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Chromosome Arrangement.

VI. The Behaviour of Chromosomes from the Moment of Disappearance of the Nuclear Membrane up to the Formation of the Equatorial Plate in the First Spermatocyte Division of the Albino Rat.[1]

By

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With 5 Text-figures.

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In mammals as well as in insects, after diakinesis the chromosomes move towards the center of nucleus and the nucleus shows a marked shrinkage losing its spherical nature (Fig. 1). When the nuclear membrane disappears, the chromosomes gather from all directions towards the center of their distribution in three dimensions, the spherical area occupied by them becoming smaller (Fig. 2). Then they draw apart from one another gradually showing a tendency to become arranged in two dimensions. Fig. 3 shows that they occupy the maximum space arranged in two layers, and are ready for the formation of the metaphase plate. Fig. 4 shows an earlier metaphase, or beginning of a metaphase plate having all the chromosomes distributed in a plane. The X and Y elements lie, in polar view, in a straight line with their long axes along it, the Y lying nearer the center of the plate than the X. The condensation process of the chromosomes goes on further and they assume finally deeply stained, massive forms, the distribution area becoming

[1] We are grateful for the author's contribution to our subject of investigation.—Y. K.

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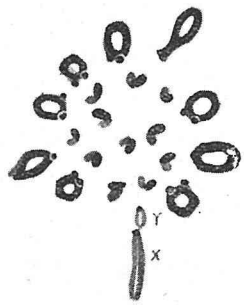

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EXPLANATION OF FIGURES.

All figures were drawn from material fixed with FLEMMING'S strong solution without glacial acetic acid and were stained with HEIDENHAIN'S iron-alum-haematoxylin. XY=sex-chromosomes ; *id*=idiosome.

Fig. 1. After diakinesis, the chromosomes move towards the center of the nucleus and the nucleus shows marked shrinkage, losing its spherical nature.

Fig. 2. The nuclear membrane disappears, and the chromosomes gather towards the center in three dimensions, the spherical area occupied by them becoming smaller.

Fig. 3. The chromosomes draw apart from one another being arranged in two layers.

Fig. 4. The earlier metaphase of the first division ; 11 V's are surrounded by 9 rings and 1 rod (XY).

Fig. 5. The later metaphase of the first division ; Y lies perpendicular to the equator of the spindle, while X is parallel to it.

smaller again (Fig. 5). This stage is commonly called the metaphase, which is here to be designated as the later metaphase. The X element lies in the equatorial plate with its long axis parallel with the plate, while the Y is found perpendicular to it being ready for disjunction. The staining capacity of chromosomes increases gradually from diakinesis to the earlier metaphase, while it increases rapidly during the period between the earlier and the later metaphase, when the chromosomes, which had the appearance of a ring in the earlier metaphase, only their peripheral region being stained, become solid black, the central region stained as well. This peripheral portion of the chromosomes stained black in the earlier metaphase seems to represent the chromonema, and the unstained central portion the ground substance. Such a differential staining of the chromosomes is obtainable only in preparations from material fixed with a fixative containing no trace of acetic acid, such as chrom-osmic or chrom-bichromate-osmic mixture.

The change in the staining capacity of the central portion of the chromosomes, as the stage proceeds, might be due to the condensation of the chromosomes in part, but chiefly also to a change in the physico-chemical nature of the ground substance of the chromosomes which causes an increase in their chromaciticy.

In the typical first meiotic metaphase of the albino rat the chromosomes form an equatorial plate with 11 V's surrounded by 9 rings and 1 rod (XY) (Fig. 4). This arrangement is always found in well preserved preparations, while it is apt to be disturbed in poorly preserved material. In mammals as well as in many Orthoptera, it has been observed that the sex-chromosomes are always found in the periphery of the equatorial plate in the first division, although some writers, such as PAINTER ('24), have often reported that it occupies a position near the middle region of the equatorial plate lying among the smaller chromosomes, and hence, can hardly be identified in side view, before the elements have already began to segregate to opposite poles of the cell, or without being exposed directly to our field of vision by cutting the spindle. Generally, in such a case the chromosomes are not arranged in a plane, but some lie above

or below the plane. It has been observed in Orthoptera on the other hand that in the normal living state the chromosomes of the first division are arranged all in a plane. From this fact, the displacement found in fixed material of some chromosomes below or above the level of the others may be regarded as a sort of disagreeable artifact produced by fixatives. In such a badly fixed condition there would be found no regularity in the arrangement of the chromosomes, chromosomes which are expected in the natural state to lie in the periphery of the plate being found in the inner region, and others being displaced from the inside to the periphery. Moreover, if a chromosome goes to a pole earlier than the others, as shown by PAINTER ('23), WINIWARTER ('19) and others, the chromosome may misinterpreted in polar view as lying in the inner region of the plate, even if it actually occupies a position in the periphery of the spindle. In discussing the arrangement of chromosomes these dangers should, therefore, be kept in mind.

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