The Rise and Fall of Lysenko

Spectacular successes of Western biology initiate a reorientation of Russian biology along Western lines.

E. W. Caspari and R. E. Marshak

Sovfoto

Academician T. D. Lysenko is again in the news, probably for the last time. Within the last several months he has been removed as director of the Institute of Genetics of the Academy of Sciences of the U.S.S.R., and his entire institute is being completely reorganized along Western lines. Furthermore, special commissions will be set up to eradicate Lysenkoist doctrine from the curriculum and textbooks used in Soviet secondary schools and institutions of higher education. What is the significance of Lysenko's downfall and what does it reveal about the state of Soviet society and its present leadership? It is certainly no accident that Lysenko's exit has followed so closely the accession of Brezhnev and Kosygin to power in the Soviet Union.

The fortunes of Lysenko have always been closely tied to the support which he secured from the top leadership of the Soviet Communist Party and government. Under Stalin, Lysenko became not only director of the Soviet Academy's Institute of Genetics but also president of the all-powerful Lenin Agricultural Academy. In this dual capacity Lysenko was in a position to crush his scientific opponents, and this he proceeded to do with great alacrity and thoroughness. When Khrushchev took over, the official attitude became one of "letting all flowers bloom," and Russian biologists formerly in disgrace were rehabilitated and allowed to resume their scientific work. Lysenko lost nominal control of the Agricultural Academy but remained director of the Academy's Genetics Institute and continued to exercise considerable influence in high government and party circles. Although Lysenko no longer dominated all Russian genetics, he still held Khrushchev's ear and received new honors from the Soviet government. The fall of Lysenko since Brezhnev and Kosygin came to power indicates that the new leaders have adopted a less emotional and more intellectual approach to science than Khrushchev did.

Not only does the decline in the fortunes of Lysenko reflect the continuing improvement in the scientific climate in the U.S.S.R. since Stalin's death, but his career is an object lesson on the harm which results from an attempt to impose an external dogmatism on science. There are numerous instances in history of such an attempt having been made—for example, Galileo's experience with the Inquisition in Rome in 1616, the Scopes trial in Tennessee in 1925, and others. But there are few cases in which the chief antagonist has been a scientist himself seeking to impose his dogmatic views on an entire scientific discipline in the name of a higher authority (in this case the Soviet Communist Party). Furthermore, the Lysenko affair has been marked by unusually brutal treatment of the opposition and by a conspicuous failure to attain the very objectives invoked to justify such treatment.

The Background

Just as the Fundamentalists' literal interpretation of the Bible led to the passage of the Tennessee law against the teaching of evolution and to the subsequent Scopes trial, a literal interpretation of Marx and Engels set the stage for the rise of Lysenko. It should be recalled that Marx and Engels published their major works before Mendelian genetics became know to the world (in 1900) and at a time when Lamarck's idea of the inheritance of acquired characteristics was still a respectable scientific theory. Even Darwin had assumed that the Lamarckian mechanism was of importance in evolution. The thesis that the environment can produce physiological and mental changes in man which can be passed on to later generations was embraced by Marx and Engels (great admirers of Darwin), who saw in such a process a happy device for hastening the achievement of a benevolent Communist society.

By 1925 the Lamarckian hypothesis was being abandoned in the West because all the evidence brought forth in its favor had turned out to be either invalid or faked. Moreover, in the West, Darwinism had been reinterpreted to exclude the Lamarckian factor in evolution. Not so in the Soviet Union. Since Marx and Engels were the prophets of the Russian Revolution, their fervent Darwinism (with its associated Lamarckian doctrine) provided the "scientific" rationale for dedicated Communists striving to mold Soviet man into a paragon of virtue, hard work, and social consciousness.

Several other factors contributed to the persistence of Lamarckian ideas in the Soviet Union. The great Pavlov,

Dr. Caspari is chairman of the biology department and Dr. Marshak is Distinguished University Professor at the University of Rochester, Rochester, N.Y.

whose work on conditioned reflexes in animals had highlighted the importance of environmental influences in behavior, announced in 1923 that a conditioned reflex in mice was inherited and even advanced in succeeding generations. Pavlov's withdrawal of this claim when the evidence collapsed did not discourage the Lamarckian Marxists in the U.S.S.R.

A Russian scientist who more directly prepared the groundwork for Lysenko was the Russian horticulturist I. V. Michurin (the Russian counterpart to the American Burbank), who died in 1935. Michurin's extensive and, in many ways, successful empirical work in plant breeding was bolstered by theoretical views which were anti-Mendelian and, in a sense, pro-Lamarckian. Michurin believed (as Darwin did) that "heredity" is in some fashion diffused throughout the organism and can be modified by many types of environmental influences. This point of view was in the Lamarckian tradition and was taken over by Lysenko.

Another factor which contributed to Lysenko's rise was the Soviet Union's great need to improve its agriculture. In the Western world Mendelian genetics was being used to develop new strains of corn and other plants and to increase agricultural productivity. But the time scale was slow, because advances depended on patient breeding of the proper genetic material and laborious crossing experiments. The Soviet government was impatient and ready to back a scientist who promised rapid improvement of Soviet agriculture.

Attack on Mendelian Genetics

Thus the stage was set in the mid-1930's, at a time when Lamarckianism had been discredited in the Western world, for Lysenko's destructive attack on Mendelian genetics. At that time there were in the Soviet Union many very active and original geneticists. Some of them were working with problems of evolution and gene action in fruit flies. There was also an outstanding group of workers in plant genetics, under the leadership of Academician N. I. Vavilov, who were concerned with the study of the evolutionary origin of cultivated plants and the application of this knowledge to practical plant breeding. As a follower of Michurin and a devout Communist, Lysenko began a violent campaign against the Russian school of classical genetics.

Lysenko derided "Mendelian-Weismannian-Morganian" genetics as passive, "idealistic," and "metaphysical," in contrast to the active, "materialistic," and "empirical" character of his own physiological theory of heredity. He had no sympathy with Mendel's original abstract concept of the gene as a calculating unit designed to describe genetic experiments, nor with the later elaboration of the concept, in which the genes are viewed as autonomous units governing the inheritance of well-defined characters which could not be modified by environment. Lysenko ignored the fact that, by the mid-1930's, some rather concrete ideas about the molecular nature of the gene had been developed. He also claimed that Mendelian genetics was anti-Darwinian, even though by 1930 modern evolutionists had succeeded in reconciling Darwin's theory of evolution with Mendelian genetics. Lysenko rejected outright the abundant experimental basis for the Mendelian mechanism of inheritance with the argument that the Mendelian rules are statistical in character. They therefore conflict, he asserted, with Marxist dialectics and cannot be regarded as "natural laws." This type of argument has been used at one time or another by Soviet scientists against Western work in quantum physics, relativity theory, theory of the chemical bond, and cybernetics.

Lysenko substituted for the Mendelian theory of heredity his own so-called "physiological" theory, following Michurin in the assumption that heredity is diffused through the whole organism, collected in the germ cells, and mixed in the course of fertilization; in this process, he argued, the weaker germ cell becomes assimilated by the stronger, in analogy to the assimilation of food in nutrition. Lysenko further proposed his theory of "development of plants by stages," according to which the successive stages in the development of a plant can be affected—that is, speeded up or slowed down—by environmental conditions such as temperature. If one of these stages is altered by environmental influences, the subsequent stages will also become changed and an organism with different physiological qualities, presumably better adapted to the environmental influence in question, will result. Lysenko finally claimed that these environmentally induced changes are transmitted to the progeny and thus result in better-adapted plant lines.

Agricultural Experiments

Lysenko's promise to improve agriculture was based on these ideas. Extensive experiments were carried out: early embryonic stages—that is, plant seeds—were subjected to treatment with strong environmental agents, like high and low temperatures, and the progeny of the treated plants were bred. Spectacular claims for the improvement of plant species by this method were made. But it appears that in fact these experiments did not measure up to expectations and that the slow "Western" method, based on quantitative classical genetics, is superior to a method based on exposing unselected material to altered environmental conditions. A particularly striking example of the effectiveness of Western methods is the successful use of hybrid corn in corn breeding—a technique which underlies the great productivity of the American corn-breeding industry. The method is based on the principle of heterosis, the production of higher yields of corn through the use of hybrid plants developed by crossing carefully inbred lines. Heterosis is well explained by classical genetics but is a complete mystery under Lysenkoist doctrine.

Another line of experimentation pursued by Lysenkoists was the production of "vegetative hybrids." If, as was claimed, heredity is diffused through the organism, it should be possible to produce hybrids by the union of two organisms, such as is accomplished in grafting one plant on another, just as well as through sexual combination. Grafting has been used for a long time in agricultural practice, but the Lysenkoists claimed that the graft hybrids propagate a combination of characters from the two species through future generations in the same way that sexual hybrids do. It is, of course, quite possible that in such grafts branches arise with tissues derived from both plants. Such "chimeras," also observed in the West, have, however, never been found to perpetuate hybrid characters in any experiments carried out outside of Russia.

The Lysenkoists attempted, furthermore, to apply this method of changing hereditary characters to animals. In this application the injection of blood from animals of one strain into animals of another was considered the equivalent of grafting in plants. It was, for instance, claimed that if white chickens are injected with blood from a colored strain, then, in the offspring of these treated birds, partly and even fully colored animals appear with a certain frequency. Since spotting in animals is by no means infrequent and can readily be accounted for by lack of genetic purity, experiments of this type have to be carefully controlled in order to be convincing. The Lysenkoists did not supply sufficient information to permit an evaluation of their results.

Lysenko the Victor

The dubious character of Lysenkoist research and the Lysenkoists' grandiose claims for success in plant breeding led, during the period 1936 to 1948, to a violent controversy between Lysenko and his followers, on the one hand, and the Western-oriented geneticists, under Vavilov, on the other. Finally, in 1948, at a meeting of the Lenin Agricultural Academy, Lysenko was declared the victor, and classical genetics was denounced as contrary to Darwinism, Michurinism, and dialectical materialism. Having won the official support of the Soviet Communist Party and of Stalin, Lysenko established control over Russian genetics and allied branches of biology. He proceeded to suppress research in classical genetics and to eliminate his opponents—by firing all of them from their jobs and having his most bitter enemies exiled to Siberia (Vavilov died in a Siberian labor camp in 1943). By the time of Stalin's death, in 1954, Lysenko had filled every position with one of his followers and had practically destroyed classical genetics in the Soviet Union.

The Khrushchev Period

When Khrushchev came to power in the Soviet Union, the conditions of scientific work began to improve greatly. Particularly in the mathematical and physical sciences, many of the ingredients of scientific freedom were restored to the Soviet researcher: the freedom to choose the subject of his investigations and to draw the conclusions to which they led without having to subject these to the arbitrary dictates of a superior power; the freedom to publish his scientific results and to engage in the usual forms of scientific criticism; the freedom to receive the voluminous Western scientific literature; and, to a lesser extent, the freedom to have personal contact with all scientists working in his own field. While these new freedoms were more grudgingly granted to the biological scientists, partly because of Lysenko's continued influence, the fact remains that Soviet biology began to lose its monolithic character. As mentioned earlier, Lysenko was deposed as president of the Lenin Agricultural Academy, although he maintained his position as director of the Institute of Genetics in Moscow. More importantly, the surviving classical geneticists in Russia, under the leadership of N. P. Dubinin, were rehabilitated and allowed to resume non-Lysenkoist research in their laboratories.

The state of affairs in Russian genetics and biology during the Khrushchev period can aptly be termed a "cold war" situation. Lysenkoists and non-Lysenkoists were permitted to coexist in the Soviet Union, but there was very little communication between them. When it came to personal contacts with Western geneticists, the Lysenkoists still held the upper hand. Thus, when the 1958 International Genetics Congress was to be held in Montreal, 27 Soviet geneticists, both Lysenkoist and non-Lysenkoist, indicated an intention to attend the congress and submitted abstracts of papers to be delivered. About 2 weeks before the congress opened, many of the Soviet scientists informed the organizers of the Montreal congress that they would be unable to attend for a variety of reasons. Finally, a delegation of 11 persons, all of them Lysenkoists, appeared at the conference. Similarly, at the 1963 Genetics Congress in the Hague, the Russian delegation consisted exclusively of Lysenkoists.

It was symptomatic of the state of genetics in the Soviet Union in 1963 that one of the members of the Russian delegation at the Hague Congress stated in private conversation with Western geneticists that Lysenkoists still denied the existence of genes but were willing to accept the existence of DNA as hereditary material. This acknowledgment—that DNA is not an abstract "idealistic" concept but a real molecule playing an important role in heredity—heralded, more than any other single event until then, the beginning of the end of Lysenkoism in the Soviet Union. Such an admission by a Lysenkoist was, of course, a tribute to the remarkable developments which have taken place in Western genetics during the past couple of decades. Indeed, while Lysenko was imposing his out-dated mixture of Michurinism, Lamarckianism, and Marxism on Soviet research, the science of biology was entering a golden age in the Western world, primarily because of the fusion of genetics and biochemistry into the field which is now commonly called molecular biology.

Catching Up

The triumphs of molecular genetics have been so overwhelming in recent years that even members of the Lysenko school have started to work actively in the less-controversial area of microbial genetics. But what is more to the point, non-Lysenkoist biologists in the Soviet Union have been trying to catch up on Western developments and to establish molecular biology as a field of its own. Unfortunately, the relatively small number of surviving classical geneticists and the weakness of Soviet biochemistry (weak for reasons of its own) have made this a slow process. If one examines recent Soviet journals of biology one finds a strange mixture of Lysenkoist papers and molecular-biology papers based on Western ideas and methods. Nothing very profound nor new has resulted from this Soviet work as yet, but this is not very surprising in view of the late start.

As distinguished members of the Soviet scientific community have become increasingly aware, during the past few years, of the impressive accomplishments of Western science, the full measure of the Lysenko disaster has permeated their consciousness. As a result, strong scientific pressures have been building up to curb Lysenkoism and to build up Western-type biology. About 3 years ago, while Khrushchev was still in power, the

distinguished Soviet physicist Peter Kapitza spoke out against the intrusion of Marxist dialectics into science (with special reference to biology) and the harm which its uncritical acceptance had done to Soviet science. Kapitza's voice did not carry the full weight of the Soviet Academy of Sciences, but it was indicative of the fact that responsible Soviet scientists were becoming increasingly concerned about the extent to which Lysenkoism had damaged Soviet biology, the plant-breeding program, and agriculture in general.

It remained for the president of the Soviet Academy of Sciences, M. D. Keldysh, to deliver the *coup de grâce* several months ago when he announced the removal of Lysenko as director of the Genetics Institute, and stated: "The exclusive position held by Academician Lysenko must not continue. His theories must be submitted to free discussion and normal verification. If we create in biology the same normal scientific atmosphere that exists in other fields, we will exclude any possibility of repeating the bad situation we witnessed in the past." Keldysh's action and forthright statement suggest that the new political leadership in the Soviet Union will not permit Communist fanaticism to injure the best scientific interests of the Soviet state.

An Instructive Story

The rise and fall of Lysenkoism is a sad and instructive story. The rise of Lysenko was due to an unfortunate combination of circumstances: the existence of the philosophical dogma of the Soviet state—to wit, dialectical materialism—with its strong convictions concerning human heredity; the existence of a strong national tradition in empirical plant breeding, founded on the Lamarckian approach to genetics (Michurinism); the desire for rapid transformation of Soviet agriculture; and, finally, the presence of a powerful dictator, Stalin, able and willing to throw the full resources of his government behind a specific ideological position. To this potent brew was added an extraordinarily ambitious and ruthless scientific adventurer named Lysenko.

The final downfall of Lysenko can be attributed to a continuous relaxation of all these factors since the death of Stalin. The political and economic tenets of Marxism have been increasingly separated from dialectical materialism as the supreme arbiter of all scientific concepts and procedures; Michurinism has been placed in its proper historical perspective; it has been recognized that the neglect of classical genetics has been in good part responsible for the lack of productivity of Soviet, as compared to Western, agriculture; and finally Khrushchev and, to an even greater degree, Brezhnev and Kosygin have been more reluctant than Stalin was to use the authority of the government to decide questions of scientific doctrine.

The tragedy of Lysenkoism is that so much precious time has been lost for the biological sciences in the U.S.S.R. The consolation is that once the Soviet Union takes a major decision to develop a scientific area (as it did several years ago in mathematical economics and econometrics), lavish provision is made for laboratories and equipment, Western ideas are widely introduced into the educational system, and no effort is spared to attract talented persons into the new field. The recent removal of Lysenko implies unequivocally that such a major decision has been taken with regard to molecular biology and the biological sciences generally. We can only applaud this decision and state our earnest hope that Soviet biologists will soon take their rightful place on one of the great frontiers of modern science. And without much prescience we can predict that at the next International Genetics Congress, to be held in Tokyo in 1968, the non-Lysenkoists will be well represented in the Russian delegation!

News and Comment

Money for Research: Congress and Scientists Have Different Ideas On How the System Should Operate

From the public utterances of the leaders of the scientific community, it can be surmised that when they contemplate a utopian relationship between science and government they see something like this:

At the apex of the federal involvement with basic research is the National Science Foundation, endowed with ample wealth (say, about $530 million for the current fiscal year, and an annual increase of at least 15 percent). The function of the Foundation is to assure unquibbling and generous support for a large proportion of the nation's creative basic researchers. It provides money for research facilities, and with fellowships and other devices it brings promising recruits into the scientific professions. In addition, to giving the public a better understanding of science and to help develop a farm system for the professions, the Foundation assumes responsibility for teaching some science to the couple of hundred thousand persons employed as high school science teachers. As the utopian design has it, political interference and social and economic considerations are nil in the Foundation's operations. The well-being of science —as determined by scientists—governs the money decisions. The Foundation is an organization exclusively of and for scientists, supported by a public that at least appreciates science even if it doesn't understand it.

Nearby in the utopian table of organization is the National Institutes of Health, operating in a fashion somewhat similar to NSF, but limiting itself to health-related research and, of necessity, taking into account public pressures to come up with cures. And at the lower levels of sicentific purity