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Pedology in the USA

Life and Works of C. C. Nikiforoff
(1886–1979)

ALFRED E. HARTEMINK

 Springer

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Alfred E. Hartemink

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*Dedicated to all acts of human kindness,
and to the uninhibited exchange of ideas*

Preface

This book reviews the life and scientific contributions of the pedologist Constantin Constantinovich Nikiforoff—or Niki as he was called by American friends and colleagues. He was a refugee. As a student of Konstantin Glinka, he obtained a PhD at the University of St. Petersburg, but fled Russia after the 1917 revolution, arriving in the USA in 1921. He started work for the University of Minnesota in 1927 and was hired by the *Bureau of Soils* in 1931. He was of the generation of Emil Truog, Jacob Joffe, and Selman Waksman.

Constantin Nikiforoff died a few years before I took my first soil science class. In the late 1980s, I read his paper *Reappraisal of the Soil* [1]. By then it was almost 30 years old but its depth and passion for soil science still stood out. It became one of those papers I revisited time and again, captivated by its elegant prose and convincing argument. There was also a subtle, authoritative undertone that hinted at both vision and erudition. Alex McBratney and I had the paper in mind when we wrote *A Soil Science Renaissance* in 2008, [2] and we included his soil morphology paper in the list of 86 classic papers in soil science [3]. The first time I saw a photo of him was in a soil science history book—his distinctive appearance unequivocally matched his writings [4].

Some years ago, I delved into the history of American soil science and how it was interwoven with the cradle of soil science in Russia and developments across the world. The spread of ideas and knowledge had taken place through international soil conferences, journals, books, translations, individual contacts but not the least through the movement of people [5].

Immigrants played a major role in the emergence of the soil science discipline in the USA and across the globe. Some of them have biographies including the soil microbiologists Jacob Lipman and Selman Waksman [6–9]. Constantin Nikiforoff escaped Russia in 1917; his life and works have received some attention, [10–12] but he is scarcely mentioned in the official historical accounts of the American soil survey, [13], [14] nor was much written about him in the unpublished biography of Curtis Marbut, who hired him in 1931, or in the diaries of Roy Simonson and Charles Kellogg with whom he worked until his retirement in 1957.

In fact, Constantin Nikiforoff helped to transform American soil survey, and he was: “...an example of a migration biography closely linked to the transfer of knowledge in Russian soil science [15].” The prime motivation to write this book was to unearth his life and his contributions in a period in which great strides were made in pedology: advances in soil morphology, formation, classification, and soil landscape relationships. The studies in this book exemplify the fascinating and sometimes groundbreaking work accomplished before the 1960s that is often ignored in literature reviews or overview articles. A further motivation to write this book was that there are so few biographies of pedologists despite the importance and maturity of the discipline.

In writing this biography, I am grateful to Elena Rusakova of the V. V. Dokuchaev Soil Science Institute in St. Petersburg, Carl Rosen and Rebecca Toov of the University of Minnesota, Joe Brannon, Max Ross of NRCS, Mandi Ray, Shelby Callaway and Amy Morgan of the Special Collections of the USDA National Agricultural Library, Laura Jolley of The State Historical Society of Missouri, Allan Lilly of The James Hutton Institute, Pavel Krasilnikov of Lomonosov University, and Dennis Merkel for providing information about Constantin Nikiforoff and the people he worked with. At the University of Wisconsin-Madison, Inna Popova translated some Russian publications, Carol Duffy helped to decipher handwritten letters, and Keith Schiller improved some of the photos. Both Del Fanning from the University of Maryland and Bruce Simonson met Constantin Nikiforoff and shared some of their stories. I particularly would like to thank my colleague and friend Jim Bockheim for reading and checking the manuscript, Pavel Krasilnikov for scrutinizing the historical facts in the first Chapter, and David

Dent for the superb editing of the entire manuscript. Robert Doe at Springer-Nature suggested publication in the Springer Biographies series. It is pleasing to see that a pedologist—and an extraordinary one—is now included in this series.

Madison-Walworth-Zelhem
June 2025

Alfred E. Hartemink

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“Pedologists trying to survive professionally in the 21st century don’t enjoy the freedoms of Constantin Nikiforoff. There are evermore new methods, procedures and rules and regulations to be considered. But directly observing *Living Soils in Living Landscapes* remains ‘the point at the horizon’ for future pedology, providing a much-needed echo at this point in time of the work of Constantin Nikiforoff.”

—Johan Bouma, *Wageningen University, Netherlands*

“Alfred E. Hartemink continues his studies of the beginnings of soil science in the USA by examining the life and contributions of Constantin Nikiforoff. He was a student of Konstantin Glinka, immigrant, translator of Russian literature, soil mapper for the *Bureau of Soils*, and author of scientific papers. The book describes the early history of soil mapping, classification, and geography and Constantin Nikiforoff’s connections to American soil scientists. The book is well-written and richly illustrated.”

—Jim Bockheim, *University of Wisconsin-Madison, USA*

“This is the life story of Constantin Nikiforoff, one of the great pioneers in pedology, who fled Russia to continue his career in the USA. It unearths in detail how excellence of soil science in Russia has benefited developments in the USA. This book is also about digging in the past for understanding contemporary issues. It reads like a novel and is compelling literature for anyone interested in progress in soil science.”

—Jozef (Seppe) Deckers, *KU Leuven University, Belgium*

“Alfred E. Hartemink believes that individuals make a difference to the course of history and, therefore, soil science. He is right. And he brings fiery, passionate and tireless energy and scholarship to bear to convert the rest of us.”

—David Dent, *Former ISRIC Director, UK*

“This is a book for Pedology Thinkers. It couples the virtues of interdisciplinarity to the strong will of obtaining pedogenic evidence and knowledge. This book deserves much applause as it is a biography of the unique Russian American Constantin Nikiforoff, and a compendium of pedological evolution. It travels effortlessly through the emerging field of soil science.”

—Selim Kapur, *University of Çukurova, Türkiye*

“The biography of Constantin Nikiforoff is a comprehensive review of his remarkable accomplishments and legacy in soil science. The book traces his journey from Russia to the USA and highlights his influential work and dedication. Alfred E. Hartemink captures the essence of his contributions to the discipline, making it an insightful read into the life of this renowned soil scientist.”

—Maxine J. Levin, *Chair SSSA Council on History, Philosophy and Sociology of Soil Science, USA*

“Truth is stranger than fiction. You can enjoy the personal history of Constantin Nikiforoff as if you were watching a Russian drama during the revolution, or a Hollywood movie. After reading this book, you will become an eloquent storyteller of Pedology, and it is highly recommended for anyone interested in soil science and its early beginnings.”

—Takashi Kosaki, *Kyoto University, Japan*

“The book is an exciting story, and it reads like a romantic journey for soil scientists. It reviews the career of Constantin Nikiforoff as well as the history and achievements of pedology. Deep digging into early studies and soil scientists teaches us to respect our past.”

—Erika Micheli, *Szent Istvan University, Hungary*

“This marvelous biography reminds me that soils have memories that tend to dissipate over time. Constantin Nikiforoff was important to the early development of soil science and well deserves Alfred E. Hartemink’s scientific account. His book provides new perspectives of early American soil science and in so doing demonstrates the genius and power of 19th century soil concepts that can be designated as Russian.”

—Dan Richter, *Duke University, USA*

“Constantin Nikiforoff played a pivotal role in the evolution of American soil science. He emphasized the importance of understanding soil in relation to the landscapes and systems that form it—not just as an agricultural resource, but as a living natural body. His views played a key role in shifting soil science from a descriptive discipline to one focused on genesis and dynamic processes. His ideas remain strikingly relevant today.”

—Kate Scow, *University of California Davis, USA*

About This Book

Constantin Nikiforoff died in 1979. Little information about his personal life has survived. There was no information on his early childhood and upbringing. During and after the 1917 revolution much was destroyed including archives and information on his studies in St. Petersburg. Most of what we know about his 35 years in Russia is through his publications, what he had told his colleagues at the *Bureau of Soils*, and from eulogies [11], [12], [16–18]. No official curriculum vitae has been found at the United States Department of Agriculture where the *Bureau of Soils* resided. As for personal information, his wife Myrtle died four years before him, they had no children, and no biographic material was saved from their house at Hyattsville in Maryland. Fortunately, there was archival material at the University of Minnesota, at the USDA National Agricultural Library, and The State Historical Society of Missouri that included correspondence with Curtis Marbut, Thomas Rice, Joseph Ellis and several others; and there were his publications, newspaper clippings, and recorded stories.

Between 1928 and 1964, Constantin Nikiforoff published 29 scientific papers and book chapters, six reports and several book reviews in English. Prior to his arrival in the USA, he had published papers and some reports in Russian. For this biography, his papers in English have been reviewed: his work was broad and deep, from musings on the origin of glacial Lake Agassiz, to the formation of Mima mounds, eluviation and neof ormation of clay, to propositions how some soil features should be studied, recorded and interpreted.

Three main objectives guided the writing of this book: to sketch his life and scientific work with a focus on pedology, to review his contributions to the field, and to shed light on the people with whom he collaborated. Biographical sketches are included to lend some understanding of his interlocutors. Where relevant, I have paraphrased freely from letters and publications that provide an authentic view of his style and thinking. Sixty-eight photographs and diagrams, mostly taken from his own publications, are included to illuminate his studies or pedological concepts. Several of his soil profile drawings as well as landscape and street scenes depict how the world appeared during his time.

For most studies, I have tried to say something about the origin of ideas; although it was not the purpose of this book, it puts his work in a pedohistoric context. For instance, his studies on Solonetz or hardpans or his ideas on the concepts of soil formation have been reviewed in detail. Granted these studies from over 80 years ago are likely to have been surpassed by new findings and theories, exploration of past ideas helps us appreciate how we arrived at our current knowledge—and it is remarkable how little some of the topics he worked on have evolved. Lastly, throughout Constantin Nikiforoff's writings there are little dainties of erudite banter that served well in his arguments and made them a delight to read; I have included that banter throughout the book.

So, this book is about the life and works of the Russian American pedologist Constantin Nikiforoff and developments in pedology as he experienced and contributed to it. It is written more or less chronologically. The first chapter reviews developments in Russian and American pedology until the 1920s. Much of the early Russian ideas were groundbreaking and it took many years before they were adopted in the USA—in part because of the language barrier; partly through resistance against Russian works. The second chapter focuses on Constantin Nikiforoff's years in Russia and how he ended up in Minnesota. The *First International Congress of Soil Science* in 1927 was a pivotal moment when he reconnected with his former Russian colleagues and was then hired by the University of Minnesota to conduct soil surveys. In 1931, he started to work for the *Bureau of Soils* and moved to Washington, D.C. Chapter 3 describes his involvement in soil surveys across the country. Chapter 4 broadens the topics he studied including soil formation, paleosols, soil morphology and structure, genetic pans, salinity and alkalinity. His works on Chernozems, soil carbon and climate are reviewed in the Chap. 5. Constantin Nikiforoff retired from the *Bureau of Soils* in 1957 but continued writing, translating Russian papers, reviewing books, and was

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About the Author

Alfred E. Hartemink trained in pedology and soil fertility, holds a M.S. degree from Wageningen, the Netherlands, and a PhD from Reading University in the UK. Since 2011, he has been professor of soil science at the University of Wisconsin-Madison where he teaches Pedology and Earth's Soil. His research focuses on novel ways to explore the soil profile, proximal soil sensors, and the management of soil carbon in natural and agricultural ecosystems. Previously, he was for 12 years at ISRIC in the Netherlands with responsibility for the World Soil Museum and the *GlobalSoilMap* project. Between 1987 and 1999, he worked at research institutes and universities in Tanzania, DR Congo, Indonesia, Kenya, Papua New Guinea, and Australia. From 2001 to 2014, he served as (Deputy) Secretary General of the *International Union of Soil Sciences*. He is the founding Editor-in-Chief of *Geoderma Regional* and the *World Soils Book Series*. Besides his regular scientific contributions, he has written and co-authored short biographies about Konstantin Gedroiz, Vasily Dokuchaev, Emil Truog, Charles Kellogg, Roy Simonson, Jules Mohr, Ferdinand van Baren, and some historical works about developments in soil science.

Books by Alfred Hartemink:

Pedology in the USA. Life and works of C.C. Nikiforoff (1886–1979) (2025)

Soil Science Americana (2021)

The Soils of Wisconsin (2017) with Jim Bockheim

Invasion of Piper aduncum in Shifting Cultivation Systems of Papua New Guinea (2006)

Soil Fertility Decline in the Tropics (2003)

Publishing in Soil Science (2002)

Wildvreemd (1999)

Soil Fertility Decline under Sisal Cultivation in Tanzania (1995)

Alfred edited the following books:

- Sandy Soils* (2024) with Jingyi Huang
The Soils of the USA (2017) with Larry West and Mike Singer
Digital Soil Morphometrics (2016) with Budiman Minasny
Soil Carbon (2014) with Kevin McSweeney
Digital Soil Mapping (2010) with Janis Boettinger et al.
Profiel van de Nederlandse Bodemkunde (2010) with Johan Bouma et al.
Soil Science—4 volumes (2009) with Alex McBratney and Bob White
Digital Soil Mapping (2008) with Alex McBratney and Lou Mendonca
The Future of Soil Science (2006)



1

Russian and American Pedology

*“...Russian soil investigations are worthy
of the careful study of all interested in the subject.”*
US Department of Agriculture (1901)

Soil research in Russia in the 1870s revolutionized understanding of the origin and formation of soil through the works of Vasily Dokuchaev. The new insights came from studies across a large area that combined field observations with laboratory data of soil profiles. A key discovery was that soils had inherited their features and properties from the weathered rock, the climate and the vegetation, or in other words, the soil had a genetic base. The Russian findings and theory spread slowly. In the USA the study of soil had an unswerving, agrarian emphasis, and there was resistance towards Russian ideas. Several immigrants and the Chief of the soil survey, Curtis Marbut, helped in the dissemination and acceptance of Russian soil science in the USA.

1.1 Dokuchaev and the Chernozem

The first soil mapping in Russia was conducted in the mid-1800s for the Ministry of Imperial Domain in cooperation with the Commission on Land Surveys. Soil maps were made but the black soils of the steppes were not shown and how they had formed was a mystery [1]. In the 1760s it had been suggested that their formation was not mineralogical or geological and that they: “...belonged to the other two natural kingdoms, vegetable and animal.” [1] One of the first publications on the black soils was prepared by

Mikhail Lomonosov (1711–1765) who introduced the term Chernozem [2], standing for black and soil, earth or land (*chorny* + *zemlya*). He described relief and surface layers, most of which: “...is occupied by Chernozem, which, if fertilized by human hands for fruiting, is called arable and vegetable land.” It was assumed that the black soils were a geological formation and that they originated from the weathering of black shales, marine silts or lake sediments. Others thought that the soils had developed in the peats of northern regions and had been deposited by ancient floods [2, 3].

The Austrian botanist Franz Ruprecht (1814–1870) travelled across the steppes in the early 1860s and became fascinated by its black soils. He studied some soil samples under the microscope and found tiny structures made of silica and presumed these structures, named phytoliths, were the remains of the roots of the steppe grasses. So, he concluded, the organic matter and the black color of the soils was from decomposed grasses [3]. Franz Ruprecht dismissed the marine sediment, forest or peat hypotheses and viewed the Chernozems from a botanic viewpoint, but his opinion was not widely accepted. According to Konstantin Glinka (1867–1927): “Since Ruprecht had not worked out his subject with sufficient detail, the origin of the humus in Chernozems, even by those who regarded it as of land-plant development, was still given an explanation different from that given by him.....The matter was cleared up by Dokuchaev who published in 1883 his fundamental work.” [1]

Much of Russia’s agriculture was supported by the black soils of the steppes that extended for thousands of kilometers from the mouth of the Danube River all the way east to the Pacific Ocean. The steppes were characterized by a continental climate with hot summers and cold winters. The land north of the steppes was under forest, but in the south where the climate was drier and hotter, the boundary was unclear. In the mid-1800s, across the Russian Empire agricultural land was surveyed, maps were made, and the soils were described and classified. The surveys were paid for by local authorities, and the field crews came from the Institutes for Physical Sciences, and the Physico-Mathematical Institute in St. Petersburg. The surveys were practical but lacked a systematic and theoretical approach [4, 5]. In 1876, a research program was started for a steppe area that covered about 100 million hectares (the size of Alaska). The impetus for the program was the Imperial Free Economic Society and Vasily Dokuchaev, 30 years old and trained as a mineralogist and geologist, received the grant to lead the survey [6]. The other candidate was Pavel Kostychev (1845–1895).

Vasily Dokuchaev (1846–1903) had studied at the St. Petersburg Theological Academy, and he was assigned as a priest to one of the dioceses of

the Russian Empire. But, in 1867, he appealed to the Dean for permission to study at the Department of Physics and Mathematics, and passed his exam in 1871 [2] (Fig. 1.1). At that time, there was much interest in natural sciences following the translation of Charles Darwin's *On the Origin of Species* published in Russian in 1864. From 1875 to 1878 Vasily Dokuchaev worked with others on a soil map of European Russia (scale 1 to 2.5 million) that was based on economic surveys of landowners. During the preparation of that map Vasily Dokuchaev became interested in soils, and he found that a geological approach was more useful for the study of soils than economics. In the summer of 1877, he travelled to the steppes to learn about the Chernozems, which he had not seen before. He travelled about 10,000 km through the area making field descriptions, collecting cores and taking soil samples for analysis in the laboratory. In the early 1880s, he also conducted a detailed study in the Nizhny Novgorod region some 400 km west of Moscow along the Volga River.

These surveys focused Vasily Dokuchaev's geological experience on the study of the soil. By observation and inference, he discovered that the same rock may give rise to different soil characteristics, and that the soil at any location was influenced by the climate and vegetation. He divided the Nizhny Novgorod region into geographical morphologic units, and for each unit he collected information on the soils such as the color and thickness, and on geology, topography, vegetation, climate, and crop yields. In the field, he used letters to denote soil horizons, distinguishing:

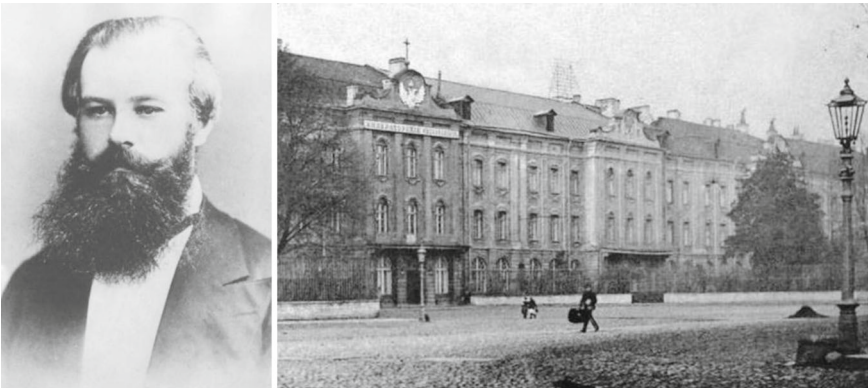


Fig. 1.1 Vasily Dokuchaev (1846–1903) in 1880, and the Emperor's University in St. Petersburg. It was here that Vasily Dokuchaev defended his PhD thesis on 19th December 1883. Some 29 years later Constantin Nikiforoff defended his thesis at the same university

- A. upper or fundamental soil horizon, intensely and homogeneously colored;
- B. lower or transitional soil horizon differing from the upper one in color and structure, and gradually assimilating with the subsoil;
- C. subsoil or parent rock. The upper portions of the parent rock are somewhat altered by soil making processes and therefore, it appears proper to connect them with the soil.

No distinction was made between the topsoil and subsoil, and Vasily Dokuchaev considered both to be part of the soil [7]. After the soils and horizons were described, they were sampled and their chemical and mechanical (texture) properties analyzed. Vasily Dokuchaev synthesized the information, and he disentangled the effects of geology, vegetation, climate and topographic factors on soil properties [8]. He studied the interactions among the different factors and why a particular soil had formed in a particular location. For example, he wondered whether Chernozems could develop under forest, whether loess parent material was essential for their development, and whether the climate had influenced their formation [1]. The report of those field investigations was extended and became his PhD thesis *Ruskii Chernozem* (376 pages) that introduced a novel way of viewing soils and their genetic origin in the natural world [9]. More than 250 analyses of Chernozems were included. He defended his thesis at St. Petersburg University on 19 December 1883, and his official opponents could not have been more distinguished: the geologist Alexander Inostrantsev (1843–1919), and the chemist Dimitri Mendeleev (1834–1907) [2] (Fig. 1.2).

Vasily Dokuchaev's approach of relating soils to the climate and vegetation followed the biogeographical zoning approached introduced by the polymath Alexander von Humboldt (1769–1859). He was not the first to describe and study soil profiles as there had been comparable efforts in Denmark, France and Germany [10–13]. But Vasily Dokuchaev's synthesis was comprehensive, and his research showed that soils were not equivalent to weathered rock, and that a soil was the result of numerous processes in addition to weathering. The soil was more than a chemical medium or a mixture of organic matter and broken-down rock particles—it was a natural body within the landscape. His work brought the study of soils out of the confusion of the geologic, chemical, and agronomic perspective [14]. He combined data and insights into a theoretical framework that could be tested elsewhere. Climate, parent material, organisms and relief were factors that formed the soil, and he considered the action of time and humans less important.

In 1881, Vasily Dokuchaev wrote that soils: "...are the surface laying mineral-organic composition that always more or less visibly colored by

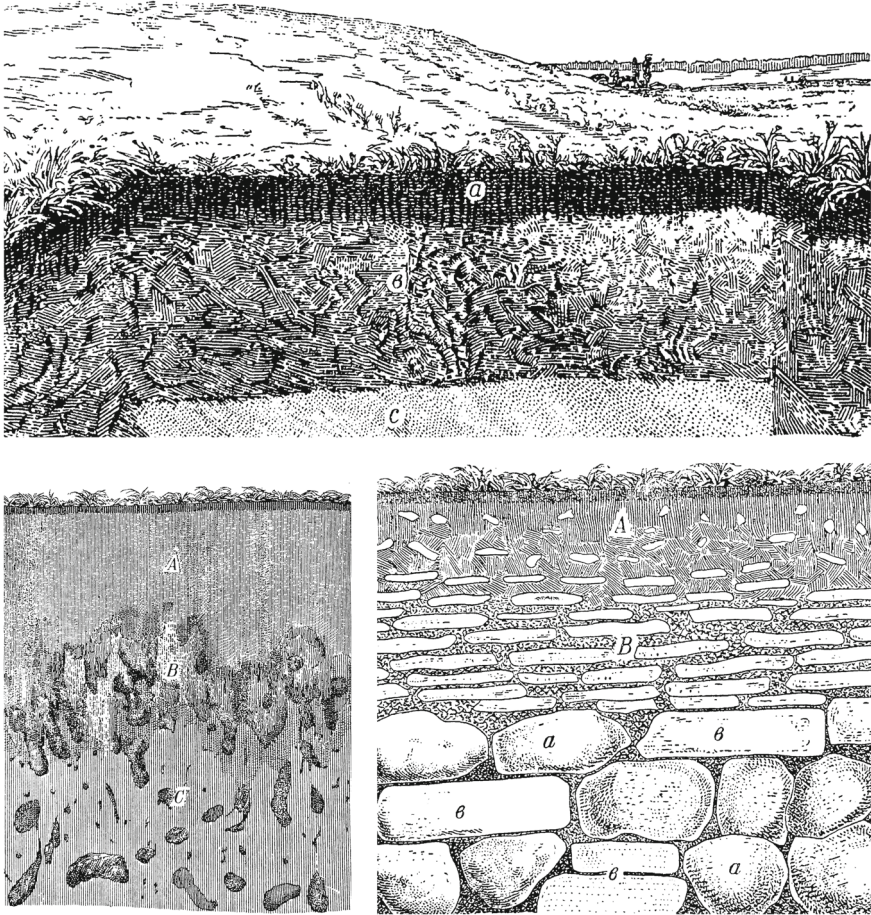


Fig. 1.2 Soil profiles drawings from Vasily Dokuchaev. Top drawing: Soil with sediments from adjacent slopes with a dark grey a horizon of about 15–45 cm thick overlying b typical peat 90–120 cm, over c gray clay with blue tints. Lower left drawing: Uniform dark grey soil of 75 cm thickness (A), over a 45 cm transitional horizon (B), over clay shale, limestone and sandstone (C). Lower right drawing: Soil on the wall of the Old Ladoga Fortress (Staraya Ladoga) on the Volkhov River near Leningrad Oblast, Russia. Drawings from *Chernozem of Russia* by Vasilii Dokuchaev, republished in 1936

humus; these bodies have its origin, they always and everywhere are the result or the total activity of parent material, living and mortified organisms (plants and animals), climate, age of the country and relief of an area.” [15] A few years later he reformulated the definition as: “Soils are the products of extremely complex interactions of the effects of local climate, plant and animal organisms, composition and structure of the parent rocks, topography

and, finally the age of the country, and therefore it is only natural that the investigator must constantly excuse into various branches of science.” [9] The need for soil understanding and information that could be used to tax the user or improve the land was brought to a new level. While the work had a clear practical value, Vasily Dokuchaev stressed that soil distribution had scientific significance, and that there should be a scientific approach to soil studies [8, 9].

There were others who worked on the origin of soil and had different ideas [16]. For example, Rafail Rizpolozhenskii (1862–1921) of Kazan University considered soil as the product of only two primary conditions: organisms and rock. Organisms changed rocks into soil and thus created an environment in which they could survive [6]. Rafail Rizpolozhenskii considered all other factors external conditions. The microbiologist and agronomist Pavel Kostychev (1845–1895) from St. Petersburg also disagreed with Vasily Dokuchaev. He considered that European Russia had two regions: one was the Chernozem region in the south-east under grassland, and the non-Chernozems land in the north and north-west covered with woodland [17]. Pavel Kostychev considered biological processes leading factors in soil formation, and also postulated that plant roots were responsible for the accumulation of organic matter in soils [18]. He emphasized the importance of soil texture over climate in the formation of Chernozems. Rivalry was fueled when Vasily Dokuchaev rather than Pavel Kostychev was selected by the Imperial Free Economic Society to lead the survey across the steppes [6]. It was Pavel Kostychev’s work, not Vasily Dokuchaev’s, that Eugene Hilgard (1833–1916) drew upon in the USA in the early 1900s. Pavel Kostychev later found adherents in Selman Waksman (1888–1973) and Dmitri Vilensky (1892–1960) both of whom underlined the importance of biological factors in soil formation [19–21].

In the long run, Vasily Dokuchaev’s ideas commanded the field. Dmitri Mendeleev wrote to him in 1895 expressing interest in the new field of pedology and thought there was much to do: “...the soil may be described as a corpse in legends, but for us it is a living provider. I regard it as very useful and timely begin teaching this science at universities. I have no doubt of the success, I have certain doubt as regards bacteria, but not for one moments regards soil.” [22] Vasily Dokuchaev died in 1903 at the age of 57 years. He has been as imperative for pedology as Charles Lyell was to geology and Linnaeus to botany [14]. Ever since the works of Vasily Dokuchaev Chernozems have become iconic soils (Fig. 1.3).

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