PROCEEDINGS
OF THE
NATIONAL ACADEMY OF SCIENCES
Volume 28 July 15, 1942 Number 7

*CHROMOSOMES OF THE RED FOX**

BY LOUISE WIPF AND RICHARD M. SHACKELFORD

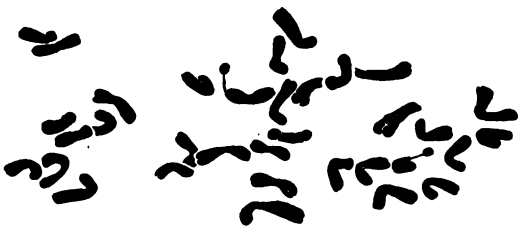
DEPARTMENTS OF VETERINARY SCIENCE AND GENETICS, UNIVERSITY OF WISCONSIN

Communicated June 11, 1942

A number of mutant color types have arisen, directly or indirectly, from the red fox (*Vulpes vulpes* L.). Two different mutations to black [standard black (silver) and Alaskan black (silver)] had occurred in wild red foxes of North America prior to ranch breeding. The platinum character is the result of a mutation from ranch-bred standard black (silver) foxes. The present study is concerned with both the number and the comparative forms of the chromosomes in red, standard black (silver) and platinum-silver foxes. Wodsedalek[1] reported 42 as the chromosome number of the male red fox. Later Andres[2] found the number to be 34.

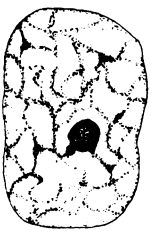
Testes were collected during the breeding season of 1942 in order to obtain meiotic and mitotic divisions. A red and a black (silver) fox were killed by electrocution, and another red fox by an injection of ether into the heart. The material from the platinum-silver fox was obtained by castration. The testes in each case were immediately excised and lacerated, and the seminiferous tubules were teased out and placed in Carnoy's alcohol-acetic acid-chloroform solution (7:2:1). The complete operation required less than five minutes. The tubules were allowed to remain in the fixative from 30 minutes to one hour; they were then transferred to 95 per cent alcohol for an hour and stored in 80 per cent alcohol. Temporary mounts prepared by the aceto-carmine smear method provided excellent material for study.

Polar views of diploid equatorial plates from seminiferous tubules show 34 chromosomes in the red, black (silver) and platinum-silver foxes (Figs. 1, 2, 3). The chromosomes of all three color types appear similar in size, shape and other morphological characteristics. Longitudinal splits and median or sub-terminal spindle fibre attachment regions are common (Fig. 3). The homologues of several chromosome pairs are easily identified. The chromosomes vary in length, the shortest being about one-half that of the longest. A pair of satellite chromosomes is present in each case.

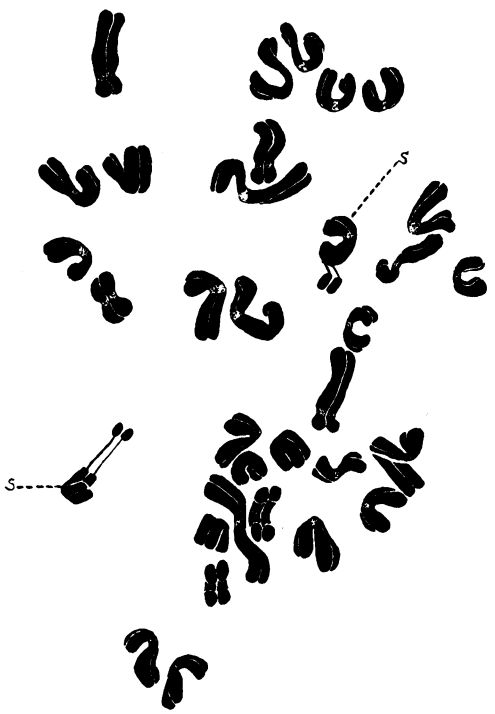


1

2



4



3

5

EXPLANATION ON OPPOSITE PAGE

These satellite chromosomes are of medium size and have median spindle-fibre attachment regions (Fig. 3 (*s*)). As a general rule, satellite chromosomes of both plants and animals are found associated with the nucleolus. This may be true in the fox, for a resting nucleus shows chromatic material attached to the nucleolus in two places (Fig. 4).

On the first meiotic equatorial plate the chromosomes are shorter, thicker and more closely packed than in the mitotic divisions; hence the determination of the haploid number is somewhat difficult. However, 17 pairs (Fig. 5), including one pair with attached satellites, are present on the heterotypic equatorial plate. Spindle-fibre attachment regions are easily recognized at this stage. There appears to be more variation in the size of the chromosomes at meiosis than in mitosis.

The occurrence of satellite chromosomes in the fox is of special interest, since, so far as the writers are aware, they have not been previously recorded in mammals. Coonen,[3] in a review of the literature on satellite chromosomes in plants and animals, found them common in plants but comparatively rare in animals. He cites reports of only six animals in which satellites have been noted: the mosquito, *Drosophila*, *Bibio*, *Amblystoma*, *Opalina* and *Salmo*. The present observations agree with those of Andres[2] as to the chromosome number in the red fox, but he makes no reference to satellite chromosomes. His figure 1 shows 34 chromosomes plus a small chromosome for which he gives no explanation. Since Andres[2] used sectioned material instead of smears it may be that the satellite connection was lost or obscured by the method used, and that the extra chromatic particle actually was the satellite.

The platinum-silver character in foxes has been reported[4] as lethal in the homozygous condition. It would be of interest to investigate the possibilities of observable differences in the chromosomes of foxes heterozygous for this character. It is not to be expected that minor differences would be seen at the equatorial plate, but further search may possibly reveal dissimilarities in the pachytene stage.

The writers are indebted to Professor W. Wisnicky, Director of Fur Farm Research, and Professor L. J. Cole for materials and suggestions.

EXPLANATION OF PLATE

Figures 1–3. Equatorial plates from seminiferous tubules of the red fox, figure 1, × 2140; black (silver), figure 2, × 2140; platinum-silver, figure 3, × 2920; showing the diploid chromosome number. Thirty-four chromosomes are present in each case. Figure 3 (*s*), satellite chromosome.

Figure 4. Resting nucleus from seminiferous tubule, red fox, showing chromatic attachments to the nucleole. × 2920.

Figure 5. Equatorial plate, first meiotic division, from seminiferous tubules of black (silver) fox. × 2920.

Further acknowledgment is extended to Professors D. C. Cooper and C. E. Allen for advice and constructive criticisms.

* Joint contribution from the Departments of Veterinary Science and Genetics (Paper No. 284), Agricultural Experiment Station. Published with the approval of the Director of the Station.

[1] Wodsedalek, J. E., *Anat. Rec.*, **51**, 70 (1931).

[2] Andres, A. H., *Cytologia*, **9**, 35–37 (1938).

[3] Coonen, L. P., *Amer. Jour. Bot.*, **26**, 49–58 (1939).

[4] Cole, L. J., and Shackelford, R. M. (in press).

SALIVARY GLAND TYPE CHROMOSOMES IN MOSQUITOES

BY EILEEN SUTTON

CARNEGIE INSTITUTION OF WASHINGTON, COLD SPRING HARBOR, N. Y.

Communicated June 15, 1942

Mosquitoes have been the subject of several cytological studies, but in these insects very little consideration has been given to the type of chromosome characteristic of the salivary glands and other organs of many Dipteran larvae. In recent work, chromosomes from the large larval mid-gut cells of mosquitoes have been described[1,2] as similar to the salivary gland type, but lacking the regular alternation of bands and achromatic regions and consisting merely of a linear series of chromatic masses.

Giant chromosomes with regular banded structure may be obtained, however, from certain tissues in the later stages of development. These chromosomes will be described here. The most satisfactory preparations were obtained from the Malpighian tubes of the imago, pupa or fourth instar larva, but such chromosomes were also found in the salivary glands, gastric caeca and mid-gut of the prepupal stage.

DESCRIPTION OF PLATE

Figure 1. Nucleus from Malpighian tubes of *Culex pipiens* male, pupal stage. Ca. × 510.

Figure 2. Chromosome from *C. pipiens* male, with nucleolus. Ca. × 1160.

Figure 3. Nucleus from *Aedes aegypti* female. Ca. × 580.

Figure 4. Part of nucleus from *A. aegypti* male showing banded regions and "weak spots." Ca. × 1160.

Figures 5 and 6. Comparison of the same region in two different cells of *A. aegypti*, fourth instar larva. Ca. × 1160.

Figure 7. Nucleus from *A. aegypti*, fourth instar larva, showing globular structure and nucleolus. Ca. × 580.

Figure 8 (*a*). Section of a chromosome from *A. aegypti* pupa, with peculiar banded structure. Ca. × 1160. (*b*) Camera lucida drawing of same.