ceived. The future may show the desirability of changing some of these matters. Any suggestions along this line by readers of this article will be gratefully received.

It is hoped that both those who use and those who manufacture or handle biological stains will cooperate in this standardization, the latter by using the nomenclature in their catalogs and price-lists and the former by ordering stains by the names given here, specifying the Schultz number whenever one is listed.

Commission on Standardization of Biological Stains.
Geneva, N. Y.
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SPECIAL ARTICLES

REVERSE MUTATION OF THE BAR GENE CORRELATED WITH CROSSING OVER

The bar gene of Drosophila melanogaster reverts to its normal or wild-type allelomorph in from thirty to sixty individuals per hundred thousand (May 1917, Zeleny 1918, 1921, 1923). This is a far higher frequency of mutation than is shown by any other locus in Drosophila. We have now found that bar reversion shows a relation to crossing over in the bar region.

Zeleny (1921) found that bar reversions usually occur singly, so that it is not probable that the mutation occurs far back in the history of the germ-cells. It has been the experience of all who have studied bar stocks that in any given specimen the gonads and the eyes are of the same constitution—that is, that a bar-eyed fly breeds as a bar, and a round-eyed fly breeds as a not-bar. These facts further indicate that the bar reversion occurs either late in the history of the germ-cells, or else before the first cleavage division.

If reversion occurs in the germ-cells of both sexes with equal frequency homozygous stocks should produce twice as many heterozygous bar females as wild-type males; if it occurs only in females the number of heterozygous females produced should be equal to the number of wild-type males; if it occurs only in males the reverted offspring should all be heterozygous females. Zeleny (1923) has obtained from homozygous bar stocks a total of fifty-two heterozygous bar females and fifty wild-type males, thus indicating that reversion occurs only (or chiefly) in the germ-cells of females. We can confirm the absence of reversion in males, from extensive experiments in which bar males were mated to not-bar females, without the production of a single reversion.

In an attempt to determine whether the reversion of bar affects one or both chromosomes of a homozygous female, the following experiment was carried out. Females were made up that were homozygous for bar and for the sex-linked recessive eye-color eosin, and that carried a Y-chromosome. These females were also made up in such a way as to give "high" non-disjunction. Such females were mated to vermilion (not-bar) males. Disregarding gynandromorphs, mutations other than bar reversion and a few anomalous results probably due to non-virginity or to mutation, the following counts were obtained by Miss E. M. Wallace:

REGULAR OFFSPRING

red heterozygous bar ♀	eosin bar ♂	red not-bar ♀	eosin not-bar ♂
46518	40303	19	8

Percentage of reversions, .03

EXCEPTIONAL OFFSPRING

eosin homozygous bar ♀	vermilion not-bar ♂	eosin heterozygous bar ♀
12223	11440	1

Percentage of reversions, .008

These results, taken together with the facts previously outlined, at once suggested that bar reversion has something to do with crossing over, since the most striking difference between the regular and exceptional offspring of an XXY female is that the former include almost or quite the normal proportion of crossovers, while the latter are only very rarely crossovers (Bridges 1916). On this view the one eosin heterozygous bar female produced might be interpreted as an "equational" exception (in which case the experiment was inconclusive for the purpose for which it was intended).

The crossover suggestion has now been verified directly in two separate experiments. The two sex-linked recessives forked (f, locus 56.5) and fused (fu, locus 59.5) lie on opposite sides of the bar locus, but are only about three units apart (Bridges 1921). In the first experiment ultra bar (B^u), an allelomorph of bar described by Zeleny (1920) was used. Zeleny has shown that homozygous ultra-bar stocks give rise to reversions to wild-type with about the same frequency as do homozygous bar stocks. In the present case females of the constitution $\frac{B}{f\,B^u\,fu}$ were tested. Three reverted offspring were produced in about 6,500 flies, thus indicating a reversion frequency for the heterozygote that is of about the same order as the frequency in homozygous bar or homozygous ultra-bar. All three of these reverted individuals arose from crossing over between forked and fused: one was forked not-fused and the other two were not-forked fused. In the second experiment ultra-bar was not used and forked and fused were in opposite chromosomes, *i.e.*, the females tested were of the constitution $\frac{B\,fu}{f\,B}$. Three reversions have so far appeared—two wild-type males and one forked fused male. Thus all six reversions in these experiments were accompanied by crossing over between forked and fused; yet such crossovers include only about three per cent. of the total number of individuals examined. It follows that *reversion of bar to normal is associated with crossing over at or near the bar locus.*

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THE ABSOLUTE VALUES OF THE ELECTRICAL MOMENTS OF ATOMS AND MOLECULES

SINCE an atom consists of a number of electrons distributed around a positive nucleus, its effect at an external point at a distance which is large in comparison with the diameter of the atom, is equivalent to an electrical doublet. The nature of the interaction of atoms or molecules in a gas or liquid must, therefore, largely correspond to that of electrical doublets. The writer has pointed out[1] that, since the doublets would tend to set themselves with respect to each other so that the potential energy is a minimum, attraction would be the outstanding force between the molecular doublets, and if repulsion occurs, it would be as small as possible. This is a different view than that taken by Debeye[2], who supposes that attraction is brought about by contractions and expansions of the molecular doublets on approaching and receding from each other, in such a manner that attraction is the outstanding force. But such changes, though probably occurring to a certain extent, need not necessarily exist in order that attraction may be the outstanding force. In any case, the determination of the absolute value of the average electrical moment associated with the atoms or molecules during their interaction in a substance is of outstanding importance.

In dealing with this problem the main difficulty is that the molecular collisions interfere with, or act in opposition to, the tendency of the molecular doublets to set themselves so that the potential energy is a minimum. The extent of this effect can not be calculated without introducing a number of assumptions. It is thus practically impossible to determine the moment of a molecule from data on the internal heat of evaporation of a liquid, the quantity most directly connected with the molecular moments. But this difficulty largely ceases to exist on considering the internal heat of evaporation at the absolute zero of temperature.[3] The average attraction between two molecular doublets in a substance in that case can be shown to be approximately given by

$$4\,\frac{M^2}{r^4},$$

where M denotes the moment of each doublet and r their distance of separation. The values of the internal heat of evaporation at the absolute zero can be exterpolated by means of the empirical latent heat equation

$$L = (\rho_1^2 - \rho_2^2)\,k$$

which is particularly well adapted for this purpose, where ρ_1 and ρ_2 denote the densities of the liquid and vapor respectively, and k a con-

1 *Phys. Review*, xviii, 4, p. 303, 1921.

2 *Phys. Zeit.* 21, p. 178.

3 The details of these deductions are given in a paper in the course of publication in the *Journal of the Franklin Institute.*