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Chromosome Banding Pattern in Fat Dormouse and Bank Vole (Mammalia: Rodentia) from Turkey

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The chromosome banding pattern (C-banding, AgNOR staining) was studied in isolated populations of two species of rodents from Turkey, *Glis glis* and *Myodes glareolus*. A single nucleolar organizer region was localized in an autosomal pair in the complement of *G. glis*. Centromeric C-heterochromatin blocks and seven pairs of NOR-bearing autosomes were observed in the complement of *M. glareolus*. A metacentric Y chromosome was found in the *M. glareolus* males examined. The detailed structure of karyotypes and the banding patterns differ from some previously published results.

Key words: AgNOR staining, Anatolia, C-banding, *Glis glis*, *Myodes glareorus*.

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The fat dormouse, *Glis glis*, occurs in southern and central Europe, but is absent from most of Iberia (AULAGNIER *et al.* 2009). The northern limit of the distribution is at the Baltic coast and the eastern one on the right banks of the Volga River in European Russia. The range is fragmented in the forest steppe zone of Russia and Ukraine and includes also isolated areas in the Caucasus and northern Anatolia (HOLDEN 2005). The Turkish range of the species is divided into two parts, in European and Asiatic Turkey. In European Thrace the fat dormouse is confined to humid deciduous forests in the Istranca Mts; in Anatolia, its range is bound to the Black sea coast. The range in Asia Minor is disjunctive with a distinct gap between the western segment in the Marmara region and the eastern one extending from the Caucasus (KRYŠTUFEK & VOHRALÍK 2005).

According to AULAGNIER *et al.* (2009), the range of the bank vole *Myodes glareorus*, covers broadleaved and coniferous forests from the British Isles to Lake Baikal in Siberia. It is widespread in Europe, except for the northernmost and southernmost parts of the continent. In Turkey the bank vole populates northern Anatolia in the Marmara region and the Black Sea region. The range is probably continuous, but the population on Mt. Uludağ may be geographically isolated. The Anatolian populations are isolated from the rest of the continuous species distribution (ÇOLAK & KİVANÇ 1991; KRYŠTUFEK & VOHRALÍK 2005).

The karyotype of the fat dormouse was studied for instance by DIAZ DE LA GUARDIA *et al.* (1980) in Spain, CRISTALDI & AMORI (1982) in Italy, ZIMA (1987) in Czechoslovakia, GRAPHODATSKY & FOKIN (1993) in Russia or MITSAINAS *et al.* (2008) in Greece. Other reports are summarized by ZIMA & KRÁL (1984) or ZIMA *et al.* (1995). DOĞRAMACİ & TEZ (1991), CIVITELLI *et al.* (1995) and ŞEKEROĞLU & ŞEKEROĞLU (2011) investigated chromosomes of this species in Turkey.

The karyotype of the bank vole was reported from various areas of its distribution (see ZIMA & KRÁL 1984 for a review), and variation in the centromeric position of the Y chromosome was re-

corded (KRÁL *et al.* 1972; IVKOVIĆ *et al.* 1975; VORONTSOV *et al.* 1978; KRÁL *et al.* 1979; GAMPERL 1982; ZIMA 1984, 1987; RADOSAVLJEVIĆ *et al.* 1988, 1990; VUJOŠEVIĆ & BLAGOJEVIĆ 1997; ZIMA *et al.* 1997). In Turkey, the karyotype of bank vole was studied by ÇOLAK *et al.* (1997).

The aim of the present study is to contribute to the cytogenetic characterization of the two species in isolated parts of the range in Turkey by examination of chromosomal banding pattern (C-banding, AgNOR staining).

Material and Methods

The animals studied were collected from isolated parts of the species distributions in northwestern Anatolia in Turkey. One male and one female of *Glis glis* were collected from Yenice, Karabük Province (41° 11′ N, 32° 19′ E). At the same site, four females of *Myodes glareorus* were examined. Other specimens of the bank vole originated from Çaycuma, Zonguldak Province (41° 22′ N, 32° 04′ E) (1 male), Abant Lake, Bolu Province (40° 38′ N, 31° 18′ E) (2 males), and Ulu Dag, Bursa Province (40° 07′ N, 29° 10′ E) (1 female). Karyotype preparations were obtained from the bone marrow of animals treated with colchicine (FORD & HAMERTON 1956). After preparation of chromosome slides, conventional Giemsa-staining was carried out. Constitutive heterochromatin and nucleolus organizer regions (NORs) were detected in individual autosomal and sex chromosome pairs via C-banding (SUMNER 1972) and Ag-NOR staining (HOWELL & BLACK 1980), respectively. From each specimen, 10 to 20 slides were prepared, and at least 20 well-spread metaphase plates were analysed.

Chromosome morphologies were determined after calculating centromeric indices as metacentrics, submetacentrics, subtelocentrics and acrocentrics. Standard voucher specimens (skins and skulls) are deposited in the Department of Biology, Faculty of Science, Selçuk University, Konya, Turkey.

Results

The karyotype of the fat dormouse consists of 62 chromosomes including seventeen small or medium-sized metacentric autosomal pairs (nos. 1-17), eleven submetacentric autosomal pairs of variable size (nos. 18-28) and two large subtelocentric autosomal pairs (nos. 28-30) (FN = 120, Fundamental Number – i.e. the number of chromosome arms excluding the XY chromosomes). A secondary constriction was observed in the long arms of the autosomal pair no. 10. The X chromosome is a large metacentric, and the Y chromosome a small acrocentric (NF = 124). By using silver-nitrate staining, the nucleolar organizer region was localized in the secondary constrictions in autosomal pair no. 10. All observed NORs were homomorphic and occurred in both homologues (Fig. 1).

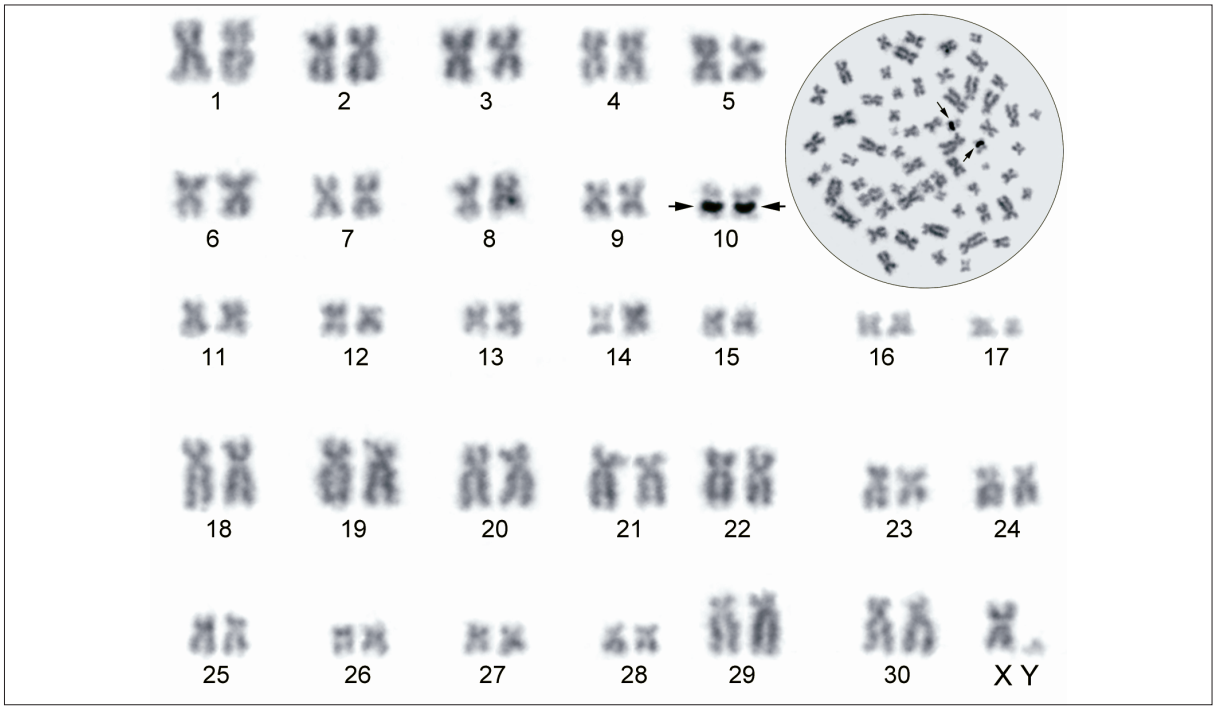

Fig. 1. Silver-stained metaphase spread and karyotype of male *Myoxus glis*. Arrows indicate the position of the secondary constriction with active Ag-NOR.

The karyotype of the bank vole consists of 56 chromosomes including one small-sized metacentric autosomal pair (no. 1) and twenty-six acrocentric autosomal pairs (nos. 2-27) of gradually diminishing size (FN = 56). Tiny short arms were observed in most of the acrocentric autosomes. The X chromosome is a large acrocentric (NF = 58), the Y chromosome is a metacentric with similar size as the small biarmed pair of autosomes. All the autosomes possessed distinct C-positive bands in pericentromeric areas, except for pair no. 5. The X chromosome had a pericentromeric dark C-band (Fig. 2). Ag-NOR regions were found in seven acrocentric autosomal pairs (nos. 2, 5, 8, 12, 19, 21, and 26). In some of these autosomes, the NORs were observed in telomeric regions of the short arms. In certain pairs the observed NORs were heteromorphic and occurred in only one homologue (pairs no. 5 and 26, Fig. 3).

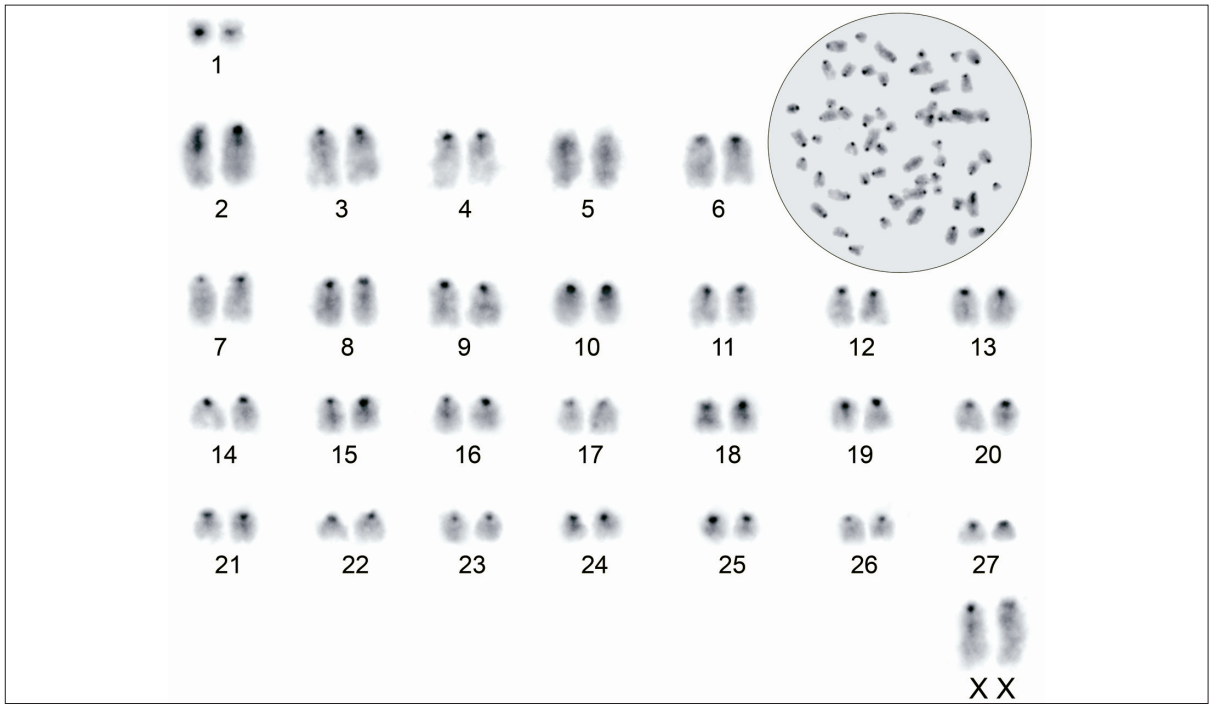

Fig. 2. Metaphase spread and C-banded karyotype of female *Myodes glareolus*.

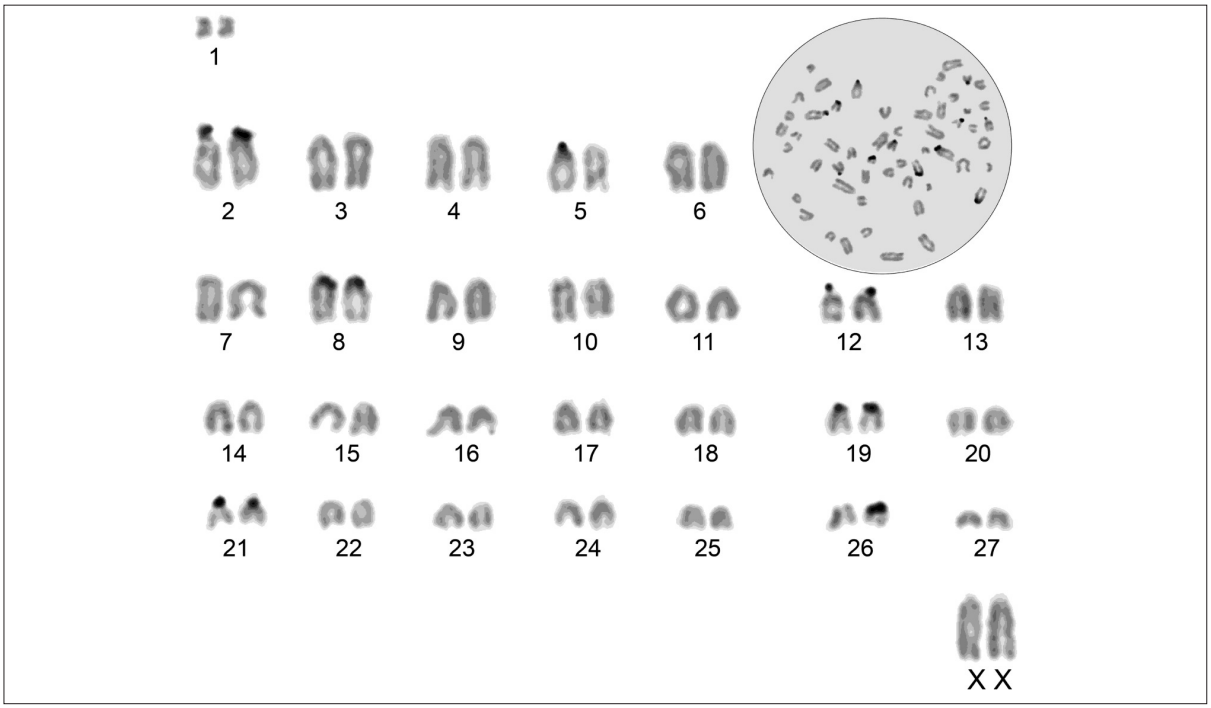

Fig. 3. Silver-stained metaphase spread and karyotype of female *Myodes glareolus*.

Discussion

The results obtained are generally congruent with previous studies dealing with conventionally stained chromosomes of both species, and no gross karyotypic variation was revealed. DOĞRAMACİ and TEZ (1991) reported slightly different karyotypes between populations of *Glis glis* from European Thrace and Anatolia. This variation inhered in different proportions of metacentric, submetacentric, and subtelocentric autosomes in the complements. Determination of the actual types of chromosomes according to their centromeric position is usually difficult in conventionally stained preparations, and results obtained in the same areas (CIVITELLI *et al.* 1995, own results) are not consistent with those of DOĞRAMACİ & TEZ (1991). Structural banding or FISH chromosome painting with higher resolution should be applied to resolve this question.

The position of a nucleolar organizer region in a small metacentric autosome in the karyotype of *Glis glis* was also indicated in other studies (GRAPHODATSKY & FOKIN 1993). This secondary constriction bearing a NOR is a chromosomal marker of various glirid species (ZIMA *et al.* 1995).

The distribution of C-heterochromatin in the karyotype of bank voles from north-western Anatolia is similar to that reported by others (GAMPERL 1982; MODI & GAMPERL 1990). The presence of multiple autosomal NORs in the bank vole karyotype is apparently a typical feature found in microtine karyotypes (e.g. MODI and GAMPERL 1990), and its pattern may be characteristic for individual geographic populations. MODI & GAMPERL (1989) reported considerable variation in *M. glareolus* in the occurrence and distribution of NORs and they noted a great extent of intraindividual variability. On the other hand, BELCHEVA *et al.* (1987) recorded NORs in only three autosomal pairs in the karyotype of *M. glareolus* from Bulgaria.

In two of the sites examined, we found a metacentric Y chromosome in the male karyotype of the bank vole, in accordance with previous findings of ÇOLAK *et al.* (1997). This result does not support the idea that the acrocentric Y chromosome may particularly occur in marginal and isolated bank vole populations (KRÁL *et al.* 1972; VORONTSOV *et al.* 1978).

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