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DISTRIBUTION AND CONSERVATION OF EPIPHYTES ON THE YUCATÁN PENINSULA

INGRID OLMSTED AND MAURO GÓMEZ JUÁREZ

Centro de Investigación Científica de Yucatán, A.P. 87, Cordemex, Mérida, Yucatán, México

ABSTRACT. Approximately 100 species of epiphytes of the Orchidaceae, Bromeliaceae, Cactaceae, Araceae, Piperaceae and Polypodiaceae occupy the canopy and tree trunks of the various tropical forests of the Yucatán Peninsula. We established the geographic distributions of most of these epiphytes, and at the same time assigned them to different habitats: tall and medium-statured semi-evergreen and subdeciduous forest, and low-statured deciduous and seasonally inundated forests, as well as mangroves. The number of epiphyte species vary between forests. The low-statured inundated forests, unique to the Peninsula and the least disturbed, are home to about 56% of the epiphyte species, while the tall semi-evergreen forest hosts approximately 78%. Perturbations of the tropical forests are widespread but patchy. For example, in southern Quintana Roo between 1975 and 1990, the increase (hectares) in agriculture and cattle ranching was 80% whereas in secondary vegetation it was 48%. With > 50 % of the original forest gone, the Peninsula's eleven protected natural areas occupying 10% of the surface area, will give some protection to the epiphytes.

INTRODUCTION

Today's concern about the loss of tropical forests has given rise to a large number of publications on the subject (Dirzo & García 1992, Houghton 1994, Krummer & Turner 1994, Baker 1989) in every country within the tropics. In a recent account of tropical deforestation rates throughout the world by the Environmental Protection Agency, México was listed with the highest annual rate (Cairns pers. comm.).

The forests on the Yucatán Peninsula are part of the major tropical vegetation in México's southeast. Once boasting a 90% forest cover, the three states of Yucatán, Campeche and Quintana Roo may actually have a total of 1 million hectares of mature forest left today, of which 99% are located in Quintana Roo and Campeche. The major pressures are intensive cattle ranching, large-scale commercial agriculture, tourist development, urbanization, timber harvest and illegal collection of epiphytes. However, the disturbed forest may not be irrevocably converted to agriculture, cattle ranching, urbanization or tourism, and has the potential of eventually reverting to mature forest.

The epiphyte community of the Yucatán Peninsula is composed of species in the Orchidaceae, Bromeliaceae, Piperaceae, Araceae, Cactaceae and Polypodiaceae. By comparison with other Mexican epiphyte communities and certainly those of other South American countries, the epiphytes of the Yucatán Peninsula are not very diverse. We estimate 107 species for the abovementioned families.

The disturbance and loss of forests during the last 20 years, which coincides with a burst of development in many sectors, has caused the loss of habitat for many epiphytes on the Yucatán Peninsula. In this paper, we describe the distribution and state of conservation of the epiphytes and their habitat in this area.

Tropical Forests of the Yucatán Peninsula— The major potential vegetation types of the Peninsula were described by Miranda (1958). FIGURE 1 is a presentation of the potential forest types as suggested by INEGI in 1981.

The Peninsula has five types of forest. From northwest to southeast, they include low-statured deciduous forest, medium-statured subdeciduous forest, medium-statured, semi-evergreen forest, tall semi-evergreen/evergreen forest and low-statured inundated forest. The climatic gradient with regard to precipitation influences the distribution of the forest; the annual rainfall increases from about 500 mm in the northwest to 1500 mm in the southeast and southwest.

Low-Statured Deciduous Forest—This forest only occurs in the northwestern portion of the state of Yucatán, on rocky entisols with very low water retention. The trees lose their leaves during the spring dry season when many species flower (Olmsted *et al.* 1994). The Leguminosae is the dominant family in this community. The most common tree species are *Bursera simarouba, Caesalpinia gaumeri, Acacia pennatula, Metopium brownei, Gymnopodium floribundum, Caesalpinia yucatanensis, Plumeria obtusa,* etc., with a total of about 50 species/2000 m^2.

The canopy is open, with the tallest trees reaching 10 m, and an average tree height of 6–8 m. Many trees have branches starting very low on the stem. Coppicing is common in this forest. The composition includes a number of species with spines.

Medium-Statured Subdeciduous Forest—The subdeciduous forest was determined by Miranda

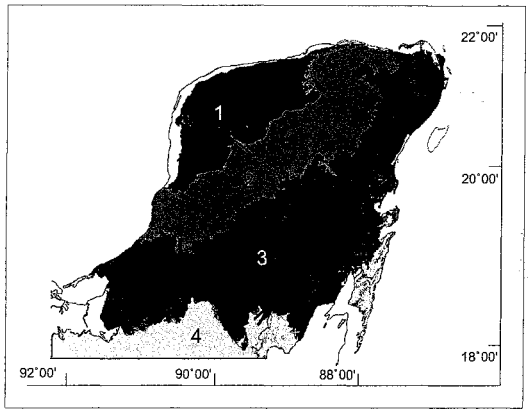


FIGURE 1. Potential forest vegetation on the Yucatán Peninsula: 1. Low-statured deciduous forest 2. Medium-statured subdeciduous forest 3. Medium-statured semi-evergreen forest 4. Tall semi-evergreen or evergreen forest.

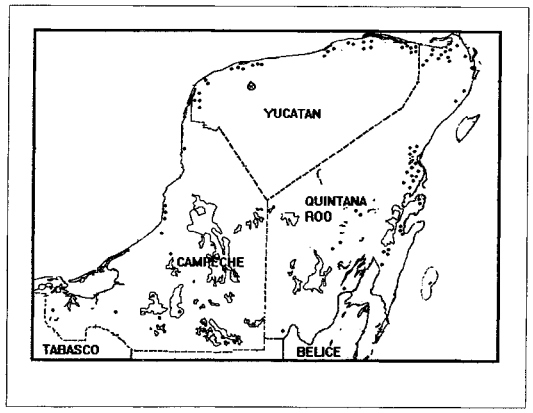


FIGURE 2. Distribution of low-statured seasonally inundated forest on the Yucatán Peninsula.

(1958) as one in which 50–75% of the individuals lose their leaves during the dry season. It occurs in the eastern portion of Yucatán (FIGURE 1), northern Campeche and a small portion of western Quintana Roo. Precipitation oscillates between 1000 and 1200 mm per year. However, this forest type may occur in small extensions if edaphic conditions are appropriate, within the same area as the semi-evergreen forest. Trees reach up to 18 m, and the density of trees and their cover are less than in the semi-evergreen forest. Epiphytes and vines are not very common.

Some of the more common tree species are *Vitex gaumeri, Brosimum alicastrum, Piscidia piscipula, Enterolobium cyclocarpum, Caesalpinia gaumeri,* and *Cedrela odorata.* Other important species are *Cochlospermum vitifolium, Gliricidia sepium,* and *Bursera simarouba.* As for deciduous forest, very little area is left today with mature subdeciduous forest.

Medium-Statured Semi-Evergreen Forest—As in Figure 1, this is the most extensive forest type on the Yucatán Peninsula. It is structurally very similar to the tall evergreen forest. This forest type develops in a climate with between 1100 and 1400 mm of rain over shallow entisols and rendzinas as well as slightly deeper kankab. The trees reach between 15 and 25 m and develop anywhere from 30–50 m ^{2}/ha of basal area. According to Miranda (1958), 25 % of the trees lose their leaves during the dry period.

The typical tree species of this forest is *Manilkara zapota,* from which chicle gum is produced. Other common species are *Brosimum alicastrum, Talisia olivaeformis, Pouteria campechiana, Simarouba glauca, Swartzia cubensis, Lonchocarpus castilloi, Alseis yucatanensis,* and *Sabal yapa.*

Tall Semi-Evergreen Forest—This forest type occurs in the very southern portion of the Peninsula on the Guatemala and Belize borders. Almost all of the individuals keep their leaves throughout the year. Structurally the tallest forest, it reaches up to 30 m. Trees do not start to branch until at least halfway up the straight trunks or sometimes not until the last third. Many of the trees have buttresses. Woody vines abound. The dense canopy does not allow much light to penetrate to the forest floor which makes for a less abundant understory of palms and ferns.

The most important species are *Swietenia macrophylla, Brosimum alicastrum, Talisia olivaeformis,* and *Manilkara zapota.* Other species frequently represented are *Pouteria campechiana, Swartzia cubensis, Ceiba pentandra, Lysiloma latisiliquum, Andira inermis,* and *Lonchocarpus castilloi. Cryosophila argentea,* and *Sabal mauritiformis* are some of the palms present in this forest.

Low Inundated Forest—This forest is considered typical of the Yucatán Peninsula (FIGURE 2), even though it is the least extensive of the forest types. Several different communities of this forest type are known (Olmsted and Duran in press). The low seasonally inundated forest occurs in mosaic fashion within the tall and medium-statured forests, most of the time in small areas, especially along the coast. It is not a climax forest type. Toward the south, this forest occurs inland in larger tracts. They occur in slight depressions which have poor drainage and cause inundations during the rainy season. The forest is semi-evergreen. Usually one tree species dom-

inates in these associations and the overall diversity is low by comparison to the other tropical forest types on the peninsula. Species that grow here have to be adapted to prolonged inundation and sometimes prolonged dry periods. The tallest trees reach 10–12 m, but the average height is 6–8 m or less. The trunks of the trees are often twisted, with branching at soil level and many species possessing spines.

Each community of this forest type has a dominant species, such as *Haematoxylum campechianum* in the tintal (logwood community), or *Bucida buceras* in the pucteal (from 'pucte' in Maya), or *Dalbergia glabra* in the mucal (from 'muk' in Maya). One important aspect of these communities is the abundance of epiphytes, especially orchids and *Tillandsia* species. Other tree species are *Erythroxylum confusum, E. rotundifolium, Byrsonima bucidaefolia, Jacquinia aurantiaca,* and *Cameraria latifolia.*

Mangroves—The mangrove habitats on the Peninsula are divided into three major categories: fringe, basin and dwarf mangroves. *Rhizophora mangle, Avicennia germinans,* and *Laguncularia racemosa* are the mangroves growing in these communities along with *Conocarpus erecta.* The coastal fringe and slightly more inland basin mangroves reach heights of up to 15 m, but most grow to 8–10 m. Dwarf mangroves are only 1.5–4 m, with varying densities. Epiphytes occur mostly in dwarf and fringe mangrove communities, growing on red and white mangroves as well as on *Conocarpus.*

Methods

We studied the epiphytes of the families Orchidaceae, Bromeliaceae, Piperaceae, Araceae, Cactaceae and Polypodiaceae. As a basis for the presence of the epiphytic orchids, we used the list by Andrews & Gutierrez (1988) for the Yucatán Peninsula and the updated list of orchids for México by Soto Arenas (1988). We also looked at the specimens and their origin in the CICY Regional Herbarium. The locations of collected live specimens in the CICY Regional Botanical Garden were used as well. For Bromeliaceae, we used Garcia-Franco (1987), as well as the Etnoflora Yucatanense (Sosa *et al.* 1985). The latter was also used for the Piperaceae, Araceae and Cactaceae. For ferns, we referred to the bachelor thesis by Silvia Torres (1991). Other references which helped us with identification and distribution were Gardner (1982) and volume 6 of Flora Mesoamericana.

During 1992–1994, we made numerous field trips throughout the Yucatán Peninsula looking for epiphytes. We noted their location and identification, and evaluated the conservation of the habitat and the state of the populations.

We listed epiphyte species by their family, habitat(s), and geographic distribution. For all of the epiphytes found we noted the occurrence to the closest village on a topographic map. The information was then put on a map divided into quadrats of ½ degree on the side. The habitats were identified according to Olmsted and Duran (1990). The conservation status of the habitats, where we found epiphytes was determined by the structure and composition of the community. For instance, a secondary forest usually did not have any epiphytes. Most of the forests were mature, with perturbations such as selective cutting of trees for timber and for domestic use by indigenous people.

Size of populations varied from one habitat to the next. Because of our previous studies of bromeliads and orchid distributions (Olmsted & Duran 1986, Zimmerman & Olmsted 1992), we could judge the relative size of populations. For instance, if we found about 10 plants or groups of plants on different trees in a small area in the inundated forest, we considered the species to have a good population size. The same number of epiphytes was required over a much larger area in the medium-statured or taller forest to be considered a sufficient population size.

The state of the forests from the 1970's to the 1990's on the Peninsula was examined with satellite images, aerial photography and groundtruthing. This vegetation study is part of an ongoing project with EPA and Instituto de Geographia of UNAM. We considered only the Mexican portion of the Yucatán Peninsula in the geographic distributions.

Results and Discussion

Epiphytes—During our field work, we did not see every species that occurred in our checklists (Andrews & Gutierrez 1988, Soto 1988, Torres 1991, Garcia-Franco 1987). Some of the rare orchids, that were originally found in one or two places on the peninsula, are examples of species that we have been unable to relocate. Based on our visits and on literature, we list 63 epiphytic species of Orchidaceae, 19 species of Bromeliaceae, 5 species of Cactaceae, 2 species of Piperaceae, 2 species of Araceae and 10 ferns (Table 1).

The number of epiphytes found to date on the peninsula is probably conservative for several reasons. First, the Orchidaceae and Bromeliaceae are better known than the other families treated here, so that we would expect some ferns, cacti, peperomias and anthuriums to be unac-

counted for on the peninsula. We expect that the orchids and bromeliads will increase slightly as more species are encountered in the southern forests along the border with Guatemala and Belize. (Between 1988 and 1994, five more species of orchids were added to the list for the peninsula.) However, some of the orchids which have not been found again during the last 10–20 years may have to be deleted, because they probably do not exist here anymore. (Joann Andrews, from Pronatura A.C., has worked on orchids of the Peninsula for the last 25 years and estimates that 50% of the populations of orchids have disappeared.)

Distribution of Epiphytes by Habitat—TABLE 1 shows our assignment of the epiphytes to the different habitats. We should mention that even though it is possible to find a certain species in a certain habitat once, it does not mean that it is the usual habitat for that epiphyte. For instance, several epiphytes, whose major habitat is either the semi-evergreen or inundated forest, also occur infrequently in the subdeciduous forest; and this information is included here.

We classified epiphytes that occur in almost all forest types as generalists (e.g., *Aechmea bracteata*). Others, such as *Epidendrum isthmi,* grow only in one habitat. TABLE 2 indicates the total number of epiphytes/family that occur in a certain habitat. For the orchids, the tall forest is the most important habitat, followed by the low inundated and the medium-statured forests. Several points should be made here that are not obvious from the results. Although the tall forest has the highest diversity, the inundated forest has the greater abundance of individuals/species. The tall forest occurs only in the south, while the inundated forest occurs all over the peninsula. However, the canopy of the inundated forests is higher in the south and consequently much richer in orchid species than in the north.

The Orchidaceae is the most diverse family, but also represents the greatest number of species which we did not locate (about 20 species); however, they are still included, because we were not able to visit all the sites previously explored by other researchers.

The Bromeliaceae has 19 species in 3 genera, with 17 species in the genus *Tillandsia,* and is most abundant in the low-statured inundated forest. Though the difference in species between the inundated and the tall and medium-statured evergreen forest is only 2, the abundance of individuals is greatest in the inundated forest.

We have insufficient habitat information about the 10 fern species. However, the medium-statured and tall semi-evergreen and evergreen forests are the dominant habitat of these species. The low inundated forest has few fern species, as far as we could ascertain.

The five epiphytic cacti are quite clearly separated by habitat, with *Epiphyllum phyllanthus* and *Rhipsalis baccifera* only occurring in the tall and medium-statured semi-evergreen forest, the two *Selenicereus* species being almost generalists, and the edible *Hylocereus* growing in the deciduous forest.

We do not have sufficient habitat information for Piperaceae and Araceae. Our observations suggest that the two peperomias and *Anthurium schlechtendalii* are found mostly in the semi-evergreen forests.

The environmental differences of the forest types determine to a great extent the richness of species and abundance of individuals of epiphytes. The tall forest or semi-evergreen forest and its medium-statured variety provide shade and humidity in their closed canopy. The low inundated forest has an open canopy throughout most of the peninsula (Olmsted & Duran 1986), but the canopy tends to close in the south, when *Bucida buceras* is the dominant tree species. The subdeciduous and deciduous forests are much drier than the other forest types. The deciduous forest tends to have a discontinuous canopy, letting in large amounts of sunlight. The subdeciduous forest is also more open than the semi-evergreen forest.

The low inundated forest is dominated by different tree species which have morphological characteristics that make them very good phorophytes (Olmsted & Duran 1986). The branching architecture and small spines of *Bucida spinosa* and *B. buceras* (Dejean *et al.* 1995) seem to catch the seeds of *Tillandsia.* While annually these forests may completely dry out for extended periods in the northern half of the Peninsula, such dry periods are shorter and less pronounced in the south, resulting in higher epiphyte richness in the southern low inundated forests than the northern ones.

Geographic Distribution of Epiphytes—Based on our field visits, current literature, and other investigators' results, we made geographic distribution maps for most species. However, in order to reduce the number of maps for this paper, we produced some general maps for several species that had similar distribution patterns. Orchids, in particular, had similar distributions. For some orchids, for which we only had one or two points, we were unable to map those for this paper.

Orchidaceae—FIGURES 3–7 are an indication of some distribution patterns. Eight species occur over most of the peninsula (FIGURE 3), in most of the forest types. We should point out that in

TABLE 1. Epiphyte species by family and habitat. Forest types: LIF = Low inundated MSD = Med-stat. subdeciduous. MSE = Med-stat. semi-evergreen, LDF = Low deciduous, TR = Tall evergreen, MG = Mangroves. + Indicates not seen by authors.

	LIF	MSD	MSE	LDF	TR	MG
Fam. Orchidaceae						
1. *Brassavola cucullata* (L.) R. Br.	*		*		*	
2. *B. nodosa* (L.) Lindl.	*	*	*			
3. *Brassia* cf. *maculata* R. Br. +					*	
5. *Bulbophyllum oerstedii* (Rchb. f.) Hemsl. +					*	
6. *Campylocentrum micranthum* (Lind.) Rolfe	*		*		*	
7. *C. pachyrrhizum* (Rchb. f.) Rolfe	*		*		*	
8. *C. peoppigii* (Rchb. f.) Rolfe	*		*		*	
9. *C. porrectum* (Rchb. f.) Rolfe	*				*	
10. *Catasetum integerrimum* Hook.	*	*	*		*	
11. *Coryanthes* cf. *picturata* Rchb. f. +	*					
12. *Dimerandra emarginata* (G. Mey.) Hoehne +	*					
13. *Encyclia alata* (Bateman) Schltr.	*	*	*	*	*	
14. *E. belizensis* (Rchb. f.) Schltr.	*	*	*	*	*	
15. *E. boothiana* (Lindl.) Dressler	*		*		*	
16. *E. bractescens* (Lindl.) Hoehne	*		*			
17. *E. cochleata* (L.) Lemée			*		*	
18. *E. livida* (Lindl.) Dressler +	*					
19. *E. nematocaulon* (A. Rich.) Acuña	*					
20. *E. papillosa* (Bateman) Aguire-Olavarrieta +				*	*	
21. *Epidendrum ciliare* L. +					*	
22. *E. difforme* Jacq.	*		*		*	
23. *E. imatophyllum* Lindl. +					*	
24. *E. isthmi* Schltr.					*	
25. *E. nocturnum* Jacq.	*		*		*	
26. *E. raniferum* Lindl. +			*		*	
27. *E. rigidum* Jacq.	*		*		*	
28. *E. secundum* Jacq.	*				*	
29. *E. stamfordianum* Batem.	*		*		*	
30. *E. strobiliferum* Rchb. f. +	*					
31. *Gongora unicolor* Schltr +					*	
32. *Ionopsis utricularioides* (Sw.) Lindl.					*	*
33. *Isochilus carnosiflorus* Lindl.	*		*		*	
34. *Laelia rubescens* Lindl.	*			*		
35. *Leochilus scriptus* (Scheidw.) Rchb. f. +					*	
36. *Maxillaria aciantha* Rchb. f. +					*	
37. *M. crassifolia* (Lindl.) Rchb. f. +					*	
38. *M. tenuifolia* Lindl.			*		*	
39. *Mormolyca ringens* (Lindl.) Schltr.					*	
40. *Myrmecophila* cf. *brysiana* (Lem.) G.C. Kenn. +					*	
41. *M. tibicinis* (Bateman) Rolfe	*	*	*		*	*
42. *Nidema boothii* (Lindl.) Schltr.	*		*		*	
43. *Notylia* cf. *barkeri* Lindl.	*		*		*	
44. *Oncidium ascendens* Lindl.	*	*	*	*	*	
45. *O. carthagenense* (Jacq.) Sw.	*	*	*		*	
46. *O. cebolleta* (Jacq.) Sw.		*			*	
47. *O. lindenii* Brongn. +					*	
48. *O. luridum* Lindl. +					*	
49. *O. sphacelatum* Lindl.			*		*	
50. *Ornithocephalus inflexus* Lindl.			*		*	
51. *Pleurothallis grobyi* Batem. ex Lindl.					*	
52. *P. tikalensis* Correll & C. Schweinf.	*				*	
53. *P. yucatanensis* Ames & C. Schweinf. +	*				*	
54. *Polystachya foliosa* (Hook.) Rchb. f.	*		*		*	
55. *Ponera striata* Lindl.			*		*	
56. *Rhyncholaelia digbyana* (Lindl.) Schltr.	*	*	*		*	*
57. *Scaphyglottis behrii* (Rchb. f.) Hemsl.	*					
58. *S. major* (C. Schweinf.) Correll +	*					
59. *Stelis gracilis* Ames. +	*				*	

TABLE 1. Continued.

	LIF	MSD	MSE	LDF	TR	MG
60. *S. ciliaris* Lindl.					*	
61. *Trichosalpinx foliata* (A. Griseb.) Luer +			*			
62. *Trigonodium egertonianum* Batem. ex Lindl.			*		*	
63. *Vanilla odorata* Presl			*		*	
64. *V. planifolia* G. Jackson		*	*		*	
Fam. Bromeliaceae						
1. *Aechmea bracteata* (Sw.) Griseb.	*	*	*	*	*	*
2. *Catopsis berteroniana* (Schultes f.) Mez	*		*			
3. *Tillandsia balbisiana* Schultes f.	*	*	*	*	*	
4. *T. brachycaulos* Schltdl.	*	*	*	*	*	
5. *T. bulbosa* Hook.	*		*		*	
6. *T. dasyliriifolia* Hook.	*					*
7. *T. elongata* var. *subimbricata* (Baker) L. B. Sm.				*		
8. *T. fasciculata* Sw.	*	*	*		*	
9. *T. festucoides* Brong. ex Mez			*	*	*	
10. *T. flexuosa* Sw.	*					
11. *T. paucifolia* Baker						*
12. *T. polystachia* (L.) L.		*		*		
13. *T. pseudobaileyi* C. S. Gardner	*		*		*	
14. *T. recurvata* (L.) L.		*		*		
15. *T. schiedeana* Steud.	*	*	*	*	*	
16. *T. streptophylla* Scheidw. ex Morren	*		*		*	*
17. *T. usneoides* (L.) L.	*	*	*	*	*	
18. *T. utriculata* L.	*					
19. *T. variabilis* Schltdl.	*	*	*			
Fam. Polypodiaceae						
1. *Adiantum tenerum* Sw.		*	*		*	
2. *Campyloneurum phyllitidis* (L.) Presl			*		*	
3. *Microgramma nitida* (J. Smith) A. R. Smith	*	*	*		*	
4. *Nephrolepis biserrata* (Sw.) Schott			*		*	
5. *Nephrolepis exaltata* (L.) Schott			*		*	
6. *Pecluma ferruginea* (Mart. & Gal.) M. G. Price			*		*	
7. *Phlebodium decumanum* (Willd) J Smith			*		*	
8. *Polypodium polypodioides* (L.) Watt.	*	*	*		*	
9. *Polypodium triseriale* Sw.			*		*	
10. *Vittaria lineata* (L.) J. E. Smith	*		*		*	
Fam. Cactaceae						
1. *Epiphyllum phyllanthus* (L.) Haworth	*		*		*	
2. *Hylocereus undatus* (Haworth) Britton & Rose			*	*	*	
3. *Selenicereus donkelaarii* (Salm-Dyck) Britton & Rose	*	*	*	*	*	
4. *S. testudo* (Karw.) Buxbaum	*		*		*	
5. *Rhipsalis baccifera* (J. Miller) W. T. Stearn			*		*	
Fam. Piperaceae						
1. *Peperomia crassiuscula* Millsp.	*		*		*	
2. *P. obtusifolia* (L.) Dietr.	*		*		*	
Fam. Araceae						
1. *Anthurium schlechtendalii* Kunth	*	*	*		*	
2. *Anthurium* sp.	*	*	*		*	

the central portion of Yucatán, where there is only secondary vegetation derived from low deciduous forest, these orchids do not exist.

In an area that covers practically all of the state of Quintana Roo and the southern portion of Campeche, where we find medium statured and tall semi-evergreen and inundated forests, another 12 species (FIGURE 4) are broadly distributed. Another six species (FIGURE 5) only occur in the very southern portion of the peninsula, in the tall semi-evergreen forest. However, as indicated in TABLE 1, there are many species that

TABLE 2. Total number of epiphytes per family and habitat.

	LIF	MSD	MSE	LDF	TR	MG
Orchidaceae	35	10	32	5	52	3
Bromeliaceae	14	9	12	9	10	4
Polypodiaceae	3	3	10		10	
Cactaceae	3	2	5	2	4	
Piperaceae	2		2		2	
Araceae	1	1	2		2	
Total number of epiphytes per habitat	58	25	63	16	80	7

occur in the tall forest, where we lack geographic information about them. For instance, Ucan, Ortega and Andrews (unpubl.) list 50 epiphytes for Calakmul Biosphere Reserve (4 are new registers for the Peninsula). Calakmul has the three most important habitats for orchids, but we do not know exactly where they occur.

However, other species, such as *Laelia rubescens,* seems to occur only in the western portion of the peninsula, in the drier forests. The newly registered orchid for the peninsula, *Epidendrum isthmi,* only occurs in a small area of the tall forest on the Belizean border. *Epidendrum imatophyllum,* several *Campylocentrum* species and the rarer *Epidendrum* and *Encyclia* species would have distributions like FIGURE 7, just one or two points.

The geographic distribution of the orchids on the Yucatán Peninsula is concentrated in the states of Quintana Roo and Campeche for two main reasons: the state of Yucatán is very disturbed, and the deciduous and subdeciduous forests that grew there are not major orchid habitats. If orchids do occur in northern Campeche and Yucatán, it is mostly along the coast where there are inundated forests and semi-evergreen hammocks.

Bromeliaceae—The most common species of this family is *Aechmea bracteata,* occurring in all vegetation types over the whole peninsula (FIGURE 8). *Tillandsia fasciculata* (FIGURE 9) is also common, occurring along with *T. brachycaulos, T. balbisiana* and *T. schiedeana.* Certain *Tillandsia* species, such as *T. elongata* var. *subimbricata* (FIGURE 10), only occur in a small area of the deciduous and subdeciduous forest in the state of Yucatán. *Tillandsia festucoides* (FIGURE 11) grows in the tall and medium semi-evergreen forest in the very southern portion of Quintana Roo and probably Campeche. *Tillandsia flexuosa* (FIGURE 12), only registered in 1984 for the Peninsula, was found in the seasonally inundated forest in northeastern and central Quintana Roo. *Tillandsia bulbosa* (not mapped) does not occur north of Sian Ka'an. *Tillandsia streptophylla* and *T. dasyliriifolia* (FIGURE 13) have a coastal distribution in hammocks and inundated forests as well as in mangroves, but do not occur inland, except in some of the extensive low inundated forests (FIGURE 2). *Tillandsia variabilis* (not mapped), which grows mostly in the subdeciduous forest, surrounded by semi-evergreen forest, and in the drier semi-evergreen forest, occurs mostly in central Quintana Roo and central Campeche.

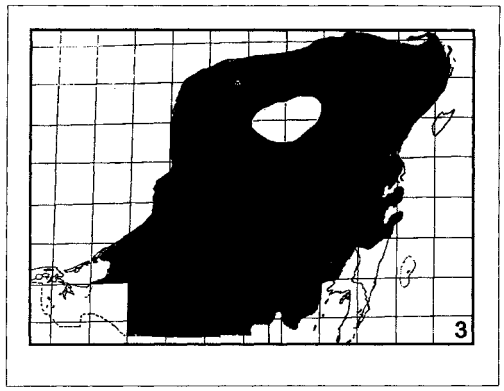
Tillandsia paucifolia, T. polystachia and *T. utriculata* (not mapped) have only two or three point distributions in the deciduous forest of Yucatán for the first two and the inundated forest on the island of Cozumel for the latter one. *Tillandsia pseudobaileyi* (not mapped) occurs commonly in the inundated forest of Quintana Roo and Campeche. *Catopsis berteroniana* (not mapped) has currently a discontinuous distribution between northern Quintana Roo, Sian Ka'an and western Campeche.

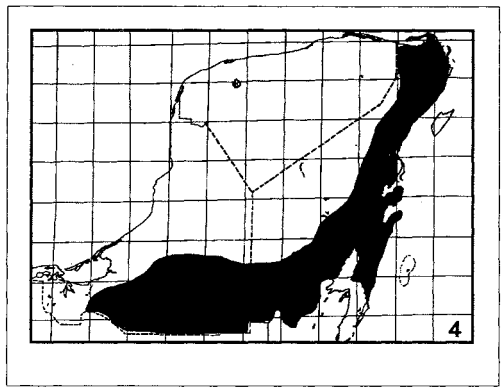
Where epiphyte species of certain forest types today show discontinuous distributions, we suggest several reasons: the once continuous habitat is now disturbed, the habitat is very restricted and not continuously distributed, our geographic distribution information is not sufficient, or the distribution is naturally disjunct.

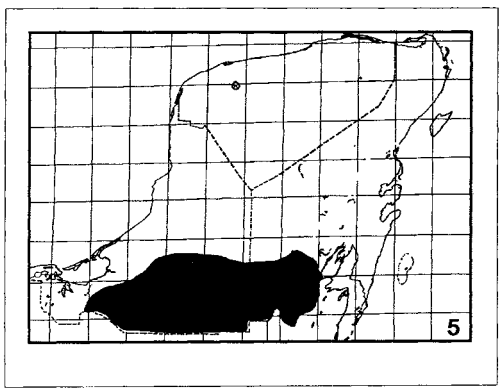
Cactaceae, Piperaceae, Araceae and Polypodiaceae—The species of the Cactaceae are indicated in FIGURES 14–16. *Selenicereus donkelaarii* occurs over most of the peninsula in most habitats, while *Selenicereus testudo* seems to be restricted to the more humid forests in Quintana Roo and Campeche. *Epiphyllum phyllanthus* seems to have a similar distribution to *S. testudo* in the semi-evergreen forest. *Rhipsalis baccifera* is a rare species today and has a disjunct distribution. *Hylocereus* occurs in the deciduous forest types in Yucatán and scantily in the semi-evergreen forest of the other two states.

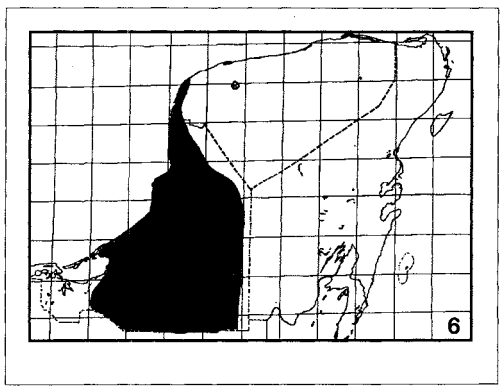
The peperomias (not mapped) also have a wide distribution, occurring in Quintana Roo and Campeche and much less in Yucatán.

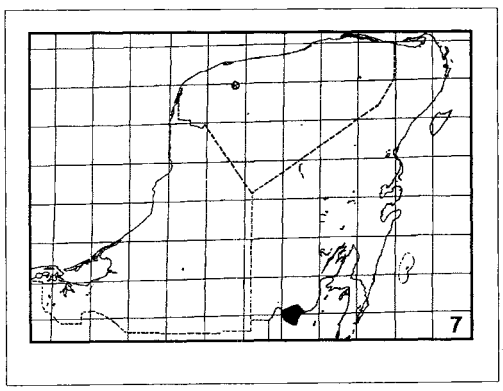
Anthurium schlechtendalii is widely distrib-



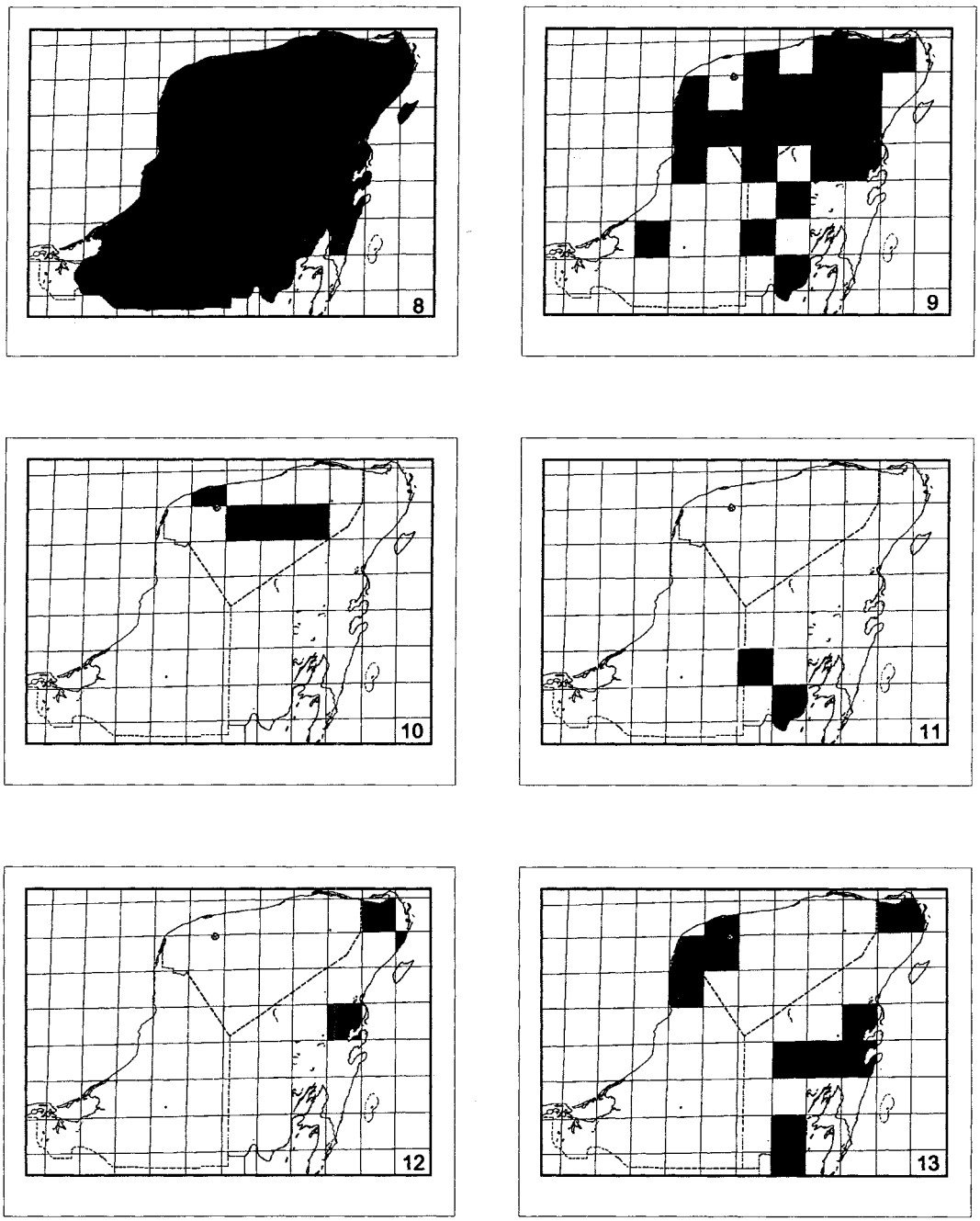








FIGURES 3–7. Distribution patterns of orchid species on the Yucatán Peninsula: 3. *Encyclia belizensis, E. alata, Oncidium ascendens, O. carthagenense, Rhyncholaelia digbyana, Brassavola nodosa, Catasetum integerrimum, Myrmecophila tibicinis.* 4. *Vanilla odorata, Brassavola cucullata, Encyclia boothiana, E. cochleata, Pleurothallis grobyi, Epidendrum rigidum, E. difforme, E. stamfordianum, Oncidium sphacelatum, Ornithocephalus inflexus, Polystachya foliosa.* 5. *Ponera striata, Scaphyglottis behrii, Isochilus carnosiflorus, Maxillaria tenuifolia, Nidema boothii, Trigonidium egertonianum.* 6. *Laelia rubescens* 7. *Epidendrum isthmi.*

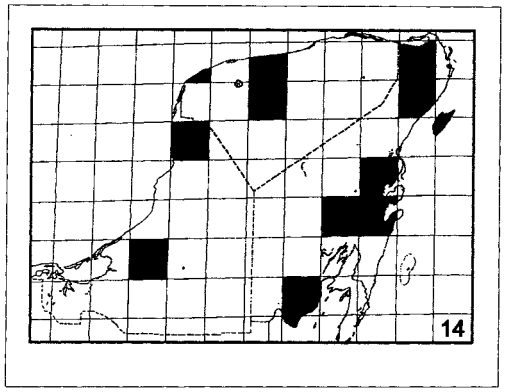


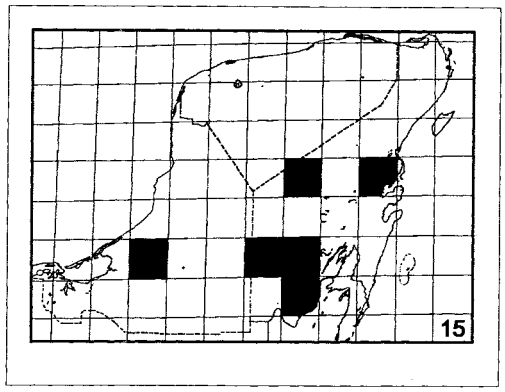
FIGURES 8–13. Distribution patterns of Bromeliaceae. 8. *Aechmea bracteata* 9. *Tillandsia fasciculata* 10. *Tillandsia elongata* var. *subimbricata* 11. *Tillandsia festucoides* 12. *Tillandsia flexuosa* 13. *Tillandsia streptophylla.*

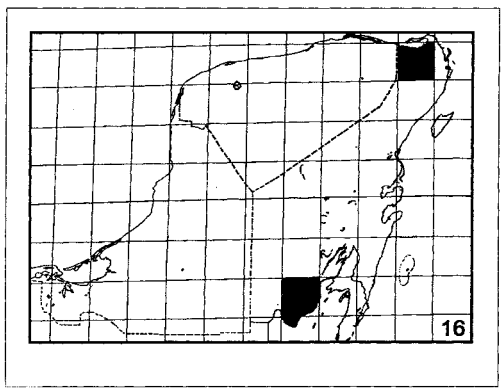
uted over the Peninsula (similar to the orchid distribution pattern of FIGURE 3), while the unknown species is only found in the southern portion of Campeche and Quintana Roo in the tall-medium semi-evergreen forest.

For the epiphytic ferns we have scant information for southeastern Quintana Roo and therefore have not included the maps.

Conservation of Habitats and Epiphytes—Dur-







FIGURES 14–16. Distribution patterns of Cactaceae: 14. *Selenicereus donkelaarii* 15. *Epiphyllum phyllanthus* 16. *Rhipsalis baccifera.*

ing the last 20 years, we have witnessed a large reduction of mature forest and an increase in disturbed vegetation and agricultural and cattle land on the Yucatán Peninsula. FIGURE 1 is an indication of potential vegetation. By 1981 INEGI estimated that the state of Yucatán was totally disturbed, and that the remaining non-disturbed land was located in Quintana Roo and Campeche. During the last 13 years much more forest has become disturbed or permanently lost. In an ongoing study about vegetation change in México between the 1970's and the early 1990's, we have begun an evaluation of the Peninsula, starting with the southern portion of Quintana Roo, based on Landsat satellite images. Table 3 shows the percent conversion that has occurred from mature semi-evergreen and inundated forest to agriculture and cattle ranching as well as other developments.

Much secondary vegetation of the semi-evergreen forest, usually as a result of burning and abandonment after milpa, is totally devoid of epiphytes. The epiphytes usually do not survive fire. Natural recolonization would take many more years than the recuperation of the trees. We have looked at many different ages of secondary vegetation (5–30 years) without finding epiphytes. In the Yucatán, the medium-statured semi-evergreen forest is still the most extensive and continues to provide a habitat for epiphytes

TABLE 3. Change of vegetation cover 1975–1994 in southern Quintana Roo.

	1975 Hectares	1994 Hectares	% change
Low inundated forest	381 566	280 646	−26.4
Medium semi-evergreen forest	520 594	321 655	−38.2
Agriculture-cattle	12 519	66 472	430
Secondary vegetation	236 307	405 351	71

though it is harvested on a continual basis. Most of the harvesting (except for cattle or tourism) is not done on a clearcut basis, so that many trees are left standing and epiphytes saved. The tall semi-evergreen or evergreen forest is severely threatened because of its restricted distribution and people's preference to clearcut it for agriculture and cattle ranching. Despite the fact that the low inundated forest is now being used for extensive agriculture, its inaccessibility, wide mosaic pattern distribution over the peninsula, and its infrequent fires may make it the safest habitat for many epiphytes.

Most epiphyte populations have been reduced during the last 20 years due to habitat loss and overcollecting. But what about the existing populations? There are relative differences in detection of populations of epiphytes between the populations of the semi-evergreen forest and the inundated forest. Since the inundated forest is usually dominated by one tree species (e.g., one of the major phorophytes such as *Bucida spinosa, B. buceras* or *Haematoxylum campechianum),* the chances of encountering epiphytes are great over a short distance. In the tall forest, with good phorophytes scattered over a larger area, finding epiphytes is more difficult. In some very dense inundated forests, populations of orchids and tillandsias are continuous over extensive areas. This is not the case in the tall forest, where one tree may be host to a lot of epiphytes and these trees may be rare.

Almost all *Tillandsia* species occur in groups of ramets, vegetatively produced, with various groups sometimes occurring on one tree. Exceptions are *T. dasyliriifolia, T. flexuosa, T. utriculata* and *Catopsis.*

Common species of *Encyclia* and *Epidendrum* as well as *Oncidium* occur in groups. Some of the largest in the inundated forest are *Rhyncholaelia digbyana* and *Brassavola nodosa.* However, we agree with Bennett (1986) that, except for the orchids mentioned, there are fewer orchid individuals within a large number of species, but the reverse holds true for bromeliads.

Of 63 epiphytic species of orchids known in this region, we did not see 22 species. Some are probably not on the peninsula any more because of their rarity, or perhaps they have become locally extinct due to loss of their habitat. The remaining 44 species contain some of the most common orchids which are healthy and have quite a few populations in the same habitat, such as *Encyclia belizensis, Rhyncholaelia digbyana, Oncidium ascendens, O. carthagenense,* and *Brassavola nodosa.* Species for which we found few and small populations are all the *Campylocentrum* species, *Epidendrum isthmi,* and *Scaphyglottis behrii. Isochilus carnosiflorus, Ponera striata,* and *Trigonidium egertonianum* fall into a pattern between the other two groups.

The most common epiphyte in the Bromeliaceae is *Aechmea bracteata,* represented by all age groups in all habitats. This species has a mutualistic association with an ant as well as other fauna (Dejean *et al.* 1995). These associations may provide advantages which allow *Aechmea* to grow in many habitats. *Catopsis berteroniana* was found in variable populations, once in a large population with lots of adults and non-reproducing plantlets, but mostly with very few adults and some young plantlets.

We found most of the *Tillandsia* species in reproducing populations, especially those which sprout vegetatively more than others, such as *T. brachycaulos* (on trunks), *T. schiedeana,* and *T. recurvata* (on canopy branches). Where they occur, *T. bulbosa* and *T. pseudobaileyi* have sizeable populations. In certain areas of Quintana Roo, *T. balbisiana* and *T.flexuosa* have disappeared. *Tillandsia flexuosa,* which was found in 1984 for the first time on the peninsula, has not been found again by the senior author in the same sites. We found *T. elongata* in large populations outside of Dzibilchaltún, increasing its known distribution.

Tillandsia paucifolia was seen only infrequently in very small populations. A species mentioned by Garcia (1987), *T. polystachia,* was not found. *Tillandsia streptophylla* and *T. dasyliriifolia* are usually found in large populations with individuals of all sizes. *Tillandsia festucoides* grows in small populations in the shade of the evergreen forest in only a few places.

We know very little about the fern populations, since most of our information was taken from Torres (1991), which covers only the southeastern portion of Quintana Roo. In most of the places we visited, we did not come across many epiphytic ferns. However, our observations suggest they are more common in the tall forest. *Anthurium schlechtendalii* occurs commonly in various habitats and has reproducing populations. Only a few individuals of the unknown species of that genus were seen, so we cannot give any information on populations. *Peperomia* populations occur infrequently, but sufficiently, to guarantee its survival. Its vegetative sprouting capacity makes for large cushions of both species.

The epiphytic cacti, especially *Selenicereus, Hylocereus,* and *Epiphyllum,* grow almost as vines on trees, so that it is difficult to define a population. However, they appear in sufficient vegetative volume that they appear abundant. All five species have been found flowering.

Rhipsalis is the only species that occurs as several plants high up in the forks of branches of trees, but it is rare and may be collected.

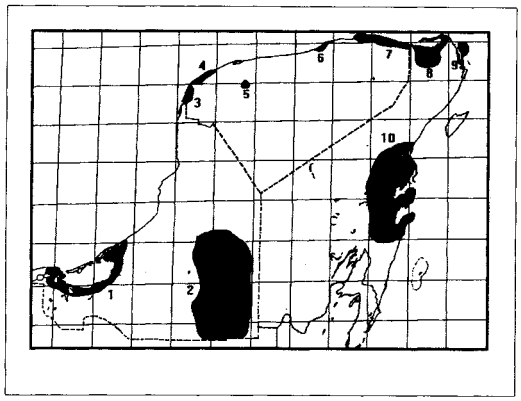


FIGURE 17. Natural protected areas of the Yucatán Peninsula.

Natural Protected Areas—FIGURE 17 shows the natural protected areas of the peninsula. In June of 1994, the Mexican president decreed one marine and two more terrestrial reserves: Yum Balam in northern Quintana Roo and the area around Laguna de Terminos in Campeche, comprising a total of 11 reserves with about 10% of the area protected. This is unprecedented in México. The largest reserves, Calakmul and Sian Ka'an, have a good representation of all important epiphyte habitats. The coastal reserves protect inundated forests and mangroves. Yum Balam has medium semi-evergreen forest and quite a bit of inundated forest and marshes, as well as mangroves.

The natural protected areas facilitate habitat conservation, but will not necessarily deter people from collecting due to lack of enforcement. The tall semi-evergreen or evergreen forest is endangered, because of its restricted distribution and its desirability for agriculture and cattle ranching. The new environmental laws on the Peninsula will help reduce destruction of the habitat. Tourist development needs to be in accordance with strict environmental rules regarding use of plants and animals, clearing and reforestation. The growing awareness by the campesinos that plants in general may be of importance to them if left intact, also holds for epiphytes. With CICY's help, rural communities are beginning to propagate plants from seed, creating an alternative income. They are propagating native orchids *in vitro* for sale in the future. An environmental program in the Regional Botanical Garden of CICY educates school children about the need for conservation.

We conclude that the 101 epiphytes listed occur in five different habitats on the Yucatán Peninsula. All habitats are threatened to some degree, but the tall forest and the deciduous forest are the most threatened (the latter having the least epiphytes). The low inundated forest is rich in epiphytes, and probably the least threatened, although there are increasing threats from cattle ranching and rice cultivation. Many of the epiphytes studied have healthy populations in the natural protected areas. However, some orchids are endangered because they are rare and grow in the tall rainforest. Most of the *Tillandsia* species are well established in the low inundated forest and in certain hammocks.

It is difficult to enforce the law against epiphyte collection. The cultivation of orchids and bromeliads for sale is an effective conservation mechanism.

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