

Variation of Nucleolar Organizer Regions in Two $2n=48$ Chromosomal Forms of *Nannospalax nehringi* (Satunin, 1898) (Rodentia: Spalacidae) from North-eastern Anatolia

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Abstract: We describe the Ag-NOR distribution in two $2n=48$ populations of blind mole rats of the genus *Nannospalax* from two localities (Çaldıran and Aşağısutaşlı) in the Van and Iğdır Provinces in North-eastern Anatolia, Turkey. The karyotypes of the studied populations differed in the proportion of biarmed and acrocentric autosomes (NFa=64 and 68, respectively). The nucleolar organizer regions (NORs) occurred on four autosomal pairs in the Van population whereas only three NOR-bearing autosomal pairs were detected in the Iğdır population. The karyotype of the individuals from the Iğdır population was similar to the previously studied population from the Van-Erciş Province. This similarity indicated that geographical barriers did not limit dispersal of the cytotype with NFa=68 chromosomal form in North-eastern Anatolia.

Key words: Spalacidae, *Nannospalax nehringi*, Ag-NOR banding, Eastern Anatolia, Turkey

Introduction

According to many authors, the family Spalacidae consists of two genera, *Spalax* Guldenstaedt, 1770 and *Nannospalax* Palmer, 1903, recognised on the basis of morphological characteristics, fossil records, karyological and molecular studies (CHIŞAMERA et al. 2014, CSORBA et al. 2015). However, MUSSER & CARLETON (2005) accepted *Nannospalax* as a synonym of *Spalax* and treated the family as monotypic. If this approach is followed, three species, *Spalax leucodon* Nordmann, 1840, *S. nehringi* Satunin, 1898 and *S. ehrenbergi* Nehring, 1898, are distributed in Turkey. However, with more than 50 cytotypes included in this genus, the genus *Nannospalax* is frequently accepted as valid in many recent studies (CHIŞAMERA et al. 2014, CSORBA et al. 2015).

Nannospalax nehringi was first described as *Spalax nehringi* by SATUNIN (1898) from the Gaziler-Kazkoparan Village, Iğdır Province. The species is distributed in most of Turkey (except the Turkish Thrace and south-eastern region of Turkey), Armenia and Georgia (MUSSER & CARLETON 2005).

KRYŠTUFEK & VOHRALIK (2009) proposed the name *Nannospalax xanthodon* (Nordman, 1840) as a senior synonym of *N. nehringi* but, since the nomenclature of this group is unstable, we prefer to use the more widespread species name.

Several studies examined the conventional stained and the banded karyotypes of *Nannospalax nehringi* and recorded chromosomal forms differing by the diploid chromosome numbers, fundamental numbers, G-, C- and Ag-NOR banded chromosomes (NEVO et al. 1995, IVANITSKAYA et al. 1997, 2008, SÖZEN et al. 2000, COŞKUN 2003, COŞKUN et al. 2009, 2012, ULUTÜRK et al. 2009, ARSLAN et al. 2011, 2014, 2016, MATUR et al. 2011, AŞAN BAYDEMİR et al. 2013, COŞKUN & KAYA 2013, ARSLAN & ZIMA 2013, 2014, 2015, 2017).

The present study aimed to present and compare the distribution of nucleolar organizer regions (NORs) of two different $2n=48$ chromosomal forms of *Nannospalax nehringi* in north-eastern Anatolia.

Materials and Methods

A total of five specimens of *Nannospalax nehringi* from Van – Çaldıran – Gönderme Village (39° 05' N 43° 48' E; 1 ♂, 1 ♀) and the Iğdır – Tuzluca – Aşağısutaşlı Village (40° 02' N 43° 41' E; 3 ♀♀) were karyotyped (Fig. 1).

Mitotic metaphases were obtained from the bone marrow as described by LEE & ELDER (1980). The location of NORs was determined using the method of HOWELL & BLACK (1980). The diploid chromosome number (2n), autosomal fundamental number (NFa) and fundamental number (NF) were determined. The voucher specimens and the metaphase slides are deposited in the Department of Biology, Faculty of Science, University of Dicle.

Results

The karyotype of *Nannospalax nehringi* from the Çaldıran Village (Van Province) showed 2n=48, NFa=64 and NF=68. The chromosome set consisted of nine pairs of meta- and submetacentric autosomes (nos. 1-9) and 14 pairs of acrocentric autosomes decreasing in size (nos. 10-23). The X chromosome was large submetacentric, whereas the Y chromosome was small acrocentric (Fig. 2A). Active NORs were located in the telomeric regions of three biarmed autosome pairs (nos. 1, 3 and 6) and only one homologue of the acrocentric pair no. 13 had an active NOR (Fig. 2A).

The karyotype of *Nannospalax nehringi* from the Aşağısutaşlı Village (Iğdır Province) revealed 2n=48, NFa=68 and NF=72. The chromosome set consisted of 11 pairs of meta-submetacentric autosomes (nos. 1-11) and 12 pairs of acrocentric autosomes with decreasing size (nos. 12-23). The X chromosomes were large submetacentrics (Fig. 2B).

Active NORs were observed on both homologous chromosomes in the telomeric regions of one biarmed and an acrocentric pairs (nos. 2 and 14). Another biarmed pair (no. 6) possessed a heteromorphic NORs (Fig. 2B).

Discussion

The conventional stained karyotypes of the 2n=48 chromosomal form of *Nannospalax nehringi* from Eastern Anatolia were studied by COŞKUN (2003), COŞKUN et al. (2009) and COŞKUN & KAYA (2013). The karyotype of Van-Çaldıran population recorded in the present study was in accordance with those described by COŞKUN (2003) and COŞKUN et al. (2009).

The 2n=48 chromosomal form, with NF=68 and NFa=64, was first examined by COŞKUN & KAYA (2013) from the type locality (Gaziler-Kazkoparan) of the species in the Iğdır Province. The chromosome set consisted of nine biarmed and 14 acrocentric chromosome pairs, a submetacentric X and an acrocentric Y chromosomes, being generally similar to the karyotype of the Van-Çaldıran population. However, the karyotype of *Nannospalax nehringi*

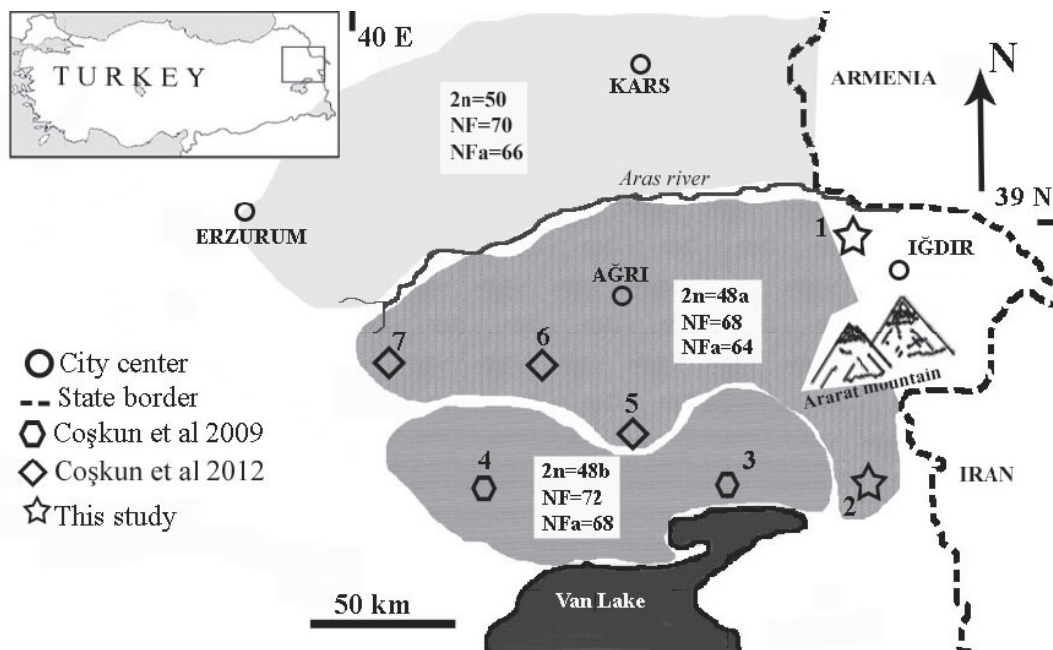


Fig. 1. Sampling localities of *Nannospalax nehringi* in North-eastern Anatolia. 1. Iğdır-Tuzluca-Aşağısutaşlı Village. 2. Van-Çaldıran-Gönderme Village. 3. Van-Erciş. 4. Muş-Malazgirt. 5. Ağrı-Patnos. 6. Ağrı-Tutak. 7. Erzurum-Hımış.

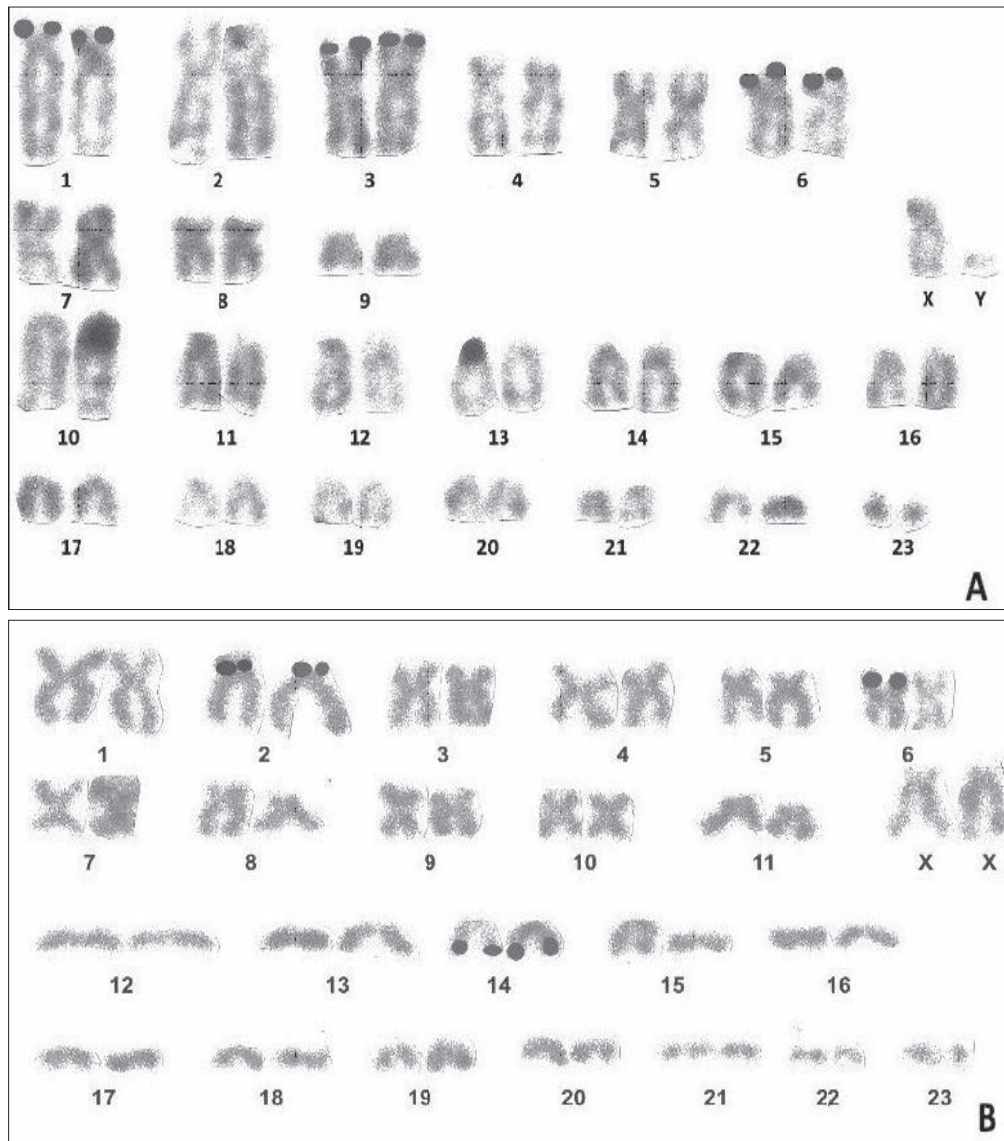


Fig. 2. Ag-NOR stained karyotypes of specimens of *Nannospalax nehringi* from the Van Province (A) and the Iğdır Province (B).

from the Iğdır – Aşağısutaşlı Village is reported for the first time in this study. The $2n=48$ karyotype, with $NF=72$ and $NFa=68$, was different from the one of the Kazkoparan population. The chromosome set consisted of 11 biarmed and 12 acrocentric autosome pairs, with a submetacentric X and an acrocentric Y chromosomes. Therefore, two distinct chromosomal forms were determined from the Iğdır Province. The karyotype of the specimens from the Aşağısutaşlı Village was found to be similar to the karyotype of the specimens from Muş (Malazgirt) and Van (Erciş, Bozkaya Village) given by COŞKUN et al. (2009). Consequently, we concluded that geographical barriers do not limit the spreading of the $2n=48$, $NF=72$ and $NFa=68$ chromosomal form from the Van – Erciş to Iğdır – Aşağısutaşlı Villages.

In recent years, karyotypes of blind mole rats of

the genus *Nannospalax*, possessing enormous variation in the diploid and the fundamental numbers in Turkey, have become attractive for studying karyotype divergence of the species, no matter whether or not distinct chromosomal forms represent distinct species as stated by NEVO et al. (1995). Hitherto, IVANITSKAYA et al. (2008), ARSLAN et al. (2011, 2014), AŞAN BAYDEMİR et al. (2013), ARSLAN & ZIMA (2013, 2015) and SÖZEN et al. (2015) have recorded different numbers of active Ag-NORs in the telomeric regions of the autosomes in *Nannospalax nehringi*. The $2n=48$ populations in the present study differed in the number of NOR-bearing chromosomes.

Recently, KANKILIÇ et al. (2014) have accepted *Nannospalax nehringi* as a distinct species with regard to the different shape and size of the bacula of the specimens from Kazkoparan Village. In addition to the mor-

phological studies, new chromosomal forms and various banded karyotypes of the genus *Nannospalax* are being discovered continuously with examining more specimens in Turkey. Further studies on the karyotype divergence mechanism and its role in the speciation of the genus might be crucial for better explanation of the speciation in this genus (ZIMA & ARSLAN 2014).

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