Taxonomy and New Collections of Wild Potato Species in Central and Southern Peru in 1999

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ABSTRACT

Peru contains about half of the described wild potato taxa, and many of these are not yet preserved in genebanks. This paper reports results of the second of a series of five planned collecting expeditions to Peru. Collections were made in the central Peruvian departments of Ancash, Huancavelica, La Libertad, and Lima, from March 8 to April 25, 1999. They follow collections in 1998 in the southern Peruvian departments of Apurímac, Arequipa, Cusco, Moquegua, Puno, and Tacna. We collected 101 germplasm accessions, including first germplasm collections of the following 22 *Solanum* taxa: *Solanum amayanum*, *S. anamatophilum*, *S. arahuayum* (lost in germplasm increase), *S. augustii*, *S. bill-hookeri*, *S. cantense*, *S. chavinense*, *S. chomatophilum* var. *subnivale*, *S. chrysoflorum*, *S. gracilifrons*, *S. hapalosum*, *S. huarochiriense*, *S. hypacrarthrum*, *S. jalcae*, *S. moniliforme*, *S. multiinterruptum* f. *longipilosum*, *S. multiinterruptum* var. *machaytambinum*, *S. peloquinianum*, *S. rhombilanceolatum*, *S. simplicissimum*, *S. taulisense* (lost in germplasm increase), and *S. wittmackii*. In addition, new collections were made of the under-collected species *S. hastiforme* (three collections). The above taxonomy is that used in planning our expedition, that we compare to a new treatment of Peruvian wild potatoes published by C. Ochoa in 1999. This paper reports the collection and new species identifications of the 1999 collections, and germplasm conservation and survival of the 1998 and 1999 collections. In addition, chromosome counts are provided for 134 accessions from the 1998 and 1999 expeditions, including first reports for *S. chomatophilum* var. *subnivale* ($2n = 2x = 24$), *S. megistacrolobum* subsp. *purpureum* ($2n = 2x = 24$), and *S. multiinterruptum* var. *multiinterruptum* f. *albiflorum* ($2n = 2x = 24$); we also report the first triploid count of an accession of *S. immite*.

RESUMEN

El Perú tiene aproximadamente la mitad de las taxa

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ADDITIONAL KEY WORDS: *Solanum* sect. *Petota*.

EXPLANATION OF ABBREVIATIONS:
CIP, International Potato Center (Centro Internacional de la Papa), and a herbarium code used by this organization for their herbarium in La Molina, Peru
CGN, Centre for Genetic Resources, The Netherlands
INIA, Instituto Nacional de Investigacion Agraria (National Institute for Agrarian Research), Peruvian Ministry of Agriculture
IPK, Institut für Pflanzengenetik und Kulturpflanzenforschung, Gatersleben, Groß Lüsewitz, Germany
MOL, Herbario Weberbauer, Departamento de Biología, Sección Botánica, Universidad Nacional Agraria, La Molina, Peru
NRSP-6, National Research Support Program-6, Sturgeon Bay, Wisconsin, USA (the United States potato genebank, formerly called the Inter-Regional Potato Introduction Project, IR-1)
PTIS, Herbarium of NRSP-6
WAG, National Herbarium Nederland, Wageningen University branch, Wageningen, The Netherlands

de papa silvestre descrita, muchas de las cuales aún no están conservadas en bancos genéticos. Este articulo consigna los resultados de la segunda de una serie de cinco expediciones planificadas de recolección en el Perú. Se colectó en los departamentos de Ancash, Huancavelica, La Libertad y Lima, entre el 8 de marzo y el 25 de abril de 1999. Fueron la continuación de colecciones realizadas en 1998 en el sur del Perú, en los departamentos de Apurímac, Arequipa, Cusco, Moquegua, Puno y Tacna. Recolectamos 101 accesiones de germoplasma, incluyendo las primeras colecciones de germoplasma de las siguientes 22 taxa de *Solanum*: *Solanum amayanum*, *S. anamatophilum*, *S. arahuayum* (perdida al incrementar germoplasma), *S. augustii*, *S. bill-hookeri*, *S. cantense*, *S. chavinense*, *S. chomatophilum* var. *subnivale*, *S. chrysoflorum*, *S. gracilifrons*, *S. hapalosum*, *S. huarochiriense*, *S. hypacrarthrum*, *S. jalcae*, *S. moniliforme*, *S. multiinterruptum f. longipilosum*, *S. multiinterruptum* var. *machaytambinum*, *S. peloquinianum*, *S. rhombilanceolatum*, *S. simplicissimum*, *S. taulisense* (perdida al incrementar germoplasma) y *S. wittmackii*. Además, colectamos una especie poca colectada: *S. hastiforme* (tres colecciones). La taxonomía aquí usada es la del planeamiento la expedición que fue comparada con el nuevo tratamiento de papas silvestres peruanas publicado por Carlos Ochoa en 1999. Este articulo informa sobre la colección y la identificación de nuevas especies de las colecciones de 1999 y de la conservación y supervivencia del germoplasma de las colecciones de 1998 y 1999. Asimismo, se proporciona el conteo de cromosomas de 134 accesiones de las expediciones de 1998 y 1999, incluido el primer reporte de *S. megistacrolobum* subsp. *purpureum* (2n = 2x = 24), S. *multiinterruptum* var. *multiinterruptum* f. *albiflorum* (2n = 2x = 24) y *S. velardei* (2n = 2x =24); también informamos sobre el primer conteo de triploide de una accesión de *S. immite*.

INTRODUCTION

Wild and cultivated potato species have proven value in breeding programs for disease resistance, environmental tolerances, and other agronomic traits of interest (Ross 1986; Hawkes 1990; Spooner and Bamberg 1994; Ochoa 1999; Jansky 2000). Peru contains about one-half of the described wild potato taxa, and many of these are not yet preserved in genebanks. This paper reports collections in the departments of Ancash, Huancavelica, La Libertad, and Lima, from March 8 to April 25, 1999. This is the second of a series of five planned collecting expeditions to Peru, and follows collections made in 1998 in the southern Peruvian departments of Apurímac, Arequipa, Cusco, Moquegua, Puno, and Tacna. This paper details the collection and taxonomy of the 1999 collections, germplasm survival of the 1998 collections, and chromosome counts of 1998 and 1999 collections.

We planned and conducted our 1998 and 1999 collections prior to a monograph of the Peruvian wild potatoes (Ochoa 1999). These prior data (mainly Hawkes 1990, see Spooner *et al.* 1999) documented 36 wild potato taxa in the targeted central Peruvian departments of Ancash, Huancavelica, La Libertad, and Lima. A total of 24 of these taxa had no germplasm collections in any genebank worldwide (Spooner *et al.* 1999). The goal of this expedition was to collect these 24 taxa and other rare taxa.

MATERIALS AND METHODS

The report of the 1998 expedition (Spooner *et al.* 1999) contains details not repeated here regarding permission to collect, ecogeographic data, a list and map of Peruvian type localities of wild potatoes for all of Peru, and further details on taxonomy that relates to this report. All methods reported there were followed on the 1999 expedition, with the exception of the targeted collection areas in central Peru, rather than southern Peru. Herbarium vouchers were deposited at the herbaria of CIP, MOL, PTIS, and WAG (herbarium codes MOL and WAG follow Holmgren *et al.* [1990]; PTIS will apprear in the next edition; CIP is not listed there). An unpublished report of this expedition that includes many details not reported here is deposited at CIP, CGN, INIA, IPK, NRSP-6, and other genebanks.

In addition, we obtained somatic chromosome counts of germplasm of the 1998 and 1999 collections, grown in greenhouses at the CIP station in Huancayo, Peru. Mitotic counts were obtained from root tips by the acetocarmine squash technique (Smith 1974).

Ochoa (1999) was not available for trip planning until after both the 1998 and 1999 expeditions were completed. We changed the identifications of some of our 1998 collections based on taxonomic changes in Ochoa (1999). We also made changes based on observation of more mature plants of 1998 and 1999 collections at the CIP station in Huancayo, Peru, in March 2000 (Tables 1, 2).

TABLE 1—*Prior germplasm collections at NRSP-6 and new germplasm collections made on the 1999 expedition in central Peru. The taxonomy of this list differs from that in the report of the 1998 expedition (Table 2 of Spooner* et al. *1999) by the incorporation of taxonomic changes of Ochoa (1999), by the deletion of* S. limense, *shown by Ochoa (1962, pg. 297) to be a synonym of* S. chacoense, *and by the listing of taxa in all departments in which they were collected in 1999.*

Department	Taxon	Prior germplasm collections from Peru (all departments) at NRSP-6	New germplasm collections from each department in 1999
Ancash	*S. albicans* (Ochoa) Ochoa	19	2
	S. anamatophilum Ochoa	0	1
	S. ancophilum Correll[1]	0	4
	S. augustii Ochoa	0	1
	S. ×*blanco-galdosii* Ochoa[2]	4	1
	S. chomatophilum Bitter var. *chomatophilum*	18	1
	S. chomatophilum var. *subnivale* Ochoa	0	2 (1 lost)
	S. dolichocremastrum Bitter[3]	4	3
	S. medians Bitter, ploidy and variety undetermined[4]	9	1
	S. multiinterruptum var. *multiinterruptum*[5]	0	9 (2 lost)
	S. orophilum Correll	1	1
	S. peloquinianum Ochoa	0	2
	S. sogarandinum Ochoa	2	1
Huancavelica	*S. amayanum* Ochoa	0	1
	S. bill-hookeri Ochoa	0	1
	S. brevicaule Juz.[6]	168	1
	S. gracilifrons Bitter	0	1
	S. huancavelicae Ochoa[7]	0	1
La Libertad	*S. albicans* (Ochoa) Ochoa	see Ancash	3
	S. ×*blanco-galdosii* Ochoa[2]	see Ancash	1
	S. chiquidenum Ochoa var. *chiquidenum*[8]	5	2
	S. chomatophilum var. *chomatophilum*	see Ancash	3
	S. hastiforme Correll	1	3
	S. immite Dunal	See Lima	1
	S. jalcae Ochoa var. *jalcae*[9]	0	3
	S. mochiquense Ochoa[10]	4	0
	S. multiinterruptum var. *machaytambinum* Ochoa	0	1
	S. sogarandinum Ochoa	2	3
	S. taulisense Ochoa	0	1 (lost)
	S. yamobambense Ochoa	0	0
Lima	*S.* ×*arahuayum* Ochoa[11]	0	1 (lost)
	S. brevicaule Juz.[6]	168	1 (lost)
	S. cantense Ochoa	0	4
	S. chancayense Ochoa[10]	2	0
	S. chomatophilum var. *chomatophilum*	See Ancash	1
	S. huarochiriense Ochoa	0	1

RESULTS AND DISCUSSION

Taxonomic Overview

The target species and germplasm holdings prior to the 1999 expedition for the central Peruvian departments of Ancash, Huancavelica, La Libertad, and Lima are presented in Table 1. This is a subset of Table 2 of Spooner *et al.* (1999) for these four departments, and with taxonomic changes by Ochoa (1999). As detailed in Table 1, these involve four classes of changes: (1) the new recognition of one formerly synonymized taxon, (2) the placement of four formerly recognized taxa in synonymy, (3) the description of two new taxa, and (4) new hypotheses for hybrid origins for three taxa. Our taxonomic observations are presented below.

Series Piurana

Solanum series *Piurana* is one of 19 tuber-bearing series recognized by Hawkes (1990), who included 15 species, distributed from southern Colombia and Ecuador (where four species occur) to central Peru (with 11 species). This series contains some of the morphologically most diverse species in sect. *Petota*, but the morphological definition of the series and its taxonomic limits remain controversial. The most distinctive features of ser. *Piurana*, used by all major taxonomists of sect. *Petota* (Correll 1962; Hawkes 1990; Ochoa 1999) are the globose to ovoid fruits and coriaceous glossy leaves.

The problem is that these traits vary so much in species placed in other series that it is difficult to clearly decide what to include in ser. *Piurana*. All the above authors have expressed doubt as to the limits of the series, but perhaps the clearest statement of this difficulty was by Correll (1962: 139): "This series, more than any of the others, may be considered a catchall. Paradoxically, its component species are held together not so much by their similarity as by their differences."

Ochoa's (1999) treatment of the series clearly reflected these differences of opinion. Relative to the treatment of the 11 Peruvian species of ser. *Piurana* of Hawkes (1990), Ochoa (1999) included two species Hawkes placed in ser. *Tuberosa* (*S. chiquidenum*, *S. humectophilum*), and placed species that Hawkes included in ser. *Piurana* in two other series (*S.* ×*blanco-galdosii* in ser. *Cuneoalata* and *S. jalcae* in ser. *Ingifolia*). In addition, Ochoa placed *S. pascoense* in synonymy

TABLE 1—*Continued.*

Department	Taxon	Prior germplasm collections from Peru (all departments) at NRSP-6	New germplasm collections from each department in 1999
	S. hypacrarthrum Bitter	0	5 (1 lost)
	S. immite Dunal	4	2
	S. medians Bitter var. *autumnale*[3]	0	8
	S. medians Bitter var. *medians*[3]	9	3
	S. medians Bitter var. undetermined[3]	0	2
	S. multiinterruptum Bitter var. *multiinterruptum*[5]	9	6
	S. multiinterruptum var. *multi-interruptum* f. *albiflorum*[5]	0	0
	S. neoweberbaueri Wittm.[10,12]	0	0
	S. simplicissimum Ochoa	0	2
	S. sogarandinum Ochoa	see Ancash	1
	S. wittmackii Bitter	0	7 (1 lost)

[1]Ochoa (1999) recognized *S. rhomboideilanceolatum* var. *ancophilum* Correll as *S. ancophilum* (Correll) Ochoa. Ochoa (1999) provided an invalid spelling change from his original spelling of this species in 1952 to *S. rhombilanceolatum.*

[2]Ochoa (1999) designated *S.* ×*blanco-galdosii* (type locality in Cajamarca) as a hybrid between *S. anamatophilum* and *S. peloquinianum.*

[3]Ochoa (1999) placed *S. chavinense* as a synonym of *S. dolichocremastrum.*

[4]Ochoa (1999) recognized two varieties of *S. medians*: var. *autumnale* (diploid) and var. *medians* (triploid), and synonymized *S. weberbaueri* (type from department of Tacna) in the former variety. Distinction of these varieties rests on morphological and ploidy characters and we here rely on ploidy determinations for identifications.

[5]Ochoa (1999) made *S. chrysoflorum* (from Lima), *S. moniliforme* (from Ancash), and *S. multiinterruptum* f. *longipilosum* (from Ancash) synonyms of *S. multiinterruptum* var. *multiinterruptum.* He also recognized the new taxon *S. multiinterruptum* var. *multiinterruptum* f. *albiflorum* Ochoa.

[6]Ochoa (1999) placed *S. hapalosum* (from Lima Department) in synonymy with *S. bukasovii* Juz. We temporarily treat the 168 collections of *S. brevicaule* here in a very broad and likely artificial sense to include *S. bukasovii* and many other species. *Solanum brevicaule* may later be treated as the two species *S. bukasovii* and *S. brevicaule* (see text).

[7]Ochoa (1999) described this new species.

[8]Ochoa (1999) placed *S. chiquidenum* var. *cachicadense* as a synonym of *S. chiquidenum* var. *chiquidenum.*

[10]These species grow in the coastal desert lomas and are best collected in June to September.

[9]Ochoa (1999) recognized *S. jalcae* var. *pubescens* (Correll), creating the autonym var. *jalcae.*

[11]Ochoa (1999) designated *S.* ×*arahuayum* as a hybrid between *S. medians* Bitter and *S. wittmackii* Bitter.

[12]Ochoa (1999) designated *S.* ×*neoweberbaueri* as a hybrid between *S. medians* and *S. chancayense.*

with *S. chomatophilum.* In summary, ser. *Piurana* includes some very distinctive species, and various authors have made their best judgement as to the species to include in it based on individual assessments of character states that are not clearly defined (a "gestalt" approach).

A chloroplast DNA restriction site phylogenetic study of sect. *Petota* and immediate outgroup relatives in sect. *Etuberosum* (Bukasov and Kameraz) A. Child (Spooner and Castillo 1997) defined four clades. One of these four clades included all seven examined species of ser. *Piurana* and seven other species placed by Hawkes in ser. *Conicibaccata*, *Megistacroloba*, *Yungasensia*, and *Tuberosa*. Another chloroplast DNA restriction site study by Castillo and Spooner (1997) additionally added *S. chomatophilum* to this clade. While some of these species assigned to other series match our "gestalt" impressions of ser. *Piurana* (*S. andreanum*, *S. chancayense*, *S. chomatophilum*, *S. mochiquense*, *S. immite*), others appear misplaced (*S. huancabambense*, *S. sogarandinum*, *S. tundalomense*). Two possible explanations for these problems are misidentifications of germplasm used in these studies or "chloroplast capture". The latter phenomenon, common in plants, is caused by hybridization between members of different species differing by chloroplast types, followed by backcrossing to the paternal parent, resulting in discordance between "species trees" and "maternal gene trees" (Wendel and Doyle 1998). Examination with biparentally inherited molecular markers will be needed to resolve the true phylogenetic relationships of ser. *Piurana.*

Our collections in 1999 gathered germplasm of species useful for continued morphological and molecular resolution of the limits of ser. *Piurana.* Relative to the concept of ser. *Piurana* by Ochoa (1999), we collected *S. cantense*, *S. chiquidenum*, and *S. hypacrarthrum.* Relative to our agreement with an expanded concept of the series by the chloroplast DNA studies of Spooner and Castillo (1997) and Castillo and Spooner (1997), we additionally collected *S. chomatophilum* and *S. immite.* These latter two species have round to ovoid fruits and glossy leaves present in other members of the series, and our best guess of relationships based on these characters (gestalt approach) and the cpDNA data places them in ser. *Piurana.* We additionally suspect that the following species we collected to be members of the series: *S. blanco-galdosii*, *S. huarochiriense*, *S. jalcae*, *S. peloquinianum*, and *S. simplicissimum.* We will include them in future studies of ser. *Piurana.* We had difficulty distinguishing collections *7320* and *7325* as *S. chomatophilum* or *S. jalcae* and our identifications of these may change. Additional planned

TABLE 2—*Summary of 1998 and 1999 wild potato* (Solanum *sect.* Petota) *and close outgroup species* (S. lycopersicoides, S. suaveolens) *germplasm collections, chromosome counts, and their survival at CIP.*

Coll. no	Map locality of the 1999 collections (Fig. 1)[1]	Species[2]	Somatic chromosome number (2n)	Germplasm status[3]
7201		*Solanum tuberosum* subsp. *andigena*	48	CIP
7202		*S. acaule*	48	CIP, USA
7203		*S. suaveolens*		CIP, USA
7204		*S. yungasense*	36	CIP
7205		*S. limbaniense* (type locality)	24	CIP
7206		*S. megistacrolobum* subsp. *toralapanum*	24	CIP, USA
7207		*S. raphanifolium*	24	CIP, USA
7208		*S. raphanifolium*	24	CIP
7209		*S. marinasense* (type locality for *S. cuzcoense*)	24	CIP, USA
7210		*S. raphanifolium*		Lost
7211		*S. lignicaule*	24	CIP, USA
7212		*S. brevicaule*	24	CIP, USA
7213		*S. brevicaule*	24	CIP
7214		*S. tarapatanum* (type locality)	24	CIP
7215		***S. tarapatanum***[4]	24	CIP
7216		*S. tarapatanum*	24	CIP
7217		*S. urubambae* (type locality)	24	CIP
7218		*S. laxissimum*	24	CIP
7219		*S. brevicaule*	24	CIP, USA
7220		*S. pillahuatense* (type locality)	24	CIP
7221		*S. brevicaule*	24	CIP, USA
7222		*S. lignicaule*	24	CIP, USA
7223		*S. tuberosum* subsp. *andigena*	48	CIP, USA
7224		*S. lignicaule* (type locality)	24	CIP
7225		***S. urubambae***[5] (type locality of *S. multiflorum*)	24	CIP
7226		***S. urubambae***[5] (type locality of *S. multiflorum*)		CIP, USA
7227		*S. santolallae* (type locality of *S. santolallae* f. *velutinum*)		CIP, USA
7228		*S. santolallae* (type locality of *S. santolallae* f. *velutinum*)	24	CIP, USA
7229		*S. buesii* (type locality)	24	CIP, USA
7230		*S. buesii*		Lost
7231		***S. urubambae***[6] (type locality of *S. villuspetalum*)		Lost
7232		*S. buesii*		CIP, USA
7233		*S. buesii*		Lost
7234		***S. incasicum*** (type locality, see text)	24	CIP, USA
7235		*S. buesii*	24	CIP, USA
7236		*S. sawyeri*? (type locality, see text)	48	CIP
7237		*S. santolallae*	24	CIP
7238		*S. sawyeri*? (type locality, see text)	48	CIP
7239		*S. chillonanum* (type locality)	24	CIP, USA
7240		*S. velardei* (type locality)	24	CIP, USA
7241		*S. marinasense*[4]	24	CIP
7242		*S. marinasense*	24	CIP
7243		*S. acroscopicum* (type locality)	24	CIP, USA
7244		*S. lycopersicoides* (type locality)	24	CIP, USA
7245		*S. acaule*	48	CIP, USA
7246		*S. tacnaense*	24	CIP
7247		***S. acroscopicum***[7]	24	CIP, USA
7248		***S. acroscopicum***[7]	24	CIP, USA
7249		***S. acroscopicum***[7]	24	CIP, USA
7250		*S. sandemannii* (type locality)	24	CIP, USA
7251		***S. tacnaense***[4]	24	CIP
7252		*S. sandemannii*	24	CIP, USA
7253		*S. acaule*	48	CIP, USA
7254		*S. megistacrolobum* subsp. *megistacrolobum* f. *purpureum* (type locality)	24	CIP, USA
7255		*S. longiusculus* (type locality)		Lost
7256		***S. marinasense***[7]	24	CIP, USA
7257		*S. aymaraesense* (type locality)	24	CIP, USA
7300	34	*S. medians* var. *autumnale*	24	CIP
7301	34	*S. medians* var. *autumnale*	24	CIP
7302	35	*S. medians* var. *autumnale*	24	CIP
7303	35	*S. medians* var. *autumnale*	24	CIP
7304	35	*S. medians*	36	CIP
7305	29	*S. brevicaule* (type locality of *S. hapalosum*)	24	CIP
7306	30	*S. gracilifrons* (at or near type locality)	24	CIP
7307	30	*S. bill-hookeri* (type locality)	24	CIP
7308	32	*S. amayanum* (type locality)	24	CIP
7309	31	*S. huancavelicae* (type locality)	24	CIP
7310	26	*S. medians* var. *autumnale* (type locality)	24	CIP
7311	28	*S. huarochiriense* (type locality)	24	CIP
7312	28	*S. multiinterruptum* var. *multiinterruptum*	24	CIP
7313	27	*S. medians*	36	CIP
7314	27	*S. immite*	36	CIP
7315	4	*S. immite*	24	CIP
7316	3	*S. jalcae* var. *jalcae* (type locality)	24	CIP
7317	3	*S. jalcae* var. *jalcae*	24	CIP
7318	6	*S. albicans*	72	CIP
7319	6	*S. albicans*	72	CIP
7320	6	*S. jalcae* var. *jalcae*	24	CIP
7321	7	*S. chiquidenum* var. *chiquidenum* (type locality of *S. chiquidenum* var. *cachicadense*)	24	CIP
7322	2	*S. chomatophilum* var. *chomatophilum*	24	CIP
7323	2	*S. chomatophilum* var. *chomatophilum*	24	CIP
7324	2	*S. hastiforme*	24	CIP
7325	1	*S. jalcae* var. *jalcae*	24	CIP
7326	1	*S. sogarandinum*	24	CIP
7327	1	*S. chomatophilum* var. *chomatophilum*	24	CIP
7328	1	*S. sogarandinum*	24	CIP
7329	1	*S. hastiforme*	24	CIP
7330	2	*S. albicans*	72	CIP
733	5	*S. chiquidenum* var. *chiquidenum*	24	CIP
7332	5	*S. sogarandinum*	24	CIP

TABLE 2—*Continued.*

Coll. no	Map locality of the 1999 collections (Fig. 1)[1]	Species[2]	Somatic chromosome number (2n)	Germplasm status[3]
7333	5	*S. multiinterruptum* var. *machaytambinum* (type locality)	24	CIP
7334	14	*S. multiinterruptum* var. *multiinterruptum*		CIP
7335	14	*S. sogarandinum*	24	CIP
7336	10	*S. peloquinianum*	24	CIP
7337	10	*S. peloquinianum* (type locality)	24	CIP
7338	9	*S. albicans*	72	CIP
7339	8	*S. ×blanco-galdosii*	24	CIP
7340	8	*S. hastiforme*	24	CIP
7341	8	*S. chomatophilum* var. *chomatophilum*	24	CIP
7342	10	*S. taulisense* (type locality)		Lost
7343	9	*S. ×blanco-galdosii*	24	CIP
7344	11	*S. ancophilum*	24	CIP
7345	11	*S. ancophilum* (type locality)	24	CIP
7346	11	*S. chomatophilum* var. *subnivale* (type locality)		Lost
7347	11	*S. chomatophilum* var. *subnivale* (type locality)	24	CIP
7348	12	*S. ancophilum*	24	CIP
7349	12	*S. ancophilum*	24	CIP
7350	12	*S. chomatophilum* var. *chomatophilum*	24	CIP
7351	12	*S. dolichocremastrum*	24	CIP
7352	16	*S. multiinterruptum* var. *multiinterruptum*	24	CIP
7353	17	*S. dolichocremastrum* (type locality of *S. chavinense*)	24	CIP
7354	17	*S. dolichocremastrum* (type locality of *S. chavinense*)	24	CIP
7355	13	*S. orophilum* (type locality)	24	CIP
7356	19	*S. multiinterruptum* var. *multiinterruptum*	24	CIP
7357	19	*S. multiinterruptum* var. *multi-interruptum* (type locality of *S. multiinterruptum* f. *longipilosum*)	24	CIP
7358	19	*S. multiinterruptum* var. *multiinterruptum*	24	CIP
7359	18	*S. multiinterruptum* var. *multiinterruptum* (type locality of *S. moniliforme*)	24	CIP
7360	18	*S. multiinterruptum* var. *multiinterruptum*	24	CIP
7361	22	*S. medians* var. *autumnale*	24	CIP
7362	22	*S. medians* var. *autumnale*	24	CIP
7363	21	*S. wittmackii*	24	CIP
7364	21	*S. simplicissimum*		CIP
7365	21	*S. hypacrarthrum* (type locality)	24	CIP
7366	21	*S. hypacrarthrum*	24	CIP
7367	23	*S. hypacrarthrum*	24	CIP
7368	23	*S. cantense*	24	CIP
7369	23	*S. medians*	36	CIP
7370	23	*S. cantense*	24	CIP
7371	23	*S. medians*		CIP
7372	22	*S. cantense* (type locality)	24	CIP
7373	21	*S. wittmackii*	24	CIP
7374	21	*S. multiinterruptum* var. *multiinterruptum* (type locality)	24	CIP
7475	21	*S. multiinterruptum* var. *multiinterruptum*	24	CIP
7376	21	*S. multiinterruptum* var. *multiinterruptum* f. *albiflorum* (type locality of *S. chrysoflorum)*	24	CIP
7377	20	*S. immite*	24	CIP
7378	20	*S. simplicissimum*	24	CIP
7379	20	*S. medians*		CIP
7380	20	*S. wittmackii*	24	CIP
7381	25	*S. wittmackii*		Lost
7382	25	*S. cantense*	24	CIP
7383	25	*S. medians* var. *autumnale*	24	CIP
7384	25	*S. hypacrarthrum*		Lost
7385	25	*S. multiinterruptum* var. *multi-interruptum* f. *albiflorum* (type locality)	24	CIP
7386	24	*S. sogarandinum*	36	CIP
7387	24	*S. multiinterruptum* var. *multiinterruptum*	24	CIP
7388	24	*S. chomatophilum* var. *chomatophilum*	24	CIP
7389	33	*S. brevicaule*		Lost
7390	19	*S. medians*		CIP
7391	19	*S. anamatophilum* (type locality)	24	CIP
7392	23	*S. wittmackii*	24	CIP
7393	23	*S. wittmackii*	24	CIP
7394	23	*S. hypacrarthrum*		CIP
7395	23	*S. wittmackii*	24	CIP
7396	23	*S. arahuayum* (type locality)		Lost
7397	16	*S. augustii* (type locality)	24	CIP
7398	14	*S. multiinterruptum* var. *multiinterruptum*	24	CIP
7399	15	*S. albicans*	72	CIP
7400	15	*S. multiinterruptum* var. *multiinterruptum*		Lost

[1]See Spooner *et al.* (1999, Table 3) for map localities of the 1998 collections.

[2]Species names of the 1998 collections in **bold** are changed from those listed in Spooner *et al.* (1999, Table 3), see footnotes here and text.

[3]CIP, USA = Germplasm at CIP and also transferred to USDA quarantine for disease screening, with later transfer to NRSP-6 for a seed increase,
CIP = Germplasm still all at CIP,
lost = germplasm died in attempts to increase it at CIP.

[4]These accessions were collected when young and these more accurate identifications will be possible with flowering material observed at CIP.

[5]Ochoa (1999) placed *S. multiflorum* (this accession collected at the type locality of this name) in synonymy with *S. urubambae.*

[6]Ochoa (1999) placed *S. villuspetalum* (this accession collected at the type locality of this name) in synonymy with *S. urubambae.*

[7]Previously listed as *Solanum* unidentified species.

collections in northern Peru will allow even more members of this series to be collected.

It is possible that the series may be even further expanded by including a character not used by any taxonomist to date. All species placed by Hawkes (1990) and Ochoa (1999) in ser. *Piurana* possess tubers in a moniliform arrangement (arranged like beads on a string, see for example Figures 37, 113, 173, 178 in Ochoa [1999]), unlike the more typical arrangement of single tubers placed at the end of stolons. This character, like many in sect. *Petota*, is difficult to assess because some tubers are constricted in the middle, and it is not clear if they represent transitions to this trait.

Solanum brevicaule *Complex*

Perhaps the most difficult taxonomic problem in sect. *Petota* concerns the species status and interrelationships of the more than 30 taxa of the *Solanum brevicaule* complex. Spooner *et al.* (1999) provided details of this complex that extends from central Peru to northern Argentina. In short, members of this complex show extensive variation, but apparently without any "species-specific" characters useful for the construction of keys and descriptions to clearly define them. Combined data from morphology (van den Berg *et al.* 1998) and two molecular markers appropriate for investigation of closely related taxa (single- to low-copy nuclear Restriction Fragment Length Polymorphisms, RFLPs; and Random Amplified Polymorphic DNAs, RAPDs) were all concordant in not being able to clearly define these species (Miller and Spooner 1999). At best, only two highly polymorphic groups could be recognized, one from Peru, and another from Bolivia and Argentina.

The recognition of these two components of the complex (*S. bukasovii* as the Peruvian element, *S. brevicaule* as the Bolivian and Argentinean element), however, is fraught with problems. First, the morphological data can be used to define these two "species" only with many characters that overlap greatly in range, and then only with computer-assisted multivariate techniques. Essentially, the characters that define them are impractical to use when germplasm collections from throughout the range are planted together and identifications are attempted without knowledge of place of collection, prior identifications, or ploidy determinations.

A second problem is that the two molecular markers (RAPDs, RFLPs) suggested that the *S. brevicaule* complex was not a natural taxon, but rather each of the two elements formed separate clades with other species that themselves were morphologically distinct. To lump *S. bukasovii* and *S. brevicaule* as a single highly polymorphic taxon would be convenient, but contrary to the natural (monophyletic; e.g., Baum and Donoghue 1995) classification we are pursuing in sect. *Petota*.

A third problem is the apparent expansion of the complex by additional species we observed in the field in 1998 and 1999 and data of Ochoa (1999). These additional species include *S. aymaraesense* Ochoa, *S. bill-hookeri* Ochoa, *S. huancavelicae* Ochoa, *S. orophilum* Ochoa, *S. puchupuchense* Ochoa, *S. saxatilis* Ochoa, *S. sawyeri* Ochoa, *S. tapojense* Ochoa, and *S. velardei* Ochoa.

Yet a forth problem is the apparent breakdown of the formerly convenient geographical division of the two elements of the *S. brevicaule* complex at the Peruvian and Bolivian border. Ochoa (1999) cited specimens of *S. sparsipilum* (relatively wide leaves and few interjected leaves) from the southern Peruvian departments of Cusco and Puno. Two of our collections from Cusco that we provisionally label as *S. brevicaule* match the *S. sparsipilum* morphotype (*7213*, *7221*). However, the morphological and molecular studies of the *S. brevicaule* complex mentioned above placed this species into the southern element of the complex. Our examination of photos in Ochoa (1999) suggest to us that *S. sawyeri* (Cusco) also is a match for the *S. sparsipilum* morphotype (compare Figures 379, 389 of Ochoa [1999]).

As practical taxonomists responsible for the stable and repeatable identifications of these economically important and widely used genetic resources, we are faced with a problem without an apparent easy solution. To address this problem we are conducting a replicated morphological study of the complex in central Peru (Huancayo, elevation 3200 m, latitude 12°S, longitude 75°W). This location more closely approaches that of climate, elevation, and daylength than that of the first morphological study in the northern United States (Hancock, Wisconsin, elevation 328 m, latitude 44°N, longitude 90°W). If these morphological data likewise fail to clearly define taxa, it would further argue for placement of species in synonymy in this group. However, it is yet unclear to us how this will be done considering our inability to clearly key out even the two larger "species", one from Peru and the other from Bolivia and Argentina. Until such studies are complete, we maintain identifications of all members of the complex under the clearly artificially broad concept of *S. brevicaule*.

Solanum incasicum

One of the important new collections of the 1998 expedition was *S. incasicum* (collection *7234*), known from a single

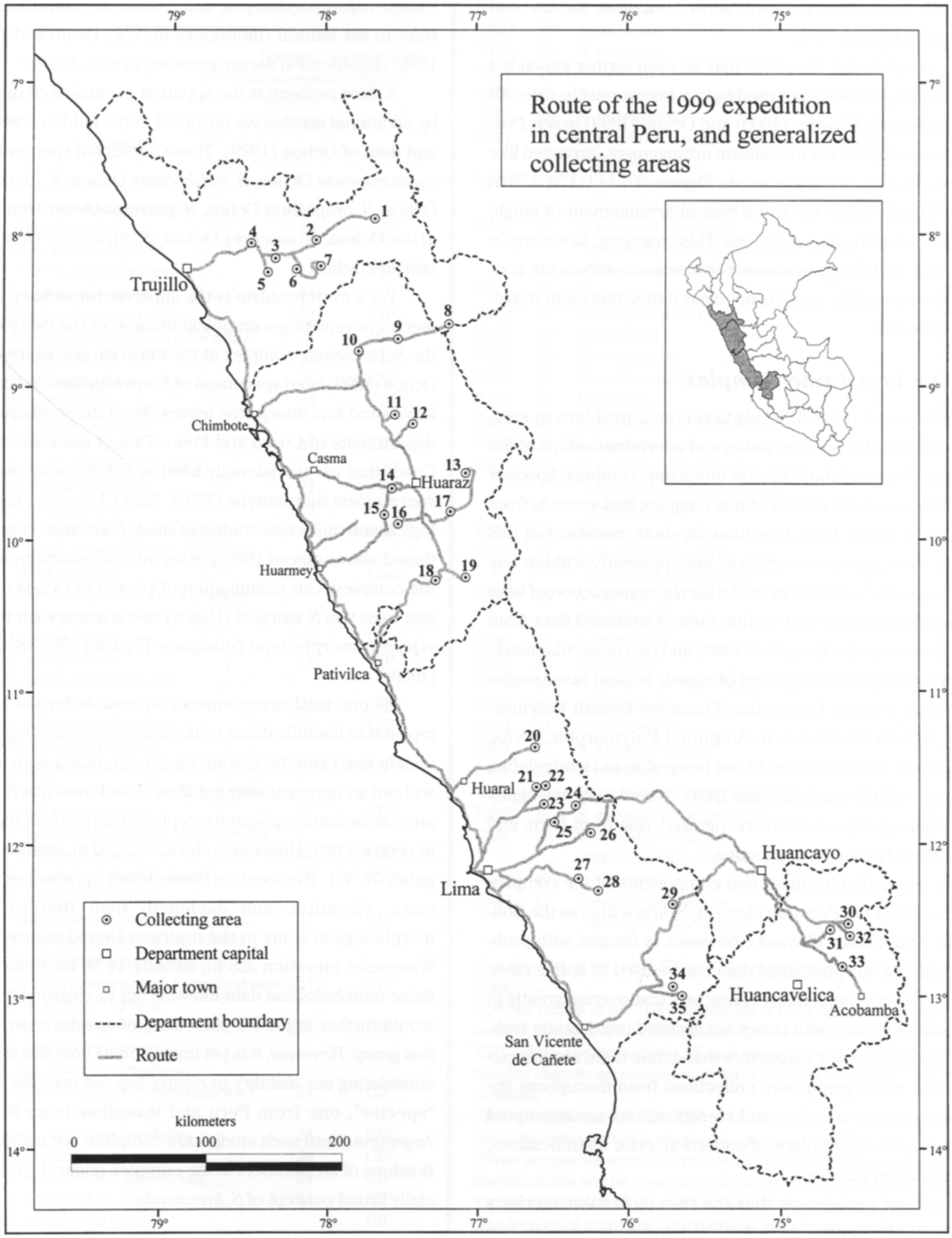

FIGURE 1

Route of the 1999 expedition to central Peru, and generalized sites for wild potatoes corresponding to "New Collections in 1999".

locality in Cusco Department. Our field collection of mature flowering and fruiting plants at the type locality was similar to one of the morphotypes of *S. raphanifolium* as illustrated in Ochoa (1962). This morphological similarity, and the fact that collection *7234* was found at the northern end of the range of *S. raphanifolium*, and its growth in similar habitats as that species led us to suspect that the two species were the same (Spooner *et al.* 1999). Plants grown from seed of the original collection lack the typical morphology of *S. raphanifolium* and *S. incasicum* likely is a distinct species. Distinctive chloroplast DNA restriction site markers for *S. raphanifolium* (Spooner *et al.* 1991; Spooner and Castillo 1997) will allow us to better determine the species limits and relationships of *S. incasicum*.

Solanum sawyeri

Two important collections in 1998 were possibly *S. sawyeri* (*7236*, *7238*), known from a single site in Cusco Department. The type locality was not exact (several kilometers west of Vestapata), and we found that the correct spelling of this town was Pistipata. Our collections 0.4 and 1.7 km east of this town were close matches for the type, and we identified *7236* and *7238* as this species. However, the chromosome counts of these two collections are both $2n = 48$, while Ochoa (1999) provided a count of *S. sawyeri* as $2n = 24$.

Our collections of these two accessions in disturbed areas in a fruit plantation, and their similarity to cultivated potatoes, led us to suspect that *S. sawyeri* was an escaped cultigen. Ochoa (1999) indicated that *S. sawyeri* was very similar to *S. sparsipilum*, a species we place in the *S. brevicaule* complex. *Solanum sparsipilum* is so similar morphologically to the cultigen *S. tuberosum* that it commonly has been advanced as its close relative or parent (e.g., Hawkes 1956; Cribb and Hawkes 1986). We will need more collections at the type locality of *S. sawyeri* to determine the identity of collections *7236* and *7238* and the species status of *S. sawyeri*.

New Chromosome Counts

Chromosome counts are first reported here for *S. chomatophilum var. subnivale* ($2n = 2x = 24$), *S. megistacrolobum* subsp. *purpureum* ($2n = 2x = 24$), and *S. multiinterruptum* var. *multiinterruptum* f. *albiflorum* ($2n = 2x = 24$); we also report the first triploid count of an accession of *S. immite* (*7314*). All other chromosome counts match those reported for these species before (Hawkes 1990; Bamberg *et al.* 1996; Ochoa 1999; Spooner and Hijmans in press).

Germplasm Access and Plans for Future Collecting

Peruvian materials collected in 1999 and used in this study are not available for international distribution at the moment. Peru is in the process of finalizing its germplasm access regulation in conformity with the Convention on Biological Diversity and the Andean Pact Genetic Resources Decision 391. When the regulation is officially in place, Peru will make the materials available under the conditions of the official regulation in accord with international agreements. However, any scientist wishing to work with the materials in Peru can easily do so. Figure 2 outlines the ten of the 24 departments in which we collected wild potatoes in 1998 and 1999 and goals for future potato collecting in the nine remaining departments with wild potatoes, planned after the regulation is in effect.

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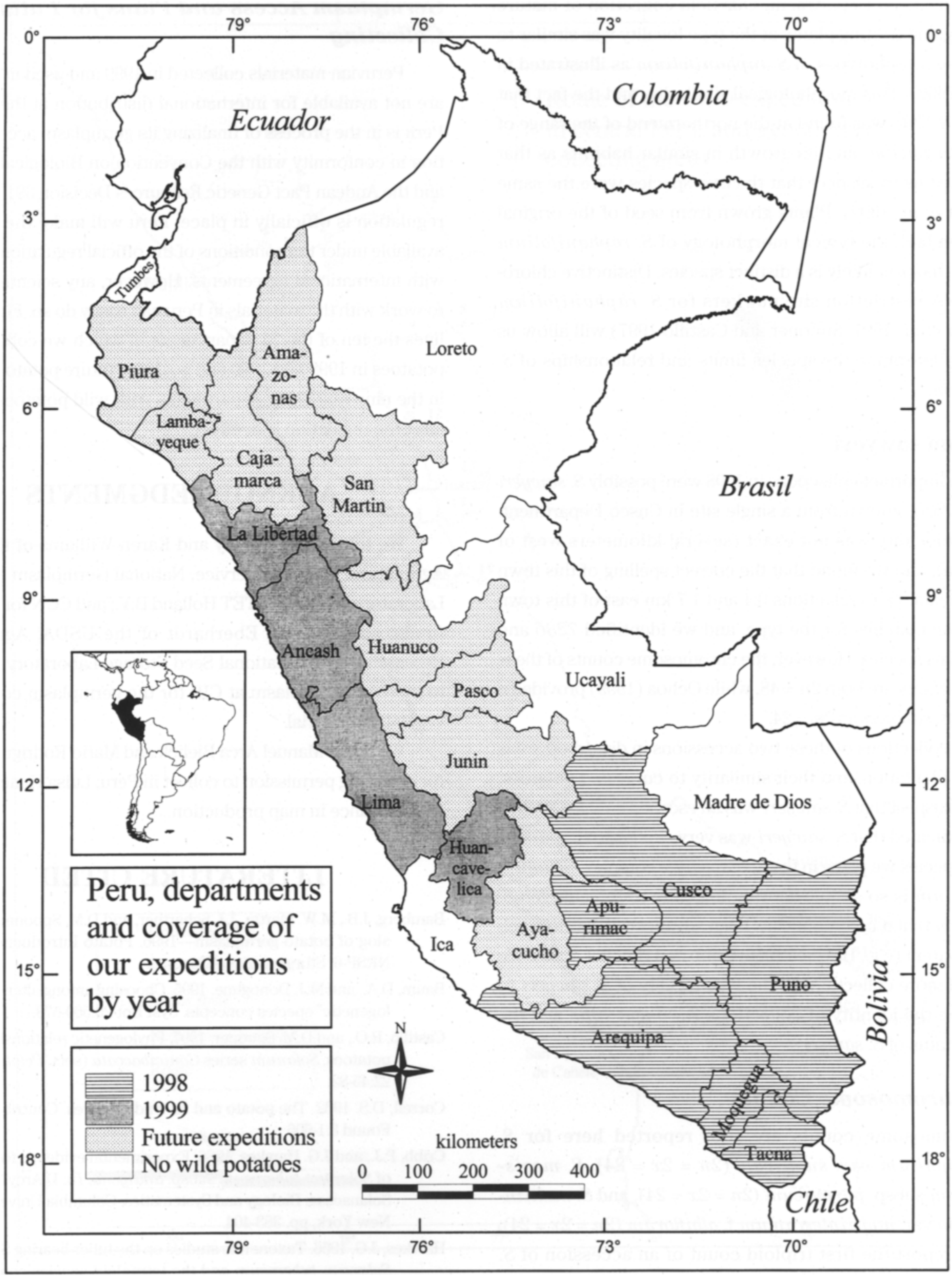

FIGURE 2
Departments in which wild potatoes were collected in 1998 and 1999, and planned future departments to collect.

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