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STATUS OF THE IN SITU COTTON GERMPLASM IN FOUR SOUTHERN STATES OF MEXICO

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Abstract

A germplasm collection for dooryard and feral cottons repr nesenting the designated landraces of cotton and wild diploid *Gossypium* species related to cotton was conducted in the parts of the Mexican states of Puebla, Chiapas, Oaxaca, Guerrero, and Michoacán in order to document the *in situ* status of the landraces, and the range and diversity of the wild diploid *Gossypium* species. The project was approved by the Cotton Germplasm Committee and funded by the USDA-ARS, National Germplasm Resource Laboratory. This germplasm does not exist in other germplasm collections and can only be obtained by collection. Knowledge of the diversity and, consequently, utilization of the genetic resources residing in these species cannot be fully realized *in situ*. Additionally, grazing activities and urbanization threatens the continued existence of these species if not placed in an *ex situ* collection. Exploration was made in compliance with Mexico's laws governing foreign access to germplasm, and in collaboration from personnel of INIFAP, Mexico. The expedition began on Sunday, Feb. 24, 2002 when the four participants met in Mexico City and ended on March 20, 2002. In total seven species of *Gossypium* were collected including *G. aridum* (15), *G. barbadense* (9), *G. gossypioides* (2), *G. hirsutum* (52), *G. laxum* (5), *G. lobatum* (1) and *G. schwendimanii* (2). The numbers in parentheses are the number of accessions collected for each species. The number of accessions for the diploid species should be considered tentative until specimens have been grown and compared in a nursery. In as much as no foliage was available for the arborescent species and diversity in capsules and flowers between locations was noted, the samples need additional verification of identity. After collection seed was deposited in a Mexican permanent cotton nursery that was newly established in Iguala, Gro. In conjunction with this collaborative collection effort, samples of the germplasm were incorporated into the National Plant Germplasm System where they are curated on behalf of the U.S. Government and will be available from the USDA-ARS *Gossypium* Species Collection to all qualified scientists/ organizations, domestic and foreign, who are eligible to receive it.

Introduction

Gossypium hirsutum introductions to the USA that have contributed to our modern cultivars date from around the late 1800's. In "The National Collection of *Gossypium* Germplasm," Southern Cooperative Series Bulletin No 321, June 1987, the collections from formal, planned exploration for *G. hirsutum* date from 1940 to 1950 from the southwestern states of Mexico and Guatemala. After 60 years of *in situ* propagation under increasing population, modernization and urbanization, it is imperative to determine if the diversity of this species has been maintained, or if the old accessions in the USA collection now must assume an even more significant role as the extant diversity. Upland and long-staple cottons are tetraploids consisting of an A and a D genomic subset of chromosomes. All 13 of the known wild diploid *Gossypium* species of the Western Hemisphere possess a D genomic set of chromosomes, hence all are in the secondary germplasm pool of cotton (Stewart, 1995). Eleven of the species are endemic to Mexico, and more specifically, to the western (Pacific) States of Mexico.

Gossypium Section *Erioxylum* Subsection *Erioxylum* currently contains four arborescent species (*G. aridum, G. lobatum, G. laxum, and G. schwendimanii*). These species are the least known and utilized species in the genus because of their size and their unique flowering habit (following defoliation by drought). The known distributions of the last three species are highly restricted to small areas of single Mexican states (Fryxell, 1979, 1992). A fifth species, *G. gossypioides* [Section *Erioxylum* Subsection *Selera*], shares a similarly restricted distribution. However, *G. aridum* extends for 3/4s of the Mexican Pacific coastal ranges (from Sinaloa to Oaxaca). According to the most recent cotton germplasm assessment report of the CGC, "the most widely distributed and most taxonomically diverse species, *G. aridum,* is surprisingly one of the least represented. The cotton germplasm assessment report also states, additional populations of *G. lobatum*, *G. laxum*, *G. schwendimanii*, and *G. gossypioides* are necessary for conservation and should be collected to maintain them. Special attention should also be given to obtaining samples from the range of *G. trilobum*, which has an extensive distribution but is poorly represented in the US collection. Seed accessions of three of these species are very limited in the USDA *Gossypium* Species Collection.

Mexico is the center of diversity for diploid *Gossypium* species of the Western Hemisphere and for *Gossypium hirsutum.* It has been the gene pool source of improvement for most Acala and Upland cotton growing in the U.S. today. We have planned a systematic exploration for *Gossypium* in Mexico anticipated to take three years. The first exploration, conducted in 2002, was in the southern states. The coastal western states have not previously been surveyed and sampled in a systematic fashion. Most of the *G. hirsutum* and other species from the southern and western states were collected from 1940 to 1970 in a number different exploration trips by different groups. The team in this plant exploration intends to explore the pertinent states of Mexico in a systematic and organized manner in order to collect *Gossypium spp.* taxa in the process of becoming extinct or taxa that possibly has not been collected or recognized as unique. The southern most states were explored first. During the second year, we propose to explore the west central states. In the third year the more northerly states where *Gossypium* is known to occur will be surveyed, as well as areas needing additional survey based on results obtained during the first two years. The proposed exploration areas include the habits and ranges in diversity of *G. hirsutum* and eleven diploid *Gossypium* species endemic to Mexico. Samples from this collaborative collection effort will be deposited in the Mexican Cotton Permanent Nursery that was recently established by INIFAP in Iguala, Gro.

Materials and Methods

Most of the equipment required was carried from the U.S., (e.g. altimeter, GPS units, seed bags, plastic gloves, note books, clippers, binoculars, cameras, APHIS permit labels, etc.). The USA participants met in Mexico City traveling from their official station by air.

The primary search method in other regions was by vehicle. Plants of *G. hirsutum* were most likely encountered in settlements, so particular attention was given to dooryard plants when passing dwellings. The diploid species are usually associated with dry deciduous woodlands and most likely to be encountered in canyons along drainage courses or on hillsides. In addition to the specific sites determined from herbarium collection labels, periodic surveys with binoculars along road courses are an appropriate approach to locating these species. In these cases climbing on foot may be necessary. When species were encountered and seed was available, the team collected sufficient seed for all parties. In most cases it was not necessary to collect individual plants, so seeds of the population were bulked. In special circumstances (e.g. apparent interspecific hybrid population) plants were sampled individually. Each collection was assigned a field collection number and passport and habitat data recorded on site. Voucher specimens were obtained that represented each of the populations collected and cross-referenced to the field seed collection number

Gossypium species are subject to quarantine and require a permit to import into the US. Permits were obtained prior to departure. Additionally, the inspector of USDA APHIS Plant Protection and Quarantine Permit Unit, Riverdale, MD was notified of the collection effort and of seed shipments prior to the start of the trip.

At the end of the collection period, all seed was shared between Mexican and US representatives. Seed destined for the U.S. was packaged, addressed with APHIS shipping permits and hand-carried and surrendered to APHIS officials at Port-of-Entry for shipment to the Plant Quarantine Center, Beltsville, MD.

Cotton seeds (after processing and cataloging by the Plant Introduction Unit) were sent to A.E. Percival, curator for cotton, College Station, TX. This seed will be deposited in the appropriate collection for increase and subsequent distribution to persons involved in research projects that require this material.

The number of contacts is too numerous to list. The most obvious Mexican contact is Dr. Salvador Godoy Avila, who was listed as a collaborator in the funded proposal. In addition, potential or confirmed participants from each state were provided by the Director of the Agricultural Division (Dirección General División Agrícola) of INIFAP and at the US Embassy in Mexico City.

Results and Discussion

Our expedition (2002) established that the former landraces of *G. hirsutum* in the southern Mexican states exist only as occasional garden plants, if at all. In only one location (in western Oaxaca) did we see or hear of a local landrace being cultivated commercially. The greatest phenotypic diversity among garden plants was in the state of Chiapas. Thus, we feel that our first expedition has provided samples of the remaining genetic diversity. The loss of local landraces has occurred in the western Mexican states, and those remaining garden plants will be the most/only remaining vestiges of the genetic diversity of the landraces. Table 1 displays the different species collected during this exploration trip.

G. hirsutum

This species of cotton in the southern states of Mexico seems to survive as a curiosity in garden plots or as escaped plants from garden plots. Long-term survival of a population outside of a garden or in a disturbed waste area is questionable. In this case human activities such as horticulture, road construction, land clearing, etc. is generally required for the diversity to

be maintained. Clearly some of the race types are better adapted to survival in this type of environment than others. Particularly in western Oaxaca and Guerrero race palmeri frequently (but not abundantly) escapes and survives in disturbed waste areas such as roadbanks and fence rows. The characteristics one might associate with the persistence of race palmeri are its small bolls but high fruiting rate, ability to withstand drought by defoliation during the dry period, and a strongly okra-leaf shape that allows light penetration during the wet season. Usually very little insect damage was seen on these plants, but this could be related to the fact that plants or populations generally are several kilometers apart.

In Chiapas race palmeri was not seen. All the cotton plants seen in the central depression of Chiapas were in garden cultivation or escapes closely associated with such plants, and were normal-leaf types. Extensive search around the Acala area again confirmed that very little cotton remains in that area, even as garden plants. Only five samples of *G. hirsutum* were collected in pueblos surrounding Acala. Acala is at the northeast side of the central depression, where as Villa Flores is at the southwest side. Exploration around a semicircular area to the south and west of Villa Flores also yielded 5 accessions of *G. hirsutum.* Since this was a considerably smaller area than that search around Acala, the impression was that there is more residual cotton in the Villa Flores area. Intuitively the genetic diversity of the cotton in this area seemed to be greater, but this needs to be confirmed during evaluation of the accessions. One accession was particularly notable for its productivity and fiber quality. The possibility exists that it is a remnant from an imported cultivar that was grown in the area in the 1970s, but this is uncertain.

Since the central depression of Chiapas experienced a period of cotton production then abandonment, survival of the genetic diversity that was in the original landrace(s) of the area cannot be confirmed. One must assume that the vast majority of it is no longer extant. On the other hand, the genetic lines that have survived do so because they possess characteristics that are adapted to the prevailing environment. The materials collected in all of the southern states during this expedition should not be viewed as an effort to capture the past, but as representing potentially useful genetics because of their present day survival, however tenuous.

G. barbadense

This species was encountered only in Chiapas as a garden plant, but then nearly as frequently as *G. hirsutum*. No feral plants were seen. With only 2-3 exceptions the material belonged to the subspecies *brasiliense,* characterized in part by fusion of the seeds of a locule. This is commonly known as "kidney-cotton." This species was not encountered outside of Chiapas.

G. aridum

This species, as currently circumscribed, is the most widely distributed wild *Gossypium* in Mexico, occurring from Sinaloa to Oaxaca. Diversity among accessions of *G. aridum* currently growing in Dr. Stewart's and Dr. Ulloa's greenhouses indicated a need to examine this species more closely. This was, in part, justification for the exploration reported here. In 1984 Percival and Stewart collected what was thought to be this species north of La Ventosa in Oaxaca. This is the only seed accession available from that state. Comparisons among herbarium specimens in MEXU from Oaxaca and other states such as Colima and Jalisco indicate that leaf size is considerably larger in the Oaxaca specimens. Also, the lysigenous glands on the capsules are more prominent and raised above the carpel surface. Other differences that may be different are leaf vestiture and period of flowering. This *Gossypium* occupies a niche that extends along the lower coastal foothills from about the center of the state to east of the Isthmus of Tehuantepec. In this sense its distribution is disjunct from the distribution of *G. aridum* in Guerrero north and west. This Oaxaca material needs to be studied closely to determine the degree of divergence from other *G. aridum*.

A herbarium specimen at MEXU indicated that *G. aridum* occurred in Puebla. Since the site was near the route to Chiapas, the itinerary included this area. Later in the trip a *Gossypium* thought to be *G. aridum* was found in eastern Guerrero. Subsequent study of maps revealed that the two sites are on adjacent major tributaries leading into the Rio Balsas. Since no foliage was available and some time separated observations of these collections, they need to be studied and compared to other *G. aridum* and related *Gossypium* of the general area such as *G. laxum*. Both bollweevil and Heliothines attack these wild species to a limited extent.

In the area of Infernillo and perhaps as far south as the coast (e.g. La Union area) the *Gossypium* has characteristics that are intermediate between *G. schwendimanii* and *G. aridum.* Gene flow between species probably occurs in this area.

G. laxum

Previous collections of this taxon were limited to the Canyon Zopilote in central Guerrero. The range of this species has been extended east and west along the canyon of the Rio Balsas from the entrance of Zopilote. The full extent of the distribution of this species is yet to be determined, but it is expected to be considerably greater than even now recognized.

G. lobatum

Collection of this species was limited to one canyon site where it was abundant.

G. schwendimanii

The full range of distribution of this species is also not known. As discussed above it appears to intergrade with other *Gossypium* species in the general area. In one instance (US-83) an apparent intergressant population was separated from "typical" *G. schwendimanii* by only 2 km. Information on a herbarium specimen collected in 1990 suggests that the collector (Dan DeJoode) considered some plants collected several kilometers NE of Infernillo to be hybrids between *G. schwendimanii* and *G. lobatum*.

G. gossypioides

Because of the limited availability of lodging in the areas where this species occurs, the decision was made to collect only along the main highway between Tehuantepec and Oaxaca. Accordingly, this expedition does not provide additional information on its distribution. Based on two accessions that were obtained, and the extensive distance along HWY 195 where it was not encountered, the conjecture is advanced that the distribution of *G. gossypioides* may be strongly influenced by altitude, being limited to 1,000 to 1,200 meters.

References

Fryxell, P.A. 1979. The natural history of the cotton tribe. Texas A&M University press.

Fryxell, P.A. 1992. A revised taxonomic interpretation of Gossypium L. (Malvaceae). Rheedea 2:144.

Stewart, J.McD. 1995. Potential for crop improvement through germplasm enhancement and genetic engineering. Pp. 313-327. *In*: G. Constable and N. Forrester (eds.). Challenging the future. Proceedings, World Cotton Research Conference-1. CSIRO, Melbourne.

The National Collection of *Gossypium* Germplasm. Southern Cooperative Series Bulletin No. 321 June 1987. Agriculture Communications, Texas A & M University, College Station Texas, Texas 77843.

Table 1. Distribution of accessions of species of *Gossypium* collected in the southern states of Mexico.

	SPECIES								
STATES	**aridum**	**barbadense**	**gossypioides**	**hirsutum**	**palmeri**	**laxum**	**Lobatum**	**schwendimanii**	**Total**
Puebla	2	0	0	7	0	0	0	0	9
Oaxaca	8	0	2	10	12	0	0	0	32
Chiapas	0	9	0	13	0	0	0	0	22
Guerrero	3	0	0	3	4	5	0	0	15
Michoacán	2	0	0	0	3	0	1	2	8
Total	15	9	2	33	19	5	1	2	86