that an increased growth accompanied the heterozygous condition. All the essential facts were accounted for. A decade later the great extension of knowledge in the field of heredity has made possible a still closer linking of the facts of imbreeding and outbreeding with Mendelism. The hypothesis of the complementary action of dominant factors is the logical outgrowth of former views and makes the increased growth of hybrids somewhat more understandable. The fact of a stimulation accompanying heterozygosity is supplemented by a reason why such an effect is obtained. The former view of a physiological stimulation and the more recent conception of the combined action of dominant factors are not then two unrelated hypotheses to be held up for the choosing of the one from the other. The outstanding feature of the latter view is that there is no longer any question as to whether or not inbreeding as a process in itself is injurious. Homozygosity, when obtained with the combination of all the most favorable characters, is the most effective condition for the purpose of growth and reproduction.

A chapter on the value of inbreeding and outbreeding in plant and animal improvement gives a very sane and well-balanced discussion of the practical application in agriculture of the principles set forth in the earlier portion of the work. So far as thoroughly scientific exposition may hope to do so the bogey of the necessary and inevitable harmfulness of inbreeding is laid to rest. It is pointed out that, so far as may be judged from the past, inbreeding has been the greatest single instrument in the breeder's hands for securing uniformity and the concentration of desirable qualities. It has the further advantage of bringing clearly to light undesirable qualities which may then be easily eliminated by selection or otherwise.

The last two chapters of the book are of a more speculative character, but surely no one will deny to those who have made such solid experimental deposits in the bank of knowledge the right to speculate a bit. The first of these chapters deals with effects upon the individual and the second with effects upon the race. Both chapters may fairly be regarded as among the sanest and most cogent arguments for the integral incorporation of eugenic ideas and ideals into the conduct of the social and political affairs of life which have yet been put forth. The known facts are examined critically, though briefly, and there is a refreshing absence of blind and blatant propaganda. To take a single simple example it is shown with great clearness that the ridding of a racial germ-plasm of defective characters is very far from being the simple process that enthusiastic devotees of sterilization legislation would have us believe. To prevent the multiplication of individuals visibly bearing the defects is, in theory at least, not particularly difficult. But to do this alone will not even approximately solve the problem. The residual and vastly more difficult question concerns the somatically normal transmitters of defective qualities.

Altogether this is a notable book, in which American science may well take pride. It should form a part of the required reading of every student of biology, because nowhere else is there brought together in such clear and well-digested form the results of a mass of experimental work which has successfully lighted a dark corner of biological science.

RAYMOND PEARL

## SPECIAL ARTICLES

### CORRESPONDENCE BETWEEN CHROMOSOME NUMBER AND LINKAGE GROUPS IN DROSOPHILA VIRILIS

A STUDY of twenty-seven mutant characters[1] in *Drosophila virilis* Sturtevant, reveals the presence of at least five groups of linked genes in this species—in contrast to the four groups in *Drosophila melanogaster* (*ampelophila*). This difference in number of linkage groups agrees in a significant manner with the difference in number of chromosomes in the two species. *D. melanogaster,* as is well known, has four pairs of chromosomes—three large and one very small—and correspondingly has three large groups and one small group of linked genes. *D. virilis,* on the other hand, has six pairs of chromosomes—five large and one

[1] Descriptions of some of these have appeared in two earlier papers: Metz, C. W., *Genetics,* 1: 591–607, November, 1916, and Metz, C. W., *ibid.,* 3: 107–134, March, 1918.

very small[2]—and should, therefore, according to the chromosome theory, have six linkage groups, one of which might be expected to contain relatively few genes. From present evidence it seems probable that the five linkage groups, thus far detected, represent the five large pairs of chromosomes. Detection of the sixth group, representing the very small pair, would hardly be expected until a larger number of mutants had been obtained.

The data upon which these conclusions are based will be published in detail elsewhere, but may be summarized as follows:

Fourteen of the 27 characters are sex-linked, forming Group I. The remaining (non-sex-linked) characters fall into four groups—Group II. with three characters, Group III. with four characters, Group IV. with three characters and Group V. with three characters.

Maps of the five groups, based on crossover values, as determined thus far, are respectively about 90, 40, 60, 0 and 20 units long. These lengths are based, respectively, on data involving 12, 2, 4, 3, and 2 "loci," and hence will probably be extended considerably when more characters are studied. Although the values are only approximations, because of the small number of genes involved, they show that a relatively large amount of crossing over occurs in some of the groups. In the fourth group the three genes appear to be completely linked, but since there is no other evidence to indicate that they are allelomorphs they are assumed, tentatively, to represent three different loci.

Owing to the fact that in *D. virilis,* as in *D. melanogaster,* there is no indication of crossing over in the male, it has been possible to secure clear-cut evidence of the distinctness of the linkage groups, because back-crosses of heterozygous males always give complete linkage, if the genes belong to the same group, or free segregation if they do not. Thus representatives of each group (exclusive of the sex-linked group) have been tested with representatives of every other group and found to give free segregation, whereas with members of their own groups they gave complete linkage. The crossover values were, of course, obtained by back-crossing females instead of males.

It should be noted that in the case of the fourth group no crossing over has yet been detected in either sex, but only three characters have been studied in this group, and there can be little doubt that the sexual difference, as regards crossing over, will prove to be the same here as in the other groups.

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[2] See Metz, C. W., *Amer. Nat.*, Vol. L., pp. 587–599, October, 1916.

## THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

### SECTION H—ANTHROPOLOGY AND PSYCHOLOGY

At the St. Louis meeting of the American Association for the Advancement of Science, Section H presented a two-day program. The Monday morning program was given over to papers of especial anthropological interest. Unfortunately due to conflict in the announcements few were present and the session was postponed, resulting in only a few papers being given. On Tuesday morning the Section united with Section L—Education—in a joint program. The address of the retiring chairman of the Section, Dr. Aleš Hrdlička, was entitled "The relations of anthropology and psychology."

Due to action of the Council of the Association the old Section H—Anthropology and Psychology—has been divided up into new sections. The new Section H will be restricted to anthropology and the new Section I to psychology. Officers for both Sections were elected on Tuesday afternoon.

The officers for Section H—Anthropology—are: *Vice-president of the Association and chairman of the Section,* Dr. G. B. Gordon, University Museum, Philadelphia, Pa.; *Secretary,* Dr. E. Hooton, Peabody Museum, Cambridge, Mass.; *Members of Sectional Council,* Dr. F. W. Hodge, Museum of the American Indian, 1 year; Professor R. J. Terry, Washington University, 2 years; Dr. B. Laufer, Field Museum of Natural History, Chicago, 3 years; and Dr. Aleš Hrdlička, United States National Museum, 4 years.

The officers for Section I—Psychology—are: *Vice-president of the Association and chairman,* Professor Edward K. Strong, Jr., Carnegie Institute of Technology; *Secretary,* Professor F. N. Freeman, University of Chicago (for 4 years);