



# **PLANTS CONSUMED BY BLACK HOWLERS IN THE STATE OF CAMPECHE, MEXICO**

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**ABSTRACT.** Information on the plants used as food sources by herbivorous is fundamental to acknowledge many basic aspects of their biology and to understand their habitat requirements. The aim of the present study was to provide a list of plants used by black howlers (*Alouatta pigra*) as food sources throughout the state of Campeche. From March 2005 to March 2008 we studied 11 groups using the focal-animal sampling (1 h samples) with a continuous recording. Each time the focal-animal fed, we recorded the feeding time, marked the plant that was used, and all marked plants were subsequently identified to species level. We listed the plant species, families and life forms that were used, the similarity between groups (with the Sorensen index) in terms of species used as food sources, and defined top-food species for these groups. During 1,925 h of systematic recordings, black howlers fed from 132 different plants species, belonging to 56 families. Trees were the most used life form (65.9%), followed by vines (23.5%), parasite forms (5.2%), shrubs (4.6%) and palms (0.8%). The average similarity between study groups was low ( $0.27 \pm 0.14$ ), suggesting that diet diversity was different among groups. We identified eight top-food species for our sample of groups. These represent only 6.1% of all plants used but accounted for *ca.* 50% of the total feeding time: *Ficus cotinifolia*, *Brosimum alicastrum*, *Manilkara zapota*, *Trophis racemosa*, *Platymiscium yucatanum*, *Ficus maxima*, *Piscidia piscipula*, and *Ficus lundellii*. Our results show that black howlers have a highly diverse diet, as they use a large array of plant species as food sources, and the composition of their diet was extremely variable across groups. This variation is probably the result of both a process of dietary adaptation to the local availability of foods, and the generalist feeding habits of howlers.

**Key Words:** *Alouatta pigra*, diet, Campeche

**RESUMEN.** La información acerca de las plantas usadas como fuentes de alimento por herbívoros, es fundamental para conocer varios aspectos básicos de su biología. En este trabajo se aporta un listado de las plantas usadas como alimento por los monos aulladores negros (*Alouatta pigra*) en el estado de Campeche. De marzo de 2005 a marzo de 2008



estudiamos 11 grupos con el muestreo animal-focal y un registro continuo. Se registró el tiempo de alimentación, se marcaron las plantas usadas, y todas las plantas marcadas fueron identificadas a nivel de especie. Se reportan la especie, familia y forma de vida de cada planta usada, la similitud entre grupos de estudio en términos de las especies usadas como alimento, y se definen las especies de alimento más usadas para estos grupos. A lo largo de 1925 h de observación, los individuos consumieron 132 especies pertenecientes a 56 familias. Los árboles fueron la forma de vida más usada (65.9%), seguidos por las enredaderas (23.5%), parásitas (5.2%), arbustos (4.6%) y palmas (0.8%). La similitud promedio entre los grupos fue baja ( $0.27 \pm 0.14$ ), lo que sugiere que la diversidad de la dieta fue diferente entre grupos. Identificamos ocho especies más usadas para estos grupos. Éstas representan solamente el 6.1% de todas las plantas usadas pero suman *ca.* 50% del tiempo total de alimentación: *Ficus cotinifolia*, *Brosimum alicastrum*, *Manilkara zapota*, *Trophis racemosa*, *Platymiscium yucatanum*, *Ficus maxima*, *Piscidia piscipula*, y *Ficus lundellii*. Nuestros resultados muestran que los monos aulladores negros tienen una dieta muy diversa, ya que usan un conjunto muy amplio de especies de plantas como fuentes de alimento, y la composición de su dieta es notablemente variable entre grupos. Esta variación es probablemente el resultado de un proceso de adaptación a la disponibilidad local de alimentos, y de los hábitos alimenticios generalistas de los monos aulladores.

**Palabras clave:** *Alouatta pigra*, dieta, Campeche

## INTRODUCTION

An organism's diet is a fundamental aspect of its ecological niche, and the quantification of diets has long been, and continues to be, one of the first steps in studying a species' basic ecology. In herbivores, studies of behavioral mechanisms that lead to diet choice have sought to understand the relation between plant nutrient content and preferences (e.g., Arnold 1981), how herbivores attempt to overcome the defenses of plants to gain



access to these nutrients (e.g., Belovsky & Schmitz 1994), and how resource abundance, distribution and density affect animal foraging strategies (e.g., Stephens & Krebs 1986).

Howler monkeys (*Alouatta* spp.) are folivorous-frugivorous primates known for their ability to exploit a large array of life forms, plant species and plant parts (Di Fiore & Campbell 2007). In spite of their generalist diets, several studies have found that howlers show a marked preference to consume plants from the Fabaceae and Moraceae families (e.g., *Alouatta belzebul*: Pinto & Setz 2004; *Alouatta palliata*: Milton 1980; *Alouatta seniculus*: Orihuela *et al.* 2005). In the case of black howlers (*Alouatta pigra*) the food sources used by individuals have been described in a few studies, and for the Mexican populations of this species, only two studies have been published. Pozo-Montuy & Serio-Silva (2006) and Rivera & Calmé (2006) studied one and five groups, respectively, and report the plant species used as food sources. These studies, as well as studies with Guatemalan (Coelho *et al.* 1976) and Belizean populations (Behie & Pavelka 2005; Silver *et al.* 1998), found that, like other howlers, black howlers show a preference for Moraceae.

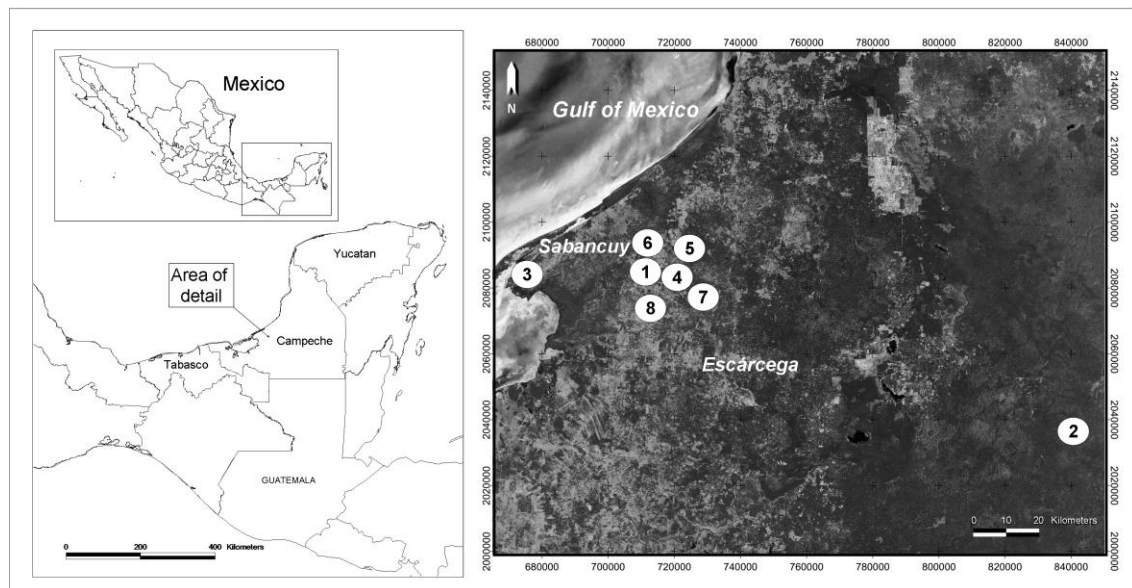
The objective of the present study was to examine the use of plants by black howlers in the state of Campeche. In particular, we 1) present a list of the plant species used as food sources by 11 groups of black howlers distributed throughout this state, 2) evaluate the similarity in the use of plant species across groups, 3) and provide a list of top-food species for this sample of groups. This information will improve our knowledge about the feeding behavior of black howlers, and shed light on the habitat requirements of this endangered primate species in terms of vegetation composition.

## **MATERIALS AND METHODS**

**Study sites.** The Campeche state is located in the Yucatan Peninsula, and approximately 40% of its territory is protected (Gobierno del Estado de Campeche 2009). However, several areas have been disturbed by human activities, and therefore, many populations of



black howlers live in forest fragments with varying sizes, vegetation characteristics, isolation, etc. For this study, we selected 11 groups of black howlers living in eight different sites (Figure 1): two groups were studied in a 96 ha fragment inside a silvicultural ranch called El Alamo ( $18^{\circ} 48.5' N$ ,  $90^{\circ} 58.9' W$  and  $18^{\circ} 48.7' N$ ,  $90^{\circ} 58.9' W$ ); two groups were observed in the Reserva de la Biósfera Calakmul, both in the southern core-area of this preserve, which sums up to 140,000 ha ( $18^{\circ} 27.7' N$ ,  $89^{\circ} 54.1' W$  and  $18^{\circ} 18.7' N$ ,  $89^{\circ} 52.1' W$ ); at the buffer-zone of the Área de Protección Especial Laguna de Términos, we observed another two groups. These groups lived in a 3,000 ha area surrounded by flooded areas ( $18^{\circ} 51.1' N$ ,  $91^{\circ} 18.6' W$  and  $18^{\circ} 50.1' N$ ,  $91^{\circ} 18.4' W$ ); five groups that lived in small forest fragments in the Sabancuy area, namely, Chicbul with 5 ha ( $18^{\circ} 46.9' N$ ,  $90^{\circ} 56.3' W$ ), Chilar with 2.1 ha ( $18^{\circ} 54.1' N$ ,  $90^{\circ} 53.5' W$ ), Oxcabal with 7.5 ha ( $18^{\circ} 51.8' N$ ,  $90^{\circ} 57.7' W$ ), Torre 39 with 1.1 ha ( $18^{\circ} 42.2' N$ ,  $90^{\circ} 53.2' W$ ), Torre 59 with 5.8 ha ( $18^{\circ} 45.2' N$ ,  $90^{\circ} 57.6' W$ ). Our observations were performed in a total of 20 males and 28 females; we analyzed data corresponding to only adult individuals to avoid any possible age-related bias in feeding behavior.



**Figure 1.** Map of Mexico showing the location of the study sites (see Appendix 1 for site names).



**Data collection.** As part of a broader research on the activity patterns of black howlers, we used the focal-animal sampling method with a continuous recording (1 h samples; Whitehead 2008) to study the feeding behavior of individuals. A feeding bout was defined as any instance the focal animal took a plant into his mouth. The duration of all feeding bouts was recorded (to the nearest second), and the plants used by the focal as food sources were marked for posterior taxonomic identification. Recordings were rotated among group members so that all were observed for similar amounts of time. We observed each group for 175 h, distributed through approximately 30 continuous days of fieldwork per group. Similar proportions of data were collected in morning (7:00 to 12:00) and afternoon (12:00 to 17:00) hours. All observations were performed during the months of December to May (i.e., dry seasons; Vidal-Zepeda 2005) of the years 2005-2008.

**Vegetation sampling.** Each marked plant that was used as a feeding source by black howlers was identified to species level, and plants that could not be identified in the field were collected for identification at the "Alfredo Barrera Marín" (UADY) and UCAM (Centro de Investigaciones Históricas y Sociales, UAC) herbaria. During field identification we also noted the life growth form of each plant: epiphyte, palm, shrub, tree and vine.

**Organization of data.** In this study we follow the nomenclature proposed by the Missouri Botanical Garden database Tropicos (Tropicos.org 2009). In the case of family names, we also indicate the updated names proposed by The Angiosperm Phylogeny Group (APG 2003). Nevertheless, in Appendix 1 we follow prior family nomenclatures, as they allow an easier comparison with previous studies on the diet of howlers.

We describe and number the species, families and life forms used by individuals. Additionally, in order to assess variation among groups in the use of plant species, we calculated the average Sorensen similarity index with the software EstimateS (Colwell 2006). Finally, to provide a preliminary list of preferred (i.e., most used) plants used by



black howlers as food sources, we quantified which plant species and families represented 50% and 80% of feeding time (Bicca-Marques 2003).

## RESULTS

The groups used a total of 132 plant species, belonging to 56 families (Appendix 1). Trees were the most used life form (65.9%), followed by vines (23.5%), parasite forms (5.2%), shrubs (4.6%) and palms (0.8%).

The average ( $\pm$ SD) similarity between groups concerning the use of plant species was low,  $0.27\pm 0.14$ , as an important proportion of species (61.4%) were used by only one or two groups. In contrast, although no species was used by more than nine groups, nine species (6.8% of the total number of species used) were consumed by eight and seven groups. Eight species (i.e., 6.1% of the total number of species used) contributed with 50% of the total feeding time, and 28 species (i.e., 21.2% of all species) contributed with 80% of total feeding time (Table 1).

Some families were represented in the diet of black howlers by many species, such as Fabaceae (23 species), Moraceae (9), and Sapotaceae (8), and only two families were present in the diet of all groups, Fabaceae and Moraceae. After excluding unidentified families, 62.7% of the families were represented in the diet of black howlers by a single species. Moraceae (35.2%) and Fabaceae (25.7%) represented more than 50% of total feeding time, and together with Sapotaceae (9.8%), Anacardiaceae (3.5%), Convolvulaceae (3.0%), Sterculiaceae (2.0%) and Verbenaceae (2.0%), more than 80% of total feeding time.



**Table 1.** Top-food species of black howlers in Campeche: species accounting for 50% (shaded) and 80% (plain) of total feeding time

Species	% *	Family	Nº groups
<i>Ficus cotinifolia</i> Kunth	8.68 (0 - 44.97)	Moraceae	4
<i>Brosimum alicastrum</i> Sw.	8.09 (0 - 37.17)	Moraceae	6
<i>Manilkara zapota</i> (L.) P. Royen	7.98 (0 - 27.21)	Sapotaceae	7
<i>Trophis racemosa</i> (L.) Urb.	5.70 (0 - 25.81)	Moraceae	6
<i>Platymiscium yucatanum</i> Standl.	5.66 (0 - 19.88)	Fabaceae	2
<i>Ficus maxima</i> Mill.	5.43 (0 - 45.55)	Moraceae	2
<i>Piscidia piscipula</i> (L.) Sarg.	4.55 (0 - 31.61)	Fabaceae	8
<i>Ficus lundellii</i> Standl.	4.19 (0 - 74.93)	Moraceae	3
<i>Lysiloma latisiliquum</i> (L.) Benth.	3.32 (0 - 15.26)	Fabaceae	8
<i>Lonchocarpus yucatanensis</i> Pittier	3.21 (0 - 33.06)	Fabaceae	2
<i>Ficus sp.</i>	2.28 (0 - 10.04)	Moraceae	5
<i>Guazuma ulmifolia</i> Lam.	2.02 (0 - 8.31)	Sterculiaceae	6
<i>Lonchocarpus castilloi</i> Standl.	2.02 (0 - 18.58)	Fabaceae	7
<i>Vitex gaumeri</i> Greenm.	2.00 (0 - 25.49)	Verbenaceae	7
<i>Metopium brownei</i> (Jacq.) Urb.	1.72 (0 - 7.69)	Anacardiaceae	4
<i>Bursera simaruba</i> (L.) Sarg.	1.66 (0 - 11.02)	Burseraceae	8
<i>Acacia dolichostachya</i> S.F. Blake	1.47 (0 - 6.24)	Fabaceae	2
<i>Aristolochia pentandra</i> Jacq.	1.45 (0 - 7.30)	Aristolochiaceae	6
<i>Swartzia cubensis</i> (Britton & P. Wilson) Standl.	1.32 (0 - 5.35)	Fabaceae	4
<i>Bucida buceras</i> L.	1.24 (0 - 2.91)	Combretaceae	8
<i>Leucaena leucocephala</i> (Lam.) de Wit	1.01 (0 - 12.12)	Fabaceae	5
<i>Enterolobium cyclocarpum</i> (Jacq.) Griseb.	0.91 (0 - 21.59)	Fabaceae	2
<i>Jacquemontia agrestis</i> (Mart. ex Choisy) Meisn.	0.91 (0 - 5.04)	Convolvulaceae	5
<i>Ipomoea</i> L.	0.89 (0 - 2.14)	Convolvulaceae	7
<i>Luehea speciosa</i> Willd.	0.87 (0 - 3.80)	Tiliaceae	3
<i>Astronium graveolens</i> Jacq.	0.83 (0 - 4.73)	Anacardiaceae	5
<i>Evolvulus nummularius</i> (L.) L.	0.81(0 - 3.33)	Convolvulaceae	3
<i>Spondias radlkoferi</i> Donn. Sm.	0.78 (0 - 8.77)	Anacardiaceae	5

\* Percentage of total feeding time and range of variation among groups.





## DISCUSSION

First, it should be noted that the present study represents a broad-scale evaluation of the use of plants as food sources by black howlers, not a research on dietary selectivity, as the composition, abundance and distribution of plants in our field sites were not quantified. Therefore, although we discuss trends in terms of dietary preferences, these must be corroborated in the future through direct assessments of species availability in black howlers' habitats (see Rivera & Calmé 2006).

We defined a preliminary list of top-food species for black howlers in Campeche, Mexico. This information may be used to evaluate habitat quality for *Alouatta pigra* in disturbed landscapes (e.g., by estimating food availability in habitat remnants), similar to what has been done in studies with *Alouatta palliata* (e.g., Arroyo-Rodríguez & Mandujano 2006). In general, this list is coincident with previous research (Coelho *et al.* 1976; Silver *et al.* 1998; Behie & Pavelka 2005; Pozo-Montuy & Serio-Silva 2006; Rivera & Calmé 2006), and highlights the role of species belonging to the families Fabaceae and Moraceae as keystone taxa in the diet of howlers (e.g., Serio-Silva *et al.* 2002). Legumes are among the most dominant plant families in rainforests, and both Fabaceae and Moraceae are common among the tree flora of any tropical rainforest (Primack & Corlett 2005). *Ficus*, in particular, is the most important genus within the Moraceae family, with more than 750 species currently recognized (Jousselin *et al.* 2003). As figs produce successive fruit crops year-round, they are very important in supporting the vertebrate communities of tropical rain forests (Shanahan *et al.* 2001). Therefore, the dietary preference shown by howlers towards common food sources highlights their energetically conservative lifestyle.

Similarity in the use of plant species was low, reflecting an important variation in the use of food species across study groups. It is important to note that our samplings were short-termed and included groups inhabiting different areas. These aspects may have



underestimated similarity due to insufficient sampling and/or to variation in vegetation characteristics. However, our sampling effort was very high, concentrated in a single season and similarity levels were, in all cases, higher between groups living in the same location (e.g., Alamo A and Alamo R). Based on this effort and internal consistency of data, we believe that our results are representative of the diet of black howlers in Campeche. In addition, comparable levels of similarity (i.e.  $\approx 30\%$ ) have been found in previous comparisons of the species used as food sources by howlers and *Ateles* spp. (Cristóbal-Azkarate & Arroyo-Rodríguez 2007; González-Zamora *et al.* 2009). In the future, we will expand our samplings in order to include wet season observations, add new groups to our sample and analyze the effects of variation in habitat characteristics on the diet of black howlers.

As a concluding remark, note that some of the species used by black howlers as food sources in this study are categorized by the IUCN in risk categories, such as *Vitex gaumeri* (Endangered), *Cedrela odorata*, *Swietenia macrophylla* (Vulnerable), *Acacia dolichostachya* and *Aspidosperma megalocarpon* (Near Threatened). Additionally, the conservation status of the majority of species reported in this study (92%) has not been evaluated by the IUCN. In order to improve our understanding of the population dynamics of this endangered primate, and in particular, of the persistence of individuals in disturbed habitats, we need to assess more thoroughly the patterns of occurrence, distribution and abundance of the plants used as food sources by black howlers.

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## Perspectivas en Primatología Mexicana



**Appendix 1.** Families, species and life forms of plants used as food sources by 11 groups of black howlers in Campeche

Family	Species	1*	2	3	4	5	6	7	8	9	10	11	Growth form
Anacardiaceae	<i>Astronium graveolens</i> Jacq.			x		x	x			x	x		Tree
	<i>Metopium brownei</i> (Jacq.) Urb.	x	x			x		x					Tree
	<i>Spondias mombin</i> L.					x							Tree
	<i>Spondias radlkoferi</i> Donn. Sm.	x	x	x			x	x					Tree
	<i>Spondias</i> sp.					x							Tree
Annonaceae	<i>Annona glabra</i> L.							x					Tree
Apocynaceae	<i>Aspidosperma megalocarpon</i> Müll. Arg.	x		x						x			Tree
	<i>Echites</i> sect. <i>Umbellatae</i> Woodson	x					x			x			Vine
Aquifoliaceae	<i>Ilex</i> sp.	x											Tree
Araliaceae	<i>Dendropanax arboreus</i> (L.) Decne. & Planch.	x											Tree
	<i>Schefflera morototoni</i> (Aubl.) Maguire, Steyerl. & Frodin										x		Tree
Arecaceae	<i>Sabal yapa</i> C. Wright ex Becc.	x	x			x						x	Palm
Aristolochiaceae	<i>Aristolochia pentandra</i> Jacq.	x	x			x	x	x		x			Vine
Asclepiadaceae <sup>1</sup>	<i>Gonolobus yucatanensis</i> (Woodson) W.D. Stevens	x	x					x		x			Vine
	<i>Marsdenia coulteri</i> Hemsl.			x									Vine
	<i>Mateleia campechiana</i> (Standl.) Woodson	x				x							Vine
	<i>Mateleia crassifolia</i> Woodson	x								x			Vine
Asteraceae	<i>Eupatorium quadrangulare</i> DC.							x					Shrub
	<i>Otopappus guatemalensis</i> (Urb.) R.L. Hartm. & Stuessy					x	x						Vine
Bignoniaceae	<i>Arrabidaea floribunda</i> (Kunth) Be	x					x	x		x		x	Vine
	<i>Bignoniaceae</i> sp. 1			x									Vine
	<i>Macfadyena unguis-cati</i> (L.) A. Gentry	x				x	x						Vine
	<i>Tabebuia chrysantha</i> (Jacq.) G. Nicholson			x									Tree
	<i>Tabebuia rosea</i> (Bertol.) A. DC.				x	x	x						Tree
Bombacaceae <sup>2</sup>	<i>Ceiba aesculifolia</i> (Kunth) Britten & Baker f.		x	x									Tree
Boraginaceae	<i>Cordia curassavica</i> (Jacq.) Roem. & Schult.						x						Shrub
	<i>Cordia</i> sp.	x											Tree



Perspectivas en Primatología Mexicana



Appendix 1. (cont.)

Family	Species	1*	2	3	4	5	6	7	8	9	10	11	Growth form
Boraginaceae	<i>Ehretia tinifolia</i> L.			x									Tree
Burseraceae	<i>Bursera simaruba</i> (L.) Sarg.	x	x			x	x	x		x	x	x	Tree
Cactaceae	<i>Hylocereus undatus</i> (Haw.) Britton & Rose		x							x			Epiphyte
Caricaceae	<i>Carica papaya</i> L.							x					Tree
Cecropiaceae <sup>3</sup>	<i>Cecropia obtusifolia</i> Bertol.					x		x					Tree
Clusiaceae	<i>Calophyllum brasiliense</i> Cambess.	x	x										Tree
Cochlospermaceae	<i>Cochlospermum vitifolium</i> (Willd.) Spreng.						x						Tree
Combretaceae	<i>Bucida buceras</i> L.	x	x			x	x	x		x	x	x	Tree
Convolvulaceae	<i>Evolvulus nummularius</i> (L.) L.	x						x		x			Vine
	<i>Ipomoea</i> sp.	x	x			x	x	x		x		x	Vine
	<i>Jacquemontia agrestis</i> (Mart. ex Choisy) Meisn.	x	x			x	x			x			Vine
	<i>Merremia cissoides</i> (Lam.) Hallier f.	x	x										Vine
	<i>Turbina corymbosa</i> (L.) Raf.								x				Vine
Cucurbitaceae	<i>Cucurbita lundelliana</i> L.H. Bailey	x					x			x			Vine
Dioscoreaceae	<i>Dioscorea polygonoides</i> Humb. & Bonpl. Ex Willd.							x		x			Vine
Euphorbiaceae	<i>Croton draco</i> Schlttdl. & Cham.	x	x										Tree
	<i>Croton schiedeana</i> Schltr.		x										Tree
	<i>Dalechampia scandens</i> L.	x	x	x		x	x	x		x			Vine
	<i>Drypetes lateriflora</i> (Sw.) Krug & Urb.						x						Tree
	<i>Euphorbiaceae</i> sp. 1					x							Tree
	<i>Phyllanthus ferax</i> Standl.							x					Tree
	<i>Sapium lateriflorum</i> Hemsl.	x											Tree
Fabaceae	<i>Acacia dolichostachya</i> S.F. Blake					x	x						Tree
	<i>Acacia</i> sp.			x									Tree
	<i>Cassia grandis</i> L. f.						x						Tree
	<i>Centrosema virginianum</i> (L.) Benth							x		x		x	Vine
	<i>Cojoba arborea</i> (L.) Britton & Rose						x						Tree
	<i>Enterolobium cyclocarpum</i> (Jacq.) Griseb.						x		x				Tree
	<i>Fabaceae</i> sp. 1							x					Tree





Perspectivas en Primatología Mexicana



Appendix 1. (cont.)

Family	Species	1*	2	3	4	5	6	7	8	9	10	11	Growth form
Fabaceae	<i>Fabaceae</i> sp. 2							x					Tree
	<i>Haematoxylum campechianum</i> L.	x		x	x								Tree
	<i>Leucaena leucocephala</i> (Lam.) de Wit	x	x	x				x				x	Tree
	<i>Lonchocarpus castilloi</i> Standl.	x	x	x		x	x			x	x		Tree
	<i>Lonchocarpus yucatanensis</i> Pittier							x		x			Tree
	<i>Lysiloma acapulcense</i> (Kunth) Benth.					x	x						Tree
	<i>Lysiloma latisiliquum</i> (L.) Benth.	x	x	x		x	x	x			x	x	Tree
	<i>Lysiloma</i> sp.					x	x						Tree
	<i>Piscidia piscipula</i> (L.) Sarg.		x			x	x	x	x	x	x	x	Tree
	<i>Pithecellobium lanceolatum</i> (Humb. & Bonpl. ex Willd.) Benth.	x					x						Tree
	<i>Platymiscium yucatanum</i> Standl.					x	x						Tree
	<i>Schizolobium parahyba</i> (Vell.) S.F. Blake							x					Tree
	<i>Stizolobium pruriens</i> (L.) Medik.					x	x						Vine
	<i>Swartzia cubensis</i> (Britton & P. Wilson) Standl.	x	x							x	x		Tree
	<i>Sweetia panamensis</i> Benth.	x											Tree
	<i>Vatairea lundellii</i> (Standl.) Killip ex Record	x	x										Tree
Fam. 1	Sp. 1	x	x			x				x			Tree
Fam. 2	Sp. 2	x	x		x	x							Tree
Fam. 3	Sp. 3							x					Tree
Fam. 4	Sp. 4	x						x					Vine
Fam. 5	<i>Epiphyte</i> sp. 1		x			x	x			x			Epiphyte
Flacourtiaceae <sup>4</sup>	<i>Zuelania guidonia</i> (Sw.) Britton & Millsp.	x	x					x					Tree
Hippocrateaceae <sup>5</sup>	<i>Hippocratea excelsa</i> Kunth	x	x										Shrub
	<i>Salacia</i> sp.						x	x		x			Vine
Lauraceae	<i>Nectandra salicifolia</i> (Kunth) Nees	x	x	x									Tree
Loganiaceae	<i>Strychnos tabascana</i> Sprague & Sandwith	x	x			x	x			x			Vine
Loranthaceae	<i>Psittacanthus mayanus</i> Standl. & Steyerem.	x					x			x			Epiphyte
Malpighiaceae	<i>Stigmaphyllon</i> sp.	x	x	x	x	x	x						Vine
Malvaceae	<i>Abutilon permolle</i> (Willd.) Sweet			x	x	x							Shrub



Perspectivas en Primatología Mexicana



Appendix 1. (cont.)

Family	Species	1*	2	3	4	5	6	7	8	9	10	11	Growth form
Malvaceae	<i>Abutilon</i> sp.	x				x	x						Shrub
Melastomataceae	<i>Miconia argentea</i> (Sw.) DC.	x											Tree
Meliaceae	<i>Cedrela odorata</i> L.		x				x	x					Tree
	<i>Swietenia macrophylla</i> King				x	x							Tree
Menispermaceae	<i>Cissampelos pareira</i> L.	x						x					Vine
Moraceae	<i>Brosimum alicastrum</i> Sw.			x	x	x	x		x		x		Tree
	<i>Ficus cotinifolia</i> Kunth			x	x	x	x						Tree
	<i>Ficus lundellii</i> Standl.	x	x						x				Tree
	<i>Ficus maxima</i> Mill.							x		x			Tree
	<i>Ficus obtusifolia</i> Kunth		x										Tree
	<i>Ficus ovalis</i> (Liebm.) Miq.				x								Tree
	<i>Ficus perforata</i> L.					x		x					Tree
	<i>Ficus</i> sp.	x				x	x			x		x	Tree
	<i>Trophis racemosa</i> (L.) Urb.	x	x		x			x			x	x	Tree
Myrsinaceae	<i>Ardisia escallonioides</i> Schltld. & Cham.						x						Tree
Myrtaceae	<i>Eugenia capuli</i> (Schltld. & Cham.) Hook. & Arn.					x					x		Shrub
Orchidaceae	<i>Epidendrum</i> sp.						x	x		x			Epiphyte
	<i>Oncidium</i> sp.		x				x						Epiphyte
	<i>Pleurothallis yucatanensis</i> Ames & C. Schweinf.						x	x					Epiphyte
Polygonaceae	<i>Coccoloba barbadensis</i> Jacq.							x					Tree
	<i>Coccoloba</i> sp.						x						Tree
Rhamnaceae	<i>Gouania lupuloides</i> (L.) Urb.							x					Vine
Rubiaceae	<i>Alseis yucatanensis</i> Standl.	x											Tree
	<i>Guettarda combsii</i> Urb.	x											Tree
	<i>Morinda yucatanensis</i> Greenm.					x	x						Vine
Sapindaceae	<i>Cupania dentata</i> DC.	x	x										Tree
	<i>Cupania glabra</i> Sw.	x	x										Tree
	<i>Matayba oppositifolia</i> (A. Rich.) Britton	x											Tree
	<i>Paullinia pinnata</i> L.		x				x						Vine



## Perspectivas en Primatología Mexicana



### Appendix 1. (cont.)

Family	Species	1*	2	3	4	5	6	7	8	9	10	11	Growth form
Sapindaceae	<i>Serjania yucatanensis</i> Standl.						x						Vine
	<i>Talisia oliviformis</i> (Kunth) Radlk.			x	x	x	x						Tree
Sapotaceae	<i>Chrysophyllum mexicanum</i> Brandegees ex Standl.	x	x										Tree
	<i>Manilkara zapota</i> (L.) P. Royen	x		x	x	x	x			x	x		Tree
	<i>Pouteria campechiana</i> (Kunth) Baehni	x	x									x	Tree
	<i>Pouteria</i> sp.						x						Tree
	<i>Pouteria unilocularis</i> (Donn. Sm.) Baehni	x	x										Tree
	<i>Sideroxylon floribundum</i> Griseb.			x									Tree
	<i>Sideroxylon gaumeri</i> Pittier						x						Tree
	<i>Sideroxylon obtusifolium</i> (Humb. ex Roem. & Schult.) T.DPenn.			x								x	Tree
Simaroubaceae	<i>Simarouba glauca</i> DC.	x	x					x				x	Tree
Sterculiaceae <sup>6</sup>	<i>Guazuma ulmifolia</i> Lam.		x			x	x	x		x	x		Tree
Tiliaceae <sup>7</sup>	<i>Luehea speciosa</i> Willd.	x	x					x					Tree
Ulmaceae	<i>Trema micrantha</i> (L.) Blume							x		x			Tree
Verbenaceae	<i>Vitex gaumeri</i> Greenm.	x			x	x	x	x			x	x	Tree
Violaceae	<i>Rinorea guatemalensis</i> (S. Watson) Bartlett	x											Vine
Viscaceae <sup>8</sup>	<i>Phoradendron quadrangulare</i> (Kunth) Griseb.		x							x			Epiphyte
Vitaceae	<i>Cissus gossypifolia</i> Standl.	x	x				x	x					Vine
N° species per group		62	48	21	13	43	54	43	5	34	14	14	

\* 1: Álamo A; 2: Álamo R; 3: Calakmul 9; 4: Calakmul 27; 5: Calax C; 6: Calax T61; 7: Chicbul; 8: Chilar; 9: Oxcabal; 10: Torre 39; 11: Torre 59.

<sup>1</sup> Apocynaceae according to APG (2003)

<sup>2</sup> Malvaceae according to APG (2003)

<sup>3</sup> Urticaceae according to APG (2003)

<sup>4</sup> Salicaceae according to APG (2003)

<sup>5</sup> Celastraceae according to APG (2003)

<sup>6</sup> Malvaceae according to APG (2003)

<sup>7</sup> Malvaceae according to APG (2003)

<sup>8</sup> Santalaceae according to APG (2003)