

Theme: Environment: Ecology and Environmental Concerns

Mexican national living bamboo collection *ex situ* conservation

Ma. Teresa Mejia-Saulés and Rogelio Macías Ordóñez

Instituto de Ecología A.C. Carretera antigua a Coatepec 351, El Haya, Xalapa, Ver. 91070 México.
email: teresa.mejia@inecol.mx rogelio.macias@inecol.mx

In the Americas, the highest bamboo diversity and endemism is found in Brazil, the northern and central Andes, Mexico and Central America. In 2003, there were 40 native species of bamboos described for Mexico in eleven bamboo genera. Recent work has brought this number to 56 species. More than the half (34) of the Mexican bamboo species are endemic. The Mexican bamboos grow in tropical dry and perennial forests, mixed pine-oak and pine-fire forests, pine forests, and cloud forests from sea level to 3,000 m elevation. Genera of described Mexican woody bamboos species (and spp number) are: *Arthrostylidium*(1), *Aulonemia*(1), *Chusquea*(22), *Guadua*(7), *Merostachys* (1), *Olmeca*(5), *Oatea*(11), *Rhipidocladum*(4). Herbaceous genera are *Cryptochloa*(1), *Lithachne*(1), *Olyra*(2). Many of them have a diversity of rustic uses such as material for roofs or walls, furniture, fences, baskets, walking sticks, handicrafts, beehives, agricultural tools as well as ornamental plants.

Live collections at the Botanical Gardens that preserve plant genetic resources are curated for various purposes including scientific education and research. The Francisco Javier Clavijero Botanical Garden at the Instituto de Ecología, in Xalapa, Mexico, houses the Mexican national living bamboo collection. It was established in 2003 with the collaborative support of INECOL, Bamboo of the Americas, and the Instituto Tecnológico de Chetumal for the *ex situ* conservation of Mexican bamboo diversity, research and education. There is a current effort to have all of the described species present in the collection. As of January 2018, 47 of the 56 described species are present, some of which have been challenging to cultivate due to requirement for special environmental conditions. By the date this talk is presented we expect to report that all described species are present in the collection.

Introduction

In the Americas, a great diversity of bamboo endemic species is found in Brazil, North and Central Andes, Mexico and Central America. In 2003, Mexico was represented by eleven genera and 40 species of native bamboos of which 13 were recorded as endemic (Cotes, 2000; Clark and Cortes, 2004). With recent studies, the list of species has increased to 56, of which more than half (34) are endemic.

Mexican bamboo species are found in tropical areas and temperate forests, mixed forests of oak and spruce, and cloud forest, from the sea level up to the high mountains over 3000 m of altitude. Native bamboos are found mainly in the States of Chiapas, Oaxaca, Veracruz, Guerrero and Jalisco. The genera of woody bamboos described for Mexico (and number of species) are: *Aulonemia*(1), *Arthrostylidium*(1), *Chusquea*(22), *Guadua*(7), *Merostachys* (1), *Olmeca*(5), *Oatea*(11), *Rhipidocladum*(4). The herbaceous genera are: *Cryptochloa*(1), *Lithachne*(1), *Olyra*(2). Many of these species are used for the manufacture of ceilings or walls, furniture, fences, baskets, poles, crafts, beehives, agricultural tools as well as ornamental plants

In 2003 the Mexican bamboo knowledge was scarce with only a few botanical descriptions of species as well as the taxonomic revision of bamboos in Veracruz and Jalisco (Cortes 1982; Anaya 1989), regional uses (Mejia-Saules and Campos, 1996; Ordoñez, 1999) or publications which included some species of bamboos (Vela *et al* 1976; Mejia-Saules and Davila 1992, Davila *et al.* 2006).

The habitat of bamboo and other plant species is being destroyed every day by factors such as excessive collection, agriculture, urbanization, pollution, introduction of exotic species and climate change, among others. Concern on bamboo conservation and knowledge of the Mexican species resulted in an institutional effort that resulted in the project "The native bamboos of Mexico". This collection was established at the Botanical Garden "Francisco Javier Clavijero", of the Instituto de Ecología A.C. (INECOL), a botanical garden located in the region of the mountain cloud forest and recognized both nationally and internationally which would provide the right conditions for the establishment of the majority of the Mexican bamboos. Participating institutions and agencies were: Instituto Tecnológico de Chetumal (ITCh), Bamboos of the Americas (BOTA) and INECOL. The Mexican national living bamboo collection would host live specimens of woody and herbaceous bamboo species, promoting education, research and preservation of genetic resources.

Conservation of species outside their natural habitat (*ex situ*) is part of the actions and activities of botanical gardens. Therefore the collection of native bamboos is within the framework of the global strategy for plant conservation (CONABIO 2012; CBD 2012). This strategy seeks to understand, explain, preserve and use species diversity in a sustainable manner. Education and awareness about the diversity of species and capacity-building for the conservation of this diversity are also promoted. These strategies have been adopted by the Mexican national living bamboo collection.

The Mexican national living bamboo collection has been a platform for the study and conservation of several bamboo native species, the description of many new species, and implementation of new potential uses and propagation techniques both in traditional nurseries and *in vitro*. Along these lines, training of human resources at the technical, undergraduate and graduate level has also been a priority.

Materials and methods

Collection of specimens has been carried out following standard techniques for live and herborized botanical material. Full collection data is stored in electronic databases and include collection date, precise coordinates, locality name, collectors, date, relevant ecological information such as soil and vegetation type. Live specimens used to be planted in flower pots under greenhouse conditions, but recently we have tried to plant at least one specimen directly on soil in exhibition areas as they arrive from field collecting trips. All specimens are individually tagged with record numbers that are also included in the database. The collections have been conducted mainly in the States of Chiapas, Guerrero, Michoacán, Morelos, Oaxaca, and Veracruz.

Most collected material has been identified based on morphological characteristics and using some of the available keys. However, many of the collections have resulted in new species descriptions (see Results).

Curatorial activities –Herborized material collected has been mounted and labelled to be included to the Herbarium (XAL) of the INECOL, UNAM (MEXU), Politécnico Nacional (ENCB), Chapingo (CHAPA) and herbaria from abroad as the National herbarium of USA (US), the Iowa (ISC), the New York (NY), Missouri (MO) herbaria, etc.

Results

With the collection of botanical material, taxonomy and molecular phylogeny studies have been carried out describing several new species (Ruiz-Sanchez *et al.*, 2011a, 2011b, 2014a, 2014b, 2015, 2017, 2018; Ruiz-Sanchez, 2012, 2013; Ruiz-Sanchez and Clark, 2013; Londoño and Ruiz-Sanchez, 2014). Currently 56 species of woody (Figures 1, 2, 3) and herbaceous native bamboos have been described, more than half (34 species) are endemic to Mexico (Figures 2, 3, 4). By the date this manuscript is being submitted, the collection has 47 of these species present. We are making an effort to have all 56 described species (Table 1) (plus 3 still undescribed) represented in the Mexican national living bamboo collection by the time of the WBC Congress.

Research studies that have developed at INECOL include: physical and mechanical properties of the Mexican guaduas (Figure 4), study on anatomy of the species of *Guadua*, study on insects associated with bamboo, asexual propagation of "chiquian" (*Rhipidocladum racemiflorum*) (Figure 6), vegetative propagation and germination in *Otatea acuminata*, germination in *Lithachne pauciflora*, uses of bamboo in Cuetzalan (Figure 7) and Monte Blanco, traditional uses of the *Guadua aculeata*, conservation of *Chusquea enigmatica* and *Chusquea bilimekii*, taxonomic and phylogenetic-molecular studies of genus *Otatea* and the management sustainable of the chiquian in coffee plantation (see reference list).

References

- Anaya, C. M. C. 1989. Estudio de la subfamilia Bambusoideae (Poaceae) con revisión taxonómica para el estado de Jalisco. Tesis de Licenciatura, Ingeniero Agrónomo. Facultad de Agronomía, Universidad de Guadalajara, Las Ahujas, Jalisco.
- Clark, L.G. and Cortés, G.R. 2004. A new species of *Otatea* from Chiapas, Mexico. *Bamboo Science & Culture. Journal of the American Bamboo Society*. 18, 1-6.
- CONABIO (Comisión Nacional para el Conocimiento y Uso de la Biodiversidad). 2012. Estrategia Mexicana para la Conservación Vegetal, 2012-2030. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad, México, D.F.
- CBD (Convention on Biological Diversity). 2012. Global strategy for Plant Conservation: 2011-2012, Botanic Gardens Conservation International, Richmond, U.K.
- Cortés, R. G. 1982. Revisión taxonómica de los bambusoides leñosos (Gramineae: Bambusoideae) del Estado de Veracruz. Tesis de Licenciatura. Facultad de Ciencias Biológicas. Universidad Veracruzana, Xalapa, Ver.
- Cortés, R. G. 2000. Los Bambúes nativos de México. *Biodiversitas* 30, 12-15.
- Dávila, P.M.; T. Mejía-Saulés, M.T.; Gómez-Sánchez, M.; Valdés-Reyna, J.; Ortíz, J.J.; Morín, C.; Castrejón, J. y Ocampo, A. 2006. Catálogo de Gramíneas de México. Universidad Nacional Autónoma de México (UNAM) y Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO). México, D.F.

- Londoño, X. and Ruiz-Sanchez. 2014. *Guadua tuxtensis* (Poaceae: Bambusoideae: Bambuseae: Guaduiniae): an overlooked new species from Los Tuxtlas region, Veracruz, Mexico. *Botanical Sciences*. 92. 481-488.
- Mejía-Saulés, M. T. y Dávila-Aranda, P. 1992. Gramíneas Útiles de México. Cuadernos No. 16. Instituto de Biología, UNAM. México, D. F.
- Mejía-Saulés, M. T. y Castillo-Campos, G. 1996. Bamboos. A natural resource in Monte Blanco, Mexico. *Temperate Bamboo Quarterly* 2 (3-4), 86-93.
- Ordóñez, V. R. 1999. Perspectivas del bambú para la construcción en México. *Madera y Bosques* 5(1), 3-12.
- Ruiz-Sanchez, E. 2012. A new species of *Otatea* (Poaceae: Bambusoideae: Bambuseae) from Queretaro, Mexico. *Acta Botánica Mexicana* 99, 21–29.
- Ruiz-Sanchez, E. 2013a. *Otatearamirezii* (Poaceae: Bambusoideae: Bambuseae) flower description and the importance of the Mexican national living bamboo collection. *Phytotaxa* 150, 54–60.
- Ruiz-Sanchez, E.; Castro-Castro, A.; Clark, L.G. 2017. *Chusqueaseptentrionalis* sp. nov. (Poaceae: Bambusoideae) from the Madrean region in Durango, Mexico. *Nordic Journal of Botany* 35 (5), 546-551.
- Ruiz-Sanchez, E.; Clark, L.G. 2013b. Two new species of *Chusquea* (Poaceae: Bambusoideae: Bambuseae) from Mexico, one of them morphologically unusual, and a key to the Mexican sections of *Chusquea*. *Phytotaxa* 92, 1–12.
- Ruiz-Sanchez, E.; Clark, L.G.; Mejía-Saulés, M.T.; Lorea, F. 2018. A new species of *Merostachys* (Poaceae: Bambusoideae: Bambuseae: Arthrostylidiinae) with the northernmost distribution of the genus. *Phytotaxa* 344, 31-38.
- Ruiz-Sanchez, E.; Sosa, V.; Mejía-Saulés, M.T. 2011a. Molecular phylogenetics of the Mesoamerican bamboo *Olmea* (Poaceae: Bambuseae): Implications for taxonomy. *Taxon* 60, 89–98.
- Ruiz-Sanchez, E.; Sosa, V., Mejía-Saulés, M.T.; Londoño, X. and Clark, L.G. 2011b. A taxonomic revision of *Otatea* (Poaceae: Bambusoideae: Bambuseae) including four new species. *Systematic Botany* 36, 314–336.
- Ruiz-Sanchez, E.; Mejía-Saulés, M.T.; Clark, L.G. 2014a. A new endangered species of *Chusquea* (Poaceae: Bambusoideae) from the Acatlán volcano in central Veracruz, Mexico, and keys to the Mexican *Chusquea* species. *Phytotaxa* 163, 16–26.
- Ruiz-Sanchez, E.; Mejía-Saulés, M.T.; Clark, L.G. 2014b. *Chusqueanedjaquithii* (Poaceae: Bambusoideae, Bambuseae, Chusqueinae), a new endemic species from Oaxaca, Mexico. *Phytotaxa* 184, 23-30

Ruiz-Sanchez, E.; Mejía-Saulés, M.T.; Cortes, G.; Clark, L.G. 2015. *Chusqueagibcooperi* (Poaceae: Bambusoideae: Bambuseae: Chusqueinae), a new species endemic to Mexico. *Brittonia* 67 (3), 227-232.

Vela, G. L.; Boyas, J. y García, F. 1976. Los Bambúes. *Boletín Técnico. Instituto Nacional de Investigaciones Forestales* 50, 1-38.

Table 1. List of Mexican bamboo species

Species	Endemic	Woody (W) or Herbaceous (H) bamboos	Species in exhibition in the collection	Species in nursery in the collection
1. <i>Arthrostylidium excelsum</i>		W	√	√
2. <i>Aulonemia laxa</i>	√	W	√	√
3. <i>Chusquea aperta</i>	√	W		
4. <i>Chusqueabilimekii</i>	√	W		√
5. <i>Chusqueacircinata</i>	√	W	√	
6. <i>Chusqueacoronalis</i>		W		
7. <i>Chusqueacortesii</i>		W		√
8. <i>Chusqueaenigmatica</i>	√	W	√	√
9. <i>Chusqueagaleottiana</i>	√	W		
10. <i>Chusqueagibcooperi</i>	√	W	√	
11. <i>Chusquea glauca</i>	√	W	√	
12. <i>Chusquealanceolata</i>		W	√	√
13. <i>Chusquealiebmannii</i>		W	√	
14. <i>Chusquealongifolia</i>		W	√	
15. <i>Chusqueamatlatzinca</i>	√	W	√	√
16. <i>Chusqueamuelleri</i>	√	W	√	
17. <i>Chusqueanedjaquithii</i>	√	W	√	√
18. <i>Chusqueanelsonii</i>	√	W	√	
19. <i>Chusquea perotensis</i>	√	W	√	
20. <i>Chusqueapittieri</i>		W	√	
21. <i>Chusquearepens</i>	√	W	√	√
22. <i>Chusqueaseptentrionalis</i>	√	W		
23. <i>Chusqueasimpliciflora</i>		W	√	√
24. <i>Chusqueasulcata</i>		W	√	

25. <i>Cryptochloastrictiflora</i>		H	√	√
26. <i>Guadua aculeata</i>		W	√	
27. <i>Guadua amplexifolia</i>		W		
28. <i>Guadua inermis</i>	√	W	√	
29. <i>Guadua longifolia</i>		W	√	√
30. <i>Guadua paniculata</i>		W	√	
31. <i>Guadua tuxtensis</i>	√	W		
32. <i>Guadua velutina</i>	√	W		
33. <i>Lithachnepauciflora</i>		H	√	
34. <i>Merostachys mexicana</i>	√	W	√	
35. <i>Olmecaclarkiae</i>		W	√	√
36. <i>Olmeca fulgor</i>	√	W	√	
37. <i>Olmeca recta</i>	√	W	√	√
38. <i>Olmeca reflexa</i>	√	W	√	
39. <i>Olmeca zapotecorum</i>	√	W	√	√
40. <i>Olyraglaberrima</i>		H		
41. <i>Olyra latifolia</i>		H	√	
42. <i>Otateaacuminata</i>	√	W	√	√
43. <i>Otateacarrilloi</i>	√	W	√	√
44. <i>Otateafimbriata</i>		W	√	
45. <i>Otatea glauca</i>	√	W	√	√
46. <i>Otateanayeeri</i>	√	W		√
47. <i>Otatearamirezii</i>	√	W	√	
48. <i>Otateareynosoana</i>	√	W	√	
49. <i>Otatearzedowskiorum</i>	√	W	√	√
50. <i>Otateatransvolcanica</i>	√	W	√	
51. <i>Otateavictoriae</i>	√	W		
52. <i>Otateaximенаe</i>	√	W	√	
53. <i>Rhipidocladumbartlettii</i>		W	√	√
54. <i>Rhipidocladummartinezii</i>	√	W	√	√
55. <i>Rhipidocladumpittieri</i>		W	√	√
56. <i>Rhipidocladumracemiflorum</i>		W	√	√

LIST OF FIGURES



Figure 1. Label and specimen of *Rhipidocladum racemiflorum* present at the Mexican national living bamboo collection



Figure 2. *Otateaglauca*, endemic species present at the Mexican national living bamboo collection.



Figure 3. *Aulonemialaxa* endemic species in its natural habitat



Figure 4. *Chusquearepens* endemic species in its natural habitat



Figure 5. Tests of physical and mechanical properties of the Mexican guaduas



Figure 6. *Rhipidocladum racemiflorum* at the Mexican national living bamboo collection



Figure 7. Bamboo uses. Penacho (tuf) for traditional dance “Quetzales”.