

Arten mit XX/XY -Typus findet sich bei *X. laevis* mit ZW/ZZ -Typus eine gleichzeitige Replikation aller Chromosomen (Figur 1 und 2). Figur 1 zeigt eine Mitose mit mittlerem Markierungsgrad. Geringe Schwankungen der Markierungsintensität sind allerdings vorhanden, entsprechend den Befunden von LIMA-DE-FARIA⁹, der eine stückweise Replikation der Chromosomen beschrieb.

Bei Tieren vom Geschlechtsbestimmungsmechanismus ZW/ZZ sind also keine Replikationsunterschiede im selben Kern festgestellt worden, gleichgültig ob Heterochromosomen bekannt sind oder nicht. Bei *Xenopus* lässt sich über das Vorhandensein von morphologisch unterschiedlichen Geschlechtschromosomen diskutieren. Ein Teil unserer Karyotypen weist eine Inhomologie des ersten Chromosomenpaares auf (Figur 2). WEILER und OHNO⁷ und MORESCALCHI¹⁰ deuteten dies als *W* und Autosom, MIKAMO und WITSCHI¹¹ jedoch als inhomologes Autosomenpaar, da sie es auch in Tieren beobachteten, die nach genetischem Test ZZ -Tiere waren. Das von WEILER und OHNO⁷ als *Z* vorgeschlagene Chromosom ist in unserem Material nicht zu erkennen. In der Gruppe der kleinen subtelozentrischen Chromosomen befindet sich nie ein inhomologes Paar. Ausserdem scheint uns die Zuordnung zu homologen Paaren schwierig, weil die

Chromosomen benachbarter Paare infolge Ähnlichkeit in Länge und Centromerindex austauschbar sind. Da unsere Karyotypen keine neue Auskunft über das Vorhandensein oder Fehlen cytologisch sichtbarer Geschlechtschromosomen geben, verzichten wir auf die Wiedergabe der Karyotypen.

Summary. Autoradiographics showed synchronous replication of all chromosomes in *Xenopus laevis*.

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⁹ A. LIMA-DE-FARIA, *Mammalian Cytogenetics and Related Problems in Radiobiology* (Pergamon Press, Oxford-London-New York-Paris 1964), p. 31.

¹⁰ A. MORESCALCHI, *Rc. Accad. Sci. (Napoli) Ser. 4*, 30, 310 (1963).

¹¹ K. MIKAMO und E. WITSCHI, *Cytogenetics* 5, 1 (1966).

Chromosomes of the North American Prairie Dog *Cynomys ludovicianus*

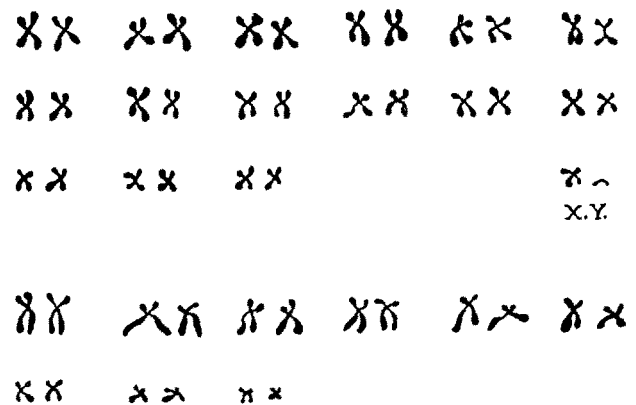
Chromosomes have been analyzed from various species of North American Sciuridae and most have a characteristic chromosomal complement with diploid numbers ranging from 30 in *Spermophilus beldingi* to 46 in *Spermophilus townsendi*¹⁻⁵. Species with higher diploid numbers ($2n$) usually have karyotypes with numerous acrocentric autosomes, whereas species with lower diploid numbers have progressively fewer acrocentric chromosomes. These observations parallel those derived from studies of primate chromosomes⁶. BENDER and CHU⁶ suggest that primitive primate species are often characterized by a higher $2n$ and more acrocentric autosomes in contrast to more specialized and recently evolved forms which have a lower $2n$ and fewer acrocentrics; this hypothesis is neither substantiated nor refuted by chromosomal data from the Sciuridae.

The purpose of the present study was to examine chromosomes from *Cynomys ludovicianus ludovicianus* (Ord), representing one of the most specialized and recently evolved genera of the Sciuridae⁷, and compare the chromosomes with those from species previously studied. 5 male and 5 female specimens of *C. ludovicianus ludovicianus* were obtained from northern Texas. Chromosomes were analyzed from femoral bone marrow using a Colcemide, hypotonic citrate, acetic orcein squash method⁸. All specimens had a modal diploid chromosome number of 50.

Karyotypes contained 15 pairs of metacentric and 9 pairs of submetacentric autosomes. Males exhibited a small metacentric *X* chromosome and a small acrocentric *Y* chromosome, as shown in the figure. Female karyotypes contained 2 metacentric *X* chromosomes.

Taxonomic relationships within the family Sciuridae have been reviewed elsewhere, and a variety of morpho-

logical characters which distinguish between *Cynomys* and the ground squirrel genus *Spermophilus*^{7,8}. However, *Cynomys* has unique highly-specialized dentition and a skeleton better adapted to fossorial life than



Drawing of a karyotype from a male *Cynomys ludovicianus*, $\times 2000$.

¹ C. F. NADLER, *J. Mammal.*, in press.

² C. F. NADLER and M. H. BLOCK, *Chromosoma* 13, 1 (1962).

³ C. F. NADLER, *Syst. Zool.* 15, 199 (1966).

⁴ C. F. NADLER and D. A. SUTTON, *Proc. Soc. exp. Biol. Med.* 110, 36 (1962).

⁵ R. L. RAUSCH and V. R. RAUSCH, *Chromosoma* 16, 618 (1965).

⁶ M. A. BENDER and E. H. Y. CHU, in *Evolutionary and Genetic Biology of the Primates* (Ed. J. BUETTNER-JANUSCH; Academic Press, New York 1963), vol. 1, p. 261.

⁷ C. C. BLACK, *Bull. Mus. comp. Zool. Harv.* 130, 109 (1963).

⁸ M. D. BRYANT, *Am. Midl. Nat.* 33, 257 (1945).

that of *Spermophilus*⁷. Paleontological data provide evidence that *Cynomys* originated during the late Pliocene or Pleistocene and is, therefore, one of the most recently evolved genera of North American Sciuridae⁷.

The chromosomes of *Cynomys* are also distinctive because they represent the highest $2n$ yet found among the Sciuridae (Table). Because acrocentric autosomes are lacking, the number of chromosome arms (fundamental number (FN)¹⁰) is 96, the highest FN seen within the family.

Cynomys is of theoretical interest to cytotaxonomists because the complete lack of correlation between high $2n$ and numerous acrocentrics contrasts sharply with data from primates⁶ and other rodents¹¹. Furthermore, *Cynomys* is an exception to the current concept of mammalian cytotaxonomy, which postulates that among related taxa the more specialized and recently evolved species are characterized by a lower $2n$, fewer acrocentric and more metacentric chromosomes⁶. This view is based upon

the frequent observation that karyotypes appear to evolve from high to low $2n$ by a series of Robertsonian centric fusions; the absence of acrocentrics and high $2n$ of *Cynomys* are arguments against centric fusion as the explanation for intergeneric karyotype divergence.

Evolution from low to high $2n$ may result from dissociation or fragmentation of metacentric chromosomes. *Cynomys* could have evolved from a *Spermophilus*-like ancestral stock with lower $2n$ by dissociation, provided the acrocentric chromosomes produced by this process were later converted to metacentrics by a series of pericentric inversions. Proof of this hypothesis cannot be obtained because of the striking degree of karyotypic divergence seen between *Cynomys* and *Spermophilus*, and chromosomes alone do not support a close intergeneric affinity. Nevertheless, the dissociation-pericentric inversion sequence is compatible with the taxonomic opinion, based on several reliable lines of evidence, that the 2 genera are closely related^{7,8}. If correct, *Cynomys* is one of the few examples of chromosome dissociation observed in mammals, although it has been previously postulated by MATTHEY¹¹.

Analysis of chromosomes from the other 4 species of *Cynomys* may provide greater insight into chromosome evolution of this genus¹².

Zusammenfassung. Die Analyse der mitotischen Chromosomen bei *Cynomys ludovicianus* ergibt die diploide Zahl 50 und einen Karyotypen mit nur metazentrischen und submetazentrischen Autosomen. Der Fall *Cynomys* ist einzigartig unter den Sciuridae: hohe $2n$ Zahl und Fehlen acrozentrischer Chromosomen.

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Medical School, Chicago (Illinois 60611, USA),
October 4, 1966.

⁸ C. F. NADLER, in preparation.

¹⁰ R. MATTHEY, *Experientia* 7, 50, 78 (1945).

¹¹ R. MATTHEY, *Rev. suisse Zool.* 64, 39 (1957).

¹² Supported by National Science Foundation Grant No. GB 3251.

Chromosomal characteristics of representative species of Sciuridae

Species	$2n$	Fundamental No.
<i>Spermophilus beldingi</i> ¹	30	56
<i>Sp. columbianus</i> ¹	32	60
<i>Sp. undulatus</i> ¹	34	64
<i>Sp. richardsoni</i> ¹	34, 36	64
<i>Sp. townsendi</i> ¹	36, 38, 46	68, 66, 66
<i>Sp. lateralis</i> ²	42	78
<i>Sp. beecheyi</i> ²	38	72
<i>Marmota broweri</i> ⁵	36	62
<i>M. caligata</i> ⁵	42	62
<i>Eutamias minimus</i> ²	38	58
<i>Glaucomys sabrinus</i> ⁹	48	74
<i>Sciurus carolinensis</i> ⁹	40	76
<i>Cynomys ludovicianus</i>	50	96

On Reproduction Studies and the Occurrence of Cataracts in Rats after Long-Term Feeding of the Insecticide Heptachlor

The widespread use of pesticides has led to many cases of poisoning in animals, both acute and chronic. As yet, few experiments on the chronic effects of pesticides on animals have been carried out. It is especially essential to investigate the toxicity of those pesticides, such as DDT and other chlorinated hydrocarbons (of the cyclodienic compound type), that are not eliminated for a long time and can accumulate in the body fat. Their presence suggests a potential hazard to human health.

To evaluate the significance of accumulation of these insecticides in the body, we studied the effect of heptachlor (1, 4, 5, 6, 7, 10, 10-heptachloro-4, 7, 8, 9-tetrahydro-4, 7-methyleneindene) on the fertility of rats. The experiments showed firstly that low dosages of heptachlor ad-

ministered with food result in a marked diminishing of litter size, both in several litters of one generation as well as in successive generations. Secondly they showed that the life span of the sucklings is significantly shortened, the death rate being highest in the first 24–48 h (Table). The applied dose of standard heptachlor, purity 98.1%, was 6 mg/kg body weight, and did not cause any clinical toxicological signs in all the investigation time (18 months). Function studies of the parenchymatous organs (Quick test, BSP clearance, concentration and dilution tests of the Kidneys, and the elimination of phenol red) did not show disturbances, with the exception of the liver tests which approached the limit of significance in the female rats¹.

¹ M. MESTITZOVÁ, *Prac. Lék.* 18/4, 153 (1966).