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THE CHROMOSOMAL COMPLEMENT OF THE YELLOW-CHEEKED VOLE

Microtus xanthognathus (Leach)

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The karyotype of *Microtus xanthognathus* (Leach) is described, based on material from one female and one male vole. The diploid chromosomal number was found to be 54, and the fundamental number 62. The metacentric X-chromosome was of medium size and averaged 6.6% of the haploid complement. The designated Y-chromosome was near acrocentric. The specific distinction of *M. xanthognathus* and *Microtus chrotorrhinus* (Miller) was confirmed by the recognition of major differences in karyotype and differences in fundamental number. The distributional history of *M. xanthognathus* is briefly discussed.

Introduction

The yellow-cheeked vole, *Microtus xanthognathus* (Leach) is a biologically little-known species occurring in boreal North America from west-central Alaska to the western shore of Hudson Bay. The northern limits of its range in Canada correspond approximately to the timber-line. Within this extensive region, the voles are generally considered to be rare, although they sometimes become numerous locally. A morphologically similar vole, *Microtus chrotorrhinus* (Miller), has a disjunct distribution in eastern North America, from northern Labrador to the Great Lakes, and south in the Appalachian Mountains to North Carolina. Whether these voles differ only infraspecifically or represent distinct species has not been determined (cf. Hall and Kelson, 1959, p. 741), although Guilday and Bender (1960) identified remains of both voles in late Pleistocene deposits in Pennsylvania, and considered that their coeval association was indicative of specific distinction.

During the spring of 1973, yellow-cheeked voles locally attained high densities in north-central Alaska, where we were able to obtain a series of animals. This provided an opportunity to determine the chromosomal complement of *M. xanthognathus* and compare it with that of *M. chrotorrhinus*.

Materials and Methods

Karyotypes were prepared from an adult female vole captured at Bettles Field, Alaska (lat 66°55'30" N, long 151°30'00" W), on about 25 May 1973, and from a subadult male caught at mile 28, Yukon Highway, Alaska (approx. lat. 65°40' N, long. 149°07' W), on 21 June 1973. The animals were given 0.5 ml of 0.05% Colcemid (Ciba) intraperitoneally, and after 1.5 h, bone marrow, spleen, and testes were collected for squash-preparations. Hypotonic treatment, fixation, and staining followed the method of Nadler and Block (1962). Dry ice was used to make permanent mounts (Conger and Fairchild, 1953). The chromosomes were photographed on Kodak high contrast copy film and enlarged. Arm-ratios were determined for all chromosomes in six cells from the male and three from the female (all from bone marrow), and for the metacentric-submetacentric elements and sex-chromosomes in an additional four male and seven female cells; total length only

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was recorded for subtelocentric-acrocentric autosomes in these latter eleven. The chromosomes of one cell from each animal were used in the karyotypes, which were assembled by grading the 52 autosomes by size and selecting pairs on the basis of arm-ratios and morphologic characteristics.

Results

The diploid chromosomal number for *M. xanthognathus* was found to be 54, and the fundamental number 62.

Male: The karyotype of the male is shown in Fig. 1. Fifty-four chromosomes were present in 39 of 40 cells examined from bone marrow and testes (spermatogonia). Among the 52 autosomes, three groups were distinguished by centromeric position, expressed here by arm-ratio: 1| submedian, bordering on subterminal, in the largest autosomes (pair 1 in the karyotype), in which the range of arm-ratios was 2.61-4.40 (av 3.12); 2| subterminal to terminal in 46 autosomes of medium to small size (pairs 2-24), in which the arm-ratios ranged from 4.0 to ≥ 13.66 ; and 3| median in the smallest autosomes (pairs 25 and 26), in which the ranges of arm-ratios were 1.26-1.88 (av 1.47) and 1.0-1.44 (av 1.16), respectively. In the second group, the ratios indicated that all were subtelocentrics or acrocentrics, but the small arms were minute and individually indistinct even when the chromosomes were less contracted than those shown in Fig. 1. The consistent exception was the acrocentric pair 2, with well defined arms; the range of arm-ratios in this pair was 6.11-8.69 (av 7.55). The arm-ratio of the X-chromosome ranged from 1.01 to 1.34 (av 1.16). The Y-chromosome was one of a series of small-size subtelocentrics-acrocentrics (arm-ratio range 4.0-7.80, av 5.04), but was not identified with certainty; the chromosome so designated in the karyotype was selected by inspection. In the preparations from testes, meiotic figures showed 26 autosomal bivalents and one sex-chromosome bivalent, the latter with an end-to-end relationship in some cells (Fig. 3).

Female: The karyotype is shown in Fig. 2. Fifty-four chromosomes were counted in 61 of 65 cells from bone marrow and spleen. As in the male, three autosomal groups were distinguished: one pair of large submetacentrics (range of arm-ratios 2.43-3.63, av 2.88); 23 pairs of subtelocentrics-acrocentrics (range of arm-ratios 4.0 to ≥ 13.33); and two pairs of very small metacentrics (range of arm-ratios for pair 25, 1.31-1.77, av 1.60, and for pair 26, 1.09-1.31, av 1.20). In the X-chromosomes, the centromeres were median, and the range of arm-ratios was 1.02-1.35 (av 1.15). The X-chromosome of *M. xanthognathus* was of medium size, and constituted an average of 6.6% (range 5.7-7.9%) of the haploid complement.

Discussion

The karyotype of *M. chrotorrhinus* was described by Meylan (1967), who found the diploid number to be 60, and the fundamental number 64. With the exception of a single pair of small metacentrics, the autosomes were acrocentric. The sex-chromosomes, a submetacentric X and an acrocentric Y, were much larger than any of the autosomes. Meylan noted that the karyotype of *M. chrotorrhinus* resembles that of the palaearctic *Microtus agrestis* (Linnaeus) ($2n = 50$, FN = 54), which also has giant sex-chromosomes.

The karyotype of *M. xanthognathus* differs from that of *M. chrotorrhinus* in number of chromosomes, in fundamental number, and in having sex-chromosomes well within the range of size of the autosomes. The average lengths of the

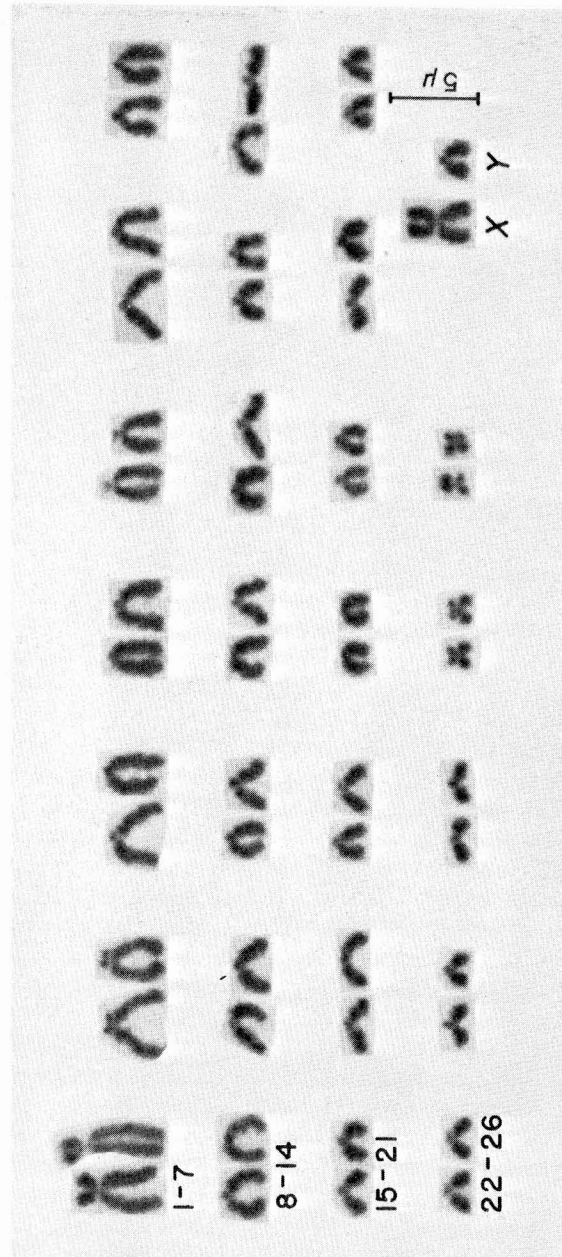


Fig. 1. Karyotype of *Microtus xanthognathus*, male, $2n = 54$ (marrow).

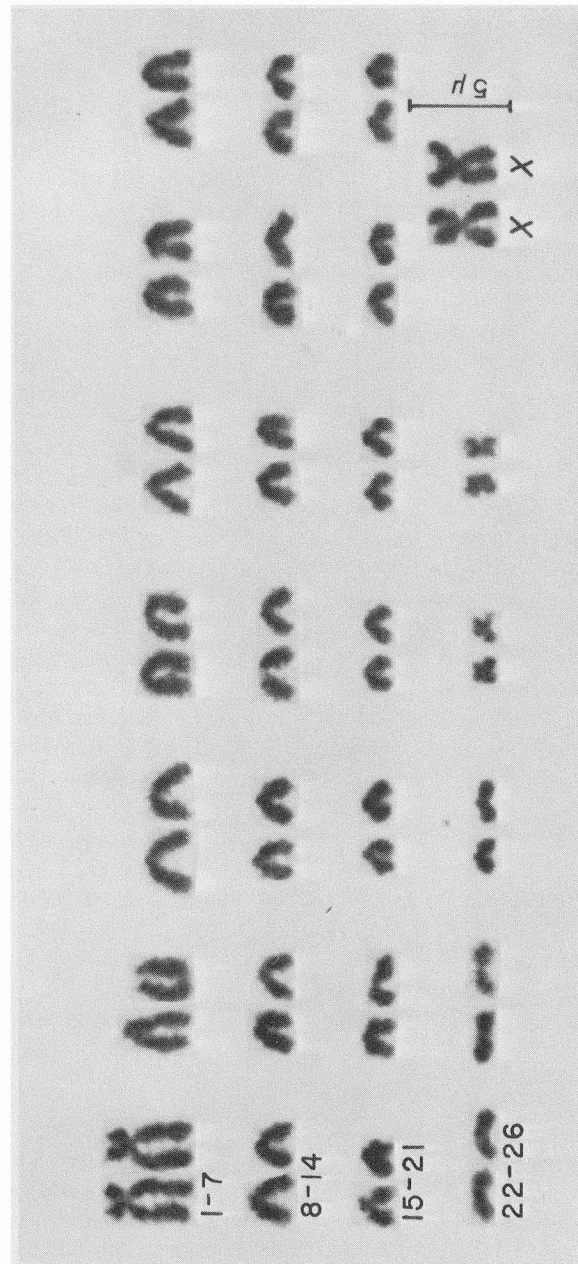


Fig. 2. Karyotype of *M. xanthognathus*, female (marrow).

X-chromosome in our material were 3.8μ (female) and 4.2μ (male), and of the Y-chromosome 1.9μ . The X-chromosome of *M. chrotorrhinus* was 8μ (female) and 7.5μ (male), and the Y-chromosome, approximately 5μ (Meylan, 1967). The yellow-cheeked vole has in addition a pair of large submetacentric and a pair of small metacentric autosomes not found in the other species. In chromosomal characteristics, *M. xanthognathus* does not seem to resemble closely any other species of *Microtus* for which karyotypes have been defined.

The pattern of the present geographic range of *M. xanthognathus* suggests that this vole spread from the Beringian Refugium during post-glacial time (cf. Guthrie, 1968). Its distribution resembles those in North America of *Clethrionomys rutilus* (Pallas) and of *Citellus parryi* (Richardson), both holarctic species that were present in Beringia during the last (Würm or Wisconsin) glaciation (Rausch, 1963; Macpherson, 1965). Teeth indistinguishable from those of *M. xanthognathus* have been found in late Pleistocene deposits and in the basal portion of post-glacial deposits in central Alaska (Repenning *et al.*, 1964; Guthrie, 1968). Guilday and Bender (1960) reported a dehydrated specimen of possible Pleistocene age from permanently frozen deposits in east-central Alaska.

Guthrie (1968) noted that the absence of any counterpart of this vole in Eurasia might be taken as support for the argument that it spread into northwestern North America post-glacially from the south. Since *M. xanthognathus* occupies a restricted biotope, the lowland tundra in central Beringia would seem to have been an ecological barrier to extension of its range westward during the last glacial period, but a further argument in support of its post-glacial immigration from the south

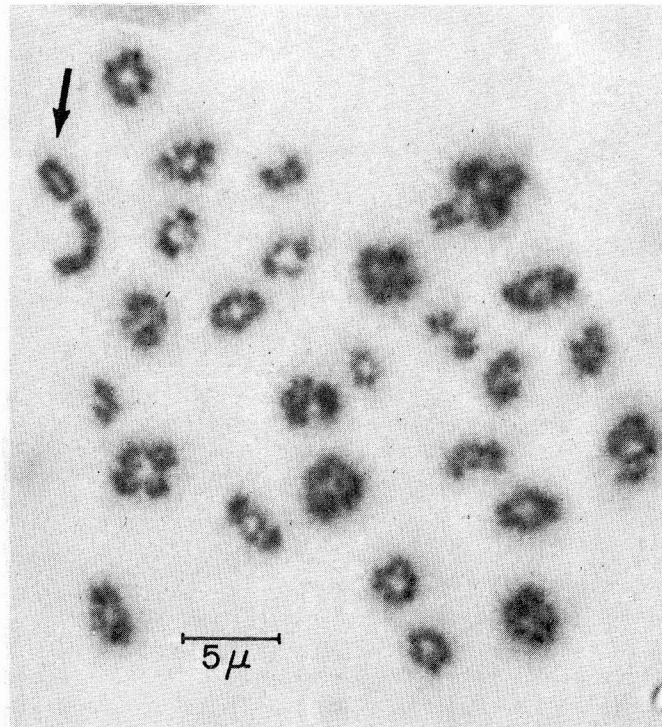


Fig. 3. Meiotic preparation from testis, *M. xanthognathus*, 26 II + XY (arrow).

might be based upon the limited extent of taiga in Beringia during Würm time (Hopkins, 1972). In any case, if this vole became widely distributed during the last (Eem or Sangamon) interglaciation, the glacial advances of Würm (Wisconsin) time might have left relict populations in Beringia and south of the continental ice-sheet, as is indicated in the case of varying lemmings, *Dicrostonyx* spp. (Macpherson, 1965; Rausch and Rausch, 1972). If unequivocal palaeontological evidence can confirm that *M. xanthognathus* was present in Beringia during the last glacial period, it would be the first known instance of survival there of a late-Pleistocene immigrant of nearctic origin.

During the period 1949-1973, in addition to those specimens from Bettles and the Yukon Highway, we have obtained *M. xanthognathus* from Lake Minchumina, McGrath, and Fairbanks, in central Alaska. The record from Bettles represents a significant extension northward of the known range of this vole in Alaska.

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