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From The Veterinary College of Norway, Department of Animal Husbandry and Genetics.

# THE CHROMOSOMES OF CHINCHILLA LANIGERA[1])

By
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As far as the writer is aware, no investigation has previously been carried out concerning chromosomes in Chinchilla Lanigera.

The present work deals with the number of chromosomes and their morphology studied in the mitotic metaphase in cells cultivated in vitro.

## MATERIALS AND METHODS

The materials for this examination have been taken from two Chinchillas, a female and a male, reared in captivity. Cultures from skin tissue and testicle tissue have been used. The skin samples were taken as biopsies and the testicle tissue by castration. The tissue samples were collected in test tubes with a culture medium. The cultures were set up immediately or within an hour after sampling. Cultivation, collecting of mitosis, preparations for microscopy, photomicrography, counting, measuring, as well as identification and arrangement of the chromosomes in karyograms have been accomplished with the same methods as described in a previous work (*Nes,* 1962).

About half the countings of chromosomes were performed by means of photomicrographs and the rest by direct microscopy. If any doubt, both methods were applied.

Two cells have been used for measurements of chromosomes to obtain information concerning the relative length of the X chromosome.

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## RESULTS

*The Chromosome Number.*

As it appears from Table I the chromosomes of 71 mitotic cells have been counted, 43 testicle cells and 28 skin cells. The last mentioned from the female. In most cells (69) the number of chromosomes were found to be 2n = 64, *i. e.* 31 pairs of autosomes and 2 sex chromosomes.

Divergent number of chromosomes (63) were found in two cells, *i. e.* in 2.8 % of the cells investigated.

Apart from the deviation mentioned above a few tetraploid cells have been found. (See Fig. 3).

Table I. The result of chromosome counts in mitotic cells from testicle and skin tissue cultures.

| Sex | Tissue | Chromosome number | | | Cells counted |
|---|---|---|---|---|---|
| | | 63 | 64 | 65 | |
| ♂ | Testicle | 2 | 41 | — | 43 |
| ♀ | Skin | — | 28 | — | 28 |
| Total for both tissue investigated | | 2 | 69 | — | 71 |

*The morphology and identification of the chromosomes.*

The autosomes are serially numbered, 1—31, as nearly as possible in descending order of length, *i. e.* the groups of chromosomes are arranged according to their average chromosome lengths. When the chromosomes are equal in size the one with the most median centromere is ranged at first. The sex chromosomes are placed at the end of this array.

Chromosome 1 is acrocentric and the largest of the autosomes. It is thus easily identified. (See Figs. 1 and 2).

Chromosome 2 has a secondary constriction which set off a bit more than ⅓ of the chromosome arm concerned. If this part is included in the measurements, chromosome 2 is nearly the same size as the first one and is to be considered metacentric or nearly so. This characterization is, however, open to argument and accordingly also the position of this chromosome in the karyogram.

Each of the chromosomes 3—5 is nearly the same size. No. 3 is metacentric and is therefore as a rule distinguishable from

Nos. 4 and 5 which are submetacentric chromosomes. The last ones are so equal that they hardly differ and are consequently grouped together. The same applies to the chromosomes 6—7, (2nd row in the karyograms). They are also submetacentric, but slightly smaller than Nos. 4—5 and are usually identified owing to this. If the chromosomes are unevenly contracted, the identification will be uncertain, and to be safe the chromosomes 4—7 are grouped together.

Chromosome 8 is nearly the same size as the preceding ones. It is submetacentric to acrocentric and according to this easily identified. Nos. 9 and 10, which are slightly smaller, are metacentric chromosomes. It is usually hard to distinguish them, and they are thus placed together in one group.

No. 11 (3rd row in the karyograms) is nearly the same size as the preceding ones, but it is submetacentric, and identification

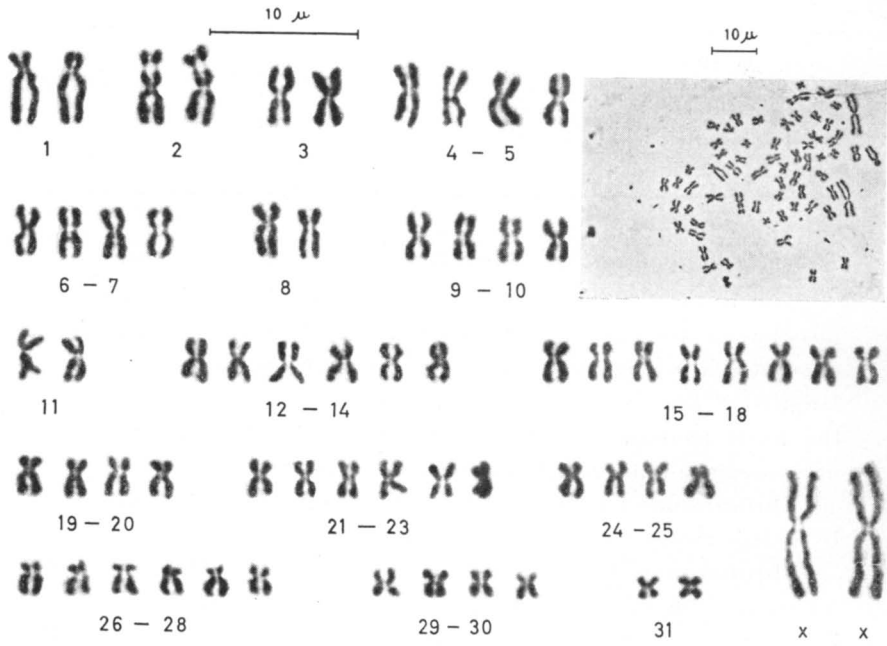


Fig. 1. Karyotype of Chinchilla Lanigera female. The photomicrograph (top right corner) shows the chromosomes at metaphase in a skin cell grown in vitro and treated with colchicine, 0.1 γ/ml. medium, 14 hrs. and with hypotonic citrate, 0.7 %, 10 min. Air-drying acetic orcein preparation. In the karyogram the chromosomes are arranged according to size and the position of the centromeres. Original magnification 400 ×.

is usually possible. The remaining chromosomes (12—18) in the same row, are a bit smaller, but the variation in size within these is so small, that an identification according to size is very unreliable. By the position of the centromere they are divided into two groups 12—14 and 15—18 with metacentric and submetacentric chromosomes respectively.

The chromosomes 19—25 (4th row) are nearly the same size and they differ very little from those in the former group. According to the location of the centromere they are divided into 3 groups: Nos. 19—20 with submetacentric to acrocentric chromosomes, Nos. 21—23 with metacentric, and Nos. 24—25 with submetacentric chromosomes.

The chromosomes Nos. 26—30 in the 5th row, are generally considerably smaller than those in the 4th row. They are divided into two groups: Nos. 26—28 and Nos. 29—30 with acrocentric and submetacentric chromosomes respectively. No. 31 the smallest of the autosomes, is metacentric and usually easily identified.

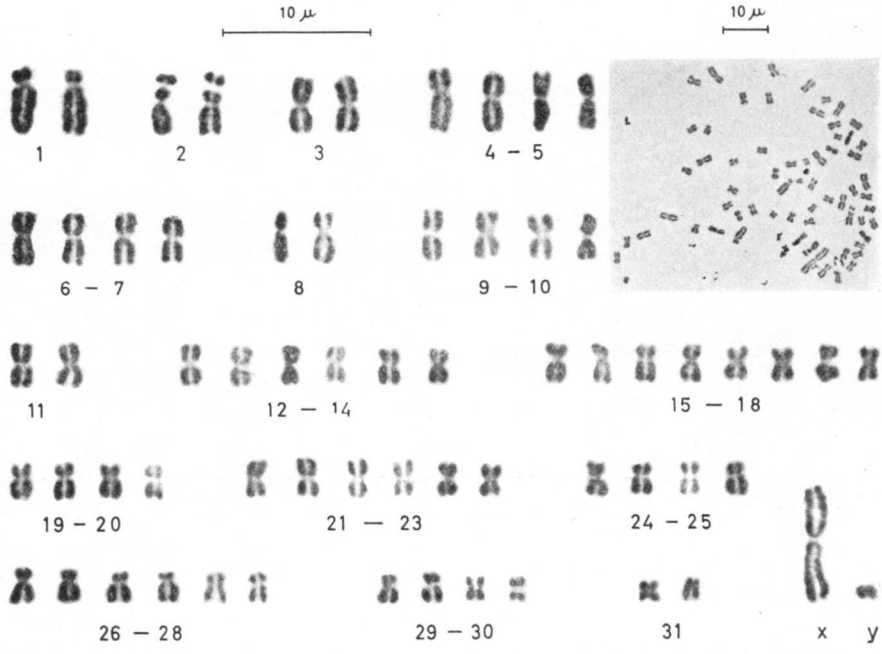


Fig. 2. Karyotype of Chinchilla Lanigera male. The photomicrograph in the upper right corner shows the chromosomes at metaphase in a testicle cell cultivated in vitro and treated with colchicine 0.1 γ/ml. medium, 4 hrs. and with hypotonic citrate, 0.7 %, 15 min. The karyogram is arranged similar to Fig. 1. Original magnification 400 ×.

The X chromosome is the largest chromosome in Chinchilla and has a relative length of approx. 82, while the autosomes varied from 47 to 15. It is submetacentric.

The Y chromosome is the smallest chromosome in Chinchilla. It is acrocentric, but being so small, it is usually impossible to distinguish the particular chromosome arms.

## DISCUSSION AND CONCLUSION

The diploid chromosome number in Chinchilla Lanigera is found to be $2n = 64$. The deviations involved are likely due to technical errors. The tetraploid cells on the other hand are obviously the result of endomitosis. In Fig. 3, showing such a cell from a male, the bivalents are seen lying in couples. The autosomes occur in the tetraploid number which is clearly ascertained when examining the easily identified chromosomes such as Nos. 1 and 2.

As will be seen the cell contains two X chromosomes and two Y chromosomes. There is much precipitation in the preparation

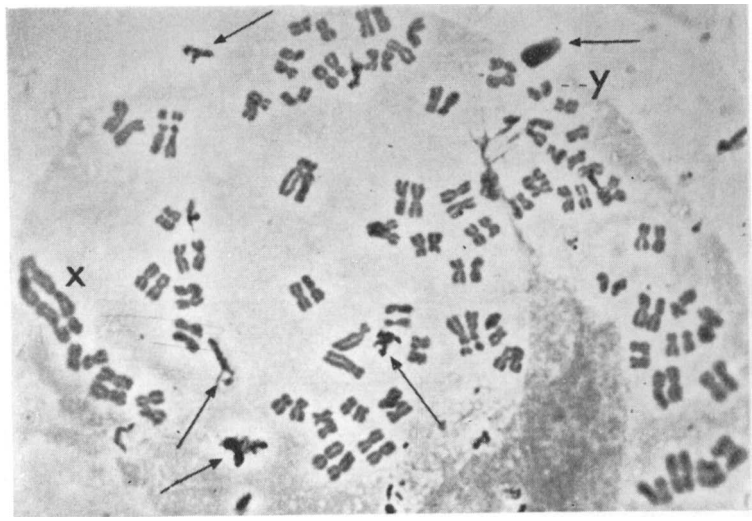


Fig. 3. Endomitosis in a tetraploid testicle cell from the same preparation as the mitotic cell Fig. 2. The endomitotic reduplication is just finished and therefore the chromosomes are seen lying in couples, two and two bivalents side by side. There are 64 such couples corresponding to the 64 (2n) chromosomes in Chinchilla — making up a total of 128 chromosomes in this cell. X indicates the two X chromosomes and Y the two Y chromosomes. The arrows point at the many coloured stains of precipitation in this preparation.

and this complicates the counting of the chromosomes both under the microscope and on the photo, but a careful examination proves the cell to contain the tetraploid number of chromosomes, *i. e.* 128.

As to the morphology of the chromosomes the extraordinary size of the X chromosome is noteworthy. It is so easily distinguishable in any preparation that even a quich look is sufficient to state whether the cell is a female or a male one. As mentioned before, the relative length of the X chromosome is approx. 82. In comparison, the X chromosome in man has a relative length of about 55 (A Human Chromosomes Study Group, *Denver,* 1960) and in mink about 48 (*Nes,* 1962). Taken for granted that the length of a chromosome as a rule is a function of the number of genes present in a chromosome (*Swanson,* 1958) a relative length of approx. 82 is suggestive of Chinchilla having a comparatively higher quantity of sex-linked hereditary factors than the species mentioned above, provided the X chromosome in Chinchilla does not contain a larger proportion of genetic inert regions. Comparative examinations to support any conclusions do not exist. Worth mentioning is also that in many chromosome preparations from Chinchilla slightly coloured areas are noticed in the X chromosome. Thus in the original photo (Fig. 1) on the left-hand X chromosome three pale sections are visible across the lower arm of the left chromatid. These are most likely heterochromatic and as heterochromatin usually seems to be genetic inert, the number of genes is probably lower than the length of the chromosome suggests.

While the X chromosome is the largest the Y chromosome is the smallest of the chromosomes in Chinchilla Lanigera. Being so small, it nearly always appears as a telocentric chromosome, but in a few preparations studied under a microscope it proves to be an acrocentric chromosome. It has also been possible to ascertain this in original photos.

As seen from the karyograms the autosomes form an array comparatively evenly decreasing in size, but the difference between pairs is often less than the difference found within pairs due to a varying contraction of the chromosomes. Because of the great number of chromosomes the distinctions based on the position of the centromeres offer very small intervals. On the whole the identification of the autosomes is therefore difficult, and only 6 of them, *i. e.* 6 pairs, can be identified with a fair

certainty. The remaining 25 pairs of autosomes are classified into 10 groups. The difference between the chromosomes in two of these groups (4—5 and 6—7), however, is as already stated so small that it might be more correct to group them together (4—7) until more reliable criteria are available for the identification of these chromosomes.

Secondary constriction is found in one chromosome. It provides a very reliable basis for identification of this chromosome, which is placed as No. 2 in the karyogram. The chromosome part set off by the secondary constriction has been included in the measurement of length and the chromosome is consequently in this paper said to be metacentric. Some others might prefer to classify this chromosome as a submetacentric to acrocentric satellite chromosome and then place it further out in the karyogram.

## REFERENCES

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## SUMMARY

The chromosomes of Chinchilla Lanigera, their number and morphology, have been studied in the mitotic metaphase in cells grown in vitro. The diploid number of chromosomes has been found to be 2n = 64.

The X chromosome is submetacentric and considerably larger than any of the other chromosomes in Chinchilla. The Y chromosome is acrocentric and the smallest of the chromosomes of this animal.

The identification of the autosomes is difficult, and many of them are therefore grouped together in the karyograms. Secondary constriction has been found in one chromosome, No. 2.

## ZUSAMMENFASSUNG

### *Die Chromosomen der Chinchilla Lanigera.*

Die Anzahl und Morphologie der Chromosomen bei der Chinchilla Lanigera wurden in der mitotischen Metaphase bei in Vitro gezüchteten Zellen studiert. Der Befund war dabei eine diploidische Chromosomenzahl von 2n = 64.

Das X-Chromosome ist submetazentrisch und ansehnlich grösser als jegliche der übrigen Chromosome bei Chinchilla. Das Y-Chromosome ist acrozentrisch und stellt das kleinste der Chromosome bei diesem Tier dar.

Die Identifikation der Autosome ist schwierig, und infolgedessen sind viele davon in den Karyogrammen gemeinsam gruppiert. Sekundäre Einschnürung wurde in einem Chromosome, Nr. 2, vorgefunden.


## SAMMENDRAG

*Kromosomene hos chinchilla lanigera.*

Kromosomenes antall og morfologi hos chinchilla lanigera er studert i den mitotiske metafase hos celler dyrket in vitro. En har funnet at det diploide kromosomtall er 2n = 64.

X-kromosomet er submetacentrisk og betydelig større enn noen av de andre kromosomene hos chinchilla. Y-kromosomet er acrocentrisk og det minste av kromosomene hos dette dyr.

Identifikasjonen av autosomene er vanskelig, og mange av dem er derfor gruppert sammen i karyogrammene.


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