

THE MECHANISM OF HEREDITY IN RELATION TO THE THEORY OF NATURAL SELECTION

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Darwin meant to deal with "hereditary modification" (?1912, p. 3) but he went on to include individual differences ("for they are often inherited," *ibid.*, p. 38), which according to present information, are mostly noninheritable. Since these individual differences ("of the highest importance for us," *ibid.*, p. 38) were postulated as the material upon which natural selection acts to produce organic modification, their prevailing noninheritance at once deals the theory a deadly blow.

As a practical consideration, vital to his theory, Darwin assumed that any variation may be inherited. In the field of individual variations, now called fluctuating variations, what is inherited is not particular variations but the tendency to vary more or less from the average racial standard. Fluctuating variations, the range of which remains about the same from generation to generation, reflect not exactness but rather the inexactness of heredity. Darwin evidently considered that all characters, all variations, of any organism are represented in its germ-plasm so that they may be inherited but this is now known not to be the case.

On this point D. H. Scott says, "The small variations which are so common, and on which the Darwinian tended to rely, as the material for natural selection to work on, have turned out for the most part to be mere fluctuations, oscillating about a mean, and therefore incapable of giving rise to any permanent new forms. Such fluctuating variations appear to depend on some action of the environment on the individual, and not to indicate differences in the germ-cells." (1924, pp. 10-11.)

Charles O. Whitman makes a far more sweeping statement contradicting the Darwinian view of heredity, saying: "There is really no transmission of characters anywhere in the organic world. . . . Parent and offspring are each independent developments, alike or different according as the germs from which they develop are alike or different, and according as the conditions of life are alike or different." (1919, p. 175).

THE CHARACTERS OF THE SOMA DO NOT AFFECT, AND MAY NOT REFLECT, THE CONSTITUTION OF THE GERM PLASM

When Darwin attempted to link the utility of a character with its inheritance, he was further misled. Among other ventures of this nature, he launched the following: "If variations useful to any organic being ever do occur, assuredly individuals thus characterized . . . from the strong principle of inheritance . . . will tend to produce offspring similarly characterized." (?1912, p. 115.) "variations, however slight . . . if they tend to be in any degree profitable . . . will generally be inherited by the offspring." (*ibid.*, p. 55.)

Omitting comment on the question as to whether "variations, however slight" can be profitable, it should be pointed out that the "utility" of a character has no bearing on its hereditability. Inheritance depends upon the germ plasm while utility is an experience of the soma; there may be no connection. From this distinction ensue various considerations damaging to natural selection theory.

Without taking an extreme view as to the distinctness of somatic and germ cells (unwarranted, anyway, in the light of animal regeneration and vegetative propagation), it may be safely said, nevertheless, that in most organisms the germ plasm is a continuous stream from which the representatives of each generation derive, but upon which they do not have any effect, so far as known.

Walter notes that, "Darwin felt this difficulty and presented with apologies his provisional hypothesis of pangenesis . . . Pangenesis assumes that every bodily part sends contributions to the germ-cells in the form of 'gemmules.' Such gemmules . . . then reconstruct in the germ-cells the characters of the entire body, including acquired modifications as well as all others, and thus there is no theoretical reason why acquired characters cannot be transmitted. Unfortunately there is no tangible basis in fact for this delightfully simple explanation to rest upon. . . . Nothing we have subsequently learned of minute cell structure favors this hypothesis, while many facts go quite against it." (1930, p. 73.)

The great unanimity with which biologists have rejected the hypothesis of transmission of acquired characters (and none have been more emphatic than selectionists in this respect) is further evidence that knowledge of a mechanism for modification of the germ plasm by somatic influence is lacking.

The phenomenon of a *Begonia* leaf regenerating an entire plant, including flowers and seeds, has been urged against the theory of continuity of the germ plasm, but as bearing upon the present thesis this argument is harmless—on the contrary, indeed, it is beneficial. Vegetative propagation is the usual way of preserving uniformity in horticultural productions. Let seeds be matured and grown, however, and there occurs a flood of variation which demonstrates clearly that keeping the somatic characters to a certain standard for an indefinite period has not affected the germ cells in such a way as to make them reproduce those characters.

Maimed animals, shattered trees, leaving whole, not crippled, descendants, and moribund creatures making reproduction their last effort, prove that individuals, themselves defective, can produce normal offspring. These happenings indicate that it may make no difference whether or not there is "selection." The individual is merely the custodian and (except in a nutritive sense) not the maker of the germ plasm. It is the composition of the germ plasm that largely determines the character of the next generation. As the somatic traits of the parents (temporary harborers of the germ plasm) are not necessarily reproduced, a "selection" based on merit ("fitness") may have no influence on specific characteristics of descendants.

Morgan bluntly says "the character of the parents does not affect the properties of the germ-cells." (1932, p. 188.) Pearl may be quoted as follows: The "facts in general show that the somatic and the germinal conditions or states with reference to a particular character may be quite different in the same individual. It results, then, that the somatic condition of such a character in the progeny has no direct or necessary relation to the somatic condition of the same character in the parent. Nothing is brought out more clearly by all recent experimental studies of inheritance than that the somatic condition of a character in a particular organism is a very unreliable criterion of the probable condition of that character in the progeny of that organism. (1915, pp. 65-66.)

"Let us now turn to the consideration of our second rule, which must be fully enforced if natural selection is to be an important factor in the causation of evolutionary change. This, it will be recalled, was that the survivors must produce offspring which bear characters like those which had led to the survival. Or, to put the matter crudely, the survivors must transmit their characters to their offspring. In pre-Mendelian days this phase of the subject was always neatly and summarily disposed of by stating, as one of the *facts* on which the theory of natural selection rested, that 'variations are inherited' or 'like produces like.' Times have changed. We are a great deal less certain about that particular brand of inheritance which the theory of natural selection demands than we were before any one had taken the trouble to make experiments on heredity. The essential difficulty lies here. The differences upon which natural selection directly operates are

somatic differences, by hypothesis and in fact. Every worker in genetics has learned since the truly epoch-making researches of Johannsen to be extremely cautious in assuming *a priori* that any particular somatic difference is so inherited." (Pearl, 1917, pp. 71-72.)

"Expressed in Johannsen's words, the basis of the modern conception of heredity is: 'Personal qualities are the reactions of the gametes joining to form a zygote; but the nature of the gametes is not determined by the personal qualities of the parents or ancestors in question.'" (East, 1912, p. 644.)

A bar to the success of natural selection, unknown to Darwin, is the presence of recessive genes, not apparent in an individual, but which may crop out, even with lethal effect, in descendants. It is possible, therefore, that an individual, entirely fit, might be one whose survival would insure the termination, through lethal genes in its progeny, of that particular line of descent.

Shull notes that, "An important evolutionary consequence of this lack of correspondence between the characteristics of an animal or plant and its genes is that whatever relation exists between the organism and its environment need not exist between many of its descendants and the environment, even though the environment be wholly unchanged." (1936, pp. 118-119.) The consequences of this line of argument to a hypothesis like that of natural selection, which is wholly one of environmental influence, are anything but constructive.

THE CONSTITUTION OF THE GERM PLASM DOES NOT AFFECT, AND MAY NOT REFLECT, THE CHARACTERS OF THE SOMA

"To put this thought in other words," says W. D. Lang, "the morphic expression of the difference between two forms is by no means proportional to the fundamental or genetic difference." (1921, p. iv.)

These conclusions follow from the relations of soma and germ plasm stated in preceding pages and need be repeated only for the benefit of those who consider "possibilities infinitely wider than the actual," one of which is the environmental selection of genes.

The essential independence of soma from germ is asserted by Jennings in the following passage: "Since most mutations are recessive in their effects, and since only one gene of the pair of genes present is mutated, as a rule the mutation produces no manifest effect on the individual in which it occurs. The fact of its occurrence cannot be detected in that individual. It is only when, by the processes of mating in ordinary reproduction, two of the recessive mutations get together in the same pair, in some of the descendants of this individual, that the effect of the mutation appears to view. Thus when the mutation becomes manifest, it has actually occurred, as a rule, at least two generations earlier, in one of the ancestors of this individual." (1935, p. 344.) More recently, McClung has phrased it, "By some insulating device the germinal elements within the gonad do not participate in somatic processes, but merely perpetuate themselves." (1941, p. 266.)

CYTOPLASMIC INHERITANCE

There is some evidence of cytoplasmic, as contrasted to chromosomal, transmission of characters (for a review of the literature see Sirks, 1938) but this is no comfort for selectionists as it tends to show the possibility of the inheritance of acquired characters—a principle which, so far as it is effective, renders natural selection superfluous. A recent statement, however, minimizes the importance of this type of heredity, Dobzhansky, saying "judging from the present incomplete data, cytoplasmic inheritance is so rare relative to genic inheritance that in the general course of evolution the former can hardly play more than a very subordinate role." (1937, p. 72.)

CONCLUSIONS

Hereditary modifications are now called mutations. They originate in the germ plasm and, therefore, occur first in an individual that does not, in its own body, manifest the mutation. Under natural selection theory the individual will survive or not in accordance with the fitness of its "personal" or somatic characteristics. The constitution of its germ plasm can have nothing to do with its survival. Hence the fate of a mutation at the outset is decided by chance. As mutations are of rare occurrence and as they are chiefly injurious or even lethal in effect, the probability that they can be an important factor in progressive evolution under selection theory is slight.

This state of affairs is admitted by neo-darwinians but they attempt to save the situation as best they may by pointing out that mutant genes, which by chance enter into the germinal constitution of the race, "will get distributed to many individuals, the gene complexes of no two of which are alike." (Wheeler, 1936, p. 99.) The acceptability of natural selection doctrine is not improved by this argument. It is tacit in the expression quoted and apparent from the phenomena of fertilization that each individual of a sexually reproducing organism has a unique gene complex. If it become a parent it will contribute to other gene complexes, each unique. These combinations, a different one for each successful fertilization, may be and usually are numerous. The gene complexes of offspring then are many, each with different potentialities, but they derive from parents of only two somatic complexes. Again it is evident that there can be no exact correspondence of soma and germ, hence no effectual selection of gene-complexes on the basis of somatic characters. In sexual reproduction, under the present understanding of heredity, gene complexes, whether favorable or otherwise, can not be perpetuated. Their very nature implies unending change, and as those of descendants are not like those of ancestors there is no way in which selection can get an effective grip on the process.

Weismann, the ultra-selectionist, did Darwin little service by proving the essential independence of the germ plasm from the somatoplasm. Selection, if it exists at all, must be through the medium of the soma, thus cannot act directly on the germ plasm upon which continuity of the race depends. It would seem, therefore, that there is no mechanism that can make evolution by natural selection possible.

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