

A study on the Morphology and Karyology of *Nannospalax nehringi* (Satunin, 1898) (Rodentia: Spalacidae) from Northeast Anatolia, Turkey

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Abstract: Twenty-two (12 males, 10 females) specimens of *Nannospalax nehringi*, collected from Northeast Anatolia (Turkey), were used for morphological and karyological studies. The specimens from the Kars population have foramina on the premaxillonasal suture. These foramina are absent in the Erzurum, Ağrı and Van populations. The diploid number of chromosomes in the Erzurum and Kars population is $2n = 50$. The number of chromosomal arms (NF) is 70 and the number of autosomal arms (NFA) is 66. Their karyotypes consist of nine pairs of metacentric and submetacentric autosomes and 15 pairs of acrocentric autosomes. The Ağrı and Van populations have $2n = 48$ chromosomes. The number of chromosomal arms (NF) is 68 and the number of autosomal arms (NFA) is 64. The autosomal set has nine pairs of biarmed, and 14 pairs of acrocentric chromosomes. The X chromosomes are large submetacentric and the Y chromosomes are small acrocentric in all populations. When these results are compared with previous studies, *Nannospalax nehringi* specimens from Northeast Anatolia have some differences in their skull and chromosome morphology.

Key Words: Rodentia, Spalacidae, *Nannospalax nehringi*, Morphology, Karyotype, Turkey

Kuzeydoğu Anadolu'daki *Nannospalax nehringi* (Satunin 1898) (Rodentia: Spalacidae)'nin Morfolojisi ve Karyolojisi Üzerine Bir Çalışma

Özet: Kuzeydoğu Anadolu'dan elde edilen 22 (12 erkek, 10 dişi) *Nannospalax nehringi* örneğinin morfolojik ve karyolojik özellikleri üzerinde çalışıldı. Kars populasyonu örneklerinde premaxillonasal diğişler üzerinde delikler bulunmaktadır. Bu delikler Erzurum, Ağrı ve Van populasyonu örneklerinde bulunmamaktadır. Erzurum ve Kars populasyonlarının diploid kromozom sayısı $2n=50$; kromozomal kol sayısı $NF=70$ ve otozomal kol sayısı $NFa=66$ 'dır. Karyotipleri 9 çift meta/submetasentrik ve 15 çift akrosentrik otozomdan oluşmaktadır. Ağrı ve Van populasyonları $2n=48$ kromozoma sahipler. Kromozomal kol sayısı, $NF=68$ ve otozomal kol sayısı, $NFa=64$ 'tür. Karyotipleri 9 çift meta/submetasentrik ve 14 çift akrosentrik otozomdan oluşmaktadır. Bütün populasyonların X kromozomu büyük submetasentrik, Y kromozomu küçük akrosentriktir. Sonuçlar önceki çalışmalarla karşılaştırıldığında, Kuzeydoğu Anadolu'da farklı morfolojik ve karyolojik özelliklere sahip populasyonlar olduğu görülmektedir.

Anahtar Sözcükler: Rodentia, Spalacidae, *Nannospalax nehringi*, Morfoloji, Karyotip, Türkiye

Introduction

The family Spalacidae is currently restricted to the Palearctic region. The distribution area of this family includes Northeast Africa, the Balkans, Southeast Europe, Central Asia, the Middle East and the Caucasus (Mehely, 1909; Miller, 1912; Ellerman, 1940; Ognev, 1947; Ellerman and Morrison-Scott 1951; Topachevskii, 1969; Lay and Nadler, 1972; Corbet, 1978; Savic and Nevo, 1990; Musser and Carleton, 1993).

Gromov and Baranova (1981) recognized two genera, *Nannospalax* and *Spalax*, and eight living spalacid species: *Nannospalax ehrenbergi*, *N. nehringi*, *N. leucodon*, *Spalax giganteus*, *S. arenarius*, *S. microphthalmus*, *S. polonicus* and *S. graecus*.

Two taxa of mole rats (Spalacidae) are present in Turkey (Asia Minor). The ancestral *S. leucodon* is present in most of Turkey, whereas the descendant *S. ehrenbergi* is restricted to Southeast Turkey (Nevo et al., 1995).

N. nehringi was first described by Satunin (1898), based on specimens collected from the Kars-Gaziler-Kaskoparan, Ararat region (Fig.1). *N. nehringi* is distributed in the Caucasus and Asia Minor (Ellerman and Morrison-Scott, 1951; Topachevskii, 1969; Corbet and Hill, 1991).

Morphological studies on this species have been published by various authors (Mehely, 1909; Topachevskii, 1969; Mursaloğlu, 1979; Kıvanç, 1988; Coşkun, 1994 and 2000). According to Mehely (1909),

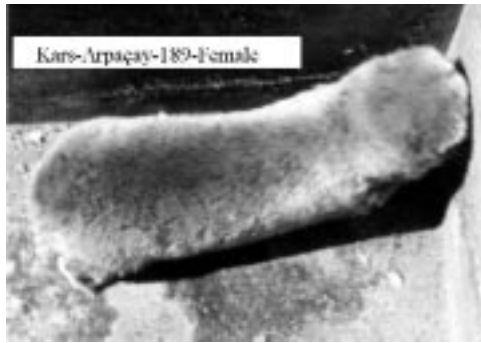


Figure 1. *Nannospalax nehringi*.

two subspecies (*S. monticola nehringi* and *Spalax monticola armeniacus*) live in the region. Mursaloğlu (1979) also reported *S. leucodon* to have been living in this region, and Topachevskii (1969) reported that the subspecies *Microspalax nehringi nehringi* is distributed in the region, while Kıvanç (1988) indicated that the subspecies *S. leucodon armeniacus* and *S. leucodon nehringi* were living in East Anatolia. Nevo et al., (1994), and Nevo et al., (1995), employed the term superspecies, *S. leucodon*, for this region's mole rats.

The first studies on the karyological peculiarities of *N. nehringi* were carried out in 1959 by Matthey (1959), who recorded $2n = 48$ in the material from the Caucasus. Later, Nevo et al., (1995) reported the diploid number of chromosomes of specimens from Erzurum and Kars (Sarıkamış) as $2n = 50$. Sözen et al., (2000) found $2n = 50$, $NF = 72$ in the population from Kars (Susuz), Erzurum and Ardahan.

The current study of East Anatolian populations provides a further contribution to the knowledge of karyotypic and morphological peculiarities through the range of this species. This study is intended to evaluate the chromosomal forms and the distribution of the populations of *N. nehringi* species in this region.

Materials and Methods

The study was conducted in East Anatolia, which is characterized by high mountains and highland areas, mostly covered with steppe vegetation. The study area is climatically arid, with elevations from 900 to 2200 m.

Twenty-two live specimens (12 males, 10 females) were collected from eight different localities by digging

out their burrow systems (Fig. 2). Age determination was based on molar crest patterns. Morphological (skull variables) and karyological characteristics were studied in detail. Preparations of mitotic chromosomes were obtained from bone marrow by means of the general air-drying technique (Lee and Elder, 1980). The data obtained from the specimens were compared with the results of previously published accounts. The specimens are deposited at the Biology Department, Science and Art Faculty, Dicle University Diyarbakır.

Results

All the specimens examined have a supracondyloid foramen above both sides of the occipital condyles. The lambdoid and sagittal ridges are well developed in mature and old samples. The parietals are uniform and longer than wide (Fig. 3, left). The foramen postpalatines are placed in front of the line passing between M^2 and M^3 (Fig. 3). The palate is extended behind the line connecting the rear edges of the alveoli of the last upper molars, and possesses a well developed styloid process (Fig. 3, right).

The anterior surface of the upper incisors is orange and smooth, without longitudinal ridges. The sella externa is placed below the sella interna on the mandible in all samples, except for adult specimens from Kars. These specimens have at least one or two foramina above both sides of the posterior region on the premaxillionasal suture. These foramina are absent in the Erzurum, Ağrı and Van populations. The alveolar process of the lower jaw is higher than the condyloid process.

In mature specimens, M^3 has one, rarely two, enamel islands on the chewing surface. $M^{1,2,3}$ have three roots in all specimens, and the antero-palatal and posterior roots of M^3 are welded together in old samples, while $M_{1,2,3}$ have two roots. The anterior root of M_3 is bifurcated. The alveoli of all molar teeth are completely separated by a septum.

Chromosome types and the number of arms are shown in Table. The table gives a comparative survey of all populations analysed to date in eastern Turkey.

The karyotypes of seven specimens from the Ağrı and Van populations have $2n = 48$, chromosomal arms (NF) = 68 and autosomal arms (NFa) = 64. Their karyotypes

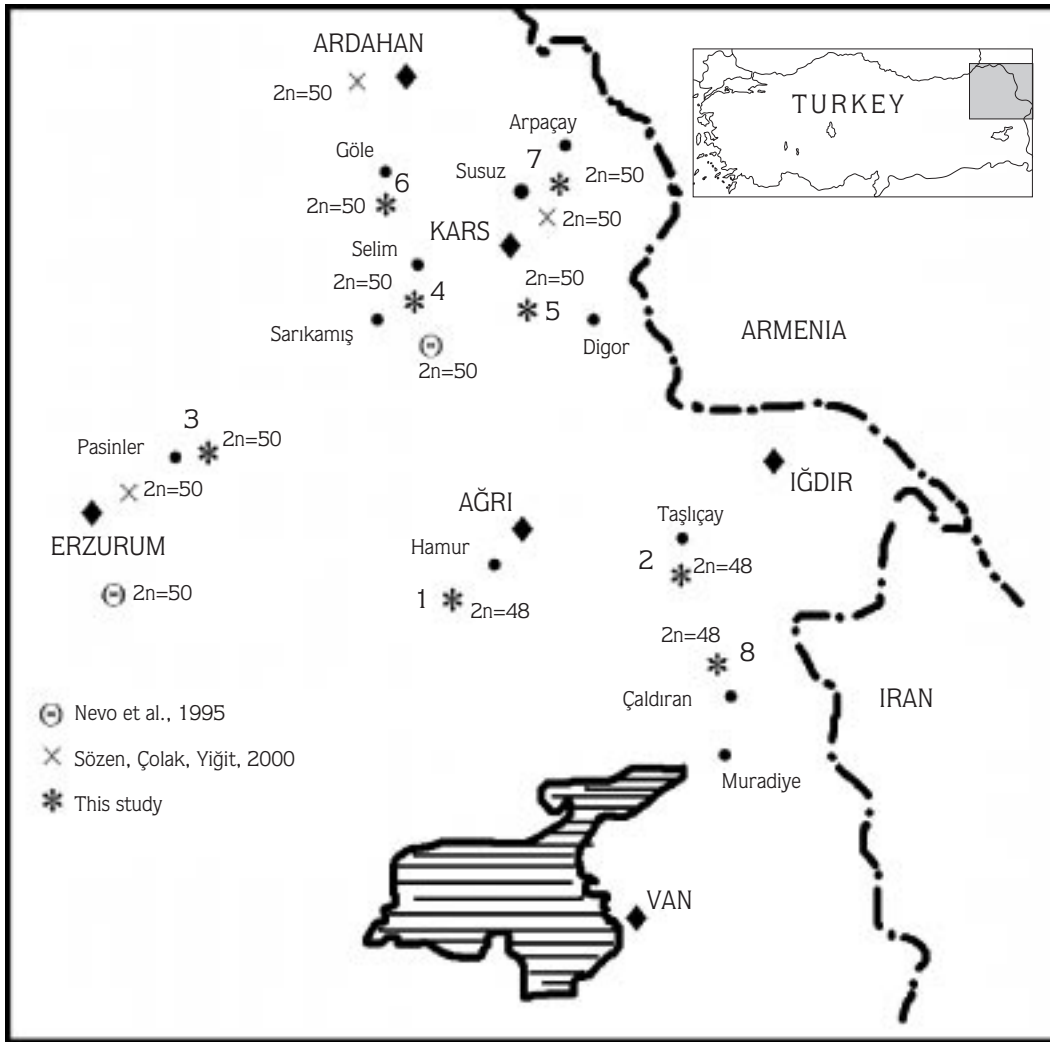


Figure 2. Sampling localities of *Nannospalax nehringi*. 1. Ağrı-Küpüran (1♂, 1♀), 2. Ağrı-Taşlıçay-Yanalıo (1♀), 3. Erzurum-Pasinler (1♂, 1♀) 12 km east, 4. Kars-Selim-Benliahmet village (2♂, 1♀), 5. Kars-Digor road 8 km (2♂, 1♀), 6. Kars-Göle-Boğatepe (3♂, 1♀), 7. Kars-Arpaçay 3 km west (1♂, 3♀), 8. Van-Çaldıran 1 km east (2♂, 1♀).

consist of nine pairs of meta/submetacentrics and 14 pairs of acrocentric autosomes. The X chromosomes are large submetacentric, whereas the Y chromosomes are small acrocentrics (Fig. 4).

The karyotypes of nine specimens from the Erzurum and Kars populations have $2n = 50$, $NF = 70$ and $NFa = 66$. Their karyotypes consist of nine pairs of meta/submetacentric chromosomes, and of 15 pairs of acrocentric autosomes. The X chromosomes are large and submetacentric, whereas the Y chromosomes are small and acrocentric (Fig. 5).

Discussion

According to Gromov and Baranova (1981), Spalacidae have two distinct genera, *Nannospalax* and *Spalax*, and the Turkish spalacids belong to the genus *Nannospalax*. The genus name *Nannospalax* is used in this paper.

The anterior surface of the upper incisors is smooth, without longitudinal ridges, the third upper molar bears one enamel island on the chewing surface, which is of taxonomic value for the identification of *S. nehringi* (Satunin, 1898; Ellerman and Morrison-Scott, 1951;

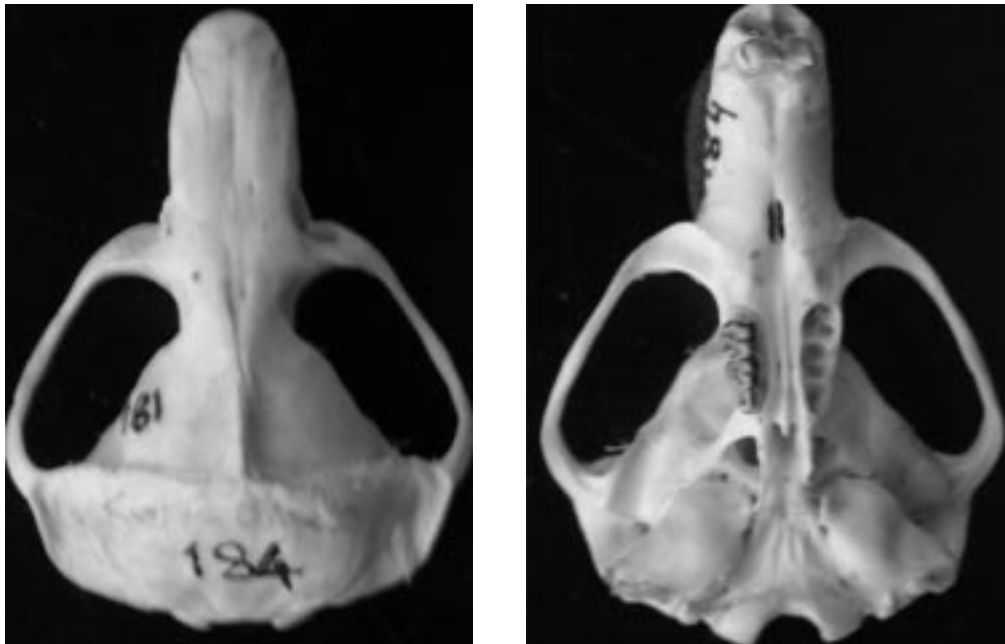


Figure 3. Skull of *Nannospalax nehringi*, dorsal (left), and ventral side (right) (Kars Digor, male, no:184).

Table. Comparative survey of the karyotypes of *Nannospalax nehringi* from East Anatolia. (N: sample size, 2n: diploid number, m/sm/st: metacentric, submetacentric, subtelocentric, A: acrocentric, X: X chromosome, Y: Y chromosome, NF: chromosome arm number, NFa: autosome arm number).

Population	Reference	N	2n	m/sm/st.	A	X	Y	NF	NFa
Erzurum	Nevo et al., (1995)	2	50	9	15	Sm	A	70	66
	Sözen et al., (2000)	3	50	10	14	Sm	A	72	68
	This study	2	50	9	15	Sm	A	70	66
Kars	Nevo et al., (1994)	3	50	9	15	Sm	A	70	66
	Sözen et al., (2000)	3	50	10	14	Sm	A	72	68
	This study	7	50	9	15	Sm	A	70	66
Ağrı	This study	4	48	9	14	Sm	A	68	64
Van	This study	3	48	9	14	Sm	A	68	64

Topachevskii, 1966; Mursaloğlu, 1979; Coşkun, 1994). According to Topachevskii (1969), *M. nehringi* have three rooted upper molars, and the nasal bones have a sharply defined longitudinal slit-like depression in the region of the suture between them; the ratio of the upper and lower molar widths to the antero-posterior cross section is also given. These characteristics are similar in the East Anatolian populations. These result, show that the species living in this region is *N. nehringi*.

Kıvanç (1988) classified the specimens from Kars, Susuz, Haciveli, Göle, Ardahan and Sarıkamış as *S.*

leucodon armeniacus, and those from Kars-Tuzluca, Erzurum, Ağrı, Muş and Van as *S. leucodon nehringi*. This latter subspecies is distinguished from the other subspecies by the presence of foramina on the premaxillonasal suture. The specimens from the Kars population possess these foramina, but they are absent in the Erzurum, Ağrı and Van populations. This is consistent with the findings of Kıvanç (1988) for the Kars population. Thus, these results show that *N. nehringi armeniacus* is living in the Kars region but not in the Erzurum, Ağrı and Van regions.

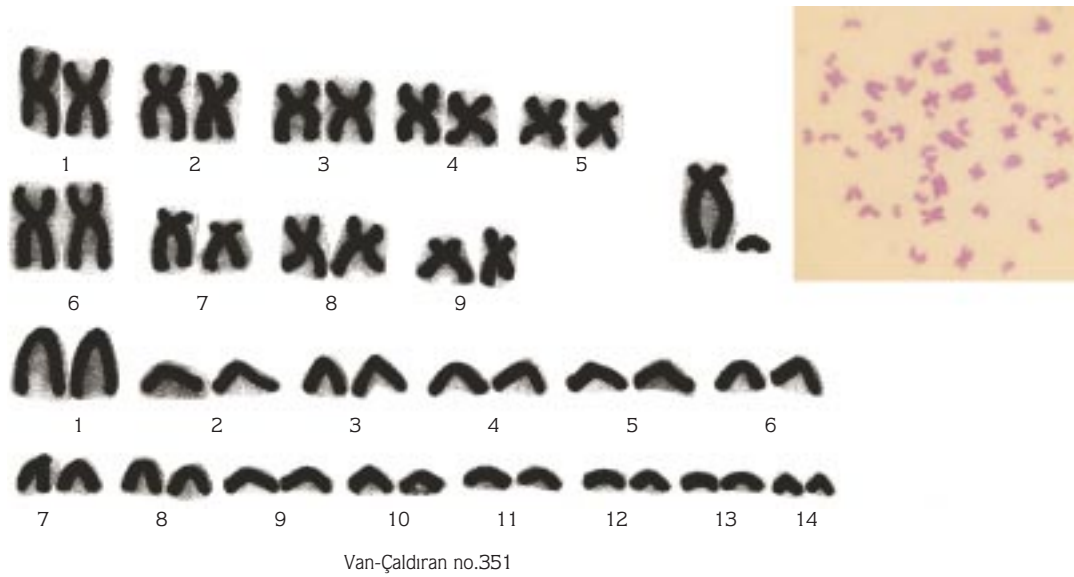


Figure 4. Karyotypes of the Ağrı and Van populations.

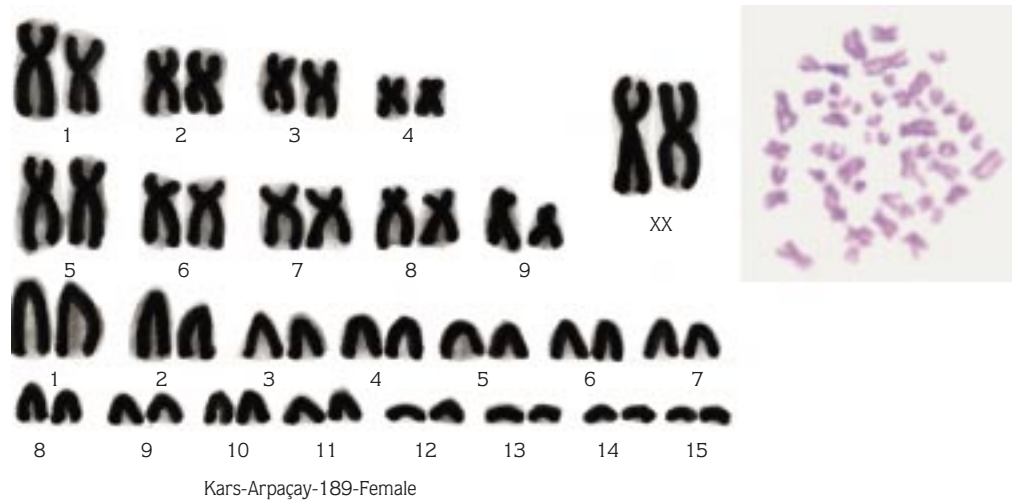


Figure 5. Karyotypes of the Erzurum and Kars populations.

In this study the diploid chromosome numbers of the specimens from Ağrı and Van are $2n = 48$ and $NF = 68$. In this respect, the specimens from Ağrı and Van differ from those from the Erzurum and Kars populations in terms of chromosome number and morphology. This result is a new record for Turkish *Spalax* (Table). According to this result, the Ağrı and Van population is *N. nehringi nehringi* and the Erzurum population is a *N. nehringi* subspecies.

The X chromosome is submetacentric in all populations.

On the basis of a comparative analysis of karyotypes, it can be concluded that there are two different chromosomal forms in this region, which can be distinguished by differences in the number and morphology of their chromosomes.

These peculiarities show that the at least three subspecies (*N. nehringi nehringi* (Ağrı and Van population) and two other subspecies *N. n. armeniacus* (Kars population) and *N. nehringi* subspecies (Erzurum population)) are living in this region.

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