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## SUPPLEMENTARY ONLINE MATERIAL FOR

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### **Late Miocene bovids from Şerefköy-2, SW Turkey, and their position within the sub-Paratethyan biogeographic province**

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#### **SOM 1**

**Table 1.** Relative abundances of bovid genera from Greek, Turkish, and Iranian Turolian assemblages.

**Table 2.** Proportions of size, taxonomic, and feeding categories of bovid assemblages from Greek, Turkish and Iranian Turolian assemblages.

#### **SOM 2**

**Correspondence analysis, size and diet spectra.**

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#### **SOM 3**

**Table 1.** Upper tooth measurements (in mm) of *Gazella* cf. *capricornis*, *Palaeoryx pallasii*, *Sporadotragus parvidens*, *Skoufotragus* cf. *Sk. schlosseri*, and cf. *Sinotragus* from Şerefköy-2 (Turkey).

**Table 2.** Lower tooth measurements (in mm) of *Gazella* cf. *capricornis*, *Palaeoryx pallasii*, *Sporadotragus parvidens*, *Skoufotragus* cf. *Sk. schlosseri*, and cf. *Sinotragus* from Şerefköy-2 (Turkey).

**SOM 1. Table 1.** Relative abundances of bovid genera from Greek, Turkish, and Iranian Turolian assemblages.

	<i>Skoufotragus/</i> <i>Protoryx</i>	<i>Sporadotragus</i>	<i>Palaeoryx</i>	<i>Miotragocerus</i>	<i>Tragoportax</i>	<i>Urmiatherium</i>	<i>Criotherium</i>	<i>Plesiadax</i>	<i>Oioceros</i>	<i>Prostrepsiceros</i>	<i>Palaeoreas</i>	<i>Nisidorcas</i>	<i>Majoreas</i>	<i>Paraoioceros</i>	<i>Protragelaphus</i>	<i>Gazella</i>
NIK			1.52		19.70						7.58	66.67				4.55
RZO					54.82					22.84	2.54	10.66				9.14
Cc	3.00			3.00			1.00	4.00	23.00			3.00	50.00		4.00	10.00
KTD		14.29					42.86						28.57			14.29
Sivas	3.77				41.51					16.98						30.19
Mahm	3.75	7.50	1.25	2.50	33.75			16.25			1.25		5.00	1.25		27.50
PXM					57.53					15.07	1.37	15.07				10.96
MYT	70.83	12.50	4.17										4.17			8.33
KTAB	39.6		12.50											8.33		39.58
PER	6.81		2.09	1.05	35.08					21.47		21.47			7.85	3.66
Kinik	68.2	4.55		6.82						2.27						18.18
PIK	1.16	2.62	3.49	10.17	18.90				4.65	3.20	15.12				1.74	38.95
MAR7-13	4.11		1.58	3.16	8.86	4.11			32.91	21.84	0.95	0.95			2.85	10.44
MTLABC	41.72	5.96	8.61	6.62	0.66	1.99										34.44
Seref	43.14	17.65	6.86			5.88										23.53
Akkas	22.17		3.30	3.30	2.36					23.58						45.28
DYTI			2.02	34.41	2.02						9.72				21.86	19.43

**SOM 1. Table 2.** Proportions of size, taxonomic, and feeding categories of bovid assemblages from Greek, Turkish, and Iranian Turolian assemblages.

	PROTO	BOSE	OVIB	SPIRA	GAZE	Small	Medium	Large	Br	Mix	Gr	NISP
NIK	1,5	19,7	0	74,2	4,6	78,8	19,7	1,5				66
RZO	0	54,8	0	36	9,1	45,2	54,8	0	35,6	0	64,4	197
Cc	3	2	5	80	10	86	9	5	?	?	?	100
KTD	14,3	0	43	28,6	14,3	42,8	14,3	42,9	42,9	0	57,1	56
Sivas	3,8	41,5	0	17	37,7	54,7	45,3	0	17	11,3	71,7	53
Mahm	12,5	36,2	16,3	7,5	27,5	33,8	48,7	17,5				80
PXM	0	57,5	0	31,5	11	42,5	57,5	0				73
MYT	87,5	0	0	4,2	8,3	12,5	83,3	4,2	87,5	4,2	8,3	24
KTAB	53	0	0	8,3	39,6	39,6	47,9	12,5	20,8	39,6	39,6	48
PER	8,9	36,1	0	51,3	3,7	47,2	50,8	2	30,6	45,3	24,1	191
Kinik	72,7	6,8	0	2,3	18,2	20,4	79,6					44
PIK	7,3	29,1	0	24,7	39	61,9	34,6	3,5	21,8	76,5	1,7	344
MAR	5,7	14,2	4,1	59,5	16,5	73,1	19	7,9				316
MTLABC	56,3	7,3	2	0	34,5	34,4	57	8,6	30,5	48,3	21,2	151
Seref	67,6	2,9	5,9	0	23,5	23,5	69,6	6,9	24,5	43,1	32,4	102
Akkas	25,5	5,7	0	23,6	45,3	68,9	27,8	3,3	6,6	50	43,4	212
DYTI	2	36,5	0	42,1	19,4	39,7	58,3	2	6	47,8	46,2	247

Abbreviations.—Greek faunas: NIK, Nikiti-2; RZO, Ravin de Zouaves-5; PXM, Prochoma; MYT, Mytilinii-3; PER, Perivolaki; PIK, Pikermi; MTLABC, Mytilinii-1A,B,C; DYTI, Dytiko-1,2,3. Turkish faunas: Cc, Çorak-yerler; KTD, Kemiklitepe D; Sivas, Sivas; Mahm, Mahmutgazi; KTAB, Kemiklitepe A, B; Kinik, Kinik; Seref, Şerefköy-2; Akkas, Akkaşdağı. Iranian faunas: MAR, Maragheh (mainly levels MMTT7-13). NISP, number of identified specimens. Size categories: small, <50 kg; medium, 50–150 kg; large, > 150 kg. Diet categories: Br, browsers; Mix, intermediate feeders; Gr, grazers. See SOM 2 for further details.

## **SOM 2. Correspondence analysis, size and diet spectra**

We performed two separate correspondence analyses. The first followed the basic concepts of Bibi and Güleç (2008: 515, 519), based on the relative abundances of bovid genera per site for Turolian (Late Miocene; 8.7–5.0 Ma; Steininger 1999) assemblages from Greece (n = 8), Turkey (n = 8) and Iran (n = 1). Relative abundances of bovid genera were estimated based on the number of identified specimens (NISP), which is closely related to the minimum number of individuals (MNI) [a regression analysis of MNI-NISP pairs of 60 bovid genera from 10 of the Greek and Turkish faunas resulted  $r^2 = 0.93$  and  $p$  (uncorr) =  $2.8E - 33$ ; analysis not shown, but available on request], and weakly related to the number of bovid genera per site [ $r^2 = 0.49$ ;  $p$  (uncorr) = 0.001]. Counts for Sivas and Çorak-yerler are from Bibi and Güleç (2008), for Kinik and Mahmutgazi from Köhler (1987), for Akkaşdağı, Perivolaki, Mytilinii-3, and Mytilinii-1A,B,C from Kostopoulos (2005, 2006, 2009b), for Nikiti-2 from Kostopoulos and Koufos (1999) and personal data, for Maragheh from Kostopoulos and Bernor (2011), and for Kemiklitepe D and A,B from Bouvrain (1994). Data for Pikermi include specimens from the NHML, MNHN, and KNUA collections. Counts for Ravin de Zouaves-5, Prochoma, and Dytiko are based on personally collected data. Single occurrences at the genus level were excluded from the analysis.

In contrast to Bibi and Güleç (2008), we grouped bovid genera into five taxonomic units in our second correspondence analysis: PROTO, including protoryxoid bovids (*Skoufotragus/Pachytragus*, *Protoryx*, *Sporadotragus*, and *Palaeoryx*); BOSE, including Late Miocene boselaphines (*Miotragocerus*, *Tragoportax*, and *Samokeros*); GAZE, including Late Miocene representatives of *Gazella* and its allies; OVIB, including Late Miocene “ovibovines” (*Criotherium*,

*Urmiatherium*, *Sinotragus*, and *Plesiaddax*); and SPIRA, including Late Miocene spiral-horned antelopes (*Oioceros*, *Paraoioceros*, *Dytikodorcas*, *Hispanodorcas*, *Prostrepsiceros*, *Palaeoreas*, *Majoreas*, *Nisidorcas*, *Protragelaphus*, and *Pheraios*). These taxonomic bins, based principally on phenetic similarity (but in some cases also phylogenetic relationships), simply reflect the basic taxonomic structure of the bovid assemblages and allowed us to (1) emphasize general patterns in the taxonomic structure; (2) incorporate genera with low abundances that otherwise require exclusion from the analysis; and (3) overcome differing taxonomic opinions (e.g., Bibi and Güleç 2008).

We do not follow Bibi and Güleç (2008) in assuming that all species of a genus tend to have similar environmental responses, but agree with their assumption that the absolute abundance of a taxon or group of taxa through time is itself time-independent. As body size appears to be a crucial ecological parameter both at the level of the organism and the community level (e.g., Western 1979; Eisenberg 1990), we assume that the size structure of a bovid assemblage is important in understanding its paleoecological context and paleogeographic relationships. We therefore also performed an analysis of the relative abundances of small (less than 50 kg), medium, and large bovids (more than 150 kg) per site. All size categories include taxa of different tribal affiliations, thus making them sufficiently independent from a taxonomic point of view.

Finally, we classified all of bovid genera into three main groups of feeding preferences (based on their relative abundances), so as to be able to show the diet spectra of several local bovid associations. These groups consisted of grazers (including intermediate grazers), mixed feeders, and browsers (including intermediate browsers). However, because a single genus may include species with rather distinct

feeding behaviors (e.g., *Prostrepsiceros*; see Merceron et al. 2004, 2005a; Solounias et al. 2010), bovid genera from Ravin de Zouaves 5 (RZO), Perivolaki (PER), Pikermi (PIK), Dytiko (DYTI), Mytilinii-3 (MYT) and Mytilinii-1A,B,C (MTLABC) were classified strictly based on the results of the dental-wear pattern analyses (including both microwear and mesowear) conducted by Koufos et al. (2006, 2009), Merceron et al. (2005a, b), and Solounias et al. (2010). This means that the same genus may appear as a grazer in one bovid association, but as a browser in another, depending on the local species record (e.g., Merceron et al. 2005a; Solounias et al. 2010). When available, we also considered differences within the same taxonomic unit, as in *Tragopotrax rugosifrons* from RZO and PER (Merceron et al. 2005a: 480; Koufos et al. 2006: 207), and *Gazella* from MTLAB (including three species with different ecological profiles; Koufos et al. 2009b). Owing to the absence of similar studies on Turkish faunas, we classified the bovids from Sivas, Kemiklitepe D and A-B, Şerefköy-2, and Akkaşdağı by assuming their feeding preferences to resemble those of taxa from other sites close in time and geography. We did not analyse the ecological spectra of Maragheh, Kinik, Corak-yerler, Mahmutgazi, and Nikiti-2, either because of a lack of data or because of other, similar studies on these sites currently in progress.

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**SOM 3. Table 2.** Lower tooth measurements (in mm) of *Gazella cf. capricornis*, *Palaeoryx pallasii*, *Sporadotragus parvidens*, *Skoufotragus cf. Sk. schlosseri*, and cf. *Sinotragus* from Şerefköy-2 (Turkey). L, length; W, width.

Specimen	Lpm	Lp	Lm	Lp2	Wp2	Lp3	Wp3	Lp4	Wp4	Lm1	Wm1	Lm2	Wm2	Lm3	Wm3
<i>Gazella cf. capricornis</i>															
MYŞE PV-2562	54.8	20.3	35.7	5.1	3.0	7.6	3.8	8.7	4.7	8.8	6.0	11.4	6.3	15.9	5.4
MYŞE PV-2557	54.6	20.1	34.4	5.3	3.1	6.9	4.1		4.2	9.1	6.0	10.5	6.3	14.9	6.2
MYŞE PV-2563	54.7	20.8	34.9	4.8	2.8	7.2	3.8	8.9	4.8	8.7	5.9	10.5	6.1	16.0	5.3
MYŞE PV-2558	55.0	20.2	34.4	5.7	3.1	7.2	4.0	7.5	4.8	8.2		10.8	6.6	15.4	6.6
MYŞE PV-2564	52.6	18.7	34.6	5.0	3.1	6.7	3.8	7.6	4.9	8.5	5.8	10.6	5.9	15.3	5.7
MYŞE PV-2565			32.0			6.9	3.8	7.6	4.6	8.1	5.7	9.9	6.4	14.1	6.2
MYŞE PV-2000	56.7	21.5	35.7	5.5	2.9	7.8	4.1	8.9	4.4	9.3		11.5	6.1	15.5	5.8
MYŞE PV-1528														15.9	6.1
<i>Palaeoryx pallasii</i>															
MYŞE PV-2574	138.9	54.0	84.0	14.2	7.9	18.9	10.7	20.7	11.6	22.2	12.2	27.0	13.5	33.7	13.5
MYŞE PV-1599	137.0	55.1	82.7	13.7	8.6	18.6	11.9	21.4	14.8	18.7		25.9	18.5	37.7	16.4
MYŞE PV-2552												23.4		29.6	
<i>Sporadotragus parvidens</i>															
MYŞE PV-1574		27.3		6.8	4.4	10.4	6.3	10.6	6.5	12.2	7.3	14.6	7.3		
MYŞE PV-2561		28.5		6.7	3.8	10.5	5.3	11.0	6.4	13.1	7.9	15.3	8.2		
MYŞE PV-1511			43.9			9.9	6.4	10.9	6.5	12.6	7.8	13.8	7.1	17.4	7.1
MYŞE PV-1311								11.2	6.5	12.0	8.3	14.8	8.4		
MYŞE PV-2556			43.5							11.1		14.3	7.9	19.5	8.0
MYŞE PV-1630						10.5	5.4					15.2		19.5	8.3
MYŞE PV-1407		27.0		6.8	4.2	10.0	6.3	10.8	7.1	13.2	7.8	14.8	8.5		
MYŞE PV-1406	72.6	27.8	44.5	8.0	4.6	10.0	6.3	10.9	7.1	11.1	8.8	13.6	9.4	19.5	9.2
MYŞE PV-1429								11.2	7.2	11.9	9.6	16.6	9.6		
MYŞE PV-2569			47.0					11.2	7.1		9.5	16.1	9.6	20.8	9.1
MYŞE PV-2559		27.5	47.2	7.0	4.0	10.2	5.2	12.2	7.0	11.4	8.6	14.5	10.3	22.9	9.8
<i>Skoufotragus cf. Sk. schlosseri</i>															
MYŞE PV-1543	90.0	34.8	56.0	10.1	5.8	11.4	6.6	13.6	8.1			17.8	11.2	24.9	10.6
MYŞE PV-1540			61.8					12.9	7.4	16.2	9.3	18.9	9.0	26.0	8.7
MYŞE PV-1541			63.8							16.9	10.1	19.3	9.9	25.9	10.3
MYŞE PV-1510	90.0	35.0	56.2	9.9	5.6	12.1	6.2	14.2	7.6	13.3	11.5	17.6	11.2	24.5	10.3
MYŞE PV-1542	101.2	38.5	63.8	10.5	5.9	13.2	6.7	14.0	8.0	15.9	9.9	19.6	10.3	27.4	9.9
MYŞE PV-1156												18.3	10.2	26.3	9.5
MYŞE PV-2001						12.0	6.0		7.5	16.9	9.5				
MYŞE PV-1546												18.0	10.0		10.3
MYŞE PV-2566		35.1		10.0	5.3	11.6	6.5	13.4	8.1	15.7	10.3	17.5	10.6		10.1
MYŞE PV-2560		35.2		10.4	5.3	11.9	7.0	13.4	8.2	15.0	12.2	18.4	11.7		10.7
MYŞE PV-2568			55.6									17.6	12.3	25.3	11.3
MYŞE PV-2554	92.3	37.1	55.6	11.1	5.9	13.0	7.0	13.7	8.6	13.7	11.2	16.8	12.5	25.1	11.3
MYŞE PV-2551								13.7	8.0	13.0	10.5	17.4			
<i>?Sinotragus sp.</i>															
MYŞE PV-2553	65.3	24.3	42.0	7.0	4.9	8.5	5.8	8.8	6.4	9.4	8.9	12.7	9.7	19.9	9.0
MYŞE PV-2567	65.7	24.0	42.3	7.5	4.8	8.3	5.8	8.5				13.3	9.2	18.6	8.7