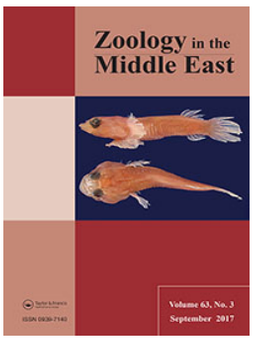

Zoology in the Middle East

ISSN: 0939-7140 (Print) 2326-2680 (Online) Journal homepage: https://www.tandfonline.com/loi/tzme20

A new chromosomal race (2n=44) of *Nannospalax xanthodon* from Turkey (Mammalia: Rodentia)

Teoman Kankılıç, Atilla Arslan, Perinçek Seçkinozan Şeker, Tolga Kankılıç, Kubilay Toyran & Jan Zima

To cite this article: Teoman Kankılıç, Atilla Arslan, Perinçek Seçkinozan Şeker, Tolga Kankılıç, Kubilay Toyran & Jan Zima (2017) A new chromosomal race (2n=44) of *Nannospalax xanthodon* from Turkey (Mammalia: Rodentia), Zoology in the Middle East, 63:3, 181-188, DOI: 10.1080/09397140.2017.1349201

To link to this article: https://doi.org/10.1080/09397140.2017.1349201

Zoology in the Middle East, 2017
Vol. 63, No. 3, 181–188, http://dx.doi.org/10.1080/09397140.2017.1349201

Taylor & Francis
Taylor & Francis Group

A new chromosomal race (2n=44) of *Nannospalax xanthodon* from Turkey (Mammalia: Rodentia)

Teoman Kankılıç[a], Atilla Arslan[b*], Perinçek Seçkinozan Şeker[c], Tolga Kankılıç[d], Kubilay Toyran[e] and Jan Zima[f]

(Received 28 March 2017; accepted 31 May 2017; first published online 13 July 2017)

[a]*Department of Biotechnology, Faculty of Science and Letters, Ömer Halisdemir University, Niğde, Turkey;* [b]*Department of Biology, Faculty of Science, Selçuk University, Konya, Turkey;* [c]*Department of Forestry, Artvin Vocational School, Artvin Çoruh University, Artvin, Turkey;* [d]*Department of Biology, Faculty of Science and Letters, Aksaray University, Aksaray, Turkey;* [e]*Department of Biology, Faculty of Science and Letters, Bitlis Eren University, Bitlis, Turkey;* [f]*Institute of Vertebrate Biology, Czech Academy of Sciences, Brno, Czech Republic*

A new karyotype for blind mole rats was recorded in Tunceli province in Eastern Turkey. The karyotype contained 44 chromosomes, including 13 biarmed pairs, 7 acrocentric pairs, and one heteromorphic pair with a submetacentric and an acrocentric homologue in the autosomal complement (FNa=69). The X chromosome was submetacentric and the Y chromosome medium-sized subtelocentric (FN=73). Distinct dark centromeric C-bands were observed on most of the biarmed and three pairs of the acrocentric autosomes. The NORs were detected on short arms of three subtelocentric pairs and one acrocentric pair of autosomes. The diploid number of chromosomes and the karyotype characteristics observed are obviously unique among hitherto studied populations of blind mole rats and the complement can be evaluated as a new chromosome race of *Nannospalax xanthodon*. The distribution ranges of individual chromosome races of the species recorded in Eastern Anatolia are revised and possible interracial hybridization is discussed in respect of the finding of a new race.

Keywords: *Nannospalax;* Pülümür race; karyotype; C-bands; Ag-NORs

Introduction

Populations of blind mole rats belonging to the genus *Nannospalax* are extremely variable in relation to karyotype constitution. It is assumed that the blind mole rats can be differentiated into more than 70 distinct chromosome races or cytotypes (Arslan, Kryštufek, Matur, & Zima, 2016) what is quite exceptional among mammals. Species of this genus occur in south-eastern Europe, Middle East, and north-eastern Africa (Musser & Carleton, 2005). The most prominent chromosomal diversity within the genus has been recorded in Turkish mole rats that are represented by three species, *N. xanthodon*, *N. ehrenbergi* and *N. leucodon* (Kryštufek & Vohralík, 2009). Differences in the karyotype of the Turkish blind mole rats have been found both between and within the individual species (e.g. Nevo, Filippucci, Redi, Simson, Heth, & Beiles, 1995; Ivanitskaya, Coşkun & Nevo, 1997; Kankılıç, Kankılıç, Çolak, Çolak & Karataş, 2007; Arslan, Akan & Zima, 2011, Sözen, Çolak, Sevindik & Matur, 2013; Matur, Çolak, Ceylan, Sevindik & Sözen, 2013). *N. xanthodon* is distributed in most parts of Asiatic Turkey and this nominal taxon includes 28 different chromosome races with recorded diploid numbers of 2n = 36, 38, 40, 46, 48, 50, 52, 54, 56, 58, 60 and 62 (Arslan et al., 2016). Many of

*Corresponding author. Email: aarslan@selcuk.edu.tr

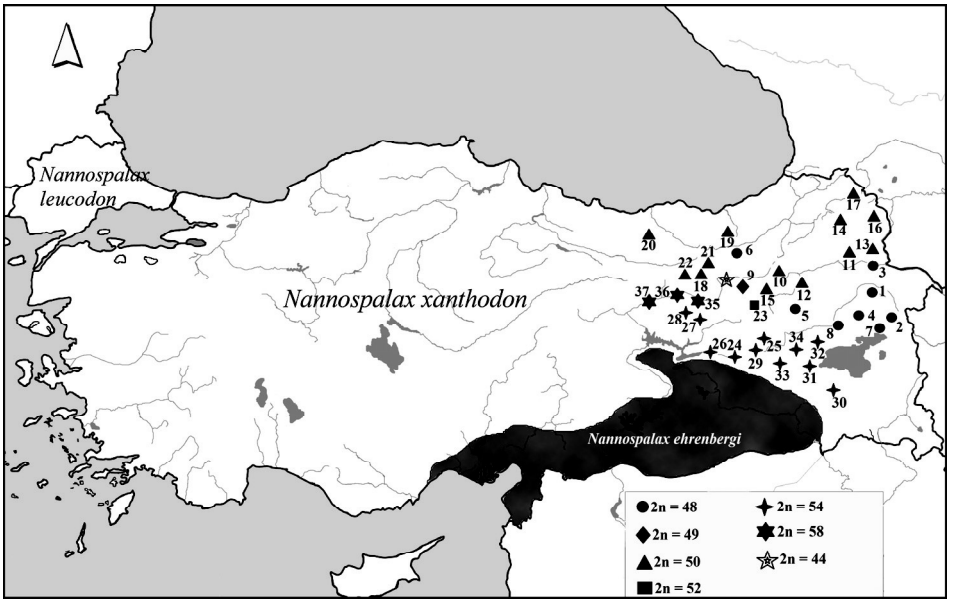

Figure 1. Distribution of chromosome races of *Nannospalax xanthodon* and their collecting sites in eastern Anatolia. See Table 1 for references.

the distinguished races are apparently endemic to Anatolia, however, their taxonomy is far from being resolved, and the nomenclature is only tentative and evolving. Morphological studies were performed in Turkish blind mole rats with the use of large samples of individuals (Kıvanç, 1988) but the resolution of divergence in morphometric traits is apparently low. Certain studies indicated that each of chromosomal races has genetic differences at the species level (Nevo et al., 1995; Arslan, Gülbahçe, Arıkoğlu, Arslan, Bužan, & Kryštufek, 2010; Kandemir et al., 2012), nevertheless, the approach of "race equal species" was refused by other authors (Kryštufek, Ivanitskaya, Arslan, Arslan & Bužan, 2012), and only particular races have been proposed to achieve the species level (Kankılıç, Kankılıç, Seker & Kıvanç, 2014; Kankılıç & Gürpınar, 2014).

The dense sampling of chromosomal records in Anatolia provided a comprehensive pattern of the distribution of karyologically distinct populations, designated as cytotypes or races (Arslan et al., 2016). In the present study, we report the karyotype with a new chromosome number which was found in an individual studied from eastern Anatolia.

Material and Methods

The cytogenetic examination was performed in a male of *N. xanthodon* collected at Pülümür (39°29'N, 39°53'E, 1491 m a.s.l.) in the Tunceli Province, eastern Anatolia, Turkey (Figure 1). Karyological preparations and examinations followed procedures described in some previous papers (e.g. Arslan et al., 2011, 2014). The skins, skulls and karyotype preparations of the examined specimen were deposited at the Ömer Halisdemir University, Niğde, Turkey.

Results

The karyotype of one male consisted of 44 chromosomes including two large subtelocentric (nos 1, 2), two large metacentric or submetacentric (3, 4), eight medium-sized metacentric or submetacentric (5–8, 10–13), one medium-sized subtelocentric (9) and

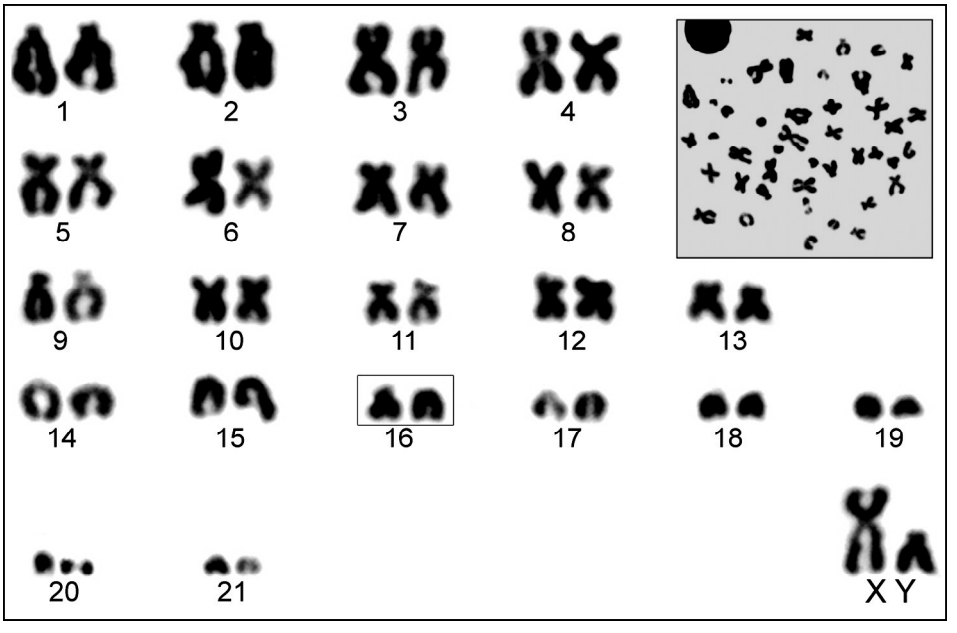

Figure 2. Standard karyotype of a male of *Nannospalax xanthodon* from Tunceli. The heteromorphic chromosome pair is within the frame.

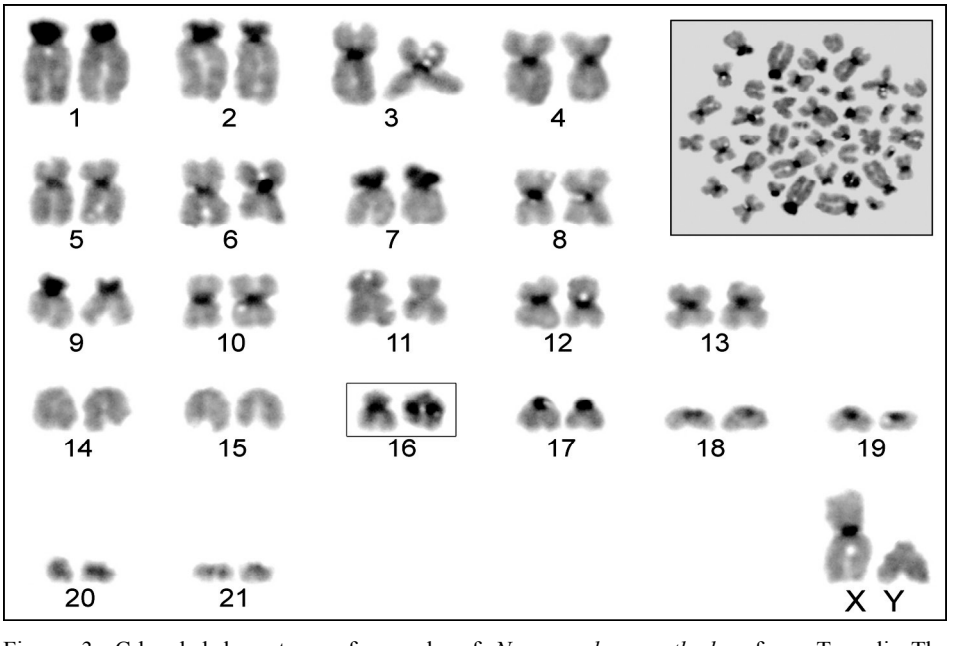

Figure 3. C-banded karyotype of a male of *Nannospalax xanthodon* from Tunceli. The heteromorphic chromosome pair is within the frame.

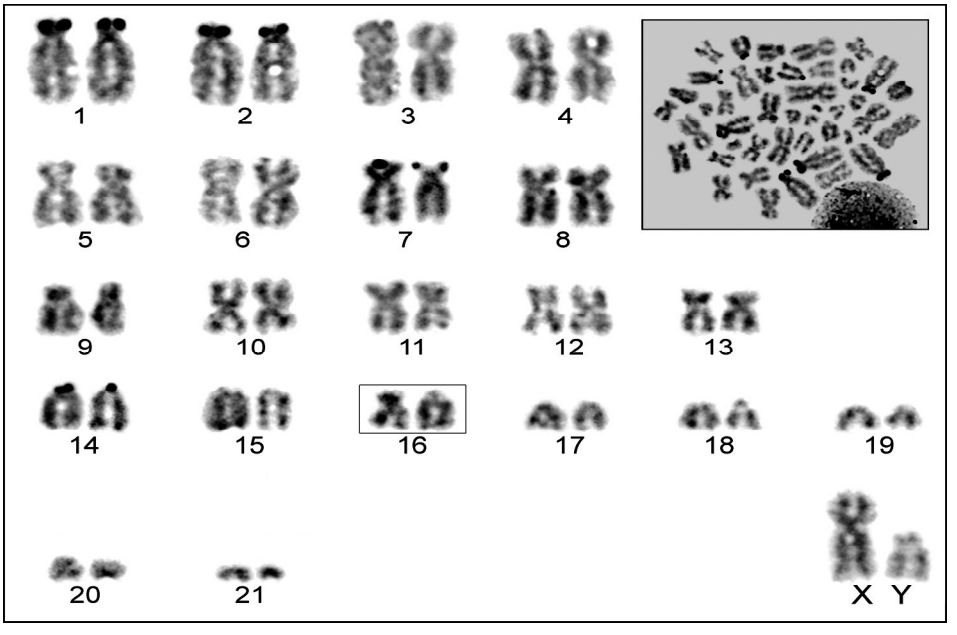

Figure 4. Silver-stained karyotype of a male of *Nannospalax xanthodon* from Tunceli. The heteromorphic chromosome pair is within the frame.

eight smaller acrocentric autosomal pairs of gradually diminishing size (14–21). The pair 16 was heteromorphic and consisted of a submetacentric and an acrocentric chromosome (FNa=69). The X chromosome was the largest submetacentric element of the complement (FN=73), the Y was a medium-sized subtelocentric. Distinct dark C-bands were observed in centromeric or pericentromeric areas of all the biarmed autosomes except for the pair 11. Whole C-heterochromatic short arms were found in three subtelocentric (1, 2, 9) and one submetacentric (7) autosomal pair. Three acrocentric autosomal pairs (17–19) possessed slight centromeric bands whereas no C-positive staining was observed in the other acrocentric autosomes. The acrocentric chromosome in the heteromorphic pair 16 had an interstitial C-band on long arm, whereas only slight centromeric band appeared on its subtelocentric homologue. The X chromosome had a distinct centromeric band, and the Y chromosome was stained C-negatively (Figure 2). The NORs were observed in the telomeric regions of the short C-heterochromatic arms of autosomes 1, 2, 7, and near the centromere on the acrocentric pair 14. The positive silver signals were detected in both homologues of all pairs (Figure 3).

Discussion

The diploid number of 44 chromosomes has never been reported in *Nannospalax xanthodon* or any other species of blind mole rats. The described karyotype apparently represents a new chromosome form and we propose to name it the Pülümür race. The closest diploid chromosome number within *N. xanthodon* was found in the blind mole rat race Yirce (2n = 46) described near Osmaniye in southern Anatolia (Arslan, Zima, Yorulmaz & Arslan, 2014). The structure of the Yirce karyotype is similar to that of the Pülümür race, but only single large subtelocentric autosomal pair was observed in the

Table 1. Localities, diploid chromosome number (2n), chromosomal arm number (FN), number of biarmed pairs of autosomes (M), number of acrocentric pairs of autosomes (A), and the morphology of sex chromosomes (X, Y) of blind mole rats (*Nannospalax xanthodon*) studied in eastern Anatolia. The map numbers (MN) are the same as in Figure 1. References: 1 – Arslan & Zima (2013); 2 – Arslan & Zima (2017); 3 – Coşkun (2003); 4 – Coşkun (2004); 5 – Coşkun (2013); 6 – Coşkun & Kaya (2013); 7 – Coşkun, Kaya & Yürümez (2009); 8 – Coşkun et al. (2010); 9 – Coşkun, Kaya, Ulutürk, Yürümez & Moradi (2012); 10 – Kankılıç et al. (2007); 11 – Nevo et al. (1995); 12 – Sözen, Matur, Çolak, Özkurt & Karataº (2006); 13 – Ulutürk, Coşkun & Arıkan (2009). – Ref. = References.

MN	Locality	2n	FN	M	A	X	Y	Ref.
1	Ağrı (Küpkıran, Taşlıçay)	48	68	9	14	sm	a	3
2	Van (Çaldıran)	48	68	9	14	sm	a	3
3	Iğdır (Tuzluca-Kaskoparan)	48	68	9	14	sm	a	6
4	Ağrı (Patnos, Tutak)	48	68	9	14	sm	a	9
5	Erzurum (Hınıs)	48	68	9	14	sm	a	9
6	Gümüşhane (35 km NE Şamanlı)	48	71-70	10	12	sm	-	2, 12
7	Van (Erciş)	48	72	11	12	sm	a	7
8	Muş (Malazgirt)	48	72	11	12	sm	a	2, 7
9	Tunceli (Pülümür-Kangallı)	49	76	12+1	11	sm	a	8
10	Erzurum (80 km Güney)	50	-	-	-	-	-	11
11	Kars (14 km Sarıkamış)	50	-	-	-	-	-	11
12	Erzurum (Pasinler)	50	70	9	15	sm	a	3
13	Kars (Selim, Digor)	50	70	9	15	sm	a	3
14	Aradahan (Göle)	50	70	9	15	sm	a	3
15	Erzurum (Çat)	50	70	9	15	sm	a	9
16	Kars (Arpaçay)	50	70	9	15	sm	a	13
17	Ardahan (Hanak, Çıldır)	50	70	9	15	sm	a	13
18	Erzincan (Başköy)	50	72	10	14	sm	-	12
19	Rize (Ovid Geçidi)	50	72	10	14	sm	-	10
20	Giresun (Eğribel Geçidi)	50	72	10	14	m	a	10
21	Bayburt (Demirözü)	50	72	10	14	m	a	10
22	Erzincan (Yollarüstü)	50	72	10	14	m	a	10
23	Bingöl (Karlıova, 3 km NE)	52	74	10	15	m	a	5
24	Bingöl (10 km Güney)	54	-	-	-	-	-	11
25	Bingöl (Solhan)	54	74	9	17	sm	a	4
26	Elazığ (Kovancılar-Taşören, Palu, Yeniköy)	54	74	9	17	sm	a	4
27	Tunceli (Kocakoç-Gömemiş)	54	74	9	17	sm	a	4
28	Tunceli (Hozat-Akmezra)	54	74	9	17	sm	a	8
29	Bingöl (Genç)	54	74	9	17	sm	a	5
30	Bitlis (Hizan)	54	74	9	17	sm	a	7
31	Bitlis (Tatvan)	54	74	9	17	sm	a	7
32	Bitlis (Ahlat)	54	74	9	17	sm	a	7
33	Muş (Kumbet)	54	74	9	17	sm	a	7
34	Muş (Bulanık)	54	74	9	17	sm	a	7
35	Tunceli (Ovacık-Sarıtosun)	58	68	4	24	sm	a	4
36	Erzincan (Kemaliye-Esentepe)	58	68	4	24	sm	a	8
37	Erzincan (Kemaliye-Başpınar)	58	66	3	25	sm	sm	1

Yirce complement. A large subtelocentric pair possessing a C-heterochromatic short arm and an Ag-NOR site was recorded also in the complement of individuals belonging the Van race (2n = 48) from the Muş and Gümüşhane provinces (Arslan & Zima, 2017). Two or three large subtelocentric autosomal pairs were found also in the races with the low chromosome numbers from western Anatolia (Arslan & Zima, 2013). The distribution of positive C-bands and active AgNORs in the Pülümür karyotype is rather standard for the races distinguished within *N. xanthodon*.

Eastern parts of Anatolia are populated by blind mole races showing various diploid numbers of chromosomes (2n = 48, 50, 52, 54, 58; see Table 1 for references). The races are distributed in a parapatric or allopatric pattern as is usual for chromosome races. Interestingly, the 2n = 60 populations, which are widespread in central Anatolia, have not been recorded in the eastern parts of Asiatic Turkey (see Arslan et al., 2016 for review).

The Tunceli province is placed in the upper Euphrates (Fırat) basin and most of its territory consists of impenetrable mountains. These high altitudes pose significant barriers for the dispersion of blind mole rats. Therefore, we assume that populations from Tunceli, distributed in the fertile subsidence field starting from Iğdır plain and extending to Erzincan plain, are effectively isolated from populations of *N. xanthodon* with 2n = 48 and 50 (the Van and Nehringi race, respectively). Furthermore, ranges of the Eastern Taurus Mts. separate from east to west the northern and southern parts of the Tunceli province, and Coşkun (2004) proposed that the Mercan Mts. may form a barrier isolating the Munzurii race (2n = 58) in the north and the Tuncelicus race (2n = 54) in the south. Similarly, the Karagöl Mts. in the north-eastern parts of the province may separate the range of the new race described in this paper from other blind mole rat races and populations.

Coşkun, Ulutürk, and Kaya (2010) recorded a karyotype with 2n = 49 and FN = 76 in a previous study on blind mole rats from a locality (Pülümür - Kangallı) which is situated rather close to the site studied in the present paper. The autosomal complement of the individuals studied consisted of 12 pairs of biarmed, 11 pairs of acrocentric and one odd metacentric chromosome. We can hypothetize that this heterozygous karyotype may have originated after interracial hybridization and the newly described race with 44 chromosome migth be potentially involved in such an event. Similarly, the 2n = 52 karyotype described from Bingöl by Coşkun (2013) may also be a product of interracial reproductive contacts.

Funding

This study was supported by TÜBİTAK (KBAG 112T660) and Ömer Halisdemir University (FEB2011/35, FEB2013/01).

Acknowledgement

We would like to thank Dr Kevin Roche for linguistic assistance.

Dislosure Statement

No potential conflict of interest was reported by the authors.

References

Arslan, A., & Zima, J. (2013): The banded karyotype of the 2n = 58 chromosomal race of mole rats from Erzincan, Turkey. *Folia Zoologica, 62*, 19–23.

Arslan, A., & Zima, J. (2017): Heterochromatin distribution and localization of NORs in the 2n = 48 cytotypes of *Nannospalax xanthodon* and *N. ehrenbergi. Turkish Journal of Zoology* (in press). Doi: 10.3906/zoo-1602-48.

Arslan, A., Akan, Ş., & Zima, J. (2011): Variation in C-heterochromatin and NOR distribution among chromosomal races of mole rats (Spalacidae) from Central Anatolia, Turkey. *Mammalian Biology, 76*, 28–35.

Arslan, A., Arısoy, A., & Zima, J. (2013): The chromosome banding pattern in two races (2n = 36 and 38) of blind mole rats from Turkey (Mammalia: Spalacidae). *Zoology in the Middle East, 59*, 95–100.

Arslan, A., Kryštufek, B., Matur, F., & Zima, J. (2016): Review of chromosome races in blind mole rats (*Spalax* and *Nannospalax*). *Folia Zoologica, 65*, 249–301.

Arslan, A., Zima, J., Yorulmaz, T., & Arslan, E. (2014): A new cytotype (2n = 46) of *Nannospalax xanthodon* from Turkey. *Zoology in the Middle East, 60*, 283–287.

Arslan, E., Gülbahçe, E., Arıkoğlu, H., Arslan, A., Bužan, E. V., & Kryštufek, B. (2010): Mitochondrial divergence between three races of the Anatolian mole rat *Nannospalax xanthodon* (Mammalia: Rodentia). *Zoology in the Middle East, 50*, 27–34.

Coşkun, Y. (2003): A study on the morphology and karyology of *Nannospalax xanthodon* (Satunin, 1898) (Rodentia: Spalacidae) from northeast Anatolia, Turkey. *Turkish Journal of Zoology, 27*, 171–176.

Coşkun, Y. (2004): A new species of mole rat *Nannospalax munzuri* sp. n., and karyotype of *Nannospalax tuncelicus* (Coşkun. 1996) (Rodentia: Spalacidae) in eastern Anatolia. *Zoology in the Middle East, 33*, 153–162.

Coşkun, Y. (2013): Bingöl ili *Nannospalax* (Körfere)'larının morfolojik ve karyolojik özellikleri [Morphological and karyological characteristics of *Nannospalax* (blind mole rat) in Bingöl province]. Pp. 119–124. In: *III. Bingöl Sempozyumu, 17-19 Eylül 2010*. Bingöl: Üniversitesi Yayınları.

Coşkun, Y., & Kaya, A. (2013): Karyological peculiarities of mole rats (*Nannospalax*) (Rodentia: Spalacidae) from Iğdır province. *Iğdır University Journal of Institute of Science & Technology, 3*, 119–124.

Coşkun, Y., Kaya, A., & Yürümez, G. (2009): Chromosomal forms of the mole rat, *Nannospalax xanthodon* (Satunin. 1898), from the Van Lake Basin in Eastern Turkey. *Zoology in the Middle East, 48*, 17–24.

Coşkun, Y., Kaya, A., Ulutürk, S., Yürümez, G., & Moradi, M. (2012): Karyotypes of the mole rats, genus *Nannospalax* (Palmer, 1903) (Spalacidae: Rodentia) populations in eastern Anatolia, Turkey. *Iranian Journal of Animal Biosystematics, 8*, 195–202.

Coşkun, Y., Ulutürk, S., & Kaya, A. (2010): Karyotypes of *Nannospalax* (Palmer 1903) populations (Rodentia: Spalalacidae) from Central Eastern Anatolia, Turkey. *Hystrix, 21*, 89–96.

Ivanitskaya, E., Coşkun, Y., & Nevo, E. (1997): Banded karyotypes of mole rats (*Spalax*, Spalacidae, Rodentia) from Turkey. *Journal of Zoological Systematics and Evolutionary Research, 35*, 171–177.

Kandemir, I., Sözen, M., Matur, F., Martínková, N., Kankılıç, T., Çolak, F., Özkurt, Ş., & Çolak, E. (2012): Phylogeny of species and races of mole rats (Spalacidae) in Turkey inferred from mitochondrial cytochrome *b* sequences. *Folia Zoologica, 61*, 25–33.

Kankılıç, T., & Gürpınar, C. (2014): Revised classification design of the Anatolian species of *Nannospalax* (Rodentia: Spalacidae) using a RFLP analysis. *Turkish Journal of Zoology, 38*, 67–78.

Kankılıç, T., Kankılıç, T., Çolak, R., Çolak, E., & Karataş, A. (2007): Karyological comparison of populations of the *Spalax leucodon* Nordmann, 1840 superspecies (Rodentia: Spalacidae) in Turkey. *Zoology in the Middle East*, *42*, 15–24.

Kankılıç, T., Kankılıç, T., Şeker, P. S., & Kıvanç, E. (2014): Morphological and biometrical comparisons of the baculum in the genus *Nannospalax* Palmer, 1903 (Rodentia: Spalacidae)

from Turkey with consideration of the taxonomic importance. *Turkish Journal of Zoology, 38*, 144–157.

Kıvanç, E. (1988): Geographic variation of Turkish Spalax species (Spalacidae, Rodentia, Mammalia) [in Turkish]. Ankara: Ankara Üniversitesi.

Kryštufek, B., & Vohralík, V. (2009): Mammals of Turkey and Cyprus. Rodentia II. Cricetinae, Muridae, Spalacidae, Calomyscidae, Capromyidae, Hystricidae, Castoridae. Koper: Knjižnica Annales Majora.

Kryštufek, B., Ivanitskaya, E., Arslan, A., Arslan, E., & Bužan, E. (2012): Evolutionary history of mole rats (genus *Nannospalax*) inferred from mitochondrial cytochrome *b* sequences. *Biological Journal of the Linnean Society, 105*, 446–455.

Matur, F., Çolak, F., Ceylan, T., Sevindik, M., & Sözen, M. (2013): Chromosomal evolution of the genus *Nannospalax* (Palmer 1903) (Rodentia, Muridae) from western Turkey. *Turkish Journal of Zoology, 37,* 470–487.

Musser, G., & Carleton, M. (2005): Superfamily Muroidea. Pp. 894–1531. In: D. E. Wilson & D. M. Reeder (Eds.), *Mammal species of the world. A taxonomic and geographic reference. 2nd edn.*. Baltimore: The Johns Hopkins University Press.

Nevo, E., Filippucci, M. G., Redi, C., Simson, S., Heth, G., & Beiles, A. (1995): Karyotype and genetic evolution in speciation of subterranean mole rats of the genus *Spalax* in Turkey. *Biological Journal of the Linnean Society, 54*, 203–229.

Sözen, M., Çolak, F., Sevindik, M., & Matur, F. (2013): Races of *Nannospalax xanthodon* (Satunin, 1898) (Rodentia: Spalacidae) from western Anatolia, *Turkish Journal of Zoology, 37*, 462–469.

Sözen, M., Matur, F., Çolak, E. Özkurt, Ş., & Karataş, A. (2006): Karyological records and a new chromosomal form for *Spalax* (Mammalia: Rodentia) in Turkey. *Folia Zoologica, 55*, 247–256.

Ulutürk, S., Coşkun, Y., & Arıkan, H. A. (2009): Comparative karyological and serological study on two populations of *Nannospalax nehringi* (Satunin, 1898) from Turkey. *North-Western Journal of Zoology, 5*, 349–356.