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Karyotype and Hair Scale Structure of *Nannospalax leucodon* (Nordmann, 1840) from Central Anatolia (Rodentia: Spalacidae)*

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Abstract: The karyotype and hair scale structure of the subterranean mole rat, *Nannospalax leucodon* (Nordmann, 1840), in Kırıkkale province were determined. The diploid number, fundamental number, and the number of autosomal arms were 54, 74, and 70, respectively. The structure of the hair scale type was examined with a scanning electron microscope (SEM) and was found to be serrate coronal, simple coronal, and erose coronal at the base, shaft, and tip, respectively. The chromosomal form and hair scale structure of the mole rat were recorded for the first time from Kırıkkale province.

Key Words: *Nannospalax leucodon*, karyotype, hair scale structure, Turkey

İç Anadolu'daki *Nannospalax leucodon* (Nordmann, 1840)'un Karyotipi ve Kıl Yapısı (Rodentia: Spalacidae)

Özet: Kırıkkale'deki kör fare, *Nannospalax leucodon* (Nordmann, 1840),'nin karyotipi ve kıl yapıları tespit edilmiştir. Diploid sayı, temel kromozom sayısı ve otozomal kromozomların kol sayısı sırasıyla 54, 74 ve 70'dir. SEM'de incelenen kıl morfolojileri taban, gövde ve uçta sırasıyla "serrate coronal", "simple coronal" ve "erose coronal" olarak bulunmuştur. Kırıkkale ilinden körfarenin kromozomal formu ve kıl yapıları ilk defa kaydedilmiştir.

Anahtar Sözcükler: *Nannospalax leucodon*, karyotip, kıl morfolojisi, Türkiye

Introduction

The family Spalacidae is represented by 2 genera, *Nannospalax* (Mediterranean mole rats) and *Spalax* (Ukrainian mole rats). *Nannospalax* is comprised of *N. ehrenbergi* (Nehring, 1898), *N. leucodon* (Nordmann, 1840), and *N. nehringi* (Satunin, 1898), while *Spalax* consists of *S. arenarius* Reshetnik, 1939, *S. giganteus* Nehring, 1898, *S. graecus* Nehring, 1898, *S. micropthalmus* Güldenstaedt, 1770, and *S. zemni* Erxleben, 1777 (Gromov and Baranova, 1981; Musser and Carleton, 1993). Two species of *Nannospalax* are distributed in the Palearctic region (Corbet, 1978; Giagia et al., 1982; Savic and Nevo, 1990; Harrison and Bates, 1991).

Mursaloğlu (1979) and Kıvanç (1988) recorded *N. leucodon* and *N. ehrenbergi* on the basis of morphological characteristics in Turkey. Later, Çoşkun (1996, 2004) described *N. munzuri* and *N. tuncelicus* according to karyological and some morphological characteristics. Currently, 30 karyological forms of *Nannospalax* have been determined in Turkey (Sözen et al., 2006). Nevo et al. (1994, 1995) first regarded those karyological forms as species and later (Nevo et al., 2001) formally defined 4 new sibling species in the *S. ehrenbergi* superspecies. Previously, they were regarded as chromosomal forms.

According to Tez et al. (2001), the main karyotypes of mole rat populations in Central Anatolia are 2n = 60 and 62, while 2n = 40-58 could also be found in this region.

Yüksel and Gülkaç (2001) reported 2 karyotypic forms of *N. leucodon* in the Middle Kızılırmak Basin of Central Anatolia (2n = 60, NF = 80, and NFa = 76, and 2n = 54, NF = 74, and NFa = 70).

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The aims of the present study were to determine for the first time the cytotype and hair scale structure of mole rats distributed in Kırıkkale province and to make a contribution to its karyological data from Central Anatolia.

Materials and Methods

This study was based on karyological data of 13 male and 8 female *Nannospalax leucodon* specimens collected from Kırıkkale province between 2003 and 2005 (Figure 1).

Karyotypes of the specimens were prepared according to the modified method of Patton (1969) and were conventionally stained with Giemsa. Approximately 10 well-stained metaphases were observed from each specimen. The centromeric index of the chromosomes was calculated according to Müdespacher-Ziehl et al. (2005). The guard hairs were taken from the shoulder blades dorsally and prepared according to Hayat (1972). Hair specimens were placed in acetone for 30 min, in an acetone-distilled water solution (1:1) for 15 min, and finally in distilled water for 10 min. Dried hairs in petri dishes were placed on stubs and coated with gold dust for 2 min with a Polaron SC 500. The tip, middle, and basal parts of the hairs were photographed at 1000× and 1600× magnification with a JSM 5600 scanning electron microscope (SEM). The determination of hair scale forms was defined according to Benedict (1957).

The slides and specimens (skinned and stuffed) were deposited in the University of Kırıkkale, Department of Biology.

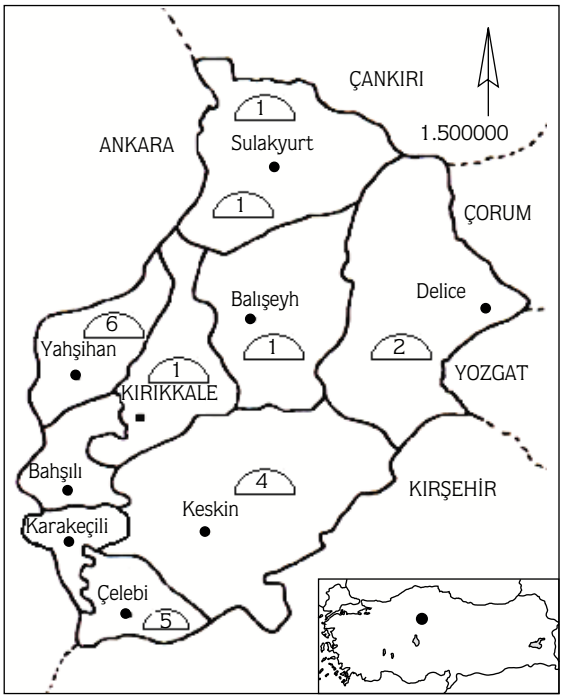

Figure 1. *Nannospalax leucodon* localities in Kırıkkale (numbers in the mounds show the number of collected mole rats).

Results

Karyology: The diploid number of chromosomes (2n), fundamental number (NF), and number of autosomal arms (NFa) of all specimens studied were 54, 74, and 70, respectively. The chromosome set consisted of 6 pairs of meta-submetacentric, 3 pairs of subtelocentric, and 17 pairs of acrocentric autosomes, gradually decreasing in size. The X chromosome was a medium-sized submetacentric, while the Y chromosome was a small acrocentric (Figure 2). No karyotypic variation was determined in the specimens karyotyped.

Hair scale structure: The structure of the hair scale of *N. leucodon* was serrate coronal at the base and simple coronal through the shaft, while erose coronal at the tip (Figure 3).

Discussion

Albayrak and Çoban (1997) examined the hair structure of *Nannospalax leucodon* with a light microscope and the dorsal hair scale structure of the mole rat we examined in Kırıkkale was in accord with their data.

Wahrman et al. (1969) stated that the ancestral karyotype of the genus *Nannospalax* was all metacentric and new forms have arisen due to fissions from this form. The chromosome number of mole rat karyotypes increased from the mesic Aegean (2n = 38) through semi-xeric Bolu (2n = 54), to xeric Ankara (2n = 62), with the fusion of large metacentrics to smaller acrocentrics. Both 2n and heterozygosity *H* increase toward the harsh, arid, climatically unpredictable, and geologically young central Anatolia (Nevo et al., 1994, 1995). According to Sözen et al. (2006), 2n values, along

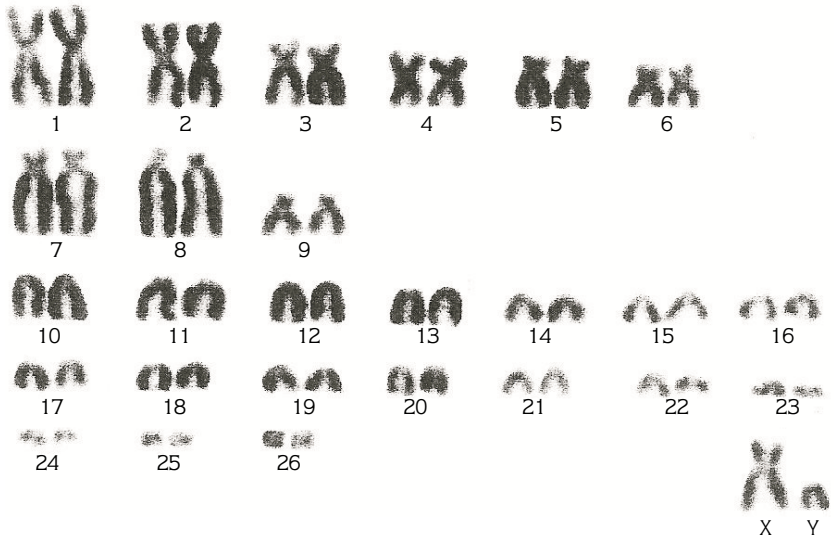

Figure 2. Conventionally stained karyogram of *Nannospalax leucodon* from Kırıkkale.

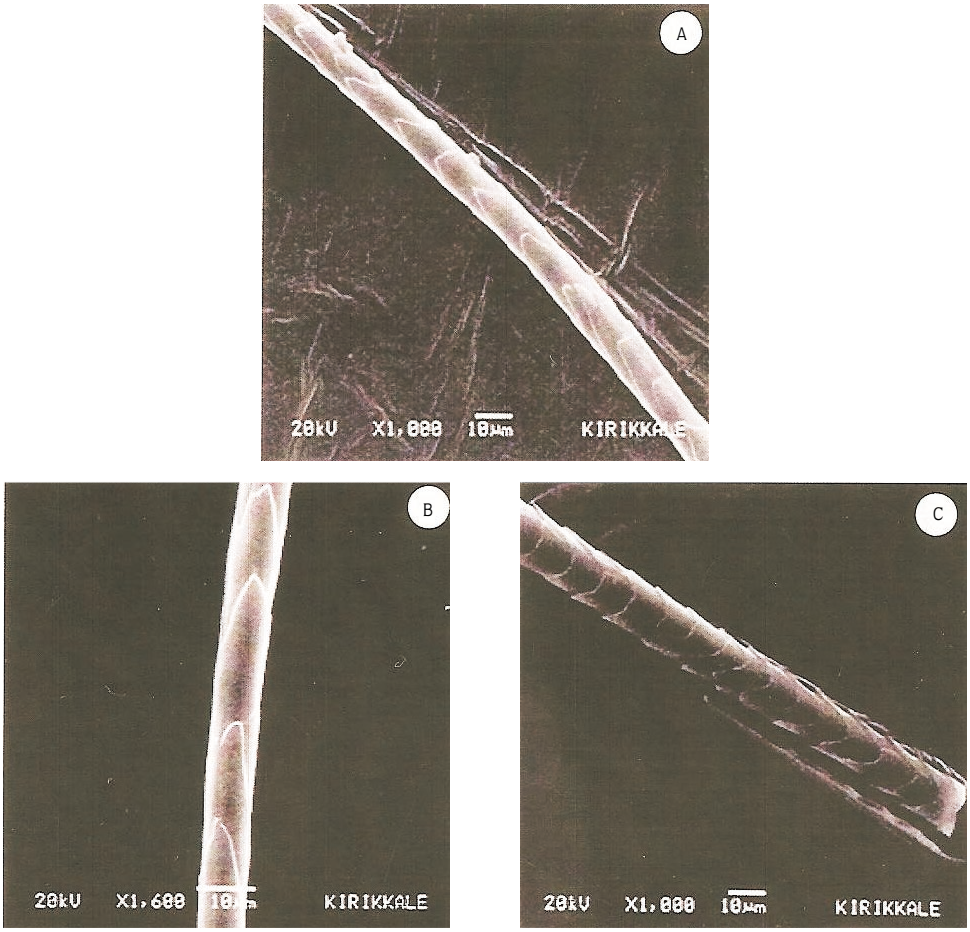

Figure 3. The hair scale form of *Nannospalax leucodon.* Tip (A), shaft (B), and base (C).

with NF and NFa values, are correlated to aridity stress and climatic unpredictability. Moreover, Nevo et al. (1995) added that populations distributed at distant localities at extreme edges of the mole rat range could have the same 2n. Although Bolu, Bingöl, Elazığ, and Tunceli are far from Kırıkkale, Yozgat and Çankırı subterranean mole rat populations possessed the same 2n.

Karyological data of our specimens were compared to the data given by Nevo et al. (1994, 1995), Sözen and Kıvanç (1998), Sözen et al. (1999, 2000), Yüksel and Gülkaç (2001), Tez et al. (2001), Sözen (2004), Kankılıç et al. (2005), and Çataklı (2004) (Table 1).

The X chromosome of all specimens examined from Central Anatolia is submetacentric; however, 2n, NF, and NFa values, along with the number of biarmed and

Table 1. Comparison of chromosomal data of *Nannospalax leucodon* from Central Anatolia (M: metacentric; SM: submetacentric; ST: subtelocentric; A: acrocentric. Chromosomes are in pairs).

Locality	2n	NF	NFa	M	SM	ST	A	X	Y	References
Kırşehir, Nevşehir, Kayseri	60	80	76					SM	ST	Sözen et al. (1999)
Ankara, Kayseri, Konya, Sivas	62									Nevo et al. (1994, 1995)
Karaman	60									
Niğde	58	72	68		1	5	22	SM	A	Sözen and Kıvanç (1998)
Ankara	60	82	78			10	19	SM	ST	Sözen et al. (1999)
Akşehir, 10 km SE	60	76	72			7	22	SM	ST	Sözen et al. (1999)
Niğde (Ulukışla, center)	58	72								
Niğde (Ulukışla, 30 km W)	60	72								
Aksaray, 12 km E	60	74						SM	A	Sözen et al. (2000)
Aksaray, 35 km W	60	76								
Ankara, 35 km S	60	82								
Middle Kızılırmak Basin (Population A)	60	80	76			9	20	SM	ST	Yüksel and Gülkaç (2001)
(Population B)	54	74	70		3	6	17	SM	ST	
Kayseri, Sivas	60	78	74			8	21	SM		Tez et al. (2001)
Ankara (5 km E Nallıhan, 2 km S Beypazarı, 2 km S Kızılcahamam)	60	78	74			8	21	SM	ST	Sözen (2004)
Ankara (Batıkent, Sarayköy)	60	80	76			9	20	SM	ST	
Ankara (Population I)	60	80	76	2		7	20	M	ST	Kankılıç et al. (2005)
(Population II)	60	76	72		1	6	22	SM	ST	
	54	74	70	6		3	17	SM	A	
Çankırı	56	72	68	3		4	20	SM	A	Çataklı (2004)
	60	78	74		8		21	SM	ST	
Kırıkkale	54	74	70		6	3	17	SM	A	This study

uniarmed autosomes, and the shape of the Y chromosome show variation in this region. Yüksel and Gülkaç (2001) reported a 2n = 54 form with NF = 74 and NFa = 70 from the Middle Kızılırmak Basin. The karyotype of specimens from Kırıkkale province differed from this karyotype in the shape of biarmed autosomes and the Y chromosome. The dissimilarities between the data could be due to the heterochromatin amount in chromosomes or to differences in author interpretations of biarmed autosomes and the Y chromosome (Table 1).

The Sulakyurt district of Kırıkkale neighbors Çankırı and the Delice district neighbors Yozgat. The cytotype of Kırıkkale might be a continuation of the population distributed in Çankırı.

The cytotype of *N. leucodon* from Ankara, Kırıkkale, Yozgat, Çankırı, Konya, Niğde, Aksaray, Nevşehir, Karaman, Kayseri, Sivas, and Kırşehir were determined, whereas those from Eskişehir have not yet been examined. The karyological status of blind mole rats in Central Anatolia will be completed with the examination of specimens from Eskişehir.

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