

## **Macro-anatomical investigations on the forelimb skeleton of mole-rat (*Spalax leucodon* Nordmann)**

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### **ABSTRACT**

In this study, five mole-rats (*Spalax leucodon* Nordmann) were used to investigate the bones of fore limb. It was observed that the area of fossa infraspinata (46%) was larger than that of fossa supraspinata (39%) Cylindrical, slender, curved clavicles about 1.52 cm long were observed. The humerus was peculiar and the ridges and the tuberosities were well developed. There was no supratrochlear foramen. The radius and ulna were distinct but in one mole-rat while the left radius and ulna were distinct and the right radius and ulna were fused. In the carpal proximal row, os carpi radiale and os carpi intermedium were fused (os carpi intermedioradiale). The manus was complete, with five digits. There were two phalanges in the first digit and the other four digits were composed of three phalanges. In the palmar face of the manus there were radial and ulnar sesamoids (ossa sesamoidea palmaria) with an irregular surface.

**Key words:** mole-rat, *Spalax leucodon*, ossa membri thoracici, anatomy

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### **Introduction**

Mole-rats are subterranean rodents which live in their own tunnel system. They are mainly phytophagous animals and inhabit by burrowing in soft and productive agricultural plants, steppes and gardens (DEMÝRSOY, 1997). Mole-rats belong to the Spalacidae family, order Rodentia (KURU, 1987; DEMÝRSOY, 1996). These animals use their extremities for burrowing and

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shovelling and are often confused with moles (*Talpa europea* Linnaeus, order Insectivora) (DEMÝRSOY, 1997; DEMÝRSOY, 1998).

There are some macro-anatomical investigations on the skeletal systems of wild carnivores such as the mink (DURSUN and TIPIRDAMAZ, 1989) and from the order of Rodentia such as guinea pig and rat (ÖZKAN et al., 1997), porcupine (YILMAZ et al., 1998) and from the order Lagomorpha such as rabbit (ÖZKAN et al., 1997), but the skeletal systems of mole-rats from the order of Rodentia have not been investigated in detail.

The literature on the macro-anatomical features of the skeletal system in mole-rats is meagre, and the aim of the present study is to investigate the ossa membri thoracici part of the skeletal systems in mole-rats and to contribute to the present level of information.

### **Materials and methods**

The bones examined were obtained from 5 adult male mole-rats inhabiting their own tunnels in plantations in Elazýđ. Maceration of bones was carried out by the method of BARTELS and MEYER (1991), TAŦBAŦ and TECÝRLÝOGLU (1966).

For measurement of the surface areas of fossa supraspinata and fossa infraspinata, digital planimeter (Kouzumý Kp, 90 Placom, No: 35513, Japan) was used.

For terminology, Nomina Anatomica Veterinaria (1994) was used, complemented by textbooks by WELLS (1964), COOK (1965) and GREENE (1968).

### **Results**

*Scapula.* The prominent ridges on the cranial (margo cranialis) and caudal border (margo caudalis) in the scapula were present. It was observed that a ridge on the cranial border was lying to the middle of the scapular spine (spina scapulae), and a ridge on the caudal border lying from an acute caudal angle (angulus caudalis) to the glenoid fossa (cavitas glenoidalis) (Fig. 1).



Fig. 1. Lateral aspect of (a) scapula, (b) humerus, (c) clavicle, (i) tuberositas deltoidea; Arrow: ridge on the caudal border

By measuring with a digital planimeter, the average surface areas of the supraspinous fossa (fossa supraspinata) and the infraspinous fossa (fossa infraspinata) were defined as 0.5 cm<sup>2</sup> and 0.6 cm<sup>2</sup>, respectively, and the total surface area (collum scapulae and its distal portion excepted) was found to be 1.3 cm<sup>2</sup>. According to these results 39 % and 46 % of the total surface area of scapula was formed by fossa supraspinata and fossa infraspinata, respectively.

A scapular spine rising from the dorsal border until 1/3 of the lateral surface (facies lateralis) and lying parallel to the collum scapulae was prominent. Acromion and metacromion processes on the caudoventral termination of the spine were observed (Fig. 2).

The glenoid notch (incisura glenoidalis) and coracoid process (processus coracoideus) were well developed. The supraglenoid tubercle (tuberculum supraglenoidale) was greater than the infraglenoid tubercle (tuberculum infraglenoidale).

Clavicles, measuring about 1.52 cm in length, comprised slender and cylindrical bones (Fig. 1).



Fig. 2. Medial aspect of (a) scapula, (b) humerus, (i) metacromion, (ii) acromion, (iii) tuberositas deltoidea, (iv) proc. coracoideus.



Fig. 3. Lateral (a) and medial (b) aspect of antibrachium. (a) Fused radius and ulna (arrow) of the right antibrachium. (b) Distinct radius and ulna of the left antibrachium. (i) Deep groove on the medial surface of the olecranon.

*Humerus.* The humerus was peculiar and there were prominent curved expansions at proximal and distal ends. The deltoid tuberosity (tuberositas deltoidea) was well developed and curved, tapering towards cranial the projection (Figs. 1-2). A greater tubercle (tuberculum majus), extending slightly higher than the head (caput humeri), and a deep intertubercle groove (sulcus intertubercularis) between the head (caput humeri) and greater tubercle, were observed. There was a lateral epicondyloid crest (crista epicondyli lateralis) extending along the lateral aspect. There was no supratrochlear foramen.

*Antebrachium.* The radius and ulna were distinct, but in one mole-rat while the left radius and ulna were distinct, the right radius and ulna were fused (Fig. 3). The olecranon had prominent ridges and there was a deep groove on the medial surface of the olecranon extending towards nearly half of the corpus ulnae. Caput radii had an oval articular surface. The coronoid process of the ulna (processus coronoideus) was prominent. The distal ends of radius and ulna had styloid processes (processus styloidei)



Fig. 4. Dorsal aspect of the manus. (a) os carpi intermedioradiale, (g) os carpal IV, (i) radius, (b) os carpi ulnare, (h) os metacarpale I, (ii) ulna, (c) os carpi centrale, (ý) os metacarpale II, (d) os carpal I, (j) os metacarpale III, (e) os carpal II, (k) os metacarpale IV, (f) os carpal III, (l) os metacarpale V.

and the carpal articular surface of the radius (facies articularis carpea) was concave.

*Ossa carpi.* There were two bones in the proximal row. On the medial side, os carpi radiale and os carpi intermedium were fused (os carpi intermedioradiale), while on the lateral side there was os carpi ulnare. In the distal row, os carpale I, os carpale II, os carpale III, os carpale IV were distinct, and there was os carpi centrale in the distal of os carpi intermedioradiale. Os carpale IV was bigger than other distal row bones (Fig. 4).

*Ossa metacarpalia I-V.* The manus was complete, with five digits, and there were five metacarpal bones lying between the carpal bones and phalanges. The shortest was os metacarpale I, and the longest was os metacarpale III (Fig. 4).

In the palmar face of the manus in mole-rats there were radial and ulnar sesamoids with an irregular surface (Fig. 5).

*Ossa digitorum manus.* There were two phalanges in the first digit, while the other four digits were composed of three phalanges. The distal phalanges had the form of claws.



Fig. 5. Palmar face of the manus in mole-rat. (a) radial sesamoid, (c) 1<sup>st</sup> digit, (e) 3<sup>rd</sup> digit, (g) 5<sup>th</sup> digit, (b) ulnar sesamoid, (d) 2<sup>nd</sup> digit, (f) 4<sup>th</sup> digit.

## Discussion

Acromion and metacromion processes are present in guinea pigs (WAGNER and MANNING, 1976; ÖZKAN et al., 1997), in rats (WELLS, 1964; ÖZKAN et al., 1997), in rabbits (ÖZKAN et al., 1997) and the metacromion process is the smaller (WELLS, 1964). Similar findings were observed in this study.

The humerus, ulna and radius of rats present no variations from the general mammalian type (GREENE, 1968) but the ridges and tuberosities are better developed in all burrowing forms than in others (SAUNDERS and MANTON, 1969). Similarly, in our study there was a peculiar humerus having prominent ridges and tuberosities in mole-rats.

The deltoid ridge (crista tuberculi majoris) in the humerus was very prominent, as stated in the Muridae family (SAUNDERS and MANTON, 1969) and tuberositas deltoidea was well developed, as in rats (ÇALITLAR, 1978; ÖZKAN et al., 1997).

Clavicles, about 1.52 cm long, were small and cylindrical, as reported in guinea pigs (WAGNER and MANNING, 1976) and with slender curved bones, as in rats (WELLS, 1964) and rabbits (UÇAR et al., 1985).

ROMER (1970) mentioned that among mammals in particular the shaft of the ulna may fuse with the radius. In the present study, in one mole-rat, while the left radius and ulna were distinct, the right radius and ulna were fused, although in four mole-rats the radius and ulna were distinct, as reported in the Rodentia (SAUNDERS and MANTON, 1969; DEMÝRSOY, 1998).

It has been stated that the manus nearly always has five digits in the Rodentia (SAUNDERS and MANTON, 1969; DEMÝRSOY, 1997; DEMÝRSOY, 1998). Similarly, five digits were observed in mole-rats. SAUNDERS and MANTON (1969) reported that in the manus of the mole (*Talpa europaea* Linnaeus, order Insectivora) there is a radial sesamoid which greatly increases the breadth of the hand and increases its efficiency in shovelling earth. In our study, there were radial and ulnar sesamoids (ossa sesamoidea palmaria) in mole-rats (*Spalax leucodon* Nordmann, order Rodentia).

A central bone is present in some forms, but os carpi radiale and os carpi intermedium are always fused in the Rodentia (SAUNDERS and MANTON, 1969). However, in porcupines 4 proximal carpal bones have

been noticed (YILMAZ et al., 1998). In this study, the carpus os carpi radiale and os carpi intermedium were fused (os carpi intermedioradiale) and there was a central bone in the distal of os carpi intermedioradiale in mole-rats.

In conclusion, there were some prominent features in the forelimb bones in mole-rats as burrowing and shovelling rodents, and ridges and tuberosities were well developed.

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**SAŽETAK**

Istraživanje je provedeno na pet bijelozubih slijepih kučeta (*Spalax leucodon*). Dokazano je da je područje podgrebenske jame lopatice (46%) veće od područja nadgrebenske jame (39%). Cilindrične, tanke i savijene ključne kosti su bile duge 1,52 cm. Opisana je i osobita nadlaktična kost s dobro izraženim brazdama i kvržicama. Na nadlaktičnoj kosti nije izražen supratrohlearni foramen. Radijus i ulna su bili odvojeni u svih, osim u jedne životinje (na kostima desne noge) gdje su bile spojeni. Karpalne kosti, os carpi radiale i os carpi intermedium bile su spojene u jednu - os carpi intermedioradiale. Kostii prednje šape bile su kompletne i sadržavale su svih pet prstiju. Na prvom prstu su opisane dvije falange dok su ostali prsti imali tri falange. Na palmarnoj strani nađene su radijalne i ulnarne sesamoidne kosti (ossa sesamoidea palmaria) s neravnom površinom.

**Ključne riječi:** bijelozubo slijepo kuče, *Spalax leucodon*, kostii prednje noge

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