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Nucleolar organizer regions (NORs) in *Cricetulus migratorius* (Pallas, 1773) and *Meriones tristrami* Thomas, 1892 (Mammalia: Rodentia) from Central Anatolia

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Abstract: The distribution of nucleolar organizer regions (NORs) in *Cricetulus migratorius* and *Meriones tristrami* from Central Anatolia was determined. In the karyotype of *Cricetulus migratorius* the diploid number, fundamental number, and fundamental autosomal number are 22, 44, and 40, respectively. The diploid number, fundamental number, and fundamental autosomal number of *Meriones tristrami* are 72, 84, and 80, respectively. In *Cricetulus migratorius*, NORs occur in the telomeric regions of metacentric and subtelocentric autosome pairs. Furthermore, terminally located NORs in metacentric and acrocentric autosomes of *Meriones tristrami* are presented in this present paper.

Key words: *Cricetulus migratorius*, *Meriones tristrami*, karyotype, Ag-NOR banding, Turkey

Orta Anadolu'daki *Cricetulus migratorius* (Pallas, 1773) ve *Meriones tristrami* (Thomas, 1912)'de nükleolar organizatör bölgeler

Özet: Bu çalışmada Orta Anadolu *Cricetulus migratorius* ve *Meriones tristrami*'deki Nükleolar Organizatör Bölgeler (NORs)'in dağılımı incelenmiştir. *Cricetulus migratorius*'un karyotipinde diploid kromozom sayısı, temel kromozom sayısı ve otozomal kromozomların temel sayısı sırasıyla 22, 44, 40'dır. *Meriones tristrami*'nin diploid kromozom sayısı, temel kromozom sayısı ve otozomal kromozomların temel sayısı ise sırasıyla 72, 84, 80'dir. *Cricetulus migratorius*'da nükleolar organizatör bölgeler metasentrik ve subtelosentrik otozom çiftlerinin telomerik bölgelerinde tespit edilmiştir. Ayrıca, *Meriones tristrami*'nin metasentrik ve akrosentrik otozomlarındaki terminal nükleolar organizatör bölgeler gösterilmiştir.

Anahtar sözcükler: *Cricetulus migratorius*, *Meriones tristrami*, karyotip, Ag-NOR bantlama, Türkiye

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Introduction

Cricetulus migratorius (Pallas, 1773) (gray dwarf hamster) is distributed from SE Europe to Western China, including Turkey, while the range of *Meriones tristrami* Thomas, 1892 (Tristram's jird) extends in Turkey, the Middle East, and Transcaucasia (Musser and Carleton, 2005). Conventionally Giemsa stained karyotypes of both species and G- and C- banded chromosomes of *C. migratorius* have been determined from Turkey. The karyotype of *C. migratorius* possesses a diploid number (2n) of 22, a fundamental number (NF) of 44, and a number of autosomal arms (NFa) of 40. However, in *M. tristrami* 2n is 72 although NF and NFa show variation as 78-84 and 74-80, respectively (Doğramacı and Kefelioğlu, 1991; Kefelioğlu, 1997; Yiğit and Çolak, 1998; Demirbaş and Pamukoğlu, 2008; Arslan and Akan, 2008).

The aim of this study was to present the distribution of NORs in *Cricetulus migratorius* and *Meriones tristrami* from Central Anatolia.

Materials and methods

This study was carried out on 2 male gray dwarf hamsters caught from Ankara (39°18'N 32°20'E) and 3 female Tristram's jirds from Ankara and Kırıkkale (39°50'N 33°49'E) provinces in 2006.

The specimens were karyotyped according to Patton (1969). Approximately 7 slides were prepared each individual and 2 of them were stained with 4% Giemsa in phosphate buffer (pH 6.8) for conventional karyotypes. Silver staining of NORs was achieved by the method described by Howell and Black (1980). At least 10 metaphases were analyzed for the assessment of NOR-bearing chromosomes. Definition of the shapes of the chromosomes was established according to Levan et al. (1964). The diploid number (2n), fundamental number (NF), and fundamental autosomal number (NFa) along with the shapes of autosomes and sex chromosomes were also determined.

All stuffed skins and metaphase slides are deposited at the Department of Biology, University of Kırıkkale.

Results

Cricetulus migratorius (2n = 22, NF = 44, NFa = 40)

The chromosome set consisted of 5 pairs of metacentric (nos. 1-10), 1 pair of submetacentric (no. 7), and 4 pairs of subtelocentric (nos. 6 and 8-10) autosomes. The X and Y chromosomes were isomorphic and large subtelocentrics. The first metacentric chromosome pair was the largest of the set (Figure 1).

Chromosome shapes of *Cricetulus migratorius* were determined and are given in Table 1.

No secondary constriction was encountered in the metaphases examined. NORs were heteromorphic and occurred in the telomeric regions of 2 metacentric pairs (nos. 1 and 2) and homomorphic and occurred in the telomeric regions of 3 subtelocentric pairs (Figure 2).

Meriones tristrami (2n = 72, NF = 84, NFa = 80)

The chromosome set consisted of 5 pairs of metacentric (nos. 1-5) and 30 pairs of acrocentric (nos. 6-35) autosomes. We did not examine a male specimen and therefore the metacentric X chromosome in the karyogram was placed according to previous studies on this species (Figure 3).

Some of the NORs were heteromorphic and located in the telomeric regions of 2 metacentric pairs (nos. 2 and 3) and the others were homomorphic and located in the telomeric regions of 1 metacentric pair (no. 4). Furthermore, 7 acrocentric autosomes (nos. 6, 8, 9, 10, 12, 14, 16) also possessed telomeric NORs (Figure 4).

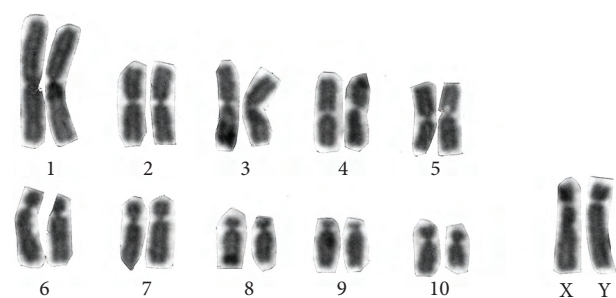


Figure 1. Conventionally stained karyotype of *Cricetulus migratorius*.

Table 1. Chromosome classification in *Cricetulus migratorius* from Central Anatolia (M: metacentric, SM: submetacentric, ST: subtelocentric) (p = short arm of the chromosome, q = long arm of the chromosome, PB = q/p, IC = p/(p + q) (100), D = (PB - 1) (10)/(PB + 1)).

Chromosome pair	p + q	PB	IC	D	Classification
1	23.53	1.11	47.30	0.52	M
2	14.15	1.16	46.21	0.74	M
3	15.42	1.08	48.05	0.38	M
4	11.52	1.02	49.30	0.09	M
5	13.04	1.03	49.15	0.14	M
6	9.80	3.99	25.00	5.01	ST
7	13.62	2.31	30.17	4.33	SM
8	9.34	5.06	16.48	6.69	ST
9	9.36	4.67	16.62	6.47	ST
10	9.31	4.55	15.67	6.39	ST
X	16.84	3.40	22.68	5.45	ST
Y	16.83	3.71	21.21	5.75	ST

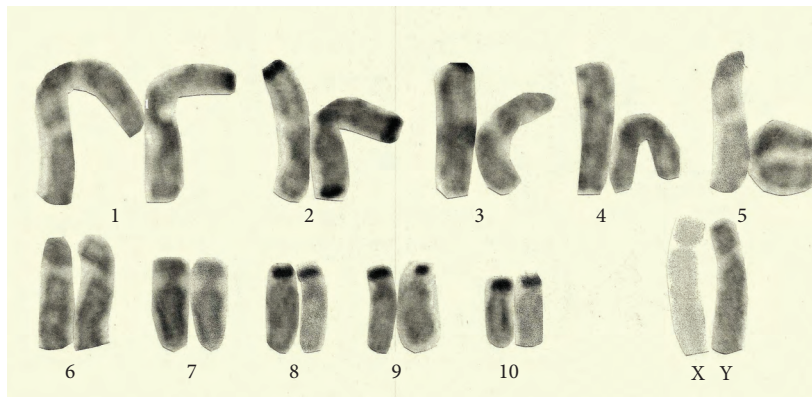


Figure 2. NOR-bearing chromosomes of Turkish *Cricetulus migratorius*.

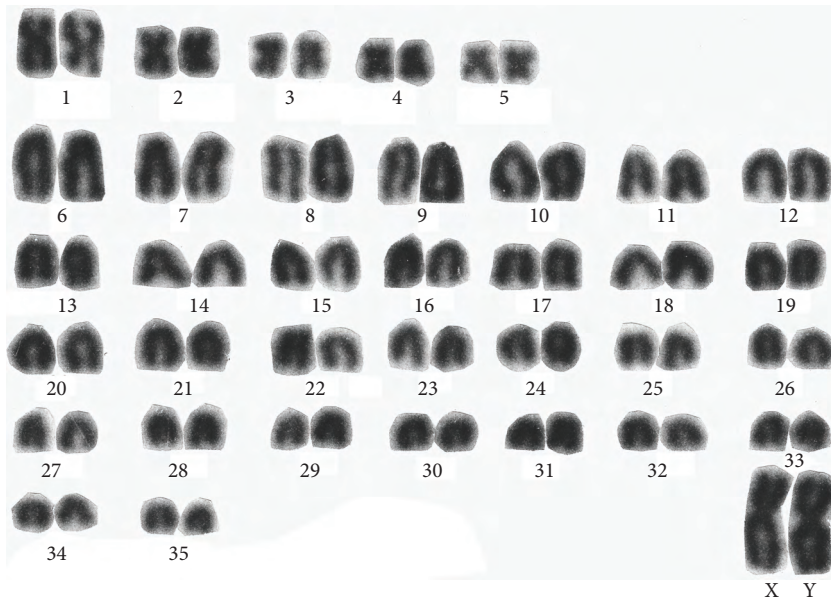


Figure 3. Conventionally stained karyotype of *Meriones tristrami*.

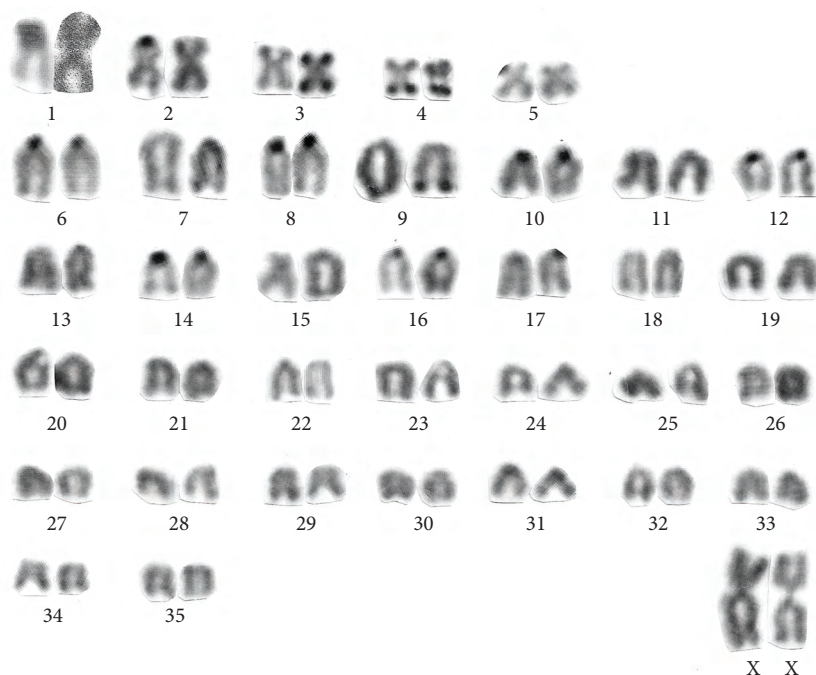


Figure 4. Silver-stained karyotype of *Meriones tristrami*.

Chromosome shapes of *Meriones tristrami* were determined and are given in Table 2.

Discussion

Our results from Central Anatolia were in accordance with the data on $2n$, NF, and NFA of *Cricetulus migratorius* given by Zima and Kral (1984), Doğramacı and Kefelioğlu (1991), Akhverdian (1993), and Arslan and Akan (2008). In contrast, Iranian specimens examined by Gharkheloo (2006) possessed a pair of acrocentrics; therefore, $2n$, NF, and NFA were recorded as 22, 42, and 38, respectively. Polymorphism was also recorded for *Cricetulus migratorius* specimens from Ukraine (Zagorodniuk, 1986). Arslan and Akan (2008) examined the G- and C- banded chromosomes of specimens from Konya and reported that the X and Y chromosomes differed in terms of G- and C-banding patterns. Zima and Kral (1984) determined centromeric heterochromatin blocks in all autosome pairs of the karyotype. In contrast, Arslan and Akan (2008) described only proximal and distal C-bands on chromosomes nos. 8 and 9, respectively. The dissimilarities between these

data could be due to the heterochromatin amounts in the European and Turkish specimens. In this study, we determined NORs in the telomeric regions of metacentric and submetacentric autosome pairs. Lavappa and Hay (1979) recorded NORs in 3 large and 1 small autosome pairs without indicating the chromosome shapes. Pathak et al. (1979) also determined terminally located NORs in 5 pairs of autosomes from Armenian specimens of *Cricetulus migratorius*. Our results however, were in accordance with those reported by Patnak et al. (1979).

Meriones tristrami shows variation in both fundamental and fundamental autosomal numbers due to the number of banded autosomes in the karyotype (Korobitsyna and Korablev, 1980; Zima and Kral, 1984; Qumsiyeh et al., 1986; Kefelioğlu, 1997; Yiğit et al., 1997; Yiğit and Çolak, 1998; Demirbaş and Pamukoğlu, 2008). In the present study, we determined $2n = 72$, NF = 84, and NFA = 80 as reported by Kefelioğlu (1997) and Demirbaş and Pamukoğlu (2008). In addition, we found terminally located NORs in metacentric and acrocentric autosomes.

Table 2. Chromosome classification in *Meriones tristrami* from Central Anatolia according to Levan et al. (1964) (M: metacentric, A: acrocentric) (p = short arm of the chromosome, q = long arm of the chromosome, $PB = q/p$, $IC = p / (p + q) (100)$, $D = (PB - 1) (10) / (PB + 1)$).

Chromosome pair	$p + q$	PB	IC	D	Classification
1	10.33	1.28	43.85	1.22	M
2	7.94	1.24	44.45	1.07	M
3	7.36	1.17	45.92	0.78	M
4	6.81	1.01	49.63	0.04	M
5	6.54	1.30	43.40	1.50	M
6	11.41	-	-	-	A
7	10.80	-	-	-	A
8	9.97	-	-	-	A
9	9.93	-	-	-	A
10	10.23	-	-	-	A
11	8.86	-	-	-	A
12	8.27	-	-	-	A
13	6.77	-	-	-	A
14	7.01	-	-	-	A
15	7.09	-	-	-	A
16	8.35	-	-	-	A
17	6.36	-	-	-	A
18	6.61	-	-	-	A
19	6.63	-	-	-	A
20	7.08	-	-	-	A
21	7.11	-	-	-	A
22	6.93	-	-	-	A
23	6.76	-	-	-	A
24	5.92	-	-	-	A
25	5.60	-	-	-	A
26	6.18	-	-	-	A
27	5.84	-	-	-	A
28	5.91	-	-	-	A
29	4.94	-	-	-	A
30	5.98	-	-	-	A
31	5.00	-	-	-	A
32	4.92	-	-	-	A
33	4.74	-	-	-	A
34	4.52	-	-	-	A
35	4.54	-	-	-	A
X	16.52	1.33	42.85	1.41	M

Not all NORs are usually stained at the same time because silver-nitrate staining of chromosomes in the metaphases phase is related to transcriptive activity of NORs at the previous interphase (Hayes and Dutrillaux, 2000). As a consequence, the number of

NOR-bearing chromosomes of *Cricetulus migratorius* and *Meriones tristrami* from Central Anatolia may facilitate future cytotaxonomic studies on the families Muridae and Cricetidae in Turkey.

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