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Banded Karyotype of *Mus musculus* (Rodentia: Muridae) from Central Black Sea Region in Turkey

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Abstract
The G -, C - and Ag - NOR banding of *Mus musculus* from central Black sea region in Turkey were presented. Standard karyotype of the house mouse was 2n = 40, NF = 40 and NFa = 38. The G-banding of the standard karyotype were similar to the ones given for the species. In addition to the standard karyotype, a metacentric pair was also detected (2n = 36, NF = 38, NFa = 36) in one specimen. Dark stained constitutive heterochromatin blocks were observed in the pericentromeric regions of the acrocentrics including the X chromosome. Two pairs of NOR - bearing chromosomes were also determined in the chromosome set.

Key Word: House mouse, constitutive heterochromatin, NORs, secondary constriction, Turkey

INTRODUCTION

The genus *Mus* is composed of small, nocturnal and terrestrial 40 species distributed in various vegetation types and altitudes [1, 2]. All the Palearctic species are located under the subgenus *Mus* [3]. Of them, *Mus musculus* L., 1758, the house mouse, consisted of two subspecies; the east European short-tailed form *M. m. musculus* and the west European long-tailed form, *M. m. domesticus* Schwarz & Schwarz, 1943 [1, 4, 5]. However, some authors attributed the western form as a species, *Mus domesticus* [3, 6, 7, 8, 9, 10, 11, 12].

The distribution of *Mus musculus* is widespread and abundant due to its close relationship with human [3, 5]. To date, the standard karyotype of *Mus musculus / domesticus* is reported as 19 acrocentric autosomes and acrocentric X and Y chromosomes with a diploid number 2n = 40 by various authors [9, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25]. However, numerous populations possessed metacentric chromosomes occured by Robertsonian (Rb) rearrangements and, a decrease in the diplid number of chromosomes from 2n = 40 to 2n = 22 are also recorded [7, 9, 16, 21, 26, 27, 28]. The first metacentric autosomes in house mouse is reported from Switzerland by Gropp et al. [29].

Danford & Alston [30] stated that only *Mus musculus* inhabited in Turkey, however, in 1880 the authors indicated that in addition to *M. musculus*, both *M. abbotti* and *M. bacterianus* also are distributed in the country. Kurtonur et al. [31] stated that *M. musculus* is distributed throughout Turkey whereas *M. domesticus,* only in Turkish Thrace. Gündüz et al. [19, 20] examined the mtDNA and karyotype of *Mus musculus domesticus* in Turkey and determined five new haplotypes added to the nine haplotypes has already known for the region.

Metacentric chromosomes of house mouse from the Middle East were also given for the first time by Gözcelioğlu et al. [11], Çolak et al. [12] and Gündüz et al. [19] examined the morphology and karyology of *M. domesticus* and *M. macedonicus* and determined a variation in the coat coloration of *M. domesticus*. In additon, the diploid number of the karyotype was found to be 2n = 40, NFa = 38 and NF = 40. Recently, Kryštufek & Vohralik [3] gave the distribution and taxonomic status of the genus *Mus* in detailed from Turkey. However, the authors accepted that both *M. domesticus* and *M. macedonicus* inhabited whereas *M. musculus* was not present in Turkey.

The aims of this study were to make a contribution to the karyotype, G- banded chromosomes, distribution of heterochromatin and NORs of *Mus musculus* from Central Black Sea in Turkey.

MATERIAL AND METHODS

Five male *Mus musculus* specimens were captured from Samsun, Vezirköprü district (41° 09.11'N; 35° 13.42'E) in Central Black Sea region. Chromosome preparations were obtained from bone marrow according to the technique of Ford & Hamerton [32]. G - banding was performed by digestion with 0.25% trypsin according to Seabright [33]. Nucleolar organizer regions (NORs) and C - banded patterns were detected with the methods of Howell & Black [34] and Sumner [35], respectively. For each individual 10 slides were prepared and at least 30 well stained and G -, C - and Ag - NOR banded chromosomes were photographed and arranged to determine the diploid chromosome number (2n), autosomal fundamental number (NFa) and fundamental number (FN) as well as the shapes of autosomes and the sex chromosomes.

The specimens from Samsun province are accepted as the West European form, *Mus musculus domesticus* with regard to the tail length, shapes of pronounced incisor notch and upper and lower molars given in Darvish [36] as well as the morphological characteristics given for the subspecies in Çolak et al. [12] and Aulagnier et al. [5].

RESULTS

The karyotype of all specimens had a 2n = 40, NF was 40 and NFa was 38. All the autosomes and the sex chromosomes in the set of the specimens were acrocentric. In some metaphase plates we encountered secondary constrictions close to the centromere. The number of the autosome pairs with secondary constriction varied between 2 - 4 however, secondary constriction on the smallest autosome pair (no.19) was mostly encountered in all examined metaphases (Figure 1).

The G - banding pattern of the chromosomes in *Mus musculus domesticus* is shown in Figure 2.

Dark stained constitutive heterochromatin was located in the centromeric regions of all acrocentric pairs. The pericentromeric heterochromatin block of X chromosome was distinctly larger than the ones in autosomes. The Y chromosome was entirely heterochromatic (Figure 3).

The number of NOR - bearing chromosomes varied between 2 - 4 pairs. Homomorphic NORs were commonly located in the autosomes with secondary constrictions. In some plates, NORs werer also occured at the centomeres (Figure 4).

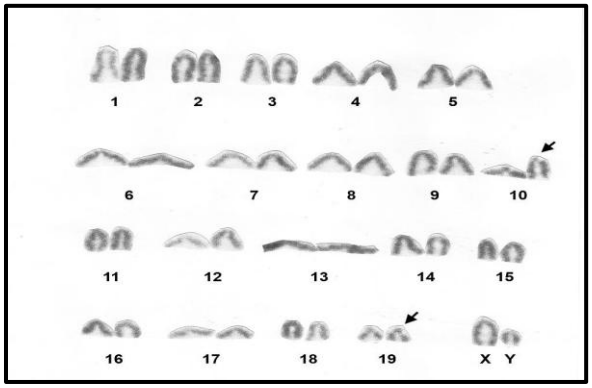

Figure 1. Conventionally stained karyotype of *Mus musculus domesticus* from Samsun province (arrowheads indicate the pairs with secondary constriction)

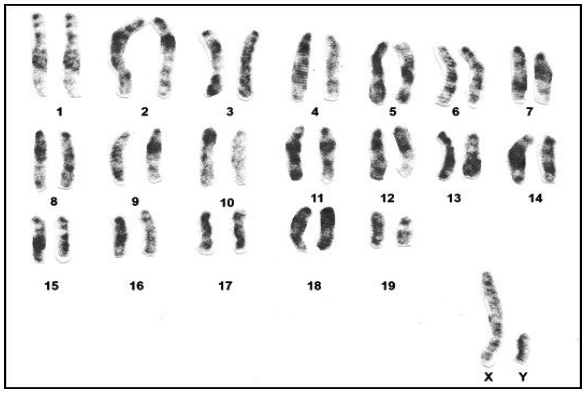

Figure 2. G - banded karyotype of *Mus musculus domesticus* from Samsun province

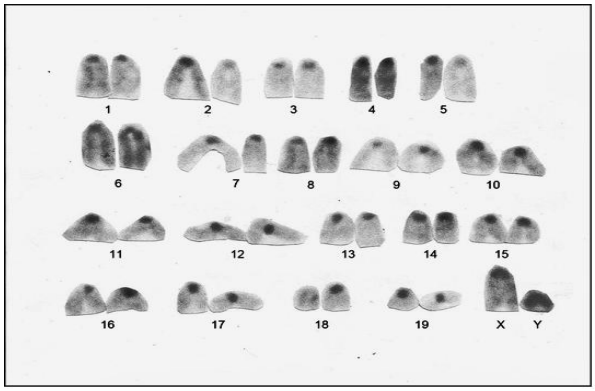

Figure 3. C - banded karyotype of a male *Mus musculus domesticus* from Samsun province

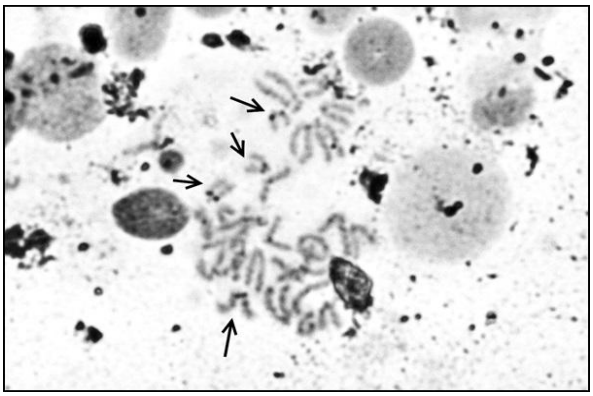

Figure 4. Ag - NOR stained metaphase of *Mus musculus domesticus* from Samsun province (Arrows indicate the homomorphic NOR - bearing chromosomes with secondary constriction)

DISCUSSION AND CONCLUSION

The house mouse, *Mus musculus,* possessed a standard karyotype with 2n = 40, is composed of 19 acrocentric pairs and a pair of acrocentric sex chromosomes in its distributrion area. However, due to Robertsonian fusions (Rb) various types of karyotypes ranged from 2n = 22 to 2n = 39 are also determined by various authors [22, and the references therein]. Although both subspecies, *M. m. musculus* and *M. m. domesticus,* are distributed in similar ecological niches through human settlements and both could hybridize, Robertsonian rearragements are determined widespread in *M. m. domesticus* while were absent from *M. m. musculus* [9, 22]. To date, karyotypes of house mouse with metacentric pairs are well recorded from Europe however, only two metacentric populations are given from Tunisia and the Middle East [19, 37 and refererences in 22]. In addition, Robinson [38] also reported a Rb fusion in *M. musculus* by conventionally stained karyotype from the Marion island. However, we also determined a metacentric pair from one specimen in this study but unfortunately, it was also an unbanded

karyotype. Therefore, we could not identify the acrocentric chromosomes rearranged to form the metacentric pair without G - banding. With more specimens from the locality, the metacentric pair should be examined in detailed.

Gözcelioğlu et al. [11] determined the karyotype of *M. domesticus* (*M. m. domesticus*) from Zonguldak province in Turkey. Our results are in accordance with those reported by Gözcelioğlu et al. [11] with respect to the diploid number (2n), NF and NFa. However, the authors stated the sex chromosomes as small and similar in size. The dissimilarities between the data given in this study and Gözcelioğlu et al. [11] were probably due to different methods used for the classification of the chromosomes. Ivanitskaya et al. [39] stated that small sized Y chromosome is encountered in wild populations of the *Mus* species. Bennett [13], determined secondary constrictions in two large, two medium-sized and two small acrocentric pairs of the house mouse. Secondary constrictions in four acrocentric pairs of Turkish *M. musculus* specimens are presented for the first time with this study.

Distribution of heterochromatin blocks in the genus *Mus* are typically localized in the pericentromeric regions of the chromosomes, including the X. Only the size of the dark C - bands were recorded as variable [39, 40, 41, 42]. Pantelis et al. [41] determined tiny heterochromatic arms in the Y chromosome, whereas Ivanitskaya et al. [39] and Rudra & Bahadur [42] recorded an entirely heterochromatic Y chromosome in *M. macedonicus* and *M. musculus* respectively. In addition to the pericentromeric C-bands, Ivanitskaya et al. [39] indicated faint interstitial heterochromatic band in the first acrocentric autosome. In Turkish specimens, all theautosomes possessed distinct and dark stained centromeric C-bands although the X chromosome had a pericentromeric dark stained C- band, and the Y was entirely heterochromatic.

Ivanitskaya et al. [39] recorded 4 - 6 pairs of NOR - bearing chromosomes in *Mus macedonicus* with 2n = 40, NF = 40 and NFa = 38. Four pairs of NOR - bearing autosomes are encountered more frequently in *M. macedonicus*. According to Ivanitskaya et al. [39] the number of NORs in other species of the genus varied from two to four pairs. Suzuki et al. [15] indicated five new NOR-bearing autosomes in addition to the six NORs given before by various authors for the house mouse. Britton-Davidian et al. [25] determined that NOR - bearing chromosomes showed significant variation within and between subspecies of the genus *Mus*. The number of NORs were recorded as 18 in *M. m. musculus* from Poland and Denmark whereas 12 in *M. m. domesticus* from France [24]. Miller et al. [14] and Croce et al. [43] demonstrated that only functional NORs on chromosomes that were active in the preceding interphase could be detected by Ag - NOR banding. However, Dobigny et al. [44] discussed the reability and validity of Ag - NOR banding for determining active NORs. In Turkish *Mus musculus* specimens, we determined NORs located in 2 - 4 pairs particularly, on secondary constrictions. Therefore, we supported the relationship between secondary constrictions and NORs as stated by Sato et al. [45].

As a conclusion, we accepted the high level of polymorphism in the karyotype within and between subspecies of *Mus musculus,* as stated recently by Britton - Davidian et al. [25].

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