Introduction

The genus *Gerbillus* Desmarest, 1804 is one of the most diversified groups of rodents inhabiting arid and semi arid habitats in North and East Africa, the Arabian Peninsula and the Indian desert (HARRISON, 1972; LAY, 1983; NOWAK, 1991). Due to the variation in habitat structure, rodents of the genus *Gerbillus* form an important component of the mammalian fauna in these arid zones as they are adapted to tolerate extreme desertic conditions (LAY, 1983; HARRISON & BATES, 1991; QUMSIYEH, 1996; GRANJON et al., 1999).

Karyotypic investigations support taxonomic studies and provide significant clarifications to confirm morphological differences for particular taxa. So far, only one report presented karyotypic data for these animals from Jordan (QUMSIYEH et al., 1986).

Two species of the genus *Gerbillus* were included; *G. dasyurus* (2N=60, FN= 66, 68 and 70) from the Lava rock desert south of Azraq ad Duruz, Shaumari Wildlife Reserve and Al Aqabah and *G. nanus* (2N=52, FN= 60) from Al Aqabah, Wadi Araba (Wadi El Khanazir) and Azraq (karyotypes not provided).

Karyotypic investigations were conducted on six species of the genus *Gerbillus* occurring in Jordan. These gerbils belong to two groups; naked-footed (*G. dasyurus, G. henleyi* and *G. nanus*) and hairy footed ones (*G. andersoni, G. cheesmani* and *G. gerbillus*). The diploid number ranged between 38–60 and 62–80 respectively. The study confirmed the doubtful presence of *G. andersoni* in Jordan.


Abstract

Karyotypic studies were conducted on six species of the genus *Gerbillus* occurring in Jordan. These gerbils belong to two groups; naked-footed (*G. dasyurus, G. henleyi* and *G. nanus*) and hairy footed ones (*G. andersoni, G. cheesmani* and *G. gerbillus*). The diploid number ranged between 38–60 and 62–80 respectively. The study confirmed the doubtful presence of *G. andersoni* in Jordan.

Kurzfassung


Key words

*Gerbillus*, karyotype, taxonomy, Jordan.
six were regarded as intermediate and the remaining two species were considered to be unknown. Table 1 summarizes reported karyotypes for species of the genus *Gerbillus* occurring in Jordan.

Lay *et al.* (1975) studied the karyotypes for 20 species of the genus *Gerbillus*. The report included karyotypic results for *G. andersoni* (2N=40 and FN=80 from Egypt), *G. gerbillus* (2N 42 q, 43 s and FN 76 q and 78 s from Sinai, Egypt and Morocco), *G. nanus* (2N 52 and FN as 61 s and 62 q) and *G. henleyi* (2N =52 and FN 61 s and 62 q) from Morocco. This genus was recently reviewed in Jordan based on morphologic and morphometric characters (Abu Baker & Amr, 2003).

The present study investigates karyotypic features for six species of the genus *Gerbillus* occurring in Jordan and contributes to the taxonomy of this genus.

### Materials and Methods

**Specimens examined:** Mitotic chromosomes were analyzed from 45 specimens representing different populations for all species of the genus *Gerbillus* in Jordan.


**Chromosome Preparation:** Chromosomes were obtained from femoral bone marrow cells and processed as described by Tjio & Whang (1992) and Nadler & Lay (1968). Standard karyotypes were constructed from micrographs of well spread chromosomes. Metaphase chromosomes were arranged in homologous pairs according to size and centromere position. The diploid chromosome number was determined from ten photographed spreads for each species. The fundamental number (FN) was counted after constructing the standard karyotypes, only metacentric and submetacentric chromosomes were considered as bi-armed chromosomes (Volobouev *et al.*, 1995). Sex chromosomes were identified from the difference between male and female karyotypes (the presence of an identical X chromosome in both). Results were used to compare the present data with previously published reports.

**Results**

Based on the diploid chromosome number (2N), species of the genus *Gerbillus* in Jordan are classified into two groups: the first consists of three species with diploid numbers ranging from 38–43. This group includes *G. andersoni, G. cheesmani* and *G. gerbillus*, with 2N of 40, 38 and 42q/43s, respectively (Table 1). All species of this group are hairy-footed gerbils. The second group also contains three species with 2N between 52 and 60. This group includes *G. dasyurus, G. henleyi* and *G. nanus* with diploid numbers (2N) of 60, 52 and 52, respectively. These three species are naked-footed gerbils.

**Hairy-footed gerbils:**

*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. *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 (Fig. 1). *G. gerbillus* have a 2N=42q/43s and FN=70 (female specimen). The autosomal complement of the female includes 18 metacentric, 10 submetacentric, 6acrocentric and 6 telocentric chromosomes. The X is a large acrocentric chromosome. Due to the lack of clear spreads and probably the small size, the two Y chromosomes could not be identified.
Naked-footed gerbils:

*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 (Fig. 2).

*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.

*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.

Discussion

Table (1) shows the diploid chromosome number for all species of the genus *Gerbillus* investigated in the present study and previously published reports.

Karyotypes for all species of the genus *Gerbillus* known to Jordan were previously reported from other parts of their distribution, while the karyotypic pattern for *G. dasyurus* and *G. nanus*, were studied based on animals collected from Jordan (QUMSIYEH et al., 1986).

The present study is considered as the first attempt to study the karyology of the remaining four species of *Gerbillus* occurring in Jordan (*G. andersoni*, *G. cheesmani*, *G. gerbillus* and *G. henleyi*).

The chromosome number for all species of the genus *Gerbillus* under the present study are in agreement with previous reports, however, some differences appear in their morphology. Hairy-footed species of the genus *Gerbillus*, showed higher number (34 or more) of bi-armed chromosomes, and the highest number of telocentric chromosomes in this group was 4, reported among *G. cheesmani* population. On the other hand, naked-footed species of the genus *Gerbillus* possessed a high number of acrocentric autosomes, reaching up to 48, 42 and 42 chromosomes in *G. dasyurus* and *G. nanus* and *G. henleyi*, respectively. The XY chromosome system was shared in all species, except for *G. gerbillus*, which showed a XY$_2$Y$_1$ system.

The chromosome pattern of *G. dasyurus* is clearly different from its closer naked-footed relatives (*G. henleyi* and *G. nanus*). This chromosomal divergence along with other morphologic differences could be easily used to determine the specific level for these species. The diploid numbers for the examined specimens of *G. dasyurus* was 60 and FN 71, with a unique X chromosome, which is a large metacentric one. QUMSIYEH et al. (1986) reported fundamental numbers in *G. dasyurus* from Azraq Oasis population as 66 and 68 and 70 from Ghor Nimrin (sex chromosomes are not included). WASSIF et al. (1969) reported FN for Egyptian specimens as 69 and 70. For the same species, LAY & NADEL (1975) reported FN as 68 from Sinai, while WAHRMAN & ZAHAVI (1955) reported FN for Wagner’s
Tab. 1. Diploid chromosome numbers (2N) and Fundamental numbers (FN) for species of the genus *Gerbillus* according to previous studies.

<table>
<thead>
<tr>
<th>Species</th>
<th>Surface of hind feet</th>
<th>2N</th>
<th>Autosomes M+SM</th>
<th>A+T</th>
<th>Sex chromosomes X</th>
<th>Y</th>
<th>FN</th>
<th>Country</th>
<th>Citation</th>
</tr>
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<tr>
<td><em>G. andersoni</em></td>
<td>Hairy</td>
<td>40</td>
<td>38</td>
<td>–</td>
<td>S</td>
<td>M</td>
<td>80</td>
<td>Jordan</td>
<td>Present study</td>
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<td></td>
<td>40</td>
<td>38</td>
<td>–</td>
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<td>80</td>
<td>Egypt</td>
<td>Wassif et al., 1969</td>
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<td></td>
<td>40</td>
<td>38</td>
<td>–</td>
<td>S</td>
<td>M</td>
<td>80</td>
<td>Egypt</td>
<td>Lay et al., 1975</td>
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<td></td>
<td></td>
<td>40</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td></td>
<td>Tunisia</td>
<td>Cockrum et al., 1977</td>
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<tr>
<td><em>G. cheesmani</em></td>
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<td>38</td>
<td>32</td>
<td>4</td>
<td>M</td>
<td>–</td>
<td>72</td>
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<td>34</td>
<td>2</td>
<td>M</td>
<td>S</td>
<td>74</td>
<td>Iran</td>
<td>Lay and Nadler. 1975</td>
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<tr>
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<td>42</td>
<td>43</td>
<td>O</td>
<td>43</td>
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<td>28</td>
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<td>Present study</td>
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<td><em>G. dasyurus</em></td>
<td>Naked</td>
<td>60</td>
<td>10</td>
<td>48</td>
<td>M</td>
<td>T</td>
<td>71</td>
<td>72</td>
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<td>52</td>
<td>8</td>
<td>42</td>
<td>S</td>
<td>S</td>
<td>62</td>
<td>Jordan</td>
<td>Present study</td>
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<td>11–13</td>
<td>39–41</td>
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<td>Lay et al., 1975</td>
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<td>62</td>
<td>Tunisia and Burkina Faso</td>
<td>Volobouev et al., 1995</td>
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<td><em>G. nanus</em></td>
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<td>52</td>
<td>8</td>
<td>42</td>
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<td>62</td>
<td>Jordan</td>
<td>Present study</td>
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<td>Tunisia</td>
<td>Jordan et al., 1975</td>
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<td>Jordan</td>
<td>Qumsiyeh et al., 1986</td>
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<td>S. A. and Pakistan</td>
<td>Volobouev et al., 1995</td>
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</table>
gerbil as 66 and 68 from Sinai.

The present results showed the highest degree of similarities between the two bare-footed gerbils, *G. henleyi* and *G. nanus* both in morphologic (Abu Baker & Amr, 2003) and cytologic features. In addition to the identical chromosome numbers, chromosome features are very much similar between these two species whereas both showed the same number of submetacentric and acrocentric as well as having similar X chromosome morphology. Diploid and fundamental numbers of *G. nanus* examined in the present study are in agreement with those reported from Palestine (Wahrman & Zahiwi, 1955), Iran (Lay & Nadler, 1975) and Morocco and Pakistan (Lay et al., 1975). *G. henleyi* karyotypic pattern is consistent with previous reports from Egypt (Wassef et al., 1969), Morocco (Lay et al., 1975). Total number of autosomal arms was reported from Senegal as 60 (Granjon et al., 1992) and 62 from Tunisia and Burkina Faso (Volobouev et al., 1995).

*G. andersoni* was found as an isolated population south of Ras’ en Naqb. Results showed a diploid number of 40 and FN=80. This result is consistent with all previous records for this species (Table 1). Due to chromosomal similarities, Cockrum et al. (1976) considered *G. andersoni*, *G. eatoni* and *G. altenbyi* as conspecific, however, Lay (1983) denied this conclusion.

Chromosome morphology for Jordanian specimens of *G. cheesmani* differs from those described by Lay & Nadler (1975) from Iran. The present result indicates the presence of two pairs of uni-armed chromosomes (considered here as telocentric) rather than only one pair of acrocentric chromosomes (Lay & Nadler, 1975). The karyotype is identical to the superficially similar *G. aquilus* in Iran and Pakistan which was previously described as a race of *G. cheesmani* (Lay & Nadler, 1975). *G. aquilus* does not possess any acrocentric chromosomes in its karyotype. Lay & Nadler (1975) presented evidence to consider *G. aquilus* as a valid species.

Cheesman’s gerbil is the largest of the known Gerbillus species in Jordan; it is superficially distinguished by its more orangish back color and by the undeveloped tail tuft. Unlike other species of hairy-footed gerbils in Jordan, the skull of *G. cheesmani* has a well-developed tympanic bulla which exceeds the supra occipital bone (Abu Baker & Amr, 2003). *G. gerbillus* is readily distinguished by its karyotype of 2N=42 in females and 43 in males. The multiple sex chromosome system was first described by Matthew (1954). Jordan et al. (1974) presented the karyotypes of a male and a female *G. gerbillus* from Tunisia. Karyotype for this species was previously reported from several regions (table 1). Unlike other authors (e.g. Lay et al., 1975; Jordan et al., 1974), the X chromosome in *G. gerbillus* was considered here as a large acrocentric one. The difference in classification schemes of chromosomes according to morphology causes some differences in the calculated FN. This discrepancy could be over-com by C-banding techniques to identify the specific location of the centromere.

Karyotypic studies proved to be useful in distinguishing species of this genus through the wide range of chromosomal morphology and numbers, especially when carried out in combination with both external and cranial morphology. However, given the normal chromosome pairs seen in the karyotypes, the existence of any chromosomal irregularities can only be resolved by using more advanced techniques.

Future studies employing advanced technique (i.e. chromosome banding techniques, mitochondrial DNA sequencing, etc.) may be considered to assess our understanding to these little known animals. Such approaches could be used in cytotaxonomy, morphology and ecology, which may address evolutionary relationships among similar taxa.

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References


