Attempts to secure a clearly positive Millon's reaction were unavailing. Other microchemical studies are in progress and will be reported elsewhere. Among the reactions which should be applied are Macallum's tests for potassium and for chlorides, because these may furnish clues to the nature and source of substances added when the nuclei undergo hypertrophy, as they often do.

From the results obtained thus far, it seems clear that, although the viruses are obviously distinct, the material forming the inclusion bodies appears to be in some respects alike throughout the series of diseases examined. But this similarity should not be taken at all as a measure of a hypothetical and corresponding similarity in the mode of action of the viruses; for the reactivity of the nucleus is so restricted that it might well respond to different stimuli in the same way. The available material for building up the inclusions is limited both in amount and in variety as compared with that existing in the cytoplasm, and the nucleus by its position is sheltered from environmental influences acting upon the periphery of the cell. Such influences may be different in kind, and there is reason to believe that they actually do differ within certain limits, while the transmitted effects to the nucleus may be identical. Consequently, in striving to know the viruses by their deeds, which is about all we can do at present, we must proceed cautiously. It is this that makes the problem largely a cytological one.

The results are, moreover, at variance but not absolutely incompatible with the theory that the inclusions are composed in large part of the causative microorganisms themselves—if indeed the inciting agents are actually living, which has certainly not been proved in the case of any of those mentioned. In the first place, iron, which is known to be of widespread occurrence in detectable amounts in living things, was observed in the nuclear inclusions to be conspicuous by its absence.

Secondly, the material responsible for the Feulgen reaction, which is probably thymonucleic acid, while not quite so ubiquitous is nevertheless an essential constituent of animal cells including the pathogenic protozoa, yet, like iron, it was absent in all the inclusions, with the possible exception of some in the submaxillary glands of old guinea-pigs. The questionable reaction which these gave should not be weighed in the balance one way or the other. They constitute a special case, for, as will be shown in a later communication, the cells tested, though persisting in the living animal, had been dead for days, perhaps for weeks, before the examinations were made.

Further evidence pointing in the same direction has been available for some years, but has not been stressed. It is known that some of the inclusions that we are considering are occasionally feebly basophilic but that the majority throughout their whole history are strongly acidophilic (or oxyphilic). A parallel is not easily found of any existing microorganism which is so consistently acidophilic in its reaction. Even the Rickettsia of Rocky Mountain spotted fever, which approximate most closely to the inclusions, being in a stage of their life history parasitic in masses within nuclei, are distinctly basophilic.

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THE EFFECTS OF X-RAYS IN PRODUCING MUTATIONS IN THE SOMATIC CELLS OF DROSOPHILA MELANOGASTER

THE signal success of my colleague, Dr. H. J. Muller, in producing mutations and rearrangements of genes in the germ cells of *Drosophila* by X-radiations, suggested the possibility of securing similar results by this method in somatic cells. It was thought that if the genes in the somatic cells could be changed by the means of X-rays, the facts thus obtained would be of importance, especially in studying the mutation rate and in determining the behavior of specific genes during development.

With this in view, a series of experiments, involving the use of several different genes, has been planned and is now being carried out in this laboratory. For the first set of experiments, the sex-linked genes for eye color were selected as suitable characters for study. The compound eye of insects is especially well adapted to this kind of work. It is composed of a series of definite units, the ommatidia, in which any change of color of one or more of the units can be detected. In this paper we shall report the results obtained from raying the F_1 eggs and larvae of crosses between the normal red-eyed fly and the white-eyed mutants.

The relatively low frequency with which mutations occur, in the individual genes, even after X-ray treatment, makes remote the chance that two identical dominant genes in the same somatic cell would be changed at the same time. The object of making the cross is, therefore, to obain females heterozygous for the sex-linked genes. Since the male has but a single X-chromosome, his somatic cells will have either the dominant or recessive gene, but not both.

The cultures to be rayed were made up in a manner such that the difference in age between the youngest and oldest eggs or larvae in any given culture would not exceed twelve hours. These cultures were

then kept in an incubator, run at 27° C. until the time for raying, and after treatment were allowed to develop at room temperature. The control cultures were handled in the same manner, except that the X-ray treatment was omitted.

The raying has been done on the standard Victor machine, equipped with a broad-focus Coolidge tube with tungsten target. The machine was operated at 50 kv., 5 ma, at a target distance of 12 cm. An aluminum filter 1 mm. thick was interposed between the tube and the culture. Several different lengths of treatment were given the different cultures, which varied in age from the egg stage to fully formed pupae. As a matter of convenience, the difference in dosages was made at five-minute intervals, and designated as D-1 for the five-minute or shortest treatment, D-2 for the ten-minute, and on up to D-10, or 50-minute dose, which was the longest treatment given.

Four different sets of experiments have been performed. The first set was necessarily of a preliminary character and consisted in treating cultures of larvae in different stages of development. The doses used were D-1, D-2, D-3 and D-5 (only three small cultures). The cultures contained the F_1 larvae of the cross between normal or wild females and yellow-white males. The results obtained were largely negative—only two flies showed any effects of the X-rays, and none was found with white ommatidia. It was evident that the lighter dosages were not sufficient to bring about much change. Consequently, in all the succeeding experiments, the longer treatments were given. I have since used almost exclusively the D-5 and D-10 doses.

In the second set of experiments the same cross was made as used in the preceding set. In all twenty-three different cultures were given the treatment, twelve the D-5 dose and eleven the D-10. These twenty-three cultures covered the entire range of development, from freshly laid eggs to fully formed pupae. From the eggs and larvae of the D-5 treatment 760 flies developed, 382 females and 378 males. White ommatidia were not found on the eyes of the males, but sixteen females had such ommatidia. These were found either singly or in groups of two or more. The numbers of white ommatidia in the sixteen females were as follows: 1, 1, 2, 2, 3, 3, 4, 5, 5, 6, 7, 12, 14, 24, 133 and 239, respectively. The D-10 treatment yielded 208 females and 180 males. Eleven females and three males had white ommatidia. The numbers were as follows: Females, 1, 2, 2, 2, 2, 3, 3, 4, 5, 9, 27; males, 2, 5, 13. In each of three cases the eyes of females had white ommatidia at two different locations, making a total for the D-10 series of seventeen different areas that had undergone the change from red to white.

In the third set of experiments, normal gray-red females were crossed to gray-white males and the F_1 larvae rayed as before. Only six cultures were treated, five at D-5 and one at D-10. These gave seventy-six females and sixty-six males. Two females showed white ommatidia; one with two groups on the right eye of ten and three, respectively, the other with a group of twenty on the left eye and a group of four on the right eye.

In the fourth set of experiments the larvae of normal flies were treated at various stages with D-5 and D-10 doses. The treated cultures gave 103 females and 98 males for the D-5 series, and 114 females and 89 males for the D-10 series. White ommatidia were not present on the eyes of the 217 females, but two males from the D-5 and three males from the D-10 series had white ommatidia, with the following numbers: 1, 2, and 1, 2, 3, respectively.

To summarize the data for the D-5 and D-10 series: the 217 females from treated larvae and homozygous for the sex-linked genes showed no change in eye color; the 666 females from treated larvae, and heterozygous for this gene, showed thirty-four separate white areas (either single or groups of white ommatidia); the 807 males from both series gave eight males showing white areas.

The various controls for the different sets of experiments gave 1,798 flies, of which 991 were females and 807 males. The eyes of all these flies were carefully examined for the presence of white ommatidia, but none was found. It is certain, therefore, that the appearance of such ommatidia in flies coming from treated eggs or larvae is due to the effects of X-radiations.

Three possible suggestions may be made as to the nature of the effect of X-rays in producing white ommatidia. One is that the effect is non-genetic, that is, it does not involve a change in the gene or chromosome. If this is correct, then the eyes of females, homozygous for the sex-linked gene for eye color, should show white ommatidia after the treatment, but this is found not to occur. A second suggestion is that the change is brought about by a gene mutation, the so-called point mutation. All eight cases found among males can be explained on this basis, and also a proportional number of cases among the heterozygous females. Since about one in every hundred males from treated larvae (eight in 807) shows the mutation, then there should be six or seven similar mutations among the 666 females, but there were thirty-four cases of white ommatidial areas present among these females. How are we to explain the appearance of this excess of cases? The best interpretation is that they are the result of chromosomal abnormalities, involving the loss of the X-chromosome,

or at least that part of it that carries the dominant gene. Muller has found cases of this character in flies derived from treated germ cells.

This interpretation will enable us to understand why it is that white ommatidial areas appear more frequently among heterozygous females than among males. If the dominant gene is lost through chromosomal elimination at any cell-division in the somatic cells of the female, the descendant-cells will show the effects of the recessive gene, in this case white ommatidia. In homozygous females the loss, by chromosomal elimination, of one of the dominant genes would not be detected, because of the presence of a dominant gene in the other X-chromosome. Finally, in males the chromosomal elimination of the dominant gene of the single X-chromosome would result in the death of the cell, and hence white ommatidia would not appear.

The limited scope of this note does not permit a report on many other interesting facts that have come out in the work. However, I shall mention briefly three facts that are of more than general interest. The first has reference to the age of the larvae at which X-radiations produce white ommatidia. Briefly stated, the general rule is as follows: If eggs or very young larvae (ten to twenty-two hours old) are treated, the resulting white areas will be large (*e.g.*, the two cases of 133 and 239 ommatidia); if raying is done at twenty-four to forty-eight hours of age, the white areas will have from three to fifteen ommatidia; if the treatment is given during the late larval stage, there is formed, usually, a single white ommatidium; finally, raying pupae stages failed to produce white ommatidia. This means that if a mutation occurs during the early stages of development, when there are yet but few cellular elements present in the eye rudiment, the white area will be amplified by cell divisions of the affected cell. If mutations are induced at successively later stages, there will be, in each instance, fewer cell-descendants, and, consequently, a series of white areas of decreasing size will be produced.

The second point of importance has reference to the production of gene mutation in the germ cells of the rayed larvae. From the cross between normal gray-red females to yellow-white males, forty-four males and twenty-nine females developed from rayed larvae were tested out for gene mutations. Thirteen females from the controls were also tested. Twelve of these were fertile and gave 1,732 offspring, among which no visible mutation was found. Fourteen of the twenty-nine females from treated larvae were fertile and gave 1,861 offspring, of which five showed visible mutations. Twenty-three of the forty-four tested males were fertile, and gave 944 male offspring, of which twenty showed visible mutations. There were four cases in which two or more flies showed the same visible mutation. This is due to the fact that an early germ cell divided two or more times after the mutation took place. Some of the mutations obtained are new, others, such as "white" and "garnet-like," are like those previously known. Several of these have been further tested and found to breed true and do not produce "mosaics."

The final point of general interest has reference to the effects of X-radiation on somatic characters other than that of eye color. Nearly every treated culture yielded flies showing somatic modifications. Some of these very closely resemble certain of the normal mutations previously described (*e.g.*, "star" and "notch"). However, these induced somatic modifications differ from those of the normal mutants in two important respects; first, they are usually asymmetrical, and second, genetic tests show that they are never inherited.

Throughout this study I have had the advantage of free access to Dr. Muller's extensive stocks of *Drosophila;* for this and many other courtesies, I am indebted to him.

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SOCIETIES AND ACADEMIES

THE AMERICAN ASSOCIATION OF MUSEUMS

THE twenty-third annual meeting of the American Association of Museums was held in Washington, D. C., from May 23 to 25. A feature of the conference was the opportunity which it afforded for wide contacts through the fact that the American Federation of Arts held its meeting at the same time, and the Association of Art Museum Directors met on the two preceding days in the same city.

The past year—the fifth since the establishment of the association in its headquarters at Washington—has witnessed work which looks farther into the future than that of any previous twelve months, according to the report of the director of the association rendered at the opening session of the meeting on May 16. Development of international relations, rapid extension of outdoor educational work and publication of books and reports were cited among other achievements.

The following excerpts from the report indicate the character of the year's activity.

The director spent part of the winter in Europe on two missions. First, by invitation, he visited the International Office of Museums at Paris and helped to develop a basis of cooperation between national and re-