Cytogenetic Analysis of *Neotomodon alstoni alstoni*

Manuel Uribe, Alfredo Laguarda, Jorge Romero,

Laboratorio de Genética Animal, Instituto de Biología,
Universidad Nacional Autónoma de México

Jorge Paulete and Susana Scaglia de Paulete

Departamento de Morfología, Faculdade Regional de Medicina,
São José do Rio Preto, SP, Brasil

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Introduction

Cytogenetics of *Rodentia* has been considerably studied because it is a group in full evolution as shown by Makino (1942), Matthey (1945, 1953, 1961, 1963, 1964a, 1964b, 1966), Hungerford and Nowell (1963), Yoshida (1965), Hsu and Arrighi (1966, 1968), Nadler (1969), Yong (1969), Bianchi *et al.* (1970), Paulete (1970), Capanna *et al.* (1970) and Gropp *et al.* (1970) among others.

Rodents of Mexico has been mainly analyzed by foreign workers since they are species and populations spread in large areas of both U.S.A. and Mexico. Nevertheless, it is worth to note that the study of mammals—mainly rodents—only distributed in the Mexican area will be of remarkable interest because their special condition for evolution. In this way, several papers dealing with the cytogenetic findings in various rodents from the Mexico Valley have been reported (Laguarda-Figueroa *et al.* 1971, Paulete *et al.* 1971, Romero-Jarero 1972, Solís-Wolfowitz 1972, Uribe-Alcocer 1972).

The Family *Cricetidae* is a very important one because the qualitative and quantitative rearrangements of the karyotype that the same species, subspecies and even populations show when located in different regions. In this way, *Neotomodon* is a very singular representative of the *Cricetidae* family because its distribution area is exclusively restricted to the transversal volcanic system of Mexico, where it is the only endemic genus of the group. Merriam (1898), on the basis of dental structure, considered the genus *Neotomodon* very near from *Neotoma* and he established three species: *N. alstoni*, *N. orizabae* and *N. perotensis*. Davis and Follansbee (1945), on the basis of skull characteristics, dental structure and behaviour, recognized only one species: *Neotomodon alstoni*, with two subspecies: *Neotomodon alstoni alstoni* and *Neotomodon alstoni perotensis*.

The aim of this paper is to analyze the karyotype and meiotic behaviour of the chromosomes of *Neotomodon alstoni alstoni* in order to throw some new light on the taxonomic problems of this genus.

Material and methods

A total of 13 specimens of *Neotomodon alstoni alstoni* (9 females and 4 males)

collected in the region of La Cima, Tlalpan, México DF at the km 43 of the México-Cuernavaca federal highway, were analyzed.

Fig. 1. Karyotype of male and female of *Neotomodon alstoni alstoni* from Mexico.

The animals were injected with 0.1 ml/10g body weight of a 0.04% colchicine solution and 2 hr 30 min after they were sacrificed. Chromosome spreads from bone marrow, spleen and testes were obtained and permanent slides were prepared following the routine techniques (Beçak and Paulete 1970, Ford and Evans 1969). In each animal no fewer than 20 metaphases from each tissue processed were analyzed.

ed. The chromosome classification was made according to the criteria of Levan *et al.* (1964) and A1-Aish (1969).

Results

A. Mitotic chromosomes

All specimens of *Neotomodon alstoni alstoni* studied had a diploid number of chromosomes, $2n=48$ and a fundamental number, $NF=66$. The analysis of the complement showed the existence of 23 pairs of autosomes (8 pairs were biarmed and the other 15 pairs were acrocentric ones). The four largest pairs of chromosomes (nr 1-4) have a subterminal centromere; the three following pairs (nr 5-7) are submetacentric and the eighth pair is a small metacentric one. All the remaining chromosomes show a terminal or subterminal centromere (Fig. 1 and Table 1).

Fig. 2. Bivalents during meiosis from male *Neotomodon alstoni alstoni*.

The X-chromosome is a long submetacentric, while the Y-chromosome is a large subacrocentric one, having the same relative length than the 11th pair of autosomes.

B. Meiotic chromosomes

Spermatocytes showed at diakinesis 23 pairs of bivalents. X and Y chromosomes showed a very short pairing segment, allowing an end-to-end synapsis. The X-chromosome in heterogametic sex always presents negative heteropycnosis being late replicating, while the Y chromosome shows a discrete positive heteropycnosis. No sexual vesicles were observed during pachytene (Fig. 2).

Discussion

Neotomodon, from the mastozoological point of view, shows morphologic similarities with the genus *Peromyscus* and *Neotoma* (Merriam 1898, Goldman 1910, Davis and Follansbee 1945). Cytogenetics of *Neotomodon alstoni alstoni*

is quite similar to that of *Peromyscus*, because they show both the same chromosome number ($2n = 48$) and also in both genera the X-chromosome corresponds to 5% of the haploid complement length.

The fundamental number of *Neotomodon alstoni alstoni* locates this species among the rate of various species of *Peromyscus* which show 8 pairs of biarmed autosomes like *Peromyscus gossypinus* and *Peromyscus truei*. Baker and Mascarello (1969) suggested that the primitive karyotype of *Cricetidae* consisted of 48 to 50 acrocentric chromosomes. According with this hypothesis both *Neotomodon*

Table 1. Different chromosome measurements in *Neotomodon alstoni alstoni* from Mexico

Chromosome number	Total length	Short arm	Long arm	Relative length	Centromeric index	Arm ratio	Classification
1	36.94	7.96	28.98	86.4	0.215	3.64	st
2	30.46	6.90	23.55	71.3	0.226	3.86	st
3	28.32	5.82	22.50	66.3	0.205	3.86	st
4	25.96	5.67	20.28	60.7	0.218	3.57	st
5	20.93	5.88	15.03	49.0	0.281	2.55	sm
6	19.67	5.55	14.11	46.0	0.282	2.53	sm
7	12.01	4.11	7.90	28.1	0.342	1.92	sm
8	10.05	3.92	6.13	23.5	0.390	1.56	m
9	26.32		26.32	61.5			a
10	23.32		23.32	54.6			a
11	19.50		19.50	45.6			a
12	16.30		16.30	38.2			a
13	15.50		15.50	36.2			a
14	14.44		14.44	33.8			a
15	13.75		13.75	32.2			a
16	13.15		13.15	30.8			a
17	12.69		12.69	29.7			a
18	12.36		12.36	28.9			a
19	11.69		11.69	27.4			a
20	11.15		11.15	26.1			a
21	10.69		10.69	25.0			a
22	9.90		9.90	23.2			a
23	8.67		8.67	20.3			a
X	23.55	6.34	17.21	55.1	0.269	2.71	sm
Y	19.50	2.50	17.00	45.6	0.128	6.80	st

and *Peromyscus* are quite evolved ones because, since both genera show 24 pairs of chromosomes, it is possible to assume that their karyotypes must be evolved mainly by pericentric inversions (Hsu and Arrighi 1968).

On the other hand, from the cytogenetic point of view, *Neotomodon alstoni alstoni* is not so close to *Neotoma* than to *Peromyscus* either in chromosome number or in fundamental number, since *Neotoma* never shows $2n = 48$ (Baker and Mascarello 1969, Paulete *et al.* 1971), and only one population out of the nine species

reported shows $FN = 66$ (Baker and Mascarello 1969).

The number of chromosomes in *Neotomodon* must be, at least, as constant as in *Peromyscus* because its distribution area is a very restricted one.

The negative heteropycnosis of the X-component of the X-Y bivalent is due to its allocyclic, since it is a late replicating one (Fredga 1964).

The results here obtained agree with those obtained by Davis and Follansbee (1945) on the basis of the skull, structure and habits. Really, cytogenetics of this species shows more affinity between *Neotomodon* and *Peromyscus* than between *Neotomodon* and *Neotoma*. This confirms and reinforces too the findings of Hooper and Musser (1964) who, on the basis of morphological characteristics of the phallus suggest more close phylogenetic relationships between *Neotomodon* and *Peromyscus*. These results also agree with Goldman (1910) who established only on morphological basis that *Neotomodon* belongs to the subfamily *Cricetinae*.

Summary

The authors report the cytogenetic analysis of *Neotomodon alstoni alstoni* (*Rodentia, Cricetidae*), an endemic species restricted to the transversal volcanic system of Mexico. The chromosome number of this species is $2n = 48$ and the fundamental number $NF = 66$. From the cytogenetic point of view, *Neotomodon alstoni alstoni* shows close relationships with the genus *Peromyscus* because several species of the latter show 8 pairs of biarmed autosomes as the former, as well as the same chromosome number and identical fundamental number. The analysis of male meiosis in spermatocytes shows 23 bivalents, while X and Y chromosomes having short pairing segments form an end-to-end synapsis. The X-Y complex shows negative heteropycnosis in the X component which seems to be related to their allocyclic portion during this phase of cellular cycle. The Y chromosome shows discrete positive heteropycnosis.

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