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Chromosomal Polymorphism of *Rattus rattus* (Linnaeus, 1758) (Rodentia: Muridae) in Central Anatolia

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In this study, conventionally stained, C- and Ag-NOR banded karyotypes of *Rattus rattus* from Central Anatolia are presented. The karyotype of the specimens from Ankara and Çankırı provinces consist of 2n=38, NF= 60 and NFa=58 while the karyotype of Kırıkkale specimens consist of 2n=38 and NFa=59 due to a heteromorphic autosome pair. The X is a large to medium sized acrocentric and the Y chromosome is a small acrocentric in all examined specimens. Constitutive heterochromatin is located in the centromeric regions of all pairs of autosomes and the X chromosome. Nucleolar organizer regions (NORs) are located only in 3 autosome pairs.

Key words: Roof rat, C-banding, Ag-NOR banding, karyotype, Central Anatolia.

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The genus *Rattus* Fischer, 1803 is one of the most speciose rodent genera that comprises 66 species distributed worldwide and is divided into 6 species group based on morphological features, cytogenetic studies and molecular data (MUSSER & CARLETON 2005). Two of these, the roof (or black) rat, *Ratus rattus* and brown rat, *R. norvegicus*, are known from Turkey and three valid subspecies of *R. rattus* have been described according to pelage coloration by YİĞİT *et al.* (1998).

YOSIDA (1980) described 5 different geographic population types of roof rat with diploid numbers from 2n=38 to 2n= 42; the Oceanic or European type (2n=38), the Ceylonese (Sri Lanka) type (2n= 40), the Asian type (2n=42), the Japanese type (2n= 42) and the Mauritus type (2n=42 Mau). The Oceanic type developed by Robertsonian fusion of 4 acrocentric pairs in the Asian type (YOSIDA *et al.* 1971b) and is distributed in Central Asia (India and Pakistan), Australia, New Zealand, New Guinea, North and South America, Europe and Africa (YOSIDA *et al.* 1974). YİĞİT *et al.* (1998) and KANKILIÇ *et al.* (2006) showed that the Oceanic type of *Rattus rattus* is present in both Asiatic and European Turkey.

To date, many cytogenetic studies have been performed on the roof rat because of its intrapopulational chromosomal polymorphism due to pericentric inversions, Robertsonian fusions, and supernumerary B chromosomes (CAPANNA *et al.* 1970; CAPANNA & CIVITELLI 1971; YOSIDA *et al.* 1971 a,b; YOSIDA & SAGAI 1972; YOSIDA 1977; BAVERSTOCK *et al.* 1977; LADRON DE GUEVARA & DIAZ DE LA GUARDIA 1981; BELCHEVA & BISSERKOV 1984; STITOU *et al.* 2000; CAVAGNA *et al.* 2002). Furthermore, KANKILIÇ *et al.* (2006) has determined a polymorphism due to pericentric inversions and supernumerary B-chromosomes in the Turkish Thracian populations of *Rattus rattus*.

The aims of this study are to present the chromosomal polymorphism, C-heterochromatin distribution and NORs of *Rattus rattus* in Central Anatolia.

Material and Methods

Ten specimens were captured from grassland habitats where no human settlements were existed in Kırıkkale (39° 50′ N 33° 30′ E) (3 ♂♂), Ankara (39° 56′ N 32° 51′ E) (2 ♂♂, 2 ♀♀) and Çankırı (40° 35′ N 33° 36′ E) (2 ♂♂, 1 ♀) provinces in Central Anatolia. Chromosome preparations were obtained from bone marrow cells according to the technique of PATTON (1969). The heterochromatin distribution and location of nucleolar organizer regions (NORs) in the chromosomes were determined using SUMNER (1972) and HOWELL and

BLACK (1980) respectively. The Ag-NOR stained chromosomes were tentatively identified by the size and arm ratio. Classification of chromosomes were established according to LEVAN *et al*. (1964). A total of 12 slides were prepared from each specimen. At least 20 well-spread and banded metaphase plates were photographed and arranged to determine the diploid chromosome number (2n), autosomal fundamental number (NFa) and fundamental number (NF). All stuffed skins and metaphase slides are deposited at the Department of Biology, University of Kırıkkale.

Results

In specimens from the Ankara and Çankırı populations, the karyotype consisted of 2n=38, NF= 60 and NFa=58. The chromosome set is composed of 18 metacentric / submetacentric (nos. 1, 4, 10-15 and 18), 4 subtelocentric (nos. 2 and 9) and 14 acrocentric (nos. 3, 5-8 and 16-17) chromosomes. The X is a medium sized acrocentric while the Y chromosome is a small acrocentric (Fig. 1).

However, in all specimens from the Kırıkkale population the karyotype consisted of 2n=38 and NFa=59. In all metaphase plates, a heteromorphic autosome pair was detected. The chromosome set is composed of 18 metacentric / submetacentric (nos. 1, 4, 10-15 and 18), 4 subtelocentric (nos. 2 and 9) and 12 acrocentric (nos. 3, 5-8 and 17) and 2 acrocentric / subtelocentric (A/ST) (no. 16) chromosomes. In addition, a metacentric autosome pair (no. 4) in the set is also heteromorphic in respect to size. The X is a large acrocentric while the Y chromosome is a small acrocentric. The X chromosome is larger in size than the Ankara and Çankırı populations. In some metaphase plates, a secondary constriction in the smallest acrocentric pair is also detected (Fig. 2).

C-positive heterochromatin is located in the centromeric regions of all pairs of autosomes and the

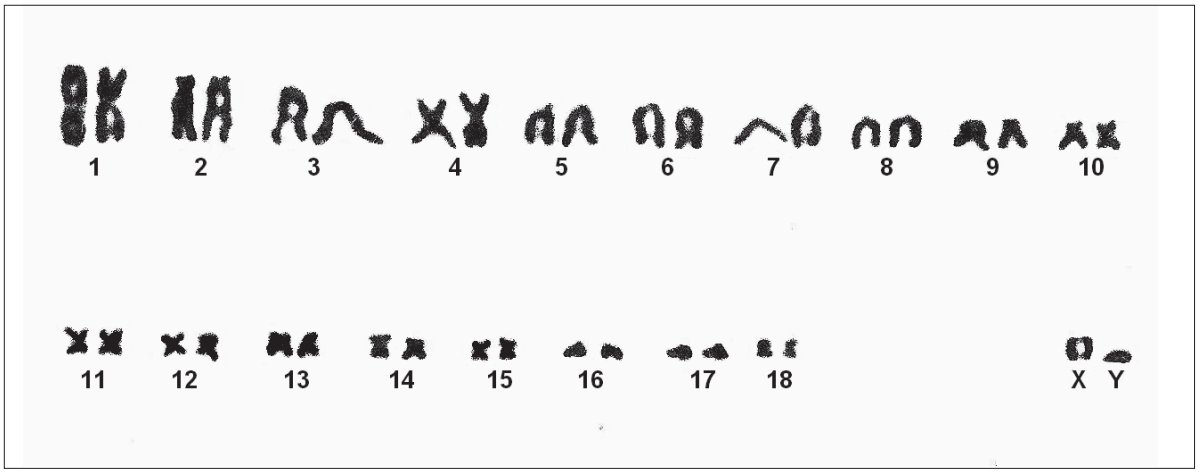

Fig. 1. Conventionally stained karyotype of *Rattus rattus* from Ankara and Çankırı provinces.

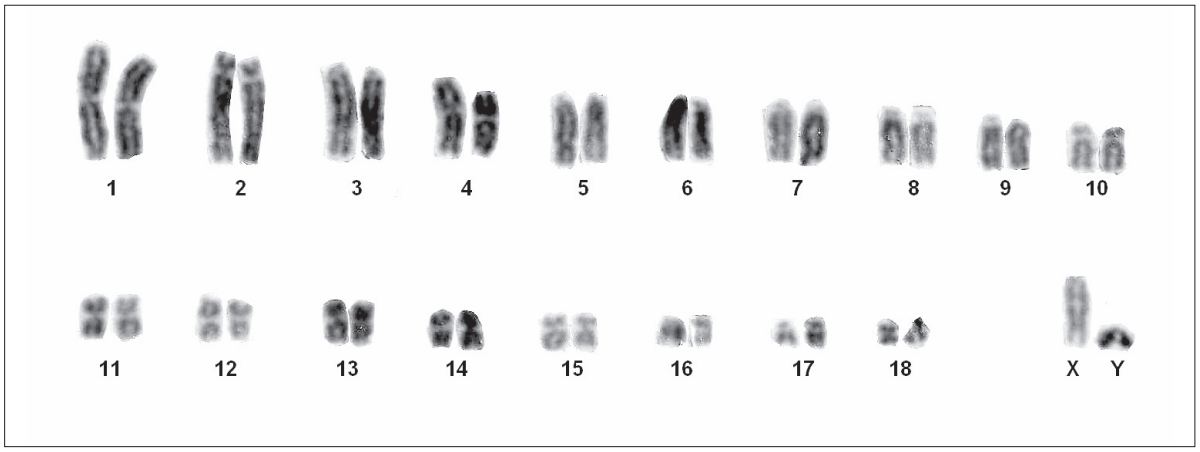

Fig. 2. Conventionally stained karyotype of *Rattus rattus* with a heteromorphic pair (A/ST) (no. 16) from Kırıkkale province.

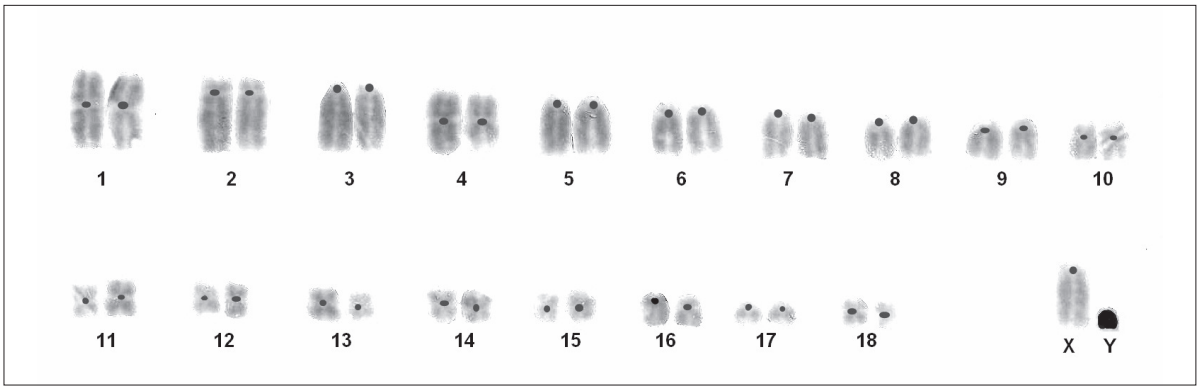

Fig. 3. C-banded karyotype of *Rattus rattus* with a heteromorphic pair (A/ST) (no. 16) from Kırıkkale province.

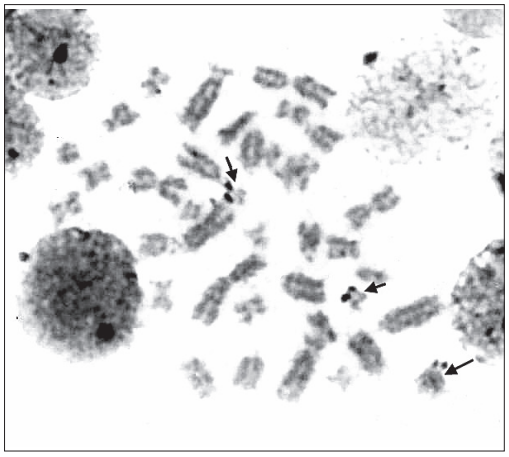

Fig. 4. Ag-NOR stained metaphase plate of *Rattus rattus* (arrows indicate the NORs).

X chromosome of specimens from Ankara, Kırıkkale and Çankırı provinces. The Y chromosome is completely C-positive (Fig. 3).

Nucleolar organizer regions (NORs) are located only in 3 autosomes; in the telomeric regions of one metacentric, one submetacentric and in the small arms of a subtelocentric chromosome pair of the Kırıkkale population (Fig. 4). No good quality NORs were detected from Ankara and Çankırı populations.

Discussion

The dorsal colour of Ankara, Çankırı and Kırıkkale specimens was dark brown and the ventral colour was yellowish white as stated for *R. rattus alexandrinus* by YİĞİT *et al.* (1998). However, recently MUSSER and CARLETON (2005) considered *R. rattus alexandrinus* and the other subspecies, *R. rattus frugivorous*, as synonyms of *Rattus rattus*.

Roof rats from East and Southeast Asia showed chromosome polymorphism, appearing as homomorphic pairs of acrocentrics (A/A) or subtelocentrics (ST/ST) or as a heteromorphic pair composed of one acrocentric and one subtelocentric (A/ST) autosomes (YOSIDA & SAGAI 1972). YOSIDA *et al.* (1965), YOSIDA *et al.* (1971 a) and YOSIDA (1977) determined heteromorphic autosome pairs (nos. 1, 9 and 13) in respect to acro-subtelocentric chromosomes of *Rattus rattus* collected from Asia, Australia and the United States. Polymorphism in pair no. 13 is found widely in all types of this species whereas polymorphism in pairs no. 1 and 9 are found only in the Asian type (YOSIDA 1977). DIAZ DE LA GUARDIA *et al.* (1979) described pericentric inversions in chromosome pairs 14, 16 and 18 of *Rattus rattus frugivorous* from the Iberian Peninsula. KASAHARA and YONENAGA-YASSUDA (1981) determined another pericentric inversion in autosome pair no. 8 and C-band polymorphism in the Oceanic type of *R. rattus* from Brazil. The homomorphic A/A pair was found more often than the ST/ST pair as well as the A/ST pair in the karyotype of *R. rattus* therefore YİĞİT *et al.* (1998) did not mention any polymorphism in the examined specimens from Turkey. However, recently KANKILIÇ *et al*. (2006) described heteromorphic

pairs no. 9, 10 and 13 from the Thracian population. In Central Anatolia only one heteromorphic pair (A/ST) was detected. The dissimilarities between the heteromorphic pair number in the chromosome set are probably due to the different arrangements of the autosomes by the authors.

YONG and DHALIWAL (1972) reported supernumerary B-chromosomes in the Malayan population of *Rattus rattus.* In addition, PRETEL and DIAZ DE LA GUARDIA (1978) determined chromosomal polymorphism (2n= 38, 39, 40 and 41) due to additional chromosomes in the subspecies *Rattus rattus frugivorous*. Recently, KANKILIÇ *et al.* (2006) determined supernumerary B-chromosomes in the specimens from Turkish Thrace. In contrast, no supernumerary B-chromosomes were detected from Central Anatolia in this study.

Constitutive heterochromatin in the metacentric pairs of the Asian type of *Rattus rattus* was large in size, however, that in both Oceanic and Ceylonese types were small (YOSIDA & SAGAI 1975). Central Anatolian populations showed small C-bands in metacentric pairs as stated for the Oceanic and Ceylonese types.

NORs have been considered as a useful taxonomic and phylogenetic marker in many species (SANCHEZ *et al.* 1990). Rats and mice all posses three rDNA-bearing chromosomes but the location of NORs differs within species. In the Italian population of *Rattus rattus*, autosome pairs nos 5, 8 and 16 possessed NORs (CAVAGNA *et al.* 2002). Furthermore, three autosomes had NORs positioned in the telomeres in Turkish specimens.

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