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Geographical distribution and karyotype of *Nannospalax ehrenbergi* (Nehring 1898) (Rodentia, Spalacidae) in Iraq

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Abstract. This paper concerns the karyological analysis of fourteen mole rats collected in four different localities of North-Iraq (Kurdistan Region). The result showed that they belong to the following cytotypes of *Nannospalax ehrenbergi*: «Duhok-Bardarash Population» $2n = 52$, $NF = 76$, and $NFa = 72$ and «Arbil-Sulaimania-Kirkuk populations» $2n = 52$, $NF = 80$ and $NFa = 76$. The karyotypes of the Duhok population are similar to those from Mosul, but the Arbil-Sulaimania-Kirkuk populations' karyotype represents a new chromosomal form. Their distribution extends from North Iraq to Sulaimania.

Keywords. Rodentia, Spalacidae, *Nannospalax ehrenbergi*, Karyology, Iraq.

1. INTRODUCTION

Scientific research on mammals in Iraq is scarce in the country and requires special attention in order to determine the mammalian fauna of Iraq. Amr (2009), Garstecki & Amr (2011) noted that the mammalian fauna of Iraq consists of 74 species, including insectivores (6), bats (15), and carnivores (19) as well as extinct species such as the leopard (*Panthera pardus*), artiodactyls (8). Rodents constituted the largest mammalian group in Iraq with 25 species. Recently, an updated checklist of the mammals of Iraq was published by Al-Sheikhly et al. (2015). The checklist takes into account 93 mammalian species of Iraq and listed the mole rats under the name *Nannospalax ehrenbergi*.

The Palearctic rodent blind mole rats (Rodentia: Spalacidae) are subterranean mammals and the chromosomally diverse and they are difficult to distinguish based on phenotype, whose phylogenetic relationships are problematic, resulting in taxonomic uncertainties at every level from species to higher taxa (Savic & Nevo 1990; Musser & Carleton 2005). Fossil, morphological, chromosomal and molecular evidence suggest that Spalacidae have two distinct genera *Spalax* and *Nannospalax* (Topachevski 1969, Lyapunova et al. 1974, Hadid et al. 2012). Morphologically *Nannospalax* differs from *Spalax*

by the presence of supracondyloid foramina and two longitudinal ridges anterior surface of the upper incisors (Topachevski 1969). Karyologically, *Nannospalax* has both low diploid ($2n$) and fundamental (NF) numbers and acrocentric chromosomes (Lyapunova et al. 1974).

The species *Nannospalax ehrenbergi* is the south eastern representative of the genus – initially described by Nehring (1898) on specimens, who were collected from Yafa-Israel – also occurs in the Middle East, Egypt, and Southeast Anatolia of Turkey (Lay & Nadler 1972; Musser & Carleton 2005; Coşkun et al. 2006). *Nannospalax ehrenbergi* exhibits great diversity in both diploid number of chromosomes ($2n= 48-62$) and the number of chromosome arms (NF= 62-90) (Wahrman et al. 1969; Ivanitskaya et al. 1997; 1998; Coşkun et al. 2006 and reference therein).

The distribution of *Nannospalax ehrenbergi* in Iraq has been known mainly from morphological studies, which have not been extensive (Cheesman 1920; Reed 1958; Harrison 1956; Hatt 1959; Turnbull & Reed 1974; Harrison & Bates 1991). Recently, spalacids from the Hawraman Mountains were identified as *Spalax leucodon* by Lahony et al. (2013). The old records and distribution of the species in Iraq were previously summarized in detail by Coşkun et al. (2012). The cytogenetic information, which was available for this mole rat (*N. ehrenbergi*) and the existing data, were restricted to conventional stained karyotypes or reports of the diploid chromosome number (Coşkun et al. 2012; 2014). The geographical distribution and karyological peculiarities have not yet been documented in detail.

The aim of the present work is to verify the distribution and the karyotype characteristics of several *Nannospalax* populations from Iraq to fill the gap in our knowledge about karyological forms as well as their distributional areas in the north of Iraq.

2. MATERIAL AND METHODS

The territory of Iraq lies between latitudes 29° to 38° N and longitudes 39° to 49° E and the landscape includes high mountains in the North (Kurdistan), desert, arid lands and sandy steppes in the western and south-western plateau (Al-Badiyah), and the Mesopotamian marshlands in the southern alluvial plain (Zohayr 1973).

The study was conducted on four populations of blind mole rats from Duhok- Bardarash, Arbil-New Arbil, Sulaimania-Mughagh and Kirkuk-Shwan in the Kurdistan Province of Iraq (Fig. 1). In total, fourteen specimens (4 males, 10 females) of blind mole rats were

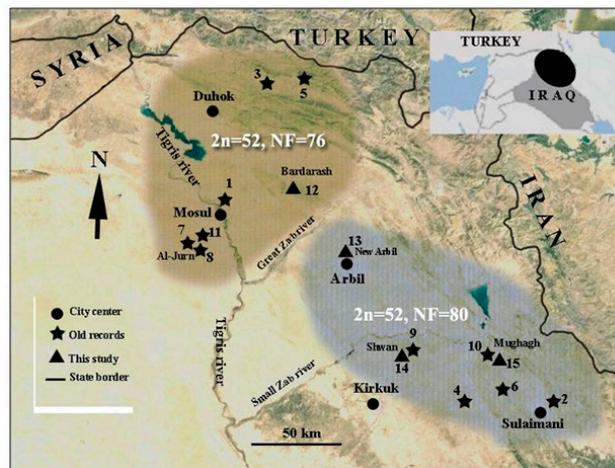


Figure 1. Sampling localities and geographical distribution of chromosomal forms of *Nannospalax ehrenbergi* in the Kurdistan region-Iraq (*: Old records) 1- Near Mosul (Cheesman 1920); 2- Near Sulaimania (Bate 1930); 3- Sarsank (Hatt 1959); 4- Jarmo, Chemchamal Valley (Reed 1958); 5- Ser 'Amadia and Tinn (Harrison 1956); 6- Jarmo, Palegawra Cave (Turnbull and Reed 1974); 7- Al-Jurn (Coşkun et al. 2012); 8- Al-Jurn (Coşkun et al. 2014); 9- Kirkuk-Shwan (Coşkun et al. 2014); 10- Sulaimania- Mughagh (Coşkun et al. 2014); 11- Al-Jurn (Coşkun et al. 2016); (▲: This study) 12- Duhok-Bardarash; 13- Arbil-New Arbil; 14- Kirkuk-Shwan; 15- Sulaimania- Mughagh.

studied. The sampled localities, the number of individuals analyzed, and karyological results are presented in Table 1.

Direct chromosome preparations were made from bone marrow (Hsu 1969) and about 25-30 metaphase cells, which were well stained, and whose chromosomes were separately examined. The diploid number of chromosomes ($2n$), the number of autosomal arms (NFa), the total number of chromosomal arms (NF), and the sex chromosomes were determined from photos of the metaphase plates according to the centromere position. The karyotype preparations and animals examined were deposited in the Department of Biology, the Faculty of Sciences at Dicle University.

3. RESULTS AND DISCUSSION

Morphological peculiarities of the mole rats of Iraq were documented in detail by Coşkun et al. (2016). They conclude that morphologically all studied populations in North Iraq show great similarities and can be morphologically classified as *Nannospalax ehrenbergi*. The approximate geographic area of each chromosomal form is shown in Fig. 1.

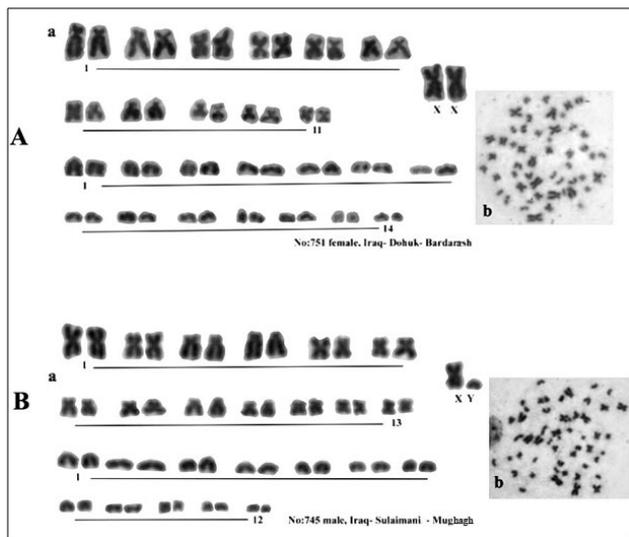


Figure 2. The karyotype *Nannospalax ehrenbergi*: A. Duhok-Bardarash population, B. Arbil population. (a: karyotype, b: metaphase plate).

3.1. Duhok Population

The karyotype of individuals from Duhok (Bardarash locality) was $2n = 52$, $NF = 76$, $NFa = 72$, which consists of 11 pairs of metacentric/submetacentric autosomes, and 14 pairs of acrocentric autosomes. The X chromosomes were large metacentrics (Fig. 2A). This cytotype is similar to that observed in the previously studied individuals ascribed to *Nannospalax ehrenbergi* from Al-Jurn (Mosul) by Coşkun et al. (2012). Mole rats of this locality (Duhok populations) inhabit the north of the Great Zab River (Tab.1).

3.2. Arbil Population

The samples from Arbil (New Arbil), Kirkuk (Shwan; 50 km north Kirkuk) and Sulaimania (Mughagh; 55 km west Sulaimania) possessed karyotypes of $2n=52$, $NF=80$,

$NFa=76$ and consists of 13 pairs meta /submetacentric 12 pairs acrocentric autosomes. The X chromosome was large metacentrics and the Y chromosome was small acrocentric (Fig. 2B and Tab. 1). The karyotypes of these three populations which is newly described here, are similar with each other's and they are located on the south side of the Great Zab river, in Iraq.

According to Gromov & Baranova (1981), Spalacidae has two distinct genera, *Nannospalax* and *Spalax*, and Turkish spalacids belong to the genus *Nannospalax*. Iraqi populations also belong to the genus *Nannospalax*. Reed (1958), Hatt (1959), Turnbull & Reed (1974), Harrison & Bates (1991), Lahony et al. (2013) have stated that mole rat samples in all Iraq are *S. leucodon* but our results show that all samples across Iraq are *N. ehrenbergi*.

Mole rat, belonging to the *N. ehrenbergi* exhibits two chromosomal forms that are widely distributed across north Iraq. One chromosomal form is $2n= 52$ and $NF= 76$, $NFa= 72$. This chromosomal form (Duhok populations) is found north of the Great Zab river and is similar to the Mosul-Al Jurn (Coşkun et al. 2012) and Turkish Diyarbakır (Coşkun et al, 2006) populations. The other form, $2n= 52$ and $NF= 80$, $NFa= 76$ (Arbil, Kirkuk-Sulaimania populations) in the south of the Great Zab river is a new chromosomal form that has not been previously described. Each of the karyotype forms exhibits an allopatric distribution, separated mostly by the Great Zab river or some ecological barriers, which may limit their dispersal (Fig. 2).

Chromosomal differences are frequently associated with taxonomic differences at the species level (Patton & Sherwood 1983). Chromosomal change has been implicated as a primary isolating mechanism in speciation. Chromosomal divergence is considered an indication of speciation events (Nevo et al. 2001).

This study filled the gaps in the knowledge of distribution of blind mole rat chromosomal forms in the north of Iraq. According to the results *N.ehrenbergi* are distributed in all parts of North Iraq, and it forms a potential species complex of *N. ehrenbergi*.

Table 1. The localities of samples that chromosomal analysis was performed in Iraq (N: sample size, $2n$: diploid chromosome numbers, NF : chromosomal arm numbers, NFa : autosomal arm number, m : metacentrics, sm : submetacentrics, a : acrocentric).

Locations			N	2n	Autosomes		NF	NFa	Gonosomes		Reference
City	Town	Village			m/sm	a			X	Y	
Kirkuk	Shwan	---	4♀	52	13	12	80	76	Sm	.	This study
Sulaimania	Dukan	Mughagh	2♂, 2♀	52	13	12	80	76	Sm	a	
Arbil	NewArbil	----	2♂, 3♀	52	13	12	80	76	Sm	a	
Duhok	Bardarash	Zamzamok	1♀	52	11	14	76	72	Sm	-	
Mosul	Al Jurn	----	3♂	52	11	14	76	72	Sm	a	

In order to fully understand the distribution and karyology of blind mole rats in Iraq, we need more information on hybrid zones in the territory, population structure and population size. There is a real necessity to establish long-term cytogenetic studies for this rodent. It is indeed very important to pay more attention to the role of natural barriers such as the Great Zab river and other ecological factors on speciation of Iraqi mole rats.

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STATEMENT OF CONFLICT OF INTEREST

The authors declare that there is no any conflict of interests regarding the publication of this article.

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