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BENEMERITA UNIVERSIDAD AUTONOMA DE PUEBLA

**BOTANICAL GARDEN UNIVERSITY**
BENEMÉRITA UNIVERSIDAD AUTÓNOMA DE PUEBLA

# Building capacity and implementing tree conservation in Mexico: Conservation of threatened tree species in Puebla.

# Final Report

BGCI

GLOBAL SEED CONSERVATION CHALLENGE

BGCI BOTANIC GARDEN • ACCREDITED

VIEP Vicerrectoría de Investigación y Estudios de Posgrados


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- Biol. Lucio Caamaño Onofre


May to December 2018

# BUILDING CAPACITY AND IMPLEMENTING TREE CONSERVATION IN MEXICO

PROYECT NAME:

**CONSERVATION OF THREATENED TREE SPECIES IN PUEBLA. FINAL REPORT.**

PROJECT FINANCED BY:

**BOTANIC GARDENS CONSERVATION INTERNATIONAL (BGCI)**

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**University Botanical Garden**
BENEMÉRITA UNIVERSIDAD AUTÓNOMA DE PUEBLA

May to December 2018

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## PRESENTATION

This report is evidence of the great interest that the University Botanical Garden BUAP has in the study, education, dissemination and conservation of plants. In particular, this project is dedicated to the conservation of species belonging to some category of risk in the state of Puebla, although some of them may also occur in neighbouring states.

Two years ago, we started in the Herbarium and Botanical Garden BUAP to develop a list of the more threatened or restricted tree species in Puebla. The species considered either had a threat category in the IUCN Red List or the Mexican NOM or were restricted to very few states in Mexico. This information served as the basis for selecting 50 species that should be monitored in greater depth in the state, in order to prevent extinction.

With financial and technical support of BGCI, this research project for conservation was planned in two parts. The first one included a training course in the collection of seeds for conservation, attended by 21 representatives of 10 Mexican botanical gardens and germplasm banks and 3 Institutions in Latin America, Ecuador, Bolivia and the Dominican Republic. The trainers (6) also came from different Centers and International Organizations such as BGCI, while Mexico was represented by the National Forestry Commission (CONAFOR) and the National Center for Genetic Resources (CNRG). The results of the Workshop given were announced at the 2018 Annual Assembly of the Mexican Association of Botanical Gardens and this Botanical Garden is committed to continue with the agreements issued.

The second part of the project is related to seed collection and fieldwork, working with 15 species that were included from the beginning, including three more that were found during the fieldwork. As will be read in the report, the results were surprising and reflect the systematic and committed work of our Botanical Garden. They also reveal the importance and necessity of continuing exploratory work in Mexico, since trees of restricted distribution can still be found that have not been evaluated and require conservation.

## ACKNOWLEDGEMENTS

We thank *Botanic Gardens Conservation International (BGCI)* for the financial and technical support to this Conservation project for species that are in some category of International or National risk in the state of Puebla.

We are also grateful to the representatives of each site visited to allow access to the areas where the species included in this project were located. In the same way, we thank all the people who in some way or another supported this project.

# INTRODUCTION

As is well known, vegetation is being damaged and/or eliminated in an accelerated way, mainly by anthropogenic actions causing the loss of species, or at least a reduction in their distribution, so organizations like BGCI support Botanical Gardens in the world to develop Conservation projects in response to the objectives of the Global Strategy for Plant Conservation. Those objectives include seed conservation and ecological restoration, among others. This support is provided through the financing of projects and technical training.

The University Botanical Garden of the Benemérita Universidad Autónoma de Puebla (JBU-BUAP) was benefited with a grant for the project entitled "CONSERVATION OF SPECIES BELONGING TO ANY RISK CATEGORY IN PUEBLA, MX ", planned to run from May to December 2018. This project aimed to collect germplasm of species that are included in the red list of IUCN (International Union for Conservation of Nature) or in the nationally recognized list of species at risk, NOM-059-SEMARNAT-2010 for their ex-situ conservation.

The initial collection data were reviewed in the BUAP Herbarium or electronic databases of other herbaria. The new or records obtained in this project were included in the database of the herbarium (HUAP).

In total, it was possible to locate 11 of the 15 originally proposed species, while four of them were not possible to locate due to factors related to the weather. From all of the collected species, herbarium specimens with location data were taken as well as the germplasm of 4 species. Some problems were encountered with the initial data collection and locating plants as many of the earlier records such as those dating from the 1980s lacked exact locations, description of phenology and habitat data.

## METHODOLOGY

To comply with the objective of this project, the methodology was divided into three phases: The first corresponded to the selection of the species to be conserved, the second to the revision of herbarium data and field trips, and the third to work in the laboratory and greenhouse.

### First Phase

From the beginning of the project, BGCI requested a list of tree species that were considered threatened and that their status be guaranteed by the internationally accepted red lists such as the IUCN Red list and the official Mexican NOM. Given that some of the participants of the project had already produced a list that includes at least 50 species of restricted distribution in Puebla and 26 that have a degree of threat, a list of 15 species was selected and included in this proposal. These species are shown below (Table 1).

Table 1 List of species in danger.

| No. | FAMILY | NAME | Herbario BUAP | Category |
|---|---|---|---|---|
| 1 | Actinidiaceae | *Saurauia villosa* DC. | Yes | IUCN: VU |
| 2 | Adoxaceae | *Viburnum microcarpum* Schltdl. & Cham. | Yes | RLM: VU |
| 3 | Annonaceae | *Cymbopetalum baillonii* R.E. Fr. | HUAP/ MEXU | IUCN: VU |
| 4 | Araliaceae | *Oreopanax flaccidus* Marchal | Yes | RLM: CR |
| 5 | Asparagaceae | *Beaucarnea olsonii* V. Rojas & L.O. Alvarado | Yes | IUCN: CR* |
| 6 | Euphorbiaceae | *Croton rosarianus* Mart. Gord. & Cruz Durán | Yes | RLM: EN |
| 7 | Asparagaceae | *Beaucarnea gracilis* Lem. | Yes | NOM: A |

| | | | | |
|---|---|---|---|---|
| 8 | Zygophyllaceae | *Guaiacum coulteri* A. Gray | Yes | IUCN: LR NOM: A |
| 9 | Melastomataceae | *Conostegia arborea* (Schltdl.) Steud. | HUAP/ MEXU | RLM: EN |
| 10 | Pentaphylacaceae | *Ternstroemia huasteca* B.M. Barthol. | Yes | RLM: EN |
| 11 | Myrtaceae | *Calyptranthes tenuipes* McVaugh** | Yes | RLM: EN |
| 12 | Asparagaceae | *Beaucarnea stricta* Lem. | Yes | NOM: A |
| 13 | Celastraceae | *Quetzalia stipitata* (Lundell) Lundell | Yes | RLM: EN |
| 14 | Euphorbiaceae | *Bernardia macrocarpa* A. Cerv. & Flores Olvera | Yes | RLM: VU |
| 15 | Fabaceae | *Leucaena pueblana* Britton & Rose | MEXU | IUCN:VU |

*Status recommended in the original publication.**Recently transferred to the genus *Myrcia*

## Second Phase: Herbarium – Field work

The University Botanical Garden-BUAP has an internationally recognized Herbarium (HUAP), which has a database in BG- BASE® software. In this database the query was made to know which specimens belong to taxa with some international and/or national risk category. In addition, other taxa were added such as species that were distributed in a maximum of two states apart from Puebla. The collection data are:

1. Risk Status.
2. Collection date.
3. Collector.
4. Municipality.

5. Location.
6. Geographical coordinates.
7. Altitude.
8. Biological description (emphasis on phenology).

To discover more collection sites and complete the phenology of species, we did a review of specimens at other herbaria such as: XAL (Institute of Ecology, Xalapa, Veracruz, Mx), MEXU (National Autonomous University of Mexico, CDMX, Mx, NY (The William and Lynda Steere Herbarium, The New York Botanical Garden), MO (Missouri Botanical Garden), JEPS (Jepson Herbarium, University of California, Berkeley).The Red List of Mexican Cloud Forest Trees was also consulted. The results of these searches are presented in Table 2.

The georeferencing data of the queries made was used to form a table that was uploaded to an account in Google Maps ® to visualize and plot the outputs to the field (Image 1).

For all field work, the necessary institutional administrative procedures were carried out, and the required collection permits were sought.

Table 2 Phenology of endangered and threatened selected species.

| No. | FAMILY | NAME | Herbario BUAP | Category | Fenology | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Jan | Feb | Mar | Apr | May | Jun | July | Aug | Sep | Oct | Nov | Dec |
| 1 | Actinidiaceae | *Saurauia villosa* DC. | Yes | IUCN: VU | | | | | | | | FL | | RIPE | | |
| 2 | Adoxaceae | *Viburnum microcarpum* Schltdl. & Cham. | Yes | RLM: VU | | | | | FL/ UNR | UNR | RIPE | | RIPE | | | |
| 3 | Annonaceae | *Cymbopetalum baillonii* R.E. Fr. | HUAP/ MEXU | IUCN: VU | | UNR | | | FL | FL | | | | | SD | |
| 4 | Araliaceae | *Oreopanax flaccidus* Marchal | Yes | RLM: CR | | | UNR | RIPE/ UNR | | RIPE | FB/ FL/ UNR | FL | | | RIPE | UNR |
| 5 | Asparagaceae | *Beaucarnea olsonii* V. Rojas & L.O. Alvarado | Yes | IUCN: CR | | UNR | | | | | | | | | | |
| 6 | Euphorbiaceae | *Croton rosarianus* Mart. Gord. & Cruz Durán | Not | RLM: EN | | | | | | | | UNRIPE | | | | |
| 7 | Asparagaceae | *Beaucarnea gracilis* Lem. | Yes | NOM: A | | SD | | | | | | | UNR | | | |
| 8 | Zygophyllaceae | *Guaiacum coulteri* A. Gray | Yes | IUCN: LR NOM: A | | | | | | | | | S | | | |

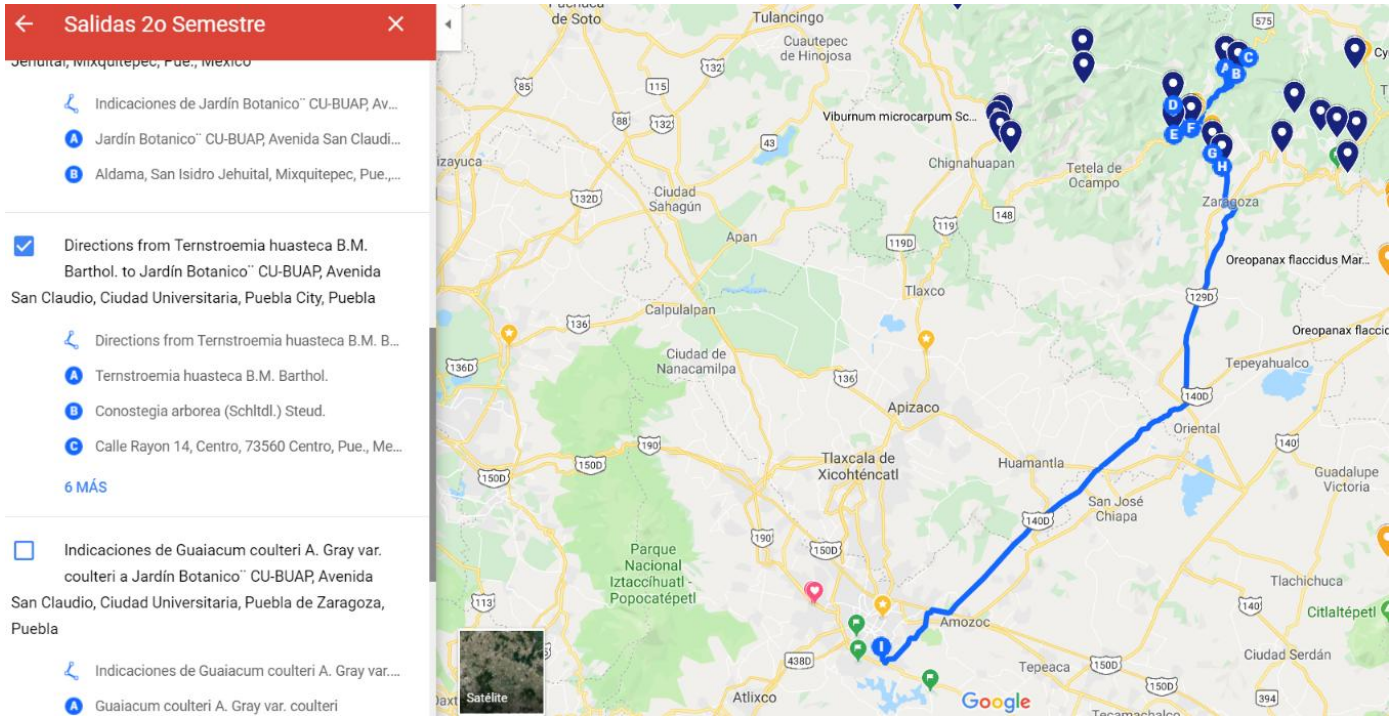
| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9 | Melastomataceae | *Conostegia arborea* (Schltdl.) Steud. | HUAP/ MEXU | RLM: EN | | | | | | FL | | | RIPE | | | | | |
| 10 | Pentaphylacaceae | *Ternstroemia huasteca* B.M. Barthol. | Yes | RLM: EN | FL/ RIPE | | | UNR/ RIPE/ FL | FL | UNR/ RIPE | UNR/ RIPE | FL/ SD | FB | RIPE | FB | | | |
| 11 | Myrtaceae | *Calyptranthes tenuipes* McVaugh | Yes | RLM: EN | | UNR | | | UNR | | | FL | | | UNR/ RIPE | | | |
| 12 | Asparagaceae | *Beaucarnea stricta* Lem. | Yes | NOM: A | | UNR | | | | | UNR/ RIPE | | | RIPE | | | | |
| 13 | Celastraceae | *Quetzalia stipitata* (Lundell) Lundell | Yes | RLM: EN | | | | | | | UNR | | | | | UNR/ RIPE | | |
| 14 | Euphorbiaceae | *Bernardia macrocarpa* A. Cerv. & Flores Olvera | Yes | RLM: VU | | UNR | UNR | RIPE/ UNR | | | | | | | | | | |
| 15 | Fabaceae | *Leucaena pueblana* Britton & Rose | MEXU | IUCN:VU | | | | | | | | | | | FL | | | |

**FL:** flower**; FB:** flower buds**; SD:** seeds**; UNR:** immature seeds**; RIPE:** mature seeds.

**IUCN (Red List of Threatened Species, RLM (The Red List of Mexican Cloud Forest Trees):** Extinct (**EX**), Extinct in the wild (**EW**), Critically Endangered (**CR**), Endangered (**EN**), Vulnerable (**VU**), Near Threatened (**NT**), Minor Concern (**LC**), Insufficient Data (**DD**), No evaluated (**NE**) (species not evaluated for any of the other categories).

**Norma Oficial Mexicana la NOM-059-SEMARNAT-2010:** Probably extinct in the wild (**E**); In danger of extinction (**P**); Threatened (**A**); Subject to special protection (**Pr**).

**Image 1** Example of route planning in Google Maps with data for *Guaiacum coulteri*, *Conostegia arborea* and *Ternstroemia huasteca*



### Third Phase: Laboratory-Greenhouse

All germplasm collected, seeds or cuttings, were taken to the laboratory where they were cleaned and depending on the number of seeds different pre-germinative treatments were proposed. Once they germinated, they were transplanted into a peat-moss compost and placed in the greenhouse.

## RESULTS

### Field exploration (Herbarium and field work).

A total of 11 field trips were made, 4 to the north and 7 to the south of the state of Puebla. On average**,** 2 to 4 species were sought per trip, each of which was from 2 to 4 days, to allow time to explore each area to locate other plants of the species sought. Once the species were located, a return to one of the sites was planned if seeds were not found.

Of the 15 proposed species, 7 species were found: *Saurauia villosa*, *Viburnum microcarpum*, *Cymbopetalum baillonii*, *Oreopanax flaccidus*, *Beaucarnea olsonii*, *Croton rosarianus*, and *Guaiacum coulteri*. Another 3 species not included in the original list were found in the field and are included on lists of threatened plants. These were: *Fouquieria leonilae*, *Pseudosmodingium barkleyi*, and *Podocarpus matudae* spp. *matudae*, they were recognized in the field and the status was checked in NOM-059-SEMARNAT-2010 and/or in the IUCN Red List. Details of the populations and material collected for these species is given In Table 2. From *Viburnum microcarpum*, *Beaucarnea olsonii*, *Guaiacum coulteri*, *Croton rosarianus* and *Pseudosmodingium barkleyi* (5 species) it was possible collect fruits, while from *Saurauia villosa*, *Oreopanax flaccidus*, *Fouquieria leonilae*, *Croton rosarianus* and *Pseudosmodingium barkleyi*, we collected cuttings or plants (5 species), since those of the latter group had no or very few seeds. Annex 1 includes details of herbarium specimens collected.

Table 2 Description of the populations of each species in the field and indication of the type of biological material collected.

| No. | FAMILY | NAME | ABUNDANCE | DESCRIPTION OF THE POPULATIONS IN THE FIELD | BIOLOGICAL MATERIAL OBTAINED | | |
|---|---|---|---|---|---|---|---|
| | | | | | Seeds | Plants | Cuttings |
| 1 | Actinidiaceae | *Saurauia villosa* DC. | Scarce | We found one population with only 6 individuals in an area of 100 m2. The phenological stage was mostly sterile, with one plant flowering and one fruiting. There is no evidence of disturbance. Access to the site and collection: Difficult, because the trees are very high and are in a very stony area, which makes the ground unstable. | NA | NA | 6 |
| 2 | Adoxaceae | *Viburnum microcarpum* Schltdl. & Cham. | Scarce | We found three populations, the first with 3 individuals and the second with 5, in an area of 300 to 500 m2. Phenological state was vegetative and reproductive with mature fruits. There is one seed per fruit, each tree on average can have 60-150 fruits. Fruits were collected from 8 individuals. There is evidence of disturbance due to changes in land use: seasonal agriculture, extensive livestock farming. It is used as a: living fence and as an ornamental. Access to the site and collection: Easy. The third population has around 10 plants from which 7 herbarium specimens were taken, in an approximate area of 500 m2. The phenological state of the majority was reproductive with mature fruits from which seed was collected. There is evidence of disturbance due to the change of land use to homes and cultural centers. | 224 g= c. a. 5487 seeds | NA | NA |
| 3 | Annonaceae | *Cymbopetalum baillonii* R.E. Fr. | Scarce | We found two populations of 10 and two individuals respectively in an area of 30 to 100 m2. The phenological stage was vegetative and reproductive with: immature seeds. There are 7 to 10 seeds per fruit, and each tree can have approximately 100 fruits. There is evidence of disturbance by changing land use and roads. | NA | NA | NA |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | Access to the site: Easy. Harvest: Difficult due to the height of the trees. | | | |
| 4 | Araliaceae | *Oreopanax flaccidus* Marchal | Scarce | We found two populations of three and two individuals respectively in an area of 20 to 60 m2. The phenological state was vegetative. It has an epiphytic habit on *Quercus*, *Podocarpus* and *Pinus*. There is no evidence of disturbance.<br>Access to the site and collection: Medium to difficult, it is distributed in ravines. | NA | NA | 18 |
| 5 | Asparagaceae | *Beaucarnea olsonii* V. Rojas & L.O. Alvarado | Scarce | 25 individuals were found in an area of 500m2, arranged along roadways. The phenological stage was reproductive with immature fruits. It has one seed per fruit and the total number of fruits per infructescence is 130 seeds. It is located in an area disturbed by extensive cattle ranching and land use change due to road widening.<br>Access to the site and collection: Medium to difficult, on a steep slope. | 150 g= c.a. 6500 seeds | NA | NA |
| 6 | Euphorbiaceae | *Croton rosarianus* Mart. Gord. & Cruz Durán | Scarce | We found 20 individuals. The phenological stage was reproductive: flowering and mostly with immature fruits.<br>Access to the site and collection: easy, on the edge of the road. | 3 | NA | 28 |
| 7 | Zygophyllaceae | *Guaiacum coulteri* A. Gray | Scarce | We found two populations of 13 and 6 individuals respectively in an area of 300m2 to 500 m2. The phenological stage was reproductive with: flowering, immature and mature seeds. It has one seed per fruit, each tree can have approx. 300 fruits. Fruits were collected from 7 individuals giving a total of 752 seeds with a weight of 195.2 g. There is evidence of disturbance due to changes in land use: seasonal agriculture, livestock. It is used as a living fence and shade tree.<br>Access to the site and collection: Easy. | 90 g= c.a. 400 seeds | NA | NA |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8 | Euphorbiaceae | *Bernardia macrocarpa* A. Cerv. & Flores Olvera | Not found, due to intense rain and inaccessible road. | | | | |
| 9 | Melastomataceae | *Conostegia arborea* (Schltdl.) Steud. | These were not found. | | | | |
| 10 | Myrtaceae | *Calyptranthes tenuipes* McVaugh | | | | | |
| 11 | Pentaphylacaceae | *Ternstroemia huasteca* B.M. Barthol. | | | | | |
| 12 | Celastraceae | *Quetzalia stipitata* (Lundell) Lundell | | | | | |
| 13 | Fabaceae | *Leucaena pueblana* Britton & Rose | | | | | |
| 14 | Asparagaceae | *Beaucarnea gracilis* Lem. | Collection activities were not carried out, due to the situation of change of government and those responsible for the Protected Natural Areas, the permit was not obtained in time to have access. It will be tried again in January 2019. | | | | |
| 15 | | *Beaucarnea stricta* Lem. | | | | | |
| Especies que se anexaron posteriormente | | | | | | | |
| 16 | Fouquieriaceae | *Fouquieria leonilae* Miranda | Medium | This species was added because it is in the NOM-059-SEMARNAT-2010 in category PR and EN in the IUCN Red List<br>We found 1 population, divided by road. The first group has around 15 individuals. The majority in a vegetative state and only one flowering. From the second group, 70 individuals were observed, 30 adults and 40 juveniles, only two flowering. In the population there is disturbance due to changes in land use due to seasonal crops, housing and the widening of roads. | NA | NA | 22 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | This is the first time that this species is registered for the state of Puebla. | | | |
| 17 | Anacardiaceae | *Pseudosmodingium barkleyi* Miranda | Scarce | This species was added because according to Villaseñor (2016) this species is only known from the state of Guerrero and now we have added Puebla to that list. It seems to have a restricted distribution but has not been evaluated.<br>Two very close populations were observed as in *Fouquieria leonilae* only the highway divides them. The first has around 5 individuals. All in a vegetative state. In the second population 10 individuals were observed, 7 of them fruiting. In both populations there is disturbance due to changes in land use due to seasonal crops, housing and the widening of roads. | 53 g= c.a. 5000 seeds | 2 | 21 |
| 18 | Podocarpaceae | *Podocarpus matudae* Lundell subsp. *matudae* | Scarce | This was added because it is in the NOM-059-SEMARNAT-2010 in category PR and in the IUCN in category VU for the species, therefore, the subsp. *matudae* will also be in the same category or a greater one but has not yet been evaluated.<br>It was collected in 6 different sites, one in the state of Hidalgo on the border with Puebla and the rest within the state of Puebla. There were 1-6 individuals at each site, some with immature fruits and further visits are planned. | NA | NA | NA |
| NA: NOT applicable | | | | | | | |

## Laboratory and Greenhouse work

Of the species that were collected as seed, only 2 species so far have been placed in an incubator without photo period. Table 3 shows treatment by species and results. So far *Guaiacum coulteri* has shown the best germination results. Here is important to mention that the training course was very important to detect the importance of the seeds collection techniques, and the importance of increase the facilities trough the networking establishment (Imagen 2).

**Table 3** Pregerminative treatments

| No. | FAMILY | NAME | TREATMENTS | GERMINATION |
|---|---|---|---|---|
| 1 | Adoxaceae | *Viburnum microcarpum* Schltdl. & Cham. | Control<br>Stratification<br>Physical scarification | Not yet. |
| 2 | Zygophyllaceae | *Guaiacum coulteri* A. Gray | Control<br>Physical scarification<br>Acid scarification | 59 |
| 3 | Euphorbiaceae | *Croton rosarianus* Mart. Gord. & Cruz Durán | Control | Susceptible to fungus causing his death. |

**Imagen 2** Germination and plant of *Guaiacum coulteri*

## CONCLUSION

From the 15 species targeted in this project plus 3 added later, germplasm of 10 species was the collected. In some cases the amount of seed was very scarce, but in other species it was possible to collect a good number of seeds. The reasons for this result were several: First: the herbarium records dated from the 1990s, most of which did not give any certainty that they were found in the field due to the change in land use for housing, crops or roads and therefore fragmentation of the area. Second: because of the bad weather (torrential rains), which did not allow exploration because it hindered access to the sites. Third: it was difficult to collect from some species as the trees were very large and specialist equipment and training would be needed to climb trees. Fourth: the phenology of the seeds was unknown, or the trees did not have fruit production this year.

However, we are very pleased to have the first record for the state of Puebla for *Fouquieria leonilae*. The finding of another locality for this rare species greatly increases its chance of survival. Also, additional locations for other species will make them easier to locate and to collect seed in the future.

It is essential to continue with the location of species that could not be found in the field and return to the sites of species such as *Croton rosarianus* that only has one location in Puebla. In the case of *Saurauia villosa*, C*ymbopetalum baillonii* and *Oreopanax flaccidus* it was observed that here in the state of Puebla the populations are small and further exploration may increase their known distribution. An important case is *Beaucarnea olsonii* which is in danger of being severely damaged by the widening of a road, currently the only known locations for this recently described species are along this road.

Undoubtedly, this project has been a very important initiative supported by BGCI and the course showed the importance of capacity building. We are willing to carry on with the long term seed collection skills acquired during the training workshop and continue working with other BG in Mexico according to the Action Plan derived from that course. Networking is invaluable if we want to have an impact on tree conservation.

## Annex I Herbarium specimens

| ID | FAMILY | NAME | MUNICIPIO | LOCALITY | LATITUDE | LONGITUDE | ALTITUDE | DATE | VEGETATION |
|---|---|---|---|---|---|---|---|---|---|
| 78074 | ASPARAGACEAE | Beaucarnea olsonii V. Rojas & L.O. Alvarado | Acatlán | 4.5 km al W de localidad Nuevos Horizontes, sobre carretera Internacional. | 18.22822 | -98.16816 | 1,252 | 7 Aug 2018 | Selva baja caducifolia |
| 78082 | ASPARAGACEAE | Beaucarnea olsonii V. Rojas & L.O. Alvarado | Acatlán | 4.5 km al W de localidad Nuevos Horizontes, sobre carretera Internacional. | 18.22866 | -98.16708 | 1,255 | 7 Aug 2018 | Selva baja caducifolia |
| 78278 | ASPARAGACEAE | Beaucarnea olsonii V. Rojas & L.O. Alvarado | Acatlán | 4.3 km al W de Nuevos Horizontes, sobre carretera | 18.22833 | -98.1678 | 1,342 | 23-Nov-18 | Bosque tropical caducifolio. |
| 78279 | ASPARAGACEAE | Beaucarnea olsonii V. Rojas & L.O. Alvarado | Acatlán | 4.3 km al W de Nuevos Horizontes, sobre carretera | 18.2283 | -98.16791 | 1,341 | 23-Nov-18 | Bosque tropical caducifolio. |
| 78280 | ASPARAGACEAE | Beaucarnea olsonii V. Rojas & L.O. Alvarado | Acatlán | 4.3 km al W de Nuevos Horizontes, sobre carretera | 18.22836 | -98.168 | 1,333 | 23-Nov-18 | Bosque tropical caducifolio. |
| 78276 | FOUQUIERIACEAE | Fouquieria leonilae Miranda | Jolalpan | Entrada de calle la Unión al NE de Jolalpan | 18.32825 | -98.83644 | 907 | 28-Nov-18 | Bosque tropical caducifolio asociado a matorral |
| 78277 | FOUQUIERIACEAE | Fouquieria leonilae Miranda | Jolalpan | Entrada de calle la Unión al NE de Jolalpan | 18.33022 | -98.83727 | 908 | 28-Nov-18 | Bosque tropical caducifolio asociado a matorral |
| 78267 | FOUQUIERIACEAE | Fouquieria leonilae Miranda | Jolalpan | Al N de localidad Jolalpan, lado N de carretera | 18.3325 | -98.83588 | 910 | 29-Nov-18 | Bosque tropical caducifolio asociado a matorral |
| 78067 | ZYGOPHYLLACEAE | Guaiacum coulteri A. Gray | Tehuitzingo | Loc. Tehuitzingo, esquina calle La presa y calle 2 de abril. | 18.33105 | -98.269 | 1,240 | 7 Aug 2018 | En Jardín de casa |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 78085 | ZYGOPHYLLACEAE | Guaiacum coulteri A. Gray | Guadalupe | Sobre camino, 5.4 km al S de Guadalupe | 18.0495 | -98.13525 | 1,233 | 8 Aug 2018 | Matorral perturbado |
| 78091 | ZYGOPHYLLACEAE | Guaiacum coulteri A. Gray | Guadalupe | Sobre camino, 5.4 km al S de Guadalupe | 18.04975 | -98.136 | 1,267 | 8 Aug 2018 | Matorral perturbado |
| 78099 | ZYGOPHYLLACEAE | Guaiacum coulteri A. Gray | Guadalupe | Sobre camino, 5.4 km al S de Guadalupe | 18.06066 | -98.13491 | | 8 Aug 2018 | Matorral perturbado |
| 78110 | ZYGOPHYLLACEAE | Guaiacum coulteri A. Gray | Guadalupe | Sobre camino, 5.4 km al S de Guadalupe | 18.0605 | -98.13575 | | 8 Aug 2018 | Matorral perturbado |
| 78112 | ZYGOPHYLLACEAE | Guaiacum coulteri A. Gray | Guadalupe | Sobre camino, 5.4 km al S de Guadalupe | 18.0605 | -98.13586 | | 8 Aug 2018 | Matorral perturbado |
| 78113 | ZYGOPHYLLACEAE | Guaiacum coulteri A. Gray | Guadalupe | Sobre camino, 5.4 km al S de Guadalupe | 18.06044 | -98.13566 | | 8 Aug 2018 | Matorral perturbado |
| 78249 | ARALIACEAE | Oreopanax flaccidus Marchal | Huauchinango | 190 al E de Teopancingo | 20.09602 | -98.05533 | 2,327 | 20-Sep-18 | Bosque mesófilo de montaña |
| 78250 | ARALIACEAE | Oreopanax flaccidus Marchal | Huauchinango | 190 al E de Teopancingo | 20.09561 | -98.05455 | 2,329 | 20-Sep-18 | Bosque mesófilo de montaña |
| 78252 | ARALIACEAE | Oreopanax flaccidus Marchal | Huauchinango | 190 al E de Teopancingo | 20.09875 | -98.0568 | 2,301 | 20-Sep-18 | Bosque mesófilo de montaña |
| 77436 | PODOCARPACEAE | Podocarpus matudae Lundell ssp. matudae | Acaxochitlán, HGO. | Al E de La Boveda | 20.12394 | -98.12077 | 2,159 | 23 Apr 2018 | Bosque de encino |
| 77542 | PODOCARPACEAE | Podocarpus matudae Lundell ssp. matudae | Huauchinango | 220 m al NE de Capilla Teopancingo | 20.09786 | -98.05897 | 2,317 | 20-Jun-18 | Bosque de encino asociado a Podocarpus |
| 77543 | PODOCARPACEAE | Podocarpus matudae Lundell ssp. matudae | Huauchinango | Al NE de Capilla Teopancingo | 20.09747 | -98.05733 | 2,318 | 20-Jun-18 | Bosque de encino asociado a Podocarpus |
| 77546 | PODOCARPACEAE | Podocarpus matudae Lundell ssp. matudae | Huauchinango | 700 m al NW de Xilocuautla | 20.14294 | -98.02472 | 1,634 | 20-Jun-18 | Manchon de nosque a orilla de camino |
| 78063 | PODOCARPACEAE | Podocarpus matudae Lundell ssp. matudae | Huauchinango | 4.1 km sobre camino al SW de Xilocuautla | 20.1253 | -98.03933 | 1,779 | 20-Jun-18 | Bosque Mesólfilo de montaña |
| 78114 | PODOCARPACEAE | Podocarpus matudae Lundell ssp. matudae | Huauchinango | | . | . | | 18-Sep-18 | |
| 78115 | PODOCARPACEAE | Podocarpus matudae Lundell | Huauchinango | Al NE de Venta Grande | 20.12186 | -98.09161 | 2,101 | 18-Sep-18 | Bosque de encino |

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| | | ssp. matudae | | | | | | | |
| 78116 | PODOCARPACEAE | Podocarpus matudae Lundell ssp. matudae | Huauchinango | Al NE de Venta Grande | 20.12455 | -98.08908 | 2,103 | 18-Sep-18 | Bosque de encino |
| 78251 | PODOCARPACEAE | Podocarpus matudae Lundell ssp. matudae | Huauchinango | Al NE de Teopancingo | 20.0983 | -98.05641 | 2,281 | 20-Sep-18 | Bosque de encino |
| 78153 | PODOCARPACEAE | Podocarpus matudae Lundell ssp. matudae | Xicotepec | Rancho "Los Quince". A 145 m al N de la casa principal. | 20.25197 | -97.96975 | 1,131 | 14-Nov-18 | Bosque Mesófilo de Montaña (perturbado |
| 78274 | ANACARDIACEAE | Pseudosmodingium barkleyi Miranda | Jolalpan | Entrada de calle la Unión al NE de Jolalpan | 18.32988 | -98.83644 | 910 | 28-Nov-18 | Bosque tropical caducifolio asociado a matorral |
| 78275 | ANACARDIACEAE | Pseudosmodingium barkleyi Miranda | Jolalpan | Entrada de calle la Unión al NE de Jolalpan | 18.33033 | -98.83636 | 910 | 28-Nov-18 | Bosque tropical caducifolio asociado a matorral |
| 78263 | ANACARDIACEAE | Pseudosmodingium barkleyi Miranda | Jolalpan | Al N de localidad Jolalpan, lado N de carretera | 18.33313 | -98.83588 | 923 | 29-Nov-18 | Bosque tropical caducifolio asociado a matorral |
| 78264 | ANACARDIACEAE | Pseudosmodingium barkleyi Miranda | Jolalpan | Al N de localidad Jolalpan, lado N de carretera | 18.33272 | -98.8358 | 918 | 29-Nov-18 | Bosque tropical caducifolio asociado a matorral |
| 78265 | ANACARDIACEAE | Pseudosmodingium barkleyi Miranda | Jolalpan | Al N de localidad Jolalpan, lado N de carretera | 18.33313 | -98.8358 | 920 | 29-Nov-18 | Bosque tropical caducifolio asociado a matorral |
| 78266 | ANACARDIACEAE | Pseudosmodingium barkleyi Miranda | Jolalpan | Al N de localidad Jolalpan, lado N de carretera | 18.33263 | -98.83588 | 810 | 29-Nov-18 | Bosque tropical caducifolio asociado a matorral |
| 78268 | ANACARDIACEAE | Pseudosmodingium barkleyi Miranda | Jolalpan | Al N de localidad Jolalpan, lado N de carretera | 18.3325 | -98.83588 | 910 | 29-Nov-18 | Bosque tropical caducifolio asociado a matorral |

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| 78269 | ANACARDIACEAE | Pseudosmodingium barkleyi Miranda | Jolalpan | Al N de localidad Jolalpan, lado N de carretera | 18.33258 | -98.83597 | 913 | 29-Nov-18 | Bosque tropical caducifolio asociado a matorral |
| 78270 | ANACARDIACEAE | Pseudosmodingium barkleyi Miranda | Jolalpan | Al N de localidad Jolalpan, lado N de carretera | 18.33247 | -98.83613 | 917 | 29-Nov-18 | Bosque tropical caducifolio asociado a matorral |
| 78271 | ANACARDIACEAE | Pseudosmodingium barkleyi Miranda | Jolalpan | Al N de localidad Jolalpan, lado N de carretera | 18.33241 | -98.83625 | 914 | 29-Nov-18 | Bosque tropical caducifolio asociado a matorral |
| 78272 | ANACARDIACEAE | Pseudosmodingium barkleyi Miranda | Jolalpan | Al N de localidad Jolalpan lado S de carretera | 18.33208 | -98.83622 | 897 | 29-Nov-18 | Bosque tropical caducifolio asociado a matorral |
| 78273 | ANACARDIACEAE | Pseudosmodingium barkleyi Miranda | Jolalpan | Al N de localidad Jolalpan lado S de carretera | 18.33197 | -98.83616 | 904 | 29-Nov-18 | Bosque tropical caducifolio asociado a matorral |
| 78257 | ACTINIDIACEAE | Saurauia villosa DC. | Coyomeapan | 1.6 km al NE de Xochiapa por camino de terracería en dirección de Tecuanipa | 18.24333 | -96.91433 | 1,722 | 17-Oct-18 | Bosque mesófilo de montaña |
| 78258 | ACTINIDIACEAE | Saurauia villosa DC. | Coyomeapan | 1.6 km al NE de Xochiapa por camino de terracería en dirección de Tecuanipa | 18.24325 | -96.91419 | 1,721 | 17-Oct-18 | Bosque mesófilo de montaña |
| 78259 | ACTINIDIACEAE | Saurauia villosa DC. | Coyomeapan | 1.6 km al NE de Xochiapa por camino de terracería en dirección de Tecuanipa | 18.24319 | -96.914 | 1,717 | 17-Oct-18 | Bosque mesófilo de montaña |
| 78260 | ACTINIDIACEAE | Saurauia villosa DC. | Coyomeapan | 1.6 km al NE de Xochiapa por camino de terracería en | 18.24333 | -96.91405 | 1,722 | 17-Oct-18 | Bosque mesófilo de montaña |

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| | | | | dirección de Tecuanipa | | | | | |
| 78261 | ACTINIDIACEAE | Saurauia villosa DC. | Coyomeapan | 1.6 km al NE de Xochiapa por camino de terracería en dirección de Tecuanipa | 18.24344 | -96.91405 | 1,728 | 17-Oct-18 | Bosque mesófilo de montaña |
| 78262 | ACTINIDIACEAE | Saurauia villosa DC. | Coyomeapan | 1.5 km al S de Xochiapa | 18.23436 | -96.93275 | 1,625 | 17-Oct-18 | Bosque mesófilo de montaña |
| 77330 | ADOXACEAE | Viburnum microcarpum Schltdl. & Cham. | Zacapoaxtla | Apulco, a 4 km de carretera en dirección de parque ecoturistico "El Chamoral", a orilla de camino | 19.90161 | -97.63283 | 1,490 | 23 Aug 2018 | Bosque de encino - pino, a orilla de camino |
| 77334 | ADOXACEAE | Viburnum microcarpum Schltdl. & Cham. | Zacapoaxtla | Camino de terracería, en zona N de Instituto Tecnológico de Zacapoaxtla | 19.83505 | -97.57272 | 2,076 | 23 Aug 2018 | Bosque de Encino - Pino |
| 77335 | ADOXACEAE | Viburnum microcarpum Schltdl. & Cham. | Zacapoaxtla | Camino de terracería, en zona N de Instituto Tecnológico de Zacapoaxtla | 19.8348 | -97.57216 | 2,088 | 23 Aug 2018 | Bosque de Encino - Pino |
| 78248 | ADOXACEAE | Viburnum microcarpum Schltdl. & Cham. | Huauchinango | 50 m al SW de Hotel Daarlu | 20.15875 | -98.08405 | 1,858 | 20-Sep-18 | Bosque de encino con elementos de mesófilo |
| 78253 | ADOXACEAE | Viburnum microcarpum Schltdl. & Cham. | Huauchinango | San pedro Xoloco, al S de Teziutlán | 19.79786 | -97.36005 | 2,049 | 20-Sep-18 | Bosque mesófilo de montaña |
| 78254 | ADOXACEAE | Viburnum microcarpum Schltdl. & Cham. | Huauchinango | San Pedro Xoloco, al S de Teziutlán | 19.79786 | -97.36005 | 2,049 | 27-Sep-18 | Bosque mesófilo de montaña |
| 78240 | ADOXACEAE | Viburnum microcarpum Schltdl. & Cham. | Teziutlán | Barrio de Coaxoxpan, al S de Teziutlán | 19.78883 | -97.35566 | 2,098 | 2 Oct 2018 | Bosque de encino |
| 78241 | ADOXACEAE | Viburnum microcarpum | Teziutlán | Barrio de Coaxoxpan, al S de Teziutlán | 19.7888 | -97.35583 | 2,090 | 2 Oct 2018 | Bosque de encino |

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| | | Schltdl. & Cham. | | | | | | | |
| 78242 | ADOXACEAE | Viburnum microcarpum Schltdl. & Cham. | Teziutlán | Barrio de Coaxoxpan, al S de Teziutlán | 19.78886 | -97.35588 | 2,087 | 2 Oct 2018 | Bosque de encino |
| 78243 | ADOXACEAE | Viburnum microcarpum Schltdl. & Cham. | Teziutlán | Barrio de Coaxoxpan, al S de Teziutlán | 19.78844 | -97.35569 | 2,087 | 2 Oct 2018 | Bosque de encino |
| 78255 | ADOXACEAE | Viburnum microcarpum Schltdl. & Cham. | Teziutlán | Barrio de Coaxoxpan, al S de Teziutlán | 19.78866 | -97.35569 | 2,148 | 2 Oct 2018 | Bosque de encino |
| 78256 | ADOXACEAE | Viburnum microcarpum Schltdl. & Cham. | Teziutlán | Barrio de Coaxoxpan, al S de Teziutlán | 19.78883 | -97.35572 | 2,095 | 2 Oct 2018 | Bosque de encino |
| 78244 | ADOXACEAE | Viburnum microcarpum Schltdl. & Cham. | Teziutlán | 1.6 km al SE de San Salvador | 19.8268 | -97.32494 | 1,823 | 3 Oct 2018 | Bosque de encino |
| 78245 | ADOXACEAE | Viburnum microcarpum Schltdl. & Cham. | Teziutlán | 1.6 km al SE de San Salvador | 19.82702 | -97.32466 | 1,828 | 3 Oct 2018 | Bosque de encino |
| 78246 | ANNONACEAE | Cymbopetalum baillonii R.E. Fr. | Hueytamalco | 3.7 km al W de Campo experimental Las Margaritas, sobre camino. | 19.99511 | -97.32275 | 560 | 4 Oct 2018 | Selva mediana subperennifolia |
| 78247 | ANNONACEAE | Cymbopetalum baillonii R.E. Fr. | Hueytamalco | 3.7 km al W de Campo experimental Las Margaritas, sobre camino. | 19.9938 | -97.31961 | 573 | 4 Oct 2018 | Selva mediana subperennifolia |
| 77289 | EUPHORBIACEAE | Croton rosarianus Mart.Gord. & Cruz Durán | Cuetzalan del Progreso | 100 m al SE de Finca El Rosario | 20.00969 | -97.47636 | 828 | 22 Aug 2018 | Bosque Mesólfilo de Montaña |

## Annex II Photos and description of the selected species.

| No. | FAMILY | NAME | DESCRIPTION | PHOTO |
|---|---|---|---|---|
| 1 | Actinidiaceae | *Saurauia villosa* DC. | Tree or shrub up to 6 m high, densely hairy. Leaves clustered at the apex of the branches obovate to elliptic-obovate. The beam smooth to sparsely scabrous, pubescent, thicker in the nerves. Inflorescence clustered. Fruit a globose berry. |  |
| 2 | Adoxaceae | *Viburnum microcarpum* Schltdl. & Cham. | Bush or tree 3-8 m tall; stems with opposite branches. Leaves with petioles, with stellate hairs, the leaf underside with dense, white pubescence, of sessile and stellate trichomes. Inflorescence terminal, umbeliforme three times compound, Fruit an ellipsoidal drupe, 3-4 mm long, ellipsoid seed. |  |

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| 3 | Annonaceae | *Cymbopetalum baillonii* R.E. Fr. | Tree 4-20 m high. Stems puberulous, glabrescent. Leaves oblong to elliptical, chartaceous to subcorceous. Fruit and seed: elongated and curved follicle, like a banana. It measures approximately 6 to 9 cm long by 3 to 5 cm wide. When ripe, open halfway. The seeds are black, a little flattened, and covered by a yellow aril. |  |
| 4 | Araliaceae | *Oreopanax flaccidus* Marchal | Tree or shrub, epiphytic, 6-8 m tall. Leaves simple, ovate, slightly coriaceous, the underside densely pubescent. Racemose-capitate inflorescence. Fruit more or less globose, sparsely pubescent, 5-7 fruits per head; seeds 23 mm long, 4 · 5 per fruit. |  |

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| 5 | Asparagaceae | *Beaucarnea olsonii* V. Rojas & L.O. Alvarado | Arborescent plant, hermaphrodite, dioecious, 3 to 5 m high, with massively swollen bases. Gray and scaly bark forming irregular grooves along the stem. Evergreen leaves. Inflorescence racemose and cimosas. One seed per fruit, immature, brown, rough seed. |  |
| 6 | Euphorbiaceae | *Croton rosarianus* Mart. Gord. & Cruz Durán | Tree 3-8 m, monoecious, young hispid stems; indument of stellate trichomes Alternate, subcoriaceous leaves, generally opposite or whorled at the base of the inflorescences. Inflorescences in terminal clusters. Fruit an ovoid-spherical capsule, 1.2-1.4 cm, glabrescent. Seeds one per fruit lobed, smooth, brown; prominent, yellow caruncle. |  |
| 7 | Zygophyllaceae | *Guaiacum coulteri* A. Gray | Shrub or tree from 1 to 12 meters high. Opposite leaves or crowded in spur buds. Bright purple flowers occurs singly or in small groups in leaf axils. Fruit: rounded capsule, bright, reddish brown, flattened with 2 to 4 lobes. |  |

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| 8 | Fouquieriaceae | *Fouquieria leonilae* Miranda | Shrubby or small tree 2-4 m tall. Bark light bronze color, thin, soft, exfoliating in thin sheets, translucent. Inflorescence racemose, flowers red. Cinnamon-colored capsules. Seeds 3-6, whitish. |  |
| 9 | Anacardiaceae | *Pseudosmodingium barkleyi* Miranda | Deciduous tree 3-4 m. high, with thick branches of red bark. Leaves pinnate, clustered the apex of the branches. Inflorescences pubescent except pedicels and flowers, Fruit broadly winged, glabrous, 6 mm long and 8-9 mm wide. |  |
| 10 | Podocarpaceae | *Podocarpus matudae* Lundell subsp. *matudae* | Evergreen tree up to 30 m tall. Leaves alternate, simple, lanceolate, rigid, coriaceous. Seed solitary, pedunculate. |  |

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