Araceae of Chiapas State, Mexico

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ABSTRACT

A comparative analysis of richness patterns by physiographic regions and a list of Araceae of Chiapas is presented based on a 6-year field study and a review of herbarium material. Eleven genera and seventy-nine species of Araceae were recorded for Chiapas, of which fifteen species are endemic to Chiapas. The genera *Anthurium* and *Philodendron* were the major components in the family. The Sierra Madre de Chiapas, the Northern Highlands and the Eastern Highlands were the richest regions for Araceae with 53, 44 and 36 species respectively with the richness apparently correlated with the broad range of elevation and climate exhibited in these regions. The Pacific and Gulf Coastal Plains as well as the Central Depression of Chiapas are regions which are less diverse with 18, 3 and 15 species respectively. Using Jaccard's Index, the Northern Highland and Eastern Highland region were found to be more similar (0.54) while Gulf Coastal Plain, Sierra Madre and Central Plateau were regions less similar in species composition (0.05).

RESUMEN

Un análisis comparativo de patrónes de riqueza por región fisiográfica y una lista actualizada de Araceae de Chiapas fue realizado en base a 6 años de estudio en campo, revisión bibliográfica y revisión de ejemplares de herbario 11 géneros de 79 especies de Araceae fueron registrado para Chiapas, de las cuales 15 son endémicos a nuestro estado. Los géneros *Anthurium* y *Philodendron* fueron los mejor representados dentro de esta familia. La Sierra Madre, Las Montañas del Norte y Las Montañas del Oriente fueron las regiones con mayor riqueza con 53, 44 y 36 especies respectivamente y aparentemente esta riqueza esta relacionada con el amplio rango altitudinal que presentan estas regiones, mientras que la Planicie Costera del Pacífico, del Golfo y Depresión Central de Chiapas fueron las regiones con menor riqueza con 18, 3 y 15 especies respectivamente. *Stenospermation, Rhodospatha, Pistia* y *Dracontium* fueron los generos menos representados en Chiapas todos con una sola especie. Las Montañas del Norte y del Oriente fueron las regiones más similares (Jaccard = 0.54), mientras que La Planicie Costera del Golfo, la Sierra Madre y Meseta Central fueron las regiones que menos especies de Araceae comparten (Jaccard = 0.05).

KEY WORDS.

Chiapas, Araceae, Richness, Endemism, *Anthurium, Philodendron*.

INTRODUCTION

Araceae are herbaceous monocotyledons and the family is one of the most diverse in the angiosperms. They are worldwide in distribution, found on all continents except Antarctica, but are predominantly in tropical and subtropical zones of the world (Grayum, 1990).

Araceae, including the genera *Anthurium, Monstera, Philodendron* and *Syngonium,* constitute a major floristic element in tropical rain forest and evergreen cloud forest of Mexico and dominate cer-

tain habit classes, such as epiphytes and hemiepiphytes, (Rzedowski, 1978; Rzedowski, 1996; Breedlove, 1981), They are important elements in the composition and structure of high evergreen tropical rain forest (Miranda, 1952), as well as montane rain forest and lower montane rain forest in Chiapas (Breedlove, 1981).

A total of 106 genera and approximately 3,500 species of Araceae have been recorded world-wide (Croat, 1988, 1992). Latin America has about 50% of the world's Araceae (Grayum,1990), however, taxonomically, it is one of the most poorly known groups in the Neotropics (Croat, 1992). Mexico is considered to be a country with high aroid diversity, with about 108 native species (Espejo & López, 1993). Research thus far completed is primarily taxonomic (Croat, 1981, 1983; Croat & Baker, 1978; Croat & Sheffer, 1983; Croat, 1986a), but a few studies have had ecological components (Croat, 1979, 1986b, 1988, 1992). In southern Mexico, Eizi Matuda made important contributions to knowledge of Araceae in Chiapas. He described about 36 species (Matuda, 1954) but many of these have not been recollected (Croat, 1983). The state remains one of the most diverse in Mexico (Espejo & Lopez, 1993), but since Croat's work reported in Breedlove (1986) no attempt has been made to produce a complete list of Araceae in Chiapas.

The principal purposes of this study are: (a) to make a current list of Araceae of Chiapas, (b) to make an analysis of species richness of Araceae for each physiographic region of Chiapas and (c) to compare different physiographic regions in order to map endemism and distribution patterns in order to assist in assigning priority areas of conservation for Araceae of Chiapas.

MATERIAL AND METHODS

This work is based on a review of specimens in Mexican herbaria (MEXU, CHIP, CHAPA, CHAP) and the available literature (Croat, 1981, 1983, 1986a, 1997; Bunting, 1960; Breedlove, 1986; Espejo & Lopez, 1993; Grayum, 1996; Madison, 1977) as well as more than 6 years of field study in Chiapas by the author between 1993 and 1999. Studies were made throughout the different physiographic regions of Chiapas from which both live and dried collections were made. All material was determined using published revisions and by reference to determined material in the herbaria in Chiapas. Some material was sent to Croat at the Missouri Botanical Garden for confirmation. Voucher specimens were deposited at CHIP and Herbarium of Escuela de Biología de la Universidad de Ciencias y Artes de Chiapas. A list of Araceae was prepared as a data set based on physiographic regions of Chiapas. This data matrix was analyzed by CAMRIS V.3 geographic information system software. Finally maps depicting endemism and restricted species patterns were generated and a matrix of similarity was made using the software Bio-dap (Park Canada & Fundy National Park, 1988).

GEOGRAPHICAL DIVERSITY OF CHIAPAS

Chiapas is situated in southern Mexico, and is bordered by Guatemala in the east, the Isthmus of Tehuantepec and the state of Oaxaca in the west, with the state of Tabasco to the north and the Pacific Ocean to the south. The geography and climate is diverse ranging from coastal strand at sea level to 4,000 m. on Volcano Tacaná in the Sierra Madre. The annual rainfall ranges widely from 550 mm in some localities to over 5,000 mm in others. The mean annual temperature varies from 12°C in some localities of the Central Plateau and the Sierra Madre to 28°C on the Pacific Coastal Plain and Central Depression (García, 1973).

Müllerried (1957) divided the state into seven physiographic regions (Fig. 1):

1. Pacific Coastal Plain. This plain is 280 km long and 15 km wide and is bordered by the Sierra Madre to the north and by the Pacific Ocean to the south.

It consists of a narrow strip of metamorphic strata and intrusive rocks, and ranges from sea level to 35 m. elevation.

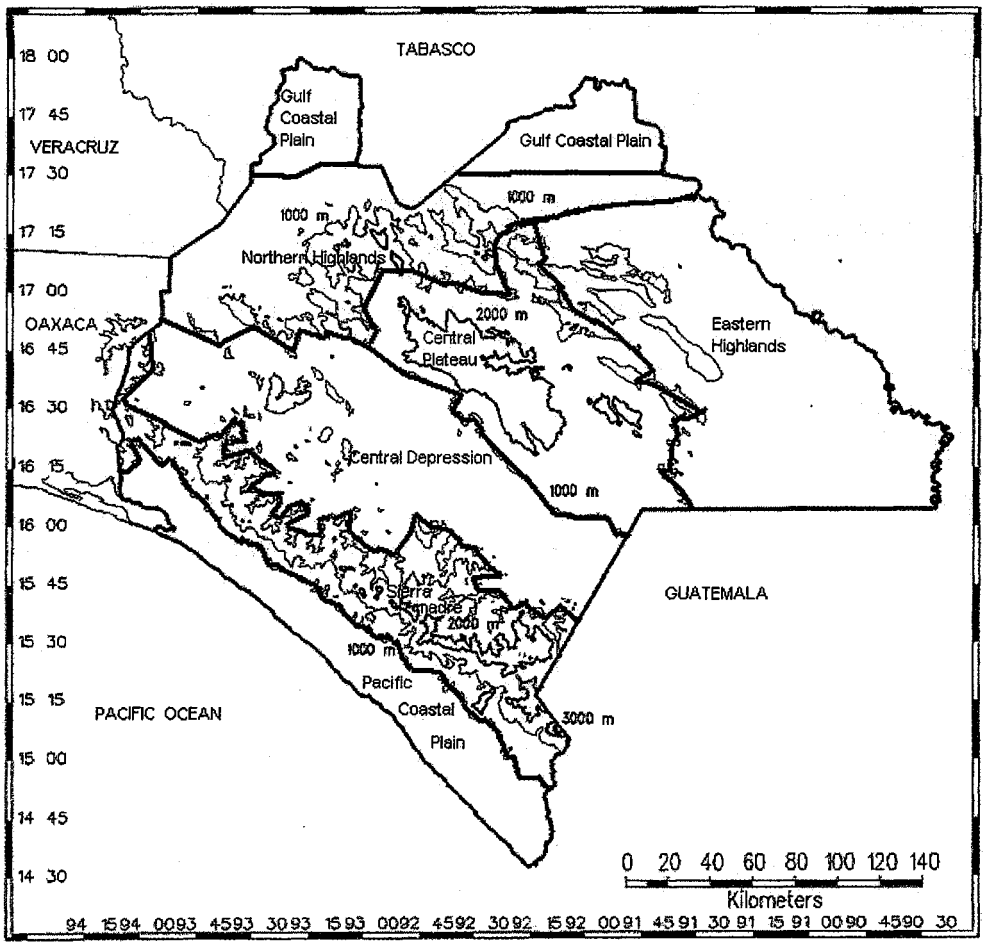

Fig. 1. Physiographic regions of Chiapas according to Müllerried (1957).

There is a small mountain system (100–800 m) in the northeast of the region between municipalities Tonalá and Pijijiapan. It has areas with tropical deciduous forest, swamp and lowland forest and fragmented areas of tropical rainforest.

2. Sierra Madre of Chiapas. This mountainous zone is 280 km long and ranges in width from 50 to 65 km. This formation continues into the mountains of Guatemala in the south and into Oaxaca to the northeast. It ranges in elevation from 1,500 to 4,000 m (Volcán Tacaná).

It has areas of evergreen cloud forest, montane rain forest, lower montane rain forest, Quercus forest, Pine-Quercus-Liquidambar forest, tropical deciduous forest and coffee plantations in the lowest part of the Sierra Madre

3. Central Depression of Chiapas. This region is also called the "Valle central" and is located between the Sierra Madre, the Central plateau and the Mountain Highlands. It is 280 km long and ranges in width from 30 to 55 km. This region continues into Guatemala in the southeast and into Oaxaca in the northwest. Along the border with Oaxaca the width ranges from 20 to 25 km and the elevation from 500 to 650 m.

One small area in the west known as Cerro Brujo, near to municipality of Ocozocoautla, has an elevation range of 1,000–1,800 m and possesses communities

such as lower montane rain forest, pine-oak-liquidambar forest and, commonly, tropical deciduous forest.

4. Chiapas Plateau. The plateau is 160 km long and 75 km wide with an elevational range of 1,000 to 2,858 m. (on Cerro Zontehuitz). In other parts of this region elevation can vary from 1,000 to 2,000 m. This area also is known as "Highlands of Chiapas".

In this region it is common to find vegetation communities such as evergreen cloud forest, pine-oak forest, lower montane rain forest and coffee plantations.

5. Eastern Highlands. This region is also known as "selva lacandona". It is bordered by the Usumacinta and Salinas rivers and is 150 km long and 70 to 100 km wide with an elevational range of 90 to 1,200 meters.

Most commonly found are Tropical rain forest, lower montane rain forest and small areas of isolated pine-oak-liquidambar forest.

6. Northern Highlands. This zone is limited by the Gulf Coastal Plain to north, the Central Depression in the south, the Central Plateau in the east and the border of Oaxaca and Veracruz in the west. The zone is 250 km long and 250 km wide and ranges in elevation from 800–2,000 m.

It is characterized mainly by karstic rock and has communities such as lower montane rain forest, pine-oak-liquidambar forest and tropical rain forest

7. Gulf Pacific Coastal Plain. This region is made up of two parts, one in the east and one in the west. These are about 45 km long and 90 km wide and the elevational range is 15 to 50 meters.

Almost throughout, this area has grassland, bunch grassland, herbaceous marsh and rarely second growth and shrub associations. It has deposits of marine limestone of Cretaceous to Miocene age.

RESULTS

Eleven genera and 79 species of Araceae were recorded for Chiapas (Appendix 1), of which 33 species are *Anthurium*, 2 *Dieffenbachia*, 5 *Monstera*, 23 *Philodendron*, 7 *Syngonium*, 2 *Spathiphyllum*, 3 *Xanthosoma* and with the genera *Dracontium*, *Pistia*, *Stenospermation* and *Rhodospatha* each having one species.

The Sierra Madre and Mountain Highlands were the regions with most richness while Gulf Coastal Plain and Central Plateau were areas with less richness (Table 1). *Anthurium* and *Philodendron* were the genera best represented in each area.

Analysis of similarity with data presence-absence of physiographic regions defined two groups (Table 2). The first group was formed by the Northern Highlands and Eastern Highlands which demonstrated more than 50% similarity. The second group was formed by the Central Depression, the Pacific Coastal Plain, the Northern Highlands and the Eastern Highlands which showed 40% similarity.

According to Espejo & Lopez (1993) the total number of Araceae for Mexico is 108 species and Chiapas has about 79 species of Araceae, or approximately 73% of the total Mexican species. Approximately 19% of the species from Chiapas are endemic to Chiapas.

Figures 2 and 3 show distribution patterns of *Anthurium* and *Philodendron* restricted to Mexico, Chiapas and Guatemala, in the physiographic regions of Chiapas. These show that the Sierra Madre, the Northern Highland and the Eastern Highland are the areas more important to conserve. It appears that the distribution of endemic species and those restricted to Mexico and Guatemala are correlated only with mountainous evergreen cloud forest and tropical rain forest of Chiapas in the Sierra Madre and the Northern Highlands. For example *A. berriozabalense*, *A. clarinervium*, *A. lezamae*, *A. faustomirandae*, *A. pedatoradiatum* are restricted to a small areas of tropical rain forest in the Northern Highlands, while *A. cordatotriangulum*, *A. nakamurae*, *A. ovandense* are endemic to evergreen cloud forest in the Sierra Madre. In regions such as the Pacific Coastal Plain and the Gulf Coastal Plain there are no endemic species of aroid present.

Table 1. Richness of Araceae for each physiographic region of Chiapas.

	Pacific Coastal Plain	Sierra Madre	Central Depression	Central Plateau	Northern Highlands	Eastern Highland	Gulf Coastal Plain
Anthurium	4	23	10	9	19	11	1
Dieffenbachia	1	1	0	0	1	1	1
Dracontium	1	0	0	0	0	0	0
Monstera	2	4	1	1	3	2	0
Philodendron	4	15	10	4	13	14	0
Pistia	1	0	1	0	0	0	0
Rhodospatha	0	1	0	0	1	1	0
Spathiphyllum	0	1	0	0	1	1	0
Stenospermation	0	0	0	0	0	1	0
Syngonium	4	5	4	0	5	4	0
Xanthosoma	1	3	1	1	1	1	1
Total Araceae	18	53	27	15	44	36	3

Table 2. Matrix of similarity of Araceae presence-absence (index of Jaccard) by Physiographic regions of Chiapas.

Regions	Pacific Coastal Plain	Sierra Madre	Central Depression	Central Plateau	Northern Highlands	Eastern Highlands	Gulf Coastal Plain
Pacific Coastal Plain							
Sierra Madre	0.27						
Central Depression	**0.40**	0.36					
Central Plateau	0.14	0.21	0.23				
Northern Highlands	0.24	0.38	**0.42**	0.20			
Eastern Highland	0.29	0.39	**0.40**	0.30	**0.54**		
Gulf Coastal Plain	0.10	0.05	0.07	0.05	0.06	0.08	

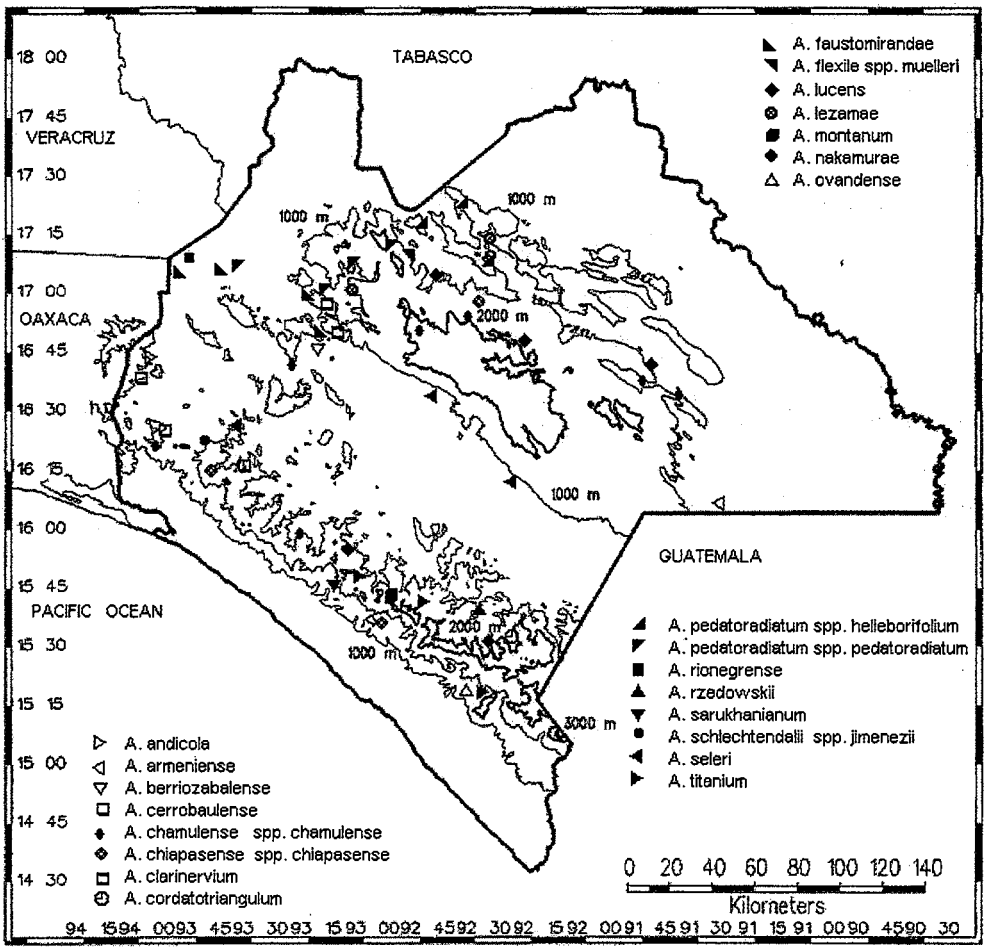

Fig. 2. Occurrence in Chiapas of species of *Anthurium* endemic or restricted to Mexico and Guatemala.

DISCUSSION AND CONCLUSION

The sharp difference in the species diversity of Araceae evident between the Gulf Coastal Plain and other regions in Chiapas is due to its narrow range of elevation, extending to only 50 m above sea level. In marked contrast, the Sierra Madre ranging from 1,000–4,000 m. has twice as many Araceae as the Central Depression (27) and three time more species that Central Plateau (15).

The distribution of aroids presents a gradient pattern of richness from less (in the Gulf and Pacific Coastal) to greater (the Sierra Madre and the Northern Highland). The lowest richness of the Gulf Coastal Plain (3 species) compared with the Pacific Coastal Plain (18 species) and the Central Depression (27 species) is because there are no mountain systems in the Gulf Coastal Plain and because primary forest areas were destroyed in the 1970s and 1980s mainly for cattle raising and agriculture (Otero *et al.*, 1999) to a more drastic extent in the Gulf Coastal Plain than elsewhere. *Dieffenbachia oerstedii* and *Xanthosoma robustum* are species which can found around rivers while *Anthurium*

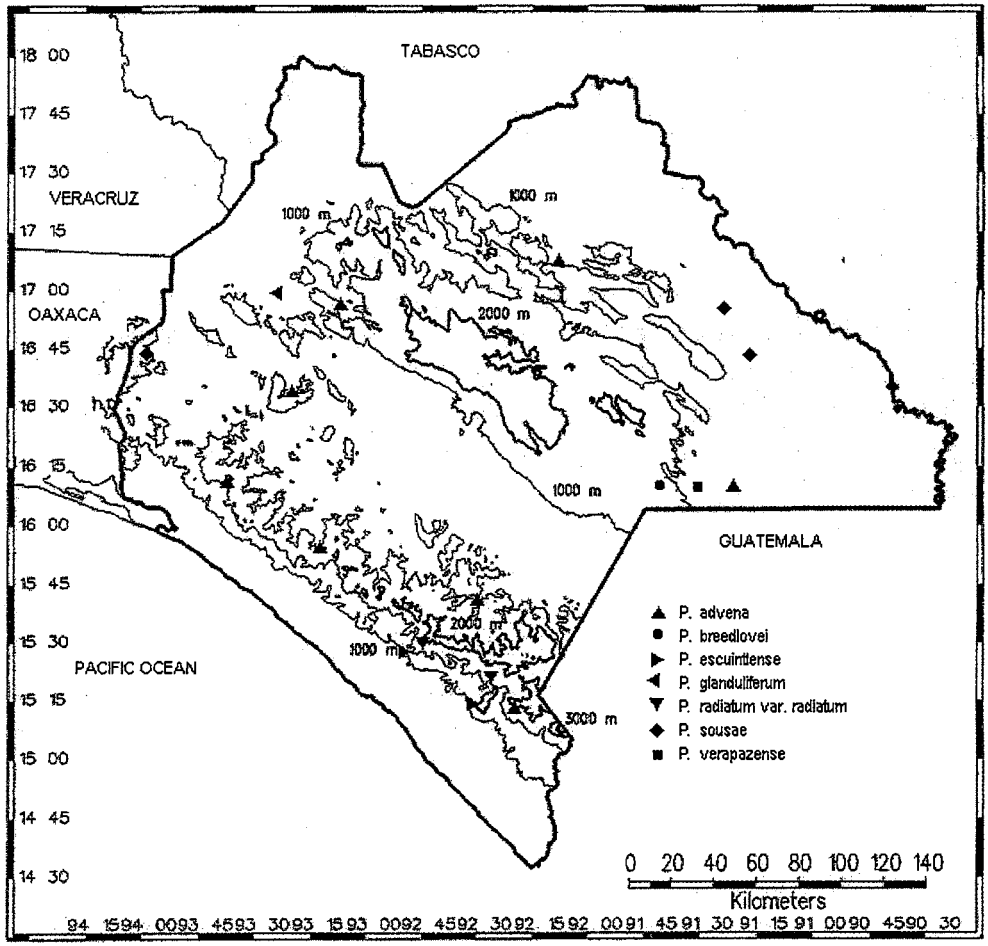

Fig. 3. Occurrence in Chiapas of species of *Philodendron* endemic or restricted to Mexico and Guatemala.

pentaphyllum var. *bombacifolium* can be found in isolated trees of this region.

In contrast the Pacific Coastal Plain and Central Depression have small mountain systems (100–800 m in the Pacific Coastal) and (1,000–1,800 m in the Central Depression) and apparently there are occasional forest fragments in southern area of the Pacific Coastal Plain. There is also a conserved area of wetland forest called in Mexico "Manglar" (Swamp and lowland riparian forest), mainly in the Pacific Coastal *selva mediana tropical* (tropical rain forest), *selva baja caducifolia* (deciduous tropical forest). In the Pacific Coastal Plain there is also a biosphere reserve named Encucijada Biosphere Reserve, and all these factors permit optimal microsites for the establishment of aroids.

Note that Chiapas is particularly rich in endemic *Anthurium* with up to one-third of the species of the genus in Mexico. Approximately 79% all species of *Anthurium* found in Chiapas are restricted to Mexico, Chiapas and Guatemala, but the overall level of endemic species in Chiapas is only approximately 18%. The endemism and restricted distribution pattern of aroids on the west side of the Northern Highland (municipality of Ocozocautla, Cintalapa,

San Fernando) is apparently due to the constant mist crossing the area from west to east

The high Jaccard's index of similarity which was present between the Northern Highlands and Eastern Highlands is to be expected because there is a continuous interdigitation and communication of the montane ridges between these two regions. Examples of the most common species that demonstrate this continuous extension in Chiapas are *Anthurium schlechtendalii* ssp. *schlechtendalii, Anthurium chamulense* ssp. *chamulense, Anthurium huixtlense* and *Anthurium pentaphyllum* var. *bombacifolium*. Probably these species are more common and widely distributed because they occupy the same type of vegetation (mountain rain forest) in both regions.

One of the possible causes of the richness of Araceae in the Pacific Coastal Plain compared with the Gulf Coastal Plain, is that the Pacific Coastal Plain has more environmental variability with both deciduous tropical forest and moist tropical forest, while in the Gulf Coastal Plain there is only moist tropical forest. Note, however, that in the last 20 years both regions have been seriously affected by cattle raising.

This work has recorded the occurrence of three additional species, since the earlier list of Araceae was made by Croat in Breedlove (1986). These are *Philodendron glanduliferum* a species formerly thought to be restricted to Oaxaca and Guatemala (Croat, 1997) but which was located in Chiapas north of Ocozocautla in the Northern Highlands; *Anthurium sarukhanianum,* a species thought to be limited to a small area of Guerrero, which was found in the Sierra Madre of Chiapas (Croat & Pérez-Farrera, 2000) and one new species, *Anthurium faustomirandae*. This species is endemic to Chiapas, and is restricted to small areas of tropical rain forest in the Northern Highlands (Pérez-Farrera & Croat, 2001).

CONSERVATION OF ARACEAE

Important priority areas for conservation of Araceae in Chiapas are the Sierra Madre and the Northern Highlands since they are centers of greatest species richness and diversity of Araceae in Chiapas and Southern of Mexico. They contain more than half the Araceae recorded for Chiapas and more than 40% of those recorded for Mexico. This aroid abundance and diversity can be explained by the elevational range from 800 to 2,000 m (in the Northern Highland) and 1,000 to 4,000 m (in the Sierra Madre) as well as diverse vegetation type. Gentry & Dodson (1987) pointed out that diversity of Araceae is closely related with altitude gradient. The discontinuous distribution of endemic species in small areas of Chiapas, such as for example *A. berriozabalense, Anthurium clarinervium, A. faustomirandae* and *A. lezamae,* in the Northern Highland of Chiapas and *A. cordatotriangulum, A. nakamurae, A. ovandense, A. rzedowskii, A. sarukhanianum* in the Sierra Madre demonstrates that these regions are rich in endemism for Chiapas and southern Mexico and that these may have been Pleistocene refugia, as suggested by Toledo (1982).

Serious taxonomic revision of *Xanthosoma* and *Spathiphyllum* in Mexico is urgently needed because there are problems in the delimitation and recognition of species for these two aroid taxa. For example, in the concept and delimitation of *X. robustum,* where adults individuals can be found ranging from about 2 m to about 50 cm. By contrast, the genera *Anthurium, Dracontium, Philodendron, Monstera* and *Syngonium* do not have problems with species identity, and a taxonomic revision of *Dieffenbachia* of Central America has recently been made by Croat (pers. comm.)

In recent years the illegal commercial traffic of ornamental plants has increased in Mexico (Ramirez, 1998). Today there are several commercial nurseries of Berriozabal who offer for sale *A. berriozabelense, A. chamulense, A. clarinervium* and several species of *Philodendron*. All these are collected illegally from natural populations in the mountain rain forest and cloud forest found to the north of Ocozocoautla and Berriozabal in the Northern

Highlands of Chiapas. There is inefficient legislation covering several groups of plants including Araceae. National law protects only six species of aroids (*A. podophyllum, Dieffenbachia seguine, Monstera adansoni, Monstera punctulata and Spathiphyllum friedrichsthalii*) (*Diario Oficial,* 2000).

The deforestation rate in the last twenty years has increased severely in Mexico, particularly in the south with an annual deforestation of about 625,000 ha per year. From 1980–1990 Chiapas alone lost 60,411 ha per year of forest cover, and in the Central Plateau of Chiapas about 32,699 ha of cloud forest have been lost by land use change (De Jong *et al.,* 1999). These processes are putting at risk a large part of the diversity of our state.

Because of this land use change, and owing to their restricted distribution and the reduced number of populations, I propose that many more species of Araceae should be conserved by Mexican law. These include *A. berriozabalense, A. cerrobaulense, A. chamulense* ssp. *chamulense, A. clarinervium, A. cordatotriangulum, A. faustomirandae, Anthurium lezamae, A. nakamurae, Philodendron breedlovei, P. escuintlense, P. sousae, P. radiatum var. pseudoradiatum, Syngonium chiapense* and *S. steyermarkii.* To strengthen the case, I suggest that the populations of these species must be evaluated to see the state of their conservation.

ACKNOWLEDGMENTS

I would like to thank to Rigoberto Hernandez Jonapa, Jesus de La Cruz Rodriguez, Armando De La Cruz Dominguez, Oscar Farrera Sarmiento, Emerit Melendez for their help in the work field. Tom Croat for his help in the identification some voucher herbarium and review of this manuscript and special thank to Michael H. Grayum and Tom B. Croat because this work could never have been undertaken without cooperation and borrowed information of Araceae.

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Appendix 1. List of species of Araceae of Chiapas.

1. *Anthurium andicola* Liebm.
2. *Anthurium armeniense* Croat
3. *Anthurium bakeri* Hook f.
4. *Anthurium berriozabalense* Matuda
5. *Anthurium cerrobaulense* Matuda
6. *Anthurium chamulense* Matuda ssp. *chamulense*
7. *Anthurium chiapasense* Matuda ssp. *chiapasense*
8. *Anthurium clarinervium* Matuda
9. *Anthurium cordatotriangulum* Matuda
10. *Anthurium faustomirandae* Pérez-Farrera & Croat
11. *Anthurium flexile* Schott ssp. *flexile*
12. *Anthurium flexile* Schott ssp. *muelleri* (J.F. Macbr.) Croat & R.A. Baker
13. *Anthurium huixtlense* Matuda
14. *Anthurium leuconeurum* Lem.
15. *Anthurium lezamae* Matuda
16. *Anthurium lucens* Standl.
17. *Anthurium microspadix* Schott
18. *Anthurium montanum* Hemsley
19. *Anthurium nakamurae* Matuda
20. *Anthurium ovandense* Matuda
21. *Anthurium pedatoradiatum* Schott ssp. *helleborifolium* (Schott) Croat
22. *Anthurium pedatoradiatum* Schott ssp. *pedatoradiatum*
23. *Anthurium pentaphyllum* (Aubl.) G. Don var. *bombacifolium* (Shott) Madison
24. *Anthurium rionegrense* Matuda
25. *Anthurium rzedowskii* Croat
26. *Anthurium salvinii* Hemsley
27. *Anthurium sarukhanianum* Croat & Haager
28. *Anthurium scandens* (Aubl.) Engl. ssp. *scandens*
29. *Anthurium schlechtendalii* Kunth ssp. *jimenezii* (Matuda) Croat
30. *Anthurium schlechtendalii* ssp. *schlechtendalii*
31. *Anthurium seleri* Engl.
32. *Anthurium titanium* Standl. & Steyerm.
33. *Anthurium verapazense* Engl.
34. *Dieffenbachia oerstedii* Schott
35. *Dieffenbachia wendlandii* Schott
36. *Dracontium soconuscum* Matuda
37. *Monstera acacoyaguensis* Matuda
38. *Monstera acuminata* K. Koch
39. *Monstera deliciosa* Liebm.
40. *Monstera siltepecana* Matuda
41. *Monstera tuberculata* Lundell
42. *Philodendron advena* Schott
43. *Philodendron anisotomum* Schott
44. *Philodendron aurantiifolium* Schott ssp. *calderense* (K. Krause) Grayum
45. *Philodendron breedlovei* Croat
46. *Philodendron escuintlense* Matuda
47. *Philodendron glanduliferum* Matuda
48. *Philodendron hederaceum* (Jacq.) Schott var. *hederaceum*
49. *Philodendron inaequilaterum* Liebm.
50. *Philodendron jacquinii* Schott

Appendix 1. Continued.

51. *Philodendron jodavisianum* Bunting
52. *Philodendron mexicanum* Engl.
53. *Philodendron radiatum* Schott var. *radiatum*
54. *Philodendron radiatum* Schott var. *pseudoradiatum* (Matuda) Croat
55. *Philodendron rojasianum* Standl. & Steyerm.
56. *Philodendron sagittifolium* Liebm.
57. *Philodendron seguine* Schott ssp. *seguine*
58. *Philodendron seguine* Schott ssp. *lingua-bovis* Grayum
59. *Philodendron smithii* Engl.
60. *Philodendron sousae* Croat
61. *Philodendron standleyi* Grayum
62. *Philodendron tripartitum* (Jacq.) Schott
63. *Philodendron verapazense* Croat
64. *Philodendron warszewiczii* K. Koch & Bouché
65. *Pistia stratiotes* L.
66. *Rhodospatha wendlandii* Schott
67. *Spathiphyllum cochlearispathum* (Liebm.) Engl.
68. *Spathiphyllum matudae* Bunting
69. *Stenospermation robustum* Engl.
70. *Syngonium angustatum* Schott
71. *Syngonium chiapense* Matuda
72. *Syngonium macrophyllum* Engl.
73. *Syngonium neglectum* Schott
74. *Syngonium podophyllum* Schott var. *podophyllum*
75. *Syngonium salvadorense* Schott
76. *Syngonium steyermarkii* Croat
77. *Xanthosoma mexicanum* Liebm.
78. *Xanthosoma robustum* Schott
79. *Xanthosoma wendlandii* (Schott) Schott