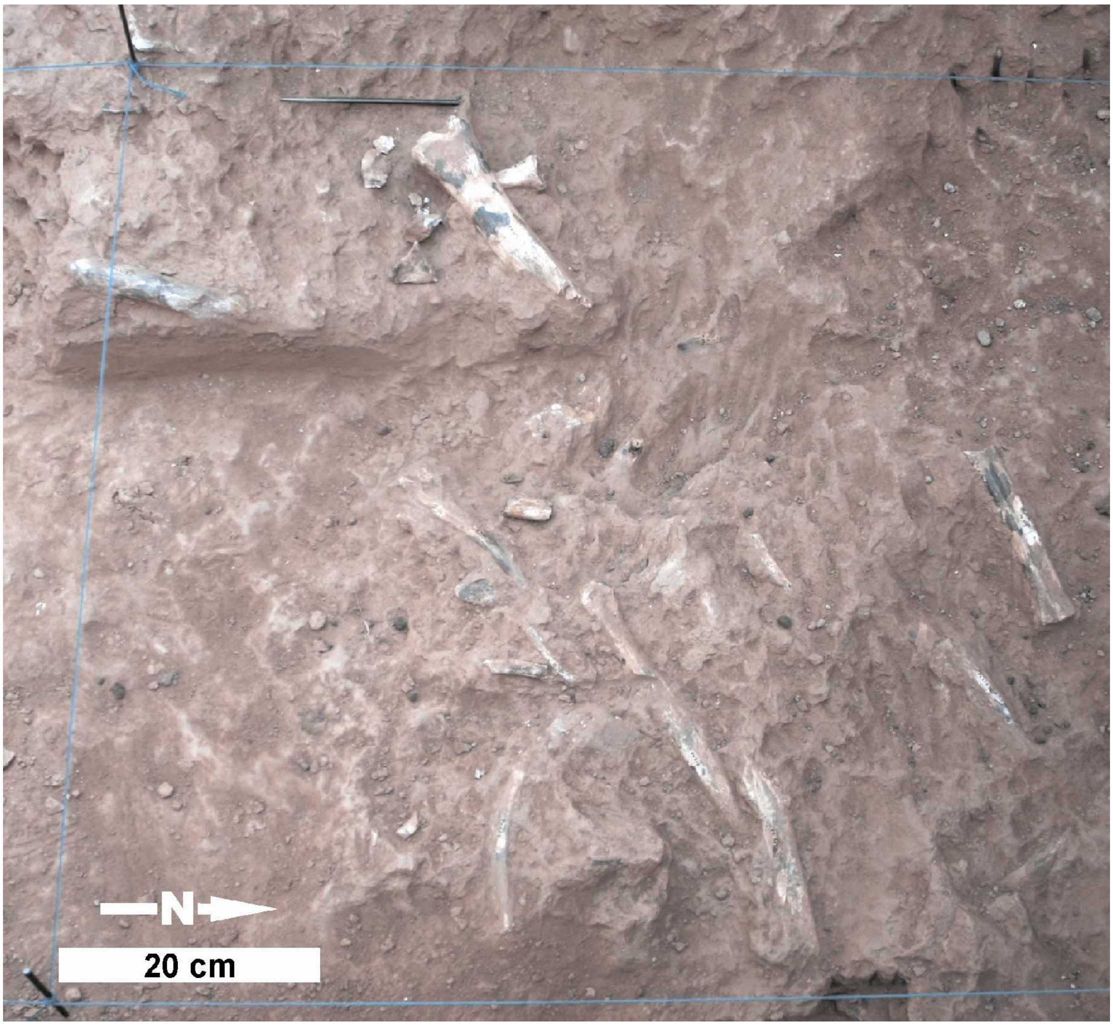


Fig. 2

Fig. 3

Fig. 4

Fig. 5

Fig. 6

Fig. 7

Fig. 8

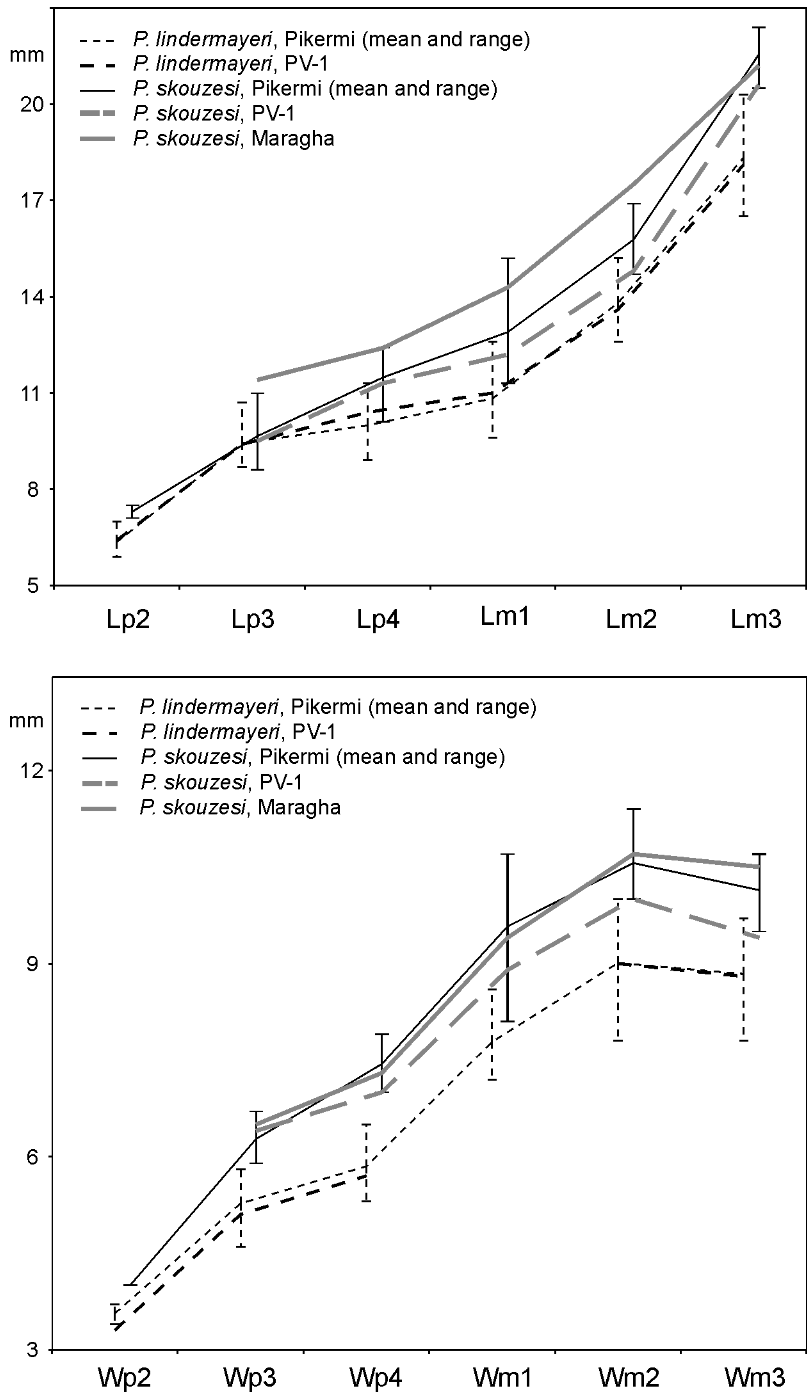

P. lindermayeri, Pikermi (mean and range)
P. lindermayeri, PV-1
P. skouzesi, Pikermi (mean and range)
P. skouzesi, PV-1
P. skouzesi, Maragha
mm
20
17
14
11
8
5
Lp2
Lp3
Lp4
Lm1
Lm2
Lm3
P. lindermayeri, Pikermi (mean and range)
P. lindermayeri, PV-1
P. skouzesi, Pikermi (mean and range)
P. skouzesi, PV-1
P. skouzesi, Maragha
mm
12
9
6
3
Wp2
Wp3
Wp4
Wm1
Wm2
Wm3

Fig. 9

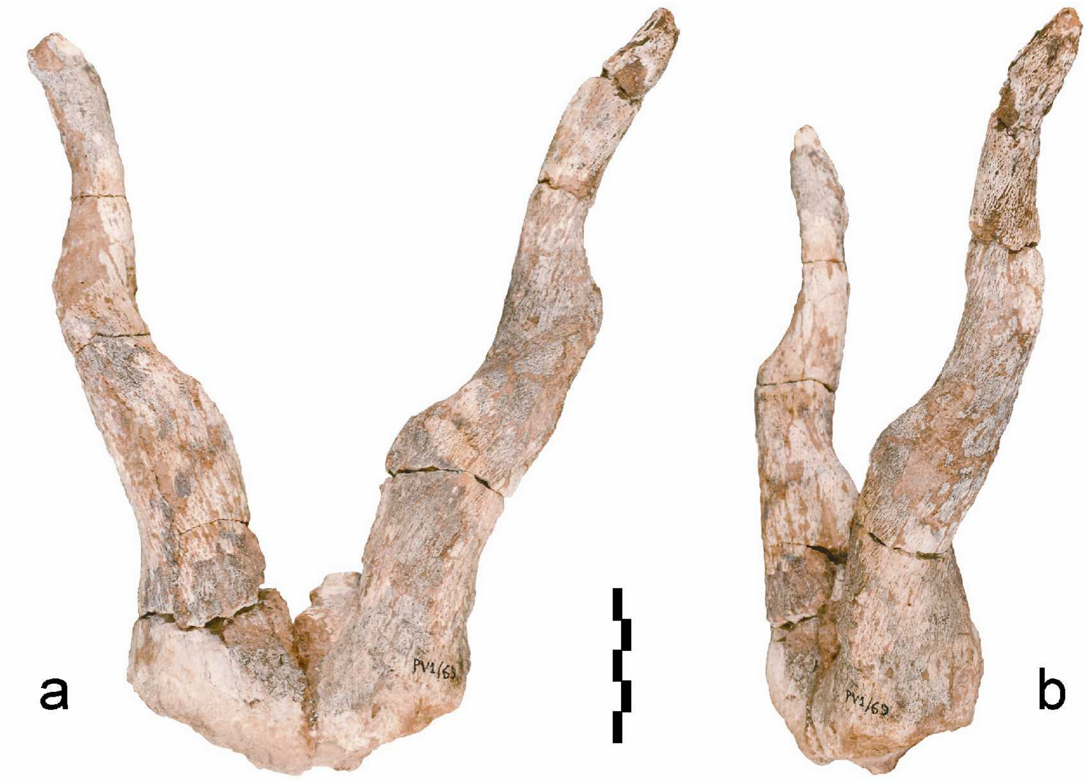


Fig. 10

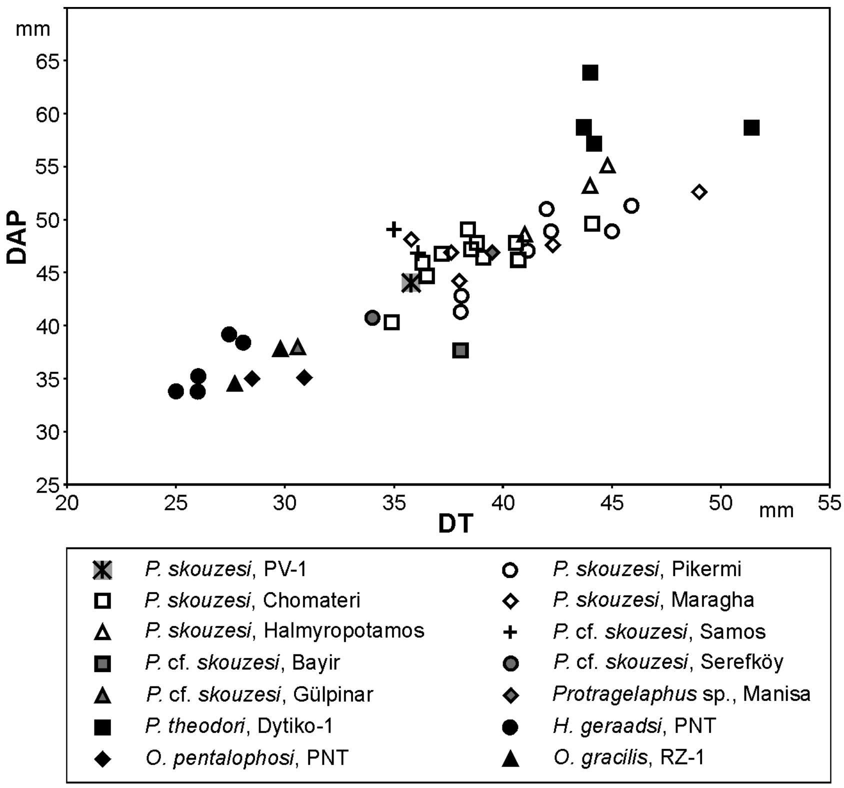

mm
65
60
55
50
45
40
35
30
25
DAP
20
25
30
35
40
45
50
55
mm
DT
P. skouzesi, PV-1
P. skouzesi, Chomateri
P. skouzesi, Halmyropotamos
P. cf. skouzesi, Bayir
P. cf. skouzesi, Gülpinar
P. theodori, Dytiko-1
O. pentalophosi, PNT
P. skouzesi, Pikermi
P. skouzesi, Maragha
P. cf. skouzesi, Samos
P. cf. skouzesi, Serefköy
Protragelaphus sp., Manisa
H. geraadsi, PNT
O. gracilis, RZ-1

Fig. 11

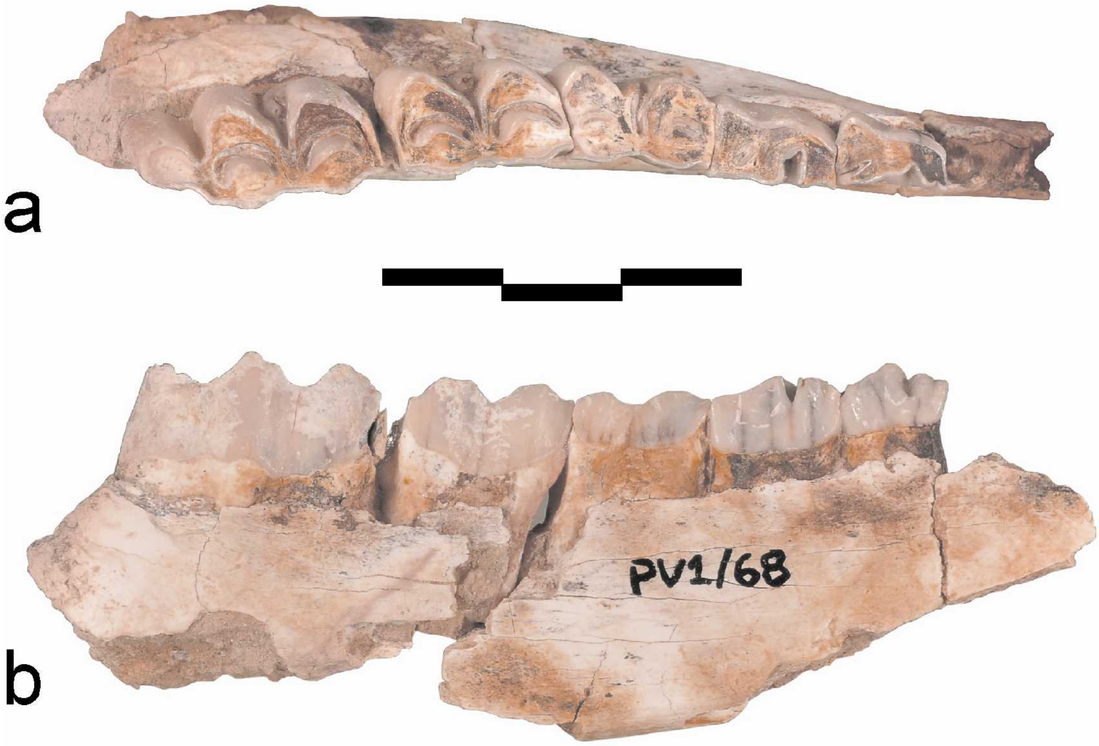
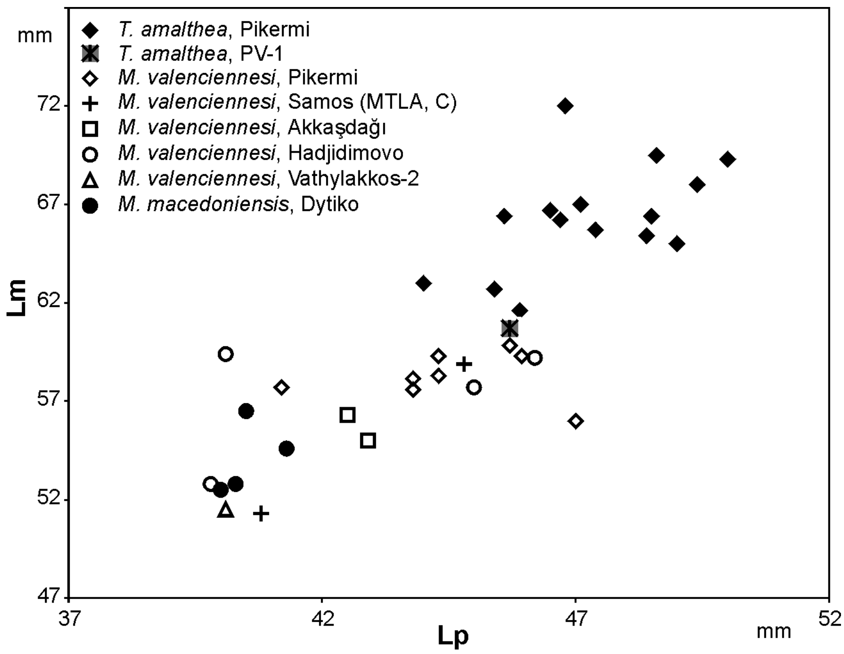


Fig. 12

Fig. 13



mm
T. amalthea, Pikermi
T. amalthea, PV-1
M. valenciennesi, Pikermi
M. valenciennesi, Samos (MTLA, C)
M. valenciennesi, Akkaşdağı
M. valenciennesi, Hadjidimovo
M. valenciennesi, Vathylakkos-2
M. macedoniensis, Dytiko
72
67
62
57
52
47
Lm
37
42
47
52
mm
Lp

Fig. 14

Fig. 15

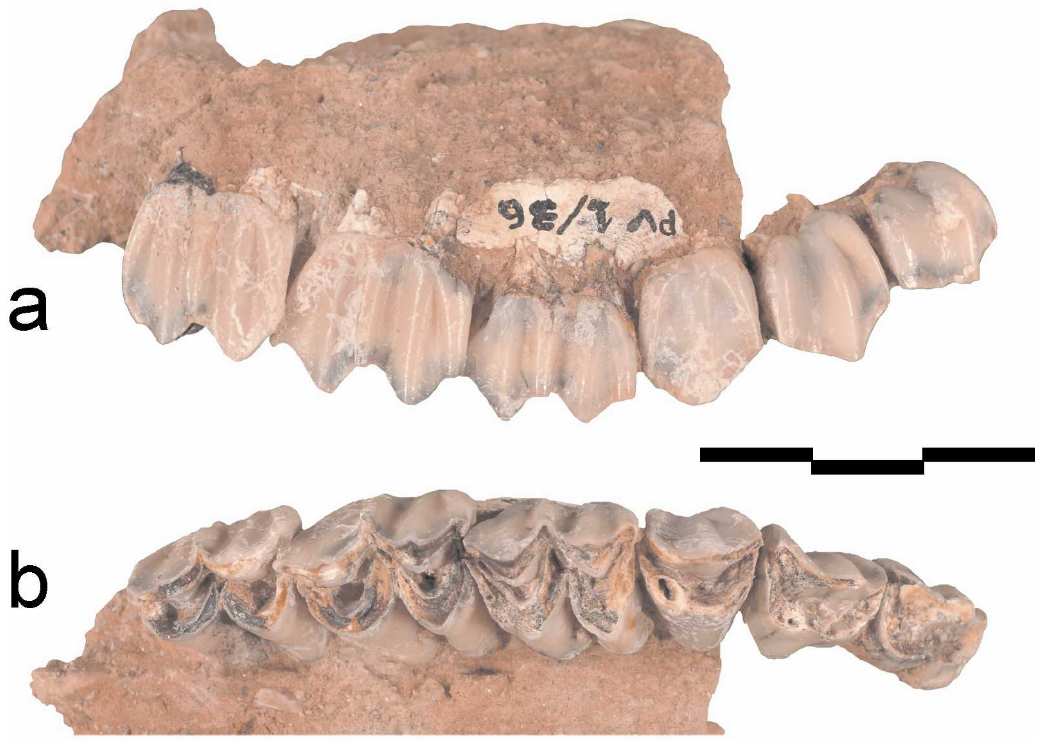


Fig. 16

Fig. 17