LETTERS TO THE EDITORS

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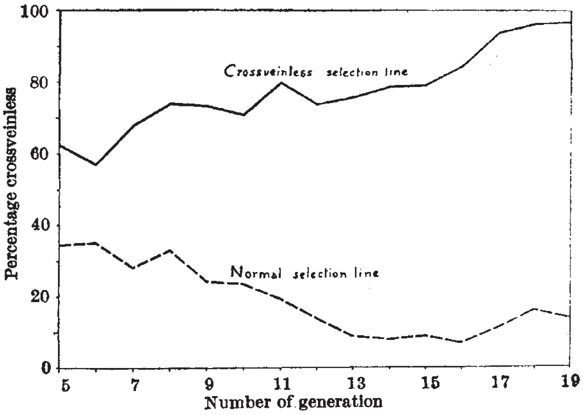
Selection of the Genetic Basis for an Acquired Character

THERE are so many examples of the adaptation of an animal to its environment which at first sight would appear to find their simplest explanation in the supposition that the effects of the environment have become inherited, that theories of this kind have continued to retain a following in spite of the lack of clear experimental evidence in their support. This following has been composed mainly of naturalists; experimentalists and geneticists have recently tended to adopt an attitude similar to that expressed by Dobzhansky[1], who writes: "This question has been discussed almost *ad nauseam* in the old biological literature . . . so that we may refrain from the discussion of it altogether". In dismissing the matter so cavalierly, Dobzhansky was explicitly referring to "direct adaptation", that is, the hypothesis that when the environment produces an alteration in the development of an animal, it simultaneously causes a change in its hereditary qualities such that the developmental alteration tends to be inherited. It has been usual, indeed, to consider this suggestion as the only possible alternative to the opposed view that environmental effects have no hereditary consequences, the phenomena of adaptation being solely due to the natural selection of chance variants.

Recent work, however, suggests another alternative. We know that environmental stimuli may produce developmental abnormalities (phenocopies) which simulate the effects of mutant genes; and a perusal of the scattered literature on the subject suggests that there is a good deal of variation among normal stocks in their sensitivity to the external stimuli. I therefore suggested some years ago[2] that all the necessary machinery is available by which a genetic basis could be, and in the course of natural selection would be, set up to reproduce any given environmental effect which was of value to the animal concerned. Natural selection will act, not solely on fortuitous variants resembling the form produced by the environment, but on the sensitivity of normal individuals to the environmental stimulus; and the genotypes sensitive to the external influence will also reinforce the action of any genes which tend to produce similar phenotypes and will canalize their activity towards the exact effect which is being selected for.

In a recent experiment, this possibility has been actually realized. Individuals of a wild-type strain of *Drosophila melanogaster* were given a strong environmental stimulus by submission to a temperature of 40° C. for four hours at an age of 17–23 hr. (in later generations 21–23 hr.) after puparium formation. A crossveinless phenocopy was produced with a frequency of about 40 per cent. Two selection lines were set up, in one of which the flies which showed the phenocopy were bred from in each generation, while, in the other, selection was against phenocopy formation. Fairly rapid changes were produced in both directions, particularly from the fifth generation onwards, at which time it was realized that the critical period for the effect was at the



Progress of selection for and against the formation of the crossveinless phenocopy, from the fifth generation onwards, the temperature shock being applied to pupæ aged 21–23 hr.

21–23 hr. stage, to which the treatment was thereafter confined (see graph).

The important point is that from the twelfth generation onwards of the stock selected for sensitivity, flies showing the crossveinless phenotype began to appear even among those individuals which had not been given the temperature treatment. Matings between these have given rise to strains which regularly produce crossveinless flies when cultured at normal temperatures. During the course of selection, a genetic constitution has therefore been synthesized which under normal conditions produces the same effect as was originally found only as a response to the stimulus of an abnormal environment. This genetic constitution is not, in the present stocks, fully penetrant, the frequency of crossveinless in the various strains reared at normal temperature never surpassing about 80 per cent; but there is no reason to suppose that further selection will not elicit a fully penetrant strain.

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[1] Dobzhansky, Th., "Genetics and the Origin of Species" (Columbia Univ. Press, 1937).

[2] Waddington, C. H., *Nature*, 150, 563 (1942).

Breakage of Chromosomes Produced by Ultra-violet Radiation in *Drosophila*

IN *Drosophila melanogaster*, ultra-violet radiation produces genetic mutations, both lethal and visible, among which the frequency of chromosome aberrations is very low[1]. In this respect, genetic changes induced by ultra-violet radiation resemble spontaneous changes, in striking contrast to those produced by ionizing radiations or, to a lesser degree, by the mustard group of chemicals.

The experiments of one of us (Fabergé[2] and unpub.) with *Zea mays* show that in this material ultra-violet radiation produces chromosome breaks at a very high frequency, but that a very high proportion of these breaks are restored and so remain undetected unless special means are used for their detection. A critical experiment in this connexion has been performed by Schultz[3]. We wish to present here data showing that, in *Drosophila melanogaster* also, ultra-violet radiation produces numerous chromosome breaks followed by restitution.