N. I. VAVILOV
1887—1942

This photograph of Dr. Vavilov was made at the time of the Sixth International Genetics Congress, at Ithaca in 1932, when he was at the height of his activity in assembling plants from all over the world for use in speeding the production of improved varieties for the USSR.

N. I. VAVILOV, A MARTYR OF GENETICS

1887—1942

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BIOLOGISTS everywhere have been concerned for almost a decade about the fate of N. I. Vavilov, the most eminent of Russian geneticists. The magnitude of the tragedy of this man has, however, become known only recently. It is now clear that genetics owes homage to his memory not only because his contributions as an original investigator have been great and his work as organizer and leader of research has been outstanding. He has suffered martyrdom for genetics. In our time, being a scientist is not usually considered a dangerous occupation, but rather one of the ways to relative security and to the little amenities of middle class existence. Not so with Vavilov. He ignored personal comforts and gave himself up entirely to his work. In his last years he had to suffer the anguish of seeing the results of his efforts being pulled down by incompetents. He met death a prisoner on the bleak and forbidding shores of Eastern Siberia.

Nikolai Ivanovich Vavilov was born in 1887, a son of a very wealthy merchant. He came from the curious class of "illustrious merchantry" of old Russia, which for centuries tended to become a closed caste, expert at profit taking but not otherwise noted for cultural achievement. Yet, in the late nineteenth and early twentieth centuries this class suddenly produced a large crop of leaders in almost all fields of intellectual endeavor. Among these leaders were Nikolai Vavilov, the biologist, and his brother Sergei, a physicist and currently president of the Academy of Sciences of USSR. The young Vavilovs had the opportunity to receive the best education which money could purchase. Nikolai chose as his specialty biology and agriculture. He graduated from the Agricultural Academy at Petrovsko-Razumovskoe (near Moscow), and soon went to continue his education and research at Cambridge University in England. There he became a student and a close friend of William Bateson, and one of the group of pioneer geneticists of that day. In 1913 and 1914 he worked at the John Innes Horticultural Institute founded and organized by Bateson.

Even before his sojourn in England, Vavilov had begun to study the immunity of cereals to fungus diseases, and published several papers on this theoretically interesting and practically important subject (1913). He then proceeded to investigate the genetic basis of the immunity, and found it adequately describable in fairly simple Mendelian terms. After his return to Russia at the start of the first world war, Vavilov commenced his great work on the origin of cultivated plants. This monumental study, unquestionably Vavilov's most important research contribution, was published in 1926, in a book which remains a classic, namely *The Centers of Origin of Cultivated Plants*. Here Vavilov gave a synthesis of the mass of information accumulated in the botanical literature since de Candolle, and developed his theory of several principal centers of origin and of concentration of genetic diversity in cultivated plant species. This work brought him worldwide recognition and acclaim. His other important theory, that of "The Law of Homologous Series in Variation" (1920, 1922, 1935), is an empirical generalization which states that related biological species tend to parallel each other in hereditary variability.

Organization of Soviet Genetics

The Russian revolution opened an unlimited field of applicatiton for Vavilov's energies. After an interlude as a professor at the University of Saratov

(1917-1920), he was placed in charge of the Bureau of Applied Botany in Petrograd (1920). Within a few years, he developed this rather inconsequential bureau of the old Ministry of Agriculture into one of the largest and most active research institutions devoted to agricultural sciences anywhere in the world. He not only did a prodigious amount of organizing work at home but also traveled all over Europe and the United States to establish contacts with scientists in other countries. Most important, he brought back with him a whole library of scientific literature, the supply of which had been cut off for several years by the war and, afterward, by the blockade of the revolution. Active biologists from all over Russia flocked to the library of Vavilov's new Institute to become acquainted with the advances of world science. Not a few of these visitors ended by joining Vavilov's rapidly growing staff of collaborators. Others undertook new types of research integrated with the work of the Vavilov group. Still others carried away with them some of the inspiration and enthusiasm which prevailed in Vavilov's entourage. In a few years, the All-Union Institute of Applied Botany and New Crops, as the Bureau was now called, became the center of a federation of agricultural research institutes distributed all over the USSR, from the Polar Circle to the subtropics of Caucasus and Turkestan. The combined staffs of these institutes in 1934 amounted to about 20,000 persons.

Despite the enormous weight of his administrative responsibilities, Vavilov managed to remain the *de facto* scientific and research leader, as well as the president, of this unprecedented research organization, which underwent one more change of name, to become known finally as Lenin's All-Union Academy of Agricultural Sciences. His seemingly boundless energy and vitality sufficed both for administrative duties and for creative research. Recognition came to him from all sides. He was made a member of the Soviet's Central Executive Committee (corresponding approximately to the American Senate), and was one of the very few non-communist members of that body. In 1929, he was elected member of the Academy of Sciences of USSR, and in 1931 president of the All-Union Geographical Society and director of the Genetics Institute of the Academy.

World Traveler

The practical problems of the improvement of agriculture in USSR were approached by Vavilov with his characteristically sweeping breadth and vision. He recognized that new and improved varieties of economic plants can be created only by combining together valuable genes. Such genes can be found scattered in the existing varieties, thoroughbred as well as primitive ones, all over the world and, especially, at the "Centers of Origin." A scientific breeder, he realized, must first of all take stock of the available resources, of the genetic raw materals, which will be useful to him in his work. Such a global inventory is completely out of the question for an individual scientist, or for a small group of scientists. But an Institute such as he had built, backed by the resources of a socialist state, could, so thought Vavilov, undertake this historic assignment. Hence, Vavilov and his colleagues journeyed and collected scientific materials in approximately sixty countries in all parts of the world. The scientific and practical value of the collections assembled in the institutions administered by Vavilov was inestimable.

Vavilov himself was probably the most widely traveled biologist of our day. He visited the United States and Western Europe several times, and was personally well known to, and liked by, most of his genetical and botanical contemporaries. But he was also an explorer not afraid to penetrate, with a very modest, not to say meager, financial support, places remote from well-trodden paths. As early as 1916, he had explored Persia, Turkomania and Bokhara. In 1920-1923 he visited various parts of Middle

Asia, including Tadjikstan and Pamir. In 1924 he covered a long and arduous itinerary in Afganistan. In 1925 he went to Khiva. In 1927 he studied the Mediterranean region from Portugal and Morocco to Syria and Trans-Jordan, and made an expedition to Ethiopia and Somaliland. In 1929 he visited Chinese Turkestan (Tarim Depression) and Songaria. Finally, in 1930 and 1932-1933 he traveled and collected extensively in Mexico and in Central and South America. The country which he was unable to visit despite his eagerness to do so was India, because its government steadfastly refused to admit him. Professor H. J. Muller informs me that, by a tragic irony, Vavilov was finally invited to visit India in the fall or winter of 1937. But when this opportunity came at last, he was refused permission to go by his own government, that of the USSR. The results of his activity can be gleaned from the fact that more than 25,000 samples of wheats alone were collected and grown in experimental plantings in various parts of USSR.

Devotion to Science

Vavilov was first and foremost a man of action. His energy, forcefulness, and working ability were marvelous. He was actually able to get along on between four and six hours of sleep per day, and appeared to neither need nor desire any rest or recreation. No wonder that his collaborators considered it as something less than a privilege to travel or to live in his company for many days in succession. Comforts and conveniences counted for little with Vavilov. In the nineteen-twenties, while he was one of the most influential scientists in the USSR, he lived in his office at the Institute of Applied Botany, an oldish leather-covered davenport serving as his bed. His meals were prepared by a janitor's wife, who did not excel in the art of cooking. When he married his scientific collaborator, E. I. Barulina, the new Mrs. Vavilov discovered that the household expenses for the first few months had to be met chiefly from her own salary. His much larger salary had been pledged for assistance to all manner of people, some of them only slightly known to him.

Despite being forced to lead the life of a busy executive, Vavilov neither abandoned his own creative research nor let it be performed in his name by assistants. More than that, he found time to read the current scientific literature, and was always fully conversant with the recent advances in genetics and in agricultural research, which is something very few scientists holding executive positions manage to do. He always enjoyed discussing current research problems with other scientists, even with beginners. But to have the privilege of such a discussion, one was often given an appointment at some altogether unorthodox hour. Vavilov did not have one iota of the self-conscious eccentricity of an eminent man, and his manner of address was equally direct, cheerful, and sincere with his equals and with his juniors.

To Vavilov, all worth-while scientific problems seemed to have bearing on the welfare of the whole world, and, hence, the whole world had to be called on to contribute toward their solution. Almost every publication that came from his pen attests this truly cosmopolitan spirit of its author. He was irresistibly fascinated by grand scales and by the world-wide implications of his ideas. In the words of one of his friends, a fundamental trait of Vavilov's personality was that he disliked quantities of less than a million. And, yet, Vavilov was an ardent Russian patriot. Outside of Russia, he was regarded by some as a communist, which he was not. But he did wholeheartedly accept the revolution, because he believed that it opened broader possibilities for the development of the land and of the people of Russia that would have been otherwise. In October 1930, during a trip to the Sequoia National Park in the company of this writer (and with nobody else present), he said with much emphasis and conviction that, in his opinion, the opportunities for serving mankind which existed in the USSR were so great and so inspiring that for

their sake one must learn to overlook the cruelties of the regime. He asserted that nowhere else in the world was the work of scientists appreciated more than in the USSR.

The Lysenko Controversy

A Congress of Genetics, Plant- and Animal Breeding, attended by about 1400 members, assembled in Leningrad in 1929 under the presidency of Vavilov. Among 348 papers read at this Congress, a fairly interesting but in no way revolutionary study on the physiology of cereals had as its junior author one T. D. Lysenko. A few years later the name of Lysenko was destined to become familiar not only to biologists but to newspaper readers throughout the USSR. He was hailed as the discoverer of vernalization, a process whereby winter wheat can be influenced to produce a crop if sown in the spring. The phenomenon of vernalization had been discovered in the United States years before Lysenko gave it a name; but Lysenko certainly proved himself a master of the art of modern publicity. He claimed, or it was claimed for him, that vernalization inaugurated a new era in Soviet agriculture, permitting, among other things, the culture of cereal crops much farther north than was formerly possible. The vernalization bandwagon was highly popular some ten to fifteen years ago but it is perhaps significant that little has been heard about practical applications of vernalization in the USSR or anywhere else in recent years.

Vavilov welcomed Lysenko's debut; although his published praises of Lysenko sound a bit hollow, he urged facilities for testing Lysenko's ideas. Lysenko was, however, interested in much bigger stakes. Sometime in the early nineteen-thirties, Lysenko formed an alliance with I. I. Present. Present was neither a biologist nor an agriculturist, but a specialist in the philosophy of dialectical materialism; he was also a highly effective polemical speaker and writer, and a possessor of a cultural refinement conspicuously lacking in Lysenko. In 1935 and 1936, Lysenko, Present, and their followers struck. In a stream of magazine and newspaper articles and speeches, they declared genetics to be inconsistent with dialetical materialism and with Darwinism as they construed the latter, and to be, in fact, tainted with fascism and with Nazi race theories. Furthermore, they contended, Vavilov's basing the work of plant and animal improvement on genetic principles had caused inexcusable delays in the successful outcome of this improvement work. Vastly more spectacular, and anyway vastly more rapid, practical attainments would come if only Vavilov's mismanagement and the suspect "Mendelian-Morganian" genetics were supplanted by Lysenko's patriotic leadership and the incorruptibly dialectico-Darwinistic approach.

In 1935 it was a deadly serious matter to be accused of having slowed down the development of agricultural production in USSR. To consider these charges a new Congress on genetics and agriculture was convened in Moscow in 1936, presided over by A. I. Muralov, a high governmental dignitary. The published transactions of this Congress make painful reading. There were Lysenko and Present with a well organized group of followers, pleading, cajoling, and threatening. Several geneticists, among them H. J. Muller, the visiting American, vainly tried to stem the tide against genetics. The least inspiring sight was that of some competent scientists who attempted to sit on the fence or who made unctuous speeches praising both factions. Vavilov himself made two speeches in defense of modern genetics and agricultural science. To judge from the published texts, those speeches lacked Vavilov's customary forcefulness and optimism, as though he felt that the issue had already been decided against him. And indeed, the 1936 genetics Congress turned on the whole against Vavilov, just as the one held in 1929 gave him his greatest triumph.

This rejection of sound scientific principles of established practical value, in favor of a witchcraft supported

only by artful propaganda and by big promises, seems utterly incomprehensible. The subversion and demolition of the work on plant improvement organized so successfully and on such a vast scale by Vavilov undoubtedly caused a setback in the development of agriculture in the USSR. Since, even with the energy of another Vavilov, such an organization could not be restored overnight, this blunder has harmed, and will continue to hamstring this development for some time to come.

No matter what else may be said about their intentions, those assembled at the 1936 Genetics Congress, including a majority of Lysenko's followers, doubtless sincerely desired the betterment rather than the deterioration of Soviet agriculture. This paradox can be understood only in connection with certain peculiar features of the development of biology, and particularly of evolutionary thought, in the USSR.

Genetics and Marxism

Some of these features have recently been analyzed by Hudson and Richens and by Beale.* Without going into detail, it may be stated that Lysenko and Present have exploited for their own ends an old antagonism toward genetics which had existed amongst some biologists but also to a greater extent among the general reading public in USSR. This antagonism arose because of an unfortunate misunderstanding of the meaning and implications of genetics by Timiriazev, a highly respected intellectual leader, and by Michurin, a successful horticulturist. Timiriazev and Michurin regarded the early work of genetics, especially that of Bateson's school, as subversive to Darwin's evolution theory and, in fact, a product of "clerical reaction" against evolutionary biology. The opinions of Timiriazev and Michurin carried, and still carry, great weight not only because of their scientific authority but also because of the political eminence they achieved. Vavilov and the other geneticists in the USSR were, of course, aware of this antagonism, but they hoped that it would be dissipated as a better understanding penetrated the public mind. Lysenko and Present fanned the antagonism to an inferno of contention in their attempt to unseat Vavilov and to grasp his place of leadership for themselves. Accusations of neglect of practical work were combined with indictments for heresy against approved philosophic principles.

In any scientific community individuals are not unknown who try to build their reputations by criticizing the work of others rather than by producing original ideas or work of their own. After the Moscow Genetics meeting in 1936, there was an open season for faultfinding regarding Vavilov's research and organizing activity. Dozens of hitherto unknown authors suddenly discovered that Vavilov's theories of the Centers of Origin and of homologous series in variation were totally unfounded. Worse than that, those theories had led Vavilov to dissipate his efforts by sending expeditions to many foreign lands, instead of confining himself to studies on local varieties in the USSR, which would have resulted in greater practical achievements. Vavilov was also accused of causing plant breeders to rely on the method of sexual hybridization which is practiced everywhere in the world, instead of the method of "vegetative hybrids" proposed by Michurin and Lysenko. Vavilov was told patronizingly by a certain I. M. Poliakov that "it is not necessary for you to bow slavishly before foreign science." And indeed, some breeders in the USSR promptly switched from sexual to "vegetative" hybridization. But Vavilov's worst sin, which negated all his research and practical activities, was his backsliding from canonical Darwinism (as handed down from Darwin through Timiriazev, Michurin, and Lysenko) into the Mendelian-Morganian heresy. This set-

*P. S. Hudson and R. H. Richens, "The New Genetics in the Soviet Union," Cambridge 1946; G. H. Beale, "Timiriazev, Founder of Soviet Genetics," *Nature*, vol. 159, 1947.

ting of Darwin as an incontrovertible authority in opposition to genetics, is one of the weirdest chapters in the unbelievable story of Lysenko's rise to power. The fact that genetics is the foundation of modern Darwinism proved to be no obstacle in the Lysenko-Present campaign.

Downfall and Exile

In August 1939, the Seventh International Congress of Genetics was held at Edinburgh, Scotland, and Vavilov was invited to become its President, thus receiving the highest honor which the consensus of opinion of the world's geneticists can bestow. He accepted the invitation. But less than a month before the Congress was to open, came a letter, signed by Vavilov, which stated that "Soviet geneticists and plant and animal breeders do not consider possible to take part in the Congress," because the latter was to be held outside the USSR. Few if any members of the Congress had any illusions as to whether Vavilov was a free agent when signing this letter. Matters were moving rapidly toward a denouement. In October 1939, a "Conference on Genetics and Selection" was held in Moscow, at which the problems thrashed out at the 1936 meeting were gone over again, with Lysenko, Present, and others greatly expanding their claims as to the theoretical soundness and practical efficacy of their "Darwinism." Vavilov, interrupted and heckled from the floor, delivered what was probably the weakest speech in his life, his attitude being almost entirely defensive, although he courageously reasserted the soundness of the basic principles of genetics. He evidently was already a broken man.

After the 1939 Genetics Conference, a shroud of silence envelops Vavilov. The closing chapter can be reconstructed only from unofficial, fragmentary, but apparently reliable information. Vavilov was arrested, probably in 1940. Part of the time during the winter 1941-1942, he was a prisoner in a concentration camp at Saratov (ironically, it was at the University of Saratov that he held his first post under the new revolutionary regime), and whence he was transported to Siberia. His destination was Magadan, on the Sea of Okhotsk, the capital of a rich gold-bearing region, but a place of sinister reputation, because of its deadly climate and even worse because it was built and operated by forced labor. According to some information, Vavilov was put to work on breeding varieties of vegetables capable of growing in Magadan's climate, but this information is not certain. The release, through death, probably came in late 1942. No mention of N. I. Vavilov's name can be found in the list of living and recently deceased members published by the Academy of Sciences of USSR in connection with its 220-years jubilee celebrated in 1945.

Vavilov's life was connected so intimately with the development of genetics in the USSR, that his martyrdom is not separable from the crisis of the Russian branch of that science. The bold and comprehensive long range program of improvement of cultivated plants inaugurated by Vavilov in the USSR was meant to take more years than were given to it. This program, except for its early fruits, is probably lost. Although the available information is still too incomplete to permit a clear view of the situation, Vavilov is certainly not the only geneticist who fell victim of the wrath of the self-styled "Darwinists." And yet, it is assuredly not true that all genetic research has been suppressed in USSR, as some writers in American journals hastily asserted. To be sure, Lysenko had the temerity to demand that the teaching of genetics be discontinued in all institutions of higher learning in the USSR, but fortunately his influence was never sufficiently great outside the sphere of agriculture. As the uninterrupted flow of publications demonstrates, enough first rate genetic research is now being done to enable the USSR at least to retain one of the places of prominence which it has secured, in part owing to Vavilov's organizing and creative activity, among the nations of the world.