

## Robertsonian Chromosomal Polymorphism in the Mouse (*M. musculus domesticus*)

Intraspecific chromosomal polymorphism due to the centric fusion of acrocentric chromosomes is well known in rodents. Nevertheless, examples of a more extensive variation of this type are reported only in few taxonomic groups, among these the African pigmy-mice of the subgenus *Leggada* of *Mus*<sup>1-3</sup>.

While spontaneous centric fusions of acrocentric chromosomes have been observed occasionally in laboratory mouse strains<sup>4-6</sup>, only little was known until recently of the occurrence of similar phenomena in the karyotype evolution of wild living palaearctic populations of the domestic mouse (Genus *Mus*). However, an extreme variant of this type of Robertsonian changes has been discovered in the tobacco mouse, *M. (musculus) poschiavinus*<sup>7</sup>: A karyotype with 26 chromosomes including 7 pairs of fusion metacentrics (T1-7Bnr)<sup>8</sup> seems to characterize uniformly the dark coloured tobacco mouse population of the Valle di Poschiavo (Grisons). Domestic mice with the standard mouse karyotype of 40 acrocentrics or hybrids have not yet been found by us in the Valle di Poschiavo during the last 4 years, though their presence cannot be excluded.

The present report on domestic mice from the Val Bregaglia (Grisons) demonstrates the occurrence of a polymorphism due to Robertsonian changes which is at least in part independent of the condition in the neighbouring Poschiavo.

**Material.** Chromosome analyses were done in 4 specimens of *M. musculus domesticus*, caught in the village of Vicosoprano (Val Bregaglia) between October 1969 and October 1970. One female (No. M/224) and 2 other females (No. M/332 and M/333) were trapped in a small shed in October 1969 and February 1970, respectively. A male animal (No. M/405) was captured in October 1970 in a stable in about 100 m distance of the shed where the other animals had been caught. This male was mated with female mice of the laboratory strain NMRI and of a strain carrying the T4Bnr-chromosome<sup>8,9</sup> before it was killed for the chromosome investigation.

Chromosome preparations were obtained from bone marrow by the use of a direct method. At least 25 metaphases per animal have been evaluated in the microscope, 5 to 10 additional metaphases were photographed for karyotyping. In the male No. M/405 and the male offsprings of crossings of this animal, additional meiotic preparations of the testis were made. The skins and skulls of 2 of the animals are registered as *M. m. domesticus* in the Zoologische Forschungsinstitut und Museum Alexander Koenig, Bonn (♀ M/224 = Reg. No. 70.36; ♀ M/405 = Reg. No. 71.38).

**Observations.** Two female mice (No. M/224 and M/332) had 40 acrocentric chromosomes corresponding to the ordinary *M. musculus*-karyotype.

A third female (No. M/333) displayed a karyotype (Figure 1) with 36 acrocentrics including the X-chromosomes and 2 metacentrics (F.N. = 40). However, the metacentrics were of different size and centromeric index. It can be concluded therefore that they represent non-homologous heterozygous chromosomes.

The male mouse No. M/405 mated with NMRI female sired a litter of 11 embryos, 9 with 39 chromosomes including 1 metacentric, and 2 embryos with acrocentric chromosomes only. The mating of the same male with a female homozygous for the T4Bnr chromosome<sup>8,9</sup> resulted in a litter of 6 mice. The 3 males of the litter were used for karyotype analysis. All of them showed 38 chromosomes with 36 acrocentrics and 2 metacentrics, one of them corresponding to the T4Bnr metacentric and the other obviously derived from male No. M/405 (Figure 2a). In fact, when this male was killed for chromosome analysis, a karyotype (Figure 3) with 38 acrocentric chromosomes and Y metacentric (F.N. = 40) was found. In meiosis I one trivalent was present. The metacentric chromosome of the male No. M/405 has similar size and shape as the smaller metacentric in the karyotype of female No. M/333. It is also comparable in size to the T4Bnr chromosome. However, the analysis of diakinesis and meiotic metaphase I figures in a F<sub>1</sub>-male derived from the cross of male No. M/405 × T4Bnr revealed the presence of a chain tetravalent (Figure 2b). This finding proves homology of 1 arm of both metacentrics but excludes at the same time complete homology. Since work is in progress to breed a laboratory mouse strain homozygous for this chromosome for experimental use, it is tentatively designated with the symbol T8Bnr<sup>8</sup>.

**Conclusions.** The findings presented in this report seem to establish the occurrence of an intraspecific polymorphic

<sup>1</sup> R. MATTHEY, Cytogenetics 2, 290 (1963).

<sup>2</sup> R. MATTHEY, Rev. Suisse Zool. 73, 585 (1966).

<sup>3</sup> R. MATTHEY, Experientia 26, 102 (1970).

<sup>4</sup> A. LÉONARD and G. H. DEKNUT, Experientia 22, 715 (1966).

<sup>5</sup> E. P. EVANS, M. F. LYON and M. DAGLISH, Cytogenetics 6, 105 (1967).

<sup>6</sup> J. B. WHITE and J. H. TJIO, Hereditas 58, 284 (1967).

<sup>7</sup> A. GROPP, U. TETTENBORN and E. v. LEHMANN, Cytogenetics 9, 9 (1970a).

<sup>8</sup> A. GROPP, U. TETTENBORN and A. LÉONARD, Experientia 26, 1018 (1970b).

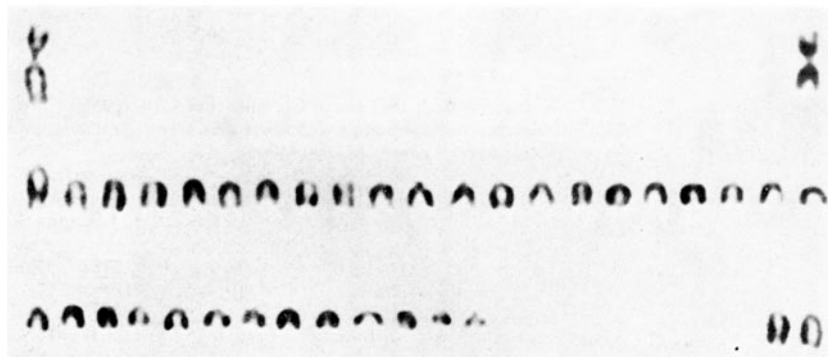


Fig. 1. Karyotype of a female house mouse (No. M/333). Bone marrow;  $2n = 38$ ; F.N. = 40. The 2 metacentric chromosomes differ in size and shape.

XX

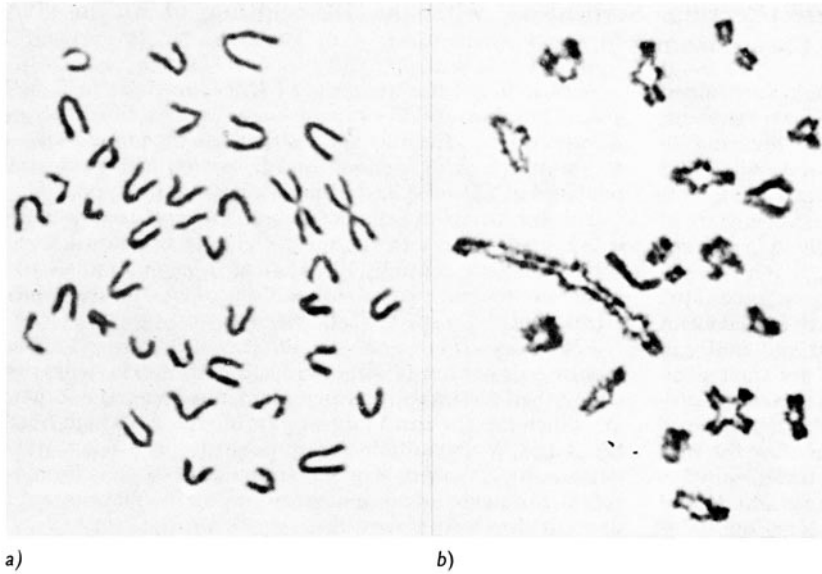


Fig. 2a and b. ( $\sigma$  M/405  $\times$  T4Bnr  $\varphi$ )  $F_1$  male. a) Metaphase, bone marrow;  $2n = 38$ ; F.N. = 40. The 2 different metacentrics (T4 and T8Bnr, see Fig. 3) are similar in size and shape. b) Testis. Late diakinesis/metaphase I. Chain tetravalent indicating homology of one chromosome arm of the T4Bnr and of the T8Bnr chromosome.

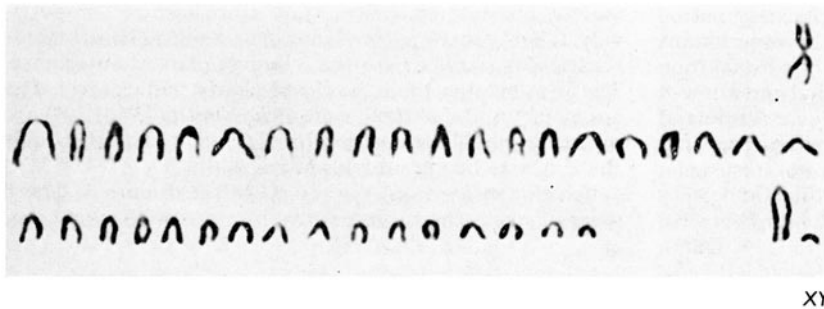


Fig. 3. Karyotype of a male house mouse (No. M/405). Bone marrow;  $2n = 39$ ; F.N. = 40. The metacentric is designated with the symbol T8Bnr.

condition in a population of the house mouse (*M. musculus domesticus*) from the Val Bregaglia (Grisons). This polymorphism is of Robertsonian type. It comprises at least 2 different metacentrics which presumably had been generated by centric fusion of acrocentrics. The 2 metacentrics present in 1 of the females studied are obviously different, while it seems to be possible that 1 of them is identical with the metacentric found in the male animal. Evidence could be provided, however, for the non-homology of the metacentric of this male animal and the T4Bnr chromosome. This latter is 1 of the 7 metacentrics of the tobacco mouse (*M. poschiavinus*). Therefore, it is unlikely that the existence of metacentrics in house mice of the Val Bregaglia is only or even mainly due to a spreading of the tobacco mouse marker chromosomes from the Valle di Poschiavo by hybridization. At least, the non-homologous metacentric shown in a mouse from the Val Bregaglia is of different origin, even though one of its arms is homologous with one arm of the T4Bnr chromosome.

The finding of a Robertsonian variation not only in the Valle di Poschiavo but also in another Alpine valley should urge cytogenetic population studies in more extended geographic areas in order to prove whether this polymorphism is restricted to some southern Alpine valleys or whether it is more widely distributed than expected at present.

It is noteworthy, however, that the polymorphism found in the domestic mouse in the Val Bregaglia could hardly be maintained if it affects the reproductive capacity of the population. On the contrary, the tobacco mouse metacentrics (T1-7Bnr) in a heterozygous condition produce extensive meiotic non-disjunction<sup>10</sup> and aneuploidy of

zygotes which cause in turn considerable fetal loss and reproductive failure. In nature this situation must result in building up an efficient reproductive barrier<sup>7</sup> which isolates the tobacco mouse. It may be concluded, therefore, that the mechanisms underlying centric fusions and their consequences may differ in various populations<sup>11</sup>.

**Zusammenfassung.** Hausmäuse (*M. m. domesticus*) aus dem Bergell/GR zeigen einen intraspezifischen Chromosomenpolymorphismus vom ROBERTSON'schen Typ mit wenigstens zwei verschiedenen metazentrischen Chromosomen. Für eines dieser beiden Chromosomen konnte gezeigt werden, dass es von den sieben bei der Tabakmaus (*M. poschiavinus*) vorhandenen metazentrischen Chromosomen unabhängig ist. Ein für dieses Chromosom (T8Bnr) homozygoter Stamm auf dem Hintergrund der Laboratoriumsmaus wird für experimentelle Verwendung herausgezüchtet.

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<sup>9</sup> B. M. CATTANACH, unpublished. We thank Dr. CATTANACH, MRC, Harwell/England, for supplying us with mice bred for homozygosity of the T4Bnr chromosome.

<sup>10</sup> U. TETTENBORN and A. GROPP, Cytogenetics 9, 272 (1970).

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