THE LYSENKO CONTROVERSY

REVOLUTION IN GENETICS

by BERNARD FRIEDMAN

THE rash of articles from the pens of publicists and scientists severely condemning Lysenko's critique of classical genetics has been based upon two interlocking propositions: that "Lysenkoism" has discarded the findings painstakingly gathered by geneticists and that Soviet biology has fallen into this error because of the political domination of science by the Central Committee of the Communist Party. The second idea was examined at length in these pages last month by Louis Aragon. Here I will discuss the first proposition.

To begin with, a clear understanding of the empirical structure of genetics is needed. Geneticists have established that ultra-microscopic particles known as genes, located in chromosomes, determine the appearance of *certain* characters in living organisms. While the effect of a gene is subject to modification by the environment, the gene itself has been found to be relatively stable and to pass on unchanged from generation to generation. Genes have been observed to change "spontaneously," that is without determined cause. It has also been discovered that the rate of this unpredicted and uncontrollable change, or mutation, of genes can be increased by exposing them to certain radioactive materials, heat and a few chemical agents. One of the most impressive achievements of genetics has been the demonstration of a close correlation between the behavior of the chromosomes and parts of chromosomes as observed under the microscope and the movements of the genes attached to these chromosomes. The position of particular genes in definite places on the chromosomes was also established.

This represents in brief the empirical structure of genetics. These are facts established by experimentation and it must be emphasized from the beginning that, contrary to the claims of Lysenko's detractors,

there exists no contradiction between these facts and Lysenko's theory of heredity. It is necessary, however, to separate the hypothetical from the factual in genetics.

The non-empirical principle of the isolation of the germ plasm from the soma or body, enunciated by August Weismann, who taught zoology and comparative anatomy at the University of Freiburg from 1863 to 1912, has unfortunately become an integral part of genetic thinking. This idea is based on the belief that when the organism begins to develop, those cells that are destined to become germ cells —eggs or sperm—are separated and isolated from the cells destined to become body cells. It is postulated by Weismann and his followers that there is no interaction between these two groups of cells.

This misleading concept of development has led to the doctrine of the non-heritability of characteristics acquired by the body cells. As H. J. Muller, a leading American geneticist, puts it in a recent issue of *Saturday Review of Literature*, "One of the fundamentals of the science of genetics is the demonstration of the existence in all forms of life of a specific genetic material, or material of heredity, *which is separate from the other materials of the body*" (my emphasis, B.F.). T. H. Morgan, the father of American genetics, claimed in *The Theory of the Gene* that "the egg produces the individual but the individual has no subsequent influence on the germ plasm of the eggs contained in it, except to nourish and protect them."

The separation of the germ plasm at the inception of development is denied by embryologists today. In the June, 1948, issue of the *Quarterly Review of Biology*, N. J. Berrill and C. K. Liu of McGill University have the following to say concerning this idea: "The germ cells, and the ova especially, are highly developed and to some extent specialized cells elaborated primarily in connection with the mechanics or physiology of development, and not as bearers of heredity although they have become so exploited. . . . As a sacred image remote from the somatic multitude, they have little meaning."

These Canadian embryologists distinctly confirm Lysenko's statement in *The Science of Biology Today* that "the reproductive cells, or the germs, of the new organisms are produced by the organism, by its body, and not by the very same reproductive cell from which the given already mature organism arose. . . ." The general conclusion of Berrill and Liu's significant study is that "the ideas which Weis-

mann arrived at intuitively or by induction from various sources, blinded him in his studies of hydroids and caused him to see imaginary migrations of visible and invisible germ cells, and that whatever the intrinsic merit of his ideas, they are not based upon the study to which they are credited." The meaning is clear: the concept of an isolated germ plasm is a purely imaginary sacred cow. As early as 1926, Professor G. T. Hargitt, an embryologist at Duke University, bluntly stated: "I believe biology would be greatly the gainer by dropping the germ plasm idea entirely and permanently." To which can only be added, "Amen."

THE isolation of the germ plasm has become widely accepted by geneticists, however, because various attempts to induce changes in heredity as a result of experimentally created body changes are regarded as having failed or as having led to "indecisive" results. From these "failures" a principle of impossibility has been established by the followers of Weismann and Morgan. This error is precisely like the one that was made when a principle of the indivisibility of the atom was erected on the basis of the failures of physics to achieve such division. This point was clearly recognized by Professor E. G. Conklin of Princeton University who pointed out in his book, *Heredity and Environment,* that "The classic argument of the Weismannians was that *we can conceive of no mechanism* by means of which somatic changes can be carried back into germ cells, and *therefore there is no such mechanism.* Now the fallacy of this argument is obvious, for even if we could conceive of no mechanism for this purpose, this does not preclude the existence of such a mechanism."

Geneticists have shown a decided unconcern for evidence clearly demonstrating the effect of the body on the germ plasm. For example, in an article on Lamarck in the *Encyclopedia Britannica,* T. H. Morgan discusses the work of W. H. Harrison who caused a heritable transformation in the color of moths by feeding the larvae on leaves treated with lead nitrate or magnesium sulphate. He states that "the evidence points to the conclusion that the treatment brought about the change and that the change was directly on the germ cells," but then goes on as if Harrison never existed.

It becomes clear that the assumed non-heritability of acquired characters is not part of the factual structure of genetics. It is a principle

which has been superimposed on genetics by a way of thinking, an ideology. It stems from an idealistic, metaphysical view of life and, in turn, is used to reinforce that view.

Weismann went beyond the facts to the assertion of an immortal hereditary substance because this idea conformed with his idealistic outlook. At the Darwin Centenary celebration at Freiburg he declared that "in man it is the spirit that rules and not the body." This philosophic idealism colored his interpretation of nature. He is defended today by those who for one reason or another are guided by the same view. Weismann's neo-Darwinism was a continuation of the struggle which was waged against Darwin's doctrine of evolution, a struggle which has traditionally hampered the progress of science. Because of the strength of these forces today, Lysenko devoted the first part of his report to an exposure of the unscientific results of this tendency.

Lysenko opposed to this false ideology a materialist view of life substantiated by experimental evidence. He demonstrated that the germ plasm is subject to modification by the conditions of life of the organism in which it resides, and therefore can be predictably changed. To a materialist, the idea that a group of cells developing in a body, protected and fed by that body, cannot be affected by bodily changes is immediately suspect. He would devise experiments to test its validity. Lysenko's study of the work of I. V. Michurin, the famous Russian horticulturist, and his own achievements—converting spring wheats and barleys to winter forms, rejuvenating old varieties of grain, making possible the summer planting of potatoes in the south, etc.—provided the experimental basis for his attack on Weismannism in Soviet biology.

Speaker after speaker at the sessions of the Lenin Academy of Agricultural Sciences last summer mentioned by name many new varieties of plants and animals, created by the application of Michurin-Lysenko methods, which had been successfully adopted by Soviet agriculture. In a country where practical achievement provides the validation of theory this is a telling argument. One might ask: If these methods are so productive, why are they not applied in the United States? Here one should note that a significant increase in the production of wheat or other crops in this country would unbalance the market. American farm policy, unlike that in the Soviet Union, shows fear of a rapid expansion of agriculture. This is borne out by the

concern recently expressed by Charles Brannan, Secretary of Agriculture, that there might be rather large surpluses of wheat, cotton and corn in 1949. Because of this, Senator Elmer Thomas, Chairman of the Senate Agriculture Committee, is planning legislation to "discourage large plantings of wheat and corn" (New York *Times,* January 25, 1949). This fundamental distinction was expressed in a statement Lysenko once made: "There would be no vernalization if there were no collective farms and state farms."

ANOTHER non-empirical principle that appears in genetic thinking is the theory of the nature of the gene and genetic mutation. In the article mentioned above, Muller stated: "Although they [genes] are relatively stable, they do sometimes undergo sudden inner changes in their chemical composition called mutations. These mutations occur as a result of ultra-microscopic accidents."

What is non-empirical in this concept is the notion of "inner" change, and the isolation of the gene from the metabolic activity of the cell. It has not at all been made clear by geneticists whether the effect of X-rays on genes is only the result of a direct hit or whether it may also be due to a disturbance of the surrounding medium. This is an important distinction because the latter possibility means that the gene may be affected by chemical changes in its environment. Jerome Alexander, a colloid chemist, provides a material basis for the latter view. In his recent book, *Life: Its Nature and Origin,* he writes: "If a genic group adsorbs a particulate unit, such as an atom, ion, or molecule, and the gene is able to duplicate itself so as to maintain the new specific catalyst surface consequent upon the adsorption we have the same effect as a gene mutation."

This is an effective argument against the exceptional status of the gene in the minds of geneticists who regard the reactions set up by genes as "adaptive" but claim that the genes themselves cannot be modified in any adaptive way. Perhaps this will be made clearer in another statement from the same book: "It is certainly reasonable to expect that in some cases stronger molecules may produce effects which are beneficial, either by modifying existing catalysts or by serving to create new ones. From the standpoint of genetics the important question is: Can these new catalysts be carried on by heredity? Experimental evidence is accumulating to show that they can, thus establishing a physiochemical basis for a mitigated form of Lamarckism, which has been taboo in biological texts and teachings because of lack of experimental evidence."

The accumulating experimental evidence to which Alexander refers is the production of specific heritable changes in paramecia by Sonneborn which I described in the January, 1949, issue of *Soviet Russia Today.* Other results that might be mentioned are the classic experiments of Avery, McLeod and McCarty with pneumonia bacteria, and Witkus with staphylococcus. Specific virus transformations have also been frequently noted.

Avery, MacLeod and McCarty secured a "predictable, type-specific and heritable" transformation by chemical means. Dr. E. Ruth Witkus of Fordham University reported that a color change in one form of bacterium "may be produced at any time by either of two different methods of induction, one environmental, the other chemical."*

These specific modifications of heredity have been first achieved with lower organisms because their internal metabolic activity is more easily subject to direct environmental control, but they point to the possibility of a similar type of control in higher organisms and they provide a material basis for the understanding of Lysenko's theories.

Another fundamental problem in biology that the gene theory does not solve is the fact that the body cells become hereditarily differentiated during development although they have the same genes and chromosomes. I have developed this point at greater length in the above-mentioned article. The distinguished Negro biologist, Ernest E. Just, in his work, *The Biology of the Cell Surface* (1939), objected to the gene theory for the same reason. It might be noted that Just was accused of being biased against the gene theory because he, as a Negro, was opposed to its racist implications!

The demonstration of the specific effect of the environment on heredity makes possible an understanding of the mechanism of evolution. Many observers have expressed dissatisfaction with the mutation theory because an overwhelming proportion of mutations are harmful. Lysenko's basic understanding of the mutation process was expressed in his statement: "We do not deny the action of substances which produce mutations. But we insist that such action, which penetrates the organism, not in the course of its development, not through

* See: *Journal of Experimental Medicine,* February 1, 1944; and *Proceedings of National Academy of Sciences,* September, 1948.

the process of assimilation and dissimilation, can only rarely and only fortuitously lead to results useful for agriculture."

STILL another brake on the scientific progress of biology which Lysenko has sought to remove is the concept that genes and chromosomes are the sole bearers of hereditary material. Lysenko holds that while genes and chromosomes may govern the appearance of certain characters, they are not responsible for all the characters of an organism. The main lines of evidence to support this contention have been the established results of cross-hybridization and grafting of diverse varieties. Both types of breeding affect the nature and heredity of the organisms involved much more profoundly than do crosses involving gene differences. The case for Lysenko was well put in Lester W. Sharp's *Introduction to Cytology,* published in 1934:

> "Breeding data indicate clearly a causal connection between chromosomes and Mendelian differences; but since the crosses made must be necessarily narrow, relatively speaking, they yield little evidence as to the basis for the inheritance of those characters which are always the same in the crossed individuals. It is to be remembered that in all cases the cytoplasm is an essential component of the system that undergoes development and produces the characters; in fact it is mainly in the extra-nuclear portion of the cells that characters are differentiated. . . .
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> "Hence the 'physical basis of heredity' in a fundamental sense is the whole protoplasmic system concerned in development, although the course of certain developmental reactions and therefore the appearance of certain characters may be correlated with the peculiarities in the organization of the nucleus. The nucleus is not an arbitrary determiner of development. . . ."

Both I. V. Michurin and Luther Burbank in America created many new, useful varieties by crossing widely diverse varieties, not restricting themselves to narrow Mendelian crosses. Their work is being continued in the Soviet Union by Lysenko and his followers with astounding success. The results of these crosses cannot be explained by Mendelian theories and this accounts for the fact that both Michurin and Burbank, despite their achievements, were not accepted as scientists by the geneticists.

Another important conclusion derived from the work on graft hybrids is that organisms may interchange characters without the intervention of genes and chromosomes. The only possible explanation of the creation of graft hybrids is that diffusible substances affecting heredity pass between scion and stock. The prevailing scepticism regarding these results would be dispelled by a review of the work of Michurin and Burbank, both of whom created new varieties by graft hybridization. Mention should be made, too, of the careful experiments of Lucien Daniel, late professor of applied botany at the University of Rennes, who reported to the International Congress of Plant Science at Ithaca, N. Y., in 1926 on "The Inheritance of Acquired Characters in Grafted Plants."

Interaction between scion and stock has been reported frequently by horticulturists in this country. As early as 1880, Trowbridge reported that in apples, fruit produced on the stock displayed characters of the scion. Similar effects were announced by Heinicke in the *Proceedings of the American Horticultural Society* for 1927 and 1936. Swarbrick, Tukey and Brase have also reported on the transmission of characters from scion to stock in apples.

Lysenko's critique clearly contains no denial that there are genes and chromosomes in the nuclei of plant and animal cells and that they play a role in heredity. Muller's charge that "Lysenko and Present deny the very existence of genes" is a patent falsehood calculated to divert attention from the real issues. Lysenko stated his position unequivocally in his report as follows: "Naturally, what has been said above does not imply that we deny the biological role and significance of chromosomes in the development of the cells and of the organism. But it is not at all the role which the Morganists attribute to the chromosomes."

THE fourteen-year debate on fundamental problems in genetics which has been conducted in the Soviet Union is the kind of scientific controversy that can only lead to the further advancement of the science of biology. There is no attempted "destruction" of facts and no limitation has been placed on genetic research. Genes and chromosomes exist and Soviet scientists will continue to study their behavior with a view to understanding them better. On the contrary, it is classical genetic thinking that limits research by discouraging experiments of a Lamarckian nature. Moreover, future research in the Soviet Union will not be based on unfounded, scholastic theories

of an isolated, independent germ plasm, unpredictable gene change and the sole role of the genes and chromosomes in heredity.

The conclusion is inevitable that Lysenko is an important figure in science who has contributed a profound criticism of genetic theories as the result of a basic analysis of their deficiencies and an accumulating mass of experimental data. His reasoning cannot be avoided by an abusive attack on the Soviet Union; cries of "fraud" and "charlatanry" may make good newspaper copy but they are of no avail. The results of this controversy will affect biological science as profoundly as did Darwin's *Theory of Natural Selection,* which was also highly controversial in its time. Classical genetic theory is beginning to crack at the seams and like every dogma will be discarded by responsible scientists here as it was in the Soviet Union.

NIGHT

Nights are the mirrors,—the black side of the glass
that holds static the reflections of subtle reality.

Day is merely the clicking of doors, the rushing of mills,
the crunch of teeth chewing, feet walking in heavy shoes,
the whisper of dollar bills shuttling from hand to hand.

Night is the mind unbound from the brain-band
of statistical fate,—a gleeful insanity that terrorizes,
or a mute despair that sees the sagged and bruised
tissues of the uncorsetted self.

Lie in your small square of darkness
and plot your heroic crimes of revenge.
Tomorrow you can dispose of your still-born
"enfant terrible" in the flush toilet
before you comb your hair just right
to go out into the daytime.

LORRAINE T. HORVATH