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RODENT DIVERSITY IN THE NORTHEASTERN DESERT OF JORDAN, WITH SPECIAL REFERENCE ON THE ECOLOGY OF *GERBILLUS CHEESMANI* (MAMMALIA: RODENTIA)

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Abstract: Eleven species of rodents representing four families (Muridae, Gerbillidae, Dipodidae and Gliridae) were reported to occur in the Northeastern desert of Jordan. Records of rodents for four consecutive years (1998–2001) have been compiled and integrated with ecological observations for each species. Confined distribution of some species indicates their habitat preference for specific type of environment; the psammophylic gerbil, *G. cheesmani*, was confined to the sand sheets and Wadi beds in the southern parts of the study area. Other petrophylic rodents, as the golden spiny mouse *Acomys russatus lewisi* and Wagner's gerbil, *Gerbillus dasyurus*, were found only in the rocky boulders of the basalt desert. However, some species were not seen as highly selective for their habitats and were collected from different vegetation types, as in the case with *Meriones crassus* and *Jaculus jaculus*. Distribution and accounts for all recorded species are included with comments on their distributional ecology. New distribution records for the known range of *Eliomys melanurus*, *Gerbillus cheesmani* and *Meriones libycus* are provided.

■ **Rodents, Badia, Jordan, Ecology, *Gerbillus cheesmani*.**

INTRODUCTION

The Northeastern desert of Jordan is a highly diversified geomorphic area with different types of habitats therefore offering shelter and space for different assemblages of communities with different ecological requirements including rock-dwelling mammals, psammophiles and others preferring open land.

Despite the published studies on diet analysis of two species of owls; which reported the presence of six species namely; *Jaculus jaculus*, *Meriones crassus*, *Gerbillus dasyurus*, *Acomys russatus lewisi*, *Cricetulus migratorius* and *Mus musculus* from the area (Amr et al. 1997; Al-Melhim et al. 1997 and Rifai et al. 2000), the Badia region has received very little attention. Few studies were conducted in the confined areas and were not devoted entirely to the rodents of the Northeastern Desert of Jordan (Searight 1987; Hatough-Bouran et Al-Eisawi 1990).

Previous records of rodents are confined only to limited areas (Searight 1987; Hatough-Bouran et Al-Eisawi 1990) or refer to occasional collections from the Syrian Desert (Atallah 1978; Harrison et Bates, 1991). One recent study (Scott et Dunstone 2000) investigated the composition of rodent communities and the environmental parameters that are important in determining such a composition, the study was situated in the area under the Badia research and development project and did not include the whole North Eastern desert.

Hatough-Bouran and Al-Eisawi (1990), studied the rodent ecology at Shaumari Wildlife Reserve. Of the seven species recorded, they found that *J. jaculus* and G. *dasyurus* were the two most abundant species in the reserve. This study was followed by an extensive study of configurations of rodent borrows belonging to *J. jaculus* and *G. dasyurus* in the reserve (Hatough-Bouran 1990). Recently, Scott et Dunston (2000) studied the spatial and temporal distribution of rodent communities in the northeast Badia, where they reported nine rodents.

Twenty-six species of rodents representing seven families (Hystricidae, Spalacidae, Sciuridae, Dipodidae, Muridae, Gliridae and Cricetidae) occur in Jordan (Amr 2000), these include fifteen species that are considered to be desert dwellers inhabiting arid and semiarid habitats.

Gerbillus cheesmani has a wide range of distribution extending from the Arabian Peninsula through Iraq, Iran, Afghanistan and Pakistan to the east. It is a strictly psammophilic rodent, inhabiting areas with very soft wind-blown sand only (Lay 1967, Hassinger 1973, Lay et al. 1970, Harrison 1972). Cheesman's gerbil was first recorded in Jordan form near Disi in Wadi Ramm area, which represents a favourable habitat for this species (Qumsiyeh 1996).

The present study is one of the few publications dealing with the diversity, ecological preference and distribution among rodents in the Northeastern Desert of Jordan.

MATERIALS AND METHODS

Rodents and/or rodent remains were collected from different sites covering all vegetation types and habitats distributed throughout the study area. Eleven sites (Fig. 1) were selected based on their substrate and vegetation differences, all being influenced by the arid and semi arid geographic zones of the Syrian and Arabian Deserts. The study area covers two biogeographic regions; the Saharo Arabian, which comprises most of the area with diversified subdivisions of vegetation types, and the Irano-Turanian region along the northern side of the area. Accordingly, vegetation types and substrate cover divide the area into gravel flat deserts (Hammed), saline flat dunes (Sabkhah), rocky basaltic fields and boulders (Harra), wadi beds, flat sandy sheets and low land depressions (Marab). The region is characterized by its cold winters with temperatures going down to –10 °C, and very hot summers with temperatures exceeding 40 °C. Annual rain fall ranges between 50–150 mm. The soil is very poor, mostly of Hammed, saline, sandy or mudflat types (Disi et Amr 1998; Disi et al. 1999).

Rodents were trapped during different seasons in the period between 1998–2001. Sherman folding live-traps (23x9x9cm) were set for one or two consecutive nights in each site, 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.

Burrows belonging to *G. cheesmani* were investigated during June–October 2001. The study was undertaken in Al Wisad area. This area is a typical habitat for psammophile species. Four burrows were excavated using a short shovel, and the number of openings, food and nesting chambers, and tunnel length and width were recorded. A scaled diagram for two burrows was mapped.

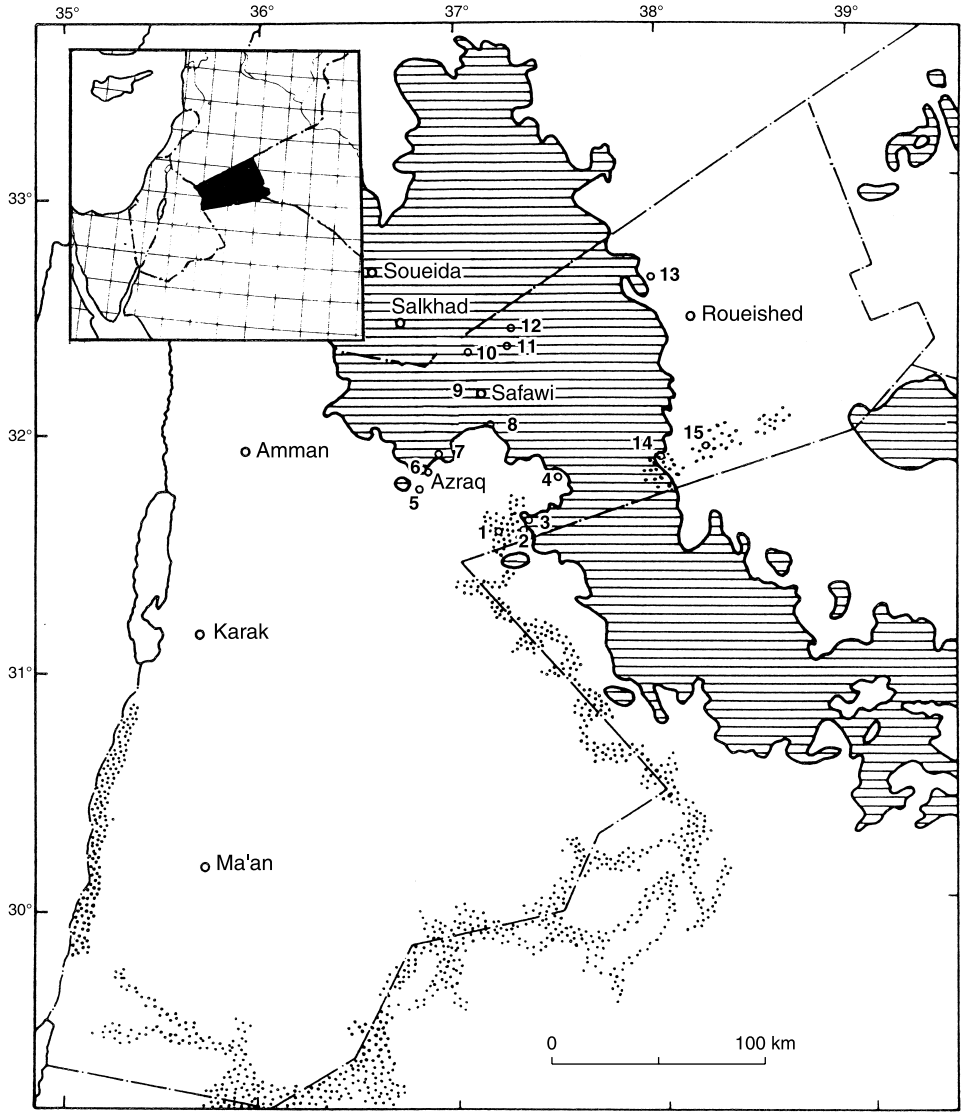

Fig. 1. The Northeastern Desert of Jordan showing study sites. 1 – Faydat ad Dahikiyah; 2 – Hazim; 3 – Al Ghamr; 4 – Qattafi; 5 – Shawmari; 6 – Azraq ash Shishan; 7 – Azraq ad Duruz; 8 – Buqay'awiyah; 9 – Safawi; 10 – Jawa; 11 – Hashad; 12 – Wadi Salma; 13 – Qasr Burqu'; 14 – Al Wisad; 15 – Dumaythat.

The examined materials (skin and/or skull) are deposited at the Jordan University of Science and Technology museum (JUSTM), Irbid, Jordan. Rodents were released after being recorded and identified or recorded as remains in owl pellets.

HABITATS AND LOCALITIES INVESTIGATED

Basaltic fields and boulders (lava desert)

This area lays within the Saharo-Arabian region which constitutes the majority of the

country, locally it is referred harra, where it is covered with bare black basaltic pebbles which originated from ancient volcanic activities. Vegetation of the area is poor, lichens cover most rocks in the area turning their color into white, the plant covers concentrate in water sheds and small wades where they get more support by the soil moisture.
Localities: Azraq ad Duruz, Buqay'awiyah, Hashad, Jawa, Qasr Burqu', Safawi and Wadi Salma.

The flat low land areas (marab)
These are flat depressions of land with soil of various origins, mostly calcareous. The vegetation cover is highly dependent on the season. Dominant plants include: *Artimesia* sp., *Origanum* sp. and *Achillea fragrontissima*.
Localities: Buqay'awiyah, Hashad, Wadi Salma.

Saline dunes (sabkhaht)
This type occurs in depressions and water sheds (run-off wadis) with high salty soil providing the areas with a fascinating landscape appearance, having the wind blown sand covering bushes and shrubs in the middle of the Hammed vegetation. Vegetation is dominated by wild palm, *Phoenix dactylifera*, *Nitraria retusa* and *Tamarix* sp. Other plants include; *Peganum hormola*, *Retama raetam Alhai maurorum, Astragalus dactylocorpus,* and *Atriplix* sp.
Localities: Hazim, Faydat ad Dahikiyah and Azraq ash Shishan.

Wadi beds
The red sand dune areas were seen as either patches in the middle of the Hammada vegetation south of Ruwieshid, or as thickly vegetated low wadis surrounded by a series of rocky cliffs and basaltic mountains of the Harra vegetation as in Al Wisad area. The sand dunes are dominated mainly by *Hmmada salicornica*.
Localities: Al Wisad and Qattafi.

Sandy sheets
These areas are composed of several patches and stretches of sand sheets fixed in the middle of the gravel deserts. Soft wind-blown sand stabilizes in low areas supported by healthy vegetation cover of *Seidlittzia rosmarinus*.
Localities: Dumaythat.

Flat deserts (gravel Hammada)
The gravel Hammed is a flat desert of clayey loam covered by gravel. Vegetation is dominated by low shrubs of *Seidlittzia rosmarinus* and some annual shrubs and succulent plants as; *Spergularia diandra*, *Herniaria hirsute* and *Anthemis deserti*.
Localities: Al Ghamr and Shawmari.

RESULTS AND DISCUSSION

Family Dipodidae
Allactaga euphratica THOMAS, 1881

Localities: Jawa and Shawmari Wildlife Reserve.
The Five-toed jerboa is a very rare and secretive animal; it was never encountered during

the present study. Previous records include, Jawa (Searight 1987) and As Shawmari (Hatough-Bouran and Eisawi 1990). The species was collected from Qaisumah, northeast Saudi Arabia (Lewis et al. 1965).

Jaculus jaculus (LINNAEUS, 1758)

Material examined: JUSTM620, (Skin, Skull), ♂, Hazim, 3. 9. 2000; JUSTM621, (Skin, Skull), ♀, Dumaythat, 5. 9. 2000; JUSTM622, (Skin, Skull), ♂, Dumaythat, 5. 9. 2000; JUSTM626, (Skin, Skull), ?, Shawmari, 14. 8. 2001.

Localities: Shawmari Wildlife Reserve, Azraq ash Shishan (observations), Hazim, Safawi (owl pellets), Rwieshid (Dumaythat), Hashad, Faydat ad Dahikiyah (observations), Buqay'awiyah (owl pellets), Qattafi Al Wisad and Qasr Burqu' (observations).

The Three-toed jerboa is probably the most common jerboa of the Badia area. Although it prefers open flat areas with scattered vegetation (Hammada), it was collected and spotted in different areas of the lava desert and sand dunes. Skull remains of this rodent were recovered from the pellets of *Athene noctua* in Safawi area. This is a strictly nocturnal rodent with no specific time of activity. It was encountered during different periods at night; after sunset, early night hours and after midnight. Burrows are usually located in open areas and are plugged with soft sand during daytime. No other rodents are known to share its burrow. This jerboa was found along with *G. nanus*, *G. henlyi* and *M. crassus*.

This is a common rodent for all arid habitats in Jordan, the authors collected the Three-toed jerboa from the sandy deserts of Wadi Rum, Wadi Araba and Jafr. It comprised 17 % of the diet of *Bubo bubo* in Dahek area and 2.1% of the diet of *Athene noctua* at Safawi (Al-Melhim et al. 1997; Rifai et al. 2000). In Saudi Arabia, it was found to inhabit a wide variety of habitats including sabkha, sandy deserts and alluvial desert depressions (Büttiker et Harrison, 1982; Bauer, 1988). Lewis et al. (1965) reported the Three-toed jerboa as one of the commonest rodents throughout the deserts of the Arabian Peninsula.

Family Gliridae

Eliomys melanurus (WAGNER, 1839)

Localities: Al Wisad, Jawa and Azraq ad Duruz.

During the study, the dormouse was recorded only once in a rocky edge of a densely vegetated wadi at Al-Wisad area. The area is located at the most southeastern corner of the lava desert, the record extends the known range for this species from the closest known records from the northern parts of Wadi Rajil at Jawa area (Searight, 1987) and Azraq basin (Atallah, 1967;1978).

The occurrence of the garden dormouse in this desert habitat is noteworthy since it is originally an arboreal rodent. The authors collected this rodent from arid mountains of Wadi Rum desert where it was found to exists with *Sekeetamys calurus*, *Acomys cahirinus, A. russatus* and *G. dasyurus* and from oak forests at Dana Nature Reserve (unpublished data). It was reported from arid mountains of Sinai and the rocky hills of Negev (Krasnov, 1996). The Arabian garden dormouse became adapted to semi arid non-arboreal life style 1.2 million years ago (Bates, 1996).

Family Muridae

Acomys russatus lewisi ATALLAH, 1967

Material examined: JUSTM655, (Skin, Skull), ♂, Azraq ad Duruz, 10. 3. 2000;

JUSTM657, (Skin, Skull), ♂, Azraq ad Duruz, 31.8.2000; JUSTM658, (Skin, Skull), ♂, Jawa, 24.12.2000; JUSTM659, (Skin, Skull), ♀, Azraq ad Duruz, 28.11.2001; JUSTM660, (Skin, Skull), ♂, Azraq ad Duruz, 28.11.2001.
Localities: Jawa, Azraq ad Duruz, Wadi Salma (owl pellets) and Buqay'awiyah (owl pellets).

The melanistic form of the Golden spiny mouse was found to be a strictly rock-inhabitant, it was collected from very arid rocky cliffs within the lava desert. Although this mouse was recorded as diurnal (Searight, 1987 and Al-Melhim et al. 1997), it was never seen or trapped during the day. Small individuals were caught during late summer. The activity of the Golden spiny mouse is known to shift to daytime if it coexists with the Cairo spiny mouse, *A. cahirinus,* (Kronfeld et al. 1994) as in the Dead Sea region.

Individuals of this species were successfully kept in captivity, they were fed sunflower seeds and supplied with water. 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 Wadi Rum 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 (3–5 individuals).

Atallah (1967) treated the melanestic form as a distinct species (*A. lewisi*) according to bacular morphology, whereas Qumsiyeh et al (1986) considers the two forms as conspecific due to having the same chromosome number. This suggests that the spiny mice in Jordan should be considered as separate species rather than a subspecies.

Family Cricetidae
Cricetulus migratorius (PALLAS, 1773)

Localities: Jawa.
The Gray hamster was not trapped or seen during the course of the present work. It was previously reported in the Badia region including a specimen from Jawa (Searight, 1987) and a recovery of a skull from Eagle owl pellets from Dahik (Rifai et al. 2000).

Family Gerbillidae
Gerbillus dasyurus (WAGNER, 1842)

Material examined: JUSTM327, (Skin, Skull), ♂, Jawa, 23. 12. 2000; JUSTM328, (Skin, Skull), ♀, Azraq ad Duruz, 24. 12. 2000; JUSTM337, (Skin, Skull), ♂, Burq'u, 15. 02. 2001; JUSTM339, (Skull), ♂, Azraq ad Duruz, 11. 8. 2001; JUSTM340, (Skull), ♂, Burq'u, 23. 8. 2001; JUSTM346, (Skin, Skull), ♂, Burq'u, 5. 9. 2001; JUSTM352, (Skull), ?, Azraq ad Duruz, 8. 9. 2001; JUSTM357, (Skull), ♂, Burq'u, 12. 9. 2001; JUSTM373, (Skin, Skull), ♂, Ruwaishid, 29. 9. 2001; JUSTM399, (Skin, Skull), ♂, Burq'u, 24. 10. 2001; JUSTM400, (Skin, Skull), ♀, Burq'u, 24. 10. 2001; JUSTM401, (Skin, Skull), ♂, Burq'u, 24. 10. 2001; JUSTM406, (Skin, Skull), ♂, Azraq ad Duruz, 29. 10. 2001; JUSTM426, (Skin, Skull), ♀, Azraq ad Duruz, 28. 11. 2001; JUSTM436, (Skin, Skull), ♀, Jawa, 23. 12. 2001; JUSTM437, (Skin, Skull), ♀, Jawa, 23. 12. 2001; JUSTM438, (Skin, Skull), ♀, Al Wisad, 22. 9. 2001.
Localities: Wadi Salma, Hashad, Buqay'awiyah (pellets of *Athene noctua*), Qasr Burqu', Azraq ad Duruz, Shawmari Wildlife Reserve (pellets of *Tyto alba*), Al Wisad and Jawa.

This gerbil is one of the most common rodents in the studied area. The preference for rocky areas with low vegetation and high avoidance of sandy soil was clearly observed. In Safawi area, it constituted 5.1% of the diet content of the little owl (Al Melhim et al. 1997). Although variations in the pelage colour was seen during the study ranging from light brown to dark brown, the darker form was more common. It was mostly found to coexist with the spiny mouse, *A. r. lewisi* in the lava desert.

Hatough-Bouran (1990) presented a thorough study on the burrow system of the Wagner's gerbil inhabiting Shawmari Wildlife Reserve, she found that the run-off wadis was the most preferred habitat rather than the Hammada type vegetation.

Gerbillus cheesmani THOMAS, 1919

Material examined: JUSTM310, (Skin, Skull), ♀, Dumaythat, 5. 9. 2000; JUSTM311, (Skin, Skull), ♀, Dumaythat, 5. 9. 2000; JUSTM321, (Skin, Skull), ♂, Dumaythat, 20. 9. 2000; JUSTM322, (Skin, Skull), ♂, Dumaythat, 23. 9. 2000; JUSTM330, (Skin, Skull), ♂, Dumaythat, 1. 2. 2001; JUSTM331, (Skin, Skull), ♂, Dumaythat, 1. 2. 2001; JUSTM332, (Skin, Skull), ♂, Dumaythat, 1. 2. 2001; JUSTM355, (Skin, Skull), ♂, Al Wisad, 10. 9. 2001; JUSTM356, (Skull), ♀, Al Wisad, 12. 9. 2001; JUSTM366, (Skull), ♂, Al Wisad, 22. 9. 2001; JUSTM432, (Skin, Skull), ♀, Al Wisad, 4. 12. 2001; JUSTM433, (Skin), ♂, Al Wisad, 4. 12. 2001.

Localities: Dumaythat, Al Ghamr, Qattafi (released) and Al Wisad.

The occurrence of this elegant gerbil in the Badia area is rather interesting having its distribution confined to soft wind-blown sand dunes areas. These areas are found mainly in the southern borders of the studied area along the Saudi borders. The soft sand stabilizes at lower wadis of the Hammada area serving to extend the range of this gerbil northwards. Cheesman's gerbil was found to be the most solitary of the recorded rodents as no other species was collected in the same area where it lives, except for 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.

Gerbillus cheesmani could be described as a grainivorous rodent. The incisors are well developed for removing shells of seeds as being the main diet of this species. The animal was found to survive in isolated or mixed plant associations dominated by *Haloxylon percicum*, *Anabasis articulata*, *Hammada salicornica* and *Seidlittzia rosmarinus*.

In the present study, *G. cheesmani* was reported from ten localities throughout Jordan including: Wadi Ramm, Disi, Al Quwierah, Ras en Naqb, Al Mudawwara, Jafr, Qattafi, Ghamr, Al Wisad and Dumeithat, south of Ruwishid.

In Wadi Ramm area, Cheesman's gerbil occurs among *H. percicum*, *H. salicornica* and *A. articulata* shrubs. Although the specimens were trapped in higher numbers among *H. salicornica* and *A. articulate* communities, it was found to be the only rodent inhabiting *Haloxylon* vegetation in that area. 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*.

Specimens from Al Wisad and Dmeithat south of Ruweishid, extends the known range of *G. cheesmani* to the east of the Badia region, the closest record for this species is the Qattafi record by Scott and Dunstone (2000). The two areas are separated by the range of basaltic fields and rocky boulders. The nearest record for this species occurs in Turaif, northeastern Saudi Arabia (Lewis et al. 1965). The new records in eastern parts of the Badia regions fills

up the gap of distribution of *G. cheesmani* between its closest records in Iraq (Hatt 1956), northeastern Saudi Arabia (Lewis et al. 1965) and eastern Syria (Kock 1998).

Cheesman's gerbil is the sole rodent species inhabiting sand dunes. No other rodents were found in association with the *G. cheesmani* burrow system. It is a strictly nocturnal species and was never trapped or seen during daytime. This activity pattern was also observed among captive animals. However, Hassinger (1973) reported seeing at least ten individuals retrieving seeds from the top of a shrubby *haloxylon* under an appreciable amount of daylight in Afghanistan.

Only on peripheries of sand dunes and around mudflats, *G. cheesmani* was found to live in sympatry with *G. nanus,* the later is a naked-soled gerbil inhabiting salty terrains. Other species living in the proximity of *G. cheesmani* includes: *Meriones libycus, M. crassus* and *G. henleyi.*

Pregnant females were collected in March, August and September from Wisad. Within one burrow system, three and four sucklings in two nesting chambers were observed during August. Juveniles were caught in August from Wisad and Dmeithat.

Perhaps, the horned sand viper, *Cerastes gasperettii* and the desert monitor, *Varanus griseus* are among the predators of Cheesman's gerbil. On several occasions, traps were molested (opened) by foxes and only tail remains indicated that *G. cheesmani* was the victim.

Four burrows were excavated during the present work. Figure 2 shows an upper view of two burrow systems. Number of openings ranged 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 fecal 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.

The burrow system of *G. cheesmani* was excavated during an ectoparasite survey conducted by the Trans-Arabian Pipeline Company (Lewis et al. 1965). In their study, Lewis et al. (1965) described its burrow as an extensive network of tunnels possessing 3 to 4 entrances of varying degree of use. The burrow was found to extend up to 2 meters attaining the depth of 125 cm. The nesting chamber was located at the maximum degree of depth. Only vegetation material was used as nesting material.

Furthermore, this study investigated the burrow system for *G. cheesmani* within its range of distribution.

Further studies should focus on the intra and inter-relationship of rodent communities in a desert ecosystem for example. Yet, the ecological niche for each of these gerbils is still to be investigated.

Gerbillus nanus BLANFORD, 1875

Material examined: JUSTM305, (Skin, Skull), ♂, Hazim, 15. 7. 2000; JUSTM306, (Skin, Skull), ♂, Hazim, 4. 9. 2000; JUSTM307, (Skin, Skull), ♂, Hazim, 4. 9. 2000; JUSTM308, (Skin, Skull), ♂, Azraq, 5. 9. 2000; JUSTM312, (Skin, Skull), ♂, Azraq, 5. 9. 2000; JUSTM313, (Skin), ♀, Hazim, 5. 9. 2000; JUSTM314, (Skin, Skull), ♀, Haz-

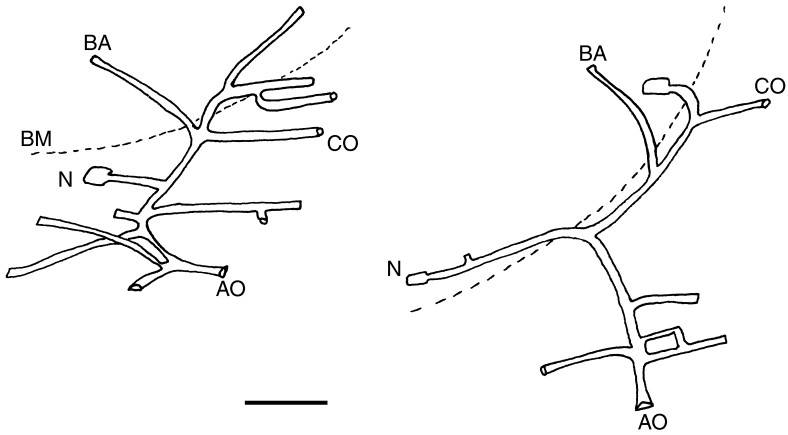

Fig. 2. Burrow system of *Gerbillus cheesmani* excavated in Al Wisad. AO = active opening; CO = closed opening; BA = blind allay; N = nest chamber; BM = bush margin (Scale bar 50 cm).

im, 5. 9. 2000; JUSTM315, (Skin, Skull), ♀, Hazim, 5. 9. 2000; JUSTM316, (Skin, Skull), ♀, Azraq, 5. 9. 2000; JUSTM341, (Skull), ♂, Azraq, 23. 8. 2001; JUSTM342, (Skin, Skull), ♂, Shawmari, 28. 8. 2001; JUSTM343, (Skull), ♂, Azraq, 28. 8. 2001; JUSTM344, (Skin), ♀, Faydat ad Dahikiyah, 4. 9. 2001; JUSTM345, (Skin, Skull), ♂, Al Ghamr, 4. 9. 2001; JUSTM347, (Skin, Skull), ♀, Faydat ad Dahikiyah, 5. 9. 2000; JUSTM348, (Skin), ♀, Faydat ad Dahikiyah, 5. 9. 2001; JUSTM349, (Skin, Skull), ♀, Shawmari, 6. 9. 2001; JUSTM350, (Skin, Skull), ♀, Shawmari, 6. 9. 2001; JUSTM351, (Skin, Skull), ♀, Shawmari, 6. 9. 2001; JUSTM353, (Skin), ♀, Azraq, 9. 9. 2001; JUSTM354, (Skin), ♀, Azraq, 9. 9. 2001; JUSTM430, (Skin, Skull), ♂, Hazim, 3. 12. 2001.

Localities: Hazim, Azraq ad Duruz, Azraq ash Shishan, Shawmari Wildlife Reserve, Al Ghamr and Faydat ad Dahikiyah.

The Baluchistan gerbil was collected from low sandy wadis with considerable salty nature and characterized by rich plant cover of *Nitraria retusa* or *Tamarix* sp. in Hazim and Azraq. It was found coexisting with either one of the large-sized jirds, *M. crassus* or *M. libycus*. *Gerbillus nanus* can be distinguished from the similar bare-footed gerbil, *G. dasyurus* by cranial characters. This gerbil along with *G. cheesmani*, inhabit the sand dunes of Wadi Rum mostly around the mud flats, and the salty terrains (Sabkhah) areas in Wadi Araba (Amr, 2000). Openings of borrows for both *G. nanus* and *M. crassus* were seen under bushes of *N. retusa* in Hazim.

Gerbillus henleyi (DE WINTON, 1903)

Material examined: JUSTM395, (Skin, Skull), ♂, Shawmari, 22. 10. 2001.

Localities: Hazim, Shawmari Wildlife Reserve and Faydat ad Dahikiyah.

The pygmy gerbil is the smallest rodent known to inhabit the Arabian Peninsula. It was collected from the Hammada areas with scarce vegetation cover. *G. henleyi* was mostly associated with the Sand jird, *M. crassus* and the Three toed jerboa, *J. jaculus*. The authors collected the Pygmy gerbil from El Jafr and Mudawwarah area in southern Jordan

Table 1. Species distribution in all collecting Localities.

Basaltic fields and boulders Species	The flat low land areas (lava desert)							Saline dunes (marab)			Wadi (sabkhaht)			beds		Sandy sheets	Flat deserts (gravel Hammada)	
	Buqay'awiyah	Azraq ad Duruz	Hashad	Jawa	Qasr Burqu'	Safawi	Wadi Salma	Buqay'awiyah	Hashad	Wadi Salma	Hazim	Faydat ad Dahikiyah	Azraq ash-Shishan.	Al Wisad	Qattafi	Dumaythat.	Al Ghamr	Shawmari
Family Dipodidae																		
Allactaga euphratica				+														+
Jaculus jaculus					+	+		+	+		+	+	+	+	+			+
Family Gliridae																		
Eliomys melanurus		+		+										+				
Family Muridae																		
Acomys russatus lewisi	+	+		+			+											
Family Cricetidae																		
Cricetulus migratorius				+														
Family Gerbillidae																		
Gerbillus dasyurus	+	+	+	+	+		+							+				+
Gerbillus nanus											+	+	+				+	+
Gerbillus cheesmani														+	+	+	+	
Gerbillus henleyi											+	+						+
Meriones libycus syrius											+	+	+	+				+
Meriones crassus								+	+	+	+	+			+			+

where it was also associated with the sand jird. Collected specimens did not exceed 10 g in weight.

Meriones libycus syrius LICHTENSTEIN, 1823

Material examined: JUSTM509, (Skin, Skull), ♀, Hazim, August, 1997; JUSTM510, (Skin, Skull), ♂, Hazim, August, 1997; JUSTM511, (Skin), ?, Hazim, August, 1997; JUSTM512, (Skin), ?, Hazim, August, 1997; JUSTM513, (Skin), ?, Hazim, August, 1997; JUSTM525, (Skin, Skull), ♀, Azraq ash Shishan, 31. 8. 2000; JUSTM526, (Skin, Skull), ♀, Al Wisad, 14. 10. 2000; JUSTM529, (Skin), ♀, Hazim; JUSTM530, (Skin, Skull), ♂, Al Wisad, 22. 11. 2000; JUSTM531, (Skin, Skull), ♂, Al Wisad, 10. 11. 2000. Localities: Azraq ad Duruz, Azraq ash Shishan, Al Wisad, Hazim, Faydat ad Dahikiyah (released) and Shawmari Wildlife Reserve (released).

This is the largest rodent recorded from the Eastern Desert. It was seen active in the early morning hours at Al-Wisad area. The Libyan jird is a colonial rodent, it was caught in groups around the same borrow system which had several close openings. The Libyan jird was found to coexist with *M. crassus*, *G. nanus* and *G. henleyi* in many areas such as Hazim, Dahik and Ash Shawmari.

Meriones crassus SUNDEVALL, 1842

Material examined: JUSTM551, (Skin, Skull), ♀, Hazim, 10. 4. 2000; JUSTM552, (Skin, Skull), ♂, Hazim, 10. 4. 2000; JUSTM553, (Skin, Skull), ♀, Hazim, 1. 7. 2000.

Localities: Buqay'awiyah (owl pellets), Hazim, Shawmari Wildlife Reserve (released), Wadi Salma, Hashad (owl pellets), Faydat ad Dahikiyah and Qattafi (released).

The sand jird is a very common rodent for the study area collected from a wide range of habitats. Colonies of this jird dominated the sand dunes of Hazim area, it was collected from low lands (Marab) between the Harra vegetation and the open areas. it was associated with either one of the small sized gerbils *G. henleyi* and *G. nanus*. Skull remains were recovered from eagle owl pellets at Hazim area.

It comprised the highest proportion (18.8 and 10.4%) of the diet of both *Bubo bubo* at Dahik (Rifai et al. 2000) and of *Athene noctua* from Safawi area (Al-Melhim et al. 1997) respectively.

The highest species diversity was seen in the sand dune habitats of Hazim (as five species were collected; *M. crassus*, *M. libycus*, *G. nanus*, *G. henleyi* and *J. jaculus*) characterized by the rich healthy plant cover. The lowest diversity was in the red sand dunes in Rweishid area where only one species (*G. cheesmani*) was recorded.

Habitat distribution (or the so-called habitat preference) of individual species was clearly observed for most of the recorded species (Table 1). *Gerbillus henleyi* is one species that inhabits flat areas with gravel surfaces with scarcely vegetated patches. *G. cheesmani* was confined to sand dunes, whereas *G. nanus* occurred in large sandy wadis. *Acomys russatus lewisi* and *G. dasyurus* were restricted exclusively to rocky areass. *Eliomys melanurus* was found mainly in densely vegetated habitats located in riverbeds and on slopes. *M. crassus* occurred more frequently in more vegetated patches, along with *J. jaculus* these two species were seen to have the broadest distribution in the whole studied area. This pattern of distribution among the different species indicates their special responses to environmental gradients.

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APPENDIX

Gazetteer for collecting Localities.

Locality	E	N		Locality	E	N
Al Ghamr	31 41	37 17		Hazim	31 34	37 14
Al Wisad	31 35	37 57		Jawa	32 20	37 02
Azraq ad Duruz	31 53	36 50		Qasr Burqu’	32 37	37 58
Azraq ash Shishan	31 50	36 49		Qattafi	31 55	37 29
Buqay’awiyah	32 03	37 07		Safawi	32 10	36 49
Dumaythat	31 56	38 10		Shawmari	31 47	36 49
Faydat ad Dahikiyah	31 33	37 10		Wadi Salma	32 25	37 15
Hashad	32 29	37 15				