Chromosomal Polymorphism of *Rattus rattus* (Linnaeus, 1758) (Rodentia: Muridae) in 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, *Rattus 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 Yiğit 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 Mauritian 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). Yiğit 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. 1971a,b; Yosida & Sagai 1972; Yosida 1977; Baeverstock et al. 1977; Ladron de Guevara & Diaz de la Guardia 1981; Belcheva & Bissekrov 1984; Stitou et al. 2000; Cavagna et al. 2002). Furthermore, Kankiliç et al. (2006) has determined a polymorphism due to centric 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 Kirikkale (39° 50’ N 33° 30’ E) (3♂♂, 1♀), 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 Sunner (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.](image1)

![Fig. 2. Conventionally stained karyotype of Rattus rattus with a heteromorphic pair (A/ST) (no. 16) from Kırıkkale province.](image2)
X chromosome of specimens from Ankara, Kirikkale 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 Kirikkale population (Fig. 4). No good quality NORs were detected from Ankara and Çankırı populations.

**Discussion**

The dorsal colour of Ankara, Çankırı and Kirikkale specimens was dark brown and the ventral colour was yellowish white as stated for *R. rattus alexandrinus* by YILÎT 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 YILÎT 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 Thracic 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 chromosome polymorphism (2n = 38, 39, 40 and 41) due to additional chromosomes in the subspecies Rattus rattus frugivorus. 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 possess 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 telomers in Turkish specimens.

References


