

**HUNTING THE WILD POTATO
IN THE SOUTH AMERICAN ANDES**

ISBN

Cover: *Solanum goulayi* Hawkes, sp. nov.

In October 2002 we were invited by Jack Hawkes and Richard Lester to come to Birmingham to help them to sort out the wealth of Solanaceae related material that Jack had accumulated over the many years of his professional career. Much of this valuable material has now been deposited at the Nijmegen University Botanical Garden and at the Department of Biosystematics of the Wageningen University and Research Center. During our stay Jack showed us the manuscript of 'Hunting the wild potato in the South American Andes', and asked us to investigate the possibility of its publication. Back in The Netherlands we started fund raising and we received the financial support of three potato breeding companies, a foundation and a commercial plantgrower. Their sponsorship made this publication possible and we gratefully acknowledge the support of all contributors mentioned below. During the following year Jack and Richard finalized the text and figures, which we prepared for the printer, to produce a book that is fitting memento to Jack Hawkes' lasting contribution to potato science.

Gerard van der Weerden and Ronald van den Berg

Agrico Research BV
Burchtweg 17
8314 PP Bant
The Netherlands
www.agrico.nl

Averis Seeds BV
Valtherblokken Zuid 40
7876 TC Valthermond
The Netherlands
www.averis.nl

C. Meijer BV
Stationsweg 18a
4416 PJ Kruiningen
The Netherlands
www.meijer-potato.com

Stichting Veenhuizen-Tulpfonds
p/a Laboratorium voor Plantenveredeling
Wageningen
The Netherlands

H. Stolk
Voshol 1
2771 NK Boskoop
The Netherlands

HUNTING THE WILD POTATO

IN THE SOUTH AMERICAN ANDES:

**MEMORIES OF THE BRITISH EMPIRE POTATO COLLECTING
EXPEDITION TO SOUTH AMERICA 1938-1939**

BY

J.G. HAWKES



FIG. 28. *S. Ballsii* Hawkes, sp. nov. ($\times \frac{1}{2}$).

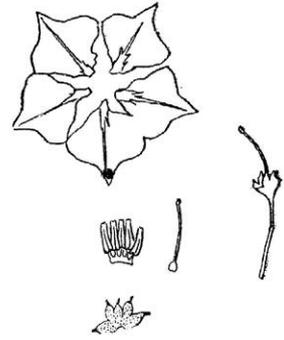


FIG. 29. *S. Ballsii* Hawkes, sp. nov. Floral dissection.

Solanum ballsii Hawkes, named after Edward Balls.

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FOREWORD

The potato (*Solanum tuberosum*) was introduced into Europe in the 16th century from South America, but the genetic diversity was very small, and therefore plant breeders had limited success, especially in their search for disease resistances and wider ecological tolerances. It became obvious that new genes were needed, and that those must come from its area of origin. The Russians pioneered the way with several expeditions in the period 1925-32, specifically intended to collect the diversity of potatoes and their wild relatives; and expeditions from Germany, U.S.A. and Sweden soon followed. The British Imperial Agricultural Bureaux also realised how important such germplasm might be, and therefore planned the British Empire Potato Collecting Expeditions to Mexico in 1938 (Balls and Gourlay) and South America in 1939 (Balls, Gourlay and Hawkes). At that time, Jack Hawkes was starting his Ph.D. research on potatoes at the University of Cambridge when fate dictated that he would become the potato taxonomy expert not only for this expedition but for the whole world. To prepare himself for this he first went to Russia to study with Vavilov, Bukasov and Juzepcuk, which was an adventure in itself, as described in Chapter 1. The rest of this book describes the actual expedition, from when he left England in December 1938 to when he just managed to get back home in November 1939 at the start of World War II. Thus he here describes his experiences in Russia in 1938, and in 1939 in Argentina, Bolivia, Peru, Ecuador and Colombia.

Altogether the British Empire Potato Collecting Expedition to South America made 1164 collections. Subsequently, in Cambridge, Hawkes worked on these materials studying in particular their taxonomy and cytogenetics for his Ph.D. thesis (Hawkes, J.G., 1941. Cytogenetic studies on South American potatoes. Ph.D. thesis, University of Cambridge, U.K. 245 pp.), and he described 31 new wild and 5 new cultivated species of potatoes, though some were reduced later. His first publication was his scientific account of this expedition, and the present personal account of this expedition is number 241. Salient extracts from that first publication (Hawkes, J.G., 1941. Potato collecting expeditions in Mexico and South America. Imperial Bureau of Plant Breeding and Genetics, Cambridge. 30 pp.) and the results of his Ph.D. studies (Hawkes, J.G., 1944. Potato Collecting Expeditions in Mexico and South America. II. Systematic classification of the collections. Imperial Bureau of Plant Breeding and Genetics, Cambridge. 142 pp.) are reproduced in Appendices I and II, all of his publications are listed in Appendix III, and a brief curriculum vitae is given in Appendix IV.

The present account, based on his carefully kept diaries and his lucid memories of so long ago, records fascinating journeys at a time when modern travel by ship, plane, train, lorry, bus and car was becoming possible, but older and less comfortable modes such as on foot, mule or horse were still essential. He recalls many of the interesting plants they found, and observes many other phenomena both natural and artificial. Hawkes' perspicacity, understanding well all that he encountered and making penetrating yet kindly observations of strengths and weaknesses of all persons he met, is remarkable and entertaining. It is fascinating to see his great adventures through the eyes of a young Englishman, who a year earlier had never left his native land, but who 60 years later was one of the most traveled and experienced men in this World, and thus able to add valuable hindsight's to his first youthful impressions.

Richard N. Lester, 13 June 2003

ACKNOWLEDGEMENTS

I appreciate greatly the help of many people and organisations who helped with the expedition or subsequently until the finishing of this book:

- to the Imperial Agricultural Bureaux who funded the Expedition;
- to the Russians Vavilov, Bukasov and Juzepczuk who taught me the essentials of potato systematics and collection of genetic resources;
- to E.K. Balls and W.B. Gourlay, my fellow plant collectors on the expedition;
- to the British Embassy staff and all others who helped the expedition on its way;
- to the indigenous peoples of the Andes who developed and safeguarded the domesticated potatoes over thousands of years, yet let the wild species flourish naturally;
- to R.N. Salaman, my Ph.D. thesis supervisor;
- to my many students and other colleagues who helped me to elucidate the systematics of potatoes, both wild and domesticated, as well as stimulating me to develop the whole field of conservation and utilisation of plant genetic resources;
- to R.N. Lester for helping me to bring the present work to completion, to D.A. Wilkins for painstaking printing of ancient photographs, and to G.M. van der Weerden and R.G. van den Berg for obtaining funds and arranging the actual publication;
- to my dear wife, Barbara, for constant love, companionship and understanding for many, many years, as well as to my children and grandchildren, to whom this work is dedicated.

JGH 2003

PREFACE

Although several books have been written on plant hunting in South America, few of these have dealt with the indigenous crops of the Andes. These mountains form an enormous chain spreading from Colombia in the north to the southernmost tip of Argentina and Chile, in what is known as Tierra del Fuego (Land of Fire - so called by the early navigators rounding Cape Horn, who mistook the Indian camp fires for volcanic eruptions!).

The native tribes of the High Andes evidently invented agriculture quite independently from a similar invention in south-west Asia. Whereas the Old World invention was based on cereals such as wheat and barley, that of the Andes was based on tuber-bearing plants. The potato (*Solanum tuberosum* and other species) was certainly the most important tuber-bearing food plant, though there were others such as *Ullucus tuberosus*, *Oxalis tuberosus* and *Tropaeolum tuberosum* which never established such a world-wide extension as the potato. The potato crop was brought to Europe in the early 16th century and has now been cultivated throughout the temperate and even in some tropical regions of the world. There are also many related wild species of potato, not only in the Andes of South America but also extending from Central America northwards through Mexico and even into the southern parts of the U.S.A.

Many people have asked me why I became interested in potatoes. The 'humble spud' as it is often called, holds little interest to most people until it is cooked and on a plate. And so it had been for me, as a student of botany at Cambridge. How did it change my life?

To begin with, the Director of the Commonwealth Bureau of Plant Breeding and Genetics at Cambridge (Dr. P.S. Hudson), had been translating the results of the N.I. Vavilov Russian plant collecting expeditions, and particularly the ones to Mexico and South America by S.M. Bukasov and S.W. Juzepczuk. They had collected both wild and cultivated potatoes, and Commonwealth potato breeders in Canada, Australia, New Zealand and elsewhere had shown considerable interest in this work. These breeders needed a wider range of genetic diversity to bring a greater resistance to the pests and diseases that attack potatoes in Europe and elsewhere. Wild species related to the potato were known to exist in the western region of the U.S.A., in Mexico and Central America, and in the Andes mountains of South America, where the cultivated potato was thought to have originated.

An expedition to study the fauna of Lake Titicaca in Peru/Bolivia was to take place in 1937, and Dr. Hudson thought it might be a good idea to join it and collect potatoes for our own breeders. He needed an assistant, I applied, and got the job. Life seems to be full of such curious coincidences. However the plans for this expedition did not go so smoothly.

Hudson's health broke down, the Percy Sladen expedition to Lake Titicaca took place without us, and finally it was decided that I should go out to Peru later. The plant collector, E.K. Balls, was appointed as leader of this expedition, after he had been travelling in Mexico in 1938, and he had agreed to go on to South America in January 1939.

This, of course, meant that I had some time to spare until the expedition took place. I studied the potato literature, did some cytological work under the guidance of Dr. David Catcheside, and had long conversations with the world-famous potato historian and breeder, Dr. R.N. Salaman. Dr. Salaman was just about to publish his life-time's work on 'The History and Social Influence of the Potato', and he asked me to verify a number of points in South America, particularly concerning its pre-history. It was well known that the potato was one of the crops, along with maize, cassava, French and runner beans, etc. to have been domesticated in the New World. However, the potato was brought into cultivation in South America, and much archaeological evidence was available in Peru, in which Salaman was interested.

With time still available to prepare myself for the potato collecting expedition I felt that it would be extremely valuable to visit Vavilov, Bukasov and Juzepczuk in Leningrad, especially to find out which particular areas in South America we should concentrate on when we were in the Andes and also to study the materials which they had collected and were being grown out in their experimental plots. Permission was granted and I spent some three weeks in the U.S.S.R. mostly in Leningrad (now St. Petersburg), but with a few days in Moscow, meeting N.I. Vavilov, S.M. Bukasov, S.V. Juzepczuk and V.S. Lechnovicz, and discussing the areas where they thought we should collect.

Several potato-collecting expeditions have been organised in the 20th century, of which the Russian ones led by S.M. Bukasov and S.W. Juzepczuk were the best known up to the 1930's. The British Empire expedition described in this book took place just before the outbreak of the Second World War. Indeed, the author of this book was only just able to reach England by boat after war had already been declared. Many post-war potato-collecting expeditions have since taken place, among them those from the U.S.A., led by David Spooner.

Because the Russians, S.M. Bukasov and S.W. Juzepczuk, had collected in Mexico and the Andes in 1938 and the Director of their institute, N.I. Vavilov, had also travelled in those areas, it seemed useful for the present author to visit their institute in Leningrad and to study their work and learn about their collecting experiences. This forms most of Chapter 1 and attempts to provide an outline of the work and personalities of Vavilov and Bukasov in particular. Vavilov's work and personality were, and still are, known throughout the world.

In his early days he studied with Bateson in England, as well as with Percival at Reading and Biffen at Cambridge. Bukasov was a much quieter personality but he also had collected potatoes in the Americas, particularly in Mexico. Another Russian who had collected potatoes in the New World was S.W. Juzepczuk, who had travelled in the South American Andes, and sent back many examples of the cultivated species. These, then, were the experts whom I was anxious to meet in Leningrad so as to equip myself with the valuable knowledge that they could provide. Indeed, they were extremely friendly and willing to impart all the knowledge of their experiences - an indispensable basis for our British Empire expedition.

I describe my visit to the U.S.S.R. in Chapter 1, because my experiences there were vital to the success of the expedition. I now find myself to be one of the very few people still alive to have met and worked with the world-famous geneticist, N.I. Vavilov. He was a colossus among his colleagues both within and outside the U.S.S.R., both then and now. It was a privilege to have known him, and I think his influence helped to shape my career. It was a tragedy that he died so young.

In the subsequent chapters I describe my experiences during the potato collecting expedition to the Andes of South America in which the previous knowledge of our Russian colleagues was of such great value. Those were the days when we collected genetic resources before that name had been invented; nonetheless my experiences in Russia and South America were of great importance to me in my subsequent career.

It was a great privilege also to have travelled and collected with Edward Balls - a kindly decent man whom everyone liked - a Quaker who had a gentle understanding of people. He helped to smooth off the rough corners of my personality and taught me by his attitude to people and circumstances how to deal with many of life's problems. I owe a great deal to him and shall never forget his warm-hearted kindness and consideration to me.

Edward was also accompanied by William Balfour Gourlay who was a gifted amateur botanist and horticulturist of independent means. He often came along with us on field excursions from Cambridge in the summer vacation courses and was known to us students as "Uncle Bill". He, also, was a first class expeditionist, never grumbling, even under the most harsh conditions. Edward and Bill together had collected ornamentals in Turkey and several other Mediterranean countries, as well as in Mexico in 1938 before coming to South America.

I hope you will enjoy joining me on my journey of yesteryear to distant, unique and beautiful lands.

J.G.Hawkes
Birmingham 2003



MAP I

Route of the British Empire Potato Collecting Expedition in South America. The thick black line represents land and sea travel, the dotted lines show travel by aeroplane.

CHAPTER 1

EXPEDITION PLANNING: MEETING VAVILOV

Early Days

As I mentioned in the Preface, the leader of our potato-collecting expedition, Edward Balls, was an experienced plant collector with virtually no knowledge of potatoes. Whilst I, as a raw recently graduated student, knew very little about potatoes, apart from what I had learned from the well-known potato expert, Dr. R.N. Salaman, about European varieties. This was to act as a valuable background. Nevertheless, I had no experience of collecting potatoes in South America, or much knowledge of them either.

It thus seemed important to try to learn about South American potatoes from the Russian experts who had acquired first-hand experience of potato collecting in Mexico and the Andes mountains. I asked permission to visit these Russian experts from the Imperial Agricultural Bureaux, who agreed with the idea. So it was arranged that I would visit Russia to study for a few weeks with the world-famous geneticist, N.I. Vavilov and his colleagues S.M. Bukasov, V.S. Juzepczuk and V.S. Lechnovicz.

This was to be an experience that changed my life in many ways, and I shall never forget the kindness shown to me, particularly by Vavilov and his colleagues at his Leningrad Institute. From the beginning, I was treated as a learned colleague, rather than a somewhat raw young student. It did a lot for my ego, but at the same time left me feeling extremely humble and privileged to have learned so much from these Russian experts.

Dr. Salaman had previously been sent a few samples of Peruvian potatoes by a Czechoslovak priest, Padre Soukup, who taught in a religious school by the shores of Lake Titicaca, in southern Peru. So, I was able to take some of these with me to Russia as a gift. This impressed the Soviet authorities, as we shall see later. Thus, in August 1938 I was ready to set out on a journey to Russia - one that made a lasting impression on me as a young man, 23 years of age.

Russian Experiences

In 1938 it was not considered advisable to travel to Russia by train through Germany, and clearly the age of universal air-flights had not yet begun. However, in those days there was, unbelievably, a regular passenger/cargo sailing from London bridge to Leningrad by a Soviet steamship line. I booked a passage on the "Felix Dzerzhinsky" and embarked on 20th August, 1938.

My fellow passengers were mostly British communists or at least Soviet sympathisers. However, their efforts to cement Anglo-Soviet friendships with the crew met with frosty receptions. The crew were just not interested I thought at the time, but with hindsight I think that they were more likely to have been afraid of being spied on by Soviet informers. In addition there were some Russians on holiday, returning from their consular and trade mission work in Britain.

The voyage passed quickly enough, since the ship took a direct route across the North Sea, through the Kiel canal and across the Baltic Sea to Leningrad.

The food was very basic, but weak vodka cost only threepence per glass! I spent the whole voyage listening to the life histories of the other British travellers and in general being told what a paradise Russia was, compared with England - at least for the workers, it was explained. I was also told that communism leads to a greater freedom of expression. How naive these communist sympathisers seemed to be in hindsight.

After six days on board we arrived in Leningrad and went through the usual meticulous customs examination. I was taken to the Hotel Europa and after lunch met Dr. S.M. Bukasov, who had previously collected potatoes in Mexico and South America. I was then taken to the Lenin Academy of Sciences where I met the world-famous Professor N.I. Vavilov. After some general conversation I was taken by taxi through Pushkin (formerly Tsarskoe Selo), then past Queen Catherine's Summer Palace and on to the potato field station named Krasnyi Pakhar (Red Ploughman). Here, together with V.A. Lechnovicz and his wife Voskresenskaya, I began to study South American potato varieties in the field, getting to know the Russian collections of Vavilov, Bukasov and Juzepczuk. Bukasov spoke German and Spanish, so I had problems in understanding them. However, on later, post-war visits, after I had learned Spanish in South America, we could converse with each other freely. My later counterpart in the Vavilov Institute was Ludmila Gorbatenko, and we were also able to converse and correspond in Spanish, which we used as a *lingua franca*. Lechnovicz, however, spoke good English, and so did Vavilov.

Andean potatoes possess what is called a "short day photoperiodic reaction" which means that they are adapted to form tubers only under a short, twelve hour day-length. In order to get yields here during the long summer day length of Leningrad the Russians had constructed a series of little huts on wheels, running on metal rails. These were pulled over the plots to reduce the day length to ten hours. Tests for yield were later carried out.

After a somewhat tiring day in the field I was taken at about 8.00 P.M. to visit Vavilov in his Leningrad apartment (he had another in Moscow and a house in Pushkin). We talked about Lysenko and his strong criticism of Mendelian genetics; Vavilov did not seem to be at all upset at Lysenko's rejection of his results, saying that he (Lysenko) had done good work in wheat vernalisation, which was true, of course. Vavilov also applauded Lysenko's work on potato "degeneration" in warm climates, which to us in the west was already known to be due to virus infection, as Salaman and Kenneth Smith had shown in Cambridge. Lysenko was supposed to have "cured" degeneration by growing potatoes in the earlier cooler parts of the year, or on the Baltic coast. I suggested to Vavilov that this lack of "degeneration" had been shown in Britain and elsewhere to be due to a lack of or reduction in the aphid vectors that spread the viruses. Vavilov seemed impressed and talked (in Russian) to Bukasov about it.

Apparently, Lysenko, recognised only three authorities: (i) Darwin, (ii) Luther Burbank, and (iii) Timareizeff. I would imagine that Darwin might not have cared much for the honour bestowed on him by Lysenko.

I was surprised that Vavilov did not feel more antagonistic towards Lysenko, since I certainly found Lysenko, when I was introduced to him later, a dangerous and wholly repellent person. He was a politician rather than a scientist, and very much able to ingratiate himself with the communist politicians in Moscow. Here was, they thought, a Soviet man, born an unlettered peasant and now the sort of "first-class" scientist that the communist system had created. However, to return to the account of the visit, I dined with Vavilov in his Leningrad flat that night and got to know him better.

He was a large, jovial, hospitable and friendly person, putting me at ease and talking to me as an equal about his work and that of his colleagues. Vavilov conceded that Lysenko had done well with his vernalisation work, and indeed he had received general acclaim for that. However, Vavilov seemed surprised to hear western views of potato "degeneration" being due to virus infection, rather than to the bad effects of a warm climate on a plant naturally adapted to cooler conditions.

Vavilov, as is well known to western scientists, had collected plants, particularly cereals, legumes and grasses from all over the world, and especially in Middle Asia, China, the Near East, the Mediterranean and Latin America. The seed collections from these expeditions were of course being used to breed better adaptation and yield into Soviet crops. It was always a source of amazement to westerners that the Soviet government could find so much money for funding Vavilov's expeditions and for testing and evaluating the seeds he had collected. My friend and colleague, Max Nicholson, provided what may have been the answer. He had asked the same question of Vavilov at a Soviet Embassy reception some years ago in London. Vavilov answered that he had seen Trotsky standing in a bread line in Moscow, which apparently was done by the "Nomenclatura" from time to time to show solidarity with the proletariat. Vavilov insinuated himself into the queue just behind Trotsky and struck up a conversation about his extremely important wheat and barley collections and their breeding value. Evidently Trotsky was impressed and told Lenin about them. Hence, it was postulated that Lenin supported Vavilov's work financially for this reason. Now, however, in 1938, Lysenko was in the ascendance, and was obtaining more money for his work than Vavilov, who was always being harassed by the government for more practical results.

We stayed talking until the early hours so that on the following day Bukasov did not call for me at my hotel until 2.00 P.M., though 11.00 A.M. was the time agreed. We worked on the plots at Krasnyi Pakhar until 8.30 P.M. however, and had long discussions about diploid, triploid and tetraploid potatoes in which I learned a very great deal. After more discussions with Vosskresenskaya on her pet theme of flowering potato tubers, I was taken to Vavilov's apartment at 10.00 P.M. Fine, said Vavilov, let's go to the Opera. Naturally, it was half over, but we took reserved seats in the middle of the front row of the dress circle. We listened to an opera the title of which I never understood, sung in Georgian with a Russian verbal interpretation at the beginning of each act. It sounded very melancholy, and had an incomprehensible plot. However, it was a great experience for me to be treated as an honoured guest by such a world-famous scientist. It seemed like a dream, in fact.

The following day, 28th August, I was supposed to be ready at 8.00 A.M. and whereas on previous days the people were two or three hours late, of course that day when I overslept, they were punctual. I was taken by Dr. Govorov in Vavilov's car to have breakfast with him and Vavilov. Vavilov showed me a press cutting stating that "Dr. J. Hawkes, vice-director of the Imperial Bureau of Plant Genetics has come to Russia in the "Felix Dzerzhinsky" to inspect Russian genetical research and has brought some valuable specimens of potato tubers for the Russian geneticists." It was true that I brought some potatoes with me that had been sent to us from Peru, but my position in Cambridge had been very much exaggerated since I was not yet a Doctor and not even employed by the Bureau! However, no doubt this would have impressed the Soviet Government, and in any case my visit was an official one, sponsored by the Imperial Agricultural Bureaux.

That day, Vavilov showed me his amazing wheat collections at Pushkin from all over the world, with every conceivable type growing there.

The collections from China showed awnless wheats and awnless barleys also, which led him to believe that in certain areas parallel or converging evolution had taken place. On this and other evidence Vavilov explained to me his Laws of Homologous Series. He talked a great deal about primary centres of cultivated plant origins, bound up with the rise of civilisations, and secondary centres of evolution in other areas where crops had been introduced later.

We also examined the flax collections and breeding plots, in which he and his associates were trying to combine tall-stemmed characters for fibre production with large pods and seeds for oil production. He discussed at length the use in breeding of rare and surprising flax variants from Turkmenistan and the progenies which did not show the sort of variation expected, but something of a heterotic effect with much higher yields than the parental ones. After lunch at Vavilov's Pushkin house I was taken to the potato plots at Pushkin, again by Bukasov, who showed me his hybrids of cultivated potatoes with the wild frost-resistant species *Solanum acaule*. There were some five acres under potatoes here at Pushkin, five at Krasnyi Pakhar, fifteen at the polar station and fifteen more at the Caucasus Station.

I also met the world-famous cytologist, Karpechenko, who was working with colchicine, and hence very close to my Ph.D. thesis work. Lutkov, Karpechenko's assistant, was studying the effects of colchicine on flax. We also looked at the work on the rubber-producing dandelion, *Taraxacum kok-saghyz* which gave a latex with up to ten percent rubber. I never found out whether this work led to commercial production - quite possibly it did. I was also shown Razumov's work on potato grafting, under the control of Lysenko. I did not find anything of much significance in this work, though the propaganda component was quite strong.

This had been an extremely gruelling day, but at least I was able to return to my hotel at a reasonable hour. August 29th looked as though it was going to be another tiring day, and I was again taken out to the experiment station at Pushkin. Here I was shown plots of alkaloid-free lupins in the morning, of which the seeds tasted like ordinary peas. This was followed by lunch with Vavilov again. After this, we went to Krasnyi Pakhar to learn some more facts about potatoes with Lechnovicz. We took herbarium specimens for the Cambridge collection of the new Russian cultivated potato species. I learned to my naive surprise that Russian scientists did not seem to have any interest in politics. Looking back on it I think they were very wise, since most of them, having kept quiet, seem to have died of old age, whilst others, more vocal in their views, were not so lucky.

August 30th was a so-called rest day, though in fact I took the opportunity of going on sightseeing tours to the Hermitage, the Winter Palace and the Peter and Paul Fortress, as well as the Kazan Cathedral, the Admiralty building, the former Stock Exchange and other features of interest in what I still believe to be the most beautiful city in the world. At that time I was going through a phase of architectural modernism unfortunately, and was more impressed by Palaces of Culture and other communist atrocities. However, one changes one's views as one grows older.

On August 31st I was back at Krasnyi Pakhar again, learning about potatoes, and in particular the tetraploid *S. andigenum* of which large collections were made by Bukasov and Juzepczuk. Lechnovicz, who showed me these potato varieties, thought that the tuber-bearing *Solanum* species should be separated into a new genus, *Papa* (named after the Andean Indian word for them). Fortunately, so far as I know, this idea was never published.

Vavilov came to the farm at 8.30 P.M. when we were just about to leave and took me to his home for supper.

Again, he talked far into the night about the unscientific Lysenkoist tirades against "Mendelism-Morganism". Lysenko apparently considered all the results of geneticists as merely an expression of averages, naturally obtained. What a tragedy that Lysenko was allowed to publish such rubbish and regarded so highly by the communist government. However, over supper we mostly talked about potatoes; Vavilov told me that he would not be satisfied unless I brought back at least twelve new species! Of course, looking forward a little, I did indeed describe quite a number of new species and varieties. I also sent subsamples of nearly all our living collections from South America to Vavilov and Bukasov.

On 1st September Bukasov and I went to the Botanic Gardens (Komarov Botanical Institute) to meet his colleague S.W. Juzepczuk, who had collected cultivated potatoes in the South American Andes. The Institute of course possessed a very large herbarium, and it took an hour before we managed to find him! He gave me a list of interesting places to visit in Peru, and particularly the region between Cuzco in southern Peru and around Huancayo in central Peru, at about the latitude of Lima. Juzepczuk also suggested that we should collect in Bolivia and north Argentina as well as north Peru. During the 1939 expedition we took Juzepczuk's advice, with the exception of northern Peru, which I was not able to visit until many years later.

After lunch Bukasov took me to Vavilov's Institute. This was housed in the old building of the Czarist Ministry of Agriculture just close to St. Isaac's Cathedral, in Herzen Street, formerly Bolshaya Morskaya (Great Maritime Street) and now restored to this name after the collapse of the Communist system. At the time of my visit this world-famous Institute was named the All Union Institute of Plant Industry. Now it is renamed the N.I. Vavilov All Russian-Scientific Research Institute of Plant Genetic Resources, but it had suffered several name changes during the interim period.

This was my first visit to the Institute Building, with sections for all crops in a maze of offices, laboratories, staircases and corridors. I was then taken into the Staff Common Room to meet many people, whose names I instantly forgot, except one, the now infamous V.S. Lysenko* - . He struck me as a dangerous, bigoted personality, entirely wrapped up in his own ideas. I had a long discussion with him, telling him that our scientists (some of them very sympathetic to the U.S.S.R.) had tried to repeat Lysenko's work and they were unable to obtain the same results. Lysenko's classic reply was: "I am not surprised; you live in a bourgeois environment": How could I answer that? I expressed these views later to Vavilov, but he only replied (perhaps cautiously?) that Lysenko had some new ideas which he should be allowed to develop.

On the following day, 2nd September, Vavilov, Bukasov, Juzepczuk and his son all called for me and took me out to Pushkin. On this occasion Juzepczuk gave me a list of his travels and the places where he made his collections - a very useful adjunct to our forthcoming expedition. At Pushkin Vavilov showed us his wheat collections and spoke at length on his ideas on the taxonomy of cultivated plants. Apparently Vavilov thought that the time had come for a revolution in thought and method, replacing the old taxonomy by a "differential method of form analysis". The same method should also apply to the cultivated tetraploid potato species, *Solanum tuberosum* and *S. andigenum*, Vavilov thought.

* - I met him again in 1956 in Moscow after Vavilov's death when he was Director of Vavilov's Genetic Institute.

This method seemed to me to be a highly complex system of species, subspecies varieties, sub varieties, etc which really (in hindsight) seemed to me to complicate rather than throw light on the materials under study. Thus, when I later described and classified my own collections of potatoes I followed Vavilov in establishing far too complex a system. Much later I had to simplify this drastically. These ideas of Vavilov, however, were published in his Chapter of Julian Huxley's edited work entitled "The New Systematics". His complex system of splitting large widespread species into a series of smaller ones has not survived. Juzepczuk, it must be noted, had previously worked on the apomictic forms of the genus *Hieracium* (Hawkweeds) in which each form "breeds true" because the seeds are in fact produced asexually. Thus, any number of small or "microspecies" have been described. Potato species, on the other hand, are sexually reproducing and show different combinations of characters at each generation, unless they are propagated from asexually produced tubers. *Solanum andigenum* has now been "sunk" within *S. tuberosum* as a subspecies, since they have the same chromosome number and are completely interfertile.

After spending about an hour in Pushkin we motored to Pavlovsk where we had breakfast in a station waiting room and my first half litre of Russian beer, which I found to be quite good. We continued on to Krasnyi Pakhar where I did some photographing of wild potato species. I was still unable to convince Lechnovicz that "degeneration" of potatoes was due to virus infection, and that in the south potatoes do not "degenerate" if planted early enough in the season to avoid aphid infections. Up to then, however, there had been no entomologists or virus specialists working on this problem at the Institute. We returned to Pavlovsk in a very ramshackle lorry and then on to Leningrad by train. At the hotel I was met by a Miss Wilm of VOKS [later INTOURIST] with tickets for the opera. This time it was Prince Igor by Borodin, with Fokine dances - a marvellous performance and much more understandable than the Georgian one that I saw with Vavilov.

On 3rd September Bukasov, Lechnovicz and I visited the Ministry of Agriculture building across the road from the Institute of Plant Industry. There we studied herbarium sheets and analyses of starch, sugar and protein contents of the various potato species. Vavilov came in later and told me of the arrangements he had kindly made for me in Moscow, where I was to go by overnight train, starting that evening.

4th September. Arriving at Moscow the next day I was met by Dr. Asseyeva from the Moscow Potato Institute. Leaving my bags at the hotel we drove straight out to this Institute, some twenty five kilometers south of Moscow at Korenevo. Although Dr. Asseyeva's English was not as good as that of Vavilov and Lechnovicz I found that I was easily able to understand her. I was shown the methods of testing for late blight (*Phytophthora*) resistance, very similar to those used in England. One of Dr. Asseyeva's colleagues, Dr. Felipov, showed me photographs of Lysenko, who was clearly Felipov's hero. Potato grafts were exhibited to show not only the influence of the scion on the stock, but the inheritance of such influence. I have to say that I had considerable doubts about the levels of scientific accuracy of this work. Asseyeva showed me her "mutant" potato varieties produced from adventitious buds where the potato "eyes" had been removed. Claims of red to purple tuber skin were made and vice-versa.

Unfortunately, on returning from the fields to the Research Station I was immediately asked to give a lecture on British Agriculture, about which I knew very little. However, I somehow managed to struggle through it.

On learning about our views on viruses the ardent Lysenkoists took up the gauntlet, resulting in a really heated argument with much standing up and shouting and arm-waving for at least half an hour. The rather bewildered interpreter was quite unable to translate all this for me.

On 5th September Vavilov, who had also travelled on the same train to Moscow, took me to see his new Institute of Genetics and to visit the laboratories, with glasshouses attached to them - the first time such an Institute had been built in Russia it seems. Vavilov was enormously pleased about this. A discussion with the Bulgarian cytologist, Dr. Kostoff ensued, particularly concerning his use of colchicine in the production of tetraploids and octoploids in the tobacco genus *Nicotiana*. He had also synthesised the domesticated species, *N. tabacum* from its putative ancestral forms.

Vavilov explained to me a new scheme of the diversification of certain wheats, legumes, flax, etc., whose greatest complexity was in Asia Minor. From this area forms had spread into Asia, Africa and Europe, as is now widely accepted. Again, he discussed the law of Homologous Series in relation to disease resistance. A careful analysis of different forms of edible legumes from Asia showed that during the domestication process dominant colour genes tended to be lost. The reverse seemed to be the case for size and edibility. This was, he thought, a demonstration of the process of plant domestication, one of loss, the other of gain. I returned to my hotel in Vavilov's car with Kostoff, who was on the one hand happy about all the facilities and assistants available to a scientist in the U.S.S.R., but on the other was unhappy about not being allowed foreign travel to attend conferences. He also found it dangerous to criticise Lysenko's views, and had learned to keep quiet. Only Vavilov had the courage and the position to voice such criticism, he said.

On 6th September, since my hotel was just on the other side of the river from the Red Square and the Kremlin, I was able to watch youth parades of some three million people. However, for some unexplained reason we were not allowed to approach the windows for a distance of some six metres. This was a rest day, so no scientific visits had been arranged. I left at 9.15 P.M. on a night train, returning to Leningrad, and the following day visited Museums and Art Galleries as it was also a day of rest there. I could not understand why there appeared to be two days of rest, one after the other, but I think the one in Moscow may have been just a 'Youth Day'.

September 8th was spent in Leningrad with Bukasov at the Institute studying herbarium specimens. I returned to the hotel with some stomach infection, but at 5.30 P.M. a press interview had been arranged for me. A reporter from "Pravda" asked about my impressions of the U.S.S.R. in general and about life in Cambridge. His questions were searching and when I could not answer questions about politics, wages, salaries, etc he seemed quite amazed at my ignorance. The reporter was also interested in my criticisms of Lysenko's work, or so he said. Furthermore, he asked whether I would write an article about the opinions of British scientists on Lysenko's work, which would be published in Pravda.

The following day (9th September) seemed to be a rest day (yet again?) for people at the Institute. I took sightseeing tours, visiting a knitting factory, a creche and the Peterhof Palace of Peter the Great with its gardens, fountains and waterfalls. In the early evening at the hotel I settled down to write my "Pravda" article and sent it to the Intourist guide, Miss Wilm, who later came to see me with the reporter, Comrade Petroff. They seemed very pleased with it and told me that it would be translated and printed in "Pravda" and that they would send me a copy of the newspaper containing it.

This of course never happened, or at least if it was printed I never received a copy. I believe now, that this was just a ploy to engage my sympathy for the communist system. Like many young people of that period I was interested in what we used to call the Soviet Experiment, and the so-called 'Popular Front' against fascism.

We were at the same time worried about the rise of fascism in Germany, Italy and Spain. The U.S.S.R. spoke of itself as a country which resisted fascism and in that way tried (often successfully) to enlist the support of young people in the Western Democracies. I, however, was so disgusted with the support by the communist government of Lysenko's pseudoscientific work that my initial sympathy for the USSR had considerably diminished.

On 10th September, my last day in the U.S.S.R., I visited Vavilov at his Institute in Leningrad and told him about my requested article for Pravda. He laughed and said he did not suppose for one minute that they would publish it, which seemed to be so, as I would find out. Vavilov told me that he had made complete ecological surveys of Russia for agricultural purposes so that crop selections could be tailored to each area, using the genetic diversity available in his collections. I was interested to know how the seeds in his very large world collection remained viable, and this was at a time when physiological research on seed preservation was still some thirty years into the future. He told me that, with a very large number of assistants, the seeds were re-sown every three years according to the habitats in which they were originally collected. This was made possible by means of the vast network of substations established by the Institute throughout the U.S.S.R.

Vavilov was hoping to attend the International Genetics Congress in 1939. He asked me to tell his genetics colleagues such as Haldane and Crewe, that if he appeared offhand it was not due to him but to difficulties with the Government. Vavilov's budget was still maintained and even increased, but there was continued fighting between him and the Lysenkoists which made relations rather strained in Government quarters. Lysenko, of course, could do no wrong in Government eyes and had already been made President of the Lenin Academy of Sciences, with Vavilov only Vice-President. Thus Lysenko's influence went on increasing, with Vavilov constantly struggling to keep his Institute going but finding it more and more difficult to do so. As we found out later, Vavilov was imprisoned in 1940 on some kind of charge, and died in 1943. Now he is held in very high regard and his Institute bears his name.

I said my final good-byes to Vavilov and his colleagues and returned to my hotel. There I found Miss Wilm waiting for me, together with Mr. Petroff of Pravda, who had commissioned my report but of course would never publish it. After some preliminary conversation, I was shocked and dismayed when Petroff asked me whether I would consent to act as an informer - in other words, to be a Soviet Spy. He and his colleagues had recruited several Cambridge scientists, (Blunt, Burgess and Maclean) as is now well-known. When they saw that I was horrified by the suggestion they said that "of course" I would not be asked to inform them about my fellow-countrymen.

I am glad that I found the will-power to resist their arguments and thus to save myself from becoming entangled in a horrible network of lying and subterfuge that would have inevitably followed.

This was not a very happy way of leaving the Soviet Union, but I held firmly in my mind the friendship, warmth and scientific honesty of Vavilov, Bukasov, Lechnovicz and other colleagues at the Leningrad Institute. I still treasure those feelings to this day, more than sixty years later.

Back in England

Because my Soviet visa had expired, I needed to return a different way from my outward journey, and one which provided some training of a sort for the expedition later in the year. On the evening of 10th September I took a train from the Finland Station to Helsinki, arriving there by sleeper on the morning of the 11th. I explored the town and admired the architecture until the afternoon when I took the train westwards for Turku, stopping at every small village on the way. From here I took the night boat to Stockholm, with a wonderful smorgasbord supper in the evening.

The boat arrived in the early morning, giving me time to go to the station to leave my bags and arrange a sightseeing tour of Stockholm, including a complete precis from the guide on Sweden's people, life and work. A night train took me through southern Sweden to Gothenburg, across the Kattegat to Denmark and then to Copenhagen. After some sightseeing in Copenhagen I took another train to the North Sea port of Esbjerg. Here, I embarked on a ship bound for Harwich, then took a train to London, and finally another train to Cambridge. This travel was clearly rather exhausting, but since one can sleep on the trains and boats in between it was not so hard as it seems. In fact I did that in reverse on another visit to the U.S.S.R. after the war - but that - as they say - is another story.

By and large, I found my visit to the U.S.S.R. extremely interesting and rewarding. Apart from getting to know Vavilov, whom I admired tremendously, I learned a very great deal about potatoes. I tried to use the Russian taxonomic system for cultivated plants when I returned to South America but found it cumbersome and, in the end, of very little value. The Russians were, what we now call, taxonomic "splitters". Every small variant was given some sort of taxonomic rank and name, which was a rather tedious way of building up an understanding of the diversity and promoting the use of the material in plant breeding. Apart from that, however, the vitality, enthusiasm and capacity for hard work of Vavilov and his colleagues was extremely impressive, and I have treasured the memory of my visit throughout the rest of my career. Whilst Lysenko has sunk into deserved neglect, Vavilov's world reputation is as strong as ever, and likely to remain so for a long time to come.

CHAPTER 2

THE VOYAGE OUT AND EXPEDITION PLANS IN PERU

In these days of long distance air travel it seems hardly possible to understand that in 1938 it took four weeks to journey by boat from England to Peru, whilst now it can be done in less than twenty four hours by high-speed jet aeroplane. I embarked at Liverpool on 17th December on the Pacific Steam Navigation Company ship "Oropesa" and did not arrive at Lima until 13th January 1939. This bare statement makes the trip sound very tedious, but in fact it was quite the reverse. One relaxed, made friends, talked and listened to fellow voyagers endlessly, and in fact took the whole trip as a wonderfully relaxing holiday.

The ship took cargo, as well as passengers, and many of these passengers were doing what is now so popular, namely, taking a luxury cruise. In this case it was a three month cruise from Liverpool to Valparaiso in Chile, returning in March and missing the worst of the British winter weather. To entertain us the Purser provided dancing and music every night, interspersed with fancy-dress balls, Christmas and New Year celebrations and many other festivities besides. I, like a complete fool, had thought this trip might be rather like the one to the U.S.S.R., and had packed only expedition clothes and a couple of rough tweed suits. I was embarrassed to find that the ladies wore evening dress at dinner and the men wore either dark lounge suits or dinner jackets. The fellow guests at my table noticed my embarrassment and without asking lent me dinner jackets, starched shirts, black bow ties and much more besides. So all went well.

Time seemed to slip by quickly, with deck games and swimming as well as endless chatting, so that I was told innumerable life histories, and warned by all and sundry not to believe a word those dreadful Russian communists had told me on my previous trip. I must confess that I often had bad twinges of conscience about all this enjoyment during what was supposed to be a serious scientific expedition. Even so, I comforted myself by thinking that the expedition had not yet begun and that I had not had a summer holiday in 1938; so I pushed my uneasy conscious to the back of my mind, well out of the way!

Apart from the passengers who were just on a cruise there were also several Jewish refugees from Nazi Germany, hoping to make new lives for themselves in South America. I got to know them well and to sympathise with their stories of oppression and degradation. These were the lucky ones, though; mainly business people who had managed to buy their way out somehow or other, unlike so many who were sent to the gas chambers during the holocaust. Mixing pleasure with what I persuaded myself was work, I spent many happy hours with a pretty Peruvian girl, improving my rudimentary knowledge of Spanish. She had been staying in France with her grandmother, who was returning to Peru with her. When the conversation became too personal she, with remarkable powers of hearing, always thought she heard her grandmother calling for her. Looking back, it was probably just as well.

Although we had set out from Liverpool in icy weather, with snowstorms beating down on us in the Irish Sea, by the time we had got out into the Atlantic the weather quickly changed. By 24th December it had become really warm and after Bermuda the rest of the journey was in subtropical to tropical climates. We were in Bermuda by 30th December and there for long enough to take a tour of the island. I was amazed by a group of birds swimming around like ducks, but which turned out to be Bermuda Penguins.

We were at Nassau in the Bahamas on 2nd January and taking a tour of Havana in Cuba the following evening. These were pre-Castro days when life (for the tourist at least) was one long round of bands and night-clubs in a perfect climate. With my conscience now almost stifled to death I was able to enjoy all this. After all, I needed a break before the undoubted hardships of the expedition, I decided.

We called in at Kingston, Jamaica, but were not allowed to disembark for a tour. On 7th January we arrived at Colón, the port at the Caribbean end of the Panamá canal, and there was also time to have a look round Cristóbal at the Pacific end. Of course, I realised later, that these cities were named in honour of the discoverer of the New World (as the Americas were named by him) no less than Christopher Colombus (in his Anglicised name). In Cristóbal I had my first sight of a tropical butterfly which I took to be a bird to begin with, and with a wing span of at least seven or eight inches. The canal itself, with its surroundings of tropical forest, was astounding, but we sailed through it all too quickly. Out in the Pacific Ocean and passing Balboa (named after the first Spaniard to see the Pacific - not "stout Cortes" as the poem goes), with Panamá city following, on the other side of the ship. We caught a glimpse of the Ecuadorian coast at mid-day on 10th January and arrived at the oil port of Salinas in Ecuador.

On 11th January we came to Paita, in northern Peru, where the coast is completely dry and pale brown (as it is throughout Peru and northern Chile also). Indians came out in their boats, selling fruit (avocados, bananas), Panamá hats, silver bangles, coloured woven cloth and interesting pottery. These pots were copies, more or less, of the Moche and Chimu pots of long-dead civilisations. Some were in the form of maize cobs (no potatoes unfortunately), some black, some brown, with different coloured geometrical patterns. We left just after midday.

Although the coast was dull and uninteresting the sea birds were absolutely amazing. They flew in immense flocks, often so low that their wings seemed to touch the ocean surface. They settled also on the rocky islands whose surfaces were thickly covered with their white droppings ("guano"). There were clearly very many different kinds of birds, mostly white, but there were particularly interesting albatrosses, having a wing span of some four feet or more and brown or black plumage with a pale yellow bill. They seemed to be completely effortless flyers, gliding along in groups of twenty to thirty birds in perfect unison.

At about 11.30 P.M. on 12th January we docked at Callao, the port for Lima. Again there were many sea birds and several guano islands. We did not disembark that night as it was too late.

On 13th January at 8.30 A.M. I was met by E.K. Balls and W.B. Gourlay, my fellow expeditionists. The expedition, I felt, had at last really begun. In fact, it had not, because there were many arrangements to make before we set off on our potato collecting activities on 19th January.

In Lima we could hardly have had better connections. Because we were financed by the British Government in the form of the Imperial Agricultural Bureaux, we had an extraordinary amount of help from the Embassy. Also, because Bill Gourlay was a cousin of Mr. Balfour, local representative of the British Export/Import Company, Milne and Co., we were feather-bedded by them also. We were met by a Mr. Williams from the company, also by the British Vice Consul and by a Mr. Gregg, Secretary to the British Minister.

I should have said that Balls and Gourlay had arrived the day before from their Mexican expedition, so all arrangements for the three of us were being made at the same time. We just stood around whilst customs formalities were waived and we strolled about until all was set for us to get into the Embassy Limousine. From being VIPs then, we just went down and down once we had left Lima. It was nice while it lasted, but it gave us the idea to begin with that everything would be at the same level. It was certainly not, as we were soon to learn, once we got up into the Andes.

At that time, Callao was quite separated from Lima by a dry sandy plain with one or two ancient mud-brick pyramids here and there. Now, unfortunately, it is all one enormous conurbation. Where there is irrigation water, flowering trees and shrubs grow everywhere and are extraordinarily beautiful. Where there is no water, all is dry sand and mud.

During the first afternoon we explored the old city of Lima, with its ancient balconied houses, churches and cathedral. The houses had stone porticoes and some of the churches and the cathedral were extremely ornate. We also visited Mr. Archie Balfour, and a Mr. Brown of the Peruvian Corporation. General expedition plans were discussed also.

I described to Edward Balls and Bill Gourlay my experiences in Russia with Vavilov, Bukasov, Juzepczuk, Lechnovicz and others. Juzepczuk's advice was probably the most important, because he knew Peru and thought that no proper potato collection expedition had ventured further south.

We decided then to travel quickly southwards as far as north-west Argentina, and from there move northwards, little by little, collecting as we went. A difficult decision was - how far south should we penetrate before starting on the actual collection work? We finally decided to go as far as Jujuy, the northernmost province of Argentina, with a quick dash further south to Salta where I had read from George Bitter's works that there was good material of what he called *Solanum simplicifolium* subsp. *gigantophyllum* to be found.

As I learned later, there is an enormous diversity of wild potato species further south in the Argentinian provinces of Tucumán, Catamarca and other parts of Salta. The problem would then have been that if we stayed too long in Argentina we should not have had time to do extensive collecting of cultivated potatoes in Bolivia and Peru. After all, we were commissioned to collect cultivated potatoes mainly, and there are very few in Argentina. Also the time factor was important, because the growing season south of the equator ends more or less in May. Therefore we decided to go no further south than northern Argentina. Mr. Gregg at the British Embassy in Lima was a keen cinematographer, using 16 millimetre film, as I proposed to do. In fact, 16 millimetre Kodachrome had just come onto the market, so I bought a good supply of that for future use. It has still retained its colour now, nearly sixty years afterwards.

After doing some shopping, Edward Balls and I went into the Cathedral where the special display was the semi-mummified remains of Pizarro, the Conqueror of Peru, lying in a glass-sided coffin, set in a chapel completely covered with Italian mosaics, representing various biblical scenes.

I had never entered or even known much about Gentlemen's Clubs, but Archie Balfour "put us up" (as they say) for the Phoenix Club in Lima, where we had tea with him.

I began to feel rather uncomfortable (that conscience again) with all this high life in Lima, but this was not all. The following day (Sunday) we were invited by Archie Balfour to spend the day with him and his wife at his house in Chosica in the Andean foothills, east of Lima, and on the road to Oroya in the central Andes. The valley had well-marked irrigation canals along its sides some twenty to thirty feet up, taking water from the river Rimac higher in the valley. Everything below the canals was a riot of greenery, with cotton fields and flowering trees and shrubs. Everything above was a completely dry, barren desert.

All the land around Chosica when irrigated had a tropical luxuriance of plant life that was quite amazing. The house and grounds had been bought from an Indian, who had dug up bones and gold ornaments (the latter sold long ago in Lima). Archie Balfour had excavated several pots ("huacos" as they were called in the Inca Quechua language) made in the form of heads and perfectly moulded and painted. We saw many like these later on, displayed in the Ethnological Museum at the suburb of Magdalena Vieja. The woven textiles in that museum were quite breathtaking in their rich colours and patterns.

Mrs. Courtney Forbes, the wife of the British Minister, invited us to lunch on 17th January. Also present was Bennet Gregg, Secretary to the Minister, and a Miss Johnson, who went off on vast treks into the interior, painting and taking photographs. After lunch Mr. Gregg took us to see the ruins of Pachacamác, about fifteen to twenty miles south of Lima, on the coast. More mud brick pyramids appeared as we were motoring along, all considered still to be holy places [huacas] by the Indians. The ruins of Pachacamác are situated on a hilly promontory jutting out somewhat into the sea, and although this city was conquered by the Incas it was still said to be flourishing when the Spaniards arrived. We found it to be a heap of desolate ruins, with vast graveyards in which the tombs had been desecrated by grave robbers seeking treasures. Human bones were lying all over the surface, together with remains of mummy cloths and pottery. There was a large stepped pyramid with plastered and painted panels, most of which had been destroyed. The colours of these panels were various shades of yellow and buff, a rich red and an eggshell green, with pictures of fish in the designs, as well as birds and trees.

The following day, 18th January, was quite hectic, getting visas, packing our kit and, later, going to a cocktail party in the early evening, arranged for us by Mrs. Courtney Forbes. Here we had the great privilege of meeting the world-famous botanist, Professor Augusto Weberbauer who had worked all his life with the plants of Peru and had published a book on the plant geography of that country. He was too old then for field collecting but had helped the Goodspeed *Nicotiana* (tobacco) collecting expeditions in the early 1930s.

Another person whom I had been hoping to meet in Peru was Fortunato Herrera, who, together with E. Yacovleff had written a scholarly work on the plants of ancient Peru: "El Mundo Vegetal de los Antiguos Peruanos".* - As well as a very wide range of plants, they had described potatoes and other tuber crops also. Herrera was a quiet softly spoken man who talked about the crops themselves and the clay models and paintings which the ancient peoples had made, not only the Incas, but ones long before them. He deserves to be better recognised in the future for this work.

** - Herrera had also published articles on the Flora of Cuzco in southern Peru, and as part of this he listed and described the various types of potato found there.- Altogether, he distinguished thirty-seven "sweet" varieties and twelve "bitter" ones, all with their quechua names.

This would be useful to us later, of course, since we could ask for these varieties in the markets, using the names provided by him. He was kind enough to present me with a copy of this work, which I have long treasured.

* - Yacovleff, E. and Herrera, F. El Mundo Vegetal de los Antiguos Peruanos. Published in 1934-5 as a separate issue from the Revista del Museo Nacional, 3, 243-332; 4 (1), 29-102.

** - Herrera, F. (1921) Contribución a la Flora del Departamento de Cuzco. Universidad de Cuzco, Peru.



03 Feb. 1939. Bolivia, view from Viacha of snow capped Illampa mountain range, and the Altiplano with cultivation ridges and furrows.



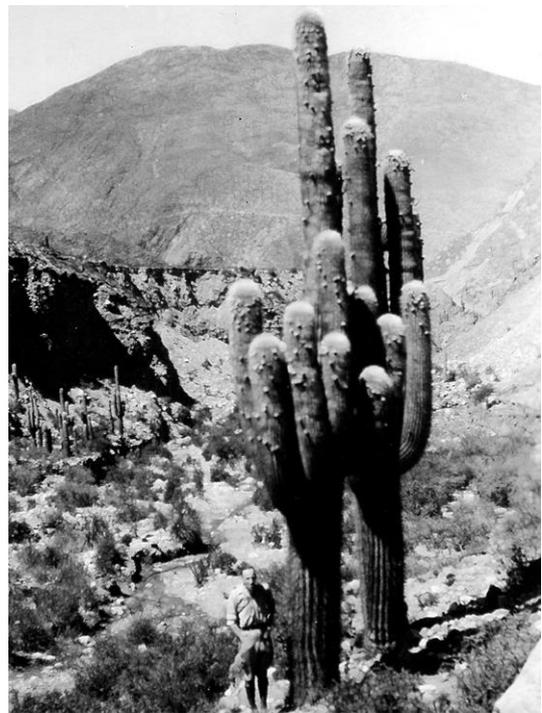
04 Feb. 1939. Bolivia, going towards Villazón, between Atocha and Tupiza; rugged dry valley, flat river bottom and railway embankment.



08 Feb. 1939. North Argentina, near Salta, San Lorenzo; *Solanum microdontum* plant.



08 Feb. 1939. North Argentina, near Salta, San Lorenzo; *Solanum microdontum* inflorescence.



09 Feb. 1939. North Argentina, Tilcara, near Alfarcito, 2750 m; giant cactus (*Cereus* sp.) and Edward Balls.

CHAPTER 3

FROM PERU TO ARGENTINA

I find it difficult to decide exactly as to when the potato collecting expedition really began. Lima seemed on the whole to be just an introduction, where we made our plans and contacts, sorted out our luggage, obtained our visas, and at last were ready to set off. Even then, the first part was yet another boat trip - this time going due south to the port of Mollendo. From there we would take a train to Arequipa and then up again to Lake Titicaca in the high Andes.

We sailed southwards down the Peruvian coast on 19th January in a American ship whose name I do not remember. It was very clean, with large cabins provided with tables, chairs and plenty of cupboard space, but nothing in the way of entertainment. Those happy days had gone for ever! The following morning we drew in close to the guano islands and the usual brown and grey barren hills.

At our destination, the port of Mollendo, there was a great sea swell running. There was no harbour as such, and we got off into tenders which rose and sank in the swell with a difference of some six feet or more. So, one had to step off the gangplank sharply at just the right moment. A similar experience awaited us at the quay, with an even greater swell. A crane sent down a little chair, so again we had to jump quickly onto it or miss until the next time that the boat came to the right level. I remember that Bill Gourlay sat on the chair while Edward, the Consul and I hung on to the rungs. We were then hoisted up and deposited on the quay - a hair-raising experience, but no doubt quite a usual occurrence for the inhabitants of Mollendo. Even so, we had to get seventeen pieces of luggage taken off too.

Mollendo was then a small and dirty town with cobbled streets. The railway up to Arequipa, Puno and Lake Titicaca started from here, so it was very important for getting goods and supplies up into the interior. For me it was really the beginning of the expedition, leaving behind the luxuries of Lima and the ships on which we had travelled. Now the really hard and exciting part was about to begin. Even here, though, we were still feather-bedded, in the first class coach of a British-owned railway company, with comfortable swivel seats and large windows.

To begin with, the train ran along the sandy barren coast southwards for about fourteen miles, and then entered the Tambo valley, climbing steadily between the irrigated fields of sugar cane, cotton and alfalfa. Still climbing, we got into a region of mist with columnar cacti, bearing brilliant red flowers, then various Compositae shrubs and herbs with orange and yellow flowers. By the side of the track there were red-flowered *Salvias*, a heliotrope species, a fleshy Nolanaceous plant and a *Solanum* with fleshy leaves. The mist extended from 750 metres to about 1,200 metres and then totally disappeared, together with all the plants which had depended on it for moisture.

We then reached the level plain of La Joya with its extraordinary crescent-shaped dunes, all pointing in the same direction. The main formation of the plateau is of a coarse brownish lava sand, too heavy to be blown by the wind. The dunes are light grey, composed of smaller lighter grains, and ranging from ten to thirty metres long and two to three metres high, with the points of the crescent on the leeward side.

There is a light wind from the south constantly blowing these dunes across at a rate of some twelve to eighteen metres a year. It was a most impressive sight.

When we were leaving this plain we could just glimpse the peak of mount Misti at an incredible height of 5,800 metres (19,300 ft), above the clouds with a snow capped tip. The rocks now were an incredible range of colours from yellows and browns, to reds and purples. After a while we emerged into the valley of the Rio Chile, and stopped at a local station. Here we were surrounded by hoards of Indians selling yellow melons ("Meloncitas"), water-melons ("Sandias"), light biscuits with jam inside ("alfajores"), pacay beans (*Inga edulis* - a small leguminous tree), cooked immature maize cobs known as "Choccllo", with slices of cheese, and lots more beside. We seemed to be eating on and off until we got to Arequipa - a large and pleasant city in a wide valley surrounded by mountain peaks. The rainfall - or perhaps mists - seemed to be higher here, since the canyons again were sprinkled with various types of columnar cacti. Irrigated fields surrounded the city and - at last - we saw a few potato fields, but there were many other crops growing in this very fertile irrigated valley, with an equitable climate and an altitude of some 2,350 metres.

We were met at the Station by a Mr. Murgatroyd, who was the head of the Arequipa Office of the Southern Peruvian Railways (British-owned, as I mentioned before), and were whisked away to our hotel - "Quinta Bates". This was one of the several hotels we stayed in run by American women of great character. This one was run by Tia (= Aunty) Bates, who was over eighty years old and known throughout Peru. Actually, she was now staying in Lima but the hotel was in charge of an equally interesting character - a Mrs. White, assisted by her daughter.

After settling in we went for a stroll round the city, which was almost entirely built of white pumice stone in the old Spanish style, with Doric pilasters at the entrances to the houses and courtyards. On one side of the large main square or plaza stood the Cathedral, built one hundred years before in the same white volcanic stone, and decorated with Corinthian columns, as well as much wrought ironwork.

On the morning of 21st January we were again happy to see an almost cloudless sky, and enjoy the crisply invigorating dry air. From our hotel we could also see the peak of Chachani mountain, some 6,000 metres high. In the town we made contact with a Professor of Agriculture who agreed to take us on a tour at 3.00 P.M. to study the local potatoes. In fact a Señor Huaco, second in command at the local Agronomy Centre (Estación Agronómico), picked us up, and kindly lent me a paper he had written on the poor state of agricultural research in Peru. We inspected a few fields which were planted with the *andigena* subspecies of *S. tuberosum*, but there was not a great deal to interest us that day. Later, I bought a water-colour painting for five soles of a corner in the Bishop's Palace, which I still possess.

In the evening I had a most interesting conversation at the hotel with a Mr. Kidder, an archaeologist, who was going to excavate at Juliaca on the shore of Lake Titicaca. He thought that agriculture had begun in several of the eastern valleys of Peru (the western ones being too dry). The coastal cultures with irrigation agriculture he considered to have arisen later, but no doubt using the crops from the higher regions. The discussions went on far into the night!

On the morning of 22nd January we went out with Sr. Huaco again, to a farm where potatoes were cultivated under irrigation quite extensively.

Here we took fourteen samples from various fields, seemingly all *andigena* forms. The following day (23rd January) Sr. Huaco took us out to see fields of "chauchas" (early potatoes) but he could not find any! We did see a field of what was called "Salamanca" potatoes, (which was a variety that we had already collected) whilst in another field the planting of tubers by hand was taking place. Here, one or two tubers were placed in previously hand-dug holes. There seemed to be no use of machinery here.

Both that day and the previous day I had come across some curiously diseased tubers, called "Mapa" by the local people. I collected these and sent them back to Cambridge later. They did not seem to fit with any potato disease I had seen previously, and after the expedition when I returned to Cambridge I showed them to my Professor in the Botany School, Professor Brooks. He had not seen anything like these either and it was not until several years later that an American mycologist, Dr. Barrus, described and named this disease as new to science. Dr. Barrus (*Phytopathology*, 1944, 34: 712) named it *Thecaphora solani* Barrus, and it is figured and described in Prof. F.T. Brooks' second edition (1953) of "Plant Diseases", (page 252). Luckily, this disease does not seem to have been introduced into Europe or North America, though I did see it later in Colombia

Continuing our drive, on rough stony roads by irrigated fields on one side and dry hills on the other we saw a range of large columnar cacti, *Prosopis chilensis* (Mesquite) trees and a strange latex-bearing shrub - a kind of spurge with scarlet flowers (*Jatropha macrantha*). The Indians were living very primitive lives in stone or wattle and daub huts. Even so, they seemed very healthy and friendly. The beasts of burden were mules, whilst higher up they would be replaced by the llama and alpaca. We continued on our journey on 23rd January by train at 9.00 P.M. for Puno, having engaged sleeping cars - again far too luxurious in comparison with the harder modes of travel we were to suffer later.

Arriving at Puno in the early morning of 24th January we suddenly stopped with a crash. Apparently our engine had run into a stationary truck full of workmen with an engine in front of it. The driver of that engine panicked and jumped off, as well as most of the workmen. However, the Lake Superintendent hurt his head by the collision, did not jump off, and died in a few minutes. There being no-one to stop the engine it went careering through the buffers and a shed together with its truck, and crashed into the lake. When we got there the engine was completely under the water and only the near end of the truck was visible. This bad accident could have been avoided if the other engine driver had not lost his nerve completely. Eventually, after a lot of shouting and verbal abuse between drivers and lots of others, who felt that the whole thing was the most exciting event that had happened at Puno since the Spanish Conquest, after all this, we managed to get onto the lake steamer - the 'Inca'!

This line was also run by the British, and the ship, it was said, had been brought up from the sea coast in pieces on the backs of mules before the railway was completed. The ship was rather dirty, but at least it was efficient enough. At that altitude we began to feel slightly light-headed. After all, we were at a height of 3,800 metres (12,644 feet) above sea level. We became used to these heights after a week or two, but mountain sickness "soroche" as they called it) was usual for people coming up from the coast, and some reacted very painfully, with vomiting and bad headaches. Luckily for us, we just had the headaches and a kind of emptiness feeling, but no vomiting.

The views across the lake were superb, with yellow reed boats being paddled about on the blue water. These boats were made from the totora reed (*Scirpus totorus*) which was growing in the shallow water by the lake edge. At last, I was where I should have been in 1937, with the Percy Sladen Expedition, two years earlier. Nevertheless, we were now on a proper extensive potato collecting expedition, with a useful background of knowledge gained in Russia. We soon embarked on one of the lake steamers, heading south for Bolivia.

The weather now was superb, with a deep blue sky and a few fleecy clouds. After a while we passed on the left the Island of the Sun (Isla del Sol), sacred to the Incas, and from where, according to legend, the first Inca and his sister-wife had come later to found the Inca Empire with its capital at Cuzco. One could see very steep slopes with ancient cultivation terraces on them. On the right-hand side of the ship we passed the Copacabana peninsula and went through the Straits of Tiquina into a wider part at the south-eastern end. During the night, at about 1.00 A.M. we docked at the Bolivian port of Guaqui but were not allowed off the ship until 8.30 A.M., after which we spent a long time in the Customs. This was now 25th January and after much delay we then took a train for La Paz at about 9.30 A.M., besieged previously by dozens of Indian children all of whom claimed to have carried our luggage.

In Guaqui the whole population seemed to be pure-blooded Indian. The women were wearing dozens of brightly coloured skirts, one over another, blouses and shawls, and walked barefooted or with light sandals. The men wore a woollen cap which came down in flaps to cover the ears often with a tassel at the end of each flap. They often also wore a Panamá or trilby hat over this cap. Some sort of knee length or calf length trousers with a shirt and a poncho over that completed the ensemble. The poncho is a sort of square blanket with a slit in the middle, through which the head is pushed.

The women's skirts as well as the men's ponchos were of very bright colours, reds and oranges chiefly, with black, as well as metallic blues and green. The women more often than not were carrying a heavy bundle or a child slung over their shoulders. Their black hair was plaited into two pigtailed and on top of their heads they generally wore a sort of bowler hat titled down over the forehead. Both women and men squatted down on the street for a rest, and the women often laid out for sale a little food such as cakes or fruit. Whether the ground was dry or extremely wet from the frequent showers at this season did not seem to worry them. They just sat down wherever they happened to be.

From Guaqui the railway line runs through the Pre-Inca city of Tiahuanaco (Huari culture), with gigantic stone figures and gateways cut out of single blocks of stone. The Tiahuanaco civilisation was thought to be flourishing from about 500 to 1000 A.D. and to have influenced coastal cultures towards the end of that period. There was no time to stop and study it then, but we went back for a closer look later. The railway track went right through the city, laid on broken-up stones taken from old temples it was said. We gradually gained altitude after passing through Tiahuanaco, and saw plots of potatoes here and there, though none were near maturity.

The train arrived at Viacha, a large town where there were interchanges of roads and railways. This was at about 3,850 metres above sea level, but we still went on ascending until we reached the aptly named El Alto (The High Point) at over 4,100 metres (some 13,700 feet). This was really high, but even so there was a golf course laid out there for the inhabitants of La Paz.

How they managed to play golf at an altitude of 4,100 metres I could not then imagine. Later, I realised of course that people can become adapted to the altitude in two or three weeks, whilst those born there may well be already adapted at birth.

El Alto is at the edge of a deep wide canyon, so that when we looked over we could see the whole of La Paz at once, some 300 metres below. It was a marvellous sight to see the rugged canyon slopes, and in the far distance the snow peaks of the Eastern Andes. The highest of these was Mount Illimani, soaring up to over 21,000 feet (about 6,800 metres), with Huayna Potosí at 6,200 metres, and Nymururata at 6,000 metres. La Paz city was on a slope, gradually going down into the lower part of the canyon, but the original city centre was at nearly 3,400 metres.

There was a railway from El Alto to La Paz itself, zig-zagging down over a five mile route, past fields of potatoes and several other crops, which at that stage we were not able to identify. At the station we were met by the Schwarzenbergers (my Jewish refugee friends from the boat out), the Archivist from the British Legation and a Bolivian named Figaroa. He had been instructed by the Bolivian Government to show us around, act as an interpreter and generally help to make things easy for us.

We were taken to our lodgings in a private house down at the other end of the city near the British Legation. Apparently nearly all the possible accommodation in La Paz was filled with Jewish refugees, and the largest hotel, called the Hotel Paris, was said then to be very dirty and thus not to be recommended, whilst all the Pensions were full. We got into some accommodation where the Embassy Archivist also lodged, run by a Bolivian lady. At this stage we all had to walk very slowly without getting out of breath because of the rarefied atmosphere. The British Minister was a Mr. Donaldson Rawlans, who kindly invited us to call and see him at 6.00 P.M. and for lunch the following day.

Back at our lodgings after we had sent Sr. Figaroa off to make arrangements for transport, we had an enormous meal of some six courses (the landlady always provided that many) after which we went to bed immediately and slept until 8.00 A.M. the following morning - such was the effect of the altitude.

January 26th was largely taken up with formal calls, passport registration, with the police, a visit to the Ministry of Foreign Affairs and the Ministry of Agriculture, Sr. Figaroa acting as interpreter. There then followed a conversation on potatoes and the diseases which had supposedly been disseminated from potatoes imported from Holland. I found that very difficult to believe, but thought it better not to get into an argument over these assertions. Sr. Figaroa told us all about his English lessons when he was nine years old, attending an English school. Even though he talked too much for our liking, he was very useful, spoke Quechua as well as Spanish and knew everybody in town.

At 1.00 P.M. we were invited to lunch by the British Minister and his wife. The guest list was imposing, including the American, French and Paraguayan Ministers (or Consuls) and their wives, and the Manager of the Bolivian Railways, Mr. Pickwood and his wife. Our hosts were very charming and spoke many languages. We were told about the Bolivia/Paraguay war over the disputed Chaco territory, which Bolivia lost, and in which seven eighths were ceded to Paraguay.

The causes of this defeat were not discussed in front of the Bolivians for obvious reasons, but the lack of communications between the officers (all Spanish speaking) and the soldiers (all Indians, speaking Quechua or Aymará) may have been a strong disadvantage. Bolivia has a wealth of natural resources such as silver, tin, copper and wulfram (or tungsten), as well as great agricultural potential, all of which in 1939 were very poorly exploited, we were told.

From 27th January to 2nd February we seemed to be rushing round to see various people, changing money, obtaining permits to take plants out of Argentina, getting loans of vehicles and many other minor items. On the 27th Mr. Pickwood of the Bolivian railways kindly gave us free first-class passes, including free luggage transport. The Argentinian Minister in La Paz who was an extremely quick talker offered us all facilities in Jujuy, personal introductions, etc.

On the 28th we finally managed to get a vehicle and driver from the Ministry of Agriculture. We drove up toward the altiplano and collected a very fine *Cajophora horrida* with brilliant orange-red flowers and vicious stinging hairs. Nearby, we were able to see the other important tuber crops, such as *Oxalis tuberosa* (Oca), with bright yellow flowers and chewable stems; *Tropaeolum tuberosum* (Mashua, Isaña), with orange flowers but smaller than those of our garden "Nasturtium", and *Ullucus tuberosus* (Ulluco, Olluco, papa lisa, etc.), with glossy heart-shaped leaves and minute flowers. This latter belongs to a family of plants, named Basellaceae, which is unknown in Europe. There were potato plots there, as well, with several different varieties, but not mature enough to collect.

Other high Andean crops, which we did not see on that occasion were *Arracacia esculenta* (Arracacha), and *Pachyrrhizus ahipa* (Huitoto, ajipa).* - Several other subtropical to tropical tuber crops were domesticated in the Americas, in contrast to the predominantly seed agriculture of Europe and Asia.

Later that day Bill Gourlay and I drove down the road from La Paz into the Obrajes valley in an area of eroded mud and boulder pinnacles. There we collected a fine *Calceolaria* (*C. parviflora*) with brilliant yellow flowers, a beautiful mallow-like species (*Malvastrum rusbyi*), and several non-tuber-bearing *Solanum* species. At the first village we found what seemed to be a wild potato (our first collection), the tubers of which we collected (Balls 5890, 5895). We asked an Indian girl for its name, "Quipa choque" she replied, we found afterwards that this meant "wild potato" in the Aymará Indian language, or perhaps what we call a "ground keeper" and the Americans call a "volunteer". It was a weedy or more or less wild potato, which I collected many times also in Bolivia and southern Peru. I subsequently named it *Solanum sparsipilum*. We often call these species "ruderals" or "segetals", because they grow by paths, roadsides, waste heaps and other man-made habitats, and no doubt they are closely linked to the truly cultivated species. We saw more of these at Chalcoto, further down the valley, in someone else's garden. Finally, on the same farm we collected two cultivated potatoes (Balls 5896 and 5897), both called Chiar imilla (Aymará for "Black girl", because the skin was very dark purple).

* - See Hawkes, 1989: The domestication of roots and tubers in the American tropics: In Harris, D.R. and Hillman, G.C., Foraging and Farming pp. 481-503. Unwin Hyam, London.

Bill and I made another excursion down the valley on 29th January, this time on foot. We found another wild potato in great abundance on the steep stony slopes of the river canyon, much of it in flower. It appeared again lower down, and it was certainly the same species, *S. sparsipilum* (Nos. 5902, 5903) that we had seen on the previous day. To begin with I had followed Bukasov's practice of giving a separate latin name to each variant I came across. Later, it proved to be an impossible goal, and I then lumped quite a lot of them under the one binomial. This particular species seemed to be highly variable, having had at one time twelve separate latin names, given by Juzepczuk, Cárdenas, Vargas and me at different times!

The 30th and 31st January were frustrating days of going to various ministries and offices trying to persuade unwilling functionaries to take a little action on our behalf instead of continuing their pleasant relaxed life to which they had previously been accustomed. We had been promised potato collections, published literature and further information. People we most wanted to see happened to be out of their offices or whatever. So in the afternoons we continued our custom in La Paz of meeting the sympathetic Schwartzenbergers for tea, coffee and cakes in the Café Opera. (Why "Opera"? There never had been one in La Paz, but it sounded very French, and thus rather sophisticated).

At last, on 31st January we were rewarded at the Ministry of Agriculture with a copy of Cevallos Tovar's publication on potato classification, another one on chuño production, and a third which was a Spanish translation by a German author, Rathlef, which I knew already in English translation. This work of H. von Rathlef (1937) was interesting, but dealt only with Peruvian potatoes and their classification. However, as they said "Algo es algo, mejor que nada".* - A man called Ballivian who had published on potatoes, and whom I had been bullying poor Sr. Figaroa to find for me, turned out to be dead! So that, at least, was a positive answer!

There were still two more frustrating days to suffer (1st and 2nd February) before we finally got away from La Paz, including more passport examinations, permits to re-enter Bolivia, letters of introduction from the Argentine Minister to his colleagues in Jujuy and Salta, taking heavy luggage to the railway station and having it cleared by customs, being offered drinks by the Station-master, who it appeared had been to the same school as Bill Gourlay, etc. There was no doubt about it that these expats were bored to death by La Paz, so they extracted as much mileage as possible out of us unworthy beings, poor things. There was, as one of them said, nothing to do in La Paz, but gamble and get drunk.

The Journey to Argentina

February 3rd: At last, we managed to struggle out of La Paz, which we had to some extent enjoyed, though longing to get away and do something useful for a change. Everyone had been extremely kind, but the red tape imposed by the Bolivian authorities was almost unbelievable.

We left at about 2.30 P.M. in a very long train with three engines, two in front and one behind, to push us up the steep ascent to the altiplano at El Alto. Once there we settled down to one engine for a journey which remained at about 3,750 metres above sea level for about 500 miles in a slight south-eastern direction. Bill and I were in a first-class carriage with quite comfortable seats, whilst Edward had a sleeper.

* - Something is something, better than nothing!

We had magnificent views of Mount Illimani, Illampu and Huayna Potosí, all of them snow-capped and well over 6,000 metres high, connected by a seventy mile unbroken snowline. The very clear air seemed to reduce the distances, making these peaks seem to be closer than they actually were. The vegetation on the Altiplano was very sparse, though comparatively luxuriant in hollows where water had collected. As we travelled south the soil showed salt crystals, and several saline lakes began to appear. Local showers in the distance were beating down from suddenly appearing clouds.

We reached the mining town of Oruro in the evening and had to turn out of our luxurious coach because it was not going any further. From Oruro, the line to Cochabamba turned off, which we would be following later. Our new coach was very crowded and not very comfortable. At Rio Mulatos another line branched off to Potosí and Sucre. It was then early morning of 4th February, so we got off for a stroll and drank hot coffee from an old Indian woman at about a farthing a cup, and a boiled egg at three farthings which was so underdone that I had to break a small hole and suck out the contents.

Meanwhile, we had passed the shallow Lake Poopó and were headed for Uyuni, by one of the very large salt flats (Salar de Uyuni) which formed in this inland drainage basin. This was at about 4.30 A.M. when the air was extremely cold but very dry. Again, we had to change, because our coach went off south-west to the Chilean port of Antofagasta. I formed the impression that no-one in Bolivia was interested in going by train straight to Argentina, except us, of course.

Our next coach was more comfortable, and I managed to snatch a few hours' sleep. Edward, on the other hand, had wisely booked himself a bunk in a "sleeper" and was unaware of Bill and me having to change from coach to coach at every junction. At sunrise we were travelling over a rather bare landscape, with tufts of Tola shrub and coarse grass. This resinous Tola plant (*Lepidophyllum quadrangulare*) is a member of the Compositae or Daisy Family, and was the only plant that could be used for fuel in that area. The grass was probably *Stipa ichu*, known widely to the Incas and useful as a food for their grazing llamas and alpacas. There were, of course, no trees on this cold, desolate, windswept plateau, which was still more than 3,000 metres high.

Further on, at Atocha, we changed yet again, since apparently the line to the frontier was owned by a different company! Actually, Atocha was a rather pleasant little town, comparatively speaking, as against the previous ones we had been subjected to. It lay in a little mountain valley and most of its inhabitants were engaged in silver mining. There was quite a large mining plant there with a branched chimney which crawled right up the mountainside. For the first time, I saw a herd of llamas, which I quickly photographed. They seemed to be very docile creatures with a rather haughty look in their eyes.

After Atocha the train wound round a very impressive canyon where we began to see all kinds of columnar cacti with red flowers, Opuntias of an attractive grey-green colour and many small barrel-shaped species. Lower down the valley were gigantic candelabra-shaped cactus species, generally with masses of cream-coloured flowers. This would have been a wonderful paradise for the succulent enthusiast. We also saw some red-orange-flowered *Loasa* species, blue-flowered lupins, various shrubby Compositae and Umbelliferae species, as well as a great many Solanums. Unfortunately, none of these latter were the tuber-bearing ones which interested us.

Further down the valley again the rocks were of red sandstone, eroded by the wind into extraordinary pillars - some like Bhuddist temples and others like Renaissance cathedrals, and others again like termite nests. The next town was Tupiza, a very hot sticky little place where we had to wait for over an hour because they were waiting for the Argentine Minister from La Paz who was coming in a special car. Why did he not travel the whole way by car? No-one knew. After Tupiza we began to climb again to about 3,900 metres, through fields mostly of maize, but some of potatoes also. Soon we were in the cactus zone again, and then on a high plateau like the Altiplano, finally arriving at the frontier town of Villazón. Whilst Edward checked through the luggage, Bill and I did some botanical collecting, finding various non-tuber-bearing *Solanum* species, (*S. sinuatirecurvum*) a dwarf *Caesalpinia*, a *Zephyranthes* in flower (of which we took some bulbs), various Verbenas and a *Dalea* (Leguminosae). Since Edward had had a "sleeper" so far, Bill and I thought it only fair that we should have "sleepers" for the next part of the trip in Argentina, so we booked one each. It had been difficult to get our heavy luggage out of Bolivia at Villazón, and it proved just as difficult to get it into Argentina at La Quiaca, with much customs and passport checking.

After a good dinner (the first since La Paz) we turned in early and slept like the dead, only to wake up on 5th February when we were coming close to the city of Jujuy in Argentina.



10 Feb. 1939. North Argentina, near Tilcara, Alfarcito village; *Solanum infundibuliforme* (Balls 5956) growing amongst pebbles.



12 Feb. 1939. North Argentina, prov. Jujuy, near Tilcara, Laguna Colorada; high altitude lake with red water weeds.



13 Feb. 1939. North Argentina, prov Jujuy, above Tilcara, San Antonio; Indians by their homes with thatched roofs and plank walls, in a woodland clearing.



15 Feb. 1939. N.W. Argentina, Jujuy, above Tilcara; trekking with mules in mountains at 3,600 m in an area where wild potato species grow.



15 Feb. 1939. North Argentina, prov. Jujuy, above Tilcara, San Antonio; steep sided valley with typical potato habitats.

CHAPTER 4

IN ARGENTINA

The difference between Bolivia and Argentina seemed to be more marked as we came closer to Jujuy in the early morning of 5th February. Jujuy, at only 1,200 metres above sea level, looked like England in the late spring, with lush vegetation and clearly a much lower altitude than what we had been used to so far in Bolivia. We put up at the Hotel París in the main street for the equivalent of 35p a day, everything included. After several sleepless nights and general inconveniences on the trains we slept a lot the first day, but went for a stroll and found a large fiercely thorny *Solanum sisymbriifolium* (subgenus *Leptostemonum*) in a dry stream bed with brilliant red fruits and white flowers. Another spiny type had almost entire leaves and purple flowers. There were masses of Zinnias (*Z. multiflora*, etc.), Commelinas, and other plants we could not even identify to the genus. In the warm evening there was an extraordinary plague of grasshoppers or locusts, flying into people and vehicles, and being stepped on or run over. Looked at closely, they were extremely handsome, with mottled brown backs and a green streak on both sides of the body.

On the following day, 6th February, we attempted to see the Governor, with our letter from the Agricultural Minister given us in La Paz. After being shunted around from building to building, floor to floor and office to office, we were then told that there was no such person! A few minutes later we were told by someone else that he existed and would see us immediately! He told us that he would send round his District Officer, Señor Campero, to our hotel at mid-day, who arrived promptly and turned out to be an exceedingly obliging and well-informed person. He said that only introduced potatoes were grown in these lower altitudes, the indigenous ones being found only very much higher up. As for wild potatoes, he knew of only one kind which he offered to show us after lunch. He arrived in a very old car and took us through countryside rather like parts of Shropshire near Ludlow. The wild trees and herbs were in full flower and the whole area seemed like a paradise in contrast to the bleak cold barren uplands we had been passing through by train. The country people all rode horses and looked completely Spanish with apparently no Indian influence. The women rode side-saddle and looked very beautiful. The men wore very baggy breeches and their saddles had great flaps of leather in front on both sides of the horse, presumably to protect the rider's shins and knees from damage by thorny shrubs or hard branches.

Our destination was a farm at a place called San Antonio, south-west of Jujuy. We found our wild potato growing as a field weed, and dug up a lot of small tubers with the enthusiastic help of the farmer's son. These turned out to be *Solanum chacoense*, which the farmers called "Papa del Zorro" (fox potato). It then began to rain and we were invited into the farm for glasses of beer and a large bag of apples.

On the early morning of 7th February I made a rather quick decision to go over to Salta for the wild potato species *Solanum simplicifolium** - for which I had previously seen some herbarium records. This is a wild potato species with undivided leaves - quite different from the majority which have many leaflets, as does the cultivated potato.

Bill Gourlay, always game for anything, and a wonderful expeditionist, volunteered to go with me, Edward staying behind to do some paper-work and herbarium drying.

* - Now known as *S. microdontum* subsp. *gigantophyllum*

We went by taxi, costing the equivalent of only £2.50p, and covering a round trip distance of at least one hundred and twenty miles, which seemed extremely cheap. The road wound up and around, through densely wooded hills, and down again after we had passed the provincial boundary between Jujuy and Salta. Down in the valleys again we saw pleasant green fields with cattle grazing in the sunshine. Going through Salta we eventually found the Quebrada (valley) of San Lorenzo, a week-end resort with picturesque summer houses and cottages, flower-filled gardens and a tea-house in the valley bottom. We followed a winding path through the woods, with trees covered with epiphytes, including various *Polypodium* ferns.

The original record for *S. simplicifolium* had been made about a hundred years earlier, and we were not very hopeful of finding it. To our great surprise we soon saw it growing everywhere, along the path sides and in the wood, seeming to like the shade, though flowering in the more sunny areas by the path. We also collected what turned out to be *S. chacoense*, often mixed with *S. simplicifolium*. Amongst the other plants were other, non-tuberous, Solanums, a white-flowered *Calceolaria* with very small flowers, an interesting iridaceous plant, and an epiphytic creeping fern with small ovate fronds and the rhizome covered with closely-fitting scales. Some trees were covered with a species of *Peperomia* (*P. parapana*) and there was a completely leafless cactus hanging down like orchid roots. There were also many Bromeliads - altogether a botanist's paradise.

Having collected our wild potatoes we returned to Jujuy, making various collections along the way from time to time. On our return, Sr. Campero gave us a letter of introduction to his colleague, Sr. Casas, in Tilcara. This town lies in the valley that runs northwards from Jujuy along the Valle Grande, through which we had come by night train. In that region, Sr. Campero thought, we should find a lot of wild potatoes and suggested that we should spend a few days based at Tilcara. So from then onwards we began to travel northwards on the main part of our collection mission, nearly four weeks after our arrival in Lima. Of course, we had made collections in Arequipa and also in La Paz, and the travel south had taken nearly two weeks in any case. Arrangements for expeditions take time, particularly when one is asking for help from many different people. On most of my later expeditions I have borrowed Jeeps and Land Rovers. On this one and at that time such a possibility did not exist. In fact, there was then no road or rail connection between Lima and Cuzco, so even if we had had an expedition truck or any other kind of vehicle we could not have used it for the whole expedition.

On 8th February we were up bright and early, taking the train northwards which had to negotiate some very steep slopes with two engines behind and one in front. In fact it went so slowly that we were able to get out and walk beside the track collecting plants as we went along. There was a brilliant red *Verbena peruviana*, a white-flowered *Senecio*, brilliant yellow cucurbitas, a kind of *Mentha* which did not have much scent (actually *Hyptis mutabilis*), and plenty of Pampas Grass (*Cortaderia sp.*). As we approached Tilcara the climate had become much dryer, and only plants capable of withstanding considerable drought would grow there without irrigation. We got our luggage and ourselves on to the back of a lorry, together with a crowd of young men and women in very high spirits, no doubt on vacation. We stayed at the Hotel Esperanza - a nice comfortable little place with a central patio, and with good food.

Sr. Casas, to whom we had the letter of introduction, was out, so we walked a little way up a side valley behind Tilcara, passing a hydroelectric station and some cultivated plots near the winding mule track. There were many columnar cacti here, various spiny cushion bromeliads, Adesmiads and some purple-flowered Acanthaceous plants.

This hillside was composed of stony drift, possibly glacial, with large boulders embedded in it here and there. We could look up to the distant mountain peaks which were coloured in places with large yellow, red and grey areas. This mountain region looked promising, and we decided to try and get up to it on the following day. Returning again to see Sr. Casas we found him still to be out, so we were invited to go in and wait for him. The furniture in his house was made of a peculiar kind of wood with many slits and diamond-shaped holes in it. His wife explained that it was cactus wood, taken from the enormous candelabra-type cacti which are very common in the area. The wood forms in a hollow cylinder and later is presumably split down one side and flattened out. Even the plant pots were made of cactus wood sections, as well as doors and window frames.

Sr. Casas did not arrive, but we returned to our hotel and he came to find us soon afterwards. He suggested that we made a reconnaissance trip the next day, followed by a three to four days camping trip later, if the reconnaissance trip seemed promising. Sr. Casas then, to our surprise, took us to see an Englishman, a Mr. Cummins, and his wife, living in Tilcara. He had settled there because of his wife's asthma, and had previously been a British Consul in Mexico. He showed us a sweetly scented *Verbena* growing in his garden, with tubers like those of a wild potato.

We had made arrangements to start off at 7.00 A.M. on 9th February, but, as seemed to be usual in South America, our guide was late, and did not arrive until 8.30 A.M. He led a horse on which we tied our presses, collecting equipment and food. Our destination was a small village called Alfarcito where we were told we would be able to hire horses from a Sr. Valdo for a few days to make a trek into the mountains eastwards. We climbed about 300 metres (1,000 feet) and then dropped down into a small valley with green patches of irrigated fields standing in great contrast to the brownish-grey hills around us, and gigantic cacti at least twenty feet tall and as thick as a man's body. The sun was blazing down on us and we were glad to find a patch of shade for a rest and something to eat.

Eventually we found Sr. Santiago Valdo's house in the village of Alfarcito, though there seemed to be only two or three houses there in total. As bad luck would have it, he had just gone into Tilcara for the day, and we might even have passed him without knowing it. The villagers were very suspicious of us, so we walked up the valley and collected some five different cultivated potatoes, when we were out of sight of these people. The potatoes were mixed varieties, sometimes two or three in a bunch. We paid the owner something for them later, on our return. Not far from there were some wild potatoes, one being a mixture of *Solanum megistacrolobum* and what we later recognized as *S. infundibuliforme* but very small and hardly worth collecting.

When we got back to Tilcara we asked our guide to contact Santiago Valdo and hire three horses for us for three to four days. We planned to go right over the mountains into a valley on the eastern side where there were supposed to be two lakes, one black and one red. We later found the red one, "Laguna colorada", but not the black one. In the evening, Edward's plants which were drying over the stove caught fire. Several were destroyed, but our "*S. simplicifolium*" (now known as *S. microdontum*) got rather singed.

On 10th February I returned to the area in which we had seen wild potatoes on the previous day, in what was called the Quebrada de Huasamayo, though this name did not appear on any of our maps. This was at about 2,400 metres, and the plants had tubers as well as berries.

This very delicate wild potato (Balls 5956) I described later as *Solanum glanduliferum* because of its dense glands on the leaves.

Much later, I had to admit that it was just a form of *S. infundibuliforme*, named thus because of its funnel-shaped corolla. Also, quite a number of my "new" species from this area had to be later slotted back into ones already described!

In the early morning of 11th February we set off with four mules and two muleteers; most of the heavy luggage (tents, etc.) was strapped onto two of the mules, and the muleteers had another. So it was a question of the three of us taking turns on the fourth mule if we felt exhausted. By 12.20 P.M. we had indeed exhausted ourselves in the heat and by climbing up such steep slopes. We stopped for lunch and a rest in the partial shade of a giant cactus at a place called San Gregorio (at about 3,600 metres). There, we found, incredibly, what seemed to be a carpet of wild potatoes. These when studied showed themselves to be *S. infundibuliforme* (which we had collected lower down), *S. megistacrolobum*, and a really new species which I later named after Bill - *S. gourlayi*.

This was a tremendously exciting area, because not only were the living plants of interest but there were large fossil corals and pieces of Jurassic limestone lying around on the surface. The general vegetation in these limestone areas had changed also. Below this we had seen a sparse covering of *Baccharis*, and other xerophytic shrubs. Up here, however, there was much more variety, with not only the wild potatoes, but *Verbena* species (*V. stranguloides*) and a curious Compositae shrub with yellow and orange bracts round the inflorescence heads (*Chilotrichiopsis keideli*).

From there on it was my turn to ride on the mule - a very calming experience, except that, the mule would try to stop for a rest now and again and needed a jerk from the reins to get it moving. *Solanum megistacrolobum* (to which I had at first given a new name, *S. tilcareense*) was commoner higher up, varying in leaf form and in the intensity of its flower colour also. Above 3,800 metres we came across what seemed to be a dwarf *Taraxacum*, a white-flowered stinging *Cajophora coronata*, several *Senecio* species, and a queer Umbellifer (probably *Laretia yareta* or *Bowlesia incana*), which grew in large green mats, with minute leaves and small flowers. It exuded a resin here and there, smelled like carrots and was difficult to dig up.

In the early afternoon it started to rain but cleared up later. We found a camping site at 3.30 P.M. at an altitude of about 3,700 metres, not far from the triangular yellow patches on the ridge which we had seen even from the valley below. A small muddy spring gave us some water of a kind, and although the ground was extremely stony we managed to get our tents up. Bill Gourlay found that he had pitched his tent on a carpet of *S. megistacrolobum*, which was useful because we could dig up the plants in dry and comparatively warm comfort. We found then, and at various other places on our expedition that, *S. megistacrolobum* tubers were infected with the *Spongospora subterranea* fungus, which deformed them completely and which also attacks *S. tuberosum*. Many wild species are susceptible, though various authors have found resistance in *S. chacoense*, *S. sparsipilum* and several indigenous cultivated species (see Hawkes and Hjerting 1989: 17). After supper we felt quite exhausted and went to bed early.

February 12th was one of the worst days I had ever experienced. It began to rain at about 4.00 A.M. and went on steadily, turning soon into a sleety snow.

The muleteers remained under a tarpaulin, whilst the mules stood around getting wet and looking as though they had seen all this before, which no doubt they had.

The men would not light a fire to make some tea or coffee or stir themselves until it stopped snowing; so Edward and I decided to explore the path higher up to keep ourselves warm. The top of the ridge did not seem to be more than 50 metres higher, but it was probably over 4,000 metres high, and at about 3,950 metres we decided to turn back, because the sleet and snow was getting worse all the time. However, the *S. acaule* and *S. megistacrolobum* plants seemed quite adapted to these cold snowy altitudes.

We reached the camp at about 11.30 A.M., where it was rather warmer and drier; the muleteers condescended to get up and make a fire, so at last we had hot drinks all round, helping us to warm up. After a bit to eat we took down our tents, packed up our gear on to the mules, and were on our way up again by about 3.30 P.M., with the weather drier if not warmer. At long last we got to the summit of the ridge at about 4,300 metres after an extremely exhausting climb. There were several alpine plants there, including a blue gentian in bud, a whitish carpeting plant that looked like a *Raoulia* (but could not have been, because this genus is limited to Australia and New Zealand), a number of Cruciferae, minute Calceolarias (including *C. glacialis*) and other plants which we had no hope of identifying.

Over the ridge we continued eastward, dropping down into a valley at about 4,000 metres, and arriving at a reddish-coloured lake which our guides appropriately called "Laguna colorada" (red lake) with some kind of red decaying water-weed floating on the surface. Our guides suggested that we should camp there, but since the ground was covered with large boulders and the same *Stipa ichu* that we had been pushing through for a long time, it did not seem a very propitious place to pitch tents. At least it was not raining, sleeting or snowing so we looked out for places just large enough between the boulders to pitch our tents and began to settle down, just above the lake level. Luckily, we were using small one-man tents; larger ones would certainly not have been possible. As before, we drank coffee made from muddy water lying in pools, but comforted ourselves that no human pests or diseases could have survived in that climate. White clouds were floating up from the valley in front of us, reflected in the lake, and there was scarcely a sound at night except for a few birds and the gentle noises made by our tethered mules.

The next morning (13th February) was a cold one but at least a dry one. During breakfast we saw small herds of up to a dozen Vicuñas on the distant skyline. These are said to be the wild ancestors of the Llama, which was the universal beast of burden in the Andes before the Spaniards brought horses, donkeys and mules from Europe. I rode a mule but one of the others started to buck and kick, turning his load round right underneath him. Constant adjustments to the loads seemed always to be needed. When we got to the far end of the valley at 1.00 P.M. it seemed like the end of the world, with a great abyss in front of us. Nevertheless, we found a way, zig-zagging down the very steep slope. It was a queer sensation to see the clouds coming up towards us as we made our way into the depths, occasionally having glimpses of a green valley with cattle grazing in it, some hundreds of metres below. Soon we began to see patches of a plant looking just like a crocus, but on closer examination it seemed closer to a mallow (probably *Malvastrum?*). The lower we went the more frequently this plant occurred. We reached a saddle at about 3,900 metres where it was forming a complete carpet of flowers.

From there we descended into the loveliest valley I have ever seen, with grassy scree slopes and wonderful views. This was named the Chorru valley, and it had some very interesting variants of *S. acaule* which I at first called var. *chorruense*.

However, the work of Okada and Clausen many years later showed that they were in fact natural hybrids of *S. acaule* and *S. megistacrolobum* (*S. x indunii*). These came under Edward's collection number B5986 (in part) and B6037. We also made many collections of true *S. acaule* and *S. megistacrolobum* in that valley, which we thought of as a paradise for plant collectors. The valley was also very prolific in *Calceolaria* species: at the top were those minute rosette-like species with large lemon-yellow flowers. Further down we saw a larger species but with rather insignificant flowers; and growing in the stream was a one to three feet high species with enormous leaves and masses of flowers (both *C. heironymi* and *C. lorentzii* were collected). There were also several distinct blue-flowered lupin species, one of them being so prolific that it covered the slopes with a blue haze (*L. subinflatus*). A species of *Cosmos* with red-purple flowers lower down and a large red-flowered *Oxalis* were quite plentiful.

A little lower down again there were some old cattle enclosures where a side valley entered the main one. The ground there was covered with masses of deep blue-flowered *Salvias* (*S. rhinosina*), probably taking advantage of the soil which had been well manured by the cattle in and around the enclosures. Our destination was a place called San Antonio even further down the valley but still two or three hours' travel away. We were told that there were many cultivated potatoes there. It was getting towards the late afternoon so we decided to split forces. Edward would stay with the younger muleteer for the night, whilst Bill and I, with the older muleteer, would continue on down towards San Antonio, and return the next morning.

We just took a camp bed and a couple of sleeping bags hoping to get into some hut for the night. As we continued on down we found yet another wild potato, this time with white flowers, tinged with purple. This was not far from San Antonio and at about 3,500 metres; but as we descended down to San Antonio at about 2,500 metres we saw more and more of these. In fact, after further study back in England we found we had been seeing *Solanum microdontum*, subsp. *microdontum* with white flowers, and *Solanum vernei*, subsp. *Ballsii** - with purple flowers. There had clearly been some natural hybridization between the white and purple flowered species, so what we had seen at first was *S. microdontum* with a tinge of purple due to genes picked up by introgression from *S. vernii*. These two species had, I suspect, evolved quite separately until man came along and provided intermediate habitats for them to move together and provide hybrids and back-crosses.

After a little while we came to a ridge and could see San Antonio 200-300 metres below. This "village" lying at about 2,500 metres above sea level, consisted of two or three small huts with grass roofs and low walls, surrounded by some cultivated fields. On arriving we found that only one hut was inhabited but nothing was available for us to eat. We became very accustomed to the phrase "no hay" ("there is not" or "we don't have" whatever it is you are asking for), and so there was no bread, potatoes or maize etc. There were, however, some goat cheeses; so we bought three, and although they were rather dirty and no doubt highly unsanitary, we ate them. All provisions there were hung up or stored in the rafters of the roof and covered with very dirty sheep skins.

* - I had at first thought that this purple-flowered species was a new one and had named it later as *S. ballsii*, in honour of Edward Balls. Alas, this also turned out to be a subspecies only.

Eventually, we managed to convince the owner that we would like to see his potato fields and take a few samples. We collected three varieties, probably the same as the ones we had collected earlier, but of course we could not be certain.

Along the banks of a nearby stream a species of *Begonia* was growing, though it was not as handsome as the one we had collected higher up. Both that day and the following day (14th February) we made many collections of wild potatoes, which were generally called "Papa aphauma", which is an Aymará Indian word meaning a wild potato, not an escaped one (See my article on Indian Potato Names published in 1947 in the Journal of the Linnean Society, 50: 218). At this 2,500 metres altitude, with very high rainfall, the vegetation was wonderful, very luxuriant and with incredible numbers of species, very different to the places where we had camped, in the high 3,000-4,000 metre regions.

Well, to return to our own circumstances, we did not fancy the idea of sleeping in those bug-infested huts; so we went back up the track a little and picked out a piece of ground that was less sloping, so decided to pass the night in the open. Bill dug some holes for two of his camp bed legs so that he would sleep more or less on the level and I spread my sleeping bag out just above, so that if I rolled down I should be stopped by Bill's camp bed. The wife of the Indian who had showed us his potatoes took pity on us and came up after a little while with some meat that she had cut off a carcass and cooked over her fire on a skewer. We had to eat it as best we might by holding it in our fingers; luckily, we could not see what we were eating as it was then completely dark. Apart from a herd of sheep wandering round us now and again we slept like the dead. Our luck held out and it did not rain.

The next day (14th February) dawned bright and sunny, with rosy-pink clouds scattered over the eastern sky. For breakfast we asked the people who lived in the huts down below if they could sell us something to eat. "No hay" (there is not anything) was the reply we were getting used to. Both the man and his wife tried to get some milk out of the cow for us, but she just was not going to co-operate - all her milk was going to her calf. So then the woman managed to get some from her sheep and goats, which she heated up over her fire. It was a slow process, but when it came it was quite delicious. This was a good start, and it was followed by plates of cooked unripe maize cobs and more slices of the cheese we had been given for supper. We paid well for them, took a photograph of the family and then started on the long return climb at about 8.40 A.M.

Stopping on the way back now and again we made several more collections of the two wild potato species that were growing, sometimes mixed and sometimes separate (*S. microdontum*, subspecies *microdontum*, with white flowers, and *S. vernei*, subspecies *ballsii*, with purple flowers). The apparent hybrids also could be found from time to time with purple-tinged white flowers. One plant was conveniently growing with its tubers in the stream or "chorro", from which this valley was named. We got up to Edward's camp at 10.30 A.M., a wonderful place, full of flowering plants and surrounded by mountains. It was very tempting to spend a few more days there but unfortunately we were running out of food and also running behind in our schedule. Although the sun was shining brilliantly to begin with we soon got up into the cold mist again. We did not arrive at our camp site at Laguna Colorada until about 5.15 P.M. after a very steep climb of about 1,700 metres. We got our tents up again, and had some food, during which the mist turned into torrential rain and there was a strong wind. It was a miserable night, but being completely exhausted we slept all through it.

We were awoken by the sun on the morning of 15th February, but not for long. The mountains were covered with snow and there was a bitterly cold wind. Why we decided to have a shave that morning I cannot now imagine, but it was certainly extremely painful. The hot water practically froze on our faces.

Again, we started off before the muleteers, and when we reached the ridge we were rewarded with a breathtaking view of the Andes mountains stretching away into the far distance to the north and south. A little lower down we made more collections of *S. megistacrolobum*, as well as *S. infundibuliforme* and my "new" species, *S. gourlayi*. We again passed the region of the gigantic corals, up to one metre in diameter, with chalky limestone and some clays and shales. I wished that we had a geologist there to explain everything.

In due course we had our lunch, which finished up all our provisions. Bill had gone back to fetch his knapsack and came down later. He was always leaving things around when he saw really interesting plants. Soon after lunch the weather changed again, clouds gathered and there were ominous claps of thunder. We hoped Bill was all right. We got down to Tilcara at 5.15 P.M., the muleteers an hour later, and Bill soon after them. The small stream that we had easily stepped across earlier was by then a raging torrent of mud, stones and boulders.

February 16th was a day spent in arranging and drying specimens, having my shoes mended and writing up notes. I wrote down some "half crazy" ideas on cultivated potato origins and later scrapped them. On the 17th we packed up and posted our tuber collections for Cambridge. We learned later from an Englishman that "derrumbes" (landslides) had broken the railway lines both north and south of Tilcara. At a place called "Volcán" (volcano-appropriately enough named) where the line was laid on dried river mud and stones - quite sensible when dry, but the track was pulled away by the liquid mud after a storm. Luckily, this lay near Jujuy, and we had already passed that hazard.

On the 18th we planned to carry on up the main valley towards La Quiaca on the border with Bolivia and were told all was well with the railway line. So we got all our gear up to the station, mainly strapped to two wheelbarrows, over a plank stretched across a stream that had not existed a few days earlier. We were then told (a) that it was not possible to take our heavy luggage further than Humahuaca, (b) we could take it only to Huacalera, a few miles upstream, and (c) that we could go right through to La Quiaca, luggage and all! It seemed to us that people made up these stories to show how knowledgeable they were. So we just booked everything, including ourselves, right through to La Quiaca, and trusted to fate.

In about an hour we reached the mud flow which had left the line hanging in the air over a rushing torrent. However, an auxiliary line had just been laid and we passed through. Much further up, at Humahuaca, we found, amazingly, that our heavy luggage was still in a van attached to the end of the train. Streams from side valleys were dry one minute, rushing torrents the next, and dried up quite soon afterwards. Later we passed a series of vertical multicoloured crescents where strata had been laid down, turned up by ninety degrees and then eroded to form crescents between the streams. Unbelievably, we had a quiet dinner on the train and arrived at La Quiaca by about 8.30-9.00 P.M.!

All the gloomy forebodings had just dropped away. The "Grand Hotel" at La Quiaca was said to be superb, with hot and cold water laid on to washbasins and baths in each room. However, the hotel was full because Carnival began the following day.

The management produced a lot of beds which they put at the end of the dining room in rows like a hospital, when dinner was over. A flimsy screen was produced to separate the sexes (though one man slept with his wife on the ladies' side), and we settled down to sleep as if we were in a hospital. If this expedition did nothing else for us it certainly provided lots of hilarious surprises.

February 19th was a Sunday, and there was no hope of travelling onwards that day. Far from there being hot and cold running water in all the bathrooms, there was no water at all. Water was soon brought to us in large tin cans. Then later on, hot water did in fact appear, but queerest of all, the toilets were flushed down with boiling water. Using these toilets, I have to say, produced a most unusual sensation. After breakfast we were given a room with three beds and a door leading out only into the street, and no window. I thought that was very strange at the time but on many later collecting trips I got so used to it that I took it for granted.

There was no hope of getting transport that day. All the vehicles were filled with people dressed up, shouting or singing and circling round and round the town endlessly, to the strains of very loud highly distorted Argentine dance tunes on loudspeakers at every street corner. There seemed to be no particular theme on any vehicle except one, which carried a Dutch windmill with very precarious sails and lots of young girls wearing Dutch hats. The Indian dances, on the other hand, were fascinating, and luckily they took place away from the other so-called festivities. The women wore the sorts of costumes we had seen in Guaqui by Lake Titicaca, the men in dark Sunday best with the inevitable black trilby hat. The women always seemed more conservative than the men in retaining their ancient dress and customs. The dances consisted of something rather like the Helston Floral Dance in Cornwall, without the flowers, but with couples (man and woman) snaking around and led by the first couple holding a flag on which was written something like "Long live the Carnival". All this was accompanied by a simple tune played on wooden flutes (or on violins or even a brass band, according to the troupe) and repeated for many hours. People seemed to join in as they felt like it and dropped out when they were tired.

Whilst I was filming all this I happened to notice a large patch of potatoes in the Station Master's garden, many of them in flower. Bill and I asked the Station Master if we could take a few samples. He agreed, and we got three distinct kinds, all of which proved later to be *andigena* varieties. No names were given to them.

We really hoped to get across the border on 20th February, but although we were told by the hotel manager and various other people that the border would be closed all day, we later found that it was open from 2.00-6.00 P.M., both at La Quiaca and at Villazón in Bolivia. The problem then was to find a lorry or truck to take our luggage across. At about 2.30 P.M. a likely looking vehicle rushed past us, we shouted the driver to stop; he looked round and then crashed into a water pipe which stood out about six feet into the road. He knocked it right over and went straight on to get some petrol, followed by the Chief of Police who promptly arrested him! He was drunk, apparently, so that was the end of him and his lorry so far as we were concerned.

We scoured the town then, but all the lorries were standing outside pubs or restaurants and their drivers could do nothing until "mañana" (tomorrow). So in the end we had to confess ourselves beaten and settle down to another night in the Grand Hotel. The dining room was full of dancers, with vast amounts of streamers, confetti and mica dust which they were throwing at each other. We slept very unsoundly that night, as can be imagined.

CHAPTER 5

IN BOLIVIA AGAIN

Early Days

At last, our feelings of frustration were temporarily assuaged when we actually managed to find transport to take us over the border from La Quiaca (Argentina) some hundred metres or so, to Villazón in Bolivia, on 21st February. The lorry driver, along with many others, was released from prison and started to help us load up our luggage. This was the sign for streams of guests to pour out from the hotel asking for lifts. The usual phrase (translated into a less flowery English) was: "Oh, are you going to Villazón? Just take my luggage along, too, will you? And mind and place it the right way up". Also "Just wait a bit longer, would you, because someone else who is nearly ready might want to put their luggage on, too". If we had had any sense we should have charged a fee; instead, Edward and I just sat down, swearing under our breath. Here we were, having almost sweated blood to get hold of this lorry, only to have these "parasites" hitching free lifts. If only our Spanish had been better and Edward had not been such a kind person, we could have made quite a bit of money out of these people.

There were no customs problems on leaving Argentina because we had letters of authority. At Villazón, on the Bolivian side, the customs officer was temporarily absent, and our bags had to be unloaded. By the time he arrived the lorry had disappeared, so we had to spend the night in Villazón, at the Hotel Central, where the kitchens did not bear looking at, but the food when it came was quite palatable. Various negotiations for transport came to nothing, probably because all the drivers had drunk too much at the Carnival. At last, we managed to hire a car for the next day, or at least we thought so. Our idea was to drive eastwards to the town of Tarija, where no-one seemed to have collected potatoes before.

The following morning (22nd February), of course our car and driver did not appear. After a fruitless time scouring around for several hours we found someone who would drive us down by truck, and a lady in the hotel offered to pay half the rather extortionate price. Meanwhile, the Carnival was still going on, the favourite pastime there being to throw little balloons filled with water at other people and watch them burst; it was great fun for the thrower, but not so hilarious for the person who got soaked. The lorry eventually arrived at 3.00 P.M. and we piled our light luggage on it (the rest staying in Villazón). The Señora had her two children and masses of luggage mostly wrapped up in inadequate bundles or baskets, which almost at once started to disintegrate. We had to be doing them up all the way for her.

It was a wonderful cloudless day to begin with and we felt most light-headed to be away at last from La Quiaca and Villazón. Perhaps the most remarkable thing about this trip was the number of times the road crossed the frontier. The frontier posts were poorly manned and we mostly sailed just through them without any trouble. The road went past high mountain lakes where we noticed a few flamingos and some black and white geese. The whole area was completely unpopulated except for a few patches of cultivation in some lower valleys. The air was very clear up there and one could see far away to the west the distant snow peaks of the Chilean Andes, and to the east the mountains over which we were to pass.

The plains were sparsely covered with *Baccharis* bushes on which herds of donkeys and llamas were grazing. At one point we drove down into a large valley where potatoes, maize and barley were cultivated. On the upper slopes *Stipa ichu* grass was the only plant to be seen.

At Tarija, Bolivia

Once off the high plateaux the road twisted down the mountain and valley sides towards Tarija. There we saw the Peruvian pepper trees (*Schinus molle*), weeping willows (*Salix babylonica*) and other temperate climate plants at about 2,500 metres altitude. We got to Tarija at about 9.00 P.M. and were pleasantly surprised with the streets, buildings and parks. We put up at a hotel in the main plaza and were at last able to relax a little.

On the following day (23rd February) our favourable impressions of Tarija were reinforced by its cleanliness, its palm trees, its flowers and its idyllic climate. Just outside our window there was a chiming clock which tolled hours and quarters, with an unintelligible (to us) number of strokes. No matter how hard we tried, we never could understand the system it worked by. We visited the Municipality after breakfast and asked for the Governor. He was away, but we saw the Mayor.

There was no department of Agriculture there but he promised to put us into touch with people who possessed transport and would show us potatoes. After a while a large lorry with two lads turned up and we went out to a series of potato fields where we collected samples at places called El Rancho and San Lorenzo. On our return we collected a scarlet *Verbena peruviana* whose native name (amor seco) when translated was "dried love"! There seemed to be no reason for this name, so far as we could see. In the afternoon they tried to take us out in another direction but were stopped by the flooded river. The potatoes cultivated round there were variants of the "runa" and "collarejo" varieties, both good yielding and apparently with high starch contents.

February 24th was exciting in some ways, in that we attempted to cross the river by wading, stepped on uneven stones, and all three of us fell over and got a wetting. Edward's camera and Bill's watch were temporarily damaged and our clothes were soaked. On the other side we stripped off completely and laid our clothes out on bushes to dry. A group of washerwomen on the other bank (whom we had not noticed until then) were rolling about with laughter at the sight of three very pale "gringos" (foreigners) with no clothes on. Apart from all this, the vegetation was of a cactus thorn-bush type, with *Opuntias*, as well as species of Malvaceae and Zygophyllaceae (*Kallstroemia boliviana*), and no matter what clothes one took off, one certainly had to keep ones shoes on, with so many thorns and spines on the ground.

February 25th was mostly a rest day, but on the 26th, walking through the thorn bush, I found a wild potato, unfortunately not in flower. We returned in the afternoon with trowels and dug tubers. All green parts were covered with a very short glistening glandular pubescence. This was certainly a species that had not been seen before, and which I afterwards named *Solanum tarijense*. Apart from this we were all feeling very worn out after our Tilcara experiences, and thus rested quite a lot to try to recover.

We left Tarija on 27th February in a truck which, as usual, did not arrive at the time agreed; we had become used to this anyhow. "Hora Inglesa" (English time) was routinely replaced by "Hora Latino-Americana" (Latin American time), so we came to accept this and always allowed one or two hours' difference in our calculations. The weather had broken and there was a thick mist about. This did not stop us from seeing a wild potato by the roadside which was very abundant, with large white corollas and simple leaves, at about 3,300 metres.

This was evidently the same species that we had seen in Salta (San Lorenzo) and which we then called *S. simplicifolium* (B6125) (now *S. microdontum*). In that area we also saw a pale red-flowered *Cajophora rusbyana*, a small white-flowered liliaceous plant rather like *Ornithogalum*, two handsome *Calceolaria* species, a yellow and orange *Lobelia*, a brilliant red *Begonia* and much else besides.

On a high ridge at about 3,400 metres at a place called Chorcoya, we made some more collections of cultivated potatoes. A little lower down at Iscayachi (3,150 metres) we collected yet more samples. All these cultivated potatoes in Tarija department were of the *andigena* type. We collected also some *S. megistacrolobum* at a place called Sama at about 3,490 metres. They had the same carrotty smell as those we had collected in San Gregorio, Argentina. Edward collected a fine *Buddleia*, which was covered with a thin silky down. There was also an *Alstromeria* with some small white tubers. Quite close to Villazón, at a place named Quebrada Honda, we found some more of the delicate wild potato *S. infundibuliforme*, which we had also seen at San Gregorio.

Although we were late in arriving back at Villazón we had to make an early start on the following day, 28th February, because we planned to take the northbound train to Rio Mulatos en route for Potosí. We loaded up with peaches, grapes and *Opuntia* fruits for the journey. These latter had of course been peeled to remove the spiny outer layer, but although the flavour was nice the fruit itself consisted mainly of pips, which had to be spat out as one was eating them. As before, we stopped for about an hour in Tupiza. A little later on, near Oploca the train stopped because of a stationary goods train in front of us. As usual, we all three jumped out and started botanising.

Here I found to my delight a wild potato on the embankment but without flowers. Further away we found many specimens in flower, which showed quite clearly that we had found another new species. This one, which I later named *S. oplocense*, was very different from any we had seen previously, and had it not been for the stationary goods train in front we might never have found it. Luckily, we found many tubers, and managed to grow them later, back in Cambridge. So, by the rare chance of a stopped goods train, a new species was found! We had to change trains at Uyuni on to one that had come up from Antofagasta in Chile, but since first, second and third class coaches were completely full we had to sit on our bags in the corridor until we arrived at Rio Mulatos, where we changed on to the Potosí line, at 6.00 A.M. on 1st March. First class seats were all taken and we had to sit in second class with the Indian passengers - not a very salubrious situation. The train went along quickly eastward over the plateau to begin with but later started twisting and turning to gain height. At the highest point, nearly 4,700 metres above sea level there was at first frost in the shadows and then complete snow drifts. This was a place called Cónдор (after the bird, of course), and from then on we began a twisting and turning descent. Most of the Indians around here had left their fields to work in the mines, and hence we saw many abandoned farms. Higher up we had seen groups of wild Vicuñas grazing on the short grassy turf; later there were groups of alpacas.

A crowd of Indian miners boarded at a place called Agua Castilla, all chewing coca leaves and speaking Quechua to each other. It did not sound at-all like the words in the dictionaries, of course. These men had been working in the Antimony mines and were very dirty. No pit-head baths were available presumably. An American miner on the train told us that the famous silver mine at Potosí had been almost worked out and that tin was taking the place of silver.

At Potosí, Bolivia

We arrived at Potosí at about 1.00 P.M. This city, reputedly the highest in the world, lies at 3,945 metres above sea level, and is higher than La Paz. From the station we could see the famous silver mountain - "Cerro Rico de Potosí" - which is all but worked out and is said to contain a honeycomb of passages. A taxi took us to the Hotel Londres, which was run by two Jugoslavs and was quite comfortable (apart from the lavatories, but we had become used to all that by now!). Bill and I even had a room with a window - a very rare thing! After settling in, we registered with the police and were put into touch with some Ministry of Agriculture people. They were very pessimistic about travel, saying that the roads were broken in nearly every direction, suggesting that the only possible travel would be on horseback. After a great deal of talking we decided to do a trip on the following day by truck or some similar vehicle.

Potosí is of course a very old Spanish town, full of colonial buildings and old churches. At one time there were thirty two churches, but some had been pulled down or used for other purposes. One was used as a cinema with the old colonial carvings still intact, especially round the doorways. The old houses still bore the coats of arms carved in stone over the doorways of the Spanish noble families who once lived in them. Potosí would be a wonderful tourist place if it were not for the great altitude and the damp cold which seemed to get into ones bones (no central heating there). We decided to stay for as short a time as possible in that damp cold city.

2nd March. Bill and I were up at 6.30 A.M., keen to get out of our cold, damp beds. All our heavy luggage and sleeping bags had been left at Rio Mulatos where the Potosí line branched off, and even though we were told that they would be forwarded that night by goods train, they did not arrive. We were told these kinds of things so many times that after a while we did not believe them any more. In general I think that people told us what they thought we wanted to hear and so hoped to calm things down and make us happy. Of course it did not work; they just did not have "a strict regard for truth", as Hilaire Belloc wrote.

We had hired a good car for the day, even though we probably paid twice as much for it than we should. We went out on the Sucre road, collecting potatoes at various places. There was quite a lot of cultivated land, with crops of potatoes, wheat, barley, and quinoa (*Chenopodium quinoa* - a native grain crop with nutritious protein-rich seeds (13-22% according to Brücher). We made collections of cultivated potatoes at a place called Tejatambo and later at Chaqui, where the local Alcalde (Mayor) helped us to get samples. The plants themselves had been badly damaged by a very bad hail storm, but the tubers were all right. Most of these collections were *andigena* varieties but one was *S. curtilobum* and another *S. ajanhuiri*, both of which were frost-resistant (see later).

Many fields in the area were terraced and irrigated, the walls being composed of rounded granite boulders, carefully graded in size from base to top. In the nearby village we were given some lupin seeds (probably the native species *Lupinus mutabilis*) which they said needed boiling for twenty four hours to destroy the bitter alkaloids. They often conveniently made use of the many hot springs in the region for that purpose.

On the way back we stopped to collect a rather peculiar *Mutisia* (*M. viciaefolia*) species with brilliant orange flowers and pinnate leaves ending in tendrils. We found another species also, with grass-like leaves, the tips of which also formed tendrils.

On Friday, 3rd March, Bill Gourlay discovered that he had lost his keys and so had to hire a car to go back and look for them. Meanwhile, Edward and I arranged and packed plant collections and talked to a Scottish missionary over lunch. Bill arrived back at 1.30 P.M. and his wife telling us that he would be late for lunch arrived later, at 2.00 P.M.!

At Potosí, because the silver mines were so close, the Spaniards had built a mint which probably provided much of the currency of Spain and possibly all of South America. The building was grim and repellent, and we were not surprised to hear that it had also been used as a prison. We were told that the timber beams and ceilings had all been brought up on mule back from Tucumán, hundreds of kilometres to the south. The machinery was activated by prisoners on tread mills until, no doubt, they died of exhaustion. The rollers and cog wheels were all made of wood. The whole place was horrendous. An interesting feature of the streets in Potosí was the frost-resistant wild potato *S. acaule*, which grew abundantly between the cobble-stones. It also grew as a weed in the plaza (main square), in gardens and very abundantly in the railway station yards. Since it was highly frost-resistant it could easily withstand the icy climate of Potosí. This was really an extremely widespread wild potato, extending from northern Peru southwards to La Rioja province in north-west Argentina.

We left Potosí by train on 4th March, bound for Sucre, which was the judicial capital of Bolivia. The train was what they called an "autocarril", using petrol engines to drive the coaches. The scenery was superb, with wonderful views of wide upland valleys and jagged peaks on either side. Every available piece of ground, even though very steep, was ploughed and used for cultivation. The main crop at high altitudes was barley, followed by maize (a small variety with purple stems), quinoa and potato. There was also a pea variety with white and purple flowers and another with white flowers - both quite frequent. At one place the railway track was blasted into a sheer rock face, with pinnacles and large jagged rock spikes at the top. At the highest point of the line it was comforting to see a large field of cultivated potatoes. Later on, the whole country was a mass of hills and valleys, the latter often very dry with evidently a minimal rainfall, and patches here and there of brilliant green vegetation where there was water available for irrigation. We finally descended into a very wide irrigated valley with well-cultivated farms. Having gone through a small town called Yotala we soon arrived at Sucre - a very attractive city, with fine buildings and a "Hotel Central" where we took a room each.

At Sucre, Bolivia

After dinner we strolled around the wide well-lit streets for a while; we then found a cinema which advertised a violin recital by a so-called Viennese player called Freddy Wang, which really sounded more Chinese than Austrian. Whatever his antecedents he played brilliantly some pieces of Corelli, Paganini, Bach, Mozart, Brahms and Kreisler. This was an unexpected luxury, and verified the statement we had heard a few days earlier that Sucre, not La Paz, was the cultural capital of Bolivia. This tremendous contrast between hard, cold, dirty and even degraded conditions, being followed closely by luxury and culture, was, as I found many times, typical of South America. The poor Indians in the high mountains had a really tough life, whilst the cities at lower altitudes were very Europeanised and in complete contrast to the conditions in which the Indians had to live.

The following day, 5th March, was a Sunday and it was hence impossible to see anyone or make any arrangements. Still, we needed a rest after our travels.

In the evening we strolled into the main square (plaza) listening to a band playing, and watching all the young men stroll round in one direction and all the young women in the other. This is common to South America and indeed to the whole of southern Europe, I believe, and is evidently a time-honoured way for the young men to look at the young women and *vice-versa*.

On 6th March, after the usual ceremony of registering with the police, we visited the Prefect in the Government building who was extremely obliging and promised to do everything he could for us. Although we had heard empty promises like this on many occasions, these were rarely put into action. He showed us an interesting exhibition of agricultural products and even put his car at our disposal. We then called on a Sr. Pisco, a man concerned with rural economy, who promised to take us out to collect material the following day. Meanwhile, someone collected eight different potato samples in the market for us, all but one being *andigena* varieties. There was a zoo, with several poor dispirited looking birds and beasts in cages, not one of which had a label.

More in our interest was a trip out to a nearby quebrada (valley). There we found the wild potato species, *S. boliviense*, and two new species which I later named *S. sucrense* and *S. subandigena*, both of which when studied carefully later, were shown to be fixed hybrids between *S. tuberosum* subsp. *andigena* x *S. oplocense*. These were collected at relatively low altitudes - about 2,550 metres. This had really turned out to be a most successful day. People here were actually doing what they had promised!

Sr. Pisco arrived on 7th March, as agreed, at 9.00 A.M. in the Prefect's car to take us out to an hacienda (farm) at a place called Azari, about seven kilometres from Sucre. There we collected about a dozen varieties, all of *S. andigena* type from a freshly harvested field; they were being hand-graded, the largest ones for human consumption, the medium ones for sowing and the smallest ones for the pigs. Both there and in the market, all the varieties were grown in complete mixtures, and we had to ask for them to be sorted, which was done without demur. The identifications and classifications were mainly based on tuber shape, colour patterning, eye depth and (occasionally) flesh colour, much as they are classified in Europe. No-one bothered to identify the plants in the field, which were in any case grown in mixtures. Outstanding general types were the rounded ones with deep eyes, called "Imillas", and the longer, flattened oval types called "Runa". As the names are generally composed of two words, a noun, followed by an adjective, the farmers can identify their varieties quite accurately in these southern regions. However, as one went northwards to the La Paz, Lake Titicaca and southern Peruvian regions, the diversity increased enormously, as I shall show in later chapters, and the names increased in complexity as well.

The garden and house of the Azari farm were very large, and the garden especially was very beautiful, with flowering herbs, shrubs and trees. Wild or weedy potatoes were very common throughout the area, though Sr. Pisco assured us that these were "ground keepers" (volunteers), left over from previous harvests, a point we did not argue about. I identified these potatoes later as *S. sucrense*. We were then invited into the house to meet the owner, Sr. Urriolagatia (a very Basque name) and to drink a glass of beer. He was a former Charge d'Affaires in the Bolivian Embassy in London for twenty years and spoke perfect English. Also, interestingly, he was one of the four people who took part in the Chaco expedition about which the book "Green Hell" was written. He had a large album of interesting photographs of the Chaco and its wild animals (mostly after having been shot).

We had to return for lunch to Sucre as the Prefect needed his car for the afternoon. However, as compensation, Sr. Pisco insisted on guiding us round Sucre. The Cathedral was the first stop with pictures on the interior walls of saints undergoing excruciating tortures. We escaped from that as quickly as possible and were taken to an old woman's herbalist shop, with seeds and dried plants said to be useful for curing all known diseases. There was undoubtedly a certain amount of faith healing involved with all this.

We were also shown a rather architecturally uninteresting University campus and a school in a former monastery building which was of beautiful construction. This was called La Recoleta de San Francisco, and there we collected another sample of "Imilla negra" (Black girl) and a wild/weedy potato, identified later as *S. subandigena*. I never quite understood the meaning of "La Recoleta" but found later that it was a monastery built by/for "Franciscan friars of a reformed branch aiming at a detachment from living creatures and a mystical contemplation of God". Horrible pictures of St. Bartholomew being flayed alive turned up both in the Cathedral and in this Recoleta. Spaniards in those early days seemed to delight in these painful and, to us, disgusting scenes.

On 8th March, Sr. Pisco obtained a car to take us up into the mountains in a different direction, northwards, to a place called Guerraloma, which seemed fairly promising. About three kilometres out of Sucre we found a slender graceful plant with short thick hairs which I named *S. pachytrichum*, but which later I classed as a subspecies of *S. gourlayi*. We also found *S. sucrense* again, and a bit further along, *S. boliviense*. All these were in rather dry sandy soil at nearly 3,000 metres altitude. These two latter species were growing in cultivated fields of potatoes and beans as weeds, but were definitely not ground keepers of cultivated potatoes.

The Indians who owned the fields had just harvested a potato crop and invited us to try each kind, giving us a dish of ground red pepper to use as an appetiser. The potatoes had very good flavours but the pepper was explosively hot! The Indians also showed us samples of just harvested *Tropaeolum tuberosum* tubers, as well as beans and lupins. On our return we took some samples at a place named Carapunco, all of which were *andigena* types. Bill and Edward collected several ornamental plants nearby, among them being a scarlet *Salvia* (*S. haenkei*) and a red-flowered Scrophulariaceous plant (*Alonsoa acutifolia*). The Indian men in this region wore wide baggy trousers down to mid calf, and long hair coming down in a bob to the side of the face and at the back plaited into a single pigtail. The hat varied according to the district from whence they came. The poncho completed the picture. The women wore a multitude of skirts and petticoats but were less conspicuous in their appearance than the men.

On the way back to Sucre we explored a small valley within sight of the city. It had such steep sides that we had to dig small holes for our feet before we could collect the wild potatoes growing there. Better specimens were growing in the valley bottom; all these were *S. sucrense*, which seemed very common around Sucre, and thus we felt that it was really well-named.

On the next day, 9th March, we spent most of the time sorting and packing samples to post back to England. Potatoes said to be available in the market did not make an appearance, or at least we could not find any. When we returned to the hotel we met the British Consul, a very sad man who had spent forty years of his life in Bolivia and had never returned to England at all during that time. He had practically no knowledge of Bolivia outside Sucre.

There were only four or five English people living in Sucre, and we were, it seemed, the only English visitors to visit this city during the whole period of his residence. We supposed that he must have married a Bolivian woman but he said nothing about a family, and was of course pleased to speak English again, even though he seemed to be thinking in Spanish and translating his thoughts into English as he went along.

We left Sucre by train early in the morning of 10th March. It would have been more logical to go by road or by plane but the weather was so bad that many roads were damaged, and the plane service had been cancelled during the wet season. This was always a problem for plant collectors - the dry season is better for travelling but the plants have died down; some people even told us that we had picked the wrong season for our expedition! Even so, it would have been good to travel from Sucre to Cochabamba by air in two hours, rather than by train, which took two days. At Potosí station we collected some more *S. acaule* in the railway yards and changed trains for the onward journey to Rio Mulatos, where we arrived at 11.00 P.M. There we had to wait for five hours and took refuge in a warm railway carriage. At about 1.00 A.M. (11th March) we were turned out into the cold to wait for our next train, due to start at 4.50 A.M. but not leaving until 6.30 A.M. when it was just getting light. We had kept reasonably warm by drinking hot coffee and eating fried eggs, produced by a row of Indian women who kept little fires burning in large tin cans. Unhygienic, probably, but the food and drink seemed to do us no harm. The train passed quite close to Lake Poópo (pronounced Po-o-po) - a very large but quite shallow body of water at about 3,700 metres altitude, reflecting the sky in an intense blue colour.

At Oruro we changed trains again, and took a route rather similar to, but not so high up, as the route from Rio Mulatos to Sucre. At a place called Aguas Calientes (Hot Springs) we collected a wild potato from some steep banks by the station, thinking it was an escape from cultivation. As so often happened, it later turned out to be a weedy form of *S. sparsipilum*, which we had seen previously in the outskirts of La Paz. We got down soon to pleasant valleys which were extensively cultivated with crops of potatoes, quinoa, barley and wheat in the higher regions and maize lower down, right through to Cochabamba. This city was on a broad plain at about 2,550 metres and had a reasonably warm climate. It was livelier and larger than Sucre and Tarija, with many shops and pleasant squares (plazas).

We were recommended by various people on the train to stay at the Hotel Roma, which we did and found it to be cheap and clean. This was like many South American buildings with patios and open corridors round them. The inner patio walls were liberally decorated with pictures of roses and leaves. We were given a dormitory with five beds and settled down to sleep quite early, after the hard almost sleepless nights on our rail journey.

The following day, 12th March, Sunday, we rested, read and wrote letters, strolled round the town a bit, and tried to sum up what we had been collecting thus far.

At Cochabamba, Bolivia

By the time we arrived at Cochabamba we had been in South America for two months and were just about to reach the Vavilovian Gene Centre for Andean crop diversity. So far, our collecting "strategies" had depended largely on good or bad travel opportunities (generally bad ones!), as well as information obtained in Russia and the help kindly provided by local agronomists.

We also had information from my study of dried wild potato specimens on herbarium sheets and descriptions of species and varieties in the botanical literature. Most of this latter information came from the works of the French taxonomist M.F. Dunal, and the German taxonomist Georg Bitter.

We knew from Juzepczuk and Bukasov that there was much potato diversity in southern Chile - apparently all confined to *Solanum tuberosum* subspecies *tuberosum*. We had already decided before we left England that we could not possibly collect in Chile as well as throughout the Andes from north Argentina to Colombia - a total distance of about 13,000 kilometres. Even the Andean stretch would be very difficult to cover in the eight months we had allowed ourselves, both financially and in terms of travel time. There was also the dual problem of both the cultivated and the wild potato species. On the whole we had laid most stress on cultivated potatoes, taking samples of wild and weedy potatoes whenever we could find them, and this is what we hoped to continue.

A really systematic search in every mountain region was clearly impossible. In the first place we had no expedition vehicle, and the constant search and many disappointments in hiring transport slowed us down considerably. Even if we had had an expedition vehicle there were vast regions with no roads at all, only mule tracks and pathways. Thus, travelling by horses or mules would have been very slow indeed, though it was undoubtedly useful in some regions, as we had found in our trip into the mountains from Tilcara. Our collecting strategy was, therefore, to try to collect in as many regions as possible, and to take samples from markets, farms and, where possible, Indian field plots. We had purposely made duplicate collections in different areas of varieties with similar names, such as "Runa" and "Imilla", even though each might be a sample from a single clone. However, we were not certain of this, and in fact we later found in England that there were many genetically different "Imillas" and "Runas", and other types as well. So, our instincts later proved to be correct.

Of course, we had no means of knowing whether we were missing much genetic diversity or not. Even so, in retrospect I do not think we missed much, because up to now we were collecting in southern Bolivia outside the Vavilov gene centre. In looking through the literature recently (see Vavilov, 1992, translated by Doris Love, 1997) it was clear that Vavilov had not allocated exact boundaries to his gene centres in Bolivia and Peru. However, after studying his maps very recently I believe that the southern boundary of the Andean centre seems to lie at about twenty degrees south latitude, which would include the areas round Potosí and Sucre.

Although we ourselves did not find much diversity in those regions, later work (see Hawkes and Hjerting, 1989), showed that there was a great deal there and particularly of *andigena*, which we had evidently missed through not having the right contacts. The map of the northern boundary of the Vavilov Andean Centre indicates that it stops at about five degrees south latitude near the boundary of Peru and Ecuador. This is a low altitude area in any case, but the northern highlands of Ecuador and the south of Colombia, as I found much later, can well be considered as a sub-centre for potatoes also.

I must apologise to the reader for this diversion and now continue with the 1938/39 results. Most of our southern Bolivian collections were of the tetraploid *Solanum tuberosum* subspecies *andigena*, but even in Potosí we had found three samples of other cultivated species - the frost-resistant pentaploid *S. curtilobum* the frost-resistant diploid *S. ajanhuiri* and the earlier maturing triploid *S. chaucha*. The Sucre collections were all *andigenas*, though.

This was to change for two reasons: firstly, in Cochabamba we should be well within the Vavilov gene centre, and secondly, we had got into touch, almost by chance, with Dr. Martín Cárdenas, who had taken a scientific interest in potatoes and other crop plants in the department and was a Professor in the Agricultural University of Cochabamba. His knowledge and help were extremely valuable to us, since for the first time we had the scientific advice of a South American potato specialist.

Because from that point we were to be collecting other cultivated potato species as well as *andigenas* I feel that I should digress for a little to explain the rather complicated system of species and chromosome levels in this group. Most wild potatoes (but with some notable exceptions) possess twenty-four chromosomes in their body cells and twelve chromosomes in their sex cells. These are spoken of as diploids. Although the Russians described several cultivated diploid species I later limited them to three (*S. stenotomum*, *S. phureja* and *S. ajanhuiri*). Past hybridization and chromosome doubling has resulted in the tetraploid *S. tuberosum*, with the two subspecies already mentioned above, possessing forty eight chromosomes in their body cells. Hybridization between diploids and tetraploids (one of them being the wild species *S. acaule*) has resulted in two triploids, with thirty six chromosomes in their body cells (*S. juzepczukii* and *S. chaucha*). Finally, a cross between *S. juzepczukii* and *S. tuberosum* has resulted in the pentaploid *S. curtilobum* with sixty chromosomes in its body cells. Potatoes are probably the most complex of ancient crop species from a cytological point of view, involving at least two wild species *S. acaule* and *S. megistacrolobum* which are both frost-resistant, as well as two other species *S. leptophyes* and *S. sparsipilum*. The original wild ancestor of the group was probably *S. leptophyes*, and the second diploid in the formation of *S. tuberosum* was probably *S. sparsipilum*.

This complex picture was basically elucidated by S.M. Bukasov and N.I. Vavilov in Russia, and much later confirmed and sometimes modified slightly by various Ph.D. students under my supervision. However, much of this understanding was completely unknown to us during the expedition, except for the chromosome numbers, showing what is known as a polyploid series, elucidated by Bukasov and Vavilov in the 1930s.

Returning to our expedition strategy, it was clear that we needed more help and advice, which was freely given by Dr. Cárdenas in Bolivia and in Peru by Drs. Soukup and Vargas, which I shall describe later. It was already certain, however, that without this help we would not have been able to collect more than a fraction of the wide range and amount of material that we sent back to England and received later from very helpful South American colleagues. From then onwards we were fortunate in being given much larger collections than we could possibly have made ourselves with the time and poor transport that we had at our disposal.

As before, we continued also to look for wild potato species, and again, particularly from Cárdenas and Vargas, we were given much information and many samples of these species. After two months of travel then, we were only just entering the really interesting area of cultivated potato diversity. We still had five months in front of us, but we had northern Bolivia and the whole of Peru, Ecuador and Colombia to cover. It seemed (and indeed was) a daunting prospect.

We had already heard of Dr. Martín Cárdenas from various colleagues and on the morning of 13th March we were taken by someone from the Prefect's Office to meet him at the University where he was the Rector. He was probably the only systematic botanist in Bolivia, was most friendly, and spoke good English.

Dr. Cárdenas suggested several excursions into the surrounding countryside and then after lunch at our hotel took us to his house where he showed us herbarium specimens and told us of his plans to set up a national Bolivian herbarium. He lent us books on agriculture and the potato in Cuzco, and suggested a trip in the surroundings of Cochabamba the next day, with one further afield the day after.

Uncharacteristically for Bolivia, Dr. Cárdenas called for us the next day (14th March) at the time he said he would - 8.15 A.M. with a University camion (truck). Dr. Cárdenas had also promised to take along an American botanist, Dr. J. Eyerdam, who was looking for *Nicotiana* (tobacco) species for the T.H. Goodspeed collection at Berkeley, California.

At a small brewery in the hills just above Cochabamba (Cervecería Colón) we found a weed potato in the garden of the Director, named "Aphuruma", a descriptive name which we had already come across, meaning "wild or escaped" potato. However, the truck driver insisted that it was a seedling from a cultivated potato, which I did not believe but agreed to so as to prevent a long argument. Sr. Pinto at Sucre had said the same thing. We also collected a cultivated variety (*andigena*) in the same garden.

From that place we had a magnificent view of Cochabamba, lying in a wide valley with mountains all around, and a large lake to the left. The vegetation was tremendously diverse, and we collected some thirty numbers, all of which Dr. Cárdenas identified for us. There were some delicate white-flowered orchids and *Salvia haenkei*, *Cleome pungens*, *Malvastrum peruvianum*, *Eupatorium connivens* and many others, in a wonderfully colourful array.

On returning to the hotel we had lunch with Dr. Cárdenas and made plans for a 7.00 A.M. start the following day. The rest of the day was spent arranging collections, typing notes and discussing the plants we had seen.

The next day, 15th March, we started out at 7.50 A.M. with Sr. Mario Prada driving, as before. He was an agricultural student at the University, with another year's study to finish his four year course, and was hoping to specialise in plant breeding and plant diseases. He was twenty-six in 1939, having had to spend four years as a conscript in the Chaco war. Dr. Cárdenas told us that the Prado family were of pure Spanish descent, and many had been Governors of Cochabamba in past years.

We travelled eastwards over the flat fertile Cochabamba valley towards a mountain range which was the last before the descent to the rain forest "Yungas" region. We then passed through the town of Sacaba, capital of the vast tropical province of Chapare which stretched away to the east. After this we began the ascent of the eastern mountain range, with sharp hairpin bends and a very poor road surface. At the top of the ascent the view was surpassingly lovely, with wild mountain scenery, scattered patches of cultivation and brilliant emerald green splashes of barley and wheat, with scattered rather dried up potato fields. There were also many fields of cultivated yellow-flowered *Oxalis* (oca) mixed with its wild pink-flowered relative.

After a while we reached Colomi, a larger village than the ones we had passed previously. We were then introduced to a lady who owned a shop in the main square and a farm, and who in due course prepared lunch for us.

Our afternoon excursion (minus Bill who felt unwell) included a man and a boy to carry our presses, two horses, and sufficient food for our evening meal. We crossed the river by truck and then made our way up a side valley on foot. Colomi itself was at about 3000 metres above sea level and we probably climbed another 300 metres on foot in the afternoon. We saw many *Polylepis latisejala* (Rosaceae) trees, and melastomaceous and ericaceous shrubs, several magnificent gentians (the white one - *G. buchtienii*, and the purple one - *G. dielsiana*). There was also a mauve-flowered *Solanum* (*S. leptocaulon*), which was common, but unfortunately not tuber-bearing. The steep path we were following was surprisingly well paved with large stones, and was an old Inca "road", the first we had come across. This path or road led down eventually to the Inca ruins of Incachaca, where it is said they mined gold.

About two to three kilometres from the summit we walked into a rain cloud and decided to turn back. Some way down we found a wild potato which looked from the leaf shape to be *S. megistacrolobum*, but later was found to be *S. toralapanum*. There were no flowers but we dug up tubers. Down by the truck we found some more, with flowers but no tubers. Back in the village we were given a large room for sorting our collections; a peculiar rather sour smell came from sacks of chuño, the freeze-dried potatoes which the Indians prepared. We of course stayed overnight and Bill and I were given a room in another house behind the shop, which seemed to be used as a shrine. It had an altar with all sorts of dolls dressed as saints in the most gaudy robes imaginable. There was also an angel hanging on the wall, praying to a sacred heart hanging in the clouds behind it. We certainly felt an aura of great religious fervour in that room.

On the following day, 16th March, we got away on another trip in the same direction, with a horse each and a couple of farm lads (peones). They were immensely strong, carrying large bundles on their shoulders composed of plant presses and food. They romped up over the mountains more quickly than we could on our horses - quite amazing. This was the first time I had ridden on a horse and I found it less tough but more tractable than mules. In fact, I found it quicker to get off and walk, pulling the horse along behind me - a complete role reversal! We went over the pass and descended the other side which was evidently a very high rainfall region with much richer vegetation. Melastomataceous shrubs were even more frequent, and and there were masses of an extremely showy red-flowered gentian (*G. umbellata*), as well as a yellow-green *Halenia vincetoxicoides* (also Gentianaceae).

At midday we reached an Aduana (Customs House), evidently set up to tax the trade routes from the lowlands to the cities, such as Cochabamba. It then began to rain and we had a lunch of boiled potatoes which we skinned and dipped in chilli sauce; there was ham, cheese and beer, so it all made an excellent meal.

After lunch the rain stopped and we went on down the path on foot, collecting plants (that we had not seen before) of every description - pink-flowered *Gaultheria vaccinioides*, ferns, melastoms (*Brachyotum microdon*, etc) and much more besides. Cárdenas had previously found a wild potato there and we found it again at about 3,450 metres, with conical berries and purple flowers. This was *S. violaceimarmoratum*, with quite large tubers, and typical of the Series Conicibaccata, both species and Series having been described by the German taxonomist, Georg Bitter. The habitat of this species was high mountain rain forest, with very lush vegetation.

A little higher up we found some more, over two metres high, with the flowers showing over the tops of the bushes which the stems had grown through. After a while we turned round and re-mounted our horses, getting back rather soaked by nightfall. It had been a very good day for plant collecting, despite the rain.

We returned to Cochabamba the following day (17th March) and arranged and dried our plant collections. On the way back we stopped to look for potatoes at an hacienda and found the weed species *S. brevicaule* at the edges of potato fields; also several *andigena* varieties, one *S. phureja* and an *S. stenotomum* (Kkulla).

On Saturday 18th March, Dr. Cárdenas told us that Sr. Cevallos Tovar would be in his office that day. We had been looking for him ever since we had arrived in Bolivia because he had written an article in 1914 on the "Classification of The Bolivian Potato". Tovar was rather negative, suggesting that we should look for samples in the market but not offering to go with us. A colleague who was Professor of Zoology in the University came into the office, talking incessantly in a mixture of French and English. He offered to take us round the market which occupied a vast area, both covered and in the open. Here we got six *andigena*, one *phureja* and two *chaucha* potato varieties, as well as three *Ullucus* and one *Oxalis* collection. It was certainly becoming clearer that diversity was increasing as we went northwards. A consignment of seven samples was later sent to us from Tarija, all *andigena* varieties, and most of them "Runa" and "Collareja", two types that seemed common there. My ideas that Tarija lay outside the Vavilov centre of diversity were strengthened by this set of examples.

During our market visit, we saw every conceivable item for sale, and at every corner drinks of *chicha* (maize beer) were available as well as large platefuls of red soup. As in most peasant markets everyone had something for sale but there did not seem to be anyone buying anything. Did they perhaps come out to buy their foodstuffs very early in the morning? It could have been the answer, perhaps. On our way home we were asked to return to Bolivia again and teach in the University, living in our guide's house, the Prof. of Zoology. We said we would consider it (but with no idea of accepting!).

Mr. Eyderdam had told us that there was a little rocky hill outside Cochabamba to the south-east where he had seen a wild potato growing. The hill was called Cerro San Pedro and when we got there we found an abundance of wild potato plants with glandular pubescence and a pleasant aroma. The tubers were quite large and some plants had green berries.

This was certainly a new species, which I later named *S. berthaultii* in honour of the well-known French Solanaceae expert Pierre Berthault. It later became quite famous, showing resistance to potato blight, wart, common scab, *Fusarium* wilt, potato viruses X and Y, various insects and spider mites, and some races of potato cyst nematodes. Consequently, Cerro San Pedro later became a kind of pilgrimage site for potato germplasm collectors! Why this one species possesses so much resistance to all sorts of pests and diseases nobody knows. Finding it was just an extraordinary example of chance, or some would say, "serendipity".

On Sunday 19th March we took a train to a place called Quillacollo, a few kilometres west of Cochabamba, where Sr. Cevallos Tovar had told us that there was an interesting Sunday market. Dr. Cárdenas accompanied us. The train was an extremely ancient affair with one first-class and six second-class open-sided trucks. It went very slowly with much noise for about three quarters of an hour.

The market itself was most interesting but the potatoes were not. There were only "imillas" and "runas". These were said to be the marketable varieties, the Indians keeping all the others for themselves. This was an object lesson on how not to collect genetic diversity!

Go to the farms, but in general do not hope to find much in markets. Dr. Cárdenas, who spoke Quechua, got promises of about twenty varieties in fifteen days' time and one hundred in April or May when the main harvests would take place. These promises were kept, and we received large collections later in Cambridge, kindly sent by Dr. Cárdenas. Many people made promises to send us samples. Most people, apart from Cárdenas, Soukup and some others, did not keep these promises, as we suspected. Indeed, we succeeded in interesting Dr. Cárdenas so much in our mission that several years later he came to Cambridge on a British Council Scholarship to continue his potato studies.

Cevallos Tovar had promised on 20th March to verify the native names of the tubers we had collected, but despite my frequent visits to his office, he did not appear and we finally had to pack up the tubers and post them off to England. Dr. Cárdenas dined with us on our last evening in Cochabamba, and we said our farewells to him. Setting off on the morning of 21st March, the railway journey to La Paz entailed a four hour wait in Oruro, which seemed to be a very pleasant well-kept town, even though it was situated some 3,900 metres above sea level. The plaza was large, tree-lined and with many shops. We had dinner in a hotel run by an Italian, then went back to the station where we had booked sleepers. The night was bitterly cold and it was raining hard.

At La Paz, Bolivia

Having started at 11.00 P.M., we did not arrive at La Paz until 9.00 A.M. on March 22nd which was a very busy day. We had previously written to friends, asking them to book us rooms but it seemed that the letter had been lost in the post. However, Edward and I managed to get a small room with two beds, whilst Bill stayed in the Hotel Paris in the main plaza. He had decided to get back to England because he had already been away for nearly a year. I was sorry that he had to leave us because he was a very friendly, kindly and unflappable person who we were certainly going to miss very much for the rest of the expedition.

After an extraordinary combination of misunderstandings and misinformation we eventually got ourselves transferred to a "Pension" where rooms had *actually* been booked for us. This was really an absolutely typical South American scenario! The new accommodation was ideal, situated in a beautiful garden at Miraflores near the lower border of the city, and with very friendly managers. Meanwhile, at the Ministry of Agriculture, after all the promises of collections, they had managed to get only six samples of potatoes, and these from Tarija, where we had made many collections already. In any case they were only *andigena* varieties!

We had a rather lazy day on 23rd March with a real eggs and bacon breakfast for the first time since leaving Lima. Bill invited us to dinner at the Hotel Paris that evening. It was his last night and he left at 7.00 A.M. the following morning, taking trains and boats back to Lima and then by ship to England.

On 24th March our friend Figueroa gave us letters of introduction to various places near mount Illimani and to some haciendas in Rio Abajo, below La Paz. Our truck and driver from the Ministry of Agriculture were supposed to have picked us up on 25th March at 8.00 A.M., but what with a lack of petrol and oil, the unknown whereabouts of the driver, and the need for a customs permit to leave the city, we did not get off until 11.00 A.M., some three hours later. We should have become used to his sort of thing by that time, but we could never get accustomed to the sheer incompetence which never seemed to change in Bolivia. We hoped for better things in Peru.

On this trip we again went down below La Paz to Obrajes by the Rio de La Paz, passing very colourful red and yellow rocks and mud denuded by the rain into pillars and cones - a really fantastic scene. We came to a village just above Mecapaca (probably La Carrera), where messengers from the owner of a farm some way down, a Sr. Yanguas, who had had word of our arrival, would send up horses for us (this because the motor road was practically washed away by the rains.

After a snack, by 3.00 P.M. still no horses appeared and we decided to walk, which shocked the villagers greatly. After a short distance we quite saw why wheeled vehicles could not pass; even tanks could not have negotiated it, because the river had worn huge chasms, so steep that the former road surface was at eye level. We waded through the river without boots and socks on, and later we had to negotiate mud floes. It was a long five kilometres to get down to the estate, which had fields of apples and pears and a well built farm house.

All was quiet and when we knocked on the door a gruff voice shouted "who is disturbing my sleep"? However, after a while he calmed down (he was the owner) and brought us out some beer. When he had read our letters of introduction he told us that to get up on the slopes of Mount Illimani was quite impossible from there and cursed the tourist bureau for sending us in this direction. We apparently should have gone out through a place called Palca, where we could have started collecting at once. Down here, there was only the "Imilla Colorada" potato variety, but we collected some berries, and also some seeds of wild cotton. The hospitality of the farm people, once they got to know you, was extraordinary. We were fed ripe figs, made to fill our pockets and then invited to stay for dinner. Our baggage had arrived by then, and after much conversation we got to bed.

On March 26th, after a large breakfast which included clotted cream, fruit and a sugary substance called "dolce de leche" we were taken around the estate. The usual wild potato was found on the estate, growing as a troublesome weed, and was probably *S. sparsipilum*, the same species that we had seen in January higher up the valley.

The gardens were full of both native and introduced flowers, hedges of bromeliads and *Schinus molle* (Peruvian pepper) trees. It was altogether a wonderfully restful and beautiful place, ideal for a holiday. In a nearby church the local maize harvest had been stored. We were given a selection of all the different "varieties", varying in colour from brown, orange, yellow, dark blue, and blue spotted to yellow streaked with red.

The morning was hot, so we were given grapes, followed by a couple of bottles of beer; after that we were invited to lunch, starting with salad, then onion soup, meat and potatoes and chuño. The custom with soup was to squash a small red pepper in the plate before being served the soup. Edward and I tried a half pepper each, which nearly blew our heads off.

The son-in-law had six peppers, without turning a hair. I suppose one gets used to these very hot peppers in time. After lunch we sat around and talked until it was time to leave for La Paz.

We were lent horses and were instructed that the length of the stirrup strap should be adjusted to the length of one's arm, which would then be right for one's legs. I had never heard of this before, but it seemed to work. Finally, we got into the lorry which had been sent down for us from La Paz, and I had never had such a shaking, with enormous potholes and curves in the road. One also had to try and avoid spiny shrubs and cacti bending over the lorry, whilst when going through tunnels we had to bend down to prevent our heads being knocked off against the tunnel roof. This was a really hazardous journey for Edward and me, but of course the Bolivians took it in their stride.

On getting to our Pension we were given an extra large supper because they thought we must have been under-fed during our trip. Little did they know the vast amounts of food we had been given by our kind hosts. After all this effort and luxury we had managed to make only two potato collections!

The following day, Monday 27th March, we spent the whole time writing up notes and letters. On the 28th we went up to the Ministry to ask Sr. Figueroa about transport for more collecting trips in the La Paz area, stressing the need for high altitude areas. Meanwhile, we visited a Mr. Herrick, Director of the American Institute, who took us to meet a Mr. Poznansky. He was a Pole who had been living in Bolivia for forty years or more, earning enough from his brick works to run the "Bolivian Historical Film Company". At the headquarters, decorated in Tiahuanaco style, he had books, photographs, Indian skulls, and all the miscellaneous paraphernalia of an amateur anthropologist's study. He offered to take us later to his farm at a place called Eucaliptus on the altiplano, near Oruro. Back at the Ministry, Srs. Figueroa and Jacob gave a severe reprimand to our driver on his slackness at the weekend and gave him strong orders, backed by threats, to take us to Tiahuanaco the following day.

On 29th March we had given orders to the driver to pick us up at 6.00 A.M. The driver actually turned up at 7.00 A.M. - not bad for him considering his recent laziness. When we had ascended about two-thirds of the way up to the altiplano we ran into a damp cold cloud. We had to stop to get a permit from the aduana (customs) and pick up a "chico" (a young lad assistant for the driver), the ordinary chico having overslept.

On the altiplano there were wonderful views when the clouds had lifted, of undulating brown scenery with green patches of cultivation here and there and snow-capped mountains in the distance. Later, we passed through a village named Laja, with a picturesque old church with a large dome over the centre and two separate bell towers. This was not built of adobe (mud) as was usual, but of well-cut stone.

We arrived at the ruined ancient city of Tiahuanaco at about 9.40 A.M., some of it partly excavated, with massive sandstone blocks standing up in many places. The modern village was quite close to the ruins, and we decided to make collections first, and explore the ruins later, if there was time. On going through the village we noticed that there were two sandstone statues taken from the ruins and placed one at each side of the church entrance. These were about two metres high, obviously pagan gods, with ugly square faces and blank glaring eyes. (But why put them in front of a Christian church?). In the plaza we met the Alcalde (Mayor) with our letter of introduction, who lent us a gendarme to take us out to make collections and show us the different varieties grown in the general region.

We were able to make a very interesting collection of thirty-one samples, ten of which were *andigena*, four of *S. chaucha*, six of *S. stenotomum*, three of *S. ajanhuiri*, four of *S. juzepczukii* and three of *S. curtilobum*, and one of the wild species *S. acaule*. This was the best collection we had made to date, clearly indicating that we had reached the Vavilov gene centre for cultivated species of potatoes, with six out of the seven species now recognized. This was really exciting, and we were then able to visit the ruins with clearer consciences! The most exciting part was the temple, surrounded with massive oblong stones set on end, each about five metres high. Outside this was the so-called "Gate of the Sun" formed from one massive block and carved with curious figures supposed to be of calendaric significance. At the other end of the temple was a flight of four steps cut out of enormous blocks of stone, the top two all of one block, some six metres long and two metres wide. The whole city covered an enormous area, and had wharves which were once at the edge of Lake Titicaca when the water level was higher.

In a "museum" nearby (really a small shed!) were various idols, broken pottery, beads, charms and scarf pins, all for sale and some said to be replicas, others declared to be "genuine". On returning to the village we saw another gateway, said to be the Gateway of the Moon. Much seems to have been written about this Tiahuanaco or Huari culture, and not all based on concrete evidence, of which there is very little. However, the modern archaeologists place it between two thousand, two hundred years and one thousand, two hundred years before present, and spreading widely into southern Peru in pre-Inca times.

At a few kilometres from Tiahuanaco we made some more potato collections, which I have included in the list of thirty-one samples already referred to. We were busily taking samples when an Indian woman let forth a string of abuse in Aymará, answered equally abusively by our three helpers, the driver, his chico, and our soldier. She was right to think we were stealing her crop, but we gave her some money, which settled her down quite a lot. Of course, we should have asked permission to take samples, but there was no-one there to begin with.

Our lorry on the return trip was loaded with Indians, hitching a free ride and by their weight helping to steady the truck on the very rough road to La Paz. We had an invitation to dine with Mr. and Mrs. Herrick and arrived late, because we had not got to our Pension until 6.45 P.M., and were invited to dine at 7.30 P.M. We got back from dinner at about 9.00 P.M. and worked on our material up to 3.30 A.M., having been up for nearly twenty four hours - a tiring but very rewarding day.

On 30th March we packed up and posted our spoils of the previous day. Edward arranged with Poznansky for us to go up to his farm at Eucaliptus on the altiplano on the following day starting at 5.00 A.M. At the Ministry we found that another parcel of potatoes had arrived from Tarija.

There were twelve samples, all of them being varieties, again indicating that the diploid, triploid and pentaploid species had not spread so far south. After fetching them I indulged myself with afternoon tea at the Café Opera and chatted to our friends the Schwarzenbergers (whom I had got to know on the boat out). For supper we had some of the surplus potatoes from Tiahuanaco. Even the so-called bitter potatoes (*S. juzepczukii* and *S. curtilobum*) tasted quite good, whilst all the others were excellent, with a fine flavour.

On 31st March Edward and I managed to haul ourselves out of our beds at about 4.00 A.M. and get to Poznansky's house by 5.15 A.M.. We had breakfast with him and were introduced to two Czechs and a German - all chemists, who had come up for the ride and would return the following day. We actually got away at 5.40 A.M. on a lorry piled with sacks of meal and other things, and although we started in the dark, it was quite light when we reached the altiplano. Up there at that hour it was bitterly cold. There had been a hard frost the night before and the ground was quite white. As we were on the back of the lorry we caught the wind, and nearly had our hands and faces frozen off. We stopped now and again at various villages to thaw out and eat bread, meat and oranges.

It was interesting, as we went along, to see many potato patches growing where they had clearly been subjected to frost but showing no damage at-all. As we went south the climate became drier with fewer crops and wild *Baccharis* bushes with *Stipa* grasses in between. As the sun came up we felt a little warmer, and arrived at Eucaliptus at about 1.30 P.M. The farm was just outside the village and was called Finca Huancaroma. This could not have been far from Oruro, and was certainly situated in that Department. It was sited pleasantly on the east bank of the river Desaguadero, which runs southwards from Lake Titicaca to Lake Poópó. After that the water drains down to several large salt pans where it finally evaporates. The farm was situated at about 3,650 metres on a slight rise, looking out westwards for some two hundred kilometres towards the western range of the Andes. The altiplano clearly heated up quickly in the sun and this resulted in mirages with apparently small hills floating in what seemed to be water, but was really the reflection of the sky. In the distance one could also see many 'dust devils' - pillars of whirling dust and sand brought up by the thermals. The whole effect was extraordinarily beautiful.

After a cold lunch Poznansky took the Czechs and German to Eucaliptus to see salt deposits which he thought might be Glauber Salts and if so, potentially marketable. Disappointingly for him the samples taken were almost pure sodium chloride (common salt). Even so, some cushion plants seemed to grow in that area despite the very high salt content. The visitors had also been inspecting an alcohol distillery - quite legal in Bolivia. Meanwhile, Edward and I had been dropped off at some fields where the potatoes were so dry that the plants were nearly dead, and of course with no tubers. We all returned to the farm, had an early supper and went to bed early, after a long and exhausting day.

The next morning, 1st April, Edward and I walked round the potato fields with an Indian who could speak only Aymará. However, he knew what we wanted, so conversation, although short, seemed to get through. Each field had a different variety planted in it but at least we made a series of collections. Later, we came across an old cattle enclosure, with very rich soil and every plant quite distinct.

We got fourteen collections from these dry stony fields of which nine were *andigena* varieties, two were *S. curtilobum*, one was *S. juzepczukii*, one *S. stenotomum* and one a wild form which could have been *S. sparsipilum* but died before we could identify it. In the cattle enclosure we made seven collections - two *andigena*, two *S. curtilobum*, two *S. juzepczukii* and two *S. ajanhuiri*. The latter three species were all frost-resistant, the first two having genes of the wild species *S. acaule* and the third with genes of the wild species *S. megistacrolobum*. Of course we did not know this at the time but only after much later research with my Ph.D. students in Birmingham were we able to understand the origin of these potato species.

After lunch we went out collecting again and found potatoes growing as weeds in wheat fields. They were called "kipa" - which means "ground keepers" (or "volunteers" as the Americans called them). These words indicate that they are potatoes that have been left behind after harvest and grown up as another crop of their own accord. These turned out, on analysis, to be a mixture of *andigena* and *S. curtilobum*. As we were just about to return to the farmhouse the sky turned very dark and threatening, with heavy rainstorms in distant parts of the altiplano, looking extremely dramatic, and a strong wind blew up also. The views of sun, dark clouds, rainstorms and constantly changing colours were extremely dramatic.

On Sunday, 2nd April, the early morning weather was perfect, as it always seemed to be in the mornings. After many delays we managed to borrow a mule and an Indian guide. The mule was supposed to be for our presses etc but the Indian insisted on carrying them on his back and then climbed on to the mule! Our journey led us through Eucaliptus to a place called Kelkata in La Paz Department, at about 3,700 metres altitude. In Eucaliptus our Indian disappeared and then turned up again later. We never found out what he had been doing because he only spoke Aymará, as I mentioned previously.

However, all was well, and going in a north-westerly direction we came into the region of Kelkata. In the distance we could see the beautiful brilliant green fields of wheat and barley, the yellow and red of quinoa (*Chenopodium quinoa*), and the dark green of potatoes. At first we had some sort of path to follow but after a while it came to places where someone had decided to plough a field and sow a crop. Then, later, there were large fields of 'Luqui' (*S. juzepczukii*) through which we had to stumble, and finally, the path disappeared altogether. All around were scattered patches of potatoes in no particular order or system. We were making collections here and there but very few plants had flowers on them. Our mule found a pool of very dirty water to drink from, followed also by the Indian. We decided not to try it.

At about 1.00 P.M. we came nearer to the fields we had seen in the distance, but our guide thought there were no potatoes there. Fields a lot further off he said were "le-jos" - in other words far too far away. We decided to have our lunch by a nearby "stream" (mostly muddy pools), where to our joy we found masses of potato patches. We made a few collections, had lunch and felt much better. A group of young lads appeared and stood around solemnly watching us eat our lunch. They brightened up tremendously on being offered cigarettes and even more so when looking through our field glasses. After some haggling, we gave some money to the oldest of them, together with some more cigarettes in order to get our potato samples. This turned out to be a good area, where we got five samples of *andigena*, two of *juzepczukii*, one of *curtilobum*, one of *chaucha*, six of *stenotomum* and one of *ajanhuiri*, as well as a *S. acaule* collection.

On the return trip our guide insisted on-going through that god-forsaken place Eucaliptus again. We did not, and the guide finally arrived without our press, which he said he had left in Eucaliptus. Eventually it turned up in a lorry. We thought he had been drinking, but anyhow it had been a very hot dry day, so we did not chide him.

We returned to La Paz on 3rd April by train with Poznansky and spent some time drying and packing samples, and checking names with Poznansky's copy of Bertonio.* -

* - Bertonio, L. (date unknown). Etymologias Aymaras y Quechuas

On 4th April we took potato samples in La Paz market including six types of chuño, six collections of *stenotomum*, two of *phureja*, one of *ajanhuiri* and five of *andigena*. April 5th - slight toothache. April 6th - very bad toothache. April 7th - 8th agonizing toothache and face swollen. Saw American doctor. April 9th - absolute agony. Went into hospital with a high temperature and a blocked maxillary sinus infection. Operated on that evening with local anaesthetic.

Recuperating on 9th, 10th, 11th, 12th April in hospital, whilst we decided that it would be better for Edward to go on to Peru, rather than wait around while I convalesced. Had the most horrendous nightmares.

So, whilst I was in hospital Edward collected on 11th April on the shores of Lake Titicaca, near Huarina, six samples of *andigena*. At the Colegio de Huarisata, near Achacachi and in the market he collected from 12th -18th April, forty-two samples of *andigena*, six samples of *curtilobum*, three of *stenotomum*, five of *chaucha*, one of *juzepczukii*, one of *phureja* and one of *acaule*. This was an extremely good number of samples from that region. He then took the ferry across the Straits of Tiquina between San Pablo and San Paulo by lorry, continuing along the Peruvian shore to Puno, where we were to meet.

On 13th - 20th April I continued to recuperate and got tickets for Peru, as well as a visa, and exit permit from Bolivia. General thanks and farewells were made to Figueroa, who had really worked very hard for us, and to Herrick also. Eyerdam, whom we had got to know in Cochabamba, was planning to travel with me to Puno. On my last day I had supper at the American Institute, said my farewells and thanks to various friends and packed my suitcases ready for an early morning start.

On 21st - 22nd April I took the train up to the Lake Titicaca shore at Guaqui and embarked on the "Ollanta", the largest ship on the lake service. The weather was perfect, and the contrast between the yellow rocks and the blue water and sky was fascinating.

After we had passed through the Straits of Tiquina, the Isla del Sol (Sun Island) came into view on the right. One could catch a glimpse of Inca ruins as well as the steep terraced slopes. The snow-clad mountain peaks showed up clearly beyond this, and to the east as night fell. This was my last day in Bolivia and looking back on it, I think this part of our trip had been most successful. The Bolivians at official and unofficial levels had tried their utmost to help us, with the results that we had amassed two hundred and eighty-seven samples, mostly cultivated potatoes. Our contact with Professor Cárdenas in Cochabamba had been extremely valuable, and our collections in the high altitude of La Paz department had brought in a good quantity of frost resistant varieties.

This included the rare species *S. ajanhuiri*, which my former student and later my colleague, Dr. Z. Huamán, later verified as a natural hybrid of *S. stenotomum* and the wild frost-resistant species *S. megistacrolobum*. It seemed to be confined to the northern parts of Bolivia, but has since been found in Peru just across the border with Bolivia. Of course, the frost-resistant species *S. juzepczukii* and *S. curtilobum* were quite commonly grown at high altitudes, and we made many collections of these also. As is well-known now, they inherited their frost resistance from *S. acaule*, one of their parent species.



15 Feb. 1939. North Argentina, prov Jujuy, near Tilcara at ca. 3800 m; high Andes, fine clump of high altitude cactus (*Oreocereus* sp.) on dry mountain side.



18 Feb. 1939. North Argentina, prov Jujuy, between Tilcara and Humahuaca; low bridge washed away by flash floods, and workmen repairing damaged railway line.



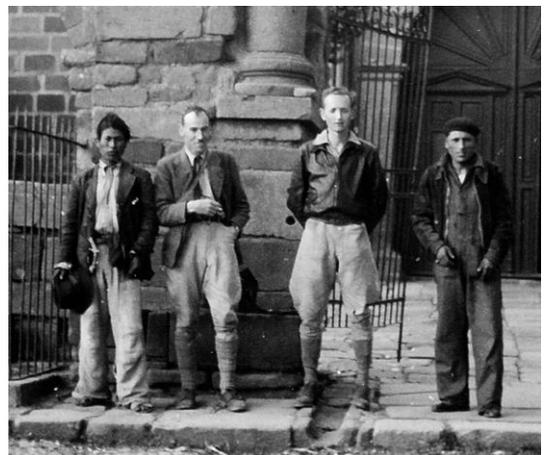
24 Feb. 1939. Bolivia, dept Tarija, near Tilcara; Bill Gourlay wading through the Rio Grande de Tarija.



02 Mar. 1939. Bolivia, Chaquí near Potosí; hill covered with field terraces for potatoes and cereals.



10 Mar. 1939. Bolivia, between Sucre and Potosí; view of Andes and cultivated valley.



29 Mar. 1939. Bolivia, dept. La Paz, near Lake Titicaca, Tiahuanaco; boy, Edward Balls, Jack Hawkes and driver, standing outside a church.

CHAPTER 6

IN SOUTHERN PERU

Puno and Lake Titicaca

The ship docked at Puno harbour, at about 6.30 A.M. on 21st April, but we could not disembark until 7.00 A.M. when the customs officials arrived, and our passports were signed and stamped. After customs examinations Edward and I compared notes as to what we had done. He had not been able to get up on to the slopes of mount Illampu, but he had been able to photograph harvesting at the Huarisata Mission College where he had made about seventy collections. He had had trouble in getting transport on the Peruvian side of the Straits of Tequina and in fact had only just arrived at Puno at the same time as I had. In Copacabana he was fortunate to witness the Indian dances, which continued for three days. The costumes were of brilliant reds, pinks, yellows, blues and purple, using many parrot feathers.

At Puno we booked in at the Hotel Extra. Extra-what, we wondered, and certainly not extra-clean, but reputedly extra flea-ridden! Whilst Edward was eating breakfast Eyerdam arrived with a Scotsman - a Mr. Arnold, who was working on a new dredger for Puno Bay. He was a great local character, apparently, who lived almost entirely on pisco (fermented and distilled sugar cane liquor) and whisky. Arnold lived at the Hotel Ferrocarril and wanted us to shift over and stay with him. He also introduced us to his club, where he plied us with pisco and whisky, whilst a friend of his - a Sr Parodi - joined us. We finally managed to get away and to bed at 1.30 A.M. Arnold, though something of an old soak, was a friendly, talkative individual who one could not help liking. We saw more of him later!

On Saturday, 22nd April we planned to visit Dr. R.P.V. Soukup at the Granja Salcedo (or Granja Taller Escolar, i.e. Farm Workshop School). We had already been in correspondence with him and had found out that he was of Czech origin. He had sent us many potato samples previously, the first through the kindness of the Percy Sladen Expedition (CPC 1066-1150). The second was given to us during our visit (B 6545-6615 and B 6619-6666) but was unfortunately lost in the post in Peru. The third collection was sent down to Lima and incorporated into the general collection at the end of May (B 7009 - 7020).

The Granja Salcedo was an agricultural college, designed to teach poor Indian boys the basic skills of reading, writing and arithmetic, together with suitable agricultural methods, both theory and practice. It was a missionary college of the La Salle order. The word "Salcedo" could have referred to the name of the founder, the original owner, or even a willow garden. In view of the high altitude and harsh climate I do not think the third alternative was very likely. Unfortunately, I never thought to enquire about the antecedents of this farm college. It certainly seemed to be successful, though I do not know whether it still continues.

We took a taxi over to the Granja which was fairly near to Puno, and was a very large building, and quite close to the lake shore. Soukup met us at the door and struck us as an extremely likeable kindly person. He showed us his study, where he had just had a new microscope installed, with every conceivable gadget included. The entrance hall was stunning, decorated with Inca motifs in glowing colours. On the wall of the staircase was an enormous painting of Manco Capac, the first Inca, with his sister/wife Mama Capac, and a golden wedge in his hand, standing on the Island of the Sun in Lake Titicaca.

This is part of the legend or creation myth, that the first Inca and his wife appeared on that Island and were told by their Sun God to voyage northward until they came to a place where the golden wedge would sink into the earth. It did so at Cuzco, which the Sun God decided would be their capital city.

On being shown round the Granja we were especially impressed by the biology laboratory, with many wall diagrams. There were also rooms for weaving, rug-making, woodworking, metalworking, baking, etc. The dormitory had two hundred beds in it with cupboards etc, all made by the boys. The plates of pewter and aluminium in the dining room were also made by the boys. Tailoring and shoe-making workshops were included as well. One might conclude that this was merely the use of cheap labour, but on the other hand the boys were learning crafts and processes which would be very useful to them as adults.

The gardens around were quite extensive, irrigated, and with all the vegetables needed by the Institution. There were also some glasshouses for more delicate plants. Cows, horses and sheep were reared here as well. Behind all this were the original very small farm buildings that had been used until nine years previously when the current palatial building was constructed. There was also a minute church.

It was now lunch time, and in the dining room we met the other padres, some of whom I had seen on the boat the previous day. These padres provided an enormous lunch with liberal quantities of red wine and were most jolly and friendly. About half-way through lunch a large group of Indian boys entered and sang "Abide with me" heartily but not too tunefully perhaps, with a very uncertain violin accompaniment. They sang this hymn particularly for us English visitors, for "Was it not the hymn sung when the Titanic was sunk"? We didn't quite see the logic of this but no doubt they meant well.

After lunch came the serious business of selecting potato samples brought up from the vast stock they kept in the basement. We took about seventy samples, entirely different from those which had already been sent to Cambridge. Unfortunately, as I mentioned earlier, over one hundred of these were lost in the mail between Puno and Lima. To return to our activities: we did not leave the Granja until about 7.00 P.M. The Granja and its activities were most impressive, and I only hope that the Indian boys benefited from it. Nothing was said about training Indian girls, but presumably that task would be undertaken by nuns. We saw some of this kind of work later, when we were in the Cuzco region.

On Sunday, 23rd April, Mr. Arnold, the dredging engineer, took us to see a fellow Scot, who according to Arnold, "had the largest potato farm in the world". Before going on to the farm, however, we had a good stroll round the Sunday market which completely filled the market square and was very colourful, with lots of produce for sale, particularly different kinds of potatoes, ullucos and chuño (freeze dried potatoes) for sale. All the people from miles around went to these Sunday markets. I tried to take ciné shots, but found it difficult to prevent small boys from standing in the centre of the foreground, and older people getting out of the picture as quickly as they could. However, I did manage to photograph a few typical scenes.

Later, we found a taxi to take us to the farm at a place called Ilpa, which was situated a little to the north of Puno near the Lake Titicaca shore. The intrepid Mr. Arnold told us spine-shivering tales of how a lorry had fallen over a bank here and a car there, just as we were approaching these places. On our arrival we met the owner of the farm, Mr. Reeve, with a week's beard on his face and taking life easy in pyjamas and dressing gown.

Arnold first insisted on our having drinks of pisco from a bottle he had taken with him, and a plate full of bananas and cream - a speciality of the house.

A little later, Reeve came out, freshly shaved and properly dressed. We were taken round the farm and shown all his potato fields, full of mature plants or with the harvest already taken. He did not have much of a variety - mostly "Imillas" for table consumption, or "Ruquis" and "Pinazos" for chuño* - and tunta production. He used mechanical harvesting equipment and sold the potatoes for seed in the Tambo valley below Arequipa. We found fruits on the bitter varieties, so probably they might not all have been *S. juzepczukii* which is a sterile triploid. Unfortunately, all but one of our collections from there were sent to Lima with the Soukup materials and were lost. A collection made from seed collected along the field edges, named "Ruqui" [or Luki =bitter], turned out to be *S. acaule* (Balls 6617) - a wild frost-resistant species from which the bitter cultivated species *S. juzepczukii* was derived.

We returned to Puno with Mr. Arnold, but halfway back we were fortunate to see two teams of Indians working with the traditional foot plough, which had been in use since Inca times. The only modern change was that an iron point had been given to the instrument instead of a hard wooden or bronze one. The way it was worked was that a trench was dug by the two men by lifting pieces of turf from one side to the other, whilst a woman followed to settle the turfs in place. The turfs were then broken up a bit and the potato tubers planted in them. A little manure was added if it was available. Although this method of "ploughing" was quite slow and arduous it was apparently quite efficient. Of course it could be used only on fallow land where a grass sward had already developed.

We also witnessed harvesting by the Indians who used a small hand hoe-like implement. This was a short stick with an iron blade bound on to one end, forming an acute angle with the stick. Unfortunately we witnessed this latter activity in a hail storm, so could take no photos.

On Monday morning (24th April) Edward and I went down to the jetty to take photos of the Indian balsas or rafts, which are made of sun-dried Totora reed (*Scirpus lacustris*) tied up in bundles, and then worked up into the form of a boat. Sails of the same reed are used but if there is no wind a long paddle or pole is used to move the balsas. The large balsas generally had two masts, joined at the top, to which the square reed sail was attached. Some even had a little "cabin", also made of reeds. We got some good cine and still photographs of balsas in dock and bringing Indians into market, mostly women and girls. The kind of costumes worn here were quite different from those in the La Paz region, most women wearing black with a black shawl over the head and shoulder and a rather flattened bowler hat over that. They wore many brightly coloured petticoats which could be seen swaying gracefully when they walked. Very often they used the shawls for carrying food or babies.

From another region the women's hats were black, very wide, and low in the crown, almost square, with a floppy brim falling over the square one. Some brightly coloured pink or red material was often used on the under-surface of the black hats. The male costume was comparatively uninteresting and Europeanised except for the inevitable poncho and the knitted cap with ear flaps. Thinking about these women's costumes with regional variants led me to wonder whether they were based very much on 16th - 18th century Spanish dresses and hats.

* - Chuño is freeze dried potatoes, and "tunta" is the same, but washed afterwards in a stream, generally.

Of course there was an influence even on men's costumes in some places, though in others the men wore ordinary 20th century clothes. Indian ideas and love of bright colours were obviously influencing the dresses also.

On Tuesday, 25th April the Chief Padre of the Granja Salcedo called for us to take us to lunch there. It seemed as though this part of the expedition was one gigantic lunch and dinner party, but we did do some collecting in-between! Furthermore, in those isolated places everyone was only too glad to have someone different to talk to. We talked to Soukup about modern ideas of potato taxonomy and diversity, followed by another colossal lunch with much red wine.

After lunch we staggered out to make an excursion into the hills above the Granja to look for wild potatoes. In that high and apparently desolate landscape there were in fact plenty of wild plants, many in flower. We saw many yellow *Calceolaria* species, the same scarlet *Cajophora horrida* which had been a feature of the mountain landscapes in Bolivia and Argentina; also a white gentian, a *Bomarea*, a *Eupatorium*, a *Zephyranthes*, and many other species.

The wild potatoes from the Ilpa potato farm were *S. acaule*, mentioned above, and what I then called *S. punoense* (later to be united under *S. canasense*). The two collections from above the Granja, which I described as *S. soukupii*, also, I am afraid, had to be later included under *S. canasense*. This was a particularly beautiful species, with delicate leaves and exquisite large blue-violet flowers.

The slopes of the hills above the Granja were covered with little patches of cultivation scattered right up as far as one could see. Dr. Soukup explained that the Indian communities of about twenty families owned very large areas of ground but after using a plot for one or two years it was then left fallow for at least four to six years. So the apparently deserted areas were really lying fallow, because the Indians used very little manure to fertilise the ground. Most of these plots were cultivated by foot plough, as the Indians owned no oxen.

The fauna of that area was very restricted, with a few lizards, abundant snails and beetles, and big flocks of small green parakeets, making loud chattering noises. It seemed extraordinary to find what one thought of as tropical forest birds at altitudes of about 4,000 metres above sea level.

We had been finding a quite common disease on the potatoes which we had assumed to be wart (*Synchytrium endobioticum*), but which later was found to be powdery scab (*Spongospora subterranea*) in its 'canker' form. It seemed to attack wild potatoes also, as we had noted in Argentina, but it did not seem to do any real damage.

After some bowls of coffee at the Granja we went away with some more potatoes and various useful pamphlets. We spent the evening describing our collections and packing them up. Edward and I also had a big argument as to whether the work of the Granja was of any lasting use to the Indian boys. Edward thought that a girls' school would be more useful in the long run than one for boys, because the women played a more important role in bringing up the family and teaching the children about traditional customs and beliefs. Ideally, of course, schools for boys and girls were needed.

Wednesday and Thursday, 26th and 27th April were somewhat uneventful, except that Mr. Arnold took us to the studio of a Sr. Landaeta who painted in oils. I bought an oil painting of balsas on Lake Titicaca, whilst Edward bought three, one of them being an attractive view of an Indian market, another of the Lake and a third of an old colonial patio. I also bought a Vicuña rug, the vicuña being the wild ancestral form of the domesticated llama. Looking back, of course, I should not have bought it, since this encourages trappers to kill more of these animals. No-one in those days was interested in conservation of wild species of course. After these transactions, we ended up with more whiskeys at the Club I am afraid!

On the following afternoon we went out to find Reeve and to take ciné shots of foot ploughing and of potato harvesting. Two out of the four men ploughing wore black trousers, rolled up inside to just below the knee and no sandals. They had black jackets and scarlet ponchos folded back on each side onto their shoulders and tied round the waist. On their heads they wore the traditional pointed woven caps with ear flaps. The other two were dressed in more sombre-coloured grey and brown ponchos and head caps to match. The foot ploughs were used rather like spades except that the blades were narrower and rather pointed.

On our return to Puno we came to an area named Silustani where there were some ancient burial towers called "chulpas", reputedly built by the Incas. These were situated on a peninsula jutting out into a small lake which was itself leading off from Lake Titicaca. The name "silustani" is a quechua word meaning 'finger nail', from the shape of the peninsula.

It was a grand, awe-inspiring and unforgettable sight, with the towers situated on a table-land with twenty foot cliffs down to the lake; and in the distance other similar peninsulas with towers on them, always built on the edges, near the cliffs - never in the centres. The towers themselves were about fifteen to twenty feet tall and perhaps eight to ten feet in diameter, built of gigantic blocks of a volcanic stone perfectly cut and fitting closely together without cement or mortar between them. The towers splayed out slightly from the base until they reached a raised band near the top, afterwards curving sharply inwards. The interiors were filled with rubble. On the centre of the plateau were various blocks of stone that had been in the process of shaping, and on some of them a lizard or frog was carved in relief. It seems that these may have been towers on which corpses of priests, or perhaps sacrifices were set out, but no-one really knows. Another curious feature on each tower was a square hole right at the base, looking as though it penetrated right to the centre. What was it for? No-one knows. We were told that there was a cave not far away, full of bones and skulls, and that it was possible to dig out corpses ("huacos" in Quechua) from some of the towers. The truth was that the ritual or sacrificial significance of the towers was unknown, though the most likely explanation was that they were for some kind of religious or ritual burials.

For supper we tried some tunta - the white freeze-dried and washed potato products. We did not really like it much since it tasted like laundry starch, and was very fibrous and hard.

April 28th was our last day in Puno and we decided to take a boat trip on the lake to visit the Uro Indians - a tribe that lived continually on Lake Titicaca. They made their homes on floating reed islands and only returned to the mainland to go to the weekly market at Puno. Mr. Arnold lent us a motor boat, with a small rowing boat attached. It was a marvellous sunny day to begin with, and the lake and hills seemed to sparkle in the clear air and sunshine. We passed masses of birds, either floating on the water or perched on buoys.

Some were grebes, others moorhens and coots, whilst others again looked like cormorants and shags. Many of the birds did a great deal of diving, probably after fish.

Our route led towards the vast totora reed beds in the shallow north-western end of the lake, which we reached in about two hours. There we found the floating reed islands which were never more than about six to twelve inches above water level, with living reed plants round the edges and a flat spongy surface inside. They were certainly floating because although the lake level varied from year to year the island level always remained the same.

The Uro Indian islanders lived in primitive huts made from sheets of reeds bound together with grass or reed ropes, which we saw the women busily making. The huts themselves were about four and a half to five feet tall, and each island had one or two of these, presumably one for each family. There were also several stacks of drying reeds piled up like sheafs of corn. When dry, the reeds assumed a brilliant straw-yellow colour. Outside the huts the ground was littered with cooking pots, some with cold, cooked and very diseased-looking potatoes. Patches of ground were spread out with slit-open fish drying in the sun, smelling very strongly. Tethered pigs rooted round at the edges of the reeds, looking quite happy. No cultivation went on except on one of the islands where there was a small patch of potatoes in flower and with quite large, healthy looking tubers (*Imilla negra*: - *andigena*).

The inhabitants themselves were very timid and we had to leave our launch some way away and approach quietly in the rowing boat. As it was, all the men had disappeared, probably in fear of being conscripted into the army. We found only women and masses of children of both sexes. On every island it was the same. It was interesting that up to ten years earlier (that is, up to about 1929) these people were said to have lived absolutely naked, with no clothing whatsoever, although it was often bitterly cold at those altitudes. However, the Peruvian Government did not think it altogether proper that these people should live in such a happy unashamed state, and therefore told them that unless they wore clothes they would be exterminated (at least that is what we were told). This parallels apparently the former situation in Tasmania.

The adults did what they were told but the children wore a shirt reaching down to the navel only. No need for nappies! They were incredibly dirty but seemed quite happy. The people became quite friendly when they saw that we did not want to harm them and did not mind being photographed, apart from an old woman who declared that she would die if photographed. If one gave a small coin, however, the shadows of death were averted. They kissed the coin and murmured a few words - perhaps a prayer.

After our visits to the islands we espied some fishing balsas in the distance, but they outdistanced us to begin with. After a while, word got round probably that we were harmless, and thus they allowed us to approach them. We finally caught up with an old man in a balsa about seven to eight feet long and quite narrow, rather the shape of a canoe. They had much larger ones for going into market with their fish produce. The old fellow did not seem to have much fishing tackle with him, though he had caught some fish. He also had the usual bag of coca leaves for chewing and was paddling his craft merely with a long stick. In shallow water when going fast he stood up and poled his canoe along with this pole, using each end alternately. We got several photos of this man and gave him some cigarettes, but he hardly knew what to do with them.

Later on we stopped at an island in Puno bay where Dr. Soukup had told Edward that there were some interesting amaryllid bulbs. There were masses of them, so we took some samples. On the top of the island there was a monument to some US savant who died whilst crossing the lake. We had hoped to photograph a group of balsas going into Puno but none arrived. Since it was by then 4.00 P.M. and we had not eaten since 8.00 A.M. we decided to call it a day and return to the hotel for a large meal. We went to visit Arnold later, but he did not seem well, so after a Peruvian friend looked in and played a few Peruvian songs on his mandolin we returned to the hotel and retired to our beds early.

To sum up, in effect, most of our collecting in Puno had already been accomplished for us by Dr. Soukup, who, with the help of his pupils, had amassed a far larger collection than we alone could have hoped to have made. We were thus extremely grateful to him and to the other Padres at the Granja. On later analysis, I found that the collections contained seven samples of *S. stenotomum*, none of *S. ajanhuiri* or *S. phureja*, eleven of *S. chaucha*, seven of *S. juzepczukii*, six of *S. curtilobum* and a magnificent fifty two of *S. tuberosum* subsp. *andigena*.

It was surprising that there were no collections of *S. ajanhuiri* or of *S. phureja*. We learned later that *S. phureja* was adapted to lower altitudes right through the Andes from Bolivia to Colombia: *S. ajanhuiri* appeared to be confined to northern Bolivia, though later reports indicated, as I said earlier, that it did just penetrate into Peru (Puno department).

Cuzco, Paucartambo and the Valley of the Rio Vilcanota

The Cuzco area promised to be perhaps the most interesting of all the Andean regions, both for the genetic diversity of potatoes and, of course, the archaeological remains of the Inca empire, of which it was the capital. We therefore had high hopes of our stay there, centred in Cuzco, but exploring as much as possible of the whole valley and mountain systems around it, particularly the valley of the Rio Vilcanota (or Urubamba), whose waters led through the Rio Ucayali and thence past Iquitos into the Amazon.

We began the journey from Puno to Cuzco on April 29th. The train was an unexpected luxury, with Pullman coaches and separate swivel seats. After passing Juliaca we ran into the tourist zone, where every station sold pretty souvenirs for American and European travellers, not always in good taste and clearly made for the overseas visitors.

The line gradually rose for the first one hundred miles; at Pucará we saw Mrs. Kidder whom we had previously known in Arequipa. Her husband, the archaeologist, was currently out on a dig. The highest station on the line was La Raya, at about 4,300 metres, very cold, with a great deal of snow around. We then dropped down into the valley of the Rio Vilcanota. Patches of cultivation ran up both sides of the valley on to the steep mountain sides but there was practically no terracing. Further on down, at Sicuani and right through to Huambutio we saw different Indian hats, worn by men and women alike. They were perfectly flat-topped, with a brim sloping back down to the head. The flat tops had various designs on them, but many other types of hat were also worn.

From Huambutío (3,000 metres), the railway line turned up to the left, into the Cuzco valley where it climbed slowly, reaching Cuzco at about 3,300 metres and two hundred and forty miles from Puno.

At Cuzco the Hotel Ferrocarril (Station Hotel) was most luxurious (including the price!), very clean, with good food and service, and was probably the best we had found ever since leaving Lima. After supper we strolled round the town, seeing enormous numbers of churches (we calculated an average of three in every plaza). Apart from the elegant churches the side streets were really filthy, with rubbish and excrement everywhere. Eventually, we found a street lined on both sides with perfect Inca masonry, the stones superbly cut and fitted; these walls had occasional trapezoid doorways and rounded street corners. Further on, we found the Cathedral of Santo Domingo, built on the foundations of the Inca Temple of the Sun, with its curved Inca eastern wall still showing. Through a window, long destroyed, the rising of the sun was said to have been observed each morning. By this edifice was a plaza in which the first storey of all the buildings around it was of Inca construction. However, the second storeys were of adobe, because the Incas, as far as I could understand, hardly ever built more than one-storied houses and temples.

The following morning (30th April) we set out by hired car down the valley we had ascended the night before to the Rio Vilcanota at Huambutio, thence turning left down the Rio Vilcanota to Pisac. The object, of course, was to see the Sunday market, and hope to collect potato samples there. The vegetation on the way was very exuberant though cultivations were confined to the valley floor, with rocky cliffs on either side.

On reaching Pisac we crossed the river Vilcanota by a suspension bridge which sagged slightly as our hired car went across it. The main plaza was an unforgettable sight, fairly large, and with two enormous bright red flowered *Erythrina crista-galli* trees in the centre.

The ground was almost entirely covered with rows and rows of Indian women sitting with their wares displayed on woven shawls in front of them. The predominant colour was a beautiful red or crimson, with occasional splashes of dark blue. The whole effect was breathtaking. The colours were not so varied as those in La Paz, but those were aniline dyes, whereas those at Pisac were natural vegetable ones, of a deep glowing red and dark blue. The hats were the flat-topped ones which I have already described, and many women had striped shawls with babies slung on their backs. The skirts were generally dark blue. The men wore dark blue trousers coming down to the knees, whilst the shirt was generally red. All wore fairly short ponchos striped with red as the dominant colour, but with some stripes of soft shades of blue, yellow and green. Occasional ponchos were patterned, not striped. The men wore a rather skimpy cap with ear flaps, tied under the chin. On top of this was a flat-topped hat almost identical with the ones worn by the women. Both men and women had very fine intelligent-looking features. There was an immense variety of goods for sale, including a great variety of *Ullucus*, red, yellow and green peppers, potatoes and many other foodstuffs.

The church service started at 11.00 A.M. and involved a certain amount of ritual. The women, on entering the church, removed their hats, knelt or sat down on the dirt floor and threw shawls over their heads. The men had a lot more to do. A man, on arriving at the church steps would take off his sandals, then remove his large hat and hang it over his left shoulder, push his woven cap back over his head and stand or kneel, according to which part of the service was in progress.

The local mayors (alcaldes) from all the surrounding villages were there and wore their insignias of office. Some wore "tail coats" with queer square ends, the tails reaching to behind their knees, whilst others had white llama fur gloves which they hung from the waist.

Others were dressed almost entirely in dark blue and each carried a black staff with silver bands. Some staffs were flattened, others cylindrical. Perhaps the most interesting pieces of equipment were large conch shells which they blew during the service, towards the end. They all looked both picturesque and devout at the same time.

The church itself is worthy of comment having a thatched roof, dirt floor and an altar completely covered with images, whilst the walls bore various painted designs. The crowning piece was the organ, with two colossal bellows, side by side, with a stick attached to each. During the playing a small boy rushed from one to the other keeping them inflated - at least, that was the intention, but often he did not get to one or the other in time; thus the note at the end of each loss of inflation went very flat. I wondered why they had not thought of having two small boys, one for each bellows? The general effect was that the tunes were clearly unrecognisable and the whole performance was to us rather funny, though of course it was deadly serious to the priest and congregation.

As I have said, the conches were blown towards the end of the service, the noise sounding like a donkey or a cow in pain. At the close of the service the alcaldes went out first, standing in two rows like a guard of honour at a wedding, blowing their conches as the rest of the congregation trooped out. Last of all was the priest, whom the conch-blowers escorted to his dwelling in a turning off the square, walking in front of him and blowing fresh blasts on their conches as they walked along.

Originally, this ceremony was said to have been enacted only on the election of a new alcalde (mayor), but they evidently liked it so much that it was now repeated every Sunday, with a new alcalde initiated every week. This of course led to the situation that the word of the alcalde bore very little weight, but of course I am writing about 1939. Things may be quite different now in 2003.

Up above the town and quite visible from the market square were the old Inca ruins of Pisac; they were situated on a steeply sloping spur and pinnacle of the Paucartambo valley. The site was supposed to have been used as an observatory. Below, were wonderful cultivation terraces, perfectly walled and running parallel to each other, all seemingly intact and well-preserved. Unfortunately, we had no time to visit them.

On 1st May we looked for Professor Cesar Vargas at Cuzco University, but to no avail, finally tracking him down at his house after three visits. He proved to be quite a young man, not yet thirty years old and a very keen plant collector and photographer, interested also in potatoes. He was really the only botanist in the south of Peru, and we were lucky to find him. He and I remained friends for the next fifty years or more until his death. He presented us with a copy of his Ph.D. thesis on potatoes,* - and promised to take us after lunch to the Inca fortress of Sacsahuamán, above Cuzco. Without a vehicle, it took us about an hour to get to the top!

The fortress itself was built on a spur, with very steep slopes below on three sides. The third side abutted on to a flat space - probably an ancient military parade ground. The walls were laid out in a zig-zag fashion so that invaders might be shot at (with sling stones, presumably) from the side.

* - Vargas, C. 1936. El *Solanum tuberosum* a traves del desenvolvimiento de las actividades humanas [S. *tuberosum* in relation to the development of human activities].

There were three lines of walls, one above the other, but the most impressive aspect was the sheer size of the stone blocks, up to twenty feet (6 m) high and some six to eight feet (1.8-2.4 m) broad. No-one knew how these ancient builders managed to cut and move into place such cyclopean blocks. Added to this, each stone was perfectly cut and fitted into its neighbour, whilst none were laid in courses. Occasionally, in the back angles of the walls the stones would be cut so that they curved right round through ninety degrees, from one face to another. One had the impression - false of course - that all the stones had been melted and pressed together! How could these megalithic builders have accomplished any one of those fantastic tasks? No-one knows and probably never will do!

Inside the outer wall were two others, each at a much higher level than the wall below, built of somewhat smaller stones, but even so, much larger than those of any modern wall. Inside the fortress one could see the remains of rooms with niches in the walls, still easily discernible. In one area there was an extraordinary system of what appeared to be concentric circular water tanks with four to five feet thick curved walls and one to two feet thick radial ones. How did they get water up there? Again, no answer. In fact the whole edifice was quite inexplicable in modern terms.

On the other side of the arena was what appeared to be a glaciated rock face with a set of seats above, on which it was suggested that the Inca and his retinue would have sat and watched displays in the arena. It was said that these Cyclopean walls were of an earlier culture, the Incas adding to and adapting them only. There were always lots of such suggestions about Sacsahuamán but no real knowledge, because of the complete lack of written records. Some of the houses in the city also gave evidence of three cultures - very large stones below, followed by smaller Inca-type ones in neat courses above, and Spanish adobe ones on top.

Back to Sacsahuamán again. We missed a wild potato species, which was found only on a later trip. This was in a sort of limestone pavement with one to two feet crevasses in it. At the bottom of the crevasses Cárdenas and Gandarillas had found this species (number 3,500) in 1943 and we later named it *S. raphanifolium*, as the leaves looked rather like those of radish (*Raphanus*) I collected it again in 1971 and 1974; also Vargas had found it there in February 1939, but had forgotten to tell us about it. So, it was well-collected by these and other botanists. Tourist spots are always an attraction, both for tourists and botanists!

Back in Cuzco we did a bit more tourism, by visiting a famous stone with twelve sides and angles, in an Inca wall, all perfectly fitted into the twelve stones around it, and these also to each other. The Incas and their ancestors were incredible stonemasons, particularly as they did not have iron or steel, only bronze, and other harder stones to shape the ones they fitted so beautifully together.

On May 2nd we went out to find a Sr. Santiago Astete to whom we had an introduction. However, we lost our way in a disgustingly filthy part of the city. Eventually, we made contact with him. He turned out to be the supervisor of all archaeological works in the city, to be an authority on the Quechua language, and to have friends who owned potato farms at Oropeza, a small village twenty kilometres down the railway line towards Puno. A visit was arranged for the following day, so meanwhile he took us round various museums, with ancient pottery, golden llamas, silver pins and brooches, various rather frightful "mummies" in crouching positions, and wonderful mats of dyed vicuña cloth of exquisite workmanship. These last items had central panels depicting fishes, birds, reptiles and mammals in very natural poses.

We could easily identify jaguars, snakes, parrots, several different kinds of fish and a large selection of other birds. In some places there were little groups of playing vicuñas. The colours of one mat were predominantly red, those of the others, blue.

Mr. Astete gave us a reprint of a paper he had written on Quechua etymology, using quite a different kind of spelling than we had been used to. For instance "Cuzco" was spelt "Ccoscco" and Quechua was "Cjeswa". We were promised a letter of introduction to the people at Oropesa, and Vargas gave us a letter to a missionary lady at Paucartambo, a town situated in another valley.

On 3rd May, setting off for Paucartambo, we managed to get seats in a sort of home-made bus that had started life as a lorry. The seats were planks, and excruciatingly hard; still, that is what expeditions are all about. We saw a very English-looking lady in the bus whom we decided must be the missionary, Miss Lunn, and so it transpired. She kindly invited us to stay in her house (an orphanage) because of the lice and fear of typhus in the Paucartambo hotels. She said she could not feed us but would give us a room to sleep in. We went on the same road as we had done to Pisac, then carried on over the mountains between the Vilcanota and Paucartambo valleys by a well-paved but single track road, twisting and turning to gain height, and of course to lose it when we had passed the highest point. The traffic was controlled: to Paucartambo one day and to Cuzco the next. The views were marvellous - steep mountains with rocky crags, with Paucartambo itself lying in the valley bottom, and a beautiful high single-arch bridge over the river.

The plaza was trapezoid in shape with a pool in the centre, a few stemless palms and a row of small poplar trees. The houses were whitewashed, with red roofs and upper floor balconies painted blue. It was really a very Spanish type of town, highly picturesque and, like many such places, incredibly dirty. The streets were cobbled, with a central gutter into which all the dirty water was thrown.

At the Mission House we were received by an eighty year old American lady - a Mrs. Stockwell - and met various orphans whom those kind ladies fed and looked after. Their house was reputed to be the oldest in the town with beautifully carved doors formed of four quarters so that the top two could be opened separately from the bottom ones. The missionaries said that the town bullfight was once held in the patio of the their house and that treasure had been found in cupboards and ceilings. Mrs. Stockwell was a quaint old lady, and showed us round the house and garden with pride. Although she agreed that the town was very picturesque and colourful, that was just on the surface, and that most people lived in squalor and misery, and were poor, dirty and diseased. That day was the first day of the feast of the Cross, which lasted for several days, in which all the Indians from miles around brought their crosses in to be blessed by the priest. Then they danced round the streets to the music of pipes and drums. It was an extraordinary scene.

We did some botanising up a side valley after lunch and saw a procession of Indians returning home, with their pipes playing and their crosses duly blessed. We found many plants in flower, three colour forms of *Salvia*, red, blue and purple, a bright pink *Passiflora gracilens*, various *Bomareas*, many Compositae and a vile tree-like cactus with short four to six inch branches which tended to drop off on to ones legs and arms with long hooked spines which were difficult to remove. It was certainly a tremendous dispersal mechanism, so much so that one got the impression that they jumped out at one. There was a species of *Solanum* with pale green, purple-striped berries, but unfortunately no tubers.

We returned at about 4.00 P.M. to find Miss Lunn and her two friends, Miss Smith and Miss Norrie, just arrived from Huambutío. Mrs. Stockwell showed us our room and told us where to eat in the town. We strolled up to the end of town and met a Sr. Yabar, to whom we had a letter of introduction from his cousin in Cuzco. He talked with us whilst we were having dinner in the hotel but I found him very difficult to understand. He was a queer stick, and we found out later that he was called "El loco" (the madman). He decided that I was a typical "gringo" (obviously a term of abuse) but Edward less so. Both he and his cousin were communists, extolling the earthly paradise of Russia; but I doubt whether they would have actually liked it any more than Peru, in fact probably much less.

It was a relief to sit quietly afterwards drinking cups of tea with the missionary ladies. They naturally disliked our communist "friend" who had apparently half murdered his wife on several occasions and of course he did not approve of Miss Lunn and her fellow missionaries at all. His poor wife looked terrified of him - with reason!

On May 4th we had breakfast with our "loco" friend, named most inappropriately Ángel Yabar, and were then shown round his garden of fruit trees with many grafted varieties, and were given fruit and pots of jam. He also grew many rose varieties, fuchsias, violets, passion fruits, papayas and much else besides. Not only this, but he offered to get us a complete collection of the potatoes of the Paucartambo region. Amazingly, he did just that, from his various farms in the mountains. These included various potato species, *S. stenotomum* (nineteen varieties), *S. chaucha* (twenty-four varieties), *andigena* (forty-eight varieties), *S. juzepczukii* (two varieties) and *S. curtilobum* (one variety), and thus a total of almost one hundred varieties. These, of course, were sent on to us later.

In the afternoon we set out to visit a Sr. Flores whom we had met on the bus going down to Paucartambo. He invited us to visit his farm, where we met his father, mother, two large sons and several small ones, plus a daughter. We were immediately offered plates of boiled potatoes and butter. The youngest son was very interested in my eyes, having never seen anyone with blue eyes before. On returning to the mission, we played "Up Jenkins" and "I Spy" with the orphans. It was great fun playing these games in Spanish and with such charming children.

May 5th started off with torrential rains, but cleared up after lunch. Before lunch we managed to get out to the Paucartambo market where we collected a few *andigena*, *S. chaucha* and *S. stenotomum* varieties. It seemed that the Indians were sleeping off the Feast of the Cross and did not feel like coming in to market that day. In the afternoon Julio (the chauffeur), Miss Norrie, Miss Lunn, Edward and I got into their large car for a trip "down" the valley. The road actually climbed up the side rather than down so that we ended at an altitude of nearly 4,000 metres. We gradually got into a cool mountain rain forest vegetation with the trees covered with epiphytes, flowering shrubs (*Fuchsia austromontana*, Melastomes, *Calceolaria speciosa* and red-flowered *Mutisia bipontina*) being very abundant. Higher up were fields of beautiful white and reddish-mauve gentians, small blue lobelias (*L. tenera*), pale pink *Cosmos* and a queer green-flowered gentianaceous herb called *Halenia umbellata*.

At the top of the ascent the road branched. To the left it went in the direction of Tres Cruces (a tourist spot) and to the right it went over into the next valley. There I found a wild potato, but the tubers died and I was not able to identify it, even though it had a white flower and one pair of lateral leaflets. It probably belonged to Series Conicibaccata, possibly *S. santolallae*, but I am not certain.

We had an English picnic tea in the car and then went out to make collections of bell-shaped white-flowered ericaceous plants, a ground orchis, a daisy-like shrub, bamboos, lichens, etc. Lower down the road the two ladies showed us a waterfall with another Conicibaccata plant behind it, but completely inaccessible. There were also large yellow-flowered *Calceolarias*, *Mutisia bipontina* with scarlet flowers, *Fuchsia boliviana* and another wild potato, again inaccessible. This was a wonderful place, with enormous amounts of plant diversity. These high mountain rain forests are unfortunately disappearing rapidly, as more trees are cut down to provide pastures for sheep and cattle.

That particular place was famous for its sunrises also; from that point, the most easterly mountain chain in the Andes, the sun, it was said, seemed to rise below you, and on a clear day this was an extraordinary sight. Coloured stripes appeared in the sky just as the tip of the sun appeared. There was also a volcanic peak on the left as one looked out over the sea of clouds to the east. This was said to have been the last refuge of a group of Inca caciques (chiefs) who alone knew the secret of how to reach the summit, thus saving themselves from death at the hands of the Spanish soldiers who were pursuing them. Tribes of Indians living in the valleys below were said to be direct descendants of those chiefs. Whether this is true or not, it is certainly a romantic story.

Saturday, 6th May started as a day of pouring rain in the morning, so the orphanage children helped us clean up seeds and asked all about our presses and drying stove. It cleared up later and we walked with some of the orphans up a nearby hill, finding an extraordinary range of plants, including two or three distinct *Calceolaria* species, two or three *Solanum* species (not tuber-bearing) and a plant with white bell-shaped flowers and red nectar. The children knew this, because they ate the nectar, which stained their lips red, and they then said "now we are like the señoritas!". We also found a *Solanum* whose leaves, curiously enough, looked and smelt like those of a *Cestrum*, even though the flowers were those of a *Solanum*. In a small damp lane we got a silvery *Salvinia*, which unlike most, was not floating on water but merely on very wet banks. There was also a pale Amaryllidaceous flower with green veins (*Stenomesson pearcei*) and an Iridaceous plant with a golden flower, a dark purple centre and a sweet scent.

We returned to the Orphanage at about 5.00 P.M. to find that most of the children had been bathed and looked very fresh and clean. They were all so friendly and trusting, but I wondered what would happen to them in later life. We later contacted Sr. Yabar to ask him to take us to the market the next morning, with Miss Lunn as interpreter, to which he agreed. When we returned from supper we found all the children seated round the dining room looking very solemn, with old Mrs. Stockwell at the end. Edward said "May we come in?" and we then found that we were listening to a Bible reading. I had feared as much but as it was all in Spanish it helped at least to improve our understanding of the language.

This reminded me of my Sunday School days, because after the bible reading we had a long prayer. Then Mrs. Stockwell left and the children asked Edward to give a Christian address to them, but when he said he could not he got into serious trouble. "What religion was he, then?". "Did he not believe in Jesus Christ?". "Had he a bible with him that he read every day?". "No"? "Then he could not be a Christian, etc". These children had been very well trained, but of course they were most intrigued that we were not the usual sort of visitors, who were, of course, missionaries, and who provided prayers and hymns without being asked.

They were sure that I was Edward's son, but when being told I was not, they were very sad for me because they were certain that my parents had abandoned me; but of course I told them that this was not so. This made them even more mystified. They then asked me to sing a song, but the only one I could think of was "Three Blind Mice". Unfortunately, they then asked for a translation, and when they found out that it was not a holy song they were greatly shocked and just could not understand what it all meant. Well, I got out of the ordeal eventually, hoping that I had not destroyed their faith completely.

The next morning, 7th May, we went to the market with Sr. Yabar, but there were very few potatoes on display, and they were of poor quality and not worth collecting. After lunch we packed our bags and caught the very crowded *camión* back to Cuzco. They seemed to use the word "*camión*" for "bus" in South America, which in Spanish really means "truck". I have to say that in many parts of the Andes there was not much difference between a bus and a truck, so the word "*camión*" was generally quite apt.

At two points on the road we could see many Chulpas or burial towers. These were smaller and more roughly built than the ones we had seen by Lake Titicaca. They also differed by being hollow, roofed over at the top and with a small door at the bottom. Unfortunately, we were not able to stop and investigate further. In Cuzco we met various other Missionaries who were going down to Macchu Picchu the day after next on the same train as us, staying the night and then planning to stop at Urcos in the Vilcanota valley where there was another mission station. They kindly invited us to stay there and take samples from the potatoes growing on their farm.

May 8th was spent in writing notes and packing and posting samples. A Sr. Astete was supposed to have come to take us to Oropesa by train but he simply did not appear - a very common situation in those countries.

On 9th May the train for Macchu Picchu started from a different station (and was run by a different company) than that of the train from Puno to Cuzco. The train was an autocarril (a kind of bus) leaving at 7.30 A.M. and we were accompanied also by the Missionaries, Miss Norrie and Mr. and Mrs. Horley. The train zig-zagged backwards and forwards up the hill behind Cuzco to a ridge and then down into the wide fertile Anta valley. After this the valley became steep and rocky, descending by some more zig-zags and coming down into the Vilcanota valley, not far from the town of Ollantaytambo. The whole district must have been densely populated in pre-Spanish days, as witnessed by the numerous ancient cultivation terraces, roads, forts and granaries. In one place we passed what had been an ancient bridge with heavy ironstone piers in the water. The bridge was made of rope and sticks, suspended from the piers. Not far away there was an iron-stone quarry with gigantic pieces of stone about twenty metres long, ready to be transported to bridge the gap between the three stone piers. This work was never carried out, probably because of the destruction of the Inca empire by the Spaniards.

At Ollantaytambo itself, Edward and I decided to get off to see the town and ruins, continuing on by a later train. We hired a boy to take us up to the ruins which were built on a rocky eminence. As we went up we got a good view of the cultivation terraces, showing that even the gently sloping ground in the valley bottom was terraced. The Incas seemed to have a horror of even the slightest slopes, perhaps because it was more efficient to irrigate the land when it was contained in flat terraces.

The town itself had Inca walls and foundations, and there were tombs set on the steep hillside. The most astounding building was the half finished temple, built of gigantic blocks of red sandstone, each about fifteen feet tall and six to eight feet wide, set on end. These blocks did not touch each other but the spaces between them were elegantly filled with rows of smaller, longer stones. Below the temple was a room built of very long horizontal stones and said to be where the "quipas" were kept - the knotted strings which conveyed census and other details from one part of the empire to another. The keeper of the ruins called this room "El Correo" (the Post Office) - not a bad description of the function of those knotted cords! The gigantic stones had been taken from a quarry right over on the other side of the valley and quite high up. How did (and why did) they do it? No-one seems to know. Was there a sudden catastrophe, such as a war, or change of government? Again, no-one knows.

In the village (or small town) of Ollantaytambo all the foundations and sometimes the whole houses were pre-Spanish Inca constructions, with trapezoid doorways and niches. This little town, in its completeness, gave a better idea of how an Inca town looked than did Cuzco, which had suffered so many later additions.

We got back to the station at midday, in time to catch the next train down to Macchu Picchu, passing many Inca towns and cultivation terraces, none of them any longer in use except for grazing. One interesting feature was the steps for getting up or down from terrace to terrace. These were stones jutting out of the wall and forming a diagonal row, rather like those in sea walls or jetties in England. There was an attempt at a design, because each successive terrace would have its steps going in a different direction. They thus formed a zig-zag pattern when seen from a distance, up or down the terraced hillside.

As we descended in the train the vegetation became greener, so that when we reached the Macchu Picchu valley station we found ourselves to be in subtropical rain forest. On leaving the train one walked down the valley a little way, crossed a bridge over the river and then took a steep zig-zag path up to the ruins. Edward and I were so interested in the plants, however, that when we got to this path all the horses and mules had been taken by the other tourists, and we had to climb up on foot with our heavy coats and cameras. But first we wandered down the main valley road admiring the calceolarias, begonias, tree-ferns (*Cyathium*), and orchids. Masses of other sub-tropical flowers were growing in abundance, with brilliant humming birds darting from flower to flower. It was a wonderful paradise.

We started the ascent at 3.00 P.M., of course dressed for a Cuzco climate and getting extremely hot in the bright sun and very little wind, perspiring profusely. We were quickly caught up by a small Indian boy, actually running up the path. He easily carried our coats for us and kept the same pace. As we got up higher we saw on the other side of the valley a very large spur which had the shape of a parabola, which the boy said was named "media naranja" (half an orange), though it looked to us more like half an avocado. Behind and around this were rocky spurs going into the distance, tipped with clouds and quite inaccessible to human beings.

We arrived at the hotel, which was on a ridge, some three hundred metres above the valley road. We then went off with our friends on a tour of the city. Macchu Picchu really is unique in itself and unique in its position, with sheer drops on three sides down to the river, and an even higher peak called Huayna Picchu at the far end, towering at least two hundred metres above the city. Even this had some Inca ruins right at its tip. Apparently "Macchu" means "old" and "Huayna" means "young" in Quechua.

"Picchu" refers to the shape of the bulge in the cheek caused by a mouthful of coca leaves when it is being chewed - a very common sight, even now, amongst the Indians. To get up to the tip of Huayna Picchu there was a path going up an almost inaccessibly steep slope. We did not try it!

It is almost impossible to describe the beauty and the mystery of Macchu Picchu. It was quite unknown to the Spaniards and discovered only in this century by an American explorer, Hiram Bingham. Another version is that it was discovered by an English miner, prospecting for gold in about 1885, which Bingham re-discovered in about 1920. In all such cases there is often a history of claims and counter claims as to who found or saw something first.

The first impression was of many cultivation terraces in well-ordered lines, with clusters of dwelling houses here and there, linked by long flights of steps. Near the highest point there was a low flat space, presumably for ceremonial meetings and displays, surrounded by temples and royal buildings. Higher still was the observatory with a special "intihuatana" or "sun stone", about two feet high and carved out of the living rock. In another part of the city was a flight of steps, with a stream and twelve small pools here and there, presumably for ablutions. At the top was a small temple with a short round tower. By it was said to be the Temple of the Virgins - the only two-storied building in the whole city. The dwelling houses were generally gabled, originally no doubt thatched with straw. The extraordinary thing about Inca architecture is that the buildings hardly ever had stone roofs, and of course they had not invented the arch. Buildings often had plenty of internal niches, and very occasionally windows, but no signs of glass. The people must have been extraordinarily hardy to withstand the mountain climate, particularly in the rainy season.

After dinner at the hotel the management asked us all to go to bed at 9.00 P.M. because they had no more petrol to run the electric light plant! I think everyone was so exhausted that they found this announcement most welcome.

On 10th May we got up at 5.00 A.M. when it was still dark, but with a brilliant moon. The whole city in moonlight looked even more wonderful and mysterious than by day. There were no clouds and one had a magnificent view of the near and distant peaks blending into a dark purple silhouette. Suddenly the silence was broken by the songs of all kinds of birds, waking up in the half-light of the dawn. Then the sun lit up some snow peaks in the far distance, whilst the nearer ones were touched only later.

At about 7.30 A.M. Macchu Picchu itself caught the sun's rays, including of course the sun stone in the observatory. The whole effect was stupendous, and words cannot convey adequately the beauty of the scene. We took the path down into the valley at 8.30 A.M. with both of us taking flowering specimens as we went along, ready to be put into the presses which of course had not been sent up to us according to our instructions! We were particularly impressed by a wonderful climbing orchid with red and purple flowers and large curved leaves. A six-foot high *Calceolaria* was no less impressive, with eight inch long leaves and flowers an inch or more in diameter. We also collected a *Fuchsia sanctae-rosae*, *Lupinus urubambensis* (type), *Brachyotum quinquenervium*, (Melastomataceae), *Desmodium vargasianum* and many other plants whose names we did not know. However, there were plenty of *Bidens squarrosa* whose hooked fruits clung onto our jackets and socks. It took until Ollantaytambo to clear those off only one leg. Meanwhile, Edward and I had a trying time getting all our plants into presses.

This trip to Macchu Picchu was, I am afraid, completely touristic so far as potatoes were concerned. I am ashamed to say that some years later Professor Cárdenas from Bolivia and Professor Vargas from Cuzco visited this area (in 1943) and found a new potato species which they kindly named after me: *Solanum hawkesii*. It occurred quite close to the hotel, but was destroyed when that building was pulled down and a larger, more comfortable one was built in its place. In 1942 Christopher Sandeman had found a conical-berried potato at Macchu Picchu, and Vargas found something similar in the forests in 1946. There was no doubt that we had rushed round too quickly and had been overawed by the archaeology at the expense of the botany there; but no-one has seen *S. hawkesii* again, which belonged to a different group from those collected later. Could it have become extinct? If so, it must have had a very limited distribution area.

After some time we got out of the train into a small van, normally used as an ambulance, heading towards the town of Urubamba, which lay in the same valley of the Rio Vilcanota, whilst the train turned off towards Anta and Cuzco. In a little while we saw on the other side of the valley a long shallow cave in the cliffs. Within this cave roofless houses (now ruined) had been built. They looked extremely old, but of course we did not have an opportunity of seeing them in detail. We carried on past the ancient town of Yucay, which was the Inca's winter resort and said to have the best climate in Peru. On the hillside, were the palace and the hanging gardens where the fabled plants and flowers were said to have been made of gold and silver.

Following along the same valley road, past Calca and Pisac, we arrived at Urcos at about 3.00 P.M. The estate was said to have been the seat of an Inca nobleman and was set on a hill which jutted out into the main valley. This was now an English missionary farm, run by a Miss Smith, who had kindly invited us to stay there. They grew potatoes and we were promised samples later. Meanwhile, we wandered a little round the Inca terraces, towers and temples, and later listened to the fairy-tale account of a princess who was loved by one of two brothers, but turned into a stone by the other, who also loved her but could not have her. I have to say that the stone in question did not look anything remotely like a beautiful princess, but was very rugged and shapeless. The number of legends concerning the Incas seem to be boundless. I just wondered if some of them were fabricated for the tourists by the travel agents!

At 5.00 P.M. an old farm worker came down from the upper part of the farm and sorted and named in the barn samples of potatoes which had been recently harvested. We got some twenty three different varieties, most of which (thirteen) were *andigena*, nine were *S. chaucha* and one was *S. stenotomum*. The farm lads brought in a weedy potato sample of *S. calcense* also.

I ought to explain that all these species identifications throughout the whole trip were made after careful study at Cambridge when they were grown out and chromosome counts made. It was particularly interesting that nine out of the twenty three varieties in this batch were the triploid *S. chaucha*, whilst there was only one sample of the diploid *S. stenotomum*. The tetraploid *S. tuberosum*, subsp. *andigena* was the most common of the species in practically every batch collected on our expedition.

On 11th May Mr. Payne, of the same mission, was planning to drive us to Cuzco but was confined to bed with a chill. Meanwhile we sorted and pressed plants, and wrote up our notes and diaries; later on we rambled round the estate, collecting and pressing plants.

Particularly interesting here was the deep orange-flowered climber *Mutisia cochabambensis*, named after the famous Spanish botanist, Mutis. After a very good lunch of roast guinea pig and enormous baked potatoes, known as "boli" we went back in the ambulance wagon to Calca and thence continued by bus to Cuzco, arriving at 5.00 P.M.

I was up early the following day, 12th May, to take the train at 7.30 A.M. down the Cuzco valley to Oropesa, which lies not far from the junction with the main Vilcanota valley. I had a note from Sr. Astete to a Sr. Rodríguez, the owner of a large farm who grew potatoes. Edward stayed back at Cuzco to write notes and letters, meanwhile. Sr. Rodríguez kindly provided me with a horse and one for himself and a small boy; we went up into the mountains for about 300 metres to about 3,900 metres and found a wild potato growing in rocky sandy ground amongst cacti. Although there were no flowers the plants had fruits on them - dark green with pale green spots, and were called "arak papa" by the Indians, meaning no more than "wild potato". This I was able to grow at Cambridge, and it was finally named *S. canasense* var. *xerophilum*. I also collected a very sticky *Cerastium* and a climbing *Mutisia*, neither of which we had seen before.

After a good lunch at the farm I went out at 2.30 P.M. to hitch a lift, but did not get one until 4.30 P.M. Before this, the people at the railway station to whom I had been chatting suddenly produced a large meal for me because they thought I might be hungry. It was so full of onions that I thought my mouth would burn out. It was so kindly meant that I had to eat it all and look as though I was enjoying it.

On the bus I met yet another missionary lady - a Mrs. Thompson, together with a friend. They told me that they were going to establish a new mission centre at Acomayo. From our rather superficial observations there seemed to be an extraordinary efflorescence of missionary activities in southern Peru, whereas in Bolivia and other parts of Peru, missionary efforts seemed to be lacking. Of course, ease of travel may have been one reason, perhaps, and possibly we just did not come across the missionaries in Bolivia.

When I reached Cuzco, Edward had just returned from visiting Professor Vargas, who had offered to make a collection of potatoes from two Sunday markets and to send them down to us at Lima. He also gave us some herbarium specimens of wild *Solanum* species which he had collected in various parts of Peru, some being tuber-bearing and others not. These looked very interesting, and most were probably undescribed.

Saturday 13th May was spent in describing and packing specimens and in the evening talking to Professor Vargas and making plans for the next part of our expedition. This part of our expedition had been extremely interesting from an archaeological and botanical viewpoint. We also had amassed useful collections of potatoes from markets and farms, thanks largely to our Missionary friends and to Peruvians, such as Vargas, Yabar and others.

What came as a great surprise, though, were the rather few samples of diploid potatoes, such as *S. stenotomum* and *S. phureja*. We did not hope to find *S. ajanhuiri*, which seemed to be completely confined to the altiplano of central to northern Bolivia and just over the border in Peru, dept. Puno. It seemed strange also not to find many samples of the frost-resistant species *S. juzepczukii* and *S. curtilobum* in the Cuzco area. On the other hand, we found very many samples of the triploid *S. chaucha* and, of course, even more of the tetraploid *S. tuberosum* subsp. *andigena*.

Some of these apparent anomalies may have been that we were collecting rather late in the season, though even Yabar's collections were very short on the frost-resisters *S. juzepczukii* and *S. curtilobum*. This was something that could be verified with the much later collections of the International Potato centre at Lima, but that was not in existence when we were collecting in 1939.



29 Mar. 1939. Bolivia, dept. La Paz, near Lake Titicaca, Tiahuanaco; ancient stone doorway and statue with pre-Inca carvings.



27 Apr. 1939. Peru, near Puno; two teams foot ploughing.



30 Mar. 1939. Bolivia, near Eucaliptus, on the Altiplano at ca. 3,000 m; harvesting potatoes.



25 Apr. 1939. Peru, Puno, by Lake Titicaca; Granja Salcedo - the La Salle missionary college, set in a barren hilly landscape.



28 Apr. 1939. Peru, dept. Puno, Lake Titicaca; man in Totor reed sailing boat (balsa).

CHAPTER 7

IN CENTRAL PERU:

To Abancay, Andahuaylas and Ayachucho

This part of our expedition was for us a journey into unknown territory, where no potatoes had been collected before. Although there are roads now which connect Cuzco with Lima, at that time it was impossible to get further than Abancay (Apurímac department) by road. After that it was a long trek over mountains and valleys to Ayacucho and Huancavelica, always with the threat of bandits and under very rough and exhausting conditions. Even so, it was the only way to Lima unless we retraced our journey through Puno, Arequipa, Mollendo, and thence by boat to Lima. Clearly we had no inclination to do that, so we set out with hope and some trepidation on this - the most exhausting and least rewarding - part of our expedition.

On 14th May we began well enough by taking a hired car from Cuzco to Abancay, though with the usual delays that South American drivers inevitably cause (eg he had to go for oil and petrol, buy food and other things) so that having started at 8.00 A.M. we did not get away until 9 A.M. - not bad compared with Bolivia though! The road to Abancay led up the hill behind Cuzco, following the railway and the old Inca road for some way and then dropping down into the valley of the Rio Apurímac which formed much of the boundary between the Cuzco and Apurímac departments.

Before lunch we stopped to photograph a purple-flowered composite (*Onoseris albicans*) which we had first collected in Paucartambo. We also collected a white-flowered *Solanum* shrub with velvety leaves and brown tomentose stem. Passing Anta we dropped down to Limatambo - a small village with Incaic ruins which we had no time to explore. For the first time I had a meal of Cassava (*Manihot*) or Yuca, as it was called there - much used by the ancient Peruvians. It was rather tasteless, but at least much more acceptable than chuño or tunta (*moraya* in Peru) which, of course, are made from dried potatoes. There were lots of bananas and oranges for sale also. At this point we had a tyre burst, so whilst the wheels were being changed we made some collections. There were two Convolvulaceae plants, one a tree and the other a shrub (*Ipomoea phyllomega*), both with white flowers; also a Bignoniaceous shrub with long tubular orange flowers, very similar to a plant we had seen in northern Argentina. This was not a very nice place to stop as the air was thick with horrible little blood-sucking flies swarming over our faces and hands, with after effects like those of fleas and bugs. We were glad to get away from them, but we suffered from lots more of these later on.

In a little while we descended into the main Río Apurímac valley, where the vegetation was almost dried up and the heat was intense. This was about 1,750 m above sea level, quite low for us. Crossing the river by a hanging bridge we followed along the other bank for a while, gradually ascending by brilliant green fields of sugar cane, irrigated of course. Passing the small town of Curahuasi we then ascended quite quickly into a mountainous region, with breathtaking drifts of gentians. The most beautiful one had white flowers with red veining inside the corolla tube (*G. campanuliformis*), whilst another species had completely red flowers, but was not very common. Yet another Gentian species had white and purple flowers (*G. scarlatiflora*).

Of course, there were *Calceolaria* species, a *Salvia*, a *Castilleja*, and a shrubby *Scutellaria benthamiana* as well as a curious Amarantaceous flower with two dark red bracts subtending each head of flowers.

We reached the pass at about 5.00 P.M. and had a marvellous view of the eastern Andean ranges in the evening sun, with the snow fields of Nevado Ampay on the right. We were then just over 4,000 metres above sea level. This is the extraordinary thing about Andean travel - you go from blistering heat to freezing cold in a matter of no more than two to three hours. Well, by then we had got used to the sudden changes of temperature and pressure, but one certainly had to be tough to survive them.

We did not get into Abancay until after dark and were at once taken to the Hotel Apurímac. We had a letter of introduction to a Sr. Nuñez, a schoolmaster there, and after supper we found him and got him to promise to help us buy potatoes in the market the following day.

On 15th May after a night in which we were troubled by our insect bites and kept awake by the scuttling of mice over our luggage, we went round the shops and market with Sr. Nuñez, and collected about twenty-nine potato varieties, most of them from the Saivite region (an area we could not find on our maps or gazetteers). Most of these (twenty two) were *andigena*, two were *S. stenotomum* and two were *S. chaucha*. The materials were not in very good condition and at least five died on the way back to England, unfortunately.

We started off again by road down the Abancay valley in a south westerly direction until we arrived at the Rio Pachachaca at about 1,750 metres. Here we crossed an interesting old Spanish colonial bridge on to a road in partial construction, with at least a single car width available. From there we wound up, backwards and forwards, until we again reached an altitude of nearly 4,000 metres. After that we continued for many kilometres at the same altitude. The upper part of the road was quite old, having been constructed by a German company. It seemed curious to start road construction right out in the wilderness, but perhaps they began it at the other end, in Andahuailas.

When we had covered about eighty-four kilometres (fifty one miles) from Abancay our driver came to a roadside hut and refused to go on, saying that the road was just too bad for driving and he did not want to ruin his car. I must say that I agreed with him, but it was not very pleasant to be left in the middle of nowhere on a bare mountainside by a small hut at some 4,000 metres (13,000 ft) above sea level. His parting words as he prepared to return to Abancay, meant no doubt to comfort us, were that some muleteers would probably pick us up and take us down to Andahuaylas.

Various people arrived in lorries on the way to a road-makers' camp down below, and some offered to take our luggage down for us but we refused, thinking it might get stolen. There was a Peruvian man and his wife, Sr. and Sra. Negri, who wanted to make the same trip as us, and who had come thus far on the back of a lorry. Some people said we should walk down to the camp, whilst others said we should have a better chance of hiring horses here. Well, of course, no horses came, so in the end we walked down to the camp, some three kilometres away, hoping for horses or a lift to Andahuailas. None came, so we walked back up again and spent a miserably cold night in our tent with all our clothes on and very little to eat, as we had not thought we should be stranded. We shared our food with the Peruvian man, Sr. Negri and his wife, who had only a packet of sugar, which they shared with us!

May 16th dawned uncomfortably and we got up early, waiting for horses, but none came of course. Looking back on this I realise that we were very naive to believe that horses would materialise as if by magic! After a while, Edward went again down to the camp whilst I guarded our luggage. The weather was frightful, with wind, mist, cold rain and sleet. Luckily the man and wife who lived in the hut provided us with a stew at about 11.30 A.M. Some Indian women then appeared and began to cry, since apparently a relation had been stabbed in the stomach and another in the neck by a drunken alcalde. We had seen them previously, covered in blood and looking very ill.

At last, a sort of rescue service arrived in the form of a trail of men, with a note from Edward saying that it was impossible to get horses that day but that we should go down and stay overnight at the camp. Horses were said to be promised for the following day, but I privately thought that I would believe that promise when I saw them. Ten men carried all our luggage - a stupendous feat - down to the camp. The camp was situated on level ground and was clean and well arranged. We met the chief engineer, Sr. Martinelli, a Peruvian of Italian ancestry who spoke perfect English. He invited us to sleep in his bungalow, where, in his sitting room he had two bamboo sleeping couches. The Peruvian traveller and his wife stayed in another building nearby.

After settling in we wandered down the quebrada (valley) to look at the plants. There was a very handsome tree lupin (*Lupinus holabilis*) with silvery leaves on an island in the stream. In a side valley we collected a Loranthaceous plant of a queer brown colour with berries like mistletoe growing parasitically on a *Berberis* plant. Nearby was a *Brachyotum grisebachii* (Melastomataceae), whilst a little further up was a climbing *Bomarea sanguinea* with large reddish-orange flowers, brown spotted on the inside. It was growing all over several bushes, in great splendour. We also saw *Calceolaria urubambae*, a green-flowered ground orchid and a Rosaceous tree with spiny fruits which puzzled us completely.

We returned at dusk to talk to the engineer; in fact he kindly invited us to eat all our meals with him and sleep in his sitting room for the whole of our enforced stay. Amongst some of the most difficult journeys often under terrible conditions, it was wonderful to find such havens of warmth and human kindness. People like Sr. Martinelli were not all that common, but were really the salt of the earth.

We were full of hope on 17th May that our horses would arrive by 11.00 A.M.; at 3.00 P.M. they were said to have arrived but of course it was too late to start by then. We spent most of the time studying and photographing plants and llamas, and Edward got his plant drying stove going. Meanwhile, I went out to look for wild potatoes but found none. There was an attractive bush *Solanum* with large mauve flowers and an abundant orchid with large red flowers, with the sepals ending in a long acuminate apex (*Masdevalia davisii*). There was another *Bomarea*, a thorny *Solanum* shrub, and various small-flowered orchids scattered around. Edward's plant dryer proved very useful to warm up our rather cold sitting room/bedroom.

At last our hopes were realised on 18th May, when some of the horses arrived at 7.00 A.M., but at first saddles and ropes could not be found for them. We actually got off by 11.00 A.M. with two young lads as muleteers. They seemed never to have strapped loads on to horses before, since we had to stop three times even before we had left the nearby village of Kishuara. The horses, as we always noticed, were very nervous, starting at the slightest noise.

Our first mishap was when the one carrying our tent and bed rolls started to run round in little circles ending up with the load underneath him. He had to be re-adjusted of course, and the others did not do much better. Outside the village we got into a small side valley, when suddenly, one of the horses, getting to the edge of a steep slope, took fright, bolting off down into the valley and strewing his load in all directions. My small fibre suitcase was split open, one end nearly ripped off, and all the contents thrown on to the grass. The rucksack had its metal framework bent and the case of the typewriter became cracked. It took us some time to catch the horse, gather up all the luggage, and finally rope it onto its back again.

The problem really was that the ropes were inadequate, some of them being no more than agave leaves, and several horses had no harness or bridles to lead them by. One would have thought that the muleteers would have got saddles, ropes, bridles, etc ready the evening before; but not them. The habit in those countries was to leave everything to the last minute, not even to think about anything before necessary; so that until that morning the muleteers did not even dream about looking for ropes and saddles, which should have been got ready the night before. Then, when they had caught the horses they had the nerve to suggest that they should unload and leave us there whilst they went back to the village to look for ropes, etc and return the next morning. Luckily, we had Sr. and Sra. Negri with us; he could speak Quechua so could tell the muleteers (who could not speak Spanish - so they said) that we would not dream of doing any such thing. Someone was to be sent back for ropes, whilst the main party went on. If only I could have spoken fluent Spanish then I would have let rip at these lads, and thus would have felt much better! Even Edward seemed a bit upset, but he was such a decent person that he never seemed to lose his temper. When we started off again things seemed a little smoother, the sun came out and there were wonderful views of distant mountains and the eastern snow-capped cordillera. When we got up to the level of the new road an old man came up from the village with some more rope, so that we could use it for leading the horses, who seemed to have calmed down by then.

We followed the so-called road for a few miles until it disappeared, passing gangs of workmen, all of whom stood up, lifted their hats and said "Buenas dias" in such a very servile manner that I felt quite uncomfortable. If Royal Personages feel like this, I pity them thoroughly. At 12.00 noon we got to a grassy place where the muleteers decided that the poor horses might be hungry, so we should stop for half an hour to let them feed. At every stop we had made these beasts had done nothing but munch grass, except when strewing our luggage all over the hillside. Anyhow, we could do nothing, so sat down and ate biscuits and jam. From there we could even still see where our car from Abancay had deposited us, so we had not made much progress in three days. I should mention that we had four horses, all for our luggage, whilst Sr. and Sra. Negri had three horses, one each for them and one for their baggage. However, the riding saddles were so negligible that Sr. Negri's was no more than a couple of sacks. Edward and I, as good expeditionists, just walked!

Halfway up the slope on the other side of the valley Sra. Negri declared that she had lost her bag, with a lot of money in it; so Sr. Negri had to go back to look for it whilst we were kept waiting for a half an hour. He got it all right, and with all the money still in it.

We climbed continually after this and just before the summit, at a particularly unpleasant boggy place, the muleteers suggested that we should stop for the night. We firmly declined, saying that it would be far better to get down the other side and stop if possible near a village. We were more or less at 4,200 metres, far too high for comfort, especially if the weather was bad.

Eventually, we descended to about 400 metres on a piece of flat dry ground and put up two tents (one for the Negris). During supper, which we all ate in our slightly larger tent, Sr. Negri showed us a pistol that he had bought for the journey and was very surprised when we said we did not have one. He told us dreadful tales of people who had been held up and robbed, and how, when he was looking for his wife's handbag, someone had started to roll stones down onto him, and he had fired his pistol up at whoever it was. We concealed our amusement at this earnest young man and his tales of horror. In any case we had not heard a shot, so he probably waved the pistol about as a warning to the imagined stone thrower.

After supper I went for a stroll and on my return he flashed his torch at me, shouting in Quechua, which I did not understand anyway. He then started waving his pistol at me and would undoubtedly have started shooting. I shouted to him in Spanish to stop all that, at which point he calmed down and we all went to bed early, at about 7.30 P.M. What a lucky escape!

A night without bandits followed, and on 19th May, although we were up at 6.00 A.M. we did not get away until after 10 o'clock. To begin with the grass and tents were covered with hoar frost, and water in a saucepan was frozen over. Everything went on at a leisurely pace, so that the muleteers would not dream of catching the horses until all the suitcases etc were ready. The horses that day were quite well-behaved but the muleteers were really hopeless at loading them and tying the ropes. In fact until midday I calculated that we spent more time in waiting for the luggage to be re-tied to the horses than actually trekking towards Andahuaylas.

At lunch time we ate the last of our rations and began the descent to Andahuaylas past a small mountain lake and many fields and villages. The temperature of course increased and we had to stop at one place to buy chicha (fermented maize drink) to quench our thirst. We were now down in the Andahuaylas valley, passing San Gerónimo, where our Peruvian co-travellers left us to stop with relatives. It was another ten kilometres to go, so Edward and I went ahead, hoping that the muleteers would eventually turn up with our luggage. The valley road was very pleasant, with shady trees of Eucalyptus and *Salix humboldtiana*. So we finally arrived at the small town of Andahuaylas!

As the next day was Saturday and it would be impossible to hire mules for the next part of our journey that night, and the day after was Sunday, when it was unlucky for muleteers to start out on a journey, we resigned ourselves to at least two days of "rest" in a highly insalubrious hotel - the worst we had ever stayed in. The patio smelt strongly of urine and our bedroom which opened separately onto the street smelt like a crypt and was about as warm. There was no window, only a double door opening right on to the street. So one got light with publicity and darkness with privacy! Added to this - the beds were damp!

However, there were compensations. The coffee was good, served with goats milk, and there was butter and strawberry jam to put on our bread. The dinner was rather questionable, but in any case we felt too tired to eat much, our feet ached and we could hardly stand up with fatigue. We felt dirty as well. We went to sleep at 8.00 P.M. and did not wake up the next morning until 9.00 A.M.

Our view of the hotel on Saturday morning (20th May) confirmed our impressions of the previous night. The dining room had been a stable with a dirt floor and really had hardly been converted from that state.

The food was poor and unappetising and our room was anything but enchanting. However, it was somewhere to sleep and in fact we did exactly that, all day long, apart from waking up for very indifferent meals.

On Sunday 21st May we tried our luck in the market but it was not a very big one and we got only nine collections, eight of them *andigena*, of which four died on the way back to England. Later in the day a shopkeeper came in with two dark brown tubers which he called "Cuchipacon" (pigs excreta in Quechua) because they did rather look like that. These also were *andigena*. Later in the day a mule owner called in, offering to rent us two pack mules, and he would be there at 5.00 A.M. in the morning without fail. Judging from past experience we did not believe it.

The following morning, 22nd May, we did get up at 5.00 A.M., only to have to wait until 7.00 A.M. for the muleteer to arrive. In the end, we got five mules, one large white horse and three muleteers. They brought their wives to help them load up (but not to join the group, I am glad to say), and we got away, on the road to Ayacucho by 8.00 A.M. Not bad - only three hours late!

Our route lay down through the valley, past fertile fields where a large maize harvest was being gathered. We passed mules and men with enormous bundles of maize stalks on their backs looking as though they would collapse under the strain. The fields were bordered with beautiful large blue-leaved *Agave* plants, with leaves up to six feet long and inflorescences from thirty to forty feet tall.

About two miles away from Andahuaylas my mule showed signs of stubbornness, persisting in turning down a side lane to the left. When I tugged its head round it just stopped. I got off and pulled it with a rope but I might have been trying to move a mountain for all the use it did. Then the muleteer came along and managed to get it to go straight on. Apparently the side road led to its pasturage! "Stubborn as a mule" was really a very appropriate saying, I thought, and even at the best of times it walked so slowly that the white horse which Edward had was the fastest of the lot.

We had just crossed a stream and were thinking of ascending the valley slopes when someone came running up with some story in Quechua, which our chief muleteer tried to translate into Spanish. We did not understand him at-all until someone else came along and translated it into normal Spanish. Apparently the white horse had no iron shoes and should go back to be shod before it was fit for the journey. "Why hadn't they thought of that the day before?" Edward and I grumbled. Well, of course, people out there never did think things out in advance, as I have already remarked. The muleteers suggested going back and starting early the next day. We were having none of that, so we told the head man to take the horse back to be shod, whilst we carried on with the other beasts and two muleteers. This was agreed to, surprisingly enough, and we continued along as before.

We saw various wild *Solanum* species in the hedges as we went along, but these were not tuber-bearing ones, so we did not bother to collect them. Later, we made our way up a steep but lovely rocky valley, with the track quickly ascending, and later on had a curious lunch of tinned ham and plums. After that, the ascent was continuous, past a region of prickly shrubs, the chief of these being *Barnadesia* - a composite very similar to *Mutisia* in its flowers.

At 3.00 P.M. the muleteer and the newly shod white horse caught us up, but was going very slowly from its exertions. One of the mules also turned out to be such a poor beast that the tent it was carrying had to be taken off and carried by a muleteer! It only just managed to carry one small suitcase, and all this resulted in our going ahead very slowly. The summit was extremely high, over 4,200 metres (about 14,000 ft), and took us a long weary climb to get to it. Towards the top the rocks were completely formed of carboniferous limestone, looking like the Mendips or parts of Derbyshire at first glance; but then when one looked across to range upon range of high mountains stretching away in every direction, the illusion was soon destroyed!

We made our way along a level path with the sun almost setting. Afterwards we descended quickly in the dusk to find a camping site not too exposed to the night frosts. A very thin crescent moon provided some light to prevent us stumbling on the rough path. We put Edward's tent up, but had some trouble with the muleteers, who, we quickly learned, did not respond at-all to polite requests. So we had to learn to shout at them, which Edward did not like at-all because he was a Quaker. As I did not have such a high opinion of my fellow men as he did I found shouting at them not quite so difficult! We had a meagre supper (why did we never seem to have enough to eat?) partly marred by the fact that a tinned cheese we had been looking forward to turned out to be bad. We threw it away, but the next day one of our men had a bad stomach ache, and we thought he might have unwisely eaten it.

On 23rd May we were up at 6.00 A.M. packed at 7.00 A.M. and away by 8.00 A.M.! It always seemed to take an hour for the muleteers to catch and bridle the horses or mules and tie on the luggage. I remarked on this before. No animal would be caught before all the luggage was ready. Why, for heaven's sake? Whilst this was going on we found some wild potatoes in the cracks (grikes) in the limestone pavement. Unfortunately there were no flowers or fruits, and the tubers which were immature, did not survive the journey back to England. There were many *Berberis* species there, also.

Soon after starting we began the descent, seeing many gentians (including the red-flowered one), *Buddleia* bushes, a saxifrage, several composites and, of course, the usual quota of calceolarias. Lower down, at about 9.00 A.M. we found ourselves in a wide fertile valley, almost wholly cultivated. Maize seemed to be the only crop and it had all been recently harvested. The fields were full of cattle, sheep, goats and pigs - I had never seen so many of them together - all brought in from the hills to clear out any plants or seeds remaining there. Our animals were going very slowly, with the muleteers continually wanting to stop and feed them, when we knew that they had been grazing on and off all night. We shouted at them (at least I did) to get a move on because, come what may, we were determined to be in Chincheros (the next town) by lunch time. The normal trip was one day from Andahuaylas to Chincheros, and we were determined not to take more than a day and a half, if we could help it. Chincheros always seemed to be just round the corner!

It is a curious thing but Andean valleys seem to play tricks on you. They start off pleasantly wide and gentle, but suddenly narrow in and their streams rush from boulder to boulder, whilst the poor traveller finds it difficult to find a foothold. Then, just as suddenly, they become wide and smiling again. This was what happened to Chincheros, the stream being caught in a narrow valley, hardly wide enough to accommodate it. We entered by (not over) a lovely old colonial bridge with a high semi-circular arch. Unfortunately, half of the bridge had been washed away in recent storms!

We had trouble again with the muleteers, who wanted to stay the night there (even though it was only 1.00 P.M.) so we called the police to tell them off properly. We had asked the sub-prefect of Andahuaylas to telegraph his colleague in Ayacucho to send a car down to wait for us where the road began again at a place called Pajonal. We should have been there by then, but instead we were half a day's journey away.

After a good meal at the hotel we were ready to start at 2.30 P.M. and had given the muleteers fifty centavos each for food. Instead of buying food they had spent it all on chicha, so they were then extremely loud and talkative. Luckily, they could still just about stand up and walk, so we got them to push on. They would persist in talking Quechua to us and seemed most surprised that we did not know what they were talking about. After a bit we took no notice of them and they gradually cooled off.

After about a half an hours journey we passed through a grassy pasturage, where again the muleteers wanted to stay the night; we were not having this, because they would just have walked back to Chincheros to drink Chicha again, so we pushed on.

Somewhat later, the valley did the usual Andean trick of becoming a precipitous gorge with rather thick vegetation (probably due to the mists and fogs), trees covered by "Spanish moss" (*Tillandsia usneoides*) and some rosette-shaped bromeliads. On descending further we came into a dryer hotter region with *Opuntia* species and *Acacia* bushes. Here we were attacked by thousands of those horrible blood sucking flies from which we had suffered earlier, at Limatambo. They settled in swarms on the backs of our hands, arms, faces, ears and necks. Even though we tried to brush off as many as possible they all came swarming back so that we looked as though we had contracted some terrible disease. The individual fly, only about one point five millimetres long, injected some anti-clotting highly irritating substance into the hole it made in one's skin, so that when it flew off the blood oozed out or made a small blood blister.

The Chincheros valley widened out at the end, joining the much larger valley of the Río Pampas, which forms much of the boundary between the Apurímac and Ayacucho departments, though higher up crossing the Ayacucho department into Huancavelica. At the junction of the valleys there was a reasonably flat place which we unadvisedly selected for a camp site. What a mistake that was! When darkness fell, with a clear night and the moon in the sky, we looked forward to a tranquil night. Never were we so mistaken! Armies of mosquitoes descended on us, making sleep impossible unless one hid ones arms, hands and head inside the sleeping bag, and then began to suffocate. Even oil of citronella kept them away for only ten minutes. What with the itching bites of the blood sucking flies and, added to them, the mosquitoes, we slept very little. Our muleteers were troubled also, for they talked all night.

At 4.00 A.M. we could stand it no longer. It was now 24th May and we had breakfasted and packed up at 6.00 A.M. feeling tired and discomforted, our hands and faces red and swollen from the bites, unwashed and unshaven. Our tempers were badly frayed, and we threatened the men with no tips unless they reached Pajonal by before midday, hoping that the driver of the car sent there for us would wait that long.

We soon reached the valley of the Río Pampas - quite a large river and a tributary of the Río Apurímac. We followed a path near to the river for about twenty kilometres; each side of this path was a "forest" of large, tree-like Opuntias, interspersed with small agaves with spikes of yellow flowers, and *Acacia* trees also, with clusters of small white snails on the branches, tightly closed in the hot dry period, and waiting for the next rainy season. We also found some berries on a dried-up potato plant by the path. these turned out to be a new species, which I later described and named *S. pampasense*.

The trip that morning seemed never ending and my legs felt very stiff from riding on the back of a mule. My behind was completely numb! At about 10.30 A.M. the valley became much more closed in and the river bed narrowed, with cliffs rising steeply, forming a rocky gorge. There the bridge for the new road was being made, but had not got much beyond excavations for its foundations. A little below it was the old bridge - a very flimsy sort of suspension bridge with two thin steel cables slung across with vertical ropes to a wooden slatted pathway. It looked as though it was about to collapse, and evidently the mules thought so also, apart from the fact that they could easily have put one or more of their feet down between the slats. They were obviously very nervous, and got across one by one, with a muleteer behind shouting at them. We walked over - with the bridge swaying up and down and from side to side. It was an interesting, as well as a terrifying experience, and we tried not to think about the book describing the collapse of the Bridge of San Luís Rey. However, all went well at last!

The path on the other side of the river ran up an almost vertical cliff in a very disconcerting way. I stopped to take a picture, my mule going ahead; so I had to walk up, getting the full force of the sun. We were now, thank goodness, in the Department of Ayacucho, so there were only three more Departments to go before Lima!

Because of the heat and dry conditions the muleteers began asking for money to buy chicha. We were not having any of those tricks, so we said we might do so when and if we reached Pajonal. There was a small village nearby so they bought chicha with their own money that time. Edward went on quickly ahead to see if the car was still there, whilst I brought up the rear with my very slow mule and the rest of the party. I have never felt so mentally and physically discomforted, what with heat, flies, slow mules and lazy muleteers. I was at a really low ebb indeed.

Eventually we got up to the road where, by what seemed like a miracle, the car was waiting for us. This was at about 11.30 A.M. and once the muleteers had unloaded the mules and then been paid (but not before) we said good-bye to them with great relief. However, our trials were not yet over, because it seemed that there would be nowhere for a long way before we could buy food. Again, I wondered why we had not stocked up well beforehand. We stopped at an orange grove and asked to buy fruit but were refused. Our driver and chicos (assistants) meanwhile went in round the corner and picked some for themselves and us. Why had he brought any chicos at-all anyhow, for he knew we had lots of luggage? That is what just happened in those countries, but as we found later, we needed them.

So of course the car was overloaded, and added to this it was in a terrible condition. Every so often the engine would miss a few strokes because the carburettor was in need of repair, and thus the petrol was not getting through properly.

Furthermore, we had to stop every few kilometres to let the boiling water out of the radiator and fill up with cold water - when we could find it. After about five leagues we had to stop for a half an hour whilst they filled up with oil and started to mend the engine! Of course they could have done all this whilst waiting for us - but as I said earlier, none of the ordinary people in those countries every thought ahead.

The road continued to wind up into the mountain gaining height from the Rio Pampas (ca. 1,950 metres 6,500 ft) to the summit at about 4,300 metres (14,300 ft). Of course, the vegetation changed immensely, from the parched cactus scrub in the river valley up through grassland with prickly bushes, then into evergreen shrubs and woodland, and finally into high Andean pastures, with *Stipa* grass and gentians. At about 3,150 metres (10,000 ft) we found another wild potato (Balls 6927) growing on very moist banks among moss. This was the same species that we had seen earlier in limestone pavements near Chincheros (Balls 6921), which I later named *S. multidissectum*, and we saw it again a little lower down (Balls 6931). I thought to begin with that this latter collection was distinct, and named it *S. fragariifrutum*. Unfortunately, it turned out to belong also to the species *S. multidissectum*, even though the ripe berries did smell of strawberries. (I found out later, though, that many wild potato fruits had this strawberry smell, possibly to attract birds to eat them and so disperse the seeds).

We were still up in the mountains when the sun set and it got very cold. Suddenly, without any warning, the driver took a corner too sharply and steered too close to the edge of the road which crumbled away as we touched it. In vain he tried to get out on to the road again but we were left stuck with the centre of the car resting on the edge and the two outside wheels unsupported. The only piece of luck was that by chance there was no precipice below us, otherwise I would not be writing this book!

At that altitude, spending the night there would be no joke, for it was already freezing by 7.00 P.M., and my sinuses had not quite recovered from the operation in Bolivia. We lit some of the *Stipa* grass in the hope that someone might see us and come to our aid, but of course no-one came. So we had to try and deal with the situation by ourselves. We first unloaded all the luggage and loose parts like seats. Then the driver and his chicos dug out the ground below to make an incline way for the wheels to run up. Then they dug out the soil under the axles and differentials. Finally, when the driver started up the engine, we all four of us pushed, so got the car up by slow degrees. This illustrated the need for chicos, which I had doubted previously. At last, we were on the road again, and all loaded up, having been delayed by an hour and a half. It was really a miracle that we had got away, particularly as the car did not seem any more damaged than it was when we saw it first, down by the Río Pampas. Our trip down from the mountains was a bit of a nightmare also, because for one thing the steering was extremely loose. The driver had to turn the steering wheel a considerable amount before the car itself began to turn. Consequently we only just scraped round the hairpin bends. When we went over loose large stones the whole steering column jerked up into the car by about four inches. However, all good (and bad) things come to an end eventually, and at about 11.00 P.M. we saw the lights of Ayacucho below us. At 11.30 P.M. we got into the town, which was quite deserted, and the Imperial Hotel, where we had booked rooms, was all shut up and everyone fast asleep. Eventually we woke someone up who let us in and took us to a filthy room with a sickening smell. The manager was asleep in an upper room, so I went and woke him up, saying we wanted a better room. When properly awake he realised who we were and told us that he had reserved the "Pieza Grande" (Grande Suite) for us.

It was a colossal room with lots of large tables and two good beds. Edward was certain that there were fleas in them, but if I was bitten I did not realise it amongst all the other insect bites that I had suffered from in the last few days. Sleep in a real bed was a such a luxury, that a few extra minor occupants did not matter at-all, and I was fast asleep in a minute or two.

Looking through my expedition notes long afterwards I was amazed to see that the next morning, 25th May, we were already getting up at 8.00 A.M. after the exhausting and harrowing experiences we had suffered from Abancay and Andahuaylas onwards. We went to see the Sub-Prefect after breakfast who apologised for the car he had sent us, but apparently that was all there was available at the time. (The bottom of the pile, we thought!). We told him that we would like a guide, if possible, to take us round the market to buy potato samples. He lent us one who could speak English and Quechua - both, it seemed later, far less well than we could speak Spanish, for by that time we had become quite experts at shouting at muleteers in a language they could understand and respect. It was rather sad really that these men were so used to being shouted at, that polite speech made no impact on them. Well, back to the market, which was one of the largest and most varied that I had ever seen. As we were buying our first samples the Intendente (Market Manager) came up and helped us for the rest of the time, by asking the names and any other relevant information. He was very much more helpful than the man from the hotel, as he could speak and understand Quechua perfectly.

We got a good selection of about thirty different kinds, including the yellow-fleshed potato "Papa Amarilla", probably the one that the Russian botanist S.W. Juzepczuk had described as *S. goniocalyx*. Of those samples, fifteen were *andigena*, eight were *S. chaucha*, two were *S. stenotomum* and two were its subspecies *goniocalyx*. A few died on the way to England, unfortunately. This collection was thus predominantly *S. tuberosum* subsp. *andigena*, but the triploid hybrid species *S. chaucha* was quite common; however, the diploid species *S. stenotomum*, including its subspecies *goniocalyx*, was rather rare. The market was also interesting from other points of view. We saw lots of the carved gourd bowls that we had first seen at Andahuaylas, masses of different sorts of bread, and many kinds of fruit, beans (of one of which one ate the white cottony pulp round the seeds), Sapote fruits, as well as many others which we did not recognize, and masses of wonderfully sweet and juicy oranges.

We found our hotel to be very pleasant, with a charming patio full of plants, including banana trees, and flowers all round the balcony. Half-way up the stairs was a large green parrot in a cage. It was extremely intelligent, talking to itself or to anyone nearby in perfect Spanish and Quechua. At other times he would do acrobatics on his trapeze. I had some toasted maize with which I fed him when I went past, and we became great friends. Apart from the flowers on the balcony there were small caged birds which sang very sweetly all day. What a paradise that hotel was after the horrors of our recent journey!

After lunch we had a stroll round the city in the brilliant sunshine. There, I am sad to say, they still allowed bullfighting, though no corridas were taking place that day. After returning to the hotel we wrote up notes on our collections and turned in early. Our impressions of Ayacucho were most delightful. It had a strong Spanish flavour, even though it was not in very close connection with Lima.

Departments of Huancavelica, Junín and Lima

The last lap of our journey in Peru, was even more complex than some of the previous ones. Firstly, we had to go to a place named Huanta by bus, stay overnight, and then on by bus to La Mejorada very early in the morning to catch the train which ran from Huancavelica to Huancayo, the argument being that there were no buses leaving from Ayacucho early enough to catch the train!

So, on 26th May, we took a bus at 11.30 A.M. for Huanta, the departure being considerably delayed by an old lady who was taken on to the bus by many female relatives, all calling out instructions and weeping on each other's shoulders, whilst enquiring at the last minute, whether she had this or that. After that, another female had to be called for at the main square, just near where the bus had been standing for the previous hour. This charade was so typical of Peru then, and maybe still continues in some country places where everyone knows everyone else, in a sort of extended family. We eventually started at 12.10 P.M. and arrived at Huanta at 2.15 P.M. That was the day's journey, nice and short and relaxed! Huanta was really a very pleasant town. We stayed overnight at a very good hotel in an old colonial house with walls about four feet thick. It had pretty balconies painted sky-blue and we had a clean room in which, after lunch, I dozed for the rest of the day. It was a wonderful relaxation after our journey from Cuzco to Ayacucho; but energetic scenes were soon to materialise.

On Saturday, 27th May, we had to get up at 3.30 A.M. in order to be ready for the 4.00 A.M. bus to La Mejorada, and thus to catch the Huancavelica to Huancayo train much later. This went off successfully, and we then stopped for breakfast at 7.00 A.M. which consisted of soup and coffee - a rather curious combination. Off again, we got to La Mejorada at 9.30 A.M., quite a small place in the same valley that we had been following all the morning, which eventually led to Huancayo itself. The river was almost a torrent, running between cliffs and with some of those swaying and dangerous rope and fibre bridges that one reads about in adventure stories and which we ourselves had sampled a few days earlier.

At La Mejorada we spent some time in trying to get a fifty per cent reduction on the fare that was costed from Huancavelica to Huancayo. Eventually, the Station-master, after telephoning and cabling to various chiefs and superintendents managed to book our luggage at half fares all the way down to Lima. I still do not know how he managed this, because the line from Huancayo to Lima was owned by a different company. However we did not ask questions about how he did it, but thanked him profusely. And although the train was supposed to leave at 11.00 A.M. when he was still cabling, it did not set off until he had finished, at midday.

It felt wonderful to be sitting comfortably in a train again, even though the seats were not as good as those of the British-owned lines. But compared with walking or sitting on the back of a mule for hour after hour, it was like paradise! After a while the narrow valley suddenly opened out into a saucer-shaped plateau of size enough to accommodate London. Huancayo (dept. Junín) was set in the middle of it. This plateau was intensely cultivated with cereals and other crops but seemed to be too low for potatoes, which were grown on the surrounding mountains.

We got into Huancayo Station at about 5.00 P.M., and found a reasonably clean and not too expensive hotel, the Colón. The train for Lima did not leave until Monday, so as we had little luggage we thought of hiring a car to take us down to Lima on Sunday.

Meanwhile, we got a few samples and decided to go to the Sunday market the following day for more material. The Sunday market at Huancayo on 28th May was crowded, even at 8.00 A.M., with Indians and Cholos (half-castes), selling all kinds of goods, even chairs and bedsteads, but from the point of view of local crafts it was very dull, and most of the manufactured goods were of German or Japanese origin. The Cholos wore European clothes and the Indians wore the same rather dull costume that we had been seeing ever since Abancay. The only point of interest was the highly embroidered half sleeves that the women wore on the forearms. These were detachable, like false cuffs, but were of very fine workmanship.

The number of potato varieties for sale, however, was very interesting, and by 9.30 A.M. we had collected some forty-four different varieties. Later research in England showed that six were *S. stenotomum*, two were its subspecies *goniocalyx*, ten were *S. chaucha* and no less than twenty six were *andigena*. This was the best market record we had had so far. Presumably, all these varieties had come from a wide region in the Huancayo area.

It was curious that in all this region the frost-resistant species *S. curtilobum*, *S. juzepczukii* and *S. ajanhuiri* were not available. Of course, we did not expect to see *S. ajanhuiri* because it occurs in northern Bolivia and hardly penetrates into Peru. Even so, Juzepczuk (1929) did not find either *S. juzepczukii* or *S. curtilobum* in Central Peru, either, so it would seem that these species had not spread so far north, or if they had, they must have been very rare. Later studies of herbaria showed only one collection of *S. juzepczukii* and one of *S. curtilobum* both from Chicchi, dept. Junín, collected by the Peruvian potato specialist, C. Ochoa.

We had hired a car to take us down to Lima on Sunday, but the driver needed another passenger, so we had to wait until midday. He found an American whom I had met on the Lake Titicaca boat previously, on the trip from Bolivia to Puno. It seemed that he was head of the Singer sewing machine agency for Peru and Bolivia.

We set out on a good straight road to Jauja and then down a side valley to Oroya, a rather dirty mining town with factories and smoking chimneys, without a green plant in sight. Even so, we had a very good lunch there. Just as we were about to continue our journey, a Peruvian lady assailed us, asking if she could beg a lift to Lima, as her husband was ill there, and she had just had a cable asking her to go down immediately. We relented, as she said she only had a small suitcase and a little girl. Arriving at her house, she brought out various sacks and bags, with a huge suitcase that filled the car boot. Added to this she brought her girl of ten and her boy of fourteen as well. When would we ever begin not to believe all those stories!

We were thus extremely crowded, and not only that, but they all started to have mountain sickness, because it seems that one can suffer this going down as well as up the mountains, and especially because this family had been living even higher up at Cerro de Pasco. Well, I suppose one day we shall learn not to believe those hard luck tales.

From Oroya we drove by lakes and glaciers over the pass, which was said to be some 4,800 metres (16,000 ft) high, keeping near the railway line all the way. From there on, the road and railway continued down, sometimes it seemed as though playing hide and seek. First the road would be above the railway and then vice versa. Both were remarkable feats of engineering. In a famous place called El Infierno (hell), the road performed a figure of eight, going over and then under itself to lose height. The railway did equally tortuous turns, shooting out of one rock face and into the opposite one at certain points.

Eventually we got down into warmer climates, whilst at Chosica, at 600 metres, we ran into a fog or mist which lasted all the way to Lima, it being the winter season there. It was not actually cold but very damp - a great contrast after the dry sierra.

We finally arrived at 7.00 P.M. and were settled into the Quinta Morris an hour later, where we found a room waiting for us and the best meal we had had for months.

From 29th May (Monday) up to and including 4th June we spent most of our time drying plants, writing up collecting notes and diaries, and sending letters back home. We had booked a passage on 12th June to go northwards to Guayaquil in Ecuador, but the boat due to leave on 12th June had gone to the bottom! So our booking was put forward to the 6th giving us less time in Lima than we had planned. Well, at least we were not to be on the original 12th June ship that sank!

Our last day in Lima was 5th June. We met Mr. Greig again, who had just returned from an exciting voyage on the eastern Andean slopes. Our cine films had been processed and returned, seeming to be correctly exposed, and had not been lost in the post, as I had feared. After several tries, I eventually found Dr. Fortunato Herrera at the Museo Bolivariano. He was a delightful person and extremely easy to talk to. He told me that his works had all been written in the Cuzco area, but that he had made some sort of potato classification on which that of Vargas seemed to be based, but with the added advantage of a translation of the Quechua names. He presented me with a copy of this, and told me that he was engaged in a general floristic list for Peru with Latin, Spanish and Quechua equivalents. [Herrera, F. (1921) *Contribución a la Flora del Departamento del Cuzco*] (Potatoes pp.158-162).

We also motored out to the State Agricultural Research Station at La Molina, just east of Lima and were given a few cultivated potato samples, including one from the northern department of La Libertad, in which none of the previous expeditions had collected. Our enquiries about wild potatoes along the coast elicited the answer that they had been found and cultivated at La Molina, but now were lost. We assumed that these collections might not have been grown carefully, or under the right conditions. I think the people at La Molina were rather annoyed that we had not written or called on them earlier, and I am sure that this was understandable. However, we were too late by then, so nothing could be done about it. Our fault, I am afraid. We were invited to an informal dinner at the Legation, followed by a showing of my cine films taken in Argentina and Bolivia. Thank goodness - they were a success! The Legation people handed out many congratulations!

On 6th June we went off to the hills behind Lima called Amancaes to look for wild potatoes. These hills are now all covered with houses and huts where the poor Indians and Cholos live, but in 1939 they were still open countryside.

In a side valley we saw thousands of the beautiful Amancay "lily" (strictly speaking an *Amaryllis*) - a wonderful sight with sheets of yellow flowers spreading off into the distance; they were mostly in the bottom of the gullies. The car driver who had taken us there said that there was a "Fiesta de Amancaes" on 24th June, to which many people came from miles around.

They picked the flowers and made garlands of them to wear on their heads whilst they were dancing and feasting. Alas, all this has disappeared long ago, but it was still celebrated in 1939.

As one got closer to those bare hills one noticed a faint flush of green caused by the presence of millions of minute seedlings germinating in the moisture condensed from the mists, which are known locally as the Garrua. This ephemeral vegetation grows, flowers and sets seeds by September when the dry season sets in.

Besides the *Amaryllis* we saw a *Nicotiana* with cabbage-like leaves and white flowers, a *Lycopersicon* species with small purple fruits (possibly *L. hirsutum*), and a tuber-bearing plant which did not seem to be a potato. Unfortunately, we were a bit early in the season, so we did not find any wild potatoes.

We later got our luggage down to the ship which was to take us north to Guayaquil in Ecuador. I then made a visit to the Archaeological Museum in Avenida Ugarte (now Larco Hoyle) to try to see something of the potato pots (huacos) from the ancient coastal civilisations. Only a small number were in the form of potatoes, possibly because the coastal peoples could not grow them at such low altitudes. The majority of the ceramics were of tropical fruits, gourds, peppers, etc and all kinds of human and animal representations. It was truly amazing that every human activity including birth, sexual activities, eating, drinking and death were represented. The Inca cultures, on the other hand, did not produce much representative work, but rather aimed mainly at elegant proportions and purely geometrical designs.

We paid our bill and said our good-byes at the Pension, took a taxi to the docks and boarded our ship, the "Maipo", which was already in dock. We weighed anchor at about 2.00 P.M. and set off northwards for Guayaquil. From 7th-10th June, virtually all the voyage, I was in bed with a fever. Where and how I caught the infection I do not know. However, by the 10th I had recovered, thanks to a whole variety of tablets prescribed by the ship's doctor who was very worried about me. I still have no idea as to what this was, but possibly I had been rushing around so much during the previous few months that I had laid myself open to anything going about.

So that was the last we saw of Peru, where we had been travelling and collecting for nearly eight weeks. It had been extraordinarily useful for the highly diverse potato collections as well as the wild flowering plants, which were Edward's great interest. We had collected all the cultivated potato species, though very little of *S. phureja*, which we were hoping to find in great quantities in Ecuador and Colombia. This and *S. tuberosum* subsp. *andigena* were the only cultivated species we were likely to collect in those two countries. We still regretted not being able to collect in northern Peru, but unfortunately there was just not enough time for that area if we were to collect in the northern Andes of Ecuador and Colombia. Similarly, we had no time to collect in the high mountains of western Venezuela. I was able to do this only much later when I was living and working in Colombia from 1948 to 1951.

CHAPTER 8

IN ECUADOR

Although the ship arrived at the estuary of the river Guayas early in the morning of 11th June we did not approach the city until 11 A.M. Milne and Co's representative (or Anglo-Ecuadorian Trading Co as it was called there) took us to the quay in their private launch and got our luggage passed through without a customs examination, except looking into one suitcase as a formality.

Guayaquil struck us as a pleasant city with a beautiful waterfront esplanade on the Guayas river, where there were imposing buildings in the neo-classical style. A room had been booked for us in the self-styled "Grand Hotel". The restaurant was on the top floor and thus caught whatever breezes that might be blowing off the sea. Our room even had the luxury of a bath - something we had not encountered very often up to then. Our Milne representative (Mr. Orsés) took us for a ride round the town and took me to an American doctor, as I was still feeling rather weak from the fever and lack of food. Chicken broth and tea were prescribed, for that day at least.

The next day, 12th June, saw us visiting the British Vice-Consul, a Mr. Ashton, who invited us to lunch on 13th June. He was born in Ecuador and although of English nationality, had lived there all his life. His wife was an Ecuadorian woman. Little happened on the 14th apart from my getting back to health, writing letters and eating an almost normal diet.

Mr. and Mrs. Ashton came to dinner with us on 15th June, and during the course of conversation we learned that he had a brother, Frederick Ashton, the well-known choreographer and ballet dancer at the Vic-Wells. It was most surprising that that man, who was a quiet and self-effacing person, should be the brother of the famous dancer in London. He asked me to visit Frederick when I was back in U.K. which I eventually did. Of course the two brothers, with such different personalities and life-styles, had completely lost touch with each other.

June 16th - 8th were mostly taken up with making plans for our collecting trip to the southern part of Ecuador, with the help of Mr. Orsés in getting tickets and permits for travel. The railway line from Guayaquil went to the east and then south to a place called Tambo, not far from Azogues, so we ordered tickets for that place on 19th June. There was much rain in Guayaquil and also plagues of insects, including crickets, beetles, flies and mosquitoes. I did not think of this delay at the time but looking back I think that Edward was making sure that I had fully recovered from the fever before we set out again.

Our train on 19th June set off for Tambo at the unearthly hour of 6.45 A.M. and of course on the other side of the river Guayas, there being no bridge across it. This meant that we had to leave the hotel at 5.45 A.M. and the Anglo-Ecuadorian Company had kindly arranged for their motor launch to take us and our luggage across the river. It was a lovely morning, the sky in the east primrose yellow, with purple-grey clouds in the west, so that the water reflected these two colours on its ripples. Small rafts of water hyacinths were floating up river on the surface with the tide, and would float down again when the tide turned, no doubt. The railway station at Durán on the east bank was slightly higher up the river than Guayaquil. Looking back over the water at Guayaquil in the rays of the just rising sun it took on an extraordinary beauty and mystery which was lost when one was close to it.

The train had a large proportion of refugee Jews on it who were going up to Quito. To begin with, the scenery was of very low marshy ground, frequently inundated and with one or two sad-looking bamboo shacks built on stilts. A few scantily-clad people were standing around, probably infected with malaria from the ever present mosquitoes. Occasional small herds of cattle and a few horses were the only animals to be seen. In the slightly higher areas there were plantations of pineapples with their lovely greyish-mauve leaves and red fruits. We also passed very frequent rather unkempt and ragged looking banana plantations.

The occasional "so-called" towns, such as Yaguachi, Chobo, Milagros, Sucre and Naranjito, were all composed of bamboo houses on stilts, and with listless people leaning out of the windows or sitting on their doorsteps. In such an enervatingly hot damp climate it was a wonder that people were able to do anything at all. Plantations of rice and sugar cane were occasionally visible, and one or two refineries. In between the fields were woods and dense entangled tropical vegetation, which made us thankful that the potato grew in cooler climatic conditions.

Gradually, we began to gain altitude, where cholos (people of Indian/Spanish origin) sold bananas, oranges and other fruits at the stations. There were also naranjillos - *Passiflora quadrangularis* (granadilla) or *P. edulis* (passion fruit). Passion fruit drinks were extremely good, and one does not have to separate the flesh from the seeds, as when eating the fruit itself. At Bucay, fifty miles from Durán, the railway line suddenly began to climb through valleys clothed with dense tropical vegetation, many of the trees covered with red-leaved epiphytic bromeliads. At 600 metres altitude the tropical vegetation disappeared, and the line ran through deep gorges. At Sibambe it divided into two. The northern one for Quito zig-zagged up a steep slope called the Nariz del Diablo (Devil's nose), whilst our line for Cuenca went back along the same valley but at a much higher altitude. At Sibambe, things became very complicated, with engines, trucks and autocarrils coming and going in various directions. There were terrible complications about luggage, and various ideas about times of departure, such as 12 noon, 2.00 P.M., etc.

We strolled around for a while, collecting another wild tomato (*Lycopersicon hirsutum* f. *glabratum*), and decided to have lunch, steering clear of a place called "The Savoy", as it was definitely not up to the standard of its London namesake. We finally got ourselves and our luggage on to a second class coach, which set off at 2.00 P.M. after the engine indulged in all kinds of pushing and shunting for reasons we could not understand. Our route lay through a cloud zone with interesting vegetation, and with the engine skidding now and again on the slippery rails. By 2.30 P.M. we were in a maize region followed later by a wheat and barley zone. The train took us as far as Tambo where the line stopped, even though it was later continued on to Azogues.

From then on we had to travel by road, after being harangued by a buxom hotel lady with a long and rambling discourse, interspersed with expression of pity for our lack of Spanish. (We could not have got a word in any language against this women's speech). Apparently, the man to whom we had sent the cable was not there, had not received it, and did not have a car waiting for us! However, with the help of countless "chicos" (small boys) we got our luggage into a hired car, which we shared with a German traveller.

The road to Azogues was rough but not rutted, and I was agreeably surprised at the comparative opulence of the countryside in contrast with that of Bolivia and Peru. Peasant huts, scattered around, looked tidy and had neat tiled roofs.

The small towns through which we passed looked quite prosperous also. We passed through Cañar - quite a large town and the home perhaps of *Solanum caniarensense* (now subsumed under *S. phureja*). We then rose to about 3,600 metres in an area with plenty of potato fields in full and brilliant flower. Most flowers were large and of a pale magenta colour with white petal tips - very striking. Others were of an intense dark purple. Many of the fields were irrigated, and there were plantings at different growth stages. We also saw fields of ocas (*Oxalis tuberosa*). Descending from those high altitudes, we motored through Azogues, capital of the province of Cañar, and finally reached Cuenca at about 8.00 P.M.

We stayed at the Hotel Internacional: although the colleagues at Guayaquil had cabled their representative there - a Dr. Arizaga - to reserve us rooms, needless to say, the hotel denied having received a message of any kind from Guayaquil. An English geologist, Mr. Barrington Brown, was also staying there. We found Dr. Arizaga at a Town Council meeting, who was most surprised to see us; the cable had not reached him (of course!), though sent on Saturday and we arrived on Monday. In any case Barrington Brown was actually staying at another hotel, so we went along and booked rooms there. These comic opera plots were all too frequent, and whereas to begin with we would have felt outraged, we had by then accepted them with a shrug of our shoulders as a way of life. After all that, Barrington Brown was out somewhere and was not to be found! We felt that a good night's sleep was indicated.

The next day, 20th June, we found the elusive Barrington Brown at breakfast but he and Dr. Arizaga were going out of town that morning, so we left them to their own activities. As was customary in those countries, we had to visit the Departamento de Extranjería (Foreign Visitors' Department) with our passports and came across the only British official in Cuenca - a Mr. French! What he did, we could not imagine, but it must have paid him well.

After all this we were instructed to go to the police station, to have our photographs taken. These were to be stuck on to identification cards. What bureaucracy! Edward had never had one during his previous visit, and nor did we have one in Guayaquil, but the people there said that they had received more recent instructions. The photographer's shop was shut, anyhow, and the police did not possess photographic facilities!

Apart from all this, the town of Cuenca seemed very pleasant, with paved streets, a nice main plaza and houses in good repair. There seemed to be a tradition for painting pictures on the walls of the houses, especially in patios. We saw a battle scene on a house in the plaza, with soldiers dying - probably referring to the 19th century Wars of Independence. Many houses had no pictures but even so, there were painted lines, panels, marblings and so forth. There was also a local "marble" with which some houses were entirely clad. However Barrington Brown told us that it was not really a marble but a form of hard limestone tinted with iron deposits. A gigantic cathedral was being constructed in the main plaza, covered with this false marble, but although it had been in construction for a long while it had not got very far.

We had lunch in a restaurant (so-called!) with Barrington Brown, most of which we found inedible! Then back to the police office where we settled down to an hour's form-filling - in quadruplicate.

Great confusion was caused by our not adding our mother's names at the end of our surnames - a common procedure in Latin America. Edward ended up with "Edward Kent Balls Kent", because his second Christian name was also his mother's name, and this caused endless confusion. Not only that, but we had to give our father's and mother's mother's names.

The brain reeled with all this and to what end, for heaven's sake? Even that was not all, because we then had to have finger prints on both hands done in triplicate, with the thumbs in quadruplicate. This excess of bureaucracy can hardly be imagined! In the afternoon I had a recurrent attack of the fever I contracted on the recent boat trip from Lima. Luckily, I had kept some of the tablets from the ship's doctor, and in the morning felt fine again. That was Wednesday, 21st June, and on the previous afternoon Dr. Arizaga had taken Edward to see an agriculturalist called Enrique Malo. He took us to see a Sr. Abadi in the State Agricultural Bureau, who, believe it or not, was young, energetic, active, and keen to tackle problems from a scientific point of view (or so he said). He promised to get us samples of all the local varieties but such promises were very common; the execution of them was generally much rarer! We had thought of going much further south to Loja, nearer the Peruvian border, but Sr. Abadi told us there was very little potato diversity there, so we did not continue with that idea.

On 22nd June we explored the local markets with Sr. Abadi. There were two of them, the first situated in what could only be described as a sea of mud. The rope and pottery sections were very interesting, the latter containing samples from a particular village which specialised in those wares. I bought a nice flat wine bottle with a small neck and holes in side flanges for attaching a string to hang it round ones neck or over the shoulder. There were also bowls, bird whistles and other objects, all very similar to items excavated from pre-historic Inca tombs and those of other Andean civilisations. The designs were simple, but rather crude I suppose. Even so, they had great artistic charm. Many shawls were displayed also, typical of the area; they were thin, indigo blue and white, with fine lace work, which was being done in the market itself. These markets were very different from those in Peru and Bolivia, showing much more Spanish influence, I thought. There were Panamá hats everywhere, generally in the half-finished state, with the uncut fibres sticking out all round the edge in a fringe. Many hats were of more than one colour, with a design cleverly woven in. Those hats, of course, were for half-castes (cholos or mestizos), and were not worn by pure-blooded Indians. Unfortunately for us, although both markets were so full of ceramics and clothes of all kinds, as well as foodstuffs, we did not see any potatoes.

Friday, 23rd June was very frustrating because all the promises of help and transport came to nought. Nevertheless, Sr. Abadi suggested that we should go out to Cañar on the Monday. He made a half-promise for the Friday afternoon but did not arrive. After all, if two foreigners suddenly appeared and hoped for help from the local agronomists, we could not expect them to cancel all their previous commitments for our benefit every time.

On Saturday 24th June we went out with Barrington Brown on one of his geological excursions in the direction of Azogues. Whilst he looked at rock formations we did some plant collecting. We found a beautiful *Passiflora* (*P. manicata*) which had scarlet flowers with purple centres. We also saw and photographed a strange red-flowered ground orchis. We then continued to Azogues, which was having a market day also, and was full of people from the surrounding areas. The streets were bright with the scarlet ponchos worn by the Indian men. The market women wore curious little flat cook's hats made of cotton.

Panamá hats were being made and offered for sale there also, showing all stages from bundles of fibres to the finished articles. This part of southern Ecuador was really the centre of Panamá hat production, but because so many of them had been sent for sale to Panamá they had erroneously been given the name of that country. Only the Mestizos wore those hats, whilst the true-blooded Indians wore only low-crowned felt hats.

Just a sprinkling of Indians was at that market, having probably come down from distant mountain villages. Whilst we were wandering round the market a policeman came up and wanted to see our identity cards which we did not yet possess because they were being prepared in Cuenca. He was looking for some French criminals and asked if we were French. As if we would have admitted it, had we been the criminals! However, Barrington Brown told him that Arizaga from the Ministry of Hacienda in Cuenca (!) had told us we could go there etc and that induced the policeman to let us go. Over tea Barrington Brown told us how his father discovered the famous falls in British Guiana, whilst geological prospecting.

We took a rest on Sunday, 25th June, going to see the hot springs at a place called Baños where there was a swimming pool. Masses of iron-tinted limestone was deposited from the springs, which, when it hardened with age was named "travertine marble" and used as decoration to houses and elsewhere, as I have already mentioned.

On Monday, 26th June, we had arranged to go collecting potatoes with Sr. Abadi, the agricultural specialist, but he was not in his office as he had promised, even by 9.30 A.M.. So, feeling that we could not wait any longer, we hired a car and planned to motor to the top of the ridge near Cañar and collected the potatoes we had previously seen growing there. These were mostly *andigenas*, but surprisingly, there was one *S. chaucha* (triploid) which we had not thought would be found in Ecuador. Near the top of the ridge we found a wild potato with conical berries, which I later identified as *S. colombianum* var. *meridionale*. It was very abundant on the bank and in the woods behind where it grew up in the shade to more than half a metre. There were stolons but no tubers; however, there were many long conical berries with abundant seeds.

As we went over the other side of the ridge we found several patches of cultivated potatoes, many in flower. Most had tubers, which we collected. All were *andigena*, except one collection of *S. chaucha*, and one or two, which did not survive, seemed most likely to be *S. phureja* (*S. rybinii* of Juzepczuk and Bukasov). We returned to Cuenca at about 6.15 P.M. and had dinner with Barrington Brown and some friends - a delightful meal only marred by the fact that I was encouraged to drink too much whisky.

June 27th was my 24th birthday - but I forgot about it until Edward reminded me half-way through the morning. There was no way of celebrating it except by going to the cinema. However, we did some collecting of ornamentals, including a pale mauve-flowered *Gentiana diffusa*, a red-orange *Philoglossa peruviana*, *Castilleja communis* (scarlet) and *Tropaeolum peltophorum* with scarlet flowers also.

On the following day, 28th June, Sr. Abadi came to pick us up, bringing a friend from the Agricultural Office. We motored north to Azogues, stopping to take samples here and there on the way. All these, also, turned out to be varieties of *andigena*.

A curious variety, named "Zhio" (Balls 7117) grew as a weed in maize and other crop fields, but it seemed only to be a form of *andigena*. Even so, the tubers were collected and used as food. At the farm I jumped off a wall on to what I supposed to be hard ground but which turned out to be soft mud, mixed ready for adobe constructions. It came up to my knees and smelt terrible, no doubt having been mixed with farm manure and straw!

Back in Cuenca, Edward decided that it would be better to go to Riobamba by Autocarril, so as to have all our luggage with us. After supper a Sr. Malo brought us four potato samples grown on his farm near Cuenca, two of which came from northern Ecuador and seemed to be late-maturing. They, also, were *andigena*. Sr. Abadi and a friend in the Agricultural Office offered to go out on the road between Cuenca and Azogues to a place called Huangarcucho where they expected to find many potato varieties. In fact, we made a good collection of ten different varieties, all *andigena*. The rest of the day was occupied by packing and describing our collections, thanking our Ecuadorean colleagues for their help and getting ready for a 5.00 A.M. departure the following day. Before leaving the area of southern Ecuador I set down some notes on the people who lived there, as follows.

"On the whole, the Indians here seem to live in the higher more remote regions, possibly having been pushed out of the warmer lower parts by the Spaniards. The Indians wear sombre coloured clothes, dark red, black or dark blue, and felt hats, never using the Panamá hat. Also, they carry their possessions slung over their backs. The men never cut their hair but wear it long and plaited into a pigtail at the back (as we saw also in Potosí, Bolivia).

The half-casts, called Mestizos here, are taller than the Indians and live lower down, in the warmer areas with better agricultural conditions. The women are quite tall and graceful, wearing lighter-weight clothes, and with much richer colours of brilliant yellow, purple, red, and/or magenta skirts; the men's ponchos are also much brighter than the Indian ones. All the men and many of the women wear Panamá hats and weave them in this area. The industry came originally from the Ecuadorean coastal regions where the Toquilla palm (*Carludovica palmata*) grows. This is not a true palm but to the casual observer it certainly looks like one. The women (mestizas) would never think of carrying anything on their backs but always balance their baskets of goods on their heads, walking along with wonderful grace, elegance and beauty.

We were woken up at 4.00 A.M. on 30th June, to be away an hour later. It was a cold grey misty and drizzly morning as we ascended by hired car past Azogues. We got to Tambo at the rail head by 7.20 A.M. ready for the autocarril which was due to start at 8.00 A.M. , but did not do so until 9.00 A.M. because the Stationmaster, who was the only person who could issue the tickets, had overslept and did not arrive until then! Whereas in Britain the man would possibly be fired on the spot, in South America it was not considered unusual.

The so-called 'especial' autocarril was not at-all comfortable, was too large, was furnished with wooden seats, and when in action made such a noise that one had to shout loudly to make oneself heard. At 11.30 A.M. we arrived at the Sibambe junction where more tickets had to be bought for Riobamba in the Central Valley. From Sibambe the line zig-zagged up the very steep "Nariz del Diablo" (Devil's Nose!) and then through narrow valleys to the desert-like páramo (high cold plateau) at Palmira. The landscape there was very dry and covered with black sand dunes, similar to those at La Joya on the Peruvian Mollendo to Arequipa line.

The Indians near Riobamba differed markedly from those of Cañar. They were very short, and the women mostly wore black. Although in most regions of South America, as well as Mexico, the women plaited their hair at the back into two pigtails, in this district it was gathered up at the back and bound round and round by a narrow woven band for about four inches, and left hanging down the back. At the sides it just hung down in a rather untidy "bob".

The men generally had their hair cut in the usual way, but one or two wore a pigtail as in southern Ecuador. Hats were flat, crowned and wide brimmed, with the brim turned up vertically at front and back. Red or (occasionally) magenta ponchos were worn by the men over white shirts and trousers, the latter being wide and going down midway over the calves.

Nearer to Riobamba we passed a town (Cajabamba) with a very colourful market, the Indians being dressed in red, blue, purple and magenta. Unfortunately the train did not stop there. Riobamba is situated at about 2,700 metres altitude, and the train ran through the streets. We stayed at the Hotel Metropolitano (an imposing name!) quite close to the station. We had only two porters, one a young boy of about ten years old who carried four of our largest pieces of luggage on his back - a stupendous feat (including tent, bedrolls, presses and a large suitcase). We visited the Office of the Anglo-Ecuadoriano Company, where the representative promised to put us in touch with a Sr. Teofilo Saenz, the President of the local Agricultural Society. After this, we called it a day.

July 1st. Only two more months left and we still had the major part of Ecuador and the whole of Colombia to cover. So we continued to battle on. It was market day in Riobamba and we did the usual tour, finding that there were no less than three markets. The first one sold food only, including fruit and vegetables; the second was for bulk purchase of grains, chiefly maize, and also ocas (*Oxalis*) and some potatoes; whilst the third seemed to be all clothes stalls. Here we were accosted by a professional cadger, who not only claimed to have rich relatives in Lima but to be related to the whole of the British Royal Family. He certainly earned one hundred per cent for audacity!

At the far side of the market reed pipes were for sale, with up to about thirty pipes of different lengths bound together. The Indian selling them produced an entrancing melody, but I could not even get a proper note at all. Back at the hotel our leech-like cadger had to come in and write a long letter to the British Minister in Quito, and we promised to deliver it, so as to get rid of him. Sr. Saenz arrived after lunch and took us to his house where he gave us five varieties (all *andigena*) from his farm above Riobamba, but apologized for the fact that they were "degenerated". This seemed to be a common complaint amongst Hacienda owners but they probably did not know the real meaning of the word. I thought at the time, that a farmer would order a variety from a wholesaler but would receive, without knowing it, a mixed bag of different varieties. After growing and harvesting them and finding them to be mixed they assumed that the original 'pure' purchase had degenerated. This seemed to be the likeliest explanation, but the peones might possibly add other varieties also. To the Indian a really good mixture of different genetic types was ideal, if a disease or pest infected them, some might be resistant and thus would produce a yield and he would be happy. If he had only one genetic line he was likely to lose the lot if it was susceptible. The landowner, however, thought that uniformity equalled purity - a common misconception in the Andes - and felt superior to the Indian with his mixed plots.

In the hotel after dinner, a man came in selling ivory nuts, called there 'Tagua' or 'Tahua'. They were from a coastal palm species *Phytelephas macrocarpa* whose nuts were often called 'vegetable ivory' and were once exported to make studs and buttons in Europe and elsewhere. Probably now, at the time of writing, they may have been completely supplanted by plastic. In 1939 there was a thriving industry in turning rings, small jars, cups, goblets, etc which were dyed in different colours. Even busts of persons were carved, generally profiles in bas-relief, leaving the original surface of the nut on the other side. The carvers were very ingenious, and one of the nuts was hollowed out and even had a complete miniature chess set inside it.

On Sunday, 2nd July, Sr. Saenz took us to see an old man who owned farms on Mount Chimborazo. According to him, he owned the whole of the mountain and had farms everywhere, but he would give us nothing. So we took our leave amongst many polite expressions of help etc - all meaning nothing. Sr. Saenz was rather upset by the reception and offered us an audience with the provincial Governor the next day. However, we later decided that what was needed was a letter from the Minister of Agriculture in Quito and some powerful official introductions; so we decided to go up to Quito, the capital, first thing on Monday morning. However, it was true that potatoes were rather scarce now because of a hard frost that had severely damaged the crop.

The following day, 3rd July, we booked a car to take us to Quito at mid-day. Before departure we visited the local Governor - a charming person - who confirmed the bad frost story and told us about a place called "Guamote" where there were wild potatoes called "Aya papas", meaning "soul" or "spirit" potatoes. The idea was that they were potatoes once cultivated by the ancestors of the present day Indians, but had since been let go and now grew as weeds. They were occasionally eaten but were rather bitter, and were supposedly resistant to some potato diseases such as the 'lancha' (probably potato blight - *Phytophthora*). Of course, as we know today, such wild potatoes could be ancestors of the cultivated ones, and thus in one sense cultivated by the ancestors of the present day Indians. However, this is rather unlikely, because potato cultivation seems to have originated in southern Peru.

The Governor told us of a German living in Riobamba, named Herr Rheinbach. This man proved to be very pleasant, a graduate of the University of Jena who had worked in the USA. and also at Montevideo. He was interested in the identification of wood from a study of wood anatomy, and had had a species of holly named after him (presumably *Ilex rheinbachii?*). He told us of two wild potato localities; "Guamote" and "Guana", probably the place that the Governor had mentioned. From the map it seemed to be a place on the railway, south of Riobamba.

We left after lunch for Quito, and as usual took a "freeloader" with us who was said to be the driver's uncle, and being a relation could not possibly have paid (though he could of course have paid us!). The driver said he would go as a 'chico' (young assistant) though he seemed too old for that role. "Ah well", we thought, "that's South America".

The journey could have furnished spectacular views if it had not been cloudy, passing the slopes of Volcán Chimborazo on the left at about 3,400 metres, then down past hordes of Indians on donkey back going to the weekly fair at Ambato. The main Ambato market square was a sea of red ponchos. There, the Indians wore the usual wide-brimmed hat but with the brim turned up all the way round. Some of the women had black shawls over their heads with the hat on top. The local dress customs really fascinated me, and I wondered if they would continue to the end of the century. The Indian dwellings were interesting, in that they had very short walls but very steep roofs covered with *Stipa* thatch, looking from a distance like so many hay-stacks. This hut design seemed to spread all through these interandine valleys.

Passing on from Ambato (capital of Tungurahua province) we arrived at Latacunga (capital of León province). It seemed to be drained dry of its inhabitants who were all probably at the Ambato market. As we neared Quito we just caught a glimpse of the snow-capped Volcán Cotopaxi on the right, and saw Cerro Corazón on the left. The countryside began to get greener near Quito, with pastures and forests on either slope of the wide valley.

Just before reaching Quito there was a low gap in the western chain through which a sheet of clouds was pouring, gradually dissolving as it settled down into the valley. At last, Quito came into view, with its central hillock and the Pichincha hills behind to the west. It was a lovely city of hills and slopes, with many church spires and domes scattered throughout the whole area.

In Quito

All South American hotels of any size have imposing names, and we (not being able to get into the Metropolitano), found rooms at the Majestic! It was a very good hotel on a corner of the main plaza, and quite new (the only trouble being that it was unfinished!). Each room had what are now known as *en suite* facilities (in 1939 known as "private conveniences"). During dinner, the Anglo Ecuatorian Representative dropped in to see us, though he was a permanent resident at the Metropolitano, clearly a step up from the Majestic.

After a good night's rest we called on Mr. Lee, the British Consul, the Minister, Mr. Bullock, being on leave. The Legation was situated out of the city, and we were taken round the garden with its lawns and pine trees, by Mr. Lee. The Secretary, an Ecuadorian, promised to take us to the Ministry of Agriculture the next day so that we could arm ourselves with permits and other important papers with which to impress the Ecuadorian farmers.

The visit on 5th July to the Ministry of Agriculture, where we explained our mission to various personages, was rather confusing, since we did not get a clear idea of their names and functions. However, we found that the chief among them was a Sr. Molestina, who seemed really interested and willing to help. He, in turn, passed us over to a Sr. Viver, the potato specialist. Although there was no potato material available, because most had been recently planted and none recently harvested, it was decided that we might get Sr. Viver to take us on one or two trips in the vicinity of Quito. Sr. Viver then took us to the "Centro Agrícola" where an exhibition of agricultural and food products was displayed. There were some very good wax models of the tubers of the commonest potatoes grown in the country, which were life-size and painted in the right colours.

That evening we changed to the Hotel Metropolitano, because our British Legation people said it was the right thing to do! I can scarcely imagine how they would have reacted to the ghastly hovels in parts of Peru in which we had to sleep. It was true, however, that the Metropolitano food was better than that of the Majestic. However, I felt that both were far and away superior to anything that we were normally offered on our expedition! Things went slowly and on 6th July we picked up the letters of introduction, etc and later went to lunch at the British Embassy. As usual, excellent food and pleasant company made the time go by quickly. At 5.00 P.M. we met Sr. Viver, who took us to his chief - a very impressive man with a huge bushy black beard, named Luís de Ascásabi. In fact, he was quite interesting, and told us about the localities of several wild and cultivated potatoes, one of which he promised to get for us.

At last, after all the kind hospitality, we started out to do some collecting again; and so on 7th July, by 9.20 A.M. and in a private car, we headed back south to Ambato. On the way we collected a very handsome climbing *Bomarea* (*B. oligantha* with red-orange flowers, deep yellow inside), and also *Miconia crocea* (with small white flowers) (*Melastomataceae*).

North Ecuador is really dominated by its magnificent snow-capped volcanoes. That day, we saw parts of Antisana and Cotopaxi, and further on - Chimborazo. We were back at Ambato by 12.30 P.M. and checked in at the Villa Hilda - a guest house run by an Austrian lady in a suburb named Miraflores. This was a fruit tree growing area, to which many people came up from Guayaquil to help with harvesting (and no doubt to help with eating, also). This area, with its large gardens and orchards was idyllic and the guest house food was excellent. After lunch we walked down to the Agricultural Centre at the "Quinta Normal", where both instruction and experimentation went on, both in fruit growing and cereal production - the two local agricultural industries. There were a few potato plots, but only three months old and thus not ready for harvesting.

From Ambato a river running south-east had cut a deep narrow gorge. We followed down the gorge over a very narrow bridge to a place called Baños (=Baths) where hot springs gushed out and a cascade of pure water fell down from the cliff, forming a rainbow in its spray. The hot spring ran into private bath houses, the whole area being patronised by Indians. This contrasted with the hot spring at Cuenca which were largely used by people of Spanish origin. It seemed that the Indians were mostly engaged in washing their hair. The women, also, as it were, washed their bodies in bits, never uncovering the whole at one time for fear of offending their modesty. The men and boys had no such inhibitions, bathing naked in the tanks. There was no splashing around for pleasure, and it was all a serious affair for giving themselves a hard scrub. On the steps above the baths the Indian women and girls sat around in picturesque groups with their hair spread out to dry. They then took it in turns to comb and plait each other's hair. They all had contented sleepy expressions and the whole scene looked idyllic.

Sr. Viver tried hard to get us to join in the bathing, but we told him we preferred to bathe in our hotel. There were no potatoes there or even naranjillas (passion fruits), so that trip in one sense had been a waste of time. However, we made collections of a climbing *Bomarea* (Amaryllidaceae), *Monochaetum* (Melastomataceae) and *Siphocampylus jamesonianus* with yellow-green flowers and other plants, so we did not feel that the journey had been completely useless. We were surprised to see in Baños men in bright scarlet trilby hats. They were mestizos, but when we had seen these types of hat in the shops we had doubted that anyone would wear them. The day had been rather disappointing on the whole, with no potatoes collected. Nevertheless, some good contacts had been made, which in any country, and especially in South America, could always be of value.

The morning of 8th July was the most boring period we had undergone, employed in seeing various officials and hacienda owners and trying to find out the best places to visit. Vows of eternal service came in, together with excuses from all sides. Because the next day was Sunday, and Market Day was Monday, nothing could be done by anyone. So all we could do was to try to get some arrangements made for Tuesday onwards. All potatoes in the area were either just planted, not in flower, or nowhere near ready for harvest we were told! The only possible places for collecting were Pillaro and Salcedo it seemed. So, ever hopeful, we set off after lunch for Pillaro, in the central valley, just north-east of Ambato.

The road was perilously perched on the side of the river valley that led to Baños lower down. Pillaro was the usual type of small adobe village, and the potato farm was higher up. There we were told that the potato crop was being harvested three hours' climb away and that there was only one variety.

Not to be daunted we climbed up and found the potatoes, which seemed to be infected with a yellowing virus of a mosaic kind and were also infested with a small black beetle. However, we got four potato varieties (all *andigena*) as well as seeds of *Nicotiana rustica* at the farm, which was called Hacienda Carbón (coal farm) for some reason unknown to us. We continued rather hopelessly to a place called Salcedo, on an exceedingly bad earth track which quickly became impassable. It had been a very poor potato day, but we at least found a very nice *Echeveria quitensis* with reddish orange flowers, growing on walls and rocks, and a handsome bushy *Satureja tomentosa* with striking scarlet tubular flowers. There was also a plant rejoicing in the name of *Boussingaltia baselloides* with spikes of small white flowers. At the farm we were introduced to a national drink - a sort of cider, which tasted of burnt sugar, apple and a lot of fizz. We got back to Ambato, feeling very frustrated. The number of specimens collected seemed to be in an inverse ratio to the money and time spent in collecting them. That seemed to be a fact of life in South America, and was certainly so in Ecuador.

On the morning of 9th July we had a walk round the outskirts of Ambato. The only potato we found was a field of 'Yungara', in flower, but not yet with tubers. In any case it was the commonest variety grown in the area. The day was not entirely wasted, however, because we made some collections of wild plants instead. Amongst them was *Menzelia fendleriana*, with apricot orange flowers, *Senecio terebifolius*, with flat heads of small yellow flowers, *Coursetia dubia*, with slightly aromatic mauve-pink and white flowers and woolly leaves, *Salvia humboldtiana*, with small, clear blue flowers, and a wild *Capsicum* (pepper), with scarlet globular fruits.

In the evening we went to the cinema ("flicks" we called it in those days) and were amused to read a notice telling members of the gallery to: "Behave themselves with the best cultura" (politeness) and "if this rule is not obeyed they will be clapped into prison". Luckily for the gallery people, they did behave sufficiently well to avoid that fate. Afterwards we met an English plant collector who struck us as a complete "Colonel Blimp" - an absolutely perfect example of the Englishmen whom all South Americans considered to be typical of us.

July 10th was market day, five plazas (= squares) being given over entirely to it, with meat in one, cattle in another, fruit in a third, clothes in a fourth, and tubers and vegetables in a fifth. Of course, the fifth was the one we visited first, to look for potatoes. We were rewarded by sixteen samples, all from around Ambato in the province of Tungurahua. All were *andigenas* except one *S. phureja*. Sr. Viver called it an early variety, maturing in three months and with a very short tuber dormancy; so that fitted perfectly with this species, which was called "Santa Roseña". In the evening we went to Huachi, near Ambato, where we got three more samples - all *andigena*.

On the following day (11th July) we set out with a Sr. Coloma to visit his farm at Mocha, near the Chimborazo provincial border. The weather was dull, cold and raining now and again - not surprisingly in this, the growing season. The farm, called "Yanayacu" (= black water) was very large and in good order, and we were at once taken to see a field of the "Tabla" variety, about two months old and of course with no tubers.

We were then provided with a horse each and went up over the mountains to about 3,200 metres to some more potato fields. The track was steep and slippery, but I have to confess that I had never enjoyed a ride so much.

These were energetic beasts anxious to trot quickly, whilst the other poor creatures in the past had needed to be goaded on, not with spurs, but by a process hard to describe, but which needed to be learned, and consisted mainly of leaning forward and shouting a bit, moving ones feet and legs etc. On these lovely beasts at Yanayacu we trotted and even galloped. What bliss!

Our host had lent us each a thick, warm poncho to keep out the rain. They were wonderfully cosy, mainly because they trapped the heat rising from the horse and so warmed the rider. We got up to a potato-growing region at about 3,300 metres with gigantic *Buddleia* bushes - really trees - of the orange ball type. These were covered with climbing *Bomarea rigidifolia*, with deep scarlet outer and bright yellow inner tepals, *Tropaeolum tuberosum* (wild) and various other plants. *Salvia hirtella* with bright scarlet flowers, was common. We also collected *Senecio pimpinellifolius* var. *nubigenus* with deep yellow flowers, the stinging *Cajophora aequatoriana* (climbing, with scarlet flowers) and *Fuchsia loxensis*, also with scarlet flowers. There were many bromeliad epiphytes and even parasitic *Loranthaceae* on those *Buddleias*. The whole area was tremendously full of very striking wild plants, with scarlet, orange and yellow being the predominating colours.

Well, back to potatoes: we got nine varieties from this area, all being *andigenas*. Then later we went down to the main road and reluctantly (at least in my case) left the horses and motored up to the divide at Urbina, where the Guayaquil - Quito railway reaches its highest point, on the slopes of Volcán Chimborazo. This lies on the border between the provinces of Tungurahua and Chimborazo.

Near Urbina there was a potato field with the variety Ubilla - a very large-leafed kind which had been planted in December. It had black-skinned tubers and was being attacked by a small orange thrip insect. The owner, a Sr. Sembrana, came along and he and Sr. Coloma, who were both big potato growers, addressed each other with very flowery complements which were really enchanting to listen to. Returning to Sr. Coloma's farm at 1.00 P.M. we were invited to an excellent lunch, with cheese, potatoes and artichokes, followed by soup, a meat and fried potatoes course, followed by fried eggs and bananas, ending with coffee. Sr. Viver ate so much that he was quite unable to eat any dinner later. We ourselves spent the evening describing, pressing and packing all the day's finds. I have to add that there was a very strange plant, a lupin, that grew as a weed in the potato fields. It had deep purple and white flowers, and our collections constituted the 'Type' for a new species later named and described by C.P. Smith as *Lupinus solanagrorum*. Readers with some knowledge of Latin will realise that this name means "A lupin from a potato field"!

We left Ambato on July 12th by car, headed for Latacunga, capital of the province of Cotopaxi. The Hotel Paris accommodated us for the modern equivalent of ten pence. per day, excluding breakfast.

There was nothing much doing here, since the market was on a Saturday, and it was now Wednesday. We got three specimens of potato (all *andigena*) in the market square from a few old women who were selling various odds and ends, and who seemed to be the kind who "would sit all day selling three tired tomatoes" (to quote a Mexican author whose name I cannot recall). We then wandered out into the lanes around the town to "take a stroll" ("dar una vuelta" as Sr. Viver was fond of describing it).

The fields were well-irrigated, and on the south-east side was a part with an ornamental lake.

A nice, yellow-flowered specimen of *Chrysanthemum frutescens* was our only trophy today. We started out the next day (July 13th) for Saquisilí, through roads thronged with Indians going to market on foot and on donkey back. There was a fairly large potato section in the market which we of course visited immediately. The father of the car driver had naturally got himself a free ride (The usual 'freeloading' that we had only too often suffered). He made himself a double nuisance by offering to help us. Instead of saying (in Quechua) to the Indians "what variety of potato in this"?, he would say "This is such-and-such a variety", and generally the Indian would be only too glad to say "yes" in the hope of making a sale. It would not have been too much bother if this man had known the varieties, but he was restricted to only a few varieties, and would confuse things by insisting that a different variety was the same as one we had seen already. He was a real pain. However, we managed in spite of him to get nineteen varieties, one of which turned out to be the Central Peruvian "*S. goniocalyx*". This was not so strange as we thought then, because its vernacular name was "Limeña" (from Lima), and of course *S. goniocalyx* is indigenous to the Central Peruvian Andes above Lima; so it must have been exported from there and retained the name, which was the clue to its origin. All the rest of the collections were *andigenas*.

There seemed to be nothing more of interest in Saquisilí despite its charming name, so we left by another road to take us on to the main Quito highway. Again, we passed a continuous stream of people with their goats, sheep, llamas, cows and pigs all going to market. I had never before seen pigs with a string round their necks being led along by dogs, but they did not seem to mind it! Goats were the most frightened by the car and would make great leaps into the air as we neared them. Some of the Indians were wise to this and would sit aside their goat so as to "cushion" its jump. Llamas seemed rather out of place in Ecuador, especially when surrounded by a sea of sheep, as was generally the case. These Ecuadorian llamas were much smaller than the Peruvian breed - only about two-thirds their size and more uniform in colour (generally brown with a few white patches). We did not see any in herds, but possibly there might have been some up in the mountains. Here in Ecuador the llama seems to have lost the proud position it assumes in Peru, even allowing small boys to ride on its back - a thing unheard of in Peru.

At various places along the road to Machachi we made collections of some quite striking plants, such as *Calceolaria ornata* (deep yellow flowers) and *C. saxatilis* (paler). We also collected the Type specimen of *Piper machachianum*, yet another *Calceolaria* (*C. chelidonioides*) and tangled masses of *Tropaeolum smithii*, with scarlet flowers on the outside, but yellow, brown spotted, inside. We stopped at a potato harvest on the Cotopaxi páramo (high cold moorland), where the men were wearing sheep and goat skin trousers and were using spades in the shape of canoe paddles, pointed at the end. We had never seen these before. Unfortunately, there were only two varieties of potatoes available here (both *andigena*).

We had lunch at Machachi and were relieved to find that the food was more palatable than in Latacunga, though only just. Edward and I decided that to save time we would split forces. He would go eastwards to collect alpiners on the slopes of Volcán Antisana, where he was particularly keen to find a rosulate *Viola* there. I, on the other hand, wanted to climb El Corazón to the west of Machachi to look for a *Solanum pichinchense*, said to have been collected on its slopes. I think Edward's *Viola* was *V. nivalis*, with white flowers and thin purple veins in the centre. As Sr. Viver had to return on Saturday he decided to climb El Corazón with me.

We tried to visit the "Jefe Política" or Mayor four times before we found him in, and were eventually promised five beasts (two for Edward and three for Viver and me), which would be ready for us tomorrow, we hoped.

The Pichincha countryside was very beautiful, with green fields, and high mountains quite close to us, whose lower slopes were covered by forests. To the west was Corazón, which we were to explore the next day, and a little to the south was Iliniza, with its twin peaks. To the east was Mount Sincholagua and behind it the much higher peak of Antisana. All these high peaks are said to be extinct volcanoes, active when the Andes themselves were being formed.

Although on July 14th we were ready to start at 7.00 A.M., we were informed that the horses or mules would not be ready until 10.00 A.M. Therefore, Sr. Viver and I decided to walk on to the slopes of Corazón, as it was quite near. On the other hand, it was said to take two days to get to Antisana, so Edward clearly needed to wait for the beasts to carry him and his equipment. To find a guide for the ascent of Corazón was very difficult, but eventually we found an unwilling boy at the railway station who grudgingly agreed to go with us, "but only to the potato fields", he said.

As we ascended we had marvellous views of mount Iliniza to the south and mount Pichincha to the north. The boy was no use at all, and we got nothing at the potato fields. In the upland bushy area above the forest zone there were some fine plants in flower - *Bomarea caldasii*, a climber (with orange-red flowers outside and yellow, spotted with brown inside), a deep blue-flowered *Salvia rumicifolia*, *Oenothera cuprea* (Evening Primrose) with orange-red flowers, and a small *Valeriana alophis* with small whitish flowers. Unfortunately, we could not find any wild tuberous *Solanum* species.

Back at Machachi we decided to visit the mineral springs about one and a half miles away. These waters were bottled at source using natural carbon dioxide from the springs also. The open-air baths had water that tasted just like the bottled product. Large funnels had been placed over the bottom of the bath to collect the natural CO₂ bubbling up, used for the bottled water and compressed into cylinders. This was *really* mineral water. I was tempted to bathe in these open-air baths but Sr. Viver told me that the CO₂ lay over the water and could asphyxiate me. I wonder if he was right?

On July 15th our bus to Quito started punctually, for once, at 7.00 A.M. We were packed on to the seats as tightly as sardines in a tin can. A very portly gentleman who had paid for two seats was extremely annoyed when a young lady tried to push into his row. Eventually, everyone settled down and we got to Quito at 8.30 A.M. We had kept our rooms at the Hotel Metropolitano, so all was well.

The 16th and 17th July were rather uneventful, as I found no wild potatoes in the vicinity. Even so, when I climbed Mount Pichincha, above Quito, I collected some fine, ornamental flowering plants, including *Altensteinia fimbriata* (a ground orchid with green and white flowers), *Phaedranassa dubia* (an Amaryllid, with pale crimson flowers), another Amaryllid called *Stenomesson aurantiacum* (with apricot orange flowers), a beautiful reddish purple star-shaped gentian (*G. defusa*), yet another *Salvia* (*S. tortuosa*) with a purple-red flowers, and a scarlet-flowered *Fuchsia* species, together with a *Gaultheria* (*G. pichinchensis*) and the usual genus *Calceolaria*, (*C. hyssopifolia*) with very pale yellow flowers, white below. This genus, *Calceolaria*, seems to be everywhere, and with different species in each area.

The books say, not surprisingly, that there are two hundred and twenty five species, spread throughout Mexico, South America and New Zealand!

Edward returned from Antisana in the afternoon in an exhausted condition, but with some very fine collections. These included a beautiful bright scarlet gentian (*Gentiana cernua*), a tiny *Astragalus* (*A. geminifolius*), with pale purple and white flowers, a blue-purple *Lupinus rubigenus*, *Caltha involuta* (pale green flowers), another gentian (*G. limoselloides*), with white flowers, *Potentilla andicola* from the type locality, and, of course, another *Calceolaria*, (*C. halliana*) and much else besides. It had taken two days for Edward to ascend Antisana on a very erratic and wayward mule, and he "slept out" in the open the first night feeling very cold. The second night he "slept" in the Hacienda Antisana, where there was no food or bedclothes. A particularly interesting plant that day was a Lupin species with a flower spike as thick as a man's wrist but a hollow stalk and minute flowers engulfed in woolly bracts.

On the morning of July 18th we again met Sr. Luís de Ascásabi (the man with the thick black beard) who told us that he had made arrangements for us to go north of Quito to his father's farm on Mount Cayambe. This is a large snow-capped extinct volcano rising to 5,700 metres. (over 19,000 feet), though the farm was well below the snow line. Sr. Luís de Ascásabi gave us a collection of nine potatoes, of which two were *andigena*, two were *S. rybinii* (now *S. phureja*) and four died by the time they arrived in England. Unfortunately, two of these were wild potatoes, so I was never able to identify them. Sr. Viver also gave us a few varieties that day, collected in various places.

A visit to the Quito market with Sr. Viver was unlucky - we found only three common varieties. On the way back we entered the cathedral church of San Francisco, which had more ornate and carved pillars, statues and walls than in any church we had seen - the epitome of Andean Baroque. Another church, the Compañía, showed a ferocious doom painting in fearsome reds and browns, with various tortures being meted out to the sinners, each of whom had a label round his neck indicating his particular vice. In the centre of the picture was the prince of darkness, sitting on a fire-breathing dragon, and below him was a simmering cauldron with sinners being cooked and a demon with a mallet ready to bash anyone's head who tried to escape. Many other tortures, too horrendous to describe, were also being perpetrated on these sinners, who although naked, had a convenient flame covering their private parts (or perhaps burning them?). A wonderful altar had much gold plating on it, as well as a great deal of silver.

An extraordinary resurrection painting caught my eye. Skeletons were ascending from their graves, but as they did so they began to take on flesh, skin, and finally hair, where appropriate. At first they popped their heads out as skulls, and as they rose layers of flesh were piled on, with, finally, the skin. One man had all his muscles but no skin. Another had his complete head, but lower down was still only bones. What seemed to me to be very unfair was that monks and priests were emerging intact, with all their flesh, skin, hair and clothes, whilst the common people had only a bit of rag on them. We wondered what happened to people who had been dismembered in battle. The artist had got that all worked out too. In the foreground was a man busily putting his head on and others literally "putting themselves together". In the distance people were being judged, the sheep separated from the goats. A sheep is shown bounding happily away, whilst the 'goats' or wicked people were being pitchforked into hell, the smoke and flames surrounding them. It was a great picture!

After that experience we "came down to earth" as it were, and visited the potato exhibition, with Sr. Viver providing details on planting and cultivation in Ecuador. Later, Luís de Ascásabi talked about the Indians of Ecuador. It seems that not all were Quechua speaking, but others were from remnants of troublesome tribes which were deposited there by the Inca kings from Peru. The Zambisas or Nayones, for example, from an area north-north-east of Quito are of this type. The women's hair is cut into a sort of bob at the sides and they wear a piece of white cloth with black stripes over the head, rather like an Arab turban. Their skirts are rather short and not full. The men wear pigtailed. We were to see, also, some of the forest Indians in markets north of Quito, who were very different from the quiet, rather stolid people of the mountains.

The morning of July 19th was very clear, and when we went up above the town to collect bulbs the views were breathtaking. The perfect cone of Cotopaxi was cloudless, and we could see ice and snow in streaks on the flanks as well as the peak, looking so like the tip of the Japanese Fujiyama. A little to the south-west, Corazón was clearly visible, though Iliniza and Antisana were cloud-covered. To the north the less regular but immense snow-capped peak of Cayambe was clearly visible, with the sun shining on its icy slopes. This was a breath-taking and never-to-be forgotten experience.

The next day, Thursday July 20th, I woke up at 2.00 A.M. with a start to the noise of my bed shaking and the table rattling. Later that day I found that there had been a slight earthquake. These are not uncommon, and during a later visit to Quito. I found the whole bed moving and the ceiling lights swinging from side to side. Much later, when I was in Lima on another visit, the noise of the earthquake was like an express train approaching at sixty miles an hour or more, finally rumbling away into the distance.

After packing potatoes, seeds and bulbs to send back to England, we lunched with our "Colonel Blimp" whom we had seen previously in Ambato. He turned out to be a well-known English botanical collector - Christopher Sandeman (of the well-known Port Wine importers), who had many tales to recount of his experiences. I felt soaked in whiskey and sodas and cannot remember what we did for the rest of the day. (Nothing at all, but sleep it off I think!).

On Friday 21st July we set out in two cars in the late afternoon with Sr. Ascásabi and his father for their farm at Cayambe, north of Quito, passing large Eucalyptus plantations on the way. On the whole, this area in the valley of the Rio Huaillabamba seemed rather dry, and reminiscent of the Ayacucho region of Peru. The vegetation consisted of sparse tufts of grass, spiny *Mimosa* bushes, occasional cacti and parched shrubs. Passing the village of Huaillabamba, and continuing for another two and a quarter hours, we finally arrived at the Ascásabi farm, named "Guachala". It seemed a vast place, since after we had entered under a stone arch we motored for a mile or two through an avenue of Eucalyptus trees; then another gate was opened and we got to the house after a further quarter of a mile. No expense was spared on the house with its tiled bathrooms, polished floors, rugs, luxurious furniture and pictures.

The older Sr. Ascásabi was already there to meet us and was a keen photographer with many of his framed photographs hanging on the walls. Dinner was lengthy, with many rich courses and plentiful wine. During dinner various guides came in to discuss the next day's times and routes for an ascent of Mount Cayambe, at least to the snow line. We retired early, because we were to be called the following day at 4.30 A.M.

It was still dark at 4.30 in the morning of July 22nd when we were awoken. Some of the horses had broken loose, the ones belonging to Sr. Luís (the son) because he had brought them up from Quito and they were evidently trying to get back; so it was about 7.00 A.M. before the horses were caught and we got away. We could now see the house, an enormous three storey building with the grounds planted with Eucalyptus trees and the area in front sloping down to an ornamental lake. Although the party included only three "main" people, ourselves and Sr. Luís, a whole army of retainers seemed to be needed also, with eight horses and riders, plus two mules. One of these mules carried a basket of food and the other ran along unsaddled to provide a change for Don Luís. (He was a large, heavy man!). Another retainer carried a gun whilst yet another had a couple of dogs on a leash, because Sr. Luis thought there might be some bird shooting. He himself turned out in an extraordinary cowboy costume of wide, baggy trousers and a jacket to match, all in black deerskin with white spots and a big fur collar. He also had a tall cowboy hat with a chin strap and he wore a pair of silver spurs. He rather fancied himself in all this, to such an extent that we thought he might have hired a film crew. However, none appeared.

We started off at a spanking pace, trotting, cantering and galloping for as long as the ground was level or gently sloping. It was all extremely invigorating - a far cry from the poor beasts we had hired elsewhere. Later, we trotted over seemingly endless foothills, with the peak of Cayambe visible now and again. At about 11.00 A.M. we came to a steep valley with a covering of silvery-leaved shrubs (possibly a *Senecio*?). We saw here again the extraordinary *Lupinus* with its thick woolly inflorescences about three to four inches in diameter and very hairy grey leaves. There was also a reddish-orange and yellow-flowered *Ranunculus*, called by the Indians "Puca rosa" (meaning "red rose"). Higher up was an evergreen *Gaultheria* with brilliant red flowers looking like berries (*G. glomerata*?) and a rusty-red *Lycopodium crassum*. A minute lupin was growing abundantly, flat on the ground, and had small dark blue flowers.

Luís Ascásabi pointed out condors to us, gliding effortlessly high up in the air, and we saw at least seven of them. Of course, although they are very large birds they looked quite small so high up in the sky. One of them came closer and we could clearly see the white ruff round its neck and the white patch on its back as it sailed and glided with almost motionless wings. Apparently, the condor is one of the few birds that turns its head and looks about it whilst flying. Don Luís told us that if someone lay seemingly dead and quite still, the condors would come to investigate, thinking that he or she might make a tasty meal for them. We did not try it!

At about 11.30 A.M. we climbed up on to a high ridge from where we got a good view of the forbidding and grim countryside around us. The vegetation was very sparse here, with steep rock screes above and below us. Above us towered the colossal peak of Cayambe, with clouds pouring up from the eastern side and quickly dissolving into threads and columns like cigarette smoke. The snow-cap of the mountain above us shone brilliantly when the sun was on it, seeming to be like a mirror. Just above us was a snow field at the base of a glacier, which ended at the top of a cliff some sixty to one hundred feet high; the glacier itself being some thirty to forty feet thick. It had a peculiar greenish colour when one looked up at it from below. As it descended, large pieces broke off over the edge of the cliff and fell on the snow-field below. Standing on the snow in their bare feet were several Indians and their mules, trimming the lumps of ice into rectangular blocks which they then wrapped in sacking and tied on to the mules' pack-saddles.

These would be taken down for sale in the Cayambe market. Some of the Indians were planning to walk down with the large blocks of ice strapped on their backs even.

We were told later that the same thing used to be done on Mount Pichincha to take ice down to Quito. In the winter when there was ice on the mountain the inhabitants of Quito could eat ice cream. In the summer, when there was no ice on the mountain and Quito was hot there was no ice cream! Nowadays, of course, refrigerators are available and the ice-carrying Indians near Quito no longer have jobs. Evidently there are no refrigerators yet in Cayambe village.

We had a snack a little further down and whilst Don Luís was off trying to shoot birds Edward and I did some botanical collections. What we took to be grass turned out to be an *Azorella*, but we did not collect it for some reason which I do not remember. We did find a green-flowered *Lachemilla hispidula* (close to *Alchemilla*), a creamy-white flowered *Lisipomia acaulis* (related to *Campanula*), an attractive *Gentiana nummularifolia* with white flowers and dark-violet veins in the throat, and a type of 'sea holly' (*Eryngium humile*). Of course, the usual genus *Senecio* was present. It was *S. ericaefolius*, with heather-like leaves and bright golden flowers.

We then ate an enormous lunch, in which the two dogs took part with enthusiasm. After this we took off down-hill at a quick pace which is always a nightmare because of the bumping action the horses make. To add to the discomfort, my horse had box stirrups which were too small for my feet. Thus only the tips of my boots would go in and also kept slipping out. Anyone who has ridden a horse down a steep mountain without stirrups will be able to sympathise with me. Well, of course, this was just one of the many painful experiences we had to accept. When we arrived at the Hacienda I felt extremely saddle-sore and Edward had a bad leg, contracted on Antisana. After supper we dozed by a large log fire drinking hot whiskey and lemon. The hot baths we had been promised before supper were in fact cooler than our body heat. Still, it was meant kindly; and as we continually were finding, one must be prepared to suffer if one decides to be a plant collector!

Sunday 23rd July was a day of rest and recuperation. After breakfast we were shown the deer in the park round the house, looking at times up at Cayambe where there were clouds interspersed with rain and hail, and so glad that we were down here. We then went up to the "home farm" in the luxurious car of the older Sr. Ascásabi to see the church and the Indians going to service. This was their pay day, and all the tribes or communities from this immense hacienda were standing in line to receive their wages. This was so feudally medieval that we could hardly believe that we were in the 20th century. As Sr. Ascásabi approached them they all took off their hats and said "Buenos dias, patrón" or "Buenos dias, patroncito". Each then received a wage of a few sucres for one week's work, whilst the patrón was spending thousands on his hobbies or an added luxury for his house. I have often wondered whether this still continues when I am now writing. Such large contrasts between the field workers and the landowners have ultimately ended in revolutions, as in Russia, Cuba, Peru and other countries. Perhaps Ecuador has been spared these - I do not know - but it struck me as just not right, though of course Edward and I had benefited from it in a minor way.

We drove later to Cayambe village in search of potatoes. Apart from half a dozen women selling fruit there was nothing. Back at the house again we were shown relics of the Independence Wars against Spain in which the Ascásabi family had participated.

Sr. Ascásabi also showed us his photographic equipment and studio, together with some old "Lumiere" colour slides taken in France in 1922. He had even prepared stereoscopic colour slides taken in Monte Carlo, where he used to live.

After lunch Edward rested his bad leg whilst Don Luís and I went for a short horse-back ride (on level ground I was glad to find) which I always enjoy. We cantered down to the river in a steep quebrada (ravine). Right down by the river there was a small circular swimming pool fed by warm spring water, but it was unfortunately empty. Don Luís was a superb horseman, who could make his horse do various tricks without touching the reins. He could get it to start, stop, gallop, go backwards and go sideways, all by inclination of his body.

At 5.00 P.M. the car came out from Quito to take us back. We stopped at a place called Guayllabamba where there were groves of aguacates (*Persea americana*) and Cherimollas (*Anona cherimolia*). I collected samples of aguacate buds and young fruits. A little further on we saw turkey buzzards (the American vulture) perching in the trees, and on the left, completely thornless agaves. This was the green-leaved type used for fibre production, whilst I was told that the grey-leaved form was used for making an intoxicating liquor called pulque (well-known in Mexico). To do this, the terminal bud that would have formed the inflorescence is removed and the sap constantly baled out for fermentation. A stone was put over the cut shoot so as to prevent dogs (or perhaps wolves?) from drinking it. We arrived at Quito by 7.45 P.M. for a light meal and a long sleep.

On Monday July 24th Edward's leg was very painful. He received treatment from a doctor and went straight to bed. I made some arrangements with Don Luis de Ascásabi for a trip up Pichincha the next day, together with Sr. Viver. Ascásabi very kindly gave me a skin of the native wolf which was of course most generous; however, it had such an abominable smell that I made a firm but secret decision to get rid of it as soon as I possibly could.

The next day, July 25th I picked up Sr. Viver in a car at 10.00 A.M. with a view to look for the wild potato, *S. pichinchense*. Dr. Bitter had given the locality as Chinguy, but no such place existed. We decided tentatively that George Bitter, the German botanist who had described many potato species, who described this species, had misread the label for Cerro (or C.) Unguay. This was a place just south of Quito, in a small valley that ran west down to the tropics. The small peak of C. Unguay is not marked on the one to a million American Geographical map, so we concluded that it must be very small. However, we motored south to Lloa, just south-west of Quito, and were told about wild potatoes in the vicinity. The trouble with such questioning is that any wild plant with tubers is called a potato (papa) and also that people are anxious to tell you anything they think you want to know.

Well, enough of that. We got a local lad to guide us and, driving the car right up to it we surveyed C. Unguay for likely localities. We asked various people working on their fields if they had seen wild potatoes but without success. The general story seemed to be that they seemed to remember seeing wild potatoes but had forgotten just where and at what time of year. We had a good look round but found none. However, we collected a lot of other plants, including a *Vaccinium floribundum* with small pink bells, a purple *Satureja stachyodes*, a scarlet and yellow *Phrygilanthus* (Loranthaceae), a pale pink *Cuscuta* and a *Dendrophthora* (also Loranthaceae). I wondered why there were so many parasitic flowering plants around there. There was also an epiphytic green flowered orchid (*Epidendrum frutex*); and of course there were the usual Bomareas and Calceolarias in some abundance.

Little of note happened on July 26th. Sr. Viver and I went to the University Botanical Department to see the Professor of Botany, Dr. Acosta Solís. He was out, and although we wanted to see the original Sodiro specimens, the cases were locked. Sodiro's specimens of wild potatoes had of course been described by George Bitter. Poor Edward was still in bed with his poisoned leg and feeling rather suicidal.

On 27th July (Thursday), our return visit to the Botany Department was successful. Acosta Solís was a youngish man of about the same age as Vargas in Cuzco and equally enthusiastic and energetic. He wanted to know all about our trip, how we liked Ecuador, etc., for an article he wanted to write about us in "El Comercio" newspaper. Asked about Sodiro's collection, he told us that since Sodiro was an Italian Jesuit his collection was in the convent where Sodiro lived, and that he would make arrangements with the priests for us to see it. "Come back in the afternoon", Solís advised us, which we did, only to be told that the priests were holding exams, and to come back the next Monday!

I asked Solís for advice about the Otovalo Saturday market and he advised me to go up the day before on an early bus. The bus on Friday, 28th July was indeed very early, starting at 6.00 A.M., and I was advised to get up at 4.00 A.M. to be ready by 5.30 A.M. since otherwise I would not get a seat. Of course it was quite dark even at 5.30 A.M. and only half light by 6.00 A.M. I finally found the right bus after having first waited by the wrong one. This often happens. Either you are given the wrong information or none at all. We were just about to start when a policeman came up and asked for my cédula (identity card) which I did not have; then my passport (left in the hotel). Then he got the idea that I was a German, coming from Vienna. Why did I need to go to Otovalo when I was in Ecuador already? Anyhow, I was not allowed to travel, and had to go back to the hotel for my passport. There was another bus at about 10.00 A.M., so why was I not told about that one? Finally I got to the bus station in time and started looking for the policeman to show him my passport. However, the bus employees said that the police had all gone away; they were there only in the early morning. What is so dangerous about the early morning I wondered? No answer! On the outskirts of Quito an officious-looking policeman came up; hooray! I could show him my passport. But no; he only wanted to look at the passenger list and examine the driver's cédula. What haphazard lives they seem to live here, I thought. After seven months in South America I could only conclude that regulations there are both inconsistent and unpredictable. One just has to shrug ones shoulders and do what one is told.

Otovalo lies to the north of Quito, and is further north along the road on which we had travelled to Cayambe. The bus itself was one of those rattling, springless vehicles, which seem to siphon up the road dust between the floor boards as well as the hot engine fumes. It could not have been described as comfortable in any way. Still, it travelled to where one needed to go, and by now I was accustomed to this sort of travel. There was a high ridge between the province of Pichincha (of which Quito was the capital) and Imbabura, the next province to the north, so we went on climbing after buying a snack at Cayambe. After passing the ridge, we could see the Laguna San Pablo through the clouds and rain. It was set beautifully with the conical Mount Imbabura behind it.

We arrived at Otovalo at about 3.40 P.M. and after asking for advice about hotels I was told by some that the Hotel Sucre was the best place to stay, whilst others recommended the Roma. I chose the Hotel Sucre, but when I finally asked for the bill the letterhead was printed "Roma", but crossed out and overprinted "Sucre". I never did find out whether there were two hotels or only one!

As a matter of fact the Sucre was very good, clean and with up-to-date sanitation. A stroll round the town showed clean single-storied whitewashed houses with wide, even, cobbled streets. As usual, the public buildings were only half-finished. Dinner was good, and having got up so early I went to bed and fell fast asleep instantly at 8.00 P.M.

On Saturday, July 29th I walked out into the market by 7.45 A.M. to find it in full swing. It was one of the most colourful and interesting ones that I had ever seen. There was, however, a big drawback; search as I could in the potato section I could only find two varieties. One was "Yungara", which we had seen everywhere in central Ecuador. The other was one I had never seen before, called "Pintada". It was rather irregular, and coloured purple, but was only an *andigena* variety. However, there were vast quantities for sale, and I returned every three-quarters of an hour to see if any new varieties had been brought in, but with no luck. The market Intendente (Manager) told me that sometimes new varieties came in, and at other times (like that day) the potatoes were all very uniform.

The handicrafts, however, were most interesting, though not as good as those I had seen in southern Peru. Men's ponchos, women's embroidered blouses, rings, beads, raw wool and cotton, earthenware, pots, ropes, belts for "huahuas" (babies), vegetables and fruit, but very little of souvenir value. The Indians and their dress were interesting, so I got out my cine camera and photographed the various people and their clothes. The men's ponchos were often red but sometimes dark blue, worn over white shirts and trousers. Hats were trilby shaped or the large round ones with turned-up brims. The men's hair was braided into a large pigtail at the back. The hair at each side of the head was braided into a small pigtail, then taken round the back to be woven into the large one. The women's dresses were not the usual very full ones that we had seen all through the Andes, but very narrow, black or dark blue, split on one side to allow them to walk freely, and with another skirt underneath in red, orange or magenta. They wore loose white blouses and over these a shawl in brightly coloured wool, red, magenta or orange. Their necks were festooned with gilt and coral-red beads and their hands loaded with rings on market day. Sometimes they wore a hat like the men did; at other times it was a bright shawl and at others a piece of white calico striped with dark blue and wound on the head like an Arab turban. They seemed fond of putting pieces of cloth on their heads or hats. The babies were carried on their backs and frequently wound round with yellow cloth. The women's hair was worn at the sides in a long bob, similar to that at Riobamba. The Indian tribes in this northern district seemed at least more ready to smile, and they looked more dignified and intelligent than those in the centre and south of Ecuador. They are said to be proud and independent. I left for Quito after lunch and it took five and a quarter hours to get back, stopping at Guallabamba where we ate fresh paltas (avocados) and cherimoyas (custard apples).

Sunday, 31st July was spent typing notes and letter-writing. Sr. Viver brought us eight more potato varieties from various parts of the Pichincha province in the environs of Quito. Five of these died in transport, two were *S. phureja* and one was *andigena*, so it would seem that they had been harvested a few months before.

Edward and I had been getting more and more worried that we had only one month left to cover the far north of Ecuador and the whole of Colombia. We were fairly certain that there would be many varieties grown in the southern Colombian departments of Nariño, Cauca and Valle de Cauca, as well as in the eastern mountains of Cundinamarca and Boyacá. We therefore decided that Edward would continue by land and collect plants also from the very rich flora of the eastern Andean slopes in which he was particularly interested.

I would fly to Bogotá on August 5th and collect potatoes mainly in the east-central massif. We would join up in Bogotá towards the end of the month. The next few days were occupied by the usual boring exercises of getting permits to leave the country and others to enter the country one needs to visit, as well as booking a plane ticket to Bogotá.

On August 1st, I went with Acosta Solis to try to see Sodiro's specimens in the Jesuit College herbarium. Various moves of the herbarium had resulted in a mix-up of the Solanaceae genera and even other families. I had to look through the whole family to find the species in which I was interested, but even then I did not find the species described by Bitter. However, there were various wild Conicibaccata specimens labelled *S. tuberosum* and I also found sheets of *S. ochranthum* sometimes under the old name of *S. caldasii*. Wild tomatoes (*Lycopersicon* species) were also represented. That evening I decided to celebrate my birthday (a bit late, but better than nothing) by dining with Edward at a German-run restaurant called the "Fiesta". We were afterwards pressed into another party at the "Boris Bar", where we danced with two Scottish girls, finally not getting back to bed until 2.30 A.M.

I had an appointment the next day (August 2nd) with Sr. Viver at 10.00 A.M., but since I did not wake up until 9.45 A.M., I was a little late (though only a quarter of an hour!) We gave Acosta Solis details of our careers on the following day for an article he was writing about us in his University botanical magazine "Flora".

So these few days were occupied by saying good-byes to our Ecuadorian friends. I was due to fly by "Panagra" on August 5th to Bogotá. This was one of the early monoplane "clippers" with an engine on each wing. To begin with the plane flew southwards to Guayaquil to pick up more passengers; so the first part of the journey was over the various volcanic peaks which we had already seen from below. At Guayaquil we disembarked and entered a much larger plane which soon took off for Colombia. So this was the end of our expedition to Ecuador. Although a small country it had provided a significant amount of cultivated potato germplasm. Wild species of potato were hard to find, but ornamental plants were extraordinarily abundant and interesting.



30 Apr. 1939. Peru, Cusco region; youth with poncho and knitted cap.



30 Apr. 1939. Peru, Pisac; Cusco region man in traditional costume with poncho, and knitted cap and hat.



09 May 1939. Peru, Huayna Picchu mountain at Machu Picchu, in evening light.



09 May 1939. Peru, Machu Picchu; view of ancient dry stone wall and tourists sitting on the Intihuatana (= 'hitching post of the sun').



10 May 1939. Peru, Machu Picchu; the Intihuatana (= 'hitching post of the sun') at 7 a.m., just as the sun is striking its tip.

CHAPTER 9

IN COLOMBIA

Colombia was the last of the five Andean countries in which we had decided to make collections. It was now the beginning of August and it was necessary to finish the expedition at the end of that month. Edward's wife, Natasha, was already in the U.S.A. making arrangements for him to embark on a lecture tour.

The probability of war in Europe was becoming stronger every day because of the Fascist and Nazi threats to France, Britain, the Netherlands and Belgium. Hitler had already engulfed Czechoslovakia and threatened other countries in south-east Europe. Although my parents had suggested that I went to the U.S.A. with Edward, I felt that my place was back in Britain, and so I made arrangements to return in early September.

Meanwhile, we continued our plans to collect in Colombia. On 4th August I flew to Bogotá. In order to fly to do this I had firstly to fly down to Guayaquil and then take a plane to Cali in central Colombia. It seemed a roundabout way but that seemed to be the best method. The plane touched down in Cali, the principal city in the valley of the Río Cauca, and separated from Bogotá by the Central Cordillera and the Rio Magdalena. Here I disembarked, to take another - SCADTA plane for Bogotá after a few hours' wait. Passengers were taken into the city to lunch at the main hotel. After a short time in the lounge my friend "Colonel Blimp" - alias Christopher Sandeman - walked in. Apparently, he was going back to Lima via the port of Buenaventura, after spending some time in the southern Colombian city of Popayán. He liked that city very much, as I did also when I lived for three years in Colombia after the war from 1948-1951. I was then married, and my wife and I spent a marvellous Easter holiday there during that period. At Cali airport my bag weighed fifteen kilos whilst at Quito airport it had weighed seventeen kilos, and in the Quito hotel over twenty kilos! No comment! The SCADTA plane was quite small, and full of passengers, but it arrived punctually at about 4.20 P.M. I was taken by a legation car to central Bogotá and settled into the Hotel Regina. Although it was quite a normal hotel, for the first time in my experience of South American hotels, it actually employed waitresses. Everywhere else, "only waiters" seemed to be the rule.

There was very little to do on Sunday 5th August and Monday the 6th which was, unfortunately for me, a public holiday. Bogotá struck me as a very busy commercial centre, full of cafes and men's shops, with a very affluent well-kept appearance. I visited Mr. Wise, the Vice-Consul, on Monday but as it was a holiday he could do nothing to make arrangements for me. In the afternoon I had hoped to take the funicular up to the top of Mount Monserrat, but it was not working for some reason. Nevertheless, I walked partly up, to get a good view of the plain or "sabana" of Bogotá to the west. Lower down there were very attractive parks and gardens and a beautiful new city library.

At last, on Tuesday August 8th I could get moving again, and met Mr. Murray Simpson, the British commercial attaché, who gave me a letter of introduction to the Ministry of Economy. The Secretary to this Ministry arranged for me to visit the Agricultural Department. The Director, a Sr. Raul Vasela Martínez, was most obliging and offered to get the potato specialist to take me out to make collections the next day.

On August 9th I was introduced to a Sr. Ossa, who spoke very quickly and did not sound any of his consonants, so that it was extremely difficult to understand him. We then went to the Botany Department of the University City, outside Bogotá. Here I met various people whose names I instantly forgot, was talked to by a Sr. L.M. Murillo on potato diseases in Colombia and finally met the famous Director Padre Pérez Arbalaez. He showed me round the herbarium, but there was only one specimen of wild potato, collected far away. In the afternoon Ossa and I fixed up to go out on the sabana to a Potato Research Station at Cajicá, north of Bogotá. I made six collections in the market, mainly *andigena*.

After some discussion on August 10th it was arranged that we should go by motor car to Cajicá. I met a Sr. Camacho in the Department who had met Bukasov there in 1934. We eventually found the farm ("Granja" they called it) but the head, a Dr. Pineros, had left because we had arrived earlier than the day before's telegram! We inspected the plots of Ecuadorian, Peruvian and Colombian varieties, but there were very few Colombian varieties there. So, as Dr. Pineros would not be back until the following day we could do nothing, since no-one else seemed to know anything about potato varieties.

On the following day (August 11th) I tried again, going out to Cajicá by train which got me to a station a half an hour's walk from the Granja. Dr. Pineros was there that day, and he identified and named the collections I had made the previous day. There were about twenty of these, all *andigenas*, although some did not survive the journey back to England. A plot of early varieties (diploids) were unquestionably *S. phureja* (or *S. rybinii*, as we called it then); they seemed to have no dormancy period, and were beginning to sprout even when they were on the mother plant. The Director of Agriculture, Dr. Washington Bernal, was visiting the farm with a group of students from Cali University. He spoke good English and told me of a wild potato which he would later show me.

I took herbarium specimens to the Botanical Department on August 12th to get them dried. Here I met the keeper of the Herbarium, a Spaniard, Dr. Cuatrecasas, who had come out from Madrid to collect plants. When the Republican Government in Spain fell to General Franco, Cuatrecasas feared to return, as he was a "red" sympathiser. Thus, he settled permanently in Bogotá. His Spanish was wonderfully clear, and much easier to understand than that of the Colombians, who always boasted that theirs was the best in South America - a statement that I rather doubted then, but later came to agree with. Arrangements for further trips were rather nebulous, as most people in the Department of Agriculture seemed to do nothing but talk, joke and send out for cups of black coffee - "tinto" they called it.

Tuesday August 14th was yet another public holiday so staff were given Monday off as well - a "puente" (bridge) they called it! I checked my dried plants at the Botanical Institute on Sunday and arranged with Bernal to go on Tuesday for samples to the Zipaquirá market, north of Bogotá. I took a train out on Monday to a Station on the sabana called Sibaté to look for a wild "potato" *Solanum juglandifolium*. This is a yellow-flowered climber and not strictly a potato at all, although related in some way. Sibate was in a dry region on the southern edge of the sabana. The hills around there were covered with dry scrub and trees. Higher up, after an hour's walk, I got to a vegetation of "Frailijones" or *Espeletia* (Compositae) species, with large rosettes of silvery or hoary leaves and cymes of yellow flowers. It was most striking. There were plenty of Ericaceous and Melastomataceous shrubs also, but no potatoes. I missed the 3.30 P.M. train back to Bogotá, the next one had been cancelled and I finally squeezed into an overcrowded bus, getting back to Bogotá at about 7.30 P.M.

Edward Balls had arrived meanwhile, by plane from Cali, having taken less time to get through than we had calculated. The following notes are from Edward's records:

Edward left Quito on August 5th travelling north by road to Ibarra and then over the páramo of El Ángel to the border at Tulcán. He collected two *andigenas* at the Ibarra market, two at San Gabriel and three at Tulcán. On the journey he also collected *Bomarea*, *Senecio*, *Tibouchina*, *Fuchsia* and *Lupinus* species, as well as *Solanum ochranthum* at San Gabriel. He then crossed the border to Ipiales in Colombia on August 8th and collected seven *andigena* varieties in Ipiales market, as well as many other non-potatoes on the way. In Nariño department at Pasto market he got twelve *S. phureja* collections, but most of these died in transit to Britain. His fifteen *andigenas* fared better, and most survived. From Pasto Edward made many collections on August 11th at and around the Laguna La Cocha, east of Pasto and in a mountain rain forest area. Amongst them was the wild potato *Solanum colombianum* (CPC 1301, 1303). Further north at Popayán market, on August 12th he made five more potato collections, but only one survived. Continuing further north he arrived at Cali on August 13th. There, in Cali market, he made ten more collections, but only the five *andigena* collections survived, the probable *phureja* ones dying in transit. From Cali he flew up to Bogotá on August 14th, meeting me at the hotel on my return from Sibaté.

August 15th was scheduled for a visit to the market at Zipaquirá a market town on the sabana two hours' distance by train in a northerly direction from Bogotá. My companion was a Sr. Juan B. Arias, agricultural advisor to the potato farmers. The weather was terrible - cold, damp and raining. After arriving, the most important thing from a Colombian point of view was to go to a cafe and order a "tinto". Dr. Arias then felt much better (and so did I!). The market was held in the streets, and potatoes were being sold in bulk by the sack-load. There was very little diversity, but the best and most frequent variety on offer was "Tocana blanca"; there were also some "Tuquerreña" and a few other varieties. We collected four *andigenas* and two *S. phureja* varieties, both of which died in transit. Time and time again these diploids, called "criolla" in Colombia, did not survive the journey. They seemed to have no, or at least a very short, dormancy period. We also collected an *Oxalis tuberosa* variety called "cubio", which also did not survive the journey back to England. By 9.30 A.M. we had collected all we needed to, and whiled away the time until our train left at 11.30 A.M. by drinking tintos (of course!).

On August 16th Dr. Arias and I went off to the forested area on the western edge of the sabana to a place called San Miguel to look for wild potatoes. We found none, but in the process got entirely tangled up in densely forested areas with lianes, tree ferns, palms, spiny bromeliads and dozens of other plants. It was extremely difficult to move, very damp, but at least with no insects to pester us. We found a wild *Solanum* with simple leaves and white stellate flowers, which unfortunately was not a potato. In a small plot we collected two *andigena* varieties but that was all we found after a day of intense activity in this primaeval forest. In a forest clearing there was a kind of wild strawberry with yellowish flowers and large red tasteless fruits. On returning to Bogotá Sr. Camacho showed me his collection of potato tubers taken from many parts of Colombia. He offered to sell them to us at 15 pesos per sample, so we told him that this would have to be referred to our London committee. After this we heard no more of the offer.

A better prospect, however, emerged on August 17th involving a visit with Dr. Arias to the owner of a farm near Zipaquirá.

As usual, tintos were taken by everyone whilst we waited for the horses. The farmer, who was our guide, set out with a large bottle of whiskey (to keep out the cold, of course), offering various tots, or noggins to us throughout the journey. I had a marvellous horse, full of energy, and responding immediately to my instructions. It was thus an extremely pleasant ride, up into the hills above Zipaquirá, past a mountain lake which was a reservoir at the same time and on to a high ridge. From here we had a marvellous view of the sabana of Bogotá. The sabana was completely flat, giving credence to the old Chibcha Indian legend that it was once a lake until their god broke down the barrier at one end and thus drained it dry. This old legend, as so often seems to be the case, had a strong element of truth in it, probably. There were salt deposits here and there, and indeed nearby there were caverns cut into solid salt, which was taken away for sale elsewhere. At about 11.30 A.M. we arrived at a hut belonging to our host where we were served a hot soup or stew called "locro", mostly composed of the potato variety "Pera". We were also offered pieces of roast mutton. Later we reached a very large potato field in a forest clearing where we made collections, obtaining two *andigenas*, three *S. phurejas* (two of which died in transit) and two *S. colombianum* wild potatoes, so the day was certainly not wasted. One variety, called "Argentina" had developed tubers in the leaf axils above ground, as well as the usual underground tubers. I had never seen this before or since.

After a rest day on August 18th I arranged to go on the 19th in a north-westerly direction to a place called San Francisco, near Facatativá. (These Chibcha Indian names were generally long and often ended with the stress on the last vowel). The owner of the farm was a Sr. Arturo Padillo, a friend of Bernal who was obviously going to his farm for the weekend. We descended to a sub-tropical region at about 1,500 to 1,800 metres where surely there could be no wild potatoes, and I concluded that there must have been another San Francisco higher up where I had seen a record for a wild potato. So, having let myself in for it, I could do no more than accept Don Arturo's kind hospitality. The farm was in the coffee-growing zone shaded by fruit trees. The carload was greeted by Don Arturo's wife, at least three sisters and various other people, including a brother-in-law. This gentleman had been in England for quite a long time, but so long ago that he had forgotten his English.

Don Arturo enquired from his retainers at once if anyone had heard of or seen wild potatoes. One had, so he was ordered to take me out to find them the following day. Meanwhile, we had a very good supper, with all farm produce including the meat and the coffee. Although Don Arturo could speak English, he would not do so when the family were about. I therefore had to do the best I could in Spanish.

After a somewhat disturbed night, because the dogs came to sleep in my room and barked at the slightest sound, I awoke at 5.45 A.M. on August 20th to a misty morning. Don Arturo's nephew, Jorge, decided to come with me and we got away at 7.00 A.M. Again, I had an extremely good horse, and the ride up through the farm was most pleasant, past fields of white cattle and then into scrub and woodland. After a while it became too steep for horseback riding and we had to continue on foot. Here I collected *Bomarea racemosa* with crimson outer and yellow inner tepals; also *Selaginella kunzeana*. There were thorny bushy bamboos ("chusquea"), a type of palm with feathery leaves and bright red fruits and another palm climbing over trees. Search as we could, we saw no trace of wild potatoes, though there were some thorny *Solanum* species, and we found a *S. phureja* planted in a woodland clearing. We decided that, apart from these samples, it was not much use in looking for others, so we returned to the farm. Jorge and I then had a very refreshing swim in the pool.

After lunch the brother-in-law and I rode over to see the citrus groves, with various types of lemons, oranges and tangerines. We all drove back later to Bogotá in Don Arturo's very large car, getting in at about 8 o'clock. I received a letter from Sr. Echevarría about the potato campaign in Sogamoso, which lies north-east of Bogotá in Boyacá department, suggesting that we meet there to make collections.

The train from Bogotá on August 22nd started at 7.00 A.M. and I boarded it in a rather luxurious first-class compartment. We passed over the sabana east of Zipaquirá and through Tunja, the departmental capital, to Sogamoso, the terminus of the line. The hotel was in the main plaza, where the market was in full swing. Echevarría was already there, spoke perfect English, and suggested that we should go round the market straight away. We managed to find ten distinct samples from the surrounding region, all of them *andigena*, apart from one Criolla (*S. phureja*) which died in transit. The rest of the day was spent in talking potatoes and politics. Echevarría introduced me to a friend who spoke Esperanto, the only one in Colombia I should think. Imagine a fellow esperantist from a foreign country having to go through the whole of Colombia to Sogamoso before he could find anyone to understand him!

There seems to be a very strong co-operative farmers movement in this area, fostered by the government. It provides free advice, loan of tractors, fumigators, cheap fertilisers and so on. It also builds roads and drains low-lying ground in order to provide more land for cultivation.

On August 23rd Echevarría planned to take me to potato growing areas near Sogamoso, starting with Pueblo Viejo near Lake Tota where the potato is the only crop. The lake was very beautiful, set in a deep depression, with a string of long islands across the centre.

The potato fields here were in full flower and looked very beautiful, with the "Pana" variety predominating. We collected twelve *andigena* varieties, a wild potato with no tubers, and a few "criollas" (probably *S. phureja*). One variety, named "Arbalona" (like a tree) grew up to two metres high. This was extraordinary, but because the tuber flesh was flecked with purple, people did not like it much and so it was confined to the one farm. In the farmer's grandfather's time Arbalona was grown extensively. Nowadays the white-fleshed Tocana and Tuquerreña varieties are probably more widely grown than any others. Near Sogamoso we found a wild potato species which I later identified as *Solanum flahaultii*.

On August 24th we again set out to find more potato varieties but got only one, given us by a farmer. Further on we came to an area of hot sulphurous springs. We bathed in them and found the experience very exhilarating. There was so much salt in the water that one could float "standing up" as it were, but without standing on the bottom of the bath. We took a stopping train to Tunja later, which took four hours to arrive. The weather was, as usual, cold and damp, but after quite a good dinner we cheered ourselves up by going to see a French film in the Municipal Theatre.

Our first task on August 25th was to go to the Tunja market. Tunja itself was now four hundred years old and had old doorways with Spanish coats of arms. The market was in a palatial new (but not completely finished) building, with many people selling their wares outside also. We did well with potatoes, finding thirteen distinct varieties, all but one *andigena*. The other was a "Criolla" (*S. phureja*) which, as usual with this species, died in transit. We also found a very interesting type of maize with very small cobs for making popcorn.

After the market we hired a car to take us to a place called Toca (where perhaps the variety "Tocana" came from originally?). A wheat expert came with us to see all the wheat cultivation in the region at medium-high altitudes. At a slightly higher páramo region, near a place called Sihuachoque, there were handsome orange-flowered *Echeveria columbiana* plants on wall tops, which I collected. A little further on we stopped at a farm belonging to a Sr. Flores - "El Molino" - to see his potatoes. His fields were almost entirely filled with the "Tocana rosada" variety, and the Tuquerreña variety also. We made only two collections of potatoes here, both *andigena*, seemingly weeds or "ground keepers" from a previous crop.

Meanwhile, in Bogotá, Edward had gone to the market and collected thirteen potato samples. Nine of these were *andigena*, and the others were "criolla" types with no dormancy (*S. phureja*), which died in transit. I did not realise until I returned to England and grew out the samples for multiplication that so many of these criolla types had died in transit. In fact, very few survived, having evidently sprouted during the journey, and finding no soil to grow in, just expired. The word "criolla" means native, leading one to wonder whether these diploid *S. phureja* varieties were the original ones grown in Colombia, whilst the *andigena* forms might have been introduced at a later date. Certainly a lot of them had names derived from places such as Argentina, Alemana (German), Papa Londres (London), Tocana (Toca), Tuquerreña (Tuquerres, in south Colombia near the Ecuadorian border). However, this is clearly supposition, and may be impossible to verify.

When I returned to Bogotá on August 26th Edward had packed and sent away all our previous Colombian collections. We later went out to Sibaté on the sabana with Sr. Camacho who wanted to show us his collection of early potatoes made in various parts of Colombia. Unfortunately Camacho had forgotten his record book, so could not tell us what each variety was or where it came from. He did not have, so far as I could see, any "criollas" (*S. phureja*). We did not take samples for these reasons, and also because he wanted to be paid quite a lot for them.

From August 27th - 30th we spent most of our time in typing up field notes, getting our diaries up to date and getting permits to leave the country. I was to have returned on the Hamburg-America line but as news of a future war between Britain and Germany became more likely I certainly did not want to be on a German ship when or if war broke out. I therefore re-booked on the Pacific Steam Navigation Company ship due out a little later from Panamá. This meant flights to Baranquilla (the northern Colombian port) and then to Panamá, and of course a Panamá visa. However, all this was negotiated, after some trouble. Meanwhile, Edward was making arrangements to get to the U.S.A. to be with his wife. We finished by having a farewell dinner together on the evening of the 30th.

It had been a wonderful expedition for me, and I found Edward to be a first-class leader - very kind and courteous, and with a good sense of humour. He was always most understanding and polite to everyone, though I thought that he could have got better results at times by shouting at people! This was not in his nature, though. I benefited enormously from his knowledge and understanding, which helped me throughout my later career, and particularly during the three years I spent with my wife and children in Colombia after the war, and during my many other later expeditions.

I think that we were glad in one way and sorry in another that the expedition was over. It had often been both tiring and frustrating, but it certainly had been a success from every point of view.

It set me up as a future expedition leader and had knocked quite a lot of rough corners off my personality. I felt that I had learned a very great deal from Edward for which I shall always be extremely grateful.

We had made about one thousand potato collections and over one thousand collections of ornamental plants and seeds. The herbarium specimens of these ornamentals were distributed to various herbaria, including Kew, Washington and to several specialists, who later identified them for us. All these specimens named in my text were from this source on the master set of Edward's field notes at the Royal Botanic Gardens Archives at Kew. I made the potato identifications on the living collections grown at Cambridge after I had returned to England.



10 May 1939. Peru, Machu Picchu; view of ruins and terraces from near the observatory.



24 May 1939. Peru, Cuzco to Ayacucho, a spectacular gorge of the Río Pampas, a tributary of the main Apurímac valley. The mules crossing this suspension bridge looked down to make sure their hooves landed on the planks and not between them!



15 May 1939. Peru, Cuzco to Abancay; Spanish colonial bridge over Pachacacha river gorge.



28 May 1939. Peru, between Oroya and Lima; Oroya glacier and snow covered mountains.



15 May 1939. Peru, Cuzco to Abancay; snow-capped high Andes.



25 June 1939. Ecuador, Cuenca market; Amerindians in local dress, selling wooden spoons.

CHAPTER 10

THE VOYAGE HOME

I had at first not intended to add this chapter to the book but my friends encouraged me to do so because of my experiences in the convoys of ships across the Atlantic when war had already broken out.

Of course the first part of the journey was to get to Panamá in time to embark on the Pacific Steam Navigation Company ship, as I mentioned previously. On August 31st I took a SCADTA plane to Barranquilla on the north coast, following the course of the Rio Magdalena. I was surprised to learn that this company had been established in 1919, making it probably the oldest commercial airline in the world.

The flight from Barranquilla to Cristóbal in Panamá was a short one, but provided marvellous views of the Pacific ocean and the coral islands surrounded by white sand beaches. Flying inland over Panamá we passed over the artificial Gatun Lake formed during the construction of the Panamá canal, and came down at Cristóbal airport, round the other side of the bay, not far from the city of Colón. The two cities, of course, are the Spanish versions of the name of the man whom we English call Christopher Columbus.

On September 1st and 2nd there was very little to do but obtain my boat ticket and wander round Colón. The residential part of the city was pleasant and clean, whereas the conditions for the poorer people - mostly Afro-Caribbeans - were terrible, though even then not so bad as those in which some of the mountain Indians live in the Andes. I at last found my luggage, which came by a "United Fruit" boat on September 2nd. My passport was returned with a page and a half of stamps on it!

The weather broke later, and we had a great deal of rain in the form of a horrendous storm lasting for several hours and flooding the streets.

"Threats of a European war are imminent", was a headline in the local newspaper. I think we had all been thinking this for quite a long time! On September 3rd a notice circulated which announced that Britain had declared war with Germany. What we all feared had now happened.

On September 4th I was given a passage on the PSNC ship "Orbita", which docked at 9.00 P.M. They were just lowering the gang plank as I arrived and was quickly shown on board. There were quite a number of West Indians on the ship but they left at various Caribbean ports. Apart from these, there were very few passengers left, and some of these also disembarked at various ports before we crossed the Atlantic.

The painters were already putting the ship on to a wartime basis, using a grey paint to cover the whole ship, including the port-holes and all the saloon windows. Later, the cabin port-holes had their covers clamped on, so that no-one could open them to show a light (or to get a breath of fresh air, either!).

On September 5th, a British cruiser came quite close to us at 11.30 A.M. and then steamed away after exchanging signals with our ship. The painters were out in force now, painting the whole ship "battleship grey".

Complicated systems of blankets were being hung over the saloon doors to keep the lights from being seen at night when they were being opened onto the deck. There were no deck lights except for one or two dim blue ones on the sidewalks. The only interesting result of this (apart, of course, from making us as invisible as possible to enemy ships) was the wonderful *Noctiluca* phosphorescence in the ships bow waves, which could not be seen on the voyage out, because of the ship's lights.

On September 6th we lay off by what I deduced to be Kingston, Jamaica. A searchlight shone on to the ship, and a voice shouted out to declare what we were carrying. People for Kingston were taken off by tender, but although we got here at 1.00 A.M. we were off again by 4.30 A.M.

On September 7th - 8th I learned today that all British possessions were under martial or naval law. No-one, except Britons with bona-fide reasons for travelling to England, could travel any further than Bermuda.

We had some strong electrical storms this evening. I talked to an American who had been washing for gold in Ecuador and an Ecuadorian who was going to the States for military training. What seemed to be very clear indeed was that there were not going to be any parties, dances, concerts etc., - in fact no entertainment whatsoever.

Apart from the Captain, crew and stewards no other people were employed in this ship that I could find. The masts were now being painted grey and yellowish-brown in odd areas to break up the outline. The rails were brown; all the rest was grey - very depressing but of course very necessary.

On September 9th we arrived at Habana, Cuba, and were actually allowed off the ship for a walk round the city, but had to wait to get a stamped ticket first. An American lady, a Mrs. Caldwell, asked me if I wasn't one of the people who had been collecting potatoes in the Andes. She had recognised me from Cuzco, had been with the American Minister in La Paz and whom we had seen later in Cuzco when she was on vacation. She and her husband were travelling back to the States via Habana.

Once off the ship I posted letters home telling about my arrival. I found out afterwards that they were all censored and did not arrive until months after I did. A group of us toured the Capital buildings, which were said to have cost 16.5 million dollars. The reception chamber was six hundred feet long with the centre under the dome, which itself was said to be the world's third highest. A gigantic bronze statue, forty feet high, of a woman labelled "Justice" and covered with gold leaf was placed under the dome and exactly under its apex was a large diamond about a half inch in diameter. What conspicuous waste!

We left port at 4.30 P.M. but although the Habana papers said that our ship, the "Orbita", was escorted by two cruisers we saw none!

Sunday, September 10th was a beautiful calm day with hardly a ripple in the sea, just as we had experienced on the way out. A few people got off at Nassau in the Bahamas and one got on. Our passenger numbers were very limited, not more than fifty on the whole boat, with about eighteen in the second class, as against two hundred on the way out.

Monday to Wednesday, 11th - 13th September. Arriving at Bermuda on the 13th, some passengers left by tender for New York on the “Monarch of Bermuda”, without landing on the island. No-one was sure about our route, and of course the captain did not tell us.

Some thought we should go to Halifax in Nova Scotia, whilst others believed we should go straight across the Atlantic. From Bermuda onwards it became cold and rainy, and we had torrential rain on the 13th with great claps of thunder. It took us five days to zig-zag northwards from Bermuda to what in fact was Halifax, Nova Scotia, though we were not told where we were at the time. The harbour was circular and almost land-locked. Apparently, the zig-zagging was to try and prevent U-boats from torpedoing us. If there were any U-boats, which I doubt, I am sure they could have hit us without too much trouble.

Safely outside Halifax on about September 18th, we then waited for a week to 10 days, I think, for other ships to arrive. Meanwhile, several battle cruisers and destroyers came out of the harbour, the most formidable being the “Rodney”, a three-funnel ship. Behind them came a stream of merchant ships, tramp steamers, etc some seventeen to nineteen of them, French and British.

They were, like us, all painted grey and going back to Europe in convoy with the warships. We understood that we would be escorted half way across the Atlantic by the battle cruisers and then picked up by some others coming out from Britain.

Meanwhile, we entered the harbour, waiting until about September 25th for the escort to return, being joined by four British ships (The Andorra Star, The Duchess of Richmond, The Cameronia and The Antonia) as well as three French ones (Champlain, De Grasse and Lafayette). Many of these ships were later sunk by U-boats, but, luckily, for us, not on this occasion.

Halifax harbour looked rather Scandinavian, with huge oil dumps grain elevators and factories. The houses were mostly made of wood. I think we left on about the 30th September or 1st October, in convoy, with the armed escort, but only for one day. After this, for some unaccountable reason, the escort left us, presumably to return for another convoy later.

Here we were then, eight ships without any escort, slowly moving east across the Atlantic Ocean in war time. On quite a number of occasions there must have been U-boat warnings, at which time all the ships would steam off in different directions over the horizon, evidently so that the U-boats would not be able to torpedo all eight of us at the same time. After several hours the ships would then re-assemble and we would get going again. I did not count how many times this happened but, clearly, life on board was more tedious than frightening.

There were now only about a dozen passengers in the second class, and we spent most of the time playing cards and chatting about what war with Germany would be like. It was a tedious journey in which I think we more or less successfully put all thoughts out of our minds of being torpedoed. If it happened, we could do very little about it. If not, well and good. Eventually, we came closer to Britain and docked at Liverpool early in November.

Meanwhile, I had assumed that my parents would have heard from me about my return to Britain, but of course they had not, since all correspondence was censored and held back. I took a train from Liverpool to London, and then another to Brimscombe, near Stroud in Gloucestershire, where my parents lived.

I shall never forget the scene, at about 3.00 A.M. on this November night with a brilliant full moon and everything covered with sparkling hoar-frost, walking home for two or three miles from the station and savouring every minute of it.

I had survived innumerable hazards, including trigger happy travellers, as well as dizzy heights and enormous changes of food and altitudes. I was back home at last, having gathered about one thousand potato collections, and enough memories to fill this book, some sixty years later!



17 July 1939. Ecuador, Quito; view of city and hills beyond.



17 July 1939. Ecuador, near Quito; Indian children in front of stacked adobe bricks.



22 July 1939. Ecuador, Mt. Cayambe, on ridge in front of snowfield; Sr. Louis Ascásabi (standing centre left), Jack Hawkes (standing top right), six retainers and a dog.



23 July 1939. Ecuador, Cayambe, farm of Sr. Ascásabi at Guachala; Edward Balls stroking a deer.



17 Aug. 1939. Colombia, dept. Cundinamarca, near La Caldera; potato field.



Summer 1940. Cambridge, U.K.; South American potato species grown in pots in glasshouse.

APPENDIX I. Extracts from:

Hawkes, J. G. (1941)

Potato Collecting Expeditions in Mexico and South America.

I. Potato collections, culture in South America and utilisation of germplasm.

Imperial Bureau of Plant Breeding and Genetics, Cambridge. 30 pp.

I. THE POTATO COLLECTING EXPEDITIONS

INTRODUCTION.

During the first eight months of 1939 an expedition was sent to South America by the Imperial Agricultural Bureaux to make collections of indigenous wild and cultivated potatoes. A growing need had been felt by potato breeders both in Britain and the Dominions and colonies for fresh breeding material in order to introduce disease immunity into our domestic stocks and to produce varieties better adapted to the various ecological conditions within the Empire where the potato was grown or into which it was hoped to introduce it.

Introductions into Europe of material bearing immunity to late blight (*Phytophthora infestans*) were made many decades ago. Cases of frost and drought resistance and immunity and high degrees of resistance to certain viruses have been reported amongst South American varieties or in crosses between these and European domestics. The latter varieties as Salaman (1937b, 1938) has pointed out, represent a very limited supply of breeding material, since they have all been produced from crosses between probably not more than two initial varieties introduced into Europe during the last quarter of the 16th century. Subsequent to that time potato breeding has consisted merely in the combination and recombination of the comparatively few characters present in the original introductions with the loss of many that were considered undesirable from the point of view of the ordinary breeder.

Introductions from South America—the original home of the potato—were small and haphazard until the systematic Russian expeditions in 1925-32, followed by several other large scale expeditions by Germany, the U.S.A. and Sweden. The great gene diversity in the cultivated potatoes of South America as compared with the gene paucity of the European domestic varieties was thus realized in the third decade of the 20th century, about 350 years after the first potato introductions into Europe. Following on the same general lines as the expeditions just mentioned, the Empire Potato Collecting Expedition to South America was sent out to make as complete a collection as possible of the native material, paying special attention to those districts which the other collectors had missed or from which they had collected little material.

The expedition was suggested originally by Dr. P.S. Hudson, Deputy Director of the Imperial Bureau of Plant Breeding and Genetics in Cambridge, who planned to start in 1937 with the writer acting as assistant. Unfortunately Dr. Hudson's health would not allow him to proceed with the expedition and after two postponements he was finally advised not to undertake it. Mr. E.K. Balls, a professional plant collector and world traveller, was invited to lead the expedition in 1939 in the place of Dr. Hudson, and as he and Dr. W. Balfour Gourlay were to be collecting plants in Mexico in 1938, they were also asked to make potato collections from that country in addition before undertaking the South American trip.

Dr. Gourlay also travelled for three months with the main expedition, where he rendered invaluable assistance with the collections.

We wish to express our thanks to the Governments of the Empire countries who have contributed to the financing of the Expedition and to the British Legations and Consulates in South America for the many facilities they offered us. Our acknowledgment is also due to the Institute of Plant Industry, Leningrad, and many other institutions which have contributed much valuable material.

We desire to express our special appreciation to Dr. R.N. Salaman for his invaluable advice and help in receiving and examining the material; also to the Director of the Plant Virus Research Station and to Dr. S. Dickinson for assistance in the examination for the presence of disease, and to the many others who have directly or indirectly contributed to the success of the Expedition.

PREVIOUS EXPEDITIONS.

Although the potato was brought to Europe in the latter part of the 16th century, the material introduced was extremely scanty and did not by any means represent more than a small part of the total genic diversity present. With the systematic expeditions lasting from 1925 to 1932 of the Russian geneticists, a new era dawned in potato breeding and many other expeditions were organized from other countries on the same lines.

In order to organize the British Empire Expedition in the most economical way it was necessary to make a survey of the results of these previous expeditions; in addition, the writer visited Russia in 1938 to discuss the problem with Vavilov, Bukasov and Juzepczuk and to learn whether it was possible to make collections from areas previously left unvisited by them.

The Russian geneticists had visited and made collections from Mexico, Guatemala, Colombia, Ecuador, Peru, Bolivia, Argentina and Chile, and had mapped out the general areas of distribution for the cultivated and wild species. Bukasov in 1925-26 (1930) collected in Mexico, Guatemala and Colombia, visiting in the latter country chiefly the central departments and the Bogotá region; he did not, however, obtain specimens from the southern part of the country south of Popayán. Juzepczuk in 1927-28 (Juzepczuk and Bukasov, 1929; Bukasov, 1933 a and b) made extensive collections in South and Central Peru, North Bolivia and Chile; whilst Vavilov, besides collecting in North and Central America, made many collections in Ecuador with Kesselbrenner in 1932 (Bukasov, 1933 b, 1934).

Expeditions were also sent out by other countries, Sweden being amongst the first to profit by the example of the Russians. Baur and Schick from Germany (Schick, 1931) collected in North Argentina, North Bolivia, South and Central Peru, Central and North Ecuador and in Colombia. MacMillan and Erlanson, sent out by the United States Department of Plant Industry in 1933 collected in Chile, North Bolivia and South and Central Peru.

It might be thought that the whole of the available material would have been thoroughly surveyed and investigated by these numerous potato collecting expeditions. This is, however, far from the case. Most of the potato growing areas lie in wild inaccessible mountainous country where travel is slow and life exceedingly primitive.

Many of the regions where wild potatoes are to be found are almost uninhabited or at the best only support a backward peasant population. In large areas only the fringe of the total indigenous potato cultivations have been touched whereas in others no collections have been made at all. Thus, for example, only a few specimens had previously been collected from the mountainous regions of North Argentina, promising a vast number of wild and cultivated varieties. South Bolivia had been left practically untouched, as also had the Peruvian regions of Lake Titicaca (department of Puno) and the eastern side of the lake. Good and extensive collections had been made from the Cuzco region by all the expeditions but between here and Huancayo in Central Peru, owing partly to the great difficulties of transport, no collections had been made. Central Peru (department of Junín) had been well investigated although the north of the country was still untouched.

Southern Ecuador, south of Cuenca was little investigated as also were the great potato growing regions of Pasto in Colombia. Much had been taken from Cundinamarca and Boyacá departments in Central Colombia by Bukasov, though most of his early varieties unfortunately perished and he considered that from these interesting regions a large amount of material was yet to come. In short, previous collectors had kept to the main routes of communication, steamship and railway, and to a lesser extent roads. Excursions in the less accessible parts of the Andes or where roads had only recently been constructed, seemed to offer very good chances of large and interesting collections.

THE EMPIRE POTATO COLLECTING EXPEDITION

ROUTE PLANNING.

With the knowledge outlined in the previous section it was possible, taking into account the altitudes at which potatoes would be likely to grow and the growing seasons, to map out a preliminary route. It was decided to omit a visit to Chiloé in South Chile since that region had been fairly well collected in the past and furthermore the time available would hardly allow it. Hence it was decided to collect mainly in North Argentina, Bolivia, the Lake Titicaca region of Peru, the region between Cuzco and Huancayo in South and Central Peru and also, if possible, in North Peru. Considerations of time made this latter impossible. It was also provisionally decided to collect extensively in Ecuador and in Colombia in the Pasto and Bogotá regions, then to return by air to Lima in August. Many wild species of potatoes occur on low hills near the coast known as "lomas". In the months of June to September dense mists ("Garrua") condense sufficient quantities of water on the lomas to support a short lived vegetation, existing for the rest of the year in the form of seeds, bulbs and tubers. However, this part of the expedition proved impossible, since the schedule could not be maintained where the conditions of travel were so much slower than had been anticipated.

ROUTE.

Starting from Lima in January 1939 and ending in Panama at the end of August of the same year, the expedition travelled during these eight months some 9,000 miles, exclusive, of course, of the journeys to and from South America. Travel was accomplished by air, steamship, rail, lorry, car, horse, mule and on foot.

[MAP 1. Route of the British Empire Potato Collecting Expedition in South America. The thick black line represents land and sea travel, the thick dotted lines, travel by aeroplane. See illustration on page 12.]

TABLE 1.—ROUTE OF SOUTH AMERICAN EXPEDITION, 1939

Date	Place	Dept. / Prov.	Country
12.1-19.1.	Lima and district	Lima	Peru
19.1-20.1.	Lima to Mollendo	Arequipa	Peru
20.1.	Mollendo to Arequipa	Arequipa	Peru
23.1-25.1.	Arequipa to La Paz	La Paz	Bolivia
03.2-05.2.	La Paz to Jujuy	Jujuy	Argentina
07.2.	Jujuy to Salta & return	Salta	Argentina
08.2.	Jujuy to Tilcara	Jujuy	Argentina
18.2.	Tilcara to La Quiaca	Jujuy	Argentina
21.2.	La Quiaca to Villazón	Potosí	Bolivia
22.2.	Villazón to Tarija	Tarija	Bolivia
27.2.	Tarija to Villazón	Potosí	Bolivia
28.2.	Villazón to Potosí	Potosí	Bolivia
04.3.	Potosí to Sucre	Chuquisaca	Bolivia
10.3-11.3.	Sucre to Cochabamba	Cochabamba	Bolivia
15.3.	Cochabamba to Colomi	Cochabamba	Bolivia
17.3.	Colomi to Cochabamba	Cochabamba	Bolivia
21.3-22.3.	Cochabamba to La Paz	La Paz	Bolivia
25.3-26.3.	La Paz to Obrajes valley & return	La Paz	Bolivia
29.3.	La Paz to Tiahuanaco & return	La Paz	Bolivia
31.3.	La Paz to Eucaliptus	Oruro	Bolivia
03.4.	Eucaliptus to La Paz	La Paz	Bolivia
11.4.	La Paz to Achacachi & district	La Paz	Bolivia
14.4.	Achacachi to Copacabana	La Paz	Bolivia
21.4.	Copacabana to Puno	Puno	Peru
29.4.	Puno to Cuzco	Cuzco	Peru
30.4.	Cuzco to Ppisacc & return	Cuzco	Peru
03.5.	Cuzco to Paucartambo	Cuzco	Peru
07.5.	Paucartambo to Cuzco	Cuzco	Peru
9.5	Cuzco to Ollantaitambo & Macchu Pijchu	Cuzco	Peru
10.5.	Macchu Pijchu to Calca	Cuzco	Peru
11.5.	Calca to Cuzco	Cuzco	Peru
14.5.	Cuzco to Abancay	Apurimac	Peru
15.5-19.5.	Abancay to Andahuailas	Apurimac	Peru
22.5-24.5.	Andahuailas to Ayacucho	Ayacucho	Peru
26.5-27.5.	Ayacucho to Huancayo	Junín	Peru
28.5.	Huancayo to Lima	Lima	Peru
06.6-11.6.	Lima to Guayaquil	Guayos	Ecuador
19.6.	Guayaquil to Cuenca	Azuay	Ecuador
26.6.	Cuenca to Cañar & return	Cañar	Ecuador
28.6.	Cuenca to Azogues & return	Cañar	Ecuador
30.6.	Cuenca to Riobamba	Chimborazo	Ecuador
03.7.	Riobamba to Quito	Pichincha	Ecuador
07.7.	Quito to Ambato	Tungurahua	Ecuador
12.7.	Ambato to Latacunga	León	Ecuador
13.7.	Latacunga to Mejía (Machachi)	Pichincha	Ecuador

15.7.	Mejía (Machachi) to Quito	Pichincha	Ecuador
21.7.	Quito to Cayambe	Pichincha	Ecuador
23.7.	Cayambe to Quito	Pichincha	Ecuador
28.7.	Quito to Otovalo	Imbaburra	Ecuador
29.7.	Otovalo to Quito	Pichincha	Ecuador

From 04.8 to 14.8 the expedition was divided into two sections:—

(a) Route of E.K. Balls:—

04.8.	Quito to Ibarra	Imbaburra	Ecuador
05.8-06.8.	Ibarra to Tulcán	Carchi	Ecuador
07.8.	Tulcán to Ipiales	Nariño	Colombia
08.8.	Ipiales to Pasto	Nariño	Colombia
11.8.	Pasto to Laguna La Cocha, & return	Putumayo	Colombia
12.8.	Pasto to Popayán	Cauca	Colombia
13.8.	Popayán to Cali	Valle de Cauca	Colombia
14.8.	Cali to Bogotá	Cundinamarca	Colombia

(b) Route of J.G. Hawkes.—

05.8.	Quito to Bogotá	Cundinamarca	Colombia
0.8 & 11.8.	Bogotá to Cajicá & return	Cundinamarca	Colombia
14.8.	Bogotá to Sibaté & return	Cundinamarca	Colombia
16.8.	Bogotá to San Miguel & return	Cundinamarca	Colombia
17.8.	Bogotá to Zipaquirá & return	Cundinamarca	Colombia
19.8.	Bogotá to San Francisco	Cundinamarca	Colombia
20.8.	San Francisco to Bogotá	Cundinamarca	Colombia
22.8.	Bogotá to Sogamoso & district	Boyacá	Colombia
24.8.	Sogamoso to Tunja	Boyacá	Colombia
26.8.	Tunja to Bogotá	Cundinamarca	Colombia
31.8.	Left Bogotá.		Colombia

TABLE 2.—SOUTH AMERICAN EXPEDITION, 1939. Localities where collections were made

Date	Locality	Provinces	Country	Altitude	Collection No.
22.1.	Arequipa	Arequipa	Peru	8,300 ft	B.5860-B.5877
28.1-29.1	La Paz	Murillo	Bolivia	11,500-12,000 ft.	B.5890-B.5903
6.2.	Jujuy	Jujuy	Argentina	4,300-5,300 ft.	B.5921-B.5952
7.2.	Salta	Salta	Argentina	5,000 ft.	B.5935-B.5936
9.2-15.2.	Tilcara and distr.	Jujuy	Argentina	8,000-13,500 ft.	B.5956-B.6056
19.2.	La Quiaca	Jujuy	Argentina	11,300 ft.	B.6097-B.6081
23-26.2.	Tarija	Cercado	Bolivia	6,800 ft.	B.6084-B.6093
27.2.	Tarija to Villazón	Sudchichas	Bolivia	9,800-11,600 ft.	B.6094-B.6126
27.2.	Oploca to Oro Ingenio	Bolivia		12,600 ft.	B.6127
2.3.	Potosí	Frias	Bolivia	11,500-13,000 ft.	B.6129-B.6141
6.3-8.3.	Sucre	Oropeza	Bolivia	8,500-11,000 ft.	B.6146-B.6199
10.3.	Potosí	Frias	Bolivia	14,500 ft.	B.6201

11.3-14.3	Cochabamba	Tapacari	Bolivia	9,000-10,900 ft	B.6202-B.6222
15.3-17.3.	Colomi	Chapare	Bolivia	10,500-12,000 ft.	B.6241-B.6292
18.3	Cochabamba	Tapacari	Bolivia	about 11,500 ft.	B.6300-B.6311
25.3.	Palomar	Murillo	Bolivia	9,100 ft.	B.6324-B.6325
29.3.	Tiahuanaco	Ingavi	Bolivia	12,500 ft.	B.6327-B.6357
31.3-2.4.	Eucaliptus	Cercado	Bolivia	12,100-12,300 ft.	B.6375-B.6413
4.4.	La Paz	Murillo	Bolivia	9,000-13,000 ft.	B.6414-B.6442
11.4.	Huarina	Omasuyos	Bolivia	12,500 ft.	B.6443-B.6446
11.4-14.4.	Achacachi & distr.	Omasuyos	Bolivia	12,500-14,000 ft.	B.6447-B.6512
14.4-18.4.	Copacabana	Omasuyos	Bolivia	12,500 ft.	B.6513-B.6543
22.4-25.4.	Puno	Puno	Peru	12,500-12,700 ft.	B.6545-B.6668
3.5-7.5.	Paucartambo	Paucartambo	Peru	11,500-13,000 ft.	B.6672-B.6743
11.5.	Calca	Calca	Peru	11,000-14,000 ft.	B.6744-9.6769
12.5.	Cuzco	Cuzco	Peru	13,000 ft.	B.6770
15.5.	Abancay	Abancay	Peru	about 13,500 ft.	B.6853-B.6887
16.5.	Quisahuara	Andahuailas	Peru	11,900 ft.	B.6888-B.6890
21.5-24.5.	Andahuailas	Andahuailas	Peru	10,500-13,000 ft.	B.6910-B.6931
25.5.	Ayacucho	Huamanga	Peru	–	B.6933-B.6962
28.5.	Huancayo	Huancayo	Peru	–	B.6964-B.7008
6.6.	Lima	Lima	Peru	500 ft.	B.7072
23.6.	Cañar	Cañar	Ecuador	11,500-12,000 ft.	B.7084-B.7111
25.6.	Cuenca	Azuay	Ecuador	8,300 ft.	B.7112-B.7115
25.6.	Azogues	Cañar	Ecuador	8,300 ft.	B.7116-B.7118
1.7.	Riobamba	Chimborazo	Ecuador	–	B.7129-B.7133
8.7.	Píllaro	Tungurahua	Ecuador	10,000 ft.	B.7141-B.7144
9.7-11.7.	Ambato	Tungurahua	Ecuador	8,500-11,700 ft.	B.7154-B.7183
12.7.	Latacunga	León	Ecuador	–	B.7193-B.7195
13.7.	Saquisilí	León	Ecuador	–	B.7197-B.7215
29.7.	Otovalo	Imbaburra	Ecuador	–	B.7267
5.8.	Ibarra	Imbaburra	Ecuador	–	B.7331-B.7332
6.8.	San Gabriel	Carchi	Ecuador	about 12,000 ft.	B.7340-B.7341
7.8.	Tulcán	Carchi	Ecuador	10,000-12,000 ft.	B.7347-B.7352
7.8-8.8.	Ipiales	–	Colombia	10,000-10,300 ft.	B.7353-B.7473
9.8.	Pasto	–	Colombia	about 10,000 ft.	B.7474-B.7498
9.8.	Pasto	–	Colombia	about 10,000 ft.	B.7548-B.7549
11.8.	Laguna La Cocha	–	Colombia	11,000-11,500 ft.	B.7506-B.7542
12.8.	Popayán	–	Colombia	–	B.7543-B.7547
14.8.	Cali	–	Colombia	–	B.7550-B.7558
25.8.	Bogotá	–	Colombia	–	B.7560-B.7572
9.8.	Bogotá	–	Colombia	8,500-9,000 ft.	B.7373-B.7378
15.8.	Zipaquirá	–	Colombia	8,000-9,800 ft.	B.7402-B.7409
16.8.	San Miguel	–	Colombia	9,800 ft.	B.7410-B.7414
17.8.	La Caldera	–	Colombia	11,400 ft.	B.7418-B.7426
20.8.	San Francisco	–	Colombia	6,500 ft.	B.7427-B.7428
22.8-23.8.	Sogamoso and Tota	–	Colombia	10,000-11,100 ft.	B.7438-B.7466
24.8-25.8.	Tunja	–	Colombia	8,400-9,700 ft.	B.7467-B.7586

The first part of the journey consisted in travelling by ship from Lima to southern Peru, ascending to Lake Titicaca and crossing over it into Bolivia to La Paz, the capital. From here the expedition journeyed to North Argentina spending about 3 weeks in this region, thence back into Bolivia where detailed collections were made from the eastern valleys and altiplano. About two months were spent in Bolivia and the expedition then travelled into South Peru, collecting in the departments of Puno and Cuzco. From Cuzco the overland journey to Lima was accomplished. The Peruvian part of the expedition lasted about 1½ months.

The journey from Lima to Guayaquil in Ecuador was accomplished by ship and the expedition then travelled in the south, centre and north central regions of Ecuador for two months. As there were only three weeks left in which to make collections in Colombia before the expedition came to an end, Balls and Hawkes collected separately in Colombia. The former worked through by road from north Ecuador into the Pasto region of Colombia, thence to Cali and by air to Bogotá. The latter travelled by air (via Guayaquil and Cali) to Bogotá and made collections in the departments of Cundinamarca and Boyacá. The expedition terminated at the end of August, Hawkes flying to Colón, Balls returning to Cali and leaving the country by Buenaventura.

COLLECTIONS.

Table 2 shows the chief localities from which collections were made. (In addition to the samples collected by members of the expedition, many collections were made by local botanists, agronomists and persons interested in potato culture. Some of these represented portions of experimental collections, others being collected at the request of the expedition and sent on to various points at a later date. Portions, however, were sent straight through to Cambridge.)

Throughout the whole course of the expedition constant enquiry was made from the local inhabitants for any varieties of economic interest, such as forms able to withstand disease, extremes of heat and cold and of drought and moisture so that all available material might be gathered to form a basis for breeding the many different varieties required for the widely differing conditions of climate in the Empire and combating the diseases which attack European potato varieties.

Collections were first made from Arequipa, where cultivation is possible only under irrigation. On ascending to Puno a very richly cultivated country is entered, potatoes, quinoa (*Chenopodium quinoa*), canahua (*Chenopodium pallidicaule*), ullucus (*Ullucus tuberosus*) and oca (*Oxalis tuberosa*) being the chief crops. On the vast altiplano which stretches as far south as the Argentine border very little cultivation is carried on south of Oruro. In northern Argentina in the province of Jujuy there is a moderate amount of potato cultivation south of the capital, but it is all confined to varieties of *S. tuberosum* mostly of Canadian origin. Collections of wild material were made here as well as near Salta. The most interesting region from the point of view of indigenous varieties was in the mountains north of the town of Jujuy where a great wealth of material, especially wild, was collected, several days being spent on expeditions into regions where potatoes had not before been collected. Wild varieties occurred in the cactus scrub vegetation as well as at high altitudes right up to the snow level and on the humid eastern slopes of the Andes. At Tarija in Bolivia, situated in a fairly low, predominantly maize growing region, there were quite a number of cultivated varieties but very few wild ones though both were prolific in the higher paramos. The next important potato growing district was Potosí in Central Bolivia, situated at an altitude of 13,600 ft.

The town itself is slightly above the general area of potato cultivation though wild species were abundant, and in the surrounding lower districts a large number of samples were collected. Sucre, though like Tarija and Cochabamba, situated at an altitude somewhat lower than the richest potato growing districts was, nevertheless, well furnished with both wild and cultivated forms. Cochabamba, situated in an eastern Andean valley to the north of Sucre, also proved of interest, though the richest area was that of La Paz and the surrounding altiplano.

Collections were made in South Peru in the neighbourhood of Puno, Cuzco and Paucartambo. The expedition travelled from Cuzco to Lima over the partly constructed road and along mule tracks, collecting samples from the markets of Abancay, Andahuailas, Ayacucho and Huancayo, in addition to many plants taken from along the route.

In Ecuador, samples were taken from the lower lying regions of Cuenca, Azogues and Cañar as well as from the central valley north and south of Quito. In these latter regions, with the help of Ecuadorean potato experts, very detailed collections were made.

Finally, in Colombia, E.K. Balls collected in the little-investigated Pasto district; many of the samples from these regions are early potatoes maturing in 3-4 months. J.G. Hawkes made detailed collections aided by the Colombian Ministry of Agriculture from the Sabana de Bogotá and the interesting potato growing regions of Tunja and Sogamoso.

The following Table (Table 3) gives an indication of the amount of material collected from the various countries:—

TABLE 3.—NUMBER OF SAMPLES COLLECTED ON THE SOUTH AMERICAN EXPEDITION

Country	Number of Samples
Argentina	42
Bolivia	359
Peru	478
Ecuador	125
Colombia	160
Mexico	46 (Collected by Balls and Gourlay in 1938.)

Total number: 1,210 (1,164 collected in South America)

METHODS OF COLLECTING AND DISPATCH.

Collections of cultivated material were made primarily in Indian markets where large selections of varieties were often displayed that otherwise would have taken many months to obtain from the places in which they were grown. When any local persons were interested or knowledgeable on the subject it was often possible to obtain their services to take the expedition members into the cultivations. In this way observations could be made on the growth and appearance of the plants and information obtained on the methods of cultivation and any peculiar qualities of the varieties. It was also possible to draw some preliminary conclusions as to the systematic positions of the potatoes when flowering. Great attention was paid to this latter method of obtaining plants from the field though unfortunately considerations of time did not always allow it since it took much longer and was often more expensive than the method of collecting samples in markets.

The majority of local agronomists were unhelpful on the subject of wild potatoes, since they often considered them to be mere escapes from cultivation. Hence small or, in some cases, large excursions were made from the centre from which the expedition happened to be working, often on mules in order to get into wilder and less known country. Even in the towns and cities themselves and especially on the outskirts it was possible to find many interesting wild potatoes, some more or less related to the cultivated ones, others quite distinct. The question of the relationships of these wild potatoes to each other and to the cultivated ones will be considered in a later bulletin.

Although the main collections were of tubers, most of the Andean potatoes produce abundant berries and when the season was propitious a fair amount of seed could always be collected. In addition, herbarium specimens were taken of both cultivated and wild material wherever possible in order to aid in the identification; for this reason also, cultivated material was obtained from the field rather than the markets when at all possible. A herbarium of several thousand sheets was made and has since proved extremely valuable in the work of identification.

The tubers were generally dried and packed in peat, sawdust or moss according to the supplies available. On the whole, peat proved to be the most successful material. In addition, the samples were placed in parchment bags and often in cardboard boxes. The samples were sent to England in fairly small batches as they were collected, either through the post or by the courtesy of the British Legations of the various countries visited. Small, delicate tubers were occasionally sent by air mail as this only necessitated from 10-14 days in the post instead of 4-5 weeks by ordinary mail. By these careful methods of dispatch practically all the material arrived in England in a living state. Out of the 1,210 specimens sent back, only 9 samples of cultivated and 10 of wild forms died or rotted on the journey.

On arrival at Cambridge, the tubers were carefully examined by Dr. R.N. Salaman and Dr. S. Dickinson for the presence of disease. Wart infected material was immediately destroyed or sent to a wart testing station. All material was surface sterilized by immersion in 1/1000 HgCl₂ before being planted out in the glasshouses.

(The E.K. Balls Mexican Expedition is summarised on pages 10-12. See original paper.)

Whilst travelling in the potato growing regions of South America the members of the expedition made a fairly comprehensive survey of the potato in its natural home and its primitive cultivation by the Indians. The data so obtained form the basis of the second part of the present bulletin.

II. DISTRIBUTION AND PRIMITIVE CULTURE OF THE POTATO IN SOUTH AMERICA

The potato is cultivated throughout the Andes from Western Venezuela and Colombia to the Argentine province of Jujuy. It is also to be found in the Chiloé region of Central Chile. In the present account we shall confine ourselves to the Andean species.

In considering the problem of the distribution of cultivation it is necessary to recognize and distinguish the areas of indigenous cultivation from those regions where the potato is an introduced crop only maintained by special processes.

(a) *Indigenous cultivation* is largely carried out by Indians, very rarely with irrigation and is confined to higher altitudes. These areas represent the "natural habitat" of the cultivated potato in that it is maintained in a healthy state with no disease control or introduction of fresh seed from other areas. The paramo and puna steppes are virtually the only areas where this type of cultivation can be carried out.

(b) *Non-indigenous cultivation* may be effected at lower altitudes, in fact, right down to sea level, necessitating disease control and fresh introductions of healthy stock from the indigenous cultivation areas. In those regions where the rainfall is less than the optimum required for potato growth, irrigation is necessary. The altitudes of 6-9,000 ft. are usual for non-indigenous plantations in Bolivia, Ecuador and Colombia.

In general, the expedition visited only the indigenous cultivation areas, since they were of greater interest both from the point of view of the larger numbers of varieties grown and the amount of genic diversity. Unless otherwise stated the following account always refers to cultivations of this type.

The cultivated potato is one of the highest crops in the Andes, extending above the limits of maize cultivation. It is not found much below 10,000 ft., with an optimum of 12,000 ft. and extends actually up to 13,500 ft., and possibly to 14,000 ft. in some places. The upper cultivation limit for maize probably lies somewhere between 11,000 and 12,000 ft. Mangelsdorf and Reeves (1939) assert that it extends up to 13,000 ft. but the writer's own observations are at variance with this probably over optimistic estimate. Certain potato species such as *S. phureja* in Bolivia and the varieties known as "criolla" (*S. boyacense?*) in Colombia have an optimum growth level of about 8,000 ft., whilst the frost resistant *S. Juzepczukii* and *S. curtilobum* are most at home at an altitude of 12,500 ft.

In general, the potato needs a deep rich loamy soil with plenty of humus and sufficient but not too much rainfall. Individual species and varieties vary slightly in their requirements though not so much as many of the wild species of potato.

POTATO CULTURE

For the sake of clarity the problem of Andean potato culture will be considered in four sections:

1. Bolivia and North Argentina.
2. Peru.
3. Ecuador.
4. Colombia.
- [5] [Mexico.]

1. BOLIVIA AND NORTH ARGENTINA.

(1) *Period of Growth.*

The season of high rainfall and equable temperature conditions lasts in Bolivia approximately from October to April, whilst at altitudes of over 9,000 ft. heavy night frosts occur in May to September. Connected with this the sowings above this altitude are generally begun in October to November with the harvest in March to May. In localities under 9,000 ft.

Indian cultivations of potatoes are generally absent but half caste and Creole farmers may sow crops under irrigation at other seasons.

Table 6 (not reproduced here) gives some indications of the correlations between growing period, altitude, presence or absence of frosts and irrigation in Bolivia and North Argentina. The heavy black line represents in every case the main crop, the thin lines representing subsidiary sowings. These latter, as will be seen from the Table, are only present at localities of lower altitude where frosts do not occur or are less severe and generally where irrigation is possible. The dotted portions of the lines indicate the periods of sowing or harvesting, which naturally vary according to season. At both Sucre and Cochabamba the small subsidiary crop is spoken of as "Miska". In the latter district there are four separate sowings:

- (1) The true Miska, sown in August and harvested December to January.
- (2) Chaupi Miska, sown in November, harvested March to April.
- (3) Papas de ano temprano, or early main-crop, sown at the end of December and harvested in April.
- (4) Papas de ano, or main-crop, sown in February and harvested in May to June.

The sowings at La Palomar, near La Paz, are not actually very large as this district is not eminently suitable for potato cultivation. The three main sowings all rely on natural precipitation, whilst the two subsidiaries are grown on irrigated ground during the dry season and hence cultivation is carried on all the year round, the temperature not falling below 2° C in the coldest months (June and July).

The majority of the potato cultivation in Bolivia and North Argentina is carried out by Indians in relatively small plots, especially in the smaller and more inaccessible mountainous regions. Large "fincas" or farms run by Creoles of Spanish descent are however scattered over the country especially in the eastern valleys of Tarija, Sucre and Cochabamba and below La Paz. A few also are situated on the altiplano. In Argentina in the province of Jujuy, south of the town of that name, large farms cultivate European potato varieties. In the department of San Antonio, Canadian varieties are mostly used. They are cultivated all the year round and mature in 90-120 days. In the mountainous regions north of Jujuy and above about 7,000 ft. only Indian cultivations in small plots are to be met with and the varieties cultivated all belong to *Solanum andigenum*.

(2) Cultivation Methods.

Primitive cultivation methods are in general use except on those farms and haciendas owned and run by Europeans or the more advanced Creoles. Amongst Indians it is a general practice to leave the ground fallow for several years and very little manuring is practised. The wooden oxen-plough, introduced with the advent of the conquistadores is still in use in an apparently little altered state. The soil is not ploughed at all deeply, sometimes in hard soil only the surface few inches are turned over. In the district immediately surrounding Tarija the ploughshare is iron tipped, the ground being turned up twice and given a dressing of sheep manure. Furrows are then ploughed, into which the tubers are dropped and covered over by splitting the ridges.

At Azari, near Sucre, we were told that 3-4 tubers, according to size, were planted together in one hole and sheep manure added. The practice of planting more than one tuber is, in fact, very widespread.

At a large hacienda at Huarisata on the shores of Lake Titicaca the heavy clay soil was trenched to a depth of about 18 in. and the potatoes planted on the intervening ridges. This method, however, does not appear to be very satisfactory in the dry years.

Harvesting may be accomplished by mechanical methods on large haciendas but on the small Indian plots is effected manually with hoes or some similar instrument.

(3) *Yield.*

It is extremely difficult to obtain any accurate data for yields for the Bolivian cultivated potatoes but, in general, the best varieties grown at optimum altitudes (ca. 12,000 ft.) and with proper care and attention give yields little inferior to the European domestic varieties. Under conditions of Indian cultivation, the yields are of course much smaller, owing partly to the greater number of low yielding types grown.

(4) *Grading.*

In general the potatoes are hand graded into two or three main classes. In some districts such as Sama, near Tarija, the largest tubers are kept for planting. This is also the case with the large hacienda owners where occasionally the tubers are cut into portions. Much more frequently and especially amongst Indians the large tubers are used for eating, the medium sized for planting and the small ones for chuño manufacture, or where frosts do not occur for feeding to cattle.

At Cochabamba the size classification is as follows:—

- (1) Large — Kollke (= silver).
- (2) Medium— Murmu.
- (3) Small — Ttuna (= small).

Here the small tubers are retained for planting, whilst the medium or large sizes are eaten.

(5) *Chuño Production.*

In the highlands of Bolivia as well as in Peru where heavy night frosts occur in the winter months (June and July) a special type of dried food product known as chuño is made from potatoes. It can be manufactured from sweet or bitter potatoes, but generally only the bitter frost resistant varieties are used since they are grown almost to the exclusion of other types at those high altitudes where frost occurs and chuño can be made. The potatoes are spread out on the fields during the times of heavy frosts. If the earth is not covered with grass a layer of straw is spread out in order to insulate the tubers as much as possible from the heat of the earth. They are left in a layer of not more than one tuber thick for about two or three nights of the heaviest frosts and the tubers are then trodden by natives with bare feet in order to expel the juice from the broken cells. Generally this process is done very early in the morning when the ice is just beginning to melt from the surface of the tubers. Sanz Guerro (in a written communication) recommends that the tubers be put between two pieces of ewe hide in order to keep the treading process more or less clean. It is doubtful, however, whether this refinement is in general use. As much as possible of the juice is expelled in this way and the tubers are then left in the fields exposed to sun, winds and frosts until completely dry. If the frosts are not sufficiently strong the interior core of the potato remains unaffected by them and thus gives rise to fermentations, especially dangerous when bitter varieties are being used.

Again, if the localities are damp or the sun and winds not sufficiently powerful the chuño does not dry quickly enough and the growth of moulds is encouraged. Inefficient trampling does not remove all the skin and leaves behind part of the sap so that the quality of the final product is, according to Guerro, decreased. The tubers when converted into chuño are said to contain all the starch and a greater part of the protein. Ballivian (1914) states that from 4-5 fanegas (1 fanega = about 1.6 bushels) only one fanega of chuño is produced. He states that the tubers should be left to freeze for 12-15 days with a further period of 15-20 days after trampling for the drying out process to be completed.

A superior brand of chuño known as "Tunta" or "Moray" is frozen and trodden in a way similar to that for producing chuño, then placed in a stream of running water, covered with straw on which are placed one or two stones or some similar device to prevent the water from carrying the potatoes away. The potatoes should apparently be left in the stream for 30-40 days, at the end of which they are brought out and dried in the sun as with chuño. In this way a pure white starchy product results (ordinary chuño being black), very much prized amongst Indians and Creoles alike.

A product known as "Cachuchuño" is nothing more than potatoes frozen for one or two nights and used without being trampled and generally without having been dried in the sun.

The production of chuño, it is interesting to note, goes back to pre-Colombian days, for its use was mentioned in the earliest Spanish chroniclers such as Garcilaso de la Vega (1609) and others.

It has been since then and still remains the ordinary food of the highland Indians, being generally used in soups and stews after a preliminary soaking in water.

2. PERU.

(1) *Extent of Cultivation.*

Potato cultivation in this country is carried out in two distinct zones, each with its particular problems and special characteristics:

(1) The "Sierra" or mountain zone, comprising altitudes of above about 8,500-9,000 ft. and ending roughly at 13,000 to 13,500 ft. The cultivation here is similar in many respects to that of Bolivia.

(2) The "Costa" or Pacific coast zone, where potatoes are grown under irrigation in the river valleys and up to altitudes of 8-9,000 ft.

Cultivation in the Sierra is chiefly carried out by Indians whilst in the Costa the haciendas are owned by Creoles or Europeans and are worked on more modern lines. One might expect the greatest amount of potatoes to be grown in the mountains where the conditions of growth are more natural to the species, but this is not always the case. The figures for potato production in the year 1929 are shown in Table 7 (not reproduced here). The second column in the Table is of course somewhat approximate since many of those departments marked as "coast" also spread up into the mountains, whilst many of those marked "mountain" extend over into the Amazon basin. No later statistics have been published so far as I am aware.

Gilardi (1938), however, mentions that the production for Puno department is 315,000 tons and that for Arequipa 16,500 tons, so that there is reason to believe that the figures in Table 7 (not reproduced here) give a fairly accurate representation of the potato production in Peru at the present day. Puno, a predominantly mountainous department bordering on Lake Titicaca, has by far the greatest potato production in Peru, whilst the coastal department of Ancash is the next heavy producer, though in point of fact probably half this department is also situated in the sierra.

(2) *Seasons of Growth.*

(a) *Sierra.*—As in Bolivia, the advent of sharp night frosts and lack of rainfall in the winter months (May to September) precludes the cultivation of potatoes at that time. Thus in the Puno region of Lake Titicaca sowing begins in September as soon as the frosts have finished and goes on until October or November. Harvesting, again depending on the times the rains cease and frosts begin, is effected from March to April or even in the beginning of May.

Vargas (1936) gives very detailed notes on the cultivation of potatoes in the Cuzco district and chiefly for the province of Paucartambo. There are three sowings here: (a) early, (b) middle early, and (c) late, corresponding respectively to the harvests (a) "papa nueva" (mosoc papa) appearing at the first harvest (misca mahuay), (b) "papa nueva intermedia" (chapuy mahuay), and (c) the late harvest (atub tarpuy). For the first or early sowings only special early varieties are planted, such as "chaucha" (? *S. chaucha*) which develops in three months, or "puca mama" which matures in four months. The situation must also be very sheltered from late frosts and with possibilities of abundant irrigation. The sowing starts from 15th June till July and the crop is harvested in November and December. The second or semi-late sowings do not require such special seed selection though Vargas mentions varieties such as "ccompis," "alckay huarmi" and "puca mama" (all *S. andigenum*?) as being specially suitable. Sowing takes place in July, August and September, harvest being in January and February. Finally, the third or main sowing in which a large unselected number of varieties are used and the sowing is much more extensive than the other two, takes place in September, October, and the beginning of November with the harvest in May or June.

It was not possible to make any detailed observations on times of planting and harvest in the places visited by the expedition between Cuzco and Lima. However, data in an official publication of the Peruvian Ministerio de Fomento (1934) indicate that in the Ayacucho region (province Huamanga) sowing takes place from August to November whilst the potato crops are lifted from December to June. Presumably the dates depend amongst other things upon the altitude. At Huancayo sowing is in July and September to November, whilst harvesting is in January, February and April to June. Unfortunately, no data are yet available for department Apurimac in the regions of Andahuailas and Abancay but there is little doubt that the times will be approximately similar to those for Cuzco given by Vargas.

(b) *Coast.*—In view of the absence of frosts in the coastal regions up to 8-9,000 ft., potato cultivation is possible all the year round as in the low dry eastern Bolivian valleys.

Arequipa, at an altitude of about 7,600 ft., although not quite devoid of rainfall at all seasons (there is a certain amount in January, February and March, though not enough to dispense with irrigation) may be conveniently classed as belonging to the dry coastal zone. It is doubtful whether the temperature ever falls below freezing point here.

According to information gained on the expedition and from a table prepared by Sr. L.J. Vivanco (date unknown), the main sowings take place in January, the crops being harvested in June and July (see Table 8, not reproduced here). Potatoes of the type of "Salamanca" (*S. andigenum*), "Chaucha" (*S. chaucha?*) and "Nortena" (*S. andigenum*) are grown at this time. The other crop is planted in June and July and harvested in November (chiefly chauchas), December (chiefly salamancas) or January ("miscas"). A class of tubers known as "Negras" (*S. andigenum*) are apparently sown in September and October and harvested in March and April.

According to the previously mentioned statistical data the times for planting and harvesting at Lima (0-500 ft.) are as follows: Sowing: May to July; Harvest: August to November.

(3) *Cultivation Methods.*

As in Bolivia and North Argentina the native potato culture is carried on in scattered plots, whilst that in the large coastal haciendas is on more modern scientific lines. A very striking feature in connection with the ground used by the Indians is the immense amount uncultivated, perhaps only one-sixth or one-eighth bearing crops. The rest is in various stages of fallowing, since under foot-plough cultivation and with no manures one piece of ground never bears more than one crop in 3-8 years. At first sight the impression is gained that the land was formerly more thickly populated and more intensely cultivated than to-day when the vast amount of grass covered fields and cultivation terraces are noticed. Although, by all accounts, the population was greater during the Inca period, the neglected aspect of the fields is due to the fallowing system mentioned above. There is no doubt that more land was under cultivation in pre-Colombian times and that soil conservation and amelioration, with very careful manuring, had arrived at a high degree of efficiency. South Peru especially is rich in remains of ancient cultivation terraces now long since abandoned.

The coastal potato growers regard the mountains as regions for seed tuber production, while the prevalence of diseases and conditions of temperature very much higher than optimum in the coast zone render it necessary to procure fresh seed at frequent intervals. On the other hand, in districts such as Puno, the potatoes are remarkably healthy and there are several large farms entirely devoted to the production of seed for the coastal growers.

(4) *Preparation of the Soil.*

On the coastal haciendas and the large haciendas of the sierra modern mechanical methods of ploughing, etc., are in use. Amongst the Indians, however, cultivation is very primitive. As in Bolivia the wooden oxen plough is widely used. In the departments of Cuzco, Apurimac and Puno, however, an extremely interesting type of ploughing using an instrument called a foot plough (in Spanish = "tirapie"; in Quechua = "Chaqui taclla") still takes place. This method was used during the Inca period and possibly long before that; at any rate it was in general use before the conquest and was remarked upon by many of the early chroniclers. The foot plough is a spade-like instrument, used without any beasts of burden since before the conquest there were no draught animals in South America. Vargas (1936, p. 16) figures and describes a model of a foot plough from the Chimu period made in black pottery and about 25 cm. long. According to Salaman (1937a) the Chimu period began at about the beginning of the 8th century A.D. and lasted over into the Inca period.

In the region south of Puno, foot ploughing is not in use and this is probably so along most of the southern shores of Lake Titicaca and undoubtedly so in Bolivia. The foot ploughing regions at the present day are centred in the Cuzco district and in department Apurimac. The smallest and most inaccessible fields where the foot plough is not used are worked entirely with small pick-like instruments used normally for harvesting. In these latter places the very small size of the plots makes this tedious method practicable.

There is no need to give a lengthy description of foot ploughing here since it has already been fully dealt with by Garcilaso de la Vega (1609), Cook (1918), Bukasov (1933a) and Salaman (1937a). Vargas (1936) mentions and figures two different types of instrument:—

(a) The Cuzco style, with a straight handle about 1.5 metres long or more.

(b) The Apurimac style, with a curved handle much smaller than the previous one and scarcely 1.3 metres in length.

In the Puno district members of the expedition examined another kind which will be referred to here as the Puno type since it differs considerably from the other two. It possesses one main straight handle with a side one almost as large branching off from it. This type is probably shorter than the Apurimac model, being only 3-4 ft. long. It is difficult to make out the exact shape of the Apurimac plough from Vargas' figure (l.c., p. 16), but it seems probable that it is more similar to the Puno than to the Cuzco type with the difference that the left hand handle is very much more curved over in the Apurimac model, whilst in the Puno one it stands out stiffly from the main shaft. In the Cuzco type the left handle is curved over but is very short and reduced to a small hooked over piece at the base of the instrument near the foot rest. The ceramic model figured by Vargas also possesses a left handle of this type.

(A demonstration of foot ploughing was viewed and photographed by the members of the expedition at Ilpa, near Puno. A cinematograph film was also made of the process. The following account is a description of this with additional notes obtained from the Indians.)

The type of plough in use near Puno is, as was stated above, about 3-4 ft. long. The main shaft is straight, with a pointed, flat, iron blade attached to one end. In pre-conquest times when iron was unknown a piece of very hard wood from a tree found in the montaña was used. A foot rest about 4-5 in. long stands out at right angles near the base on the left hand side, whilst another wooden handle stands out at a slightly acute angle in front, about 12-15 in. higher. The various pieces are bound together with fibre or leather thongs.

In use the main shaft is grasped by the right hand, the front handle by the left. The left foot on the foot rest gives the necessary power to force the blade into the ground, aided by the hands. The ground is dug in trenches, one trench being dug at a time by each group of workers. Three workers are needed for each team—two men with foot ploughs and a woman or boy to turn over the clods. These are lifted out and turned over, grass side downwards at the sides of the trenches, one row being turned over to the left and the other to the right by the woman, who stands facing the men. The pressure of the left hand on the front handle of the plough to one side or the other assists in turning out the turfs from the trench. Often several trenches are dug together, leaving enough space between each two to be covered by the turfs that are removed.

After the ploughing process the top surface of the ridges is broken up by the women with small pick-like instruments, the same as are used in harvesting.

Although it might be thought that the above described process seemed lengthy and tedious this is not actually so. In practice the whole community do each man's field in turn and hence the ground is covered with amazing rapidity.

The ground is ploughed in April or May after the previous year's harvest has been gathered (but not, of course, in the same field) and it is left in this condition all through the winter before planting commences in the following spring. Presumably during this time the grass on the turf will have rotted considerably. In September or the appropriate sowing time the tubers are planted in between the clods and the underlying undisturbed turf. It should perhaps be mentioned here that foot ploughing is a method of cultivation that can of necessity only be used on ground whose surface is bound together by a good turf, that is to say, ground that has been left fallow for 3-6 years. If the soil surface is not bound together by a mass of grass or other roots it will not be possible to remove the turfs without their breaking to pieces and at the best an uneven trench will result. At the times of planting, therefore, the ridges consist of an undisturbed but somewhat rotted turf with reversed, also somewhat rotted, clods lying on it.

The potatoes are planted between these two layers by hand, generally two or three of the very smallest being dropped in each hole or occasionally one medium sized and one small tuber. In spite of this apparently disadvantageous method of planting the tubers between two hard practically undisturbed turfs the best yield is obtained in this way. The method indeed seems eminently suitable for potato culture.

The method of ploughing in use in the Cuzco and Paucartambo regions seems, according to Vargas (1936) to be somewhat different from that in use at Puno. Here, the soil is prepared in the spring (= "rompe" on fresh or virgin soil, also "Barbecho"). Next comes manuring. In the Indian "ayllus" (= communities) with common lands it is customary to rest the land from cultivation for 2-3 or more years according to the cultivable extent which they possess. The gently sloping lands are worked with oxen plough and those in almost "vertical" situations with the foot plough, the depth being about 30 cm. in each case. After a little time they proceed to the second ploughing to break up the clods and prepare the furrows, which latter are disposed at a distance of 80-100 cm. (Presumably the foregoing sentence, translated from Vargas, refers chiefly to oxen ploughing.) Vargas also mentions that special methods are in use for frost resistant varieties which are not adapted to conditions of the preparation of the ground as detailed above ("yapuy ssuca"). In this case the ground is opened up by a foot plough, a tuber placed in the cavity and the turf replaced. Later, when the tubers sprout through the soil they are earthed up by turning with the *taclla* a row of turfs on either side (Salaman, 1937a). This process is known as "kkaya ssuco".

(5) *Planting.*

In the Arequipa district this is effected by hand on well irrigated soil. Holes are dug in the ground about 1 ft. apart and from 3-5 tubers put in the same hole, the number depending on the size. The method of planting has already been detailed for the Puno district on Indian cultivations. At a modern farm where potatoes were grown for seed purposes the tubers were planted singly or sometimes half a large to medium sized tuber.

The ground was also fertilized with guano, which is sold by the Peruvian government in the Sierra at subsidized rates in order to stimulate the use of fertilizers and to promote the practice of soil amelioration.

(6) *Harvesting.*

Where mechanical methods are not used the tubers are merely removed by hand with small pick-like instruments. These consist of a small wooden shaft, 8-12 in. long with an iron blade bound to one end, forming an acute angle with the shaft. It is merely drawn through the soil and loosens it sufficiently for the tubers to be secured by hand.

Often, as at the seed-growing farm at Ilpa, the furrows are turned over by tractors and the tubers then collected by Indians. The latter process is generally effected very inefficiently by the Indian labourers owing to a peculiar local custom by which hacienda owners hire free Indian labour on the understanding that the latter may return to the fields later and take any tubers remaining in the ground for their own use. Naturally, they tend to retain the custom even though at Ilpa, at any rate, they are paid for the work done.

(7) *Yields.*

It is difficult to get any very accurate estimates of yield for the different regions of Peru. For Arequipa it was stated that for every 5 topos sown (1 topo = 3,496 sq. metres), on an average only three topos gave any yield, the other two being destroyed by disease. The average yield according to Sr. A. Huaco (in a verbal communication) is about 450-600 arrobas per topo (1 arroba = 95 lb. or 11.5 kg.) which is roughly equivalent to 5.85-7.75 tons per acre. In view of the fact that the average yield for the United Kingdom between the years 1928-37 inclusive was only 6-7 tons per acre, this estimate for Arequipa might seem to be a little optimistic. According to Abbott (1928) the average yield for Arequipa is 50-55 arrobas per topo (= 0.64-.70 tons per acre), whilst Gilardi (1938) places the figure between 50-70 arrobas per topo (= 0.64-.90 tons per acre). These low yields are quite in accordance with the large amount of disease present in the crops.

The figure for yield at Ilpa, near Puno, where the plants are kept healthy and the best yielding varieties are grown (imilla negra, etc.) is from ten to thirty fold by weight, the variety Ruki (*S. andigenum*?) apparently giving the highest yield. This is rather higher than the average for European domestic varieties grown in Britain.

(8) *Storage.*

According to Vargas (1936) the late varieties which keep for anything up to a year are stored in clamps at altitudes of 3,800 metres or more. A hole about 100 cm. deep is dug in the form of a circle and the base and sides covered with dry straw and a plant known as "muña" (*Minthostachis serosa*), which is said to protect the tubers from fungal attack by virtue of the essential oils which it contains. The potatoes are covered with muna (and presumably earthed over) when they can be stored for 8-10 months. At the lower, more humid altitudes the tubers are stored within the dwelling houses in wicker (?) baskets together with large amounts of muña.

(9) *Chuño*.

The production of chuño has already been dealt with in some detail in connection with Bolivian potato culture. The methods in use in Peru are essentially similar and it will therefore not be necessary to give a further account here.

(10) *Uses*.

Although the majority of potato varieties are used for eating, either fresh or in the form of chuño, one interesting type presented to us by Dr. Soukup and obtained from the department of Puno is used by the natives for dyeing cloth. The flesh is of a very dark purple, practically black colour and the expelled juice is a bluish purple tint. The native name is "Chapiña". It is of interest to note that Bertonio in his dictionary of Aymará mentions amongst other types of potatoes "Cchapina" — "purple potatoes from the flesh of which they [i.e. the Indians—J.G.H.] are accustomed to make a dye".

3. ECUADOR.

(1) *Extent of Cultivation*.

The potato is cultivated in the south and central provinces of Ecuador, namely Azuay, Cañar, Chimborazo, Bolívar, Tungurahua, León, Pichincha, Imbabura and Carchi. There may be a small amount of cultivation in Loja also. These provinces all lie along the Andean cordillera, where cultivation is carried out from altitudes of about 4,700 ft. to 12,000 ft., the optimum altitudes probably being from 8-10,000 ft. It seems probable that Indian cultivations were only situated at the higher altitudes where growth was easier and diseases and pests at a minimum. In view of the complete absence of frost-resistant varieties in Ecuador (in contrast to Bolivia and Peru), cultivations above 11,500 ft. are rare. At altitudes of 4,700-8,000 ft. cultivation is only carried out by large hacienda owners where the best commercial varieties can be grown, the "seed" changed periodically and diseases more or less controlled.

In the central provinces of Ecuador (Tungurahua, León and Pichincha) the potato is grown in the high rather dry interandine valley. Rains occur from November to May with the exception of the short dry spell occurring from 15th December to 15th January, though on the Atlantic and Pacific facing slopes of the Andes the seasons may be reversed in certain places (i.e. Oyacachi). Rainfall in the central valley differs considerably in intensity according to the situation; opposite large gaps in the range such as is found at Machachi (Mejía) in South Pichincha the rainfall is higher because rain bearing clouds can penetrate without losing moisture on the way. The mountain-ringed basins of Latacunga and Riobamba are however much drier.

Frosts occur in the central provinces during the months of August to October and also in December in the dry seasons. They are most frequent in November in the central provinces, though some years there may be none at all. At any rate they are generally confined to altitudes of over 9,000 ft. In Azuay frosts do not occur, but in Cañar they are very erratic, arriving in some years in full force and in others not coming at all.

The most likely times are:—

(a) End of June — " Helado de San Pablo ".

(b) February — " Helado de San Andres ".

They may also occur spasmodically at other periods.

(2) *Times of Sowing and Harvest.*

In Cañar and Azuay the times of sowing and harvest are not at all definite, depending greatly on the altitude, aspect, type of soil etc. In general, late varieties are sown in April and May and harvested in December, whilst the earlies are planted in December and harvested in February (see Table 9, not reproduced here).

At the altitude of Cuenca (9,000 ft.) where there are no frosts, if irrigation is possible, the potato is grown all the year round. Higher up, in the Cañar region, potatoes do not need irrigation as there is sufficient rainfall, but here, of course, there is frost danger. Irrigation in the lower regions is done a little before and after flowering. In the provinces of Tungurahua, León and Pichincha, there is one sowing of late varieties and two of earlies per year. In Tungurahua sowing occurs from November to February with harvesting in 3-8 months' time according to the variety. In Pichincha the sowings are extremely variable, January and February being the most popular months, but it depends largely on the zone, Indians, local customs, etc. In July, at the time of the expedition's visit to those regions the crops had either been lifted or were about 2-3 months old, but there were also other stages. Irrigation is practised in the different provinces where possible and according to the need. Thus, there is a great deal in Tungurahua and Pichincha north of Quito where it is very dry. On higher slopes where the increased precipitation renders irrigation unnecessary there is always danger of frost damage. From one source it was heard that potatoes were planted in small amounts at monthly intervals so as to preclude the loss of the whole crop in the event of an untimely frost.

(3) *Cultivation.*

The foot plough described for Peru is apparently entirely absent in Ecuador. The Indians make use of the oxen plough while on the larger haciendas more modern methods are in use. The potatoes are planted in rows roughly 1-2 metres apart, the plants being spaced at intervals of 30-40 cm. Generally the Indians sow the smallest tubers and eat the larger ones, as is the custom amongst the majority of Indians throughout the Andes.

In certain districts in the north of Ecuador (El Quinche, prov. Pichincha) there is a custom amongst the natives, according to Ascásabi (in a verbal communication), to sow the true seed of the potato. The tubers raised in the first year are kept and planted again, the second year's harvest being large enough for eating purposes. Potatoes of this type are known as "papa chimbaló" (= berry) and are considered to be of better quality than the ordinary varieties. It is interesting to note also that this custom prevails in some of the southern parts of Colombia.

4. COLOMBIA.

The whole problem of potato cultivation in Colombia has been very well dealt with by Bukasov (1930). It will only be necessary in this section to outline the general position, add details which have been discovered since Bukasov's visit in 1929 and deal with certain aspects which he has not described.

(1) *Distribution.*

The average altitude is much lower in Colombia than in the other Andean countries we have previously been considering. Hence we shall expect to find that potato cultivation is not so widespread. As Bukasov mentioned, the departments of greatest potato production are those of Cundinamarca, Boyacá and Nariño where the amount of land at high altitudes is fairly considerable. Thus the figures for potato production in the different departments for 1934 show that the greatest amount is in Cundinamarca (see Table 10, not reproduced here).

There is no potato cultivation in either Bolívar or Atlántico since both these departments are completely low lying. Potato growing does not extend below 6,500 ft. and is generally confined to altitudes of over 8,000 ft. Although the Sabana de Bogotá (= plain of Bogotá, the capital of the country and situated in Cundinamarca) is said to be a very prolific potato growing region, in the neighbourhood of Bogotá itself there is very little potato cultivation. Potato fields are not found on the flat plain so much as on the edges and foot hills of the sabana and also in the valleys of the north and east towards the department of Boyacá. The sabana is largely used for pasture and cereals. In the drier Boyacá valleys also, potato growing seems to be absent and is confined to the higher wetter regions. Thus, for instance, there is none in the wide fertile Sogamoso valley (though attempts have recently been initiated with fair success), nor in the valley floor of Toca, though on the hills above and in the Tunja district, potatoes are extensively grown. The most thickly cultivated potato area seen was in the region of Lake Tota where potatoes were practically the only crops, yielded abundantly and appeared very healthy.

(2) *Times of Sowing and Harvest.*

In Nariño there are two seasons for planting late potatoes, namely December to March and July to August. The former sowings take place in the higher altitudes whilst the lower are confined to the valleys. The times of maturity for these late varieties which mature in 5-6 months will therefore be May to September and December to February respectively. In many of the valleys, however, peasants make sowings in almost any month. The early varieties germinate and grow so rapidly that there are three crops of these per year. They are sown immediately after harvesting and in less than two weeks are above the ground see Table 11, (not reproduced here).

The rainy season in Cundinamarca and Boyacá is divided into two parts, one from April to May and the other from October to November. Thus, the main sowings on the Sabana de Bogotá (Cundinamarca) are in February to March, taking advantage of the April and May rains, the crop being harvested in August. This is known as "papa de año". The "papa de travesía" or subsidiary crop is sown in July or August and harvested in about February, taking advantage of the October and November rains. Frosts are likely to occur in October to January, especially in December, and hence this latter crop is not regarded as very important, for the risk of frosts precludes the possibility of safe returns.

At the higher altitudes, such as La Caldera, above Zipaquirá (11,500 ft.), where the frosts are more severe in October to January, only one crop is sown in the summer months. Sowings take place in February with the harvest in August (or September?), mostly of early varieties. At Lake Tota (10,000 ft.) the main crop is sown at the end of March and harvested in August and September (and October). The subsidiary crop is sown in June and harvested in January but only a very small amount is planted, since the frosts of October to January may destroy it.

Thus, whilst the main growing periods in Peru and Bolivia are October to April, in Colombia the reverse is the case, March to August being the chief time when potatoes are grown. In Ecuador the picture, as has been seen, is not clear cut but depends largely on situation and altitude. This is of course to be expected since Colombia and especially the departments of Cundinamarca and Boyacá are situated well to the north of the equator, whilst Peru and Bolivia are some distance south. The regions about 3° north and south of the equator do not show well-marked differences in growth periods because of the erratic climatic conditions already mentioned.

(3) *Cultivation.*

The primitive agricultural methods have already been fully dealt with by Bukasov (1930). In Cundinamarca and Boyacá, probably more than in any other districts visited by us, modern farming methods and machinery are in use by co-operative production societies, assisted by Government propaganda and aid with farm implements, fertilizers, fungicides and insecticides. Potato growing is practised on a very large scale compared with that in the more Indian districts of Peru and Bolivia.

There is probably little irrigation in the department of Nariño since the rainfall here is fairly high. In Cundinamarca and Boyacá also the precipitation is sufficient to maintain the crops if they are planted at the times indicated.

In the Pasto district there exists a custom amongst the peasants similar to that already noted for Northern Ecuador of growing potatoes from true seed. The "chaucha" type of variety is chiefly used. In this way the peasants consider that they get a better standard of tuber. The habit of growing potatoes from seed results in a good deal of variation amongst certain varieties which are still called by the same name though any very marked differences will eventually be distinguished by a new name. The first year tubers of the sowings of seed are known as "Chimballeta".

This curious custom of raising potatoes from true seed has only been observed in South Colombia and North Ecuador and is apparently unique in the American continent. So far as the writer is aware it has not been previously mentioned in the literature.

5. MEXICO.

Bukasov (1930) has made a thorough survey of the potatoes of Mexico, and from a study of the literature available on the subject has come to the conclusion that there was little, if any, indigenous potato cultivation in this country before the Spanish conquest. Introductions of cultivated potatoes were probably made from Europe and represented varieties of *Solanum tuberosum*. At the present day, according to notes made by E.K. Balls in Mexico, only European domestic varieties are grown. The lowest limit of potato cultivation is about 5,000 ft., whilst fields may be found as high as 13,000 ft. in some regions.

The general level of cultivation is from about 9-12,000 ft. A very frequent practice is to grow potatoes partially shaded by pine trees.

III. UTILIZATION OF THE COLLECTIONS

On the return of the expedition from South America it became evident that the best possible use should be made of the vast collection of specimens on which such a large amount of time and money had already been expended. It is clear that the collection represents an extremely valuable, in many respects unique, store of material for use in plant breeding, not only from the point of view of resistance to disease, but also in the spheres of drought and frost resistance, yield, culinary quality and so on. If its full potentialities were to be realized it should be subjected to tests and investigations from all these and many other points of view. Only by so doing could a basis be made so that breeders would be fully aware of the qualities and characters available in the collection and could direct their work accordingly.

SYSTEMATICS AND CYTOLOGY.

It was necessary in the first place to know the taxonomic position of the specimens in order to be able to apply to them the results obtained by previous workers on South American potatoes. In this way breeders would be able to turn their attention to particular species or groups of species known to possess certain desirable qualities, or, if looking for certain new qualities, to examine those specimens which the taxonomic studies showed had not been previously investigated.

With this end in view a comprehensive systematic and taxonomic study of the Empire Potato Collection was initiated in the beginning of 1940 and it is hoped that this will be completed by the end of 1941. Some 15 cultivated and 21 wild species have already been identified, besides a large number of varieties and forms. Several new species and many new varieties are in the course of description, whilst many species previously studied only as dried herbarium specimens are now available for investigation in the living state.

Cytological work has also been in progress and a large number of chromosome counts have been made. The specimens fall into the polyploid series (24, 36, 48, 60 and 72) described by the Russian investigators. Besides acting as an efficient aid in the work of identification and giving some insight into the affinities of the specimens, the cytological data will also serve as a basis for breeding, since the causes of sterility and the relative probability of success with the crosses can be fully understood only with at least some knowledge of the chromosome behaviour of the material under consideration.

DISEASE RESISTANCE.

One of the most important functions of the South American and Mexican expeditions was the collection of disease resistant types.

Tests in progress for blight resistance indicate that quite a large proportion of the Mexican species exhibit high degrees of resistance and in some cases absolute immunity to blight under laboratory conditions. For the first time a diploid species (*S. lanciforme*) has been shown to possess complete immunity to blight, far exceeding that exhibited by the tetraploid species *S. Antipoviczii* and *S. ajuscoense*. The high degree of fertility in this species renders it extremely promising as a basis for breeding blight resistant varieties.

So far, none of the South American material has proved at all resistant to *Phytophthora* attack.

Only a small portion of the collection has been tested for immunity to wart (*Synchytrium endobioticum*). A large amount is probably wart resistant since this character seems, according to Bukasov, to be fairly common amongst South American potato varieties. It is therefore most desirable that the whole of the collection should be tested for resistance to this disease.

It is now generally recognized that more losses in yield may be attributed to the degeneration consequent on virus infection than to any other disease to which the potato is subject. If genes exist which contribute towards immunity to virus diseases (and there seems every likelihood that this is the case) then it is possible that they will be found in the collections now at our disposal, since as we have seen above, specimens were taken from widely differing climatic, geographical and altitudinal regions. Bukasov considered *S. Rybinii*, a diploid Colombian species, to possess a high degree of resistance to virus disease. He was only able to obtain a very limited number of diploid clones from Colombia; the Empire Collection contains over 30 samples of diploid types related to *S. Rybinii* and *S. boyacense* which might well repay testing for virus resistance. At the present stage no tests have been possible owing to lack of facilities but it seems highly desirable from what has been said above that this important work should be carried out.

FROST RESISTANCE.

Tests carried out by the Russian investigators and observations made by the author in South America indicate that many South American potatoes are completely resistant to several degrees of frost. Already in the U.S.S.R. work has been carried out with the aim of introducing this valuable character into domestic varieties. For northern countries such as Canada the quality of frost resistance might be very important, since it would enable potato cultivation to be extended far to the north of its present limits. Possibly the greatest advantage for British growers would be the production of hardy early varieties.

Here again, tests are needed in order to explore the potentialities of the collection before embarking on a large-scale breeding programme. Although certain species (e.g. *S. acaule*, *S. Juzepczukii*, *S. curtilobum*, *S. demissum*) are known to be resistant it may be possible to discover other frost resistant species that are more readily hybridized with *S. tuberosum* or which possess additional desirable qualities.

DROUGHT RESISTANCE.

The question of breeding for resistance to drought is very important for those regions where, owing to insufficient rainfall, potato cultivation has been fraught with risk and expense or has even been completely impossible. The problem has not been satisfactorily solved in the U.S.S.R. since potatoes grown in arid regions were found to "degenerate" very rapidly. It is possible that genes contributing to drought resistance may not exist but there is at least a chance that they may be found in the Empire Collection, the more so as wild potato species often occur in semi-desert conditions where the precipitation is extremely low. Such a species, for example, as *S. infundibuliforme* which possesses several xeromorphic characters might therefore be valuable in this respect. In this problem of breeding for adaptation to arid conditions, as with that of frost resistance, no tests have yet been possible but would undoubtedly be profitable to undertake.

PHOTOPERIODICITY.

In determining the relative adaptability of potato varieties to different latitudes, the factor of length of day in determining yield is extremely important. *S. tuberosum*, the European domestic potato, yields best under the long summer day of temperate latitudes, giving a very decreased yield under the 12-hour day of equatorial and tropical latitudes. The Andean species are, however, adapted to a short day length, yielding considerably better under these conditions than under long day. For those parts of the British Empire where potatoes are grown under short 12-hour days, *S. andigenum* and other Andean species may well prove to be a valuable and indispensable basis for breeding varieties adapted to those conditions. Experiments have been in progress at Cambridge during the past year in determining the reaction of certain Andean species to different day lengths but unfortunately the facilities at present available are not yet extensive enough to enable the whole collection to be studied from this point of view. When it is possible to obtain the photoperiodic index (yield under short day/yield under long day x 100) of a large portion of the collection a more accurate and scientific basis for breeding in the tropical latitudes of the world will be afforded.

YIELD.

Linked up with the question of photoperiodicity is that of yield. Many species that yield badly under certain conditions do so, not in direct consequence of factors for low yield, but because of their adverse photoperiodic reaction. Thus many varieties of *S. andigenum* although yielding badly in temperate latitudes actually bear valuable factors for high yield which are masked by the adverse effect of length of day. Yield is in fact a product of photoperiodic reaction and the inherent yielding capacity. Many samples in the collection, especially of *S. andigenum*, show great promise in this respect so far as can be derived from observations made by the author in South America, but here again, accurate scientific investigations are necessary.

SHORT DORMANCY.

Many of the "primitive" species (i.e. those with diploid and triploid chromosome complements) such as *S. phureja*, *S. boyacense* and *S. Kesselbrenneri*, all of which are represented in the Empire Collection, possess a very short dormancy period. They mature rapidly, often in 3-4 months, and begin to sprout sometimes even before the tubers are lifted from the ground. Two or even three crops may be obtained in a year in those regions where growth is possible all the year round. These varieties seem to be particularly well adapted to semi-tropical conditions since they are cultivated indigenously at lower altitudes than the other Andean potato species. It seems of great importance that the material in the collection of this type should be used and thoroughly tested for serving as initial material in the breeding of special tropical and subtropical varieties.

CULINARY QUALITY.

Several of the Andean species (e.g. *S. phureja*) are known to possess a protein content much higher than is ever found in the European domestic varieties. Several forms of these have been identified in the collection though analysis of protein content has not yet been attempted. It is also important that tests for starch and vitamin content should be carried out if all the valuable characters present in the collection are to be utilized.

The range of flavour and culinary quality amongst Andean cultivated potatoes is also much more extensive than with *S. tuberosum* in Europe and in this field again investigations would no doubt well repay the effort expended on them.

In summing up, one can say that although the preliminary investigations have been initiated, chiefly the more basic ones of naming and classification, a vast amount of work is still to be done. In a subsequent bulletin it is hoped to publish the results of the systematic and cytological studies, together with the results of the tests for blight resistance now in progress. It is to be hoped, however, that with such an important crop plant as the potato and with such valuable material waiting at the disposal of Empire breeders a large-scale breeding programme on at least some of the lines indicated above may sooner or later be carried out.

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APPENDIX II. Extracts from:

Hawkes, J. G. (1944)

Potato Collecting Expeditions in Mexico and South America.

II. Systematic classification of the collections.

Imperial Bureau of Plant Breeding and Genetics, Cambridge. 142 pp.

SUMMARY (of original publication)

This Bulletin deals primarily with the classification and naming of the specimens obtained on the Imperial Agricultural Bureau Potato Collecting Expeditions. It is divided into six sections and carries three appendices.

Sections 1 and 2 comprise an introduction and a short historical survey of potato taxonomy. Section 3 is a general account of the botanical classification of potato species from the time of Dunal down to the present day. Embodied in this section is a dichotomous key to the various series within subsection *Hyperbasarthrum*, the portion of the genus *Solanum* to which all potatoes belong. The phylogenetic relationships of the series are then discussed, and a map showing the recorded localities of all the wild species with an indication of those collected by the expeditions is given.

Section 4 (pp. 12-96, not reproduced here) deals with the taxonomy of the specimens collected by the expeditions. The descriptions of specimens not brought back in the living state, and hence of no use to plant breeders, are included here, though in smaller type, in order to present a complete and scientific account of the work done and for the benefit of future expeditions. Some 30 new wild species and five new cultivated species are described, together with one new series. Where previously known species are dealt with a certain amount of taxonomic and phylogenetic information is included where it has been thought necessary to clarify the situation or bring together certain obscure and previously isolated facts.

Section 5 (pp. 96-101, not reproduced here) gives an account of the cytological investigations on the collection. The somatic chromosome number of over 900 samples was determined, the results being contained in the previous section on systematics. The relationship between systematic and geographical grouping and chromosome number in the different species is discussed, and the probable lines of evolution in the polyploid series of both wild and cultivated species are indicated.

Section 6 deals with the several theories on the origin and evolution of cultivated potatoes. An examination of the historical evidence for the antiquity of agriculture based on the potato leads the author to conclude that this plant was first cultivated in the region of S. Peru-N. Bolivia. This is followed by a discussion on the lack of indigenous potato cultivation in Mexico. An enquiry into the different types of weed and semi-cultivated potatoes is shown to throw some light on the types of potatoes that were first cultivated and their subsequent development. The probable relationships of the different cultivated species are discussed and the importance of the role played by man in their distribution is emphasised. The two tetraploid species *S. andigenum* and *S. tuberosum* (*s. str.*) are considered to have had a common origin in Peru--Bolivia and were not formed each from distinct wild species as the Russian investigators have suggested. The final portion of this section deals with the various theories for the origin of the European potato.

Evidence is presented from historical, geographical, morphological and photoperiodic points of view to show that the first introductions of potatoes came from the Andes, most probably Colombia, and not, as has so often been supposed, from Chile.

The first two Appendices to this paper (pp. 112-133, not reproduced here) give the latin descriptions and complete list with chromosome numbers, respectively, of the new species and varieties. The third Appendix (pp. 134-140, not reproduced here) gives a complete list of identifications of the Empire Potato Collection.

1. INTRODUCTION

The potato collecting expeditions in Mexico and South America, sent out by the Imperial Agricultural Bureaux, represent perhaps the first attempt within the British Empire to make a thoroughly scientific and exhaustive collection of indigenous plant material for the initiation of a large-scale breeding programme. Unlike expeditions sent out by other countries in the past, the energies of the collectors were directed wholly towards the problem of potatoes, since no attempt was made to collect samples of food plants in general. This concentration of efforts enabled a very large and detailed collection of over 1,000 specimens to be made. Samples were obtained from the whole length of the Andes mountains, not only in the more populous and easily accessible regions, but also in the wildest places far from human habitation, where no expeditions had collected previously.

At the close of the expeditions in September 1939 the intervention of the second world war rendered the subsequent work with the collections much longer than would have been the case under peace-time conditions. The fundamental work of description and classification has only now been completed and forms the basis of the present Bulletin. The task of carrying out tests for the various qualities of disease resistance and physiological adaptation to a wider habitat range than has hitherto been possible in our domestic varieties has only recently been initiated. The judicious use of promising material for breeding new types in which all the desired qualities are incorporated is almost entirely a matter for the future.

The present work, therefore, represents the results of nearly three years' study of the taxonomy and systematic classification of the Empire Potato Collection, using as a basis chiefly geographical, morphological and cytological criteria. In the U.S.S.R., Vavilov's complex taxonomic method was applied with signal success in elucidating the systematic relationships of the potatoes collected by the Russian expeditions. Use was made, not only of the three criteria mentioned above but also of genetical, biochemical and physiological data. For reasons already mentioned, it was not possible to employ all these methods in the present study, nevertheless the author ventures to believe that it is fairly complete in its essentials and will not need substantial alteration when the results of the tests for disease and frost resistance and for protein and vitamin-C content become available.

In order to clarify the subject of potato taxonomy, rather more than was necessary for a bare catalogue of the species encountered by the collectors has been included in the present work. There is indubitably a great need for a comprehensive treatise on potato taxonomy, especially on the problem of the wild species, which are described in scores of different periodicals in nearly every European language; moreover these publications are often inaccessible to both plant breeder and botanist. The present Bulletin cannot attempt to present a monographic treatment of the subject, since it would be rendered too cumbersome thereby.

An outline of our present knowledge on the phylogeny and systematic relationships of wild and cultivated potatoes has, however, been embodied, and this will be found chiefly in sections 2, 3, 5 and 6, though a great deal has also been incorporated in section 4. In certain places in this latter section species are described and named from herbarium specimens only. In these cases the descriptions are given in small print, only those of which we have living material being featured in normal-sized type. The legitimacy of including descriptions of dried specimens in a bulletin written primarily for potato breeders may be seriously questioned. It was felt, however, that this was perfectly justifiable, since breeders could tell at a glance by the size of the type whether any particular species was likely to be of practical importance for them. Furthermore, these descriptions were included in order that a complete and scientific account of the entire collection might be given in one publication; this would form a record for the use of future collectors who could benefit by the information on the localities of the different species given in the present work, and bring living specimens back to Europe at a later date.

In the Appendix (p. 134 of the original publication) a list is given of the entire Empire Potato Collection, showing at a glance the species determination and whether the sample is available for distribution. The page number enables one to refer back to the main part of the work for more detailed information on the sample in question.

My thanks are due in the first place to Dr. P.S. Hudson for constant advice and criticism during the whole course of this work and for making translations of all the relevant Russian studies on South American potatoes. I also wish to record here my thanks to Dr. R.N. Salaman for advice, especially on the question of the origin and history of the potato; to Mr. N. Sandwith of Kew and Mr. H. Gilbert Carter of Cambridge for advice on systematics and taxonomy and to Mr. R.A. Blakelock of Kew for making Latin translations of my descriptions of *S. colombianum* var. *meridionale*, *S. Vargasii*, and *S. violaceimarmoratum* var. *papillosum*, also for correcting the other Latin descriptions translated by Dr. A. Koppel, whom I also have to thank for German, French and Latin translations, for making most of the cytological preparations and many of the chromosome counts. I also wish to thank Mr. C.M. Driver for his kind permission to mention certain of his unpublished results.

My thanks are also due to the Institute of Plant Industry, Leningrad, and especially to Prof. N.I. Vavilov, Dr. S.M. Bukasov, Dr. S.V. Juzepczuk and Dr. V. Lechnovicz, who gave me such valuable and unstinted advice on their systematic methods as applied to the potato on my visit to the U.S.S.R. in 1938; also to the authorities of the Kew, British Museum and Cambridge Herbaria for permission to examine their type specimens and to the following foreign Herbaria for sending photographs: Geneva; Smithsonian Institute, Washington; Field Museum, Chicago. From the latter source and through the kind agency of Mr. E.K. Balls it was possible to obtain a number of photographs made before the outbreak of hostilities of the type specimens in the continental Herbaria. My thanks are also due to Messrs. George Philip and Son for permission to reproduce the two outline maps.

2. HISTORY OF POTATO TAXONOMY

The early history of the potato and of its introduction into Europe from the American continent has for the last hundred years been the subject of constant enquiry and interest.

Our knowledge of the original point from whence the potato was first brought to Europe, by whom it was brought and in what year, rests almost entirely on circumstantial evidence, since we have little documentary proof to establish these points conclusively.

Towards the middle of the 16th century, when the conquest of Peru had already been achieved, expeditions were being forced from the Caribbean coast through the region that is now known as Colombia. Until quite recently the credit for being the first European to see and describe the potato went to Pedro Cieza de León, a private soldier on one of these expeditions into the unexplored hinterland. In his *Crónica del Peru*, published in 1550, Cieza describes in the district of Quito "Of provisions, besides maize, there are two other products which form the principal food of these Indians. One is called potato, and is a kind of earth nut, which after it has been boiled, is as tender as a cooked chestnut, but it has no more skin than a truffle, and it grows under the earth in the same way. This plant produces a plant exactly like a poppy. The other food is very good and is called quinoa".

Salaman (1937) has found an even earlier reference to the potato in an account written by Castellanos which remained unpublished until 1886 and was consequently overlooked. Castellanos was also an ordinary soldier, in an expedition led by Gonzalo Jimenez de Quesada in the Magdalena valley of Colombia. He tells how, in the year 1537 they saw a kind of truffle in native huts near the village of Sorocota. These were of course potatoes, which he describes as "Floury roots of good flavour, a gift very acceptable to Indians and a dainty dish even for Spaniards".

These two accounts, written as they were by untutored soldiers, although accurate enough so far as they went, were obviously not intended as anything in the nature of botanical descriptions. It is not until the potato had been introduced into Europe that we find the first of these, written by Caspar Bauhin in his *Phytopanax*, published in 1596. In this work he gives it the name *Solanum tuberosum* which was retained by Linnaeus in his *Species Plantarum* and is the name by which we know it today. Later, in 1620, Bauhin again described it in his *Prodromus*, this time adding a woodcut, but giving it the trinomial *Solanum tuberosum esculentum*. It is extremely likely that Bauhin obtained his tubers from a supply that the celebrated botanist Clusius had obtained from Philippe de Sivry in 1588. De Sivry was given tubers by a friend of the Papal Legate in Belgium who had probably obtained them from Italy where, Clusius (1601) tells us, the potato was commonly grown at that time. There is no doubt that they came originally from Spain in the first place since, as Salaman (l.c.) has shown, potatoes were grown in that country as early as 1573 or even 1570. They had probably been brought over from America as ships' stores, since, so far as is known, they were not considered of sufficient importance for the exact date of their introduction to be recorded.

From Spain, as we have seen, they spread to Italy, Belgium and Germany. Clusius, who did much to distribute and popularize the potato in Germany, describes and figures it in his *Rariorum Plantarum Historia* published in 1601, whilst Gerard also describes it in his *Herball* of 1597. Gerard's plant is, however, not the same variety of *Solanum tuberosum* as that described by the continental botanists, since the tubers are of a light brown colour, whilst those figured by Clusius are distinctly reddish. Other evidence also inclines us to believe that Gerard's potato was obtained from quite a different source as he states that it was obtained from Virginia. Whilst, of course, this is quite incorrect since the cultivated potato is not native to North America, it does serve to show that there were two distinct introductions of the potato into Europe in the latter half of the 16th century.

Drake brought Raleigh's settlers back from Virginia in 1586 amongst whom was the scientist Heriot who had made a collection of indigenous plants from that country and no doubt showed them to Gerard. It is very probable that Drake, who had been pillaging on the north coast (New Granada) of South America prior to returning with the Raleigh settlers, obtained potatoes as stores or loot and that these were confused with the plants brought from Virginia by Heriot. The evidence for this is set out very fully by Mitchell (1886), Roze (1898), Wittmack (1909) and Salaman (1937) and need not be given in detail here. So much for the early accounts of the cultivated potato *Solanum tuberosum* sensu latiore. In another section of the present work (p. 108) I shall deal with the problem of from where the first introductions were made and whether they should be classified as *Solanum andigenum* or *S. tuberosum* sensu strictu.

Now let us turn to the wild potato. Apparently no mention of wild potatoes was made in the early literature, and for over two centuries after the introduction of the cultivated type wild potato species were either not observed or were considered unworthy of mention as mere "escapes" from cultivation. Indeed, the native name "Papa cimarrona", which is given to wild potatoes of many species at the present day, implies this very thing. Probably the first mention is that of Molina who, in his *Historia Natural de Chile* published in 1786, described a wild potato known to the Indians as *maglia*. He also mentions the cultivated potato, known to the natives as *pogny* and considers Chile to be the source from which all cultivated potatoes were derived.

The first half of the 19th century witnessed a great increase of interest in wild potatoes, chiefly because it was thought that they might throw light on the origin of the cultivated species, and later that they might be used to breed varieties able to withstand the "potato disease" (*Phytophthora infestans*). Collections of wild potatoes were made by the early scientific travellers such as Humboldt, Bonpland and Commerson, and brought back to Europe to be described and classified. Even so, in those days it was rather fashionable for lay persons to insist that all the so-called wild species were mere varieties of our cultivated types, generally without having made any study of the specimens in question. On the other hand, the accompanying table (Table 1) shows that quite a large number of wild species had been described by the end of the 19th century. The great majority of these were from easily accessible coastal districts or from Mexico and the United States.

Walpers' *Repertorium*, published in 1844, mentions about 10 tuberiferous *Solanum* species, whilst Dunal (de Candolle's *Prodromus*, 1852) lists 17 species excluding the non-tuberiferous *Juglandifolia*.

Despite these advances it was customary as late as 1911 for authors to consider all or most wild potatoes to be sub-species or even varieties of *S. tuberosum*. Thus we find Baker (1884, 1886) recognizing only 6 species although almost 30 had been described at that time. Wittmack (1909) even goes so far as to assert that only four species existed, inclusive of *S. tuberosum*, though he modified his views to some extent later (1914).

It was Bitter (1911-13) who by his thorough and painstaking researches confirmed the descriptions of many obscurely mentioned and little known species. Furthermore, he demonstrated that a wealth of dried material was already lying in the European herbaria awaiting study and description and himself described over 52 new species from the above mentioned sources. After Bitter, few species were described until Rydberg in 1924, in his monograph on the potatoes of Mexico and Central America, defined about a dozen more.

Juzepczuk and Bukasov during the years from 1929 to the present day have enriched the literature by describing over 30 wild species (see Juzepczuk 1937; Juzepczuk and Bukasov 1936; Bukasov 1930, 1936, 1937a, 1940a, 1940b; Bukasov and Lechnovitz 1935), whilst in the present Bulletin 31 new wild species are described.

With the cultivated potato the tendency to include everything under *S. tuberosum* was even more marked. This was due primarily to the fact that the botanists and collectors of the last century were comparatively uninterested in cultivated plants, whilst before this time very few scientific explorers were allowed to penetrate into the interior of the South American continent. In consequence, the wealth of specific variation amongst cultivated potatoes was completely unrealized, especially since the need for studying living material is even more apparent than it is for the wild species, and the only specimens of cultivated species sent to Europe seem to have been dried herbarium material.

TABLE 1: DESCRIPTIONS OF WILD POTATO SPECIES (UP TO THE YEAR 1900)

- 1816 *S. Valenzuelae* Pal. (Mem. du Mus. Paris, 2, 350.)
 1816 *S. Commersonii* Dun. (Synopsis, 6.)
 1816 *S. bulbocastanum* Dun. (Synopsis, 8.)
 1816 *S. ochranthum* Dun. (Synopsis, 5.)
 1816 *S. juglandifolium* Dun. (Synopsis, 5.)
 1828 *S. Jamesii* Torr. (Ann. Lyc. Nat. Hist., N.Y., 2, 227.)
 1833 *S. stoloniferum* Schlechtd. et Bouche. (Verh. Vereinz Beford. Gartenb. preuss. Staat, 9, 317.)
 1835 *S. etuberosum* Lindl. (Bot. Reg., 20, t 1712.)
 1839 *S. verrucosum* Schlechtd. (Index sem. hort. Hal.)
 1841 *S. Maglia* Schlechtd. (Hort. Hal., 1, 6.)
 1841 *S. oxycarpum* Schiede. (Schlechtd., Hort. Hal, 1.)
 [before 1844?] *S. palustre* Poepp. (pl. esicc. Chil, 1, 73.)
 1848 *S. cardiophyllum* Lindl. (J. Hortic. Soc., 3, 70*)
 1848 *S. demissum* Lindl. (J. Hortic. Soc., 3, 70.)
 1852 *S. immite* Dun. (DC. Prodr., 13, 1, 32.)
 1852 *S. colombianum* Dun. (I.c. 33.)
 1852 *S. collinum* Dun. (I.c. 36.)
 1852 *S. Lycopersicoides* Dun. (I.c. 38.)
 1852 *S. otites* Dun. (I.c. 39.)
 1852 *S. pinnatisectum* Dun. (I.c. 40.)
 1852 *S. boliviense* Dun. (I.c. 43.)
 1856 *S. Fendleri* A. Gray. (Amer. J. Sci., 2, 22.)
 1858 *S. fernandezianum* Phil. (Linnaea, 29, 23.)
 1858 *S. Bustilosii* Phil. (Linnaea, 29, 24.)
 1873 *S. brevidens* Phil. (Anal. Univ. Chile, Santiago, 43, 521.)
 1884 *S. Ohrononii* Carr. (Rev. Hortic., 497.)
 1884 *S. Andreanum* Baker. (J. Linn. Soc., 20, 498.)
 1893 *S. subandinum* Meigen. (Engl. Jahrb., 17, 271, 293)
 1891 *S. infundibuliforme* Phil. (Anal. Mus. Nac. Chile, 65.)
 1893 *S. Pearcei* Phil. (Anal. Univ. Chil., 91, 5.)

One ought perhaps to record, however, that the concept of cultivated species or varieties other than the hitherto known *S. tuberosum* was realized to some extent by Sabine as early as 1824.

He says: "With the potatoes cultivated in South America at the present time we are very little acquainted; there is one especially which has been heard of, but which has not yet reached us, known at Lima as the Yellow or Golden Potatoe, and which is reported to be far superior in flavour to any now grown in Europe". This potato was actually brought to England in 1846 and grown in the garden of the Horticultural Society (see Lindley 1848). In the Cambridge Botany School herbarium there is a dried specimen of it with the inscription "Golden potato Peru. H.H.S. 1847". There is also a note by Baker on the sheet to the effect that "This is typical *S. tuberosum* L., the old long cultivated type to which belongs the specimens of Sloane, Miller etc". We know now that the Golden Potato or Papa amarilla of Peru belongs to the species *S. goniocalyx* and the herbarium specimen that I have just mentioned agrees very well with this species. That Baker considered the specimen to be *S. tuberosum* is not very surprising, however, since it would have been impossible to arrive at a conception of the specific diversity of cultivated potatoes without a large amount of living material at hand and without some knowledge of their polyploid nature.

In general, however, the quest for the wild ancestor of the cultivated potato entirely obscured the fact that the cultivated potato itself in South America showed an immense amount of variation of paramount importance to plant breeders. The Russian scientists were the first to realise this to the full. In 1925 and subsequent years three expeditions with the express purpose of collecting cultivated plants were sent to Mexico and South America, as a result of which some 18 new cultivated potato species were catalogued and described from living material (see Juzepczuk and Bukasov 1929; Bukasov 1930, 1933, 1934, 1937b). So important were the practical implications of these expeditions that others were sent out in their wake by the governments of Sweden, Germany and the United States respectively. None of these latter excursions, however, collected any new species, either cultivated or wild. In 1938-9 the British Empire Potato Collecting Expedition, profiting by the experience of the Russian collectors, sent back material in scope and quantity commensurate with that of the three Soviet excursions a decade before and from which five new cultivated species have been described, besides the 31 wild species already mentioned.

At the present time, therefore, some 20 cultivated and 150 wild species of potato have been described. Even so, it is probable that so far as the wild species are concerned, the wealth of variation lies practically untouched. Indeed it is possible that three to four times the quantity of species that we know now has yet to be discovered and described, from material growing in the more isolated and inaccessible regions of the South American Andes.

3. CLASSIFICATION AND PHYLOGENETIC POSITION OF POTATO SPECIES

The genus *Solanum* L., to which both wild and cultivated potatoes belong, is extremely large, containing about 2,000 species according to the latest supplement of the Index Kewensis. Most are herbs and small shrubs, often clothed with batteries of spines and thorns; and in fact only about 150 species in this vast genus are tuber-bearing.

Dunal (de Candolle 1852), who wrote the first important systematic works on the genus, divided it into two sections, *Pachystemonum* and *Leptostemonum*. The former section included plants with short thick anthers and no thorns whilst the latter contained species with long narrow anthers and stems and leaves generally provided with thorns or spines.

The genus *Lycopersicon*, although included in *Solanum* by Linnaeus and other authors, has generally been regarded as distinct, chiefly by virtue of its elongated anthers which dehisce along their whole length and whose narrow apical portions are quite sterile.

Section *Pachystemonum*, in which all the tuberiferous members of the genus are included, is characterized, as we mentioned above, by the short thick stamens whose pollen sacs open at the apex by a large pore which becomes frequently elongated into a lateral fissure. Dunal further divided this section into five subsections, namely:

1. *Tuberarium*, which includes the tuber-bearing species and is distinguished by a jointed or articulated pedicel and generally imparipinnate leaves;
2. *Morella*, which includes *S. nigrum*, the Black Nightshade, with simple leaves and small white corolla;
3. *Dulcamara*, with simple leaves, white or purple flowers and round or oval berries. Here belongs *S. dulcamara*, the Woody Nightshade;
4. *Micranthes*, embracing shrubs and undershrubs with entire glabrous, pilose or hispid leaves;
5. *Lycianthes*, with one-flowered pedicels which are axillary or sub-opposite to the leaves, and often 10-toothed calyx. The latter subsection was elevated to generic rank by Hassler (1917) but as only about 70 species were involved the genus *Solanum* remained practically as large as before.

Bitter (1911-13), who made perhaps the most extensive contribution to our knowledge of the Genus *Solanum*, elevated the sections *Pachystemonum* and *Leptostemonum* to the rank of subgenera, the subsections (including *Tuberarium*) being then considered as sections. He furthermore described several new sections, though none of them contained tuberiferous species.

Dunal had previously divided *Tuberarium* into two groups, *Potatoe* and *Pterophyllum*; the first contained species with interruptedly imparipinnate leaves, whilst the second included species with uninterruptedly imparipinnate or simple leaves. That this division was extremely artificial was pointed out by Bitter, since many very obviously closely related species were widely separated by it, whilst others of diverse affinities were placed in close juxtaposition. Furthermore, with some species the presence or absence of interjected leaflets may depend to a large extent upon environmental conditions. Bitter preferred to use the position of the pedicel articulation as a criterion of greater systematic value in separating two subsections of *Tuberarium*. Those species with the articulation situated at the very base of the pedicel and possessing characteristic two-celled "bayonet-hairs" he grouped as subsection *Basarthrum*. None of these have ever been known to bear tubers nor are they at all closely related to the tuberiferous species. The second subsection, named by Bitter *Hyperbasarthrum*, possesses a pedicel articulation situated at least some distance above the base. This articulation may be very low down in certain species though never right at the pedicel base as in *Basarthrum*, and it is most frequently situated near the centre or even higher up, just below the calyx.

Bitter further recognized several series of nearly related species within *Hyperbasarthrum*, such as *Conicibaccata* with long conical berries and others with stellate corollas to which he does not give a name. He also recognized that there was a group of nearly related species quite close to *S. Maglia* sp. coll.

Rydberg (1924), in a study of the section *Tuberarium* of Mexico and Central America elaborated Bitter's scheme by dividing *Hyperbasarthrum* into five groups or series. Juzepczuk and Bukasov (1929), after considering the problem of South American species in addition to those from Mexico and Central America, considered it necessary to add two more series from species confined to South America.

Several new series were differentiated by Bukasov since then, and in 1939 he distinguished some twelve distinct series within subsection *Hyperbasarthrum*. Finally, in the present work one new series is proposed. A key to these appears below.

The complexity of the section *Tuberarium* renders the task of compiling dichotomous keys to aid in the identification of species extremely difficult. Bitter, indeed, never attempted the task and Berthault's (1911) key to 25 species is completely out of date since about 150 have been described at the present time.

Although the key compiled by Rydberg for the Mexican and Central American species was complete for those described up to 1925 he does not, of course deal with the South American species. Lechnovicz' key to the wild species (Bukasov 1937b), based on observations of the living plant, is necessarily limited since many species were described and have only been studied in the form of dried herbarium specimens.

Thus we have no complete up to date key for this difficult genus, since a monographic treatment has not yet been attempted and the inaccessibility of the type specimens, most of which are deposited in European herbaria, renders it impossible for one to be attempted in the present work. The study has therefore been mainly confined to the specimens collected by E.K. Balls, W.B. Gourlay and the author in America and to specimens sent to us later, though even this work has been hampered by the difficulty in examining type specimens or in obtaining photographic copies of them.

It has been thought worth while, however, to compile a dichotomous key to the different series within subsection *Hyperbasarthrum*. This key possesses the usual weaknesses of "artificial" keys and depends for its working on an abundance of material, and on some previous botanical knowledge. It is only possible to use it with speed and accuracy on living material but with some practice herbarium material can also be assigned to the appropriate series.

KEY TO THE SERIES WITHIN SUBSECTION *HYPERBASARTHURUM*

A. Plant shrubby; flowers generally yellow; inflorescence pushed to one side by a branch from the axil of the last leaf; plant not tuberiferous (S. America):

I. *Juglandifolia* Rydb. (p. 12*).

A. Stem herbaceous; flowers not yellow, inflorescence pushed to one side by a branch from the axil of the penultimate leaf; generally tuberiferous.

B. Fruit elongated-ovoid or subconical, acute at the apex; stems fistulose; plants may or may not bear tubers: II. *Conicibaccata* Bitt. (p. 12*) (= *Oxycarpa* Rydb.).

B. Fruit globose or ellipsoidal, rounded at the apex.

C. Plants never producing tubers or stolons, pedicel articulation very near the base (S. America): III. *Etuberosa* Juz. (p. 15*).

C. Plants with stolons and tubers (when grown under appropriate photoperiod); pedicel articulation above the base.

D. Corolla stellate, its lobes longer than broad.

E. Leaves simple; flowers small, white (Mexico): IV. *Bulbocastana* Rydb. (p. 16*).

E. Leaves imparipinnate.

F. Leaves dark green, glabrescent, shining in the living state; leaflets 2-3-jugate; flowers buff or cream coloured (Mexico): V. *Cardiophylla* Buk. (p. 16*).

F. Leaves not as stated above; flowers white, cream or mauve.

G. Leaflets generally rather narrow, + 3 times as long as broad; flowers white (Mexico and Central America): VI. *Pinnatisecta* Rydb. (p. 17*).

G. Leaflets generally broader, not more than twice as long as broad (S. America): VII. *Commersoniana* Buk. (p. 17*).

D. Corolla rotate or pentagonal, its lobes broader than long.

H. Corolla rotate, with very short lobes and small acumens so that it seems almost 10-fid; often growing as rosette forms.

I. Articulation of pedicel obsolete (S. America): VIII. *Acaulia* Juz. et Buk. (p. 21*).

I Articulation of pedicel quite clearly marked (Mexico): IX. *Demissa* Buk. (p. 23*).

H. Corolla lobes not particularly short or the acumens small.

J. Pedicels rather long; corolla completely circular in outline, with the large acumens standing out sharply (Mexico): X. *Longipedicellata* Buk. (p. 31*).

J. Pedicels not very long; corolla not as described above.

I. Leaves with wedge-shaped wings on the rachis running down from the leaflet bases; plants small, never more than 30 cm. tall (S. America): XI. *Cuneoalata* Hawkes (p. 35*).

I. Wings on the leaf rachis absent, or if present, not wedge-shaped.

L. Plant very densely covered with a glandular pubescence, with an unpleasant odour (N. America): XII. *Polyadenia* Buk. (p. 37*).

L. Plant not densely glandular (or if endowed with manifestly visible glands, coming from S. America): XIII. *Tuberosa* Rydb. (p. 37*).

*) See pages in original publication.

The relationships of the different series, one to the other, can only be surmised in certain cases, and although many are obviously closely related to *Tuberosa*, others are probably quite distinct. Thus, for example, *Juglandifolia* is not at all closely related to the other series and although possessing a pedicel articulation situated above the base may have developed this feature independently, as has been the case with the genus *Lycopersicon*. There is little doubt that the basally articulated pedicel is more primitive than one in which the articulation is situated some distance above the base; and we should therefore expect the *Etuberosa*, with very low, semi-basal articulation, to be a primitive series also, more related to the other subsection *Basarthrum*. This view is held by Juzepczuk (1937) who regards the absence of tuberization in *Etuberosa* as a primitive and not a degenerative feature.

Another line of evolution has probably been the replacement of a stellate by a rotate corolla in which the petals are less sharply delimited from each other and are more or less fused together by an interpetalar membrane. Species with stellate corollas are found in Mexico in the nearly related series *Pinnatisecta*, *Cardiophylla* and *Bulbocastana*, whilst they are also to be found in South America in *Commersoniana*. This latter series is, however, not closely related to the Mexican series with stellate corollas although it may form a link between the stellate and rotate corolla types. In North Argentina, for example, there are several species which, although grouped in *Tuberosa* (e.g. *S. oplocense* Hawkes), form a link between this latter series and *Commersoniana*. A point worthy of notice, however, is that the supposedly primitive *Etuberosa* possesses rotate corollas, so that this feature must either have been developed independently in several different series or the phylogeny of the groups is to some extent reticulate. It is quite possible that this latter supposition may be correct, since interspecific crosses are possible throughout the subsection at the present day.

Series *Conicibaccata*, in the opinion of the present author, is probably quite advanced, having been derived from a portion of the *Tuberosa* by the development of conical berries and certain other features. The rotate corolla and high pedicel articulation are both advanced features, though the poor tuberization indicates that this series must have been differentiated at very early times.

Juzepczuk (1937) considers *Acaulia* to be the most recently formed series, since the pedicel articulation, besides being situated very high up, is almost obsolete, and the corolla lobes are very much fused together. The leaf type and pronounced frost resistance also render this series rather unique. The latter feature and the corolla form are also to be found in *Demissa* which is probably also quite recently formed. Both series are related to *Tuberosa*.

By far the largest number of wild species and all the cultivated ones belong to series *Tuberosa*. This series may have been originally derived from *Commersoniana* in the South Bolivia-North Argentina region and contains a varied assemblage of species about some of which we do not possess sufficient knowledge to separate them into distinct groups.

Longipedicellata and *Polyadenia* have probably originated fairly recently from *Tuberosa*, and it is probable that other groups of species may, at a later date, be separated into new series.

The origin of *Cuneoalata* is obscure, but it is possible that it may bear some relationship to *Commersoniana*. At any rate it differs enormously from *Tuberosa*. It is evident, therefore, from this brief survey that the phylogenetic relationships of the different series in *Hyperbasarthrum*, although well known in certain cases, are not in general, very clear. No doubt the gaps in our knowledge will be filled in to some extent when further species are made known from the results of future expeditions, especially in those regions where the greatest abundance of forms and species are to be found.

The wild species described and recorded in the next section of the present work are obtained from various parts of South America and Mexico. In order to clarify their position in relation to the other wild potato species I have thought it worth while to insert here a map showing all the recorded localities of wild potatoes so far as they are known, indicating on the accompanying list which of these were collected by the Empire Expedition or are available in our collection. Maps showing the distribution of the cultivated species are to be found facing pages 98 and 99 in the section on cytology since I have dealt with their distribution when considering the results of the chromosome counts. Certain of the data for the list below have been obtained from Dr. S.M. Bukasov (1937b). I have, however, added not only the results of the present work but also those of Bukasov's later descriptions so far as they are available in this country.

Those species collected by the expedition are printed in italic type. Those added to the Empire Potato Collection from other sources are, in addition, marked with an asterisk (*).

- | | |
|---|--|
| 1 <i>S. Abbottianum</i> Juz. | 25 <i>S. calcense</i> Hawkes. |
| 2 <i>S. acaule</i> Bitt. | 26 <i>S. calvescens</i> Bitt. |
| 3 <i>S. acroglossum</i> Juz. | 27 <i>S. Candolleanum</i> P. Berth. |
| 4 <i>S. acroleucum</i> Bitt. | 28 <i>S. cardiophyllum</i> Lindl. |
| 5 <i>S. aemulans</i> Bitt. et Wittm. | 29 <i>S. catarthrum</i> Juz. |
| 6 <i>S. agrimonifolium</i> Rydb. | 30 <i>S. Cayeuxi</i> P. Berth. |
| 7 * <i>S. ajuscoense</i> Buk. | 31 <i>S. chacoense</i> Bitt. |
| 8 <i>S. alticolum</i> Bitt. | 32 <i>S. chiloense</i> D.C. |
| 9 <i>S. Andreanum</i> Baker. | 33 <i>S. chomatophilum</i> Bitt. |
| 10 <i>S. anomalocalyx</i> Hawkes. | 34 <i>S. circaeifolium</i> Bitt. |
| 11 <i>S. Antipoviczii</i> Buk. | 35 <i>S. collinum</i> Dun. |
| 12 <i>S. aracc-papa</i> Juz. | 36 <i>S. colombianum</i> Dun. |
| 13 <i>S. Ballsii</i> Hawkes. | 37 * <i>S. Commersonii</i> Dun. |
| 14 <i>S. Berthaultii</i> Hawkes. | 38 <i>S. demissum</i> Lindl. |
| 15 <i>S. bijugum</i> Bitt. | 39 <i>S. depexum</i> Juz. |
| 16 <i>S. Boegeri</i> Buk. | 40 <i>S. dolichocarpum</i> Bitt. |
| 17 <i>S. boliviense</i> Dun. | 41 <i>S. dolichocremastrum</i> Bitt. |
| 18 <i>S. brachistotrichum</i> (Bitt.) Rydb. | 42 * <i>S. edinense</i> P. Berth. |
| 19 <i>S. brevimucronatum</i> Hawkes. | 43 <i>S. Ehrenbergii</i> (Bitt.) Rydb. |
| 20 <i>S. brevicaule</i> Bitt. | 44 <i>S. Emmeae</i> Juz. |
| 21 <i>S. brevidens</i> Phil. | 45 <i>S. Ervendbergii</i> Rydb. |
| 22 <i>S. Bukasovii</i> Juz. | 46 <i>S. etuberosum</i> Lindl. |
| 23 <i>S. bulbocastanum</i> Dun. | 47 <i>S. famatinae</i> Bitt. et Wittm. |
| 24 <i>S. Bustilosii</i> Phil. | 48 * <i>S. Fendleri</i> A. Gray. |

- 49 *S. fernandezianum* Phil.
 50 *S. Flahaultii* Bitt.
 51 *S. Fonckii* Phil.
 52 *S. fragariaefructum* Hawkes.
 53 **S. Garciae* Juz. et Buk.
 54 **S. gibberulosum* Juz.
 55 *S. glanduliferum* Hawkes.
 56 *S. Gourlayi* Hawkes.
 57 *S. gracilifrons* Bitt.
 58 *S. Henryi* Buk. et Lechn.
 59 *S. Herrerae* Juz.
 60 *S. Horovitaii* Buk.
 61 *S. hypacrarthrum* Bitt.
 62 *S. immite* Dun.
 63 *S. infundibuliforme* Phil.
 64 **S. Jamesii* Torr.
 65 *S. juglandifolium* Dun.
 66 *S. jujuyense* Hawkes.
 67 *S. Knappei* Juz et Buk.
 68 *S. Kurtzianum* Bitt. et Wittm.
 69 *S. lanciforme* Rydb.
 70 *S. lapuzense* Hawkes.
 71 *S. laplaticum* Buk.
 72 *S. laxissimum* Bitt.
 73 *S. Lechnoviczii* Hawkes.
 74 *S. leptophyes* Bitt.
 75 **S. leptostigma* Juz.
 76 *S. Lobbianum* Bitt.
 77 *S. longiconicum* Bitt.
 78 *S. longipedicellatum* Bitt.
 79 *S. Looseri* Juz.
 80 *S. lycopersicoides* Dun.
 81 **S. Macolae* Buk.
 82 **S. Maglia* Schlechtd.
 83 *S. malinchense* Hawkes.
 84 *S. malmeanum* Bitt.
 85 *S. manoteranthum* Bitt.
 86 *S. Mathewsii* Bitt.
 87 **S. mechonguense* Buk.
 88 *S. medians* Bitt.
 89 *S. megistacrolobum* Bitt.
 90 *S. mercedense* Buk.
 91 *S. michoacanum* Rydb.
 92 *S. microdontum* Bitt.
 93 *S. microphyllum* Hawkes.
 94 *S. Millanii* Buk. et Lechn.
 95 *S. Molinae* Juz.
 96 *S. morelliforme* Bitt. et Muench.
 97 *S. Muelleri* Bitt.
 98 *S. multidissectum* Hawkes.
 99 *S. multiinterruptum* Bitt.
 100 *S. nayaritense* (Bitt.) Rydb.
 101 *S. nicaraguense* Rydb.
 102 *S. ochranthum* Dun.
 103 *S. Ohrononii* Carriere.
 104 *S. oplocense* Hawkes.
 105 *S. otites* Dun.
 106 *S. oxycarpum* Schiede.
 107 *S. pachytrichum* Hawkes.
 108 *S. palustre* Poepp.
 109 *S. pampasense* Hawkes.
 110 *S. papita* Rydb.
 111 *S. Parodii* Juz. et Buk.
 112 *S. paucijugum* Bitt.
 113 *S. Pearcei* Phil.
 114 *S. pichinchense* Bitt. et Sod.
 116 *S. pinnatisectum* Dun.
 116 *S. piurae* Bitt.
 117 *S. platypterum* Hawkes.
 118 *S. polyadenium* Greenm.
 119 *S. polytrichon* Rydb.
 120 *S. pumilum* Hawkes.
 121 *S. punoense* Hawkes.
 122 *S. Salamanii* Hawkes.
 123 *S. saltense* Hawkes.
 124 *S. sambucinum* Rydb.
 125 *S. semidemissum* Juz.
 126 *S. Schenckii* Bitt.
 127 *S. Schickii* Juz. et Buk.
 128 *S. schizostigma* Bitt.
 129 *S. setulosistylum* Bitt.
 130 *S. simplicifolium* Bitt.
 131 *S. Solisii* Hawkes.
 132 *S. sorianum* Buk.
 133 *S. Soukupii* Hawkes.
 134 *S. sparsipilum* (Bitt.) Juz. et Buk.
 135 *S. Spegazzinii* Bitt.
 136 *S. stenophyllidium* Bitt.
 137 *S. stoloniferum* Schldt. et Bouche.
 138 *S. subandigenum* Hawkes.
 139 *S. subandinum* Meigen.
 140 *S. subtilius* Bitt.
 141 *S. sucrense* Hawkes.
 142 *S. tarijense* Hawkes.
 143 *S. tilcarense* Hawkes.
 144 *S. tlaxcalense* Hawkes.
 145 *S. Valenzuelae* Pal.
 146 *S. vallis-mexicae* Juz.
 147 *S. Vargasii* Hawkes.
 148 *S. Vavilovii* Juz. et Buk.

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|--|---------------------------------|
| 149 <i>S. velascanum</i> Bitt. et Wittm. | 153 <i>S. Weberbaueri</i> Bitt. |
| 150 <i>S. Vernei</i> Bitt. et Wittm. | 154 <i>S. Wightianum</i> Rydb. |
| 151 * <i>S. verrucosum</i> Schlechtd. | 155 <i>S. Wittmackii</i> Bitt. |
| 152 <i>S. violaceimarmoratum</i> Bitt. | |

4. TAXONOMY OF THE SPECIMENS COLLECTED BY THE BRITISH EMPIRE EXPEDITION

(pp. 12-96 in original publication)

5. CYTOLOGICAL INVESTIGATION OF THE COLLECTIONS

(pp. 96-101 in original publication)

6. ORIGIN AND EVOLUTION OF CULTIVATED POTATOES

(1) ORIGIN OF POTATO CULTIVATION

The problem of the wild ancestors of the European domestic potato has been a subject of speculation for several centuries. A food plant which had taken such an essential place in the dietary of nearly all European nations, and which had been introduced in quite recent historical times, could not fail to elicit a large amount of curiosity as to its origin.

Although it was known that this plant had been brought from the New World, it was imperfectly realized that it had been in a cultivated state long before it came to Europe. If certain people did realize this fact they still believed that wild potatoes similar in every respect to the cultivated ones were of frequent occurrence and could be easily collected. The earliest species to be collected and brought over to Europe were the triploids *S. Maglia* and *S. Commersonii* and the hexaploid *S. demissum*. These species were severally thought to be the original wild potato. Even though they had no knowledge of the difference in chromosome number between these species and the tetraploid domestic potato, the nineteenth-century botanists made a fundamental mistake in comparing it with those recently introduced ornamental and medicinal plants which could still be found growing wild in their original habitats. It is now realized that food plants such as the cereals and many root crops, which have been cultivated for a period as long as the history of agriculture itself, have no wild ancestors similar in every respect to the cultivated plant living at the present time.

The potato is no exception to this rule, since we know from the reports of the early Spanish chroniclers that it was widely grown in the Andes and in south Chile before the advent of the conquistadores. Stores of dried preserved potatoes (chuño) have been discovered in ancient tombs and ruined cities in Peru, showing that potatoes were probably a staple article of diet several centuries before the Spanish conquest; furthermore, the potato is represented on the ceramics of some of the most ancient Peruvian cultures, probably dating back to the second century of the Christian era. It seems probable, therefore, that the potato, at any rate in the high Andes where no other crop can survive the cold bleak conditions, was taken into cultivation when agriculture first began to be practised in these regions.

Having given a very brief outline of the evidence for the antiquity of potato cultivation we can now go on to consider the regions in which cultivation first started and the wild species that were involved.

At the present day wild potato species are to be found in both South and North America, and are especially abundant in the Andes and the central regions of Mexico (see in original publication Map 1, p. 10,). Cultivated species, on the other hand, are confined to the South American Andes and to South Chile (see in original publication Maps 2 and 3, pp. 98 and 99). Vavilov (1928, 1931) in a study of the origin of cultivated plants showed very clearly that the centre of origin of a crop plant was to be looked for in those regions where the specific and varietal diversity was highest and where the largest number of endemic characters was to be found. From a study of Maps 2 and 3 in the present work one can see that the cultivated potato must have originated in the Lake Titicaca-Cuzco region of North Bolivia and South Peru; in this region one finds the greatest variety of species and forms, possessing many characters that are not to be found elsewhere. This region was the cradle of the Peruvian Indian civilizations, where a high level of material culture had been reached at the time of the Spanish conquest. The cultivated potato in Chile on the other hand, did not exist in a variety of species and it is, therefore, unlikely that this country was the centre of origin of potato cultivation.

Salaman (1937) considers that the Bolivian and Peruvian Andes were first inhabited by Indian tribes who ascended from the Amazon basin and settled down on the high Andean plateau (*altiplano*). They were driven, in his estimation, by fear of beasts and enemies from the even more inhospitable jungles. In the opinion of the present writer the first agricultural beginnings were probably attempted in the high eastern valleys such as that of the Urubamba, Apurimac, etc., and not on the altiplano itself. It seems probable also that these valleys were inhabited by reason of general population pressure rather than to any specific fear of jungle or enemies.

Be that as it may, certain tribes of previously hunting Indians must have settled down in these valleys to a primitive type of hoe-culture, using potatoes as a basis. The necessary prerequisites for the beginnings of agriculture would probably have all been present. Firstly one had a restricted environment with lack of game and isolated inaccessible valleys. In the second place there were suitable plants for food and ultimate cultivation—in this case the potato. Thirdly, there were the Indian tribes who had presumably reached a level of development appropriate for the change over to a higher stage of society. Thus, with these three factors and possibly also partly by a lucky chance the beginnings of potato culture were effected.

The normal process of development amongst primitive societies is for agriculture based on roots and tubers to precede that based on seeds and fruits, since in the former case the operations of planting and harvesting are almost identical, whereas in the latter, these processes are very dissimilar. Although it was thought that maize was first cultivated in South America (see Mangelsdorf and Reeves, 1939), later spreading to Central America and Mexico, this cereal never supplanted potato culture amongst the Indians of the high Andes. Undoubtedly the chief reason for this is that the potato can be grown at higher altitudes than maize or, indeed any other New World crop with the exception of Quinoa (*Chenopodium Quinoa*), Cañahua (*C. pallidicaule*), Ullucus (*Ullucus tuberosus*), Oca (*Oxalis tuberosa*) and Anu (*Tropaeolum tuberosum*). Of these plants the last three are tuber bearers and are not cultivated to any great extent. The first two are grown for their seeds, and Quinoa is quite widespread. It was of sufficient importance to be mentioned by Pedro Cieza de Leon in his *Crónica del Perú* We have already quoted the relevant passage in an earlier section of the present work (p. 4). Nevertheless, Quinoa is not so important to the highland Indian at the present day as the potato, and there is reason to believe that it was not more popular in the past.

To sum up, we can say that agriculture in the high Andes has probably always remained at the root and tuber stage, the normal trend towards cereal cultivation or seed cultivation having been prevented by the high altitude. The potato was the first and most important cultivated plant in the Andes, retaining its supremacy up to the present day.

What, however, were the factors which contributed to the rise of agriculture based on potatoes in the Andes and not in Mexico or Central America, although wild potatoes are to be found in both countries at the present day? Many have considered the question answered by stating that the Mexican agricultural beginnings were developed at too low an altitude for potato cultivation, although more or less correct for that of maize. We have just stated, wrongly however, that maize cultivation was not indigenous to Mexico but rather to South America. If primitive cultivation had been developed at all in Mexico it would have been developed on squashes and beans—both tropical plants. The three conditions for the independent beginnings of agriculture may perhaps not have been present in Mexico. We know that the geographical conditions were suitable in that country, but we do not know whether there was a suitable food plant. The fact that maize was cultivated when it spread northwards from Central America indicates that the Indians had arrived at a suitable stage for turning over to a settled agricultural life. Probably, therefore, the indigenous food plant was lacking. Mexican potatoes may have been such poor yielders as compared with those in South America that the incentive to cultivation did not arise. In the Peruvian Andes, on the other hand, the wild potatoes were probably comparatively good croppers even in the pre-cultivated condition. The best ones formed the basis for the food crops whilst the poorer ones were left uncultivated. Intermediate yielders were possibly cultivated only sporadically when for certain reasons the normal crop failed or was not sufficient to supply man's needs.

The final question to consider is why the potato evolved in the direction of high yield in South America and did not do so in Mexico. One must presumably look for geographical or ecological differences to account for this phenomenon. The latitudinal differences north and south of the Equator are probably not very significant, although the differences in altitude are much greater. Thus the amount of land over the 12,000 ft. level is thousands of times greater in South America than in Mexico and Central America, where it is confined to not more than six mountain peaks. This, however, cannot have been directly responsible for bringing about greater specific diversity since in Mexico there is a wider range of variation than in South America.

(2) WEED AND SEMI-CULTIVATED POTATOES

In the previous section we have seen how, in South America, there were probably moderately high-yielding wild potatoes that were taken into cultivation and formed the basis of Peruvian Indian agriculture. What were these first cultivated potatoes like? To obtain a partial answer to this question we shall have to discuss the problem of the most nearly related wild and semi-cultivated potatoes, those which grow as weeds of cultivation at the present day. These are probably somewhat similar to the types that the Indians brought into cultivation.

In studying the origins of a cultivated plant the old hard and fast distinction between "wild" and "cultivated" to a large extent breaks down, since one may observe all stages between the truly wild and genuine cultivated potato.

Thus, for example, the tubers of many wild potatoes are gathered by the Indians from the woods and hillsides in order to supplement their ordinary food supplies.

Other potatoes occur in and around native settlements, often as weeds of cultivation. The tubers of these may be eaten at certain times when the normal crop fails, and they probably represent types whose tubers were gathered from the wild and portions dropped around the huts and thrown away as inedible. *S. Salamanii* and the Colombian type known as "Chava", of which unfortunately no tubers could be collected by our expedition, seem to be at this stage.

Bukasov (1930) describes the beginnings of cultivation in Guatemala where the potato is never planted, the tubers being removed from the fields and enough left behind in order to keep the crop from dying out. A certain amount of tillage of the soil may be attempted however.

A few primitive cultivated species such as *S. Kesselbrenneri* are apparently equally at home in the wild and under cultivation. This species may be found cultivated in the Central Ecuadorian valley or growing wild in the high Andean forests; probably a similar state of affairs holds good with some of the "criolla" types of potatoes in Colombia. The high yielding species such as *S. andigenum* and *S. tuberosum* s. str. have, however, apparently lost their capacity for survival in a natural environment, possibly because they have been under cultivation for so long.

Let us now turn to examine in more detail the various types of weed potatoes that exist both in Mexico and South America.

In the former country we have the pentaploid species *S. Salamanii*, which, according to the evidence available, may very probably have been cultivated to some extent at one time and now persists as a weed in potato fields.

In South America weed potatoes all belong to the series *Tuberosa*, the same series in which the cultivated potatoes are found. One may distinguish two groups: there are those with a somatic chromosome number of 24, quite closely related to the other wild species in the series *Tuberosa*; there are also certain tetraploid species, some of which seem to be more closely linked to *S. andigenum*. In the former group we have the diploid species *S. aracc-papa*, *S. catarthrum*, *S. Bukasovii* and *S. Abbottianum* described by Juzepczuk and Bukasov, and the new species *S. anomalocalyx*, *S. brevimucronatum*, *S. lapazense*, *S. calcense* and *S. fragariaefructum* described in the present work. In the tetraploid group comes *S. Herrerae*, described by Juzepczuk, and *S. sucrense* and *S. subandigenum* which are described by the present author.

All these species show marked similarities to the cultivated potatoes, differing from them chiefly in their smaller habit, longer stolons and smaller, watery tubers. The tetraploid species are especially close morphologically to the tetraploid cultivated species. *S. sucrense* seems however, to occupy a position rather removed from the other tetraploid and diploid weed species and has probably not taken any part in the evolution of cultivated types. *S. subandigenum*, on the other hand, is so closely related to *S. andigenum* in many features that one was almost constrained to place it with the latter species, perhaps as a subspecies or variety. Nevertheless, there are many difficulties in this course of action, since *S. subandigenum* is not cultivated and possesses small watery tubers; furthermore, all its dimensions are smaller than those of *S. andigenum*, whilst at the same time it differs considerably from other weed species.

That *S. andigenum* is a vast polymorphic species arising from many different ancestors is a generally accepted fact. It is also, as we have seen in the section on cytology in the present work, very likely to have evolved from diploid progenitors. It is difficult to decide, however, whether the tetraploids were formed from wild or cultivated diploid types. Although of course the diploids do occur in the cultivated state, and one is at first tempted to think that the tetraploids came from these after they had been taken into cultivation, it is quite possible that the tetraploids arose from wild diploids by amphidiploidy with a consequent increase in size, due both to polyploidy and heterosis. These polyploid potatoes would then have been quickly taken into cultivation by the native population. The tetraploid weed types according to this view would have been either (a) types in which less favourable combinations of genes had occurred and which did not yield well enough to make them worth while cultivating, or (b) types that had been cultivated at one time and later discarded because of the spread of better varieties.

There are several indications that the tetraploids varied enormously in yield and tuber quality and that some which had been cultivated at first dropped out later and returned to a wild or semi-cultivated state. Certain Indian traditions tend to support this theory. The name "Aya papa" meaning "Ghost potato" or "Ancestor potato" applied to several types in Ecuador and Peru (see Hawkes and Howard, 1941), indicating that they were cultivated by the ancient Indians, shows, if there is any truth in the tradition, that the semi-cultivated potatoes may have been tended with greater care than they are to-day.

The common lay idea in South America about these weed species is that they were once cultivated but have since "degenerated" after they fell out of cultivation, reverting back to the wild type. This rather implies that a good high-yielding variety has now become changed into a low-yielding watery-tubered potato such as *S. subandigenum*. It is probable, however that this is not the case since when a cultivated species such as *S. andigenum* is allowed to "run wild" and is subjected to competition with wild vegetation it dies out completely. The author observed this process in several parts of South America, and the same thing happens with our potatoes in England. If *S. subandigenum*, *S. Salamanii* and others have been allowed to drop out of cultivation they have not altered or degenerated very much. They probably had, even when cultivated, long creeping stolons and small tasteless tubers, since they could only remain as a weed or wild species if they possessed these primitive characters to a marked degree. Another piece of evidence for discounting the "degeneration" explanation is afforded by the fact that cultivated potatoes in South America receive very different treatment from those in Europe. By "degeneration" is generally meant the cropping up of "wild" or primitive characters that are not removed by artificial selection. This applies to the improved varieties grown in Europe but certainly does not to those cultivated by the Indians. No selection is practised amongst these indigenous cultivators except perhaps in a reverse way by the eating of the large tubers and the planting of the small ones. Nevertheless, a mutation or segregation for very long stolons would probably result in the tubers of that plant not being harvested; hence there is a possibility of this potato becoming established as a weed, difficult to eradicate from the Indian fields.

Summing up, the tetraploid weed species may be either types that had once been cultivated and have now been replaced by higher yielding varieties of *Solanum andigenum* or amphidiploids which were never cultivated to any great extent. The diploid species, on the other hand, although they may have been previously cultivated, are quite probably the wild species most closely related to our cultivated diploids from which the tetraploids arose at some period either before or after they had been taken into cultivation.

S. Salamanii, the only pentaploid weed species so far known, may have been brought into cultivation to some extent after its formation as a hybrid between tetraploid and hexaploid wild species. It would no doubt have become fully cultivated if the process had not been deflected by the introduction of higher yielding forms of *S. tuberosum* from Europe.

The evidence for the views put forward above is not conclusive and other interpretations may very well be placed on it. On the whole, however, and with the data to hand, the conclusions reached here seem to the present author to be the most likely.

(3) EVOLUTION OF CULTIVATED POTATOES

The evolution of the cultivated South American potatoes can only be dealt with here in a very tentative manner since we have no detailed knowledge of the way in which it has taken place.

In a previous section of this work, in dealing with the cytology of the cultivated potatoes, mention was made of the probable evolution of the polyploid series of species from diploid to pentaploid. The diploid cultivated species were regarded as more primitive than the tetraploids, both by virtue of their smaller yield and habit and also because they probably preceded the tetraploids historically and were the sources from which these latter species were derived.

We shall, therefore, discuss the affinities of the diploid species first, going on to the triploid, tetraploid and pentaploid species later.

The most important of the diploid species from a phylogenetic point of view is, without any doubt, *Solanum stenotomum*. Like *S. andigenum*, this species occurs in a large number of varieties and forms and possesses quite an extensive geographical range. Its most primitive varieties are probably v. *pitiquilla* (f. *ccami*, f. *phiñu*, f. *eucaliptae*, f. *pitoca*, f. *huamanpaman* f. *kantillero*, f. *orcco-amajaya*), v. *chapiña* and v. *cyaneum* (f. *canastilla*, f. *cochicallo*, f. *kamara*, f. *phituhuayacas*, f. *negrum*, f. *chilcas*, f. *huallata-chinchi*). The less primitive varieties are probably v. *megalocalyx* (f. *alcay-imilla*, f. *catari-papa*, f. *chojllu*, f. *piticana*, f. *koso-ñahui*, f. *yana-cculi*, f. *ttele*, f. *kehuillo*, f. *huañuchi*), v. *puca-lunca*, v. *keccrana* (f. *pallidum*, f. *roseum*), v. *peruanum* (f. *cohuasa*, f. *chincherae*, f. *cuchipacon*), v. *huicu* and v. *putis*.

The other diploid species, occurring more or less within the range of *S. stenotomum*, but with a much more restricted distribution, are *S. Yabari*, *S. Churuspi*, *S. goniocalyx*, *S. phureja* and *S. ajanhuiri*. They have probably been derived from *S. stenotomum* in recent geological times. *S. Rybinii*, *S. Ascasabii* and *S. Kesselbrenneri*, on the other hand, although bearing many points of resemblance to *S. stenotomum*, are separated from it both geographically and morphologically. *S. Cardenasii* also occupies a position somewhat remote morphologically from *S. stenotomum* although its geographical range is very close to the edge of that of the latter species. Although separated by many thousands of miles from the range of the *S. Rybinii* group of species it is perhaps more similar to them in its morphological features.

There is not a great deal that can be said about the evolution of the triploid species. With one exception they were probably formed as hybrids between diploid and tetraploid cultivated species and have since spread, probably by human agency, without any propagation from seed. Bukasov (1929) considered *S. chaucha* to have been formed as a result of natural crosses between *S. phureja* and *S. andigenum*.

This may well be so, though it is possible that *S. stenotomum* may have been the diploid parent in this case. In a similar way, *S. tenuifilamentum*, *S. mamilliferum* and *S. coeruleiflorum* were probably formed in *S. stenotomum*-*S. andigenum* crosses. The triploid hybrids are certainly of this nature, some of them approaching the diploid parent (*S. stenotomum*) very closely, whilst others are almost indistinguishable morphologically from *S. andigenum*. *S. Juzepczukii* has undoubtedly been formed as a hybrid between the wild species *S. acaule* and some diploid cultivated species. The pentaploid *S. curtilobum* may, according to Bukasov (1939a), have taken its origin from a cross between *S. andigenum* and *S. Juzepczukii*, the gamete from the latter species not having undergone reduction. If this is true it arose in quite a different way from the wild pentaploid species of Mexico, *S. semidemissum* and *S. Salamanii*, which seem to have been derived from tetraploid-hexaploid crosses.

The most widespread and abundantly represented of all the cultivated species are the two tetraploids *S. andigenum*, occurring in the Andes, and *S. tuberosum* s. str. from South Chile.

In discussing the problem of the origin and evolution of these two species the importance of the rôle played by man in their distribution should not be underestimated. The tetraploid complex very probably originated in the Cuzco-Lake Titicaca region of Peru and Bolivia where the potato itself was first cultivated. The spread of these most successful tetraploid forms, of higher yield than any of the diploids, can be best illustrated by considering the process at the present day. We shall, therefore, digress a little here to discuss the distribution of the varieties of *S. andigenum* in the various potato growing countries of South America.

In nearly every region visited by the Empire Expedition there was exhibited a well marked tendency towards the replacement of low-yielding varieties by better yielders. In general, this process is haphazard and uncalculated, yet its effects are none the less obvious. In Colombia, for example, the good yielding varieties Tocana and Tuquerreña have spread all through the potato growing districts in the last 100 years. Thus at Tota, near Sogamoso, the writer was shown a few plants of the variety Arbolona, which although of good flavour possesses purple tinted flesh. The owner of the land stated that in his grandfather's time this variety had been quite commonly grown but that it had been gradually replaced by the white fleshed better commercial varieties Tocana and Tuquerreña. Verification of this fact came from several sources — that varieties grown in different districts were being replaced by these two standardised commercial varieties. The spread has been very rapid here, partly owing to the more advanced commercial development of the country, and it is more similar to the sort of thing that happens in Europe. It is probable, however, that something of the same nature has always been taking place, though at a slower rate, in the other countries of South America. As yet, varieties have not spread over the whole country. Thus the best varieties in Central Ecuador are not found in the south and vice-versa.

Now, although the spread of the better yielding and more palatable varieties is an obvious fact we know less about the poorer, less palatable types. These types, cultivated only by the Indian peasants, of poor marketing quality, which keep for a short time, bruise easily on transit and are of no use for large-scale consumption, would not tend to move very rapidly, if at all, from their original localities. Their poor quality would offer no incentive for introducing them into other regions, whilst varieties of better quality, on the other hand, would be taken to market by the peasants and hence might be distributed throughout a certain district served by that particular market. It is probable that moderately good varieties would not move beyond that region since the custom of bringing goods from a certain district always to the same market is very strongly ingrained amongst the peasantry.

Each market, therefore, would be expected to display its best type or types which were distributed over the whole of the surrounding district, whilst the poor non-marketable ones would be more isolated and confined to their points of origin. This state of affairs still exists in most of South Peru and in some parts of Central Bolivia. If any superlatively good type originated in one district it would probably be taken up by the large *hacienda* owners and distributed to other districts according to the lines of communication. Such a state of affairs is beginning in Bolivia with the varieties known as "Imilla" and has progressed very far in Colombia, as we have already seen. Thus it seems probable that the higher yielding varieties have spread for large distances far from the region in which they first originated, probably hybridizing with the original varieties to a greater or lesser extent.

Although the situation outlined above deals with potato varieties at the present day, there is reason to believe that this process of the differential spread of varieties has been a continuous one even though modified more or less by the social conditions of the Indian communities at different periods in the history of potato cultivation. With the more rapid spread of high yielding types we should expect to find that these were more fully represented at the edges of the distribution area for tetraploid potatoes. In the original centre of distribution genes for high yield would be constantly masked or weakened by admixture with low yielding genes due to hybridization with more primitive forms. This is, in fact, just what happens, since at the northernmost point of the range of indigenous cultivated potatoes, namely Colombia, and the southernmost, Chile, the highest yielding and best commercial varieties have originated. In the centre of the range, in Peru and Bolivia, there are thousands of types with more primitive characters such as deep eyes, deep pigmentation, irregular shape, poor yield, etc., but not one that is of such all-round good quality as those from Colombia and Chile.

It will at once be objected, however, that whereas in the Andes we are dealing with *S. andigenum*, in Chile another tetraploid species *S. tuberosum* s. str. is found. The Russian scientists (see Bukasov, 1933) asserted that these two species were of independent origin, each from separate wild species. The present author shares Salaman's opinion, however, that these species are not so distinct as was formerly supposed and that they both have a common origin. This point is clearly of paramount importance, since if the thesis put forward by the Russians is correct, the theory of origins outlined above falls to the ground. It will, therefore, be necessary here to consider the evidence put forward by Bukasov and his co-workers for the separation of these two species. It can be summarized under three main heads, morphological, geographical and photoperiodic:

1. Morphological. The morphological differences between *S. andigenum* and *S. tuberosum* s. str. are given on p. 78 of the present work (original paper); the two species differ by the sum of a number of minute features, present in different proportions and combinations in the different varieties, rather than by any one sharp clear-cut character. The most extreme forms of *S. andigenum*, those taken by Juzepczuk and Bukasov (1929) as the type specimens of the species, come from Central Peru. Morphologically *S. andigenum* approaches *S. tuberosum* s. str. in its Colombian forms, though these are not actually identifiable with the latter species.

2. Geographical. The ranges of the two species are not apparently confluent, *S. andigenum* being found in tropical latitudes (10° N. to 24° S.) at high altitudes, whilst *S. tuberosum* s. str. is found at sea-level from 40° to 45° S. They are separated by the range of the Andes and by the salty infertile Atacama desert. This fact induces Bukasov to consider the two species as distinct.

3. Photoperiodic. *S. andigenum* yields better in tropical 12-hour days, whilst *S. tuberosum* s. str. is adapted to the long summer days of temperate latitudes. Each species will produce in the conditions appropriate to the other, but the yield in such cases is much poorer.

In the view of the present writer these facts mentioned above only tend to strengthen the theory of common origin for the two species. The high yielding forms from Chile have migrated so far from the Equator that their reaction to the day length (photoperiodic reaction) has been modified to suit the new conditions. The Colombian forms on the other hand, have not passed beyond that country owing to the unsuitable low-lying tropical regions of Central America. But they do show that the better yielding types are to be found here as well as in Chile. Moreover, these Colombian types are not separated geographically from the sources of *S. andigenum* in Peru and Bolivia as are the Chilean ones, and so would not be expected to have become distinct. In Chile, the 48-chromosome potatoes, in a different latitudinal belt and isolated from their sources in Peru and Bolivia, eventually evolved into the new species which has been spoken of in the present work as *S. tuberosum* s. str.

Although Southern Chile is separated from South Bolivia by the Atacama desert, it is just possible that the 48-chromosome potato may have migrated southwards along the eastern slopes of the Argentine Andes, being brought over to the west side at the more southerly latitudes. The Atacama desert is confined chiefly to the west side of the Andes of North Chile, whilst the east side in North Argentina is much moister and might quite well be able to support potato cultivation. Few collecting expeditions have explored in these regions of Argentina, embraced by the provinces of Jujuy, Los Andes, Salta, Catamarca, La Rioja, San Juan, Mendoza and Neuquen, but if they did so, explorers might still find relics of potato cultivations.

Little is known, so far as the writer is aware, of the migrations or history of the Araucanian Indians, who cultivated the potato in Chile. If they did obtain it from Andean sources either by the route suggested above or by some migrations of peoples southwards along the Chilean coast it must have been long before the Inca civilization. The Araucanian name for the potato is "Pogny" or "Poñi," a word unknown to the Incas, who called it "Papa" a name which is in use in the Andes at the present day. The Aymará Indians from the Lake Titicacaca region also had a different word for the potato, since they knew it under the name of "Choque". In the light of this evidence the assertion made by Wight (1916) that the potato was brought to Chile by an Inca invasion in the fifteenth century, is certainly not tenable. It must have arrived there long before the Incas or, indeed, before any of the recorded Peruvian civilizations.

One other point must be dealt with here, since it affords further argument against the indigenous origin of the Chilean tetraploid potatoes.

We saw above that the cultivated tetraploid potatoes arose in the first place from diploid ancestors either wild or cultivated. If, therefore, the Chilean potato had been domesticated from a separate source of wild potatoes in Chile, as Bukasov and Juzepczuk assert, we should expect to find either wild or cultivated diploid potatoes growing by its side as we do with *S. andigenum* in Bolivia and Peru. This is just what we do not find, however. The most closely related wild potatoes in the series *Tuberosa* occurring in Chile are the triploid *S. Maglia*, and the tetraploids *S. leptostigma*, *S. Fonckii*, and *S. Molinae*. No diploid wild species in this series have been found in Chile, neither are there any diploid cultivated ones. *S. tuberosum* is in fact, an isolated cultivated potato with no close relatives in this region except the three species just mentioned.

In view of this evidence it would seem probable that the tetraploid complex spread outwards from Peru and Bolivia, differentiating when it reached Chile into *S. tuberosum* s. str. and the related wild species *S. Molinae*, *S. Fonckii*, and *S. leptostigma*. If the tetraploid potato was cultivated before it spread to Chile, then the tetraploid wild species here represent types that have since dropped out of cultivation. If, however, the spread took place before potato cultivation had been initiated then we should assume that cultivation arose independently in Peru-Bolivia and Chile. The view advanced by the present author for the spread of the tetraploid complex from Peru-Bolivia and the differentiation of *S. tuberosum* s. str. in Chile suggests that this was accomplished only after cultivation had been effected and that the wild Chilean tetraploids at any rate are low yielding types that have dropped out of cultivation.

These points disposed of, we can finally attempt to sum up the conclusions reached in this section of the present work. The points are as follows:—

1. The diploid cultivated species have all been derived from and bear more or less close relationship to *S. stenotomum*.
2. The triploid species have been formed as hybrids between diploids and tetraploids and are propagated entirely by vegetative reproduction. The special case of *S. Juzepczukii* is dealt with at length on page 73 (In original paper).
3. *S. curtilobum*, the only cultivated pentaploid species has been formed probably as the result of the fusion of unreduced triploid and normal tetraploid gametes. It therefore differs in its formation from the Mexican pentaploid species *S. Salamanii* and *S. semidemissum*.
4. The tetraploid potatoes arose in the Peruvian and Bolivian Andes, spreading rapidly, chiefly by human agency. The higher yielding types moved more quickly than the lower yielding ones and hence became especially abundant at the edges of the distribution range. They are, therefore, to be found in Chile, the southern end, and in Colombia, the northern end of the Andes. In the south (Chile) the widely different climatic and latitudinal conditions, coupled with a more or less complete geographical barrier, aided in the differentiation of a new species *S. tuberosum* s. str. The environmental conditions in the northern part of the range of the tetraploid complex were not sufficiently different from those at the centre of origin to produce changes of a specific character. The Andean forms therefore are all identifiable with *S. andigenum*.
5. The evidence to hand is not sufficient to show us how complete the geographical barriers between the two species actually are. There may have been a path for the passage of the southern forms along the east side of the Argentine Andes or these Chilean types may have accompanied the coastal migrations of Indian tribes from the Andes to Chile. Whichever theory is correct the introduction of cultivated potatoes into Chile must have been prior to the Incas, since the native names for potatoes in Chile and Peru are quite dissimilar.
6. Further evidence from the complete lack of diploid species, either wild or cultivated, in Chile suggests that *S. tuberosum* s. str. did not obtain a separate origin from *S. andigenum*.

(4) ORIGIN OF THE EUROPEAN POTATO

Although we have discussed at some length the problems of origin of the cultivated tetraploid potatoes we have not yet considered how they came to be brought to Europe.

At the present day the tetraploid potato has not only spread over Europe but has been carried to the furthest ends of the civilized world. We shall not deal here with the spread of the potato from Europe or with its propagation in that continent itself. What we do wish to know, however, is the exact locality from where the potato was brought to Europe and, if possible, the type or varieties involved.

With the first question there are two main schools of thought. Some believe it to have been brought as *S. andigenum* from some part of the Andes, whilst others consider that *S. tuberosum* s. str. from Chile was the most likely source.

The chief exponents of the Chilean theory of the origin of the European potato are the Russian scientists Juzepczuk and Bukasov (see Bukasov, 1933). The main point in their thesis is the similarity in photoperiodic reaction between the Chilean and European potato. Both are adapted to the long summer days of temperate latitudes and yield best under these conditions. *S. andigenum*, the Andes potato, is adapted to the short 12-hour day of tropical latitudes and hence could not, in Bukasov's estimation, have been used as a food plant in Europe owing to its poor yield in temperate latitudes.

Bukasov also presents evidence from the morphology of these potatoes to support his theory. The type of *S. andigenum* from Central Peru, differing in photoperiodic reaction, as we have seen above, from *S. tuberosum* s. str., possesses rather more highly dissected leaves with narrower, more widely-spaced leaflets and thinner stems. *S. tuberosum* s. str. from Chile, and the European potato, which the Russians have named *S. tuberosum* var. *europaeum*, possess rather less dissected leaves with wider leaflets set more closely together and with thicker stems. It is, therefore, concluded that on morphological grounds also the evidence for the origin of the domestic potato from Chile is indisputable.

Salaman (1937) criticizes this theory strongly, his chief point being that the potato was known in Europe before the conquest of Chile had been properly effected. It is extremely unlikely that the potato could have been brought from that country in the unsettled period from 1559 to 1568, and even after the latter date internecine warfare lasted intermittently for the next two hundred years. During the wars of conquest the potato was apparently never used as an article of food by the Spanish troops, although at times they were almost starving. Salaman goes on to show the difficulties involved in taking the potato from Chile to Europe at a time when the Straits of Magellan had not been navigated, since it would have involved at least a double trans-shipment, one at Lima and another at Panama, not to speak of the overland journey across the Isthmus of Darien. The chances against such a journey being successful, even if the potato were treasured and prized as a rare plant of great value are enormously large. That the potato was not considered of value seems to be fairly evident since none of the contemporary writers suggests that it should be taken to Europe, and none mentions the date and method of its introduction. From the evidence given by Salaman it is impossible to escape the conclusion that the transport difficulties at that time were so large as to make the Chilean origin of the potato highly improbable.

The alternative to the Chilean theory of origin is that the potato was brought from *S. andigenum* sources in New Granada (Colombia, Ecuador) or Peru (Peru, Bolivia), since these countries had been discovered and conquered nearly half-a-century before the potato was known in Spain.

On p. 5 of the present work (original paper) it has been shown that Gerard's potato was very probably obtained from one of the northern Colombian ports and the same may have been true for the plants first grown in Spain. Salaman's view is that it was brought down to Cartagena from the Bogota district of Central Colombia and shipped over to Spain direct. With this view the present author is wholly in agreement. The Colombian varieties of *S. andigenum* are better yielding types with more similarities to the Chilean potato in tuber quality and leaf form than the Central Peruvian forms. When introduced into Europe these potatoes might, by the raising of plants from true seed (which was attempted prior to 1601, since it is mentioned by Clusius in his *Historia*) have had many of their more *andigenum*-like and objectionable characters removed by selection. It is possible also that later introductions from Chile in the eighteenth and nineteenth centuries may have played some part in the building up of our present domestic stocks, though this is a matter for conjecture since there is not a great deal of evidence to support this view.

One important point that has not yet been discussed here is that of the photoperiodicity of the potato, since it is this which is the corner stone of the argument put forward by the Russian geneticists. *S. andigenum*, they affirm, when grown in the long summer day of Leningrad forms poor yields owing to the fact that it is adapted to the short day of the tropics. Hence the Chilean potato could have been the only possible plant to give a good yield in Europe, since it came from approximately similar latitudes, whilst the Andean potato, if introduced at all would have been quickly discarded owing to its insignificant yield under these conditions.

There are three arguments to counter this view and support that of Salaman. In the first place *S. andigenum*, although mainly short day in photoperiodic reaction, does possess certain day neutral and even long day clones, as has been shown by the experiments of Hackbarth (1935). If, by any chance, one of these was introduced into Europe, then there would be no reason at all why it should not have yielded well from the very first. Secondly, there is no theoretical reason why the short day reaction of Andean potatoes cannot be largely eliminated under long day conditions by the simple process of selecting for yield, since we know from recent experiments (Miller and McGoldrich, 1941) that certain varieties of domestic potatoes segregate very markedly for photoperiodic response when grown from seed. Yield, as the Russians have shown, is due partly to inherent yielding capacity and partly to photoperiodic reaction. This latter is definitely inheritable, and, according to Emme and Veselovskaja (1935), the short day reaction is dominant over the long day one. Growing the potato from seed and selecting for yield would quite probably tend to eliminate the genes for short day, thus producing types more suited to the long summer days of European latitudes. We have seen above that the potato was grown from seed in very early times, and there is, therefore, no reason to suppose that our modern varieties were not produced in this way.

A third point worthy of notice, put forward by the present writer, is probably of equal importance. The potato was first grown in Spain and Italy—countries at about latitude 36-45° N., whilst the latitude of Leningrad where the Russian collections were grown is 80° N. It is, therefore, very likely that the short day reaction of *S. andigenum* may not have depressed its yield so much in those countries as it did at Leningrad, and that quite good crops were obtained even when it was first introduced. Unfortunately, so far as the writer is aware, no tests of the yielding capacity of *S. andigenum* in Spain have been carried out, but we do possess data from another country of the same latitude, namely, New Zealand (40-45° S.). Mr. C.M. Driver, of the New Zealand Department of Scientific and Industrial Research, has acquainted the author with the fact that *S. andigenum* varieties, collected by the Empire Expedition, yield remarkably well in that country.

There is, therefore, every reason to suppose that they would have yielded equally well in Spain and Italy when first introduced from South America.

In the process of selecting for yield the Andean potato from Colombia has therefore been modified in the direction of the Chilean potato to such an extent that one at first finds it difficult to accept the theory of the Andean origin of the European potato. Nevertheless, when we realize that all the 48-chromosome potatoes had a common origin in the Cuzco-Lake Titicaca region of the Andes, probably not earlier than the Pleistocene age, it will be evident that *S. andigenum* and *S. tuberosum* s. str. are not so distinct and immutable as was at first thought probable. They are sufficiently related to be included in the group species *S. tuberosum* sensu latiore and, indeed, represent a fluid complex of forms in which artificial selection can imitate natural selection. The Chilean potatoes evolved into a new species partly under the influence of primitive man but in the main because of their isolation and geographical position; Colombian forms when taken to Europe were altered in much the same way in a few centuries, though the process in South America certainly took many thousands of years.

Once adapted to the temperate latitudes and day length of Europe the tetraploid potato was taken all over the world, even being introduced into Chile where the forms produced in a similar way but under very different circumstances were so similar as to give rise to the belief that that country was its original home.

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APPENDIX III: Publications of J.G. Hawkes

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APPENDIX IV. Curriculum vitae of J.G. Hawkes

John Gregory Hawkes

Date of birth: 27th June, 1915

Married, 4 children

Formerly Mason Professor of Botany and Head of Department of Plant Biology,
University of Birmingham , U.K.

University Degrees

B.A. Cambridge 1937, M.A. Cambridge 1938, Ph.D. Cambridge 1941, Sc.D. Cambridge
1957.

Membership of Learned Societies

Fellow of the Linnean Society

Member of the European Association for Research in Plant Breeding (EUCARPIA)

Member of European-Association for Potato Research

International Committee Membership, awards, etc.

1964-1974 Member of Panel of Experts to Advise F.A.O. on Crop Plant Exploration and
Introduction (Genetic Resources).

1961 President of the Eucarpia European Gene Bank Committee and Section "Genetic
Resources".

1969 Founder of International Training Course (M.Sc.) on "Conservation and Utilisation of
Plant Genetic Resources", at Birmingham (still continuing).

1972 Advisor to International Potato Center, (CIP), Lima, Peru on germplasm taxonomy,
exploration and utilization.

1973 Frank N. Meyer Memorial Award of the American Genetic Association.

1973 Certificate of Merit of the Potato Association of America.

1975-1984 Member of Scientific Advisory Panel to Royal Botanic Gardens, Kew.

1975 Vice-President of XII International Botanical Congress in Leningrad; awarded
congress medal.

1984 Linnean Society Gold Medal

2001 Honorary Professor of the Vavilov Institute

1991-1994 President of the Linnean Society of London

1994 OBE (Officer of the Order of the British Empire)

Dates Previous Posts

- 1939-48 Botanist at Commonwealth Bureau of Plant Breeding and Genetics.
- 1948-51 Director of Colombian Ministry of Agriculture Potato Research Station, and Founder of this Station. (Three years' secondment on request of Government of Colombia).
- 1951-52 Botanist at Agricultural Research Council-Potato Genetics Station.
- 1952-61 Lecturer and Senior Lecturer in Taxonomic Botany at Birmingham University.
- 1961-67 Professor of Plant Taxonomy at Birmingham University (Personal Chair).
Mason Professor of Botany and Head of Department of Plant Biology



Professor Dr. J.G. Hawkes
