Perspectives

Nikolai I Vavilov (1887–1943)

ILYA A ZAKHAROV

Vavilov Institute of General Genetics, Russian Academy of Science, 119991 Moscow, Gubkin Str. 3, Russia

(Email, zakharov@vigg.ru)

1. Introduction

Nikolai Ivanovich Vavilov was a person of many and varied interests. He was a geographer (the President of the National Geographic Society of the USSR), a geneticist (Director of the Institute of Genetics), a plant-breeder (Director of the Ail-Union Institute of Plant Breeding), and an organizer (the first President of the Lenin All-Union Academy of Agricultural Sciences). He was a person of inexhaustible energy and unbelievable efficiency. During his relatively short life he accomplished a surprising amount: in his expeditions he travelled all over the world, he formulated very important postulates in genetics, he wrote more than ten books, and carried out the gigantic task of organizing a system of agricultural institutions in the USSR.

Beginning in his student years, N I Vavilov studied cultivated plants. His aim was to increase the productivity of agricultural plants, and, thus, to eliminate famine in his long-suffering and huge country.

In pursuing this goal, Vavilov directed his work towards solving two interrelated tasks, the importance of which was foreseen by him already in his early years. The first task was the mobilization of the genetic resources of all cultivated plants and also of their wild relatives, i.e., the identification, study and collection of plant samples in their native habitats. The second task was the conservation of all the diversity of cultivated plants and of their wild relatives (grown in experimental fields and conserved in special storehouses), a diversity that is being constantly diminished with the elimination of natural habitats and primitive agricultural systems, but the involvement of which in breeding is extremely important for securing consistently high yields.

After graduating from the Moscow Commercial College, Vavilov entered the Moscow Agricultural Institute (now the Timiryazev Agricultural Academy in Moscow), from which he graduated in 1910. As early as in his student years, Vavilov showed scientific interests that determined his future lines of research: in 1908 he took part in a student expedition to the Caucasus; in 1909 he made a report on Darwin's Theory; in 1910 he completed and published his diploma work devoted to protection of agricultural plants from pests; in 1912 in his pioneering paper "Genetics and Agronomy" he outlined a program which implied application of genetics to the improvement of cultivated plants. In his paper he considered Mendelian genetics as a scientific basis for plant breeding. Thus, from his very first steps in science Vavilov showed himself as a geographer, an evolutionist and a specialist in plant protection. It is noteworthy that all his scientific interests were interrelated; he was the first to see the possibility and the vital necessity of investigations into cultivated plants from the viewpoint of genetics, evolution and geography. Vavilov managed to implement this scientific synthesis concurrently with his tremendous organizational work in the field of agricultural science.

In 1913–1914 Vavilov worked in the best laboratories of Great Britain (in the laboratory headed by W Bateson), France and Germany. When working in the John Innes Institute directed by W Bateson and in R H Biffen's laboratory in Cambridge, he studied the resistance of wheats of different genotypes to fungus diseases.

In 1916 he went to Iran and to the mountains of middle Asia (the present Turkmenistan and Tajikistan) to study cultivated plants growing there. The task of the expedition to Iran was to establish the causes of poisoning of the Russian soldiers who were at that time in this country. It was found that wheat fields were heavily filled with a poisonous weed and plants were infected with Fusarium. Vavilov collected native cereals (wheat, barley, rye) from all examined territories pointing out their exceptional variability.

From 1917–1921 Vavilov was a lecturer at the Department of Agriculture of the Saratov Agricultural Institute, and in 1918 he became a Professor of this Institute.

There he gave lectures and carried out research into the peculiarities of cultivated plants growing in the region of the Volga and also studied the variability of plants. At that time he made one of his major scientific discoveries – in 1920 he formulated the Law of Homologous Series in Hereditary Variation which made it possible to systematize the data on variation and to forecast the possibility of finding new plant varieties (Vavilov 1922). Vavilov collected a great abundance of material demonstrating that parallel series of variations exist within species of one genus and allied genera of plants (for example, awnless forms are characteristic of different species of wheat, barley and rye). Analysing homology of characters, he pointed out that they could be associated with homology of genes. The problem of homology of genes of different species was almost not developed at all for a long time. However, in recent decades the establishment of gene homology by modern methods has become a routine procedure in genetic research.

Of great importance for Soviet genetics was the organizing work of Vavilov. He set up a Department of Genetics at the All-Union Institute of Plant Breeding in Leningrad. In 1930 he became the head of the laboratory that four years later was reorganized into the Institute of Genetics of the USSR Academy of Sciences. In 1934 the Institute was transferred to Moscow and till 1940 Vavilov was the Director of this Institute (now the Institute of General Genetics of the Russian Academy of Sciences). Many talented Soviet geneticists worked at that Institute, as well as a number of foreign scientists (H J Muller was among them).

Under the guidance of Vavilov the Institute of Plant Breeding carried out a comprehensive study of cultivated plants, their wild relatives and weeds. The collection of plant samples made by him and his co-workers was one of the richest in the world and included 200,000 recognizable forms. Numerous varieties of agricultural plants have been created on the basis of this collection.

At the 1920's and at the beginning of the 1930's Vavilov took part in and organized numerous expeditions to collect and to study cultivated plants. During those expeditions he visited 40 countries and 5 continents (Vavilov 1997). Very many of those travels were risky and difficult, especially those in Afghanistan (1924) and in Ethiopia (1927). For his expedition to Afghanistan the Russian Geographic Society awarded him a special gold medal "For Exploits in Geography".

In 1926, based on his own scientific observations and on the study of the collected materials, Vavilov worked out a theory of the origin of cultivated plants, according to which cultivated flora appeared and were developed within relatively few geographic centers located mostly in mountainous regions (Vavilov 1928, 1992). Vavilov's expeditions were targeted at verification of this theory. Later on, numerous Soviet and foreign expeditions were organized according to his plans. Formulating his theory, Vavilov began speaking, probably for the first time in science, about the "geography of genes", thus laying the foundation for a new scientific direction. Now a great many studies with a wide diversity of objects are performed in the field of gene geography.

Figure 1. Nikolai Ivanovich Vavilov and William Bateson (1925).

The significance of Vavilov's theory has become especially important nowadays, with the occurrence of mass elimination of natural habitats and primitive agricultural systems. Not only specialists in this field but also the public at large have been attracted to the problems connected with the conservation of genetic pools of cultivated and wild plants. The impoverishment or loss of this hereditary potential can cause irreversible damage to all humanity.

The gene bank of cultivated plants created by Vavilov was among the first ones in the world and the most extensive at that time. It is now maintained in the Institute of Plant Breeding in St. Petersburg. At present similar gene banks have been organized in many countries, ensuring successful breeding of new varieties.

The activities of Vavilov were widely recognized not only in the USSR, but also all over the world. In 1926 he became one of the first recipients of the Lenin Prize for his work on the origin of cultivated plants. In 1923 Vavilov was elected a Corresponding Member and in 1929 a Full Member of the USSR Academy of Sciences. He was also a Foreign Member of the British Royal Society, an Honorary Fellow of the Indian Academy of Sciences, the National Academies of Czechoslovakia, Scotland and Germany, a Member of the Linnean Society in London, a Member of the American Botanical Society and of many other national and international organizations.

Beginning in the mid 1930's, the development of biology in the USSR was greatly damaged by the process of Stalin's purges, which also involved science. During discussions of genetics Vavilov was the main opponent of T D Lysenko, who did not recognize the laws of heredity and made political accusations to geneticists. The credo of Lysenko was that (i) there are no genes as special units of heredity, a cell itself as a whole "possesses heredity"; (ii) the characters acquired in individual life are transmitted to descendants. Such statements were unacceptable for geneticists of the second quarter of the twentieth century but Lysenko had powerful backing from the governing body of the USSR.

Discussions were held not only in the press but also at special meetings (especially well-known are meetings in 1936 and 1939). Vavilov was the main speaker at those meetings and he tried to put forward scientific arguments to oppose the unsubstantiated statements of Lysenko. As a result, many talented scientists became political prisoners. In August 1940 Vavilov was arrested and sentenced to death. He spent years waiting for the sentence to be implemented, when it was substituted by 20 years of prison. In 1943 Vavilov died of hunger in the jail of Saratov on the Volga.

A bright testimonial was given by H J Muller who worked in the Institute headed by Vavilov in 1933–1937 in a letter to a Soviet journalist: "He was a truly great man, in very varied respects, scientific, administrative, human. Unlike some exceptional people, he was a thorough extrovert, without any perceptible trace of a feeling of inferiority or persecution or – in the attempt to compensate for them – of superiority. He lost himself in work, service, solving of problems, analysis and integration, perceptivity, and esthetic appreciation. Having wide and deep awareness, he was also more life-loving, life-giving, and life-building than anyone else I have ever known. His efforts and his example have not really been lost".

The whole life of Nikolai Ivanovich Vavilov is a remarkable example of wholehearted devotion to science, to his homeland and to humanity.

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