a pecan, attained an age of 170 years. . . . To overcome the inference arising from the presence of the old trees, which were well scattered, testimony was presented to show that in 1821 these trees were all on islands, which afterwards were consolidated amongst themselves and with the lands on the south side. We think this testimony is essentially speculative and not a proper basis for judgment. In this area, as elsewhere in the valley, a succession of depressions is found at the foot of the bluffs and some testimony was produced to show that in 1821 the river, or a part of it, flowed there. It may be that the river was there long ago, but the testimony that it was there in 1821 is far from convincing. Our conclusion is that the claim that the river, or any part of it, ran south of this area in 1821 is not sustained. So the boundary follows the cut bank around the northerly limit of the area.

The perusal of the thousands of pages of testimony leads to the conviction that scientific experts should be appointed by the court and not employed by the litigants. This fact has already been emphasized by one of the scientists concerned (*Geog. Rev.*, 13: 188), who points out that the present practice fosters bias and discounts the spirit of scientific research (*cf.* also SCIENCE, 45: 147, 292). Indeed, it would seem that such cases as the present should not be matters of court procedure at all, but should be left to the decision of a disinterested scientific commission.

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## SPECIAL ARTICLES

### THE CHROMOSOME COMPLEXES IN THE SOMATIC CELLS OF MALE AND FEMALE OF THE DOMESTIC CHICKEN

IN publishing the rough notes and drawings of the late Miss Stevens on the spermatogenesis of the domestic fowl, Miss Alice Boring points to the insufficiency of our knowledge of the chromosome complex of birds. This state of affairs, together with the intensive work on the genetics of fowl which has been going at the Anikovo Genetical Station of the Moscow Institute of Experimental Biology, induced Professor N. K. Koltzoff to offer this theme to me for further investigation. This work began in the summer of 1922 and was conducted on embryological material, as well as on the testicles of young and adult cocks. Last summer I also investigated some other birds of the family *Passeres*.

Some fundamental results of my investigation had already been reported at the conference of the Anikovo station last June and published as a footnote in the Russian translation of T. H. Morgan's "Physical Basis of Heredity," and the drawings of the chromosome complex of the fowl were amongst the other exhibits of the Anikovo station at the Russian Agricultural Exhibition (inaugurated on August 15), when Number 1491 of SCIENCE (of July 27, 1923) with the stimulating article of Miss Boring came to my hands. The following discoveries confirm some results of Miss Stevens and contain also some quite new facts.

The fundamental results of my investigation can be briefly summed up in the following points:

(1) The somatic complex of chromosomes in fowl of the same sex is characterized by a complete uniformity in all tissues of the embryo.

(2) The chromosome complex consists of chromosomes of very different lengths, whereas the thickness of all chromosomes when properly fixed and colored is quite the same and is nearly equal to 0.5 $\mu$. The shortest are from one fifth to one sixth the length of the longest, which may attain nearly 3 $\mu$ (see the chromosomes X, x, B and b in the given drawings). The ordinary form of the chromosomes in the somatic cells is rod-shaped. One may see that any windings, which are to be observed in the longest chromosomes in the equatorial plates, should disappear in the metakinesis stage, when all chromosomes become straight.

(3) In the equatorial plate, at first, when the chromosomes are lying very near one another, they have a very regular and constant position. Their disposition is very characteristic, the longer ones lying outside and the smaller ones inside, as has been shown also by Miss Stevens in her drawings (Figs. 1 and 2). The elements of the outer circle lie in a more or less radial arrangement. Moreover, a very essential circumstance appears here, namely, that the long chromosomes have a tendency to a symmetrical disposition, every long chromosome on the right having its homologue on the left; this is to be particularly noticed in the early equatorial plates and likewise in the daughter plates in the males. This makes the pairs easier to find, especially in the case of the long chromosomes of the outer circle. In figures 1 and 2 the paired chromosomes of the right are designated by letters, A, B, C, and those of the left by small ones, a, b, c. A detailed study of the chromosome complexes of the male and the female lead me to designate these pairs with signs different from those given in Miss Boring's drawings.

(4) The constancy and symmetry of position of the chromosomes may also be observed in some degree in the pachytene spireme, which after the dissolution of the nuclear membrane spreads very regularly like a parachute, whose meridional ribs are lying like the long chromosomes of the outer circle.

(5) In consequence of the small size and comparatively large number of chromosomes in the fowl it is difficult to count them precisely. I have tried, however, to count the chromosomes in many mother and

daughter plates in different tissues of 15–17 day old embryos, whose sex had been positively determined by the examination of their gonads, and in view of this I consider the following results as quite established:

(A) In the homozygous male sex of fowl the chromosomes in the somatic cells appear to be paired (in respect to type) and their number is equal to 32 (see my figure I and Miss Boring's figure 2). The same complex with all its peculiarities is to be found also in the primitive generative cells and in the spermatogonia.

(B) In the heterozygous female sex the somatic complex of chromosomes differs from that of the male sex in that here one of the longest chromosomes (an X-chromosome) is not present; in its place there is usually to be observed a small Y-chromosome which, however, is not always distinct in the equatorial plate.

(C) The male complex consists therefore of 30 autosomes + 2 X-chromosomes, and the female complex of 30 autosomes + X + Y-chromosomes.

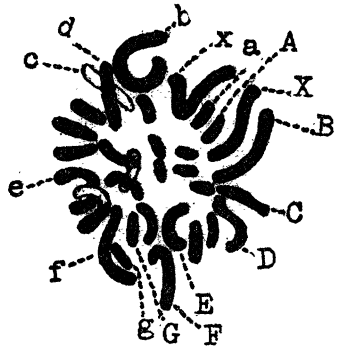


FIG. 1. Male

A comparative study of male and female complexes shows that the X-chromosome is among the longest of the chromosomes and lies in the outer circle of the equatorial plate near chromosome B (or the corresponding chromosome b of the left side), at the upper end of the axis that divides the equatorial plate into right ("paternal") and left ("maternal") sides. In the male the behavior of both X-chromosomes during all mitotic processes is not influenced by the behavior of the neighboring autosomes and they remain side by side between the chromosomes B and b. In the female, however, the unique X-chromosome always lies at first between the autosomes B and b in the early equatorial plate, as in the male, but later on it changes its place, evidently under the influence of the reciprocal attractions of both corresponding chromosomes B and b, and it may come to occupy any position, as in figure 2. Sometimes it lies quite isolated outside the outer chromosome circle. This often makes the configuration of the female equatorial plate less regular than that of the male one.

(6) The chromosome complexes of the different Passerine birds studied appear to be very similar to that of fowl in their chief characters; this induces us to believe that this complex is peculiar to most birds.

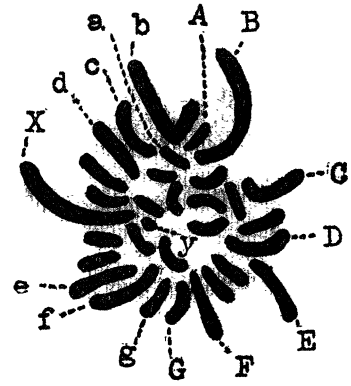


FIG. 2. Female.

In drawing the figures given a camera lucida was used, together with an apochr. oil immersion 2 mm. (Zeiss) and No. 18 compound ocular.

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## NOTE ON THE AVERAGE NUMBERS OF BROTHERS AND OF SISTERS OF THE BOYS IN FAMILIES OF N CHILDREN

THE question to be answered in this note was brought to my attention by Dr. J. McKeen Cattell. That the question presents a point of interest may be accepted from the fact that a scientist with the keen statistical intuition of Francis Galton seems to have drawn an incorrect inference where this question was involved (see Cattell and Brimhall, "American Men of Science," 1921, p. 804). Galton in his "Hereditary Genius" says: "I also have found the (adult) families to consist on the average of not less than 2½ sons and 2½ daughters each. Consequently, each judge has on the average 1½ brothers and 2½ sisters." As stated in "American Men of Science," "It seems to most people obvious that if there are equal numbers of boys and girls, a boy must on the average have one more sister than brother." Thus, the statement quoted from Galton would be regarded as obvious by most people. Dr. Cattell pointed out the error in this view, and clearly demonstrated for families of two children the fact that the boys have on the average as many brothers as sisters. It is the object of this note to demonstrate the fact stated by Cattell for families of any size, say families of n children each, in which boys and girls occur on the average in equal numbers. That is, assuming that ½ is the probability that a child taken at random