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THE CHROMOSOMES OF A POPULATION OF *Microtus mexicanus* (Muridae — Rodentia) OF CENTRAL MEXICO*

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ABSTRACT

Chromosome analysis of a population of *Microtus mexicanus mexicanus* collected in the southern part of the Valley of Mexico was carried out. The chromosome source was a bone marrow cell suspension. The diploid number found was 48, with a fundamental number (number of autosomic arms) of 58 and a sexual differentiation pattern of XX/XY. This species is polimorphic as far as the diploid number is concerned, as Matthey (1957) reported a karyotype with a diploid number of 44 from a specimen of a northern population. Two robertsonian fusions may have been the rearrangements involved in this particular type of karyotype variation. The karyological features of southern populations are probably primitive with respect to northern populations.

RESUMEN

Se realizó el análisis cromosómico de individuos de la especie *Microtus mexicanus mexicanus* procedentes de una población situada al sur del Valle de México. Los cromosomas examinados se obtuvieron a partir de una suspensión celular de médula ósea. El número diploide encontrado fue 48, con un número fundamental (número de brazos autosómicos) igual a 58 y diferenciación sexual de tipo XX/XY. La especie en cuestión es polimórfica por lo que se refiere a su número diploide, ya que Matthey (1957) registró un cariotipo con un número diploide de 44 en un espécimen proveniente de poblaciones septentrionales. Los rearreglos cromosómicos que pudieron haber intervenido en las modificaciones del número diploide son dos fusiones robertsonianas. Los rasgos cariológicos de las poblaciones meridionales estudiadas representan probablemente estadios primitivos de evolución cromosómica.

INTRODUCTION

The successful subfamily *Microtinae* of the *Muridae* family is disbuted across most of North America southward to Guatemala. In Eurasia its range covers more than the northern half of the Continent. Individuals belonging to the genus *Microtus* live in a range of different habitats: from beaches and marshes to alpine

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mountain tops, from open plaines to dense forests, being particularly abundant in humid prairies. Their runways through vegetation are characteristic of these animals.

There are approximately 50 living species in the subfamily *Microtinae*. Within the family the diploid chromosome number ranges from 17 in *M. oregoni* (Ohno *et al.*, 1963, 1966) to 60 in Microtus *chrotorrhinus* (Meylan, 1967).

Important cytogenetic data have been found in this genus, e.g. the obtention of permanent diploid lines bearing chromosomal rearrengements not commonly found in live specimens. These clonal lines have either appeared spontaneously (Cooper *et al.*, 1970) or have been induced by means of radiation (Cooper and Hsu, 1971). In *Microtus oregoni* a peculiar type of sexual differenciation pattern involving gonosomic mosaicism has been reported (Ohnn *et al.*, 1963).

The cytogenetic study of a population living in the southern limit of the geographical range seemed interesting for its location in peripheral area, as such populations would be expected to show primitive chromosomal characteristics, according to the model of centrifugal speciation of Brown (1957).

MATERIAL AND METHODS

The cytogenetic studies were carried out on 3 males and 5 females of *Microtus mexicanus mexicanus*. These specimens were collected from their natural borrows in Santa Ana Tlacotengo, Milpa Alta, D. F., a locality in the southwestern part of the Valley of Mexico. A colchicine solution (0.04% weight/volume) was injected intraperitoneally into each specimen an hour prior to their use in our cytogenetic studies. Bone marrow cells were used to obtain flame dried slides, according to routine techniques (Becak and Paulete, 1970).

The best appearing and clearest chromosome fields were photographed and enlarged. Measurements were made on four karyotypes of each specimen. Relative length values were obtained, as well as centromeric index, to enable us to classify the chromosomes according to the methods of Al-Aish (1969) and Levant *et al.*, (1964).

RESULTS

The Microtus mexicanus population studied was found to have a diploid number of 48 and a fundamental number of 58 with the sexual differentiation pattern of XX/XY.

The karyotype is formed by 23 pairs of autosomes, 6 of which are biarmed and 17 uniarmed (Fig. 1). All of the biarmed chromosomes are metacentric, except pairs 1 and 4 which are submetacentric. An idiogram of the karyotype is shown in figure 2. The results of the satistical analysis are shown in table I.

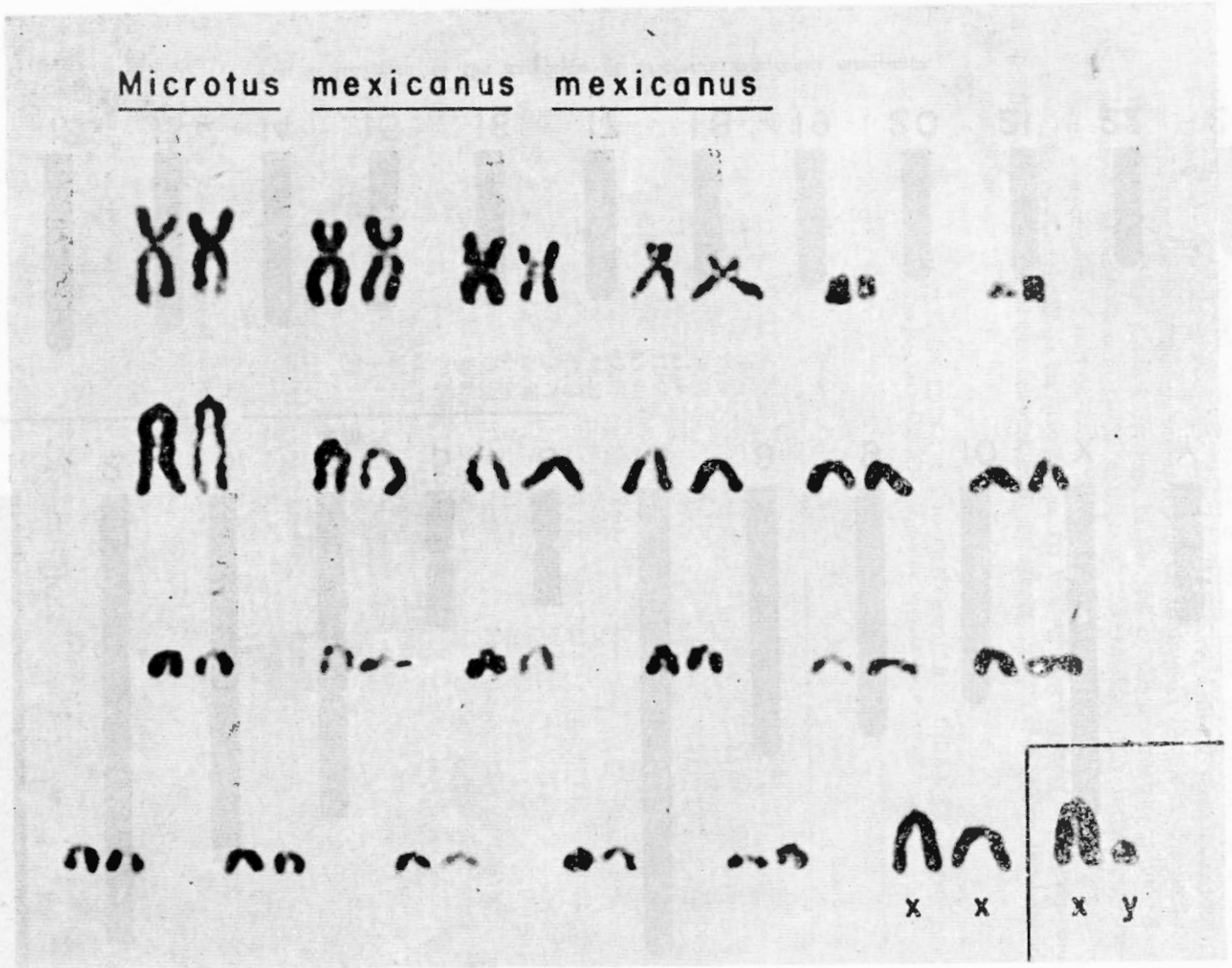

Fig. 1. Karyotype of *Microtus mexicanus mexicanus*. The inset shows the proposed heteromorphie sexual pair of the male.

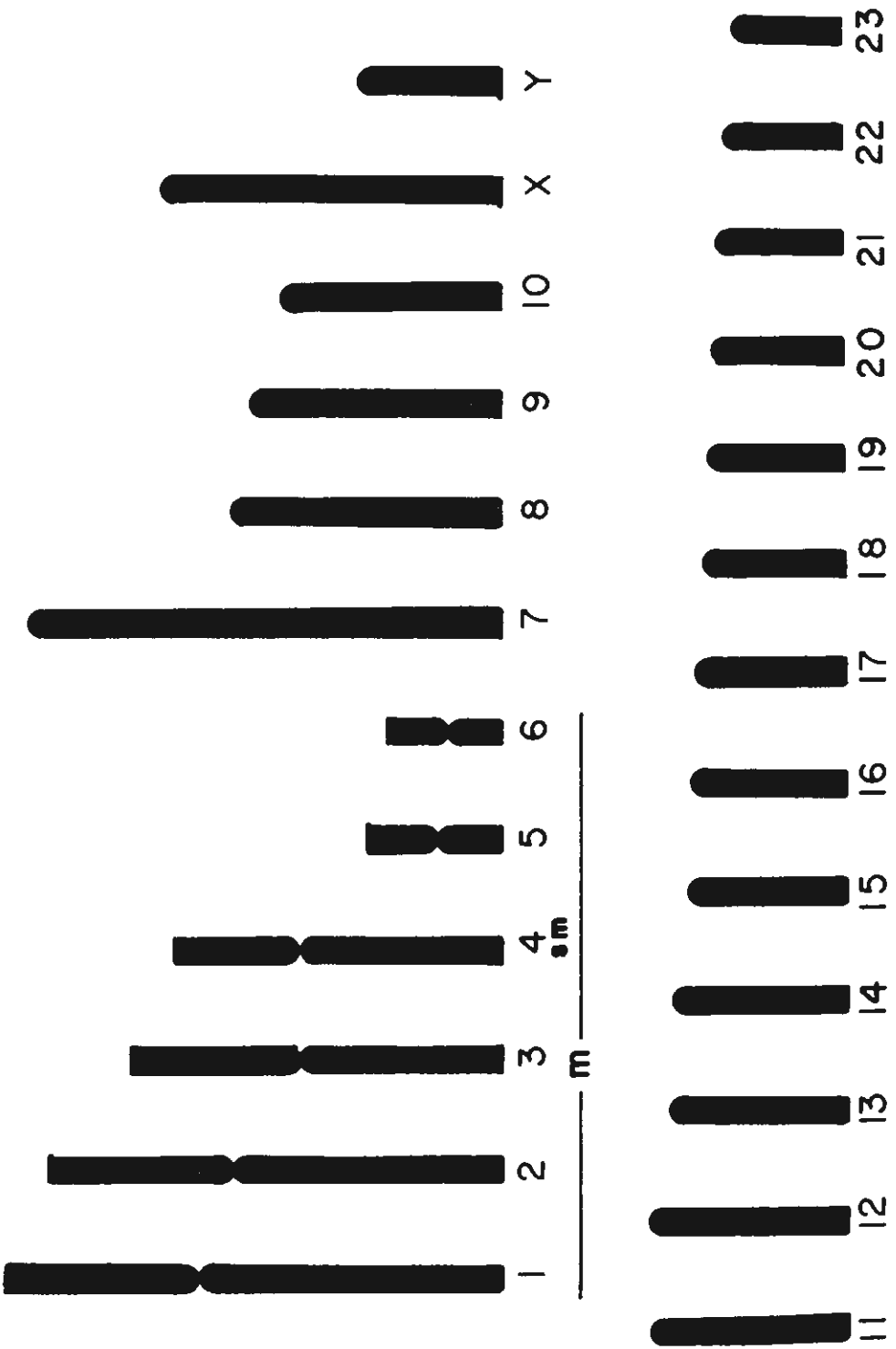

Fig. 2. Idiogram of the karyotype of *Microtus mexicanus mexicanus*.

The larger chromosomes are those of pair 1 (metacentrics) and pair 7 (acrocentrics). The proposed Y-chomosome is the smallest acrocentric, as is found in many other species of the genus *Microtus*. However, with the techniques used it was not possible to obtain a uniequivocal determination of the Y-chromosome. This was due to the gradual decrease in the size of the acrocentrics, which does not allow the odd element to be sorted out. Nevertheless, this chromosomal element was certainly found to have the centromere in terminal position.

The X-chomosome is an acrocentric. Its relative length places it between the first and third largest acrocentrics, with an average length of 6.2% of the haploid complement.

TABLE I. AVERAGE LENGTH AND CENTROMERIC INDEX OF THE CHROMOSOMES OF *Microtus mexicanus mexicanus*

Pair	RL_p	RL_q	$\frac{RL_{p+q}}{\bar{x}} \pm SEM$	*C.I.*	*Classification*
1	34.10	56.08	90.18 5.84	37.81	sm
2	33.57	49.68	83.25 5.08	40.33	m
3	30.55	37.29	67.84 3.65	45.03	m
4	22.01	38.10	60.13 3.02	36.61	sm
5	11.40	13.06	24.46 0.54	46.63	m
6	10.04	11.42	21.46 0.51	46.79	m
7		85.99	85.99 6.04		
8		48.85	48.85 3.02		
9		45.53	45.53 2.41		
10		41.14	41.14 2.73		
11		35.79	35.79 1.77		
12		34.52	34.52 1.63		
13		31.94	31.94 1.58		
14		31.36	31.36 1.77		
15		30.40	30.40 1.57		
16		29.59	29.59 1.59		
17		28.20	28.20 1.45		
18		29.39	27.39 1.43		
19		26.43	26.43 1.44		
20		25.31	25.31 1.52		
21		24.08	24.08 1.30		
22		22.42	22.42 1.19		
23		20.92	20.92 1.32		
X		62.87	62.87 3.61		
Y		25.58	25.58 1.68		

RL_p = Relative length of short arm.
RL_q = Relative length of long arm.
C.I. = Centromeric index.
m = metacentric.
sm = submetacentric.

DISCUSSION

The results differ from those of Matthey (1957) who reported the karyotype of *Microtus mexicanus*, based only on single female specimen, with an unknown

collection site, Mathey (1957) reported a diploid number of 44, with a fundamental number of 54 or 56. He found ten or twelve biarmed chromosomes, the remainder being acrocentrics. Although the number of biarmed chomosomes agrees with our findings, his camera lucida published drawings do not. In Matthey's work there is a medium sized metacentric and a large suhtelocentric which we did not find. The two small pairs of metacentrics appear in Matthey's drawing, although he apparently did not consider them as biarmed.

There is also a difference in the diploid number reported for *Microtus mexicanus*: 44 in Matthey's work and 48 in our investigation.

Assuming that the specimen studied by Matthey was representative of northern populations, the differences noted above could be explained if it is assumed that two robertsonian fusions or fissions took place involving the medium sized metacentric and the largest subtelocentric from the northen populations (Matthey's chromosomes 's' and 'o') and the largest and three smaller acrocentric pairs from the southern populations. The large one, and a small acrocentric one of *M. m. mexicanus* would therefore be the equivalent of the large subtelocentric found in the northern populations, while its medium sized metacentric would be the equivalent of the other two small acrocentrics. In this manner, the karyotypic evolution could be explained only by two robertsonian rearrengements. Otherwise, a longer succession of rearrangements would be necessary to explain such karyotypic differences.

The populations studied for this paper show some karyotypic primitive features, such as the chromosomal number of 48. This fact seems to fit in the hypothesis of centrifugal evolution, which states that peripheral populations have kept primitive features, which are not found in central more dynamicly evolving populations. Thus, the robertsonian event involved in the karyotypic divergence found was probably a chromosomic fusion, and a more advanced stage in karyotypic evolution has been attained by northern populations.

The analysis of the karyotypes suggest that a cytological reproductive isolating mechanism has probably been established between the populations of *Microtus mexicanus* inhabiting the southern and the northern areas of their distributional range. If an experimental crossing could be made between southern and northern specimens, the resulting progeny would probably have meiotic failures resulting in the formation of unbalanced gametes, such as were found in the hybrid progeny from the mating among *Mus musculus* and *M. poschiavinus* (Tettenborn and Gropp, 1970).

The cytogenetic study of some other subspecific populations of this species would be interesting, particularly those living in the strip which extendes from Central Mexico to the South of the United States. In this zone some populations bearing intermediate karyotypes, i.e. bearing only one chromosomal rearrangement, might be found. The banding patterns would also help to throw some light on the karyotypic evolution of this species.

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