having a ClB chromosome and a second X-chromosome carrying the mutant genes for yellow, white, lozenge and miniature. The single X of the Theta male had the mutant genes for yellow and scute at the left end, and a duplicated fragment attached to its extreme right end. The attached fragment is a deleted element from another X-chromosome, and has the wild-type allelomorphs for yellow, scute and broad from the left end, and the gene for bobbed (probably) from the right end. Breeding tests with this female showed that the case belonged to the so-called "eversporting" mottled type, and that mottled eyes and notched wings varied independently of each other in their phenotypic expression.

A rather extensive series of genetic tests has been carried out on this stock, but the detailed results will not be published until some later time. In this note we desire to indicate briefly some of the main points brought out in the study, and especially to suggest an explanation for the ever-sporting character of mottling and notching, as exhibited in this particular strain of flies. All the results are consistent in support of the following explanation: A piece of the left end of the treated Theta X-chromosome has been broken off and has become attached to a fourth chromosome (IV). The translocated fragment contains the mutant genes for yellow and scute and the wild-type allelomorphs for prune, white, facet echinus, and its length must therefore be greater than five and a half map units.

In the first cross made with this mottled-eyed female the Theta fragment was removed from the broken X-chromosome by a crossover. The stock has since been maintained by mating mottled-eyed females to yellow white singed males. It was found that a female zygote receiving the yellow white singed chromosome and the broken X, together with the translocated fragment, may develop into a normal yellow female (non-mottled, non-notched). But in case the fragment becomes eliminated from any cell (or cells) during morphogenesis, the descendants of this cell will produce, in combination with non-deficient cells, somatic tissue exhibiting mosaicism—mottled eyes, or notched wings, or both, depending upon whether cells that have lost the fragment happen to enter the embryonic rudiments of these structures. If the F_1 mottled females from such a cross are back-crossed to yellow white winged males, there are found among the F_2 off-spring males and females that are hyperploids.

The non-crossover hyperploid female has two yellow white singed X-chromosomes and the translocated fragment. She is therefore singed and red or mottled eyed, but never has notched wings. The non-crossover hyperploid male has the yellow white singed X-chromosome and the fragment. He is also singed and red or mottled eyed. The hyperploid males constitute the only class of males that show mottled eyes. A few yellow scute males appear in the cultures. This type of male has the broken X-chromosome and the translocated fragment. Such a male is never mottled eyed, because (apparently) the loss of the fragment during development results in the death of the zygote.

Linkage tests for the translocation demonstrate that the fragment is attached to the fourth chromosome. Cytological studies made by one of us (Painter) also reveal the presence of the fragment on the fourth in a female heterozygous for the translocation (a fact discovered before the linkage tests were completed). The metaphase plates of oogonial divisions show that the attached piece is about three times the size of a fourth chromosome (Fig. 1, a, b). In the nervous tissue of the same female larva, heterozygous for the translocation, cells have been found that show the translocation, while other nearby cells have normal fourth chromosomes, thus demonstrating that the translocated piece may actually become lost during morphogenesis.

FIG. 1, a and b.

From this brief account it will be seen that the mosaicism in this strain of flies is due to an *unstable translocation*. From the view-point of cytology, the case is of interest in that it gives us an opportunity to compare the physical size of the left end of the X-chromosome with its corresponding genetic or map size.

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THE EFFECTS OF X-RAYS ON THE GROWTH OF WHEAT SEEDLINGS

THE present study was undertaken to obtain quantitative results on the reactions of growing plants to x-rays under controlled biological and physical conditions. Wheat seedlings were used because preliminary experiments showed that the growing parts were relatively sensitive to x-rays and because the results under similar conditions were in close agreement. The roots elongate at the rate of about 1.3 mm an hour. Over two hundred thousand measurements were made on the control and irradiated material during a period of three years.

The source of radiation was a standard water-cooled Coolidge tube. The filament current was maintained at 30 ma., and a potential of 200 kv. was applied across the tube. A copper filter 0.9 mm in thickness was interposed between the tube and the seeds. To prevent evaporation the dish was covered with a thin sheet of bakelite. The distance of the seeds from the center of the target was 43 cm. Before and after, as well as in the middle of each experiment, ionization readings were taken to check up any variation in the energy output of the machine.

In preparing an experiment the dry seeds were carefully washed in distilled water and left soaking in it for 3.5 hours. Then they were "planted" in moist chambers (diam., 23 cm; depth, 7.5 cm) on filter paper moistened with distilled water. When the seeds were not being handled they were kept in a practically light-proof incubator, the temperature of which was maintained at 26° C. Twenty-four hours later the coleoptile, the leaf and the two lateral roots were all about 2 mm long, while the primary root had grown about 5 mm.

At this time seedlings for irradiation were selected. Only those in perfect condition and uniform in length were chosen. They were placed side by side for treatment in a large petri dish. After irradiation the seedlings were removed and placed in the petri dishes (diam., 15 cm), twenty being distributed in each dish. The bottom of the dishes was covered with two layers of filter paper wet with 15 cc of distilled water. These, together with the control dishes, were then put in the incubator, where they were left undisturbed until removed for measurement forty-eight hours later.

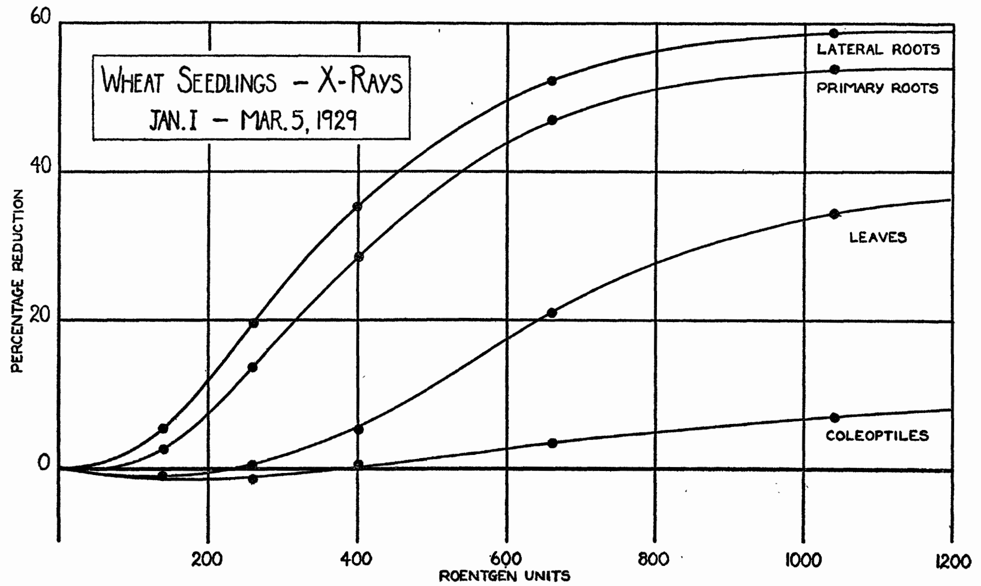
The growing parts were measured by placing them on a millimeter rule, their length being read to an assistant who recorded the figures on an adding machine.

The results may be summarized briefly:

(1) The seedlings are relatively sensitive, less than a threshold erythema dose reducing the growth of the lateral roots to half the normal length.

(2) Each of the four growing parts of the seedling are affected to a different degree by the same dose. This fact is brought out clearly by the accompanying curves. A threshold erythema dose reduces the growth of the coleoptile less than 3 per cent. Taking the percentage reduction of the coleoptile (with reference to the control) as unity, and comparing it with the other growing parts, these differences are found:

Growing part	Relative effect
Coleoptile	1
Leaf	6
Primary Root	16
Lateral Roots	18



THE EFFECTS OF X-RAYS ON THE GROWTH OF WHEAT SEEDLINGS

Each point is the average of 560 measurements, except in the case of the lateral roots where each point is the average of 1,120 measurements. The ordinate represents the percentage effect in terms of the control. For example, if the normal primary root grew 100 mm, while the treated root grew 60 mm, the "percentage reduction" in growth would be 40. The abscissa represents the dose in r-units. A threshold erythema dose is equal to 600 ± 5 per cent. r-units.

(3) In general the curves show that as the dose is increased it produces relatively less effect. This holds true for each of the growing parts. A dose of 1,000 *r*-units reduces the growth of the primary root 53 per cent.; 8,000 *r*-units reduces the growth only about 60 per cent.

(4) Differences between the controls and the irradiated seedlings can be detected a few hours after treatment. In general these differences become greater as the period between treatment and measurement is lengthened. The forty-eight hour period was chosen because the effects of the x-rays were pronounced at this time, and because the methods of seedling cultivation used would not have been so satisfactory had a longer period been adopted.

(5) Within the range studied it was found that when the product of the intensity and time of exposure is kept constant the effect produced is the same. The intensity can be cut down to 1/12 and the time of treatment increased twelve times without noticeably changing the biological effect.

(6) Seedlings which are heavily irradiated exhibit abnormalities. Instead of tapering gradually to a delicate slender tip, the roots are thickened throughout their whole length. At the end there forms a tuberous enlargement, the diameter of which is two or three times that of a normal root. The coleoptile becomes tough and much thickened, especially at its base.

(7) The growth-promoting vitamin B in the embryo is destroyed by heavy doses. The physical conditions in this phase of the work were identical with those in the other experiments except that the copper filter was omitted and the time of exposure was increased to 120 minutes. This dose is approximately 72,000 *r*-units. It requires one per cent. of embryo in a vitamin-B-free synthetic diet to sustain normal growth in a young albino rat. A similar diet containing 6 per cent. of irradiated material does not permit normal growth. I am under obligations to Dr. Kanematsu Suguira, who carried out this work in his laboratory.

Packard has brought out the fact that the effect of x-rays on *Drosophila* eggs is independent of the wavelength. Other investigators have found that short or long x-rays are more effective in inhibiting the growth of different organisms. Because of these conflicting results, extensive parallel experiments were carried out using low potentials of between 40 and 50 kv. After the completion of the work, however, new measurements showed that the graphite chamber used measured only a proportion of the energy of the soft radiation. Further interpretation of these data, therefore, must await the calibration of the graphite chamber with a standard ionization chamber.

The writer is under obligations to the physical department of the hospital for providing the apparatus and for making the physical measurements.

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RESPIRATION STUDIES ON AZOTOBACTER UNDER CONTROLLED CONDITIONS

Since the discovery of *Azotobacter* by Beijerinck, considerable work has been done on their physiology. As a result of the free energy data published by Lewis and Randall, the interest in these organisms has recently centered on the energetics and mechanism of the nitrogen fixation process. Careful studies on the rate of respiration over the entire range of oxygen tension is of utmost importance and is indispensable when the nitrogen fixation process is considered thermodynamically.

To measure the metabolic activity of *Azotobacter* at different partial pressures of oxygen, the rate of formation of carbon dioxide and the heat energy evolved was measured at the same time. The differential calorimeter built by Randall and Rossini[1] was

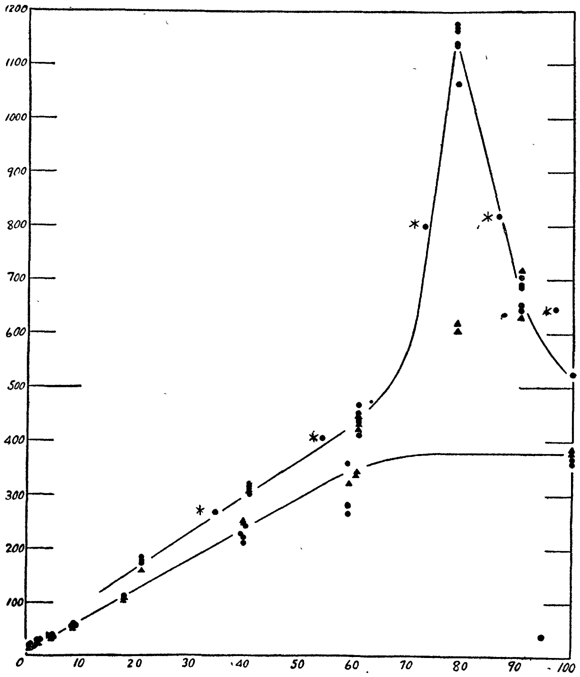

Fig. 1

Ordinate represents the calories produced;
Abscissae, the per cent. oxygen.
▲ Calories per hour measured.
● Calories calculated from the carbon dioxide evolved.
* These points represent the carbon dioxide evolved during 1 hour, 20 minutes of which the oxygen tension was at the lower value and at the higher value for the remaining 40 minutes. The average oxygen tension is therefore the lower tension plus two thirds the difference between it and the next higher oxygen tension.

[1] *Jour. Am. Chem. Soc.*, 51: 325, 1929.