

Lecture 4

Geography of Plant Domestication: De Candolle, Darwin, and Vavilov

Where did our crops first appear? There are three towering figures concerned with the problem of plant domestication and crop origins. (See **Reading 3-1**, p. 64–72.)

Alphonse de Candolle (1806–1893)

Charles Darwin (1809–1882) 1858 *Origin of Species*

Nicholas Ivanovitch Vavilov (1887–1943)

Alphonse De Candolle (Fig. 4-1)

Renowned Swiss botanist, born in Paris, ranked with Joseph Hooker and Asa Gray among 19th century. Son of a famous botanist, Augustin-Pyramus de Candolle (1778–1841), he took over his father's botanic garden with a vast collection. De Candolle remained a creationist into the 1850s even as Hooker moved towards Darwin's views, and wrote a massive tome on plant geography that assumed the derivation of each species from a specially created individual. He drafted the international rules of botanical nomenclature in 1867.

His most famous book *Origin of Cultivated Plants* (1882) is the beginning of crop geography (see **Reading 4-1** on the origins of apple and **Reading 4-2** on the origin of maize). Many disciplines were used to determine the origin of cultivated plants:

1. Presence of wild relatives;
2. Historical;
3. Names (linguistics);
4. Archeology (limited in De Candolle's time-now a major source of evidence due to carbon dating techniques);
5. Variation patterns.

Although information was faulty, his book is a model of scholarship and continues to be a useful source of information. Note that his book is pre-cytological. This work remains a classic.

Charles Darwin (Fig. 4-2)

Charles Darwin was born on February 12, 1809 in Shrewsbury, England. He was the British naturalist who became famous for his theories of evolution and natural selection. Like several scientists before

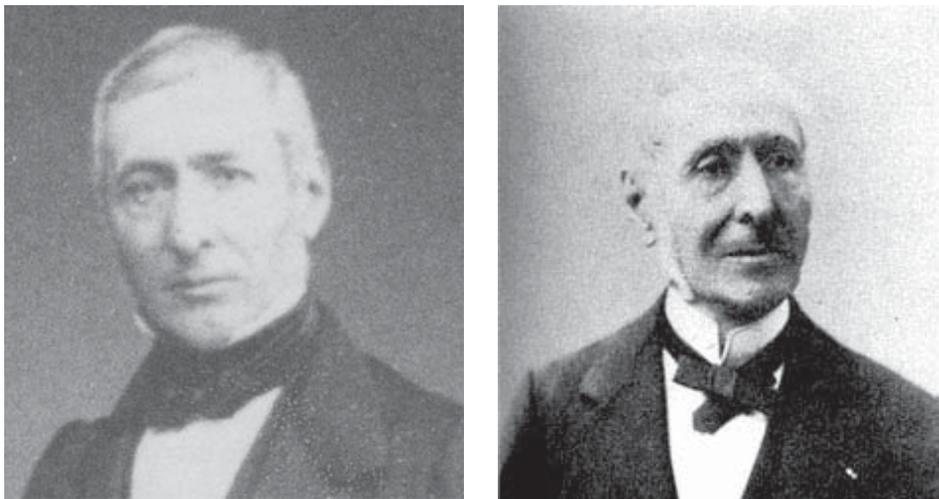


Fig. 4-1. Alphonse De Candolle as a young botanist and at the height of his career.

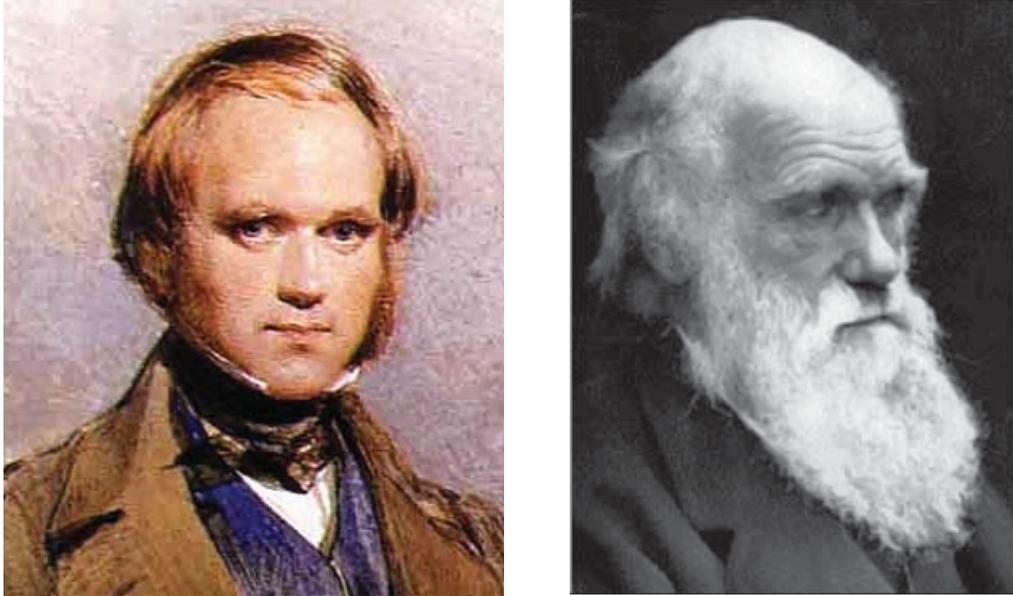


Fig. 4-2. Charles Darwin as a young man and at the height of his career.

him, Darwin believed all the life on earth evolved (developed gradually) over millions of years from a few common ancestors.

From 1831 to 1836 Darwin served as naturalist aboard the H.M.S. Beagle on a British science expedition around the world. In South America Darwin found fossils of extinct animals that were similar to modern species. On the Galapagos Islands in the Pacific Ocean he noticed many variations among plants and animals of the same general type as those in South America. The expedition visited places around the world, and Darwin studied plants and animals everywhere he went, collecting specimens for further study.

Upon his return to London Darwin conducted thorough research of his notes and specimens. Out of this study grew several related theories: one, evolution did occur; two, evolutionary change was gradual, requiring thousands to millions of years; three, the primary mechanism for evolution was a process called natural selection; and four, the millions of species alive today arose from a single original life form through a branching process called “specialization.”

Darwin’s theory of evolutionary selection holds that variation within species occurs randomly and that the survival or extinction of each organism is determined by that organism’s ability to adapt to its environment. He set these theories forth in his book called, *On the Origin of the Species by Means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life* (1859) or *The Origin of the Species* for short. After publication of *Origin of Species*, Darwin continued to write on botany, geology, and zoology until his death in 1882. He is buried in Westminster Abbey.

N.I. Vavilov (Fig. 4-3)

Nikolai I. Vavilov was born into the family of a merchant in Moscow on November 25, 1887. In 1911, having graduated from the Agricultural Institute, Vavilov continued to work at the Department of Agriculture Proper headed by Prof. Pryanishnikov. In 1911–1912 Vavilov did practical work at the Bureau for Applied Botany and at the Bureau of Mycology and Phytopathology of the Agricultural Scientific Committee. In 1913–1914, Vavilov traveled to Europe where he studied plant immunity, mostly with Prof. W. Bateson, a co-founder of the science of genetics.

In autumn 1917 the Head of the Bureau for Applied Botany Robert. E. Regel (1867–1920) supported the nomination of N.I. Vavilov, a young professor from the Saratov Higher Agricultural Courses, as Deputy Head of the Bureau. As Regel wrote in his reference letter, “*In the person of Vavilov we will employ...a*

talented young scientist who would become the pride of national science". Regel's prediction turned out to be true. Since then, all Vavilov's life and creative work have been inseparable from the world's largest crop research institute, into which he transformed the Bureau in the 1920–1930's.

Vavilov continued his investigations in Saratov where he has awarded the title of Professor of the Saratov University in 1918. During the Civil War, from 1918 to 1920, Saratov became the scientific stronghold for the Department of Applied Botany (Bureau till 1917). In 1920 Vavilov was elected head of the Department, and soon moved to Petrograd (St.Petersburg now) together with his students and associates. In 1924, the Department was transformed into the Institute of Applied Botany and New Crops (VIR since 1930), and occupied the position of the central nationwide institution responsible for collecting the world plant diversity and studying it for the purposes of plant breeding.

Vavilov is recognized as the foremost plant geographer of contemporary times. To explore the major agricultural centers in this country and abroad, Vavilov organized and took part in over 100 collecting missions. His major foreign expeditions included those to Iran (1916), the United States, Central and South America (1921, 1930, 1932), the Mediterranean, and Ethiopia (1926–1927). For his expedition to Afghanistan in 1924 Vavilov was awarded the N.M. Przhevalskii Gold Medal of the Russian Geographic Society. From 1931 to 1940 Vavilov was its president.

These missions and the determined search for plants were based on the Vavilov's concepts in the sphere of evolutionary genetics, i.e. the **Law of Homologous Series in Variation** (1920) and the theory of the **Centers of Origin of Cultivated Plants** (1926).

N.I.Vavilov was a prominent organizer of science. In the period from 1922 to 1929 he headed the Institute of Experimental Agronomy (the former ASC) which developed in 1930 into the V.I. Lenin All-Union Academy of Agriculture; from 1930 to 1935 Vavilov was its first president. From 1930 to 1940 he was director of the Institute of Genetics. Vavilov organized and participated in significant home and international scientific meetings and congresses on botany, genetics and plant breeding, agricultural economy, and the history of science. All around the world N.I. Vavilov has gained respect and renown; he was elected member of many academies of sciences and various foreign scientific societies.

Vavilov, the symbol of glory of the national science, is at the same time the symbol of its tragedy. As early as the beginning of the 1930s his scientific programs were being deprived of governmental support. In the stifling atmosphere of a totalitarian state, the institute headed by Vavilov turned into a resistance point to the pseudo-scientific concepts of Trofim D. Lysenko (died 1977). Lysenko introduced the discredited notion that acquired characters could be inherited and took Soviet genetics and plant breeding back 20 years. As a result of this controversy and Stalin's support of Lysenko, Vavilov was arrested in August 1940, and his closest associates were also sacked and imprisoned.

Vavilov's life ceased in the city where his star had once risen. He died in the Saratov prison of dystrophia on 26 January 1943 and was buried in a common prison grave. Nevertheless, the memory of Vavilov has been preserved by his followers. During that tragic period they kept on gathering Vavilov's manuscripts, documents and pictures. Since mid-1950s, after the official rehabilitation of Vavilov, hundreds of books and articles devoted to his life and scientific accomplishments have been published. Memorial displays have been opened in Moscow, St. Petersburg, Saratov, and Poltava. The name of Vavilov is born by the Russian Society of Geneticists and Breeders, the Institute of General Genetics of the Academy of Sciences, the Institute of Plant Industry, and the Saratov Agricultural Institute.



Fig. 4-3. N.I. Vavilov

Vavilov's Contribution to Plant Geography and Evolutionary Genetics

Law of Homologous Series in Variation (1920)

Characters found in one species may be found in another depending on the relationship, a principal useful as a clue for characters remaining to be discovered. Genomics, the science of gene mapping has provided the scientific underpinning for Vavilov's "Law of Homology."

Concept of Centers of Origin (1926)

The **centers of origin** is considered the area of **greatest diversity (Center of Diversity = Center of Origin)**. Furthermore the center of origin of crops contains many wild relatives and is the source of dominant genes (genes that do something). Vavilov proposed both **primary** and **secondary** centers.

On the basis of analysis from hundred of thousands of collections, Vavilov proposed eight primary world centers (See Fig. 5-1). Vavilov emphasized that distribution of plant species was not uniform over the plant growing areas of the earth, e.g. Costa Rica and San Salvador, 1% of US and Canada, possesses as many plant species.

The Primary Centers:

1. Comprise a small portion (2–3% of the land area of the earth)
2. Are geographically distinct being isolated by deserts or mountain ranges.

Vavilov listed 640 species: 5/6 Old World; 1/6 New World

Origin of crop plants is now basic to plant breeding in order to locate wild relatives, related species, and new genes (especially dominant genes, sources of disease resistance).

Jack Harlan (Fig. 4-4) AND O.H. Frankel

Twentieth century figures important in crop evolution and preservation of genetic diversity:

Jack R. Harlan, crop evolution laboratory, Department of Agronomy, University of Illinois, and

O.H. Frankel, CSIRO, Australia. Germplasm preservationist.

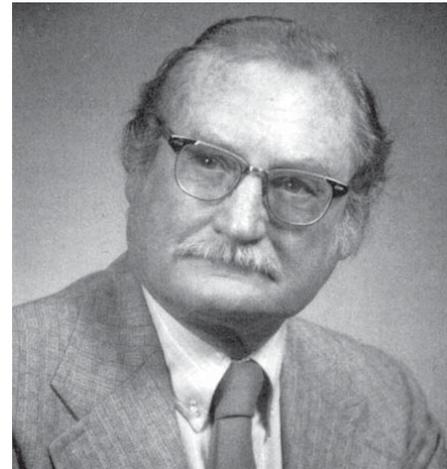


Fig. 4-4. Jack R. Harlan

References

Candolle

www.nceas.ucsb.edu/~alroy/lefa/deCandolle.html

Darwin

www2.lucidcafe.com/lucidcafe/library/96feb/darwin.html

www.honors.ccsu.ctstateu.edu/Honors/EText/Darwin/DarwinTimeLine.html

Vavilov

www.dainet.de/genres/vir/vavilov/vavilov.htm