Acta Theriologica 39 (4): 373–377, 1994.
PL ISSN 0001–7051

Karyotypes of the Mexican tropical voles *Microtus quasiater* and *M. umbrosus* (*Arvicolinae*: *Muridae*)

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Cervantes F. A., Martínez J. and González R. M. 1994. Karyotypes of the Mexican tropical voles *Microtus quasiater* and *M. umbrosus* (*Arvicolinae*: *Muridae*). Acta theriol. 39: 373–377.

The non-differentially stained karyotypes of the tropical voles *Microtus quasiater* (Coues, 1874) and *M. umbrosus* (Merriam, 1898) are described by first time, and compared and contrasted with that of the hypothetical primitive karyotype for *Arvicolinae*. The karyotype of *M. quasiater* from Veracruz, Mexico, has 2n = 62 and FN = 66, while that for *M. umbrosus* from Oaxaca, Mexico, has 2n = 56 and FN = 60. Their chromosomal morphology comprises few two-armed chromosomes and a relatively large number of single-armed chromosomes. Both species share both a medium-sized metacentric X chromosome and a small telocentric Y chromosome. This karyotypical pattern deviates from the hypothetical primitive condition. However, the karyotypes of other *Microtus*, including Mexican species of temperate affinity, seem to be even more divergent from the ancestral karyotypical pattern.

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Key words: *Microtus quasiater*, *Microtus umbrosus*, *Arvicolinae*, *Muridae*, karyotype, Mexico

Introduction

The southernmost records of the genus *Microtus* in the New World are from Guatemala and Mexico (Hoffmann and Koeppl 1985). However, the species richness of this genus in Mexico is higher. *Microtus quasiater* (Coues, 1874), *M. oaxacensis* (Goodwin, 1966), *M. umbrosus* (Merriam, 1898) and *M. guatemalensis* (Merriam, 1898) occur in cloud forests and wet oak-pine forests of the east and south of the Mexican tropics. They are remanents of the first wave of colonization of Mexico by their genus in the early Pleistocene (Hoffmann and Koeppl 1985).

In contrast, *M. californicus* (Peale, 1848), *M. pennsylvanicus* (Ord, 1815), and *M. mexicanus* (Saussure, 1861) are species of temperate affinity that inhabit grasslands, and pine and pine-oak forests in the highlands of the United States and Mexico. They arrived in Mexico during the second wave of immigration by the late Pleistocene (Hoffmann and Koeppl 1985). Teeth evidences show that *M. mexicanus* is closely related to other recent species (Anderson 1985) such as *M. canicaudus* (Miller, 1897) and *M. montanus* (Peale, 1848) which are thought to have appeared during the late Pleistocene (Hoffmann and Koeppl 1985).

Unfortunatley, the biology of the tropical voles is poorly known. Consequently, their cytogenetical attributes are poorly understood since their conventional karyotypes have not even been previously described.

The ancestral karyotype of the genus *Microtus* had a diploid number of 2n = 56, and bore a chromosomal morphology of single-armed elements (Matthey 1957). The karyotypical evolution of *Microtus* featured reduction of the 2n through Robertsonian events to produce more two-armed chromosomes (Gaines 1985). If the tropical voles display similarities to or differences from this pattern is unknown. Hence the aim of this paper is to describe the conventional karyotypes of *M. quasiater* and *M. umbrosus* to compare and contrast them with that of the ancestral karyotypical condition.

Materials and methods

M. quasiater (3 females and 1 male) were collected 18 km NW Teocelo, Municipio Ixhuacan, Veracruz, Mexico, at 1,300 m a.s.l.; *M. umbrosus* (10 females and 11 males) were collected 5 km N

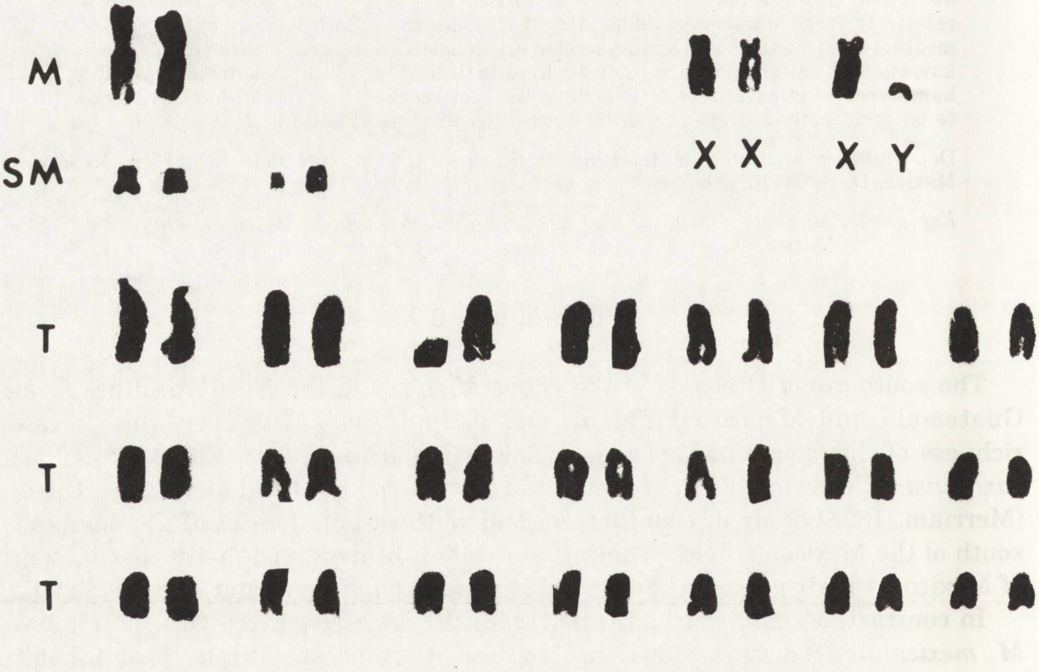

Fig. 1. Karyotype (2n = 62, FN = 66) of *Microtus quasiater* from 18 km NW Teocelo, Municipio Ixhuacan, Veracruz, Mexico, 1,300 m a.s.l. (34244 female, 34247 male; Instituto de Biología, Universidad Nacional Autónoma de Mexico). Chromosomal morphology: M – metacentric, SM – submetacentric, T – telocentric, X and Y – sex chromosomes.

Santa Maria Yacochi, Municipio Tlahuitoltepec, Oaxaca, Mexico, at 2,450 m a.s.l. Voucher specimens have been deposited in the mammalian collection of Instituto de Biología, Universidad Nacional Autónoma de Mexico (IBUNAM). Standard karyotypes were prepared using the *in vivo* bone marrow technique by Baker and Qumsiyeh (1988). A total of 60 slides were prepared and 720 mitotic fields examined for *M. quasiater*, whereas 105 and 1260, respectively, were prepared for *M. umbrosus*. Terminology describing relative chromosomal-arm ratios follows Levan *et al.* (1964).

Results

The diploid number (2n) of *M. quasiater* is 62 and the fundamental number (FN) is 66. The karyotype comprises one pair of large metacentric chromosomes and two small submetacentric chromosomal pairs. The rest of the complement is 27 pairs of small or medium size telocentric chromosomes. The X chromosome is a medium--sized submetacentric, whereas the Y chromosome is a small telocentric (Fig. 1).

The diploid chromosomal number of *M. umbrosus* is 2n = 56 and the FN = 60. Its chromosomal morphology is as follows: 3 pairs of small or medium size metacentric chromosomes, and 24 pairs of small, medium or large telocentric chromosomes. The X chromosome is a medium-sized metacentric, whereas the Y chromosome is a small telocentric (Fig. 2).

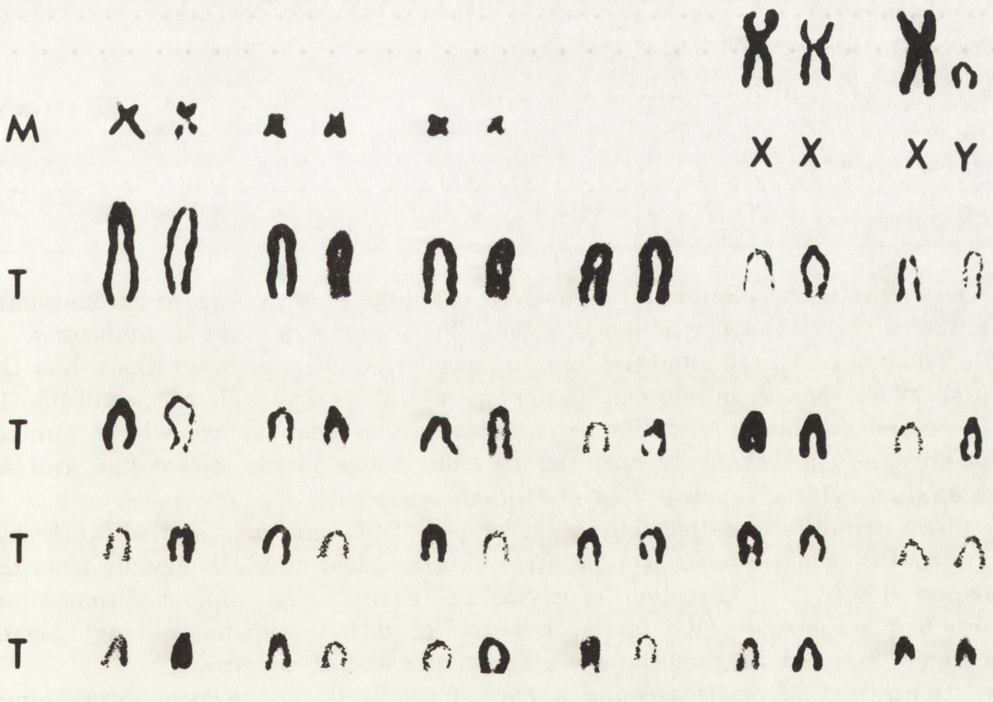

Fig. 2. Karyotype (2n = 56, FN = 60) of *Microtus umbrosus* from 5 km N Santa Maria Yacochi, Municipio Tlahuitoltepec, Oaxaca, Mexico, 2,450 m a.s.l. (33745 male, 34894 female; Instituto de Biología, Universidad Nacional Autónoma de Mexico). Chromosomal morphology: M – metacentric, T – telocentric, X and Y – sex chromosomes.

Discussion

The diploid chromosomal number of *M. umbrosus* is the same as that for the hypothetical ancestral karyotype (2n = 56) of *Arvicolinae*. In contrast, the diploid number for *M. quasiater* is higher (2n = 62). These two species present the highest diploid chromosomal complement of the Mexican vole species (Table 1). *M. pinetorum*, close relative of *M. quasiater* (Martin 1987), and *M. longicaudus* also exhibit high diploid numbers (2n = 62, and 56, respectively; Gaines 1985). In contrast, the 2n reported for *M. mexicanus* is 48, lying at an intermediate level in comparison with other voles of the genus *Microtus* (Gaines 1985).

M. quasiater has the highest number of single-armed chromosomes compared with the other three tropical vole species and *M. mexicanus* (Table 1). *M. umbrosus* has also a high number but little lower. In contrast, *M. mexicanus* displays many

Table 1. Diploid number (2n), fundamental number (FN), and chromosomal morphology (M – metacentric, SM – submetacentric, ST – subtelocentric, T – telocentric, X and Y – sex chromosomes) of the voles occurring in Mexico. [1] Gaines 1985, [2] Cervantes *et al.* in press, [3] present paper, [4] F. A. Cervantes, J. Martínez and R. M. González, pers. obs.

Species	2n	FN	M	SM	ST	T
Microtus californicus[1]	(52, 53, 54)	(60, 61, 62)		– Variable –		
Microtus pennsylvanicus[1]	(44, 48)	(54, 58)		– Variable –		
Microtus mexicanus[2]	48	58	4	2		17 (+X,Y)
Microtus oaxacensis[2]	30	56	13	1	(X)	(Y)
Microtus quasiater[3]	62	66	1	2 (+X)		27 (+Y)
Microtus umbrosus[3]	56	60	3 (+X)			24 (+Y)
Microtus guatemalensis[4]	52		–	Indeterminate	–	

fewer pairs of these autosomes; however, the number of two-armed chromosomes of its karyotype is twice as much of those for *M. quasiater* and *M. umbrosus*.

The fundamental numbers found showed that *M. quasiater* likely has the highest number of chromosomal arms among the Mexican vole species (Table 1). Moreover, similar to *M. californicus*, *M. umbrosus* also displays a large number of chromosomal arms. In this regard, the values for *M. mexicanus* and *M. pennsylvanicus* are close to that of *M. umbrosus*.

The non-differentially stained karyotypes of *M. quasiater* and *M. umbrosus* indicate that both species, comparative to other Mexican voles, deviate from the expected primitive karyotype of arvicoline rodents. High diploid chromosomal number, similar or equal to the ancestral condition, and mostly single-armed chromosomes are characteristic of *M. quasiater* and *M. umbrosus*.

In contrast, *M. oaxacensis* and *M. mexicanus* (Table 1) have lower chromosomal diploid numbers, many two-armed and few single-armed chromosomal pairs. Therefore, these patterns deviate even more from the hypothetical ancestral condition. Extreme examples of this condition are *M. canicaudus* and *M. montanus*, which exhibit diploid numbers of 2n = 22 and 24, respectively (Gaines 1985), and all their autosomes are metacentric.

Interestingly, *M. quasiater*, *M. umbrosus*, *M. mexicanus*, and *M. oaxacensis* all display a Y chromosome with the same centromeric position (Table 1). This chromosome seems to be small in the four species, although needs to be satisfactorily determined. This morphology recalls the primitive condition shown also by some other arvicolins (Modi 1987). On the other hand, the X chromosome of these species is from medium to large size. However, the position of the centromere in each species is different. In this case, the X chromosome of *M. quasiater* and *M. umbrosus* departs more from the ancestral condition of acrocentric chromosome (Modi 1987) than does that of *M. mexicanus* and *M. oaxacensis*.

In summary, the unbanded karyotypical patterns described for these two species of Mexican tropical voles have chromosomal features that deviate less from the hypothesized primitive pattern for the *Arvicolinae* than those known for other members of *Microtus*.

Acknowledgments: Financial support was provided by the MacArthur Foundation (grant 282.311.01 to V. Sánchez-Cordero and F. A. Cervantes) and by the Dirección General de Asuntos del Personal Académico, Universidad Nacional Autónoma de Mexico (grant IN203793 to B. Villa-Ramírez and Fernando A. Cervantes, and graduate scholarship to J. Martínez). R. Martínez, Y. Hortelano, and J. Vargas assisted in the field and the laboratory. F. Chiang and M. Uribe provided valuable editorial comments.

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Received 6 December 1993, accepted 4 August 1994.