Morphological Properties of *Nannospalax* (Rodentia: Spalacidae) Distributed in North-Iraq

Kuzey Irak'ta Dağılış Gösteren *Nannospalax* (Rodentia: Spalacidae) Türünün Morfolojik Özellikleri

Research Article

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ABSTRACT

The materials of 11 specimens of mole-rats (*Nannospalax*) were collected from three different localities in North Iraq. The specimens were studied in respect to their morphological characteristics in detail. Some taxonomic peculiarities and measurements of body and skull have been investigated. The data obtained from the specimens were compared with the results of the previously published accounts. The results show that morphological peculiarities between the studied populations in North Iraq show great similarities. We therefore conclude that the North Iraqi population can be morphologically classified as *Nannospalax ehrenbergi*.

Key Words
Rodentia, *Spalax*, *Nannospalax ehrenbergi*, Morphology, North Iraq.

ÖZET

Kuzey Irak bölgesinden 3 farklı lokaliteden toplanan 11 Kör Fare (*Nannospalax*) örneği üzerinde ayrıntılı olarak morfolojik özellikleri çalışılmıştır. Bazı taksonomik özellikleri, dış vücut ve baş iskeleti ölçüleri araştırılmıştır. Örneklerden elde edilen bilgiler literatür bilgileriyle karşılaştırılmıştır. Sonuçlar bu bölge Körfare'lerinin incelenen populasyonlarının benzer morfolojik özelliklere sahip olduklarını göstermektedir. Böylece, Kuzey Irak populasyonları morfolojik bakımından *Nannospalax ehrenbergi* türü olarak değerlendirilmiştir.

Anahtar Kelimeler
Rodentia, *Spalax*, *Nannospalax ehrenbergi*, Morfoloji, Kuzey Irak.

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INTRODUCTION

The family Spalacidae (which has two genera, *Nannospalax* and *Spalax*) are completely adapted to exclusively underground life spending their entire life in their tunnel system. These small mammals have cylindrically shaped bodies with no external ears and a vestigial tail, and are completely blind. The distribution area of the family includes north-east Africa, the Balkans, Eastern Europe, Central Asia, in the Middle East, and Caucasia [1-7]. The Palestine mole rat *Nannospalax ehrenbergi* (Nehring, 1898) was originally described by Nehring [8], on the specimens collected from Yafa-Israel. This palaearctic species is distributed in a narrow coastal strip in Libya and Egypt, Syria, Jordan, Lebanon, Israel, Iraq, and Southeast Anatolia of Turkey [9-12].

Although the occurence of this species is known in Iraq Bate [13], its morphological properties have not yet been documented in detail.

Cheesman [14] notes presence of mole rats in Mosul province. Bate [13] has stated that the *Spalax* cf. *ehrenbergi* lives near Sulaimania. Reed [15] regarded the mole rats of prehistoric Jarmo, Chemchemal Valley of eastern Kirkuk, as *Spalax leucodon*. Harrison [16] identified the spalacids from the same part of the country (Ser 'Amadia and Tinn, near Bermaneh, near Amadia) as *S. ehrenbergi*, while Hatt [17] doubted whether two species were actually found in Iraq, since he reported *S. leucodon* from northern Iraq. Turnbull and Reed [18] assigned specimen from Palegawra cave in the Baranand Dagh, part of the southwestern foothills of the Zagros Mountains, northeastern Iraq to *Spalax leucodon*. Later, Harrison and Bates [19] considered mole-rats of Iraq as S. *leucodon*. Until recently the species has been confused with *S. leucodon* in this country. Karyotype of *Nannospalax ehrenbergi* with 52 chromosomes was also reported by Coşkun et al. [20,21] in Al-Jurn, Mosul province.

To date, the little morphological information known for the Iraqi mole rats. Despite this vast studies the taxonomic status and especially biogeography of the *Nannospalax ehrenbergi* taxon are still unclear in this country. Here, we report the results of morphological properties of Iraqi mole rats of *N. ehrenbergi* from North Iraq, and we compare our findings with previous data, in order to fill at least partly this gap in our knowledge on this species.

MATERIALS AND METHODS

In the present investigation, we studied 11 (4 ♂, 7 ♀) adult skulls (including young and olds) which were obtained between 2009-2014 years in three different localities from Al-Jurn village at 27 km southwest of Mosul (3 ♂) (Al Jurn, 36º10′ N, 43º 03′ E, Coşkun et al. [20]); Kirkuk (4 ♀) (Shwan village, 35º43′N 44º27′E) and Sulaimania (1 ♂, 3 ♀) (Mugah village, 35º 47′ and 45º 06′) from North Iraq (Figure 1). All specimens are used for morphological analysis.

Morphological peculiarities and cranial measurements (Figure 2) of all specimens were recorded. Age determination was based on molar crest patterns. The specimens were divided into three age groups (young, adult and old), according to the criteria reported by Nevo et al [22]. Three standard outer measurements (Head+body length (HBL), hind foot length (HFL), and weight (W) were recorded.

The data obtained from the specimens were compared with the results of previously published accounts. Voucher specimens (skins and skulls) are held in the Biology Department, Science Faculty, and Dicle University, Turkey.

RESULTS

North-Iraqi mole rats have supracondyloid foramen above both sides of the occipital condyles, lambdoid and sagital crests are well developed in mature and old samples. (Figure 3A); the sella externa is placed below the sella interna on mandible (Figure 3B); and the anterior surface of the upper incisors is orange in coloration, and has two longitudinal ridges (Figure 3C) whereas the lower incisors are yellow-orange and have at least three longitudinal ridges. In general most of specimens possess a well developed styloid process (Figure 3D-3). Foramen post palatines are placed on the front of the line between M^2-

Figure 1. Sampling localities of *Nannospalax ehrenbergi* in North Iraq. 1. Al Jurn-Mosul (3 ♂) (Coşkun et al. [20]) 2. Shwan-Kirkuk (4 ♀), 3. Mugah- Sulaimania (1 ♂, 3 ♀) province (for geographical range and old records, see Coşkun et al. [20]). Sample size of localities and sexes are given in paranthesis.

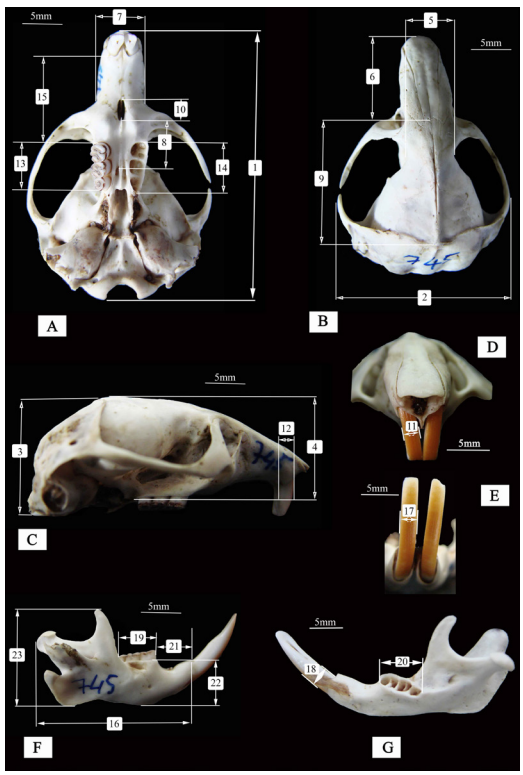

Figure 2. Craniometric characters were adapted from (Nevo et al 1988) and are abbreviated as follows: 1. Condylonasal length (CNL), 2. Zygomatic breadth (ZB), 3. Supraoccipital height (SOH), 4. Maximum skull height (MSH), 5. Interorbital breadth (IB), 6. Nasal length (NL), 7. Rostrum breadth (RB), 8. Palatal length (PL), 9. Frontal+parietal (FPL), 10. Incisive foramen length (IFL), 11. Upper incisor width (UIW), 12. Upper incisor antero-posterior cross section, 13. Upper molar length (UML), 14. Upper alveoli length (UAL), 15. Upper diastema length (UDL), 16. Mandible length (ML), 17. Lower incisor width (LIW), 18. Lower incisor antero-posterior cross section (LiapCS), 19. Lower molar length (LML), 20. Lower alveoli length (LAL), 21. Lower diastema length (LDL), 22. Mandible height (MH), 23. Coronoid process height (CPH) (modified at Nevo et al. [22].

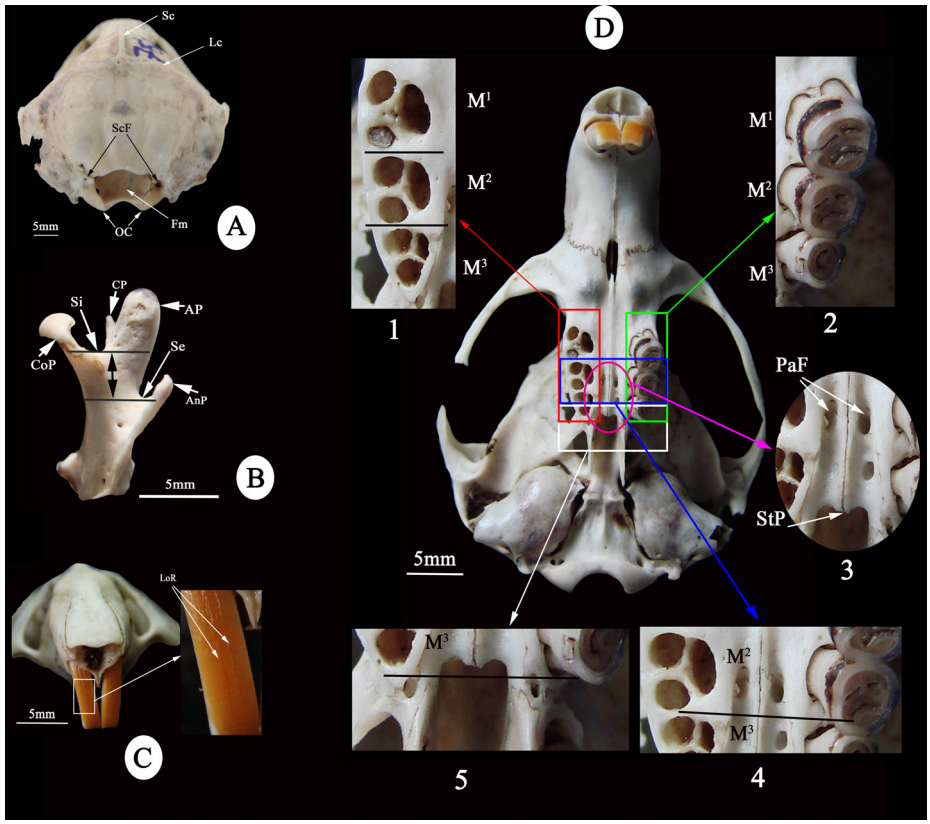

Figure 3. Cranial properties of *Nannospalax ehrenbergi* from North-Iraq province (A. dorsal, B. Mandible, C. Upper incisors, and D. Ventral side of skull) (AP: Alveolar process, AnP: Angular process, CoP: Condyloid process, CP: Coronoid process, Fm: Foramen magnum, Lc: Lambdoid crest, LoR: Longitudinal ridges, M^{123} upper molars, OC: Occipital condyl, PaF: Palatal foramens, Sc: Sagital crest, ScF: Supracondyloid foramen, Se: Sella externa, Si: Sella interna, StP: Styloid process).

M^3 (Figure 3D-4). Palate is not extended behind the line connecting the rear edges of the alveoli of the last upper molars in Kirkuk and Sulaimania populations but extended and pass through back in Mosul specimens (Figure 3D-5). External and cranial measurements of specimens were presented in Table 1.

$M^{1,2,3}$ have three roots in all specimens (Figure 3D-1), and 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 bifurciated. Alveoli of the all molar teeth are completely separated by septum. The alveolar process is about the same height as condyloid process on the mandible in all samples (Figure 3B).

In young specimens enamel folds on chewing surface of the molars as follows; the first upper molar (M^1) has two labial and one lingual fold (Figure 4A). The second upper molar (M^2) has a deep intruding fold on each side, therefore the chewing surface in the majority of cases is "S" shaped, and bears an additional inlet on antero-labial side (Figure 4B). The third upper molar (M^3) is the most variable tooth. Most commonly there are two loops. M^3 bears two converging folds on chewing surface in young specimens and the form of the wearing surfaces of M^3 is horseshoe-shaped (Figure 4B). In mature and old individuals these folds becomes 1-3 inlet and disappears in oldest specimens.

On the whole, of M_1 has one outer and two inner intruding folds on the wearing surface (Figure 4D). The wearing surface of M_2 has an S-shaped form, it is characterized by the presence of a deep intruding fold in both the outer and inner lines (Figure 4E). In mature specimens

Table 1. The external and cranial measurements (mm) and weight (g) of adult specimens of *Nannospalax ehrenbergi* from North Iraq; number of individuals (N), range (R), mean (M), standard deviation (±sd, (UiapCS), upper Incisor width/antero-posterior cross section (UIWap, %): Lower incisor width/antero-posterior cross section width (%) (LIW_ap). See text for other abbreviations.

Characters	N	R	M	±sd
HBL	3	164.0-180.0	173.3	8.33
HFL	3	20.0-23.0	21.3	1.53
W (g)	3	100.0-135.0	113.3	18.93
CNL	10	38.0-45.7	41.1	2.37
ZB	10	26.6-32.7	28.9	1.95
SOH	10	17.1-27.0	19.8	2.73
MSH	11	16.0-19.1	17.5	0.84
IB	11	6.5-7.4	6.9	0.25
NL	11	14.6-18.9	16.9	1.24
RB	11	7.0-9.0	7.9	0.64
PL	11	7.5-10.4	8.6	0.95
FPL	11	13.0-19.1	17.0	1.68
IFL	11	2.1-3.1	2.7	0.31
UIW	11	1.7-2.2	1.9	0.19
UiapCS	11	1.8-2.6	2.1	0.21
UML	10	6.0-7.0	6.4	0.32
UAL	11	5.9-8.0	7.0	0.64
UDL	11	13.5-16.5	14.9	0.98
ML	11	19.3-24.0	21.8	1.36
LIW	11	1.6-2.3	2.0	0.21
LiapCS	11	2.1-3.2	2.5	0.28
LML	11	5.6-6.9	6.3	0.38
LAL	11	5.5-7.2	6.5	0.59
LDL	11	5.2-7.5	6.3	0.70
MH	11	5.8-7.9	6.7	0.63
CPH	11	12.2-15.1	13.6	1.03
UIWap	11	77.3-105.0	90.4	8.61
LIW_ap	11	66.7-93.8	79.0	7.17

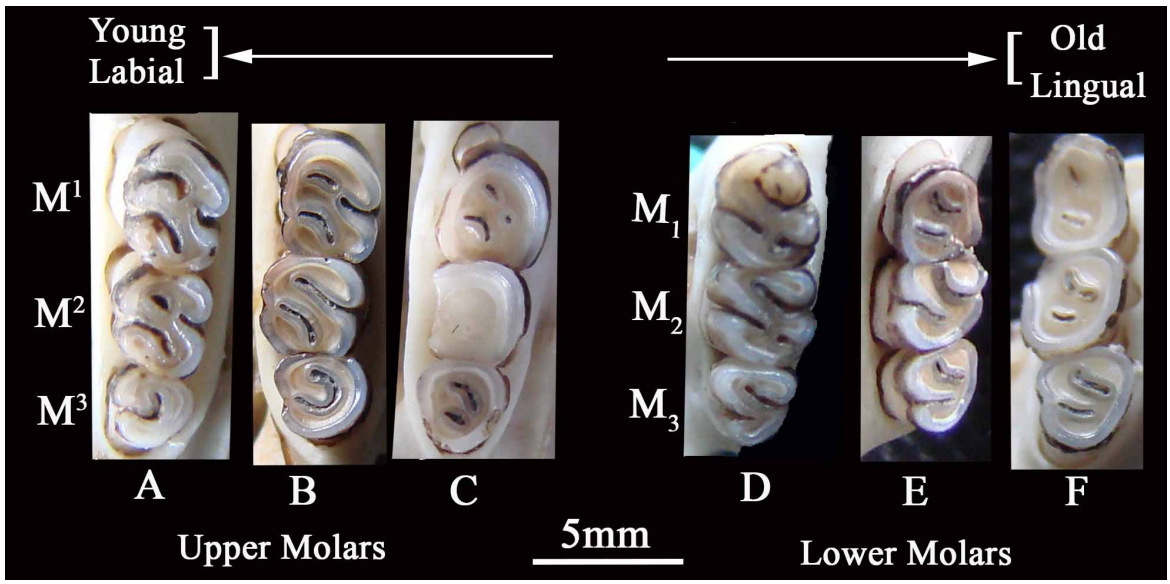

Figure 4. Chewing surface variations of upper (above) and lower (below) molar teeth of *Nannospalax ehrenbergi*. (Ant. Anterior, Post. posterior, lab. labial, lin. lingual side).

M^3 and M_3 generally has two enamel islands on chewing surface (Figure 4C and Figure 4F).

Upper and lower incisors ratio of width to antero-posterior cross section is equal to 77,3-90.4-105.0 for the upper, and 66.7-79.0-93.8 for the lower incisors.

DISCUSSION

Presence of the two longitudinal ridges on the anterior surface of the upper incisors; and appearance of the two enamel islands on chewing surface of third upper molars are two the most important diagnostic features have been emphasized in much previous work [5,6,8,22-24] to identify the *N. ehrenbergi*. According to Topachevskii [6] Micro*spalax ehrenbergi* (*S. ehrenbergi*) have three rooted upper molars; the anterior surface of the lower incisors have three longitudinal ridges and gives the ratio of upper and lower incisors width to antero-posterior cross section. These characters are found to be the same in Iraq population.

The measurements were given by Nehring [8] for *S. ehrenbergi*, such as zygomatic breadth (26-27 mm), rostrum breadth (7.5-7.6 mm), diastema (12-12.3 mm), upper alveolar length (7.3-7.5 mm) are found higher at North Iraq population except upper alveolar length (Table 1).

Topachevskii [6] gives the upper and lower incisors ratio of width to antero-posterior cross section is equal to 76.0-83.2-94.0 for the upper, and 64.0-74.5-86.2 for the lower incisors, these ratio is also found higher in North Iraq population.

Mole-rats of the genus *Spalax* show a well-marked tendency to develop local races characterized by more or less obvious differences Hinton [25]. In all examined specimens from North-Iraq population, the results show that palatines are not extended behind the line connecting the rare edges of the alveoli of the upper molars in young samples but extended or pass through the back in mature and old specimens; foramen post palatines are placed in the front of the line between M^2 and M^3. As Mehely's [1] describing the *S. ehrenbergi*, the palate ends with long and a weak styloid process, and upper molars have three roots in all examined samples. The pattern of the occlusal surface changes as the teeth wear down.

The external phenotype of mole rats is quite uniform. The morphological uniformity is obviously responsible for frequently changing and complicated systematics of this group. As previously mentioned elsewhere Coşkun [24,26] this taxon is not skull morphologically uniform, and should be reassessed from a taxonomic point of view. This will be possible

if genetic results as well as biogeoraphical data are gathered, and analyzed in order to further clarify the taxonomy of this taxon.

The comparison of morphological peculiarities between the studied populations in North Iraq shows great similarities. Morphological criteria have certainly not been sufficient to assess the real diversity of Iraqi mole rats. Hence, particularly, additional and detailed studies should be carried out in Iraq in future for contribution to distribution and taxonomy of the species. We therefore conclude that the North Iraqi population can be morphologically classified as *Nannospalax ehrenbergi*.

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