Satellite Photos & High Resolution Drone Photos

to Assist Ecologists & Botanists for studying Savannas and Wetlands

FLAAR MESOAMÉRICA

Parque Nacional Yaxha, Nakum and Naranjo
Reserva de la Biosfera Maya (RBM)
Petén, Guatemala

September 2021, Nicholas Hellmuth

Appreciation for Encouraging the Flora, Fauna & Ecology Reseatch Proyect In the Reserva de la Biosfera Maya (RBM), Petén, Guatemala

For Cooperation, Hospitality, and Assistance at Parque Nacional Yaxha, Nakum and Naranjo Proyect (August 2018 through July 2019)

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For Cooperation, Hospitality, and Assistance at Parque Nacional Yaxha, Nakum and Naranjo

all the helpful and knowledgeable guides of IDAEH CONAP at PNYNN who accompanied us each day during our hiking of 2018-2019 to explore and find biodiverse ecosystems and notable flora and fauna. It is essential to have either an IDAEH and/or CONAP guardarecursos or comparable when doing flora and fauna research in a national park.

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Jeremias Gonzales Aguilar, Alcalde de Yaxha, guide and helped carry equipment
Ricardo de Jesús Herrera Marroquín, guide and helped carry equipment

Lancha Courtesy of Gabriella Moretti, Ecolodge El Sombrero

Gildardo de Jesús Canales, helpful lanchero from the hotel Ecolodge El Sombrero; he also assisted in hiking the endless kilometers and carrying the needed equipment.

Assistance for Knowledge of Plants and Animals of PNYNN

Teco, Moisés Daniel Pérez Díaz, park ranger, PNYNN

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CAPTION FOR FRONT COVER PHOTOGRAPH:
Savanna 3 Fern species is a reservoir located into de National Park Yaxha, Nakum and Naranjo. Oriented to the west side from Laguna Yaxha.

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021. Parque Nacional Yaxha, Nakum and Naranjo, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

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Glossary

I start this report with an introductory glossary since each ecologist or ethnohistorian or botanist or archaeologist or geographer uses slightly different terms.

Bog I thought that bog moss was in Ireland; but PNYNN park ranger Teco (Moisés Daniel Pérez Díaz) led us in 2019 to an area totally covered with peat moss, *Sphagnum subsecundum*, in the center of the Savanna of 3 Fern Species. When you are hiking near this area it feels like you are walking on sponges. More library research is needed to find what term ecologists and soil scientists use for this kind of a habitat but in the Maya Lowlands. Terms that are based on other parts of the world are not always realistic in Mesoamerica.

Cibal, sibal, sival is a seasonally inundated or all-year wetland filled with sawgrass. Sawgrass is a sedge of genus *Cladium*. It literally cuts you if you attempt to walk through. Sawgrass can be up to 2 meters tall. So it is not very easy to hike though a cibal. A notable cibal is between the savanna and jimbal at the immediate west side of the ruins of Nakum. We found another cibal from satellite photos and then hiked to visit it in August 2021 in the far southeastern area of Parque Nacional Laguna del Tigre. Our field work is in this remote area since the other parts of this park are well studied by many experienced specialists. A cibal can be the same size as a savanna, usually 1 or 2 or 3 km long; but occasionally up to10 km long (two leagues in 17th century traveling measurement) in past centuries:

> ....for at a little distance we fell in with a great cibal or pond full of those grasses with broad and cutting leaves, of which I spoke before. This was, according to its distance which was lost to sight, more than two leagues long and half a league broad.
>
> **(Avendaño 1996 in Means 1917: 168)**

Cibal-savanna is a seasonally inundated or perennially moist area with cibal sawgrass as the primary plant in one area and then a transition to a savanna at one side or end. This we found at Parque Nacional Laguna del Tigre in August 2021. In 2019 we found that the Bajo La Pita transforms into a traditional savanna at its north end; this savanna transforms into a cibal a hundred meters further north and that ends in a dense jimbal. If a cibal has no tasiste, nance or jicara, then I would call it just a pure cibal and not cibal-savanna.

Classification systems: I do not use Holdridge or any international classification because Holdridge never hiked through the savannas and cibals that I have experienced in Peten. Besides, climate is only one factor: geology, especially soil, drainage and elevation are more relevant. Biomes too large an area. I prefer "ecosystem." Same with international classifications: they are used in REA, used in some Plan Maestro reports, and used in almost every internationally funded ecological or conservation project. I respect the use of these terms but the biodiversity of most wetlands in the Reserva de Biosfera Maya nullifies the standardized, academic definitions. Best would be to have a tabulation of Holdridge Life Zones and show other definitions and show what is needed to cover the biodiversity of the northern half of Peten, Guatemala. For example, the "Bioclimatic zones of Guatemala, Holdridge life zones system" does not show an iota of difference between Izabal and Peten (www.bibliocad.com/en/library/bioclimatic-zones-of-guatemala-holderidge-life-zones-system_65410/). This map is great for kindergarten and primary school perhaps. Figura 7-4 of Carrera et al. 2019 is significantly better but would help to add additional maps to show the geological differences and other maps to show the biodiversity of Peten other than in giant identically-colored areas (so no wetland habitats are documented). Tons of peer-reviewed journal articles and 300+ page scholarly monographs exist on classification systems for ecology.

Jimbal is an area of dense jimba bamboo, *Guadua longifolia*. You get this near Sayaxche, Peten (you can see lots of jimba from the highway north of the ferry crossing). You get more jimbal areas along the Arroyo Petexbatun upstream from Sayaxche. Río Holmul that crosses south of Nakum and a few kilometers north of Naranjo has jimba bamboo along most of its edges. This bamboo is native to Guatemala; it is not from Asia or South America. One river that flows into El Golfete also has jimba (Municipio de Livingston, Izabal). Jimba bamboo should be findable in hundreds of other areas.

Meadow; if I was asked to define a meadow without cogitating I would answer that a meadow is a small grassland surrounded by trees. Savannas tend to have areas with clusters of tasiste palms and areas with jicara and nance trees scattered within many portions. To me a meadow has either no trees or at least not many noticeable trees. The similarities and differences of meadow vs prairie are worthy of discussion if you are working in North America or other areas of the world. I don't use either of these words for Mesoamerica.

Plain is a generic word for flatland with few or no trees. Plains can stretch "endlessly" for miles. Savannas and Cibals you can usually see the end if you are standing up on a high ladder. Flood plain is one of dozens of varieties. I do not use the word plain for the Mayan areas of Mesoamerica.

Prairie is a grassland that stretch often to the horizon (like savannas in Africa, though savannas have more iconic trees). A prairie is often low rolling hills; so far no savanna that I have seen in RBM is "hilly" whatsoever. They are almost flat as a pancake, though the outside ring may be a bit lower (and has more water). As a child to me a prairie is an area inhabited by prairie dogs. So best never to translate any Petén or nearby flatland as a prairie. On the aspect of hilly, hillside savannas do exist in Mesoamerica; we found one near Rabinal, Baja Verapaz: lots of nance and chaparro (*Curatella americana*).

Savanna,¡ in PNYNN and in PNLT the savannas have a characteristic vegetation: tasiste, jicara, nance; no chapparo, no oak yet found and for sure no pine. This savannas and elsewhere in RBM are usually 1 to 5 km in length and several hundred meters across. Savannas in La Libertad and Poptún stretch for many kilometers with dome-shaped karst mini-hills every few hundred meters. So far, all these Peten savannas are flat: none are on hillsides. But savannas in other parts of Guatemala (like in Baja Verapaz), and in Africa, often are on rolling hills or even steep hills. The characteristics may vary depending on where you are but in all the savannahs it is possible to find grasslands and low-lying trees with a lot of separation between them.

Savanna in many areas of Belize: tasiste, jicara, nance, chapparo, pine, and oak. Logically savannas vary in Belize also, but much more pine in Belize (and south-central Petén). No pine within PNYNN, Parque Nacional Tikal (one stand of pine 3 km diagonally from northeast corner). No pine yet found by us in PNLT.

Savanna in hilly areas outside the lowlands: nance, chapparo within the savanna and pine at top of the hill; we documented this near Rabinal, Bajo Verapaz. So a savanna does not have to be flat or lowland. That said, 100% of the savannas and cibales I have hiked to and through in PNYNN and PNLT are not on hillsides whatsoever. Most savannas (that I have explored so far) have hill forest bordering one or more sides; or have bajo forests bordering one or more sides.

Savanna in Africa: stretch for hundreds of miles with millions of large mammals easily visible.

Introduction to Savannas of the Maya Lowlands

It is estimated that savannas are between 8% and 13% of Belize (depends on whose scientific REA (Rapid Ecological Assessment) you read or which copy-and-paste website you read). But the point is that savannas are a significant portion of Belize.

For adjacent Petén there is less savanna and much much more bajo (tintal and also other bajos simply seasonally inundated flatlands without palo de tinto everywhere). Most savannas and cibales (savanna with 2m high cutting sawgrass instead of low grass) south of the Reserva de la Biosfera Maya (RMB) have been destroyed. So most of the savannas around Poptún and around La Libertad are cattle ranches or commercial plantations. These are reasons why it is crucial to find, locate, document, photograph, and save the savannas in the northern half of Petén, especially in Parque Nacional Yaxha, Nakum and Naranjo, Parque Nacional Laguna de Tigre, Parque Nacional Sierra del Lacandón and the rest of the Reserva de la Biosfera Maya. In Africa the savannas stretch for hundreds of kilometers.

Photo by: FLAAR Mesoamerica, Mar. 26, 2019, park ranger Teco (Moisés Daniel Pérez Díaz) studying the *Calathea lutea*. We found these while entering the Savanna of 3 Fern Species at the northeast side, western part of Yaxha sector of PNYNN, RBM, Petén.

In Petén the largest savannas are three to four kilometers long and half a kilometer wide. In Africa there are millions of iconic animals in the savannas, often in giant herds. In savannas of the Maya Lowlands you rarely see a single solitary mammal during the day. But the savannas of the Reserva de la Biosfera Maya are literally botanical research gardens. Hiking through the 30% of the Savanna East of Nakum was like walking through a botanical garden with different mini-ecosystems every 50 to 80 meters. The Savanna of 3 Fern Species (west end of PNYNN) has so many different plants it will be an enthralling challenge to identify them all. 75% of this "Savanna" of 3 Fern Species violates almost any and every ecological classification. I call it a Savanna because at least some clusters of tasiste palms are present.

Savannas of Chiapas, Tabasco, Campeche, Yucatan, Quintana Roo, Belize and Petén come in various biodiversity. I estimate the majority are seasonally inundated. But the large hillside savanna we have visited twice, north of Rabinal, Baja Verapaz, Guatemala, is on hills so steep there would never be standing water in most areas. But savannas in most areas of PNYNN and nearby have large snail shells that document there is lots more water during the rainy season: 100% of the snail shells are empty (due to the heat, significantly less water in dry season, and fires set by invasive hunters (to move the deer to one direction so they can all be shot).

Since we all see millions of acres of grassland savannas in movies on lions, giraffes, etc., and since many savannas of Petén are also grassland savannas, it is understandable to define a savanna as a grassland with tasiste palm, nance fruit trees, and calabash gourd trees (and in Belize with pine and sometimes oak). But the seasonally inundated flatland that I found in satellite photos of west of Yaxha circa 2018-2019 had more splattered tree cover than open grassland; had more tree species besides tasiste; and had areas of 40-50cm low ferns instead of grass of roughly comparable height.

But since this circular area did have tasiste trees, is seasonally inundated, lacks thick forest of bajo type (that surrounds it), I definitely did not want to call it a bajo, so I prefer to call it a savanna, even though the vegetation here may "violate" most definitions of savannas.

Very simple: if dozens of ecologists, geographers, botanists would also visit this area, then they can update and improve their classification system, since Holdridge never set foot in this Savanna of 3 Fern Species.

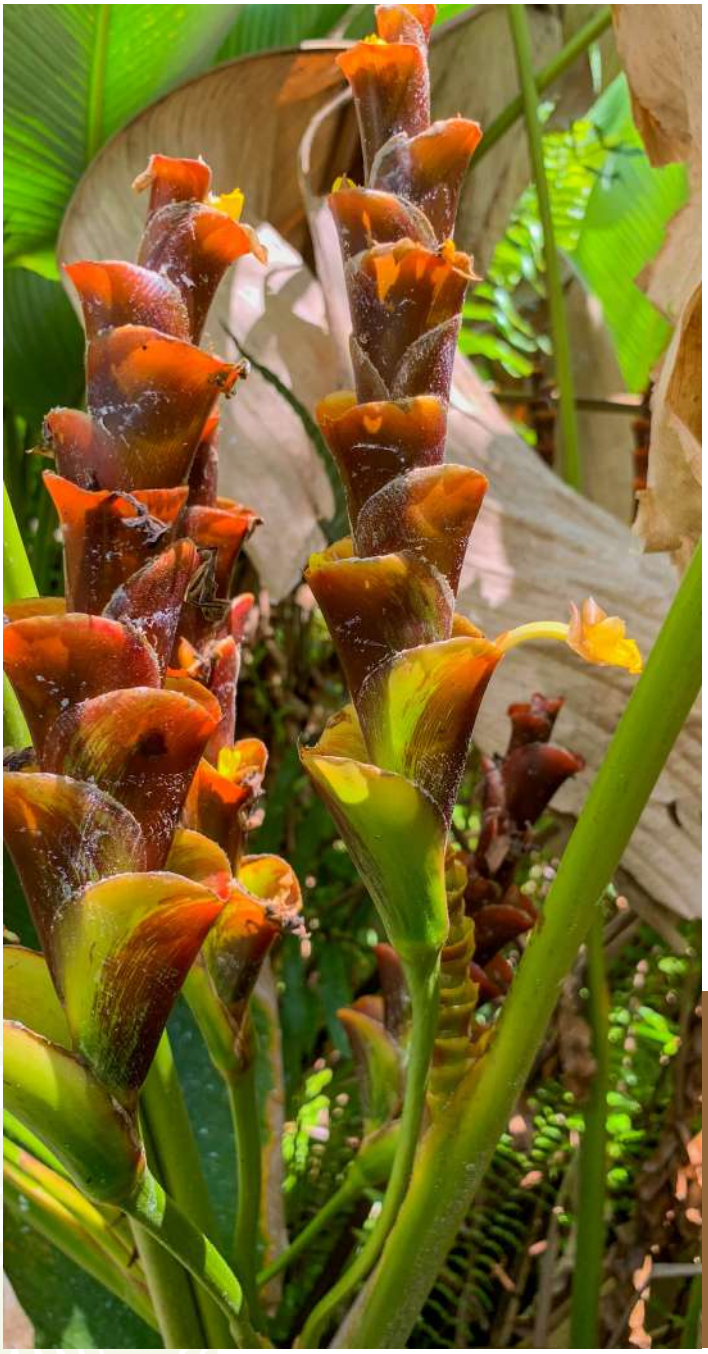
Nicholas and Teco facing lots of tall ferns when you enter the Savanna of 3 Fern Species at the northeast side. The vegetation changes every 40 to 60 meters. Many areas violate traditional definition of a "savanna." But the ring of pools of water around this oval area tell me that the oval is one unit despite the frankly remarkable variation of vegetation (from grassland savanna to fern savanna to forest of thin trees mixed with high ferns and *Calathea lutea*.

This savanna is at the far western part of Yaxha sector of PNYNN, RBM, Petén.

Photo by: FLAAR Mesoamerica, Mar. 26, 2019.
Camera: Google Pixel 3 XL.

Was there influence of the Classic Maya in creating today's botanical and ecological biodiversity in certain areas?

While hiking through Petén and discovering new savannas or ecosystems, a frequent and relevant question always is "Did the Maya create this?". Many aguadas, if they are near a Maya city, for example, are well known constructions from the Maya, and today they are filled with a significant diversity of aquatic plants and water related organisms. With that in mind, finding out which ecosystems evolved out of the conditions created by the Maya could be one of the most unique attributes of any study conducted in Petén. As a matter of fact, savannas could in the future turn out to be one of these unique ecosystems with a remarkable history.



So far, during our field trips and library research 2018 onwards, we have found that savannas at Petén have elements in common, such as the presence of certain plant species, but they differ in the diverse number of floral species that they shelter. In that way, and since they are isolated patches immersed in the forest, they might constitute ecological islands where a number of plants have evolved to thrive in very specific conditions. This particular case of evolution and adaptation is notable by itself, but if it is indeed the result of Maya activities, then any ecological study conducted here will be so much more valuable.

Certainly the relation between ecology and history in Guatemala and all the Mesoamérica region is notable. If you are a botanist, biologist or ecologist there´s so much you can learn about these connections and you'll start noticing them the moment you set foot on Petén's ecosystems.

Inflorescence, bracts, and flowers of *Calathea lutea*, hoja de sal, mashan (lots of names are used for different large-leaf plants).

Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, Jun. 4, 2019. Savanna of 3 Fern Species,
Camera: iPhone Xs

Lots of different plants remain to be botanically identified here in the Savanna of 3 Fern Species.

Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, June 4, 2019. Camera: iPhone Xs.

Our goal of the past project 2018-2019 in PNYNN and present projects in PNYNN + the associated nearby biotopes (Bio Itzá, Biotope San Miguel de la Palotada, Parque Nacional Tikal) + the rest of the Reserva de la Biosfera Maya is to find, photograph, research, and publish the remarkably biodiverse wetlands and to produce a list of suggestions and questions for future scholars to dedicate themselves to. So, our goal is not to undertake any excavations or collections; it is first useful to show which areas are still untouched and virgin, and thus deserve field work and photography to document their presence. Other scholars can utilize our material to prepare future project proposals. But most universities and research centers have been temporarily shut down, so our field work can be even more helpful. Most of our team is vaccinated so this helps.

So we hope in the future that geologists, soil scientists, ecologists and botanists can work together with Mayanists and work together with the park co-administrators to consider soil samples, core samples, etc. Many of these areas, besides just the lagoons, have permanent water. In the future let's have core samples from areas more than just Lake Yaxha and Lake Sacnab.

Shared characteristics between Savannas in Petén and Wetlands

Most of the savannas in Petén are exposed to the same tropical conditions of heat throughout the year and heavy rains over only part of the year. During the rainy season they get temporarily inundated, yet, right now they might not be recognized as wetlands by the regional institutions that work on environment and natural resources. But this has to do not only with nomenclature; many of these savannas have never been explored (as they are in remote areas) or they aren't even referred to as savannas (no exploration means no information nor classification). For these reasons, even when they might not be called wetlands at this day, it is important to mention that they share characteristics with other types of wetlands and might support many of the ecological conditions that other wetlands do as well.

Some savannas, such as the Savanna East of Nakum, have large snail shells all over the place, suggesting that during a wet month or a wet year there is surface water over much of the savanna (hence the word, seasonally inundated). And one of the savannas we found in the southeast portion of the Parque Nacional Laguna del Tigre had a white spider-like lily flower that is usually associated with river sides or along the edges of lakes. This suggests that at least parts of this savanna have standing water in some months of wet years.

Ecological importance of Savannas and Wetlands

Today wetlands are considered important ecosystems with vital influence in the global development and economy. It is well known that they have an active role on the water cycle, they also capture carbon from the atmosphere, and they shelter a diverse number of organisms. In Guatemala, wetlands sustain migratory bird populations on their route to any of the hemispheres, they are the home of endemic species such as the Morelet's crocodile (*Crocodylus moreletii*), and provide water to many of the animal species that inhabit the Maya Biosphere.

Since savannas turn bone dry in dry cycle of the year, with cracked surface, they may not have crocodiles but may have tapir. Since the Savanna of 3 Fern Species had sphagnum moss (what I call bog moss) and since even in a dry month of a dry year both me and biologist Lorena Lobos each fell into different bog holes (sinking down over a meter) while hiking across the Savanna of 3 Fern Species, there is clearly "underland" water under the surface. This is one reason you hear the sound of yourself walking on a deep wet sponge as you cross areas of this savanna where there is no surface water visible.

To have an area with potentially permanent moisture in the soil is a great area to grow all kinds of edible plants. All the more reason to encourage geologists, soil scientists and ecologists to file for permit do core samples. There is a permanent ring water surrounding much of this oval-shaped savanna. If this existed 2000 years ago the local Maya must have utilized this area for multiple purposes: in the dry months and then potentially other uses in the wet months.

Tasiste palm cluster is visible in the center. Tasiste palm identify an area as a savanna. Most of the ground cover are low ferns, hence the name: Savanna of 3 Fern Species.

Laguneta of 3 Conjoined Cenotes is visible at the top (about 50 meters from the north edge of the savanna).

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021. Savanna 3 Fern Species, Parque Nacional Yaxha, Nakum and Naranjo, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

Savannas come in remarkably diverse sizes, shapes, and humidity

The vegetation, and the amount of humidity in or under the soil, of the Savanna of 3 Fern Species changes about every 30 to 70 meters. Around the edge it is open water (varying in depth, more or less 1 meter) for about 2 meters across. Then it continues wet but only a few inches of depth. Then you reach a bog and it's like walking on a sponge. These changes continue as you slowly try to hike across the savanna without sinking into a wet area covered with vegetation so you don't realize that you will sink over a meter the minute your foot is there.

One of the best descriptions of hiking through wetlands of the Maya Lowlands is by Andres de Avendaño, who walked from Yucatan to Lake Petén Itzá twice in the 1690's. Here is just one of his personal experiences in a wetland:

> This said Indian climbed the tree, and gave us the news that he had discovered a great meadow or plain towards the northwest. Some instinct made me believe it, but to see whether imagination and the wish we had to find it, had this effect, we took that direction, so that in a little while we came upon the said meadow; but as we entered it, at the beginning it had half a yard of water; we went ploughing through it and at each step there was more water, and it took a long time to cross it, causing us pain enough in our wounds. But with the care that we took not to get submerged, we forgot that feeling, since the earth of the said marsh was so spongy that though we doubled up the reeds which grew there in large number, so as to step over it, so that the water might hold us up, yet if we stopped a moment, the overflowed earth drew and sucked us in in such a way, that if we should fall, we could not help one another, since he who should stop to help the other, would be submerged with him.
>
> **(Avendaño 1696 in Means 1917: 158-159)**

This is one of the pools of open water (about 2 meters across) that rings the Savanna of 3 Fern Species. At the other side we found lots of interesting plants that we show in separate FLAAR Reports.

Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, Jun. 4, 2019. Yaxha, Petén.

Camera: iPhone Xs

Savannas mentioned by Spanish conquistadores (Tabasco, Petén, etc.)

In the 1970's I did ethnohistorical research in the Archivo de Centro America, Guatemala City, Zona 1, about 3 blocks from where I lived in those years. I found so many important documents about Cholti Lacandón, Quejache, Petén Itzá and neighboring Maya of the 17th-18th centuries that I noticed frequent mention of savannas (that nance leaves of the savanna trees were used by the Maya to wrap cigars of tobacco).

Since 90% of these savannas have been destroyed by modern agriculture, cattle ranches, and encroaching non-native African palm oil plantations, it would be great if a student could do a thesis or PhD dissertation on all the savannas of Petén based on eye-witness experience from Hernan Cortes (and Bernal Diaz del Castillo) of the 16th century through to Cyrus Lundell of the 1930's (when at least some of the savannas around La Libertad were still with original vegetation). Cortés and Díaz del Castillo passed through Tabasco and Petén so experienced several savannas.

It is essential to learn how many and what kind of savannas existed in the 16th-18th centuries. In these years there were no longer "millions of Classic Maya as suggested by results of LiDAR technology..." so the 16th-18th century Maya did not need to use every square meter of land around them. Nonetheless, there clearly were savannas that Cortes and others marched across, starting in Tabasco:

> Y otro día caminamos la tierra adentro hacia el poniente y dejamos la costa; y no sabíamos el camino, y topamos unos buenos prados que llaman sabanas, y estaban paciendo unos venados.
>
> **(Díaz del Castillo 1632: 138)**

Parts of the middle area of the Savanna of 3 Fern Species are so humid underground (under the ferns) that "bog moss" grows along the surface. We mention this on page 13 plus have a separate FLAAR report on this peat moss.

Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, Mar. 26, 2019. Yaxha, Petén.

Camera: Google Pixel 3 XL

Lots of savannas in Tabasco; most are very wet (more wet than those of Petén because some of these savannas are near rivers).

> Otro día caminamos para ir al pueblo de Cimatán, y hay grandes sabanas llanas y en medio de las sabanas muy malísimas ciénegas, e en una dellas nos aguardaron; y fue un un ardid que entre ellos concertaron para aguardar en el campo raso de las sabanas, y propusieron que los de a caballo, por cobdicia de los alcanzar y alancear, irían corriendo tras ellos a rienda suelta y atollarían en las ciénegas. Y ansí fue: como lo concertaron, lo hicieron, que por más que habíamos dicho y aconsejado al Rangel que mirase que había muchas ciénegas y que no corriese por aquellas sabanas a rienda suelta, que atollarían los caballos, y que suelen tener aquellos indios estas astucias y hechas saeteras y fuerzas junto a las ciénegas, no lo quiso creer. Y el primero que atolló en ellas fue el mismo Rangel y allí le mataron el caballo; y si de presto no fuera socorrido, ya se habían echado en aquellas malas ciénegas muchos indios para le apañar y llevar vivo a sacrificar, y todavía salió descalabrado en las llagas que tenía en la cabeza. Y como toda aquella provincia era muy poblada, estaba allí junto otro poblezuelo e fuimos a él...
>
> **(Díaz del Castillo 1632: 744)**

Our informal English translation (by Vivian Hurtado, FLAAR Mesoamerica):

> Another day we walked to go to the town of Cimatán, and there are large flat savannas and in the middle of the savannas, very bad swamps, in one of them they waited for us; and it was a ruse that they arranged between them to wait in the open field of the savannas, and they proposed that those on horseback, out of greed to reach and spear them, would go running after them at full speed and they would run into the swamps. And so it was: how agreed, they did, that no matter how much we had said and advised the Rangel that he saw that there were many swamps and that he did not run through those sheets at rein loose, that the horses would fall over, and that these Indians tend to have these cunning and made arrow slits and forces next to the swamps, he did not want to believe it. And the first one who got stuck Rangel himself was in them and there they killed his horse; and if it were not soon helped, many Indians had already thrown themselves in those bad swamps to and lead alive to sacrifice, and he still came out broken in the sores he had on head. And since the whole province was very populated, there was another settlement and we went to it...

The following savanna was in Petén before the Spanish arrived at Lake Petén Itzá:

> Como salimos del "pueblo cercado", que ansí le llamábamos desde allí adelante, entramos en un bueno y llano camino, y todo sabanas y sin árboles; y hacía un sol tan caluroso y recio, que otro mayor resestero no habíamos tenido en todo el camino. E yendo por aquellos campos rasos, había tantos de venados, y corrían tan poco, que luego los alcanzábamos a caballo, por poco que corríamos con los caballos tras ellos, y se mataron sobre veinte. Y preguntando a los guías que llevábamos cómo corrían tan poco aquellos venados, y no se espantaban de los caballos ni de otra cosa ninguna, dijeron que en aquellos pueblos, que ya he dicho que se decían los mazatecas, que los tienen por sus dioses, porque les ha parescido en su figura, y que les ha mandado su ídolo que no les maten ni espanten, y que ansí lo han hecho, y que a esta causa no huyen
>
> **(Díaz del Castillo 1632: 744)**

Our informal English translation (by Vivian Hurtado, FLAAR Mesoamerica):

> As we left the "fenced town", which is what we called it from then on, we entered a good and flat road, and all savannas and without trees; and it was such a sun hot and tough, that another major resestero we had not had all the way going through those flat fields, there were so many deer, and they ran so little, that later we caught up with them on horseback, almost running with the horses after them, and they killed over twenty. And asking the guides we carried how they ran so little those deer, and they were not afraid of horses or of anything else, they said that in those towns, which I have already said, the Mazatecs called themselves their gods, because he has appeared to them in his figure, and that his idol has sent them to do not kill or frighten them, and that they have done so, and that this cause they do not flee

So, we learn that the Spanish found lots of deer in the savannas. Nowadays deer hide in the woods and probably only feed in the savanna when it is dark. One reason why invasive people burn savannas today is to drive out the deer (the fire is started at one end; the hunters wait at the other end to shoot all the animals fleeing the flames). Tapir also inhabit savannas that have rings of water around them. We saw skulls of killed tapir near the wetlands east of Nakum. We have seen hoof prints of tapir around some savannas (and Aguada Maya). We have seen peccary wallows (hog wallows) where wild peccary love to wallow in the mud around the edge of a savanna or cibal.

I estimate that savannas were significantly more useful 2,000 years ago when LiDAR suggests there were "millions of Maya" in the Lowlands. LiDAR for sure documents that most hilltops were occupied by people (so no space for milpa agriculture there). Plus, increasingly ecologists and archaeologists are estimating that the Classic Maya had more sophisticated farming abilities and experience than slash-and-burn milpa agriculture.

Photo by: FLAAR Mesoamerica, Mar. 26, 2019. Entering the Savanna 3 Fern Species, Parque Yaxha, Petén.

Camera: iPhone Xs

The above references were from the march of Hernan Cortes in the 16th century. Another set of references is from Nicolas de Valenzuela. I found one original handwritten book of his in the Archivo General de Indias, Sevilla, Spain (in 1970's). I did not realize that another copy was in a German library (but not very well known outside Germany). Once I announced my discovery in Spain, several German Mayanists helpfully published their version from Germany. But now at least we have a full transcript so here now you can search for the word sabana and find occasional mention (una sabana grande (page 275), sabana between Caxabon and Lake Ahiza (page 321) and page 419 are examples). Valenzuela mentions one sabana that had been burned (page 323). Mention of "grandes sabanas" (page. 376). More savannas mentioned on page 402. Lots more mentioned on pages 410-411 (are these south of Lake Petén Itzá?).

> **Y pasamos la segunda y la ttercera sabana, y de allí boluimos a enttrar en otra montaña y llegamos al rrio Chacal, q'es la última aguada, por q'desde allí hasta la laguna ya no ay agua sino es de algunas ciénegas o posos |pequeños. En este río hizimos altto y auiendo embiado …. luego q'salieron a la últtima sabana**
>
> **(Valenzuela 1695: 404).**

If you have never driven through Petén for over half a century and never hiked into remote wetlands, you would tend to be at your desk using the word meadow or plain or prairie. I would suggest savanna for some, or cibal-savanna for others. If a cibal has no tasiste, nance or jicara, then I would call it just a cibal and not cibal-savanna.

> On the next day when we left this place, we discovered a large plain or meadow, which horrified us just to see it, on account of what had happened on the preceding afternoon, but as it was free from woods, we were happy in passing over it, and more so as we had seen in the distance many pine trees all about it, so that, thinking of their fruits, we had hopes of getting something to eat; but our hope was in vain, since, when we came to see whether they had cones, they had them, but without seeds. We had recourse to other trees, which appeared to be evergreen oaks, with the acorns of which, if there were any, we might give our bodies some sustenance; but they were nothing but oak trees which had nothing but leaves. Crossing this field, we came upon a path well frequented by animals, and as the grass was tall, their tracks were not seen; notwithstanding which, in some marshes, where there was no grass and the soil was only damp, we saw that the tracks were like those of an ox or bull. We wondered at this, from there not being seen in a long distance from there any herd of cattle, so that for the time being we suspended judgment. . . . But when in the Province I told this to people who go through forests, they told me that those tracks were of deer, for there are such in this Province. I offer no objection to there being as many wild animals as can be imagined, since the woods are very well fitted for them.
>
> **(Avendaño 1696 in Means 1917: 160-161)**

Our interest is to find the savannas and other biodiverse wetlands of the Reserva de la Biosfera Maya and initiate conservation with help of respected international conservation programs.

The aerial sight allows us to see Laguneta 3 Conjoined Cenotes (at top). Across the middle: the bright green vegetation area that covers the "ring of water" around the edge of the Savanna of 3 Fern Species.

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021. Parque Nacional Yaxha, Nakum and Naranjo, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

Why I named this the Laguneta of 3 Conjoined Cenotes

I estimate there are at least three species of ferns within the oval flatland area. We have not yet had time to identify all the ferns but here are the most obvious ones and possible identifications:

- 2-meter (or more) tall leather ferns, potentially *Acrostichum danaeifolium*
- The common wandering fern that rarely grows over 1.5 m. high
- Ground cover fern that covers much of this flat area (so ferns instead of grass)

Blechnum serrulatum may also be found but is nowhere listed for Petén in Neotropical Flora herbaria search engine. It is listed only one lonesome time for Izabal, near Puerto Barrios. I bet there are thousands if not millions of these ferns in the Maya Lowlands.

Nephrolepis biserrate is listed for La Libertad, Petén, Izabal several areas, and "Yaxha-Remate road" for Petén.

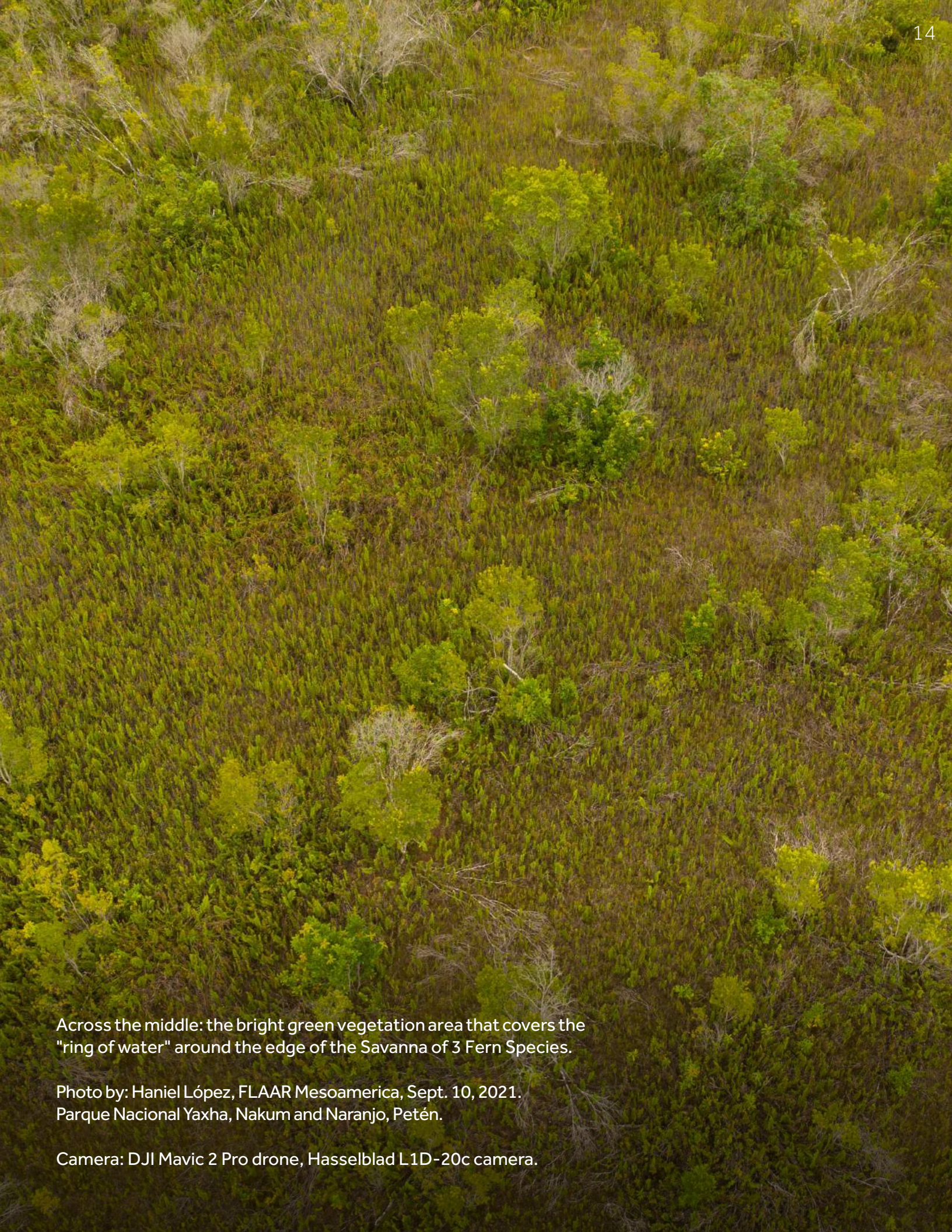
Thelypteris serrata is listed only for Izabal, three lonely specimens; zilch for Petén on this one herbaria data base (https://serv.biokic.asu.edu/neotrop/plantae/collections/list.php).

We need to photograph each fern species top and bottom; plus you need to do the photography when there are spores along the underside. Spores are only visible several months a year.

I have seen ferns everywhere in the recent year: the wandering ferns atop the steep hill of the west end of Cerro San Gil (Municipio de Livingston, Izabal) is notable. Similar looking ferns wander around the hillside overlooking Laguna Lancahá. There are two species of giant ferns in the wetlands of the Municipio de Livingston. Thousands of one species of giant fern are around 80% of the edge of Aguada Maya (Poza Maya) several kilometers north of Yaxha.

When I first entered the oval wetland here at west end of PNYNN, in 2019, we had to wade through reeds or sedges; then came to an "island" of ferns, hoja de sal, and small trees: all crowded together. Then the flatland was more open, but a literal bog, with peat moss to remind you. Felt like walking on top of a wet sponge. Then an open area with low ferns instead of grasses; and an adjacent open area with the wandering fern. So, I felt this savanna deserved to be recognized for its ferns, hence my suggested name, Savanna of 3 Fern Species, Sabana de 3 Especias de Helechos.

During the initial exploration of March 26, 2019, we did not then have a ladder or a drone, so the photos of the flat areas of ferns are not very good. I was so stunned to see them with my eyes (and so careful not to fall into a bog hole) that I did not take enough photos in 2019. But with better cameras and drone we can accomplish better (especially with telephoto lens for a new drone). The day we visited in September 2021 the water level was so high it was not realistic to cross over the ring-of-water surrounding the oval savanna. Plus, we estimated that most of the entire area would be so boggy and water-filled that walking through would be difficult. So, we stayed on the outside and did only drone photos.



Across the middle: the bright green vegetation area that covers the "ring of water" around the edge of the Savanna of 3 Fern Species.

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021.
Parque Nacional Yaxha, Nakum and Naranjo, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

Lots of low ferns covering open areas. One area does have grass, but most of the coverage is ferns. The Laguneta of 3 Conjoined Cenotes is at top right.

At the edge of the savanna you can see the bright green ring. The bright green area at left is part of the water-loving vegetation around the ring-of-water.

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021. Parque Nacional Yaxha, Nakum and Naranjo, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

Savanna of 3 Fern Species is close to Laguneta of 3 Conjoined Cenotes

When looking for unexplored wetlands in Parque Nacional Yaxha, Nakum y Naranjo you immediately notice a lagoon made out of three conjoined circles. Each circle is precisely the same and shape of the mouth of a submerged cenote, of which there are at least two well-known at the west end of Lake Yaxha: one at north side; the other at south side. These Lake Yaxha cenote mouths in the western part of the lake are known to every geologist and most ecologists who have worked at Yaxha. But to my knowledge, the three conjoined cenotes high up on a flat hill to the north, are known mainly to specialists such as Arquitecto Raul Noriega (personal communication 2021). But due to their distance, no ecologist has yet studied this area of the park. This is one reason we were asked to come to the park in 2018-2019 and asked to return for a 5-year program of coordination and cooperation, 2021-2025. We specialize in hiking long distances and recording remote biodiverse ecosystems with advanced digital cameras.

Here you can see low grass; this is one of the few low grass areas. All around this (not visible in this panorama) there are low ferns instead of low grass.
Photo by: Nicholas Hellmuth, FLAAR Mesoamerica, Mar. 26, 2019. Savanna of 3 Fern Species, PNYNN, Petén.
Camera: Google Pixel 3 XL

It would help for a geologist to document that the three conjoined circles are actually three conjoined cenotes, but in the meantime, I have given the name Laguneta of 3 Conjoined Cenotes. Local people who know a name call it Laguna Perdida. But most maps give it no name whatsoever (CONRED map (Código: 1701) has no name for this and no name for Laguneta Juleque either). Both are pictured on maps (usually with no name).

In 2019 we hiked to the southern edge of the southern of the three cenote-shaped circles of water; there is a ring of water lilies growing around the low water close to the shore. We will want to hike around all three segments before we write a report on these. Plus, we need close-up macro photographs of each segment.

On September 10th, 2021 it was raining too much to allow us to hike the extra kilometer there (and then an even wetter kilometer back to the south end of the Savanna of 3 Fern Species). But mainly with the rain there was no way to do drone photography directly over the three segments.

With rain approaching we did not want to have the drone too far away, so the cenote-shaped circles were photographed from afar.

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021. Parque Nacional Yaxha, Nakum and Naranjo, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

In many of the drone photos you can clearly see the three conjoined oval areas about 50 meters north of the north end of the Savanna of 3 Fern Species.

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021. Parque Nacional Yaxha, Nakum and Naranjo, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

Permanent water in Laguneta of 3 Conjoined Cenotes

These three conjoined circles never dry up. They have full standing water during the last 37 years (Google Earth Timelapse). In really dry years the water recedes a bit but never as much as Lake Yaxha shrinks. In distinction, Laguneta La Guitarra (Juleque) shrinks so much it turns into two separate tiny lagoons (this happened in year 2006, visible in TimeLapse and in IGN aerial photos that were all taken that year). In the same year 2006, Laguneta Julequito, an inlet of Lake Yaxha adjacent to the Southwest Cenote, was dry.

But all three of the cenote-shaped ponds of water have water every year.

Savanna-3-Fern-Species.
Instituto Geográfico Nacional de Guatemala-IGN-2373_11_ORT-RGB.

Here you see part of the "ring of water" that is widely separated open pools of water. Usually there is bright green vegetation in this ring around the Savanna of 3 Fern Species.

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021. Parque Nacional Yaxha, Nakum and Naranjo, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

Here are IGN aerial maps IGN-RGB-23673_11_ORT, RGB-23673_12_ORT, RGB-23673_17_ORT, and RGB-23673_18_ORT joined together by David Arrivillaga (we still need to obtain additional photos to show the southwest rectangle). But in these aerial photos you note that Laguneta La Guitarra is two separate lakes (the bottom one have a more mud-like color than the top one).

The Northeast Cenote is filled with water but no water from Lake Yaxha joins it. Yet a few months ago we could motor into this cenote easily; water was deep the entire way.

Same with the slightly larger and thus more visible far Southwest Cenote. Earlier this summer we motored the entire kilometer from Lake Yaxha all the way literally into the savanna. Water was deep enough the entire way (so the "Laguneta Julequito" exists in these wet months. To me it's more an inlet than a separate lagoon, but I am flexible and open to accept local names.

Cropped from IGN 23673_11_ORT_RGB aerial photo, year 2006. I made this less dark in Adobe Photoshop, so you could see more detail.

The lake in the lower middle is Laguneta Lancaja.

Photo by: Instituto Geográfico Nacional de Guatemala.

Drone photo that nicely documents the shore of the southern of the three conjoined cenote mouths. The reeds, sedges, grasses that grow around the edge are subjected to being submerged in water in a rainy month of a rainy year. This is one of several reasons why no trees grow here. That said, when Lake Yaxha water level drops several meters, trees of many species grow to be mature trees on the fresh open space; then when the water rises several years later, these trees die (but they are still standing, dead, beginning to rot; and then fall over). But no such trees whatsoever grow around the edge of this laguneta of three circular pools. This would require a soil scientist, botanist, and geologist to understand why the trees don't invade the shore?

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021. Laguneta of 3 Conjoined cenotes at the west side of Yaxha Lagoon, PNYNN, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

It is also notable that all this water (and the ring of water around the nearby Savanna of 3 Fern Species) is a substantial height above the level of all the water of the Laguneta Lancaha to the south.

Lake Yaxha	Laguneta La Guitarra (Juleque)	Laguna Lancaha (Lancaja)	Savanna of 3 Fern Species	Laguneta of 3 Conjoined Cenotes
177 m.	190 m.	197 m.	212 m.	We did not yet reach here to measure.

The elevations in meters are estimates based on our rudimentary Garmin GPSMAP 64sc (which is ten years old) in an area with no Internet signal. We will be obtaining a top of the line Garmin GPSMAP 66sr later this month so on future field trips will have more precise documentation.

I estimate that the three conjoined cenotes are not more than a few meters higher or lower than the water level of the nearby Savanna of 3 Fern Species.

To reach the Savanna of 3 Fern Species you start at the northwest part of Laguna Lancaha and try find a gully that goes up a fairly steep hill. At the top of the gully you are in a bajo vegetation area. The bajo-like area goes slowly, gradually, uphill (not steep but definitely UPhill and not DOWNhill).

So the first trial measurements shows the savanna is 15 meters higher elevation than the nearest lake which is 49 feet which is close to the height of a 5 story office building. In other words, the water inside the Laguneta of 3 Conjoined Cenotes has to be "pressured up" the height of a 5-story office building. We look forward to the cooperation of a geologist to first, measure the depth of the water and then to explain the various geological possibilities. This should be done in cooperation and coordination with the two administrators of PNYNN.

Water sources at the tops of hills have also bewondered earlier explorers: Fray Andres de Avendaño, in circa 1696 says: "On the top, then, of one of these hills, we found a broad aguada, —a thing which surprised us much, since there were not any other high places around it, from which the water could come.
(Avendaño 1696 in Means 1917: 166)

You can notice all the empty space surrounding the "cenote mouths". These areas are empty, I estimate, because water rises to cover these areas and most trees can't handle such water.

Note that these filled-with-water "cenote mouths" are only an estimated 50 meters from the totally and completely different biome of the Savanna of 3 Fern Species.

So here are two amazing geological and ecological spaces that deserve further field work. We hope a helpful individual, foundation, or corporation can assist us so we have access to a Phase One iXM 100 Megapixel aerial metric camera next time to show more details. But in the meantime, the drone photos that we did take during the few minutes before the rain poured down show the majesty of this remarkable western part of Parque Nacional Yaxha, Nakum and Naranjo.

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021. PNYNN, Petén.
Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

It Started to Rain so we had only a few minutes to accomplish drone photos

September is one of several months of the rainy season for Petén, so it rained both days that we went hiking to do photography of the lagoons west of Lake Yaxha and everything north (Savanna of 3 Fern Species, Laguneta of 3 Conjoined Cenotes). Thus it was pure luck that there was time to do a few minutes of drone photographs and video each day.

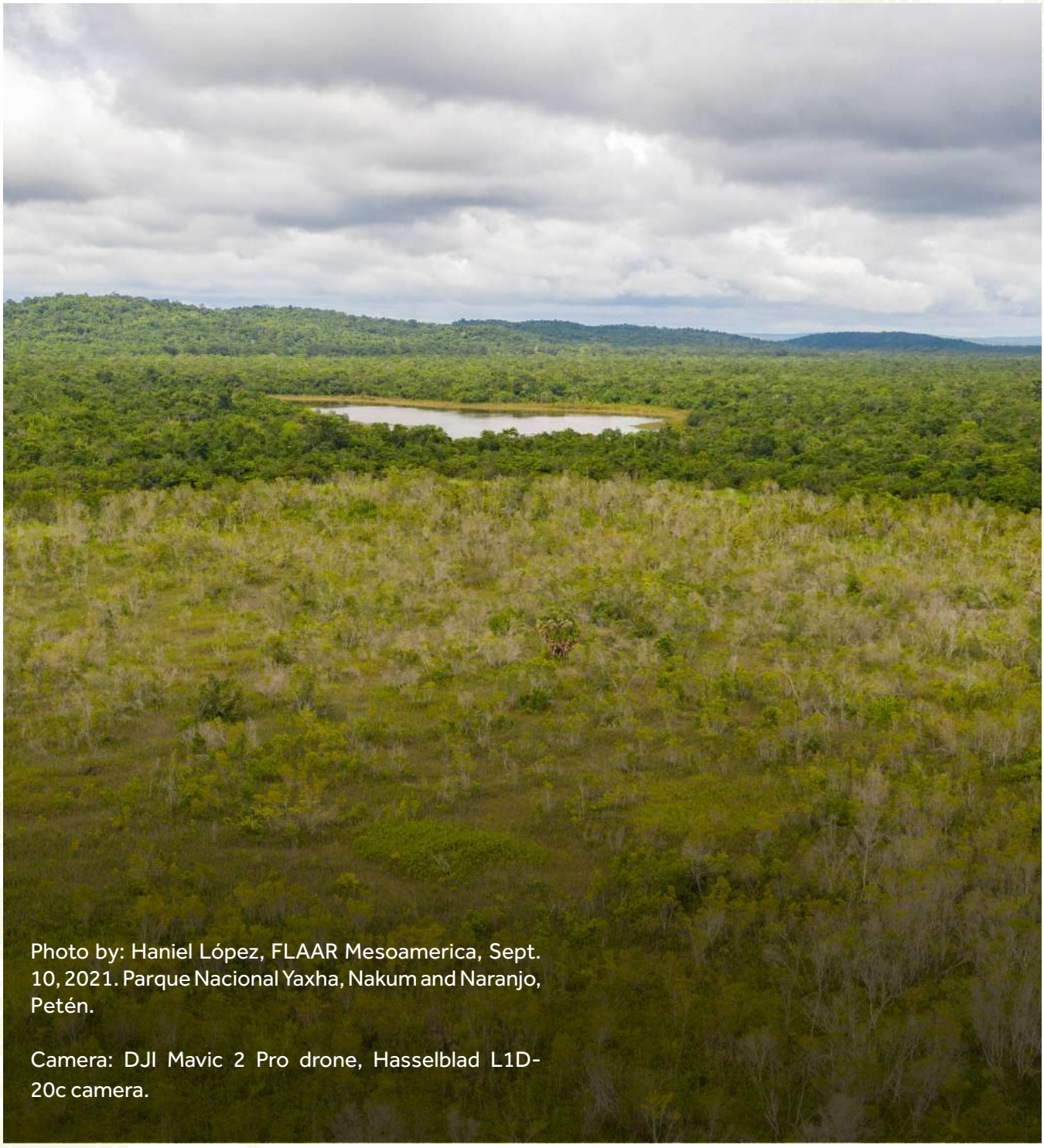


Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021. Parque Nacional Yaxha, Nakum and Naranjo, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

Open Water Areas around oval edge of Savanna of 3 Fern Species

Our two visits to this area of PNYNN were in a dry year (2018 and 2019 were both dry). But nonetheless there was standing water around the edges; not necessarily continuously visible because in some areas there was so much vegetation that you can't see the water unless you are standing there. Indeed in the following chapter we mention in which years the ring-of-water around the edge is more visible than in other years.

Rarely do you see as much open water as in this Google Earth satellite photo. I do not yet know what year or what month.

So far, we have found water around the edges of:

- Aguada Maya (Poza Maya); but this area is Maya-made.
- Savanna of 3 Fern Species
- Cibal Savanna, southeast part of Parque Nacional Laguna del Tigre

Savanna East of Nakum we have not yet hiked the entire circumference but the circumference that we have seen up close is a few centimeters lower elevation and is more humid than the rest of the savanna.

All this raises the question of whether the ring of water around savannas and cibales is always due to Maya creating what they needed, or is there a soil or ecological cause for the ring of water? Local archaeologists, biologists, geographers, geologists can best answer this question. But it's important for us to raise this question.

Here is a rare moment when the Savanna of 3 Fern Species has no water visible whatsoever. There is a band of bright green still around most of the oval area, so surely at least the soil is still moist.

In this same year 2006 aerial photo of IGN (that we will show in the separate report on Laguneta La Guitarra), it is also notable that the Laguneta La Guitarra is so dry that it is separated into two smaller lagoons. We estimate the IGN photos are from 2006.

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021. Parque Nacional Yaxha, Nakum and Naranjo, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

Linear pools of water are visible in areas around the edge of the oval Savanna of 3 Fern Species. If you look at Google Earth Timelapse you see that every year different amounts of water and in different areas of the ring have visible water.

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021. Parque Nacional Yaxha, Nakum and Naranjo, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

Water levels in Wetlands of Petén vary by month and year

In the dry season the surface soil in most savannas and bajos is so dry it is cracked. In a wet month of a wet year there will be low standing water in many parts of a savanna and bajo. They are called seasonally inundated. But this does not happen every year. 2018-2019 was rather dry. 2020-2021 has been average wet.

Google Earth Engine provides year by year satellite views of most countries around the world for the past 37 years. Surely geographers know of such sequential satellite photo options at a higher resolution, but Google Earth Engine is easy to find and see each year (even if at a low resolution):

1984, too many clouds, no usable image
1985, all parts of Lake Yaxha full; Savanna of 3 Fern Species covered with clouds
1986, bit less water but everything still pretty full; oval savanna clearly visible (low res)
1987, less water than year before.
1988, too many clouds but water level is up a tad over previous year
1989, all parts of Lake Yaxha full; oval savanna clearly visible (low res)
1990, bit less water.
1991, all parts of Lake Yaxha full; oval savanna clearly visible (low res)
1992, more water than before
1993, tad lower water level but all western parts of Lake Yaxha pretty full
1994, tad lower water level but all western parts of Lake Yaxha pretty full
1995, similar water levels as 1994
1996, similar water levels; Rectangular Savanna visible for first time
1997, tad less water; lots of invasive farm areas above Laguna Lancaja and to east
1998, less water, invaded destroyed vegetation areas now seem abandoned
1999, much lower water levels; invasive agriculture east end Laguna Lancaha.
2000, lower water levels; much more invasive agriculture
2001, SW area of Lake Yaxha now full of water; full rectangular area at east of Savanna of 3 Fern Species
2002, tad lower water levels
2003, tad lower water levels
2004, much lower water levels, but Savanna of 3 Fern Species 95% ringed with wide band of water.
2005, tad less water; Savanna of 3 Fern Species 80% ringed with visible water
2006, Yaxha, La Guitarra, Lancaja all shrink; only 10% of savanna ringed with water; La Guitarra is so low it looks like two separate lagoons. In the aerial photos of IGN it is literally two separate lagoons (we estimate the date of the IGN photo is 2006; we need to double-check).
2007, all lagoons shrink considerably; but Laguneta of 3 Conjoined Cenotes still filled
2008, levels same; but Savanna of 3 Fern Species has more water visible in segments
2009, levels rise
2010, levels shrink a bit
2011, levels return to circa 2009 level
2012, tad lower but Savanna of 3 Fern Species has continuous water around entire west, south, and south-east segments
2013, tad more water
2014, levels rise especially SW portion of Lake Yaxha
2015, similar to 2014 levels
2016, levels shrink a bit, not much of Rectangular Savanna visible
2017, levels shrink a bit
2018, levels rise back a bit
2019, levels shrink a bit
2020, levels shrink small amount
2021, not yet posted.

Physiological adaptations from plants in the savannas

As referred repeatedly in this report, savannas have specific conditions in which plants and other living beings have evolved and adapted themselves. Over almost half of the year, water is available, but during the other half of the year, savannas get dry. Under these circumstances, plants and animals have developed characteristics in their physiology to withstand them. Some of these adaptations include: seasonal growth and short life cycles (as it happens with grasses); storage organs (such as the bulbs of spider-like lilies); underground hibernation (as the Uo toad does), among others.

Surviving fire is necessary for a plant to survive in a savanna in Mesoamérica. Nance survives the fires but we have not seen a sequence of how they handle and regrow.

The tasiste palm we have studied its ability to handle fire in multiple savannas. Tasiste palm can be incinerated and regrow as soon as the rain comes. If the fire is slow and fierce the entire trunk will be burned and eventually fall over. But lots of fresh stems will grow rapidly from the underground root mass when it rains.

But in most savanna fires, the fire moves through relatively quickly: the palm leaves get burned off; the thick loose covering of the entire stem (the trunk) is burned off but the palm survives and regrows leaves when it starts to rain.

Over 90% of the Crescentia cujete, jicara, calabash trees, survive fire; they just "sit it out" and the leaves resprout when it starts to rain. Yes, occasionally the fires are so hot and slow that the entire tree will burn down. But birds or animals spread the seeds and the savanna continues to have these trees.

Keep in mind there are dozens, scores, of other plants in savannas. They all have to survive fires, and core samples document that fires date back thousands of years (which is why tasiste palms grow in every savanna but almost never a guano or corozo palm).

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021. Parque Nacional Yaxha, Nakum and Naranjo, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

Tasiste, *Acoelorrhaphe wrightii*, within the Savanna of 3 Fern Species, but more outside

From aerial drone photos of September 10th, 2021, it is possible to notice widely scattered individual clusters of tasiste palms within the Savanna of 3 Fern Species. So even though this is a fern savanna and not a low grassland savanna you still get the logo tasiste palms. We need to look for nance fruit trees and jicara calabash trees when it is dry enough to hike into the central area.

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021.
Parque Nacional Yaxha, Nakum and Naranjo, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

Here is a single clump of *Acoelorrhaphe wrightii* palms, in the middle of the fern and splattered open forest area

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021. Parque Nacional Yaxha, Nakum and Naranjo, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

Utilitarian Plants of Savannas: *Calathea lutea*, Hoja de Sal, Mashán

Savannas are filled with edible plants and plants with useable parts. Leaves of two species of *Calathea* are used to wrap tamales. I can recognize the differences between the two species because of its inflorescences and flowers (and of course due to size of its leaves).

We raise hoja de sal in our ethnobotanical research garden around our office building in Guatemala City. Mashan is all over Alta Verapaz and adjacent Petén (and other moist áreas of Guatemala including Izabal). Mashan leaves are larger than *Canna indica* (whose leaves are also used to wrap food). I estimate the plants here are *Calathea lutea*, keeping in mind that *Calathea crotalifera* is also common in the Maya Lowlands. Both are plant family Marantaceae. *Calathea lutea* grows quite tall. I use the generic word mashán; but realize this is more often applied to *Calathea crotalifera*. Hoja de sal is used more often for *Calathea lutea* but also used for *Calathea crotalifera*.

Thalia geniculata also has useful leaves but nowhere near as long as those of ***Calathea lutea.*** So far each savanna we have found has various of these, but they are easiest to find in a totally open grassland savanna. Large areas of the Savanna of 3 Fern Species is solid plants of totally different sizes and shapes, so you can only notice the hoja de sal due to their giant leaves and easy to recognize inflorescences.

Canna indica is plant family Cannaceae. We will need to hike through this savanna every two months to see whether there are *Canna indica* here also. But since it takes between 5 and 6 hours to get back-and-forth from Yaxha base camp, we need to be able to get here more quickly in the future from Ramonal to the southwest, or create a shorter more direct trail after Laguneta Juleque (so we don't have to hike the entire way around the south and west of Laguna Lancahá).

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021. Savanna of 3 Fern Species, PNYNN, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021.
Parque Nacional Yaxha, Nakum and Naranjo, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

At top left you can see one pool of water in the ring of water around the oval Savanna of 3 Fern Species. The vegetation in this transitional ring changes every 40 to 60 meters.

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021. Parque Nacional Yaxha, Nakum and Naranjo, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

Natural orchid gardens

One of the most peculiar features of the seasonally inundated bajos, as well as the perimeter of wetlands and several savannas, is the presence of abundant orchid species. The orchid family has adapted to thrive mainly on the canopy and the branches of the trees through the development of storage organs called pseudobulbs, but the humidity conditions of inundated areas and other water bodies has greatly promoted the settlement of many orchid species. That is why while visiting these places you can find an incredible diverse number of them, and when they get to flower you find yourself walking through natural orchid gardens.

One orchid that was discovered by Senaida Ba is *Habenaria repens*. This grows closely near water. Since these areas are seasonally inundated this species or orchid can evidently survive the rise of the water. Since the buds are the same green color as the plant they are a challenge to find.

Concluding Discussion and Summary on the Rectangular Savanna

We will have a separate FLAAR report on the Rectangular Savanna as soon as it is realistic to criss-cross this entire area. Since all the access trails are from the far west edge of Laguna Lancaja, we have not yet had time to reach much less to hike through the Rectangular Savanna. But we did get close during our second hike to the east side of the adjacent Savanna of 3 Fern Species in 2019 and I did see the tasiste palms, a key indicator of a grassland savanna (we next need to see if there are *Crescentia cujete* (gourd tree, jicara) and nance trees also).

The "rectangular" area with several clusters of tasiste palm is on the lower east side of the oval Savanna of 3 Fern Species.

Helpful satellite photographs from Satellites. Pro tend to be much better than satellite photos of Google Maps.

In this dry year the inlet west of the three islands of Lake Yaxha is dry; so in 2006 "Laguneta Julequito" was all dry. But the Southwest Cenote is full of water (as is the Northwest Cenote and Laguneta of 3 Conjoined Cenotes, at far top left of this aerial photo). We will have FLAAR reports on each of the Lake Yaxha cenotes and on Laguneta Julequito by late October or early November.

The IGN aerial photos were taken in 2006. This was a very dry year, so dry that Laguneta El Juleque (Laguneta La Guitarra) is dried up into two separate pools of water. Notable is the different in color of the two segments. We have separate reports on each of these lagoons.

This is IGN aerial photograph 23673_11_ORT_RGB cropped to show the Rectangular Savanna at the lower right side.

This photograph is during year 2006, a very dry year. We do not yet know the month.

I have Photoshopped it so the difference in soil wetness can be seen (wetter has greener vegetation). The left side is not human disturbance, this is how some areas of a savanna look in a dry month. But even though there is no ring of water, not even a single area of visible surface water, I bet if you hiked around the ring you would fall into a bog every 20 meters.

The light color splatches in the Rectangular Savanna are more likely a plant growth resulting from different soil or humidity. I doubt these are human gardens though I estimate this area was farmed a decade ago. But we have no evidence of farming out in the oval area: too boggy. There is so much land available that invasive farmers have no interest in trying to handle a bog. But 2000 years ago, the Classic Maya would have most likely had experience in handling any and every atypical seasonally inundated area.

Core samples would help: I suggest one core sample from a permanent water area in the circle around the Savanna of 3 Fern Species. Even though in this photo you can't see any water, there is plenty of water there.

Plus take a core sample in the Laguneta of 3 Conjoined Cenotes; this is only about 50 meters north.

The results of analysis of core samples here could reopen entirely new theories of Classic Maya (and Preclassic) and also the people before "Classic Maya" culture reached here.

This would be a separate project and separate permit requests. We are sharing our photographs and suggestions to encourage having Parque Nacional Yaxha, Nakum and Naranjo as a scientific research to advance studies of all aspects by using today's advanced technologies.

Since these are very small areas, if more sediment is needed, Laguneta La Guitarra (Laguneta El Juleque) and Laguneta Lancaja would be other options.

View looking straight down at the center of the Savanna of 3 Fern Species. I can recognize the several clusters of Calathea lutea, hoja de sal (also called Mashan; keep in mind that Spanish and even Mayan local names are often used for many different plants). If I ask three different people the local name, I get three different names. So it is crucial to have the Genus species correct.

Our next goal is to have a higher resolution drone camera, such as the Phase One iXM. If a helpful individual or foundation can provide the funds we can have high enough resolution to facilitate recognizing the other species. And crucial, to show where the ground cover is pure ferns and where a few small areas are low grass. And, for the fern ground coverage, where is the "wandering species" and there is the upright species: there are two ground ferns here: 80% the upright species and 20% another species.

Once we know what species are in the savanna area, next step is to have access to aerial camera that not only has high resolution, but a camera that can detect each individual plant species based on its infrared wavelength signals.
Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021. Parque Nacional Yaxha, Nakum and Naranjo, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

From Google Earth Engine (Google Earth Timelapse) I noticed that the rectangular area was first visible in 1996. Sadly the resolution of these timelapse photos is unusable as an illustration. But, in other words, this rectangular partial grassland savanna, partial splattered forest may be "man made" by intrusive farmers in 1996. But from the Timelapse sequence what is noticeable is that no more man-made use of this area is obvious in later dates. Keep in mind that the resolution of Google Earth Timelapse various from useless to covered with clouds. But hopefully geologists, geographers, and ecologists know of better time lapse satellite photo resources so in the future we can check on this. The IGN aerial photographs, which I estimate are 2006, will help study the situation.

Good view of the area east of the oval Savanna of 3 Fern Species that has lots of tasiste palms, a logo indicator of a grassland savanna. We need to criss-cross that area to see if there are also wild nance fruit trees or jicara (*Crescentia cujete*, calabash tree).

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021. Parque Nacional Yaxha, Nakum and Naranjo, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

If in fact this "rectangular" area was a milpa in 1996, it is remarkable that areas regrew as a savanna in at least one area. The PhD dissertation by Vaughan is a really informative discussion of rise and fall of savannas. Would help immensely to use today's digital technology and study virgin, original, complete savannas (that have not been turned into cow pastures). And to do core samples from the standing water that is around the edges of many cibales or savannas.

Concluding Discussion and Summary on the Savanna of 3 Fern Species

This oval area could be, and should be, a PhD dissertation topic for a biologist and for an ecologist and for a botany student and ethnobotany student. A student aspiring to become a soil scientist could do a PhD dissertation here that would rewrite Petén ecological history (potentially back thousands of years).

This oval area, and the "rectangular" area with grass and tasiste palms to the east, plus the nearby Laguneta of 3 Conjoined Cenotes should be a research project for geologist, geographer, archaeologist and botany/ethnobotany professor.

But if no student or professor knows of the biodiverse potential of this area of PNYNN, no student or professor will realize how much their own field work here can result in being cited and quoted for generations.

Our drone photographs of September 2021 plus the iPhone photos of our two visits during 2019 reveal only a fraction of the biodiversity of this area. Each year of our project we will hike here to do even better photography. For example, we now have high-resolution Sony mirrorless cameras (four different models, including the 50 megapixel Sony Alpha 1). The iPhone 13 Pro Max (released this week) will also be helpful, as will the Google Pixel 6 Pro (50 MP wide camera; 48 MP telephoto with 4x optical zoom; 12 MP ultrawide (which we don't recommend since it distorts). Imagine doing a panorama of each portion of a savanna with a 48 megapixel camera on a cell phone!

We do these panos from the top of a very tall ladder; this ladder is the single most useful piece of equipment to have on any field trip where you wish to see and record flora, fauna, or biodiverse ecosystems. We had this ladder with us on the September hike to the Savanna of 3 Fern Species (but used it primarily en route since by the time we got to the savanna it began to rain and the savanna itself was "so deep in water" that it was not realistic to wade into it without special wading pants (waterproof "boots" that go up to your chest, held on with suspenders)).

Essential also is the Phase One iXM 100MP metric technology aerial camera which was developed in Denmark by the industrial division of Phase One, in cooperation with DJI (for their DJI M600 PRO aerial platform drone). Another seldom mentioned but super benefit is that this Phase One drone has dual remote controllers: one person pilots the drone; a separate individual (a photographer) decides what angle, height, location, etc. for taking each photograph.

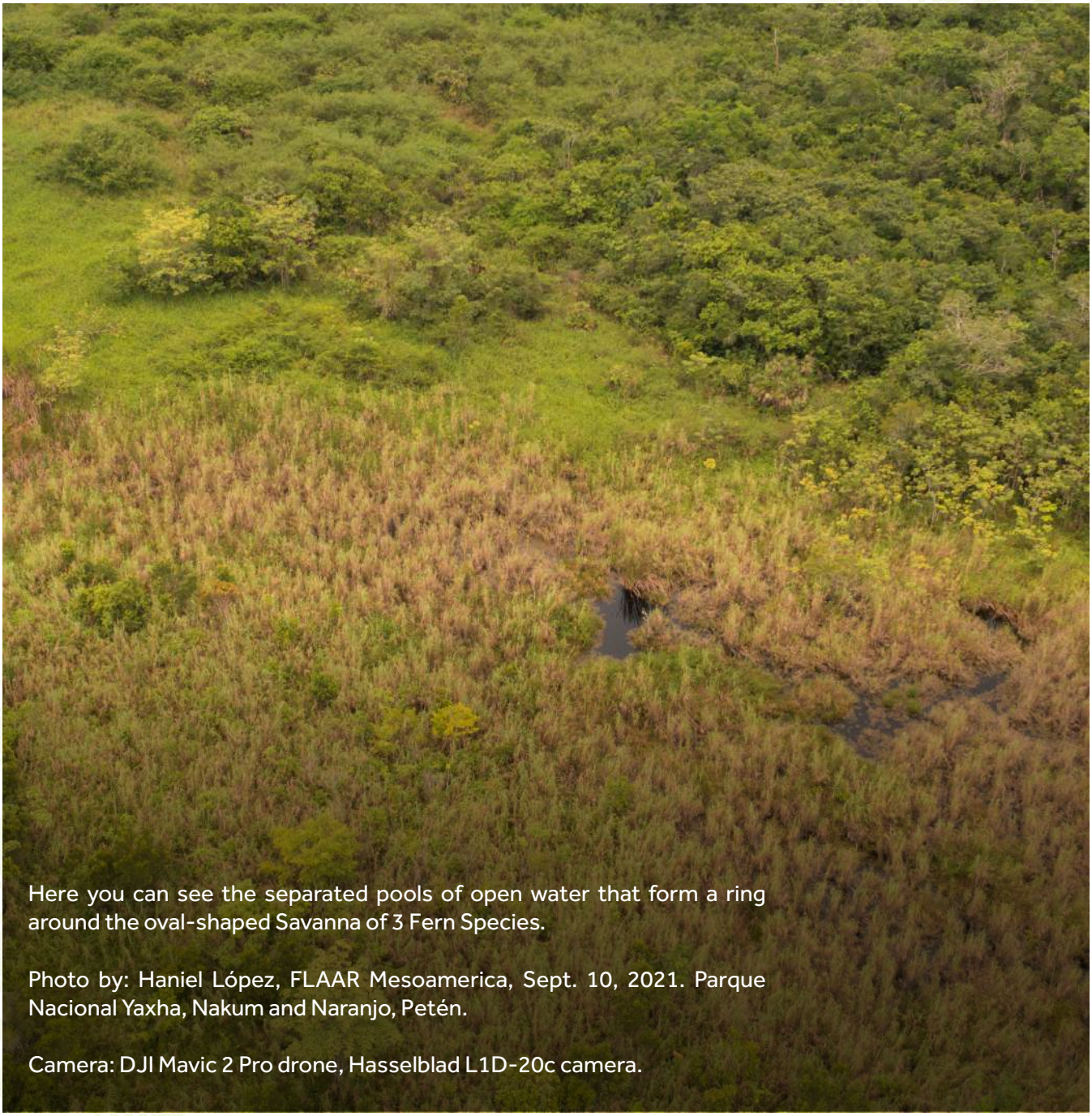
Sample photos from a distributor of Phase One iXM 100MP medium format digital camera are visible here: https://coptrz.com/hasselblad-or-phase-one/

This metric camera also allows creating 2D and 3D maps. This Phase One camera has several interchangeable lenses

Since these cameras are advertised for train rail inspection, electricity poles, wind turbines, bridges and highway inspections (to find damaged areas that need to be repaired before they become dangerous), we of FLAAR Mesoamerica can document the usefulness, helpfulness, and unparalleled fresh new digital technology benefits for:

Botanical plant identification

- Ethnobotanical documentation (wild native edible and useful plants).
- Documenting Ecology biomes at a resolution never before possible
- Providing helpful information for future Plan Maestros conservation and preservation of flora
- and fauna



Here you can see the separated pools of open water that form a ring around the oval-shaped Savanna of 3 Fern Species.

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021. Parque Nacional Yaxha, Nakum and Naranjo, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

Lots more to study here in this remarkably biodiverse Savanna of 3 Fern Species; we will take all the drone photos on a clipboard with us the next time we hike the long distance to this area. We have all the drone photos printed on paper so that we can write notes and put arrows to identify more of the plants in this photograph.

We will also want to do drone photos around the edges of all three of the conjoined cenotes that start about 50 meters north of the Savanna of 3 Fern Species.

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021. Parque Nacional Yaxha, Nakum and Naranjo, Petén.

Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

Appendix A
Additional Glossary of Wetlands Terms

The glossary at the start of this report is on savannas. The additional glossary here as an appendix has other wetlands terms, including some in Spanish.

Aguada, a waterhole, rarely as large as a pond. The water may be clear (rarely); or, more often, covered with plants that specialize growing on top of non-flowing water. Aguadas rarely have trees inside them, but have trees around them (but not in the area that is seasonally flooded). Aguadas are usually round or oval; rectangular ones, such as Aguada Maya (Poza Maya), a few kilometers north of Yaxha in PNYNN, were modified by the Maya. Most aguadas near ancient Maya cities were modified. More and more reports exist on use of aguadas by the Preclassic and Classic Maya. Also see pital, a kind of aguada filled with one species of terrestrial bromeliad.

Corozera is an area of predominantly corozo palm, *Attalea cohune*. Cohune palm in Belize. Corozal is a term also used for corozera.

Crique: is one of many ways of spelling the local rural pronunciation of Creek. I have seen it spelled several other ways; but it is pronounced crique. I only heard this word after beginning to do field work in the Caribbean area of Guatemala (Municipio de Livingston, Izabal). I have not yet noticed this word in Petén.

Humedal: is a generic term in Spanish for wetland, generally more marsh-like than swamp-like.

Lakeside: is the land adjacent to a lake.

Manantial: is a generic term in Spanish for spring, is a point at which water flows from an aquifer to the Earth's surface.

Marsh: It usually has water all year but has no total tree cover. Grasses, reeds and low plants are very common, as well as underwater plants and floating plants.

Pantano: could be considered a Spanish translation of marsh, so lots of reeds and grasses (but not many trees). If the area is a forest with water at the foot of every tree, tree, similar to a swamp. The definition of each of these words depends a bit whether you are in the wetlands of Tabasco, or Río San Pedro (western Petén), or near Monterrico (inland from Pacific Ocean coast of Guatemala) or in the Municipio de Livingston.

Pital, is an aguada surrounded by *Aechmea magdalenae* bromeliads that produce pita, a fine string (one of the best such strings from any plant of Petén). The fruit of this bromeliad is very photogenic, and reminds you of a pineapple. Aechmea magdalenae fruit is also edible.

Riperian: the bank of a river or stream. In a location such as the Petén, it would help to have a single word for the bank of a river, stream, and lagoon. I will use shoreline or comparable.

Seasonally inundated: means that during the rainy season a flatland has standing water (several centimeters to almost a meter; obviously varies by rainfall and drainage). A tintal is a seasonally inundated area of palo de tinte (palo de Campeche, *Haematoxylum campechianum*). Some corozeras, if on a flat area, are seasonally inundated (two corozeras between Yaxha and Nakum and one on the west edge of the ruins of Naranjo (Parque Nacional Yaxha, Nakum and Naranjo). A corozera is an area of predominantly corozo palm, *Attalea cohune*. The Savanna East of Nakum was bone dry when we visited it in 2018-2019 field seasons; but had snail shells everywhere, documenting that in a more rainy year much of this same "savanna" has standing water. Tasistal, some guanal areas, escobal areas are also seasonally inundated (Lundell 1937 for some areas of Petén; but not the entire departamento).

Swamp: usually has water all year but has lots of trees. During the rainy season the water simply gets deeper. Petén has more marshes than swamps; Izabal has both. You get mangrove swamps all around the Caribbean coast and parallel to the Pacific Ocean coast (several impressive mangrove swamp areas inland from the Pacific coast of Guatemala). Most "swamps" in Petén are swampy only in a wet month of a wet year; these bajos are bone dry in the dry season. But parallel to Río San Pedro and other areas of the Reserva de la Biosfera Maya surely swamps exist.

Swampo: is the way this is pronounced in the Caribbean area of Guatemala.

Wetland or wetlands: to me is a generic word to cover swamps, marshes, and seasonally inundated areas. Each ecologist and geographer and botanist use their own academic terms. But, Holdridge (initiator of life zone systems concept focused on climate) never hiked through the Savanna of 3 Fern Species nor the Savanna East of Nakum (PNYNN) nor took a boat up all the rivers entering into El Golfete. Besides, we are more interested in flora, fauna, soil, and geology than climate.

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Plus Books that help identify Trees and other Plants that are in Savannas

Note: since the present edition is a work-in-progress this bibliography also is a work-in-progress

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The handwritten diary by Avendaño is in the British Museum. I need to find at what date it was written; I assume quickly after he returned to Merida, hence circa 1696.

AVENDAÑO y Loyola, Andrés de (author)
Bowditch, Charles P. (translator)
Rivera, Guillermo (translator)
Comparato, Frank E. (editor and notes)

1987 Relation of two trips to Petén : made for the conversion of the heathen Ytzaex and Cehaches. Labyrinthos. 71 pages.

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ATRAN, Scott, LOIS, Mimena and **Edilberto UCAN Ek'**

2004 Plants of the Peten Itza' Maya. Museum of Anthropology, Memoirs, Number 38, University of Michigan. 248 pages.

Very helpful and nice collaboration with local Itza' Maya people. But would help in the future to have a single index that has all Latin, Spanish, and English plant names so that you can find plants more easily. Suzanne Cook's Lacandón ethnobotany index is significantly easier to use.

Savannas are indeed mentioned but without a digital copy to search, savanna mentions are not realistic to find.

Not available as a download.

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It is amazing that there is no such book for Parque Nacional Tikal, nor El Mirador. Even though it includes only half the estimated number of "trees," it has more tree species than Schulze and Whitacre for Tikal (they estimated about 200 but list only about 156 (their lists of species and list by plant family are not identical).

The entire book is a totally free download, however you can't copy and paste so is difficult to add to your discussion.

In the future would be helpful to have a photographer with high-resolution equipment available and a book producer that can put these photos at a resolution that allows you to see the details. The photos of the overall tree have almost no visible detail. Nonetheless, the authors all have botanical experience and this book is a good start. A second edition would be helpful. Also would help to have more than one page per photo.

http://aleph.ecosur.mx:8991/exlibris/aleph/a22_1/apache_media/74R92GMRSJSEPFDEE5NJY4SJI2I8AK.pdf

PEÑA-Chocarro, María and **Sandra KNAPP**

2011 Árboles del mundo maya. Natural History Museum Publications. 263 pages.

Helpful book; contributing authors are experienced botanists. They cover 220 species of trees, more than virtually all other "Books on Trees of the Maya." Even include tasiste (which is missing from all other books on "Trees of the Maya" except for the recent book on Árboles de Calakmul.

But if all this effort is going into a book, would help if there were more photos, larger photos, and not so much blank space at the bottom of each page. Plus would help if the text could include personal first hand experience with these trees out in the Mundo Maya. But even as is, it is a helpful book.

If you are doing field work you need this, plus Árboles de Calakmul, plus Árboles tropicales de México. Parker's book you need back in your office, since out in the field it's not much help due to lack of photographs. Back in your office the books by Regina Aguirre de Riojas are also helpful.

PENNINGTON, Terence D. and **José SARUKHAN**

2005 Árboles tropicales de México. Manual para la identificación de las principals especies. 3rd edition. UNAM, Fondo de Cultura Economica. 523 pages.

This book is a serious botanical monograph. 1968 was the first edition (I still have this), 1998 was second edition. The 3rd edition is a "must have" book. Each tree has an excellent line drawing of leaves and often flowers and fruits (though to understand flowers you need them in photographs, in full color). Each tree has a map showing where found in Mexico (such maps are lacking in most books on Trees of Guatemala or plants of Belize). But trying to fit a description of a tree on one single page means that a lot of potential information on flowering time is not present. And, this is definitely not a book on ethnobotany: for that you need Suzanne Cook.

SCHULZE, Mark D. and **David F. WHITACRE**

1999 A Classification and Ordination of the Tree Community of Tikal National Park, Peten, Guatemala. Bulletin of the Florida Museum of Natural History. Vol. 41, No. 3, pp. 169-297.

Even though 20 years ago, it's the best list of trees of Tikal that I have found. There is a web site with plants of Tikal but they are not separated into trees, vines, shrubs, etc., so harder to use. The new monograph on Arboles de Calakmul is better than anything available so far on Tikal (and the nice albeit short book by Felipe Lanza of decades back on trees of Tikal is neither available as a scanned PDF nor as a book on Amazon or ebay).

Download on the Internet.

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1936 The Forests and Flora of British Honduras. Field Museum of Natural History. Publication 350, Botanical Series Volume XII. 432 pages plus photographs.

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1923 Trees and Shrubs of Mexico. Contributions from the United States National Herbarium, Volume 23, Part 3. Smithsonian Institution.

In this one monograph the species are not listed in alphabetical order, so it's a mental adventure finding the species you are looking for.

All monographs by Standley and co-authors can be easily found and downloaded. I would recommend finding the .pdf versions as they are easier to store, easier to copy, and easier to share with students and colleagues.

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TETETLA Rangel, Ericka

2011 Diversidad vegetal de especies raras y su relación con la estructura del paisaje a múltiples escalas espaciales en las selvas de la Península de Yucatán. Dissertation, Centro de Investigación Científica de Yucatán.

This is one of the better dissertations that I have seen and is as good as most peer-reviewed articles in scientific journals. Even has location maps for most of the trees.

Download: file:///Users/new/Downloads/PCBP_BT_D_Tesis_2012_Tetetla_Erika.pdf

VALENZUELA, Nicolas de

1695 Conquista del Lacandón y conquista del Chol: relación sobre la expedición de 1695 contra los Lacandones e Itzá según el "Manuscrito de Berlin" / Nicolás de Valenzuela. Ed. y comentario de Gótz Frhr. von Houwald. - Berlin: Colloquium-Verlag.

VAUGHAN, Hague Hingston

1979 Prehistoric Disturbance of Vegetation in the Area of Lake Yaxha, Peten, Guatemala. PhD dissertation, University of Florida. 176 pages.

Very helpful discussion of whether fire and agricultural intervention in past centuries creates savannas. Rare that savannas are featured in PhD dissertations because most Mayanists work in bajos. Unfortunately I can't yet find the savanna he mentions under Lake Quexil. Possibly destruction for cattle ranches since 1970's or other modern disturbances have removed most of the original savanna. I can see a possible savanna north-northeast of the west end of Lake Quexil. But no savanna along the south.

VILLASEÑOR, José Luis

2016 Checklist of the native vascular plants of Mexico. Catálogo de las plantas vasculares nativas de México. Revista Mexicana de Biodiversidad 87 (2016) 559–902.

http://revista.ib.unam.mx/index.php/bio/article/view/1638/1296

Helpful web sites for any and all plants

There are several web sites that are helpful even though not of a university or botanical garden or government institute.

However most popular web sites are copy-and-paste (a polite way of saying that their authors do not work out in the field, or even in a botanical garden). Many of these web sites are click bait (they make money when you buy stuff in the advertisements that are all along the sides and in wide banners also. So we prefer to focus on web sites that have reliable information.

https://serv.biokic.asu.edu/neotrop/plantae/
Neotropical Flora data base. To start your search click on this page:
https://serv.biokic.asu.edu/neotrop/plantae/collections/harvestparams.php

http://legacy.tropicos.org/NameSearch.aspx?projectid=3
This is the main SEARCH page.

https://plantidtools.fieldmuseum.org/pt/rrc/5582
SEARCH page, but only for collection of the Field Museum herbarium, Chicago.

https://fieldguides.fieldmuseum.org/guides?category=37
These field guides are very helpful. Put in the Country (Guatemala) and you get eight photo albums.

http://enciclovida.mx
CONABIO. The video they show on their home page shows a wide range of flowers pollinators, a snake and animals. The videos of the insects are great.

www.kew.org/science/tropamerica/imagedatabase/index.html
Kew gardens in the UK is one of several botanical gardens that I have visited (also New York Botanical Gardens and Missouri Botanical Gardens (MOBOT), in St Louis. Also the botanical garden in Singapore and El Jardín Botánico, the open forest botanical garden in Guatemala City).

www.ThePlantList.org
This is the most reliable botanical web site to find synonyms. In the recent year, only one plant had more synonyms on another botanical web site

Video on Savannas of Petén and Belize and Africa

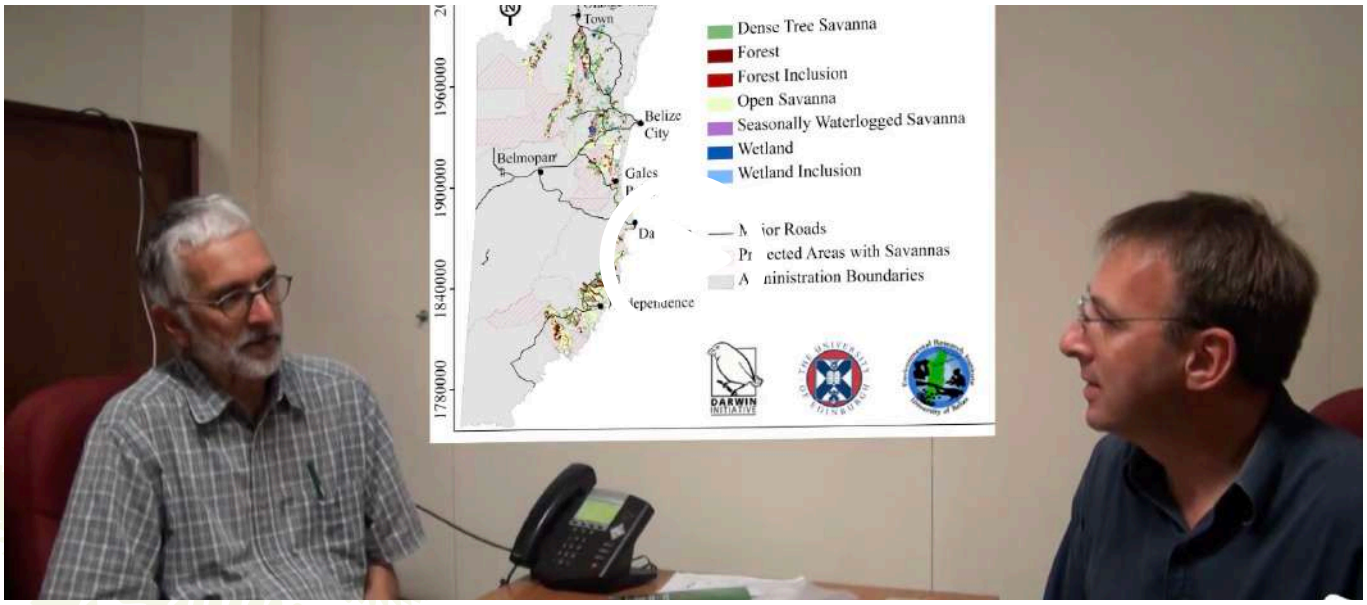
www.youtube.com/watch?v=k17R7Se28hU

Defines savannas focusing on Africa. Shows map of the world and does not mention any savannas for Guatemala or Belize (so typical).

www.maya-ethnobotany.org/video-of-presentation-of-nicholas-hellmuth-on-biodiversity-of-ecosystems-of-municipio-de-livingston-izabal-and-savannas-of-pnynn-peten.php

Presentation by Nicholas Hellmuth of biodiversity in Livingston and savannas of PNYNN. All in Spanish. We show savanna East of Nakum at 15:56 (15 minutes, 56 seconds) to 20:42). Shows all the savannas we have documented for PNYNN so far.

www.isfmi.org/resources-1/fire-leadership-for-protected-areas-in-belize
9:29 minutes
Interesting Belize documentation that managed fires are safer then letting illegal fires burn too strongly. We are neutral on this point because each park and nature reserve needs to make this decision for themselves, since vegetation within and type of forest surrounding each savanna is slightly different.



www.youtube.com/watch?v=gEZVlS4My4w
4:10 minutes
Belize savannas, especially pine savannas.

Lack of videos on savannas of Guatemala is notable. Surely such videos must exist but since 90% of the savannas of Poptún area and La Libertad area of Petén have been destroyed by cattle ranches or commercial plantations there are no easily accessible savannas to video. The majestic savannas that are still pristine are multiple hours drive (savanna adjacent to Naranjo ruins) or multiple hours hike after multiple hours drive. Thus, so far, not many videos.

This report can be cited in your preferred style. Here is the basic information:

HELLMUTH, Nicholas
2021 Satellite Photos & High Resolution Drone Photos Assist Ecologists & Botanists for studying Wetlands, Parque Nacional Yaxha, Nakum and Naranjo, Reserva de la Biosfera Maya (RBM), Petén, Guatemala. FLAAR (USA) and FLAAR Mesoamerica (Guatemala).

Base Camp Assistance in Parque Nacional Tikal

While doing field work in the Tikal national park about a decade ago we appreciate the house provided to us by the park administration. We also thank the Solis family, owners of the Jaguar Inn, for providing a place to stay when park facilities had other occupants. We also thank the Solis family for food in their Jaguar Inn restaurant.

Base Camp Assistance at SE area of Parque Nacional Laguna del Tigre

We thank
Ing. Edvin Ramírez Villalobos, CONAP administrator for Parque Nacional Laguna del Tigre
Cornelia Chable, Asociacion Balam
Julio Augustin Peña Chen, CONAP, PNLT
For access to set up tents as base camp in the area we requseted (SE entrance of PNLT, a few kilometers south of Paso Caballos).

Base Camp Assistance in PNYNN

We thank Biologist Lorena Lobos and both co-administrators of PNYNN (Arq. Jose Leonel Ziesse (IDAEH) and Lic. Jorge Mario Vazquez (CONAP) for providing a place to stay for the photographers, biologists, and assistants of the FLAAR Mesoamerica team of flora and fauna during the 1-week-a-month field trips August 2018 to July 2019.

In turn FLAAR purchased and donated a cooking stove when the original one no longer functioned, plus we have photographed and documented many tree and insect species that we found around this camp.

Ecolodge El Sombrero

I thank Gabriella Moretti, owner of Ecolodge El Sombrero, for providing hotel room and meals while we have been doing field work at Parque Nacional Yaxha, Nakum and Naranjo. We also appreciate the hospitality of her sons Sebastian de la Hoz and Juan Carlo de la Hoz. Every workday is exhausting because we are carrying and then using very heavy cameras, super-telephoto lenses, sturdy tripods, large gimbals or ball tripod heads. Thus it is crucial for my health to be able to rest and totally recuperate every night in order to be ready for the following day of botanical and zoological adventures in Parque Nacional Yaxha, Nakum and Naranjo.

Equally crucial is having a place to charge the batteries of the computers, or all the cameras, and of the cell phones. Solar power is great, but it lasts only an hour, or less, if you plug in multiple computers and cameras and flash batteries to charge. So a place with enough electricity to charge the entire mass of essential field work equipment is essential and thus very much appreciated.

In order to post photographs on botanical and zoological websites, you can't do this if there is either no Internet or weak Internet. Thus it is very helpful that when we are provided rooms and meals, that Internet is also provided by the Ecolodge El Sombrero.

Contact Info: +502 5460 2934, VentasElSombrero@gmail.com or WhatsApp.

www.elsombreroecolodge.com/en-us

Dr Nicholas, Senaida Ba Mucu, helpful Q'eqchi' assistant for many years, Erick Flores, capable photographer at FLAAR Mesoamerica for many years, and helpful local guide hiking along a road inside PNYNN (this photo is many years ago).

HOW TO GET TO YAXHA?

FLAAR MESOAMÉRICA

Go to the Mundo Maya airport in Santa Elena and then you will find a services of tourist vehicles to go to the archaeological site. If you want to go by car from Guatemala City, take the following route: Río Dulce - Poptún-Flores. At the junction further on you will find on the left the route to Tikal. Go straight on to the right towards Yaxha (towards Melchor de Mencos). In km. 521 at the village La Maquina, turn left to the site.Ecolodge El Sombrero is 50 meters before the entrance to National Park Yaxha - Nakum - Naranjo.

PERMISSIONS

Any school, college, university, botanical garden, zoological garden, botanical or zoological association (or club) may post this report on their web sites, (at no cost) as long as they link back to one of our web sites: either www.maya-ethnobotany.org or www.maya-ethnozoology.org or www.maya-archaeology.org or www.digital-photography.org or www.FLAAR-Mesoamerica.org.

FLAAR (in USA) and FLAAR Mesoamerica (in Guatemala) are both non-profit research and educational institutes, so there is no fee. And you do not need to write and ask permission; but we do appreciate when you include a link back to one of our sites.

Any school, college, university, botanical garden, etc. can post this PDF on their school or university or institute web site for their students to download at no cost. And you do not need to write and ask permission; but we do appreciate when you include a link back to one of our web sites.

Any web site in or related to the Municipio of Livingston, is also welcome to post this PDF on their web site (no fee). This permission includes travel agencies, hotels, guide services, etc. And you do not need to write and ask permission; but we do appreciate when you include a link back to one of our web sites.

CECON, CONAP, FUNDAECO, INGUAT, ARCAS, IDAEH, Municipio de Livingston, etc. are welcome to publish our reports, at no cost.

All national parks, nature reserves, and comparable are welcome to have and use our reports at no cost.

USAC, UVG, URL, and other Guatemalan universities and high schools, and schools, are welcome to post our reports, at no cost.

IF YOU WISH OUR FLORA AND/OR FAUNA MATERIAL AS A POWERPOINT PRESENTATION

Dr Nicholas (Hellmuth) is flown all around the world to lecture. He has spoken in Holland, Belgium, Germany, Austria, Greece, Italy, Serbia, Croatia, Bosnia, Russia, UK, Dubai, Abu Dhabi, Thailand, Korea, China, Japan, Canada, USA, Mexico, Panama, Guatemala, etc. He can lecture in Spanish, German, or English (or simultaneously translated to your language). He has lectured at Harvard, Yale, Princeton, UCLA, Berkeley and dozens of other universities, colleges, museums, alumni clubs, etc.

He also writes cartoon books on plants and animals of Guatemala so gives presentations to primary school, high schools, etc.www.MayanToons.org shows our educational material for children.

In today's COVID era, we present via ZOOM, Google Meet or comparable platforms. This way there are no costs for airfare, airport shuttle, hotel, or meals. But it is appreciated when a donation can be provided before the lecture presentation to assist our decades of research.

FLAAR MESOAMÉRICA FLAAR

CAPTION FOR BACK COVER PHOTOGRAPH:

Aerial view of the "Rectangular Savanna" where forest is gradually encroaching. But you can see about six clusters of tasiste palm that were once in the "savanna" but are now surrounded by the forest. Several widely separated tasiste palm clusters are in the still open grassland part.

Along the left is the ring of pools of water around the Savanna of 3 Fern Species.

Photo by: Haniel López, FLAAR Mesoamerica, Sept. 10, 2021.
Parque Nacional Yaxha, Nakum and Naranjo, Petén.
Camera: DJI Mavic 2 Pro drone, Hasselblad L1D-20c camera.

IF YOUR CLUB, ASSOCIATION, INSTITUTE, BOTANICAL GARDEN, ZOO, PARK, UNIVERSITY, ETC WISHES HIGH-RESOLUTION PHOTOS FOR AN EXHIBIT IN YOUR FACILITY ANYWHERE IN THE WORLD

The Missouri Botanical Garden (MOBOT) has had two exhibits of the FLAAR Mesoamerica photos on Neotropical flowering plants of Guatemala. Photos by the FLAAR team have also been exhibited at Photokina in Germany and in Austria, Guatemala, and elsewhere. For use of these photos in a book or exhibit, naturally we need to discuss how to share the costs. We have material for entire exhibits on:

Orchids of Guatemala (including aquatic orchids),
Dye colorants from Mushrooms and Lichens of Guatemala,
Bromeliads of Guatemala,
Trees of Guatemala,
Treetop Ecosystems of Guatemala (includes arboreal flowering cacti, bromeliads, and orchids),
Cacao Cocoa Chocolate and their Maya and Aztec Flavorings.

We naturally appreciate a contribution to help cover the costs our office expenses for all the cataloging, processing, and organization of the photos and the field trip data.

TO PUBLISH PHOTOGRAPHS

Hellmuth's photographs have been published by National Geographic, by Hasselblad Magazine, and used as front covers on books on Mayan topics around the world. His photos of cacao (cocoa) are in books on chocolate of the Maya and Aztec both by Dr Michael Coe (all three of editions) and another book on chocolate by Japanese specialist in Mayan languages and culture, Dr Yasugi. We naturally appreciate a contribution to help cover the costs our office expenses for all the cataloging, processing, and organization of the photos and the field trip data.

FOR YOUR SOCIAL MEDIA

You can post any of the FLAAR Mesoamerica PDFs about the Municipio of Livingston on your Social Media sites; you can send any of these PDFs to your friends and colleagues and family: no cost, no permission needed.

We hope to attract the attention of professors, botanical garden clubs, orchid and bromeliad societies, students, tourists, experts, explorers, photographers and nature lovers who want to get closer, to marvel at the species of flowering plants, mushrooms and lichen that FLAAR Mesoamerica finds during each field trip each month. To conserve a fragile biodiverse ecosystem you first have to know size, location, habitats, etc.

ACKNOWLEDGEMENTS TO FLAAR MESOAMÉRICA

Flor de María Setina is the office manager, overseeing all the diverse projects around the world. We also utilize the inkjet prints to produce educational banners to donate to schools.

Vivian Hurtado is the actual project manager for FLAAR's divisions: Flora & Fauna and MayanToons. She is also environmental engineer and passionate researcher

Victor Mendoza environmental engineer, is in charge of the photographic database of FLAAR Mesoamerica and its taxonomic identification. He also supports as a research assistant.

Sergio Jerez He is involved with plant identification, bibliographic research and map design for the trails explored on each expedition.

Andrea de la Paz designer who helps prepare the master-plan for aspects of our publications. She is our editorial art director.

Senaida Ba has been our photography assistant for several years. Now, she puts together PowerPoint presentations for students and teachers to learn about several subjects like Flora, Fauna and Mayan Iconography.

Jaqueline González designer who puts together the text and photographs to create the actual report.

Roxana Leal major in Communication who manages all our social media and digital community. She's sometimes part of our fieldwork trips, since she has a special interest for adventure and Guatemala's diverse nature.

María Alejandra Gutiérrez is an experienced photographer who now prepares all the Photography Catalogs for the project we're currently working on the RBM. She also contributed to the coordination of several trips we made during our Livingston, Izabal research project.

David Arrivillaga is an experienced photographer able to handle both Nikon and the newest Sony digital cameras. Work during and after a field trip also includes sorting, naming, and processing.

Juan Carlos Hernández takes the material that we write and places it into the pertinent modern Internet software to produce our web pages.

Paulo Núñez is a webmaster, overlooking the multitude of web sites. Internet SEO changes every year, so we work together to evolve the format of our web sites.

Rosa Sequén is also an illustrator for MayanToons and also helps prepare illustrations for Social Media posts and for animated videos.

Laura Morales is preparing animated videos in MayanToons style since animated videos are the best way to help school children how to protect the fragile ecosystems and endangered species

Heidy Alejandra Galindo Setina joined our design team in August 2020. She likes photography, drawing, painting, and design.

Paula García is part of our MayanToons Animation team. Her job brings our favorite jungle, wetland and savanna characters to life.

Maria José Rabanales she is part of the team for editing photographic reports and educational material of Flora and Fauna since September 2020. She works together with others of the team to prepare the finished pdf editions of the material of the Yaxha, Nakum and Naranjo Project.

Alejandra Valenzuela biology student is now part of Flora y Fauna's photographic report and educational material editing team since September 2020.

Alexander Gudiel designer who join the editorial design team on December 2020. He will combine the text, pictures and maps into the FLAAR Mesoamerica editorial criteria.

Cristina Ríos designer student who join the editorial design team on December 2020. He will combine the text, pictures and maps into the FLAAR Mesoamerica editorial criteria.

Byron Pacay handles GPS mapping of where we hike or go in the lancha (boat) each field trip day. He also lists where we stop to take photos and what each one of us is photographing and then has that tabulation ready each night.

Edwin Solares environmental engineering. He is a photographer and videographer during our expeditions and later edits this content to be able to use it in the materials we generate.

Belén Chacón her job includes organizing and tabulating data on useful and edible flora, which is listed in FLAAR's bibliography and many other references, in order to keep a complete list of plant species that are useful, along with updated taxonomical information.

Diana Sandoval her work consists of the recompilation of scientific information, which later is transformed into the FLAAR reports that are published on our websites.

María José Toralla she gathers information and bibliographies that are added to our Flora & Fauna electronic library and also make part of the information found in research, reports and websites.

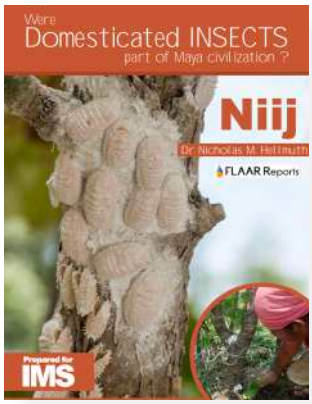
Valeria Áviles is an illustrator for MayanToons, the division in charge of educational materials for schools, especially the Q'eqchi' Mayan schools in Alta Verapaz, Q'eqchi' and Petén Itzá Maya in Petén, and the Q'eqchi' Mayan and Garifuna schools in the municipality of Livingston, Izabal.

Niza Franco is part of our MayanToons Animation team. Her job brings our favorite jungle, wetland and savanna characters to life.

Josefina Sequén is illustrator for MayanToons and also helps prepare illustrations for Social Media posts and for animated videos.

Isabel Rodriguez Paiz is in charge of the fundrasing. She is experienced in networking, social media, and organizing meetings to experience what FLAAR does out in the remote rain forest ecosystems

Other Publications of the Fauna of Guatemala



Were domesticated insects part of Maya civilization?
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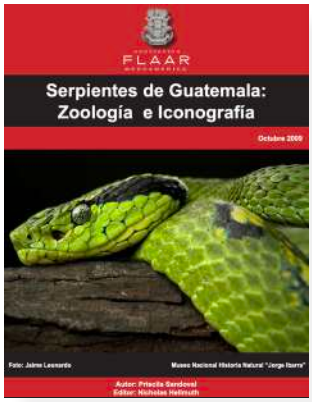

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Rescate, Crianza y Reincersión de dos crías de coaties
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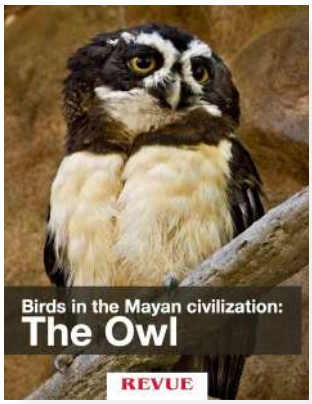

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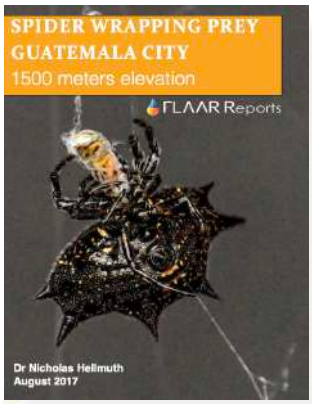

Spider Wrapping Prey Guatemala City
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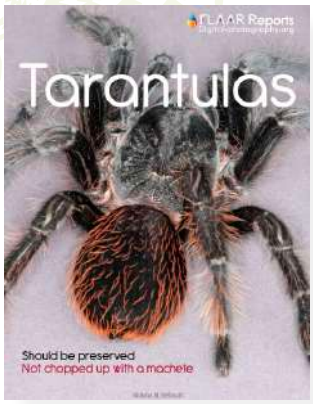

Tarantulas
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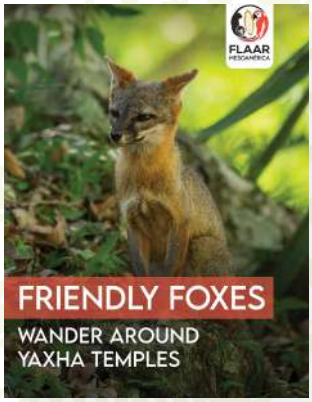

Friendly Foxes Wander Around Yaxha Temples
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Honey Bees
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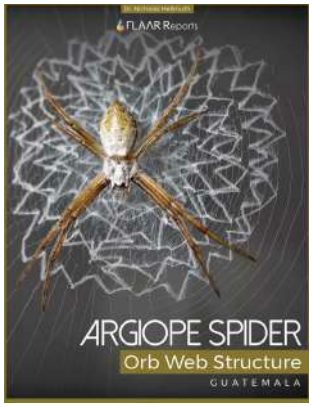

Argiope Spider Orb Web Structure
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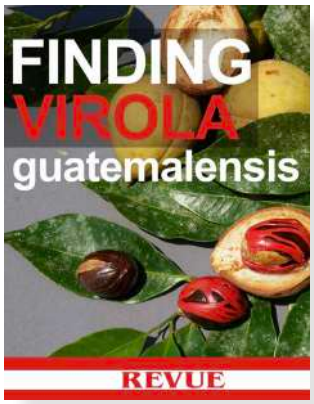
Other Publications of the Flora of Guatemala



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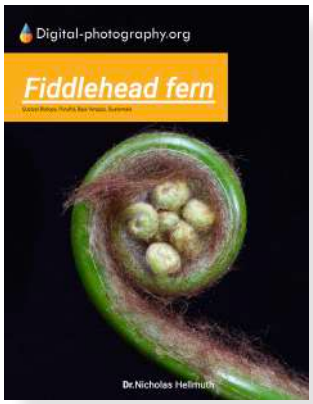

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Opening at Night
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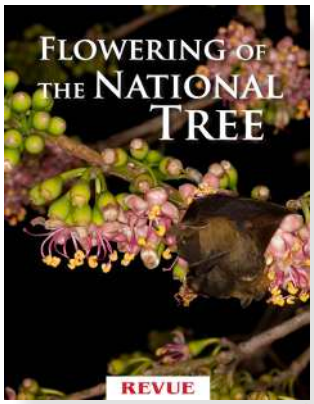

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Natural Techniques
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Heliconia
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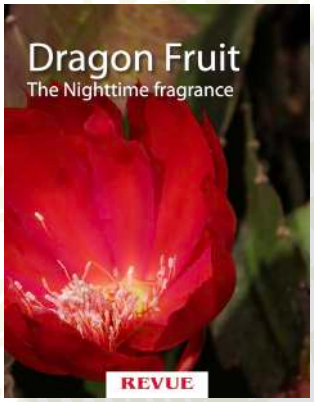

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The Nighttime fragrance
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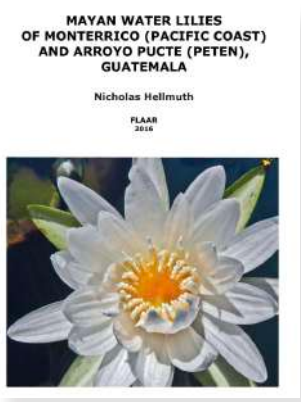

Mayan Water Lilies of
Monterrico and Arroyo Pucte
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Flor de Muerto
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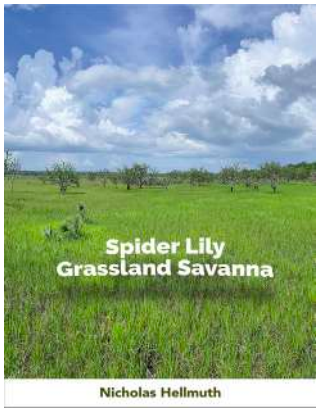
Other Publications from National Park Yaxha, Nakum and Naranjo, Guatemala



Spider Lily
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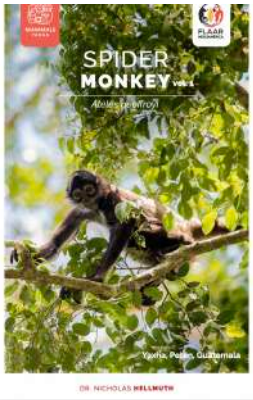

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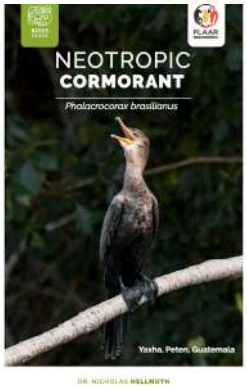

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Garcita Blanca
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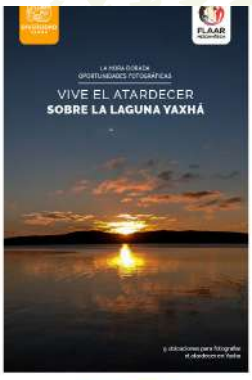

Vive el Atardecer Sobre La Laguna Yaxhá
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El Mono Araña
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https://flaar-mesoamerica.org/projects-national-park-yaxha-nakum-naranjo/

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