Systematics, distribution and ecological analysis of rodents in Jordan

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Abstract

Distributional and ecological data were given to all rodents of Jordan. The rodent fauna of Jordan consists of 28 species with 20 genera in eight families (Cricetidae, Dipodidae, Gliridae, Hystricidae, Muridae, Myocastoridae, Sciuridae, and Spalacidae), including four introduced species. Keys for families and species were provided, along with diagnosis for each species and cranial illustrations for most species. Habitat preference and zoogeographic affinities of rodents in Jordan were analyzed, as well as their status and conservation. Threat categories and causes of threats on the rodents of Jordan were also analyzed.

The distribution of rodents in Jordan represents a reflection of their global distribution ranges and habitat preferences. Species associated with the temperate forest of northern Jordan includes *Sciurus anomalus* and two wood mice, *Apodemus mystacinus* and *A. flavicollis*, while non-forested areas are represented by *Nannospalax ehrenbergi* and *Microtus guentheri*. Strict sand dwellers include *Gerbillus cheesmani* and *G. gerbillus*. Petrophiles associated with sandstone or black lava deserts are exemplified by *Acomys russatus, A. r. lewsi, H. indica* and *S. calurus*. Others including: *Jaculus jaculus, G. nanus, G. henleyi*, *Meriones crassus*, and *M. libycus* are all desert-adapted species with wider ranges of distribution where scarce vegetation, Wādībeds, and marabs with clay, loess, or gravel surfaces provide foraging grounds and shelter. A single species, *Gerbillus dasyurus*, exhibits a wide range of distribution over diverse habitat types.

The rodent fauna of Jordan consists of assemblages of different zoogeographical affinities. Nine, three, and seven were restricted or had most of its range within the Mediterranean, Irano-Turanian, and Saharo Arabian, respectively. *Sciurus anomalus*, *Apodemus* sp., *Nannospalax ehrenbergi*, and *Microtus guentheri* reached their most southern range of distribution in the Mediterranean regions of Jordan. The distribution of *Gerbillus cheesmani* extends from Asian deserts in India westwards into the Arabian Peninsula crossing Jordan as its most western range of distribution. Typical rodents of Saharo-Arabian affinities are represented by desert jerboas, gerbils, and jirds. North African species such as *G. andersoni, G. gerbillus* reached their most eastern distribution in southern Jordan. Both *G. henleyi* and *G. nanus* are widely-distributed species across North Africa reaching as far as India to the east, representing most northern outpost for these two species. *Sekeetamys calurus* is a nearly endemic to the

Eastern Mediterranean region within southern Jordan and Sinai. Relicts are represented by *Eliomys melanurus* and *Acomys russatus lewisi*.

Several threats affecting the rodent biodiversity in Jordan were identified including habitat loss and degradation, human disturbance and related activity, legislative and public awareness. The global conservation status of the rodents of Jordan according to the IUCN Red List include 22 species as least concern, one as near threatened (*Allactaga euphratica*), and one as data deficient (*Nannospalax ehrenbergi*). According to the regional assessment, one species is critically endangered, three species are considered endangered, one vulnerable.

Keywords: Biodiversity, Habitat preference, Jordan, Rodents, Zoogeography

Introduction

Rodents represent one of the largest groups of mammals worldwide as well as in the Eastern Mediterranean region. Rodents are also the most numerous mammals in their distribution in a particular area (Corbet, 1978; Qumsiyeh, 1996). They play an important role in establishing the ecosystem's biodiversity. Not only are they prey for avian and mammalian predators, but they are also good consumers of seeds and green plants, though being potential agricultural pests causing seed destruction and forestry problems in temperate regions. Rodents are also able to alter the species composition of plant communities thereby altering the vegetation of an area by selective feeding (Chaline, 1977). Rodents are one of the most diversified groups of mammals inhabiting temperate, arid and semi-arid habitats in North and East Africa, the Levant and the Arabian Peninsula (Harrison, 1972; Lay, 1983; Harrison & Bates, 1991; Wilson & Reeder, 2005). Due to the variation in habitat structure, this group of small mammals forms an important component of the mammalian fauna for these regions including the arid zones as they are adapted to tolerate extreme desert conditions (Lay, 1983; Granjon *et al*., 1999; Scott & Dunstone, 2000; Abu Baker & Amr, 2003b; 2004).

Despite its limited area, the rodent diversity in Jordan totals 28 species, including four introduced species. This is due to the remarkable habitat heterogeneity and the existence of several biogeographical regions (Amr, 2012). Our knowledge on the diversity of rodents in Jordan is a result of continuous efforts over the past 15 years. Several systematic accounts have been undertaken and yielded a great amount of data on the diversity, systematics and ecology of the rodent fauna of Jordan (Abu Baker & Amr, 2003a; 2003b; 2004; 2008; Yousef & Amr, 2005; Amr *et al*., 2004; 2006; Amr, 2008; Atallah 1977; 1978; Harrison & Bates, 1991; Qumsiyeh, 1996; Amr, 2000; Benda *et al*., 2010; Amr, 2012).

The present monograph aims to document the diversity, distribution, and ecology of all the rodents in Jordan, updated distribution ranges with remarks on their biology and habitat preferences, and a preliminary analysis of the biogeography of rodents in Jordan.

Materials and methods

Study area

In Jordan, four biogeographical regions are identified (Fig. 1): The Mediterranean region; which, has the highest rain fall and altitude and the most fertile soil. It includes the mountain ranges from Irbid in the north until Ra’s an Naqb, it is dominated by oak, pine and pistachio trees. The Irano-Turanian region; lower altitudes with poor soil characterize this region, it surrounds the Mediterranean except in the north. It is dominated by *Raetam*, *Anabasis* sp. and *Artimesia*. The Saharo-Arabian region; this region comprises the majority of the total area of Jordan with, although it has the lowest rain fall and poorest soil, diversified subdivisions of vegetation types

occur there, (Hammada, Saline, Sandy and Mud flat). *Artimesia, Achillea, Phlomis* and *Astragalus* dominate the region. The Sudanian region, this is the warmest region in Jordan, it covers the most southern and southwestern parts of Jordan, the rain fall is low and the soil is mostly saline or sandy. The dominant vegetation is *Acacia* sp. and *Haloxylon persicum* (Disi & Amr, 1998; Disi *et al*., 1999).

Within the four mentioned regions, fourteen different vegetation types occur (Alberts *et al*., 2004), these are: pine forest, evergreen oak forest, deciduous oak forest, juniper forest, mixed forest, Mediterranean non-forest, steppe, hammada, saline, tropical, sandy, Sudanian, water and mud flat.

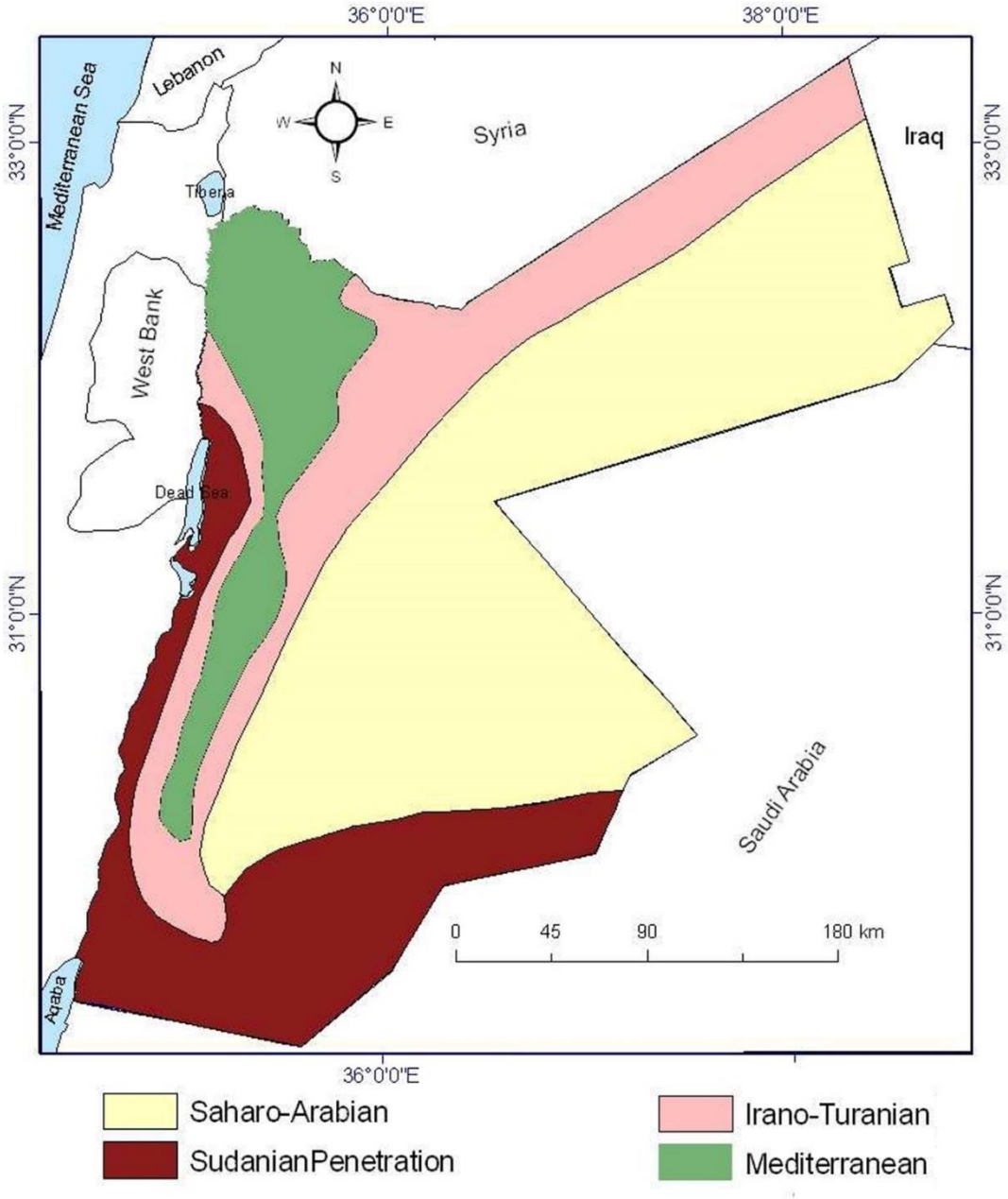

Fig. 1. Map of Jordan showing the four biogeographic regions.

Trapping and collecting

Rodents and/or rodent remains were collected from sites covering all vegetation types and habitats distributed throughout Jordan. 130 sites (Appendix 1) were explored over the past years which are characterized by substrate and vegetation differences, all being influenced by the four geographic zones. Locality name spelling and coordinates were based on the Jordan Gazetteer (Anon, 1990). Rodents were often trapped using Sherman folding live-traps (23 × 9 × 9 cm) during different seasons, traps were baited with mixed oatmeal and peanut butter, traps were set in the late afternoon and checked in the early morning hours. In areas where diurnal rodents were suspected or seen, traps were left for the mid-day hours. Jerboas were spotted at night by the automobile lights and hand torches and caught with regular insect nets. Owl pellets were collected from different localities and analyzed for rodent's skull remains, they were identified to species level based on skull morphology and dental features.

Results

The rodents of Jordan are represented in eight families (Cricetidae, Dipodidae, Gliridae, Hystricidae, Muridae, Myocastoridae, Sciuridae, and Spalacidae) with 20 genera and 28 species. Species of this order are diverse, inhabiting a wide variety of habitats, ranging from extremely arid to mountainous and cold environments. The majority of rodents are nocturnal or crepuscular; however, some are strictly diurnal (e.g. squirrels). The diet of most rodents is primarily granivorous and herbivorous, but a few species feed on insects or land snails. Most of the rodents in Jordan are relatively small in size, with the exception of the Indian crested porcupine and the introduced coypu (Wilson *et al*. 2016).

Key to the families of order Rodentia in Jordan

1. Eyes and ear pinna absent (Fig. 2A).....Family Spalacidae
   Eyes and ear pinna present (Fig. 2B).....2

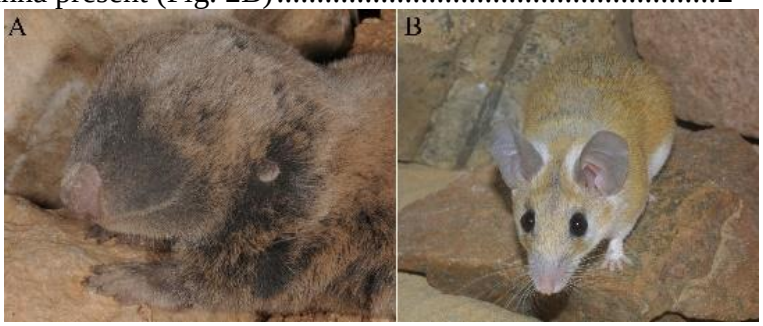

Fig. 2. A. Eyes and ears present. **B.** Eyes and ears absent.

2. Body covered with long spines (more than 150 mm). Large forms .....Family Hystricidae
   Body not covered with long spines, small to medium sized forms 3

3. Tail very thick and bushy.....Family Sciuridae
   Tail not as above.....4

4. Hind foot long, about 60 mm in length.....Family Dipodidae
   Hind foot not long, about 40 mm in length.....5

5. Ckeekteeth 4 (Fig. 3A), black stripe passes through the eye.....Family Gliridae
   Cheekteeth 3 (Fig. 3B), no black stripe passes through the eye 6

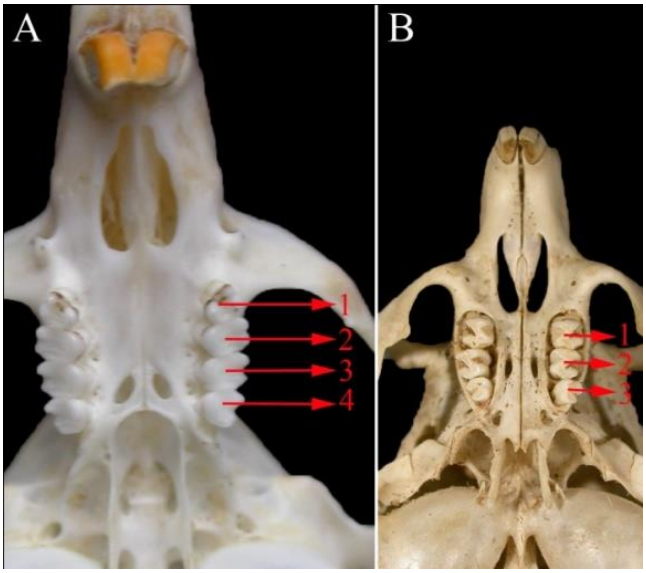

Fig. 3. Upper maxillary teeth. **A.** Four maxillary teeth. **B.** Three maxillary teeth.

6. Cheekteeth tuberculate in two longitudinal rows (Fig. 4A).....Family Cricetidae
   Cheekteeth tuberculate in one or three longitudinal rows (Fig. 4B).....Family Muridae

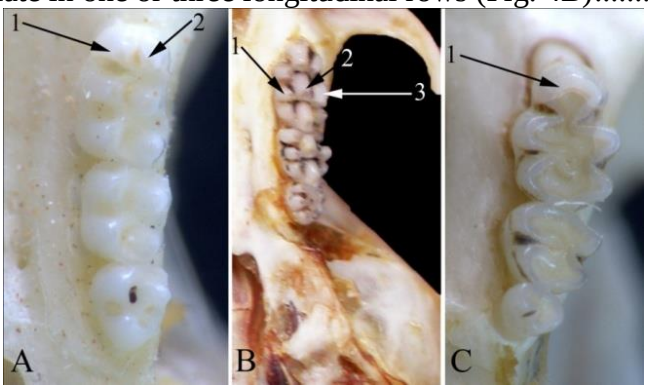

Fig. 4. Shape of maxillary teeth rows. **A.** Teeth in two longitudinal rows. **B.** Teeth in three longitudinal rows. **C.** Teeth in one longitudinal row.

Family Sciuridae

About 250 species of squirrels have been described worldwide. Three basic types of squirrels are known according to their habitat; flying squirrels, tree squirrels and ground squirrels. Squirrels are characterized by their flat and bushy tails. Their hind are feet equipped with five digits. This family is represented by one species in the Middle East (Wilson *et al*. 2016).

***Sciurus anomalus* Güldenstaedt, 1785**

Common Name: Persian squirrel.

Diagnosis: Color on back brownish gray and brownish yellow on the ventral side, fur is coarse with soft underwool (Fig. 5). Tail thick, bushy and flattened in appearance. Ears with very short tufts. Muzzle short and blunt. Eyes surrounded by yellowish hair. Thumbs of forefeet vestigial. Hind feet with 5 digits. Dorsal side of tail is light red-brownish. Five pairs of mammae. Strong depression of the braincase posteriorly. Postorbital process of frontal present and distinctively sharp pointed. Low molar crowns and square-like shaped (Fig. 6).

Localities: **Previous records.** Kufrinja (Amr & Disi, 1988); Burmā (Harrison & Bates, 1991); Ajlūn Forest Reserve, Dibbīn Forest Reserve, Rimon, between Sakib and ‘Anjara (Amr *et al*., 2006); Ajlūn (AUB specimen cited in Atallah, 1978). **New records**. Tabaqat Fahl (Fig. 7).

Habitat: It is associated with thick pine and oak forests in northern Jordan. Locally, the Persian squirrel is uncommon and hard to spot in the mountains of Ajlūn, Jarash and Ishtafayna where pine and oak trees are abundant. It uses tree holes as nests and can be located using the piles of eaten acorns and cones under trees. In a recent study, the presence of the Persian squirrel, *Sciurus anomalus,* was confirmed in Dibbeen Forest Reserve and other localities in Jordan. The records were based on direct visual observations and finding remains of consumed pine cones. Examination of freshly consumed pine-cone remains constituted an excellent tool to record the presence and distribution of squirrels across the reserve. Freshly consumed pinecones formed continuous clusters in most of the studied localities. Also, remains of fresh, old and very old pine cones were concentrated in pine forested areas, and with less frequency in mixed pine-oak forested regions (Amr *et al*., 2006).

Fig. 5. The Persian squirrel, *Sciurus anomalus* in Dibbīn Forest Reserve (photo RSCN).

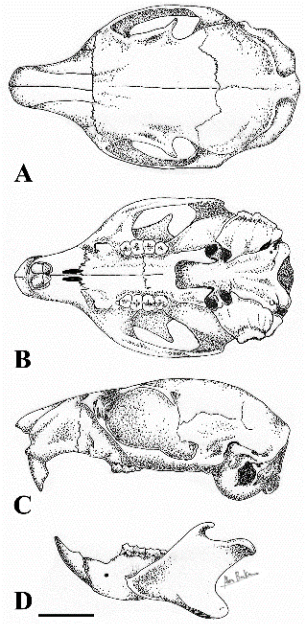

Fig. 6. A. Dorsal, **B**. Ventral, **C**. Lateral views of the skull, and **D**. Mandible for *Sciurus anomalus*. Scale bar = 10 mm.

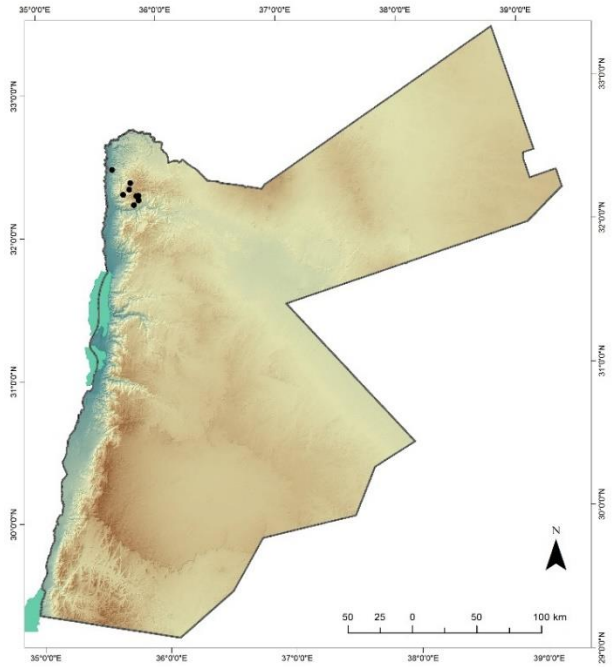

Fig. 7. Distribution of the Persian squirrel, *Sciurus anomalus*.

Biology: The Persian squirrel is an arboreal and diurnal species. Squirrels were observed either individually or in groups of up to 9 individuals. It exhibits two activity peaks, early morning hours until around 9 am, and another peak two hours before the sunset when they start making calls (Koprowski *et al*. 2016). When disturbed, animals always escape to the higher pine trees although oak trees are present. It could be seen either on the ground looking for food remains or on top of trees hiding or feeding on green cones that are usually found on the top of trees. Food remains such as cones were spotted close to or inside tree holes. Also, nests are located on thick branches with large amount of pine needles at various elevations. In Ajlūn Forest Reserve, we located a nesting site with a new born squirrel on a tree during April.

Remarks: The presence of the Persian squirrel in Jordan represents its most southern range of distribution (Amr, 2000; Koprowski *et al*. 2016). Its occurrence in Jordan may represent a relict population which have been separated from the continuous range of distribution that extends from the Caucasus through Anatolia, western Syria to Jordan. The karyotype for specimens collected from Iran was found to be 2n=40, NF=76, with 18 metcentric and one submetacentric pairs of chromosomes (Nadler & Hoffmann, 1970), while in Turkey, Al Bayrak & Arsalan, (2006) obtained 2n=40, FN=80 with 5 metacentic and 14 submetacentric chromosome pairs.

Family Gliridae

***Eliomys melanurus* (Wagner, 1839)**

Common name: Asian garden dormouse**.**

Diagnosis: A squirrel-like mouse with thick fur, large ears, and bushy tail. Dorsal side is gray and ventral side is white with a distinct line of demarcation (Fig. 8). Eyes surrounded by black hair, mask-like black stripe extending from eyes backwards to the base of ears. Forefeet have four digits, hind feet five, the soles are naked. Tail terminates with bushy black hair, covering almost half of the tail length (Fig. 7). Skull with very large tympanic bullae and long rostrum. Zygomatic arches very delicate. Slender mandible with large perforations of the angular

processes, having a distinctive secondary projection on the lower margin. Crowns of cheekteeth distinctively concave (Fig. 9).

Fig. 8. The Asian garden dormouse, *Eliomys melanurus* from Wādī Ramm (photo by David Modry).

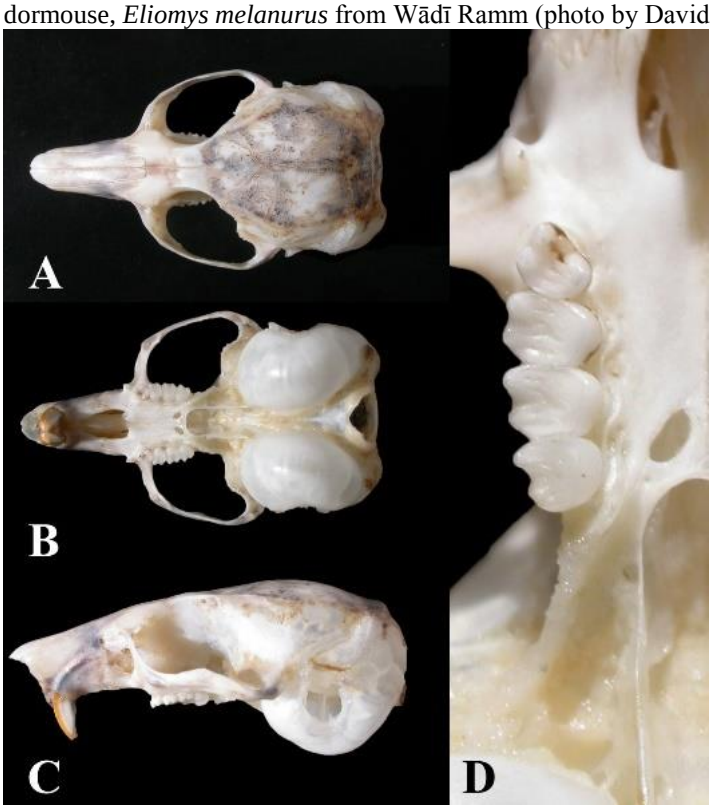

Fig. 9. A. Dorsal, **B**. Ventral, **C**. Lateral views of the skull, and **D**. Maxillary teeth for *Eliomys melanurus*.

Localities: **Previous records.** Jîza, Umm ar Rasas (Tristram, 1866); Moab and Edom (Bodenheimer, 1958); Azraq ed Duruz (Atallah, 1978); Wādī Rajil near Jāwá (Searight, 1987); Azraq ed Duruz, Dhaba'ah (Amr & Disi, 1988); Al Wisad (Abu Baker & Amr, 2003b); Wādī Ramm (Abu Baker & Amr, 2004); Ḍānā Biosphere Reserve

(Yousef & Amr, 2005). **Materials extracted from owl pellets.** Ex. *Tyto alba*, (Wādī Al Barra) Ḍānā (Obuch per. com.); Ex. *Bubo bubo*, Marj Al Hammam (Obuch per. com.); Ex. *Bubo bubo*, Qaṣr Burqu' (Obuch per. com.). **New records.** Dibbīn Forest Reserve, ar Ruwayshid (Fig. 10).

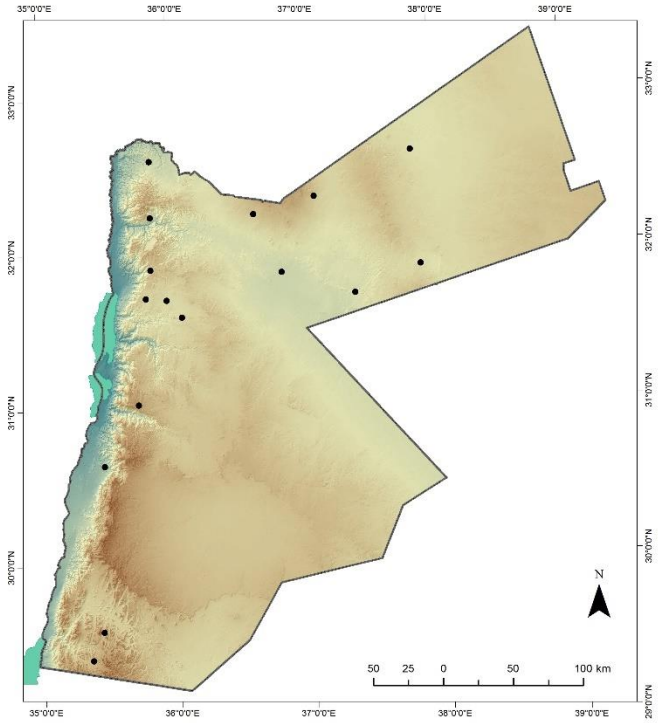

Fig. 10. Distribution of the Asian garden dormouse, *Eliomys melanurus*.

Habitat: It occurs in a wide range of habitats from the temperate forests to densely vegetated habitats and rocky deserts. As the distribution map shows, it was collected among black lava rocky habitats in the Eastern Desert, rocky juniper forest in Ḍānā Biosphere Reserve, and sand stone deserts of Wādī Ramm. It is arboreal and comes out at night to feed on *Haloxylon persicum* shrubs, oak, wild figs, and juniper trees.

Biology: Females give birth to 2-9 young, and become fully mature by one year (Kingdon, 1990). The Asian garden dormouse lives along with other desert rodents, such as *Gerbillus dasyurus* and *Acomys russatus* (Atallah, 1978). It feeds on insects, snails and centipedes (Atallah, 1978; Nader *et al*., 1983).

Remarks: The southwest Asian garden dormouse has a remarkable distribution pattern, despite being originally an arboreal species. The species became adapted to a non-arboreal life style 1.2 million years ago (Bates, 1996). Earlier geological periods and deforestation events have created relict populations of this species within the rocky habitats of Wādī Ramm and the Eastern Desert. The karyotype for specimens collected from the Negev Desert was found to be 2n=48, FN=86, with 14 metcentric or submetacentic, and 6 subtelocentric pairs of chromosomes (Filippucci *et al*., 1988).

Family Dipodidae

The elongated hind limbs and short forearms characterize members of this family, resembling kangaroo rats. This is an adaptation for saltatorial movement. Two genera are recognized in Jordan, *Allactaga* and *Jaculus*. Both contain one species that are found in dry arid parts of the country (Wilson *et al*. 2017).

Key to species of the Family Dipodidae

1. Hind foot with 5 digits.....*Allactaga euphratica*
   Hind foot with 3 digits.....*Jaculus jaculus*

Allactaga euphratica Thomas, 1881
Common name: Five-toad jerboa**.**
Diagnosis: This is a medium sized jerboa. Its dorsal side is gray-brown and ventral side is white (Fig. 11). The ears are distinctively long and narrow, more than one half of hind foot length. It has five digits on hind feet and naked soles, three functional and two vestigial digits. Four pairs of mammae. Tail composed of three distinct bands; white anteriorly, brown medially and terminates with a white tip. Zygomatic arches widely flared posteriorly. Tympanic bullae small. Four upper cheekteeth, with a small first upper premolar. Angular process not perforated (Fig. 12).

Fig. 11. The five-toad jerboa, *Allactaga euphratica* (photo by Adwan Shehab).

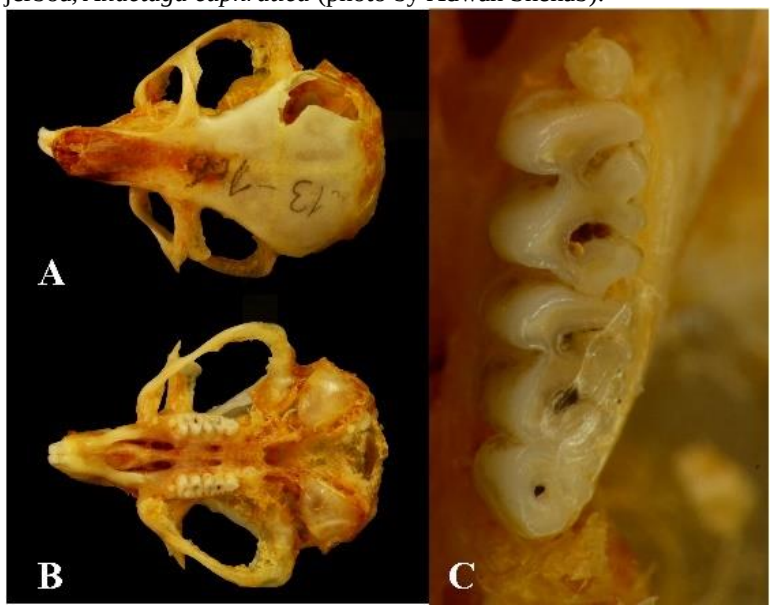

Fig. 12. A. Dorsal, **B**. Ventral views of the skull, and **C**. Upper maxillary teeth for *Allactaga euphratica*.

Localities: **Previous records.** ‘Ammān (Bodenheimer, 1958); 50 km W Al Jafr, Qaşr ‘Amra, 30 km east of Al Mafraq, 45 km N Ma'an (Atallah, 1978); Jāwá (Searight, 1987); Jāwá, Ash Shawmarī (Amr & Disi, 1988); Shawmarī Wildlife Reserve (Hatough-Bouran, 1990); Umm Al Qiţţayn (Sözen *et al*., 2008). **Materials extracted from owl pellets:** Ex. *Athene noctua*, Qaşr al Ḥallābāt (Obuch, per. com.); Ex. *Athene noctua*, Qaşr Al Kharanah; Ex. *Bubo bubo*, Burqu'. **New records**: Ernbeh (Fig. 13).

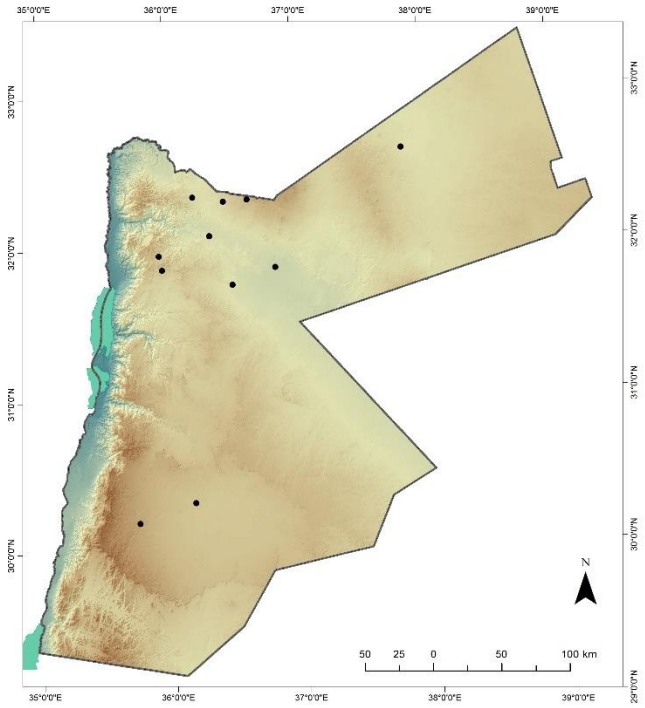

Fig. 13. Distribution of the five-toad jerboa, *Allactaga euphratica*.

Habitat: The five-toad jerboa is restricted to the steppe and gravel arid and semi-arid habitats of Jordan. It is mostly associated with Wādīs in dry parts of the country and avoids sand habitats. It was observed in densely vegetated Wādīs near Wādī Rajil. It keeps the burrow entrance plugged during daytime. Burrows may reach up to 50 cm. deep and about one meter long (Lewis *et al*., 1965).
Biology: The five-toad jerboa becomes active after sunset and looks for food close to its burrow site. Females may give birth up to nine young. Kadhim & Wahid (1986) examined the reproduction of the male *A. euphratica* and stated that the period of February to May includes higher level of breeding activity of males with a second activity during October. More details on the biology of this species are given by Çolak & Yiğit (1998).
Remarks: Jordan represents its most western range of distribution. Most of its distribution is in the eastern desert with fewer localities in the south. The karyotype of two animals from Umm Al Qiţţayn was found to be 2n: 48, NF: 96, NFa: 92. The autosomal set consists of 23 biarmed pairs (Sözen *et al*., 2008).

***Jaculus jaculus* (Linnaeus, 1758)**
Common name: Three-toed jerboa, lesser Egyptian jerboa.
Diagnosis: The lesser Egyptian jerboa is characterized by its long fur, gray-brown dorsal color, and white ventral color (Fig. 14). Hind feet are long with three toes. The back feet also have large hair tufts. Central digit of the three toes is longest. Tail is long terminating with white brush. Four pairs of mammae. Skull with very large, inflated bullae. 3 upper cheekteeth. Small first premolar missing. Angular process with perforation that has a sharp projection beneath it (Fig. 15).

Fig. 14. The three-toed jerboa**,** *Jaculus jaculus*, from the eastern desert of Jordan (photo by Mohammad Abu Baker).

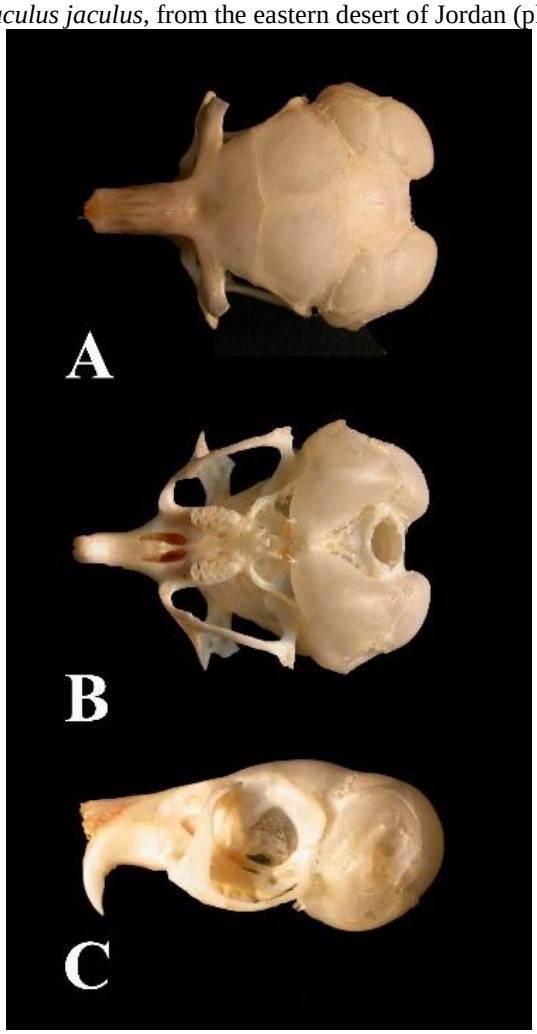

Fig. 15. A. Dorsal, **B**. Ventral, and **C**. Lateral views of the skull for *Jaculus jaculus*.

Localities: Al Jafr, Azraq Ash Shīshān, Qaşr ʻAmra (Atallah, 1978); Jāwá (Searight, 1987); Wādī Faynān (Amr & Disi, 1988); Ash Shawmarī Wildlife Reserve (Hatough-Bouran, 1990); Al Hazīm, Al Wisad, Buqay'awiyah**,** Qaşr Burquʻ, ar Ruwayshid, Safawi, Wādī Al Hashad (Abu Baker & Amr, 2003b); Wādī Ramm (Abu Baker & Amr, 2004). **Materials extracted from owl pellets.** Ex. *Athene noctua,* Wādī Al Hashad (Al-Melhim *et al*., 1997); Ex. *Bubo bubo*, S Azraq (Amr *et al*., 1997); Ex. *Bubo bubo*, Faydat ad Dahik (Rifai *et al*., 2000); Ex. *Tyto alba*, Ash Shawmarī Wildlife Reserve (Abu Baker *et al*., 2005); Ex. *Bubo bubo*, Azraq Wetland Reserve (Shehab & Ciach, 2008); Ex. *Athene noctua*, Qaşr Al Kharanah (Obuch per. com); Ex. *Bubo bubo*, Qaşr Burquʻ (Obuch per. com); Ex. *Bubo bubo* and *Tyto alba*, Ash Shawmarī Wildlife Reserve (Obuch per. com); Ex., *Strix butleri*, (Wādī um Numayr) Petra (Obuch per. com). **New records.** Jāwá, Qatar, Raḥmah, Ar Rīshah, Wādī Faynān (Fig. 16).

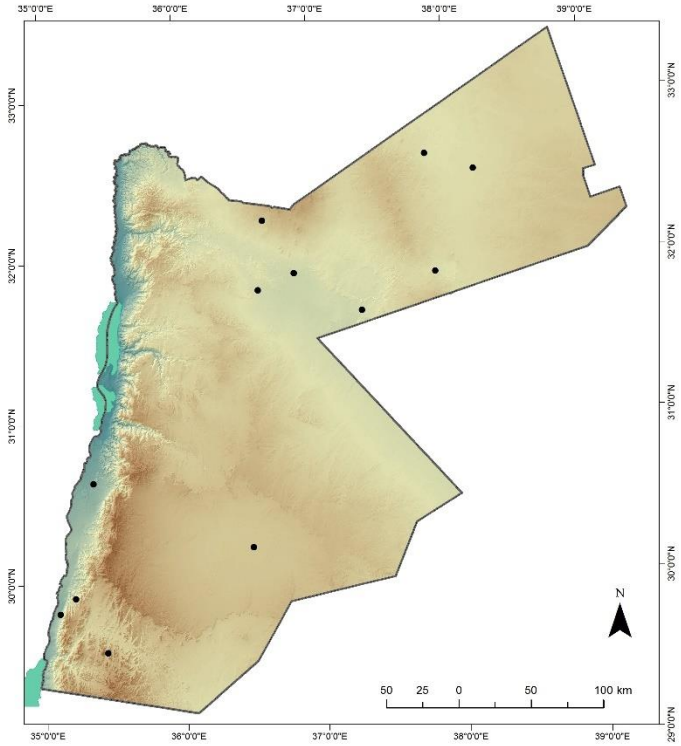

Fig. 16. Distribution of the three-toed jerboa**,** *Jaculus jaculus*.

Habitat: The ecology of the three-toed jerboa is well studied (Lewis *et al.*, 1965). It is a nocturnal species and remains active for the first 3 to 4 hours after dark. Burrows are situated in levelled arid areas and may reach up to 120 cm deep. The entrance is plugged with sand during the daytime. Hatough-Bouran (1990) reported on the burrowing habits of this species in different forms of Hammada soil. Burrows are dug in Hammada with more than one opening in addition to the main entrance. The burrow consists of several food chambers, a nest and several blind alleys. Three-toed jerboa is a successful desert species, with a wide range of distribution in the Arabian Peninsula, Iraq, Jordan, Syria and Palestine. It is mostly associated with open gravel plains.

Biology: Females produce 2-7 new born after a gestation period that lasts for about 25 days (Lewis *et al.*, 1965; Kadhim *et al*., 1979). The Three-toed Jerboa is a one of the major food items for desert owls; for example, it represented 2.1% of the little owl, *Athene noctua,* diet (Al-Melhim *et al*., 1997), and was consumed readily by the eagle owl, *Bubo bubo* (Amr *et al*., 1997; Rifai *et al*., 2000).

Remarks: Distribution of the three-toed jerboa is restricted to the arid regions of Jordan. This is a common species with unidentified direct threats. It is a main food items for desert owls. Locals

relish the meet of jerboas, but this is practiced at low scale. The karyotype for specimens collected from Jordan was found to be 2n=48, NFa= 88, with five metcentric, 14 submetacenteric and four acrocentric pairs of chromosomes (Al- Shyeab, 2013).

Family Cricetidae

Most members of this family have well developed cheek pouches. Tail is usually short and densely covered with hair. One of the most distinctive features of this family is the presence of tuberculated cheekteeth in two longitudinal rows (Wilson & Reeder, 2005).

Key to subfamilies of the family Cricetidae

1. Tail naked, ears pointed (Fig. 17A) .....Subfamily Cricetinae
   Tail covered by hair, ears short (Fig. 17B) …….Subfamily Arvicolinae

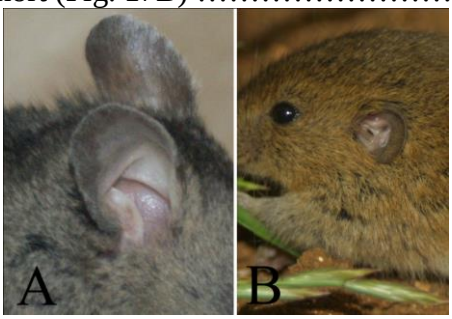

Fig. 17. Ear shape for **A.** Subfamily Cricetinae. **B**. Subfamily Arvicolinae.

Subfamily Cricetinae

This subfamily includes the hamsters. In the Middle East, Cricetinae includes two genera; *Cricetulus* and *Mesocricetus*, where only the first genus is represented by one species in Jordan (Wilson & Reeder, 2005).

***Cricetulus migratorius* (Pallas, 1773)**

Common name: Gray hamster**.**

Diagnosis: Ventral color white, with a distinct line of demarcation (Fig. 18). Fur is soft and woolly, on the back gray to grayish-brown with a distinct dark stripe along the middle of the back. Cheek pouches present. Tail is less than one-third of body length. Four pairs of mammae. Skull small, with small tympanic bullae. Very distinctive for this species is that the teeth consist of parallel rows of cusps (Fig. 19).

Fig. 18. The gray hamster, *Cricetulus migratorius* (photo by Adwan Shehab).

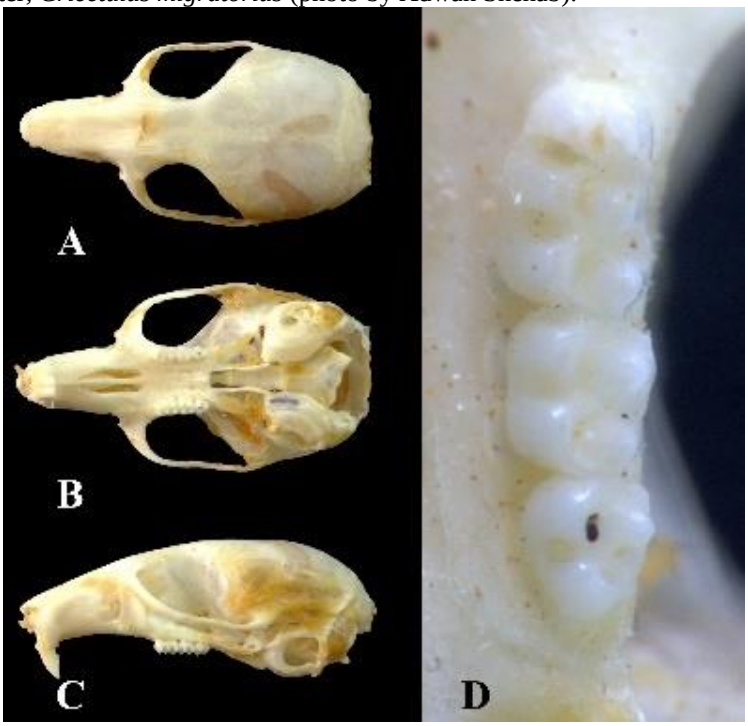

Fig. 19. A. Dorsal, **B**. Ventral, **C**. Lateral views of the skull, and **D**. Upper maxillary teeth for *Cricetulus migratorius*.

Localities: Previous records. Al Muwaqqar (Amr & Saliba, 1986); Jāwá (Searight, 1987). **Materials extracted from owl pellets**. Ex. *Bubo bubo*, Wādī Zarqā, S Jarash (Bates & Harrison, 1989). Ex. *Tyto alba*, Aş Şarīḥ (Rifai *et al*., 1998). Ex. *Bubo bubo ascalaphus*, Faydat ad Dahik (Rifai *et al*., 2000). Ex. *Athene noctua*, Qaşr al Ḥallābāt (Obuch, per. com.). Ex. *Bubo bubo*, Marj Al Hammam (Obuch, per. com.). Ex. *Tyto alba*, Wādī Al Barra (Ḍānā) (Obuch, per. com.). Ex. *Tyto alba*, Wādī Zarqā Ma'in (Pokin, per. com.). **New records.** Sūf (Fig. 20).

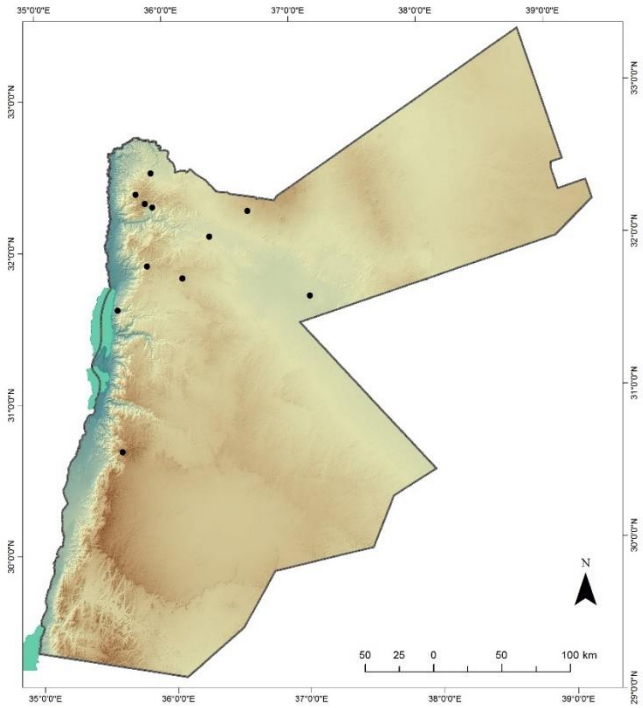

Fig. 20. Distribution of the gray hamster, *Cricetulus migratorius*.

Habitat: The gray hamster lives in diverse habitats including moderate and arid areas. It was collected from localities in northern Jordan and at high altitudes near Jāwá (about 1100 m asl). Pellets of several owl species included remains of the gray hamster collected from extremely arid regions in the Jordanian deserts (e.g. Faydat ad Dahik and Qaşr al Ḥallābāt). It was found to breed near wheat cultivated fields in Aş Şarīḥ area.
Biology: The gray hamster is a nocturnal rodent and was found to share burrows with *Meriones tristrami* in northern Jordan. It breeds all year round, where females give birth to 2-11 young (Dahl, 1954). Remains of the gray hamster were fond in the pellets of three owls in Jordan: *Athene noctua, Bubo bubo* and *Tyto alba* (Bates & Harrison, 1989; Rifai *et al.*, 1998 & 2000; Obuch, per. com).
Remarks: Apparently, Jordan represents the most southern distribution range for this species. *Cricetulus migratorius* has occurred in the southern Levant since 80,000-70,000 years before present and apparently replaced two fossil species (recorded as *Allocricetus*), *C. magnus* (70,000-60,000 years before present) and *C. jesreelicus* (not recorded later than 120,000 years before present) (Tchernov, 1992). The karyotype for specimens collected from Jordan was found to be 2n=22, NFa= 40, three telocentric, four metacenteric and four acrocentric pairs of chromosomes (Al- Shyeab, 2013).

Subfamily Arvicolinae

This subfamily includes voles, lemmings and muskrats. They are most closely related to the other subfamilies in the Cricetinae. Previously, voles were treated as members of family Muridae.

***Microtus guentheri* (**Danford & Alston**, 1880)**
Common name: Levant vole**.**
Diagnosis: Fur color of dorsum reddish brown, grayish ventrally, weak line of demarcation. Ears and tail are very short (Fig. 21). Hind feet with five tubercles on soles. Soles of hind feet densely haired posteriorly. Tail less than one third of head body length. Four pairs of mammae. Third upper molar with three re-entering folds (Fig. 22).

Fig. 21. The Levant vole, *Microtus guentheri*, from Aş Şarīḥ (photo by Mohammad Abu Baker).

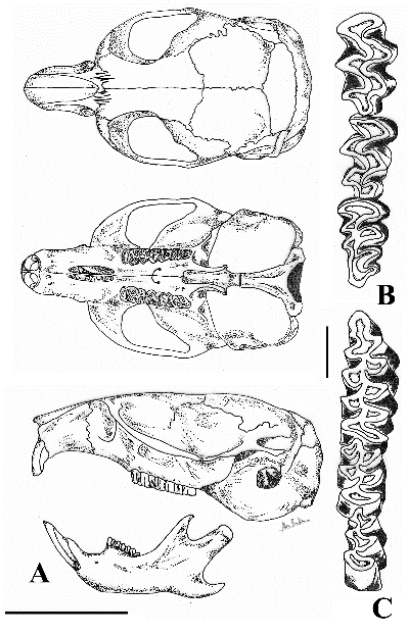

Fig. 22. A. Dorsal, Ventral, and Lateral views of the skull (scale bar = 10 mm), **B.** Upper, and **C.** Lower cheekteeth (scale bar = 1 mm) for *Microtus guentheri*.

Localities: Previous records. ʻIbbīn (Amr & Disi, 1988); Aş Şarīḥ (Rifai *et al*., 1998). **Materials extracted from owl pellets.** Marj Al Hammam (Obuch per. com.), ʻAmmān National park (Obuch per. com.), Wādī Zarqā Ma'in (Pokines per. com.). **New records.** Ajlūn Forest Reserve (Fig. 23).

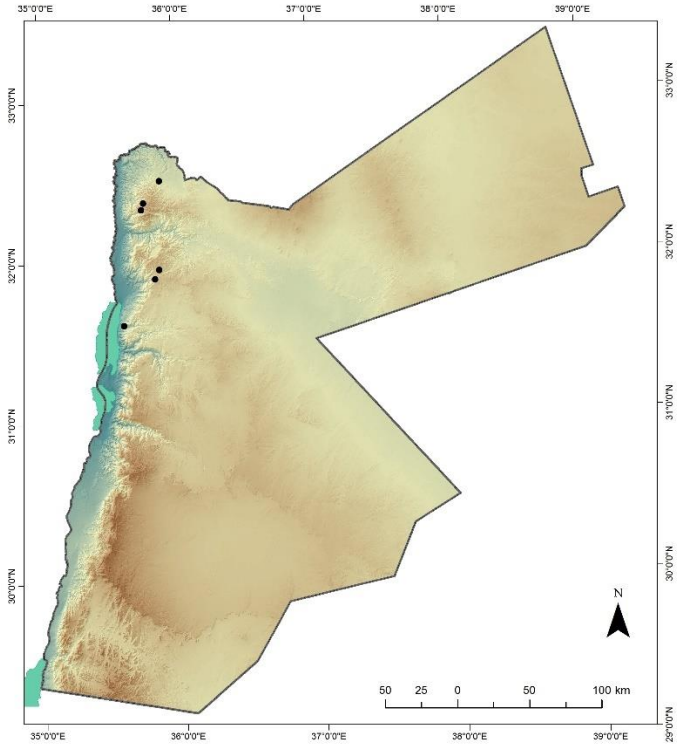

Fig. 23. Distribution of the Levant vole**,** *Microtus guentheri*.

Habitat: The Levant vole is restricted to the Mediterranean biome. Some colonies were found in the transitional areas between Irbid and Al Mafraq. This is a colonial species where colonies may exceed 40 burrow systems per 1000 m^2. It shares burrows with the gray hamster (*Cricetulus migratorius*) and Tristram's jird (*Meriones tristrami*). The barn owl (*Tyto alba*) feeds readily on the Levant vole (Dor, 1947; Rifai *et al*., 1998).
Biology: Voles have enormous reproductive abilities. Gestation period lasts for 21 days, and females give birth to up to 10 new born. Each generation may produce 6 to 7 litters per year (Personal observations). Its populations may increase suddenly inflicting severe damage to crops. In 1992, northern Jordan was plagued with a population explosion of the Levant Vole. This was manifested in severe damage of wheat fields, all summer crops (squash, watermelon, etc.) and destruction of stems of newly planted fruit trees. In the following year, the populations of this vole ceased and are now under control. The ecology and biology of *Microtus guentheri* were studied in Turkey (Çolak *et al*., 1998). Burrows were abundant at the edges of fields, burrow systems were shallow with several openings with no food chambers. In captivity, females produced seven litters with an average litter size of 5.5 between September and June (Çolak *et al*., 1998).

Remarks: Harrison & Bates (1991) continued to unite *guentheri* with *M. socialis*. Morphological and geographic definition of the species has been unclear due partly to substantial geographic variation and partly to its confusion with *M. irani* (Kock & Nader, 1983). Karyotype for this species from Turkey was found to be 2n=54, NFa=68 and NF: 70. The autosomes consist of 52 acrocentric and 2 metacentric pairs of chromosomes (Çolak *et al*., 1997).

Family Muridae

Recent treatments of Order Rodentia made radical changes in the systematic of this order. By now three main subfamilies are known to occur in Jordan (Gerbillinae, Murinae and Deomyinae). This family includes rats, jirds and gerbils. This family includes generalized species that assume different life styles. It includes rats, mice and other forest inhabitants. Many species are considered serious pests of economic and health importance (Wilson & Reeder, 2005).

Key to subfamilies of family Muridae

1. Dorsum is partially covered by spiny hairs ..... Subfamily Deomyinae
   Dorsum is not partially covered by spiny hair, most with smooth hair 2

2. Tail hairy and terminates with a tuft of various shape and size (Fig. 24A)…… Subfamily Gerbillinae
   Tail with few hairs, and have annuli, tail without a tuft. (Fig. 24B) ..... Subfamily Murinae

Fig. 24. Shape of tails. **A.** Tail covered by hair. **B.** Tail with annuli and not covered by hair.

Subfamily Deomyinae

This family includes spiny mice. In Jordan, two species of spiny mice are known: *Acomys dimidiatus* and *Acomys russatus* (Wilson & Reeder, 2005). The systematics of this problematic genus was revised by several authors. Although Denys *et al*. (1992) showed that *Acomys* is undoubtedly a murine based on dental morphology, others, suggested that *Acomys* is more related to gerbils (Gerbillinae) than to true mice (Murinae) based on molecular data (Chevret *et al*., 1993). Verheyem *et al*. (1995) suggested the placement of species of the genus *Acomys* within the proposed group "Acomyines". Furthermore, Chevret & Hänni (1994) indicated that *Acomys* cannot be considered a murine based on molecular and biochemical evidence. For consistency purposes, we apt to follow Wilson & Reeder (2005).

Key to species of Subfamily Deomyinae

1. Soles black. Ears covered with hair.....2
   Soles pale. Ears without hairs.....*Acomys dimidiatus*

2. Body covered with black spiny hair .....*Acomys russatus lewisi*
   Body covered with golden-yellow spiny hair.....*Acomys russatus russatus*

Acomys dimidiatus (Cretzschmar, 1826)
Common name: Eastern spiny mouse**.**
Diagnosis: Dorsum gray to light brown, ventral white with a very sharp line of demarcation. White patches present on the posterior side of the ear base (Fig. 25). Sharp spines mostly on the back, not reaching back of head. Ears without hair. Soles of hind feet yellow brown in color. Tail with large and easy visible scales. Three pairs of mammae. Skull with a broad braincase. Median keel on palate present. Crown area of first upper molar very large (Fig. 26).

Fig. 25. The eastern spiny mouse, *Acomys dimidiatus*, from Wādī Ramm (photo by Mohammad Abu Baker).

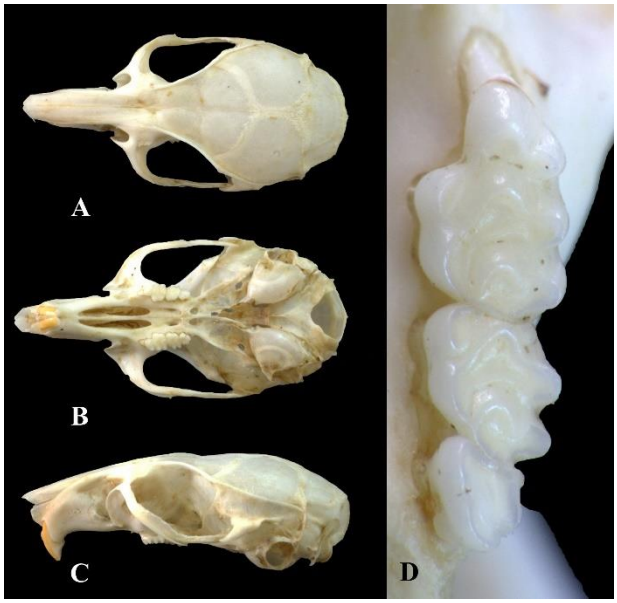

Fig. 26. A. Dorsal, **B**. Ventral, **C**. Lateral views of the skull, and **D.** Upper maxillary teeth for *Acomys dimidiatus*.

Localities: **Previous records.** ʻAqaba, Aṭ Ṭafīla, Petra, Wādī Al Karak (Allen, 1915); Moab and Ghawr es Safi (Aharoni, 1932); AUB collection: Wādī Zarqā Ma'in (Atallah, 1977); ʻAqaba, Gharandal, Ghawr as Safi (Amr & Disi, 1988); Wādī Zarqā, S Jarash (Bates & Harrison, 1989); Wādī Al Hidan, Wādī Zarqā Ma'in (Benda & Sádlová, 1999); 20 km N El Quweira, Wādī Ramm (Abu Baker & Amr, 2004); Ḍānā Biosphere Reserve (Yousef & Amr, 2005); Jarash, Petra, Wādī Mūsá, Wādī Ramm (Sözen *et al*., 2008). **Materials extracted from owl pellets.** Ex. *Bubo bubo*, Marj Al Hammam (Obuch per. com.); Ex. *Bubo bubo*, *Tyto alba* and *Strix butleri*, Ḍānā Biosphere Reserve (Obuch per. com.); Ex. *Strix aluco*, Iraq al Wahaj (Obuch per. com.); Ex. *Strix butleri*, Wādī Ibn Hammad (Obuch per. com.); Ex. *Strix butleri*, Ar Rājif, Wādī Suweid (Obuch per. com.); Ex. *Strix butleri*, Wādī Ramm (Obuch per. com.); Ex. *Strix butleri*, Petra (Obuch per. com.); Ex. *Tyto alba*, Wādī Zarqā Ma'in (Pokines per. com.). **New records.** Al Hemmah, Dhahel, Fifa, Ḥumrat Māʻīn, Jabal Masuda, Jarash, Malka, Qatar Nature Reserve, Raḥmah, Suwaymah, Wādī Al-Mujib, Wādī Tlah (Fig. 27).

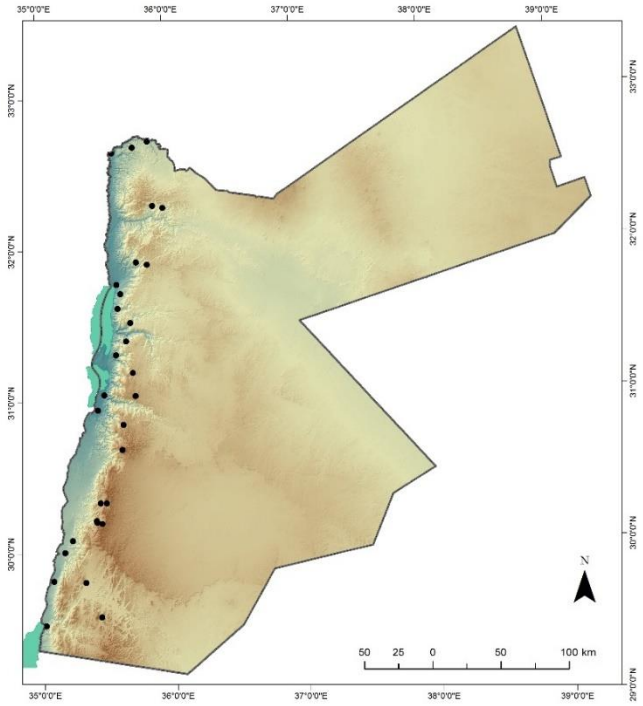

Fig. 27. Distribution of the eastern spiny mouse, *Acomys dimidiatus*.

Habitat: The eastern spiny mouse is a rock dwelling species inhabiting mesic and xeric biotopes. It is found across the entire mountain ranges extending from ʻAqaba to Al Hemmah in the extreme northern part of Jordan. It also invaded Mediterranean forest habitats in northern Jordan such Jarash and Malka forests with dense vegetation of pine and deciduous oak respectively. In southern Jordan, it is associated with dry mountains with minimal vegetation. It is found in rocky fringes in Wādī ʻAraba and along the Dead Sea eastern shores. In Wādī Ramm, Petra and Jabal Masuda, it is associated with sand stone rocky areas and in relatively high density. This species was never recorded in rocky areas in the eastern desert of Jordan.

A study of seasonal population fluctuations was conducted in the rocky slopes habitats of Wādī Fidān during 1987. Higher abundance of *Acomys dimidiatus* over its associated species, *Sekeetamys calarus* and *Gerbillus dasyurus* was observed, except in December and January, when *A. dimidiatus* population declined and *Gerbillus dasyurus* populations became co-dominant along with *A. dimidiatus* (Abu Dhayeh, 1988). In En Gedi, *A. dimidiatus* and *A. russatus* were found to co-occure. The activity pattern of these two species suggests a competitive exclusion of *A. russatus* (to daytime) by *A. dimidiatus* (Kronfeld *et al*., 1994).

Biology: In arid regions, the eastern spiny mouse feeds on land snails. The entrance of its burrow is usually piled with crushed land snails of several genera. Also, the entrance may be plugged by thorny plants, perhaps to prevent intruders (e.g. snakes) from entering. This was observed in dense populations of this species near the Suwaymah and around Zarqā Ma'in. This is social animal living in large colonies. Gestation lasts for 36-40 days, and the young (2 or 3, at most 5) are born mainly in the spring and summer months. It was found that the spiny mouse bred and produced young throughout the warm season of the year (late April to October). In early April, all the captured females were not pregnant, whereas by late April, 5 out of 7 captured females were pregnant. Neither pregnancies nor young were recorded during the period of December to March (Abu Dhayeh, 1988). In June, all the young captured were 25-40 days old (estimation of age was based upon the color and the size of the animal in comparison with the captive animals). In August, 5 young ranging between 40-60 days old were captured, while in October, 2 one month old specimens were captured from the study area. This may indicate that late pregnancies may take place in August.

Remarks: The distinction between *A. cahirinus* and *Acomys dimidiatus* is still debatable and not settled yet. Harrison & Bates (1991) considered *cahirinus* as a subspecies of *A. dimidiatus***.** Several authors doubted placing mice of the genus *Acomys* within family Muridae. Agulnik & Silver (1996) presented molecular evidences that *A. dimidiatus* is more closely related to the Mongolian Gerbil, *Meriones unguiculatus*, than it is to *Mus musculus*. Karyotype for this species in Jordan was found to be 2n: 38, NFa: 68 and NF: 70. The autosomes consist of 16 metacentric pairs and two pairs of acrocentric chromosomes (Qumsiyeh *et al*., 1986; Sözen *et al*., 2008).

***Acomys russatus russatus* (Wagner, 1840)**

Common name: golden spiny mouse

Diagnosis: Dorsal area covered with golden-orange spines. Spiny hair extends to the back of the head and the flanks (Fig. 28). Line of demarcation indistinct on flanks. White patch behind ear. Palms and soles naked. Ventral side of feet, palms and tail black, tail shorter than body length. Ears smaller than in *A. dimidiatus*. Skull with broad braincase. Median keel on palate absent.

Fig. 28. The golden spiny mouse, *Acomys russatus russatus*, from Wādī Ramm (photo by Mohammad Abu Baker).

Localities: **Previous records**. Ghawr es Safi (Atallah, 1978); near ʻAqaba (Aharoni, 1932). **New records**: Petra, Raḩmah, Reishah, Wādī Fidān, Wādī Ramm (Abu Baker & Amr, 2004), Wādī Zarqā Ma'in, Wādī Al-Mujib (Fig. 29).

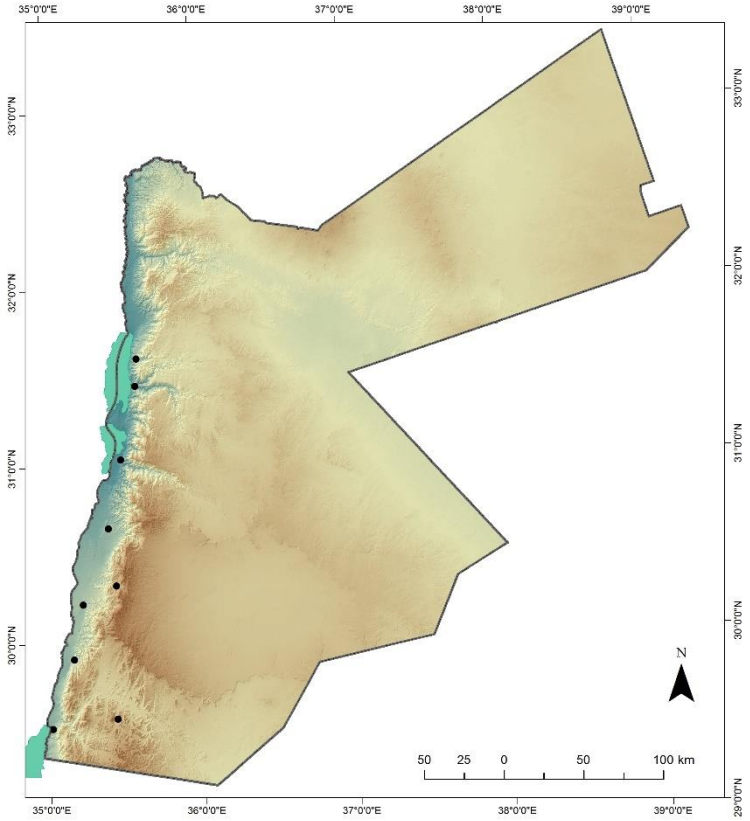

Fig. 29. Distribution of the golden spiny mouse, *Acomys russatus russatus*.

Habitat: This species inhabits the xeric, rocky areas along Wādī Al-Mujib, the mountains of Wādī ʻAraba and Wādī Ramm. The golden spiny mouse lives along with *A. dimidiatus*, as both species prefer rocky terrain (Atallah, 1978). It feeds on several halophytic plants such as *Anabasis articulata*, *Atriplex halimus* and *Hammada scorpia* (Shkolink & Borut, 1969).
Biology: The golden spiny mouse is nocturnal in areas where *A. dimidiatus* is absent, while it is active in the morning hours and late afternoon in habitats shared with *A. dimidiatus* (Shkolink, 1966). One specimen was kept in capativity and lived for about 8 years.
Remarks: Bates (1994) considered the species *A. lewisi* as a synonym for *A. russatus. A. lewisi* is darker in color and apparently is confined to the black lava deserts of eastern Jordan (Atallah, 1978; Searight, 1987). The karyotype for specimens collected from Wādī Ramm yielded a diploid chromosome number of 66 and a fundamental number of 92. The autosomal set consists of 12 biarmed pairs (subtelocentric) and 20 pairs of acrocentric chromosomes. The X chromosome is subtelocentric, and the Y chromosome is acrocentric (Sözen *et al*., 2008).

Acomys russatus lewisi Atallah, 1967
Common name: Melanistic or Lewis' spiny mouse.
Diagnosis: This is a melanistic form of *A. r. russtaus*, similar is size and form, but covered with black spines on the back and dark gray fur on the ventral side (Fig. 30). Skul morphology is shown in Fig. 31.

Fig. 30. Lewis spiny mouse, *Acomys russatus lewisi*, from Azraq.

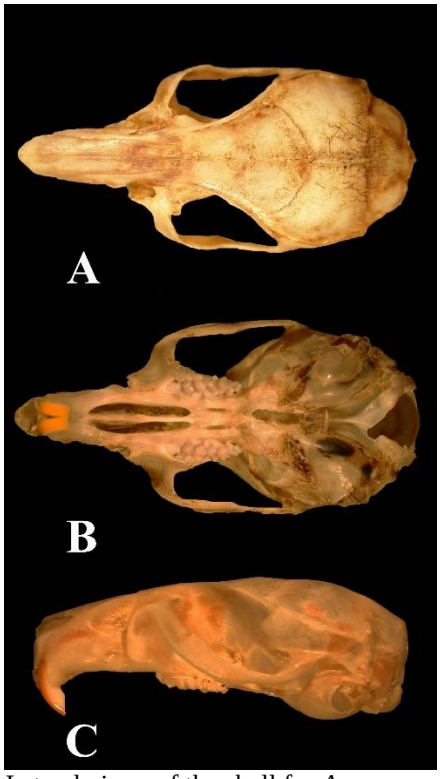

Fig. 31. A. Dorsal, **B**. Ventral, and **C**. Lateral views of the skull for *Acomys russatus lewisi.*

Localities: **Previous records**. Azraq (Atallah, 1967a); Wādī Rajil near Jāwá (Searight, 1987); Buqay'awiyah, Wādī Salma (Abu Baker & Amr, 2003a). **New records**. Ernbeh, Marab Omish (Fig. 32).

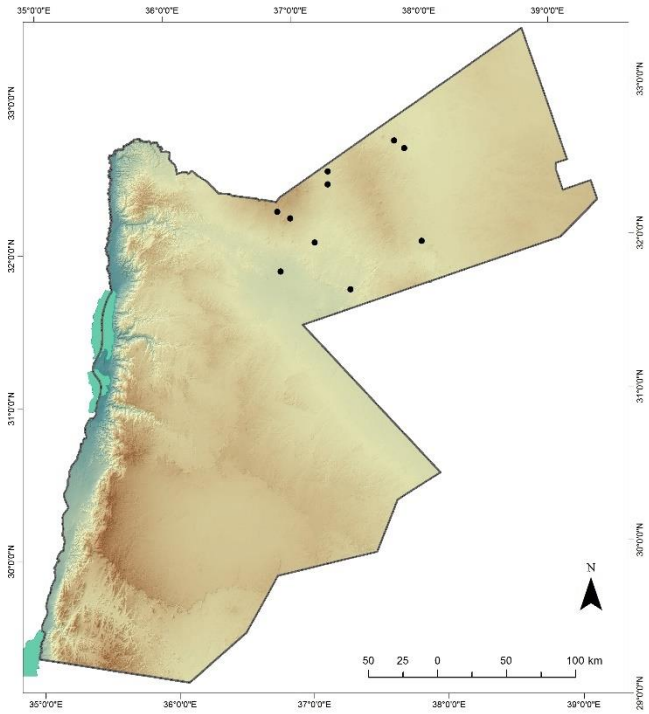

Fig. 32. Distribution of Lewis spiny mouse, *Acomys russatus lewisi*.

Habitat: This subspecies is confined to the black lava desert of eastern Jordan. It occupies rocky areas around Azraq and extends throughout the black lava desert into Syria and northern Saudi Arabia.

Biology: Individuals of this species were successfully kept in captivity; they were fed sunflower seeds and supplied with water. The activity peak in the laboratory was seen in the early morning hours of the day. The ability of interbreeding between the two forms of this species (*A. r. russatus* and *A. r. lewisi*), was tested in the laboratory with an adult *A. r. russatus* male from Wādī Ramm and an adult *A. r. lewisi* female from Azraq ed Duruz. No signs of any aggressive behavior were seen during the time of the experiment. The animals were kept together for several months, however, they failed to reproduce, while controlled groups of *A. r. lewisi* gave birth to 3–5 young (Abu Baker & Amr, 2003b).

Remarks: Bates (1994) considered the species *A. lewisi* as a synonym for *A. russatus. A. lewisi* is darker in color and apparently is confined to the black lava deserts of Azraq and Jāwá (Atallah, 1967a; Searight, 1987). The karyotype for specimens collected from Jordan yielded a diploid chromosome number of 66 and a fundamental number was 76-92. The autosomal set consists of 12 biarmed pairs (subtelocentric) and 20 pairs of acrocentric chromosomes. The X chromosome is subtelocentric, and the Y chromosome is acrocentric (Qumsiyeh *et al*., 1986; Sözen *et al*., 2008).

Subfamily Gerbillinae

This subfamily includes species of the genera *Gerbillus*, *Meriones*, *Psammomys*, and *Sekeetamys*. This subfamily constitutes the largest group of rodents occurring in Jordan with a total of 11 species. It includes small to medium-sized rodents adapted for arid and steppe areas. Teeth and soles morphology varies greatly (Fig. 33) according to food resources and habitat (Wilson & Reeder, 2005).

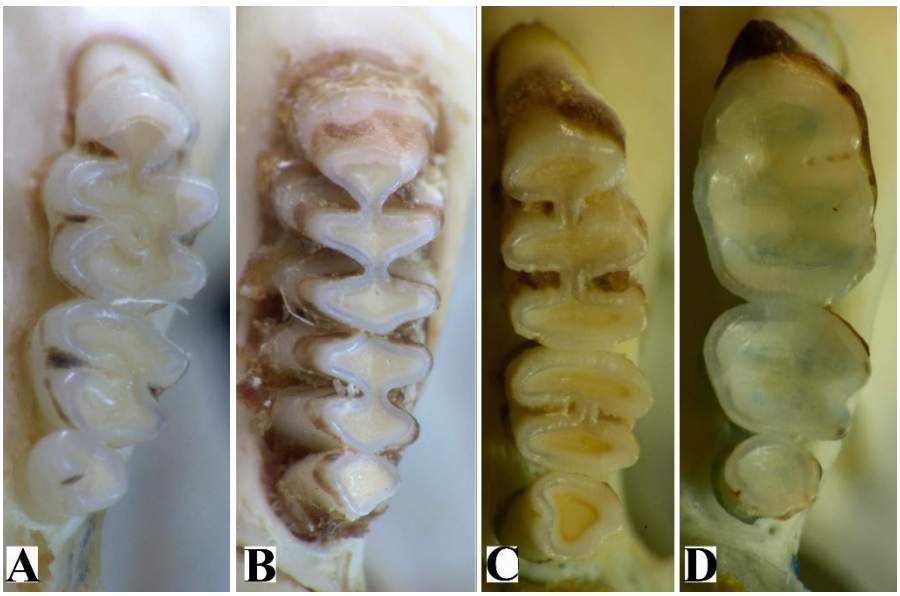

Fig. 33. Shape of upper maxillary teeth for genera of Subfamily Gerbillinae. **A**. *Gerbillus.* **B**. *Meriones*. **C**. *Psammomys*. **D**. *Sekeetamys*.

Key to species of the subfamily Gerbillinae

1. Upper incisors with longitudinal groove (Fig. 34A) 2
   Upper incisors without longitudinal groove (Fig. 34B) .....*Psammomys obesus*

2. Tail with a distinctive tuft extending about 1/2 to 2/3 of the tail .....*Sekeetamys calurus*
   Tail without a distinctive tuft extending about 1/2 to 2/3 of the tail 3

3. Large form, with skull length exceeding 30 mm 9
   Small form, with skull length not exceeding 30 mm 4

4. Soles of fore and hind feet predominantly naked.....5
   Soles of fore and hind feet predominantly hairy.....7

5. Smaller species, HB less than 68 mm, greatest length of skull does not exceed 22.5 mm .....
   .....*Gerbillus henleyi*
   Larger species, HB greater than 73 mm, greatest length of skull exceeds 26 mm.....6

6. Hair bases on the tail Rammp gray, smaller tympanic bulla, posterior margin of mastoid chamber never extends to the level of supraoccipital bone .....*G. dasyurus*
   Hair bases on the tail Rammp white, well developed tympanic bulla, posterior margin of mastoid chamber exceeds the level of the supraoccipital bone .....*G. nanus*

7. Coloration of the back is bright orange sandy buff, well developed tympanic bulla, posterior margin of mastoid chamber extends beyond the level of the supraoccipital bone .....*G. cheesmani*
   Dorsal coloration is bright yellowish sandy buff, tympanic bulla not well developed, posterior margin of mastoid chamber never exceeds supraoccipital bone.....8

8. Ears pigmented, Posterior end of the nasal bone truncate, anterior palatal foramin long while posterior foramina relatively short .....*G. andersoni*
   Ears not pigmented, Posterior end of the nasal bone rounded, anterior palatal foramin short while the posterior foramina relatively long.....*G. gerbillus*

9. Claws black.....*Meriones libycus*
   Claws not black.....2

10. Ears not pigmented .....*Meriones crassus*
    Ears pigmented .....*Meriones tristrami*

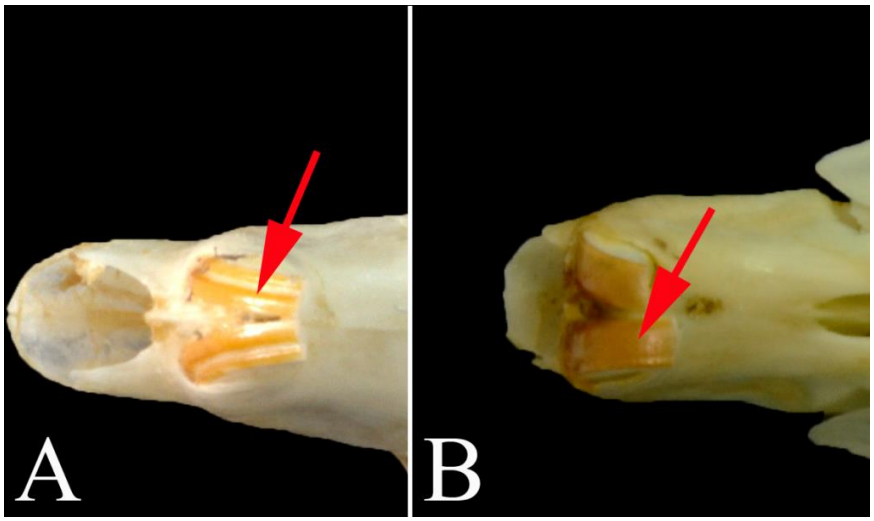

Fig. 34. A. Upper incisors with a longitudinal groove. **B.** Upper incisors without a longitudinal groove.

Subfamily Gerbillinae

***Gerbillus andersoni* de Winton, 1902**
Common nmae: Anderson's gerbil**.**

Diagnosis: This is a medium sized gerbil closely resembling other hairy-footed gerbils. Hair on the back is yellowish with gray buff, darker than *G. gerbillus*. Tail is densely covered with hair throughout, terminating in a small tuft, terminal pencil intermediate in size between the well-developed of *G. gerbillus* and the scanty tuft in *G. cheesmani*. Under parts are pure white with a distinct line of demarcation (Fig. 35). The dark pigmentation of its ears distinguishes this species from the other hairy-footed gerbil found in Jordan. Head and body length measures between 88–90 mm and tail length between 126–128 mm. It is slightly larger than *G. gerbillus*. White spots are found above eyes and behind ears. Skull of *G. andersoni* is slightly larger than that of *G. gerbillus*. Greatest length of the skull may reach up to 29.0 mm. Tympanic bulla not developed. Posterior margin of the nasal bone is truncate. Incisive foramina long, exceeding tooth row length, while posterior foramina relatively short. Posterior margin of mastoid chamber extends to level of occipital condyle but never exceeds supraoccipital bone. Posterior superior margin of mastoid chamber more inflated than inferior margin (Fig. 36).

Fig. 35. Anderson's gerbil, *Gerbillus andersoni* (photo by Mohammad Abu Baker).

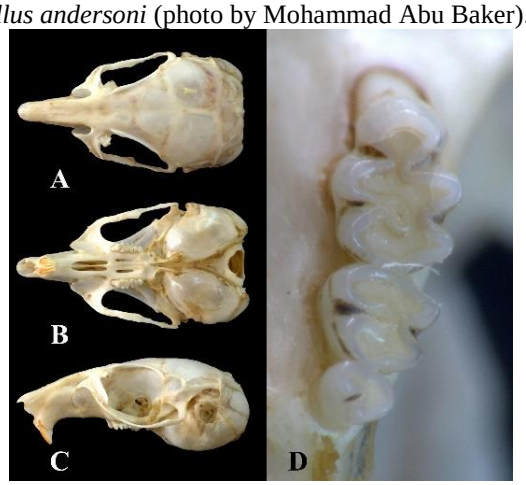

Fig. 36. A. Dorsal, **B**. Ventral, **C**. Lateral views of the skull, and **D.** Upper maxillary teeth for *Gerbillus andersoni*.

Localities: Previous records. *G. gerbillus* = El Quweira (Allen, 1915); 22 km N El Quweira, 5 Km S Ra's an Naqb (Atallah & Harrison, 1967); S Ra's an Naqb (Abu Baker & Amr, 2004) (Fig. 37).

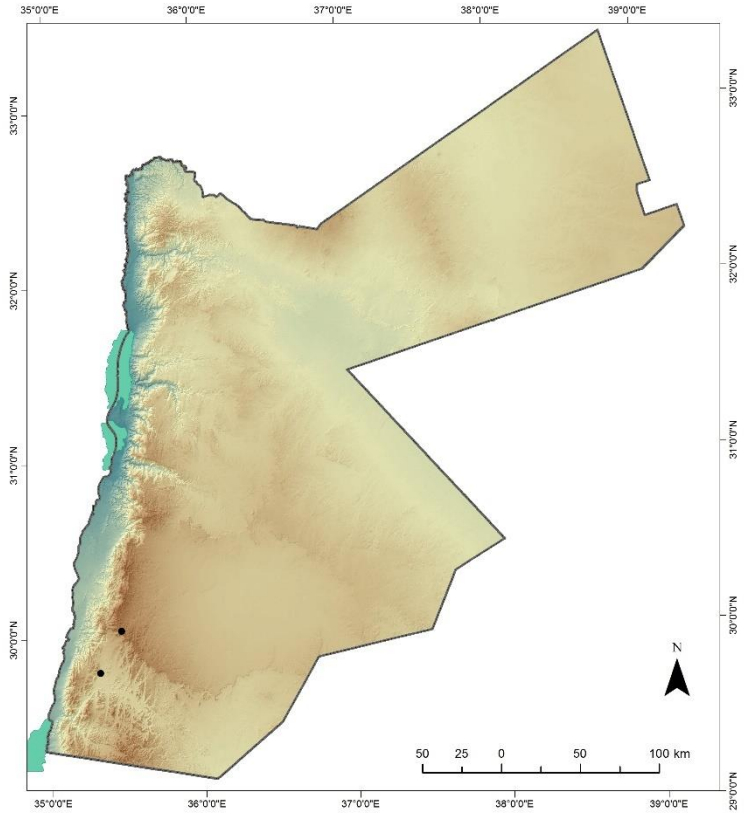

Fig. 37. Distribution of Anderson's gerbil, *Gerbillus andersoni*.

Habitat: *G. andersoni* is found in areas of light sand dunes dominated with *Anabasis articulata*. It lives in association with the hairy-footed gerbil, *G. cheesmani* and the fat sand rat, *Psammomys obesus*. Burrows of *G. andersoni* could not be distinguished from those of *G. cheesmani*. Anderson's gerbil is a strictly nocturnal species (Abu Baker & Amr, 2003a).
Biology: Anderson's gerbil is a nocturnal animal, specialized on seeds (i.e. *Thymelea hirsute*). It breeds in late winter or early spring, coinciding with the annual seed shedding. Female gives birth to a litter of three to seven offspring after a gestation period that lasts for 20 to 22 days.
Remarks: The distribution of this species is known only from the sand desert south of Ra's an Naqb. Its presense in Jordan may represent a relict population. *G. andersoni* have 2N=40 and FN = 80 (male specimen). There are 14 metacentric and 24 submetacentric autosomes. The X and Y chromosomes are medium and small-sized submetacentric, respectively (Abu Baker *et al*., 2009).

***Gerbillus cheesmani* Thomas, 1919**
Common name: Cheesman's gerbil**.**
Diagnosis: Typical small to medium-sized sand gerbil, Fur is very soft, color sandy buff dorsally, without black speckling on Rammp, ventral site white with a distinct line of demarcation. White patches above eye and behind ear present (Fig. 38). Soles of hindfoot hairy. Tail very long, more than head body length. Terminal pencil scanty. Hair bases above base of tail white. Skull with large tympanic bullae extending beyond the supraoccipital. Dentition similar to *G. andersoni* (Fig. 39).

Fig. 38. Cheesman's Gerbil, *Gerbillus cheesmani* (photo by Mohammad Abu Baker).

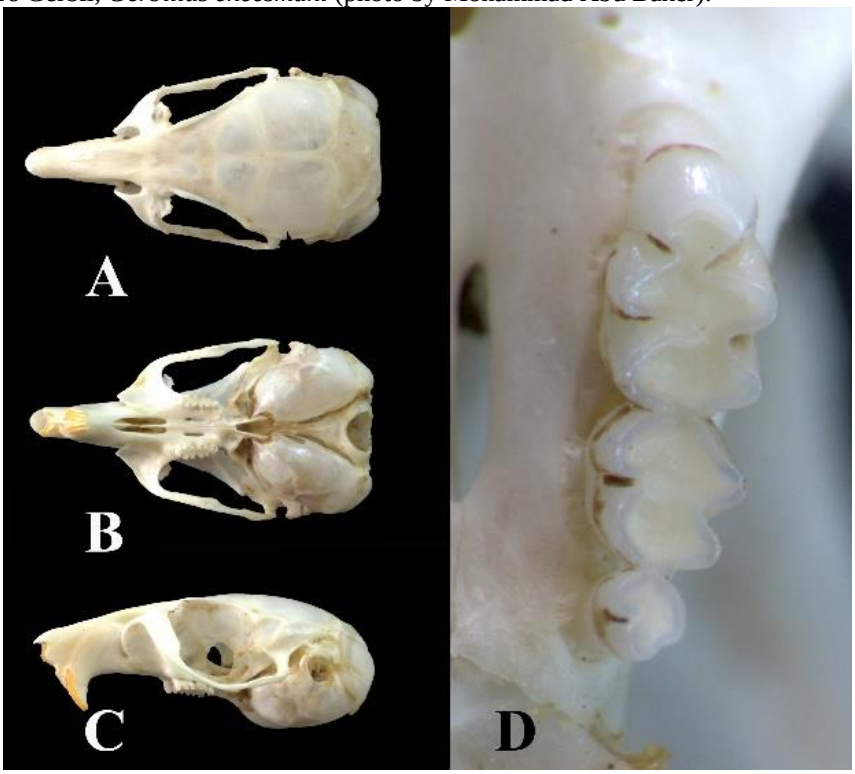

Fig. 39. A. Dorsal, **B**. Ventral, **C**. Lateral views of the skull, and **D.** Upper maxillary teeth for *Gerbillus cheesmani*.

Localities: **Previous records.** Al Ghamr, Al Jafr, El Quweira, Al Wisad, Al Qaţţāfī, Ad Dumaythat south of ar Ruwayshid (Abu Baker & Amr, 2003a & b); Ad Dīsah, Ra’s an Naqb, Al Mudawwarah, Wādī Ramm (Abu Baker & Amr, 2004), (Fig. 40).

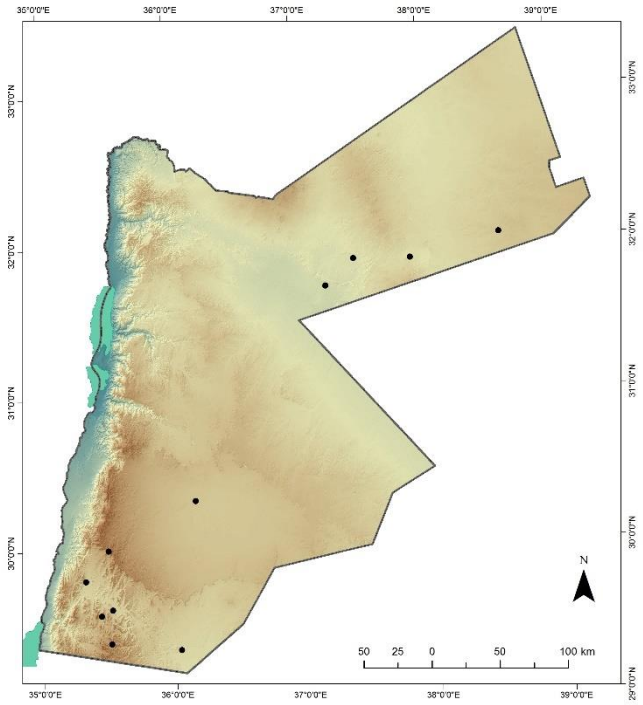

Fig. 40. Distribution of Cheesman's gerbil, *Gerbillus cheesmani*.

Habitat: The distribution of this gerbil is confined to soft wind-blown sand dunes areas. Cheesman's gerbil was found to be the most solitary of the recorded rodents as no other species was collected in the same areas where it lives except for Al Ghamr where one *G. nanus* and one *M. libycus* were collected. Cheesman's gerbil is a strictly nocturnal species, this activity pattern was also observed among captive animals. This gerbil occurs among *Haloxylon persicum*, *Hammada salicornica* and *Anabasis articulata* shrubs. Although specimens were trapped in higher numbers among *H. salicornica* and *A. articulata* communities, it was found to be the only rodent inhabiting *Haloxylon persicum* vegetation. It was caught in high numbers in flat sandy sheets south of Ruwaishid with *Seidlittzia rosmarinus* as the dominant vegetation, where as in Al Wisad, the red sand dunes are dominated with *H. salicornica* (Abu Baker & Amr, 2003b).

Burrow system of this species was described by Abu Baker & Amr (2003b). The number of openings ranges between three to five with only two main entrances showing signs of frequent use. Burrow entrances were found clumped near and around margins of shrubs where the soil is moderately hard. All burrow openings including the main entrance were always found plugged with fresh sand. Diameter of the openings ranged from 3 to 6 cm, while the tunnel width was about 4 cm. Tunnel length ranged from 20 to 118 cm and the maximum depth from the surface was about 82 cm. One to three food chambers containing *H. salicornica* seeds were found towards the end of tunnels as well as chambers containing faecal material. One to two nest chambers were found in the burrows, nests were located at tunnel ends at the depth of 25–45 cm. Dry vegetation was found as a nesting material.

Biology: Pregnant females were collected in March, August and September from Al Wisad. Within one burrow system, three and four suckling in two nesting chambers were observed during August. Juveniles were caught in August from Al Wisad and Al Dumaythat. The horned sand viper, *Cerastes gasperettii* and the desert monitor, *Varanus griseus* are likely the main predators of Cheesman's gerbil (Abu Baker & Amr, 2003b).

Remarks: *G. cheesmani* shows a 2N=38 and FN=72 (female specimen). The karyotype includes 16 metacentric, 16 submetacentric and 4 telocentric autosomes. The X is a medium-sized metacentric chromosome (Abu Baker *et al*., 2009).

***Gerbillus dasyurus* (Wagner 1842)**
Common name: Wagner's gerbil**.**
Diagnosis: Dorsum brown gray, underside white with a distinct line of demarcation. Distinct white patches behind ears and above eye present (Fig. 41). Soles of hind feet devoid of hair. Bases of hair, above tail, grayish. Tail long, covered with hair and terminating with a pencil. Four pairs of mammae. Skull of this species is very similar in size to that of *G. nanus*, however, clearly distinguished by its smaller tympanic bulla (GSL between 26.4–30.1, TBL 8.1–10.4, TBW 4–5.2mm). Posterior margin of mastoid chamber never extends to the level of supraoccipital bone. Posterior mastoid chamber small. Zygomatic arches slender and delicate. Posterior occipital bone slightly constricted. Inferior posterior mastoid chamber extends down to the paraoccipital process (Fig. 42).

Fig. 41. Wagner's gerbil, *gerbillus dasyurus* (photo by Mohammad Abu Baker).

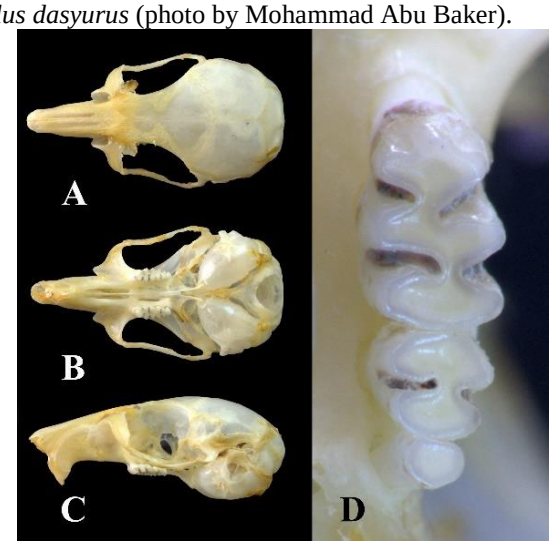

Fig. 42. A. Dorsal, **B**. Ventral, **C**. Lateral views of the skull, and **D.** Upper maxillary teeth for *Gerbillus dasyurus*.

Localities: **Previous records.** Mountains of Moab (Nehring, 1902); ‘Ain Musa, Bir ed-Doleh, Petra, Wādī Al Ḥasā (Allen, 1915); Al Jafr, N ‘Aqaba, Azraq, Jarash, Petra, Ra’s an Naqb, Wādī Mūsá, (Atallah, 1978); Al Muwaqqar (Amr & Saliba, 1985); Ash Shawmarī, ‘Aqaba, S Azraq, Ghawr Nimrin (Qumsiyeh *et al*., 1986); Wādī Rajil (Searight, 1987); Ash Shawmarī, ‘Aqaba, King Husayn Bridge, Prince Mohammed Bridge (Amr & Disi, 1988); Burqu' (Harrison & Bates, 1991); Al Lajjun, Al Wisad, Azraq ed Duruz, Buqay’awiyah, Burqu', Jāwá, ar Ruwayshid, Wādī Salma (Abu Baker & Amr, 2003a &b); El Quweira, Ad Dīsah, Al Mudawwarah (Abu Baker & Amr, 2004); Ḍānā Biosphere Reserve (Yousef & Amr, 2005); Ash Shawmarī Wildlife Reserve (Abu Baker *et al*., 2005). **Materials recovered from owl pellets.** Ex. *Athene noctua,* Wādī Al Hashad (Al-Melhim *et al*., 1997); Ex. *Bubo bubo ascalaphus,* Faydat ad Dahik (Rifai *et al*., 2000); Ex. *Tyto alba*, Ash Shawmarī Wildlife Reserve (Abu Baker & Amr, 2003a); Ex. *Athene noctua,* Mukwer (Obuch per. com.); Ex. *Athene noctua*, Qaşr Al Kharanah (Obuch per. com.); Ex. *Athene noctua*, Qaşr al Ḥallābāt (Obuch per. com.); Ex. *Athene noctua,* Ḍānā Biosphere Reserve (Obuch per. com.); Ex. *Bubo bubo,* Marj el Hamam (Obuch per. com.); Ex. *Bubo bubo* and *Tyto alba,* Ash Shawmarī (Obuch per. com.); Ex. *Tyto alba,* Ḍānā Biosphere Reserve (Obuch per. com.); Ex. *Tyto alba*, Wādī Al Barra (Obuch per. com.); Ex. *Strix aluco,* Iraq al Wahaj (Obuch per. com.); Ex. *Strix butleri*, Petra, Wādī am Numayr (Obuch per. com.); Ex. *Strix butleri*, Petra, Wādī am Numayr (Obuch per. com.); Ex. *Strix butleri*, Petra, Wādī Khariobsa (Obuch per. com.); Ex. *Strix butleri*, Wādī Ramm (Obuch per. com.); Ex. *Strix butleri*, Wādī Ibn Hammad (Obuch per. com.); Ex. *Strix butleri*, Ar Rājif, Wādī Suweid (Obuch per. com.); Ex. *Strix butleri*, Ḍānā (Obuch per. com.). **New records.** Ernbeh, Fifa, Jabal Masuda PA, Ma'an, Marab Omish, Qatar PA, Raḥmah, Wādī Al-Mujib (Fig. 43)

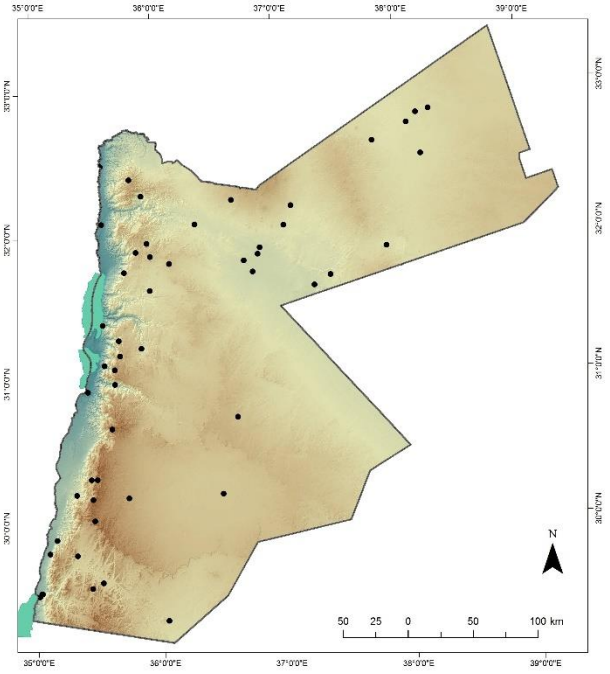

Fig. 43. Distribution of Wagner's gerbil, *Gerbillus dasyurus*.

Habitat: Wagner's gerbil inhabits a wide range of habitats including basalt deserts, sand stone mountains, hammada deserts, and temperate areas within the Mediterranean mountains. This gerbil is a very common species in the Jordanian Desert. It was also collected from several localities along the western mountains. It was found to share burrows with *P. obesus* (Atallah, 1967b; Amr & Saliba, 1986). Hatough-Bouran (1990) studied the burrowing habits of Wagner's gerbil in the Ash Shawmarī Wildlife Reserve near Azraq. The burrows were simple but deep, burrows had 1-2 unplugged emergency exists. Stored plant found includes *Anabasis articulata*, *Atriplex halimus* and *Artemisia sieberi* (Abu Baker & Amr, 2003b). This species is also found along run-off Wādīs. Recent studies in the eastern desert conducted during 2010 indicated the preference of this species to Wādī beds with hard soil. Furthermore, In the Negev, Shenbrot *et al.* (1997) reported that Wagner's Gerbil inhabits six different types of habitats including sand dunes, dry Wādī beds, flat gravel plains, limestone cliffs and rocks and narrow Wādīs and hills.

Biology: Reproduction occurs almost all year-round and pauses in December. Gestation lasts for 18-22 days with a litter size of 3-7 new borne (Shenbort *et al*., 1997). In Turkey, it prefers rocky areas with sparse vegetated soil (Çolak *et al*., 1999). They determined that the reproductive period extends over January to September, with litter size ranging between 3 to 9 (average 5.66).

Remarks: *G. dasyurus* exhibits a 2N=60 and FN=71 (male specimen). The karyotype consists of 4 metacentric, 6 submetacentric and 48 acrocentric autosomes. The X and Y are large metacentric and small telocentric chromosomes, respectively (Abu Baker *et al*., 2009). Qumsiyeh *et al*. (1986) obtained 2n=60 with FN=66, 68, and 70 for specimens collected from various localities from Jordan. Previous placement of *dasyurus* under the genus *Dipodillus* was under scrutiny. However, Abiadh *et al*. (2010) rejected the genus rank for the taxon *Dipodillus* based on molecular phylogeny analysis and that *dasyurus* should be assigned as *G. dasyurus*.

Gerbillus gerbillus (Olivier, 1801)
Common name: The lesser Egyptian gerbil**.**
Diagnosis: Medium-sized gerbil. Ears small, sandy buff in color and pigmented. Fur color pale sandy buff dorsally, white ventrally, with distinct line of demarcation (Fig. 44). White patch behind ear and above eye and Rammp distinct. Feet with fringes of hair. Soles not pigmented. Tail covered with short hair, moderate terminal pencil present. Skull with flat and broad braincase. Posterior margin of nasals rounded. Upper incisor very narrow. First lower molar with distinct cusps (Fig. 45).

Fig. 44. The lesser Egyptian gerbil, *Gerbillus gerbillus* (photo by Mohammad Abu Baker).

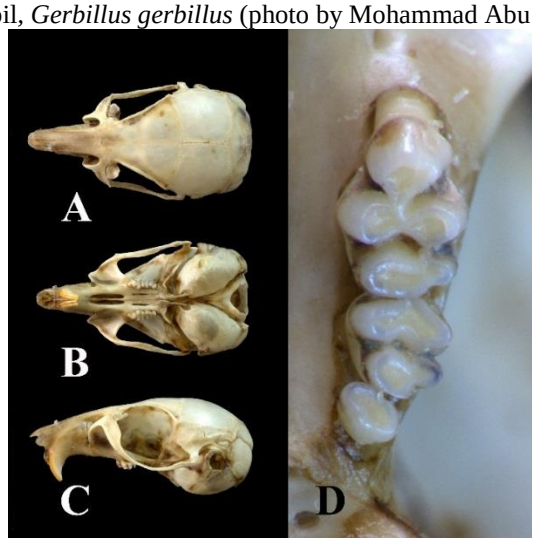

Fig. 45. A. Dorsal, **B**. Ventral, **C**. Lateral views for the skull, and **D.** Upper maxillary teeth for *Gerbillus gerbillus*.

Localities: Previous records. ʻAqaba (Allen, 1915); Quraiqira, Ar Rīshah, Gharandal, Raḥmah (Abu Baker & Amr, 2003b) (Fig. 46).

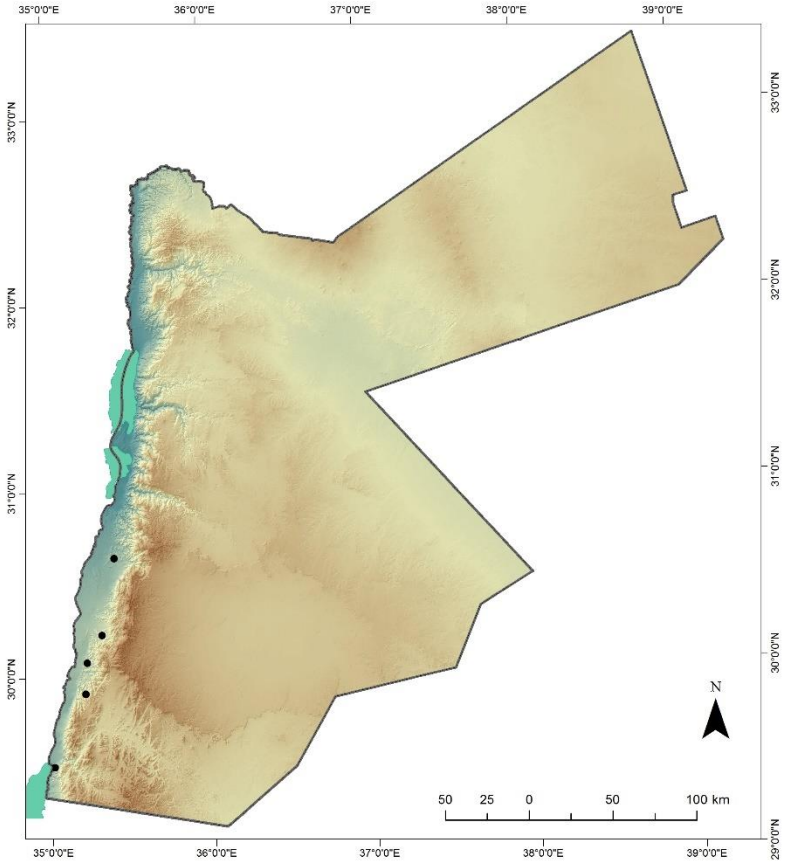

Fig. 46. Distribution of the lesser Egyptian gerbil, *Gerbillus gerbillus*.

Habitat: It strictly inhabits areas and patches of soft, wind-blown sand dunes dominated with *Haloxylon persicum* (Abu Baker & Amr, 2003a). This species was reported from dunes and alluvium in Wādīs in Sinai Peninsula (Haim & Tchernov, 1974) and sandy patches in palm groves and cultivated areas in the Nile Valley and Delta in Egypt (Osborn & Helmy, 1980). It was found in association with the Naked-footed gerbil, *G. nanus* around lower Wādīs and salt marshes with *Nitraria retusa* in Raḥmah area. Sinai *et al*. (2003) studied the ecology and behaviour of this gerbil in "sand islands" and in the mainland. They found that the home range in the mainland for males was significantly larger than that for females, but the other way around in "sand islands". No obvious sexual dimorphism in body mass was observed among the "island" population; however, "mainland" males were heavier than females.

Biology: The lesser Egyptian gerbil is a nocturnal species. Burrows are usually 30 to 60 centimetres in depth. This gerbil is a social animal, living in groups sharing the same burrow. Breeding season is between January and May. Gestation period lasts for 22 days, with the average litter containing between 3 and 6 young.

Remarks: *G. gerbillus* have a 2N=42 in females/43 in males and FN=70 (female specimen). The autosomal complement of the female includes 18 metacentric, 10 submetacentric, 6 acrocentric and 6 telocentric chromosomes. The X is a large acrocentric chromosome (Abu Baker *et al*., 2009).

***Gerbillus henleyi* (De Winton, 1903)**
Common name: Pygmy gerbil**.**
Diagnosis: Very small (hence pygmy) gerbil with small ears. White patches above eye and behind ear. Dorsal color buff brown, under parts are white, with a distinct line of demarcation (Fig. 47). Soles of hind feet naked. Skull small and delicate, with strongly inflated bullae. Braincase very broad, with short rostRamm. Teeth very small and delicate (Fig. 48).
Dental formula: i 1/1 c 0/0 pm 0/0 m 3/3 = 16.

Fig. 47. The pygmy gerbil, *Gerbillus henleyi* (photo by Mohammad Abu Baker)**.**

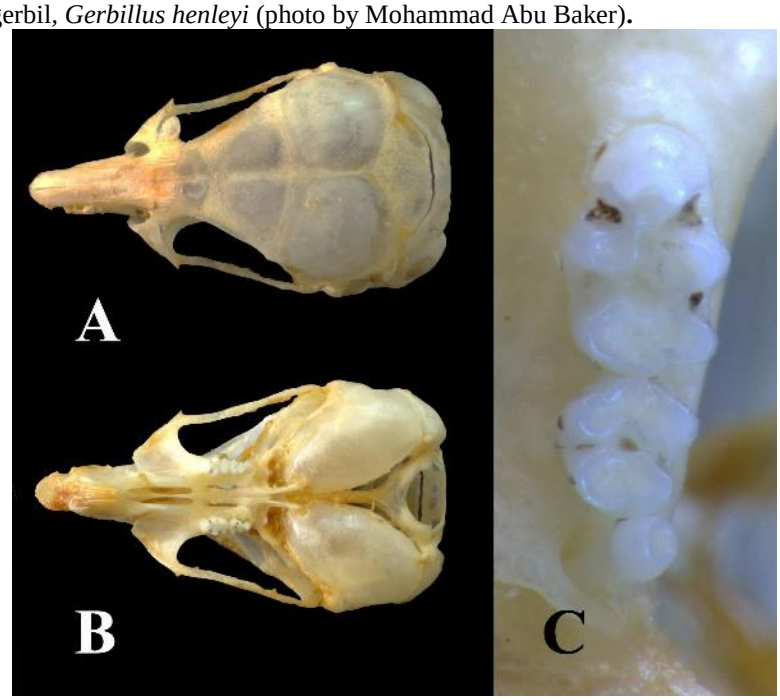

Fig. 48. A. Dorsal, **B**. Ventral views for the skull, and **C.** Upper maxillary teeth for *Gerbillus henleyi*.

Localities: Previous records. Al Jafr, Faidat Al Dhahik (Atallah & Harrison, 1967); Al Hazīm, Al Jafr, Faydat ad Dahik, Ash Shawmarī (Abu Baker & Amr, 2003 a & b); Al Mudawwarah (Abu Baker & Amr, 2004); Ash Shawmarī Wildlife Reserve (Abu Baker *et al*., 2005). **Materials from owl pellets.** Burqu' (Obuch, per. com.); Ash Shawmarī (Obuch, per. com.) (Fig. 49).

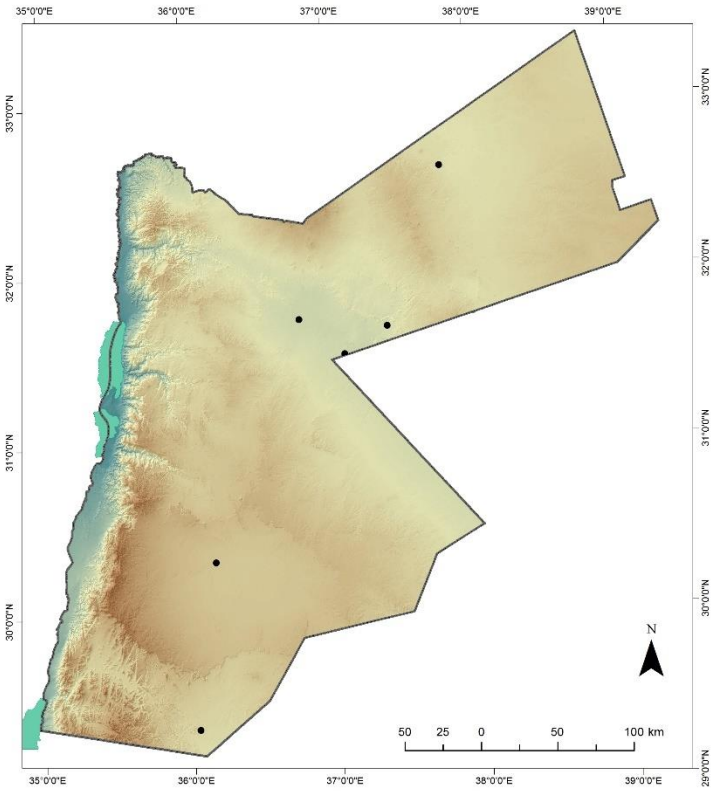

Fig. 49. Distribution of the pygmy gerbil, *Gerbillus henleyi*.

Habitat: Collected from Al Jafr area around cultivated fields (Atallah, 1978). This species prefers stony, gravelly falt deserts with ample vegetation. Its burrow is characterized by its small diameter (1-2 cm).

Biology: A female was found to have six embryos (Atallah, 1967b). In the Negev, two distinct breeding periods were observed, one in the spring and the second in late summer. In comparison with other species of the genus *Gerbillus*, *G. henleyi* is more a seed eater, more mobile with a less stable home range than *G. dasyurus*. This suggests that *G. henleyi* is more adapted to xeric habitats than other gerbils (Shenbrot *et al.*, 1994). The pygmy gerbil is the smallest rodent known to inhabit the Jordanian deserts. It was collected from the Hammada areas with scarce vegetation cover. *G. henleyi* is mostly associated with the Sand Jird, *Meriones crassus* and the Three-toed Jerboa, *Jaculus jaculus* (Abu Baker & Amr, 2003a). It was collected from Al Jafr and Al Mudawwarah area in southern Jordan and was also associated with the Sand Jird (Abu Baker & Amr, 2004).

Remarks: In coloration and skull proportions, this species is identical to *G. h. mariae* from Syria (Abu Baker & Amr, 2003a). It differs from *G. h. jordani* from Tunisia by being more grayish and having the gray hair bases longer. This conclusion is also shared by Harrison & Bates (1991). *G. henleyi* shows a 2N=52 and FN=62. The karyotype includes 8 submetacentric and 42 acrocentric autosomes. The X and Y are large and medium sized submetacentric chromosomes, respectively (Abu Baker *et al*., 2009).

***Gerbillus* (*Hendecapleura*) *nanus* (Thomas, 1918)**

Common name: Baluchistan gerbil**.**

Diagnosis: This is a small-sized gerbil with soles of feet predominantly naked except for some hair on the metatarsals. Back color is sandy buff slightly grayish (Fig. 50). Tail is distinctly discolored, lacking a well-developed terminal tuft (less developed than in *G. dasyurus*). A white

Rammp differentiates this gerbil from its closest relative, *G. dasyurus*. Belly white with a distinct line of demarcation. The skull is distinguished in that the zygomatic arches touch the auditory meatus and with well inflated bullae (Fig. 51). Another distinguishing character is that the base of hairs above the tail are white. Dentition indistinguishable from *G. henleyii*, except it is larger (Abu Baker & Amr, 2003a).

Fig. 50. Baluchistan gerbil**,** *Gerbillus nanus* (photo by Mohammad Abu Baker).

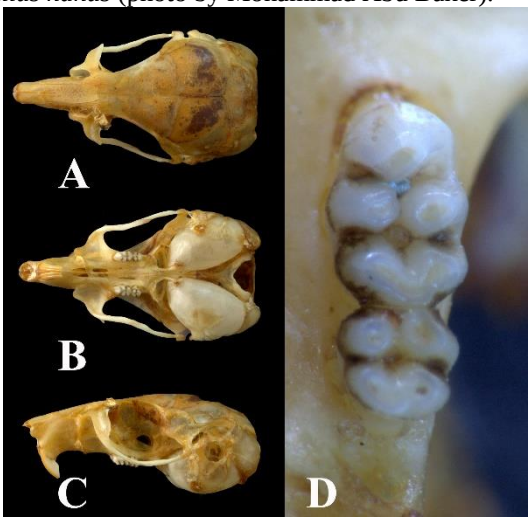

Fig. 51. A. Dorsal, **B**. Ventral, **C.** Lateral views for the skull, and **D**. Upper maxillary teeth for *Gerbillus nanus*.

Localities: **Previous records.** *G. quadrimaculatus*=‘Aqaba (Allen, 1915);14 km S ‘Aqaba (Kock & Nader, 1983); ‘Ain Al Atmash, Azraq, Wādī al Khanzair (Qumsiyeh *et al*, 1986); ‘Aqaba, Wādī Khanzira (Amr & Disi, 1988); Wādī ‘Araba, Wādī Ramm (Benda & Sádlová (1999); Al Hazīm, Al Ghamr, Ash Shawmarī, Azraq, Faydat Ad Dahik, Wādī ‘Araba (Abu Baker & Amr, 2003a & b); Wādī Ramm, Ad Dīsah, Al Mudawwarah, Ra’s an Naqb (Abu Baker & Amr, 2004); Ash Shawmarī Wildlife Reserve (Abu Baker *et al*., 2005). **Materials from owl pellets.** Azraq Nature Reserve (Shehab & Ciach, 2008). **New records.** Azraq Wetland Reserve, Qatar Protected Area, Raḥmah (Fig. 52).

Fig. 52. Distribution of the Baluchistan gerbil**,** *Gerbillus nanus*.

Habitat: The Baluchistan gerbil was collected from low sandy Wādīs with considerable salty nature and characterized by rich plant cover of *Nitraria retusa* or *Tamarix* sp. in Hazīm and Azraq. It was found coexisting with either one of the large-sized jirds, *M. Crassus* or *M. libycus*. This gerbil along with *G. cheesmani*, inhabits the sand dunes of Wādī Ramm mostly around the mud flats, and the salty terrains (Sabkhah) areas in Wādī ‘Araba (Abu Baker & Amr, 2003a;b). Openings of borrows for both *G. nanus* and *M. crassus* were seen under bushes of *N. retusa* in

Hazīm. Furthermore, Abu Dieyeh (1988) found that burrows of this gerbil were constructed in both hard and loose soil in Wādī ʻAraba. Activity is at its maximum two hours after dusk (Lewis *et al*, 1965).

Biology: Little is known on the biology of the Baluchistan gerbil in Jordan. Litter size ranges from 2-5.

Remarks: The distribution of *G. n. arabium* is restricted to southern Jordan. Many reports indicated the presence of this species in Wādī ʻArabah and ʻAqabah. *G. nanus* possesses a 2N=52 and FN=62 (Female specimen). The karyotype consists of 8 submetacentric and 42 acrocentric autosomes. The X is a large submetacentric chromosome (Abu Baker *et al*., 2009). On the other hand, Qumsiyeh et al. (1986) reported on specimens with 2n=52 and FN=60 collected from Wādī ʻArabah ʻAqabah, and Azraq.

Meriones (***Pallasiomys***) ***crassus*** **Sundevall, 1842**

Common name: Sundevall's jird, Sand jird, Silk jird, Gentle jird.

Diagnosis: Large jird with soft, dense fur. Fur color pale sandy dorsally, underside pure white, line of demarcation not very distinct. Ears small and not pigmented, claws white or pale (Fig. 53). Hind feet covered with white hair. Tail terminates with a black brush (not as well developed as in *M. libycus*). Tail length is about equal to head body length. Skull robust, with extremely large bullae that extend quite beyond the supraoccipital. Braincase broad. The suprameatal triangle of bullae large and widely open at its posterior end. Upper incisors with anterior median groove (Fig. 54).

Fig. 53. Sundevall's jird, *Meriones crassus*.

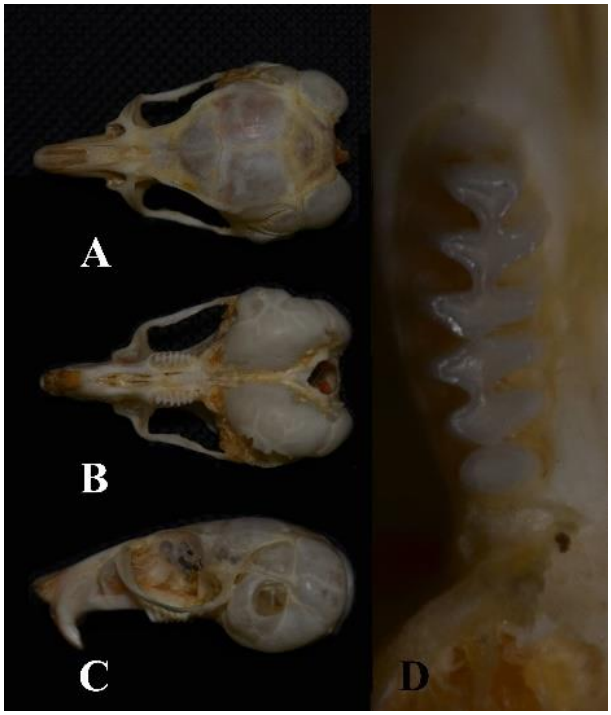

Fig. 54 A. Dorsal, **B**. Ventral, **C.** Lateral views of the skull, and **C**. Upper maxillary teeth for *Meriones crassus*.

Localities: Previous records. Suwira (Allen, 1915); Al Jafr, Azraq (Atallah, 1978); S Wādī ʻAraba (Qumsiyeh *et al*., 1986); ʻAqaba, Azraq, Ghazaleh, Al Qaṭrānah (Amr & Disi, 1988); Wādī Khuneizīra (Harrison & Bates, 1991); Wādī Al Hashad (Al-Melhim *et al*., 1997); S Azraq (Amr *et al*., 1997); Wādī Ramm (Benda & Sádlová (1999); Faydat ad Dahik (Rifai *et al*., 2000); Al Hazīm, Buqay'awiyah, Faydat ad Dahik, Al Qaṭṭāfī, Ash Shawmarī Wildlife Reserve, Wādī Al Hashad, Wādī Salma, (Abu Baker & Amr, 2003b); Al Mudawwarah (Abu Baker & Amr, 2004); Ash Shawmarī Wildlife Reserve (Abu Baker *et al.,* 2005). **Materials from owl pellets.** Qaşr Al Kharanah (Obuch per. com.), Qaşr al Ḥallābāt (Obuch per. com.), Ash Shawmarī Wildlife Reserve (Obuch per. com.). **New records.** Qaşr ʻAmra (Fig. 55).

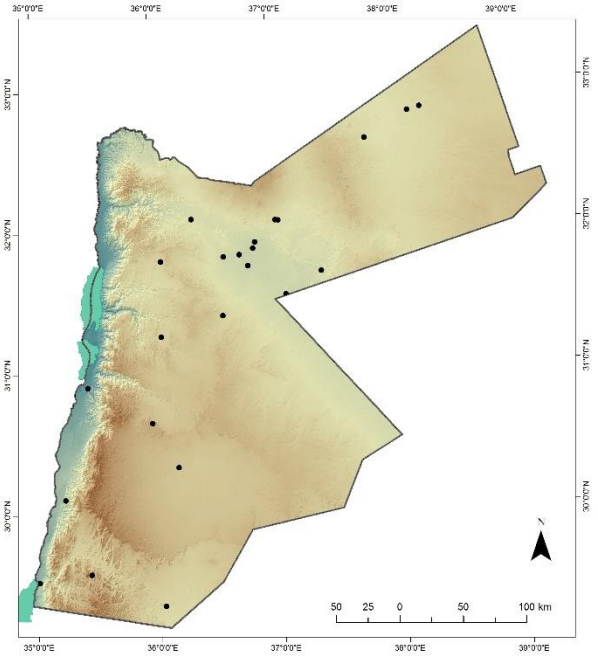

Fig. 55. Distribution of the Sundevall's jird, *Meriones crassus.*

Habitat: This is one of the most common jirds inhabiting the dry and arid habitats of Jordan. It prefers sand areas and hammada (Atallah, 1978). According to Atallah (1977), Sundevall's jird does not form colonies. Abu Dieyeh (1988) described the burrow system of the Sundevall's jird in Wādī ʻAraba. The burrow has elaborate tunnels that may reach several meters with several food and nesting chambers.
Biology: It feeds on a variety of food items including desert plants, animal dung and insects (Qumsiyeh, 1996). This is a nocturnal species, but may also forage during the day. It was observed near camel feeding areas, and comes during daytime to feed on barely and other vegetable matters. Breeding occurs during the cooler months, but may breed all year round, producing up to three litters a year. Litter size is around 3 to 7 young**.** The burrow system is simple with a single entrance and one food chamber. Litter size varies between 2 and 7 (Yiğit *et al*., 1996).
Remarks: This is widespread species with different subspecies along its distribution range. The karyotype for specimens collected from Jordan yeiled 2n=60 and FN=70 (Qumsiyeh et al., 1986).

***Meriones (Pallasiomys) libycus* Thomas, 1919**
Common name: Libyan jird**.**
Diagnosis: Large jird. Fur color brown yellowish dorsally with some black speckling, ventral color white. Ears are not pigmented. Tail reddish with black tuft (Fig. 56). Claws black. Hindfeet with partially hairy soles. Skull robust. Tympanic bullae large, extending beyond surpraoccipital, acessory tympanum present. Form of the suprameatal triangle of bullae distinguishes this species from *M. crassus*, in being smaller and nearly closed at its posterior end. Upper incisors with anterior median groove (Fig. 57).

Fig. 56. The Libyan jird, *Meriones libycus* (photo by Adwan Shehab)**.**

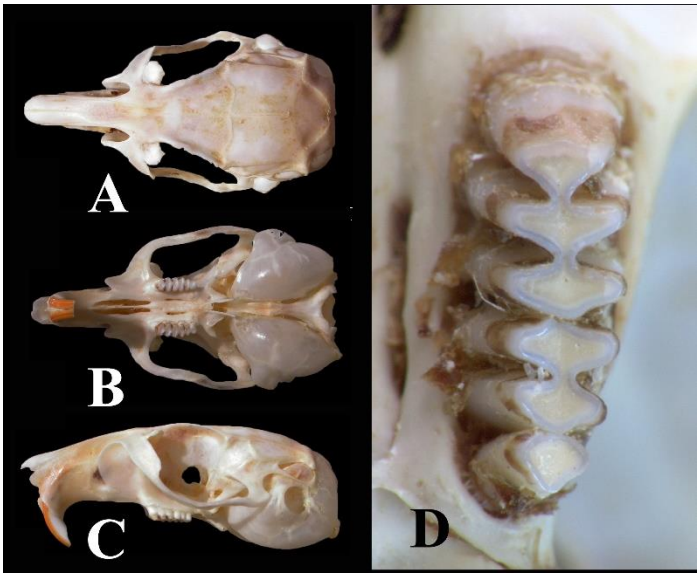

Fig. 57. A. Dorsal, **B**. Ventral, **C.** Lateral views of the skull, and **D**. Upper maxillary teeth for *Meriones libycus*.

Localities: **Previous records.** AI-Jafr, Al-Mahammadia, Azraq, Qaşr al Ḥallābāt, Al Qaṭrānah, (Amr & Disi, 1988); Al Hazīm, Azraq ash Shīshān, Al Wisad (Abu Baker & Amr, 2003b); Ad Dīsah (Abu Baker & Amr, 2004); Ash Shawmarī Wildlife Reserve (Abu Baker *et al*., 2005). **Materials from owl pellets.** Azraq Nature Reserve (Shehab & Ciach, 2008); Qaşr Al Kharanah (Obuch per. com.), Qaşr al Ḥallābāt (Obuch per. com.), Burqu' (Obuch per. com.), Ash Shawmarī Wildlife Reserve (Obuch per. com.). **New records**. Omish, Swaqa, Bāyir (Fig. 58).

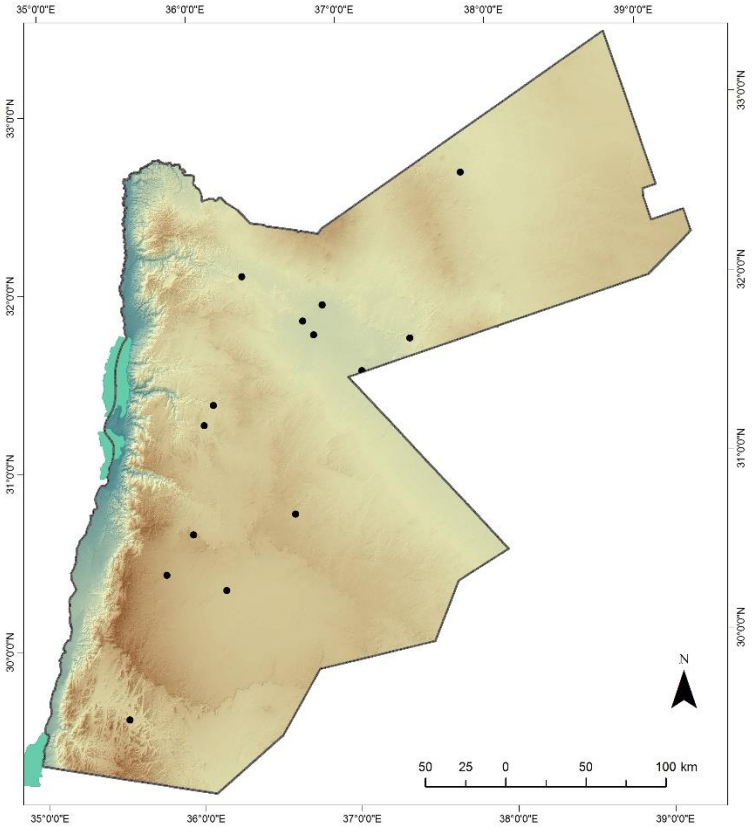

Fig. 58. Distribution of the Libyan jird, *Meriones libycus*.

Habitat: The Libyan jird is common all over the Syrian Desert; sharing its habitat with related species. It is known in Wādī ‘Araba and southern Jordan. Colonies are constructed in hard soil with abundant vegetation. Burrows are very complex and consist of many openings, nest and food chambers. Atallah (1977) reported that it feeds on *Citrullus coloycnthis*, a common desert annual plant. This is a diurnal species, however, it may appear during the night.

Biology: The Libyan jird is reported to be solitary in some areas, but to form small colonies in others as in Jordan. Females give birth to 2-4 young (Osborn & Helmy, 1980).
Remarks: This is a common species with a wide range of distribution in the arid regions of Jordan. The karyotype from specimens collected from the Jordanian eastern desert (referred to as “*M. shawi*”) yeiled 2n=44 and FN=74 (Qumsiyeh *et al*., 1986).

***Meriones tristrami* Thomas, 1892**
Common name: Tristram's jird**.**
Diagnosis: Dorsal fur color brownish grizzled with black, ventral color pure white, line of demarcation distinct. White patches above eye and behind ear. Ears with pigmentation (Fig. 59). Sole partially covered with hair. Tail longer than head body length with a small black brush. Claws pale in color. Four pairs of mammae. Skull small with small tympanic bullae, the posterior part of the bullae does not extend beyond the paraoccipital. Braincase rounded at posterior end. Suprameatal triangle of bullae completely closed. Upper incisors with anterior median groove (Fig. 60).

Fig. 59. Tristram's jird, *Meriones tristrami* from Gharandal (Photo by Mohammad Abu Baker).

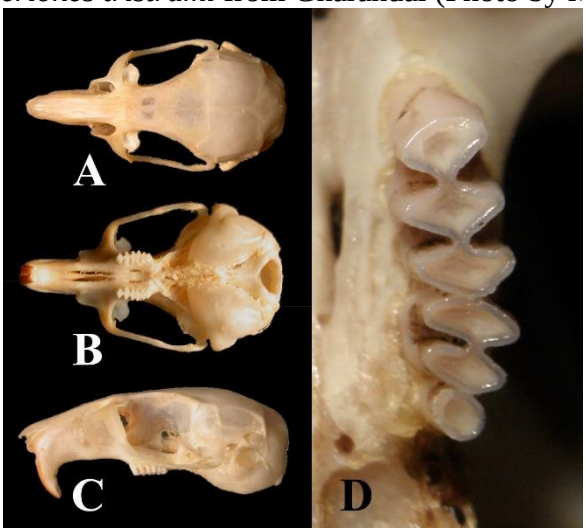

Fig. 60. A. Dorsal, **B**. Ventral, **C**. Lateral views of the skull, and **D.** Upper maxillary cheeckteeth for *Meriones tristrami*.

Localities: **Previous records.** Ash Shawbak, Aṭ Ṭafīla (Nehring, 1902); ‘Ain Gleidat, Ash Shawbak, Aṭ Ṭafīla (Allen, 1915); Azraq ed Duruz, Azraq Shīshān (Atallah, 1966; 1967a); ‘Ammān, Ra’s an Naqb (Atallah, 1978); Jāwá (Searight, 1987); Ghazaleh, Irbid, Jāwá, King Husayn Bridge, Surra Reserve Station (Amr & Disi, 1988; Amr, 2012); Ḍānā Biosphere Reserve (Yousef & Amr, 2005); Aṣ Ṣarīḥ, Umm Al Qiṭṭayn (Sözen *et al*., 2008). **Materials from owl pellets:** Ex. *Bubo bubo*, Wādī Zarqā, S Jarash (Bates & Harrison, 1989); Aṣ Ṣarīḥ (Rifai *et al.*, 1998); Wādī As Sīr (Obuch, per. com.); Ḍānā Biosphere Reserve (Obuch); Marj Al hammam (Obuch, per. com.); Ajlūn Forest Reserve (Obuch, per. com.); ‘Ammān National park (Obuch, per. com.); ‘Ammān 26; (Obuch, per. com.); ‘Ammān University (Obuch, per. com.); Iraq al Wahaj (Obuch, per. com.); Ar Rājif, Wadí Suweid (Obuch, per. com.); Wādī Zarqā Ma’in (Pokines, per. com.). **New records.** Al Lajjun, Ar Ramthā, Wādī Al-Mujib, Wādī Rattia (Ḍānā NR), Gharandal (Fig. 61).

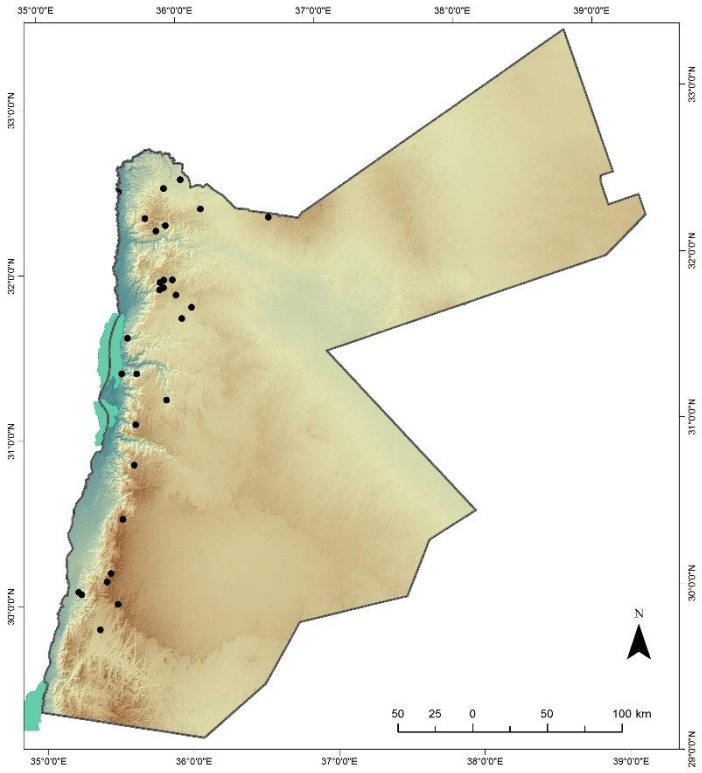

Fig. 61. Distribution of Tristram's jird, *Meriones tristrami*.

Habitat: This is a rather common species in Jordan. It inhabits the Mediterranean and steppe areas. In Jordan, this species was found mostly within the humid and dry Mediterranean areas of the country. It was found in pen areas and avoids rocky habitats. The distribution range of Tristram jird extends eastwards to the fringes of the eastern desert, where as it was collected from Umm Al Qiṭṭayn area, with elevations reaching 1000m asl. The populations Wādī Ramm could be considered as relicts in such very arid habitats. The burrows system of Tristram Jird were studied by Peter (1961), whereas it could be small (50 cm long) or extensive reaching several meters in length.

Biology: Gestation period lasts for 24 days, where a female give birth to 6-9 young (Atallah, 1978).

Remarks: The distribution of this species is important, since the Tristram's jird plays a role as a reservoir host for *Leishmania tropica*, the etiologic agent of the oriental sore. Two different karyotypic forms were determined. The karyotype of three specimens from Umm Al Qiṭṭayn was found to be 2n: 72, NF: 76-80, NFa: 72, while one of three specimens from As-Sarih was

determined to be 2n: 72, NF: 77, NFa: 73 since one of the biarmed pairs consisted of one subtelocentric and one acrocentric chromosome (Qumsiyeh *et al*., 1986; Sözen *et al*., 2008).

Psammomys obesus Cretzschmar, 1828
Common name: Fat sand rat**.**
Diagnosis: Large rodent. Fur dorsally sandy to yellowish in color, ventral side grayish white, line of demarcation not very distinct (Fig. 62). No white patches behind ears or above eyes. Ears densely haired and short. Feet with black claws. Long hair on hindfeet soles, with naked heel. Tail short and thick terminating with a black tuft. Skull robust and very angular with well-developed ridges. Upper incisors without grooves, else the crown structure of molars very similar to *Meriones* (Fig. 63).

Fig. 62. The fat sand rat, *Psammomys obesus*, from Swaqa area.

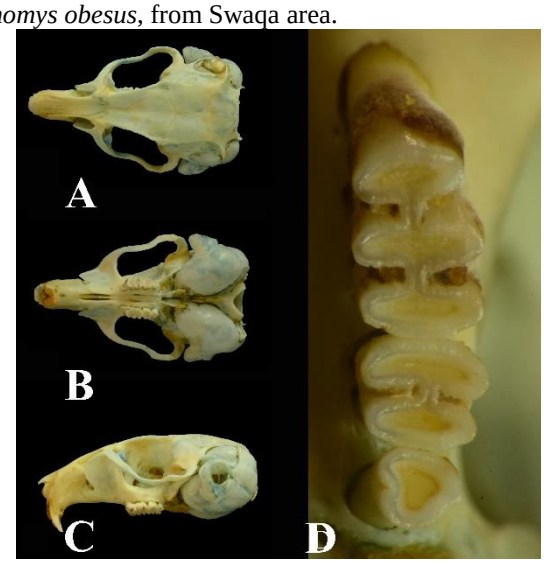

Fig. 63. A. Dorsal, **B.** Ventral, **C.**, Lateral views of the skull, and **D**. Upper maxillary teeth for *Psammomys obesus*.

Localities: **Previous records.** Al Muwaqqar (Amr & Saliba, 1986); Al Muwaqqar, Qaṣr al Ḥallābāt, 60 km S ʻAmmān (Amr & Disi, 1988); 20 km NW El Quweira, Wādī Ramm (Abu Baker & Amr, 2004); Ḍānā Biosphere Reserve (Yousef & Amr, 2005). **New records.** Al-Hassa, Al Jafr, Al Lajjun, Al Qaṭrānah, Ash Shawmarī Nature Reserve, ʻAqaba, Azraq, Dhabaʼah, Jabal Masuda, Ma'an, Swaqa, Umm ar Rasas (Fig. 64).

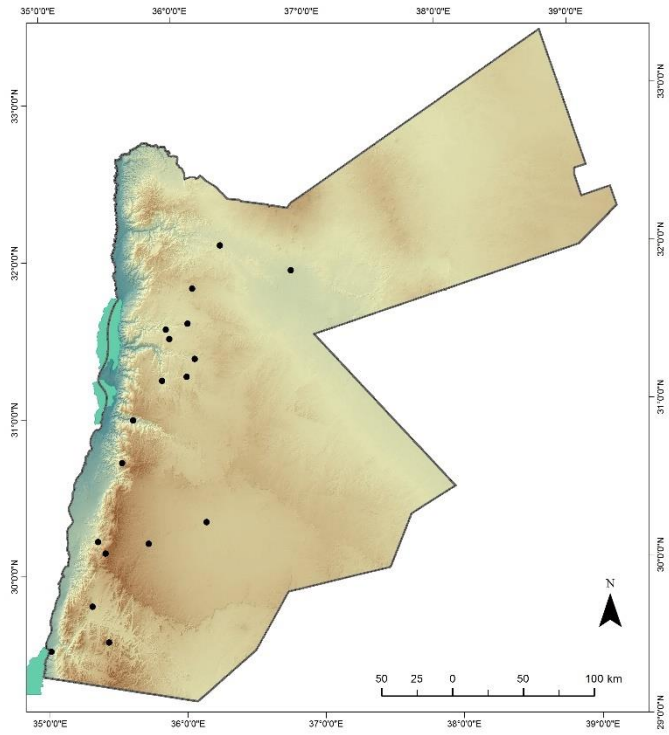

Fig. 64. Distribution of the fat sand rat, *Psammomys obesus*.

Habitat: The ecology of this species was studied by Amr & Saliba (1986), where they reported on its diurnal activity, feeding habits, burrow system and association with other animals. The fat sand rat is a colonial species forming large colonies constructed close to *Anabasis* sp. shrubs. It was found to share burrow with the Syrian hamster. In some areas, previously known to harbor dense colonies of this jird disappeared entirely; where as new colonies are established in new areas away from the original foci. Distribution of this species is associated with the presence of chenopods (i.e. *Anabasis articulata*, *A. syriaca* etc).
Biology: Gestation period may last for 23-25 days, and females give birth to 2-8 young (Osborn & Helmy, 1980).
Remarks: This is another important reservoir animal for human leishmaniasis, a disease known in Jordan and associated with areas colonized by this jird. The karyotype for specimens collected from Jordan yeiled 2n=48 and FN=74, 75 with 18 acrocentric or telocentric and 28 biarmed autosomes (Qumsiyeh et al., 1986).

***Sekeetamys calurus* (Thomas, 1892)**
Common name: Bushy-tailed jird**.**
Diagnosis: Fur very soft and dense, color brown-yellowish dorsally, ventrally pure white. White patches behind ears distinct, while the white patches above the eye are quite indistinct. Tail with black bushy hair for more than half of its length, with a white tip in juveniles and some adults (Fig. 65). Palms and soles are naked. Four pairs of mammae. Skull with very large tympanic

bullae, and with a broad braincase. Upper incisor with single groove anteriorly. Molars not cuspidate (Fig. 66).

Fig. 65. The bushy-tailed jird, *Sekeetamys calurus* (photo by Mohammad Abu Baker).

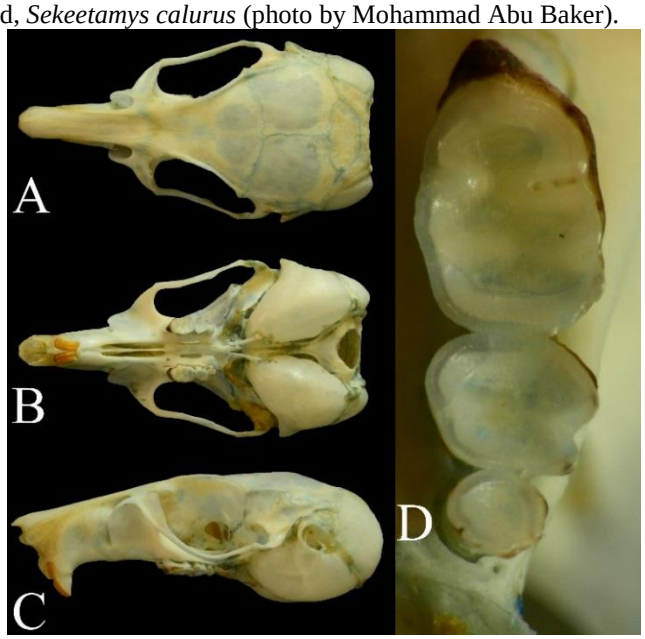

Fig. 66. A. Dorsal, **B**. Ventral, **D.** Lateral views of the skull, and **D**. Upper maxillary teeth for *Sekeetamys calurus*.

Localities: Previous records. 34 km N ʻAqaba (Atallah & Harrisaon, 1967); Wādī Fidān (Abu Dhayeh, 1988); Wādī Ramm (Abu Baker & Amr, 2004)**,** Wādī Ramm (Sözen *et al.*, 2007). **New records.** Jabal Masuda proposed protected area, Raḥmah, Petra (Disi & Hatough-Bouran 1999) (Fig. 67).

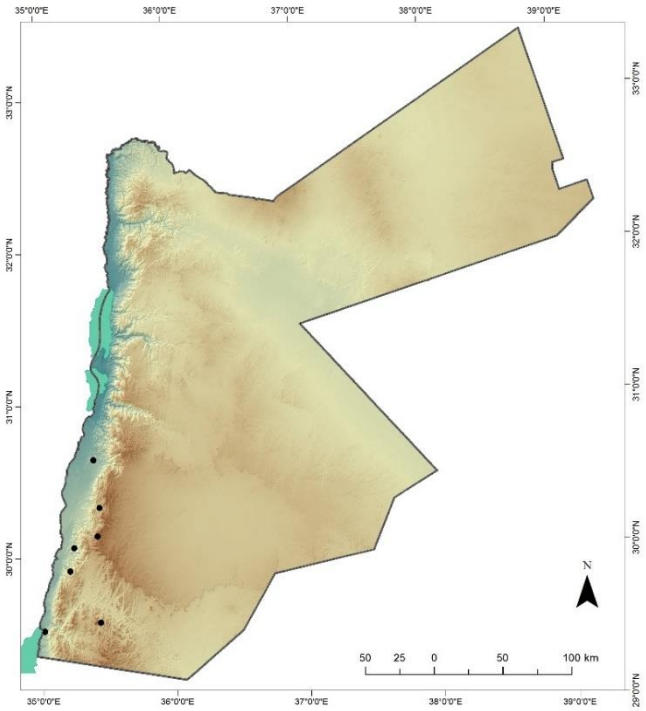

Fig. 67. Distribution of the bushy-tailed jird, *Sekeetamys calurus.*

Habitat: This species prefers to live around sandstone mountain slopes in arid regions. It is a good climber and perhaps lives under boulders. It was trapped from the sand stone deserts of Wādī Ramm in rocky slopes in association with the Asian garden dormouse, *Eliomys melanurus* and the eastern spiny mouse, *Acomys dimidiatus*, at elevations reaching 900 m asl**.** It was collected from similar habitats in Jabal Masuda near Petra.

Biology: The bushy-tailed jird is a nocturnal species with very little knowledge on its biology. Two specimens were found to be in breeding condition in February and March (Qumsiyeh, 1996). In captivity, we kept a colony of this jird for several years, with a maximum of four offspring per female. It was fed on seeds, fruits and vegetables. Vegetation observed near its burrows includes the Wild Fig, *Ficus pseudo-sycomorus.* Osborn & Helmy (1980) included many desert plants as part of its diet (*Zilla spinosa, Citrullus colocynthis* etc.). It subsists on dry vegetation, seeds, and arthropods (Shargal *et al*., 1998). Remain of this jird were found in *Vulpes cana* fecal remains (Geffen *et al*., 1992). Haim (1996) suggested seasonal acclimatization of thermoregulatory mechanisms in the Bushy-tailed Gerbil is induced partly due to changes in photoperiod.

Remarks: The bushy-tailed jird is an endemic species to the Red Sea coastal areas of Egypt and Sudan, Sinai, southern Jordan and Palestine and Arabia. The karyotype of a female specimen from Wādī Ramm was determined to be 2n:38, NFa:66 and NF:70 (Sözen *et al*., 2008).

Subfamily Murinae

Key to species of subfamily Murinae

1. Total body length more than 250 mm.....2
   Total body length less than 250 mm.....4

2. Ears do not exceed 20 mm in length.....*Nesokia indica*
   Ears exceed 20 mm in length.....3

3. Tail longer than body length.....*Rattus rattus*
   Tail shorter than body length.....*Rattus norvegicus*

4. Palm with 5 rounded tubercules.....5
   Palm with 3 rounded tubercules.....*Mus musculus*

5. Orange fulvous to yellowish brown spot on the neck.....*Apodemus flavicollis*
   No orange fulvous to yellowish brown spot on the neck.....*Apodemus mystacinus*

***Apodemus flavicollis* (Melchior, 1834)**
Common Name: Yellow-necked field mouse.
Diagnosis: This species is a relatively small-sized mouse. Dorsal fur coloration is pale buffy-brown to fulvous yellowish brown. Hair basis is gray. Ventral color is white with an orange fulvous to yellowish brown small spot on the neck (Fig. 68). Head-body length between 89 and 106 mm and skull length of 25–27mm in adult specimens. Young and immature specimens exhibit light yellow spot around the throat. Hind foot length averaged 22.8 mm. Tail is longer than head and body length. The skull is similar in structure to that of *A. mystacinus*, except smaller, tympanic bulla ranging between 4.81 and 5.3mm. Anterior palatal foramina are long 4.33-5.4mm. Posterior margin of the palatine and its passages into the medial pterygoid plates is rounded and narrow (Fig. 69).

Fig. 68. The Yellow-necked field mouse, *Apodemus flavicollis*, showing the brown spot around the neck (photo by Adwan Shehab, Mohammad Abu Baker)

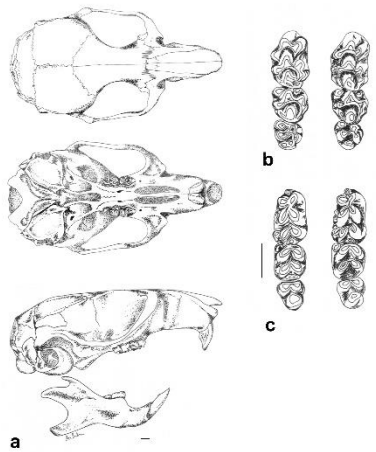

Fig. 69. a. Dorsal, ventral, and lateral views of the skull. **b**. Upper maxillary teeth and **c**. Lower mandibular teeth for *Apodemus flavicollis* (after Abu Baker & Amr, 2008). Scale bar = 1 mm.

Localities: **Previous records.** Birqish, Kufr Khall (Abu Baker & Amr, 2008), **New records**, Dibbīn Forest Reserve, Ajlūn, Al Safa (Fig. 70).

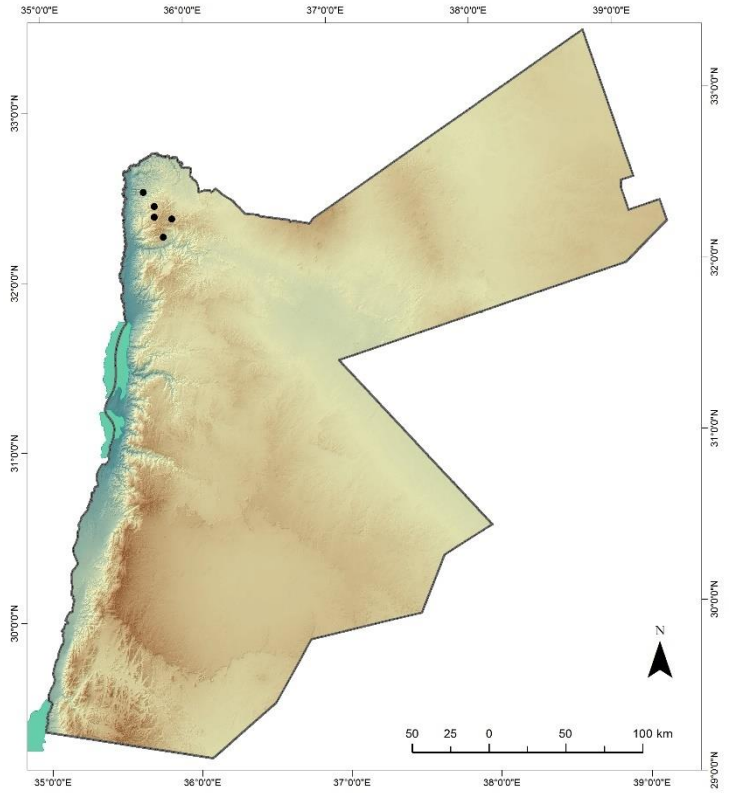

Fig. 70. Distribution of the yellow-necked field mouse, *Apodemus flavicollis*.

Habitat: This mouse appears to be associated with broadleaved woodlands, and usually occurs in close proximity to arable farmland. It tends to be a forest edge species. The yellow-necked Field Mouse may also inhabit orchards, field margins, wooded gardens, hedgerows and buildings in rural areas. Yellow-necked mice are adept climbers. *A. flavicollis* was trapped around Jarash and Birqish areas in some disconnected forest patches consisting of *Quercus calliprinos*, *Pistacia palaestina*, *Proterium spinosum* and *Cistus* sp. It was found to coexist with *A. mystacinus* at higher altitudes, where tree-cover is more scare. Its burrows were identified on open soils, under bushes of *Cistus* sp. or rocks.
Biology: Breeding occurs from March or April until October, although under some circumstances breeding may occur throughout the year. Gestation lasts for about 25 days, and a female may give birth to 2-11 young. Juveniles were collected in May.
Remarks: Abu Baker & Amr (2008) gave a comprehensive treatment for this species. The karyotype consists of 24 pairs of chromosomes 2n=48 and NF=46. All autosomal chromosomes are acrocentrics (Sözen *et al*., 2008).

***Apodemus mystacinus* (Danford & Alston, 1877)**
Common name: Broad-toothed field mouse**.**
Diagnosis: Ears large. Fur on dorsum grayish in adults, brownish-gray in younger individuals. Ventral buff white, sharp line of demarcation present (Fig. 71). Thumb on fore feet vestigial. Soles of feet naked. Claws with white tip. Tail covered with short hairs. Three pairs of mammae. Upper incisor strongly curved (Fig. 72).

Fig. 71. The broad-toothed field mouse, *Apodemus mystacinus,* from Dibbīn Forest Reserve (photo by Mohammad Abu Baker).

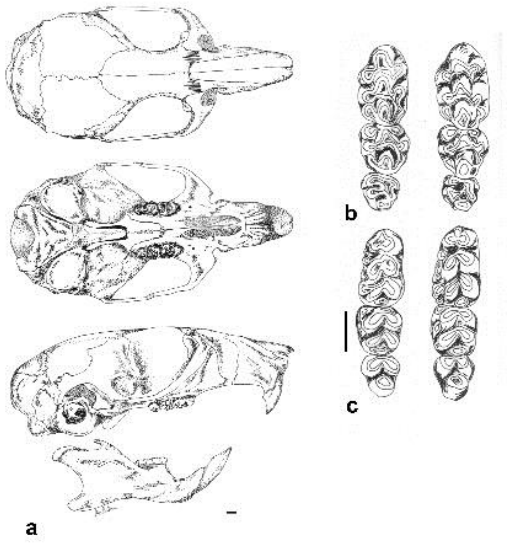

Fig. 72. a. Dorsal, ventral, and lateral views of the skull. **b**. Upper maxillary teeth and **c**. Lower mandibular teeth for *Apodemus mystacinus* (after Abu Baker & Amr, 2008). Scale bar = 1 mm.

Localities: **Previous records.** Dibbīn (Atallah, 1977); Ibbin (Amr & Disi, 1988); Ajlūn (Harrison & Bates, 1991); Ajlūn (Benda & Sádlová, 1999); Jarash, Petra, Wādī Mūsá (Sözen *et al*., 2008); Al Hemmeh, Birqish, Dibbīn Forest Reserve, Kufr Khall, Zūbiyā, Ash Shawbak (Abu Baker & Amr, 2008); Ḍānā Biosphere Reserve (Yousef & Amr, 2005). **Materials extracted from owl pellets.** Ex. *Athene noctua,* Wādī As Sīr (Obuch per. com.); Ex. *Athene noctua, Bubo bubo* and *Strix butleri,* Ḍānā Biosphere Reserve (Obuch per. com.); Ex. *Bubo bubo,* Ajlūn Forest Reserve (Obuch per. com.); Ex. *Asio otus*, ʻAmmān National park (Obuch per. com.); Ex. *Strix aluco,* Iraq al Wahaj (Obuch per. com.). Ex. *Asio otus,* Marj el hammam (Obuch per. com.); Ex. *Tyto alba*, Wādī Al Barra (Obuch per. com.). **New records.** Malka (Fig. 73).

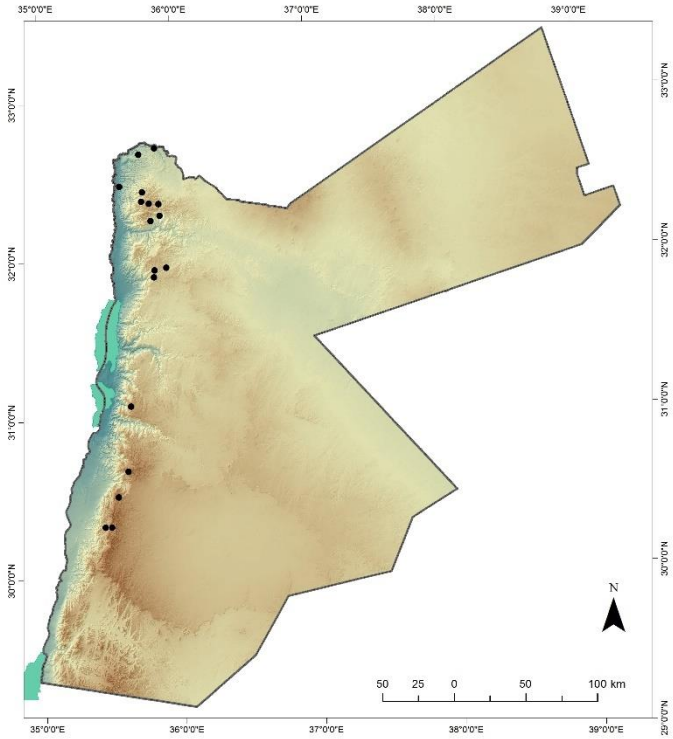

Fig. 73. Distribution of the broad-toothed field mouse, *Apodemus mystacinus*.

Habitat: *A. mystacinus* occurs throughout the natural forests of the Mediterranean mountains of Jordan, extending from the Yarmouk River area southwards to the Ḍānā Biosphere Reserve and Petra, south east of the Dead Sea. It was found to prefer dense humid oak forests with or without the presence of pistachio trees or pines. High numbers of *A. mystacinus* were collected in thick-covered Wādīs in Zūbiyā and Berqesh areas (both on the ground and on trees). Burrows of this species were found under small rocky boulders or under piles of rocks, empty oak acorns always marked their openings. Open nests were also seen inside caves (Abu Baker & Amr, 2008).
Biology: The broad-toothed field mouse can climb oak trees, where it can seek refuge when alarmed. Amr & Disi (1998) recovered this species from the stomach of the Coined Snake, *Coluber nummifer*. Females give birth to 4-5 new born during April to October. Females showing perforated vagina were collected in October, while sub-adults were collected in July (Abu Baker & Amr, 2008).
Remarks: Abu Baker & Amr (2008) gave a comprehensive treatment for this species. The karyotype consists of 24 pairs of chromosomes (2n:48). The autosomal set consists of 22 acrocentrics pairs and two pairs of small-sized biarmed chromosomes (NF: 52). The sex chromosomes are acrocentric (Sözen *et al*., 2008).

***Rattus rattus* (Linnaeus, 1758)**
Common name: Black rat**.**
Diagnosis: Ears large and rounded. Fur color very variable, ranging from blackish dorsally to grayish to brownish, with the underside being lighter (Fig. 74). Head-body length up to 200 mm. Tail longer than head and body length. Little and short hair on tail. Large and well inflated tympanic bullae. Skull elongated in shape, with laterally curved tempoparietal ridges. Outer tubercles of upper molars well developed. First upper molar with anterolateral cusp (Fig. 75).

Fig. 74. The black rat, *Rattus rattus*.

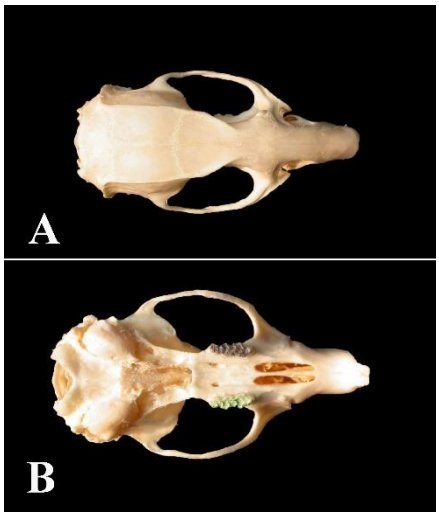

Fig. 75. A. Dorsal and **B**. Ventral views of the skull for *Rattus rattus*.

Localities: Found in all cities, villages and agricultural areas.
Habitat: This is common species occurring in cities, villages and farming areas. Its populations are increasing rapidly in association with urban and agricultural expansion. The black rat successfully invaded remote areas in the country. Now it is well-established in farms in the Badia and southern Jordan. This was facilitated by vehicles transporting animal feed and other agricultural crops.
Biology: Breeding takes place between March and November; three to five litters can be produced in a year, each litter containing 1 to 16 young.
Remarks: After the construction of the sewer system in ʻAmmān in 1979, the black rat became a serious problem for health and municipality officers. It was recovered from toilets in buildings in the second and third floor. The sewer system was a breeding shelter for the rats. It was found in large densities in open dumping sites near Zarqā and Irbid area. Currently, this pest is under control using various compounds of anticoagulants.

Not only considered as a disgusting animal by the local, it is also an important reservoir for zoonotic diseases such as Leishmaniasis and bubonic plague. Historically, the Jordan Valley was an endemic focus for the Black Death, especially during the Islamic expansion from Arabia. In the eight century "*Amwas* Plague" took its toll among Muslim soldiers while in the Jordan Valley. Archeological surveys recovered thousands of skulls for the black rat from that area. The black rat is a serious pest causing extensive damage to grain storage areas, as well as to clothing, chicken farms and electrical wiring of buildings. We have witnessed severe loss in grain storage in northern Jordan. This species is capable of chewing electrical cables of 5 cm in diameter, causing extensive losses. No direct threats are observed.

***Rattus norvegicus* (Berkenhout, 1769)**
Common name: Norway rat or Brown rat**.**
Diagnosis: Larger more robust rat, head body length about 380 mm, and tail 175 mm. The color is solid grayish brown above and below (Fig. 76). Similar to *R. rattus*, but the tail is shorter than head and body length. Tail also with distinct epidermal scales Six pairs of mammae. Large and very elongated skull, with parallel tempoparietal ridges. Tympanic bullae small and only little inflated. First upper molar without an anterolateral cusp (Fig. 77).

Fig. 76. The brown rat, *Rattus norvegicus*.

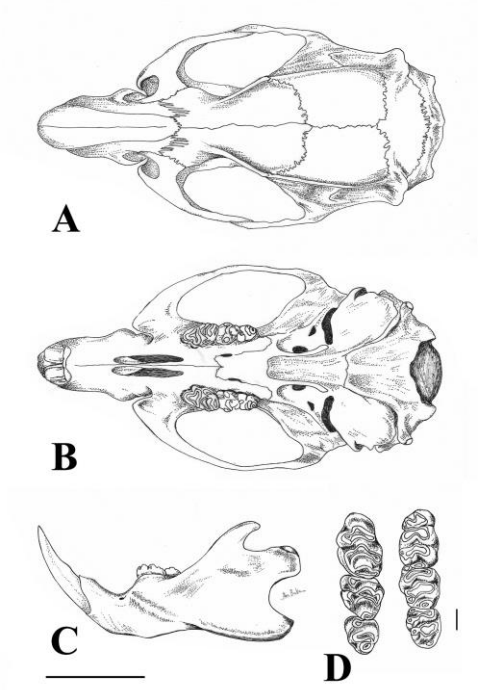

Fig. 77. A. Dorsal, **B**. Ventral views of the skull, **C.** Lower jaw (scale bar = 10 mm), and **D.** Maxillary and mandibulat teeth (scale bar = 1 mm) for *Rattus norvegicus*.

Localities: ʻAmmān, Jarash, Irbid.
Habitat: This species is associated with farm buildings in rural areas. Refuse tips, sewer systems, hedges and field margins are also suitable habitats for the brown rat.
Biology: This is one the most prolific mammals**.** Females become sexually mature when they reach 8 to 12 weeks old. Gestation period lasts for 21 and 23 days. It is possible to have 13 litters per year, each with seven to nine newborns. The Norway rat live in groups, with a dominant male who gains priority access to food, water and resting sites.
Remarks: This species may have been introduced long time ago to the Middle East. It is not as common as *R. rattus* and did not establish itself very well in our area. The Norway rat can live in close quarters with humans in buildings, trash filled streets, sewer systems, grain bins and stock feeding areas. Its introduction to our area is not known, and it may have gained entrance through commercial shipping after establishment of the ʻAqaba Sea port in the early fifties. No direct threats are observed.

***Mus musculus* Linnaeus, 1758**
Common name: The house mouse**.**
Diagnosis: Small mouse. Head body length up to 90 mm. Ears large and rounded at the edges. Fur color brown to grayish dorsally, ventrally usually lighter to white (Fig 78). Feet are white. Tail long and covered with hairs, but annulated. Five pairs of mammae. Skull very small, with a flattened braincase. Upper incisor with a distinctive notch. Crown area of the first upper molar very large in comparison to the second and third upper molars (Fig. 79).

Fig. 78. The house mouse, *Mus musculus*.

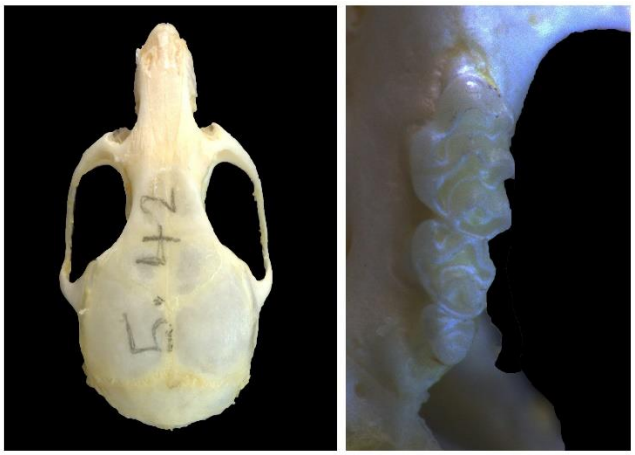

Fig. 79. A. Dorsal view of the skull, and **B**. Upper maxillary teeth for *Mus musculus***.**

Localities: Common all over the country especially where ever there are human settlements**.**

Habitat: The house mouse is a very successful species that is found in all types of habitats, including deserts. The house mouse is commonly found in modern and old houses, shops, hotels, farms.
Biology: They breed about 12 times per year giving birth to about 5-8 new born each time. Within six weeks, the young are able to reproduce. Natural enemies include the Eagle and the Barn Owls (Amr *et al*., 1997; Rifai *et al*., 1998; Abu Baker et al., 2005).
Remarks: The taxonomic status of the House Mouse in the Middle East is still unclear.

***Nesokia indica* (Gray & Hardwicke, 1830)**
Common name: Short-tailed bandicoot rat**.**
Diagnosis: Rat-like in appearance. Dorsal fur color brown, ventral lighter with a very weak line of demarcation (Fig. 80). Total length ranges from 240-316 mm. Ears small. Tail without hair and markedly shorter than head and body length. Tail color same ventrally and dorsally. Four pairs of mammae. Skull large and robust. RostRamm short. Upper incisors project beyond the anterior end of nasals. Upper molars broad and crowns without cusps in adults (Fig. 81). Lower incisor large and powerful.

Fig. 80. The Short-tailed bandicoot rat, *Nesokia indica* (Photo by Adwan Shehab).

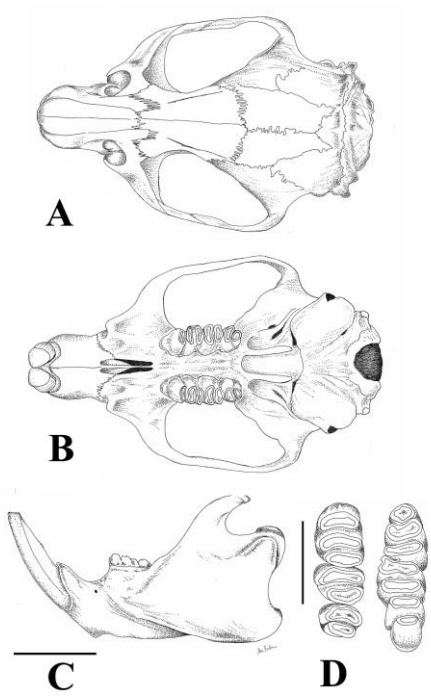

Fig. 81. A. Dorsal, **B**. Ventral views of the skull, **C.** Lower jaw (scale bar = 10 mm), **D.** Upper maxillary and lower mandibular teeth (scale bar = 2 mm) for *Nesokia indica*.

Localities: Previous records. Ghawr aṣ Ṣāfī and Moab (Aharoni, 1930), Wādī Faynān (Abu Dhayeh, 1988), (Fig. 82).

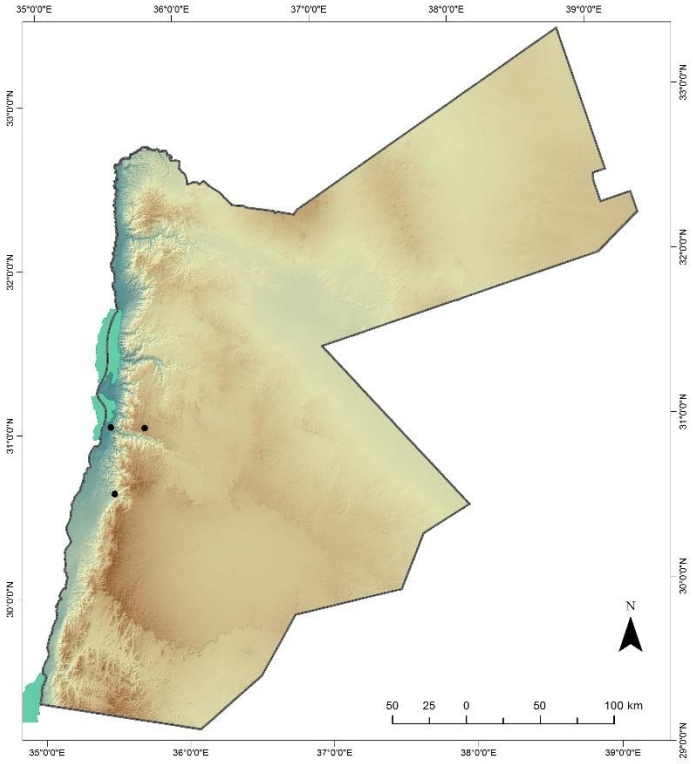

Fig. 82. Distribution of the short-tailed bandicoot rat, *Nesokia indica*.

Habitat: Moisture and permanent water bodies are essential for the short-tailed bandicoot rat. Both localities reported in Wādī ‘Araba are in farming areas with plentiful water. The burrows

are usually located near irrigation channels and water holes and plugged by shrubs. The burrow consists of a nest chamber 30 cm in length, with tunnels reaching more than 4 meters long and 90 cm in depth. It feeds on fleshy roots of *Alhaji* and *Typha* (Osborn & Helmy, 1980).
Biology: The short-tailed bandicoot rat is thought to reproduce throughout the year, producing a litter containing up to ten young, after a gestation period of around 17 days.
Remarks: The type specimen of this subspecies originated from "Ghor el Safieh" (=Ghawr aṣ Ṣāfī). It was also reported from Moab (Aharoni, 1932). The karyotype for this species from Iran was 2n=42 with 6 autosomes were metacentric 12 submetacentric and 12 acrocentric (Kamali, 1976).

Family Hystricidae

This family includes the Old-World porcupines. The head and neck are covered with a crest of long bristles. The dorsal side is covered with spines of various sizes. Porcupines are nocturnal animals that feed entirely on roots, bulbs and other cultivated crops (Wilson *et al*. 2016).

Hystrix indica Kerr, 1792

Common Name: Indian crested porcupine.
Diagnosis: Largest rodent in Jordan. Adult specimens can reach a length of up to 1 m. Body covered by long sharp spines, called quills. Fur color dark brown and blackish brown on the limbs (Fig. 83). Muzzle blunt, and covered with hair up to the lip. Eyes and ears small, ears round and covered by hair. Long and well-developed vibrissae. Tail short. Quills reach up to 400 mm in length on the posterior half of the back. They are creamy white and banded with black (tip creamy white). Quills on base of tail and tail are completely white. Forefeet with four digits, and a strong white claw; hind feet with five digits. Palms and soles are naked. Three pairs of mammae. Skull large and robust with small tympanic bullae. Infraorbital foramen very massive. Frontal region of skull very broad. Cheekteeth are strongly hypsodont and complexly folded with flat crowns (Fig. 84).

Fig. 83. The Indian crested porcupine, *Hystrix indica* (photo RSCN).

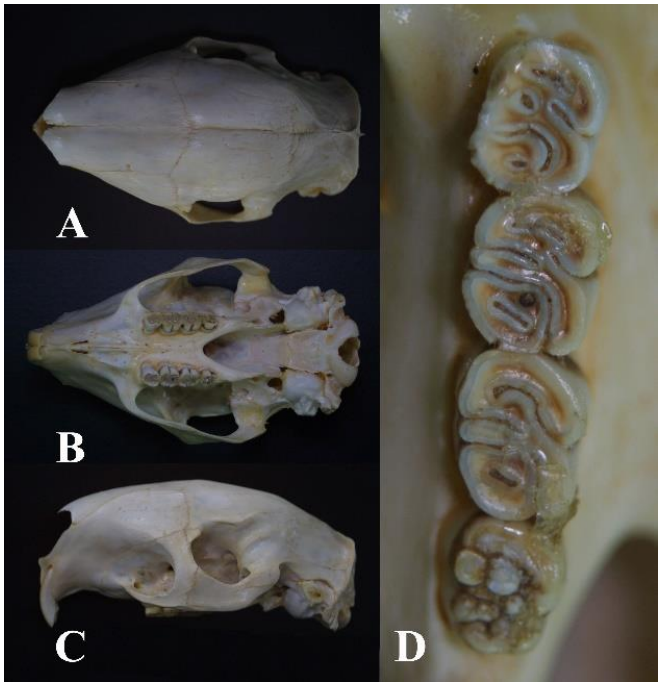

Fig. 84. A. Dorsal, **B**. Ventral, **C**. Lateral views of the skull, and **D**. Upper maxillary teeth for *Hystrix indica***.**

Localities: **Previous records**. 4 Km N ʻAqrabā (Amr *et al*., 1987), ʻAyn Laḥẓah, Fuḥeiṣ, King Husayn Bridge, Wādī Fidān, Wādī Shaʻeb (Amr & Disi, 1988), Ḍānā Biosphere Reserve (Yousef & Amr, 2005). **New records.** Birqish, Irbid, Jabal Masuda, Jāwá, Jordan Valley, Malka, Petra, Wādī ʻAraba, Wādī Al-Mujib, Wādī Salma (Fig. 85).

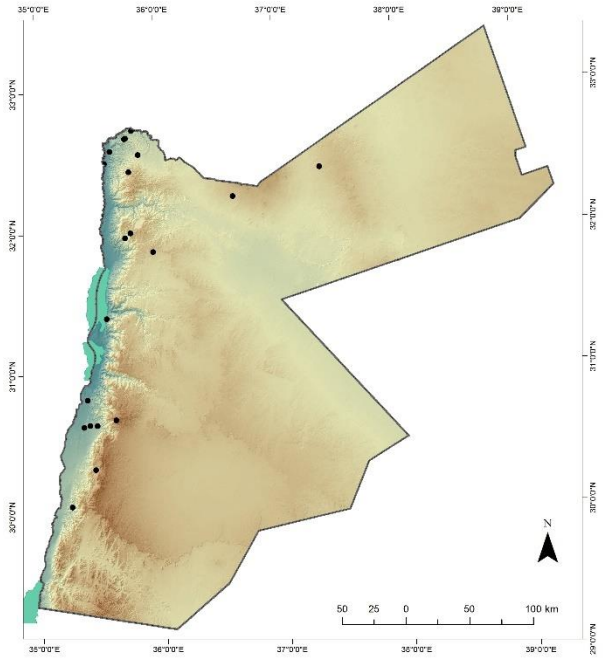

Fig. 85. Distribution of the Indian crested porcupine, *Hystrix indica*.

Habitat: The Indian crested porcupine favors rocky habitats with boulders and large and deep cervices. It lives in a wide variety of habitats, ranging from arid to humid Mediterranean. It shelters in Wādīs of rocky nature and may live in small caves or in constructed burrows. It feeds on 18 species of geophytes and hemicryptophytes (Alkon, 1999), such as fleshy vegetation and bulbs such as *Urginea maritima*, which is common along relatively dry Wādīs and cliffs. They

forage at night and can travel long distances away from their retreat. *Hystrix indica* is a generalist, adaptable animal with a wide range of distribution.

Biology: The Indian crested porcupine is a colonial animal. A female gives birth to 2-4 young, and she brings water in the hollow terminal spines to the young animals. Kingdon (1990) observed the courtship behavior of the porcupine, the female initiate courtship by moving closer towards the male in a proactive posture with the quills laid flat.

Remarks: This species is rather distributed in almost all types of biotopes in Jordan, except extreme open deserts. In Jordan, it was reported along the eastern mountains, the Jordan Valley, edges of the eastern desert and the rocky terrain of Wādī ʻAraba. The Karyotype for specimens from Turkey was 2n=66 and NF-116 with 3 metacentric, 8 acrocentric, 21 submetacentric and subtelocentric chromosome pairs (Arslan, 2006).

Family Spalacidae

This family includes the mole rats. They live entirely in underground tunnels and rarely seen on the surface. They feed on roots and bulbs. Their eyes and ears are vestigial and the tail is very much reduced. Limbs are reduced and not adapted for digging. The large head and the long incisors perform the digging activities (Harrison & Bates, 1991; Wilson & Reeder, 2005).

Nannospalax ehrenbergi (Nehring, 1898)

Common name: Palestine mole rat, the Middle East blind mole rat**.**

Diagnosis: This is a typical fossorial rodent with cylindrical shape and indistinct neck. Fur is short, soft and nondirectional, color of fur black to dark brown (Fig. 86). The flat and broad snout is shovel-like in shape, with a large naked nose pad. Eyes, ears and tail absent. Legs very short, soles of feet naked. Two pairs of mammae. Skull very robust. Long rostrum. Weak, but strongly outward bowed zygomatic arches. Strong developed sagittal crest. Incisors are very conspicuous. Lower incisors very large in comparison to mandible (Fig. 87).

Fig. 86. The Palestine mole rat, *Nannospalax ehrenbergi*, from ʻAmmān.

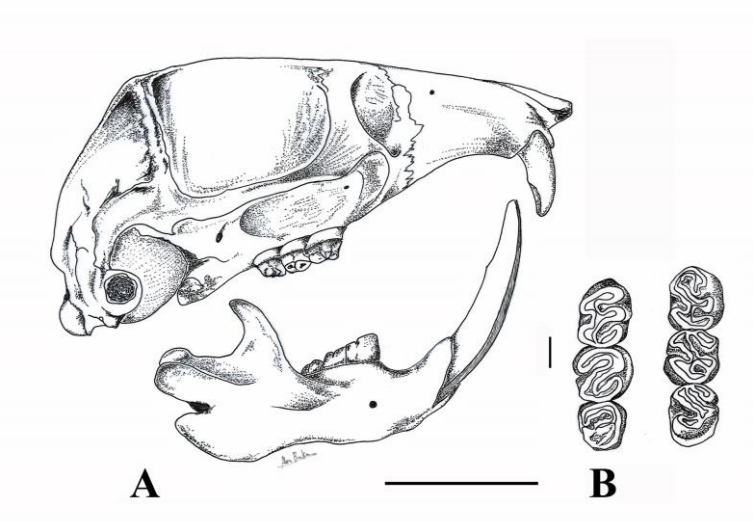

Fig. 87. A. Lateral view of the skull and mandible (scale bar = 10 mm), and **B.** Maxillary and mandibular cheekteeth (scale bar = 1 mm) for *Nannospalax ehrenbergi.*

Localities: **Previous records**. Ash Shawbak (Mountfort, 1965), ʻAqrabā (Amr *et al*, 1987); Busayra, Between Jarash and Sūf, Jubeiha, ʻIbbīn, Ar Ramthā (Amr & Disi, 1988), Ḍānā Biosphere Reserve (Yousef & Amr, 2005), 10 km NW ʻAmmān Mountains, Aṭ Ṭafīla, Dhiban, Irbid, Jîza, Karak, NW Mādabā, Mazar, Moab, Mount Nebo, As Salt Mountains, Naur, 10 km N Wādī Al Hassa, 5 km N Wādī Al-Mujib, Wādī Mūsá, Zarqā (Nevo *et al*., 2000). **Materials extracted from owl pellets:** Marj Al Hammam (Obuch per. com.); Fuḥeiṣ (Obuch per. com.); Ḍānā Biosphere Reserve (Obuch per. com.), Iraq al Wahaj (Obuch per. com.), Wādī Zarqā Ma'in (Pokines per. com.). **New records**: Al Hashemeyeh, Ajlūn, Jarash, Petra, Ra's an Naqb, Umm Al Qiṭṭayn (Fig. 88).

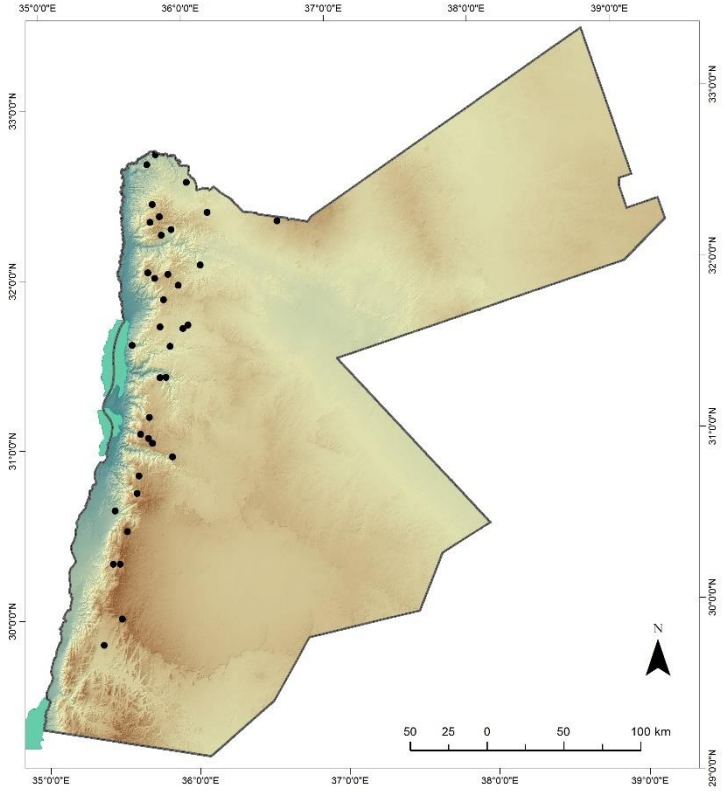

Fig. 88. Distribution of the Palestine mole rat, *Nannospalax ehrenbergi*.

Habitat: This species is confined to the Mediterranean and semi-Mediterranean biotopes of Jordan. The distribution of the Palestine mole rat is apparently associated with *terra rosa* soil, the abundant soil type covering the Mediterranean province of Jordan. Its eastern distribution limits extend to around Umm Al Qiṭṭayn on the fringes of the black lava desert. Ra's an Naqb represents its most southern range of distribution in the Middle East. This mole is an aggressive fossorial solitary species. Its presence is immediately confirmed by the existence of the variously-sized mounds that reflect its activity in open fields. Burrows are subdivided into three layers; the outer most is for food storage with connections to peripheral feeding tunnels (Nevo, 1961).
Biology: Palestine mole rat feeds on bulbs, roots and subterranean vegetation. Gestation period lasts for about one month and they give birth to 3-4 new born annually.
Remarks: The current taxonomic status of the blind mole rats in the Middle East and Turkey was revised by Arslan *et al*. (2016) based chromosomal variation between species and populations of *Spalax* and *Nannospalax*. This review indicated the existence of 73 distinct chromosome races recorded in blind mole rats classified within the genus *Nannospalax*, along with the seven species recognized within the genus *Spalax*. Within the traditional species classified in the *Nannospalax* genus, 25 races can be distinguished within *N. leucodon*, 28 races within *N. xanthodon* and 20 races within *N. ehrenbergi*. Karyotyping (2n) for the Jordanian specimens ranged between 60-62, whereas the NFa was 68-74, and NF 72-78 (Arslan *et al*.; 2016).
Previous treatments of the species adopted the taxon *S. leucodon* (Nevo, 1969) and reported several chromosomal species in Palestine. Nevo *et al*. (2000) studied the karyotype, allozyme, size and ecological diversity across the range of mole rats in Jordan from mesic Irbid in the north to xeric Wādī Mūsá in the south, they examined mole rats for chromosome (*N*=71), size (*N*=76), and allozyme (*N*=67) diversities, encoded by 32 loci, in 12 populations under the taxon *Spalax ehrenbergi* superspecies in Jordan. By a combination of chromosome morphology, genetic distance, body size and ecogeography, they identified four new putative biological species. All species (Except two animals in Mādabā) share 2*n*= 60 but vary in chromosome morphology, caused by pericentric inversions and/or centromeric shifts.

Exotic Species

***Myocastor coypus* (Molina, 1782)**

Common name: Coypu, Nutria, River rat

The Nutria (*Myocastor coypus*) is a large rodent, nearly the size of a beaver except with long, rounded, scaly, ratlike tail. Its hind feet are webbed. The upperparts are reddish brown; the underfur dark slaty (Fig. 89). Total length of adults may reach 1.4 m and weigh 8-10 kg (total length, 800-900 mm; tail, 350-400 mm; hind foot, 130-140 mm). The skull is robust with large, orange-colored incisors, relatively small tympanic bulla, and molars similar to that of a porcupine (Fig. 90).
The Nutria is the only member of the family Myocastoridae. Originally native to subtropical and temperate South America, it has since been introduced to all continent except Australia and Antarctica primarily by fur ranchers (Carter & Leonard, 2002), it occurs in North America, Europe, Asia, and Africa.
It is a large, omnivorous, semiaquatic rodent. It lives in burrows alongside stretches of water. Although it is still valued for its fur in some regions, its destructive feeding and burrowing behaviors make this invasive species a pest throughout most of its range and became a pest species, causing damage to water control structures, crops, and marsh systems and is considered a disease host. It is the only species of introduced mammals known to occur in the major permanent water bodies of Jordan (Amr, 2000a). The coypu was introduced into the area by

Jewish fish farmers for fur production in the early 1950's from Chile (Bodenheimer, 1958) and for economic reasons they were released in the River Jordan system. Also, it was introduced into fish ponds to control reeds, but proved to cause damage to fish pond dikes due to their burrowing behavior (Mendelssohn & Yom-Tov, 1999). Now, it is common along the Jordan and Yarmouk rivers and one specimen was found along Jarash creek in the mountains, which is a tributary of the Zarqā River and River Jordan. Atallah (1978) reported on a specimen caught in 1968 along the Jordan River, south of the Hula Lake.We located several populations along the Yarmouk River near 'Aqrabā village, and many others along the River Jordan and at the northern mouth of the Dead Sea.

Fig. 89. The nutria, *Myocastor coypus*, collected from the mouth of the Dead Sea.

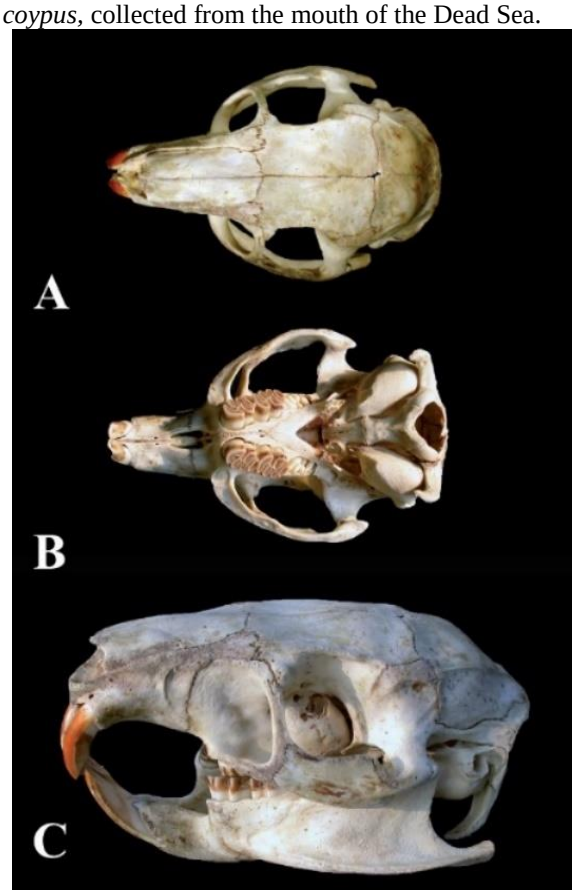

Fig. 90. A. Dorsal, **B.** Ventral, and **D.** Lateral views of the skull for *Myocastor coypus*.

Zoogeographic origins and habitat preferences of rodents in Jordan

The Levant, being affected by four main faunal elements (Palaearctic, Oriental, SaharoArabian, and Afrotropical), is characterized by high habitat heterogeneity, taking into consideration the fourteen recognized vegetation types, soil, and substrate (Por, 1975; Al Eisawi, 1996, Alberts *et al*. 2004). This has significant effects on the faunal diversity of terrestrial animals as a whole and accordingly, the rodent diversity. The Levant –including Jordan- represents extreme distribution limits for some species of rodents, with their zoogeographic affinity directed towards one geographical region, some of which are present in Jordan in confined areas due to the small proportions of these regions, while others have wide distribution ranges. The available data on distribution records was used to allocate all species according to their biogeographic affinities.

Species geographic ranges for the rodents of Jordan were obtained from Harrison & Bates (1991) and Osborne & Helmy (1980) with subsequent updates provided in Amr (2012). The rodent fauna of Jordan (excluding the four introduced species: *Rattus rattus, R. norvegicus, M. msuculus,* and *Myocastor coypus*) consists of assemblage of different zoogeographical affinities. Nineteen of the recorded species occur in a single zoogeographic region, whereas, four species occurred in two regions, and only one species ranged widely over three regions. Nine, three, and seven were restricted or had most of its range within the Mediterranean, Irano-Turanian, and Saharo Arabian, respectively (Table 1). For example, *Sciurus anomalus*, *Apodemus* sp., *Nannospalax ehrenbergi*, and *Microtus guentheri* reached their most southern range of distribution in the Mediterranean regions of Jordan. The distribution of *Gerbillus cheesmani* extends from Asian deserts in India westwards into the Arabian Peninsula crossing Jordan as as its most western range of distribution. Typical rodents of Saharo-Arabian affinities are represented by desert jerboas, gerbils, and jirds (Table 1). North African species such as *Gerbillus andersoni, Gerbillus gerbillus* reached their most eastern distribution in southern Jordan. Both *Gerbillus henleyi* and *Gerbillus nanus* are widely-distributed species across Nort Africa reaching as far as India to the east, representing most northern outpost for these two species. *Sekeetamys calurus* is a nearly endemic to the Eastern Mediterranean region within southern Jordan and Sinai. Earlier geological periods have created relict populations of some species, for example, 1. the arboreal *Eliomys melanurus* -a typical Palaearctic species- can still be found in patchy populations within the southern rocky habitats of Wādī Ramm and the Eastern Desert, 2. a separate population of *Acomys russatus* in a melanistic form (*A. russatus lewisi*) can be found in the black lava desert east of Jordan. This analysis oversimplifies the situation to some extent, yet, these distributions provided indications on whether a species is of temperate or desert origin (Table 1). The analysis of rodent distributions should also be based on the major range in terms of habitat occupied by a species to prove meaningful interpretation of the species heterogeneity.

Rodent distribution by habitat type

The biogeographic zones were further subdivided into eight subregions based on the distinguished habitat aspects such as substrate types, land cover, and vegetation (Fig. 91, Table 2), these are:

Temperate Mediterranean forests: these include the Aleppo pine and evergreen and deciduous oak forests. The Aleppo pine forests (*Pinus halipunsis*) covers small areas mainly in Diddin forest, Ajlūn and Zai and is mainly associated with evergreen oak (*Q. calliprinos*), strawberry tree (*Arbutus andrachne*), Pistachio (*Pistaia palaestina*) and *Pyrus syriaca*. The soil is white calcareuos and/or Terra Rosa with average annual rainfall 500-700mm.

Non-forest Mediterranean region (including agricultural fields): these areas may be classified as secondary (degraded) forests due to intense pressure of logging and deforestation for

agriculture, urban development, and grazing over the years. These areas are not covered by forests, but contain some bushes and shrubs are considered non-forest Mediterranean habitats and contains shrubs and bushes that are found in all Mediterranean regions.

Desert rocky slopes and boulders (including basaltic fields in the Lava Desert):
This habitat is represented by the rocky areas in Jordan including the mountains and boulders that support rock-dwelling species. This area lies mostly within the Saharo-Arabian region of the south where weathered sandstone and granite mountains and eastern regions of the country basaltic boulders originated from ancient volcanic activities.

Wādī beds, marab, and sabkha: these areas are represented by dry water courses (run-off), flat low land areas and depressions of land with high salty soil. The substrates may be of various origins, mostly calcareous, loess, or sandy. The vegetation cover is highly dependent on the season. Dominant plants include: *Artimesia* sp., *Origanum* sp., *Achillea fragrontissima*, *Nitraria retusa*, *Tamarix* sp., *Retama raetam*, and *Atriplix* sp.

Sand dunes and sandy sheets: these areas are composed of soft sand dunes and/or wind-blown sand that stabilizes by healthy vegetation cover of shrubs and bushes (sand dunes fixatives). The main species that characterize this type include *Haloxylon persicum, Retama raetam, Calligonum comosum, Neurada procumbens, Hammada scoparia* and *Seidlittzia rosmarinus*

Open hammada desert: these are flat deserts of clayey loam covered by gravel. Vegetation is dominated by low shrubs of *Seidlittzia rosmarinus, Astragalus spinosus*, and some annual shrubs and succulent plants as; *Spergularia diandra*, *Herniaria hirsute* and *Anthemis deserti*.

Steppe and gravel/pebble vegetation: This is the largest vegetation type by area within Jordan. It is represented by the open shrubby and flat open deserts covered with bare gravel and/or pebbles bordering the semi-temperate and true desert areas. The vegetation of the area is often poor and concentrated in water sheds and small wades with higher soil moisture. The main species of plants in this habitat type include: *Anabasis articulate*, *Retama raetam*, *Astragalus spinosus*, *Tamarix* spp., *Achillea fragrantissima*, *Artemisia sieberi* and *Zilla spinosa*.

Riparian/water vegetation: these habitats are confined to the limited temporary or permanent stream systems. These habitats and reed vegetation offers suitable habitats few aquatic mammals.

The distribution of rodents in Jordan represents -to a large extent- a reflection of their global distribution ranges and habitat preferences. Jordan occurs at the edge of distribution for at least 12 species from three different directions, seven of which have small ranges in Jordan. This has increased the heterogeneity of the rodent fauna of the Levant, and Jordan (Niethammer, 1987). The eastern and southeastern parts of Jordan are largely arid and semi-arid with low productivity, yet, the local habitat heterogeneity have contributed to the relatively high species richness that includes two jerboas, four gerbils, three jirds, one dormouse and one species of spiny mice. Species associated with the temperate forest and non-forested areas of northern Jordan exhibited the highest species richness with a total of ten species, including a single species of squirrels (*Sciurus anomalus*), two wood mice, *Apodemus* sp., a single species of mole rat (*Nannospalax ehrenbergi*), one vole (*Microtus guentheri*), most of which are wide-ranging species toward the north of Jordan. The steppe areas came second with nine total species, followed by the sandy habitats with seven total species. The low species richness within the non-forest Mediterranean habitats (5 species) is likely in-part due to the agricultural activities and development associated with urban expansion. Strict sand dwellers include two hairy-footed psammophiles only found in the sand dunes are: the easterly-ranging *Gerbillus cheesmani* in the southeast and eastern Jordan is replaced by the westerly-ranging, Saharan *G. gerbillus* in Wādī ʻAraba. The two species are separated by the Sharah Mountains in southern Jordan. The riparian habitat ranked the lowest in terms of species richness with only one species (*Nesokia indica*) while the remaining habitats contained 5–6 species (Table 2).

Several species have confined distributions to preferred habitats including: petrophiles (*Acomys russatus, A. r. lewsi, H. indica* and *S. calurus),* psammophiles (*G. andersoni, G. gerbillus,* and *G. cheesmani*), forest-dwellers (*S. anomalus, Apodemus mystacinus* and *A. flavicollis*).

others including: *Jaculus jaculus, G. nanus, G. henleyi, Meriones crassus,* and *M. libycus* are all desert-adapted species with wider ranges of distribution where scarce vegetation, Wādībeds, and marabs with clay, loess, or gravel surfaces provide foraging grounds and shelter (Scott & Dunstone, 2000; Abu Baker & Amr, 2003a; 2003b; 2004; 2008). A single species, *Gerbillus dasyurus,* exhibited a wide range of distribution over diverse habitat types (Table 1, 2).

Eight main habitat types were recognized for the purpose of this analysis (Table 2). The number of overlapping species between each pair of habitats was used to calculate the similarity index using the formula: $\frac{2\,C}{N1+N2} \times 100$, where C is the number of overlapping species between two habitats, N1 is the total number of species present in habitat 1 and N2 is the total number of species present in habitat 2 (Krebs, 1999). The results indicated that the highest average similarity was within the steppe and gravel/pebble areas (at 33.13%) which represent the transition zone bordering the temperate/semi temperate habitats from the west and the true desert areas from the east (Table 2, 3). The temperate forests ranked second in terms of overall similarity (at 26.21%), this area exhibited the highest species richness due to its high productivity and vegetation cover and the fact that it included several widely-distributed species. The lowest overall similarity occurred in the riparian vegetation which is confined to the limited water vegetation areas in Jordan with only one species recorded (Table 2, 3).

Fig. 91. Habitat types: A: Temperate Mediterranean habitat with abundance of evergreen oak (*Quercus* sp.) and pine forests in northern Jordan. B: non- forest Mediterranean habitat with agricultural fields. C: Desert rocky slopes and sandstone mountains. D: Wādī-bids with silt dunes and loiess substrates. E: Sand dunes with Haloxylon shrubs and Acacia trees in Wādī ʻAraba. F: Open Hamada in eastern Jordan with ample bushes of Seidlitzia rosmarinus. G: Bolders of black lava desert in eastern Jordan. H: The riparian habitat at theYramouk River Basin in northern Jordan. I: Habitat loss and degradation as a result of overgrazing. J: Fragmentation and deforestation through land tenure and agricultural practices.

Table 1. Species distribution of rodents across the main zoogeographic affinities in Jordan, species with small ranges marked in bold.

	Palaearctic	Oriental	Saharo-Arabian	Wide-ranging
Sciurus anomalus	+			
Eliomys melanurus	+			
Allactaga euphratica	+			
Jaculus jaculus			+	
Cricetulus migratorius	+	+		
Microtus guentheri	+			
Acomys dimidiatus	+			
Acomys russatus russatus	+			
Acomys russatus lewisi	+			
Psammomys obesus			+	
Sekeetamys calurus			+	
Meriones crassus			+	
Meriones libycus		+	+	
Meriones tristrami	+			
Gerbillus andersoni			+	
Gerbillus cheesmani		+	+	
Gerbillus dasyurus				+
Gerbillus gerbillus			+	
Gerbillus henleyi			+	
Gerbillus nanus			+	
Apodemus mystacinus	+			
Apodemus flavicollis	+			
Nesokia indica		+		
Hystrix indica	+	+		
Nannospalax ehrenbergi	+			
Species richness	**12**	**5**	**10**	**1**

Table 2. Species distribution, richness, percentage of rodents across the main habitats.

Biogeographic regions	**Mediterranean**		**Saharo-Arabian**				**Irano-Turanian**	
Habitat / **Species**	**Med. forest/forest fields**	**Non-forest Med. and agr. fields**	**Rocky slopes and boulders (including semiarid Med.)**	**Flat hammada deserts**	**Sandy areas and sand dunes**	**Wādī beds, marab, sabkha**	**Open gravel/pebble Steppe vegetation**	**Riparian/water veg.**
Sciurus anomalus	**(+)**							
Eliomys melanurus	+		+					
Allactaga euphratica							+	
Jaculus jaculus				+	+	+		
Cricetulus migratorius	+	+					+	
Microtus guentheri	+	+						
Acomys dimidiatus			+					
Acomys russatus russatus			+					
Acomys russatus lewisi			+				+	
Psammomys obesus					+		+	
Sekeetamys calurus			**(+)**					
Meriones crassus				+	+	+	+	
Meriones libycus				+	+	+		
Meriones tristrami	+	+					+	
Gerbillus andersoni					**(+)**			
Gerbillus cheesmani					**(+)**			
Gerbillus dasyurus	+		+	+		+	+	
Gerbillus gerbillus					**(+)**			
Gerbillus henleyi				+				
Gerbillus nanus						+		
Apodemus mystacinus	**(+)**							
Apodemus flavicollis	**(+)**							
Nesokia indica								**(+)**
Hystrix indica	+	+	+				+	
Nannospalax ehrenbergi	+	+					+	
Species richness	**10**	**5**	**7**	**5**	**7**	**5**	**9**	**1**
% (out of 24 total species)	**41.67**	**20.83**	**29.17**	**20.83**	**29.17**	**20.83**	**37.5**	**4.17**

Table 3. Similarity table for rodent species across the main habitats in Jordan.

	Med. Forest/ forest fields (10)	*Non-forest Med. and agr. fields (5)*	*Rocky slopes and boulders (7)*	*Steppe, gravel/peble vegetation (9)*	*Flat hammada deserts (5)*	*Sandy areas and sand dunes (7)*	*Wādī beds, marab, sabkha (5)*	*Riparian/water veg. (1)*
Riparian/water veg. (1)	0	0	0	0	0	0	0	
Wādī beds, marab, sabkha (5)	13.3	0	16.67	28.57	80	50		0
Sandy areas and sand dunes (7)	0	0	0	25	50		50	0
Flat hammada deserts (5)	13.3	0	16.67	28.57		50	80	0
Steppe, gravel/ pebble vegetation (9)	52.63	57.14	37.5		28.57	25	28.57	0
Rocky slopes and boulders (7)	35.29	16.67		40	16.67	0	16.67	0
Non-forest Med. and agr. fields (5)	66.67		16.67	57.14	0	0	0	0
Med. forest and forest fields (10)		66.67	35.29	52.63	13.33	0	13.33	0
Ave. similarity	**25.89**	**20.07**	**17.54**	**32.77**	**26.94**	**17.86**	**26.94**	**0.00**

Status and conservation of the rodents of Jordan

Conservation issues concerning rodents did not receive much attention as other mammalian group (Nader, 1985; Amori & Gippoliti, 2003; Kryštufek et al., 2009). Nader (1985) listed *H. indica, A. euphratica, E. melanurus* and *S. calurus* as rare species in Western Asia. Locally threatened species include *S. anomalus* and *H. indica* (Table 4), both species are trapped or hunted either for sale as live animals or as food item for the Indian porcupine. Caged squirrels and jerboas were found for sale in public markets originating from Jordan (Eid et al., 2011). *Hystrix indica* meet is in demand for medicinal purposes and consumption, causing alarming decline in their populations all over the country. Jerboas (*A. euphratica* and *J. jaculus*) are also hunted by Bedouins for their meet (personal observations). The remaining species of rodents in Jordan are considered common or pests, for example, both *M. guentheri* and *S. ehrenbergi* are poisoned or trapped since they cause damages for agriculture, especially in northern Jordan (Amr *et al*, 2004). Habitat loss and degradation asnwell as anthropogenic activities represent the main threats to the rodent fauna of Jordan (Table 5). Habitat changes in many parts of the country in the form of intensive farming destroyed habitats for sand dwelling species such *G. cheesmani, G. nanus* and *G. andersoni*. Species like *G. andersoni* have confide distribution in southern Jordan where quarrying for sand in taking place in some core areas with the highest population of this gerbil.

A number of international treaties, conventions and national laws (conservation, environmental or agricultural) have been enacted in order to provide protection for wildlife at the global, regional and national levels. Jordan is a Party to a member of these conventions and agreements. The implementation of these conventions and agreements are included in the Jordanian national environmental strategies and action plans. In addition, the Agriculture Law No. 44 of 2002 addresses to large extent Jordan obligations related to the protection of wildlife under these conventions. The Royal Society for the Conservation of Nature (RSCN) is responsible for regulating hunting within the boundaries of the Hashemite Kingdom of Jordan. The legal frame work of this responsibility was covered by a delegation by the Ministry of Agriculture since the establishment of the RSCN. The latest memo was signed after issuing Law No. 44 for the year 2002. In addition, several bylaws were issued identifying the role of the RSCN in hunting regulations and the implementation of the CITES agreement. A delegation of power by jurisdiction was entitled for all rangers and employees of the RSCN to enforce the hunting regulations, animal trade, …etc. Regulation No. Z/34 for the year 2003 regulates wildlife protection, hunting and trade. This bylaw was issued in accordance to article No. 57, paragraph (A) of the Provisional Agriculture Law No (44) for the year 2002. Bylaw No. 43 for the year 2008 categorized mammals and other wildlife banded from hunting according to its level of protection and included three species of rodents (*Hystrix indica* inAppendix 2, and *Eliomys melanurus* and *Sciurus anomalus* in Appendix 3) that suffer some level of hunting pressure in Jordan. This bylaw was issued in accordance to article No. 57, paragraph (H) of the Provisional Agriculture Law No (44) for the year 2002. In addition, Regulation No (Z/2) for the year 2009 includes instructions of regulating the International Trade in Endangered Species of Wild Fauna and Flora by virtue of Article (57) of paragraph (A) of the Provisional Agriculture Law No (44) for the year 2002. Currently, an updated IUCN status of mammals in Jordan is being compiled.

Table 4. Global and local IUCN status for the rodent fauna of Jordan. DD data deficient, CR critically endangered, EN endangered, LC least concern, NT near threatened, VU vulnerable.

Family	Species	IUCN status	Local status
Sciuridae	*Sciurus anomalus*	LC	EN
Cricetidae	*Cricetulus migratorius*	LC	LC
	Microtus guentheri	LC	LC
Dipodidae	*Allactaga euphratica*	NT	EN
	Jaculus jaculus	LC	LC
Gliridae	*Eliomys melanurus*	LC	NT
Hystricidae	*Hystrix indica*	LC	VU
Muridae	*Acomys dimidiatus*	LC	LC
	Acomys russatus	LC	LC
	Apodemus flavicollis	LC	EN
	Apodemus mystacinus	LC	LC
	Gerbillus dasyurus	LC	LC
	Gerbillus andersoni	LC	CR
	Gerbillus cheesmani	LC	LC
	Gerbillus gerbillus	LC	LC
	Gerbillus henleyi	LC	LC
	Gerbillus nanus	LC	LC
	Meriones crassus	LC	LC
	Meriones libycus	LC	LC
	Meriones tristrami	LC	LC
	Mus musculus	LC	LC
	Nesokia indica	LC	DD
	Psammomys obesus	LC	LC
	Sekeetamys calurus	LC	LC
Spalacidae	*Nannospalax ehrenbergi*	DD	LC

Table 5. Threat categories and causes of threats on the rodents of Jordan.

Threat category	Cause of threats	Species affected
Habitat loss and degradation	Deforestation	*S. anomalus, A. flavicollis, A. mystacinus*
	Land tenure and fragmentation	*E. melanurus, G. andersoni*
	Loss of vegetation cover	*A. euphartica, P. obesus, M. tristrami*
	Overgrazing	*G. andersoni, G. cheesmani, A. r. lewisi*
	Agricultural expansion	
	Quarrying	
Human disturbance and related activities	Recreational activities and tourism.	*S. anomalus, A. flavicollis, A. euphartica, J. jaculus, H. indica*
	Killing by traffic	
	Direct persecution	*S. anomalus, A. euphartica, J. jaculus, H. indica*
	Scientific collection	
	Trade and consumption	
	Hunting	
Legislative and public awareness	Enforcement	*S. anomalus, H. indica*
	Public awareness	

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Appenix 1. List of localities indicated in the text using the Geographic Coordinate System.

Locality	N	E
ʻAin Al Atmash	31° 50' 00"	36° 49' 00"
ʻAin Gleidat	30° 42' 00"	35° 37' 00"
ʻAin Musa	31° 47' 30"	35° 41' 39"
ʻAmmān (Amman)	31° 58' 00"	35° 59' 00"
ʻAmmān National Park	31° 51' 58"	35° 52' 52"
ʻAmmān University	32° 02' 49"	35° 46' 46"
ʻAnjara	32° 18' 25"	35° 45' 13"
ʻAqaba (Aqaba, Al Aqaba)	29° 31' 36"	35° 00' 28"
ʻAqrabā	31° 28' 00"	35° 48' 00"
ʻAyn Laḥẓah (Ain Lahzha)	30° 42' 00"	35° 36' 00"
ʻIbbīn	32° 22' 00"	35° 49' 00"
Ad Dīsah (Disi, Disah)	29° 39' 07"	35° 30' 45"
Ad Dumaythat	31° 58' 59"	38° 21' 30"
Ajlūn (Ajlun)	32° 20' 02"	35° 45' 03"
Ajlūn Forest Reserve	32° 22' 49"	35° 45' 49"
Al Ghamr	31° 40' 41"	37° 16' 48"
Al Hazīm (Al Hazīm)	31° 35' 03"	37° 12' 40"
Al Hemmeh (El Hamma)	32° 28' 00"	35° 36' 00"
Al Jafr	30° 17' 36"	36° 12' 50"
Al Jubayhah	32° 01' 00"	35° 52' 00"
Al Karak	31° 11' 05"	35° 42' 17"
Al Lajjun	31° 14' 04"	35° 52' 00"
Al Mafraq	32° 20' 00"	37° 55' 00"
Al Mahammadia	30° 25' 42"	35° 45' 15"
Al Mudawwarah	29° 18' 59"	36° 01' 31"
Al Muwaqqar	31° 48' 56"	36° 05' 39"
Al Qaṭrānah	31° 14' 51"	36° 03' 11"
Al Qaṭṭāfī (Wādī al Qaṭṭāfī)	31° 42' 12"	37° 15' 40"
Al Safa	32° 14' 37"	35° 46' 36"
Al Wisad	31' 53' 14"	37° 57' 06"
Ar Rājif	30° 11' 28"	35° 26' 32"
Ar Ramthā	32° 33' 33"	36° 00' 25"
Ar Rīshah	30° 13' 40"	35° 12' 59"
Ar Ruwayshid	32° 30' 00"	38° 12' 00"
Aṣ Ṣarīḥ	32° 30' 14"	35° 53' 41"
Ash Shawbak	30° 31' 12"	35° 32' 18"
Ash Shawmarī	31° 45' 00"	36° 43' 00"
Ash Shawmarī Wildlife Reserve	31° 45' 00"	36° 43' 00"

Aṭ Ṭafīla	30° 50' 00"	35° 36' 00"
Azraq Ash Shīshān	31° 50' 00"	36° 49' 00"
Azraq ed Duruz	31° 52' 56"	36° 49' 49"
Azraq Wetland Reserve	31° 53' 30"	36° 49' 00"
Bāyir	30° 45' 50"	36° 40' 46"
Bir ed-Doleh (=Beir Mathkour)	30° 28' 08"	35° 17' 28"
Birqish	32° 22' 56"	35° 46' 24"
Buqay’awiyah	30° 38' 03"	35° 23' 27"
Burmā	32° 13' 12"	35° 46' 52"
Busayra	30° 43' 54"	35° 36' 35"
Ḍānā Biosphere Reserve	30° 40' 02"	35° 34' 30"
Dhaba’ah	31° 33' 00"	36° 02' 59"
Dhahel	32° 16' 25"	35° 58' 31"
Dhiban	31° 29' 55"	35° 47' 02"
Dibbīn Forest Reserve	32° 15' 00"	35° 49' 00"
El Quweira	29° 48' 11"	35° 18' 43"
Ernbeh	32° 16' 58"	37° 02' 26"
Faydat ad Dahik	31° 34' 12"	37° 08' 37"
Fifa	30° 56' 34"	35° 26' 39"
Fuḥeiṣ	32° 00' 39"	35° 46' 00"
Gharandal	30° 04' 43"	35° 12' 53"
Ghawr aṣ Ṣāfī	31° 02' 00"	35° 28' 00"
Ghawr aṣ Ṣāfī	31° 01' 35"	35° 27' 24"
Ghawr Nimrin	31° 53' 12"	35° 34' 22"
Ghazaleh	30° 55' 00"	35° 40' 00"
Ḫumrat Mā‘īn	31° 40' 06"	35° 36' 16"
Iraq al Wahaj	32° 19' 00"	35° 43' 00"
Irbid	32° 33' 20"	35° 51' 00"
Jabal Masuda	30° 10' 17"	35° 20' 53"
Jarash	32° 16' 50"	35° 53' 43"
Jāwá	32° 20' 00"	37° 02' 00"
Jîza	31° 42' 00"	35° 57' 00"
King Husayn Bridge	31° 52' 00"	35° 32' 00"
Kufr Khall	32° 21' 34"	35° 52' 52"
Kufrinja	32° 17' 50"	35° 42' 11
Ma‘ān	30° 12' 00"	35° 44' 00
Mādabā	31° 43' 00"	35° 48' 00
Marab Omish	32° 18' 03"	37° 02' 32"
Marj Al Hammam	31° 54' 10"	35° 50' 47"
Mazar	32° 28' 20"	35° 47' 55"

Melka	32° 40' 28"	35° 45' 08"
Mount Nebo	31° 45' 44"	35° 44' 45"
Mountains of Moab	31° 54' 00"	35° 45' 00"
Mukwer (Mekawer)	31° 34' 00"	35° 38' 00"
Nā‘ūr	31° 52' 28"	35° 49' 29"
Petra	31° 07' 00"	35° 47' 00"
Prince Mohammed Bridge	32° 06' 10"	35° 32' 06"
Qaşr ‘Amra	31° 48' 16"	36° 35' 08"
Qaşr al Ḥallābāt	32° 06' 00"	36° 20' 00"
Qaşr Al Kharanah	31° 43' 44"	36° 27' 46"
Qaşr Burqu‘	32° 37' 00"	37° 58' 00"
Qatar Protected Area	29° 49' 06"	35° 05' 33"
Quraiqira	30° 37' 34"	35° 24' 12"
Ra’s an Naqb	29° 54' 00"	35° 32' 00"
Raḥmah	29° 55' 00"	35° 08' 00"
Rimon	32° 17' 00"	35° 49' 31"
Safawi	32° 12' 00"	37° 07' 00"
Sakib	32° 17' 00"	35° 48' 34"
Salt (As Salt)	32° 02' 21"	35° 43' 38"
Sūf	32° 19' 03"	35° 50' 08"
Surra Reserve Station	32° 24' 00"	36° 09' 00"
Suwaymah	31° 45' 58"	35° 36' 03"
Suwira (=Quweira)	29° 48' 11"	35° 18' 43"
Swaqa	31° 21' 42"	36° 06' 51"
Tabaqat Fahl	32° 27' 03"	35° 36' 34"
Umm Al Qiṭṭayn	32° 19' 00"	36° 38' 00"
Umm ar Rasas	31° 30' 44"	35° 55' 06"
Wādī Al Barra	30° 40' 25"	35° 35' 29"
Wādī Al Ḥasā	30° 51' 00"	35° 54' 00"
Wādī Al Hashad	32° 29' 18"	37° 15' 52"
Wādī Al Hidan	31° 27' 20"	35° 35' 38"
Wādī Al Karak	31° 17' 17"	35° 30' 54"
Wādī al Khanzair	32° 21' 43"	35° 54' 00"
Wādī Al Seer (as Sīr)	31° 57' 00"	35° 49' 00"
Wādī Al-Mujib	31° 27' 49"	35° 34' 32"
Wādī am Numayr	31° 08' 01"	35° 31' 36"
Wādī Faynān	30° 37' 32"	35° 26' 43"
Wādī Fidān	30° 40' 20"	35° 22' 41"
Wādī Ibn Hammad	31° 17' 31"	35° 31' 07"
Wādī Khanzira	32° 21' 43"	35° 54' 00"

Wādī Khariobsa (Petra)	31° 07' 00"	35° 47' 00"
Wādī Khuneizīra	30° 53' 00"	35° 26' 04"
Wādī Mūsá	30° 19' 20"	35° 28' 46"
Wādī Ramm	30° 53' 00"	35° 26' 04"
Wādī Rattia	30° 40' 22"	35° 22' 20"
Wādī Salma	32° 26' 07"	37° 15' 52"
Wādī Sha‘eb	31° 55' 09"	35° 38' 35"
Wādī Suweid	32° 17' 24"	37° 27' 15"
Wādī Tlah (=Wādī Dahl)	30° 49' 44"	35° 24' 42"
Wādī Zarqā (az Zarqā’River)	32° 06' 56"	35° 32' 30"
Wādī Zarqā Ma’in	31° 40' 49"	35° 44' 02"
Zūbiyā	32° 26' 00"	35° 46' 00"