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A LARGE ACROCENTRIC CHROMOSOME IN THE FIRST PAIR OF AUTOSOMES IN NATURAL POPULATIONS OF MUS MUSCULUS, LINNE 1758

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In this study, polymorphism of chromosomes was examined in natural populations of Mus musculus. The investigations were conducted in 5 different localities (Ševarice, Glušci, Lipolist, Bogatić, Sremska Mitrovica) in North-West Serbia, around, the rivers Sava and Danube. Besides the frequent finding of Robertsonian type of chromosomal polymorphism, the presence of one large acrocentric chromosome in the first pair of autosome, unusual for the mouse karyotype, was observed in a large number of investigated animals. With appropriate cytogenetical methods, it was established that the alter ed chromosome had two additional insertions, located in regions 1C5 and 1 R. From the results obtained for mouse karyotype tests and data from the literature, it could be concluded that the observed acrocentric chromosome resulted as an adaptation of mice to an increased quantity of environmental, agrichemical and industrial pollutants in the investigated localities.

Key words: large acrocentric chromosome, G-banding, Mus musculus, chromosome polymorphism, chromosome aberration, insertions

INTRODUCTION

The Robertsonian type of chromosome polymorphism is very frequent in Mus musculus. At the same time, this type of chromosome polymorphism is easily examined (Dulić et. al., 1980; Winking et al., 1981; Brooker, 1982; Haris et. al., 1986; Said et. al., 1986; Tichy and Vučak, 1987; Giagia et.al., 1987. Winking et al., 1988 etc). One the other hand, the type of chromosome polymorphism which is based on pericentric inversions has been poorly investigated (Yosida et. al., 1971; Matthey and Jotterand 1971).

Polymorphism of chromosomes based on isertions have also been observed, in Mus Musculus (Traut et. al., 1984; Said et. al., 1986; Agulnik et al., 1988, 1990). It was established that the unusual, large acrocentric chromosome belonged to the first pair of autosomes. Its size resulted from surplus insertions.

Agulnik et. al. (1988) assumed that these insertions of the aberrant autosome resulted from amprification of DNA sequences responsible for mouse adaptation to pesticese. The quantity of amplified chromosomal segments was correlated to mouse adaptation to the investigated pesticides (Bostock et al., 1979; Traut et al., 1984).

MATERIAL AND METHODS

Chromosomes intended for karyotype analyses were obtained either by the direct method of bone marrow from the long bones (Hsu and Patton, 1969), or by culturing lymphocytes of mouse peripheral blood using the method of Evans and O' Riordan (1976, 1977). The cromosomes were synhronized by brominedeoxyuridine according to the procedure of Dutrillaux and Viegas-Pequignot (1981). G-banding was done by employing the methods of Seabright (1971) and Yunis (1978). Chromosomes and chromosomal bands were identified on the basis of criteria established by the Committee on Standardized Genetic Nomenclature for Mice (1971, 1979) and Cowell's photoatlas of mouse chromosomes (Cowell, 1984).

RESULTS AND DISCUSSION

The results obtained for chromosome polymorphism in natural populations of Mus musculus from the investigated localities are given in Table 1.

Table 1. Karyotypic changes in natural populations of Mus musculus in the investigated localities.

Karyotype changes	Animals	
	Number N	Percentage %
Normal karyotype 2n=40; NF=40	27	36,0
Rb (5/15) 2n=39; NF=40 Heterozygotes	10	13,3
Rb(5/15) 2n=38; NF=40 Homozygotes	17	22,7
Ch I (1C 5;1E 3-1E 4 2n=39; NF=40) Heterozygotes	21	28,0
Σ	75	100,0

Of 75 cytogenetically investigated mice, (36,0%) had normal karyotypes without any changes of chromosome number or structure. The diploid number of their chromosomal sets was 2n=40 and NF=40. In twenty-seven mice (36,0%), the Robertsonian type of chromosome polymorphism /Rb(5.15)/ was found. Of these mice, 17 (22,7%) were homozygotes for the observed karyotypic change.

Thus, the diploid number of their chromosomal sets was 2n=38 but, NF=40, as in mice with normal karyotypes. It was established that 10 mice (13,3%) were homzygotes for this type of chromosome aberration. The diploid number of chromosomes in heterozygote mice was 2n=39 but, NF=40, too.

The Robertsonian type of chromosome polymorphism has been investigated bu many authors (Đulić and Soldatović, 1980; winking et al., 1981; Giagia et al., 1987; Tichy and Vučak, 1987; Winking et al., 1988). All of these studies suggested that this type of chromosome polymorphism is present in natural populationsof Mus musculus on the Balkans. Our results which refered to Robertsonian fusions of chromosomes are only affirmations for the previous findings of these authors.

Twenty-one mice (28.00 %) had altered karyotypes due to the presence of one large chromosome from the first pair of autosomes, unusual for the mosuse karyotype (Figure 1). By -banding technique, it was established that the aberrant

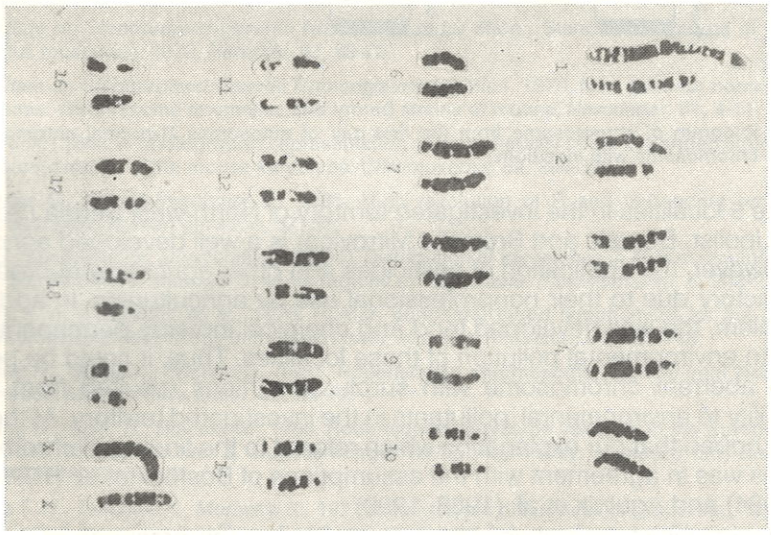

Figure 1. G-band of chromosome from the first pair of autosomes of a female mouse from Ševarice (the large chromosome from the first pair of autosomes is the carrier of two insertions in region 1C5 and region 1E)

chromosome had two insertions surplus when compared to the normal chromosome from this pair of autosomes (Figure 2). These insertions were located in region 1C5 (one segment) and region 1E (three segments between, 1E3 and 1E4 bands). All of these mice were heterozygotes for the observed crhomosome aberration, but, the diploid number of chromosomes in these mice was unchanged (2n=40; NF=40).

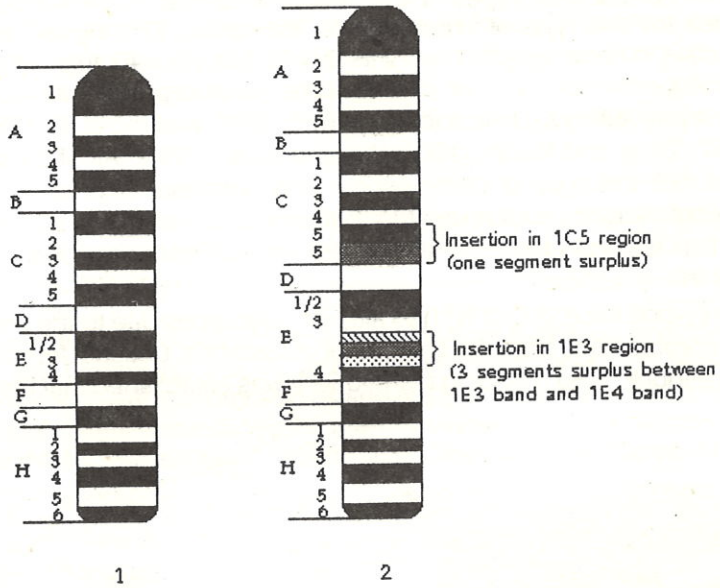

Figure 2. Idiogram of chromosome from the first pair of autosomes (1-normal chromosome; 2-chromosome with insertions)

The 5 localities in the investigated territory of North-west Serbia (Ševarice, Glušci, Lipolist, Bogatić and Sremska Mitrovica) is a well developed agricultural area. However, the application of pesticides and other agrichemical products is unsatisfactory due to their nonprofessional use by agriculturists. In addition to this problem, the well developed food and chemical industry permanently contributes to environmental pollution of these localities. Thus, it could be possible that the aberrant chromosome with surplus insertions resulted from mouse adaptability to environmental pollutants in the investigated territory. At the same time, we hoped that our explanation which refered to the finding of chromosome insertions was in agreement with the assumptions of Bostock et al. (1979),Traut et al. (1984) and Agulnik et al. (1988, 1990)

All mice which had altered karyotypes due to the presence of one large acrocentric chromosome from the first pair of autosomes were heterozygotes for this type of chromosome aberration. Therefore, it could be assumed that this aberration of chromosome structure was not yet fixed in the investigated population. However, the high frequency of aberrant chromosomes in the random sample of mice suggested that chromosome insertions had important influences on the segregation of meiotic chromosomes.Agulnik et al. (1990a) affirmed that heterozygote individuals for chromosome insertions of the first pair of autosomes transmitted the aberrant chromosome to their offspring in 80 to 85% of all cases this means that the possibility is higher that the chromosome with insertions would reach the ova rather than the polar bodies.

CONCLUSION

Based on the results obtained in this study, it could be assumed that the observed large chromosome with two surplus insertions resulted from mouse adaptability to the increase of environmental pollutants of agrichemical and industrial origin the investigated localities.

REFERENCES

1. *Agulnik S. I., Orlov I. P., Agulnik A. I.* 1988. Novij varijant 1-j hromozomi u domovij miši, *Citologija, vol. 30, 6,* 773-778.

2. *Agulnik S.I., Agnlnik A. I. Ruvinskij A. O.,* 1990. Mejotičeskij drajv aberrmtnoj 1-j hromosomi u domovoj miši, *Genetica, Tom 6, 4,* 664-669.

3. *Bostock C. J., Prescott D. M. and Hatch F. T.* 1979. Timing of replication of the satelite DNA-s in cells of kangraroo rat (Dipodomys ardii), *Exp. Cell Res, 74,* 487-495.

4. *Brooker P. C.,* 1982. Robertsonian translocations in Mus musculus from N. E. Scotland and Orkney. *Heredity, 48,* 305-309.

5. *Committee on Standardized Genetic Nomenclature for Mice;,* Standard karyotype of the mouse (Mus musculus). 1972. *Heredity, 63,* 69-72.

6. *Committee on Standardized Genetic Nomenclature for Mice,* 1979. New rules for nomenclature of genes, chromosome anomalies and inbred strains of mouse, *Newsletter, 61,* 4-11.

7. *Cowell J. K.,* 1984, A photographic representation of the variability of the G-banded structure of the chromosomes of the mouse karyotype. *Chromosoma, 89,* 294-320.

8. *Dutrillaux B., Viegas-Pequignot E.,* 1981. High resolution of R and G-banding on the same preparation, *Human genetics, 57,* 53.

9. *Đulić B., Soldatović B., Dunđerski Z.,* 1981D. Distribution of karyotypes in Mus musculus Linnaeus, 1758, (Rodentia, Muridae) in some regions of Yugoslavia, *Biosistematika, 6,* 203-210.

10. *Evans H. J., O'Riordan M. L.,* 1976. Human peripheral blood lymphocytes for the analysis of chromosome aberrations in mutagen tests, *Mutation Research, 31,* 135-148.

11. *Winking H., Gropp A., Bulfield G.,* 1981. Robertsonian chromosomes in mice from North Eastern Greece, *Mouse News Letter, 64,* 69-70.

12. *Winking H., Đulić B., Bulfield G.,* 1988. Robertsonian karyotype variation in the European house mouse, Mus musculus, Z. Sugetierkunge, *Verlag Paul Parey, Hamburg und Berlin, ISSN, 00443468, 53,* 48-161.

13. *Yosida T. H., Tsuchyja K., Moriwaki K.,* 1971.a, Karyotypic differences of black rats, Rattus rattus, collected in various localities of east and south-east Asia and Oceania, *Chromosoma, 33, 3,* 252-267.

14. *Yosida T. H., Tsuchyja K., Moriwaki K.,* 1971. b, Frequency of chromosome polymorphism in Rattus rattus collected in Japan, *Chromosoma, 33, 1,* 30-40.

15. *Yunis J. J., Sawyer J. R., Bal D. W.,* 1978. The characterization of high resolution G-banded chromosomes of man, *Chromosoma, 67,* 293.

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SADRŽAJ

Istraživan je hromozomski polimorfizam prirodnih populacija vrste Mus musculus na pet lokaliteta u Srbiji. Osim uočenog Robertsonovskog hromozomskog plimorfizma, zapaženo je i variranje veličine jednog hromozoma iz prvog para autozoma. Citogenetičke analize bazirane na G-band tehnici trasiranja hromozoma, pokazale su da je variranje veličine jednog hromozoma iz prvog para autozoma posledica amplifikacije hromozomskih segmenata u 1C i 1E regionu. Kako je ova promena bila zastupljena u 28% ispitivanih životinja, poreklom s poljoprivrednog područja, gde je prisutna nestručna i nekontrolisana upotreba raznih hemijskih preparata za zaštitu bilja i unapređenje proizvodnje, pretpostavili smo da hromozomske aplifikacije u 1C i 1E regionu imaju adaptivni značaj i doprinose lakšem preživljavanju svojih nosioca u uslovima povećanog hemijskog zagađenja životne sredine, što je saglasno sa analizama Bostock-a et al. (1979), Traut-a et al. (1984), Agulnik-a et al. (1988, 1990) i Stanimirović-a (1992), Stanimirović-a et al. (1992).