

G- and C-banded karyotypes of Hazel Dormouse, *Muscardinus avellanarius trapezius* (Mammalia: Rodentia) in Turkey

Vedat ŞEKEROĞLU^{1*}, Haluk KEFELİOĞLU², Zülal ATLI ŞEKEROĞLU¹

¹Department of Biology, Faculty of Arts and Sciences, Ordu University, 52750 Ordu - Turkey

²Department of Biology, Faculty of Arts and Sciences, Ondokuz Mayıs University, 55139 Samsun - Turkey

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Abstract: The results of a karyological study on the hazel dormouse *Muscardinus avellanarius trapezius* from Turkey were presented in this study. Using conventional staining and G- and C-banding techniques, 10 specimens were cytogenetically studied. The G- and C-banding patterns of Turkish specimens of this subspecies were provided for the first time in this study. The karyotype was composed of $2n = 46$, $NF = 90$ and $NFa = 86$. A secondary constriction was visible in one pair of metacentrics (no. 9). All of the chromosomes possessed heterochromatic bands in the centromeric and pericentromeric regions. The X chromosome was a medium-sized metacentric and the heterochromatic region was restricted to the centromere. The Y chromosome was a very small acrocentric and possessed small centromeric block of heterochromatic.

Key words: *Muscardinus avellanarius trapezius*, cytogenetic, Turkey

Türkiye'deki *Muscardinus avellanarius trapezius* (Mammalia: Rodentia)'un G- ve C-bandlı karyotipleri

Özet: Bu çalışmada Türkiye'deki *Muscardinus avellanarius trapezius* ile ilgili karyolojik bir çalışmanın sonuçları gösterildi. On örnek, klasik boyama, G- ve C-bantlama teknikleri kullanılarak sitogenetik olarak incelendi. Bu alttürün Türkiye'den G- ve C-bantlı örnekleri ilk kez bu çalışmada ortaya çıkarıldı. Karyotip değerleri $2n = 46$, $NF = 90$ ve $NFa = 86$ olarak belirlendi. Metasentrik bir kromozom çiftinde ikinci bir boğum görüldü (no. 9). Tüm kromozomlar sentromerik/perisentromerik bölgelerinde bulunan heterokromatik bantlara sahipti. X kromozomu orta büyüklükte metasentrik ve heterokromatik bölgesi sentromerle sınırlıydı. Y kromozomu çok küçük bir akrosentrik ve küçük sentromerik heterokromatik bloğa sahipti.

Anahtar sözcükler: *Muscardinus avellanarius trapezius*, sitogenetik, Türkiye

* E-mail: sekeroglu@odu.edu.tr

Introduction

The genus *Muscardinus* Kaup, 1829 is distributed in Europe and northern Turkey (Ellerman and Morrison-Scott, 1966; Ondrias, 1966; Corbet, 1978; Wilson and Reeder, 1993). The only species described of this genus is *Muscardinus avellanarius* (Linnaeus, 1758).

The first record of *M. avellanarius* in Turkey was given by Nehring (1903), from Alemdağ. Miller (1908) described *Muscardinus trapezius* from Coşandere (Trabzon), but the specimens were described as *Muscardinus avellanarius trapezius* by Ellerman (1948). Kıvanç (1983) described *M. avellanarius abanticus* from Bolu Abant (Soğuksu) and Osborn (1964), Kıvanç (1983), Doğramacı (1989), and Doğramacı and Kefelioğlu (1992) reported *M. avellanarius* from Trabzon, Ordu and Bursa.

In conventional stained karyotypes of *M. avellanarius*, the diploid number of chromosomes (2n) was 46, as was reported by Savic and Soldatovic (1972) from the former Yugoslavia, Zima and Kral (1984) and Zima (1987) from the former Czechoslovakia, Belcheva et al. (1988) from Bulgaria, Doğramacı and Kefelioğlu (1992) from Turkey, Peshev and Delov (1995) from Bulgaria, and Zima et al. (1995) from Bulgaria and Ukraine. Zima (1987) provided the G-banding pattern from former Czechoslovakia and Graphodatsky and Fokin (1993) reported the G- and AgNOR banded karyotypes of *M. avellanarius* from the former Soviet Union. However, the C-banded karyotype of *M. avellanarius* had not been reported until now.

The aim of this study was to provide data on the karyotype of this subspecies, using G- and C-banding staining techniques.

Materials and methods

We examined 10 specimens of *M. a. trapezius* collected from Ordu (Yukarıkızılen village) in Turkey and analyzed their karyological characteristics in detail.

Chromosome preparations were obtained from the bone marrow cells of femur colchicine

treated animals. The bone marrow preparation cells were carried out according to the methods of Ford and Hamerton (1956). G-banding techniques for chromosome identification and C-banding methods, in order to study the distribution of the heterochromatin, were performed according to Seabright (1971) and Sumner (1972), respectively. From each specimen, 10 to 20 slides were prepared, and at least 20 well-spread metaphase plates were analysed.

Results

The study of *M. a. trapezius* revealed a karyotype of $2n = 46$, $NF = 90$ and $NFa = 86$. According to their centromere position, the autosomes were arranged in 4 groups: 9 pairs of metacentrics (nos. 1-9), 7 pairs of submetacentrics (nos. 10-16), 5 pairs of subtelocentrics (nos. 17-21), and 1 pair of acrocentrics (no. 22). The X chromosome was medium sized and metacentric, whereas the Y chromosome was acrocentric and the smallest one (dot-like) in the karyotype. Furthermore, a secondary constriction which is characteristic for karyotypes of Gliridae was clearly visible in the pair of small metacentrics (no. 9) (Figure 1).

The G-banded karyotype of *M. a. trapezius* is illustrated in Figure 2. All autosomes and both sex chromosomes were identified on the basis of the G-banding patterns. Based on size, position, and stain density of the G-bands, they showed chromosomal regional specificity.

The C-banding staining technique showed that all autosomes possessed heterochromatic bands in the centromeric and pericentromeric regions. Some autosomal pairs have strongly stained heterochromatic bands (nos. 8, 9, 22), whereas the others have slightly stained heterochromatic bands. Furthermore, 1 of the autosomal pairs (no. 15) seemed more darkly stained than other autosomal pairs and had faintly stained pericentromeric regions. The X chromosome has centromeric large heterochromatin, while the Y chromosome has centromeric small heterochromatin (Figure 3).

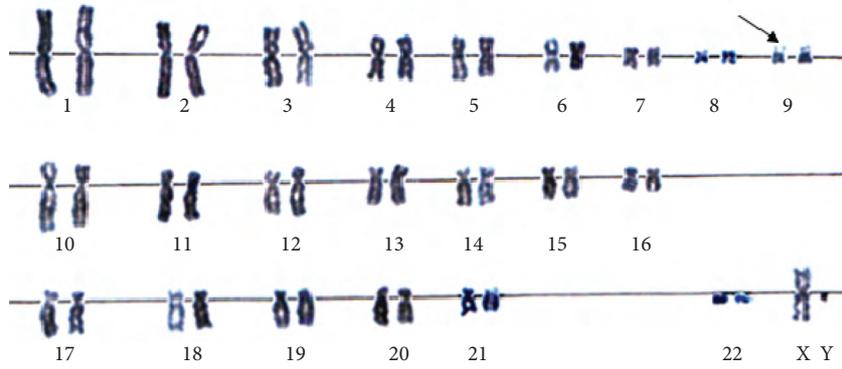


Figure 1. Karyotype of *M. a. trapezius*. Arrow indicates the 9th chromosomal pair with secondary constrictions.

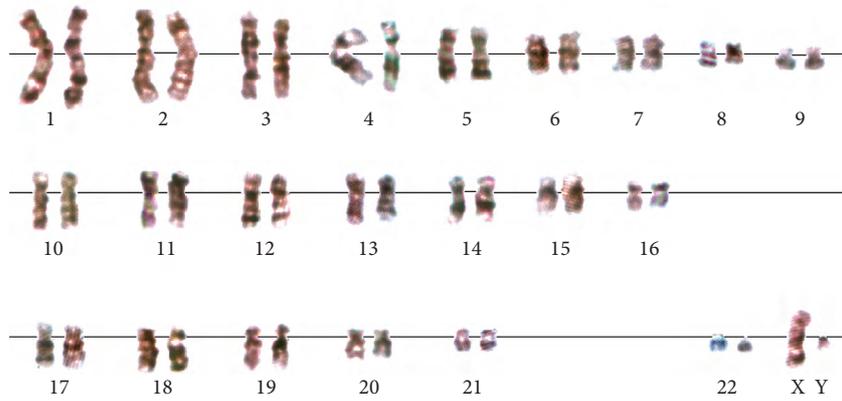


Figure 2. G-banded karyotype of *M. a. trapezius*.

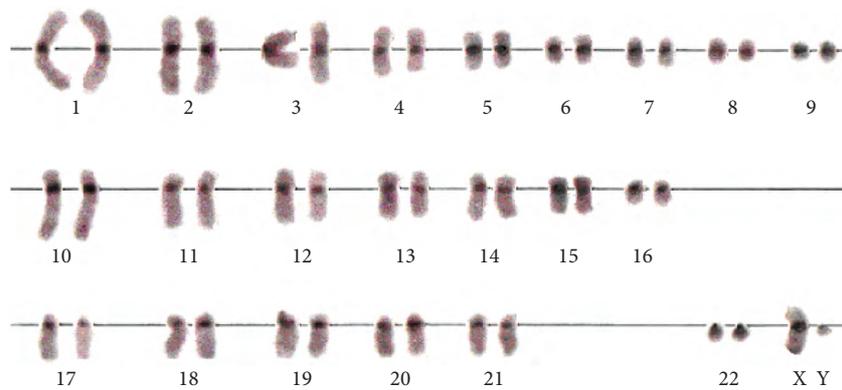


Figure 3. C-banded karyotype of *M. a. trapezius*.

Discussion

Our results on *M. avellanarius*, and those of previous works, support the view that this species is characterized by a karyotype of $2n = 46$ (Savic and Soldatovic, 1972; Zima and Kral, 1984; Zima, 1987; Belcheva et al., 1988; Dođramacı and Kefeliođlu, 1992; Graphodatsky and Fokin, 1993; Peshev and Delov, 1995). However, Dođramacı and Kefeliođlu (1992) and Peshev and Delov (1995) found that NFa = 88, whereas Savic and Soldatovic (1972), Zima and Kral (1984), Zima (1987), Belcheva et al. (1988), Graphodatsky and Fokin (1993), Zima et al. (1995), and those involved in this study determined that NFa = 86. Because of these differences, the NF was also found to be different by various other researchers. We believe that the observed differences in the NF and NFa values are probably the result of methodological discrepancies in karyotype preparation and the arrangement of the pairs in the diploid complement, rather than a real morphological diversity.

The X chromosome was emphasized as metacentric by all researchers, while the Y chromosome was emphasized as a very small acrocentric, with the exception of Peshev and Delov (1995), who described it as being dot-like (Table). Belcheva et al. (1988) didn't describe the morphology of the Y chromosome because they examined a female specimen.

Zima et al. (1995) stated that the karyotypes of Gliridae were usually characterized with a secondary constriction found in 1 or 2 pairs of bi-armed autosomes. The secondary constriction was seen by Dođramacı and Kefeliođlu (1992) and Peshev and Delov (1995), and was also noted in this study.

We could not compare our G-banding results with those of Zima (1987) because the chromosomes appeared very dark and the G-bands were not obviously discerned. When the G-banding results of the present study and Graphodatsky and Fokin (1993) were compared, it was seen as homologous between the G-bands even though the G-banded chromosomes were at different stages of condensation. Therefore, we think the karyotype of *M. avellanarius* may be rather stable throughout the geographical ranges of the species.

The specific species of the family Gliridae, in the Black Sea region of Turkey, are *Glis glis*, *Dryomys nitedula*, and *Muscardinus avellanarius*. The C-banded karyotypes in Turkish populations of these species have not been reported until now. Mitsainas et al. (2008) displayed the C- banding patterns of *D. nitedula as* ($2n = 48$) in Greek populations. These researchers found that autosomal pairs were metacentric, submetacentric and, subtelocentric. The X chromosome was a medium- to large-sized

Table. Sampling localities and karyotypic data of *M. avellanarius*.

2n	NFa	X	Y	Localities	References
46	86	m	a	Yugoslavia	Savic and Soldatovic (1972)
46	86	m	a	Bohemia and Slovakia Czech Republic	Zima and Kral (1984), Zima (1987)
46	86	m	-	Bulgaria	Belcheva et al. (1988)
46	88	m	a	Trabzon and Ordu, Turkey	Dođramacı and Kefeliođlu (1992)
46	86	m	a	Lithuania	Graphodatsky and Fokin (1993)
46	86	m	a	Bulgaria and Ukraine	Zima et al. (1995)
46	88	m	dot-like	Bulgaria	Peshev and Delov (1995)
46	86	m	dot-like	Ordu, Turkey	This study

submetacentric and the Y chromosome was dot-like. The C-banding results showed that most autosomes possessed heterochromatic bands in the centromeric and pericentromeric regions, just as they did with *M. a. trapezius*. But some pairs had fully heterochromatic large arms or heterochromatic bands at the distal end of large chromosomal arms, which had not been seen in the karyotype of *M. a. trapezius*. The X chromosome demonstrated only faint heterochromatic bands at

the interstitial and distal positions in *D. nitedula*, whereas the X chromosome in *M. a. trapezius* displayed a large centromeric heterochromatin. While the Y chromosome of *D. nitedula* was at least partially heterochromatic, in *M. a. trapezius* the Y chromosome was centromeric heterochromatin.

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