TRIP REPORT - Phaseolus germplasm collection in the Huasteca and surrounding regions, Mexico

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Summary

Seventy two samples for fifteen different taxa of Phaseolus were colelcted during a collection trip in central northeastern Mexico (the region of Huasteca). Of particular interest are several forms of the groups of P. pedicellatus, P. neglectus, P. xanthotrichus, as well as P. vulgaris found as wild and two lesser known species of this genus.

Resumen

Se colectaron 72 muestras para 15 especies diferentes de Phaseolus durante un viaje de recolección de germoplasma en la región de la Huasteca. Cabe señalar la presencia de varias formas del grupo de P. pedicellatus, P. neglectus, P, xanthotrichus; como también P. vulgaris en estado silvestre y 2 especies poco conocidas de este género.

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C O N T E N T S

Introduction

Breeders generally think about wild species when wishing to broaden the genetic basis of the crops they are working with. Wild germplasm can be a source for characters absent in the variability studied so far. For instance, wild ancestors of the common bean from Mexico have been found resistant to the bean weevil (Schoonhoven _et al_., 1983); this trait is now actively used in breeding (CIAT, 1986). Wild germplasm can also be used as a source of unpredictable characters: Harlan (1976) mentioned the case of _Gossypium thurberi_ which has no lint and gave lint strength to _G. hirsutum_. Another example of this use is found in beans: three sources of male sterility were found when crossing cultivated common beans with wild _Phaseolus coccineus_ (Bannerot, 1980).

Another possibility has been so far less considered, but could become important in the near future: the use of hybrid vigor in beans and the best combining ability between progenitors. In this case, one tries to find the best combination of nucleoplasm and cytoplasm; again alien germplasm could help a lot in it. Another possibility, but apparently not immediate in beans, is to produce cybrids and then to look for the best combination between the new "hybrid" cytoplasm and the nucleoplasm.

Germplasm collections have been built up in recent years partly in response to a problem of genetic erosion. Working collections of breeders contributed a lot to these large collections. Unfortunately, the former frequently lack the basic passport data, namely about the origin, so they lose much of their value as scientific tools. However, recent studies (Gepts and Bliss, 1986; Gepts, _et al_., 1986) have shown that in the case of beans, and thanks to the wild relatives, it is possible to assign the true origin to poorly documented collections. One can think that once nuclear probes will be available for comparative screening of bases in nucleic acids, further documentation about origin will become even more accurate. But an absolute requisite is in the disposal of large collections of well documented wild relatives. A much better documentation of previous collections - on a biochemical basis - will be therefore possible soon.

From phaseolin studies (Gepts _et_ _al_., 1986), it appears that plant domestication in the case of beans was a kind of bottleneck, i.e. that an important part of variability was left in the wild and not retained by human selection. The latter was exerted only on a certain couple of genes, mainly regarding to the harvested part (Gepts and Debouck, in press). Wild relatives appear thus not only as a reservoir of variability maybe wider than the one of the cultigens, but also as research tools in order to understand the domestication process, its successes and its failures.

The Phaseolus Case

We will try here to answer the following questions:

1) Which are the wild species of _Phaseolus_?

2) How are these species represented in gene banks?

3) Where can the species be found which are lacking? How can this situation be improved?

Thanks to the work of Maréchal _et_ _al_. (1978), the generic concepts within the Phaseolinae were clarified and an accurate definition of the genus was made available. Thanks to the contribution of Delgado (1985), the situation of _Phaseolus_ has improved a lot and a list of species the majority of which are now little questioned, is available (see annex 1).

The list of _Phaseolus_ species established by Delgado could perhaps be seen as a minimal one, i.e. that some new species could still be found as evidenced by recent collections carried out in Mesoamerica. In this list, the names of _P_. _vulgaris_, _P_. _lunatus_, etc., refer to the wild ancestors of the cultigens, all present in Mexico. Furthermore, one should add _P_. _polyanthus_ considered by Delgado within the _P_. _coccineus_. The findings of the wild ancestor of _P_. _polyanthus_ in

Guatemala legitimate to consider it as a true cultigen and species of its own. Additions or modifications to this basic list are thus possible: in a work in progress, Freytag (personal communication) spoke about 76 species distributed in 15 sections!

On the basis of the material held in gene banks (see annex 2), we can see that:

-- the collections of wild materials are not so important, especially when one excepts the wild ancestors of the five cultigens.

-- representation is incipient for some species while it is nihil for others.

Low figures can be partly explained by the following fact. One should remember that in the case of wild species, accession numbers refer to population samples while in the case of cultigens, they refer to variants. In the case of beans, these variants use to be separated because of breeding strategies, agronomical practices, consumer preferences, etc. However, there is little doubt that wild species had received less attention until recent times.

Some species are represented by only one accession. If one plans to transfer a character expressed at the species level (for instance the hypogeal germination for _P. lunatus_, Lorz, 1952), this low representativity does not matter. The case of the grassy stunt virus in rice (Khush and Ling, 1974) shows, however, that the approach is in collecting as much populations of wild species as possible. In beans, Schoonhoven and co-workers (op. cit.) found the resistance to bruchids in only a small number of wild populations. The number of accessions of wild species and relatives in germplasm banks should thus be increased.

Phaseolus has its primary diversification in the Americas (Debouck, 1986), where three centers can be identified. As shown by this author and Delgado (1985), the mesoamerican center would have the largest number of species in comparison to the other centers. This center extends from the southern USA to western Panama. As pointed out by Nabhan (1985) and Debouck (1986), it can well be split into subunits in the future where some groups of Phaseolus or sections have their main distribution, and/or express special characters.

Given the taxonomical situation of the genus, and the urgent need of work in experimental hybridology for both theoretical and practical purposes, it appears necessary to collect the type specimens, when it is still possible to do so. This would provide a less questionable basis in solving many pending taxonomical problems.

THe Case of Mexico

The large territorial extension of Mexico (the distance between Tijuana and Tapachula is 4147 km!) and its large number of phytogeographic provinces (17 according to Rzedowski, 1978) cause the approach to be partial. A geographic basis seems to be convenient (Debouck, in press) in order to study the variability and to collect it systematically if necessary. When selecting zones, one should take into account what is already existing in genebanks and also the distribution of the different species. About the latter, an element to be taken into account is the actual geographic distribution of a species, i.e. the core of its distribution and the margins of it. Here, three cases can be considered:

1) one contribution of Delgado (1985) was to show that several species (or groups of species) - e.g. P. jaliscanus, P. leptophyllus, P. neglectus - are still poorly known namely for their geographical distribution. They could thus potentially be collected in each region visited, although some preliminary indications restrict the zone to be investigated.

2) several groups of Phaseolus species have almost their whole distribution in Mexico where they occupy more than one zone: e.g., quoting Piper (1926), "P. pedicellatus and its allies", "P. coccineus and its allies". The former group is distributed mainly in the pine-oak forests and grasslands of the Sierra Madre Oriental, while the latter is present in the humid and cool highlands starting at the latitude of southern Chihuahua (Nabhan, 1985) to Chiapas. In choosing a particular zone, just a part of the distribution of these species will be covered. Core or margin could make quite a difference.

3) other species like P. amblyosepalus, P. salicifolius, P. sonorensis, with the present knowledge, appear to be endemic to one part of Mexico. This means that in chosing a particular zone, some species will be found while others not.

How to chose the zone to be investigated? On the basis of the 17 floristic provinces defined by Rzedowski (1978), it is possible to draw up a list of the potential distribution of the species (see figure 1 and annex 3).

1. California: this is the continuity of the American Pacific provinces. No wild beans have been reported so far, neither in Mexico, nor in the USA.

2. Isla Guadalupe: as far as the writer knows, it has not been explored so far for Phaseolus.

3. Sierra Madre Occidental: this is the first complex of Mesoamerican montainous ranges, with a high variability in climatic conditions. Rains increase southwards and towards the Coast. Some species are coming from the North (parvulus, ritensis) while others are coming from the south (coccineus, vulgaris). The latter two can be considered as rare in this area. One new species (DGD & JSMM # 402) could be added to the list.

4. Sierra Madre Oriental: because of lower elevations it allows more humid winds from the Gulf to cross it. The presence of P. vulgaris should be checked in more areas. P. glabellus is distributed on the eastern flank of the Sierra. Two new and quite different species (DGD et al. #1523 of the P. neglectus group and DGD Y JSMM # 2061 of the P. maculatus group) could be added to the list.

5. Serranias meridionales: Rzedowski (1978) brought together the highlands of Jalisco, the Eje Volcánico and the Sierra Madre de Oaxaca. Perhaps these montainous ranges are too diverse; so, not surprisingly, several species are distributed in only one montainous range and not in the others. P. vulgaris is particularly abundant in Jalisco and in the Eje Volcánico, while P. coccineus is abundant in the latter. P. lunatus is restricted to warmer valleys. This zone included one center of domestication for the common bean.

6. Serranias transistmicas de Chiapas: This zone covers the highlands of Chiapas: the Sierra Madre southwards and the Meseta Central northwards, separated by the Depresión Central. Several materials (vulgaris, leptostachyus, oligospermus, tuerckheimii) will extend from here into Guatemala.

7. Baja California: This zone covers the dry and hot areas of Baja California. Phaseolus species are distributed in the lowlands or at mid elevations. Many characters in physiography, climate, vegetation, etc., are shared with the following zone.

8. Planicie Costera del Noroeste: These hot and dry lowlands end up in Sinaloa around Mazatlan. The presence of leptostachyus remains to be checked: it could well be of the piedmonts of the zone of Costa Pacífica. This zone includes one center of domestication of the tepary bean (Manshardt and Waines, 1983).

9. Altiplanicie: This is the largest floristic province of Mexico, with large dry flat highlands between 1200 and 2200 m.a.s.l. Two species of the Rugosae section, *P. filiformis* and *P. angustissimus*, distributed in the southwestern USA, could be present there. *P. coccineus*, and *P. vulgaris* are only present in the more humid parts of it (Gentry 1969; Nabhan, 1985).

10. Planicie costera del Noreste: *P. lunatus* may be the only bean naturally present in these lowlands, and only in the southern part in transition to the humid forest of the Gulf of Mexico.

11. Valle de Tehuacan - Cuicatlan: This is a restricted area of dry flat valleys with traits shared with the Altiplanicie and the Balsas Valley (Rzedowski, 1978). *P. maculatus* and *P. microcarpus* could be the only species present there.

12. Costa Pacifica: Again this could be a heterogenous region starting in the dry piedmonts of Sonora and ending in the Depresión Central de Chiapas, with more humid parts in Jalisco and Oaxaca. *P. minimiflorus* and *P. salicifolius* are distributed only in Sinaloa, while *P. chiapasanus* has part of its distribution in Oaxaca (the other parts are in Chiapas in the Soconusco and north of Tuxtla Gutierrez).

13. Islas Revillagigedo: According to Rzedowski (1978), the flora is not so rich; on the basis of herbarium samples seen by the writer in the herbarium of Mexico (Mexu) in 1978, only *P. lunatus* would be present there.

14. Depresión del Balsas: This is a hot and somewhat dry valley in continuity of the floristic province of the Costa Pacífica. *P. leptophyllus* could be endemic there. Together with Yucatán, it is one of the rare places where *P. lunatus* is found as cultivated and as wild. *P. acutifolius* is only present here and eastwards, as var *tenuifolius*, a form with very narrow leaflets.

15. Soconusco in Chiapas: This zone is a transitional one - humid and warm - between the Coastal semi-deciduous tropical forest and the humid oak forest of the Sierra Madre de Chiapas. It is among the few places of Mexico where *P. tuerckheimii* can be found.

16. Costa del Golfo de Mexico: In this humid and warm zone, only *P. lunatus* can be found as wild. It needs a couple of dry weeks per year, so it could be absent in the more humid parts of Tabasco and Campeche.

17. Peninsula de Yucatán: With karstic soils and a decreasing amount of rainfall northwards, the hot lowlands of Yucatan provide a place for wild *P. lunatus*.

Phaseolus is a neotropical genus typically found in transitional areas between temperate climates at high elevations, the American deserts and the dry American tropics. Therefore, the number of *Phaseolus* species is definitively higher in all the montainous ranges of Mexico. In the Altiplanicie, drought and frost are the limiting factors, while in the tropical lowlands, high temperatures and conditions for seed preservation limit the diversity of species. The genus is represented in the humid tropics only by the lima bean, and even there it needs a couple of dry weeks for seed dispersal. Maybe the presence of linamarin - a cyanogenetic glucoside - has also some role to play in its survival there.

During this work, emphasis was put on the Sierra Madre Oriental and its link with the Eje Volcánico (a region called Huasteca), because of its low representation in germplasm banks and the need for a better knowledge of the species present there. In this regard, one should remember the group of *P. pedicellatus* as defined by Piper (1926): 19 species of which 8 are distributed in the Sierra Madre Oriental or closely related places. Moreover an exploration carried out in Nuevo León in 1985 (Rodríguez Cabrera *et al.*, in press) showed a particular wealth in *P. pedicellatus* and *P. neglectus* worth investigating further.

Methods were detailed elsewhere (Debouck, in press). Basically, in principle, one should cross as many different ecological conditions as possible. Using vegetation maps, stops were thus multiplied in each vegetation type in order to find different microsites (exposition, drainage, soil composition and texture, etc.). Given the high frequency of disturbed places (crops, grazing, etc.), a special attention was paid to cliffs, steep slopes, etc. where human influence could be less important.

Observations on the area of work

The area visited (see fig. 2) includes parts of the Sierra Madre Oriental, its foothills eastwards and the high flatlands westwards, between $19^{o}08'$ - $24^{o}52'$ lat. N. and $98^{o}34'$ - $100^{o}57'$ long. W. Altitudes were as follows: at the foothills eastwards, in the coastal flatlands of Tamaulipas, around 400 m.a.s.l. (e.g.,350 m at Ciudad Victoria, 450 m at Montemorelos); the Sierra Madre Oriental culminates at 3660 m.a.s.l. (Cerro Peña Nevada); the flat highlands westwards are around 2000 m.a.s.l. (2200 around Mexico City, 1900 m around San Luis Potosí, 1610 m at Matehuala). This part of the Sierra Madre Oriental south of Nuevo Leon and north from the latitude of Jalapa (Veracruz) - where the Eje Volcanico ends - is generally known as the Huasteca.

Rainfalls occur mainly from May to October. It rains very little around San Luis Potosí and Matehuala (about 400 mm/year, with high variations between years, as frequent in many desertical areas). The maximum of rainfall was found northeast of Pachuca, on the eastern flank of the Sierra Madre with 2400 mm a year. In the highlands, the range is about 500-800 mm, while in the mountains, the range is about 1000-500 mm decreasing north and westwards. Frost can occur in the Sierra Madre Oriental and in the interior highlands as early as late October, and lasting up to February.

From a geological point of view, one should note the dominance of cretaceous and jurassic sedimentary rocks in all the Sierra Madre

Oriental. The flat highlands in the north are made of quaternary sediments. Separated by montainous ranges of cretaceous origin. In the south, in western Guanajuato, acid effusive rocks of tertiary origin are dominant, while in western Queretaro and in the valley of Mexico, basic effusive rocks become dominant.

Combination of climate, geology and topography result in a mosaic of vegetation types. However, some basic traits can be outlined. The summits of the Sierra Madre Oriental are of pine-oak forests and its variants (oak chaparral, forest with Abies, Cupressus, etc.), changing into oak forests northwards. The eastern piedmonts are of an evergreen rain forest (mostly replaced by coffee plantations), changing into a deciduous tropical forest and then into a thorn forest northwards. The flat highlands of Mexico were occupied by a grassland (sometimes an oak-grassland), now almost replaced by irrigated fields or ... cities! Large areas of western Queretaro and Hidalgo are of cactus scrub with Opuntia, turning into desert scrub with Yucca northwards. On saline soils, the matorral with Larrea becomes dominant.

Timing

October 26:	Travel Cali-Mexico
October 27:	Contacts in Mexico City (Dr. A. Delgado S., Mexu, UNAM). Maps. Travel to Texcoco.
October 28:	INIFAP-CIAMEC, Chapingo: Discussions with Dr. F. Cárdenas R. and with Ing. J.S. Muruaga M. Plans and routes. Collection (#2025) near Calpulalpan.
October 29:	Travel to Ciudad Sahagun and then to Pachuca. Collection near Tepeapulco (#2026,27) and near Pachuca (#2028,29).
October 30:	Travel to Ixmiquilpan. Collections near San Nicolás Flores (#2030,31).
October 31:	Travel to San Francisco del Oro. Collections near Hacienda La Estancia (#2032,33,34).

November 1:	Travel to Jacala. Collections near Bca Los Marmoles (#2035,36), El Salto (#2037), La Placita (#2038,39), Horcones (#2040,41).
November 2:	Travel to Xilitla. Collections near Santa Ana (#2042), Ahuacatlan (#2043, 44,45,46), El Madroño (#2047,48).
November 3:	Travel to San Luis Potosi. Collections near El Guayabo (#2049), Alvarez (#2050,51)
November 4:	Collections at Alvarez (#2052, 2053).
November 5:	Travel to Mexquitic. Collections near Rivera (#2054), Presa Alvaro Obregon (#2055).
November 6:	Collection in the Sierra El Potosi (#2056).
Novemebr 7:	Travel to Matehuala. Collection near Realejo (#2057). Stop above Real de Catorce (2680 m.a.s.l.), in vain.
November 8:	Travel to Aramberri. Collections near Zaragoza (#2058), La Encantada (#2059).
November 9:	Travel to Galeana. Collection near Joya de Bocacely (#2060).
November 10:	Travel to Linares. Collections near Los Altares (#2061,62).
November 11:	Travel to Ciudad Victoria. Collections near Altas Cumbres (#2063,64).
November 12:	Travel to Ciudad del Maíz. Collections above Altas Cumbres (#2065,66,67), near Ocampo (#2068,69,70,71).
November 13:	Travel to Ciudad Valles. Collections near Puerto de Lobos (#2072, 2073), El Naranjo (2074,75,76)
November 14:	Travel to Cadereyta. Collections near Escanelilla (#2077,78), Pinal de Amoles (#2079,80).
November 15:	Travel to San Joaquin. Collection near San Joaquin (#2081).
November 16:	Travel around Mexico City. Collections near San Nicolás Tlamincax (#2082,83), San Cristobal Ecatepec (#2084,85).
November 17:	Travel around Mexico City. Collection near Santo Tomás Atzingo (#2086).

November 18:	Seed and herbarium samples drying and classification at INIFAP-CIAMEC, Chapingo.
November 19:	Travel to Atotonilco el Grande. Collections near Omitlan de Juarez (#2087), San Nicolás Xathe (#2088).
November 20:	Seed classification in Texcoco.
November 21:	Contacts in Mexico City (Dr. A. Delgado Salinas).
November 22:	Travel Mexico-Cali.

Results

A. General

Results were as follows:

Species	No. of populations encountered and sampled
P. coccineus (wild forms)	15
P. coccineus subsp. *glabellus*	5
P. floribundus	2
P. glaucocarpus	2
P. leptostachyus (formerly *P. anisotrichus*)	10
P. neglectus	6
P. pedicellatus	11
P. pluriflorus	1
P. polymorphus	3
P. scabrellus	1
P. vulgaris (wild form)	1
P. xanthotrichus var *zimapanensis*	11
P. sp. (group of *P. metcalfei*)	1
P. sp. (group of *P. neglectus*)	2
P. sp. (group of *P. pedicellatus*)	1

Total of taxa: 15 Total of samples: 72

On the other hand, for both didactical and research purposes, a total of 557 herbarium samples were made, of which 297 were left at INIFAP, Mexico. This will serve as reference material in germplasm management, as well as for distribution studies.

B. Results per species

1. **P. coccineus** (wild form)

Fifteen populations were found during this exploration, distribued as follows: 1 in Tlaxcala (# 2025), 5 in Hidalgo (# 2026, 31, 34, 36, 37), 2 in San Luis Potosi (# 2050, 53), 1 in Tamaulipas (# 2071), 2 in Queretaro (# 2078, 79), 4 in Mexico (# 2082, 84, 86 and 87). Most of them were found in cooler summits, in oak- or pine-oak forests, between 1170 m.a.s.l. (#2078) and 2700 m.a.s.l. (# 2025).

Three populations (# 2031, 34, 37) found in the area of Zimapan, Hidalgo, show condensed inflorescences: the numerous parts of the rachis are equally short (less than 1 cm) in comparison to the peduncle, resulting in a particular condensed aspect of the double raceme. Two of them (# 2031, 37) also show a particular brownish villosity; this heavy pubescence would be interesting to introgress from an agronomical point of view.

Natural introgression (most probably from cultivated scarlet runner bean) resulting in pink flowers and/or larger seeds and pods, was observed in three populations (# 2025, 31, 79). In the two last cases, these forms were known by local people and about # 2031 we were told: "Se come en verde cuando no se tiene que comer".

Some problems were noted about these populations: rust (# 2025, 31, 34, 36, 50), anthracnosis (# 2025, 36, 37, 78), angular leaf spot (# 2050), thrips (# 2053, 78, 79, 87), Apion (# 2025, 26, 53), Mexican bean beetle (# 2026, 31, 50, 53, 78, 79, 87), chrysomelids (# 2026, 31, 37, 50, 79), and locust (# 2084).

2. **P. coccineus subsp. glabellus**

This is the former P. glabellus Piper, transferred to the P. coccineus complex by Delgado (1985). As pointed out by this author, we are dealing with a P. coccineus taxon outstanding by its glabrousity. According to herbarium data and the present field observations, its distribution is restricted to the montane rain forest on the western flank of the Sierra Madre Oriental. The arc of distribution starts in southern Tamaulipas and ends up in mid Veracruz (around Jalapa?). According to Delgado (1985), it would be again present in Chiapas, on the Central Plateau, where according to Rzedowski (1978), this vegetation is again present. This peculiar glabrousity could be linked to the habitat of this bean where rains and mists are frequent.

We were able to find five populations in the states of Hidalgo (2, # 2041, 42), and San Luis Potosí (3, # 2043, 46, 75), distributed between 1000 and 1600 m.a.s.l. They were found on calcareous rocks with well drained deep organic soils. They are rather late in pod setting with a high rate of pod abortion; it was however possible to find germplasm seed for each population (sometimes from last year, since dried pods remained with unopened valves). In Zipatlan (Jacala, Hidalgo), local people know it as "frijol de ratón", but do not use it for eating. Interestingly enough, in one case (# 2042) near Puerto del Gavilan, Santa Ana, Hidalgo, escaped P. coccineus were observed in the bush close to the P. coccineus subsp. glabellus, but apparently there is no natural introgression between these two.

One population (# 2075) shows short racemes (6-10 cm long) with 10-30 primary bracts, giving the inflorescence a special condensed aspect.

The different populations were relatively free of fungi diseases (an interesting fact since the humid habitat where they are living), but were damaged by leaf miners (# 2041), thrips (# 2043), mexican bean beetle (# 2041, 42, 46), Apion (# 2046) and heavily by a foliar caterpillar (# 2041, 42).

It is a pluriannual vine climbing on trees and reaching 4 m high. As for other forms of the P. coccineus, the percentage of aborted flowers was high.

3. **P. floribundus**

One of the objectives of this trip was to find this taxon belonging to the P. pedicellatus group (Piper, 1926), in order to find out what it is. So we went to the type locality at Alvarez, in San Luis Potosi. Seeds were picked up for the type (# 2051) as well as for another population found in the surroundings of Alvarez (# 2052). The latter for obvious reasons of future experimental taxonomy was not mixed with the type, as usually done in sampling such populations. It looks quite like P. pedicellatus (a synonymy already done by Delgado, 1985), and there is now an experimental basis for doing so if adequate.

Both populations were found in already man-modified oak forests, on calcareous (karstic) rocks, at 2400 m.a.s.l. They were entering pod maturity, so seeds for germplasm were picked up.

Rust was observed (# 2051), as well as angular leaf spot (# 2052). Problems with Epilachna and Apion (# 2051, 52) were also seen.

4. **P. glaucocarpus**

This year we were able to find another population of this taxon (# 2058). It is an addition to the previous collection of last year (# 1509) in another place of the valley of Zaragoza in Nuevo Leon. It grows at mid elevation (1500 m.a.s.l.) in oak forest, on calcareous rocks.

In his study of Phaseolus, Delgado (1985) wrote about the distribution of P. polystachyus (L.) BSP var polystachyus: "The collections of central Texas (Kerr Co.) and from Mexico (Dulces Nombres, Nuevo Leon) are by no means typical of the species, but perhaps are better placed here than elsewhere". We have not seen the specimen mentioned by Delgado, but it should be noted that Dulces Nombres is close to Zaragoza in Southern Nuevo Leon. We are using the name of P. glaucocarpus for these populations after an unpublished name by Norvell and a poorly known type from Morelos. What prevents us to follow Delgado and use polystachyus is the gap in distribution: typical polystachyus is currently distributed in the eastern USA from Kansas to New York, and does not cross the desertical areas of Texas.

It is a strong sprawling vine (2-3 m long) starting from a fleshy, conical-cylindrical, tuberous root. It was found growing vegetative; so a few roots were dug up and planted in Chapingo for seed production. It was found relatively free of diseases and pests.

5. **P. leptostachyus** (formerly P. anisotrichus)

We are using the nomenclature as clarified by Delgado (1985): our material is all belonging to the var leptostachyus.

Ten populations were found during this exploration, 1 in Hidalgo (# 2032), 3 in San Luis Potosi (# 2044, 72, 74), 3 in Nuevo Leon (# 1505, 14, 2062)* and 3 in Tamaulipas (# 2064,66,68). They were distributed in the pine and the oak orest between 900 (# 2064) and 2100 m.a.s.l. (# 2032). This species is frequent in these open forests, on calcareous substrate, where it was often associated with another Phaseolus species: P. xanthotrichus var zimapanensis. It is a prostrate vine, poor climber, starting from cylindrical fleshy roots, growing in the shade while the former species is more heliophilous.

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* From now onwards, numbers of the series # 15.. refer to collections made in 1985 in Nuevo Leon. Readers interested are invited to consult the report related to this exploration.

It frequently shows determinate branches; because of this trait and its habitat, it could suffer heavily from grazing (as for instance in the case of # 2066 or 2072).

The following problems were observed: powdery mildew (# 2062, 63), rust (# 2044, 62, 74), spider mites (# 2032, 66), aphids (# 2072), Apion (# 2062, 66), and Mexican bean beetle (# 2062, 66, 72).

One population shows particular large seeds (# 2066). Seeds for germplasm were found for each population, with the exception of # 2064, because of the scantiness of the material.

6. The group of *P. neglectus*

We are considering here four populations which could correspond to the two races recognized by Delgado (1985): race A with pale violet flowers (# 2059, 63, 67) and race B with white flowers quickly turning yellow (# 2060). The latter is still to be considered as doubtful since it was found as vegetative: however differences in leaflet lobulation and thickness exist in relation to previous numbers. It was distributed in the mesophytic oak forest between 900 and 1500 m.a.s.l.

Pest problems were observed as follows: Apion (# 2059), chrysomelids (# 2060), Mexican bean beetle (# 2063). Seed germplasm was collected for # 2059 and 2063, while roots were picked up for # 2060 and 2067. The availability of germplasm will help a lot in order to find out the taxonomic position of this little known species, a particular trait of which in one race is the larger (2 cm) white corolla.

7. *P. pedicellatus*

We were able to find 11 populations of this species, 6 in Hidalgo (# 2028, 29, 30, 33, 35 and 39), 3 in Queretaro (# 2048, 80 and 81), 1 in San Luis Potosi (# 2057) and 1 in Tamaulipas (# 2070). They were distributed mainly in the pine- and pine-oak forest between 1540 (# 2070) and 2650 m.a.s.l. (# 2028).

This is a difficult group of species or taxa. Delgado (1985) merged together into a macrospecies, five species considered as different in the past, distinguishing them as varieties: var pedicellatus, var oaxacanus, var polymorphus. var purpusii, and var grayanus. Before reaching such conclusions, some work in experimental hybridology could be useful. We have considered here all our collections as belonging to the var pedicellatus, and yet some outstanding variants exist. For instance, # 2028 has larger and more acute leaflets and wider pods; # 2070 has poorly lobed leaflets and shorter racemes in comparison to typical P. pedicellatus; # 2080 has papery leaflets silvery beneath and a different acute pod beak. Since morphological convergences are so common in legumes, we consider it would be better to cross these forms with typical P. pedicellatus before concluding these are new species or as we say here tentatively, just variants within P. pedicellatus.

Problems of rust (# 2030), angular leaf spot (# 2030), anthracnosis (# 2028, 30), Apion (# 2028, 29, 81), leaf miners (# 2028, 29, 33), thrips (# 2080), and Mexican bean beetle (# 2030, 35, 57, 70). All are small climbers, twining in the upper stems, starting from tuberous subconical roots; they do well as underwood plants in shady places or in diffuse light.

8. **P. pluriflorus**

This is not a conspicuous species but a small climber on herbs (60 cm high), so that it could be frequently neglected. We collected it (# 2083) on a small hill near Texcoco at 2430 m.s.a.l., where frost had already occurred. It was completely dried up and seed dispersal had already begun. Seeds for germplasm were picked up.

It was too late for taking phytopathological observations. It seems distributed in grasslands on volcanic ashes and basaltic rocks in central Mexico where systematic collections are just beginning.

9. **P. polymorphus**

The type of this species ws collected in the vicinity of San Luis Potosi City ("in arenosis circa urbem") more than a century ago. Given the rapid and recent urban extension of San Luis Potosi, this type population is probably lost. We were able however to find three populations (of reduced importance indeed!))# 2054, 55 and 56) around the City, one of which may serve as type.

Because of the lack of any data from experimental hybridology, the taxonomic treatment proposed by Delgado (1985), i.e. considering it as a botanical variety of P. pedicellatus, was not followed here. Also because the primary bracts on the racemes were constantly smaller than in typical P. pedicellatus. Leaflets were also much more lobulated than in the latter. This taxon appears so far as an endemic plant restricted to the surroundings of San Luis Potosi City, where because of the drought, one could hardly find something else in Phaseolus. In the mountains westwards, P. grayanus has been reported (Delgado, 1985); in the mountains southwards (Sierra de San Miguelito), P. coccineus has been reported (Watson, 1882). We have been in the latter Sierra without finding it but P. polymorphus.

This species is distributed in a kind of stony land with desert ephemerals (Graminae, Compositae) and scattered dwarf bushes of Quercus and Arctostaphylos; starting from a fleshy tuberous rout, it grows below them, climbing 50-60 cm high. Two populations (# 2054, 55) were found as vegetative (drought!), while because of grazing we hardly found a few seeds for # 2056. A couple of root systems were dug up in order to grow them in glasshouse in Chapingo for seed production. Problems of Apion and Epilachna were observed in # 2056.

10. **P. vulgaris** (wild or weedy form)

It was found in only one place, near Escanelilla, Queretaro, on the eastern flank of the Sierra Gorda, a central westwards subdivision of the Sierra Madre Oriental. This place cannot be considered as belonging to the Eje Volcanico from which it is separated by the flat highlands of Queretaro, San Juan del Rio and Tula de Allende. As far as we know, this place would be the most extreme habitat towards the north-east for this kind of material.

The exact biological status of this form is still uncertain to us: the seed background is bayo with brown stripes and with a brown eye, suggesting a weedy form. However, it was found growing wild in the bush, distinct from some escaped P. vulgaris materials seen in the surroundings of Escanelilla and not collected. The presence of wild P. coccineus (# 2078) very close to this population of P. vulgaris at 1270 m.a.s.l. should be noted. Two major differences: P. vulgaris was not found growing wild at higher altitudes, while P. coccineus went up to 1900 m. P. vulgaris was rather uniform, while P. coccineus was variable and introgressed with cultivated material.

Local people know P. vulgaris # 2070 as "frijol del ratón" and use to eat it from time to time. In the case it is an escaped from early cultivars, it is since a while, since local people do not take care of it, "se cria así solo en el monte" (info. in Escanelilla, 1110 m.a.s.l.).

The following problems were observed in this unique population: angular leaf spot, Apion, rust, thrips and locust. In comparison to the populations sampled in western Mexico (Durango, Michoacan) in 1978, leaflets appear wider and with a more triangular acumen, but it could also be a shade effect.

11. **_P_. _xanthotricus_ var _zimapanensis_**

We were able to find 11 populations of this taxon during this work, 3 (# 2038, 40, 88) in Hidalgo, 3 (# 2045, 73, 76) in San Luis Potosi, 2 (# 2047, 49) in Queretaro, 2 (# 2065, 69) in Tamaulipas, and 1 in Nuevo Leon (# 1504). As pointed out be Delgado (1985), _P_. _xanthotrichus_ has two areas of distribution:

1) from Hidalgo to Nuevo Leon, in Mexico: var _zimapanensis_
2) from Chiapas to Costa Rica: var _xanthotrichus_.

Our material belongs to the first group. However, some variants have been observed: # 2065 has larger seeds, wider pods and lobed leaflets; # 2073 has smaller and roundish seeds and deeply lobed up to hastate leaflets. Before having more information from morphological and hybridological observations, we will maintain them within the var _zimapanensis_.

This is a small slimber (20-60 cm high), starting from a small subspherical fleshy root. It was common in oak forests where it was found between calcareous rocks where cattle and goat have an uneasy access, between 890 (# 2049) and 2180 (# 2088) m.a.s.l. Timing in pod setting seems highly variable according to the rainfall distribution: we were too late for # 2088 in Pedregal Xathe, Atotonilco, Hidalgo where the last rainfall was in July, and too early for # 2049 in El Guayabo, Landa de Matamoros, Queretaro where it rained until October. Pod setting and seed dispersal extend over a couple of weeks, since individual production is reduced (2-3 pods per plant).

The following diseases and pests were observed: angular leaf spot (# 2038, 40), leaf miners (# 2038, 45), thrips (# 2038, 40, 49), Mexican bean beetle (# 2045), locust (# 2047), aphids (# 2049), chrysomelids (# 2049), and again severe attacks of _Apion_ (# 2038, 40, 65).

12. **Phaseolus sp.** (belonging to the group of P. pedicellatus)

This material (# 2027) was found in only one place in Hidalgo, near Tepeapulco, at 2650 m.a.s.l. It is a small climber or sprawling vine (60 cm long), starting from a fleshy tuberous root. It differs from typical pedicellatus by its spherical solid black seeds, its coriaceous leaflets and its heavily marginate pods. Plant aspect and leaflet lobulation let think it belongs to the P. pedicellatus group.

It was found in a pine forest destroyed by fire and turning into a matorral with Opuntia, Yucca, and Juniperus, on igneous rock derived soil. Although it was not abundant at that place, we were able to pick up some seeds for germplasm. Some damages of Apion and thrips were observed.

13. **Phaseolus sp.** (belonging to the group of P. maculatus)

This material (# 2061) was found in only one place, close to Los Altares, Iturbide, Nuevo Leon. It was a sprawling vine with poor climbing aptitude, with coriaceous small rounded leaflets. These characters definitively favor it to belong to the P. maculatus (formerly P. metcalfei) group. As in the latter (Nabhan et al., 1980), this material has complete trifoliate leaves at the beginning of all vegetative branches. However, to the contrary to P. maculatus, it has short racemes: about 10 cm long with 1-2 fertile insertions. Also striking were the reddish nodes of all axes and the reddish bases of the calyx. Furthermore, it has small cream flattened seeds and highly curved pods without the thick margins frequently found in P. maculatus. So we do think it is a new taxon to be considered within the P. maculatus complex.

Leaves were relatively healthy, just with some damages of Mexican bean beetle and chrysomelids. Seeds for germplasm as well as some roots were picked up. More collections would be useful, taking into account the relatively low altitude (970 m.a.s.l.), since the P. maculatus group is generally found at more than 2000 m.a.s.l.

Conclusions

1. The number of Phaseolus species is still unknown: any exploration for bean germplasm especially in Mexico in poorly sampled areas or in other moments in the year, could bring some new material. In this exploration, we reported about 3 cases, two of which apparently belong to groups of species already known.

2. The knowledge of the distribution of each species can still be improved. In this regard, after this exploration, the situation was improved for P. leptostachyus, P. vulgaris, and P. xanthotrichus. Worth exploring further is the presence of wild P. vulgaris in the Sierra Madre Oriental.

   One hypothesis came out of our analysis of the distribution of some groups as the ones of P. coccineus and P. pedicellatus. The climatic modifications of the Quaternary (alternation of cold/warm and/or dry/humid periods) have worked on plastic groups resulting in isolation of some forms from a common branch. This isolation would not have been long enough in order to separate already completely these forms from the branch, thus resulting in not true species yet, but in what could still be considered as variants.

3. For future progress in plant breeding and germplasm management, it is of paramount importance to understand the relationships between the species. So far, this understanding has been limited because many taxa were unavailable. This situation has now improved, especially for a difficult group of species ("P. pedicellatus and its allies") and also for P. neglectus.

4. Documentation about diseases and pests of wild forms is just beginning and worth studying further. For instance, several species were heavily damaged by Apion: it would be interesting

to know if that pest present on wild materials then goes on cultivated material in the area. In such a case, the wild stock could serve as a reservoir for further infestation, but maybe also as a source of direct (genetic) or indirect (predators) resistance.

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ANNEX 1. List of <u>Phaseolus</u> species as in Delgado (1985).

Section 1. Chiapasana

P. chiapasanus Piper

Section 2. Phaseolus

* P. angustissimus A. Gray
* P. filiformis Bentham
* P. leptostachyus Bentham
* P. macrolepis Piper
* P. vulgaris L.
 P. leptophyllus G. Don
* P. acutifolius A. Gray
* P. microcarpus Mart.
* P. lunatus L.
 P. neglectus Hermann
* P. coccineus L.
* P. salicifolius Piper
* P. maculatus Scheele
* P. tuerckheimii Donn. Smith
* P. oligospermus Piper
* P. polystachyus (L.) B.S.P.
* P. jaliscanus Piper
 P. xolocotzii Delgado
* P. ritensis Jones
 P. marechalii Delgado
* P. pedicellatus Bentham
* P. sonorensis Standl.
 P. mollis Hook.
* P. augusti Harms
* P. pachyrrhizoides Harms

Section 3. Minkelersia

* P. pauciflorus Sesse & Mociño

* P. amblyosepalus (Piper) Morton
* P. nelsonii M.M.S.
* P. tenellus Piper
* P. parvulus Greene
* P. pluriflorus M.M.S.
P. perplexus Delgado
* P. plagiocylix Harms

Section 4. Xanthotricha

* P. xanthotrichus Piper
* P. hintonii Delgado

* taxa which are now little questioned.

ANNEX 2. List of Phaseolus species accessions held in CIAT's germplasm bank (as of Oct. 26, 1987)

Phaseolus acutifolius (cultivated forms)	157
Phaseolus acutifolius (wild forms)	50
P. angustissimus	2
P. augusti	4
P. coccineus (cultivated forms)	812
P. coccineus (wild forms)	80
P. filiformis	18
P. glabellus	1
P. glaucocarpus	1
P. grayanus	11
P. jaliscanus	1
P. leptostachyus (formerly P. anisotrichus)	30
P. lunatus (cultivated forms)	2466
P. lunatus (wild forms)	76
P. macrolepis	1
P. maculatus (formerly P. metcalfei)	11
P. microcarpus	8
P. neglectus	2
P. oligospermus	2
P. pachyrrhizoides	4
P. parvulus	1
P. pauciflorus	1
P. pedicellatus	4
P. pluriflorus	1
P. polyanthus (cultivated and weedy forms	448
P. polyanthus (wild forms)	5
Natural hybrids involving P. polyanthus	16
P. polystachyus	4
P. ritensis	5
P. scabrellus	3
P. tuerckheimii	2
P. vulgaris (cultivated forms)	32167
P. vulgaris (wild forms)	375

Annex 2 (cont.)

P. xanthotrichus	5
P. xanthotrichus var. zimapanensis	4
Grand total	**36768**

Total cultivated forms (5 species)	36006
Total wild forms (5 ancestors)	586
Total wild species (24 species)	116

ANNEX 3. Distribution of some Phaseolus species in the different floristic provinces as defined by Rzedowski (1978).

3. **Sierra Madre Occidental**

P. acutifolius (partim)

P. amblyosepalus (partim)

P. coccineus (partim)

P. grayanus

P. leptostachyus

P. maculatus

P. parvulus (partim)

P. pauciflorus

P. pluriflorus

P. ritensis (partim)

P. salicifolius (partim)

P. sonorensis (partim)

P. vulgaris (partim)

4. **Sierra Madre Oriental**

P. coccineus (partim)

P. glabellus (partim)

P. glaucocarpus (partim)

P. leptostachyus

P. neglectus (partim)

P. pedicellatus

P. plagiocylix (partim)

P. vulgaris?

P. xanthotrichus v. zimapanensis

5. **Serranias meridionales**

P. acutifolius

P. coccineus

P. esperanzae (partim)

P. glaucocarpus (partim)

P. griseus (partim)

P. hintonii

P. jaliscanus (partim)

P. leptostachyus

P. lunatus (partim)

P. microcarpus

P. nelsonii (partim)

P. oaxacanus (partim)

P. oligospermus (partim)

P. pauciflorus

P. pedicellatus (partim)

P. perplexus

P. pluriflorus (partim)

P. striatus

P. tenellus

P. vulgaris

6 **Serranias transistmicas de Chiapas**

P. chiapasanus (partim)

P. coccineus

P. glabellus (partim)

P. leptostachyus

P. microcarpus (partim)

P. nelsonii (partim)

P. oligospermus

P. tuerckheimii

P. vulgaris

P. xanthotrichus

7. **Baja California**

P. acutifolius

P. filiformis

P. minimiflorus (partim)

8. **Planicie Costera del Noroeste**

P. acutifolius

P. filiformis

P. leptostachyus?

P. minimiflorus (partim)

9. **Altiplanicie**

P. acutifolius

P. angustissimus

P. coccineus (partim)

P. filiformis?

P. grayanus

P. leptostachyus

P. maculatus

P. microcarpus

P. pauciflorus (partim)

P. pluriflorus

P. polymorphus (partim)

P. purpusii (partim)

P. vulgaris (partim)

10. **Planicie Costera del Noreste**

P. lunatus?

11. **Valle de Tehuacan-Cuicatlan**

P. lunatus?

P. maculatus

P. microcarpus

12. **Costa Pacífica**

P. acutifolius

P. chiapasanus (partim)

P. leptostachyus

P. lunatus

P. micranthus (partim)

P. microcarpus

P. minimiflorus (partim)

P. salicifolius (partim)

13. **Is las Revillagigedo**

P. lunatus

14. **Depresión del Balsas**
    - P. acutifolius
    - P. leptophyllus
    - P. leptostachyus
    - P. lunatus
    - P. microcarpus

15. **Soconusco en Chiapas**
    - P. chiapasanus
    - P. leptostachyus
    - P. lunatus
    - P. tuerckheimii

16. **Costa del Golfo**
    - P. lunatus

17. **Peninsula de Yucatan**
    - P. lunatus

N.B.

partim = the species is distributed only in a part of that province.

? = the presence of the species needs to be confirmed.

ANNEX 4. List of materials found in northeastern Mexico in October-November 1986

2025	_P_. _coccineus_ (wild	98°41'W	19°34'N	2700m
2026	_P_. _coccineus_ (wild)	98°31'W	19°48'N	2650m
2027	_P_. sp. (group of _pedicellatus_)	98°31'W	19°48'N	2650m
2028	_P_. _pedicellatus_	98°43'W	20°07'N	2650m
2029	_P_. _pedicellatus_	98°38'W	20°09'N	2380m
2030	_P_. _pedicellatus_	99°14'W	20°49'N	2180m
2031	_P_. _coccineus_ (escaped)	99°14'W	20°48'N	2370m
2032	_P_. _leptostachyus_	99°20'W	20°48'N	2100m
2033	_P_. _pedicellatus_	99°20'W	20°48'N	2100m
2034	_P_. _coccineus_ (wild)	99°20'W	20°48'N	2150m
2035	_P_. _pedicellatus_	99°14'W	20°50'N	2320m
2036	_P_. _coccineus_ (wild)	99°14'W	20°50'N	2360m
2037	_P_. _coccineus_ (wild)	99°14'W	20°53'N	2030m
2038	_P_. _xanthotrichus_	99°13'W	20°57'N	1870m
2039	_P_. _pedicellatus_	99°13'W	20°58'N	1780m
2040	_P_. _xanthotrichus_	99°12'W	21°00'N	1550m
2041	_P_. _coccineus_ subsp. _glabellus_	99°08'W	21°03'N	1610m
2042	_P_. _coccineus_ subsp. _glabellus_	99°00'W	21°07'N	1410m
2043	_P_. _coccineus_ subsp. _glabellus_	99°03'W	21°21'N	1030m
2044	_P_. _leptostachyus_	99°06'W	21°17'N	1430m
2045	_P_. _xanthotrichus_	99°06'W	21°17'N	1430m
2046	_P_. _coccineus_ subsp. _glabellus_	99°06'W	21°17'N	1430m
2047	_P_. _xanthotrichus_	99°08'W	21°16'N	1720m
2048	_P_. _pedicellatus_	99°08'W	21°16'N	1720m
2049	_P_. _xanthotrichus_	99°27'W	21°19'N	890m
2050	_P_. _coccineus_ (wild)	100°38'W	22°02'N	2400m
2051	_P_. _floribundus_ (type!)	100°38'W	22°02'N	2400m
2052	_P_. _floribundus_	100°38'W	22°01'N	2440m
2053	_P_. _coccineus_ (wild)	100°38'W	22°01'N	2440m
2054	_P_. _polymorphus_	101°11'W	22°09'N	2340m
2055	_P_. _polymorphus_	101°10'W	22°16'N	2230m
2056	_P_. _polymorphus_	101°06'W	22°02'N	2300m
2057	_P_. _pedicellatus_	100°24'W	22°39'N	2100m
2058	_P_. _glaucocarpus_	99°46'W	23°57'N	1540m
2059	_P_. _neglectus_	99°47'W	23°57'N	1430m
2060	_P_. _neglectus_	99°42'W	24°13'N	1240m
2061	_P_. sp. (group of _maculatus_)	99°50'W	24°43'N	970m
2062	_P_. _leptostachyus_	99°50'W	24°43'N	1020m
2063	_P_. sp. (group of _neglectus_)	99°08'W	23°36'N	900m
2064	_P_. _leptostachyus_	99°08'W	23°36'N	900m
2065	_P_. _xanthotrichus_	99°14'W	23°36'N	1470m
2066	_P_. _leptostachyus_	99°14'W	23°36'N	1470m
2067	_P_. sp. (group of _neglectus_)	99°14'W	23°36'N	1470m
2068	_P_. _leptostachyus_	99°41'W	22°58'N	1360m
2069	_P_. _xanthotrichus_	99°40'W	22°58'N	1500m
2070	_P_. _pedicellatus_	99°37'W	22°54'N	1540m
2071	_P_. _coccineus_ (wild)	99°37'W	22°54'N	1520m
2072	_P_. _leptostachyus_	99°34'W	22°27'N	1170m

Annex 4. (cont.)

2073	*P. xanthotrichus*	99°34'W	22°27'N	1170m
2074	*P. leptostachyus*	99°29'W	22°29'N	1150m
2075	*P. coccineus* subsp *glabellus*	99°29'W	22°29'N	1150m
2076	*P. xanthotrichus*	99°29'W	22°29'N	1150m
2077	*P. vulgaris* (weedy?)	99°37'W	21°08'N	1190m
2078	*P. coccineus* (wild)	99°37'W	21°08'N	1170m
2079	*P. coccineus* (escaped)	99°40'W	21°07'N	1400m
2080	*P. pedicellatus*	99°40'W	21°07'N	1950m
2081	*P. pedicellatus*	99°34'W	20°54'N	2360m
2082	*P. coccineus* (wild)	98°49'W	19°31'N	2430m
2083	*P. pluriflorus*	98°49'W	19°31'N	2430m
2084	*P. coccineus* (wild)	99°09'W	19°35'N	2650m
2085	*P.* sp. (affin *coccineus*?)	99°09'W	19°35'N	2650m
2086	*P. coccineus* (wild)	98°42'W	19°10'N	2480m
2087	*P. coccineus* (wild)	98°38'W	20°09'N	2420m
2088	*P. xanthotrichus*	98°48'W	20°23'N	2180m

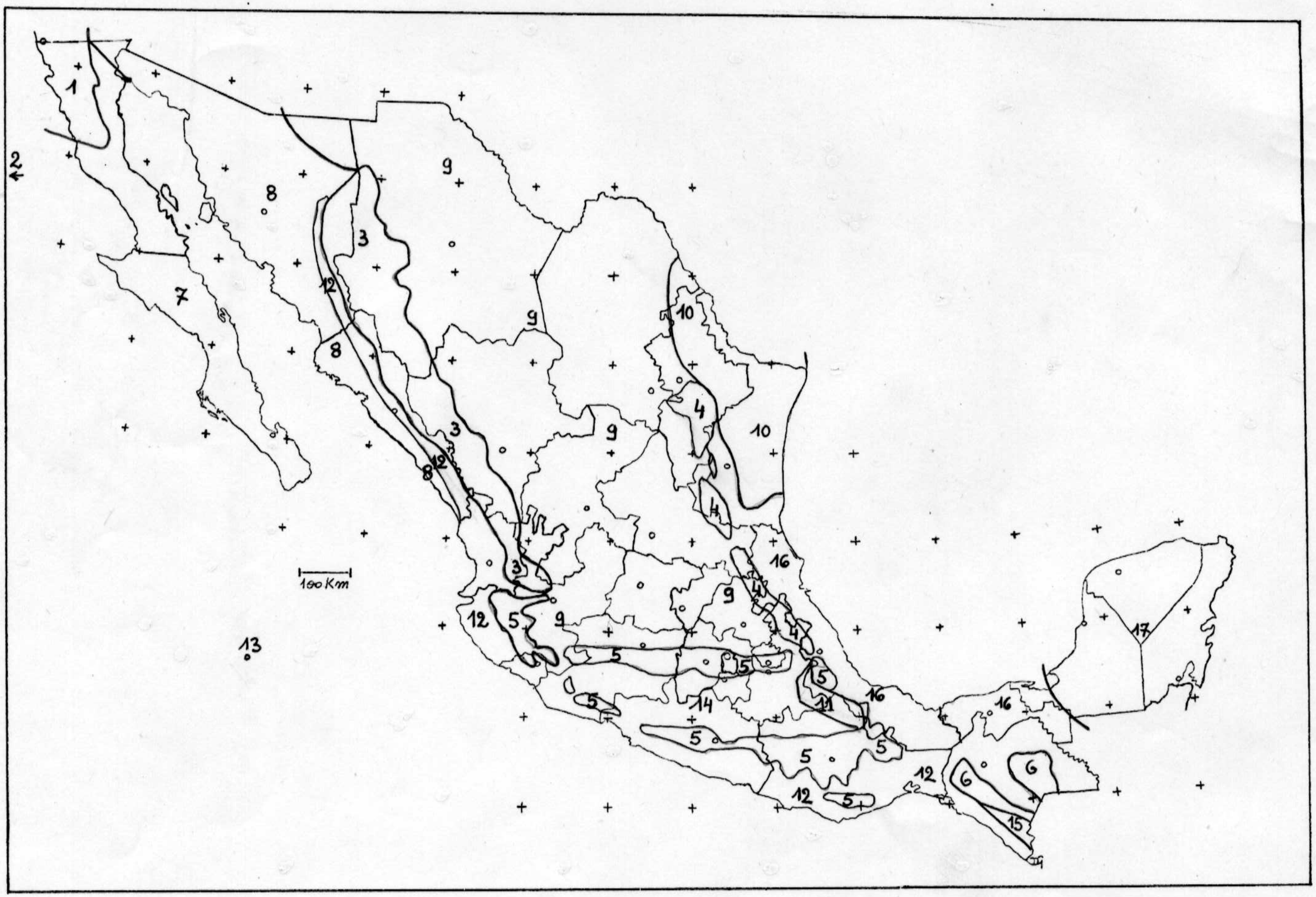

Figure 1. The floristic provinces of Mexico as defined by Rzedowski (1978). Each figure refers to a different province for Phaseolus species as detailed in the text.

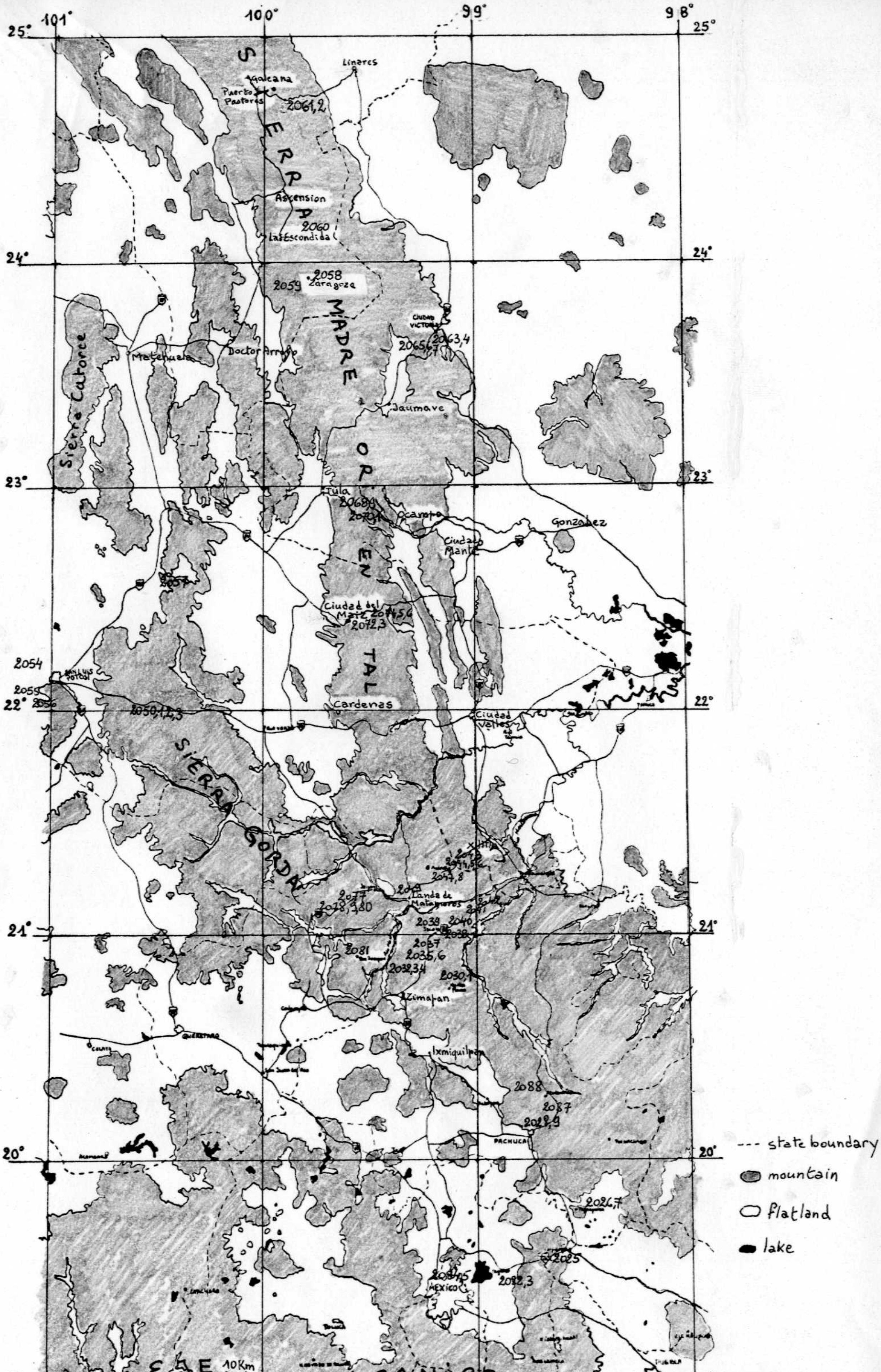

Figure 2. Region of northeastern Mexico explored during this collection. Figures refer to the collection numbers.