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Frontispiece: Plate I. – *Solanum acaule* Bitter.

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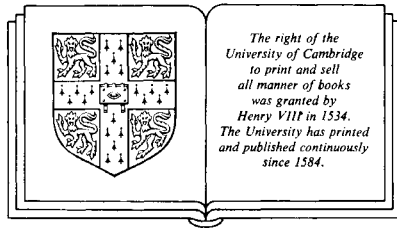
The Potatoes of South America: Bolivia

CARLOS M. OCHOA

Translated by
DONALD UGENT

Color Illustrations by
Franz Frey

*Published in collaboration with the
International Potato Center*



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Dedication

Donovan Stewart Correll

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Foreword

Potatoes, a wonderful food, are found on dinner plates around the world, but where do they come from? What were they like when they grew wild? And what are their wild relatives like? This volume addresses interesting and important questions about the potato by examining the potato and its wild relatives in Bolivia.

Even though the potato was introduced to Europe in the eighteenth century and to North America somewhat later, controversy still surrounds the exact geographic source of the potatoes that first graced European gardens and larders. Surely it was somewhere in western parts of South America, but just where? Part of the problem is that potatoes are not all alike, and they were not always just as they are now. Modern scientific works list about 200 different species of potatoes, most, but not all of which are from western South America. Some writers have shown that even today wild potatoes are undergoing change as they are accidentally or deliberately hybridized with stocks cultivated by farmers nearby. This means that in searching for wild ancestors of the potato, one must look for wild potatoes that may now be slightly altered from those that were first brought into European cultivation four centuries ago.

Scientists differ when it comes to pointing out which wild potatoes most closely resemble the present cultivated potatoes. Although scientific papers have become more precise in describing characters, mechanisms, chemical responses, and breeding behavior of the potato, this has not yet clarified the origin of the cultivated potato. Surely a clear cataloging of the wild species and their distinctions is a first step to assessing the ancestral group and the closest relatives to the potatoes we eat. Such cataloging is part of the science of systematics, or taxonomy.

As the systematic study of the potato has evolved over time, potatoes have been studied by different kinds of taxonomic botanists. At first, general

botanists described potatoes in the course of describing a wide range of plants. Carl Linnaeus described the cultivated potato, *Solanum tuberosum*, in 1753. During the past century, general taxonomists such as D. F. L. von Schlechtendal and Asa Gray each described potato species from the north of Colombia, and Alphonse de Candolle described a species from South America. Perhaps the first specialist on the potato family Solanaceae was Michel-Felix Dunal, who described potato species between 1813 and 1852. But the notion that *Solanum tuberosum* was not the only species in South America did not come into being until the time of Berthault in 1911, and the next great specialist in the family, Georg Bitter, who described many species between 1911 and 1914. These workers all worked with the collections of others, but they were never able to study the plants under native field conditions.

Beginning in the 1920s, expeditions were sent from Europe and North America to study potatoes in the lands where they occur. Among the most noteworthy of these potato-expedition leaders were those that came from Russia, America, and England. Also in this century, botanists, native or resident in areas where wild potatoes occur, some of them still living, for example, Cesar Vargas and Heinz Brücher, studied potatoes and described new species. The results of these South American workers have been largely accepted and incorporated into the taxonomic revisions of the potato group, which were prepared by workers elsewhere. This volume is the first 'magnum opus' to be written by an established South-American expert on potato taxonomy. The author has been publishing descriptions of South American potatoes for over 30 years and actively studying them in the field for much longer.

Much of the germplasm used in this century in breeding better potatoes and in studying the biochemical, inheritance, pathological, and other relationships of the potato has come from material collected by the potato expeditions from Europe and North America. Our descriptions of the group as a whole and of how the species occur in their native lands have also come largely from workers living elsewhere who either made relatively short forays into the source areas of the potato or never came to South America at all. That our knowledge of such an important crop plant should stand on such a limited base is quite undesirable. For the kind of inventory that will really document and analyze the variability, habitats, and geography of the wild potatoes, more continuous surveys are clearly needed. In recent years, the International Potato Center, headquartered in Lima, Peru, has provided facilities and encouragement for such efforts, and the Center's long-standing interest in the taxonomy of native potatoes has made this present work possible.

This volume is the first in a series on the taxonomy of the potato in South America; future volumes are promised that will cover Peru, Ecuador, and other countries as well. The three-country area hosts perhaps one hundred

different potato species. To have this important series about the taxonomy of the potato written by a native and resident of the area is a welcome development. The author has for many years been ideally placed to study the different species and varieties in the wild, under cultivation, and in native markets.

This first volume catalogues the potato species occurring in Bolivia. The wild species are placed in a traditional taxonomic framework, and the taxonomy of the cultivated species is expanded greatly from what has been done in the past. This achievement is based on the author's long-standing and intimate knowledge of the group. The notations on chromosome numbers, taxonomic affinities, distributions, and habitat preferences that appear throughout the book will be most helpful to future workers, as will be the full specimen citations.

Most texts tend to lose something in translation from one language to another; however, for this book it is more a case of two professional potato taxonomists collaborating to create a text based on the work of one of them. Ugent brings seasoned and expert skills to the translation task.

The abundant illustrations add a special utility to this book that is lacking in almost all other taxonomic texts. Clear and diagnostic line drawings, specially commissioned watercolor prints, and photographs of living material of all the species provide a useful illustrated guide to the information given in the dichotomous keys. The photographs of type specimens, and the fact that the drawings and photographs were made by the author himself, engender confidence in the scientific decisions underlying the taxonomy of the group. Colored illustrations tying together the color and shape of tubers of naturally occurring species with the taxonomic descriptions and nomenclature is a novel feature of the book. This should be especially valuable to potato scientists elsewhere who try to assess and diagnose the variability in unusual and important cultivated strains for breeding and other purposes. A series of maps show the distribution of Bolivia's potatoes and climates.

This volume is a milestone for texts published on the wild relatives of any cultivated plant. One looks forward to seeing the following volumes.

W. G. D'Arcy

Preface

Much has been accomplished in the interrelated fields of potato systematics and crop breeding since the appearance of Vavilov's monumental 1935 work on the *Origin, Variation, Immunity and Breeding of Cultivated Plants*. Following the publication of this classic work, scientists from many countries joined the Russians in their efforts to collect, classify, and maintain samples of South American potato germplasm. Especially valued by the breeders of that era were the samples of wild and primitively cultivated potato species that had been collected in the central Andes. This latter region was recognized by Vavilov as an important center of domestication for the cultivated potato.

Although the great majority of germplasm collecting expeditions of the 1930s and early 1940s were organized and carried out by European and North American scientists, an increasing number of the later expeditions were made by South American researchers, most notably from Colombia, Chile, Bolivia, and Peru. One result of these later expeditions was a rather dramatic upsurge in the number of papers published in Spanish. Today, approximately one half of the papers that appear in the fields of potato systematics and breeding carry the names of scientists from Latin American countries.

Despite a spectacular rise in the number of potato introductions that are currently maintained on a worldwide basis by germplasm stations, there remains a critical need for additional collecting. Exploration of the Andean potato zones, and particularly of the remote, isolated valleys of the arid coastal ranges and the moist western slopes of the central cordilleras, will probably continue to rank as an important priority for future investigators.

It must be pointed out, however, that the Andes constitute a formidable barrier for those wishing to engage in plant exploration. Distances between the various potato collecting localities can run into hundreds and even thousands of kilometers, and roads and communication lines are often poorly or not at all

developed. Many mountain valleys and crests are still awaiting exploration by the hardy adventurer.

My interest in the study of wild and cultivated species of potato springs from my experiences as a plant breeder with the Peruvian Ministry of Agriculture. Although I was originally assigned in 1946 to a wheat improvement project, it soon became evident that a more critical breeding situation existed with respect to the leading native root crop of Peru, the potato. This was brought home dramatically to me shortly after my employment began with the Ministry of Agriculture, when the potato plants in the area where I was working, the Mantaro Valley of Central Peru, were destroyed by an unusually early and severe frost. With the loss of the entire Mantaro Valley potato crop that year – and the resultant misery that fell upon its human population – I began the long search for new potato varieties that could improve the economy of the area. Unfortunately, there were no other Peruvian stocks suitable for the Mantaro Valley, nor were there other Peruvian potato breeders who could help me with the problem. Thus, I eventually began to experiment with the breeding of new hybrid potato varieties that had some resistance to frost, this derived from the transference of germplasm from such usually hardy wild species as *Solanum acaule* and *S. bukasovii*. But, the identification of wild forms suitable for these breeding studies was, in the beginning, a difficult task. Few taxonomic studies on the wild and cultivated potatoes of South America were available to me in the mid-1940s, and those that I had were found to have many omissions and errors. I therefore soon realized the necessity for studying both the horticultural and taxonomic characteristics of the plants on hand. In the first instance, this led eventually to the development of six potato varieties that still remain popular in Peru today (Renacimiento, Mantaro, Tomasa Condemayta, Yungay, Cusco, and Micaela Bastidas); while in the second, it led ultimately to the publication of this book.

In my more than thirty years of active botanical exploration of the central Andes, I have attempted to visit the regions that had been little collected by previous workers. My travels have taken me to the high mountains of Peru, Bolivia, Ecuador, Colombia, and Venezuela, as well as to the seaside habitats of wild potato species in south-central Chile and the Atlantic Basin, mainly the territories of Paraguay, Uruguay, and southern Brazil. These South American collections have formed the basis of numerous systematic, cytological, and horticultural papers.

Although many of my dried plant collections are found in some of the world's major herbaria, the living collections of seeds and tubers that I assembled for breeding purposes and for use in biosystematic studies on the Andean potatoes will be stored on a permanent basis by the germplasm bank of the International Potato Center (CIP), with its main headquarters located in Lima, Peru. The identification of the germplasm collections at CIP has been a job

that has occupied my attention since the opening of the Center in 1972. Today, about 90% of the collections at CIP have been classified.

By having access to CIP's excellent facilities and the important world germplasm collections, I have been able to study the phenotypes of plants grown under uniform climatic conditions. As pointed out frequently by other authorities of *Solanum*, Sect. *Potatoe*, it is extremely important to take environmental plasticity into account when revising the species of this group. Often, plants that appear very different in nature are seen to be nearly identical when grown under standard field conditions. Moreover, the growth of plants under uniform field conditions facilitates the study of hybridization, introgression, and ecotypic differentiation. Lastly, I would like to point out that without the above facilities at my disposal, my work on the crossability, fertility, and chromosomal relationships of the various species of this section would probably never have come to fruition.

The present book constitutes the first volume of a series of works that will deal ultimately with all the wild and cultivated potato species of the central and northern Andes. Bolivia was chosen as the first country for study, as its potatoes are not only among the more interesting for the region, but are also the least known.

C. M. Ochoa
International Potato Center, Lima, Peru
Research Associate, Department of Botany
Smithsonian Institution, Washington, D.C.

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C. M. Ochoa

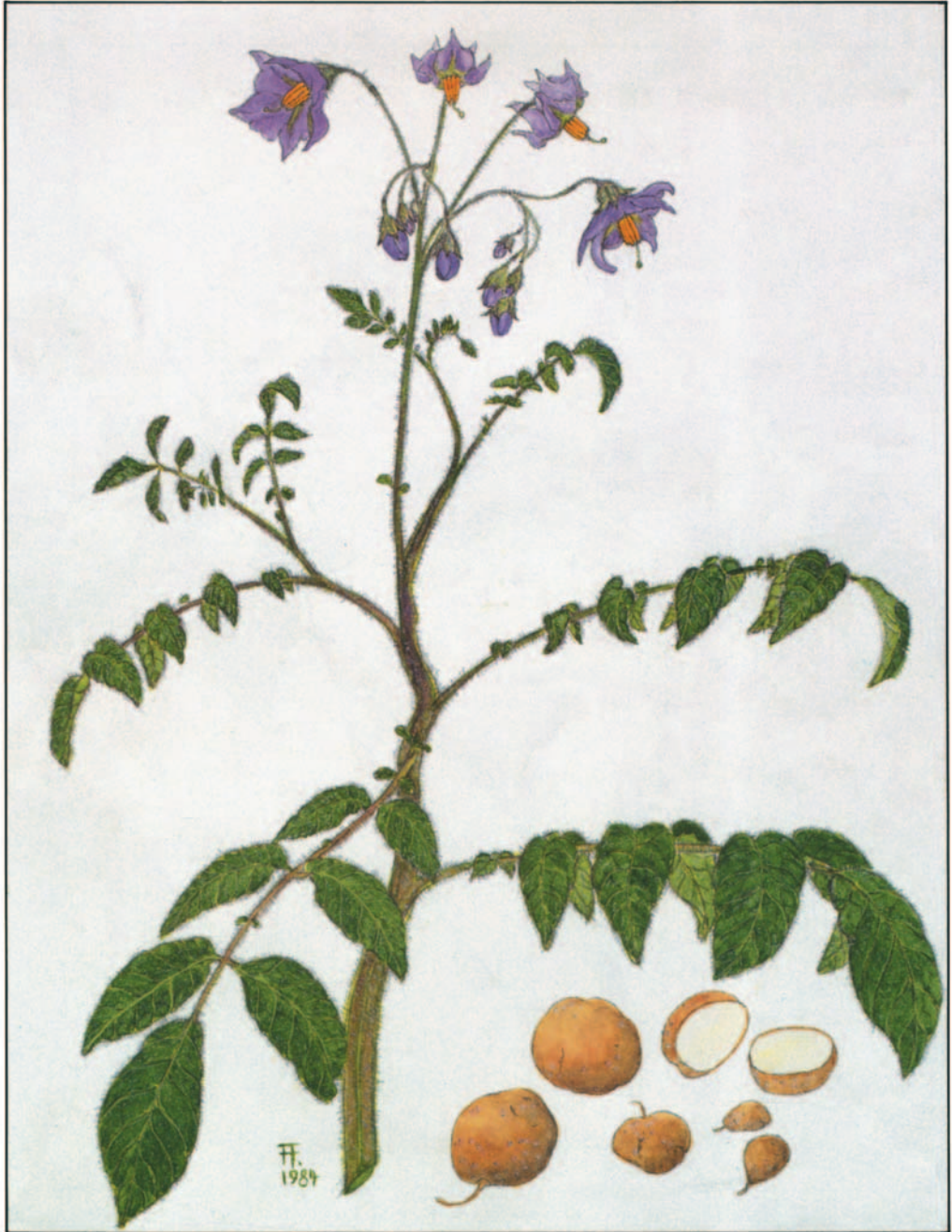


Plate II. – *Solanum berthaultii* Hawkes. (See frontispiece for plate I.)



Plate III. – *Solanum chacoense* Bitter.



Plate IV. – *Solanum litusunum* Ochoa.