Palms of Eastern Yucatan Peninsula, Mexico: Changes along a Rainfall Gradient

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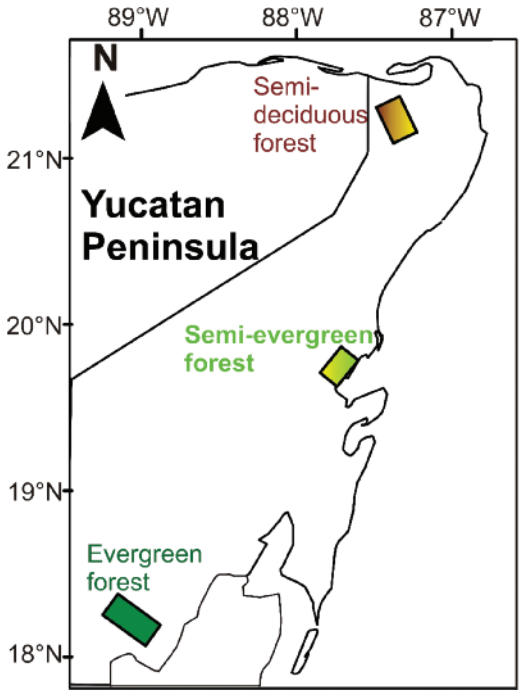
There are about 20 species of palms on the Yucatan Peninsula, the easternmost part of Mexico towards the Caribbean Sea. Yucatan is near the northern limit of palm distribution in tropical America and located exactly where dense and diverse rainforests of Central America give way to more open and drier seasonal and species-poor forests. We visited this transition zone to see how species-rich palm communities change to species-poor palm communities. Such observations are important for understanding the forces that underlie and shape diversity patterns, not only of palms but of species in general.

catecan palms are conspicuous in the vegetation. In some places single species dominate the landscape, which is then given names that follow the common names of the very abundant palms; *botanales* for open savannas dominated by species of *Sabal, corozales* for dense forests dominated by *Attalea cohune*, *tasistales* for swampy vegetation dominated by *Acoelorrhaphe wrightii*, etc. (Miranda 1958, Rzedowski 1978). But in most places palms are intermingled with trees and other plants to form a vegetation that is not dominated by a single species (Miranda 1958). This is an account of the composition of palm communities and also provides information about palm abundances, which is important in relation to their high economic value; many palms are heavily used for thatch (*Sabal*), house construction (*Thrinax*), utensils (*Sabal)* (Fig. 1) and a variety of other purposes (Quero & Flores 2004, de la Torre et al. 2009). Knowing palm distributions and frequencies also contributes to understanding their conservation status in Yucatan. Half of Yucatecan palms have been listed in the Mexican classification of threatened species (DOF 2010).

The Yucatan Peninsula (Fig 2; 17°00'–21°45'N, 86°30'–89°30'W) covers 150,000 km^2. The annual rainfall varies from 500–2200 mm along a north–south gradient and the average

1. Palm uses in Yucatan. A. Leaves of *Sabal yapa,* harvested to be used for thatch. B. Felled stems of *Thrinax radiata,* which are commonly used for house construction and lobster traps by the local population. C. Typical Maya house made out of *Thrinax radiata* (the walls) and *Sabal yapa* (the roof). D. Brooms made out of the leaves of *Sabal yapa*.



2. Sites where we observed the palm communities in three forests located along the east coast of the Yucatan peninsula with a rainfall gradient from 1200 mm precipitation per year in the north to 1500 mm precipitation per year in the south.

annual temperature varies from 25–28ºC (Herrera-Sansores 2011). The peninsula is made up of a marine limestone plateau uplifted between the Miocene (24 MY) and the Plio-Pleistocene (3.2-2 MY) and no part reaches above 350 m (Bautista et al. 2011). The limestone forms a karst landscape with subterranean drainage, caves and sink-holes. This plateau is covered by semi-deciduous forest in the northern parts, semi-evergreen forests in the central parts and evergreen forests in the south (Sánchez & Islebe 2002). Along the coastline a series of halophytic vegetation types including coastal dunes with low bush, mangroves and humid savannas dominate (Miranda 1958).

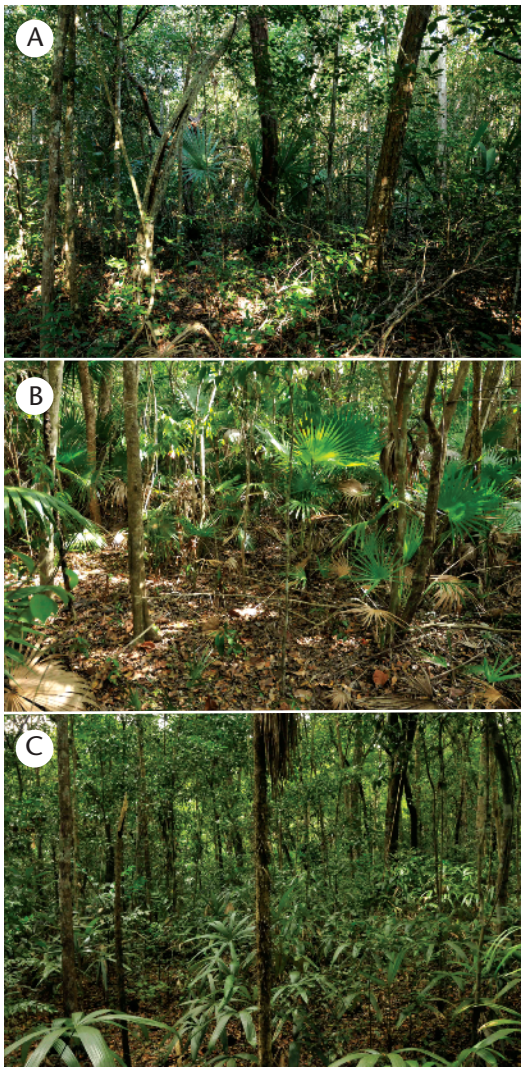
In February 2010, we observed the palm communities at three sites along the rainfall gradient in the eastern Yucatan peninsula in the state of Quintana Roo, one in the north in the semi-deciduous forest, one in the center in the semi-evergreen forest and one in the south in the evergreen forest (Fig 2). We looked for forest with as few signs of human disturbance as possible, and we then went on to locate and identify all palm individuals along a line transect. We counted all individuals including seedlings, juveniles and adults.

Palm communities

Semi-deciduous forest (Table 1; Figs. 3A) – In the northern semi-deciduous forests our observations were in the nature reserve Yum Balam, north of the town of Kantunilkin and south of the coastal village Chiquilá. We found a palm community consisting of three species: *Chamaedorea seifrizii* (Fig. 4A), *Sabal yapa* (Fig. 4B) and *Thrinax radiata* (Fig. 4C). The overall density of palms in this forest was 2411 individuals per hectare. The cespitose pinnately leaved *Chamaedorea seifrizii* with 681 individual per hectare reached four meters tall and thrived in the understory. This species was more abundant in these dry forests than in the more humid forests investigated further south on the peninsula. The other two species of palms both had solitary stems and palmate or costapalmate leaves and both reached the forest canopy. *Thrinax radiata* was found with an average density of 1173 individuals per hectare and *Sabal yapa* with 557 individuals per hectare. Because of their larger size, these two species in the subfamily Coryphoideae visually dominated the forests. The dominance of coryphoid palms in drier vegetation types is commonly found in other parts of Central America and the Caribbean (Bjorholm et al. 2006).

Semi-evergreen forest (Table 1; Fig. 3B) – This forest type was accessed in the Sian Ka'an Biosphere Reserve, some 25-50 km northeast of the town of Felipe Carrillo Puerto. The overall density of palms there was 2099 individuals per hectare. In addition to the three species encountered in the drier forests to the north we found, *Coccothrinax readii* (Fig. 4D), with a density of 722 individuals per hectare which made it the second most abundant palm in this forest type. This beautiful species has palmate leaves with a silvery glossy undersurface. It is unarmed and reaches up to six meters tall occupying the mid-canopy layer of the forest. The forest is, however, dominated by the other coryphoid palm *Thrinax radiata* which had 1116 individuals per hectare in our transects. *Chamaedorea seifrizii* (146 ind./ha) and *Sabal yapa* (115 ind./ha) are both common but less abundant.

Evergreen forest (Table 1; Fig. 3C) – This forest type we observed 34-70 km southeast of the small town of X-Pujil in the so called "area of integrated management" named Caobas. There the forest is lush, dense and tall as a rainforest. It grows on a hilly terrain on soils that are



3. The three forest types in which palm communities were studied in the eastern Yucatan peninsula. A. Semi-deciduous forest in northern Quintana Roo near Kantunilkin, with juvenile individual of *Sabal yapa* in the center. B. Semi-evergreen forest in the Sian-Ka'an reserve with many juvenile *Thrinax radiata* in the understory. C. Evergreen forest in southern Quintana Roo with a dense population of *Cryosophila stauracantha* juveniles and a spiny stem of adult individual of the same species.

much deeper and of older geological origin than the more northern forests we visited. In total we found 7396 palm individuals per hectare in the evergreen forest, which is more than three times as many as in the drier forest types. We found nine different palms in this forest: The most common palm species is the up to 10 meters tall *Cryosophila stauracantha* (Fig. 5A), which has 5524 individuals per hectare; it is solitary, has palmate leaves that are glossy below, and it is heavily armed with 10 cm long root-spines on the stem and reaches the mid-canopy of the forest. Although it is not a climbing palm, its stem often leans against the other vegetation. *Chamaedorea oblongata* (Fig. 5B) is a small palm (< 4 m) like its congener *C. seifrizii,* but it has a solitary growth form and much broader leaflets. *Desmoncus chinantlensis* (Fig. 5D) is a spiny palm with the distal pinnae transformed to hooks, which it uses to cling to the vegetation and grow all the way into the forest canopy, where it flowers and fruits in the better light conditions found there. We also found *Attalea cohune* (Fig. 5E) in the evergreen forest; this is a giant palm with tall stems to 25 m tall and 40 cm in diameter and a crown of enormous, erect, pinnate leaves that reach the forest canopy. It was commonly fruiting, and its fruits – up to eight cm long – are the largest of all wild palm fruits in our study area. *Sabal mauritiiformis* with its large costapalmate leaves and tall stems also reaches the forest canopy; it is a solitary, unarmed palm with very long inflorescences that project out of the crown. *Sabal yapa* (Fig. 4B), which is common in the drier forest types, is here much less abundant. *Bactris major*, a mid-canopy palm, grows in dense stands that may cover large areas that are then called *jahuactales*; *B. major* (Fig. 5C) has elegant pinnate leaves that contrasts to the heavy armature of spines on stems, leaves and especially the peduncular bract. *Gaussia maya* (Fig. 5F) is a mid-canopy, pinnately leaved palm found in moderate densities. The greater number of species found in the evergreen forests compared to the drier types coincide with a larger variation in life forms and morphology of the palms (Orellana 1992).

Ecological features of the palms

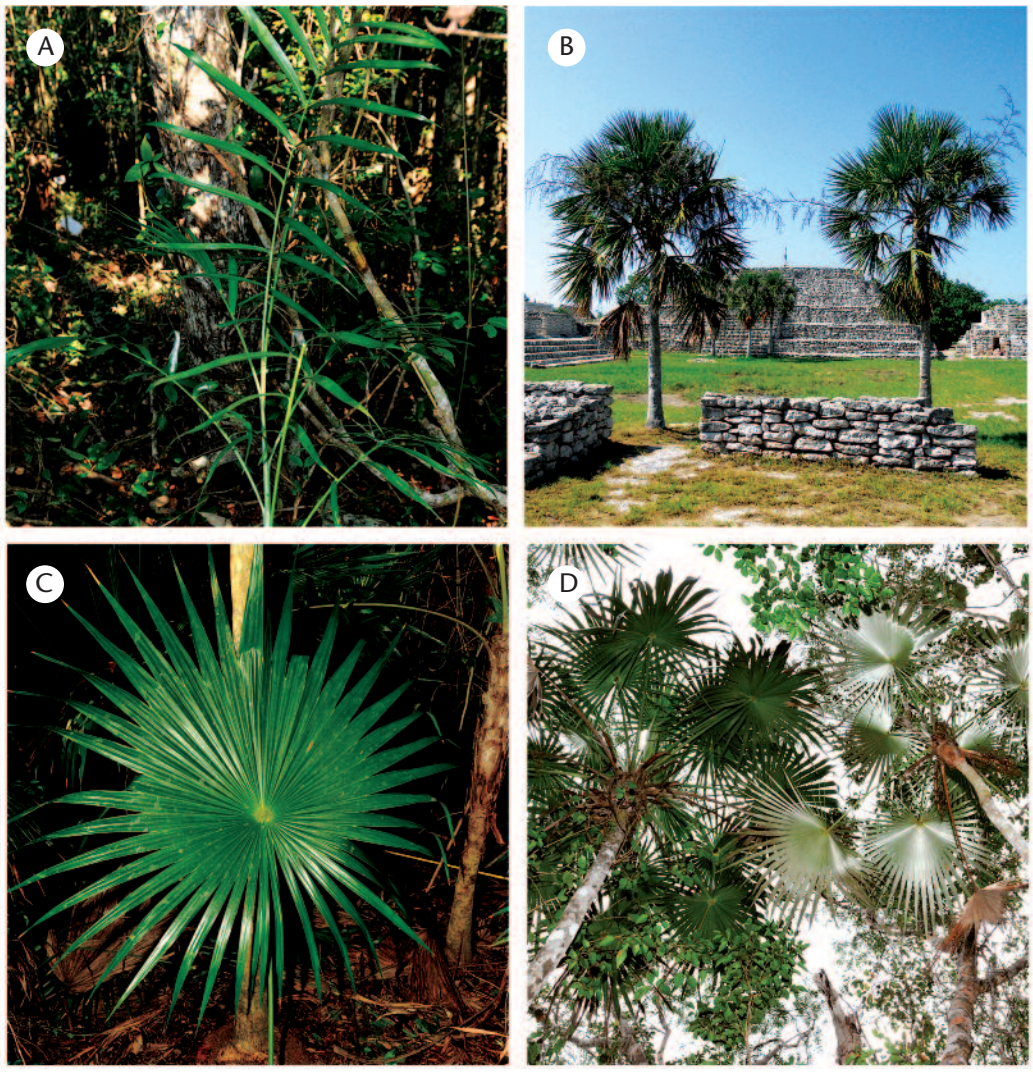
Species ranges – In general the palm species encountered are widely distributed in the southeast of Mexico, Central America, northern South America and the Caribbean. Only *Coccothrinax readii* (Quero 1980) is endemic to the study area but it is very closely related with the more wide ranging Caribbean *C. argentata*, and the name *C. readii* was actually treated as a synonym in the field guide to American palms (Henderson et al. 1995).

Species richness – The palm communities of the northern Yucatan peninsula with 3 or 4 palm species are among the poorest in tropical America. The communities in the southern part are comparable in species richness to some South American sites, such as the valleys of

Table 1. The 11 species of palms that we registered along the east coast of the Yucatán peninsula giving their average densities in the three forest types examined and in addition their habitat, uses and level of ecological risk.

	Density ind./ha					
	Semi-deciduous	Semi-evergreen	Evergreen	Habitat[1,2]	Uses[3]	Threat[4]
Thrinax radiata Schult. & Schult. f.	1173	1116		Sdtf, Setf, CoDu	1–4	T
Chamaedorea seifrizii Burret	681	146	23	Sdtf, Setf, Etf	1–3,7	NL
Sabal yapa Becc.	557	115	1	Dtf, Sdtf, Setf (SV)	1–4,6,7	NL
Coccothrinax readii H.J. Quero		722		Setf, CoDu	1,3	T
Bactris major Jacq.			27	Setf (FA)	1,4	PR
Gaussia maya (O.F. Cook) H.J. Quero			39	Setf, Etf	1,3	T
Attalea cohune Mart.			129	Setf (SV)	1	NL
Desmoncus chinantlensis Liebm. ex Mart			209	Setf, Etf	1,3	NL
Sabal mauritiiformis (H. Karst.) Griseb. & H. Wendl.			378	Setf, Etf (SV)	1,2,4	NL
Chamaedorea oblongata Mart.			1067	Setf	1,3,6	T
Cryosophila stauracantha (Heynh.) R. Evans			5524	Setf, Etf	1	T

References: [1]Orellana (1992), [2]Quero & Flores (2004), [3]de la Torre et al. (2009), [4]DOF (2010). **Habitat:** CoDu = coastal dune, Dtf = deciduous tropical forest, Sdtf = semi-deciduous tropical forest, Setf = semi-evergreen tropical forest, Etf = evergreen tropical forest, SV = secondary vegetation, FA = flooded area. **Uses:** 1 = Construction, 2 = Medicinal, 3 = Ornamental, 4 = Food, 5 = Fuel, 6 = Crafts, 7 = Social. **Threat:** PR = species that require special protection, T = Threatened, NL = not listed.



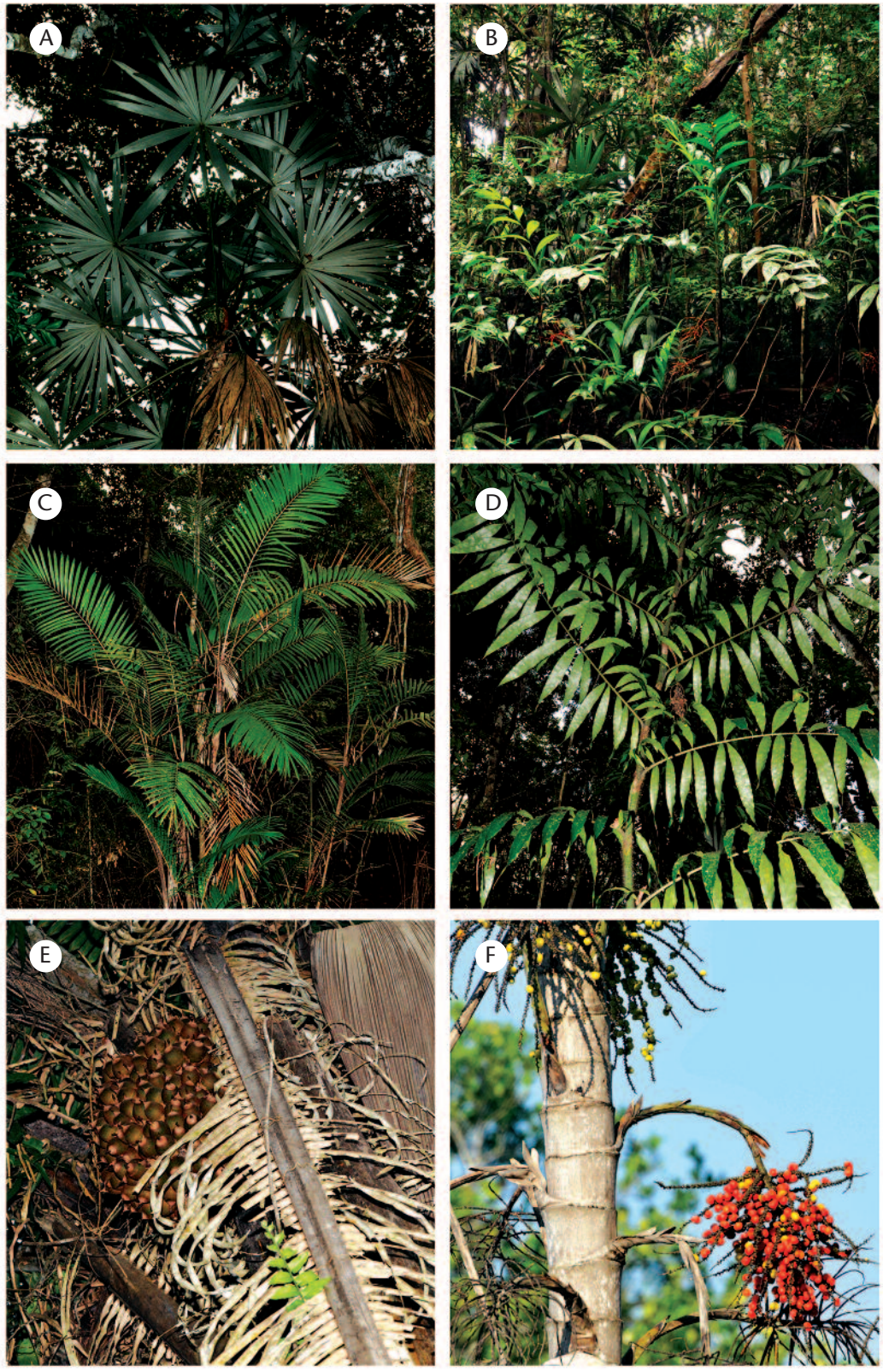
4. Palm species in the semi-deciduous and semi-evergeen forest on Yucatan peninsula. A. *Chamaedorea seifrizii* showing the narrow leaflets. B *Sabal yapa* showing its solitary habit, and crown of costapalmate leaves among which the large inflorescences protrude. C. *Thrinax radiata* leaf showing its palmate shape. D. *Thrinax radiata* (left) with green leaf undersurface and *Coccothrinax readii* (right) with silvery leaf under-surface.

the Mokoti River in Brazil and the Waki River in French Guyana (Salm et al. 2007, Kahn & de Granville 1992). In a study of palm species richness across tropical America based on range maps for palm distributions, the Yucatan peninsula had an estimated species richness of about 15 (Bjorholm et al. 2005). This suggests that the actual species richness in our study area is driven less by general and regional conditions and more by local environmental factors such as the rainfall and the very thin soils both of which limit available water and possibly nutrients.

Abundances – It is noticeable that the number of palm individuals per hectare found in the dry species poor palm communities in our study area are similar to what has been found elsewhere in tropical America (Alvarado-Segura et al. 2012), including very palm rich parts of the Amazon basin such as the Ucayali river valley described by Balslev et al. (2010). The

opposite page:

5. Palm species in the evergreen forest of southern Yucatán peninsula. A. *Cryosophila stauracantha* adults showing its palmate leaves with silvery under-surface. B. *Chamaedorea oblongata* in the understory. C. *Bactris major* growing in the mid-canopy and usually associated with wet and swampy places. D. *Desmoncus chinantlensis*, a climbing and spiny palm. E. *Attalea cohune,* the largest of all palms in Yucatan, reaches the canopy with its large, erect and pinnate leaves. F. *Gaussia maya* is a midstory palm.


A
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wet evergreen forest in our study area had palm densities (7396 ind./ha) that are comparable to the most dense palm communities in the Amazon basin, where the upper record is 9865 ind./ha in the lower Ucayali River valley (Kahn & de Granville 1992) and the second highest record is 6975 ind./ha along the Urituyacu River in northern Peru (Normand et al. 2006). This clearly shows that when the environmental conditions for palms growth limits the number of species that can thrive, the species that remain may compensate and produce higher abundances individually. But it must be remembered that in very species-rich palm communities many of the species are often represented by only few individuals that do not contribute much to the overall abundance of palms, so one should not expect a proportionality between species numbers and overall abundances.

Changes along the gradient – Although our transects were placed along a latitudinal gradient (Fig 2; 18–21°N latitude), associated with gradual change in rainfall, age of bedrocks and depth of the soils (Morrone 2005), only two species occurred along the entire gradient: *Chamaedorea seifrizii* and *Sabal yapa*. Perhaps the changes in species composition, richness and abundance observed along the gradient are caused by some thresholds in annual precipitation and seasonality. Even if the two driest sites are 150 km apart they share environmental conditions, which in turn are different from the most humid site in the evergreen forest in the south. Our observation suggest that the great phytogeographic barrier is between a southern wet vegetation with rich palm communities with as many as nine species, mostly of the arecoid subfamily, and on the other side, the drier forest types in the central and northern parts with fewer species (3 or 4) that are mostly of the coryphoid palm subfamily. This pattern is similar to that found in other taxonomic groups in Yucatan, such as legumes, trees, and reptiles (Lee 1980, Ibarra-Manríquez et al. 2002, Duno de Stefano et al. 2012).

Yucatecan palms not registered in our transects

In our 45 transects we encountered 11 of the 20 species that are known to occur in the Yucatan peninsula. Some of the species not encountered are quite common, but occur in specialized habitats that we did not visit. *Acoelorrhaphe wrightii* is cespitose with palmate leaves and spiny petioles. It is very common and abundant in occasionally flooded areas. Where it grows it is usually dominant and the vegetation with high abundance of *Acoelorrhaphe wrightii* is called *tasistales* for the local name of this species (*tasiste*). *Pseudophoenix sargentii* is a solitary palm with pinnate leaves that grows in coastal dunes and in medium stature semi-deciduous forests. Other palms that did not enter our transects include *Acrocomia aculeata,* which is a very spiny, pinnately leaved, medium-sized palm that is very common in disturbed sites. Other Yucatecan palms simply do not reach the state of Quintana Roo where we studied the palm communities (*Attalea butyracea, Sabal mexicana, Roystonea regia*). Finally *Sabal gretherae* is described from a single locality in the north of Quintana Roo where it forms a dense population in a very disturbed site. Its distinction from *Sabal mexicana* is doubtful (Henderson et al. 1995), although its karyotype is different (Palomino & Quero 1992). *Sabal gretherae* is closely related to *S. guatemalensis* and *S. mexicana* and it is by no means clear if the group should best be treated as one, two or three species.

Conservation

From a conservation perspective it is noticeable that five species (*Thrinax radiata, Coccothrinax readii, Gaussia maya, Chamaedorea oblongata, Cryosophila stauracantha*) which have previously been classified as threatened (DOF 2010) were abundant at the places we visited, *Gaussia maya* being an exception (Table 1). This points to the eastern Yucatan peninsula as an important area for the conservation of palms. Two of the species classified as threatened (*Thrinax radiata, Cryosophila stauracantha*) were actually quite abundant. Nevertheless, regardless of their abundance, the fragmentation of their habitat through agriculture, cattle farming and tourist activities threatens their ecological stability and makes them more vulnerable to natural disasters such as hurricanes and forest fires.

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