REPORT OF EXPEDITION

TO COLLECT WILD SPECIES OF POTATO

IN GUATEMALA

September 11-November 5, 1995

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Seed and tuber collections from the expedition first sent to: CGN (CPRO-DLO) and the United States National Research Support Project-6 (NRSP-6, formerly called the Inter-Regional Potato Introduction Project, IR-1). Seeds of the first increase to be shared with ICTA (Appendix 4,5). Herbarium specimens deposited at the Herbario, Facultad de Agronomía, Universidad de San Carlos (AGUAT); the Herbarium of NRSP-6 (PTIS), and at the Department of Plant Taxonomy, Wageningen Agricultural University (WAG). This report was mailed to those individuals listed in Appendix 6 on December 15, 1995.

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SUMMARY

We conducted a collaborative Guatemala and The Netherlands and United States wild potato (Solanum sect. Petota) germplasm collecting expedition in Guatemala from September 11-November 5, 1995. The goals of the expedition were to collect potato germplasm and gather field data for continuing taxonomic studies of the five species of Guatemalan wild potatoes: Solanum agrimonifolium, S. bulbocastanum, S. clarum, S. demissum, and S. morelliforme. Our 43 true seed and one tuber collection nearly quadruple the available wild potato germplasm for Guatemala, provide germplasm for most previously known localities, and add new ones. We provide geographic and logistical data; localities to update those given in Correll in 1962; map all collections, distinguishing those represented by germplasm accessions; statistics on human population growth and deforestation to help explain decline of wild potato populations; recommend areas for future collecting in Guatemala; and suggest two areas as in-situ reserves for wild potatoes.

INTRODUCTION

Solanum L. sect. Petota Dumort., the potato and its relatives, occurs from the southwestern United States to southern Chile. It consists of seven cultivated and 225 wild species, according to the latest comprehensive taxonomic treatment of Hawkes (1990). However, nine of these species are members of separate clades and are best treated in sect. Etuberosum (Buk. & Kameraz) A. Child, sect. Lycopersicum (Mill.) Wettst, or sect. Juglandifolium (Rydb.) A. Child (Spooner et al., 1993).

Most wild potato species are distributed in the Andes, but about 30 grow in Mexico and Central America, with five in Guatemala: Solanum agrimonifolium Rydb., S. bulbocastanum Dunal, S. clarum Correll, S. demissum Lindl., and S. morelliforme Bitter and G. Muench (Correll, 1952, 1962; Gentry & Standley, 1974; Hawkes, 1990). These species also grow in Mexico, and reach their southern-most distribution in Guatemala, except S. agrimonifolium, that additionally grows in adjacent Honduras (one record from Morazán Department). The Mexican distributions of these species are: S. agrimonifolium, southern Mexico (States of Oaxaca and Chiapas); S. bulbocastanum, central to southern Mexico; S. clarum, southern Mexico (Chiapas); S. demissum, northern to southern Mexico; S. morelliforme, central to southern Mexico (Correll, 1952, 1962; Hawkes, 1966, 1990; Spooner et al., 1991). A sixth species, S. oxycarpum Schiede, possibly also grows in Guatemala, but involves a taxonomic confusion with S. agrimonifolium (see below).

Central America represents a relatively under-collected region for potato germplasm. Guatemala formed a priority for collecting by the Instituto de Ciencia y Tecnologia Agricolas, Guatemala (ICTA); the Centre for Genetic Resources The Netherlands (CGN); and the National Research Support Program-6, United States (NRSP-6; formerly known as the Inter-Regional Potato Introduction Project, IR-1). This report details the results of a collaborative germplasm collecting expedition in Guatemala by these genebanks from September 11-November 5, 1995. The goals of the expedition were to collect wild species germplasm (the cultivated species are well represented at the International Potato Center [CIP] and other national genebanks), to increase them quickly and make them freely available internationally, and to gather field data for continuing taxonomic studies.

MATERIALS AND METHODS

This expedition was initiated by a letter to Ing. Fernando Vargas, Vice-Minister of Agriculture, Guatemala, who gave permission for collections (Appendix 1 -- note: our initial collaborator on this expedition was changed from Rolando Estrada to Vincente Martínez). Prior to the expedition, we compiled locality data from: 1) database files backing up germplasm records from CGN (Hoekstra & Seidewitz, 1987) and NRSP-6 (Bamberg & Martin, 1993); 2) literature records from Correll (1962), who obtained these from herbarium

material in F, G, GH, K, LL, MICH, MSC, NY, S, US, Z; 3) our own inspection of F, PTIS, WAG, WIS, and all herbaria in Guatemala (AGUAT, BIGUA, USCG, UVAL); 4) an unpublished database file of records of herbaria from Jack Hawkes (University of Birmingham, England). A summary of these records is listed in Appendix 2). Herbarium codes follow Holmgren et al., 1990 [8th ed.]; BIGUA and PTIS will appear in the 9th edition.

Geographic references were found with the aid of 1) Gall (1978, 1981, 1983a,b), 2) United States Department of the Interior (1984), 3) the 1:50,000-scale topographic maps (259 sheets), and the 1:250,000-scale topographic maps (13 sheets) from the Instituto Geográfico Militar, 4) the 1:1,000,000-scale Mapa vial turístico, 1980 road map from the Instituto Geográfico Militar. These geographic resources, and comparable resources from recent expeditions to Mexico, Venezuela, Colombia, Ecuador, Bolivia, Argentina, and Chile, are a growing and valuable component to the PTIS library (Bamberg & Spooner, 1994).

We concentrated collecting on those areas under-represented by germplasm accessions. Local residents led us to some populations. Guatemalan names for wild potatoes are papa ardilla (squirrel potato), papa del monte (mountain potato), papa silvestre (wild potato), and papa del zorro (fox potato). Solanum agrimonifolium additionally is known as papa de marrana (pig potato) and tisbotch (Gentry & Standley, 1974). Longitude and latitude data were obtained by a global positioning system.

New collections are listed in Appendix 3. Complete sets of herbarium vouchers were deposited at AGUAT, PTIS, and WAG, with some at BIGUA. Collections before Oct. 13 are labeled Spooner, Martínez and Hoekstra, 7,004-7,053 (abbreviated SMH in this report), while those after Oct. 17 are Spooner, Martínez and van den Berg 7054-7076, abbreviated as SMV. Only true seeds were collected to avoid the added expenses of screening and eliminating tuber-borne diseases, except for S. demissum, rare in Guatemala, that did not produce seeds at the population we found. By written agreement with ICTA, all true seeds were taken to CGN and NRSP-6 to insure sufficient germplasm for disease screening and increases, and ICTA will obtain seeds of the first increase (Appendix 4,5). This report was mailed to those individuals listed in Appendix 6 on December 15, 1995.

RESULTS AND DISCUSSION

Geography. Guatemala covers 108,889 km^2. It is divided into 22 Departments (Fig. 1). The northern half of the country consists mostly of tropical lowlands below 1,000 m and harbors no wild potatoes. Elevations above 1,400 m (the lowest elevations for wild potatoes in Guatemala) occur only in the southern half of the country.

Guatemala has two systems of west to east and northeast running mountain chains, with the greatest elevations in the west (Fig. 2). The northern chain is the Sierra de los Cuchumatanes, Sierra de Chamá, Sierra de Santa Cruz, and Montañas Mayas. The southern chain is the Sierra Madre, Sierra de Chaucús, Sierra de las Minas, Montañas del Mico y de la Estrella, Montañas de Copán, Sierra del Meredón, and Montañas de Omoa (Gall, 1981; Piedra Santa-A., 1994). All 33 of Guatemala's volcanoes, with elevations from 1,027 m to 4,240 m, occur in the Sierra Madre (Fig. 2). Many wild potato populations occur on these volcanoes, the five highest of which are Volcán Tajumulco (Dept. San Marcos, 4,240 m), Volcán Tacaná (Dept. San Marcos, 4,093 m), Volcán Acatenango (Depts. Chimaltenango, Escuintla, Sacatepéquez, 3,975 m), Volcán Santa María (Dept. Quetzaltenango, 3,772 m), and Volcán de Agua (Depts. Escuintla, Sacatepéquez, 3,760 m).

Logistics. Figure 3 shows our collection route. All potato populations in Guatemala can be approached within a 12 hour drive from Guatemala City, conveniently located in the center of the upland areas in southern Guatemala. Collecting at many localities, however, requires one or two days of hiking, sometimes covering a vertical distance of 1,000 m or more. Many roads are not paved and are in poor condition by the end of the rainy season in mid to late October (Fig. 4). A four-wheel drive vehicle is needed, and can be rented in Guatemala City.

Figure 1. Departments in Guatemala

Figure 2. Mountain ranges in Guatemala.

Figure 3. Route map for this expedition.

Figure 4. Average monthly rainfall, 1990-1994, Santa Lucia La Reforma Weather Station, Department Totonicapán, Guatemala, 1840 m, 15°07'57"W, 91°14'38"W. This station is located in western Guatemala where wild potatoes are most common.

Fig. 1. Departments in Guatemala

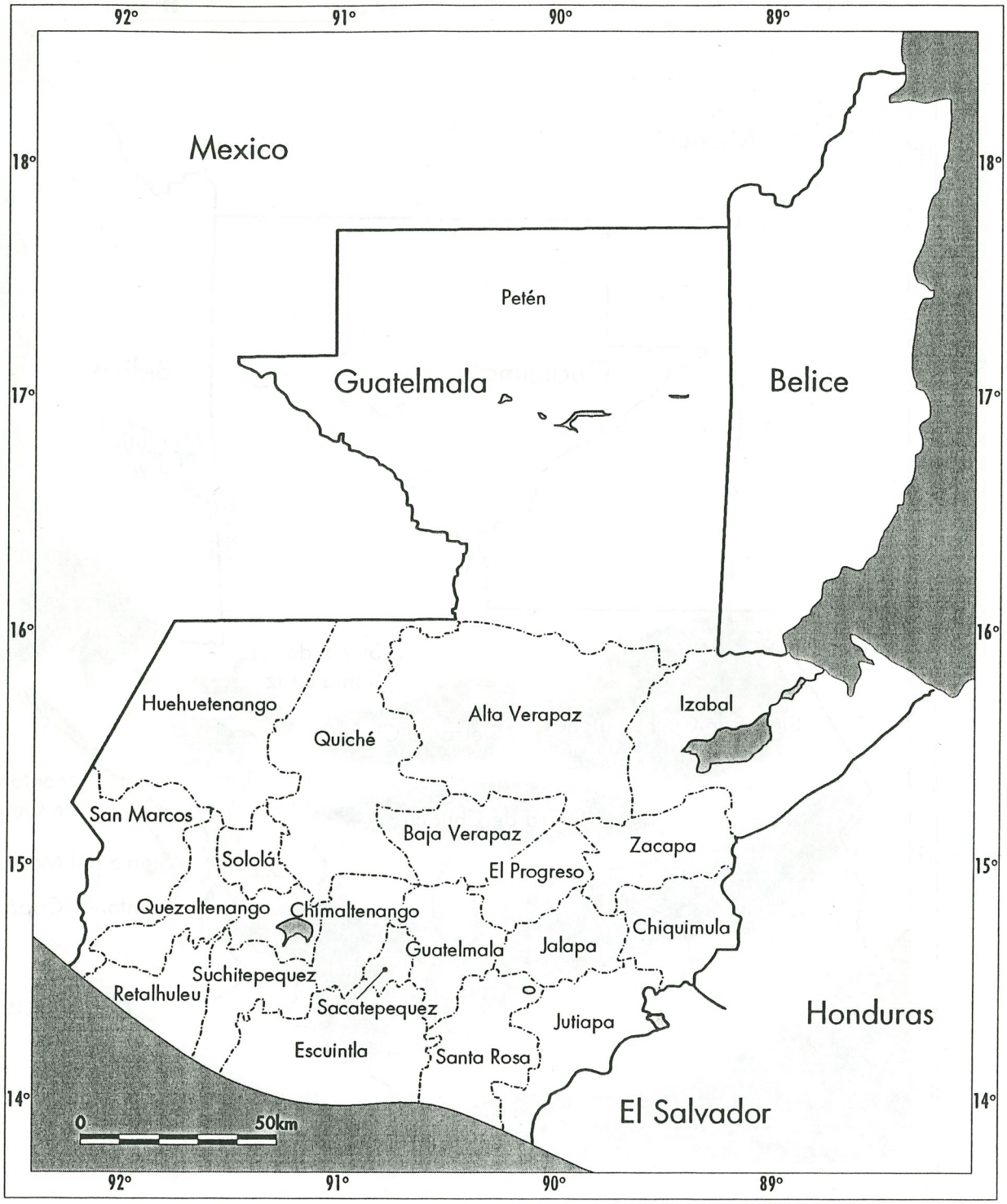


Fig. 2. Mountain ranges

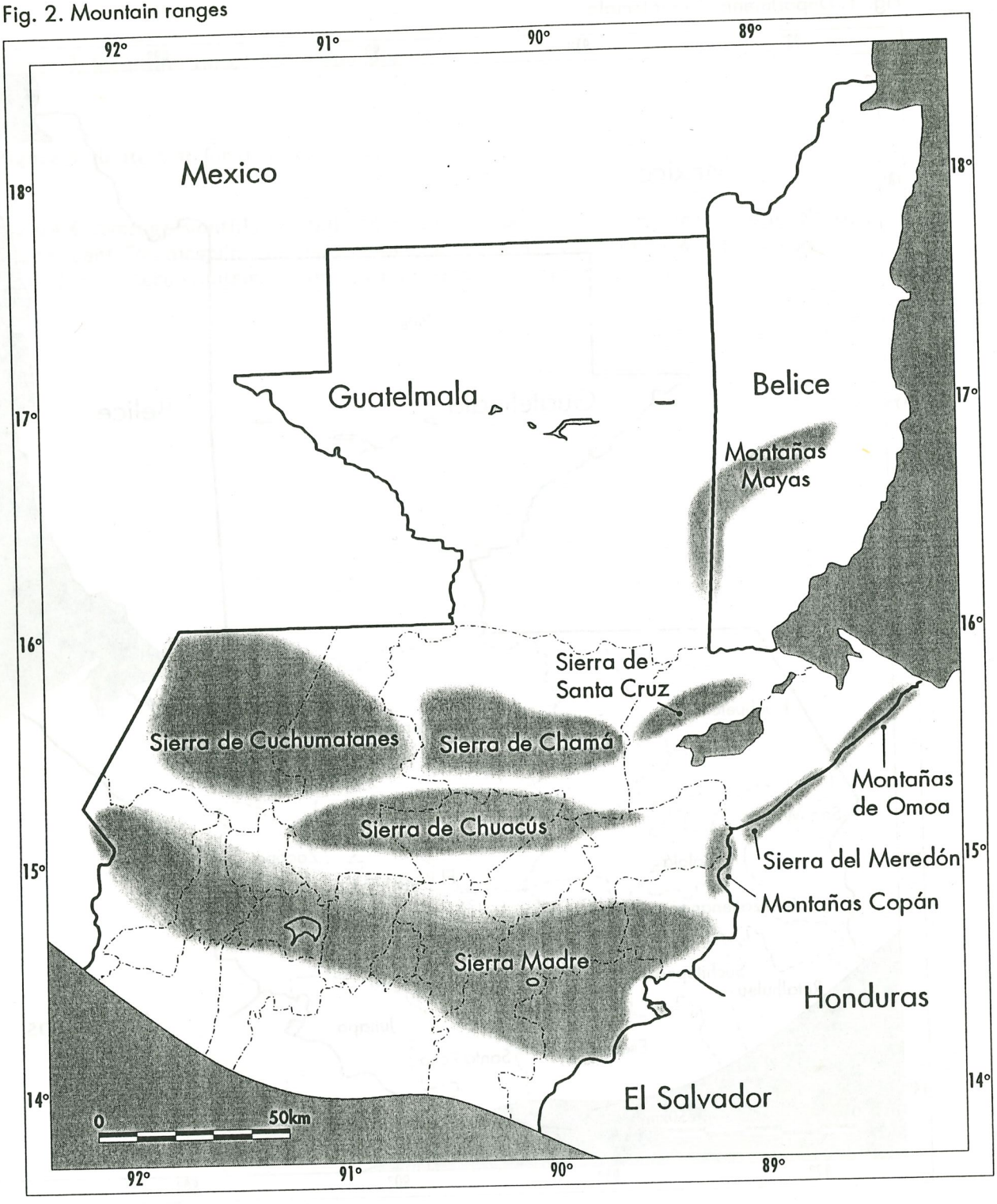


Fig. 3. Route map

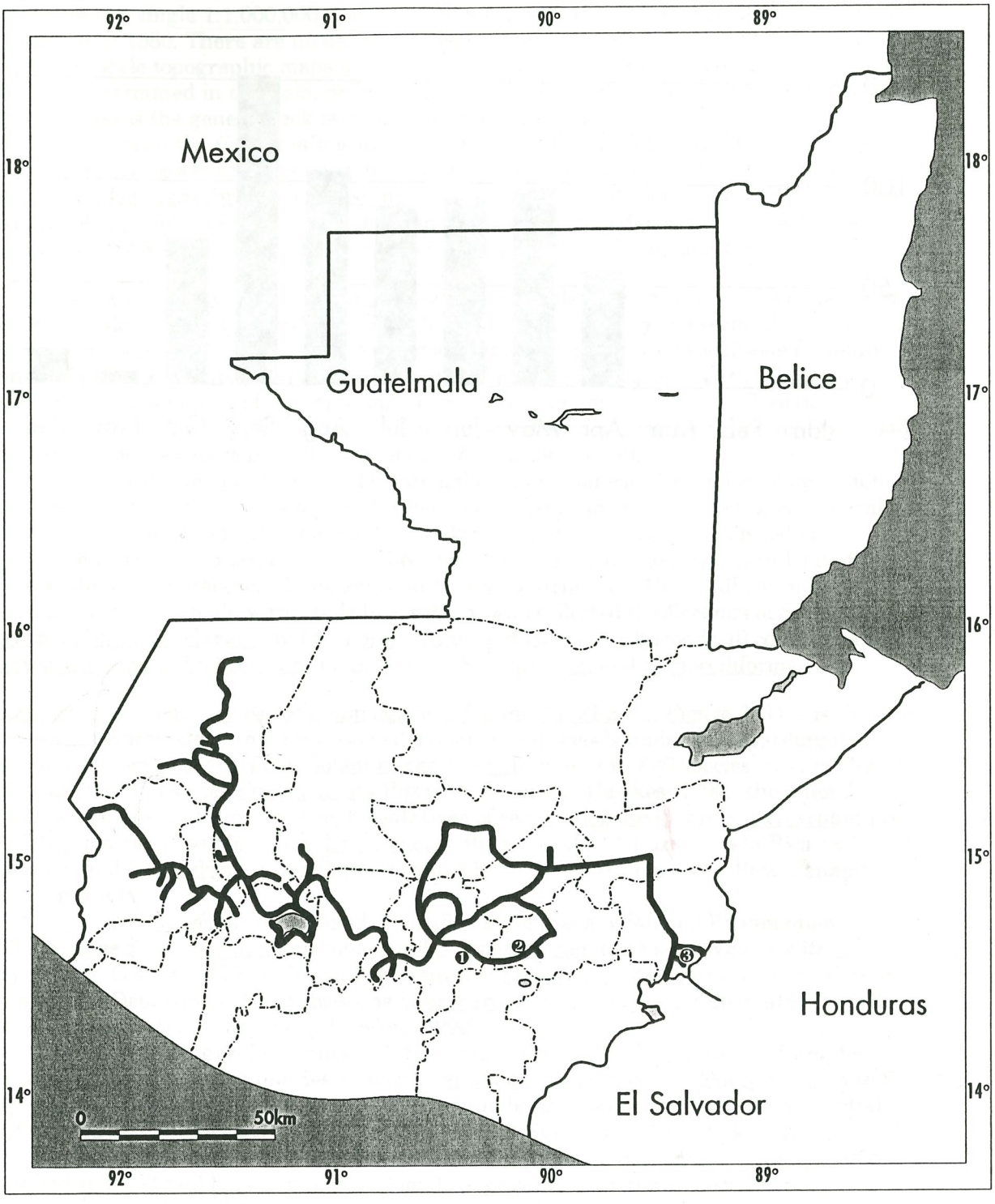
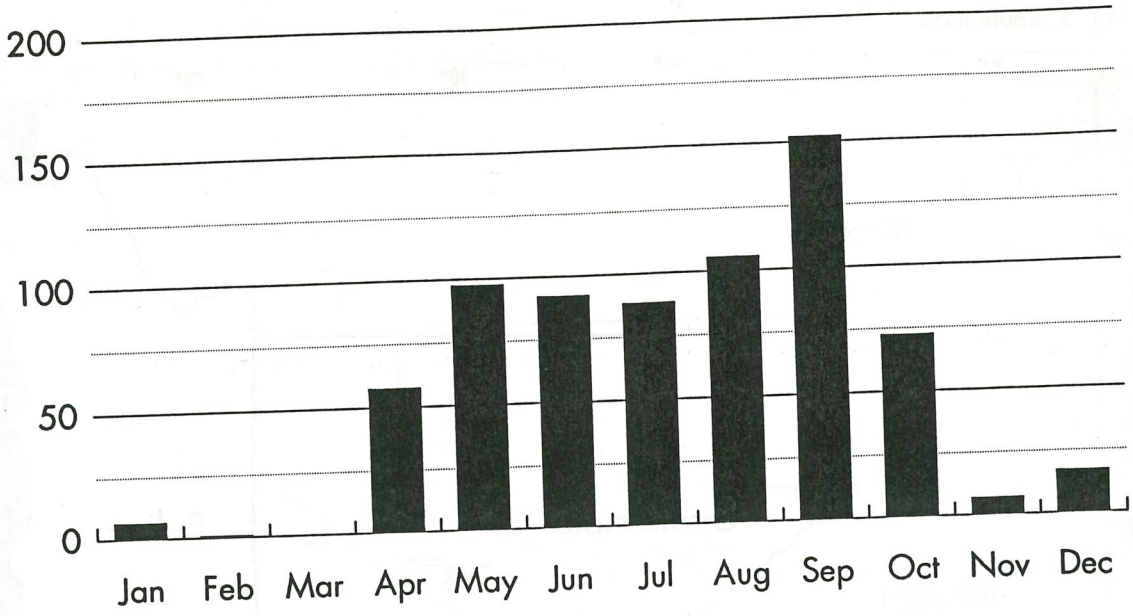


Fig. 4. Average monthly rainfall (mm), Totonicapán uplands, 1990–1994



Gall (1978, 1981, 1983a,b), and United States Department of Interior (1984) provide an excellent compilation of place names. A serious problem for finding localities in the field, however, is the lack of up-to-date road and topographic maps. The most current road map is a single 1:1,000,000-scale map (Materials and Methods) reprinted from one first published in 1980. There are no individual department road maps. The 1:50,000-scale and 1:250,000-scale topographic maps are based largely on 1964 data. Changes past these dates must be determined in the field, or from a knowledgeable collaborator. An additional complication is the general lack of road signs in most areas.

Currently, Guatemala is under a state of civil war, but most actions have been concentrated in lowland areas away from potato localities (exceptions listed below in Recommended areas for future collecting). Travel at night and camping should be avoided. We traveled at all times with a Guatemalan collaborator (Martínez), experienced no serious problems, and were treated with friendliness by local people throughout the trip.

Previous potato collecting in Guatemala. Nine individuals or teams collected wild potatoes in Guatemala (Table 1). Türckheim, Skutch, Aguilar G., Standley, Steyermark, Roe, and Beaman collected wild potatoes as part of comprehensive collecting expeditions for many plants. The most extensive of these were those of Standley and Steyermark. Their collections formed much of the material for "Flora of Guatemala," the only floristic treatment of the country. This was published in serial form in Fieldiana, Botany from 1946-1977 (wild potatoes were published in Gentry & Standley, 1974).

Graham collected in Mexico and Guatemala to gain material for studies of late blight and crossability relationships of the Mexican and Central American diploid species (Graham et al., 1959; Graham and Dionne, 1961). Hawkes, Hjerting, and Lester collected in Guatemala as part of a larger potato collecting expedition in the southwestern United States, Mexico, Guatemala, Honduras, and Nicaragua (Hawkes, 1959). All germplasm collections in Guatemala were made by Graham, who collected 6 collections of S. agrimonifolium, S. clarum, and S. morelliforme; and Hawkes, who made 10 collections of S. agrimonifolium, S. bulbocastanum, S. clarum, S. demissum, and S. morelliforme.

Notes on individual species: Solanum agrimonifolium [4x (2EBN)], Figure 5. This is the only species in Guatemala with an unresolved question of species boundaries, regarding its distinction from S. oxycarpum. Solanum agrimonifolium is one of 40 species included by Hawkes (1990) in series Conicibaccata Bitter. According to Hawkes (1990), the other Mexican and Central American representatives of ser. Conicibaccata are S. oxycarpum [4x (2EBN)], restricted to Mexico; S. longiconicum Bitter [4x (2EBN)] from Costa Rica and Panama, and S. woodsonii Correll (ploidy and EBN unknown) from Costa Rica, Panama, and Venezuela.

Correll (1962), on the other hand, identified some Costa Rican and Panamanian collections as S. oxycarpum, and considered S. longiconicum to be synonymous with S. oxycarpum. Gentry and Standley (1974) identified Steyermark 43672 (specimen at F) from Guatemala, Department El Progreso, as S. oxycarpum, a specimen collected after Correll (1962), and not commented on by Hawkes (1990).

The confusion regarding identity of these collections in ser. Conicibaccata begs the question of the species boundaries among Solanum agrimonifolium, S. longiconicum and S. oxycarpum. They are considered as distinct by number and size of lateral and interstitial leaflets and leaf pubescence (Correll, 1962; Gentry & Standley, 1974; Hawkes, 1990).

We encountered a possible population of S. oxycarpum on our expedition (SMV 7073) that had reduced numbers of interstitial leaflets, growing with more typical plants of S. agrimonifolium (SMV 7074) with many interstitial leaflets, and with intermediate phenotypes. Curiously, SMV 7073 had conical fruits rounded at the ends, unlike the more typical sharp-pointed ends of S. agrimonifolium (including the co-occurring SMV 7074).

Figures 5-9. Distributions of Solanum agrimonifolium, S. bulbocastanum, S. clarum, S. demissum, and S. morelliforme. A circle designates a generalized area with germplasm from prior expeditions (Appendix 2), or from this expedition (Summary of collections); an X indicates an area with herbarium records, but without a germplasm sample. Each site may have one to many records.

Fig. 5. *Solanum agrimonifolium*

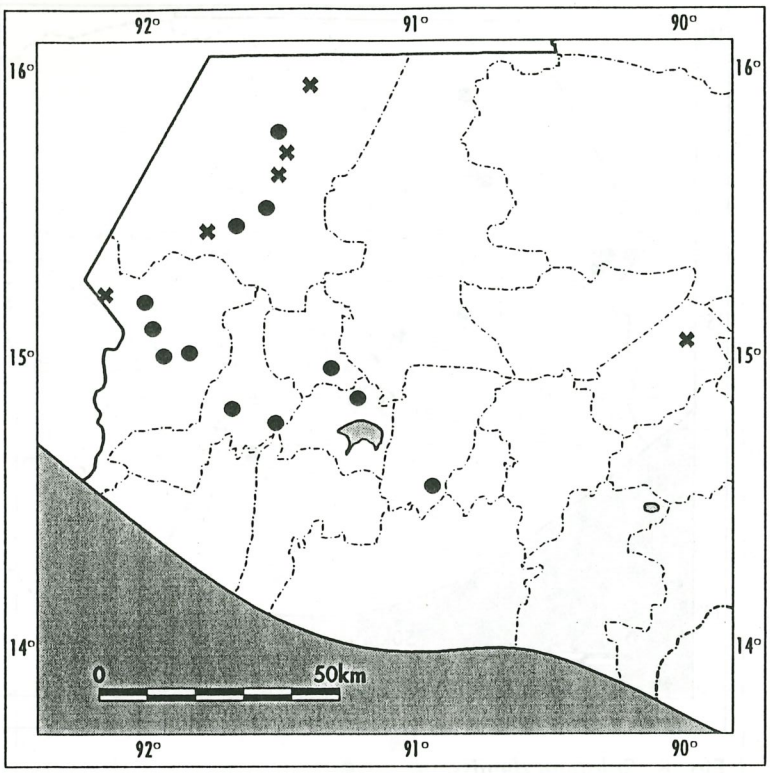


Fig. 6. *Solanum bulbocastanum* subsp. *partitum*

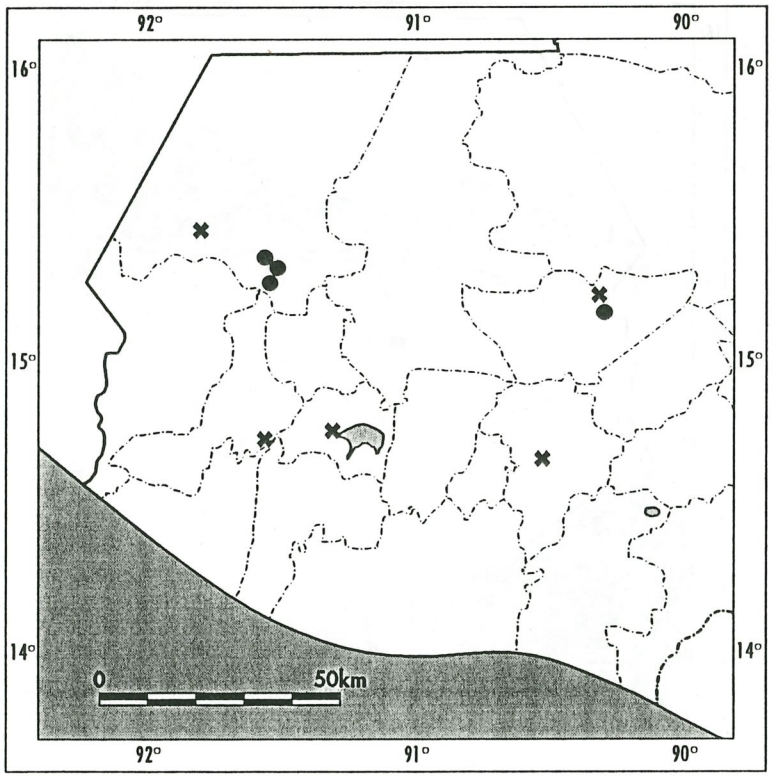


Fig. 7. *Solanum clarum*

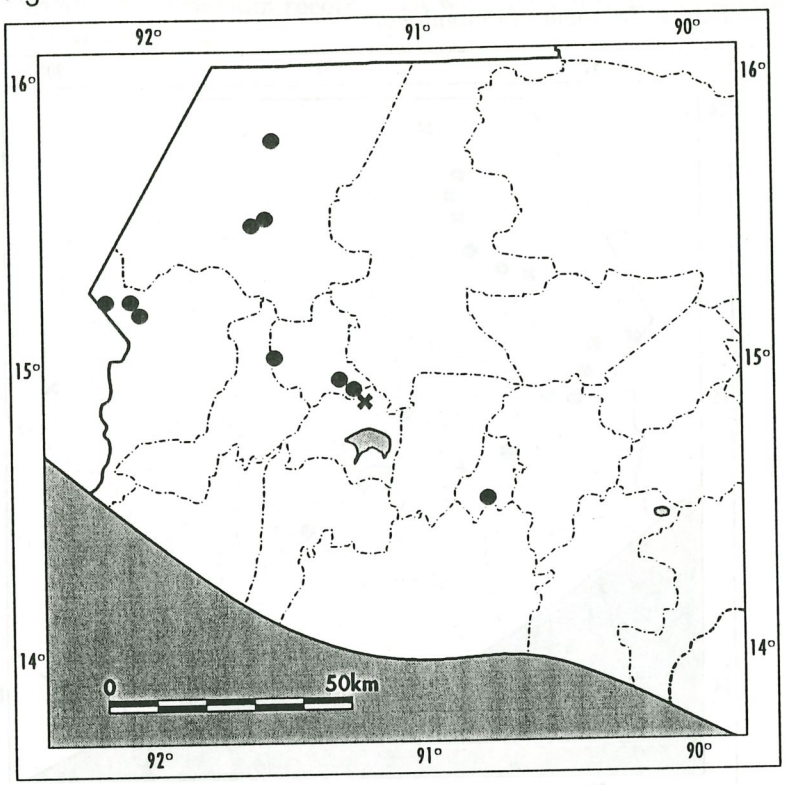


Fig. 8. *Solanum demissum*

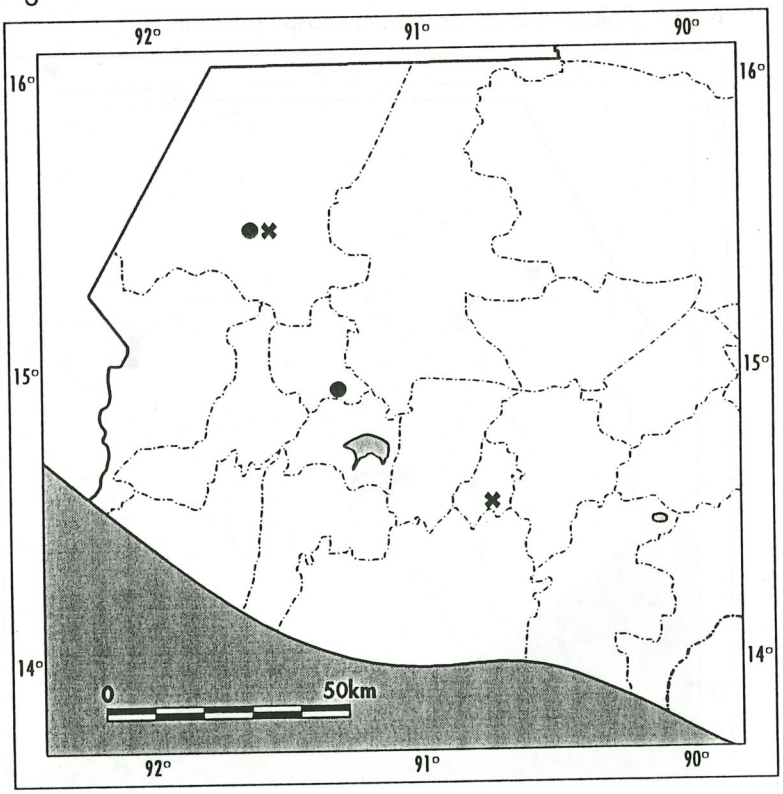
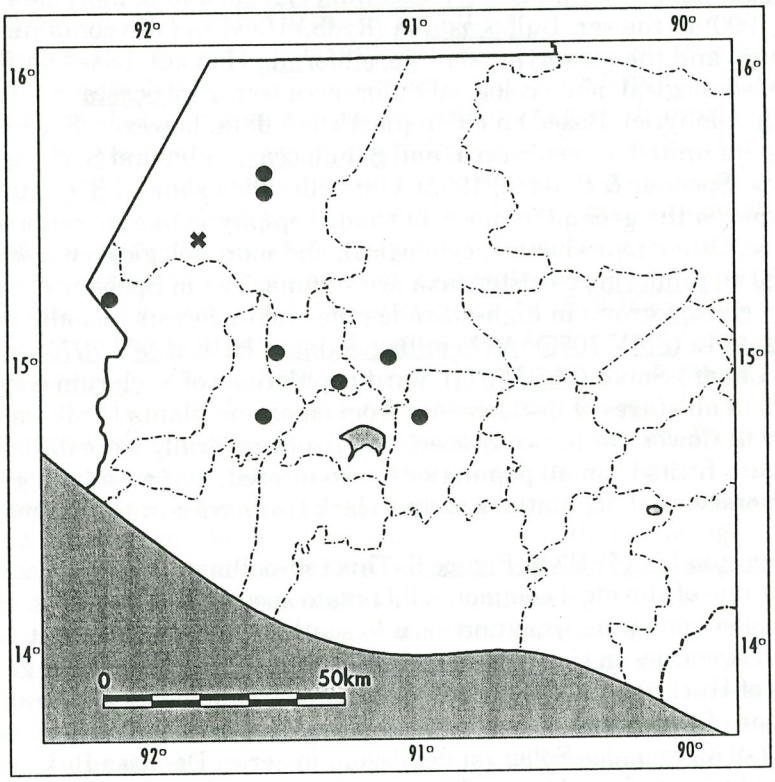


Fig. 9. *Solanum morelliforme*



For the purposes of this report, we consider all collections of ser. Conicibaccata in Guatemala as S. agrimonifolium.

All our collections of S. agrimonifolium were made in very wet and disturbed habitats, in organic soils, generally in areas of cloud forests, in full sun to partial shade. Common habitats are recently logged areas in valleys, streamsides, or in upland marshes.

Solanum bulbocastanum [2x (1EBN)], Figure 6. All of our collections have the deeply divided corolla lobes conforming to subsp. partitum (Correll) Hawkes (Correll, 1962; Gentry and Standley, 1974; Hawkes, 1990). This subspecies usually grows in low (1,350-2,300 m) and often very dry habitats, unlike all other wild potatoes from Guatemala. It persists in grazed areas, but is readily eaten by grazing animals before flowering and fruiting. All of our fruit collections in such areas were made in areas of more difficult access, such as steep rocky slopes, loose stones, rock walls, or among the dense vegetation of spiny shrubs or cacti. It is an inconspicuous plant with a widely scattered distribution throughout the dry areas of Guatemala, and likely is under-collected.

Solanum clarum [2x (1EBN)], Figure 7. Solanum clarum and S. morelliforme were divided by Hawkes (1990) in the ser. Bulbocastana (Rydb.) Hawkes (also containing S. bulbocastanum) and the monotypic ser. Morelliformia Hawkes, based on floral, reproductive, serological, and ecological differences (ser. Bulbocastana terrestrial, ser. Morelliformia epiphytic). Based on chloroplast DNA data, however, S. clarum and S. morelliforme are united as sister taxa, and S. bulbocastanum and S. clarum divided into distinct clades (Spooner & Sytsma, 1992). Our collections showed S. clarum to most commonly grow on the ground in moss, in shaded epiphytic like conditions, but occasionally as an epiphyte. Other reproductive, cytological, and morphological characters supporting S. clarum and S. morelliforme as sister taxa are summarized in Spooner & Sytsma (1992).

Solanum clarum grows in high-altitude pine and fir forests, usually in association with Acaena elongata L. (SMV 7076), Alchemilla pectinata HBK (SMV 7070), and Pernetta ciliata (Schlecht. & Cham.) Small (SMV 7071). Most populations of S. clarum consisted of hundreds of individuals in all stages of development from emerging plants to plants with mature fruits. However, flowers were rarely seen, and fruits generally were difficult to locate. We obtained mature fruits from all populations encountered, and we advise germplasm collectors to persevere if populations seem to lack fruits with initial inspection.

Solanum demissum [6x (4EBN)], Figure 8. This self-pollinated species readily sets fruit in nature, and is one of the most common wild potato species in genebanks. However, all but one of these collections were from northern to southern Mexico, where it is widespread, and this is the rarest species in Guatemala. It has been recorded from three general areas in the Departments of Huehuetenango, Sacatepéquez, and Totonicapán (Appendix 2), but we found it from only one of these, and our collections lacked flowers and fruits (we collected tubers).

Hawkes (1990) includes Solanum demissum in series Demissa Buk., containing five other hexaploid species from Mexico. The morphological characters defining this series are unclear, however. Spooner et al. (1995) showed that on the basis of morphology, the species is more similar to S. albicans (ser. Acaulia Juz.) from South America than to any other species in ser. Demissa.

Solanum morelliforme [2x (1EBN)], Figure 9. This distinctive species is the only member of sect. Petota growing almost exclusively as an epiphyte (see S. clarum, above). Occasionally, however, the species is found on the ground in the woods, in rotting wood of fallen trees, or in moss, both epiphytic-like conditions. Almost all populations were collected in shady conditions, on horizontal branches of mature elm, pine, or oak trees. We were unable to locate the species in trees of some previously documented localities that have been logged and reforested. Because the fruits and seeds of all members of sect. Petota are not airborne, the species probably is distributed in the droppings of birds or tree-dwelling animals.

Phenology. Timing is one of the most important aspects of planning a germplasm collecting expedition. In Guatemala, herbarium specimens of wild potatoes were collected in all months but April and May. Most germplasm was collected during September to November (Appendix 2). We collected germplasm of all five species throughout the expedition, but had to return to some populations of S. agrimonifolium in November to collect mature fruits (but some populations of this species had mature fruits in mid-September). Considering these data, and the greater efficiency of collecting in the dry season (Fig. 4), we suggest the best times to collect true seeds of wild potatoes in Guatemala would be during October and November.

Habitat destruction and its effect on wild potato populations in Guatemala. Guatemala has changed considerably since the major collections of wild potatoes in the 1940's and 1950's (Table 1, Appendix 2). Our expedition searched all but one of the known populations (Correll, 1962; Appendix 2). Many populations now apparently are extirpated due to habitat destruction. Much of the primary forest is being cut for firewood, structural timbers, and clearing for agriculture, and logging is a common practice in almost all of the primary forests we visited. In many areas, forests harboring wild potatoes are now reduced to small isolated stands, surrounded by cleared areas lacking them.

Population has nearly doubled in Guatemala from 4.3 million persons in 1964 (Dirección General de Estadística, 1971), to an official count of 8.3 million in 1994 (Instituto Nacional de Estadística, 1995), or a more realistic estimate of slightly over 10 million in 1994 (UNICEF, 1994). The median number of children each Guatemalan woman is projected to have during the years 1995-2000 is 4.9, resulting in an estimated population by the year 2,000 of 12 million (UNICEF, 1994). Sixty-two percent of Guatemala's population is rural, and 76% of the population live below the poverty line (UNICEF, 1994), placing growing needs on the use of Guatemala's remaining primary forests that harbor wild potatoes.

Deforestation has accelerated rapidly in Guatemala. In 1978-1988, the average deforestation was 60,000 hectares per year (Ministerio de Agricultura, Ganaderia y Alimentacion, Direccion General de Bosques y Vide Silvestre, 1994). Sixty-two percent of this wood is lost to forest fires, 35% is used for domestic firewood, and 2% is used for industrial purposes, including domestic house construction and export. Twenty-three percent of deforestation occurs in coniferous forests (Ministerio de Agricultura, Ganaderia y Alimentacion, Direccion General de Bosques y Vide Silvestre, 1994), concentrated in the uplands of western Guatemala where wild potatoes grow. Another growing cause of deforestation in Guatemala is attack by a bark boring beetle Dendroctonus spp. that is killing entire stands of pine forests, especially the upland pine Pinus rudis. The most severe attacks are again in the upland western Departments of Huehuetenango, Totonicapán, Quetzaltenango, Sololá, and San Marcos (Instituto Nacional Forestal, 1982).

Any prediction of the survival of Guatemalan wild potatoes can only be a rough guess, based on our observation of areas where potatoes now grow, their disappearance in recently disturbed areas, and a guess of how many natural areas will remain in the future. Solanum morelliforme grows in large trees, and is probably the most susceptible to disappearance by logging. Solanum clarum and S. demissum usually grow only in the shade of large trees among moss or pine needles, and are readily eaten by grazing animals, and S. demissum is now very rare in Guatemala. Solanum agrimonifolium grows in much more disturbed habitats, but almost always in areas of recently cleared primary forests in deep, moist, organic soils, and it also is readily eaten by grazing animals. Solanum bulbocastanum grows among shrubs of dry grazed areas, and is probably the least susceptible to elimination. Natural areas are disappearing rapidly, and some of our collections will be the last available for some areas.

Recommended areas for future collecting and habitat preservation. We focused collecting in areas with known localities but lacking germplasm collections to maximize our efficiency. We additionally searched areas with appropriate elevations for wild potatoes but without prior localities. These included three mountains in the Departments of Guatemala, Jalapa, and

Chimaltenango with elevations from 2,000-3,000 m (Fig. 3), but we found no wild potatoes there. These three localities had some mesic and relatively undisturbed sites with much epiphytic vegetation apparently ideal for the growth of S. agrimonifolium and S. morelliforme. Because we devoted only one day each to these areas, it is possible we overlooked wild potatoes there.

Our 43 new collections, and the 16 prior collections of Graham and Hawkes (Table 2), provide good germplasm representation for all the species in Guatemala regarding numbers of populations and geographic coverage (Figs. 5-9, Table 2). Consequently, future potato germplasm collecting should be conducted in less collected countries, such as Costa Rica, Honduras, and Panama.

If wild potato collecting is done again in Guatemala, we suggest the following areas that we did not explore to expand geographic coverage:

1. Political instability prevented us from exploring the three volcanoes south of Lago Atitlán in the Department of Sololá with elevations from 2,995-3,537 m (Volcán Atitlán, Volcán San Pedro, Volcán Tolimán). There are no records there, but these are likely to be rich areas for any of the five species known for Guatemala.
2. Political instability also prevented us from exploring the far eastern part of the Sierra de los Cuchumatanes, in the Department of El Quiché, north of the road from Río Blanco to Uspatán, with some elevations over 2,700 m.
3. The mountains in the extreme southwestern portion of the Sierra de los Cuchumanates, in the Department of Huehuetenango, north of Cuilco.
4. The extreme northern portion of the Sierra de los Cuchumanates, in the Department of Huehuetenango, north of San Mateo Ixtatán.
5. The Sierra de las Minas in the eastern part of the Department of El Progreso, and the western part of the Department of Zacapa, where the sierra is highest. We spent two days searching unsuccessfully for Steyermark's record of S. oxycarpum north of the town of Jute de La Cobana (see above). There were many appropriate habitats for this species there, and there are likely similar habitats.
6. Solanum bulbocastanum grows in much drier sites than the other Guatemalan species, and our collecting experience shows it to persist in some grazed areas. The species probably is under-collected because it is inconspicuous. In Guatemala, the species occurs from 1,350-2,300 m (Table 2), and it may occur in dry regions at these elevations, present in many places in southern Guatemala.

Two areas are notable for the concentration of wild potatoes and some remaining natural areas: 1) The Cumbre de María Tecún in the Department of Totonicapán, and 2) scattered areas in the Sierra de los Cuchumatanes. Both harbor populations of all of Guatemala's wild potato species except S. bulbocastanum. Both areas are listed in Guatemala's protected areas law (Ley de Areas Protegidas, Decreto 4-89) to have official protection under this law but lacking practical enforcement until it is formally studied, and given a push for protection.

Table 1. Previous herbarium and germplasm collections of wild potatoes in Guatemala.

Collectors	Inclusive dates of collections	Species collected	Departments collected[1]
Hans von Türckheim	July, 1908	Solanum bulbocastanum	B
Alexander F. Skutch	Aug. 3, 1933; July 27, 1934	S. clarum, S. morelliforme	C, Qe
José I. Aguilar G.	1939-1943	S. bulbocastanum	G
Paul C. Standley	Feb. 11-Mar 4, 1939; Feb. 1-16, 1941; Mar 13, 1959	S. agrimonifolium, S. demissum	Qe, Sa, SM
Julian A. Steyermark	Jan 22, 1940-Sept. 7, 1942	S. agrimonifolium, S. bulbocastanum, S. clarum, S. demissum, S. morelliforme	H, P, Qe, SM, So
Keith M. Graham	Aug. 6-Oct. 23, 1956	S. agrimonifolium, S. clarum, S. morelliforme	C, H, Qe, Qu, So
John (Jack) G. Hawkes, J. Peter Hjerting, & R. Lester	Oct. 29-Nov. 11, 1958	S. agrimonifolium, S. bulbocastanum, S. clarum, S. demissum, S. morelliforme	B, H, P, Qe, Qi, Sa, SM, T
John H. Beaman	Aug. 5-13, 1959; July 30-Aug. 14, 1960	S. agrimonifolium, S. clarum, S. demissum	H, SM, T
Keith E. Roe, E. Roe, & Scott A. Mori.	July 31, 1965	S. bulbocastanum	Qe

[1] Department abbreviations are: Baja Verapaz (B), Chimaltenango (C), Guatemala (G), Huehuetenango (H), El Progreso (P), Quezaltenango (Qe), Quiché (Qi), San Marcos (SM), Sacatepéquez (Sa), Sololá (So), Totonicapán (T).

Table 2. Numbers and distribution of germplasm of the five species of wild potatoes from Guatemala.

Species	Accessions from Mexico before the expedition	Accessions from Guatemala before the expedition: (division by Department)[1]	Total current Guatemalan accessions (division by Department)[1]	Elevations of occurrence in Guatemala
Solanum agrimonifolium	3	6: 3(H), 1(SM), 1(T), 1(Qe)	19: 2(C), 8(H), 2(Qe), 4(SM), 1(So), 2(T)	1,600-3,800 m
S. bulbocastanum	40[2]	1(H)	7: 3(B), 4(H)	1,350-2,300 m
S. clarum	1	4: 1(So), 3(T)	21: 7(H), 3 (SM), 1(So), 10(T)	2,900-3,800 m
S. demissum	140	1(H)	2: 1(H), 1(T)	2,250-3,800 m
S. morelliforme	8	4: 1(C), 2(Qe), 1(Qi)	10: 1(C), 2(Qe), 2(H), 1(Qi), 1(SM), 3(T)	1,600-3,050 m

[1] Baja Verapaz (B), Chimaltenango (C), Guatemala (G), Hueheutenango (H), El Progreso (P), Quezaltenango (Qe), Quiché (Qi), San Marcos (SM), Sacatepéquez (Sa), Sololá (So), Totonicapán (T).

[2] Does not include the nine accessions collected in Mexico by Rodríguez et al. (1995) that are still in U.S. quarantine.

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DAILY ITINERARY

September 9, 1995 (Saturday)

Roel Hoekstra arrived in Guatemala City at 10:00 PM. Stayed in Hotel El Dorado, 7a Av. 15-45, Zona 9, Guatemala 01009. Tel: (502-2) 317777; FAX: (502-2) 321877.

September 10

David Spooner arrived in Guatemala City at 5:30 PM. Changed money at airport at 5.70 quetzals/dollar. Spooner met at airport by Hoekstra; both stayed at Hotel El Dorado.

September 11 (Monday)

We went to the American Embassy and met Grant Pettrie, Agricultural Attaché, and Richard T. (Tod) Drennan, Assistant Agricultural Attaché (Ava. La Reforma 7-01, Zona 10, Tel (502-2) 311541, ext. 300, FAX: (502-2) 318293). Both were instrumental in establishing our initial contact with Ing. Fernando Vargas, the Guatemalan Vice-Minister of Agriculture, who agreed to collaborate with us in Guatemala (Appendix 1), and in setting up later contacts that authorized the trip. We explained the purpose of our trip, contacts in Guatemala, possible filming of our expedition by the German filmmaker Joerg Altekruse (Rutschbahn 17, D-20146 Hamburg, Tel: (49-40) 442014; FAX: 458607, email: 100442.2305@compuserve.com), and length of our expedition in Guatemala (nine weeks). I explained how our genebanks were trying to operate within the spirit and letter of the Biodiversity Convention relative to follow-up research, coauthorship of papers, and sharing germplasm. He indicated that he would explore possibilities for using funds from this program for student training. Drennan explained that there are potential security concerns in Guatemala, and we are scheduled for a security briefing next day at 2:00 PM.

Because of a potential disagreement between the Executive and Legislative Branches of the U.S. government, resulting in a potential failure to pass budget bills, all non-essential U.S. government employees (including Spooner and various U.S. Embassy Personnel) are preparing for a furlough beginning October 1. At present, there is no word if the furlough will occur, how long it may last, or the structure and size of the government after it may end. This impacts the completion of this expedition because of cost-sharing of Guatemalan per-diems and jeep expenses between the U.S. and Dutch Germplasm Systems, because there can be no expenditures of U.S. Government funds during the time of the furlough. Because of the potential furlough, Spooner could not obtain travel orders beyond September 30, and may have to return to the U.S. then, with a possible return to Guatemala soon after the furlough ends, depending on the length of the furlough and structure of the budgets after the resolution of budget bills. Spooner explained this to Pettrie and Drennan, and they indicated they would be passing any messages to Spooner that would be communicated through Spooner's USDA Administrative Office in Madison, Wisconsin.

Hoekstra and Spooner returned to the Hotel El Dorado and were met there by Ing. Vincente Martínez, the ICTA (Instituto de Ciencia y Tecnologia Agricolas) employee designated as our field partner in Guatemala. Together, we drove to the ICTA offices south of Guatemala City (km 21.5 Carretera hacia Amatitlán, Bárcenas, Villa Nueva, Tel: (502-2) 0312008, 0312009). We met with Ing. Astolfo Fumagalli, the Director General of ICTA, Ing. Bosbelí, Sub-Manager of ICTA. Ing. Fumagalli welcomed us to Guatemala. He explained how the successful initiation of this expedition required his work to change a law that prohibited germplasm collection by foreign collectors. He also explained that the Guatemalan government currently was discussing establishing regulations for the

conduct of germplasm collecting expeditions by foreigners, and gave us a draft copy of this document. He indicated that he fully backed our expedition, and that there would be no restrictions on us to collect or leave with germplasm for our genebanks.

We discussed our budget, and explained that we would give our collaborator (designated by ICTA as Vincente Martínez) $4,500 per-diem for the nine-week expedition, pay for all travel expenses including the jeep, divide herbarium and germplasm samples before leaving Guatemala, and co-author a paper for submission to a peer-reviewed scientific journal (in the past we have published the results of all of our expeditions in Euphytica, Potato Research, or American Potato Journal), and try to secure funds for follow-up research. Ing. Fumagalli gave us a letter of introduction to civil and military authorities to be used in the field.

We then went to Vincente Martínez's bank and transferred $1,800 of U.S. funds to his personal bank account. We went to the Instituto Geográfico Militar (Avenida Las Americas 5-76, Zona 13) and purchased 12 of the 13 1:250,000-scale topographic maps that cover all of Guatemala (the Guatemala City map currently is out of print, but is being republished), and 10 1:1,000,000-scale "Mapa Turistico," 1980. We then went to Hertz automobile rental (across the street from the Hotel El Dorado) and contracted a two-cabin four-wheel drive pickup truck for six weeks beginning Wednesday, September 13. Vincente returned home, and indicated he would make an appointment for us to visit herbaria the next day. Hoekstra and Spooner returned to the Hotel El Dorado to type the report.

September 12

Vincente Martínez met us at the hotel and we drove to the herbarium of the Centro Estudios Conservacionistas (CECON), Universidad de San Carlos, Avenida La Reforma 0-43, Zona 10, Guatemala City, located in the Jardín Botánico (herbarium acronym = USCG, Tel: 502-2-310904). We met Dr. Ava Nury Díaz de C. (curator of crytograms with specialization in ferns). We examined the herbarium, and they had approximately 25 sheets of Solanum, but no wild potatoes.

We then walked to another building in the complex of the Jardín Botánico and met workers in the Nature Conservancy funded "Centro de Estudios Conservacionistos (CECON)," Avenida La Reforma 0-63, Zona 10, email: cecon@uvalle.edu.gt. The Coordinator, Licencia Olga Valdez, was away at the offices of the Nature Conservancy in Washington, DC. We met, however, two of the other four workers of this program, Aura Elena Suchini Farfán, and Ricardo Santa Cruz. Ms. Farfán showed us the computerization of Guatemala's rare and endangered species, the data entry forms for these species, and the maps and gazetteers used in their work. In discussion of our search for all road and topographic maps for Guatemala, she indicated that we were aware of most of the maps she knew about, and that there were no individual department maps available. She let us borrow her 1:250,000-scale Guatemala map (the only one of the set of 13 that we were not able to purchase yesterday), and Vincente obtained two full-size photocopies of it from a local photocopy service. Aura also showed us the four-volume set of a Guatemalan geographic dictionary: "Diccionario geografico Guatemala, Secundo Edición, Compilacion critica Francis Gall, Tomo I (A-Ch, 833 pp., 1976), Tomo II (D-P, 1083 pp., 1981), Tomo III (Q-S, 810 pp., 1983), Tomo IV (T-Z, 486 pp., 1983).

We went to the Instituto Geografico Militar and bought this four-volume set (629 Quetzales), and two sets of five of the six maps covering southern Guatemala (the other map being the Guatemala map we made two copies of from Aura's map). This gave us a

complete set of 13 1:250,000-scale topographic maps for binding, and other maps in southern Guatemala where potatoes grow for our active field work.

We went to the herbarium of the Facultad de Agronomía, Universidad de San Carlos, Zona 12, Apartado Postal 1545, Guatemala City, Guatemala, located in Edificio T-8, Ciudad Universitaria (herbarium acronym AGUAT, Tel: 502-2-760790 to 760794, ext. 498). We met the correspondent of the herbarium, Dr. Juan J. Castillo Mont. Dr. Castillo showed us the Solanum collection. The herbarium inventory listed a specimen of Solanum bulbocastanum, but when we examined the specimen it was another Solanum misidentified as this species. There were no herbarium specimens of wild potatoes in this herbarium. Dr. Castillo agreed to let us use his drying facilities, and we agreed to leave a duplicate set of herbarium specimens at his herbarium.

Hoekstra and Spooner went to the American Embassy for a security briefing from Mr. Lance Root, one of the three Regional Security Officers at the Embassy, and Martínez returned to ICTA. Root indicated that we should telephone the Embassy our location once weekly to let them know where we could be reached, that we should not travel at night, and that there was a high crime problem in Guatemala City. We met Mr. Richard T. Drennan to discuss further the Fellowship opportunities for a Guatemalan student, and he indicated he would research this further during our trip. He gave Spooner the telephone number of an administrator of the Cocharan Fellowship Program, a part of a U.S. Agriculture Public Law 101-624 (Mr. James O'Meara, 202-720-0368).

Hoekstra and Spooner returned to the Hotel El Dorado to work on the day's report. Martínez met them later at the hotel and we mapped all our records on a working set of 1:250,000-scale topographic maps. The records were confined to four maps: ND 15-3, ND 15-4, ND 15-7, ND 15-8. We numbered all of our records for reference to map localities we penned onto the maps. We planned our field work.

September 13

We met Vincente at 7:00 A.M. We got our car (a four-wheel drive two-seat pickup truck) at Hertz Rental (502-2-315374) across the street from the Hotel Dorado, and drove to Antigua where we bought plastic and cord to cover items for the back of the truck. Because of the possibility of being stopped and robbed along the road (according to the Security Officer at the U.S. Embassy), we went to a hotel (Hotel Panchoy), and placed all non-essential items in the hotel before proceeding. We drove to Santa Maria de Jesús, a town at about 2,050 m at the north base of Volcán de Agua, 30 minutes south of Antigua. There is a road that ascends the north slope of this volcano to a microwave tower on the top of the volcano (3,760 m), but it has been destroyed by rains and cannot be driven anymore.

There are three records from Volcán de Agua: S. clarum at 2,900 m (C6), and S. demissum at 2,250-3000 m (D8, D9; Appendix 2). We began hiking at about 10:30 AM and ascended up to 3,200 at about 2:30 PM. We began to descend at about 3:00 PM, and it began to rain steadily and heavily at about 3:15 PM and we could no longer search. There are many habitats appropriate for both species there. The lower slopes of the volcano are mostly cornfields, and the upper slopes are woods that the local people use to gather firewood, but there are still many large trees. The trees have much epiphytic vegetation, and the soil is deep and organic in many areas. At about 3,000 m, the vegetation changes from hardwood woods to open grassland with scattered pine trees. We plan to revisit this area in about one month to try again to collect wild potatoes. We slept in Antigua.

September 14

We drove east to Tecpán (located at about 2,100 m), and searched for the records of S. morelliforme from this area (M1, M2, M4, M8). None of the records were specific as to the exact collection sites, but the road going north to San José Poaquil descended to lower elevations, so we first drove south along the road to Patzún that ascended to 2,500 m and higher, at appropriate habitats for S. morelliforme. Although there was much logging in the area and much of the area was completely cleared or had only small trees, there were some sites with larger trees with much epiphytic vegetation. We searched three areas, one being the Iximche Archeological site, all areas above Tecpán, no more than a 20 minute drive away, but found no potatoes.

We then drove west along the new road to Totonicapán, and searched in some places along the road. This road has many places with large trees, much epiphytic vegetation, and many mesic sites apparently appropriate for S. morelliforme, and S. agrimonifolium, S. clarum, and S. demissum. At one point along the road, at a point informally called "Alaska," it ascends to 3,000 m. This road was constructed at about 1972, and the records A18, A19, A24, C7, C8, C9, C15, D10 were apparently all made along an old and now abandoned road going from Totonicapán to Los Encuentros, north of the present road, and figured on the 1978 1:250,000-scale ND 15-8 topographic map as a dotted line. We found no potatoes along the current road, and went to Totonicapán where we spent the night, with plans to search along the abandoned road east out of Totonicapán the next day.

September 15

We drove NE along the road to Santa Cruz del Quiché. The old Totonicapán-Los Encuentros road diverges from this present road at 5.7 km NE of the town square. Our immediate goal was to search for A18, A19, A24, C15, D10. All of these collections were made by Jack Hawkes on November 5, 1958, at elevations of 3300-3350 m, along the road to Los Encuentros, at 1 mi. east of town. At this time, only the "old" road existed. However, these elevations are not reached until about 10 km NE of town, and it is likely that 1 is a transcription error for 10.

Along the route NE, we first passed the old road, and continued on the new road to Santa Cruz del Quiché. We found S. morelliforme (7004, see prior localities, Appendix 2), a species not recorded from this area. All sites of this plant were in organic debris on branches of old pine trees. There is logging in this area, and they may disappear with continued logging.

We then drove the old road to Los Encuentros, and collected another population of S. morelliforme (7005). We continued east and collected S. agrimonifolium (7006). This road traverses through very mature forests with much epiphytic vegetation. There is much moss on the ground and on exposed boulders, forming apparently ideal habitats for S. clarum, a species recorded throughout the road (C7, C8, C9, C15), but we could not locate the species and suspected we were too early. The road is in very poor shape, and we turned around at 3:00 PM, at about 15 km from the initiation of the old road, in order to get back before dark. Vincente said that the road is not traversable by jeep all the way to Los Encuentros. We planned to return in about a month to search for S. clarum and other species. We drove straight to Huehuetenango, where we spent the night.

September 16

We drove north along Rt. 9N and searched the hills west at 31 km north of Huehuetenango, where we found S. clarum (7007). We had to hike about 150 m vertical distance uphill and 1 km east, through areas under pasture, to find this population, which was found at only one small area. Of interest was that this population had no flowers. There were small plants without flowers, and mature plants with berries fallen to the ground or still on the plants, but no flowering plants. The discovery of this population led us to suspect that our inability to find plants the previous day was not due their failure to emerge yet, but because we did not discover the sites where they occurred.

We continued north to look for S. agrimonifolium, S. clarum, and S. demissum (A20, A21, A22, C1, C3, C4, D2, D4, D5, D6, D7, D11) about the area of Chémal (area spelled Xémal on the 1:250,000-scale ND 15-4 topographic map). Xémal is a general area name, and not any specific site along 9N or along a separate road diverting to the west and going to San Miguel Acatán. We found a single fruit of Solanum isolated from any plant (7008) along this road to San Miguel Acatán, and we do not know if it is from a potato. We collected it and will introduce it to see if it is a potato. We returned to Huehuetenango where we spent the night.

September 17

We drove back north along Rt. 9N, with the goal of locating A1, A2, A3. We searched a few sites along the road without success until we reached 11.8 km north of Santa Eulalia (100.0 km north of Huehuetenango), where we located S. morelliforme (7009). This species is not recorded from this area. There are many greatly disturbed habitats along this road (logged and grazed), but some isolated patches of apparently undisturbed forest also. The road is very poor beyond Xémal, and it is a four-hour drive each way to reach our ultimate collection site, making it impossible for extensive searches with the need to return to Huehuetenango. We discovered that there is lodging in Santa Eulalia, and we plan to return to this area in about a month with Santa Eulalia as our base. We returned to Huehuetenango where we spent the night.

September 18 (Monday)

We drove to the edge of Huehuetenango at its junction of 9N to search for B6. We very soon found a single flowering and fruiting plant of S. bulbocastanum and collected a single fruit (7010). It took us three hours to collect another eight mature fruits in these hills. We drove south to La Estancia de la Virgen, and additionally searched one site before this. We found two flowering, but not fruiting S. bulbocastanum plants at La Estancia de la Virgen, but made no herbarium collections.

We drove to Quetzaltenango and got a room at Hotel El Modelo. Martínez returned alone to Guatemala City to take herbarium specimens to the herbarium of AGUAT (see September 12) to be dried, and to purchase a vegetation map and relief map of Guatemala for our further trip planning and report and paper writing. Hoekstra and Spooner remained to write the report and paper.

September 19

Martínez went the herbarium and Instituto Geográfico Militar to accomplish goals listed above (September 18). Hoekstra and Spooner wrote the report, bought paper bags for storage of fruits, and extracted seeds from some fruits. Spooner called the American Embassy and was told that the U.S. Government may have a continuing budget resolution that may allow him to remain in Guatemala beyond September 30. Spooner called Phillip Simon, his Research Leader, Simon confirmed this possibility, and

indicated he would conduct the paperwork needed to try to allow Spooner to remain in Guatemala beyond September 30.

September 20

Martínez returned from Guatemala City and met Hoekstra and Spooner at 8:00 AM. Our goal was to recollect numbers C10, C11, C12, C13, C14, M7. The records indicated to us localities on the main road from Quetzaltenango to Huehuetenango, but the highest elevations on this road were about 2,500 m, not 3,250 m as in the records. We first searched in the hills ca. 15 km north of Quetzaltenango without success. We suspected that the records referred to an old road, now largely closed, that ran from Quetzaltenango through San Vincente Buenabaj, to Calel. Calel currently is reached by a new road, diverging west from the Pan-American Highway about 20 km north of the crossing of this road and a road at Puente Pologuá, going west to Totonicapán. We drove along the road to Calel (about 10 km west of the Pan-American Highway), and after about 9 km collected S. clarum (7011), mostly in the moss-covered ground about old oak trees, but a couple in the trees. The habitats up to this site are very disturbed, and there are very few old trees left with epiphytic vegetation. Most of the area was covered in crops, or in bunch grasses, a shrubby Baccharis, or the ground was eroded to rock. Of interest is our observation made during the other collection of S. clarum (collection 7007, September 16) that there were old plants with and without fruits and young non-flowering plants, but no flowers were seen.

We continued to Calel and searched in the hills northwest of town without success. We drove back east towards the Pan-American Highway and after about one-half km noted that there was an old and badly eroded road that went south that was the old road where the records were collected. We drove 1 km south and located S. morelliforme (7013, in fruit, no flowers seen), and S. clarum (7014, again, with young and old plants but no flowers seen). As in the collection site of S. clarum 7011, most of he trees were gone, and only a very few remained. It appeared that the habitats for S. clarum and S. morelliforme will be eliminated from this area in the future. We returned to Quetzaltenango where we spent the night.

September 21

We drove about 5 km south of Quetzaltenango to look for records C5, M9, M10 on the slopes of Volcán Santa Maria. We have germplasm of records M9 and M10, but not C5. We found no germplasm this day. The records of S. morelliforme are both at 2,550 m, and we were able to drive to 2,600 m. There are many apparently appropriate habitats for S. morelliforme from 2,500 up to at least 3,200 m (the highest we got that day). We did not reach the top because there are many paths on the volcano, the main path to the top is not marked, and we kept getting off the main path.

At first, we hiked along a path more to the east of the volcano that looked like the main path. It leads to what appears to be primary forest with epiphytic vegetation everywhere. There is a very wide well-used path being used by loggers who are logging with hand tools, cutting structural timbers and fuel wood to size in place, and carrying it out on their backs. There are various paths that ascend the volcano, but each gets less used and narrower as it ascends, and ends in areas of thick undergrowth that is nearly impossible to walk through. We kept trying new paths and kept running into this thick undergrowth, reaching 3,200 m at the highest point (this record is the type locality of S. clarum, at 3,600 m).

We eventually met a logger who told us that the main hiking path to the top was more to the south-facing slope, and we walked back there, only to be diverted to dead-end paths again, never to hike above 3,200 m. After trying this a couple of times, we eventually met hikers who showed us the main path, but by this time (about 3:00 PM) we were all exhausted, and decided to hike down and try another day. We returned to Quetzaltenango where we spent the night.

September 22

Our goal was to collect germplasm of A7. We drove south on the road to Retalhuleu, through Zunil. The Fuente de Aguas Termales Georgianas is a commercial tourist hot spring located 8 km southeast of the deviation from the Quezeltenango-Retalhuleu Highway (Rt. 7), near the town of Zunil. We searched the lower slopes of Volcán Zunil on the east side of the main road without success before driving to the hot springs, located at 2,400 m; and A7 is at 2,850 m. There is a path to this elevation and higher from the hot springs, with many smaller diverging paths used by small-scale loggers and fuel wood gatherers. We located S. agrimonifolium (7019) at 2,900 m in a large clearing out of mostly primary wet forest with epiphytic vegetation. There were hundreds of plants present, in various stages of maturity of young flowering plants to plants with maturing to mature fruits. At about 3:00 PM we descended the mountain, and it began to rain. The latitude and longitude of this record is an approximation from the topographic map. We did not bring the GPS (Global Positioning) machine with us on the mountain, and could not get a satellite fix in the deep valley of the hot springs. We drove back to Quetzaltenango where we spent the night.

September 23

We drove to San Marcos and placed our luggage in our hotel (Hotel Pérez, 9a Calle, Zona 1). Our goals were records A12, A13, A17. All these records were very close to each other, on the same road, with elevations between 2,100-2,700 m. The road to San Rafael Pie de la Cuesta quickly descends from San Marcos, and goes through cloud forest. We found S. agrimonifolium at our first stop, in a road ditch, at 11.9 km south of the San Marcos town square, but it was not in flower or fruit. We continued for 0.5 km more to collect record 7021. There were 30 plants or more, with many flowers, but only few young fruits. We made herbarium specimens and collected the two largest fruits we could find, with plans to return in a few weeks to collect mature fruits.

We continued west and searched along the road for more potatoes without success. We went all the way down to San Rafael Pie de la Cuesta, located at 1,100 m. At about 1,500 m the road descends into coffee plantations, and there would be no more potato populations below this elevation. We returned up to the road to San Marcos and looked at elevations above our collection site 7021 at 2,340 m, but all habitats were in cultivation or habitation and it would be unlikely to find potatoes there.

We then decided to descend the Sierra Madre at another place to see if we could find potatoes. We first tried to drive south on a road shown on the 1:1,000,000-scale 1980 tourist road map (expanded portion) going south from San Marcos to San Cristóbal Cucho. The road went only a few kilometers, and the habitats were too dry for potatoes. We then returned to San Marcos and took the other road south to La Reforma. Like the previous road, the habitats were too dry (and very disturbed), as on the road descending the Sierra Madre from San Marcos to San Rafael Pie de la Cuesta. We continued down hill on this road to 1,900 m, at its crossing with the upper reaches of Río Naranjo at 14°55'S, 91°51'W, and searched in this river valley hoping to find moist habitats where S.

agrimonifolium might grow, but did not find it. We returned to San Marcos where we spent the night.

September 24

We drove northwest towards Tacaná. Our goal was to collect germplasm from A14, A16, A23 (all the same general locality - here referred to as first locality), and A11 (second locality). There was NRSP-6 germplasm from the first, but not second locality. We reached the first locality and could not find potatoes. Much of the forest has been clear-cut in areas of the first locality by the Army, who cleared the area around a base that is no longer there.

We found, however, both S. agrimonifolium (7026) and S. clarum (7027) at the second locality (A11). Previously, only S. agrimonifolium was known from the Department of San Marcos, so the S. clarum collection is a new Department record. Most of the land between these two localities is clear cut and converted to pasture land or cultivation, and there is much deep soil erosion.

We collected additional germplasm of S. clarum from another site (7028), and continued to Tacaná where we spent the night. The road from Ixchiguán to Tacaná was severely eroded by the heavy rains of the preceding months and was barely traversable by our jeep. Our jeep bottomed out many times, and the 22 km trip between these two towns took about 2½ hours. The owner of the hostel we stayed in (Sr. Benjamin Gálvez, 8a Av. 317, Zona 1, Tacaná) was the former mayor of the town and knew the logistics of the area. Our goal for the next day was to drive to the site of A15 at the north base of Volcán Tacaná. Mr. Gálvez told us that there was no road there and you had to walk to reach it. He agreed to serve as our guide for the next day. Because there were no restaurants open in town early the next day, we bought food and water for our trip.

September 25 (Monday)

We arose at 5:00 AM and drove about 20 minutes on a road west of town (very slow driving because of a bad road), and began walking to the town of San Rafael at the north base of Volcán Tacaná to search for A15. The walk takes four hours without stopping and crosses a mountain cresting at 3,300 m. Along the way we collected germplasm of S. clarum (7029) and S. morelliforme (7030). Solanum morelliforme, like the collection of S. clarum the day before and this day, was a new Department record. We continued to Río Vega and searched for S. agrimonifolium in this river valley between San Rafael and La Vega, and on the adjacent slopes without success. The lower slopes of these valleys are now cleared of all original vegetation, and there is much clearing in the Río Vega valley. Formerly, this area was used for poppy cultivation, a practice is now heavily discouraged by the government with road signs advertising that poppy growers will lose their land. We returned to Tacaná where we spent the night. Just for fun, we took a shower that night. Try it sometime. The water coming out of the hills is near freezing, and Mr. Gálvez's quarters leave something to be desired.

September 26

We drove back towards San Marcos, and searched remaining pockets of mature forest along the way without success. We drove on the road diverting west to the town of Tajumulco, along the north base of Volcán Tajumulco with the original intent to drive to town. This road traverses original cloud forest, and we searched a couple of places without success. We met two local wood cutters (Ceserio Tomnchac and Lorenzo Rodríguez) who told us they knew where a population of wild potatoes grew. They led us

to S. agrimonifolium (7034). We never would have found this population on our own, because they had to use machetes to cut a path through bamboo and other herbaceous vegetation to a clearing where the potatoes grew. It showed us what we already knew, that there are many potatoes missed on any search.

We then kept driving to San Marcos and took the road east towards San Lorenzo where we searched unsuccessfully for potatoes in a mature cloud forest soon after diverting from the main road. This was at about 2:00 PM, and it began to rain, and we decided to return later because the site appeared promising for potatoes. We drove to San Marcos, got our things we left behind at our hotel and continued to Quezaltenengo where we spent the night.

September 27

We drove east to the road going south from the main Quetzaltenango-San Marcos Road to Colomba to search for records A6, A8, A10, A25, all in the same general area, if not the same site. It was clear the general area of collection because the distances, elevation, and vegetation (Gunnera) all matched along a 4-5 km stretch of road. We searched a few sites before the record from 2,500 m to 2,200 m without success. When we got to 2,100 m (the upper elevation of the records running from 1,800-2,100 m), it began to rain heavily. We drove along this entire stretch of road and walked some of it for one-half hour without finding potatoes. It became too difficult to search because of the heavy rain, and we drove back to Quetzaltenango where we spent the rest of the day working on this report. We spent the night in Quetzaltenango.

September 28

Our goal was to search for potatoes along the new road from an area informally called Cuatro Caminos (the intersection of four roads ca. 10 km north of Quetzaltenango) to Los Encuentros, and to collect germplasm of A17a (so numbered because we originally could not map it and we do not wish to disrupt our numbering scheme now), and C7 and C8, on the old road from Los Encuentros west to Totonicapán, in the Department of Sololá. We drove to the highest areas along the road between Cuatro Caminos and Los Encuentros, a place informally called Alaska, at about 3,000 m. There is some original forest there that has altitudes that should be appropriate for wild potatoes, but we found none in searches into three separate places about this upper elevation area of the road. There was little epiphytic vegetation, and we suspect the area is not humid enough for wild potatoes.

When we continued east to Los Encuentros, there appeared to be many more suitable mesic habitats north of the road, but it began to rain heavily (and continued to do so all day) when we were considering trying to take an extended hike north of the road into mesic uplands. We decided to see how far the old road ascended west from Los Encuentros to Totonicapán into the hills toward Totonicapán, approaching from the other direction from our visit of September 15. Although the road is heavily eroded, it can be driven all to way up to what we think is the limit with the Department of Totonicapán, at about 3,100 m. The habitats in the Department of Sololá along this old road are extremely disturbed, with much logging, tilling for agriculture, and grazing. We could not find S. clarum, but did locate germplasm of S. agrimonifolium (7036) along a stream on the north side of the road in a site in or next to a steep stream bank, and protected from grazing by the steepness of the bank and shrubby Potentilla. We returned to the Hotel El Dorado in Guatemala City where Hoekstra and Spooner spent the night, and Martínez returned to his home.

September 29

Spooner visited the American Embassy and heard that an agreement was made between the U.S. President and Congress to pass a six-week temporary resolution, allowing him to remain in Guatemala for the duration of the trip. Based on this favorable word, Hoekstra and Spooner transferred their shared expenses of per-diem to Martínez's bank.

Hoekstra, Martínez, and Spooner took recent herbarium collections to AGUAT for drying. We then visited a new herbarium (BIGUA) in Guatemala, the Herbarium of the Facultad de C.C.Q.Q. y Farmacía, Universidad de San Carlos, Guatemala (Tel: 502-2-769856; FAX: 502-2-769808). The coordinator and curator is Ing. Agr. Mario Veliz, a former staff member of AGUAT. Veliz earlier told Martínez that he had collected S. demissum in the Sierra de Cuchumatanes for his herbarium, making this the only herbarium with wild potato collections (we have yet to visit the herbarium of the Departamento de Biología, Universidad del Valle de Guatemala, Apartado Postal 82, 11 Calle 15-79, Zona 15, Vista Hermosa III, Guatemala City, Correspondent Margaret A. Dix, Tel: 502-2-670791), planned for another day. Veliz indicated that his potato collections and locality data were not yet assembled, but we made an appointment to meet with him next Monday, Oct. 9, at 9:30 AM at his herbarium. He told us that his S. demissum collection was made in high-altitude grasslands (Spanish name, panahales, and it was a very small plant there and hard to locate. We renewed our jeep rental with Hertz rental, and Spooner extended his airline ticket beyond the next day.

September 30, October 1

Martínez spent the weekend with his family in Guatemala City. Hoekstra and Spooner worked on financial accounting for the trip, extracted seeds, wrote the last few day's report, worked on the paper of this trip for submission to the scientific journal Euphytica, and contacted Joerg Altekruse of the film company "Zeitfilm" regarding plans for filming our expedition in Guatemala. Following below is a text of our letter to Altekruse:

September 29, 1995

Mr. Joerg Altekruse
Rutschbahn 17
D-21046 Hamburg
FAX: 0049-40-458607

Dear Joerg,

I am safe and sound in Guatemala, just having finished two weeks of collecting wild potatoes with Roel Hoekstra from the Netherlands and Vincente Martínez from Guatemala. I did not FAX you until now because I was awaiting word on the U.S. government's decision relative to the government shutdown and my need to return to the U.S. during a potential furlough of government employees. I went to the U.S. Embassy today and heard that the government just came to an agreement and I will remain here for the duration of our work as originally planned.

Consequently, there are no barriers to our working together on your film. We have worked the last two weeks in the mountains west of Guatemala City, and have collected in some spectacularly beautiful sites that you may wish to use in your film. Next week we visit areas to the east of Guatemala City. Although there is a civil war here, it is not manifested in danger to us, and is concentrated in lowland areas where potatoes do not grow. Our most severe precaution has been to guard against the possibility of highway robbery, especially at night, but we do not travel in the evening, and we leave all our non-essential goods in our hotel room during the day. Personally, I feel in no great danger, and am confident that we should work together safely.

We discussed the possibility of overnight camping, but that is not now possible because of the potential danger posed during the evening. I would suggest that you come prepared with good light-weight hiking boots and rainwear for yourself and your camera gear. It has rained almost every day, generally starting at 3:00 PM. However, the rainy season ends about now, so we may have much less problem with rains during your visit. As we discussed, you would have to get your own jeep because our jeep is full. Hertz Rental (Tel: 502-2-315374) is just across the street from our hotel in Guatemala City (Hotel El Dorado, 7a Av. 15-45, Zona 9, Guatemala 01009; Tel: 502-2-317777; FAX 502-2-321877). I would suggest a 4-wheel drive double-cabin pickup truck, as the other 4-wheel drive vehicle is much less comfortable. If you have a lot of gear, or more people, you may wish to get yet another second 4-wheel drive vehicle. Reserve as soon as possible to insure availability.

Because the Hotel El Dorado is comfortable, centrally located to services, and is our hotel, it would be most convenient for our working together if you stayed here. We leave again early Monday morning (Oct. 2), and will return to Hotel El Dorado on Oct. 6 or 7. I ask that you please FAX me as soon as possible on your plans relative to our working together, specifying the number of people coming, dates, and your capability to hike with your equipment. Our normal routine is to leave early in the morning, and either to stop at various places along the road or to spend the whole day hiking uphill to a single remote location and returning before dark, sometimes hiking 1,300 m vertical distance up and then back. We will modify our schedule as you wish to accommodate your needs and capability to hike. If you have heavy equipment, I suggest you bring a strong person or hire someone locally. If you wish,

I will have our Guatemalan collaborator arrange local labor for carrying your equipment.

Roel Hoekstra is leaving on Oct. 13 or 15, to be replaced by Ronald van den Berg from the Netherlands, the person you met in The United States during your visit there. He is arriving on Oct. 13 (Friday), and will rest the weekend to acclimatize himself to the eight hours time change before we resume work on Monday, Oct. 16. Because we try to stay in the field at least a week before returning to Guatemala City, it would be most convenient for our schedule if you arrived on Oct. 13 or 14. That would give you time to relax after your flight, and for us to plan our work together. Please send me a FAX soon and fill me in on your plans. If I hear from you this weekend, I will respond before leaving on Monday; otherwise the hotel will hold your FAX for me and I'll respond about Oct. 7.

I look forward to working with you. This is a beautiful country, there were good rains this year that stimulated good growth of wild potatoes, and I'm sure we will work together well to produce a good film.

Sincerely,

David M. Spooner
Research Botanist, USDA, Agricultural Research Service
Associate Professor, Horticulture

cc. H. Shands
P. Simon

October 2 (Monday)

The goal was to search the upland areas (ca. 2,500 to 3,000 m) in the two mountain peaks east of Guatemala City along Rt. 18 that passes through San José Pinula, Mataquescuintla, Miramundo, to Jalapa. The first mountain peak is in the Department of Guatemala, and is in between the towns of San José Pinula and Mataquescuintla, while the second mountain peak is in the Department of Jalapa, and is in between the towns of Mataquescuintla and Miramundo. There are no records for wild potatoes in these mountains, but we decided to check them because they have elevations that suggest that wild potatoes could grow there. Because the road was severely eroded by the heavy rains this year, and because we searched for potatoes along the way, we could only reach Mataquescuintla by Monday.

The habitats on the west-facing slopes above about 2,000 m were extremely wet, had much epiphytic vegetation, and appeared ideal for S. agrimonifolium, S. morelliforme, and possibly S. clarum (that usually grows in elevations above 3,000 m). We searched extensively on the west-facing slopes of these mountains without success.

October 3

We continued east from Mataquescuintla and searched on the west-facing slopes of the second mountain, again without success. These slopes similarly were very wet with much epiphytic vegetation that appeared ideal for wild potatoes. Much of the area, however, was converted to cultivated fields or grazing land. We also searched near the top of the second mountain, but just on the east-facing slope, on Cerro Mudo. Vincente was told by one of his colleagues who collected medicinal plants there that a local resident told him

(but Vincente's colleague did not see) that wild potatoes grew there. Our hike began just east of the town of Miramundo and took about five hours, but again we found no wild potatoes. We then drove east to Jalapa, and then northwest along Rt. 19 to the main Guatemala City to Puerto Barrios Road (CA9), and then northeast along this road to just beyond Sanarate where we spent the night.

October 4

Our goal was to search one more area in eastern Guatemala without records of wild potatoes, but with appropriate elevations. This area was at the junction of Guatemala, Honduras, and El Salvador, at a mountain called Cerro Montecristo, with an upper elevation of 2,350 m. Unfortunately, there were no roads shown going there on the road or topographic maps, but these are all outdated and the only way to check for access roads is to drive to ask local residents.

We first drove to Esquipulas, north of Cerro Montecristo, and found there was no road access. We then took Rt. CA12 that approaches from the west, and found out that there is a road going through Concepcíon Las Minas, through Jícaro Peinado, and approaching, but not reaching, the town of Las Presas (located at 14º31.6'W, 89º24.6'S, at 1,300 m, at 9.0 km southeast of Rt. CA9). We hiked from this area south to near the top of the mountain cresting at 2,054 m (unnamed on the ND 16-5 1:250,000-scale topographic map), just north of Cerro Montecristo. The lower slopes of this mountain were dry oak forest or converted to pasture land, but at 1,900 m we hiked through some very wet virgin cloud forest apparently ideal for wild potatoes, but we found none.

After hiking back to our jeep, we drove back to Rt. CA9, and then south to see if there was a better access to Cerro Montecristo. We drove all the way to the border with El Salvador, and were told that the only approach by road to the base of Cerro Montecristo was to the town of Los Planes, located on the Guatemala-El Salvador border, but with a road in El Salvador. Because the U.S. Embassy directed Spooner to not camp overnight, we could not hike to Cerro Montecristo in one day from Guatemala. We drove back to our hotel east of Sanarate where we spent the night.

October 5

Our goal was to search for the sole record of possible S. oxycarpum (O1, maybe S. agrimonifolium, see "Notes on individual species," p. 6). The approach to this site was not immediately clear from the record. Vincente was told that Jute de la Cobana could be reached by a dirt road departing the San Agustín Acasaguastlán to Salamá road (Rt. 17), at km 90, west of Acasaguastlán This road departs this main road at 400 m, and is far from the 2,500-3,000 m location of record O1. The road was severely eroded, very steep, and very slippery because of recent rains and mica-based clay soil. The car could not climb the road, and we decided to attempt to approach O1 later when the road was dry.

We changed our plans to search for B1, B2, B3, B4, all in the same general area, but not represented by any germplasm collections. We collected germplasm of S. bulbocastanum from three sites in this general area (7040, 7042, 7043). This latter collection was at or near the site of B4, with B1, B2, and B3 being farther to the north. However, the road was not maintained beyond (north) the site of collection 7043 and we could not proceed. We returned to Salamá where we spent the night.

October 6

Our goal was to drive on Rt. 5, from Salamá, through San Miguel Chicaj, Rabinal, Granados, San Pedro Sacatepéquez, to Guatemala City, to see if we could find more S. bulbocastanum. Near the end of this road by San Pedro Sacatepéquez, there are possible sites for S. bulbocastanum (B4b, B4c). Appropriate elevations for this species over 1,500 m are reached west of Salamá, in the Sierra de Chucús south of Rabinal, and in the areas north and south of San Pedro Sacatepéquez. The road from Salamá to Guatemala City was over very bumpy roads and would take a five hour hard drive without stopping. Most of the habitats appeared too wet for S. bulbocastanum, but we found a single non-flowering plant of this species in a knothole of a tree in a heavily grazed field. Extensive searches in this area failed to locate another plant. The entire road from this collection site all the way to Guatemala City is under heavy use for housing and agriculture, with some pine plantations, and it is hard to find any undisturbed habitat. We returned to Guatemala City where we spent the night.

October 7

We decided to try again to find S. bulbocastanum in the hills north of Guatemala City (B4a, B4b), and took Rt. 4, through Chinautla, San Antonio Las Flores, San Raimundo, and back to San Pedro Sacatepéquez and back to Guatemala City. No one in these areas heard of Chilloni or Challani (see B4b, B4c). All of these areas were heavily disturbed and we found no wild potatoes. We spent the night in Guatemala City.

October 8

We cleaned fruits, worked on the report, and planned next week's collecting.

October 9 (Monday)

Martínez went to ICTA and gave Ing. Fumagalli our proposal to divide germplasm from this expedition (Appendix 4). He also obtained receipts for the per diem expenses he received from Hoekstra and Spooner. All three of us then returned to the herbarium of BIGUA (see September 29) to get locality data on a S. demissum collection in Huehuetenango:

> Guatemala. Huehuetenango: Todos Santos, 3,000 m, hierba frequente, dimintua, de 5 cm de porte, las hojas son pinnatisectas, las flores de color violeta y los frutos, bayas diminutos. M. Veliz & J. Veliz 95.4962, June 8, 1995. Identified by M. Veliz. BIGUA herbarium number 3,410.

The specimens were very small and easily could be overlooked in the field. Mario Veliz told us that he collected the plants in the heavily grazed (sheep) plains of the area. He clarified the locality for us by pointing out that it was about 1 km E of the road from Huehuetenango to Santa Eulalia, on the road to Todos Santos Cuchumután.

Then we drove on to Tecpán to try to find M1, M2, M4 & M8 again (see September 14). There is a road northwest of the city going to a microwave tower that reaches 3,100 m with many wet habitats with much epiphytic vegetation where potatoes could grow, but we found none. We drove to Panajachel on the northern shore of Lago Atitlán where we spent the night.

October 10

We drove around Lago de Atitlán, east and south through San Antonio and San Lucas Tolimán, to search for B7b on the NW slope of Vulcán San Pedro. A landslide blocked the road about a 12 km hike before. Spooner and Hoekstra hiked towards the locality of B7 on the northwest-facing slopes of Vulcán Santa Clara, and Martínez drove back to look for S. bulbocastanum along the road east of Santiago Atitlán where we saw apparently suitable habitats there among rocks and cacti. The lower slopes of the vulcano were all cultivated (maize) and we were not successful in finding potatoes; nor was Martínez. On our way back to Panajachel we hiked on Cerro de Oro on the south side of Lago Atitlán, but again without success. We spent the night in Panajachel.

October 11

We drove to Chichicastenango and dropped our luggage in our hotel. First we drove north on the road to Santa Cruz del Quiché to look for S. morelliforme and S. bulbocastanum (no records, but we thought they may grow in the lowlands north of Chichicastenango. We found no dry habitats for S. bulbocastanum, and then drove back south to look for M11. There were many trees with epiphytic vegetation at that site, but we did not find any potatoes. We suspect that Hawkes collected the plants on old trees that are now all cut down.

We then drove on the old road from Los Encuentros to Totonicapán to look again for C8 in the Department of Sololá, without success. We spent the night in Chichicastenango.

October 12

Our goals were C7 and C18 on the old road from Los Encuentros to Totonicapán. At about the border of the Departments Sololá - Totonicapán the road was destroyed and we hiked further along this road and collected S. clarum 7046, 7048 & 7049. All our collections of this species were found under old pine trees, or along the side of the old road that is in deep woods. We drove to Antigua where we spent the night.

October 13

We drove to Volcán Acatenango (west of Volcán de Agua, southwest of Antigua), to look for wild potatoes. There are no records from this vulcano, but Mario Veliz from the herbarium BIGUA told us that he had recently seen S. agrimonifolium on this vulcano but did not collect it. Along the road to Le Soledad we searched unsuccessfully for S. morelliforme in old trees with much epiphytic vegetation. We met a local farmer and woodcutter (Prudencio Morales, Aldea la Soledad, Acatenango, Chimaltenango), who told us he knew where wild potatoes grew on the north-facing slopes of Volcán Acatenango. He led us to S. agrimonifolium 7050 & 7051. We drove to Guatemala city, had the car washed, and returned it to Hertz where Hoekstra paid the first month's car rental. We got Ronald van den Berg from the airport. We spent the night in Guatemala City.

October 14

We worked on the report from the previous week, worked on our paper, extracted seeds, and planned next week's work. We heard from Joerg Altekruse that he and his film crew would be arriving the following day. We had a dinner party at a local restaurant (Fumagalli and his wife Mercedes, Martínez and his wife Veronica, Hoekstra, Spooner, and van den Berg).

October 15

Hoekstra returned to the Netherlands. Spooner and van den Berg worked on the paper. Martínez picked the car up from Hertz. We met the film crew at our hotel and discussed our work. They were:

Joerg Altekruse (producer)
Zeitfilm (company name)
Rutschbahn 17
D-21046 Hamburg
Tel: (49-40) 442014; FAX: (49-40) 458607; email: 100442.2305@compuserve.com

Germán Pablo Malig Lantz (camera)
Producciones Latina (company name)
Talinay 10604
La Reina
Santiago, Chile
Tel: (56-2) 273-5232; FAX: 246-6744

Juan Ignacio Valdivieso (sound)
Casilla 275
Conneo Pingue
Santiago, Chile
Tel: (56-2) 850-4225; FAX: 850-5051, 699-3493

October 16 (Monday)

We drove west to Totonicapán with the film crew and put our non-essential things in our hotel. We then drove east in the hills to film our collection of S. morelliforme (7004) made on September 15. We returned to Totonicapán.

October 17

We spent the morning working with the film crew in the hills east of Totonicapán, including filming our collection of S. agrimonifolium (7006) made on September 15. With the crew, we looked for C15, C18, D10. We found and filmed S. demissum (7054) and S. clarum (7055) near collection 7006. As in the other record of S. demissum from this area (D10), and from another site (D9), we found no flowers or fruits, but this time we did collect tubers. We drove to Huehuetenango where we spent the night (Hotel los Cuchumatanes).

October 18

We spent the morning working with the film crew to film our collection of S. bulbocastanum (7010) made on September 18. Martínez then drove with the crew north into the Sierra de los Cuchumatanes to film a potato farm, and upon return to Huehuetenango took a bus back to Guatemala City to attend his son's graduation ceremony. Van den Berg and Spooner drove northwest on Rt. 9N and collected S. bulbocastanum (7056). We returned to Huehuetenango for the night.

October 19

Van den Berg and Spooner worked with the film crew in the morning in interviews at the hotel. Afterwards, the film crew returned alone north to the Sierra de los Cuchumatanes, while van den Berg and Spooner drove northwest on Rt. 9N and collected S. bulbocastanum (7057). We continued to the junction of the road going west into Cuilco (this junction about 30 km northeast of the junction of the road into Huehuetenango), and drove west to San Ildelfo Ixtahuacán, and then drove north a few kilometers to the mines on Cerro Pixpix to see how we might approach A4 on another day, because it was getting late. We found the path to the top of on Cerro Pixpix (pronounced Pish-Pish) and returned to Huehuetenango.

October 20

We met the film crew and discussed timing and distribution of the film. Altekruse told us that he had more filming for this project planned in March, 1996, and a one-hour program would probably air on German television sometime later in 1996. He planned additional English and French versions, but nothing was yet sure on appearing outside of Germany. He explained that he may market the film in Canada and the United States, but it had better chances of airing in Canada because United States television is airing fewer documentaries. The crew departed for Guatemala City, with filming planned on the return route, with departure scheduled from Guatemala the following day.

Van den Berg and Spooner drove north into the Sierra de los Cuchumatanes to search for A5 and D1-D7, D11, and the site told to us by Mario Veliz on October 9. We could not locate S. demissum, but found S. clarum (7059) on the road northwest to Todos Santos Cuchumatán (housing there). We could not find potatoes further on this road all the way to this town. We found out that there is a footpath from Todos Santos Cuchumatán to San Juan Atitán, taking about a four-hour hike, and a road to the latter town south of Huehuetenango, departing from Rt. CA1. It was late afternoon by this time and we had no time to search for A5, a record with locality data simply stating located between these two towns, at 2,700-2,800 m. We planned to check out the road access to San Juan Atitán the next day, and to plan a hike between the two towns, with someone waiting for us at the other end with the car. We returned to Huehuetenango. Martínez returned from Guatemala City.

October 21

We drove back to Cerro Pixpix (see October 19) to look for A4 and M5. We could ascend by jeep to 2,050 m to the end of a road leading to lead mines, and we then hiked to the top at 2,850 m. We found only three small, non-flowering plants of S. agrimonifolium at the top of the mountain, under the shade of secondary growth trees, and no S. morelliforme. We also searched on many of the slopes on all sides of the mountain, concentrating in the wettest valley sites.

This is one of the more dramatic examples of habitat destruction and its effect on wild species. It is possible that we overlooked the two species, but the entire mountain has been logged of all primary forest, and converted to cornfields or is under heavy grazing. All the primary forest is gone, and only small trees are left. There is much erosion at the middle and basal slopes of the mountain. Part of the south-facing middle slopes of the mountain has much erosion by active lead mines. We spent the night at the base of the mountain in Ixtahuacán.

October 22

We drove west towards Cuilco to search for B5. Again, we could not find fruits. Steyermark's record is not exact, stating a collection between Ixtahuacán and Cuilco, between 1,350 m and 1,600 m. Many of Steyermark's records are like this (see next day, October 23), and it is unclear exactly what he meant, that is whether he saw the plant throughout this altitude range, or whether he only remembers collecting it between these towns somewhere between these altitudes.

The road slowly descends from Ixtahuacán to Cuilco, and we began searching for S. bulbocastanum at 1,700 m shortly outside of town, to a place 24 km west of town towards Cuilco at 1,350 m. We searched the entire day at six places along the road, all on dry slopes as stated in the record. We found non-flowering plants at all but the first and last places searched. The main problem was the intense grazing all along this road. Searching for potatoes generally is done by identifying the place where they were collected (as in today's search), or identifying a possible place where they may grow, and then looking for a place where grazing animals have trouble reaching the plants. In the case of S. bulbocastanum, this generally is among cacti or thorny bushes, or on cliff margins, or growing out of rock walls, or among loose stones at the base of cliffs or along roadsides. Although the habitats were all appropriate, the entire area was heavily grazed. There are cows and goats and horses and sheep all throughout this area. The plants apparently are readily eaten, and there were very few plants around, all small and not flowering.

It is likely that the habitats during Steyermark's collection in 1942 were much less disturbed than they are now. We decided to add to our paper an explanation of the changes Guatemala has undergone that would help explain the habitat destruction we have seen throughout our trip. Upon return to Guatemala City we would gather census data, and seek additional data on deforestation, the spread of agriculture, and its effect on wild potato populations. We returned to Huehuetenango where we spent the night.

October 23 (Monday)

One of our goals was A5, a Steyermark record with locality data simply as "between Todos Santos and San Juan Atitán, Sierra de los Cuchumatanes, 2,600-2,700 m." Because you have to walk between both towns, our other goal was for Martínez to drive to Todos Santos and meet us there, and to look for potatoes along the way.

We drove to San Juan Atitán, reached from a very steep and poor road departing from the Inter-American Highway (CA1, the Huehuetenango-La Mesilla Road). The walk between San Juan Atitán and Todos Santos takes four hours. Both cities are located at 2,450 m, and are flanked by separate 3,000 m mountains, with a 2,500 m valley in between. Martínez spoke to local people on the San Juan Atitán town square, and many of them claimed to know the location of wild potatoes. We hired a guide to take us there:

Francisco Perez
García Tuiscapsan
San Juan Atitán
Departmento Huehuetenango

He is a local town guardian, and had to get permission from the town mayor to leave his duties that day. He knows the valley between the two towns very well, and led us directly to our three collections this day, S. agrimonifolium 7061, 7062, 7063. All were located on very wet habitats in separate streams draining into the valley from the east. The first was on the path between the two towns, and the other two were located on a separate logging path diverting east from main path.

The habitats in this valley are very wet, with much epiphytic vegetation and ferns. Much of the valley has been logged. Some has been replanted with trees, but much is under tillage agriculture or is being grazed. There is virgin forest to the east of the valley that is being cut (where we found all our populations), and Francisco Perez told us that the remaining virgin forest is slated for cutting in the future.

We reached Todos Santos at 4:30 PM. Martínez looked for S. bulbocastanum on the descent from S. Juan Atitán without success. He also looked for S. clarum and S. demissum on Cerro Chémal as we earlier did on September 16. We found none then, and he found none this day. We all stayed in Todos Santos for the night.

October 24

Our goals were to recollect seeds of S. clarum 7007, collected on September 16, that we later found had most fruits with immature seeds, and to search other places in the area. We split into three separate directions, with Spooner recollecting mature fruits of 7007, and locating another S. clarum population farther uphill (7066). Martínez and van den Berg located other S. clarum populations in the area (7064, 7065). The area we searched, "Chémal," is a general area name of the uplands above Todos Santos and to the north, and is a rich area for potato collections, with A20-A22 (all three apparently in the same place and with germplasm), C1, C3, C4, D1, D2, D4, D5, D6, D7, and D11 (with germplasm).

Our collections of S. clarum were the first germplasm collections from the area. Cerro Chémal originally was all forested, but most of it is now deforested and under sheep grazing. Some forested areas there also are under sheep grazing and much of the natural herbaceous understory is gone, but some of the area is fenced off and has much natural vegetation. In the latter areas we found S. clarum to be relatively common in all three areas we searched. As in earlier collections of this species, however, most individuals in populations lacked flowers or fruits, and it took a lot of searching to find fruits. Because only Spooner carried the altimeter and GPS machine to get altitude, longitude, and latitude data for 7066, we went back to 7064 and 7065 with these devices to gather these data. We returned to Todos Santos where we spent the night.

October 25

Our goals were C2 and D3 (both by Tuinimá), and A1 (by San Juan Ixcoy). There is a new road, still under construction, that goes to Huiton, and you have to walk to Tuinimá. Huiton and Tuinimá are both clusters of small villages and do not refer to exact places, and there are place names like Huito Grande, Huito Pequena, and others.

All of the primary forest in the area of C2 and D3, along the road to Huiton and Tuinimá, has been cut of nearly all original forest, and is under intense sheep grazing. Most of the vegetation in the entire area is so closely grazed that the ground looks like a putting green. Most of the woody vegetation is regrowth of juniper trees that form a low spreading canopy when young, that protects some vegetation from grazing and allows the growth of plants that grow in shade, such as moss and S. clarum. The area is also limestone karst topography, and there are many sinkholes. Some sinkholes are up to 20 feet deep with steep sides that form cliffs that the animals stay away from. We concentrated our searches under the juniper trees, and in and about the edges of the sinkholes. We found S. clarum 7067 under the shade of juniper trees in moss.

We continued to San Juan Ixcoy to search for S. agrimonifolium. Steyermark's record is vague, stating simply "above San Juan Ixcoy, Sierra de los Cuchumatanes, 2,700-2,800 m." The road approaching San Juan Ixcoy from the south descends from a high plateau of the Sierra de los Cuchumatanes from 3,350 m, down to the town at 2,100 m, but it crosses no running streams and the hills are relatively dry. These are unlikely habitats for S. agrimonifolium. The road continuing south out of town only ascends to 2,500 m, and then descends to Soloma. Therefore, if the record were collected along the road, it would have been on the one from the south. The only possible place it could have been collected would have been in occasional pockets of moist soil in small dry stream valleys crosing the road. There was no S. agrimonifolium there.

Another possibility would have been in a stream valley draining into town from the east, away from the main road. This valley also is mostly dry, above 2,550 m, where large springs emerge from the ground (the town's water source). We searched in this valley without finding the plant. We spoke to local residents who told us that there was a flowing stream a two-hour walk uphill, but this would have been far above the 2,700-2,800 altitude band of Steyermark's record. We continued to Soloma where we spent the night.

October 26

Our goals were to continue north to Santa Eulalia to collect A3, and to continue more north to see if there was road access to collection A2. Collection A3 was made on Cerro Chemalito, located 3-8 km west and then south of Santa Eulalia (the road wraps around the hill). The west-facing slopes and top of this hill are rich cloud forest covered with moss-covered trees. Most of the trees are secondary growth. There are a few large trees left, but they are in the process of being cut down. We did not locate S. agrimonifolium, but did locate S. morelliforme (7069). This is the second collection of this species from Huehuetenango, the first being our collection 7009 made on September 17.

We continued north on Rt. 9N to 5.5 km south of San Mateo Ixtatán, and located three species on the top of a mountain in a moist cloud forest, about a recently logged area: S. clarum (7072), S. oxycarpum (7073), and S. agrimonifolium (7074). It often is very difficult to find potatoes, and it is a pleasure to come across such a site. This is the first population we have collected of what may be S. oxycarpum, and it was very interesting to see it growing with its closest relative S. agrimonifolium.

The only published record of S. oxycarpum from Guatemala is "Steyermark 43672, Department El Progreso, Sierra de las Minas" (see Appendix 2). This is the species we first tried to collect on October 5, but were then turned back by slippery roads into the Sierra de las Minas. Of taxonomic interest is that there were smaller plants (up to 1/2 m) with few interjected leaflets, and short-conical fruits with rounded ends (S. oxycarpum?), and larger plants (up to 1.5 m) with more interjected leaflets, and longer fruits with sharp-pointed ends (S. agrimonifolium?), and plants intermediate for all these characters, within an area of a few hundred square meters. We only collected the extreme phenotypes under the separate species names.

We continued to San Mateo Ixtatán to see if the trail indicated on the topographic map from this town to Nacapoxlac was now a road. Steyermark's record A2 simply indicated a collection between Nacapoxlac and Xoxlac, the latter town yet farther north. We found out that it is a six-hour walk from San Mateo Ixtatán to Nacapoxlac, and a 12-hour walk to Xoxlac. Because we could not hike this round-trip in one day, and because of our collection of S. agrimonifolium just to the south on this day, we decided not to pursue this record. We returned to Huehuetenango where we spent the night (four hour drive from San Mateo Ixtatán to Huehuetenango).

October 27

We drove south on the road towards Quetzaltenango to search again for S. bulbocastanum, seen on September 18 in flower but not in fruit, at Estancia de la Virgen. As before, we found vegetative and flowering plants, but not fruits.

We returned to the uplands east of Totonicapán yet again and recollected S. morelliforme 7005. This is a rich area for potato collecting, and we did not cover all of the road. It is abandoned and in disrepair and takes long to drive, and it always began to rain heavily about 2:00 or 3:00 PM on our previous visits. We were especially interested in more populations of S. demissum, a species we collected on October 18 only as tubers (our only tuber collection made because this species in rare in Guatemala and it was not in fruit). We drove about 20 km from the beginning of the old road above Totonicapán, to a point almost all the way that we hiked to on the other approach from the east from Los Encuentros, done last October 12. We collected S. clarum (7075). Beyond about 7 km, the area was much more heavily logged, and there was much sheep grazing.

On our way back to Totonicapán we measured the distance from Hawkes's records A18, A19, A24, C15, D10, all listed as "1 mile east of Totonicapán." The distance was 9.5 km east the town square. Other distances given in the 1958 expedition by Hawkes, Hjerting, and Lester (Appendix 2) are in kilometers, not miles, and it is likely that "1 mile" is a transcription error for 10 km. We drove to Quetzaltenango where we spent the night.

October 28

Martínez drove back to the collection site of S. agrimonifolium 7021, collected outside of San Marcos on September 23, but likely with immature fruits. He was able to get mature fruits on this visit. Spooner and van den Berg remained in Quetzaltenango and worked on the report and on seed extraction.

On Martínez's return to Quetzaltenango, all went to look for B7a. This record only had altitude, longitude, and latitude data, but we could pinpoint it on our topographic map as a location about 5 km south of Zunil, located south of Chimaltenango at 14°48.6'S, 91°26.9'W. We found it there, but could not find flowers or fruits. This population was found in a very different habitat than any other we saw of S. bulbocastanum. The species usually grows in very dry habitats, but this place was on the very humid Pacific slope, the vegetation was thick and lush shrub vegetation.

We then drove east to Los Encuentros to recollect fruits of S. agrimonifolium (7036), first collected on September 28, but with possibly immature fruits, that we collected as mature this day. We continued up the hill to look yet again for S. clarum in the Department of Sololá, at the boundary of Totonicapán and Sololá, to search for records C7 and C8. We were there before, but it was always raining heavily when we searched, and it was sunny and we had more time now. We earlier found out that the boundary between the two Departments is marked by a huge rock formation, at about 3,000 m, to the north of the old road. From a distance, it looked like this area was not as heavily grazed as the area by the road. However, it was grazed at the base of the rock, and the top of the rock was very disturbed and covered by trash by people going there for religious cermonies. Martínez and van den Berg searched the sides and top of this rock for S. clarum, and Spooner walked farther north beyond the rock to the base of a stream valley to search for S. agrimonifolium. We found neither species.

We then drove west to the base of Volcán Acatenango to the home of Prudencio Morales, who on October 13 led us to two populations of S. agrimonifolium (7050 & 7051). At that time, he told us he would be looking further for more populations, and knew of one growing much higher on the volcano. On our return, he told us that he knew of one population very close to 7050, and that the population he originally thought was a wild potato at the top of the volcano was not a potato. We decided not to work with him the next day as originally planned, and returned to Guatemala City (11:00 PM).

October 29

Spooner worked on the report and van den Berg extracted seeds.

October 30 (Monday)

Spooner continued to work on the report and van den Berg continued to work on seed extraction. Martínez went to the Department of Statistics and obtained census data for our report, and in the evening we all met to incorporate these data into the report.. We changed our airline tickets to return on Monday, November 6. Spooner worked on financial accounting and found that there were sufficient grant funds to purchase the 259 available 1: 50,000-scale topographic maps, and bought them, and two sets of 1:500,000-scale topographic maps, and two sets of 1:500,000-scale "Mapa de Escolar" (giving political subdivision information) at the Instituto Geográfico Militar (9,421 Quetzales).

October 31

Spooner went to the United States Embassy to 1) get money sent to him for the trip, 2) to call the USDA Administrative Office and his supervisor (P. Simon) to report his return on November 6, and 3) to discuss possible funding opportunities for short or long-term training for Martínez under the Cocharan Fellowship Program. There may be a possible problem with the Cocharan Fellowship program because it is targeted for middle-income countries, and Guatemala is classified as a low-income country. However, Drennan said he would work with Spooner to check into all possibilities here.

We went to the ICTA main headquarters and met with Ing. Astolfo Fumagalli, General Director, to discuss our proposal to dispose of our germplasm that we outlined to him in our letter of October 6 (Appendix 4). Ing. Fumagalli agreed to our proposal, and agreed to provide us with a letter stating his agreement (Appendix 5). We discussed possible fellowship opportunities for Martínez under the Cocharan Fellowship Program and under the International Plant Genetic Resources Institute (IPGRI) Vavilov/Frankel Fellowship Program. Spooner agreed to pursue both with Fumagalli and Martínez immediately upon return to the United States.

We went to the Piedra Santa bookstore and purchased 1) base maps for Guatemala and the rest of Latin America for current and future species mapping, 2) a small book entitled "Geografía Visualizada" [of Guatemala, 1995], and 3) "Realidad Socio Económica de Guatemala", 1994, a book with useful economic data we will use in our paper to result from this trip.

We went to the AGUAT herbarium, divided our herbarium duplicates (listed in Summary of Collections), and Spooner agreed to send herbarium labels to AGUAT soon after return to the United States. Dr. Juan J. Castillo Mont. of AGUAT identified our collections 7070, 7071, 7076, made to identify species commonly associated with S. clarum.

Martínez went to the Instituto Nacional Forestal to obtain data on deforestation in Guatemala. At the end of the day, we met and incorporated these data into our report.

November 1

Spooner organized the 259 1:50,000-scale topographic maps, and chose those needed for our trip to the Sierra de las Minas. Spooner incorporated the herbarium specimen duplicate distribution data into the dBASE file of potato localities, and the word procession file of non-potato collections. Van den Berg packed the seeds for shipment to the Dutch/German Genebank. We worked on the paper, and packed for our return home on November 6.

November 2

We drove from Guatemala City east to the Sierra de las Minas to search for O1. We earlier tried to reach this record on October 5, but were unsuccessful because of wet dirt roads. The locality data of the record was very difficult to figure out. It says "El Progreso: between Finca Piamonte and top of Montaña Piamonte, along Joya Pacayal, 2,500-3000 m, on summit." The only place name approaching this description in our gazetteers or maps is "Quebrada Piamonte," a valley running north out of the town of Jute de la Cobana, a town north of the San Agustín Acasaguastlán to Salamá road (Rt. 17), at km 90, west of Acasaguastlán.

Dry roads this time allowed us to drive from the beginning of the road at 400 m, up to Jute de la Cobana (1,200 m) a one-hour very bumpy drive from the main road. The road from Jute de la Cobana continues north uphill from the town, but we were told it was not passable, and we began to walk at 1,200 m. We found that the road is even poorer yet above this point, but could be driven up to 1,650 m, so we lost the energy we could have saved by driving this extra 450 m. A big problem here is the heat, as it is very hot at these lower elevations.

Residents of a village at 1,700 m told us that "Finca Piamonte" and "Montaña Piamonte" are only general place names, and that "Joya Pacayal" was a name of a place farther uphill, but they were not clear of exactly where it was. "Joya" is a valley, and "pacayal" is a place where pacaya trees grow, a small palm that naturally grows in wet places. We continued on a logging road up to 2,300 m and it was 3:00 PM and we had to return to the truck to be back before dark. We decided to drive to a small town near the main road) and to try again the next day.

November 3

We arose at 5:00 AM, ate breakfast a local convenience store, and reached Jute de la Cobana by 7:00 AM. We continued up the road at 1,650 m, and began walking. A local resident at the village at 1,700 m provided additional details of the location of "Joya Pacayal," stating that it was a moist valley departing from the logging road from a clearing on the road at about 2,100 m, from a valley in the logging road that ascends at all other places. We initially passed Joya Pacayal and continued up the logging road past our point of 2,300 m we reached the day before, to the top of the hill at 2,400 m. The latitude and longitude there is 15º02.00´S, 90º025´W. We descended on the logging road for about 1 km more past the top of the hill. The whole logging road was dry pine forest with only a couple of wet habitats formed by small streams crossing the road appropriate for S. oxycarpum or S. agrimonifolium.

We walked back to the entrance to Joya Pacayal at 2,100 m, and hiked north up this valley, roughly paralleling the logging road but more to the west. This valley called "Joya Pacayal" apparently is the "Quebrada Piamonte" on the 1:50,000-scale 2161II topographic map. This valley is much more appropriate for the growth of S. oxycarpum than along the logging road. It has many low places with standing water in deep organic soils that looked perfect for this species. It looks like a beautiful tropical rain forest and would be pretty in a picture, but is infested with thousands of mosquitoes, and is not a pleasant place to explore.

As on the logging road, we explored to the top of the hill (here about 2,600 m), again without finding potatoes. It appears that the Joya Pacayal we searched is the place Steyermark collected this species, but his altitude data were incorrect. We could not find wild potatoes here. This was the only wild potato recorded for the Sierra de las Minas. We returned to Guatemala City where we spent the night.

November 4, 5

Spooner and van den Berg worked on finishing the paper and report, mapping species (Figs. 5-9), constructing statistics on germplasm (Table 2), and proofing the entire report. Martínez met them on Sunday to discuss future plans.

November 6

Spooner and van den Berg returned home.

Appendix 1

G. 29787-SR-11-93/T.T.N.

1142

Ministerio de Agricultura, Ganadería y Alimentación

PALACIO NACIONAL

GUATEMALA, C. A.

14 de junio de 1994

AMERICAN EMBASSY
RECEIVED
JUN. 16 1994
U.S. DEPARTMENT OF AGRICULTURE

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Señor
Richard Drenan
Agregado Agrícola a.i.
Embajada de los Estados
Unidos de América
C I U D A D.

Señor Drenan:

Tengo el gusto de dirigirme a usted, con el objeto de manifestarle que con instrucciones de este Despacho, el Instituto de Ciencia y Tecnología Agrícolas -ICTA-, ha designado al Ingeniero Rolando Estrada, quién presta sus servicios en dicha institución para que colabore con el Señor David M. Spooner en el Proyecto de Germoplasma para la Papa.

Sin otro particular, aprovecho la oportunidad para suscribirme con muestras de mi consideración y estima.

MINISTERIO DE AGRICULTURA GANADERIA Y ALIMENTACION REP. DE GUATEMALA

Fernando Vargas M.
VICEMINISTRO DE AGRICULTURA Y ALIMENTACION

VAA/ma.

Appendix 2. Species, type localities, distribution of Guatemalan wild potato species. See Materials and Methods for data sources.

Solanum agrimonifolium Rydberg

Guatemalan localities not represented by germplasm collections:
Baja Verapaz:

A -- oxycarpum?) El Progreso: between Finca Piamonte and top of Montaña Piamonte, along Joya Pacayal, 2,500-3000 m, on summit J. A. Steyermark 43672;

Huehuetenango:

A1) above San Juan Ixcoy, Sierra de los Cuchumatatanes, 2600-2700 m, Aug 23, 1956, K. M. Graham 145;
A2) cloud forest between Xoxlac and Nucapuxlac, Sierra de los Cuchumatanes, 1650-2500 m, July 17, 1942, J. A. Steyermark 48961;
A3) top of Sierra Chemalito, Sierra de los Cuchumatanes, 3 1/2 mi W of Santa Eulalia, alpine thicket with Juncus, 3100-3150 m, Aug 2, 1942, J. A. Steyermark 49938;
A4) Cerro Pixpix, above San Ildefonso Ixtahacan, on forested summit, 1600-2800 m, Aug 15, 1942, J. A. Steyermark 50555;
A5) trail between Todos Santos and San Juan Atitan, Sierra de los Cuchumatanes, 2600-2700 m, Sep 7, 1942, J. A. Steyermark 51942.

Quezaltenango:

A6) between San Martín Chile Verde and Mujulia, lower slope of Volcán Lacandón, along clearing in cloud or rain forest, 1900 m, Aug 18, 1956, K. M. Graham 136;
A7) Fuentes Georginas, western slope of Volcán de Zunil, wet forest about 2850 m, Mar 4, 1939, P. C. Standley 67499;
A8) above Mujulia between San Martín Chile Verde and Colomba, in damp dense mixed forest on white sand slopes, scarce, about 1800 m, Feb 1, 1941, P. C. Standley 85459;
A9) Volcán Santa Tomas, pine-balsam clay ridge, slopes, 2500-3700 m, Jan 22, 1940, J. A. Steyermark 34482;
A10) road from San Martín Chile Verde to Colomba, above Majuliá, 17.5 km from San Mateo, very wet region, on roadside above slope covered with Gunnera, among bushes, plants to 1.25 m tall, beries conical, pointed, to 3 cm long, 2100 m, Nov 4, 1958, J. G. Hawkes 1868.

San Marcos:

A11) on sandy roadside in pine-fir-hardwood forest, at San Luis, 4.4 mi W of Ixchiguan on road to Tacana, about 3400 m, Aug 13, 1959, J. H. Beaman 3252;
A12) Barranco Eminencia, above San Rafael Pie de la Cuesta, along brook, 2100-2400 m, Mar 13 & 14, 1959, P. C. Standley 68461;
A13) Barranco Eminencia, road between San Marcos and San Rafael Pie de la Cuesta, in upper part of the barranco between Finca la Lucha and Buena Vista, wet forest, 2500-2700 m, Feb 16, 1941, P. C. Standley 86448;
A14) along road between San Sebastian at km 21 and km 8, 8 to 18 mi NW of San Marcos, moist thickets near waterfall, 2700-3800 m, Feb 15, 1940, J. A. Steyermark 35728;
A15) between La Vega Ridge and Río Vega and along NE slopes of Volcán Tacana, to 3 mi from Guatemala-Mexican boundary, in vicinity of San Rafael, along stream in narrow shaded barranco, 2500-3000 m, Feb 20, 1940, J. A. Steyermark 36178;
A16) 12 km from San Marcos on road to Tejutla, damp gulley, deep shade of Abies and Cupressus (entering forest from left by small bridge), plants to 1.8 m tall, fruits conical, to 4.5 cm, 3000 m, Nov 3, 1958, J. G. Hawkes 1853;

A17) 13 km from San Marcos on road to San Rafael de la Cuesta, damp cloud forest, very rich vegetation in clearings and sides of paths, plants to 2.5 m tall, berries 3.5 cm long, 2400 m, Nov 3, 1958, J. G. Hawkes 1854.

Sololá:

A17a) between Quezaltenango and Los Encuentros, by mountain stream, 3050 m, Aug 7, 1956, K. M. Graham 116.

Totonicapán:

A18) Cerro El Chiché, 1 mi E of Totonicapán, on road to Los Encuentros, 3300 m, dense pine forest, growing in needle litter and moss, no flowers, tubers hairy, one plant with conical berry, Nov 5, 1958, J. G. Hawkes 1889;

A19) Cerro el Quiche, 1 mi E of Totonicapán on the road to los Encuantros, km 163.5 from Guatemala City, by a small stream on the upper side of the road, very wet bushes, corolla dark purple, berries conical, 3300 m, Nov 5, 1958, J. G. Hawkes 1892.

Guatemalan NRSP-6 germplasm holdings:

Huehuetenango:

A20-22) Chemal, 2900 m, Oct 23, 1956, K. M. Graham 145B (PI 243352, seed); Chemal, 2900 m, Oct 23, 1956, K. M. Graham 145A (PI 243351, seed); Chemal, 2900 m, Oct 23, 1956, K. M. Graham 145 (PI 243350, seed).

San Marcos:

A23) village of San Andres Chapil, 8 km on Route 12 from San Marcos to Tejutla at km 255 from Guatemala, below the cliffs with continuous spray from the cliffs, plants to 2 meters, tubers produced intermittently along the stolons, berries conical, 2750 m, Nov 3, 1958, J. G. Hawkes 1851 (PI 275175, seed).

Totonicapán:

A24) Cerro el Quiche, 1 mi E of Totonicapán on the road to los Encuentros, km 163.5 from Guatemala City, by a stream on the lower side of the road by the bushes, berries conical, 4 X 1.8 cm, 3300 m, Nov 5, 1958, J. G. Hawkes 1891 (PI 275177, seed at NRSP-6, but in low numbers and not yet available for distribution).

Quezeltenango:

A25) Mujulia, 1900 m, Oct 18, 1956, K. M. Graham 136 (PI 243349, seed).

Solanum bulbocastanum Dunal

Guatemalan localities not represented by germplasm collections:

Baja Verapaz:

B1) thicket, Patal, 1600 m, Jul 1908, H. von Türckheim II, 2316; type collection of S. bulbocastanum var. partitum, see below; road from Salamá to Copán, Patal, summit of road, 16 mi from Salamá, by roadside, damp shady bank, 1700 m, Nov 11, 1958, J. G. Hawkes 1922;

B2) road from Salamá to Copán, Patal, summit of road, 15 mi from Salamá, among stones by roadside, some shade, 1650 m, Nov 11, 1958, J. G. Hawkes 1938;

B3) road from Salamá to Copán, Patal, summit of road, 11 mi from Salamá, shade of trees on steep slope, 1350 m, Nov 11, 1958, J. G. Hawkes 1942.

Guatemala:

B4) Chilloni, 1500 m, Jun 21, 1921, Rojás 83; locality inspecific, 1939, José I. Aguilar G. 221, 1939 (note: I cannot find Chilloni on map, but there is a Chillani in U.S. gazetteer in Guatemala at 14°43'S, 90°33'W, where I placed a dot on the map);

B4a) locality inspecific, 1938-1943, José I. Aguilar G. 554.

Huehuetenango:

B5) dry slopes between San Ildefonso Ixtahuacán and Cuilco, 1350-1600 m, Aug 16, 1942, J. A. Steyermark 50687;

B6) along road between Huehuetenango and San Sebastian H., 2000 m, Aug 12, 1942, J. A. Steyermark 50404;

B7) between Huehuetenango and San Sebastian, junction of Huehuetenango and PanAmerican Highways, 1850 m, plants in rich clay and humus, Oct 31, 1958, J. G. Hawkes 1789.

Quezaltenango:

B7a) no exact locality, except 14°45'N, 91°31'S, K. Roe, E. Roe, & S. Mori 685;

Sololá:

B7b) trail between village of San Pedro, via San Juan, San Cristobál Buena Vista, and NW slopes of Volcán Santa Clara, 1800-2300 m, June 8, 1942, J. A. Steyermark 47308.

Guatemalan NRSP-6 germplasm holdings:

Huehuetenango:

B8) road from Huehuetenango to Quezaltenango, 5 km S of Malacatancito, shaded by oaks, in damp gully above the road, plants to 80 cm tall, berries round, 1800 m, Oct 31, 1958, J. G. Hawkes 1796 (PI 275200, seed at NRSP-6 but in low numbers and not yet available for distribution).

Solanum clarum Correll

Guatemalan localities not represented by germplasm collections:

Huehuetenango:

C1) Sierra de los Cuchumatanes, in open Pinus rudis forest, between Tojiah and Chemál at km 319.5 on Ruta Nacional 9 N, about 3380 m, Jul 30, 1960, J. H. Beaman 3793;

C2) alpine areas in vicinity of Tunimá, Sierra de los Cuchumatanes, 3400-3500 m, in wooded ravine of Juniperus standlei, July 7, 1942, J. A. Steyermark 48385;

C3) Cerro Chemál, summit of Sierra de los Cuchumatanes, 3700-3800 m, in shade of Juniperus standlei, Aug 8, 1942, J. A. Steyermark 50294;

C4) Sierra de los Cuchumatanes, slopes of Cerro Chemál, about 28 mi from Huehuetenango, plants small, tubers deep violet, 3300 m, Oct 30, 1958 J. G. Hawkes 1776, 1777, 1778.

Quezaltenango:

C5) type locality of S. clarum (see below).

Sacatepéquez:

C6) above Santa María de Jesús, north-facing slope of Volcán de Agua, shade of bushes and trees in the long grass by trail, 2900 m, Nov 8, 1958, J. G. Hawkes 1909.

Sololá:

C7) plentiful in leaf mould and moss in cloud forest, km 152 between Quezaltenango and Los Encuentros, 3100 m, Oct 7, 1956, K. M. Graham 115;

C8) road from Totonicapán to Los Encuentros, km 143 from Guatemala City, amongst surubs in grass and under old oaks, rare, tubers only, 3200 m, Nov 5, 1958, J. G. Hawkes 1895.

Totonicapán:

C9) near margin of small stream in semi-open meadow, near Cerro Quiche on the Tecum Uman Ridge at km 154 on Ruta Nacional No. 1, 20 km E of Totonicapán, about 3340 m, Aug 14, 1960, J. H. Beaman 4176;

C10-13) near the Quezaltenango border, 22 mi N of Quezaltenango, Cerro Calel, under the shade of Abies, in rich leaf mould and moss, rotting wood, frequent, tubers only, 3100 m, Nov 2, 1958, J. G. Hawkes 1813, 1824 (same, but at at 3150 m), 1827 (same, but 3200 m in shade of Abies), 1839 (same, but 3250 m), 1849 (same, but 3200 m as epiphyte on Abies);

C14-15) Cerro El Chiché, 1 mi E of Totonicapán, on road to Los Encuentros, among rocks and scrub just below the summit on NW side, rare, 3400 m, Nov 5, 1958, J. G. Hawkes 1884.

Guatemalan NRSP-6 germplasm holdings:

Sacatepequez:

C6) - see above- above Santa Maria de Jesús, north facing slope of Volcán de Agua, shaded by trees and bushes, in the long grass by the trail, 2900 m, Nov 8, 1958, J. G. Hawkes 1909 (PI 275205, seed at NRSP-6, but in low numbers and not yet available for distribution).

Totonicapán:

C16) between Totonicapán and los Encuentros, Oct 19, 1956, 3000, K. M. Graham 138 (PI 243355, tissue culture availability);

C17) 22 mi N of Quezaltenango, near the Guatemalan border, 3250 m, Nov 2, 1958, J. G. Hawkes 1833 (PI 275202, seed);

C18) 20 km from Totonicapán on the road to Los Encuentros, Cerro Quiche, on moss beneath the pines, sometimes epiphytically in the mosses on the pine branches, 3400 m, Nov 5, 1958, J. G. Hawkes 1894 (PI 283099, seed).

Solanum demissum Lindley

Guatemalan localities not represented by germplasm collections:

Huehuetenango:

D1) Sierra de los Cuchumatanes, in small open meadow surronded by Juniperus standlei, at edge of Llano de Tierra Blanca, near trail to Todos Santos from Llanos de San Miguel near Chémal, about 5 km W of km 311 on Ruta Nacional 9 N, about 3595 m, Aug 5, 1959, J. H. Beaman 3100;

D2) near Chémal, Sierra de los Cuchumatanes, Sep 15, 1941, J. R. Johnston 1969;

D3) alpine areas in vicinity of Tunimá, Sierra de los Cuchumatanes, 3400-3500 m, Jul 7, 1942, J. A. Steyermark 48369;

D4) vicinity of Chemál, summit of Sierra de los Cuchumatanes, rocky limestone outcrops around entrance to cave, in shade, 3700-3750 m, Aug 8, 1942, J. A. Steyermark 50247; type of S. alpicum (see below);

D5) Sierra de los Cuchumatanes, slopes of Cerro Chemál, about 28 mi from Huehuetenango, plants small, tubers deep violet, in a limestone cave poor light, 3500 m, Oct 30, 1958 J. G. Hawkes 1779;

D6-7) summit of of Cerro Chemál, about 28 mi from Huehuetenango, plants small, tubers deep violet, in a limestone cave poor light, 3450 m, Oct 30, 1958 J. G. Hawkes 1780, 1781.

Sacatepéquez:

D8) slopes of Volcán de Agua, above Santa María de Jesús, damp forest, in trail, called "papa", 2250-3000 m, Feb 11, 1939, P. C. Standley 65276;

D9) above Santa María de Jesús, north-facing slope of Volcán de Agua, by path in shade of trees, no flowers or berries, 2550 m, Nov 8, 1958, J. G. Hawkes 1915.

Totonicapán:

D10) Cerro El Chiché, 1 mi E of Totonicapán, on road to Los Encuentros, shade of small cave, base or cliff, NW facing slope, no flowers or berries, 3350 m, Nov 5, 1958, J. G. Hawkes 1887.

Guatemalan NRSP-6 germplasm holdings:

Huehuetenango:

D11) Sierra de los Cuchumatanes, slopes of Cerro Chemal, open place, pines recently burnt down, 28 mi from Huehuetenango, 3500 m, October 30, 1958, J. G. Hawkes 1782 (PI 275211, seed).

Solanum morelliforme Bitter and Muench

Guatemalan localities not represented by germplasm collections:

Chimaltenango:

M1) above Tecpám, epiphytic in crotch of oak trees, 2400 m, Oct 10, 1956, K. M. Graham 120;

M2) epiphytic on oak trees, above Tecpám, 2500 m, Oct 11, 1956, K. M. Graham 122;

M3) Santa Elena, rooted in thick moss on horizontal trunk in forest, 2400-2700 m, Jul 18, 1933, A. F. Skutch 441 (note: I cannot find this locality on map);

M4) plains about 2200 m, near Tecpám, on oak tree, Aug 3, 1933, A. F. Skutch 525.

Huehuetenango:

M5) Cerro Pixpix, above San Ildefonso Ixtahuacan, epiphyte on tree of forested summit, 1600-2800 m, Aug 15, 1942, J. A. Steyermark 50558.

Quezaltenango:

M6)above Quezaltenango to south off road to Retalhuleu, epiphytic in moss on trunks on oak trees, 2500 m, Oct 6, 1956, K. M. Graham 111.

Totonicapán:

M7) 48 km on road from Quezaltenango to Huehuetenango, epiphyte in moss and leaf mold of oak tree, 3000 m, Oct 31, 1958, J. G. Hawkes 1802.

Guatemalan NRSP-6 germplasm holdings:

Chimaltenango:

M8) Tecpam, 2250 m, Oct 10, 1956, K. M. Graham 120 (PI 243357, seed in genebank, but in low numbers and not yet available for general distribution).

Quezeltenango:

M9) 5 km SW of Quezaltenango, lower slopes of Volcán Santa Maria, Bajo, epiphyte in the oaks in the moss, damp forest, berries to 6 mm diameter, 2550 m, Nov 1, 1958, J. G. Hawkes 1805 (PI 275222, seed);

M10) 5 km SW of Quezeltenango, lower slopes of Volcán Santa Maria, bajo, epiphyte on oaks in the moss, damp forest, betties to 10 mm in diameter, tubers to 3 cm long, Nov 1, 1958, J. G. Hawkes 1809 (PI 275223, seed).

Quiché:

M11) 5 mi S of Chichicastenango on Rt 15, in the moss on oak trees by the road, in the shade, tubers purple, fruits pale transparent yellow-green, 8-9 mm diameter, 2300 m, Oct 29, 1958, J. G. Hawkes 1731 (PI 275221, seed).

Guatemalan type localities:

Solanum alpicum Standley and J. A. Steyermark, Field Mus. Nat. Hist., Bot Ser. 23: 232. 1947.

Huehuetenango:

D5) Cerro Chémal, summit of Sierra de los Cuchumatanes, 3700-3800 m; Aug 8, 1942; J. A. Steyermark 50303. (= Solanum demissum).

Solanum bulbocastanum var. partitum Correll, Agric. Monogr. U.S.D.A. 11: 83. 1952.

Baja Verapaz:

B1) Patal, 1600 m; growing in thicket; July, 1908; H. von Türckheim II 2316. (= Solanum bulbocastanum).

Solanum clarum Correll, Contrib. Texas Res. Found., Bot. Stud. 1: 10. 1950.

Quezaltenango:

C5) Volcán Santa María, terrestrial, 3600 m; July 27, 1934; A. F. Skutch 858.

Solanum mediamericanum Lechn. in Buk, F. Cult. Pl. 9: 85. 1971. nomen nudum, based on Guatemalan collections of Bukasov 9-10 (Quetzaltenango), 12 (San Felipe), 13-15 (Amatitlan), 16 (Escuintla). (= Solanum tuberosum, not mapped).