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.

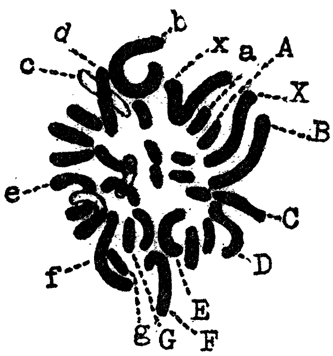

FIG. 1. Male

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.

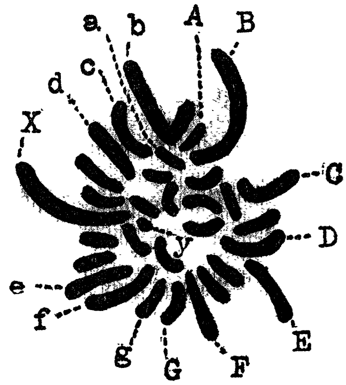

FIG. 2. Female.

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

P. J. SHIWAGO

INSTITUTE OF EXPERIMENTAL BIOLOGY,
SIVZEV VRAGEK 41, MOSCOW

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 $2\frac{1}{2}$ sons and $2\frac{1}{2}$ daughters each. Consequently, each judge has on the average $1\frac{1}{2}$ brothers and $2\frac{1}{2}$ 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 $\frac{1}{2}$ is the probability that a child taken at random

(1)	(2)	(3)	(4)	(5)
Number of Brothers	Number of Sisters	Frequency	(1) × (3)	(2) × (3)
0	$n-1$	kn	0	$kn(n-1)$
1	$n-2$	$kn(n-1)$	$kn(n-1)$	$kn(n-1)(n-2)$
2	$n-3$	$\frac{kn(n-1)(n-2)}{2!}$	$kn(n-1)(n-2)$	$\frac{kn(n-1)(n-2)(n-3)}{2!}$
"	"	"	"	"
"	"	"	"	"
"	"	"	"	"
"	"	"	"	"
$n-3$	2	$\frac{kn(n-1)(n-2)}{2!}$	$\frac{kn(n-1)(n-2)(n-3)}{2!}$	$kn(n-1)(n-2)$
$n-2$	1	$kn(n-1)$	$kn(n-1)(n-2)$	$kn(n-1)$
$n-1$	0	kn	$kn(n-1)$	0
	Totals	$kn\ 2^{n-1}$	$kn(n-1)2^{n-2}$	$kn(n-1)2^{n-2}$

from the group is a boy, it will be proved that $(n-1)/2$ is the most probable value of the arithmetic mean of the number of a boy's brothers, and likewise of the number of his sisters. Consider a large number N of families and for convenience assume that N is a certain number of time 2^n, say $N = k2^n$. Then the *a priori* most probable numbers of families with 0, 1, 2, : : :, n boys is given, respectively, by the terms k, kn, $kn(n-1)/2!$, : : :, $kn(n-1)/2!$, kn, k in the binomial expansion of $k(1+1)^n$.

First note that k families out of $k2^n$ have no boy; second, that kn families have only one boy each and therefore they have kn cases of no brothers and $n-1$ sisters; third, that $kn(n-1)/2!$ families have two boys each, and hence they have $kn(n-1)$ cases of one brother and $n-2$ sisters; fourth, that $kn(n-1)(n-2)/3!$ families have three boys each, and hence they have $kn(n-1)(n-2)/2!$ cases of two brothers and $n-3$ sisters; and so on. The manner of the distribution seems sufficiently clear without further illustration.

Then we set up the ordinary form for finding the arithmetic means of the number of brothers and of the number of sisters in the accompanying table.

The totals of columns (4) and (5) are equal, and each divided by the total of column (3) gives $(n-1)/2$. Hence $(n-1)/2$ is the arithmetic mean of the number of brothers, and of the number of sisters.

H. L. RIETZ

THE STATE UNIVERSITY OF IOWA

THE AMERICAN CHEMICAL SOCIETY

DIVISION OF ORGANIC CHEMISTRY

(Continued)

The electrochemistry of free radicals: J. B. CONANT, L. F. SMALL and A. W. SLOAN. The halochromic salts of triaryl and diaryl carbinols are rapidly reduced in acetic acid solution by vanadous salts to the corresponding ethanes which can be obtained in good yields. If these ethanes are dissociated with the formation of free radicals, a significant potential of the process can be measured by the titration method, or by mixing the free radical and the halochromic salt. Similar results can be obtained with certain more stable xanthylium salts even in an aqueous and alcoholic solution. These potentials are the equivalent of the single electrode potentials of the metals, and vary according to the nature of the free radical. The reduction of halochromic salts to free radicals is being used to prepare free radicals hitherto inaccessible; benzylxanthyl has been thus obtained.

Condensation of phthalic anhydride with aryl hydrocarbons: O. R. QUAYLE and E. E. REID. The condensation of phthalic anhydride with aromatic hydrocarbons containing fluorine has been studied, and a number of fluor-benzoyl-benzoic acids prepared. These have been condensed to form the corresponding substituted anthraquinones.

Condensation of cyclohexanone with aldehydes: C. E. GARLAND and E. E. REID. Cyclohexanone has been condensed with p-toluic aldehyde, p-brombenzaldehyde, furfural and anisic aldehyde. The complex ketones have been hydrogenated and also subjected to the Grignard reaction. The tertiary alcohols so formed have been dehydrated and the unsaturated hydrocarbons hydrogenated.

Reactions of unsaturated 1, 4 diketones: J. B. CONANT, R. E. LUTZ and L. F. LEA. Dibenzoyl ethylene and its derivatives combine with ammonia, aniline, malonic ester (in the presence of sodium alcoholate), hydrogen chloride, acetyl chloride and acetic anhydride yielding substituted 1, 4 diketones or, in certain cases, substituted furans; from the former, pyrrols can be prepared. Dibenzoyl ethylene dibromide easily loses two molecules of hydrogen bromide when treated with alkaline reagents; the resulting dibenzoyl acetylene combines at once with water, alcohol or phenol according to the nature of the reagent