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MESOAMÉRICA

MYSTERIOUS ISLAND OF *THALIA GENICULATA*
in the middle of the Savanna East of Nakum

Part I:
Botany and Ethnobotany
of *Thalia geniculata*

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

NICHOLAS HELLMUTH
FLAAR (USA) AND **FLAAR MESOAMERICA** (GUATEMALA)

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Appeciation for encouraging the research project

For their cooperation, hospitality, and assistance at Parque Nacional Yaxha, Nakum and Naranjo project (August 2018 through July 2019)
Ing. Jorge Mario Vazquez (CONAP, Santa Elena, Peten)
Arq. Jose Leonel Ziesse (IDAEH, Santa Elena, Peten)
Biolg. Lorena Lobos (CONAP)

For initiating and coordinating the cooperation project 2021-2025
Licda. Merle Fernandez, CONAP
Marla Mercedes Bolvito Jerónimo, Unidad de Cooperación Nacional e Internacional de la Secretaría Ejecutiva de CONAP
Licda. Ana Luisa De León N., Directora de Educación para el Desarrollo Sostenible, CONAP
Lic. Apolinario Córdova, CONAP Petén
Ing. Jorge Mario Vazquez (CONAP, Santa Elena, Peten)

For their cooperation, hospitality, and assistance at Parque Nacional Yaxha, we thank
All the helpful and knowledgeable guides of IDAEH CONAP at PNYNN who accompanied us each day. It is essential to have either an IDAEH and/or CONAP guardabosque or comparable when doing flora and fauna research in a national park.

Guides and equipment porters from La Maquina and nearby during November, 2021
Ricardo de Jesus Herrera Marroquin, guide and helped carry digital camera equipment

Equipment porters from La Maquina and nearby during November, 2021
Dennis Dennilson Diaz Duarte
Enrique Rodas

6WD Pickup truck driver and guide
Sebastial de la Hoz

4WD Pickup truck drivers
Edwin Pérez- Suzuki Samurái
Edwin Rodriguez- Toyota 22R

Assistance in knowledge of plants and animals of PNYNN
Teco, Moises Daniel Perez Diaz, park ranger, PNYNN

Tents and cooking equipment at Nakum Camp, PNYNN
Manola Margot Lima Diaz owner of Restaurante El Portal de Yaxha, La Maquina

We appreciate a donation during November 2021 to help cover the costs of FLAAR research projects specifically to assist and support the current FLAAR project of flora and fauna in the Reserva de la Biosfera Maya (RBM). This donation is also assisting the FLAAR (USA) and FLAAR Mesoamerica (Guatemala) research project in the Municipio de Livingston area of the departamento of Izabal, Guatemala.

This donation is from a family in Chicago in honor and memory of botanist Dr John D. Dwyer, who worked in many areas of Mesoamerica, including in the Yaxha area in the 1970's while the site was being mapped by FLAAR.

This donation is also in recognition of the urgency and need for conservation of both wildlife and rare plants in the bio-diverse ecosystems of the Reserva de la Biosfera Maya (RBM) of Guatemala. Parque Nacional Yaxha, Nakum and Naranjo (PNYNN) is one part of the over 5 million acres of the RBM.

PHOTO FROM FRONT COVER
Thalia geniculata
Photo by: Nicholas Hellmuth. FLAAR Mesoamerica,
Nov. 16, 2021. Petén, Guatemala.
Camera: iPhone 13 Pro Max.

PHOTO FROM FRONT COVER
Thalia geniculata
Photo by: Nicholas Hellmuth. FLAAR Mesoamerica,
Nov. 16, 2021. Petén, Guatemala.
Camera: iPhone 13 Pro Max.

Credits

The helpful individuals listed below are part of the FLAAR Mesoamerica research and field work team. The office research team consists of additional individuals in the main office in Guatemala City.

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Introduction to *Thalia geniculata* of Guatemala by *Diana Sandoval*

Thalia geniculata is a perennial herb that grows in flooded and swampy areas of tropical and subtropical America. The common name in Spanish with which this species is best known is "popal" and the whole of this plant is called popales, in English it is called "Alligator fire flag".

This plant is not cultivated in Guatemala, it can be found wild, although it can be used as food since its roots accumulate considerable amounts of starches. In other countries it is cultivated as an ornamental for gardens with artificial ponds, and it can also be considered a weed for irrigation canals.

Even though *Thalia geniculata* is known as an edible plant, very little is known about its nutritional value and its potential as an alternative food, after all in a plant that is distributed throughout the Americas and could be used in the diet of people in rural areas.

Because it grows in flooded soils, it is commonly found near wetlands, and the FLAAR-Mesoamerica team has found popales in the savannas east of Nakum. Lundell (1937: 56), points out that *Thalia geniculata* is common in the swamp of Lake Zotz, which is to the east of Lake Petén Itzá.

As a plant with potential ethnobotanical use, the objective of this document is to present the botanical characteristics of this species and the ecosystem in which *Thalia geniculata* develops within the Yaxhá-Nakum-Naranjo National Park, which is part of the Reserve of the Mayan Biosphere, where the efforts of FLAAR-Mesoamerica for the documentation of species are currently concentrated.

My Personal Experience with *Thalia geniculata*

In March 2019 we (FLAAR Mesoamerica together with a CONAP + IDAEH team from Parque Nacional Yaxha, Nakum and Naranjo) found two dense areas of *Thalia geniculata* within the Savanna East of Nakum:

- A large "island" of 99% *Thalia geniculata* in the middle of the savanna.
- An area with lots (but not 99%) of *Thalia geniculata* near the middle of the north edge.

This savanna was discovered by Hellmuth two months before from analyzing aerial photographs (of the Instituto Geografico Nacional, Guatemala; (there is no LiDAR analysis for the Yaxha Nakum area within this large park). We visited the savanna in February 2019 but it was so large that we studied only the northwest corner (it takes many hours to hike several kilometers to get here and back). Thus, we returned to the savanna in March, with Sergio Balan of INAP IDAEH and CONAP park guards, to document and photograph additional plants.

Although *Thalia geniculata* is surely present at Tikal, it is not well documented for Parque Nacional Tikal. Therefore, for now, as a result of the PNYNN+FLAAR Mesoamerica joint project (August 2018-July 2019), the Yaxha, Nakum and Naranjo national park is the best place to do research on *Thalia geniculata* and its ecosystem.

We also anticipate that *Thalia geniculata* will probably be found in other areas within this large park of Petén, Guatemala.

Full Botanical Name

Thalia geniculata L. is the accepted names.

Family name: Marantaceae

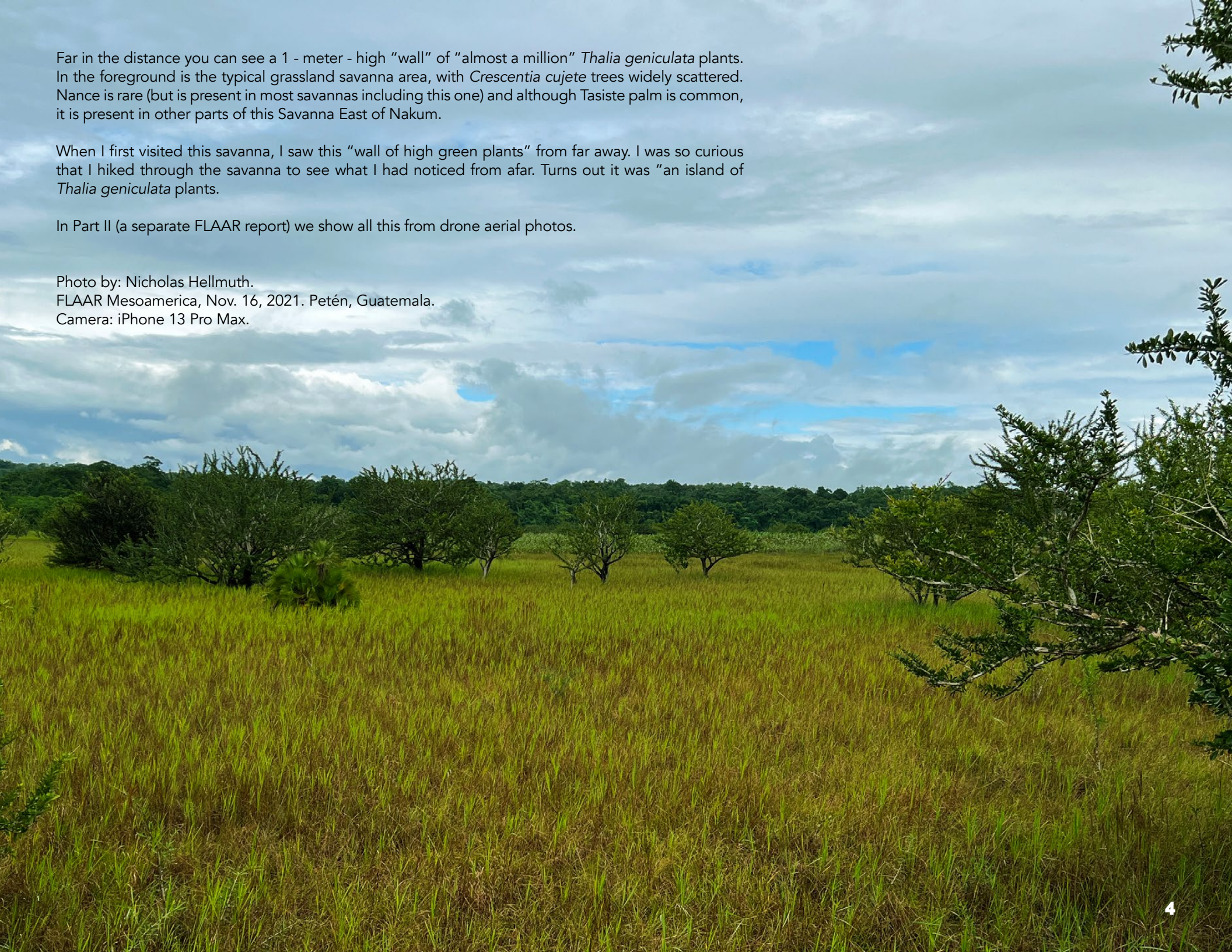
Botanical introduction to *Thalia geniculata*

Thalia geniculata L., is a plant of the family Marantaceae, the same family as the genus *Calathea,* (e.g. *Calathea lutea*.) or as *Maranta arundinacea*, wild arrowroot; however, *Maranta arundinacea* occurs in a boggier micro ecosystem. During our field trip, the FLAAR Mesoamerica project team found *Maranta arundinacea* two days before we found the *Thalia geniculata*. The *Maranta arundinacea* is present in a remarkable micro ecosystem that Hellmuth found from aerial photographs, south of Laguna Perdida and a steep climb up a ravine heading north of Laguna Lankaja west of Yaxha (*Thalia geniculata*, so far, has been noticed only east of Nakum, but surely will be found elsewhere within this large national park).

Lundell notes that *Thalia geniculata* is common in the fern and sedge bog of Lake Zotz (1937: 56), which is east of Lake Petén Itzá. We show his comments in Appendix A.

Thalia geniculata plants as far as you can see; notice they are en-masse (solidly packed together) and the front is like a "wall" with no *Thalia geniculata* plants (only where clustered in the main island).

Photo by: Nicholas Hellmuth.
FLAAR Mesoamerica, Nov. 16, 2021. Petén, Guatemala.
Camera: iPhone 13 Pro Max.



Far in the distance you can see a 1 - meter - high "wall" of "almost a million" *Thalia geniculata* plants. In the foreground is the typical grassland savanna area, with *Crescentia cujete* trees widely scattered. Nance is rare (but is present in most savannas including this one) and although Tasiste palm is common, it is present in other parts of this Savanna East of Nakum.

When I first visited this savanna, I saw this "wall of high green plants" from far away. I was so curious that I hiked through the savanna to see what I had noticed from afar. Turns out it was "an island of *Thalia geniculata* plants.

In Part II (a separate FLAAR report) we show all this from drone aerial photos.

Photo by: Nicholas Hellmuth.
FLAAR Mesoamerica, Nov. 16, 2021. Petén, Guatemala.
Camera: iPhone 13 Pro Max.

Some synonyms for *Thalia geniculata*

Maranta arundinacea Billb. ex Beurl. [Illegitimate]
Maranta flexuosa C.Presl
Maranta geniculata (L.) Lam.

Maranta arundinacea is a plant of completely different size, shape, and growth form; we discovered lots of *Maranta arundinacea* but nowhere near *Thalia geniculata*.

Standing up on a 3-meter high ladder I was able to take a photograph from a good angle to show how thick the mass of *Thalia geniculata* plants is.

Photo by: Nicholas Hellmuth.
FLAAR Mesoamerica, Nov. 16, 2021. Petén, Guatemala.
Camera: iPhone 13 Pro Max.

Renealmia erecta (Vell.) D.Dietr. [Illegitimate]
Renealmia geniculata (L.) D.Dietr.

Renealmia species are very common in the misty-moisty mountains of Alta Verapaz, from Cahabon to Senahu and then towards the southwest. *Renealmia* fruit is raised in kitchen gardens and the fruit is also sold in local Q'eqchi' Mayan markets such as Senahu.

However, *Renealmia* belongs to the Zingiberaceae family, thus it is totally different than the family Marantaceae which includes *Calathea, Marantia, Thalia* and two other genera (for the Mayan lowlands).

True Renealmia, *Renealmia aromatica* (Aubl.) Griseb. *Renealmia* sp was found on the Fallabon - Yaxha road (Lundell 1937: 55), which existed in 1933!

Renealmia aromatica is listed for Uaxactun, however, it is very easy to reproduce. All it takes is spitting out the seed when you eat the pulp and the plant will sprout and grow for the next umpteen generations. Of course, it is best to find this plant in the wild.

Renealmia aromatica is also listed several times for Tikal but there is no information as to whether in a wild state or in a kitchen garden surrounding someone's house.

www.herbariovaa.org/collections/list.country=Guatemala&state=Pet%C3%A9n&page=3

We look forward to finding more wild *Renealmia* in Parque Nacional Yaxha Nakum and Naranjo. Edible *Renealmia* grows in substantial groves around the home of the grandparents of one of the capable Q'eqchi' Mayan plant scouts who works with us, Senaida Ba. They live in Chipemech, between Senahu and Cahabon, Alta Verapaz, in an ecosystem very different than Tikal: at a higher elevation and more moisture.

There are twelve more synonyms, all genus *Thalia*. You can see everything on the "synonym web site" of Kew Gardens from the UK, **www.ThePlantList.org** on the page **www.theplantlist.org/tpl1.1/record/kew-268132.**

Common names for *Thalia geniculata* in English

Alligator fire flag, alligator-flag, arrowroot, bent alligator-flag, bent alligator flag, fire flag (listed on dozens of web sites are some of the common names given to this plant). The word flag is used because the top leaf dies, turns brown, and then leans over 90 degrees in the position of a flag.

Fortunately, there were no crocodiles in any of the bog or savanna ecosystems (there are no alligators or caiman at Yaxha Nakum and Naranjo: only *Crocodylus moreletii*). You find a few in Rio Holmul and in Lake Yaxha.

In November 2021, we found a skull of a *Crocodylus moreletti* near an abandoned camp of poachers west of the savanna. We estimate it was more likely from the Rio Holmul though it could have been shot in the savanna when it was seasonally inundated. Crocodiles are capable of hiking considerable distances between wetland areas.

Common names for *Thalia geniculata* in Spanish

Popal is the Spanish or localized Mayan name in Mexico for the plant (but rarely mentioned under this word in Peten or Belize). Since *Thalia geniculata* tends to grow in thickets, an area with "solid popal" is called a popal or popapera. This is because the standard Mesoamerican way to call an area which features on a specific tree or plant is to add "…al" to the word:

- Area or corozo palm is a corozal (or corozero, corozera, have to check whether masculine or feminine).
- Area of guano palm is called a guanal.
- Area of *Aechmea magdalenae*, pita, is called a pital.

... and so on ...

Mayan names for *Thalia geniculata*

Not found, only in other indigenous languages of Mexico cited in CONABIO.

http://www.conabio.gob.mx/malezasdemexico/marantaceae/thaliageniculata/fichas/ficha.htm

Habit for *Thalia geniculata*

This plant is a herb, but definitely not a pot herb for putting on your desk or window sill. The leaves of this plant are the same of a medium sized *Heliconia*.

In what Ecosystem(s) can you find native *Thalia geniculata*

We found *Thalia geniculata* as an island in the middle of the Savanna East of Nakum and near the northern edge of the same savanna. When we returned in mid-November 2021, we noticed that the seasonal inundation was deeper in the middle than in the surrounded edges. We did not reach the other *Thalia* area on that field trip (it takes over six hours to hike here and back so until the there is a better trail, there is only a few hours available to hike through the extensive savanna itself.

- The north edge where we entered (west of the giant Ceiba tree) had no surface water.
- Further into the savanna, occasionally there is up to 3 cm of surface water but there are many areas with no standing water.
- Towards the island of *Thalia*, the water got to over 10 cm deep.

About 20% or more of the photos on the following website:

https://www.naturalista.mx/taxa/127912-Thalia-geniculata

show *Thalia geniculata* growing in water or physically next to a pond (directly on the shore). This is, by far, the best set of photographs of the ecosystems where this plant grows best.

Thalia geniculata is at the left edge of the island. A not yet identified grass or sedge is in the middle (next to the Thalia). In front is a tiny mass of another species of grass-like plants. We will obviously return to accomplish further research. Keep in mind, it takes 6 to 7 hours back-and-forth to get here but with a better trail we could hike more quickly. The trails are usually blocked by fallen trees so, the tradition is to leave them and chop (20 to 30 saplings) a completely new trail around the trees. Thus, the hiking distance doubles. Cutting down the already fallen tree could help it decompose faster into the soil (on top of limestone) and it would not be necessary to clear a trail.

Photo by: Nicholas Hellmuth.
FLAAR Mesoamerica, Nov. 16, 2021. Petén, Guatemala.
Camera: iPhone 13 Pro Max.

Thalia geniculata is only in one massed area. Why is it not out further? What makes the *Thalia geniculata* thrive here (and not want to be further out)? It would be helpful if a soil scientist initiated a project in this savanna with pertinent permissions.

In the background is the forest that surrounds the edge of the Savanna East of Nakum. The forest is on a steep karst hill to the far left (not visible in this photo). The edge of the west side of the savanna is a logwood bajo (tintal). As for the edge of the south side we have not had time to reach it yet (remember, if it takes six hours to get here and back, so there are very little daylight hours to hike across the rather extensive savanna. Also, our focus in November was to accomplish basic aerial photos with our DJI Mavic 2 Pro.

Photo by: Nicholas Hellmuth.
FLAAR Mesoamerica, Nov. 16, 2021. Petén, Guatemala.
Camera: iPhone 13 Pro Max.

What other Trees or Plants are often found in the same Habitat?

Thalia geniculata grows in same areas as *Passiflora*. A photograph on this Mexican biology web site shows lots of helpful photos of *Thalia geniculata*, including one with *Passiflora* vines in the same ecosystem:

www.naturalista.mx/taxa/127912-Thalia-geniculata

Other articles also mention *Passiflora foetida* for the same ecosystems in Mexico as *Thalia geniculata*. I would expect both can be found together in many areas of Tabasco.

There is a lot of *Passiflora foetida* along Rio Ixtinto (that flows into the south part of Lake Yaxha). However, so far, we have not documented *Thalia* there. Since there is a lot of *Passiflora foetida* in some areas of the Savanna East of Nakum, it would not be a surprise if this vine wanders around where *Thalia geniculata* is also growing.

For Yaxha Nakum and Naranjo, is *Thalia geniculata* present or missing from earlier lists?

Thalia is listed in CONAP´s Master Plan for PNYNN.

What species of *Thalia geniculata* trees did Cyrus Lundell find in Peten?

Thalia geniculata L. Lake Zotz, Lundell 3300; without locality Cook & Martin 71. Tall herb: common in the fern and sedge bog lake zotz.
(Lundell 1937: 18)

Where has *Thalia geniculata* been found in the Peten?

On the following website you can search for more information:

https://serv.biokic.asu.edu/neotrop/plantae/collections/harvestparams.php

Are *Thalia geniculata* trees registered for Parque Nacional Tikal?

Tikal has diverse ecosystems which have been studied by Dennis Puleston and many other scholars. However, it would be helpful to have an overall list of savanna by savanna, aguadas by aguadas, micro ecosystem by micro ecosystem.

As for Tikal, *Thalia geniculata* has been found at Laguna Colorada.

https://herbariovaa.org/collections/

Nonetheless, every part of Mesoamerica has a lake named Laguna Colorada… therefore, it is necessary to locate *Thalia geniculata* in an attached map or at least written indications to find it.

So far, we have found more *Thalia* in the savanna east of Nakum than we can find online information for *Thalia* at Parque Nacional Tikal.

Elsewhere in Petén surely there is *Thalia geniculata* in many locations, especially in the area around Río San Pedro and the parks and reserves towards the Lacandon area.

Brief discussion of *Thalia geniculata* plants for Belize by Standley and Record (1936)

Record was interested mostly in commercial lumber trees, so there are not many comments or focus by him on a non-lumber tree. Also, Standley was not into ethnobotanical discussions yet (this later changed when he was joined together with Steyermark in a later decade). Thus, all this 1936 monograph states that "*Thalia geniculata* L. Frequent in swamps." (Standley and Record 1936: 97).

Thalia geniculata in Belize

Balick, Nee and Atha (2000) list

Thalia geniculata L. — **Loc Use:** FOOD. — **Nv:** platanar, purple platanillo. — **Habit:** Herb.

(Balick, Nee and Atha 2000: 178)

It may be an "herb" but its leaves are quite large, similar to *Canna indica* or a mid-sized *Heliconia*.

Use: food (Balick, Nee, Atha 2000: 178). Other web sites say *Thalia geniculata* has "edible leaves and roots" but you do not eat the leaves; you remove the leaves and eat only the tamale inside. Since the roots of other plants of the Marantaceae plant family are edible, we should definitely add the roots of *Thalia geniculata* to Bronson's 1966 list.

Purple platanillo "The leaves are used to wrap tamales for cooking and serving" (Balick and Arvigo 2015: 148)

The largest area of the island is *Thalia* but there are also several areas of grasses (or sedges) on one corner of the front and in two rectangular areas at the back. These grass areas need further study. You can see these meter-high grass-like areas better in the Part II Report that shows the entire island from the air.

Photo by: Nicholas Hellmuth.
FLAAR Mesoamerica, Nov. 16, 2021, 2:08pm. Petén, Guatemala.
Camera: iPhone 13 Pro Max.

Botanical Description of *Thalia geniculata* by Standley and Steyermark (1949)

MARANTACEAE

Reference: K. Schumann, Marantaceae, Pflanzenreich IV. 48. 1902. Perennial herbs, small or often very large, acaulescent or often with elongate stems; leaves distichous, penninerved, usually vaginate, the sheath rarely ligulate at the apex, the petiole commonly callose at the apex; flowers small or large, perfect, dichlamydeous, very irregular, generally geminate, arranged in heads, spikes, racemes, or panicles, each flower or group of flowers subtended by a con- spicuous bract and usually by several bractlets; sepals free, equal or slightly unequal: petals united below into a usually long tube, contorted, the outermost one usually largest and more or less cucullate at the apex, white or colored; fertile stamen 1, dimidiate, the anther 1-celled, dehiscent by a longitudinal slit; staminodia 2, another one usually present, this cucullate, all the staminodia free or connate with the stamen, outer petaloid staminodia often also present; ovary inferior, 3-celled or 1-celled; ovules solitary in each cell, erect, anatropous; style simple, recurved at the apex and concealed by the cucullate staminodium, elastically exserted in anthesis; fruit capsular, loculicidal, sometimes nut-like or baccate, 1-3-seeded; seeds hard and osseous, provided with a lobulate or lamellate aril; embryo hippocrepiform, the endosperm abundant. About 23 genera, in the tropics of both hemispheres. The genus *Myrosma* also is represented in Central America.

Ovary 1-celled, the fruits 1-seeded. Inflorescence often much branched and open. Perianth purple; rachis of the inflorescence zigzag

Botanical Description of *Thalia geniculata* in "Trees and Shrubs of Mexico"

Thalia is not mentioned within this text.

Is *Thalia geniculata* from the Maya Highlands or from the Maya Lowlands (or both)?

Thalia is the Maya from lowlands.

In which States of Mexico is *Thalia geniculata* listed by Villaseñor

I put in bold font the states of Mexico, where *Thalia geniculata* is documented, that are physically adjacent to Peten or Belize:

CAM, **CHIS**, COL, DGO, GRO, JAL, MEX, MICH, MOR, NAY, OAX, PUE, **QROO**, SLP, SIN, **TAB**, TAMS, VER, YUC, ZAC (Villaseñor 2016: 7899)

Thus, *Thalia geniculata* is found throughout Mexico including all around Peten and adjacent to Belize: Chiapas, Tabasco, Campeche, Quintana Roo and also Yucatan itself.

World Range for *Thalia geniculata*

The location of Thalia stretches throughout southern United States (Florida) and Mexico all the wayto Paraguay and Argentina, the Antilles.

http://www.conabio.gob.mx/malezasdemexico/marantaceae/thaliageniculata/fichas/ficha.html

Thalia geniculata in Izabal of Guatemala

Yes, there is a record of this species in the Punta de Manabique area. (Ruiz 2016: 111)

Thalia geniculata in Chiapas

Thalia geniculata is not in the botanical index of Suzanne Cook's thorough 2016 monograph on ethnobotany of the Lacandon Maya. However, surely this plant is found elsewhere, as there are plenty of rivers and humid areas in Chiapas (though most land has been destroyed by cattle ranches for many decades).

Indeed Villaseñor and Espinosa list Chiapas (and Tabasco and Campeche, but not Quintana Roo) as having *Thalia geniculata* (1998), cited by CONABIO,

www.conabio.gob.mx/malezasdemexico/marantaceae/thalia-geniculata/fichas/ficha.htm

A Mexican biology map shows *Thalia* near Tapachula, on the Costa Sur of Chiapas (so far far away from the Lacandon area).

www.naturalista.mx/taxa/127912-Thalia-geniculata

The area may be Reserva de la Biósfera La Encrucijada, which is along the Pacific Ocean coast. It would be interesting to know if *Thalia geniculata* grows in all the nature preserves and parks between there and Monterrico (Guatemala).

Thus, a lot more research is needed to learn in what areas of Chiapas can *Thalia geniculata* be found other than Reserva de la Biósfera La Encrucijada. Also, can *Thalia geniculata* be found in any of the various ecosystems of the several Lacandon areas of Chiapas?

After two more days of research I found *Thalia geniculata* mentioned as aquatic vegetation for areas around Palenque, Chiapas (Gutiérrez 2004).

Thalia geniculata

Photo by: Nicholas Hellmuth.
FLAAR Mesoamerica, Nov. 16, 2021, 2:08pm.
Petén, Guatemala.
Camera: iPhone 13 Pro Max.

After I had hiked far into the savanna the amount of water on the surface increased to 5 or more centimeters. At the north edge there had been no water but after hiking many meters south, there was 2 to 3 cm. However, half way from where this photo was taken and the from where the island of *Thalia* starts the water was deeper so much so that the grasses/reeds/sedges were thicker and stronger, so hiking forward got to be almost impossible. We also had to allow 3-hours to hike back to base camp before it was too late at night (hiking in a rain forest at night is not a clever idea).

Photo by: Nicholas Hellmuth.
FLAAR Mesoamerica, Nov. 16, 2021. Petén, Guatemala.
Camera: iPhone 13 Pro Max.

Thalia geniculata in Tabasco

Tabasco is mostly lowlands and much is wetlands from Río Usumacinta and other waterways, therefore, it is no surprise to find lots of *Thalia geniculata* ecosystems: "Esta especie acuática robusta cubre grandes superficies en los humedales tropicales del sureste de México, especialmente en Tabasco. Es la especie dominante de los llamados popales."

www.conabio.gob.mx/malezasdemexico/marantaceae/thalia-geniculata/fichas/ficha.htm

Thalia geniculata in Campeche

Thalia geniculata is present in the greater Calakmul area (Martinez and Galindo 2002). This is a pleasant surprise since El Mirador (Peten) and Calakmul (Campeche) are in areas significantly drier than Petén (though Yucatán to the north is even more dry).

If you Google *Thalia geniculata*, Quintana Roo you will also get search results, but I consider there is not much new information since Tabasco has so many wetlands that you get *Thalia geniculata* "everywhere."

Thalia geniculata in Quintana Roo

Quintana Roo is among the states in which *Thalia geniculata* has been found; according to the Biocomuni page that monitors biodiversity.

https://biocomuni.mx/especies/17722

Do *Thalia geniculata* trees also grow in home gardens?

This plant is used in water gardens and artificial ponds.

https://succulentavenue.com/thalia-geniculata-plantas-acuaticas/

Is *Thalia geniculata* also edible (more than just wrapping tamales)?

When you are served a tamale it is usually still wrapped in a green leaf which you do not eat. You remove the top of the leaf and you can use the bottom of the leaf as a "plate" or you can remove the leaf completely. The leaf may impart a flavor to the food wrapped in it.

Therefore, when *Thalia geniculata* is listed as "food" can be misleading because you need to specify whether it is the leaf as tamale wrap, or the leaf that you chew and swallow. For now, we will conclude that the leaf is a tamale wrap, and it is not eaten as spinach or lettuce.

Is there potential medicinal usage of *Thalia geniculata* by local people?

Yes, it has medicinal use. Although it is mostly used as food, in Colombia it is considered medicine for stomach pain.

(Florez and Arango 2010: 78)

Are any parts of *Thalia geniculata* trees eaten by mammals?

Its rhizomes and leaves are edible, it is used as fodder for cattle.

(Echenique 2018: 66)

What are the primary pollinators of *Thalia geniculata* flowers?

For the Marantaceae family, the most common pollinators are bees from the Euglossini tribe.

(Leite and Machado 2007: 228)

Close relative(s) of *Thalia geniculata*; how many other species of *Thalia geniculata* are in Petén?

From the same family is *Calathea macrosepala*.

This is the view looking west/southwest in the Savanna East of Nakum. The northwest corner of the "island" is at the far left of this photo (this corner is grass, not *Thalia*). What you see are the hundreds of *Crescentia cujete* calabash trees. There are a few tasiste palm trees in that area but they are not visible until you zoom in. The slightly higher tree tops at the far distance are the south and southwest border of the savanna.

Photo by: Nicholas Hellmuth.
FLAAR Mesoamerica, Nov. 16, 2021. Petén, Guatemala.
Camera: iPhone 13 Pro Max.

Summary and Conclusions: Ecosystem aspect

Thalia geniculata can be expected to be present in humid areas: in some cases physically adjacent to a river or lake. *Thalia geniculata* can also be expected in a savanna (if there are really wet micro ecosystems). I will need to check all the cival areas (Sibal in English, cibal also in Spanish) to learn whether *Thalia geniculata* is also present in micro ecosystem within a cival. Keep in mind that most research articles on ecosystems clump all the plants together. We at FLAAR Mesoamerica through our ecosystem research program prefer to document which plants are in each individual ecosystem.

So far we have not yet noticed *Thalia geniculata* along the shores of Rio Ixtinto nor along the shores of Lake Yaxha. This does not mean that it is not present, but it means that we have not noticed it, however, I estimate that *Thalia geniculata* is not present along the north shore of Lake Yaxha whatsoever as most of this edge is limestone and *Thalia geniculata* prefers a flat bog-like area. That said, so far we have not noticed *Thalia geniculata* in the Savanna of Three Fern Species either but we need a full day to explore the remarkable number of micro ecosystems here (more or less 100 meters south of Laguna Perdida, north of, and uphill from, Laguna Lankaja).

On the other hand, we have found *Thalia geniculata* in several areas of the estimated 1km x 2km size savanna east of Nakum, out in the middle of the savanna, creating an "island" (where it is more humid) and near the north side in a small area (where it is also humid). The north patch was less than 30 meters across and the island was less than 80 meters long (and perhaps 10 meters wide; we had so much to explore that day it was not realistic to measure anything as it is a 7 hour round trip hike to the base camp at Nakum).

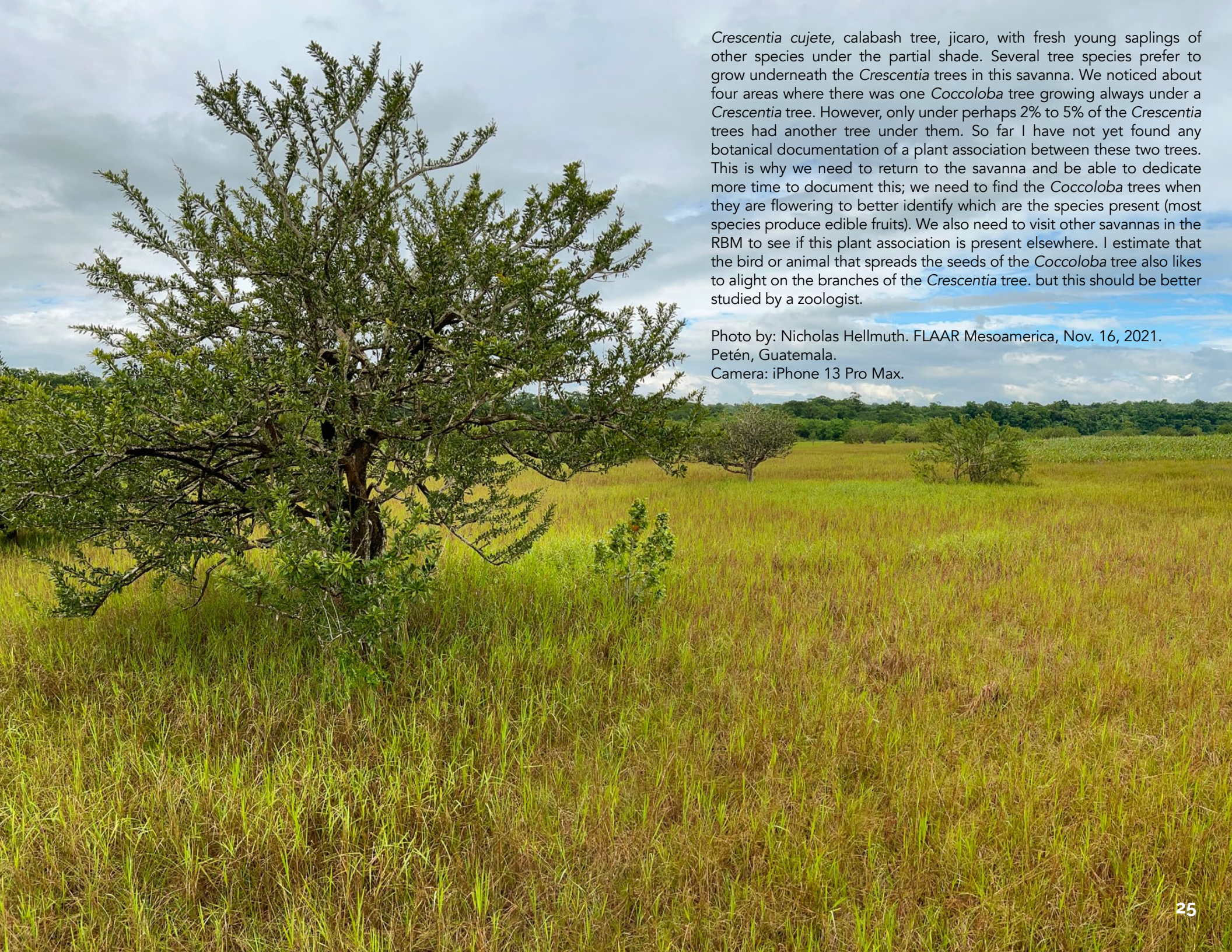
Thalia geniculata is also present near Tapachula, Chiapas and surely in other areas of Chiapas, however, since much of this state is hills, you don't get as much *Thalia geniculata* as you do in Tabasco. Campeche has *Thalia geniculata* in the Calakmul reserve area and around. *Thalia geniculata* is also present in Quintana Roo but not as well documented as for Tabasco.

As for Belize, *Thalia geniculata* is in several ecosystems as long as they are moist. On the subject of ecosystems, most authors list the surroundings of *Thalia geniculata* as soils permanently inundated (in diverse terms depending on the ecosystem). Nonetheless, there is no large area of standing water visible, from the surface, in the savanna east of Nakum during the exceedingly dry month of March 2019: there was significantly less bog than in the very wet Savanna of 3 Fern Species (south of Laguna Perdida, which had NO *Thalia geniculata* or at least we found none so far).

In other words, in all wet areas that were fully wet up to the surface in late 2018 and early 2019, we did not notice a single plant of *Thalia geniculata*. This does not mean it dislikes water, it means that every individual ecosystem needs to be carefully described and that *Thalia geniculata* is adaptable: it does not have to be in standing water all the time.

If *Thalia geniculata* exists today it means that the Classic Maya had a seasonally inundated area which in the dry season was still a bog or bog-like. These areas are wet during the same months when adjacent bajos (tintals) have cracks in its totally dried out soil (where palo de tinto, palo de Campeche, logwood is the logo tree).

The Chontal Maya have documented that if you have a special regional variety of maize, you can grow and harvest a maize crop in a *Thalia geniculata* area during the dry season. Thus, if you need a dry season maize harvest to balance a "milpa" season harvest, now you know where to look. However I estimate that the "millions of Maya" (claimed by LiDAR technology) used the savannas far more intensively 2000 years ago than the Chontal Maya of today in Tabasco. Let's hope paleoecologists and botanists can answer these questions.



Crescentia cujete, calabash tree, jicaro, with fresh young saplings of other species under the partial shade. Several tree species prefer to grow underneath the *Crescentia* trees in this savanna. We noticed about four areas where there was one *Coccoloba* tree growing always under a *Crescentia* tree. However, only under perhaps 2% to 5% of the *Crescentia* trees had another tree under them. So far I have not yet found any botanical documentation of a plant association between these two trees. This is why we need to return to the savanna and be able to dedicate more time to document this; we need to find the *Coccoloba* trees when they are flowering to better identify which are the species present (most species produce edible fruits). We also need to visit other savannas in the RBM to see if this plant association is present elsewhere. I estimate that the bird or animal that spreads the seeds of the *Coccoloba* tree also likes to alight on the branches of the *Crescentia* tree. but this should be better studied by a zoologist.

Photo by: Nicholas Hellmuth. FLAAR Mesoamerica, Nov. 16, 2021.
Petén, Guatemala.
Camera: iPhone 13 Pro Max.

Summary and Conclusions: Utilitarian aspects

Thalia geniculata has potential for the past, present, and future times: popales (areas of solid thickets of *Thalia geniculata*) have:

- Jute, edible snails, a major item of diet for many Mayan people.

No one has made a list of all the plants in the wetlands at the south area of Rio Ixtinto, in the private nature reserve that is adjacent to Parque Nacional Yaxha Nakum and Naranjo. Since there is *Thalia* along rivers and in swamps in Tabasco, Campeche, Chiapas and elsewhere, there may be present in wetlands of the Rio Ixtinto. The challenge is to get there as no lanchero likes to take his motorboat to these areas because of all the fallen logs that would break off the propellers. Therefore, a drone is needed, or boat with oars or paddles (no propeller blades).

If *Thalia* is found in wetlands, this adds the potential of:

- Fish and frogs (during the wet season; no standing water in Nakum popal).
- Crabs (during the wet season perhaps; not yet noticed in Nakum popal.

Thalia geniculata ecosystems have proven helpful to the Chontal Maya of Tabasco because of their surprisingly fast-growing, fast-harvested variety of maize, "marceño" in that area. So an experimental project with this maize in popales of Petén would help local people to utilize the land for more eco-friendly purposes than cattle ranches.

The leaves of *Thalia geniculata* are obviously used to wrap tamales. The Classic Maya had no plastic: so the leaves are a great replacement for plastic today and in the future.

The roots can make starch and are edible. So far we have not found a Mayan ethnobotanical study which shows the roots are eaten by todays Mayan people, but a good research and educational project can encourage local people to raise and eat these roots. Many areas in central Petén, that 100 years ago were popales and then got clearcut and bulldozed for cattle ranches, can be resurrected as popales.

Another benefit of entire micro ecosystems filled with *Thalia geniculata* is that the zig zag flower sprigs are very photogenic. There is huge potential for building up eco-tourism for Parque Nacional Yaxha, Nakum and Naranjo.

Glossary

- **Arrowroot**, common word in English which refers to edible root, rhizomes or other root-like plant parts which also make starch. The best known arrowroot plant is *Maranta arundinacea*, which we just discovered at Parque Nacional Yaxha Nakum and Naranjo. There are about eight other plants with the name arrowroot, best presented on this page:

https://en.wikipedia.org/wiki/Arrowroot_(disambiguation)

- **Popal**, popales, popaperas o pantanos de *Thalia geniculata*, is an area where you find lots and lots of popal plants. In Spanish they use the letters "al" to mean "place of:"
- **Corozal**, place of lots of corozo palms
- **Guanal**, place of lots of guano palm
- **Pital**, place of lots of pita plants (terrestrial bromeliads, Aechmea magdalenae).

Photo by: Nicholas Hellmuth. FLAAR Mesoamerica, Nov. 16, 2021.
Petén, Guatemala.
Camera: iPhone 13 Pro Max.

APPENDIX A

Area of Wilted (March 28, 2019) probable *Thalia geniculata* near north edge of Savanna East of Nakum

Could also be wilted *Canna indica.*

Here you see the "trade mark" zig-zag of dried *Thalia geniculata* when flowering (or after flowers have dropped off).

Photo by: Nicholas Hellmuth. FLAAR Mesoamerica, Mar. 28, 2019. Petén, Guatemala.
Camera: Nikon D810. Lens: Nikon AF-S Micro 60mm G. Settings: 1/400 sec; f/8; ISO 400.

In addition to the island of "millions of *Thalia* plants" there are hundreds of these plants in the middle of the north side but more openly scattered (with more grass and more other species separating them).

This area was photographed in March 2019; during our November 2021 field trip our focus was the island, plus it was not as easy to hike through the savanna when there was water on the surface. We don't mind getting wet but the grasses at that time are thicker and your feet can't move forward easily.

Photo by: Nicholas Hellmuth. FLAAR Mesoamerica,
Mar. 28, 2019. Petén, Guatemala.
Camera: Nikon D810. Lens: Nikon AF-S Micro 60mm G.
Settings: 1/400 sec; f/8; ISO 400.

The horizontal "flags" are why this plant is called Alligator Flag in Florida. In Guatemala should be named "Crocodile Flag" since there are no alligators in Peten, only *Crocodylus moreletii*. Interestingly, the skull of a *Crocodylus moreletii* was found near a poachers camp a hundred meters from the west edge of the savanna (on the hike back to Nakum base camp).

Photo by: Nicholas Hellmuth. FLAAR Mesoamerica,
Mar. 28, 2019. Petén, Guatemala.
Camera: Nikon D810. Lens: Nikon AF-S Micro 60mm G.
Settings: 1/400 sec; f/8; ISO 400.

Thalia geniculata

Photo by: Nicholas Hellmuth. FLAAR Mesoamerica,
Mar. 28, 2019. Petén, Guatemala.
Camera: Nikon D810. Lens: Nikon AF-S Micro 60mm G.
Settings: 1/400 sec; f/8; ISO 400.

APPENDIX B

Area of *Thalia geniculate* flowering
near the north edge of Savanna East of Nakum

Thalia geniculata flowers.

Photo by: Nicholas Hellmuth. FLAAR Mesoamerica, Mar. 28, 2019.
Petén, Guatemala.
Camera: Google Pixel 3XL.

Thalia geniculata flowers.

Photo by: Nicholas Hellmuth. FLAAR Mesoamerica, Mar. 28, 2019.
Petén, Guatemala.
Camera: Google Pixel 3XL.

APPENDIX C

Thalia geniculata associated with Lake Zotz (Lundell 1937: 17-18)

Primary successional stages lakes and banks

LAKE ZOTZ1__ Lake Zotz is a small body of comparatively shallow water located about 10 kilometers southeast of Laguna Perdida on the road leading to Lake Petén (Plate 1). The lake is somewhat oval and less than a kilometer wide.

It was formerly surrounded by high forest most of which has been felled to make way for *milpas* and *zacatales* (grass plots). The station at the lake, known as El Zotz2, is important as one of the overnight stopping places for mule-trains carrying in merchandise and bringing out chicle from the region to the northwest,

During the one day spent exploring the basin, a representative collection of the plants from each association was obtained. Other botanists who may visit the lake are urged to collect more thoroughly as some interesting species were undoubtedly overlooked.

Submerged hydrophytes ___ the association may be limited to one or at the most a half-dozen species, yet the number of individual plants may be enormous. In Lake Zotz compact beds of *Cabomba aquatica* extend out in shallow water as much as 100 meters from the edge of the floating fern and sedge bog.

Floating fern and sedge bog __ About one-fifth of the surface of Lake Zotz is covered with a matted, floating, saturated mass of intertwined fibrous, organic material which supports a distinctive association of plants adapted to a semiaquatic or aquatic habitat (Plates 8 and 9). Although the species represented are altogether different and no sphagnum is present, the general aspects of the mat suggest a sphagnum bog. Scores of species, some equally distributed throughout, others occurring in large dense patches, comprise the association.

Ferns and sedges dominate, yet species of other genera such as *Typha* stand out prominently. The ferns include *Acrostichum daneifolium* (Lundell 3310), 3 *Blechnum serrulatum* (3309), *Dryopteris serrata* (3297), and *Nephrolepis biserrata* (3320). They are gregarious, growing in large patches so closely grouped together that from a distance sections of the association appear to consist entirely of ferns.

1. Whenever the data are available each lake, river, aguada, akalche, etc., will be treated separately in order to give a clear conception of the nature of the associations of each. When the survey is completed it will then be possible to make exact analyses and comparisons between associations belonging to the same physiographical areas in various sections of the region.
2. Zotz is often spelled "Sos" or "Zos".
3. Throughout the book, if collector of cited specimens is always the same, the name of the collector precedes the number only for fist citation in each paragraph.

The species of *Acrostichum*, *Blechnum*, and *Dryopteris* are large and coarse, often exceeding 1 meter in height.

Sedges of similar habit are *Scleria aggersiana* (Lundell 3312), *Fuirena umbellata* (3392, 3979), and the polol, *Cyperus articulates* (3321). A diminutive form, *Eleocharis plicarhachis* (3325), must be considered as one of the important elements. Other sedges are *Eleocharis interstincta* (3326) and a large Scleria (3317) which was not fruiting.

Thypha angustifolia (Lundell 33145) appears in characteristic clumps. Scattered widely through the association are two orchids, *Habenaria pringlei* (3324) and *Bletia tuberosa* (3323), along with *Thalia geniculata* (3300), *Jussixa leptocarpa* (3319), *Erechtites hieracifolia* (3294), *Polygonum acuminatum* (3298), *Andropogon bicornis* (3316), *Begonia tovarensis* (3391), *Helianthium tenellum* (3293), and the slender vine, *Vigna repens* (3399). Along the outer edge of the mat, *Utricularia macerrima* (?) (33165) grows profusely.

The characteristic species of free-floating hydrophytes, *Salvinia, Pistia*, and *Eichhornia*, were not encountered. Samples taken of the plankton reveal a large microscopic flora much richer than in Lake Petén.

Shallow water association ___ Along the strand where the matted floating mass is not jammed against the bank, the *naabal*, a water-lily *association*, appears (Plate 9, fig. 2). The *naab, Nymphaea ampla* (Lundell 3313), with its large floating leaves, is dominant. The subdominants, mostly coarse gregarious aquatics, are the *polol sedges*, *Cyperus articulatus* and *Typha angustifolia*. A common margin plant is *Polygonum acuminatum* (3298), a slender herb as much as a meter high.

Bank associations ___ The exposed bank at low-water time and a narrow zone of saturated soil above the high-water level support an herbaceous association in which *Spilanthes Americana* (Lundell 3301) and *Panicum trichanthum* (3307) alternate as dominants over extended sections. With these appears *Rynchospora corymbosa* (3304). Where the banks slope very gradually, areas of *Eleocharis interstincta* fringe the strand during the low-water period. Gregarious forms, the giant *Scleria eggersiana* (3312) and species of *Heliconia*, occupy areas of moist soil in the zone lying above that subject to long periods of inundation.

This herbaceous association is most prominent on the sides of the lake where the forest has been felled, and to a certain extent in may be considered secondary. Where trees extend to the water edge, the shade prevents a luxuriant herbaceous growth on the strand.

No study was made in the undisturbed sector of the trees and shrubs of the transitional zone leading to the upland climax forest. The secondary upland growth above the herbaceous association is a *guarumal* characterized by the *guarumo*, *Cecropia* (Lundell 3395, 3296). On the steep bank near the station stand *Ficus Segoviax* (3274) and *Ficus tuerckheimii* (3275), trees about 15 meters high with large spreading crowns. Near the water edge there are smaller trees of *Pachira aquatica*.

You can see *Crescentia cujete* tree in the foreground at the left and the hillside forest upon karst hill in the background. There are multiple levels of *Thalia geniculata* in the island. Note how the *Thalia* in front is not as high as the *Thalia* further into the island.

Then, why the difference in growth between Thalia? is there a different soil? Different amount of water? Or is the middle of the island physically higher than the outside area? A LiDAR analysis would be the easiest way to initiate a study of this island (but so far, no LiDAR analysis is available for the Nakum or Yaxha areas of the park).

Our interest is to find what is "out there" and provide this information to PNYNN, biologists, botanists, zoologists, ecologists, and archaeologists so they have material and photographs to prepare a proposal for their own field work. Soil scientists and geologists could help hugely here (geologists for the geological fault down the hill at the north side). All these studies would assist the PNYNN co-administrators, especially for the next Plan Maestro, thus, our photography and publishing is a first step.

Photo by: Nicholas Hellmuth. FLAAR Mesoamerica, Nov. 16, 2021.
Petén, Guatemala.
Camera: iPhone 13 Pro Max.

APPENDIX D

Thalia geniculata in Standley and Steyermark, Flora of Guatemala

This description is another clear indication that these prestigious botanists did not hiked through Peten ecosystems. It also seems that they did not read much by Lundell for their description of this plant. Nonetheless, the multiple monographs by Standley, Steyermark and other co-authors is the single most important source to include in your botanical documentation of a plant (just not very helpful for *Thalia geniculata*).

Thalia geniculata L. Sp. PL 3. 1753.

In shallow water of open swamps, at or near sea level; Peten; Izabal. Florida; Mexico; British Honduras to Salvador and Panama; West Indies; South America; tropical Africa.

A tall, nearly glabrous perennial, usually 2-3 meters high; basal leaves long-petiolate; callus of the petiole 1.5 cm. long, terete, glabrous or puberulent; leaf blades rather stiff and paper-like, ovate-lanceolate or oblong-lanceolate, as much as 60 cm. long and 20 cm. wide but mostly smaller; sheath of the petiole broad, membranaceous, glabrous, not auriculate; panicles usually large, subtended by a single large leaf, the racemes lax, with internodes 1 cm. long or less, the rachis usually zigzag; bracts about 2 cm. long, oblong-lanceolate; ovary glabrous; sepals oblong-ovate, 2 mm. long; corolla purple, the tube very short, the lobes 7 mm. long; outer staminode purple, 14 mm. long, the inner staminodia half as long or shorter; fruit ellipsoid, 1 cm. long, the exocarp membranaceous; seed grayish, minutely tuberculate or smooth, subtended by a small whitish aril. (Fig. 42.)

Called "quento" in Tabasco; "platanillo" (Salvador). This is a common and characteristic plant of the large open swamps along the North Coast of Guatemala, and along the whole Atlantic coast of Central America.

Comments by Nicholas

Peten is nowhere near "the North Coast of Guatemala." To the north of Guatemala is Campeche, Quintana Roo and perhaps a bit of Belize (but mostly to the east).

Misses all the other common names for this plant (albeit mainly in Mexico). Nakum is nowhere near sea level, sorry.

In the savanna east of Nakum *Thalia geniculata* is in a bog, not in shallow water (I prefer to call this area a grassland savanna rather than a swamp), though I bet if you were in a helicopter over this area in a wet month of the rainy season you would indeed see standing water in parts of this savanna. However, this was an El Niño year, so it was more dry than most other years.

The meter-plus height of the front of the *Thalia geniculata* island is far far away (in the middle of the photo). It helps to have good eyesight and to be able to tell "what's out there in the distance". We do not use binoculars because there is no comfortable way to carry that much equipment; our main focus is on plants related to ecosystems (there are very few birds here or en route).

Photo by: Nicholas Hellmuth. FLAAR Mesoamerica, Nov. 16, 2021. Petén, Guatemala.
Camera: iPhone 13 Pro Max.

References Cited and Suggested Reading on *Thalia geniculata*

Most helpful report on this plant:

There is no monograph on *Thalia geniculata* that we have yet found. These trees certainly deserve more attention in Guatemala and adjacent countries.

ARELLANO Rodríguez, J. Alberto, FLORES Guido, José Salvador, TUN Garrido, Juan and **M. M. CRUZ Bojórquez**

2003 Nomenclatura, forma de vida, uso, manejo y distribución de las especies vegetales de la Península de Yucatán. Etnoflora Yucatanense Fascículo 20. Universidad Autónoma de Yucatán, UADY. 815 pages.

A challenge to find as a download.

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 plan names so that you can find plants more easily. Suzanne Cook's Lacandon ethnobotany index is significantly easier to use.

Not available as a download. To help the world learn about the Itza Maya culture and ethnobotany, would be a courtesy of the author and publisher to make as an open searchable PDF as a helpful download.

BALICK, Michael J., NEE, Michael H. and **Daniel E. ATHA**

2000 Checklist of the Vascular Plants of Belize: With Common Names and Uses. Memoirs of the New York Botanical Garden Vol. 85. 246 pages.

BALICK, Michael J. and **Rosita ARVIGO**

2015 Messages from the Gods: A Guide to the Useful Plants of Belize. The New York Botanical Garden, Oxford University Press.

BESTELMEYER, Brandon T. and **Leeanne E. ALONSO** (editors)

2000 A Biological Assessment of Laguna del Tigre National Park, Petén, Guatemala. RAP Bulletin of Biological Assessment 16, Conservation International, Washington, DC. 221 pages.

BLAKE, S. F.

1919 Native names and uses of some plants of Eastern Guatemala and Honduras. Spring. Economic Survey Mission of the United States State Department.

Helpful download:

https://repository.si.edu/bitstream/handle/10088/27024/usnh_0024.04.pdf

BUENO, Joaquín. ALVAREZ, Fernando and **Silvia SANTIAGO (editors)**

2005 Biodiversidad del Estado de Tabasco. CONABIO, UNAM, Mexico. 370 pages.

CASCO Montoya, Rosario

1984 Desarrollo rural integral de la Selva Lacandona. Comision del Plan Nacional Hdraulico, Mexico, D.F.

Finally found a mention of *Thalia geniculata* in a book on the Lacandon area of Chiapas, Mexico (but no mention of precisely where…). Now, at least we know, as I expected, that *Thalia geniculata* can indeed be found somewhere in the Lacandon areas.

Download:

www.inecc.gob.mx/repositorio/ae3/AE_004184/ae_004184.pdf

CHIZMAR, Carla

2009 Plantas Comestibles de Centroamérica. Instituto Nacional de Biodiversidad (INBio). Santo Domingo de Heredia. Costa Rica. 360 pages.

Helpful download:

www.museocostarica.go.cr/descargas/PlantasComestiblesCA-VE.pdf

CONABIO

n.d. Listado de algas y plantas presentes en Ría Lagartos (Las Coloradas), Yucatán. (CONABIO, anexo 3).

This is just Anexo 3 which had six species of *Croton* listed; the rest of the report is splattered in a dozen other PDFs.

Helpful download:

www.conabio.gob.mx/conocimiento/manglares/doctos/anexos/PY71_Anexo_3.

CONAP, MICUDE and **TNC**

2006 Plan Maestro del Parque Nacional Yaxha-Nakum-Naranjo 2006-2010. Consejo Nacional de Areas Protegidas – CONAP. Ministerio de Cultura y Deportes – MICUDE. Dirección General del Patrimonio Cultural y Natural – DGPCyN. The Nature Conservancy – TNC

Rudy HERRERA and Vilma FIALKO are listed as the editors.

CONAP, DGPCN/MICUDE, CATIE and **GITEC**

2015 Plan Maestro del Parque Nacional Yaxha, Nakum, Naranjo (PNYNN). Primera actualización. Consejo Nacional de Áreas Protegidas (CONAP), Dirección General de Patrimonio } Cultural y Natural (DGPCN)/Ministerio de Cultura y Deportes (MICUDE), Centro Agronómico Tropical de Investigacióny Enseñanza (CATIE)-GITEC Consult GmbH.

COOK, Suzanne

2016 The forest of the Lacandon Maya: an ethnobotanical guide. Springer. 334 pages.

Online journal: www.springer.com/la/book/9781461491101

DIX, Margaret A. and **M. W. DIX**

1992 Recursos biológicos de Yaxhá-Nakúm-Yaloch. 54pp.

This is one of the sources for the tree list portion of CONAP's Yaxha Plan Maestro Yaxha in the past decade. Unfortunately the Dix and Dix list is rather limited. The 1999 Schulze and Whitacre list for Tikal is more complete (but all these lists need more field work to improve).

We have asked several times for a copy of the original Dix and Dix report, but have never received one.

ESTRADA Loreto, Feliciana

2010 Indicadores ecológicos de la zona riparia del Río San Pedro, Tabasco, México. MS Thesis, El Colegio de la Frontera Sur. 131 pages.

Helpful download:

https://ecosur.repositorioinstitucional.mx/jspui/bitstream/1017/1656/1/100000050585_documento.pdf

FACCIOLA, S.

1998 Cornucopia II.

Cited in

http://tropical.theferns.info/viewtropical.php?id=Thalia+geniculata

States that roots can be baked and eaten as a vegetable, or the starch can be extracted (as with roots of arrowroot). However, I prefer these comments to come from a Mayan-focused ethnobotanist or linguist who has seen this uses firsthand. Also from Maya people that have been told that is what their grandparents did.

GARCIA de Miguel, Jesus

2000 Etnobotanica Maya: Origen y evolución de los Huertos Familiares de la Península de Yucatán, México.

GOODWIN, Z. A., LÓPEZ, G. N., STUART, N., BRIDGEWATER, G. M., HANSTON, E. M., CAMERON, I. D., MICHELAKIS, D., RATTER, J. A., FURLEY, P. A., KAY, E., WHITEFOORD, C., SOLOMON, J. LLOYD, A. J. and **D. J. HARRIS**

2013 A checklist of the vascular plants of the lowland savannas of Belize, Central America. Phytotaxa 101 (1): 1–119.

Helpful download:

www.eeo.ed.ac.uk/sea-belize/outputs/Papers/goodwin.pdf

IBARRA-Manríquez, Guillermo, VILLASEÑOR, José Luis and **Rafael DURÁN García**

1995 Riqueza de especies y endemismo del componente arbóreo de la Península de Yucatán, México. Bol. Soco Bot. México 57: 49-77

Helpful download:

www.researchgate.net/publication/306128522_Riqueza_de_especies_y_endemismo_del_componente_arboreo_de_la_Peninsula_de_Yucatan_Mexico

INE

2013 Nomination of Ancient Maya City and Protected Tropical Forests of Calakmul, Campeche. 55 pages.

There is no author on the fragment that is the most available as a download, so we put INE.

LUNDELL, Cyrus L.

1937 The Vegetation of Peten. Carnegie Institution of Washington, Publ. 478. Washington. 244 pages.

We scanned the entire hard copy book to have it as a super-helpful in-house PDF.

LUNDELL, Cyrus L.

1938 Plants Probably Utilized by the Old Empire Maya of Peten and Adjacent Lowlands. *Papers of the Michigan Academy of Sciences, Arts and Letters* 24, Part I:37-59.

MALDONADO-Polo, J. Luis

1995 Los recuerdos naturales de Centroamérica. El origen de la expedición botánica al reino de Guatemala. Consejo Superior de Investigaciones Científicas Licencia Creative Commons 3.0 España

Helpful download:

http://asclepio.revistas.csic.es/index.php/asclepio/article/view/434/431

MARIACA Méndez, Ramón

2011 El huerto familiar del sureste de México. Secretaría de Recursos Naturales y Protección Ambiental del Estado de Tabasco, El Colegio de la Frontera Sur.

MARTÍNEZ, Esteban and **Carlos GALINDO-Leal**

2002 La Vegetación de Calakmul, Campeche, México: Clasificación, descripción y distribución. Bol. Soc. Bot. México 71: 7-32.

Helpful download:

www.botanicalsciences.com.mx/index.php/botanicalSciences/article/download/1660/1309/

MEERMAN, Jan. C.

1999 Rapid Ecological Assessment, RUNAWAY CREEK WORKS, (Belize District, Belize). Belize Environmental Consultancies Ltd. 73 pages.

NOVELO Retana A.

2018 Inventario de la vegetación acuática vascular de la reserva de la biosfera Pantanos de Centla, Tabasco. Version 1.5. Comisión nacional para el conocimiento y uso de la biodiversidad.

Download:

www.gbif.org/dataset/7fac7128-936b-4da9-8baf-6020bb898fb7

OCHOA-Gaona, Susana

1996 La Vegetación de la Reserva El Ocote a lo largo del Cañón del Río La Venta. Ecosur, Conabio.

OCHOA-Gaona, Susana, MORENO Sandoval, Fernando, JIMÉNEZ Pérez, Nelly del Carmen, RAMOS Ventura, Leandro Javier, MUÑIZ Delgado, Leydy Elizabeth and **María Alejandra HAAS Ek**

2017 Guía de plantas acuáticas y ribereñas de la cuenca del Usumacinta. San Cristóbal de Las Casas, Chiapas, México: El Colegio de la Frontera Sur. Departamento de Ciencias de la Sustentabilidad, 322 pages.

ORDÓÑEZ, MARÍA de Jesús

2014 Las flores comestibles. Instituto nacional de investigación sobre medios bióticos

Helpful download:

www.academia.edu/12405169/LAS_FLORES_COMESTIBLES_MAR%C3%8DA_DE_JES%C3%9AS_ORD%C3%93%C3%91EZ

PARDO Tejada, Enrique

1979 Flores Comestibles. comunicado n° 36 sobre recursos hióticos potenciales del país.

PERAZA-Villarreal, Humberto, CASAS, Alejandro, LINDIG-Cisneros, Roberto and **Alma OROZCO-Segovia**

2019 The Marceño Agroecosystem: Traditional Maize Production and Wetland Management in Tabasco, Mexico. Sustainability 2019, 11.

The local Chontal Maya people use a special variety of local maize that grows well after floodwaters recede (and very fast) on annually flooded land. Nonetheless, no mention whatsoever is made on the local use of the abundant *Thalia geniculata.*

The Maya 2000 years ago could have raised maize in the dry season and harvested edible roots from *Thalia geniculata* in the wet season, plus had a third water-plant for other months. We need to learn how fast the roots of *Thalia geniculata* grow before they are large enough to eat.

REYES Morales, Elsa María de Fátima (Coordinator)

2009 Los Cuerpos de Agua de la Región Maya Tikal –Yaxhá: Importancia de la Vegetación Acuática Asociada, Calidad de Agua y Conservación. Herbario USCG - Centro de Estudios Conservacionistas - CECON - Laboratorio de Investigaciones Químicas y Ambientales - LIQA -Instituto de Investigaciones Químicas y Biológicas - IIQB -. Guatemala. 71 pages.

ROBELO, Cecilio A.

1904 Diccionario de Aztequismos; o sea, Jardín de las raices Aztecas, palabras del idioma Nahuatl, Azteca o Mexicano, introducidas al idioma castellano bajo diversas formas.

Many editions; many different dates; different publishers.

Helpful download:

https://bibliotecavecina.files.wordpress.com/2015/06/robelo-cecilio-a-diccionario-de-aztequismos.pdf

SELVEN Pérez, Edgar and **Miriam Lorena CASTILLO Villeda**

2000 A rapid assessment of avifaunal diversity in aquatic habitats of Laguna del Tigre National Park, Petén, Guatemala. In: Bestelmeyer, B.T. and Alonso, L.E. (eds.). A Biological Assessment of Laguna del Tigre National Park, Petén, Guatemala, pp. 56-60. Conservation International.

STANDLEY, Paul C. and **Samuel J. RECORD**

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

Every decade of Standley and co-author reports can all be easily downloaded, as open PDFs.

STANDLEY, Paul C.

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.

STANDLEY, Paul C. and **Julian A. STEYERMARK**

1958 Flora of Guatemala. Fieldiana: Botany, Volume 24, Part I Chicago Natural History Museum. 478 pages.

SUCHINI Farfan, Aura Elena et al.

2009 Endemismo florístico en la reserva de la biosfera Sierra de las Minas. USAC

Unfortunately the PDF is locked, the information has to be transcribed.

Easy download:
http://glifos.concyt.gob.gt/digital/fodecyt/fodecyt%201999.69.pdf

TETETLA Rangel, Ericka

1904 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 best 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

VILLALOBOS-Zapata, G. J. and **J. MENDOZA Vega** (Coordinators)

2000 A rapid assessment of avifaunal diversity in aquatic habitats of Laguna del Tigre National Park, Petén, Guatemala. In: Bestelmeyer, B.T. and Alonso, L.E. (eds.). A Biological Assessment of Laguna del Tigre National Park, Petén, Guatemala, pp. 56-60. Conservation International.

STANDLEY, Paul C. and **Samuel J. RECORD**

2010 La Biodiversidad en Campeche: Estudio de Estado. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO). Gobierno del Estado de Campeche, Universidad Autónoma de Campeche, El Colegio de la Frontera Sur. México. 730 pages.

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.

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

VILLEGAS, Pedro. BUROGOS, Claudia, and CRUZ, Harim

2011 Plantas medicinales y comestibles de la Reserva Natural de Usos Multiples Monterrico - RNUMM-, Taxisco, Santa Rosa. Programa Universitario de Investigaciòn en Recursos Naturales y Ambiente - PUIRNA-. Universidad de San Carlos de Guatemala. Guatemala.

Download:
http://digi.usac.edu.gt/bvirtual/informes/puirna/INF-2011-024.pdf

VOGL, C. R., VOGL-Lukasser, B. and **J. CABALLERO**

2002 Homegardens of Maya Migrants in the District of Palenque (Chiapas / Mexico): Implications for Sustainable Rural Development. In: Stepp, J.R., Wyndham, F.S., and R.K. Zarger (eds.). *Ethnobiology and Biocultural Diversity*. Pp: 631 – 647. University of Georgia Press.

Helpful web sites for any and all plants

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

However, most popular web sites are copy-and-paste (probably the authors did not do field work). Also, many of these web sites can be click bait (making when from the purchases of in the advertisements along the sides and in wide banners). 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 the 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 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.

Web pages specifically on *Thalia geniculata*

www.naturalista.mx/taxa/127912-Thalia-geniculata

It has about 20 photos of good size. About 8 or more show the flowers and the zig-zag stem pattern. Most of the rest show the ecosystems of this plant. Unfortunately you have to click on each one to find where in Mexico it was photographed.

http://tropical.theferns.info/viewtropical.php?id=Thalia+geniculata

Although it does not have "new" information and only shows the plant in a garden, I consult it several time every day all year. At least one pertinent citation is on each page (not random copy-and-paste and no commercialized ads on the website either).

Thalia geniculata

Photo by: Nicholas Hellmuth. FLAAR Mesoamerica, Nov. 16, 2021. Petén, Guatemala.
Camera: iPhone 13 Pro Max.

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.

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 y 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 y 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.

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

www.elsombreroecolodge.com/en-us

Base Camp Assistance in PNYNN

We thank Biologist Lorena Lobos and both co-administrators of PNYNN (Arq. Jose Leonel Ziesse (IDAEH) and Ing. 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.

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

HELLMUTH, N. (2021)
Mysterious Island of Thalia geniculata, in the middle of the Savanna East of Nakum. Part I: Botany and Ethnobotany of *Thalia geniculata*. FLAAR Mesoamerica and FLAAR

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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.

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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.

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.

PHOTO FROM BACK COVER
Thalia geniculata

Photo by: Nicholas Hellmuth. FLAAR Mesoamerica,
Nov. 16, 2021. Petén, Guatemala.
Camera: iPhone 13 Pro Max.

ACKNOWLEDGEMENTS TO FLAAR MESOAMÉRICA

Flor de María Setina is the office manager, overseeing all the diverse projects around the world (including FLAAR-REPORTS research on advanced wide-format digital inkjet printers, a worldwide project for over 20 years). We also utilize the inkjet prints to produce educational banners to donate to schools.

Vivian Díaz environmental engineer, is project manager for flora, fauna projects (field work and resulting reports at a level helpful for botanists, zoologists and ecologists, and for university students). Also coordinates activities at MayanToons, division where educational material for kids is prepared.

Victor Mendoza identifies plants, mushrooms, lichen, insects, and arachnids. When his university schedule allows, he also likes to participate in field trips on flora and fauna research.

Vivian Hurtado prepares the bibliography for each subject and downloads pertinent research material for our e-library on flora and fauna. All of us use both these downloads plus our in-house library on flora and fauna of Mesoamerica (Mexico through Guatemala into Costa Rica).

Sergio Jerez prepares the bibliography of each topic and download the pertinent research material for our electronic library on flora and fauna. We all use these two downloads plus our internal library on Mesoamerican flora and fauna (México through Guatemala to Costa Rica).

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

Norma Estefany Cho Cu helps with preparing the camera equipment for each field trip and helps in the office (and on field trips) as cook.

Jaqueline González is a designer who puts together the text and photographs to create the actual report (we have several designers at work since we have multiple reports to produce).

Roxana Leal is Social Media Manager for flora and fauna research and publications, and MayanToons educational book projects

María Alejandra Gutiérrez is an experienced photographer, especially with the Canon EOS 1D X Mark II camera and 5x macro lens for photographing tiny insects, tiny flowers, and tiny mushrooms. Work during and after a field trip also includes sorting, naming, and processing. And then preparing reports in PDF format.

David Arrivillaga is an experienced photographer and is 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 (total network is read by over half a million people around the world).

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.

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.

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

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.

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.

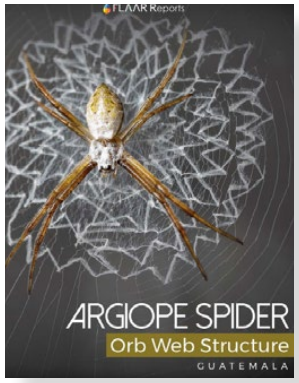
Alejandra Valenzuela biology student is now part of Flora y Fauna's photographic report and educational material editing team since September 2020.

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.

Other publications of the fauna of Guatemala



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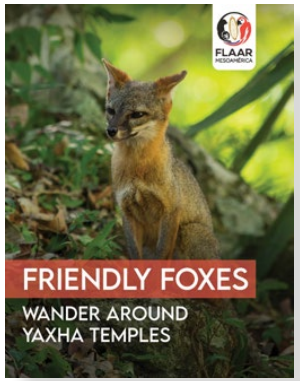

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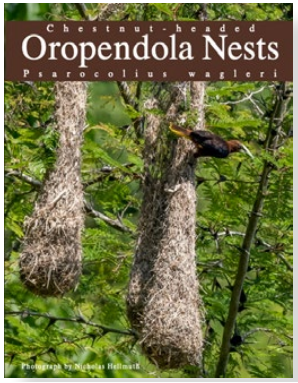

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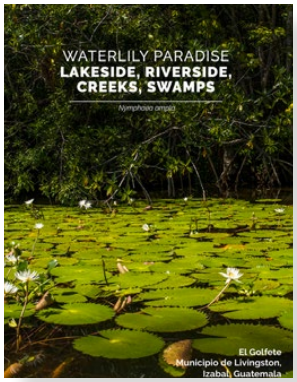
www.maya-ethnozoology.org.

Other publications of the flora of Guatemala



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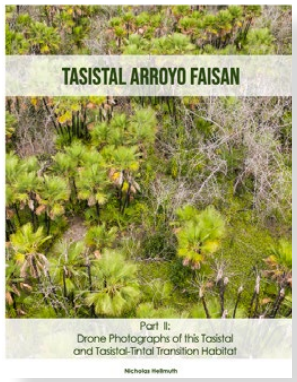

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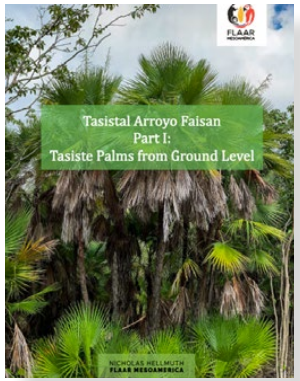

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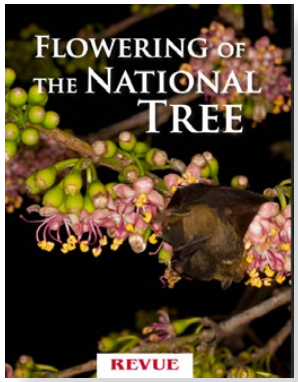

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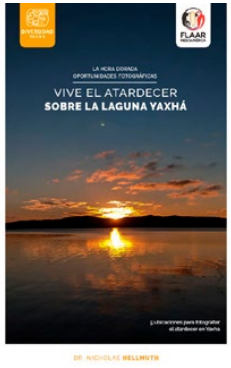

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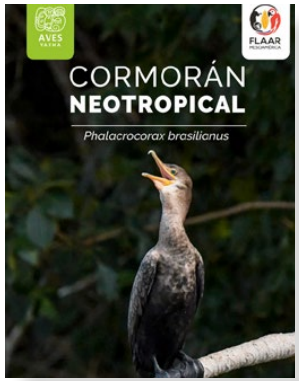

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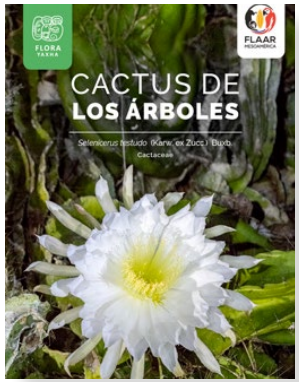

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