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Morphometric Studies on Skulls of Male Mole Rats [Nannospalax nehringi (2n = 50)] (Satunin 1898) (Rodentia: Spalacidae) Collected from Kars Province

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Thirteen adult male *Nannospalax nehringi* skulls were collected from Kars province. Lengths of 19 different points on skulls were measured with the aid of an electronic caliper (0.00, BTS, UK). Macroanatomic examination of male *Nannospalax nehringi* mole rat skulls revealed that, there were no clear external occipital crest formations, nuchael crest was quite long and sharp, external saggital crest was in a wavy form, tympanic bulla was large and long, and foramen magnum was pretty large and high. Also there was a bilateral protrusion on the midline of molar teeth on the os palatinum and holes on the premaxillo-nasal sutures and nasal bone were seen. The average lengths of the skulls were calculated 49.02 ± 4.62 mm. As a result of the correlation of the distances between measured points, strong positive correlations were determined between lengths of L2/L3, L2/L4 and L3/L4 and no insignificant or negative result was obtained.

Key words: Macroanatomy, Cephalometry, *Nannospalax nehringi*

Introduction

The Spalacidae family members adapted to underground life. It is thought to be they emerged in Anatolia during the Upper Oligocene and extensively subsided into Balkans, Russian steppes, Central Asia and extended to North Africa [22]. Members of the Spalacidae family can be found in Southeast Europe, Anatolia, the Caucasus, Trans-Caucasus, Ukraine, Armenia, Syria, Palestine, Israel, Iraq, Jordan and North Africa [1, 10, 22]. This family is a monophilic group at the family level, characterized by having semi-hypsodont, rooted and strong teeth [17]. Mehely [15] described *Spalax* genus under four sub-genus *(Nannospalax, Mesospalax, Macrospalax and Microspalax)* but Gromov and Baranova [8] gathered them under two genera as *Nannospalax* and *Spalax*. Topachevskii [24], Savic [21], Wilson and Reeder [26], Yigit et al. [27] and Sözen et al. [23], reported that *Nannospalax nehringi* is widely distributed across the Anatolia, Southeastern Anatolia but *Nannospalax ehrenbergi*

and *Nannospalax leucodon* spread on the European side of Turkey especially. They are also known as blind mole rats (BMR).

Morphometric analsis methods are frequently used in the identification of fossil model formations, determination of intrinsic phenotypic variations and evaluationof many internal and external osteological forms [5, 12]. The regional anatomy of skull is important because it contains some important organs such as brain, tongue, eye, lips, teeth, nose andeyelid. The well-known anatomical anatomy allows us to know the details of the structure related to the region in any case, and to practice in terms of clinical and surgical intervention.

There are many published research about the morphological and anatomical characteristics of *Nannospalax nehringi* [3, 4, 14, 15, 16, 24]. In this study, we aimed to determine the morphometric and macroanatomical features, and also craniofacial characteristics of *Nannospalax nehringi* (2n=50) in Kars province.

Material and Methods

Skulls of 13 adult male *Nannospalax nehringi* (2n=50) collected from Kars province for a thesis study in the Faculty of Veterinary Medicine, Department of Physiology, Kafkas University were used in the present study. This study was approved by the Institutional Animal Care and Use Committee of Kafkas University with permission no 2018-077. The skulls were cleaned from skin and coarse flesh and boiled in controlled manner and, cured with hydrogen peroxide for 25-30 minutes. Distances among 19 different points on skulls were measured with an electronic caliper (0.00, BTS, UK) according to literature. For photograph of the BMR skulls, Canon Digital Camera Zoom 5X was used. Dataset was composed from obtained measurements and, mean, standard deviation and correlation values were determined by SPSS 18.0 software.

Measurement points defined on the skull of Mole rats (*Nannospalax nehringi*) – Fig. 1.

Acrocranion (A). The most aboral point on the vertex of the cranium in the median plane, **Basion (B).** Orobasal border of foremen magnum in median plane, **Bregma (Br).** Median point of parietofrontal suture, **Euryon (Eu).** Most lateral point of braincase, **Lambda (L).** Median point of parietooccipital suture, **Nasion (N).** Median point of nasofrontal suture, **Otion (Ot).** Most lateral point of mastoid region, **Prosthion (P).** Most oral points of premaxillae on the median plane, **Postdentale (Pd).** Median point of the line combining the caudal edges of the last molar teeth alveoli on the median line of the oral cavity, **Rhinion (Rh).** Median point of the line combining the most oral points of nasals.

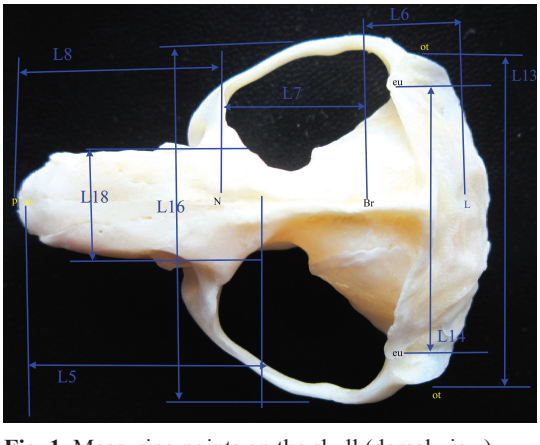

Fig. 1. Measuring points on the skull (dorsal view)

Measurements taken from the skull of Mole rats (*Nannospalax nehringi*) – Fig. 2.

L1. Skull length (acrocranion – prosthion), **L2.**Condylobasal length (aboral borders of occipital condyle - prosthion), **L3.** Basal length, **L4.** Dental length (postdentale – prosthion), **L5.** Largest nasal length, **L6.** Parietal length (lambda – bregma), **L7.** Frontal length (bregma – nasion), **L8.**Viscerocranium length (nasion – prosthion), **L9.** Length of the cheektooth row (measured along the alveoli on the buccal side), **L10.**Diestema length, **L11.** Palatal length, **L12.** Greatest width between the occipital condyles, **L13.** Widest length between the external acoustic meatus (otion – otion), **L14.** Maximum neurocranium width (euryon – euryon), **L15.** Skull width (distance between the temporal fossae), **L16.** Oral zygomatic width (between the oral parts of zygomatic arch), **L17.** Aboral zygomatic width (between the aboral parts of zygomatic arch), **L18.** Largest nasal width, **L19.** Palatal width.

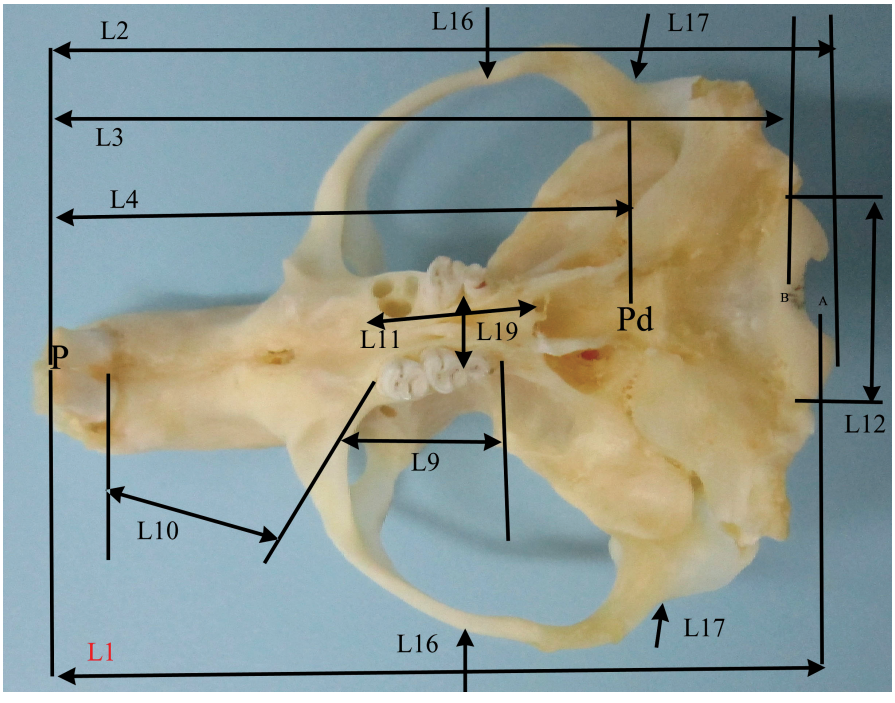

Fig. 2. Measuring points on the skull (ventral view).

Results

According to the macro-anatomic examinations of the *Nannospalax nehringi* skulls, occipital crest formation was not very clear (**Fig. 3**/thin arrow) and crista nuchae was quite long and sharp (**Fig. 3**/thick arrow). It was seen that external sagittal crest continued to descend after the beginning (**Fig. 3**/arrowhead). Tympanic bulla was in a large and long form and foramen magnum was pretty large and high. Also, a clear protrusion was observed bilaterally on the midline of molar teeth on the os palatinum. Additionally, it was seen that there were holes on the premaxillo-nasal sutures and nasal bone, as noted from previously studies (**Fig. 4**).

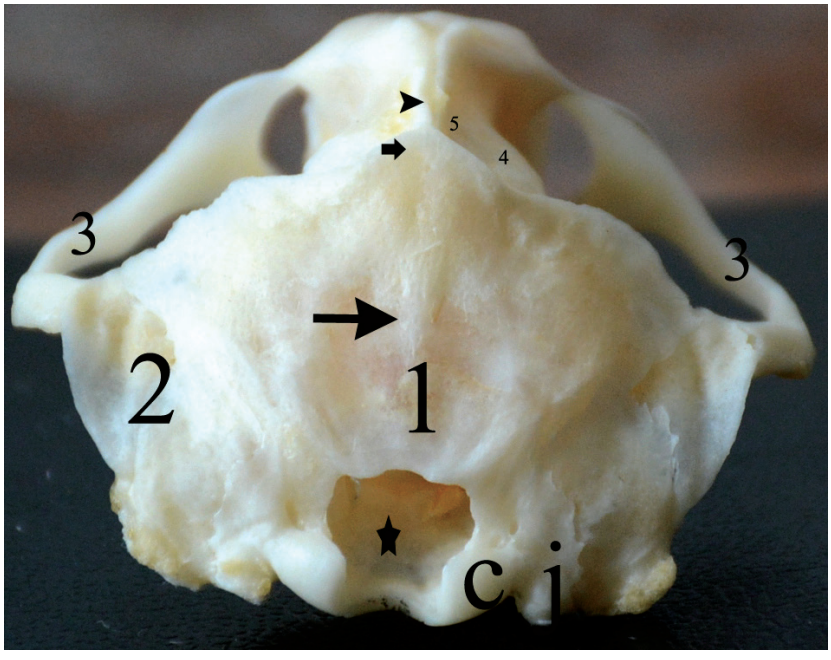

Fig. 3. 1. Occipital bone, 2. Temporal bone, 3. Arcus zygomaticus, 4. Parietal bone, 5. Interparietal bone, c. Condylar process, J. Jugular process

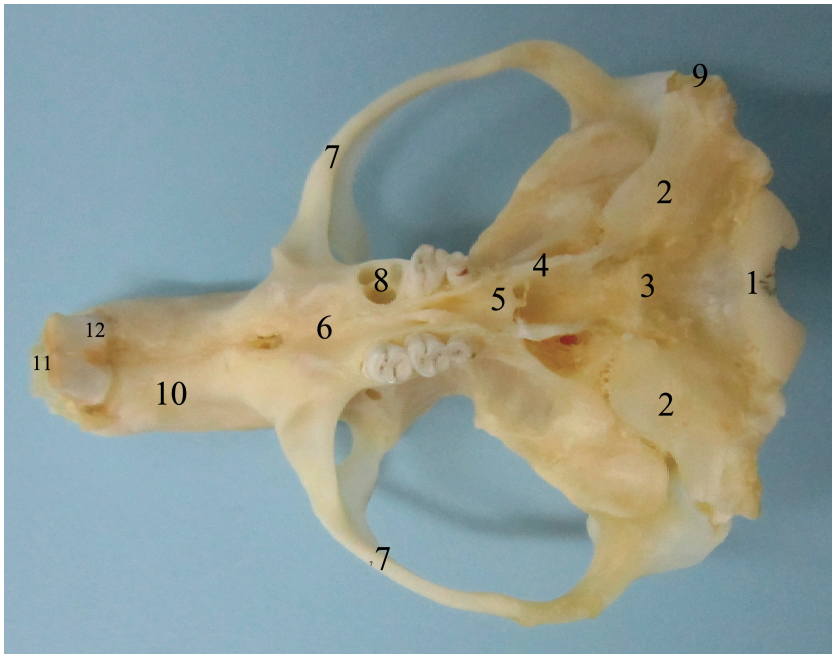

Fig. 4. 1. Occipital bone, 2. Tympanic bulla, 3. Sphenoid bone, 4. Pterygoid bone, 5. Palatin bone, 6.Maxillar bone, 7. Zygomatic arch, 8. Alveoli dentali, 9. Porusacusticus externus, 10. İnciciv bone, 11. Nasal bone, 12. Inciciv tooth.

Mean and standard deviation values of morphometric measurements of the male *Nannospalax nehringi* are shown in **Table 1** and the correlation analysis results of these values are shown in **Table 2**. According to these findings, the skull length was foundas 49.02 ± 4.62 mm on average.

As a result of the correlation analysis of obtained values, we found that there was positive correlation between the lengths of L2 / L3, L2 / L4 and L3 / L4, and no insignificant or negative result was detected.

Table 1. Mean and standard deviation values of morphometric values of skull in blind mole rat

	Mean	**Std. Deviation**
L1	49,0267	4,62838
L2	51,3617	4,15494
L3	49,4242	4,23306
L4	34,7267	3,39918
L5	23,1933	3,25571
L6	16,5675	1,31072
L7	20,2017	2,07067
L8	21,3650	1,83681
L9	7,9800	,69080
L10	18,2467	1,61045
L11	15,5842	1,79532
L12	10,2692	,72231
L13	27,6325	1,96954
L14	13,0767	,99418
L15	25,0375	2,10912
L16	33,8800	3,30935
L17	36,7842	3,52741
L18	8,8250	1,10210
L19	2,9067	,71115

Table 2. Correlation analysis of the morphometric values of the skull in blind mole rat(*P <0.05, **P <0.01).

	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	L13	L14	L15	L16	L17	L18	L19
L1	1	,931**	,940**	,959**	,902**	,834**	,909**	,901**	,751**	,897**	,881**	,251	,877**	,843**	,844**	,896**	,907**	,856**	,788**
L2		1	,998**	,987**	,919**	,883**	,812**	,909**	,681*	,890**	,921**	,246	,876**	,833**	,848**	,950**	,939**	,922**	,711**
L3			1	,992**	,923**	,882**	,811**	,924**	,681*	,904**	,933**	,246	,880**	,837**	,853**	,957**	,952**	,924**	,731**
L4				1	,942**	,898**	,862**	,910**	,697*	,913**	,937**	,262	,881**	,862**	,864**	,959**	,964**	,913**	,757**
L5					1	,763**	,845**	,882**	,605*	,915**	,871**	,258	,854**	,779**	,894**	,878**	,921**	,823**	,667*
L6						1	,795**	,706*	,545	,680*	,864**	,206	,747**	,774**	,636*	,869**	,878**	,841**	,612*
L7							1	,689*	,676*	,776**	,733**	,200	,781**	,725**	,727**	,775**	,794**	,669*	,691*
L8								1	,635*	,939**	,883**	,270	,812**	,776**	,893**	,893**	,913**	,886**	,791**
L9									1	,716**	,678*	,657*	,607*	,675*	,662*	,595*	,589*	,612*	,816**
L10										1	,880**	,353	,753**	,786**	,948**	,852**	,879**	,792**	,847**
L11											1	,462	,710**	,793**	,860**	,857**	,928**	,831**	,785**
L12												1	,044	,182	,367	,104	,250	,183	,562
L13													1	,724**	,642*	,893**	,856**	,884**	,552
L14														1	,831**	,866**	,799**	,860**	,689*
L15															1	,792**	,817**	,746**	,781**
L16																1	,961**	,945**	,718**
L17																	1	,902**	,761**
L18																		1	,647*
L19																			1

Discussion

Coşkunet Kaya. [2] and Ketani et al. [13] reported that the external saggittal crista was in only one protrusion shape but we observed that external sagittal crista was in a wavy formation in *Nannospalax nehringi* collected in Kars province.

A morphometric study on skulls of New Zealand rabbits reported that average lengths of the skulls are 94.1 mm [9]. In a different study, which was conducted on *Spalax leucodonnordmann,* the average lengths of the skulls were reported as 42.5 mm [19]. Additionally, it is known that, skulls of male rats are significantly longer than female rats have [11]. Olude et al. [18] reported the average skulls lengths of the male and female African giant rats as 63.6 mm and 62.8 mm respectively. In our study, the average length of skulls of the male *Nannospalax nehringi* was measured as 49.02 mm.

In the case of New Zealand rabbits, it was stated that all lengths other than the skull width (L15) and aboral zygomatic width (L17) were higher in the female rabbits than the 19 lengths measured over the skull [9].

Galatius [7] reported that skull measurements of Phocoenaphocoena were higher and significant in females than males.

In addition, Salih [20] reported that the average of 10 values out of a total of 16 lengths measured from rabbit skulls was higher in female rabbits than in male rabbits and that some lengths measured between genders were statistically significant. For example, measurements between 2 arcus zygomaticus and maxillo alveolar distance.

In New Zealand rabbits, all lengths except skull width (L15) and aboral zygomatic width (L17) were reported to be higher in female rabbits [9].

As a result, morphometric analyses are frequently preferred methods in determination of differences between the genders, interspecies modelling and identification of extinct or endangered species.

This study determined the macro-anatomical features, and morphometric characteristics of *Nannospalax nehringi* collected from Kars.

References

1. **Corbet, G. B.** *Mammals of the palearctic region: A Taxonomic review*. British Mus. Nat. History, London, 1978, pp**.** 1-314.
2. **Coşkun, Y., A. Kaya.** Morphological properties of nannospalax *(Rodentia: Spalacidae)* distributed in North-Iraq, Haccettepe. – *J. Biol. And Chem.,* **44**, 2016, 173-179.
3. **Coşkun, Y.** Turkey mole rat's the taxonomic status. XII. National Biology Congress Papers, Zoology Section, Volume VI, Edirne, 1994, pp. 277-283. [In Turkish]
4. **Coşkun, Y.** Morphological properties of Kars, Ağrı and Erzurum Region Spalax. XV. National Biology Congress Papers, Volume I, Ankara, 2000**,** pp. 277-283. [In Turkish]
5. **Çakır, A., İ. G. Yıldırım, O. Ekim.** Craniometric measurements and some anatomical characteristics of the cranium in Mediterranean monk seal (Monachus monachus, Hermann 1779). – *Ankara Üniv. Vet. Fak. Derg.,* **59**, 2012, 155-162.
6. **Dyce, K. M., W. O. Sack, C. J. G. Wensing.** *Textbook of veterinary anatomy*, 2nd edition, Philadelphia, Saunders, 1996
7. **Galatius, A.** Sexually dimorphic proportions of the Harbour Porpoise (Phocoenaphocoena) skeleton. – *J. Anat.,* **206**, 2005, 2, 144-154.
8. **Gromov, I. M., G. I. Baranova.** *Catalogue of mammals in USSR*. Leningrad, Nauka, 1981**.**
9. **Gürbüz, İ, Y. Demiraslan, K. Aslan.** Morphometric analysis of the skull of New Zealand rabbit (Oryctolaguscuniculus L.) According to gender. – *ARC Journal of Animal and Veterinary Sciences (AJAVS),* **1**, 2015, 27-32.

10. **Harrison, D. L., P. J. J. Bates.** *Mammals of Arabia*. Second edition, Harr. Zool. Mus. Pub, 1991 pp. 1-353.
11. **Hughes, P. C. R., J. M. Tanner, J. P. G. Williams.** A longitudinal radyographic study of the growth of the rat skull. – *J. Anat*., **127**, 1978, 83-91.
12. **Ketani, A. M., H. Sağsöz.** Histomorphometric investigation of the effects of gender on the histological structure of the mandibular condyle in rats. – *Atatürk Üniv. Vet. Bil. Derg.*, **4**, 2009, 31-38. [In Turkish].
13. **Ketani, Ş., M. Kilinc, S. Erdogan, A. Kaya, Y. Coskun.** A Macro-anatomical investigation of the some skull bones of Nehring's blind mole rats (Spalacidae: *Nannospalax nehringi*). – *Anat. Histol. Embryol*. **46**, 2017, 232–239.
14. **Kivanc, E.** Turkey mole rat's of geographical variations (Mammalia: Rodentia). *Ph.D. Thesis*, Ank. Univ. Science Fac., Ankara, 1988, 88 pp. [In Turkish]
15. **Mehely, V. L.** A Foldi Kutyak Fajai, Budapest (Mathem. und naturwissenschaftliche Berichteaus Ungarn), **28**, 1909, 4. pp. 1-273. [In German]
16. **Mursaloğlu, B.,** Turkey mole rat's in (Mammalia: Rodentia) Systematic Problems. TÜBİTAK VI. Science Congress, 1979 Communiqués, pp. 83-92. [In Turkish]
17. **Nevo, E., E. Ivanitskaya, M. Filippucci, G. A. Beiles.** Speciation and adaptive radiation of subterranean mole rats, *Spalaxehrenbergi* super species in Jordan. – *Biol. J. Lin. Soc*., **69**, 2001, 263-281.
18. **Olude, M., A. Olopade, J. O. Fatola, S. K. Onwuka.** Some aspects of the neurocraniometry of the African giant rat (Cricetomysgambianus Waterhouse). – *Folia Morphol.,* **68** (4), 2009, 224-227.
19. **Özkan, Z. E.** Macro-anatomical investigations on the skeletons of mole-rat *(Spalax leucodon Nordmann)* III. Skeleton axiale. – *Veterinarski arhiv,* **77** (3), 2007, 281-289.
20. **Salih, K. M.** Gross anatomical and morphometrical studies to the skull bones of the local rabbit (Oryctohgus cuniculus). – *Bas. J. Vet. Res*., **12** (2), 2013, 267-277.
21. **Savic, I.** Familie Spalacidae Gray, 1821 – Blindmouse. *In: Handbuch der saugetiere Europas, band 2/1 Rodentia*. Wiesbaden, Akademishe Verlagsgesellschaft, 1982, pp. 537-584. [in German]
22. **Savic, I., Nevo, E.** The Spalacidae: Evolutionary history, speciation and population biology. *In: Evolution of subterranean mammals at the organismal and molecular levels* (Eds. E. Nevo, A. O. Reig), New York, Alan R. Liss, 1990, pp. 129-153.
23. **Sözen, M., F. Matur, E. Çolak, S. Özkurt, A. Karataş.** Some karyological records and a new chromosomal form for Spalax (Mammalia: Rodenita) in Turkey. – *Folia Zool.*, **55**(3), 2006, 247-251.
24. **Topachevskii, W. A.** *Fauna USSR Spalacidae.* Leningrad, Nauka, 1969 (English translation: US Dept. Commerce. Nat. Info. Serv., Springfield, Virginia).
25. **Von den driesch, A.** A guide to the measurement of animal bones from archaeological sites. In: *Peabody museum bulletin I*, Cambridge MA, Harvard University, 1976, pp. 31-34
26. **Wilson, D. E., D. M. Reeder.** *Mammal species of the world: A taxonomic and geographic reference.* Second Edition, Washington and London, Smithsonian Institution Press, 1993.
27. **Yiğit, N., E. Çolak, M. Sözen, A. Karataş.** Rodents of Turkey. Ankara, Meteksan, 2006, 76-80.