THE BIRMINGHAM UNIVERSITY POTATO COLLECTING EXPEDITION TO BOLIVIA AND PERU, 1971

1. AIMS

The primary aim of the expedition was to arrive at a better understanding of the taxonomy and evolutionary relationships of cultivated and wild potato species in Bolivia and southern Peru, as well as to provide living material from this important potato gene centre for utilisation by potato breeders and for experimental studies in Birmingham. Although the potatoes of Argentina and Peru are now very well known, those of Bolivia were comparatively neglected. Collections had been made by Juzepczuk in 1927 and by the British Commonwealth Expedition in 1939. The German Agricultural Expedition in 1959, led by Professor H. Ross, collected wild and cultivated material, whilst that of Dr. D. Correll in 1960 paid attention chiefly to herbarium collections. Dodds and Paxman in 1960 and Dodds and Simmonds in 1962 concentrated entirely on cultivated diploids for genetical studies. The work of Professor M. Cárdenas should be mentioned here, since his collections of wild and weed species are of particular value and importance. Even so, with all these collecting expeditions, few attempts had been made to study the taxonomy of the totality of Bolivian potato species, relating them to those of neighbouring countries. For this reason, we hope that the material collected during the 1971 expedition may provide the key to a number of difficult taxonomic problems in this fascinating group of plants.

Living collections of other solanaceous genera, as well as other sections of the genus Solanum were collected for biosystematic studies in Birmingham and elsewhere. Collections of herbarium and living material were made for the Kew and Copenhagen Herbaria and Botanic Gardens, having in mind the special requirements made known to us by staff members during the planning stages of the expedition.

2. PARTICIPANTS

The expedition was led by Professor J. G. Hawkes of Birmingham University for the first two months, and subsequently after his return to England, by the deputy leader, Mr. J. P. Hjerting of the University Botanic Gardens, Copenhagen. The other members of the Expedition were Mr. P. J. Cribb of Birmingham University, Research Assistant to Professor Hawkes and Sr. Z. Huamán, taxonomist of the International Potato Centre, Lima, Peru.

Help with the collecting was provided in Bolivia by Professor M. Cárdenas and his assistant, Elías Menéses, of Cochabamba University as well as by Sr. M. Zavaleta and Sr. H. Gandarillas of the Bolivian Ministry of Agriculture, and Sr. A. Vidaurre of Potosí.

In Peru valuable assistance was also provided by Professor C. Vargas of Cuzco University and Sr. F. Flores of the University of Puno.

3. ROUTE (See Table 1)

The European members of the expedition flew out to Lima, Peru, on 29th December, 1970. Here they were met by the Peruvian member of the expedition, Sr. Z. Huamán, and arrangements were made for the loan of a vehicle (NISSAN Jeep) through the kindness of the Director of the International Potato Centre in Lima, Dr. Richard Sawyer. The vehicle was on hire to the Centre from U.S.A.I.D. Help in planning the arrangements for the expedition was also kindly supplied by Dr. E. French and by the Peruvian potato expert, Professor Carlos Ochoa. The British and the Danish Embassies, as well as the British Council representative, also provided valuable assistance at this stage.

After some collecting in the region of Lima, the expedition set out on the southern coastal road en route for Bolivia on 7th January 1971, passing through Arequipa into the southern Peruvian Andes and thence to Puno and along the side of Lake Titicaca to the Bolivian border.

La Paz, the Bolivian capital, was reached on 14th January. This formed a centre for our north Bolivian collecting activities at various times. We should like to take this opportunity of expressing our warmest thanks to the British Ambassador and Mrs. Bailey in La Paz for their generous hospitality and assistance. We are also very much indebted to Dr. A. Ballantyne, head of the British Agricultural Mission to Bolivia. Later, in Cochabamba, Mr. F. Squire and Mr. D. Penn also provided very great assistance to us at all stages.

After a preliminary series of trips in the La Paz region to the Yungas and to the Sorata area, we went with Sr. Gandarillas to the high altitude crops station on the altiplano at Patacamayo, following on to Cochabamba later in the same day.

Cochabamba formed the chief base or centre of activities for the whole expedition, thanks to the kindness of Professor M. Cárdenas who made facilities at the Botanic Gardens available to us for growing some of our living collections and for the drying and storage of our materials. The British Agricultural Mission was also of very great help to us here, as we have already mentioned.

From Cochabamba we made various trips, not only into the surrounding mountains, but also to the interesting regions to the east in the Valle Grande province of Santa Cruz Department. A longer excursion took us south-eastwards through Sucre and Potosí, then south towards the southern border with Argentina. On this occasion, however, the southern area of the country was not sufficiently seasonally advanced to make it worth while to penetrate beyond Camargo. We returned to Potosí and thence followed on to Oruro in the altiplano past the salt lake Poöpó. From Oruro we returned again to Cochabamba.

A little after this, in mid-February, Professor Hawkes and Zósimo Huamán returned to La Paz and thence to Lima. A visit was made to the Peruvian collections of cultivated potatoes in Huancayo and some preliminary identifications were carried out. Professor Hawkes then returned to Birmingham and Zósimo Huamán went back to Bolivia where he re-joined the expedition.

The first part of the expedition had been to some extent exploratory in nature, though many interesting collections had been made. By and large, however, material was not in a sufficiently advanced stage to make extensive seed and tuber collections possible; notes of interesting areas for subsequent collecting were made, however, and future routes were planned in some detail.

From March onwards intensive collecting was carried out in the same regions as before, with particular attention being paid to those considered of special interest. The route from Sucre to Potosí and Camargo was followed again, but with several side excursions to type localities and other areas known to be of importance. This time also the route was extended further south to Tarija, Entre Ríos and Villazón, next to the border with Argentina. The return northwards was by a different route, of particular interest for elucidating the relationships of the wild potato species, Solanum oplocense.

On the return to Cochabamba many different areas were visited and extremely rich seed and tuber collections were made, particularly of weed potato species.

Cultivated potato collections were made in the Cochabamba and La Paz regions towards the end of March, especially of the diploid, triploid and pentaploid species, which still deserve much further study. Wild material was again collected in the Sorata and the Yungas regions. Of particular interest botanically in Bolivia were the Yungas of La Paz and Corani, as well as the virtually untouched tropical selva of Chapare. In the south of the country the selva Tucumano-Boliviana is particularly clearly developed in the Entre Ríos area, whereas further north it is to be found only in more isolated patches. Since many wild Argentine potato species occur in this selva a further study of the Entre Ríos. part of it would be worth while.

A particularly interesting region for cultivated potatoes was that of Caquiaviri, where Sr. Zavaleta's very extensive collection was grown.

The expedition returned to Peru early in April and made wild potato collections in the Puno/Lake Titicaca area for a few days in the company of Sr. F. Flores. We then continued to Cuzco where intensive collecting of wild potato species and other material was made in the company of Professor Vargas.

By about mid-April it was necessary to resume the return journey to Lima. However, instead of taking the Arequipa coastal route, the central cordillera road was followed through Abancay, Andahuaylas, Ayacucho and Huancayo. Here many very valuable collections were made of the wide ranging S. bukasovii/multidissectum complex.

Lima was reached on 21st April and the expedition finished on 28th April, when Hjerting and Cribb returned to Europe.

TABLE 1 Route of Expedition in Peru and Bolivia

29th December 1970	London to Lima
2nd January 1971	Lima, Trapiche, Quilca and return
7th January	Lima to Nazca
8th January	Nazca to Arequipa

9th January	Arequipa to Juliaca
10th January	Juliaca to Puno
11th January	Collecting round Puno
12th January	To Huancané and return
14th January	Puno to La Paz
15th January	To Palca and return
16th January	La Paz to Unduavi and Chulumani
17th January	Chulumani to Coripata, Coroico and La Paz
19th January	La Paz to Achacachi and Sorata
20th January	Sorata towards Tacacoma and return
21st January	Sorata to Cochipata, Millipaya and La Paz
23rd January	La Paz to Patacamaya and Cochabamba.
26th January	Cochabamba to Toralapa and Punata and return
27th January	To Liriuni, Puente San Miguel, etc.
29th January	Cochabamba to Epizana, Aiquile and Sucre
30th January	Sucre to Millares, Retiro, Betanzos and Potosí
31st January	To Lecherías and Samasa and return
1st February	Potosí to Padcayo, Muyuquiri, Camargo and San Pedro
2nd February	Return to Potosí
3rd February	Potosí to Tarapaya, Yocallo, Challapata and Oruro
4th February	Oruro to Cochabamba
6th February	Cochabamba to Colomi and new road to Chapare ? and return
7th February	Cochabamba to Pojo, Siberia and Comarapa
8th February	Comarapa to Mataral, Trigal, Valle Grande, Guadalupe and return to Comarapa
9th February	Comarapa to Siberia, Pojo and Cochabamba
	Zósimo Huamán returned to Peru
11th February	Cochabamba to Cervecería Colón and return
12th February	J. G. Hawkes left for La Paz (thence to Lima and London).
15th February	Cochabamba to Parotani, Itapaya, Capinota and return
16th February	Cochabamba to Punata, Arani and return
17th February	Cochabamba to Villa Tunari
18th February	Villa Tunari to Río Chimaré, Villa Tunari and return to Cochabamba
20th February	Cochabamba to Pojo and Santa Cruz
21st February	Santa Cruz Botanic Garden and surroundings
22nd February	Santa Cruz to Cochabamba
24th February	Cochabamba towards Oruro (60 km) and return

25th February	From Cochabamba 90 kms along Corani-Chapare road and return
26th February	Cochabamba to Punete San Miguel, etc.
27th February	Cochabamba to Epizana, ruins of Incallajta and return (with Dr. Hardy Eshbaugh)
1st March	Zósimo Huamán returned to Bolivia
2nd March	Cerro San Pedro in Cochabamba
3rd March	Cochabamba to Epizana, Aiquile and Sucre
4th March	Sucre to Yamparáez, Tarabuco, Zudáñez and return
5th March	Sucre to Guerraloma, continuing towards Ravelo and return
6th March	Sucre to Yotala, Retiro and Potosí
7th March	Potosí to Lecherías and return
8th March	Potosí to Aroifilla, Tarapaya and return. Lagunas de Potosí
9th March	Potosí to Cucho Ingenio, Padcayo, Muyuquiri, Tacaquira, Camargo and San Pedro
10th March	San Pedro to Culpina, Ingahuasi and return
11th March	San Pedro to Las Carreras, Iscayachi, Cuesta de Sama and Tarija
13th March	Tarija to Entre Ríos and return
14th March	Tarija to Iscayachi, Sama, Tojo and Villazón
15th March	Villazón to Tupiza, Oploca and back to Tupiza
16th March	Tupiza to Cotagaita, Vitichi, Cucho Ingenio and Potosí
17th March	Potosí to Betanzos and Sucre
18th March	Sucre to Aiquile, Epizana and Cochabamba
21st March	Cochabamba to Liriuni and Puente San Miguel and return
23rd March	Cochabamba to Toralapa and return
25th March	Cochabamba to La Paz
26th March	Collecting in La Paz
27th March	La Paz to Viacha and Caquiaviri
28th March	At Caquiaviri
29th March	Return to La Paz
31st March	La Paz to Achacachi and Sorata
1st April	Sorata to La Paz, Río Abajo and Calacoto
3rd April	La Paz to Coroico and return
4th April	La Paz to Calacoto and Río Abajo
5th April Bol→Per	La Paz to Tiahuanaco, Desaguadero and Puno
6th April	Puno to La Huerta and return
7th April	Puno to Ilpa, Sillustani and return

8th April	Puno to Aguas Calientes, Sicuani and Cuzco
10th April	Cuzco to Urubamba, Ollantaytambo, Calca, Pisac and return
11th April	Cuzco to Pisac and return
12th April	Cuzco to Lucre, Rumicolca and return
13th April	Cuzco to Sacsahuaman, Calca, Urco, Urubamba and return
14th April	Cuzco to Tambomachay and return
15th April	Cuzco to Macchu Picchu
16th April	Macchu Picchu to Cuzco
17th April	Cuzco to Abancay
18th April	Abancay to Andahuaylas, Chincheros, Río Pampas, Ocros and Ayacucho
20th April	Ayacucho to Huancayo
21st April	Huancayo to Lima
28th April	Lima to Europe

4. COLLECTIONS (GENERAL)

Table 2 gives a summary of the collections made in Bolivia and Peru, divided into three groups: Potatoes, Solanaceae (not potatoes), non-solanaceous collections.

TABLE 2 Summary of Collections

Potatoes (wild species)	305	562
Potatoes (cultivated)	257	
Solanaceae (not potatoes)		97
Non-solanaceous collections		515
Total		1,174

Total of herbarium and other non-living collections	362
Total of seed, tuber, bulb, corm or cutting collections (with dried voucher material when possible)	812

The collections are being held at Birmingham and Copenhagen for subsequent distribution to the appropriate herbaria and research stations. Potato seeds have already been distributed to the U.S.A., Germany and Holland, and a collection is held in readiness for distribution to Scotland. Herbarium specimens will be deposited at the Kew and Copenhagen herbaria, and a set of the potato and other solanaceous material will be kept at Birmingham.

In addition to the potato collections and the other solanaceous material for experimental taxonomic studies at Birmingham, the following special collections of dried and living material were made:

	Specimens
1. Plantaginaceae; for Mr. K. Rahn, Copenhagen Botanical Gardens	93
2. Tropaeolum; for Mr. K. Sparre of Stockholm (including T. seemanii, T. peregrinum, T. pentaphyllum, T. boliviense, T. tuberosum, T. kuntzeanum, T. cochabambae, T. minus)	18
3. Commelinaceae, for taxonomic and cytological studies in Kew and Copenhagen (Dr. K. Jones and Mr. O. Mattsson).	35
4. Ipomoea for Dr. Frank Martin, U.S.A.	6
5. Solanum (aff. S. nigrum) for Dr. J. Edmonds, Botany School, Cambridge.	13
6. Labiatae, for Dr. R. M. Harley, Royal Botanic Gardens, Kew.	13
7. Begonia material for general horticultural interest (including B. veitchii, B. davisii B. pennellii, B. bracteosa and B. cinnabarina)	26
8. Orchidaceae for Mr. P. F. Hunt, Royal Botanic Gardens, Kew.	17
9. Galinsoga, Senecio and Taraxacum for Professor Th.Sørensen, University of Copenhagen.	15
10. Caryophyllaceae and Ranunculaceae for Professor T. W. Böcher, University of Copenhagen.	8

5. COLLECTIONS (POTATOES)

Some 40 species of wild and all seven cultivated species have been reported for Bolivia. Undoubtedly some of the wild species names are synonyms and it seems possible that the numbers could be reduced even further, to perhaps about 25 or so, with a few well-distributed hybrids.

Good representative collections of living material have been needed to help solve the problems of synonymy and, even more important, to promote an understanding of variation patterns, breeding systems and breeding barriers in the Bolivian potatoes.

Most collecting expeditions to Bolivia were primarily designed to obtain plant breeding material, rather than for taxonomic purposes, whilst many species had been described on the basis of single collections, often of dried material only. Thus without a wide range of living collections of each species the ecotypic and phenotypic variation could not be adequately assessed and the boundaries between species such as S. candolleanum and S. virgultorum or within the weed group S. sparsipilum/sucrense/oplocense were completely obscure In the latter group and indeed in S. oplocense itself it was suspected that some of the morphological variation might be ascribed to polyploidy or to complex patterns of hybridisation and introgression. Again, the possibly hybrid species, such as S. berthaultii, S. doddsii and S. ajanhuiri deserved close investigation before unequivocal statements on their origin could be made.

Many collections of living material were essential therefore to solve such problems and to link the weed potatoes of Bolivia to those of southern Peru. Work has been in progress at Birmingham for the past three years on the role played by weed species in the evolution of cultivated tetraploid species, but more material from Bolivia and Peru was needed to throw further light on this problem.

The potato species collected during the expedition are listed in Table 3, and work has been started to investigate their taxonomy and relationships. It is interesting to note that two Argentine species, S. vernei and S. venturii have now been found for the first time in Bolivia, whilst the known ranges of other Argentine species have been greatly extended.

TABLE 3 List of potato species collected*

	Series	Species
A. BOLIVIA		
	COMMERSONIANA	S. chacoense
		S. tarijense
		S. yungasense

*Based on J.G. Hawkes (1963) A revision of the tuber-bearing Solanums (second edition) Ann. Rep. Scott. Pl.-Breed. Sta.

CIRCAEIFOLIA	S. capsicibaccatum S. circaeifolium
CONICIBACCATA	S. violaceimarmoratum
ACAULIA	S. acaule
CUNEOALATA	S. infundibuliforme
MEGISTACROLOBA	S. boliviense S. megistacrolobum
TUBEROSA (WILD)	S. achacachense (= S.pumilum) S. alandiae S. berthaultii S. brevicaule S. candolleanum S. doddsii S. gandarillasii S. leptophyes S. liriunianum S. microdontum S. oplocense S. sparsipilum S. sucrense S. torecillasense S. venturii S. vernei S. vidaurrei
TUBEROSA (CULTIVATED) (PERU & BOLIVIA)	S. ajanhuiri S. chaucha S. curtilobum S. juzepczukii S. phureja S. stenotomum S. tuberosum subsp. andigena

B. PERU

ACAULIA	S. acaule
MEGISTACROLOBA	S. megistacrolobum S. raphanifolium
TUBEROSA	S. bukasovii (S. calcense = S. sparsipilum) S. canasense S. lignicaule S. marinasense S. pampasense S. pillahuatense S. pumilum (?) S. sparsipilum

6. FUNDING

We should like to record here our grateful thanks to the Royal Society and to the Trustees of the Percy Sladen Memorial Fund for kindly providing full financial support for the European members of this expedition, and to the International Potato Centre, Lima, Peru, for the loan of a vehicle.

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