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A Karyological Study of Some Murid Rodents (Rodentia: Muridae) of Iran

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ABSTRACT

Family Muridae consists of eight genera and 28 species in Iran. This family shows notable variability of karyological features. In this study, karyological data derived from 11 species of 7 genera of this family of Iran are presented and compared with previously published accounts. The included species were: *Mus musculus musculus* from Gonbad (2n=40, FN=40) and Birjand (2n=40, FN=38), *Rattus norvegicus* (2n=42), *Apodemus uralensis* (2n=48), *Apodemus avicennicus* (2n=48), *Apodemus hyrcanicus* (2n=48), *Apodemus witherbyi* (2n=48) from Zanjan and Gorgan, *Nesokia indica* (2n=42), *Meriones libycus* (2n=44), *Meriones persicus* (2n=44), *Meriones crassus* from Kashmar (2n=54) and Tabas (2n=60), *Tatera indica* from Zabul (2n=68) and Hoveyzeh (2n=66) and *Rhombomys opimus* (2n=40).

Keywords: Rodentia, Muridae, Karyology, Iran

Introduction

Family Muridae consists of 5 subfamilies, 150 genera and 763 species, comprising about 15 percent of the 5676 of mammal species currently identified (Musser and Carleton, 2005). Comparing with other mammalian species, Muridae species despite high morphologic similarity generally display much higher variability of karyotypes (Romanenko *et al.,* 2007). The chromosome number of family members range from 2n=10 in the South American *Akodon* species, which is the lowest diploid chromosome number known for rodents, to 2n=102 in the red viscacha rat *Tympanoctomys barrerae*, which is the largest known chromosome number of any mammal (Nakamura *et al.,* 2007).

Muridae are represented by 8 genera and 28 species in Iran (Karami *et al.,* 2008). Until recently, only few karyotypes of rodents of Iran have been presented and karyological investigations on Murid rodents of Iran have mainly been focused on *Nesokia indica*, *Meriones persicus*, *Meriones libycus*, *Meriones crassus*, *Meriones meridianus*, *Meriones tristrami*, *Meriones vinogradovi*, *Rattus norvegicus*, *Mus musculus*, (Khosravi and Darvish, 1999; Yiğit *et al.,* 2006; Moradi, 2009; Shirani Bidabadi *et al.,* 2009) and *Tatera indica* (Mirshamsi *et al.,* 2007). So, this study can provide the possibility of applying karyological investigations to ascribing taxonomic identification of unknown individuals. In this study chromosomal status within and among species and populations of the family Muridae from various geographic localities and multiple individuals were investigated.

Materials and Methods

118 Murid specimens were captured from different regions of Iran (Table 1 and Fig.

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1). Sample codes of specimens are available in the Rodentology Research Department of Ferdowsi University of Mashhad, Iran. Chromosome preparations were obtained from bone marrow cells according to Yosida (1973). About 20 to 50 metaphase plates from both male and female specimens were examined and at least 20 good chromosomal spreads were photographed using ax100 zoom digital CCD camera. The ideograms of all specimens were prepared by the Chromosome Image Processing software (CIP) software created at the Rodentology Research Department of Ferdowsi University of Mashhad, Iran. Chromosomes were classified according to Levan and each was placed next to its presumed homologue to determine the diploid chromosome number (2n), autosomal fundamental number (FNa) and fundamental number (FN).

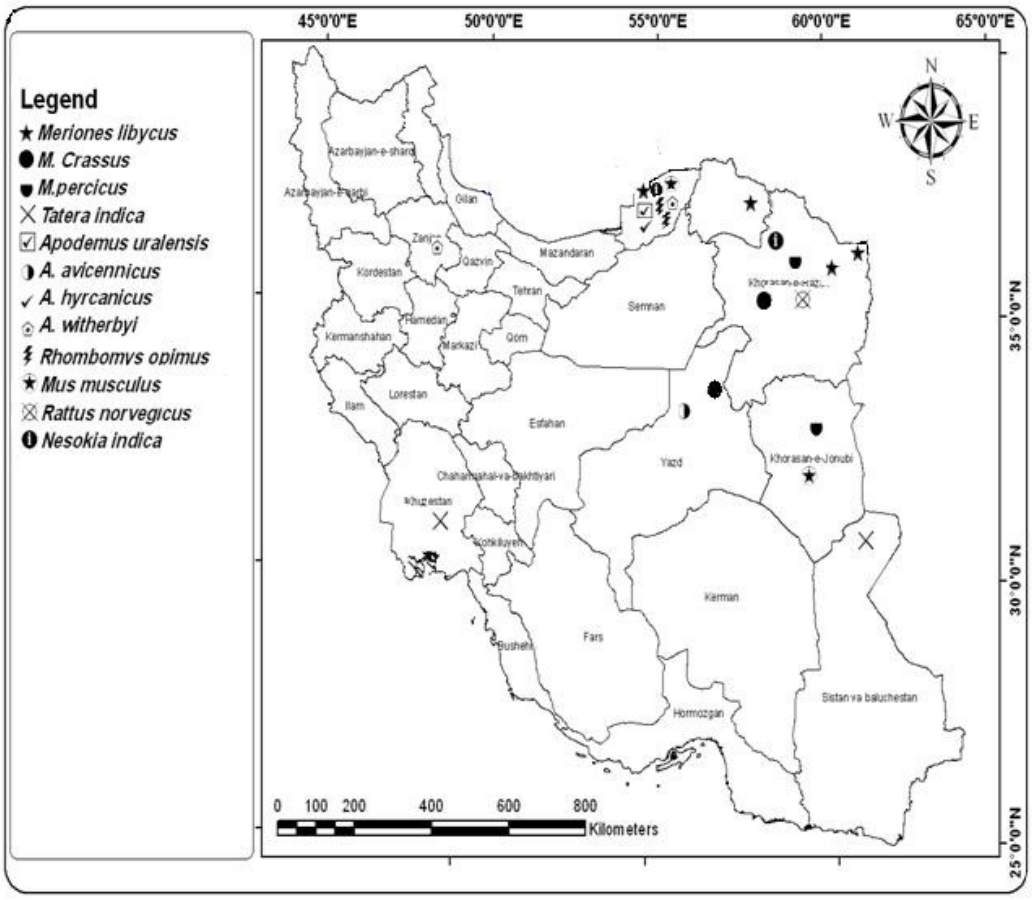


Figure1. Map of specimen collection sites for the of Murid rodents in Iran.

Results

In this study, 118 specimens of rodents of Iran including 11 species were karyologically studied. The karyological characteristics of each species are described below. In addition, the information concerning the karyological features of these species are summarized in Table 1.

Murinae Illiger, 1811

Genus *Mus* Linnaeus, 1758

In this genus, specimens of *M. musculus musculus* from Gonbad and Birjand were

studied. The results of karyological studies in this species included 2n=40, FN=40 and FNa=38. *All autosomes were found to be* acrocentric. The X chromosome was a large acrocentric while the Y was a very small and acrocentric (Table 1 and Fig. 2a, b). This result is in agreement with previous reports on this species Zanjan and Mashhad (Painter, 1928; Dobigny *et al.,* 2002; Yiğit *et al.,* 2006; Moradi, 2009).

Genus *Rattus* Fisher, 1803

Karyological study revealed diploid number of 2n = 42 and FNa=56 in *R. norvegicus* from Mashhad, Khorasan province. This species represented 8 pairs of metacentric or submetacentric and 12 pairs of acrocentric or subtelocentric chromosomes. The X and Y chromosomes were large and small acrocentric respectively, which were in concordance with previous reports (Makino, 1942; Yiğit *et al.,* 1998; Moradi, 2009) (Table 1 and 3).

Genus *Apodemus* Kaup, 1829

In this genus samples belonging to four species *A. uralensis* (from Gorgan)*, A. avicennicus* (from Yazd)*, A. hyrcanicus* (from Gorgan) and *A. witherbyi* (from Gonbad and Zanjan) were karyologically studied. This is the first study in which the karyotype of *A. avicennicus* is being reported. These four species were characterized by a diploid number of 48, and autosomal fundamental of 46, except for *A. uralensis* which had FNa=48 (Table 1 and Fig. 4a, b, c, d). The X and Y chromosomes were medium to large-sized submetacentric and acrocentric, respectively. All of the autosomes chromosomes were acrocentric. The morphology of the chromosomes is relevant to the results obtained by Macholan *et al.* (2001) and Çolak *et al.,* (2005).

Genus *Nesokia* Gray, 1842

In this genus karyotype of *N. indica* specimens from the east of Iran were studied. The specimens have 2n=42 diploid chromosome number, which is in agreement with previously published accounts (Shirani Bidabadi *et al.,* 2009). However, the karyological result of the individual from Gorgan indicated FNa=56 as opposed to FNa=54 of specimens from Mashhad (Table 1 and Fig. 5a, b). In specimens of Gorgan, there were 8 pairs of meta-submetacentric and 12 pairs of acrocentric chromosomes. In the species *N. indica*, the X was a large metacentric with equal arms, whereas the Y was a large acrocentric (Fig. 5a).

Gerbillinae Gray, 1825

Genus *Meriones* Illiger, 1811

In this genus specimens of *M. libycus, M. persicus* and *M. crassus* from different localities of Iran were studied. The karyotype study demonstrated 2n=44 for *M. libycus* and FNa varied from 70 to 76. The chromosome results of specimens from Khorasan Province were in accordance with those previously published (Yiğit *et al.,* 2006) while Gonbad specimens showed different results (Table 1). The X chromosomes of *M. libycus* were medium-sized metacentric while the Y was considered as a small submetacentric (Fig. 6a, b, c, d). Only a single specimen from Gonbad had a small metacentric X and acrocentric Y (Fig. 6d).

Specimens of *M. crassus* from two different localities of Iran were studied. This species has a diploid number of 2n=54 (Kashmar) and 60 (Yazad and Tabas), the fundamental autosomal arm number (FNa) were not

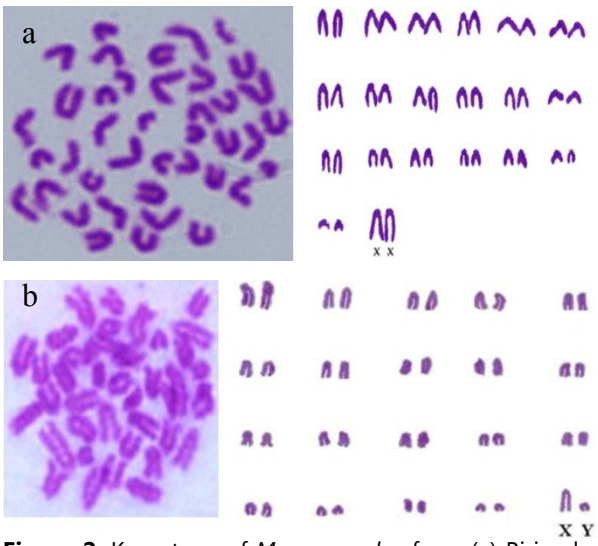


Figure 2. Karyotype of *Mus musculus* from (a) Birjand (b) Gonbad.

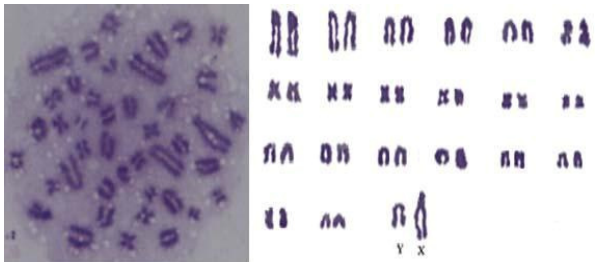


Figure 3. Karyotype of *Rattus norvegicus* Mashhad.

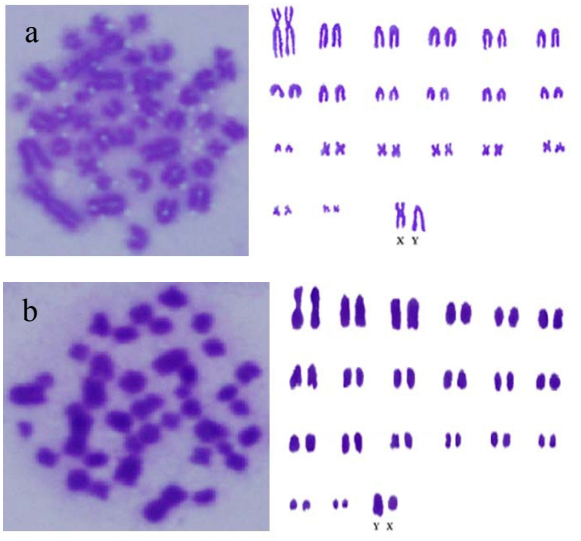


Figure 5. Karyotype of *Nesokia indica* (a) Gorgan (b) Mashhad.

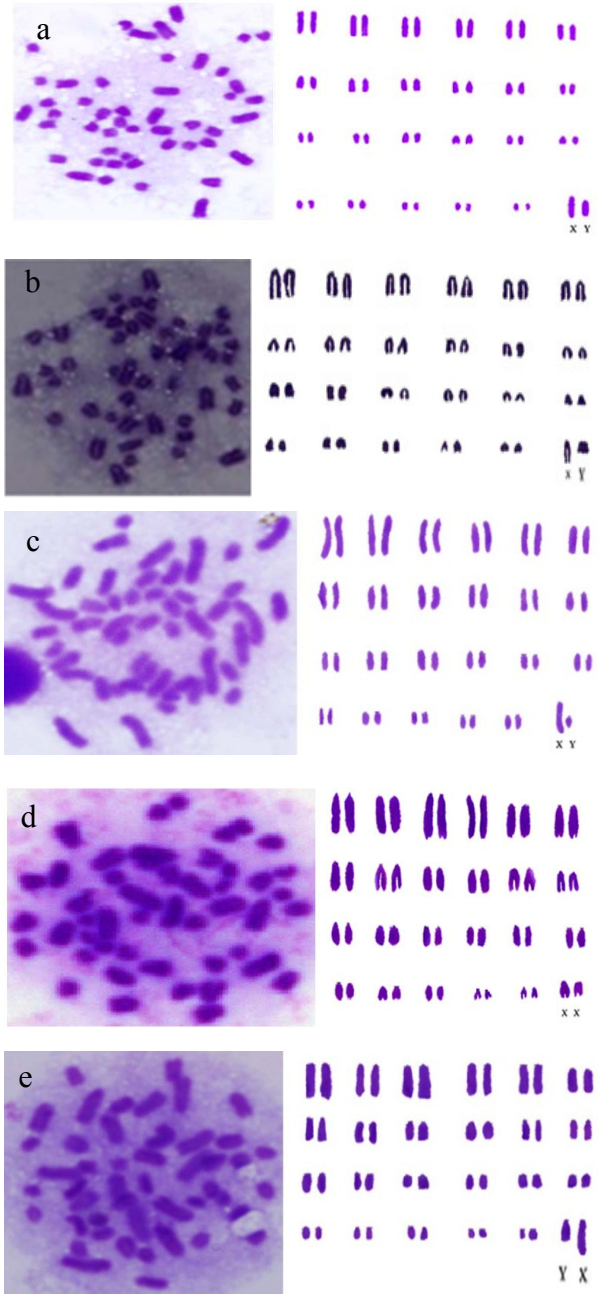


Figure 4. Karyotype of genus *Apodemus*. (a) *A. uralensis* (b) *A. avicennicus* (c) *A. hyrcanicus* (d) *A. witherbyi*, Gonbad (e) *A. witherbyi*, Zanjan.

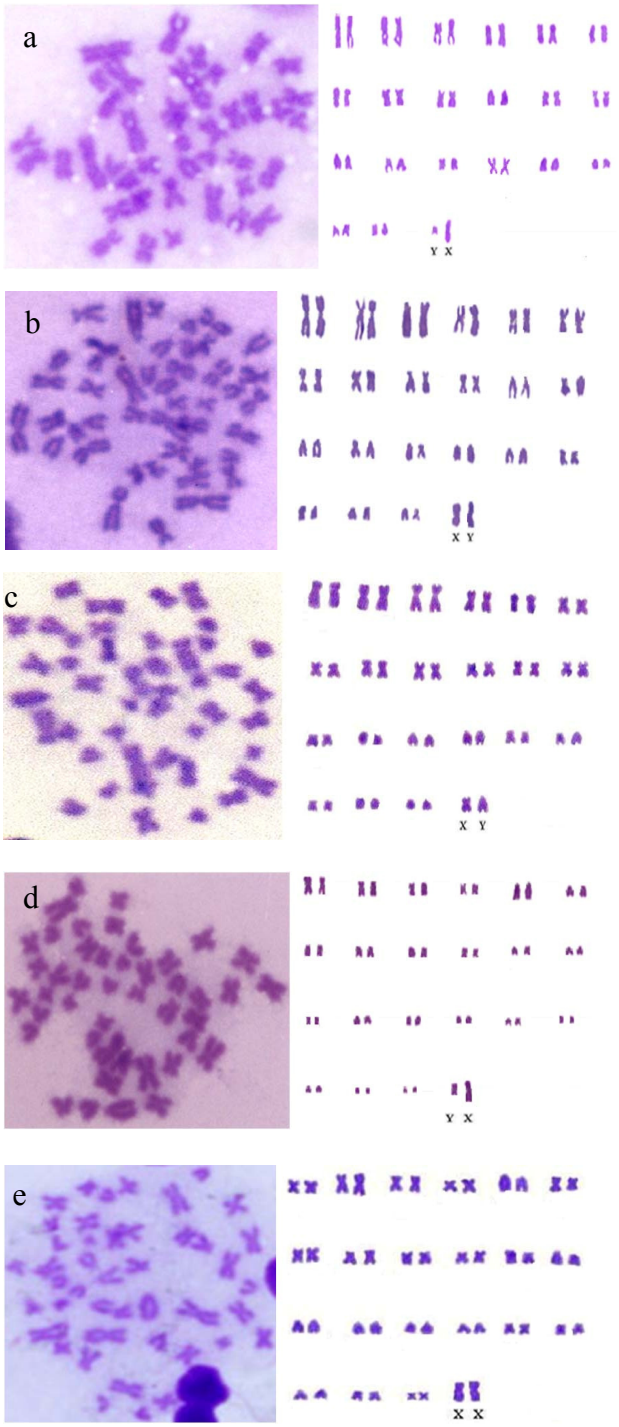


Figure 6. Karyotype of *Meriones libycus* (a) Zavin, Mashhad (b) Yazdtapeh, Sarakhs (c) Shirvan Boujnord (d) male Gonbad and (e) female Gonbad.

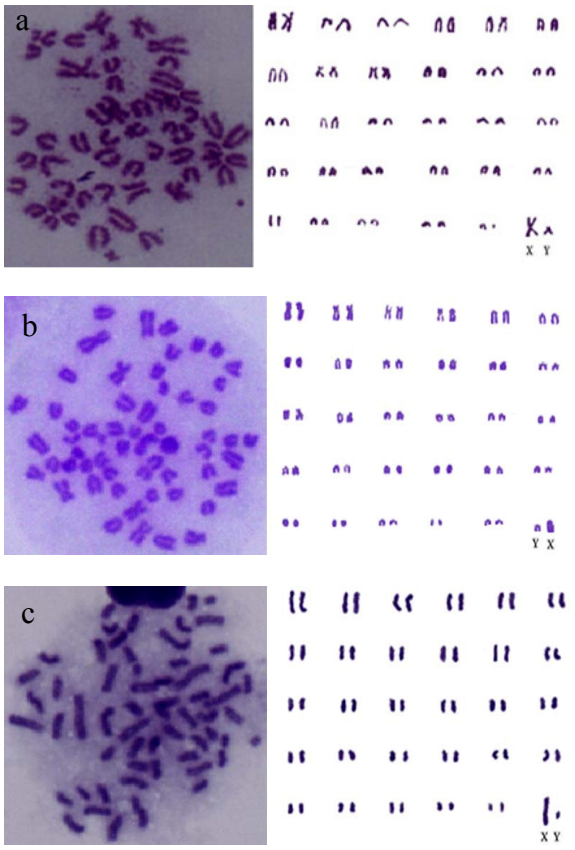


Figure 7. Karyotype of *Meriones crassus* (a) Kashmar (b) Tabas and (c) Dehshir, Yazd.

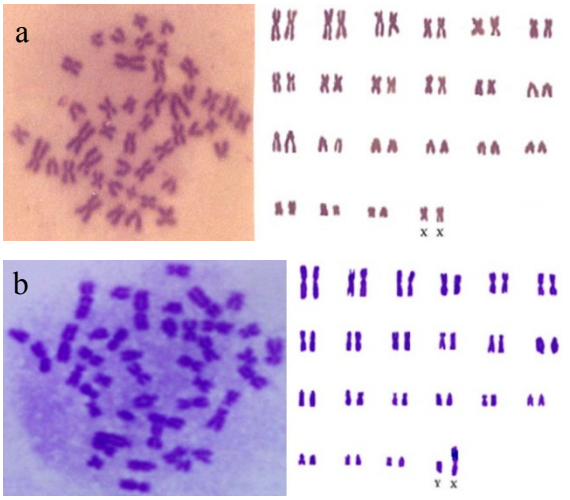


Figure 8. Karyotype of *Meriones percicus* (a) Birjand (b) Nayshabou.

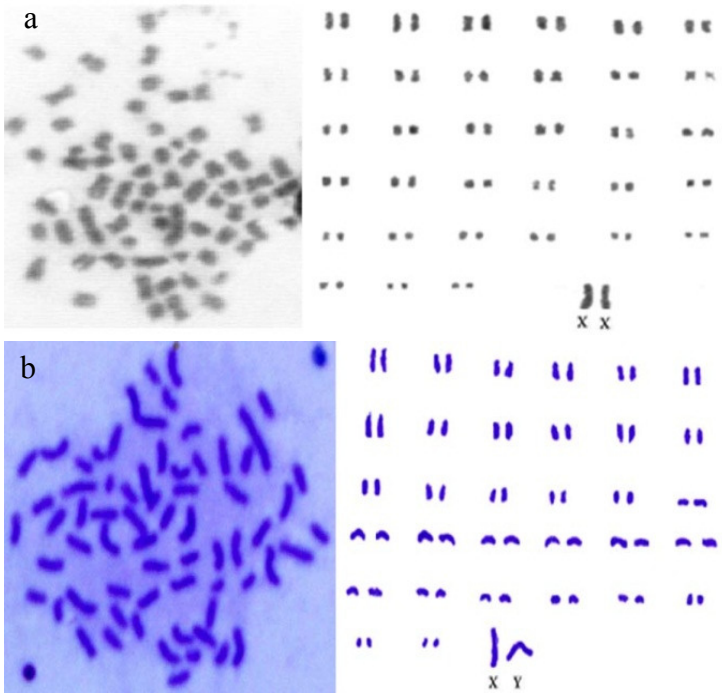
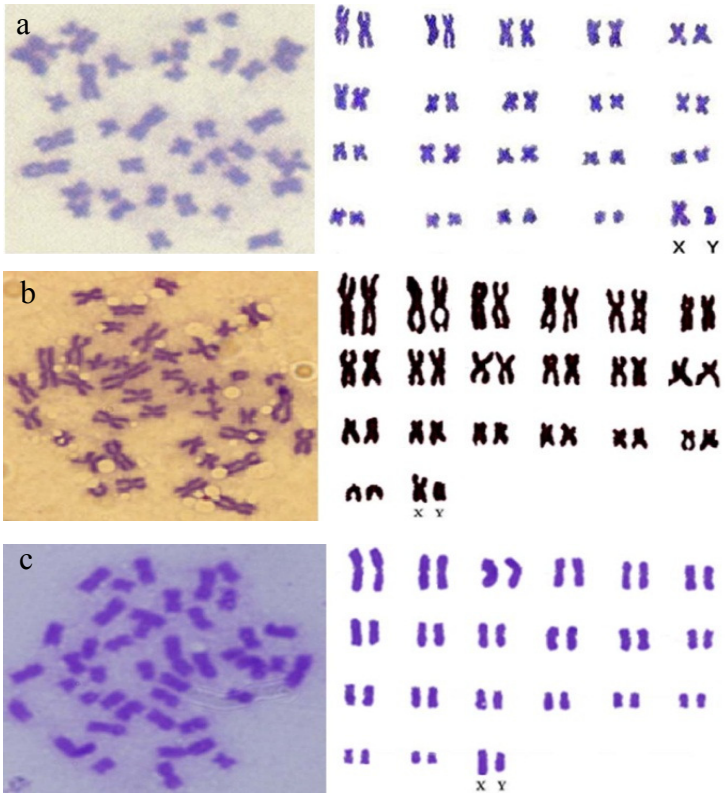


Figure 9. Karyotype of *Tatera indica* (a) Zabol (b) Hoveyzeh.



Fguire 10. Karyotype of *Rhombomys opimus* (a) Gonbad (b) Bandar Torkaman and (c) Gorgan.

Table 1. Characteristics of Karyotype in Murid Rodents from different localities of Iran

Species	Samples locality	Latitude	Longitude	2n	FNa	Samples codes
Mus musculus	Birjand	32º 50'	59º 14'	40	38	-
M. musculus	Gonbad	37º 10′	55 °10′	40	38	1701
Rattus norvegicus	Mashhad	36º 17'	59º 36'	42	56	1456
Apodemus uralensis	Gorgan	37º 17'	54º 39'	48	48	1932
A. avicennicus	Yazd	37º 20'	55º 14'	48	46	1122
A. hyrcanicus	Gorgan	37º 25'	54º 38'	48	46	1860
A. witherbyi	Gonbad	37º 15'	55º 09'	48	46	-
A. witherbyi	Zanjan	36º 42'	48º 32'	48	46	2240
Nesokia indica	Gorgan	36º 47'	54º 26'	42	56	2008
N. indica	Mashhad	36º 49'	58º 31'	42	54	2231
Meriones libycus	Zavin, Mashhad	36º 18'	60º 29'	44	74	14
M. libycus	Yazdtapeh, Sarakhs	36º 36'	61º 01'	44	76	174
M. libycus	Sarakhs	36º 29'	61º 06'	44	76	175
M. libycus	Shirvan	37º 24'	57º 55'	44	76	197
M. libycus	Gonbad	37º 50'	54º 55'	44	70	1713
M. libycus	Gonbad	37º 50'	54º 55'	44	72	1715
M. crassus	Kashmar	35º 13'	58º 13'	54	64	1371
M. crassus	Tabas	33º 35'	56º 55'	60	70 to 80	1423
M. crassus	Dehshor, Yazd	33º 49'	56º 47'	60	70 to 80	1451
M. percicus	Darmian, Birjand	33º 00'	59º 48'	44	78	553
M. persicus	Somehe, Neyshabour	36º 16'	58º 50'	44	80	2177
Tatera indica	Zabol	31º 01'	61º 29'	68	80 to 84	1117
T. indica	Hoveyzeh	31º 27'	48º 04'	66	80 to 84	2099
Rhombomys opimus	Gonbad, Golestan	37º 13'	54º 35'	40	76	1858
R. Opimus	Bandar Torkaman	37º 27'	56º 53'	40	76	2009
R. Opimus	Gorgan	37º 35'	48º 08'	42	80	2005

obvious but was a figure between 70 and 80 (Table 1 and Fig. 7a, b, c). Some of specimens were different karyologically from those have already been described in east of Iran (Khosravi and Darvish, 1999). The X chromosomes of three specimens were large matacentric, whereas the Y chromosome was telocentric.

All examined females of *M. persicus* from Birjand east of Iran consisting of 2n=44 chromosomes, with FNa of 78. The male specimens of this taxon from Nayshabour consisting of 2n=44 and FNa of 80 (Table 1 and Fig. 8a, b). The diploid numbers were different from previously published accounts (Yiğit and Çolak, 1999; Shirani Bidabadi *et al.,* 2009). On the other hand, X chromosomes were found to be submetacentric while the Y chromosome was telocentric (Fig. 8b) and for *M. persicus* from Birjand, the two X chromosome were submetacentric (Fig. 8a).

Genus *Tatera* Lataste, 1882

Only specimens of *T. indica* from Zabol, Sistan-Baluchistan province and Hoveyzeh, Khozestan province were studied. Specimens from Zabol showed a diploid number of 2n=68; although the fundamental autosomal arm number (FNa) were not clear but it was likely a figure between 80 and 84 which is in concordance with Yiğit *et al.* (2001) and Mirshamsi *et al.* (2007). Specimens from Hoveyzeh showed 2n=66. The X chromosome was a large metacentric

while the Y was a large acrocentric (Table 1 and Fig. 9a, b). The karyotype results obtained from Hoveyzeh specimens in the southwest of Iran were different from those previously obtained by Mirshamsi *et al.* (2007) on *T. indica* from south of Iran.

Genus *Rhombomys* Wagner, 1841

Specimens of *R. opimus* from different geographic regions of Golestan province in northeast Iran (Gonbad, Gorgan and Bandar Torkaman) were karyologically studied. The diploid number of 40 and a fundamental number of autosomes (FNa) of 76 were seen for *R. opimus* from Gonbad and Bandar Torkaman (Table 1 and Fig. 10a, b) while the diploid number specimens from Gorgan was 2n=42 and FNa=80 (Table 1 and Fig. 10c). The X chromosomes of three specimens were medium metacentric while Y chromosome was acrocentric.

Discussion

The average number of chromosomes in the order Rodentia is about 48. The members of this order all of whom have evolved from a common ancestor have experienced loss and gain of chromosomal parts or entire chromosomes (Painter, 1928). Stanyon *et al.* (2004) suggested a diploid number of 2n=54 for ancestral Murid forms and also proposed that the genus *Mus* underwent the highest number of chromosomal rearrangements during evolution.

As a whole, the extent of intra- and interspecific chromosomal variations are considerable in most species of rodents from Iran. For example, *Meriones crassus*, *Rhombomys opimus* and *Tatera indica* from different regions of Iran showed variation in diploid number and other karyotypic characteristics (Table 1). For *Meriones libycus* and *Rhombomys opimus,* specimens from different regions which had the same diploid numberdiffered in the fundamental number or type of chromosomes. Besides, there were some similarity and differences between our results and the karyotype of the same speciefrom other geographic regions due to intraspecific variation of chromosomal features.

In this study the lowest diploid number was belong to *Mus musculus* and *Rhombomys opimus* with 2n=40 and *Tatera indica* from Zabol had the highest diploid number which was 2n=68. Genus *Meriones* showed notable variation in diploid and fundamental number of chromosomes, reflecting high tolerance of this genus with respect to changes in chromosomal rearrangements. In contrast to *Meriones,* all four species of *Apodemus* showed a conserved diploid number of 2n=48. It may be that genetic balance causes quantitative and qualitative stabilization of chromosomes in this genus. In fact, only few speciation events have been concomitant with reconstruction of the karyotypes because the majority of alternations and rearrangements of chromosomes cause less reproductivity, viability and sterility (Painter, 1925; Bickham and Baker, 1979).

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