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From the Arctic Health Research Center, Public Health Service,
U. S. Department of Health, Education, and Welfare, Anchorage, Alaska

CYTOGENETIC EVIDENCE
FOR THE SPECIFIC DISTINCTION OF AN ALASKAN MARMOT,
MARMOTA BROWERI HALL AND GILMORE
(MAMMALIA: SCIURIDAE)

By

ROBERT L. RAUSCH and VIRGINIA R. RAUSCH

With 2 Figures in the Text

(Received December 7, 1964)

The marmot occurring in the Brooks Range of arctic Alaska is sufficiently similar morphologically to *Marmota caligata* (ESCHSCHOLTZ) of northwestern North America, including central and southern Alaska, as to be considered a subspecies of the latter, designated *M. caligata broweri* HALL and GILMORE. We have found, however, that the two animals differ cytogenetically to a degree exceeding that usually observed in closely related, but distinct, species of Sciurids (NADLER, 1962; NADLER and BLOCK, 1962).

Most authorities recognize five North American species of giant ground squirrels of the genus *Marmota* Blumenbach. Three of these, *M. caligata*, *M. olympus* (MERRIAM), and *M. vancouverensis* SWARTH, appear to be closely related (HOWELL, 1915; HALL and KELSON, 1959) and have been considered possibly to be conspecific with the Palearctic *M. marmota* L. (ELLERMAN and MORRISON-SCOTT, 1951; RAUSCH, 1953). However, accumulating evidence indicates that the latter concept is erroneous. In 1953, one of us (RAUSCH, 1953) suggested that acceptance of a more restricted definition of species of North American marmots belonging to the *caligata*-group would, on morphological grounds alone, necessitate a review of the taxonomic status of the marmot occurring in the Brooks Range. *M. caligata broweri* can now be distinguished at the specific level by morphological as well as by zoogeographic criteria; moreover, as reported herein, the results of a cytogenetic investigation demonstrate the specific distinction of *M. c. broweri*.

Cytological preparations were analyzed from 4 specimens of *M. c. caligata* from south-central Alaska (2 ♂♂, Talkeetna Mountains; 1 ♂, Kenai Peninsula; 1 ♀, Chugach Mountains) and from 3 specimens of *M. c. broweri* from the central and eastern Brooks Range (1 ♂, Chandler Lake; 2 ♀♀, Lake Peters). Chromosome numbers were also determined for *M. olympus* (1 ♂, Olympic Peninsula, Washington) and *M. flaviventris* (Audubon and Bachman) (1 ♀, Kamloops, British Columbia).

Following the injection of Colcemide (Ciba Pharmaceutical Co.), the animals were killed and the cytological material was processed according to the method of NADLER and BLOCK (1962). Synthetic orcein used for staining was obtained from both G. T. Gurr Ltd., London, and Chroma Gesellschaft, Stuttgart. The preparations were made permanent by the freezing method of CONGER and FAIRCHILD (1953).

Results of the counting of chromosomes in somatic cells (bone marrow) of *M. c. caligata* and *M. c. broweri* are summarized in the Table. It is concluded that the modal diploid number of *M. c. caligata* is 42 and that of *M. c. broweri* is 36. Cells from the inactive testes also were studied, but few meiotic figures were present. Preparations also were made from spleen. In all cases, counts obtained were in agreement with those from bone marrow.

Table. Counts of chromosomes obtained from cells in bone marrow

	38	39	39?	40	40?	41	41?	42	42?	43	43?	44	44?	45?	
<i>M. caligata</i> (3 ♂♂)	1	3	3	5	2	7	4	38	6	3	3	1	1	1	
<i>M. caligata</i> (1 ♀)	—	1	1	1	1	3	2	11	4	1	2	—	1	—	
	33	33?	34	34?	35	35?	35 ?+1	36	36?	37	37?	38	38?	39?	40?
<i>M. broweri</i> (1 ♂)	3	1	1	—	4	3	—	40	3	4	4	2	1	1	1
<i>M. broweri</i> (2 ♀♀)	1	2	2	3	13	3	1	35	4	7	5	3	3	—	1

Typical karyograms for *M. c. caligata* and *M. c. broweri* are illustrated in Figs. 1 and 2. It is evident that the karyogram of *M. c. caligata* ($2n=42$) differs strikingly from that of *M. c. broweri* ($2n=36$) in both number and proportion of chromosomal types. Both have a large pair and a small pair of metacentric autosomes; *M. c. caligata* possesses 9 pairs each of submetacentric and acrocentric autosomes, while in *M. c. broweri* these number 12 and 3 pairs, respectively. The X chromosome of *M. c. caligata* is large and submetacentric; that of *M. c. broweri* is also large, but is metacentric or nearly so. The minute, dot-like Y chromosomes are quite similar in the two animals. We conclude that the Brooks Range marmot must be considered specifically distinct from *M. caligata*, the applicable name being *M. broweri* Hall and Gilmore.

Evidently only two of the Nearctic species of *Marmota* have the same number of chromosomes. From counts of cells from one animal, we concluded that *M. flaviventris* also has 42 chromosomes; we did

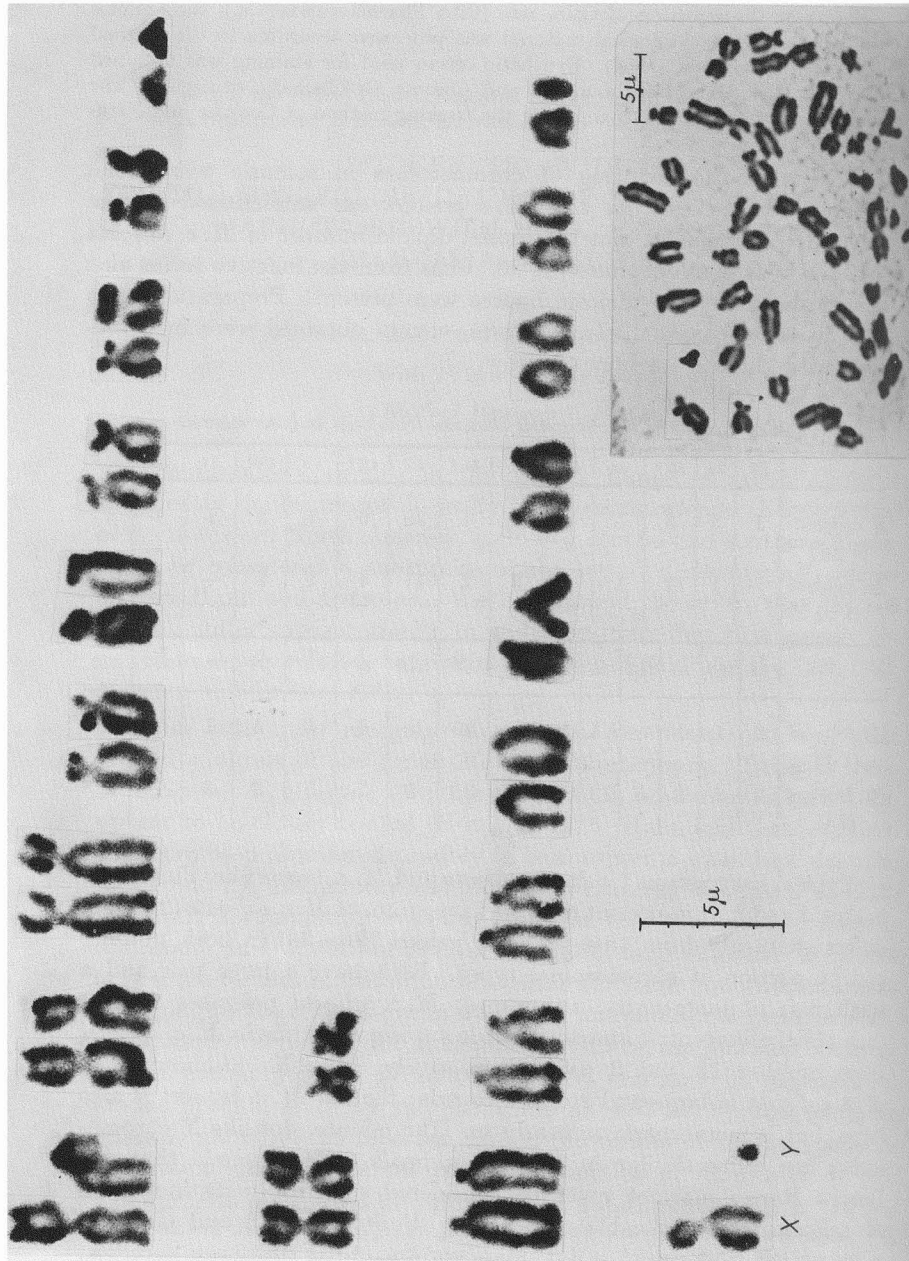


Fig. 1. Karyogram of *Marmota caligata*. Inset shows disposition of chromosomes in the preparation from which this karyogram was determined.

not, however, compare the karyogram of the latter species with that of *M. caligata*. It was determined that *M. olympus* has 40 chromosomes.

This may be found to be the case with *M. vancouverensis* as well, since it is closely related to *M. olympus*, both species being regarded as pre-Vashon (= pre-Wisconsin) relicts (DALQUEST, 1948), restricted in occurrence to alpine habitat on Vancouver Island and on the Olympic Peninsula, respectively. Further investigation may disclose that the two species are less closely related to *M. caligata* than previously supposed. In *M. monax* (Linnaeus), the number of chromosomes is smaller ($2n=38$), and there are differences in proportions of chromosomal types (COUSER *et al.*, 1963).

Contingent upon the assumption that *M. marmota* is the dominant species of the subtribe Marmotina, MOORE (1961) stated that "... it could be construed to have spread eastward successfully at least three times across the Bering land bridge, each time leaving an isolated population in the Nearctic Region which has speciated and survived." Three species, *M. caligata*, *M. flaviventris*, and *M. monax*, have extensive geographic ranges. The two occurring in Alaska, *M. caligata* and *M. monax*, seem clearly to be post-glacial invaders of northwestern North America, a conclusion supported by zoogeographic evidence and by the fact that certain parasites are not shared with Palaearctic species (RAUSCH, 1965, and unpublished). Evidence to be discussed elsewhere permits the inference that *M. broweri* survived the glaciations of Wisconsin time in the unglaciated Beringian region. Consequently, as suggested in 1959 by Dr. ROBERT S. HOFFMAN, Montana State University, Missoula (personal communication), *M. broweri* may be closely related to, or even conspecific with, the eastern Siberian *M. camtschatica* Pallas, which itself may be a race of *M. marmota* (FILLERMAN and MORRISON-SCOTT, 1951; MOORE, 1961). Cytological data on *M. camtschatica* and *M. marmota* may well provide further evidence to support these hypotheses, and the results of the present study justify the expectation that cytotaxonomic investigations of other recognized Palaearctic species of *Marmota* will help clarify evolutionary relationships within this group of mammals.

Summary

Cytogenetic studies based upon somatic cells (bone marrow) have disclosed that the marmot hitherto designated *Marmota caligata broweri* HALL and GILMORE, occurring in the Brooks Range of arctic Alaska, differs from *M. c. caligata* (ESCHSCHOLTZ) in number of chromosomes ($2n=36$ as compared with $2n=42$ in *M. caligata*) and in proportions of chromosomal types. Typical karyograms for the two species are presented. It is concluded that the Brooks Range marmot is specifically distinct from *M. caligata*, the applicable name being *Marmota broweri* HALL and GILMORE. Also determined were diploid chromosome numbers

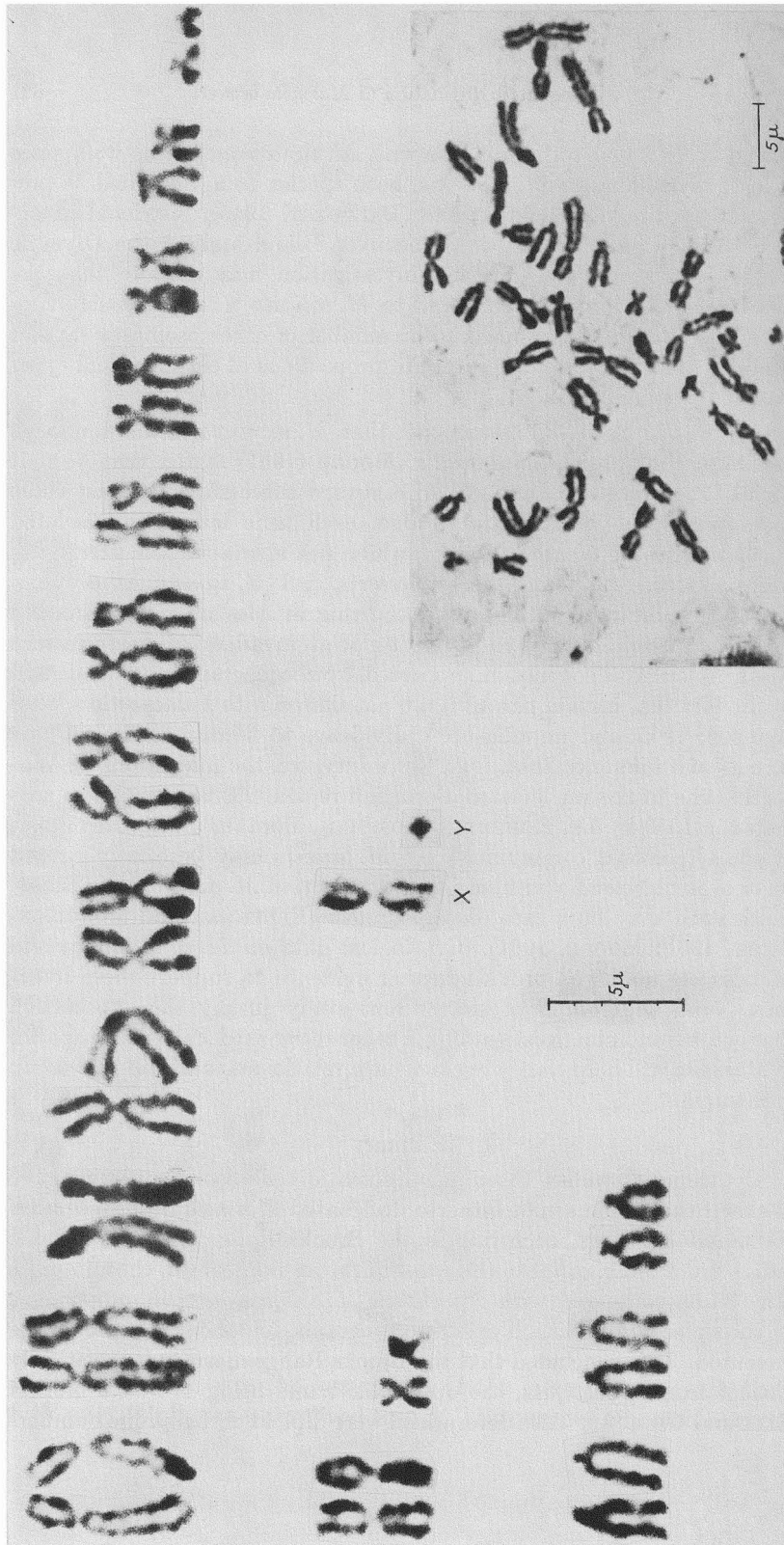


Fig. 2. Karyogram of *Macomata bracteata*. Inset shows disposition of chromosomes in the preparation from which this karyogram was determined

for two other Nearctic species of marmots, *M. flaviventris* (AUDUBON and BACHMAN), with 42, and *M. olympus* (MERRIAM), with 40. It is suggested that *M. broweri* survived the last (Wisconsin) glaciations in the amph-Beringian refugium, and that its closest affinities may be with one of the Eurasian species of *Marmota*.

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