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Colombia and Venezuela 1992 wild potato (*Solanum* sect. *Petota*) germplasm collecting expedition: taxonomy and new germplasm resources

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Summary

We conducted a joint Colombia/United States/Venezuela wild potato (*Solanum* sect. *Petota* Dumort.) germplasm collecting expedition in Colombia from June 27–August 24, and in Venezuela from August 17–September 15, 1992. The goals of the expedition were to collect germplasm and study the species boundaries of all of the 23 Colombian and Venezuelan taxa accepted by current taxonomists. We made 128 collections of 16 of these taxa, 96 as true seed collections. We collected the first available germplasm collections of *S. cacetanum, S. cuatrecasasii, S. estradae, S. lobbianum, S. orocense, S. paramoense*, and *S. sucubunense*, and obtained germplasm collections of *S. neovalenzuelae* and *S. pamplonense* as a germplasm exchange from the Colombian national germplasm collection. We had problems identifying some of our collections, and currently are investigating them for species status and interrelationships. We summarize the state of germplasm collections for Colombia and Venezuela, provide our field data regarding the taxonomy of Colombian and Venezuelan wild potatoes, and provide recommendations for future collecting.

Introduction

This paper summarizes results of our wild potato (*Solanum* sect. *Petota*) collecting expeditions to Colombia (June 27–August 24, 1992) and Venezuela (August 17–September 15, 1992). The Fondo Nacional de Investigaciones Agropecuarias (FONAIAP), The Instituto Colombiano Agropecuario (ICA), and the National Research Support Program-6 (NRSP-6, formerly known as the Inter-Regional Potato Introduction Project, IR-1) collected in Colombia and Venezuela because few to no germplasm accessions were available (Table 1), the diversity of habitats in the Andes, and the ongoing genetic erosion there. The realized and potential economic value of wild potato species has been the subject of many reviews (e.g., Hanneman, 1989; Hanneman & Bamberg, 1986; Hawkes, 1990; Hawkes & Hjerting, 1969, 1989; Hermundstad & Peloquin, 1986; Ochoa, 1990; Plaisted & Hoopes, 1989; Ross, 1986; Spooner & Bamberg, 1994). These publications detail the many resistances, some of an extreme type, for diseases or pests affecting modern commercial cultivars, and the presence of agronomically important traits. The goals of our expeditions

Table 1. Germplasm holdings at NRSP-6 prior to the 1992 expedition of the *Solanum* sect. *Petota* taxa accepted by Gorbatenko (1980, 1982, 1989), Ochoa (1978, 1979, 1980, 1981, 1982, 1992c), López (1983, 1986), Hawkes (1990)

Colombian species, date of publication	Venezuelan species, date of publication	Combined Colombian and Venezuelan accessions	Total accessions[1]
S. andreanum Baker 1884		2	17
S. bulbocastanum Dunal 1813		0	47[2]
S. cacetanum Ochoa 1980		0	0
S. colombianum Dunal 1852	*S. colombianum*	9	42
S. cuatracasasii Ochoa 1981		0	0
S. donachui (Ochoa) Ochoa 1982[3]		0	0
S. estradae L. López 1983		0	0
	S. filamentum Correll 1961	0	0
S. flahaultii Bitter 1913		0	0
S. garcia-barrigae Ochoa 1978		1	1
S. juglandifolium Dunal 1816	*S. juglandifolium*	1	10
S. lobbianum Bitter 1913		0	0
S. moscopanum Hawkes 1954		5	6
S. neovalenzuelae L. López 1986		0	0
S. ochranthum Dunal 1816		1	15
S. orocense Ochoa 1980		0	0
S. otites Dunal 1852	*S. otites*	0	0
S. pamplonense L. López 1983		0	0
	S. paramoense Bitter 1926	0	0
	S. subpanduratum Ochoa 1979	1	1
S. sucubunense Ochoa 1980		0	0
S. tuquerrense Hawkes 1954		1	18
	S. woodsonii Correll 1961	0	0

[1] Includes accessions collected on the 1991 expedition to Ecuador (see Spooner et al., 1992).
[2] All of these accessions are from Mexico and Guatemala.
[3] Originally published as *S. garcia-barrigae* Ochoa var. *donachui* Ochoa (Ochoa, 1982), and later moved to species rank (Ochoa, 1983).

were to collect germplasm of all 23 species recognized for Colombia and Venezuela by contemporary taxonomists (Table 1), to increase them quickly and make them freely available internationally, and to study their species boundaries and interrelationships.

Materials and methods

Prior to the expedition, we assembled locality data from Correll (1962), the original description literature (Table 1), and herbarium vouchers at the Herbario Nacional Colombiano, Instituto de Ciencias Naturales, Museo de Historia Natural, Universidad Nacional de Colombia, Bogotá (COL, but much of the potato collection was on loan); the herbarium of the Instituto Colombiano Agropecuario, Tibaitatá Experimental Station (ICA), Departamento de Biología, Ciencias Forestales, Universidad de los Andes, Mérida, Venezuela (MER); Herbario Victor Manuel Badillo, Agronomía, Universidad Central de Venezuela, Maracay, Aragua (MY); the herbarium of NRSP-6 at Sturgeon Bay, Wisconsin (PTIS, Bamberg & Spooner, 1994); Universidad Pedagógica y Tecnológica de Colombia, Tunja, Boyacá (UPTC), Herbario Nacional de Venezuela, Caracas (VEN); and the University of Wisconsin-Madison, Department of Botany (WIS); herbarium codes follow Holmgren et al. (1990), the new herbarium code PTIS will appear in the forthcoming edition 9 of that publication.

We found localities with the following geographic references for Colombia: 1) topographic and road

maps for individual departments, scale varies from 1:200,000 to 1:500,000; 2) all available 1:100,000, and 3) 1:200,000 topographic maps; 4) Instituto Geográfico Agustin Codazzi (1980; 1–4 published by the Instituto Geográfico Agustin Codazzi); 5) Mapa Vial de Colombia (1:2,000,000, Rodríguez Publishing, Bogotá, 1991); 6) Paynter & Traylor (1981); 7) United States Department of Interior (1988). For Venezuela: 1) individual state road maps (unspecified scale varies by map, 1976); 2) all available 1:100,000 (published from 1969–1983); 3) 1:250,000 (published from 1970–1985) topographic maps; 4) Mapa Político de la República de Venezuela (1:2,000,000, 1989); Altura de Poblaciones de Venezuela, undated (1–5 available from the Ministerio de Obras Públicas, Dirección de Cartografía Nacional, Caracas) 6) Mapa de Carreteras con Información Turística de Venezuela (1:1,500,000, Promociones Canaima, Caracas, undated), 7) Vila (1976); 8) Paynter (1982); and 9) United States Department of Interior (1961). We visited type localities to the detail permitted by the original descriptions.

We travelled throughout Colombia and Venezuela by jeep, with side trips on foot. Collections in Colombia were from June 27–August 24, 1992, and in Venezuela from August 17–September 15, 1992 (Spooner left for Venezuela a week before the end of the Colombian expedition). All herbarium and germplasm collections from Colombia are labelled Castillo, Pineda, López & Spooner (CPLS) 1200–1312; those from Venezuela are labelled Spooner, Vargas & Rivero (SVR) 6309–6319, or Spooner, León & Varela (SLV) 6321–6342. Luis López later collected true seed of 12 new populations and four populations originally visited when the plants were immature from areas 18, 19, 24, 25, 26, 27, 31, 35 (Fig. 1), during September 15–17, 1992; October 4–8, 1992; October 21–23, 1992; and August 15, 1994. Alvaro Vargas later collected true seed of 11 populations originally visited when the plants were immature from area 4, during October 1, 2, 1992. Later new collections by López are labelled López 1–6, 9, 10, 12–14, 16, 17. We located many new populations by asking the advice of local residents about sites of 'sacha papa' (wild potato), 'papa del monte' (potato growing in the wild) or 'papa silvestre' (wild potato). We deposited sets of herbarium vouchers from Colombia at COL, PTIS, and at the International Potato Center in Lima, Peru (not in Holmgren et al. (1990), but cited in Ochoa's publications as CIP), and herbarium vouchers from Venezuela at CIP, MY, and PTIS. A detailed report, with complete itineraries and details of germplasm and herbarium specimen distribution is deposited at ICA (Tabaitatá Station), NRSP-6, the United States Germplasm Services Laboratory in Beltsville, Maryland, CIP, and the International Plant Genetic Resources Institute (IPGRI, the successor to the International Board of Plant Genetic Resources, IBPGR, at both the Latin America office in Cali, Colombia, and the main headquarters in Rome, Italy). In addition, all locality data are available on-line from the United States Department of Agriculture GRIN (Germplasm Resources Information Network) system.

Results and discussion

Non-tuber-bearing species. *Solanum juglandifolium* grows in Costa Rica, Venezuela, Colombia, and Ecuador, and *S. ochranthum* grows in Colombia, Ecuador, and Peru (Correll, 1962; Rick, 1988). Both are very similar viny species with yellow corollas, classified by Hawkes (1990) in sect. *Petota*, ser. *Juglandifolia* (Rydb.) Hawkes. Recent molecular and morphological studies showed them to be more closely related to tomatoes (*Solanum* sect. *Lycopersicum* (Mill.) Wettst.) than potatoes, and not a part of sect. *Petota* (Spooner et al., 1993a). This expedition found Colombian populations of both species (Table 2). NRSP-6 no longer maintains and distributes these species; responsibility for this has been transferred to the Plant Genetic Resources Conservation Unit in Griffin, Georgia, and the Tomato Genetics Stock Center in Davis, California.

Tuber-bearing species with globose to globose-ovoid fruits. Because few taxonomists agree on affiliations of species to series (Spooner & van den Berg, 1992) we do not use this taxon, and group our collections by fruit shape.

Solanum andreanum. This diploid species ($2n$ = 24) is distributed from southcentral Ecuador (Morona-Santiago Province) to southern Colombia (Departments of Nariño and Putumayo). It grows in moist areas along roadsides and in recently cleared forests, from 1980–3000 m. Our 10 collections of *S. andreanum* in Colombia in 1992, and 22 collections in Ecuador in 1991 (Spooner et al., 1992) allowed us to document better its natural variability and led to the synononyms of other names under *S. andreanum* (Hawkes, 1990; Spooner et al., 1993b). Further explorations in Colombia, Ecuador, and Peru may expand its range.

Table 2. Summary of collections of *Solanum* sect. *Petota* from the 1992 expeditions to Colombia and Venezuela. Numbers in parentheses refer to multiple collections from an area

Species	Geographical areas[1]	Total[2]	Seeds	Tubers	Herbarium
Solanum andreanum	32(3), 33, 34, 40(5)	10	9	1	10
S. colombianum[3]	2(3), 3(3), 4(10), 8(3), 16(2), 17, 18, 20, 21, 22, 23(3), 25(4), 26(2), 27(2), 28, 30(2), 31(6), 33, 34(2), 35(3), 36(3)	54	50	8	53
S. cuatracasasii	6(3)	3	3	1	3
S. donachui	5	1			1
S. estradae	24	1		1	1
S. flahaultii	9, 11(3), 13(2), 14, 15, 16, 17(3)	12	4		10
S. garcia-barrigae	7(3)	3	3		3
S. juglandifolium	18(2), 19(2), 22(3), 40	8	7		8
S. lobbianum	20, 21(2)	3	3		3
S. moscopanum	25(2), 28(3), 29, 30(4), 31	11	10		11
S. ochranthum	25, 38	2	1		2
S. orocense	7(3)	3	3	3	3
S. pamplonense	8(2)	2		2	2
S. paramoense	1(2), 2(3), 3(6)	11	1	8	11
S. sucubunense	31	2	2		2
S. tuquerrense	37, 38	2		2	2
Totals		128	97	25	125

[1] See Fig. 1.
[2] Does not include the 48 Colombian accessions donated to NRSP-6 by ICA. These include germplasm of one accession each of *S. neovalenzuelae* and *S. pamplonense*, earlier collected at the type localities by Luis López (see Results and Discussion).
[3] Includes two accessions collected at or near the type locality of *S. cacetanum* (see Results and Discussion).

Solanum bulbocastanum. This diploid species ($2n$ =24) is distributed mainly from central Mexico to northern Guatemala (Correll, 1962; Hawkes, 1990). There is, however, one disjunct record from the southeastern United States (State of New Mexico, collected in 1912), one record from southern Brazil (State of Río Grande do Sul, 1899), and two records from central Colombia (Department of Boyacá, Chiquinquirá, 1909; Department of Cundinamarca, Chapiñero, 1908 (Correll, 1962). We searched for the Chapiñero record during this trip, and Luis López searched for the Chiquinquirá record in previous years (López, 1986) without success. To date, none of the disjunct records outside Mexico and Guatemala have been collected again.

Solanum estradae. This tetraploid species ($2n$ = 48) has large tubers (up to 10 cm long) and is indistinguishable morphologically from some clones of the tetraploid cultivated species *S. tuberosum.* López (1983) described it as a new species because it persists in the wild and lacks 'cytoplasmic relations' with *S. tuberosum* ssp. *tuberosum.* He provided no data for these cytoplasmic differences, but cited a personal communication from Jack Hawkes, who relayed information from Paul Grun (University of Pennsylvania). Hawkes (1990) repeated this personal communication from Grun, again without providing data, and transferred *S. estradae* to subspecies rank under *S. phureja* Juz. & Buk. (as *S. phureja* ssp. *estradae* (L. López) Hawkes), based on these cytoplasmic differences. Most collections of *S. phureja* are thought to be diploid, but some are thought to be autotetraploid (Ochoa, 1990). Neither Hawkes (pers. comm. to Spooner) nor López examined original data for

these cytoplasmic relations, and Grun (pers. comm. to Spooner) has no recollection of these personal communications. The criteria used to distinguish *S. estradae*, therefore, should be reevaluated.

We visited the type locality of *S. estradae*, in the Department of Quindío, at 1860 m, where it grows naturally in an area of maize and banana plantations. The site was very dry during our visit in 1992 and plants of *S. estradae* were difficult to locate. We found a few plants, but without flowers, fruits, or tubers. López collected tubers at this locality in 1994, and they are being incorporated into the U.S. and ICA germplasm systems.

Solanum paramoense. This species was described from a single herbarium specimen, lacking fruits, collected in 1921 in 'Venezuela, Mérida State, Paramo de la Sal' (Pittier, 1926). Its species status and relationships always have been controversial. Correll (1962) placed this species in ser. *Transaequatorialia*, Ochoa (1979) in ser. *Tuberosa*, Gorbatenko (1989) in ser. *Bukasoviana* Gorbatenko, and Hawkes (1990) in ser. *Tuberosa*, but implied the possibility of ser. *Conicibaccata* Bitter if later collections showed conical fruits. Ochoa (1979) provided the first chromosome count of $2n = 48$, but cited no voucher. Ochoa (1992b) provided the same chromosome count, and an Endosperm Balance Number of 4, again without citing a voucher. Ochoa (1992a) synonymized this species under *S. tuberosum* ssp. *andigena*.

We have two references for the locality of 'Páramo de la Sal': 1) Vila (1976) 'Se eleva al este de la localidad de Piñango' = found in the elevations east of Piñango. 2) the border of the Trujillo State map in Mérida (but curiously not on the Mérida State map) that shows a location approximately 8 km (air distance) east-southeast of the town of Piñango. We located 11 wild populations (SLV 6321, 6323, 6326, 6327, 6329, 6330, 6331, 6333, 6337, 6340, 6342 in areas 1–3 (Fig. 1) that appear similar to the type. Within this area of northeastern Mérida State, *S. paramoense* is common. All populations occur from 3170–3750 m, in boggy organic soil about streams or in patches of organic soil on rocky slopes, in northeastern Mérida state. All collections have tubers with purple skin and deep purple to light purple to white flesh, except SLV 6327, 6330 with tubers with tan skin and white flesh. Only one of these populations (SLV 6337) had fruits, that were globose to globose-ovoid in shape, supporting Hawkes's (1990) placement of this species in his concept of ser. *Tuberosa* (with globose- to globose-ovoid fruits), not *Conicibaccata* (with conical fruits). *Solanum paramoense* may be escaped forms of *S. tuberosum*, supporting Ochoa's (1992a) synonymy with this species.

Because Ochoa (1979, 1992b) cited no vouchers for his collections, chromosome numbers, or EBN determinations, we are unable to verify his observations. Until we complete further morphological, cytological, and molecular studies on our collections we refrain from making determinations on the validity of *S. paramoense* as a species or its possible relationship to *S. tuberosum*. Our collections provide the first available germplasm of possible *S. paramoense*, of interest for breeders and others interested in the evolution of *S. tuberosum*.

Tuber-bearing species with conical or long-ovoid fruits. The remaining species in Colombia and Venezuela (Table 1) have conical to long-ovoid fruits, and are placed by Correll (1962), Gorbatenko (1989), Hawkes (1990), López (1983, 1986) and Ochoa (1979, 1981, 1982, 1992c) in ser. *Conicibaccata*. The only exceptions are *S. tuquerrense,* placed in ser. *Ingifolia* Ochoa by Correll (1962) and Gorbatenko (1989) and in ser. *Piurana* Hawkes by Ochoa (1981) and Hawkes (1990); and *S. lobbianum*, placed in ser. *Conicibaccata* or ser. *Tuberosa* (see below). Not listed in Table 1 is *S. chomatophilum* Bitter. Correll (1962) listed a single Colombian collection of *S. chomatophilum* forma *pilosum* Correll (Fosberg 21053 from southern Colombia, in Nariño Department). Hawkes (1992) synonymized *S. chomatophilum* forma *pilosum* under the Peruvian species, *S. piurae* Bitter. We have not inspected Fosberg 21053 and *S. chomatophilum* never has been relocated in Colombia (López, 1986; this study). It is possible, therefore, that Fosberg 21053 was misidentified.

We had problems identifying many of these collections. The most serious problem was lack of a comprehensive treatment. Because nine of the 15 Colombian and Venezuelan species placed in ser. *Conicibaccata* were described after 1962, Correll (1962) is of limited value for identifications. Ochoa (1981) provided a key to the eight Colombian members of ser. *Conicibaccata* then known, not including the subsequently described Colombian species *S. donachui, S. neovalenzuelae*, and *S. pamplonense*. Hawkes's (1990) latest treatment of sect. *Petota* included 40 species in ser. *Conicibaccata*, distributed from southern Mexico to northern Bolivia. He provided a key, however, to only 23 of these 40 species because he did not see types of the remaining 17, all described by Ochoa. These 17

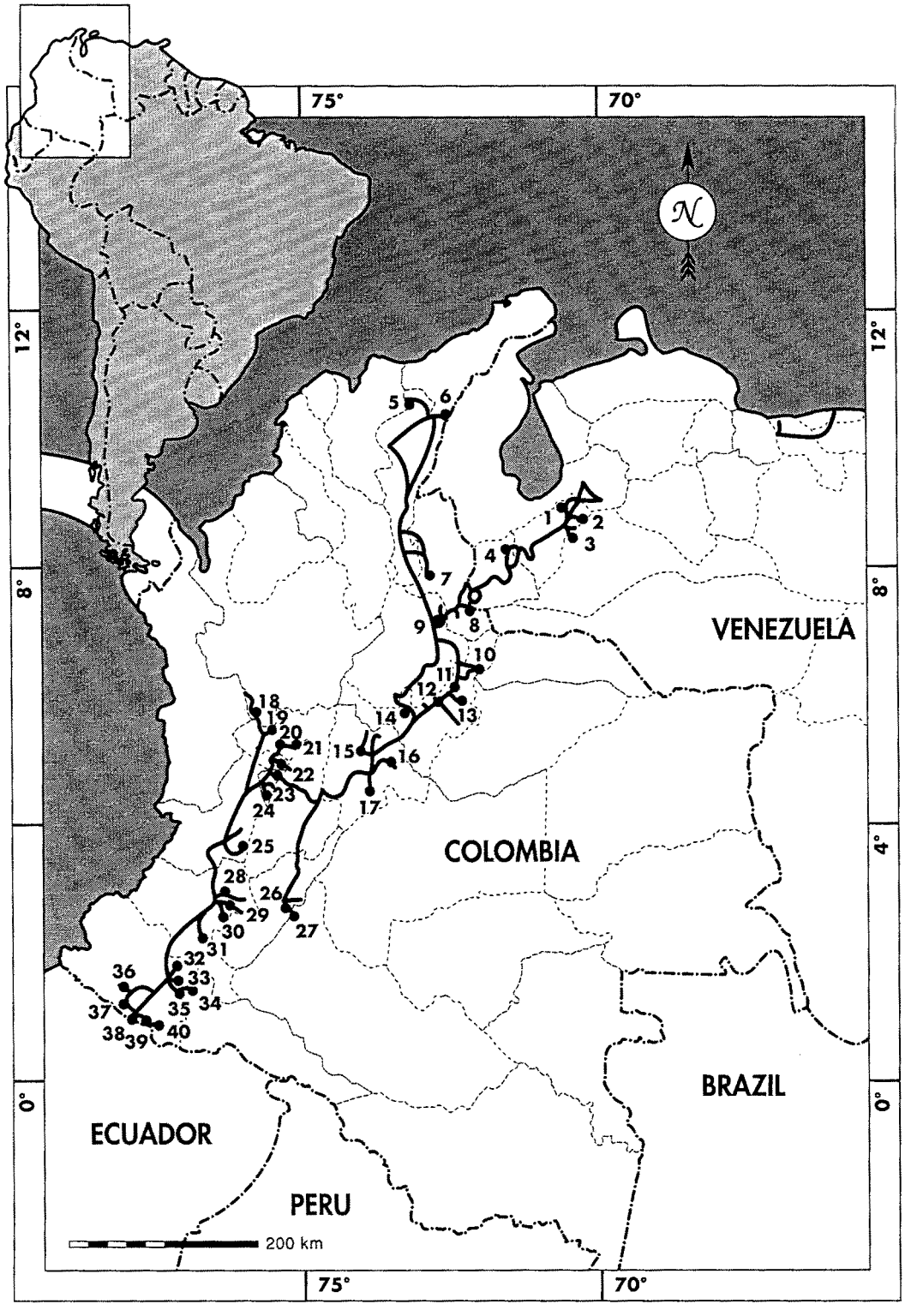

Fig. 1. Routes of the 1992 expedition to Colombia and Venezuela. The numbers refer to generalized collecting sites (see Table 2).

species include the Colombian species *S. cacetanum, S. garcia-barrigae, S. orocense*, and *S. sucubunense*.

In addition, there are disagreements among taxonomists on species boundaries. For example, Hawkes (1990) synonymized *S. cuatrecasasii* under *S. otites*, and *S. filamentum* under *S. colombianum*. Ochoa (1979) listed *S. filamentum* as an invalid species but did not provide synonymy to any species, and he suggested that *S. woodsonii* does not occur in Venezuela (listed for Panama and Venezuela by Correll, 1962; for Costa Rica, Panama and Venezuela by Hawkes, 1990). Also, criteria for recognizing these sometimes very similar species are not always clear. For example, Hawkes (1990) distinguished in his keys and descriptions *S. colombianum* by its interjected leaflets, yet synonymized *S. filamentum* under it. *Solanum filamentum* is known only from a single type specimen, and it completely lacks interjected leaflets.

Our field observations and collections show much intrapopulational variability within the conical-fruited species. This variability sometimes encompasses ranges of characters used to define more than one species. Some of these species may later be synonymized. We now identify our collections to the species expected from the type locality if they match the type description, and identify the others as *S. colombianum*. Our identifications may change when we complete our morphological and molecular studies of these collections.

Most of these populations grow from 2700–3500 m, in organic soils, in full sun to partial shade. Most grow in disturbed sites such as in recently burned or logged woods, or roadsides. Populations can be small and difficult to locate, or large, comprising scores of individuals. We provide below our field observations and literature references of our collections that illustrate problems we encountered in taxonomy.

Solanum cacetanum. Ochoa (1980) described this species, but later (Ochoa, 1992a) synonymized it under *S. colombianum*. The type locality: 'Colombia, Dept. Caquetá, western side of Alaska Mountain, near Villa Claudia, 2700 m' is ambiguous, because Alaska Mountain and Villa Claudia do not appear on any of our geographic references. Ochoa told us that the type locality was near Algeciras. No long-time residents of Algeciras or nearby areas we questioned heard of these places. We located a small hill about 35 km east of Algeciras, at 2200 m, called 'potrero Alaska', but the type locality mentioned 2700 m. The locality of Alaska Mountain, its possible relationship to potrero Alaska, and the exact type locality of *S. cacetanum*, therefore, are unknown. We made two collections (CPLS 1267, 1268, area 27) just inside the border of Caquetá from the Department of Huila, east of the town of Algeciras, at 2400 and 2680 m, that may be at or near the type locality. These collections match the description of *S. cacetanum*, but we group them under *S. colombianum* in Table 2 because of Ochoa's (1992a) synonymy.

Solanum colombianum. Our 54 collections here grouped under this species encompass much variability that may contain more than one species. These include collections with pentagonal, pure white, small (12–15 mm radius) corollas, and others with rotate pentagonal to rotate, white tinged with violet, larger corollas (14–16 mm radius). The unresolved questions of taxonomic limits of this species are discussed by Spooner et al. (1992).

Solanum cuatrecasasii. Ochoa described this species in 1981 (Ochoa, 1981). Hawkes (1990) later synonymized it under *S. otites*. We collected mature fruits of this Colombian species at its type locality in the Department of César, in the Sierra de Perijá, near the border with Venezuela (CPLS 1291), and ca. 3 km north from there (CPLS 1292). Our collections lack interjected leaflets and have long petiolules similar to the type, and additionally have distinctive conical fruits with sharp pointed apices.

Solanum donachui. Ochoa (1982) described this conical-fruited taxon as a variety of *S. garcia-barrigae* (as *S. garcia-barrigae* Ochoa var. *donachui* Ochoa) from a single herbarium collection made from the Sierra Nevada de Santa Marta in northern Colombia (H. García Barriga & R. Jaramillo M. 20618). He provided no reasons for the putative relationship to *S. garcia-barrigae*, or any explanation of how it differed from other members of ser. *Conicibaccata*. The following year, he (Ochoa, 1983) transferred this taxon to species rank (as *S. donachui* (Ochoa) Ochoa), without comment. Three years later, he (Ochoa, 1986) described the species again, from the same type specimen, with a similar, but different description, without reference to his earlier publication, and provided the superfluous name *S. donachui* Ochoa. Our collections from the type locality yielded one collection (CPLS 1300), similar to some of our collections of *S. colombianum* with immature conical fruits and immature tubers. The tubers unfortunately died, and we have no germplasm, therefore, of this taxon. The area of the type is now almost completely converted to pasture land.

Solanum flahaultii. Correll (1962), Gorbatenko (1989), Ochoa (1981), and Hawkes (1990) accepted *S. flahaultii* and *S. paucijugum*, but Hawkes (1990) stat-

ed that *S. flahaultii* is very similar to *S. paucijugum*. *Solanum flahaultii* was thought to be distributed in Venezuela, Colombia, and possibly Ecuador, and *S. paucijugum* in Ecuador (Correll, 1962; Hawkes, 1990). Spooner et al. (1992) provided a synopsis of the morphological characters that have been used to distinguish these species. We identify all of our collections as *S. flahaultii* (CPLS 1200, 1269, 1270, 1271, 1276, 1278, 1280, 1282, 1283, 1284).

Solanum garcia-barrigae. This species was distinguished by Ochoa (1978, 1981) by its small stature (< 15 cm tall). The exact locality of the type collection (H. García Barriga & R. Jaramillo 20618) was provided to us by R. Jaramillo. Our three collections there (CPLS 1301, 1302, 1305) showed a diversity of heights from 10 cm–120 cm tall. The species appears similar to *S. flahaultii*.

Solanum lobbianum. This species illustrates two common problems in sect. *Petota* about the association of a type specimen with a species: 1) The single type specimen (at the Royal Botanic Gardens, Kew) lacks precise locality data, collection date, or collection number. The only information on the sheet is 'Lobb, Columbia' (sic). 2) The specimen lacks fruits.

Three facts complicate the locality of *S. lobbianum* (Killip, 1932): 1) The place name 'Columbia' is ambiguous because of changing political boundaries and name changes involving Colombia, Ecuador, and Venezuela in the mid-1800's, 2) 'Columbia' possibly was added to the collection by someone other than Lobb, and 3) many of Lobb's 'Col[o]mbian' collections are the only Colombian representatives of species growing elsewhere, and are now implied to be mislabelled (Hawkes, 1992; Killip, 1932).

Bitter (1913) described *S. lobbianum*. It is small in stature (< 20 cm tall), with pinnately compound leaves, many interjected leaflets, and has a blue, rotate corolla. Fruits are lacking. A distinctive feature of the type is its dense pubescence, especially on the under surface of the leaves and in the inflorescence.

Because of the problems with incomplete morphology and vague locality data that hinder the association of the type of *S. lobbianum* to other collections, other sources have been sought to imply its locality and apply this name to known populations. Unfortunately, sources for Lobb's travels are scant. William Lobb (b. 1809, d. 1864) was a professional collector for the English horticultural firm of James Veitch and Sons, nurserymen specializing in the importation of rare novelties. Information on Lobb's travels written by his employers (H. Veitch, 1881; J. Veitch, 1906) provides scant data. Because of the value of his collections, Lobb likely operated under enforced secrecy regarding his itinerary. All of his letters to his firm unfortunately were destroyed when they went out of business (Killip, 1932). Lobb collected in South America from 1840–1848, with a brief respite home to England in 1844/1845. Secondary sources on Lobb's life and travels (Dallimore, 1932; Desmond, 1977; Eastwood, 1911; Ewan, 1973; Hunkin, 1942; True, 1980) provide no new data relevant to the location of *S. lobbianum*. Inferences of Lobb's itinerary come from data of presently-known distributions of his other collections, and from extant copies of letters (in the Kew archives) written by J. Veitch and others about Lobb (Hawkes, 1992). These sources show that Lobb's South American travels were wide-ranging, including Brazil, Argentina, Chile, Peru, Ecuador, southern Colombia, and possibly even Venezuela (Killip, 1932).

Hawkes (1992) and Ochoa (1992c) provided different hypotheses of the identity of *S. lobbianum*. Hawkes (1992) identified two wild potato collections with short-conical fruits made in central Ecuador (Chimborazo Province, Spooner, Castillo, and López 5071, 5138, May, 1991) as *S. lobbianum*, but Spooner et al. (1992) tentatively identified these collections as *S. paucijugum*. Hawkes (1992) attempted to discount a Colombian locality for the type. He cited correspondence in the Kew archives to document Lobb's travels in South America as far north as southern Colombia, and infers he went no farther. He quoted, however, one letter (Kew archives Volume XX, letter 297) 'Lobb has left Quito (Ecuador) and gone to Popayán (Colombia) on his way to Venezuela'. Because of the scant evidence for Lobb's travels, Hawkes's (1992) argument that Lobb did not venture farther north than southern Colombia during his entire eight-year stay in South America is unwarranted.

Ochoa (1992c), on the other hand, identified two collections with long-conical fruits made in central Colombia (Manizales Department, slopes of Volcán Ruiz, Ochoa 14109, 14110, July, 1980) as *S. lobbianum*. We also collected wild potatoes with long-conical fruits on the slopes of Volcán Ruiz (CPLS 1211, 1213, 1214) that have overall leaf shape and pubescence very similar to the type of *S. lobbianum*. These collections have rotate, pale-violet corollas and co-occur with other wild potato species (CPLS 1212, 1215) with smaller white corollas and long-conical fruits that we tentatively identified as *S. colombianum*. Hawkes (1990) placed *S. lobbianum* in ser. *Tuberosa*. Later, Hawkes (1992) suggested a relationship with *S.*

multidissectum from Peru. Ochoa (1992c) placed the species in ser. *Conicibaccata*.

Solanum moscopanum. Hawkes (1954) distinguished this species from *S. colombianum* ($2n = 48$) by its hexaploid chromosome number ($2n = 72$), 10-lobed, pale blue corollas, and pubescent filaments. Later (Hawkes, 1990) he distinguished *S. moscopanum* by its 10-lobed corollas, and stated that *S. colombianum* was a polymorphic species that had white to mauve corollas. Our collections at the type locality (area 29) showed two distinct morphotypes of conical-fruited species: those with large violet corollas (14–18 mm radius) with a white 'star' (white stripes radiating from the center of the corolla to the apex of the corolla lobes) abaxially that we identified as *S. moscopanum* (CPLS 1244, 1246, 1247, 1249) and those with small white corollas (12–15 mm radius) that we identified as *S. colombianum* (CPLS 1245, 1248). The two species were easily distinguishable. Other collections of the *S. moscopanum* morphotype were found to the south and north of the type locality (Table 2; Fig. 1, map areas 25, 28, 30, 31).

A similar pattern of the co-occurrence of *S. colombianum* and a separate conical-fruited species occurs with collections we tentatively identified as *S. lobbianum* (see above). We made many other Colombian and Venezuelan collections of conical-fruited species with pure white corollas, pure violet corollas, and sometimes both intermixed within populations (e.g. SVR 6315, 6316, map locality 4). Spooner et al. (1992) documented similar patterns of co-occurrence of white and violet corolla colors of conical-fruited species from Ecuador.

Solanum neovalenzuelae. We revisited the exact type locality, originally collected and described by one of us (López, 1986). The original collection site was destroyed by a landslide and the area was extremely dry on our visit in 1992, and we found no plants. After the collection of the type in 1981, much of the area was cleared and converted to pasture land. Fortunately, we obtained germplasm as true seeds of this species from the ICA collection.

Solanum orocense. Ochoa (1980) described this species from a single herbarium collection (H. García Barriga & R. Jaramillo 20724). The exact locality of the collection was provided to us by R. Jaramillo. It is at the same place as the type locality of *S. garcia-barrigae*. The original description of this species (Ochoa, 1980) is similar to other conical-fruited species in Colombia and Venezuela, and provides no diagnosis to similar species. Ochoa's key to Colombian representatives of ser. *Conicibaccata* (Ochoa, 1981) distinguished *S. orocense* with corollas pure white, from *S. colombianum* with corollas white, tinged with blue, mauve, or light purple. Our three collections at the type locality (CPLS 1303, 1304, 1306) match the type description and appear similar to other collections we identified as *S. colombianum*.

Solanum pamplonense. We revisited the exact type locality, originally collected and described by one of us (López, 1983). The plant was common there, but we could not find mature fruits. Fortunately, we obtained germplasm as true seeds of this species from the ICA collection.

Solanum sucubunense. This species is known only from the type, 'Colombia'. Cauca: Macizo (Mountain) Colombiano, Valle de las Papas, near Valencia, Los Andes, 2910 m, near Río Sucubun, Pinto & Bischler 3821 (Ochoa, 1980). The description mentions very large violet corollas (over 3 cm in diameter). We found these large violet corollas (with white radiating stripes) to be common in our collections of *S. moscopanum*, including our two collections of *S. moscopanum* at the type locality of *S. sucubunense* (CPLS 1255, López 12; area 30). We have not seen the type of *S. sucubunense*, but the description, and our collections along the Sucubun river lead us to suspect that it is synonymous with *S. moscopanum*.

Solanum tuquerrense. This species apparently is confined to southern Colombia and adjacent northern Ecuador (Hawkes, 1990). Both of our collections (CPLS 1217, 1221) unfortunately lacked fruits. It is a distinctive species unlikely to be confused with any other (Spooner et al., 1992).

Unidentified collections. In the department of Cesár, ca. 6 km east (uphill) of the type locality of *S. cuatrecasasii* (see above), we located a single population of a morphologically distinctive wild potato (CPLS 1296). The leaves are 1–3 jugate, but the terminal leaflet is much larger than the laterals. This collection has conical fruits (1.2 cm long, 0.9 cm wide), but they are much smaller than any other we have observed in other conical-fruited collections. Similarly, ca. 3 km beyond this locality we located a single population of a wild species that we cannot identify (CPLS 1297). These plants look very similar vegetatively to *S. colombianum*, but with globose-ovoid, not conical fruits.

Ideas for future collecting in Colombia and Venezuela. Productive germplasm collecting expeditions are best conducted with: 1) a thorough review of the taxono-

my of the group, 2) an assembly of all locality data from the literature, germplasm records, herbarium visits, and consultation with local experts, 3) acquisition of the most up-to-date road and topographic maps for the region, 4) educated guesses on new areas to explore based on existing distributional, geographical, and ecogeographical criteria. Because of the large areas involved in most expeditions, it is impossible for all sites to be explored on an individual trip. Also, unforeseen events may hinder collections as the severe drought experienced in Colombia and Venezuela that impeded or delayed the reproduction of wild potato populations. Based on our visits to areas where we found immature potato populations, our observations of areas passed by, and inferences of good collecting sites based on our surveys of topographic maps, we suggest the following areas for future collections of wild potatoes in Colombia and Venezuela:

Colombia. Departments of Antioquia and Chocó: The Cordillera Occidental and Cordillera Central reach their northern limits in these Departments, and have elevations up to 4000 m. A herbarium specimen at COL documented the following locality of *S. colombianum* north of previously known records in the Cordillera Occidental: 'Colombia. Dept. Antioquia: Municipio de Salgar, camino de ascenso a Cerro Plateado, 2700–3300 m, Dec. 4, 1985, P. Franco, G. Galeano, C.I. Orozco & G. Lozano.' Luis López revisited this area on September 15, 1992, could not find the plant, but the area should be searched again in a wet year when wild potatoes may be more common. Boyaca: Eastern slopes of the Sierra Nevada del Cocuy. Caldas: Volcán del Ruiz and Nevado del Quindío. We found many collections of *S. colombianum* and possible *S. lobbianum* from the Volcán del Ruiz. César: Sierra de Perijá. This area has frequent rains, much remaining primary forest, deep organic soils, and apparently ideal habitats for wild potatoes. This is the type locality of *S. cuatrecasasii*, and we found two other morphologically distinct collections (see above). Cundinamarca: Páramo de Guasca, across the Cordillera to Caquetá. Tolima: Volcán del Tolima. Huila: Volcán de Huila. Magdalena: All slopes of the Sierra Nevada de Santa Marta. The extensive area of this isolated mountain, incorporating the highest elevations in Colombia, contains the type locality of *S. donachui*. Huila: Cordillera Oriental near Caquetá. Norte de Santander and Santander: Páramo del Almorzadero, Páramo de Fontibón. General: *Solanum andreanum* and other species may extend up the eastern slopes of the Cordillera Oriental, at elevations of 1980–3000 m. This area has few roads, and the lack of records here may be a result of few explorations in the area.

Venezuela. Aragua State and immediately adjacent Distrito Federal: 1) The hills above Colonia Tovar, 2) El Avila, a national park on the hill bordering the north of Caracas. These areas are at the northeastern-most collection areas for sect. *Petota* in South America. We documented the following localities for *S. colombianum* and *S. otites* from records in Correll (1962) and examination of herbarium sheets at the Herbario Nacional de Venezuela: 1) Aragua State: Near Colonia Tovar, Moritz, 829, Fendler 971; Distrito Federal: Caracas, Linden 420. These records were collected from 1842–1857, and to our knowledge have not been collected from these areas since these dates. We searched the hills above Colonia Tovar without success. The severe drought in 1992 may have hindered the emergence of wild potatoes that year, or they truly may be extirpated. However, there are many suitable habitats near Colonia Tovar that appear to us to be ideal habitats for wild potatoes. Correll (1962) incorrectly lists the collection by Fendler 971 as having been made in Mérida State, instead of in Aragua State, because he likely confused the town of Tovar (in Mérida State) with Colonia Tovar. Tovar is in a dry valley at 1000 m and an unlikely locality for *S. colombianum*. There are mesic woods in the mountains south of Tovar, however, in elevations over 3000 m, that may harbor populations of wild potatoes. Mérida: 1) Chachopo to La Venta to Pico El Aguila, 2) Mucubají to Santo Domingo, in the valleys and páramos south of this road, 3) Pueblo Llano to Tuñame, 4) Apartaderos to Mucurubá, 5) Mérida to La Culata, 6) El Hatico to one-half way to Piñango (this is the general area for *S. subpanduratum*, and we found our sole fruiting population of *S. paramoense* here (but no populations of *S. subpanduratum*). This area is very dry and overgrazed, but potatoes should be searched for in the many narrow, isolated, and mesic quebradas, 7) Mérida, west to Jají, 8) Valley to the east of the path from the fourth to the third teleférico stations north of Mérida, 9) Throughout the south side of the crest of both the Sierra Nevada and the Sierra de Santo Domingo. One route across the Sierra Nevada would be to take the path south over the Sierra, beginning from the fourth station of the teleférico north of Mérida. Trujillo: High páramos southeast of the road from Las Mesitas to Niquitao, 2) The páramos on the border with Trujillo and Lara States (Páramo Cendé, Páramo Jabón, Páramo de las Rosas). Trujillo forms the northeastern border of the high Andes in South America. There are no unambiguous locality records from Trujillo State,

because the only records from this area are collections by Linden 426, 427, 473, that state simply 'Andes of Trujillo and Mérida'. Correll (1962) identifies these collections as *S. colombianum, S. otites*, and *S. woodsonii*. Táchira: 1) Páramo de Tamá, 2) Queniquea to Morretón to San José de Bolívar. Many of these areas in Colombia and Venezuela have no roads, and extensive hiking or travel with horses, and camping would be required.

New Germplasm Resources. The expedition collected from southwestern Colombia (Ipiales, map locality 38, Fig. 1, 0°50′N, 77°50′W), to northeastern Colombia (the Sierra de Perijá in Cesár Department, map locality 6, 10°22′N, 72°48′W), and throughout the high Andes of western Venezuela from the Colombian border, east to the border of the high Andes in north central Venezuela (locality 2 at 8°47′N, 70°48′W). We searched unsuccessfully for potatoes in the coastal hills of Aragua State and immediately adjacent Distrito Federal (10°20′N, 67°16′W). We collected at elevations of 1750 m (*S. estradae*) to 4310 m (*S. flahaultii*).

This expedition resulted in 101 collections from Colombia and 27 collections from Venezuela; 96 of these are true seed collections (Table 2). We collected the first available germplasm collections of *S. cacetanum, S. cuatrecasasii, S. estradae, S. lobbianum, S. orocense, S. paramoense,* and *S. sucubunense*. Also, ICA donated 48 wild potato collections of various species, most of them currently identified as *S. colombianum* and *S. flahaultii*. Of great value are two ICA collections not obtained on this trip, one accession each of *S. neovalenzualae* and *S. pamplonense*.

Seed, tuber and *in vitro* collections from the Colombia expedition are deposited at ICA and NRSP-6. At the request of FONAIAP and the Centro Nacional de Recursos Fitogenéticos, all seed from the Venezuela expedition was taken to the United States to insure the first increase and insure reintroduction into Venezuela. When seed are increased at NRSP-6, samples of the first increase will be sent to ICA and the Centro Nacional de Recursos Fitogenéticos. Some germplasm collected as true seed is available from NRSP-6, and USDA quarantine still is processing the remaining true seed and tuber collections. Some germplasm listed in Table 2 will not be available because the seeds did not germinate or tubers failed to pass quarantine; final status of germplasm introductions can be obtained later at NRSP-6.

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