Savanna-Tasistal #14

Seasonally Inundated Wetland with solid Tasiste Palm area

FLAAR
MESOAMÉRICA

Acoelorrhaphe wrightii, Palmetto Palm - Part I
Parque Nacional Laguna del Tigre (PNLT)
Reserva de la Biosfera Maya (RBM) Peten, Guatemala

FLAAR (USA) and FLAAR Mesoamerica (Guatemala)
January 2022, 2nd edition February 2022
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HELPFUL COOK AT BASE CAMP, FEBRUARY 2022
Amalia Jalal

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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.

Credits

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

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CONTENTS

Introduction to *Acoelorrhaphe wrightii* in Savannas and Tasistales of Guatemala 1

My Personal Experience with *Acoelorrhaphe wrightii* 3

Full Botanical Name 8

Here are synonyms for *Acoelorrhaphe wrightii* 9

Local names for *Acoelorrhaphe wrightii* 9

Habit for *Acoelorrhaphe wrightii* 10

Is *Acoelorrhaphe wrightii* a vine? Or a bush? Or a Tree? 10

What other Trees or Plants are often found in the same Habitat? 11

Where has *Acoelorrhaphe wrightii* been found in the PNYNN and PNLT? 12

Acoelorrhaphe wrightii in Belize 12

Botanical Description of *Acoelorrhaphe wrightii* by Standley and Steyermark (1958) 14

Is *Acoelorrhaphe wrightii* from the Maya Highlands or from the Maya Lowlands (or both)? 15

In which States of Mexico is *Acoelorrhaphe wrightii* listed by Villaseñor 15

Do *Acoelorrhaphe wrightii* trees also grow in home gardens? 15

Are any parts of *Acoelorrhaphe wrightii* edible? 15

Is there potential medicinal usage of *Acoelorrhaphe wrightii* by local people 17

Are any parts of *Acoelorrhaphe wrightii* trees eaten by mammals? 17

A Tasistal means “thousands” of tasiste clumped closely together 17

A Savanna means open grassland with scattered tasiste palm clumps and with calabash trees 51

Bushes, Shrubs are also in Savannas and Tasistales 45

Surface Grasses are different height, potentially different Species, in different areas of a Savanna 63

Water on the Surface: Seasonally Inundated 64

Trees and Bushes of Transition Zone between Savanna and surrounding Bajo Forest 67

For the next field trip it is crucial to reach all
the other dozen savannas that need to be studied 80

Concluding Discussion and Summary on *Acoelorrhaphe wrightii* and Tasistal-Savanna #14 83

References Cited and Suggested Reading on *Acoelorrhaphe wrightii* 84

Helpful web sites for any and all plants 91

Web pages specifically on *Acoelorrhaphe wrightii* 91

Videos on *Acoelorrhaphe wrightii* 91

Introduction to *Acoelorrhaphe wrightii* in Savannas and Tasistales of Guatemala

The following definitions are a glossary-like introduction to savannas of Peten and around: Chiapas, Tabasco, Campeche, Quintana Roo, Yucatan, Belize. These savannas are an open grassland, generally flat, with three specific trees widely scattered in some parts of the savanna:

1. Tasiste palm
2. Calabash trees
3. And nance fruit trees

Savannas in karst geology areas to the south in Guatemala do not have tasiste. A few savannas in Parque Nacional Laguna del Tigre have no calabash trees, and one savanna has not even tasiste. That said, "90% of savannas of PNLT and 100% of savannas of PNYNN have tasiste palm trees AND calabash trees."

Savannas in Belize to the east tend to have pine, oak and sandpaper-leaf trees in addition to tasiste, calabash trees, and nance. No pine or oak in PNYNN; in PNLT you get oak around the edge of Spider Lily Savanna (Savanna #10) but so far no pine whatsoever anywhere.

With the help of CONAP (Julio Peña and Rony Chata Soza) we have learned of tasiste savannas at the far southeast border of Parque Nacional Laguna de Tigre. The largest areas of these tasiste palm areas are probably outside the park (to south and east). We estimate that potentially this could be the largest area of tasiste palm in all of Guatemala and potentially larger than any tasistal in Belize to the east. Since the PNLT tasistal areas are in remote areas, with no roads, and since we would need to visit each area in-person and undertake drone photography, the present FLAAR report is just a starter. This is Part I: on the Tasistal-Savanna (named #14 in the list of open grassland wetlands of PNLT). Part II will introduce the area we have not yet visited.

During December 2019 and early 2020 Julian Mariona led us to two seasonally inundated tasistal areas upstream from Sayaxche, Peten. Tasistal Arroyo Faisan had endless thousands of tasiste palms. Just a few kilometers away, Tasistal Arroyo Petexbatun we estimate had close to one million tasiste palms (in an area no larger than 350 meters wide by perhaps a kilometer or so long).

In Guatemala you can find tasiste palm primarily in two areas:

- Along rivers and lagoons of Rio Dulce and of east part of Izabal (Municipio de Livingston).
- Widely spaced in relatively open grassland savannas of Parque Nacional Yaxha, Nakum and Naranjo and savannas of Parque Nacional Laguna del Tigre.
- Densely packed in tasistal savannas (thousands packed together in clumps and clusters, Municipio de Sayaxche, Peten).

In seasonally inundated savannas the tasiste palms are either:

- Widely scattered in small clusters in the open grassland; this is a typical savanna of the Reserva de la Biosfera Maya (RBM).
- Closely packed in continuous clusters: in this case the area is called a tasistal (or, tasistal savanna).

Surely this palm species can be found elsewhere, but riversides of Izabal and savannas of Peten are the two areas where it is most common. So far we have not found tasiste palms along any riverside in PNYNN.

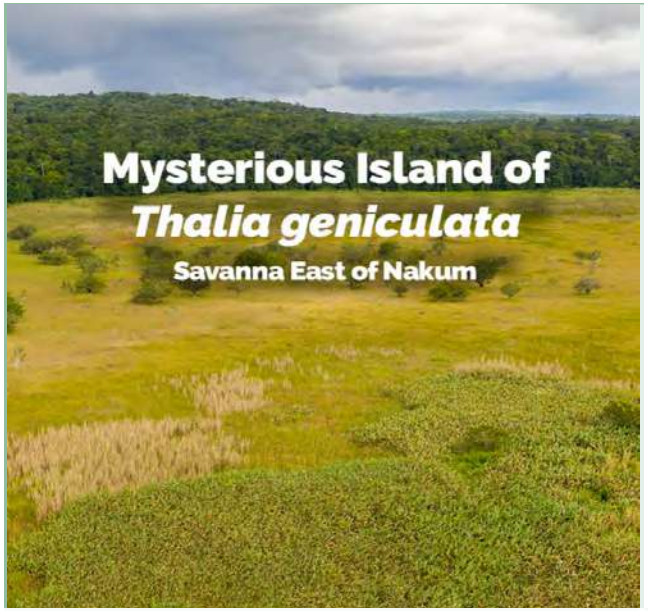
Photo by: Nicholas Hellmuth, FLAAR Mesoamérica, Jan. 10, 2022. Parque Nacional Laguna del Tigre, Reserva de la Biosfera Maya Peten, Guatemala.

Camera: iPhone 13 Pro Max.

My Personal Experience with *Acoelorrhaphe wrightii*

I first noticed tasiste palm while exploring seasonally inundated areas within Parque Nacional Yaxha, Nakum and Naranjo (project of cooperation and coordination with the co-administrators of the PNYNN, August 2018-July 2019). I quickly learned that these palm clusters were a logo plant of seasonally inundated palms: we found

- A lot of clusters of tasiste palm in the Savanna East of Nakum,
- Several clusters in the Savanna of 3 Fern Species
- A few clusters in the Rectangular Savanna (adjacent to the fern-covered savanna)
- One cluster in the Savanna West of Naranjo-Sa'al



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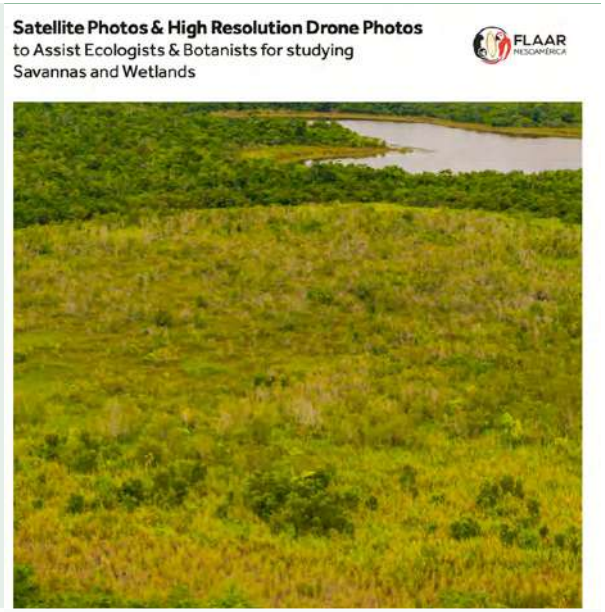
Savanna East of Nakum

Click to Download

Savanna of 3 Fern Species



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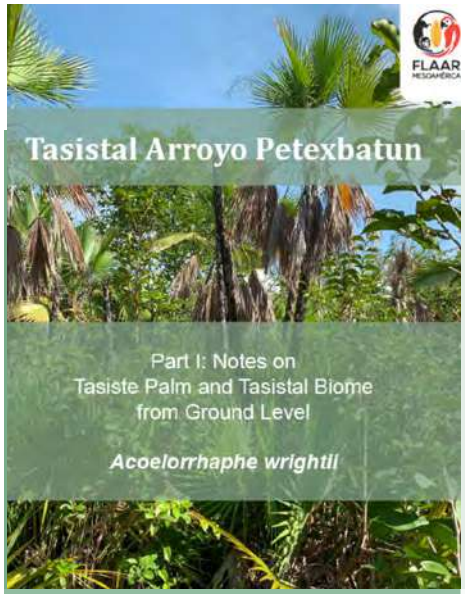
Satellite Photos and High Resolution Drone hotos.

With the help of Julian Mariona (Posada El Caribe, Arroyo Petexbatun, Sayaxche, Peten) we dedicated several field trips starting in December 2019 then returned to photograph another seasonally flooded area with thousands of clusters of tasiste in January 2020 to accomplishing comprehensive photography of two extensive tasistal ecosystems near this hotel. We have published four volumes of reports.



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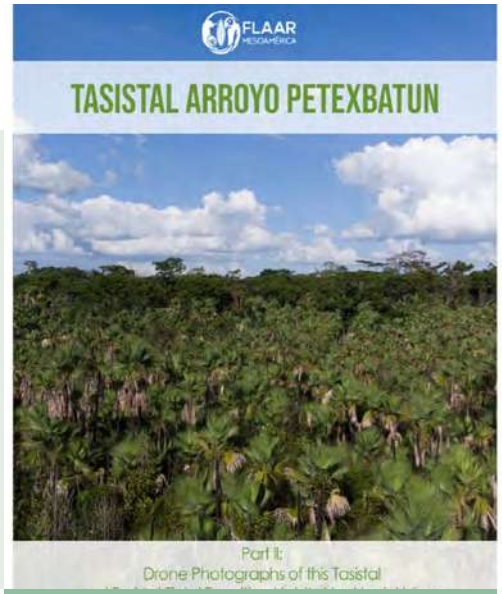
Tasistal Arroyo Petexbatun, photos from ground level



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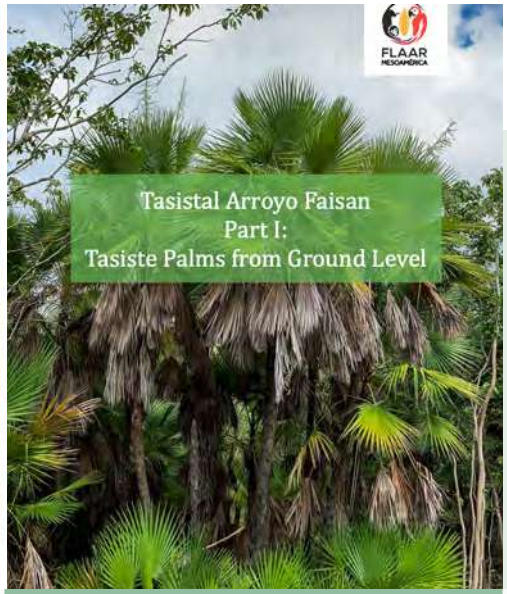
Tasistal Arroyo Petexbatun, drone photos



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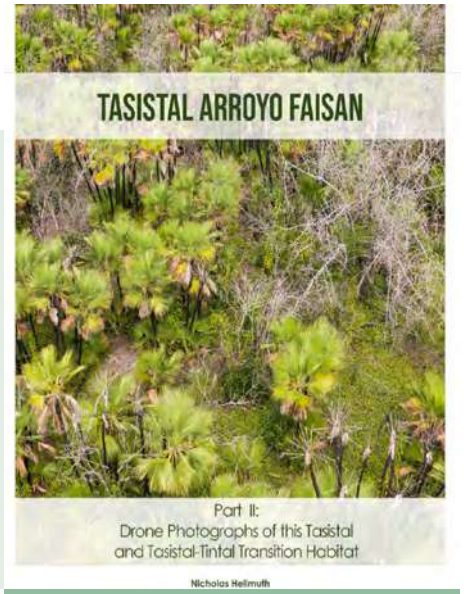
Tasistal Arroyo Faisan, photos from ground level



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Tasistal Arroyo Faisan, drone photos

Based our botanical and ecological field work of recent years we were asked to do a 15-month project of flora, fauna, and ecosystem research in the entire Municipio de Livingston. So during Feb and March 2020 (then closed down due to COVID closure of Guatemalan airports), then restarted for 15 sequential months: October 2020 through all twelve months of year 2021 (so actually 17 months total). We found *Acoelorrhaphe wrightii* palm in many locations along rivers, along the sides of lagoons: yet not one single savanna in this part of Izabal, Guatemala.

In other words, this *Acoelorrhaphe wrightii* palm has evolved to prosper in

- Seasonally inundated savannas because it loves surface water over the base of the root mass at least a month or so each year;
- And in Peten it survives frequent fires (set in almost all savannas by intrusive hunters to get the deer and other animals to run away from the fire (into where the hunters are waiting to shoot them).
- And in Izabal has adapted to flooded riverbanks including with brackish water

Would be interesting to learn whether the brackish-water loving *Acoelorrhaphe wrightii* palm of the Municipio de Livingston, Izabal, Guatemala are a regional variant of the normal rain water (no marine water ever) Acoelorrhaphe wrightii palm that gets "burned to the ground" every several years.

This is a field work Project best initiated by capable botanists or soil scientists. I am an ethnobotanist and dedicated to learning about biodiversity of the ecosystems of the Maya Lowlands.

While hiking north from the home of finquero Julio Trabanino to the north (towards the southeastern edge of Parque Nacional Laguna del Tigre) we noticed clumps of tasiste scattered around. Since much of this area had been cleared for cattle ranches in past years, the full original forest was gone (in the area we walked through, see our GPS map). Part II will show the photographs of the tasiste palms in the cattle ranch area.

Photo by: Nicholas Hellmuth, FLAAR Mesoamérica, Feb. 9, 2022. Parque Nacional Laguna del Tigre, Reserva de la Biosfera Maya Peten, Guatemala.

Camera: iPhone 13 Pro Max.

Map showing which open grassland is located in which part of the far southeast of Parque Nacional Laguna del Tigre. Number sequence by Nicholas Hellmuth; estimated coordinates by Vivian Hurtado.

Trails used to reach Savanna #13 and #14 to the south, February 20, 2022. These trails were selected by Julio Peña.

FLAAR Garmin GPSMAP 66sr by Byron Pacay.

Full Botanical Name

Acoelorrhaphe wrightii (Griseb. & H.Wendl.) H.Wendl. ex Becc. is the accepted name.

Family name is Arecaceae

Photo by: Nicholas Hellmuth, FLAAR Mesoamérica, Feb. 19, 2022.
Parque Nacional Laguna del Tigre, Reserva de la Biosfera Maya Peten, Guatemala

Camera: iPhone 13 Pro Max.

Here are synonyms for *Acoelorrhaphe wrightii*

Acanthosabal caespitosa Prosch.
Acoelorrhaphe arborescens (Sarg.) Becc.
Acoelorrhaphe pinetorum Bartlett
Acoelorrhaphe wrightii f. inermis Hadac
Acoelorrhaphe wrightii* var. *novogeronensis Becc.
Brahea psilocalyx Burret
Copernicia wrightii Griseb. & H.Wendl.
Paurotis androsana O.F.Cook
Paurotis arborescens (Sarg.) O.F.Cook
Paurotis psilocalyx (Burret) Lundell
Paurotis schippii Burret
Paurotis wrightii (Griseb. & H.Wendl.) Britton
Serenoa arborescens Sarg.

www.theplantlist.org/tpl1.1/record/kew-2153

Local names for *Acoelorrhaphe wrightii*

Called tasiste in Peten but various other names in Izabal, closer to the name pimento palm in Belize. But in Belize: chi-it, hairy tom, hairy tom palmetto, honduras pimenta, palma, palmetto, papta, pimento palm, pim-iént, pim-int, prementa, primenta, taciste, tasiste, ta-sis-te (Balick, Nee and Atha 2000: 194). Te, usually with accent, te', often means tree (che' in other Mayan languages).

Photo by: Nicholas Hellmuth, FLAAR Mesoamérica, Jan. 10, 2022. Parque Nacional Laguna del Tigre, Reserva de la Biosfera Maya Peten, Guatemala.

Camera: iPhone 13 Pro Max.

Mayan names for *Acoelorrhaphe wrightii*

I would guess ta-sis-te, but we need more time to find all the actual Mayan names.

Habit for *Acoelorrhaphe wrightii*

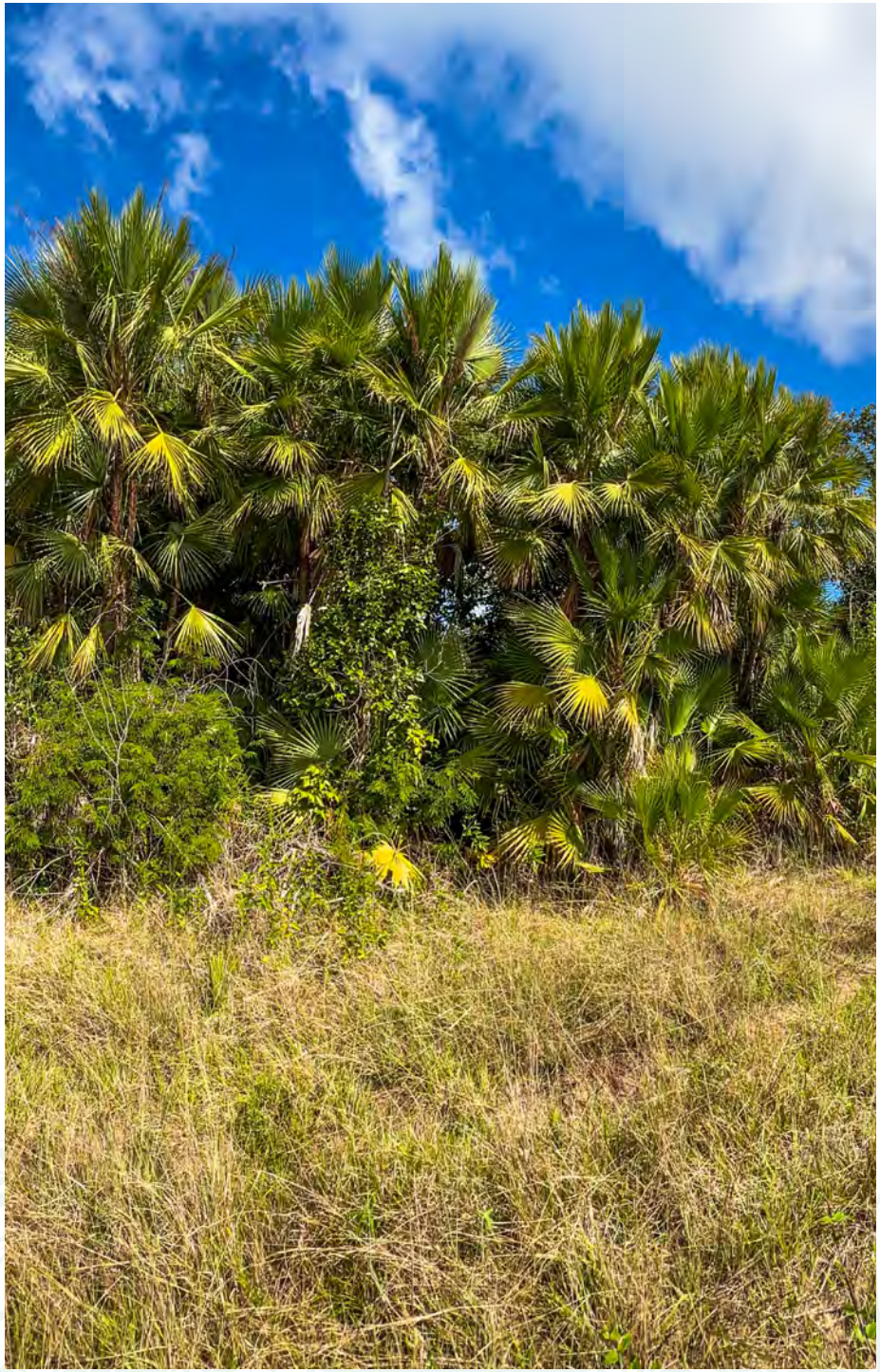
Palm.

Is *Acoelorrhaphe wrightii* a vine? Or a bush? Or a Tree?

Mid-sized palm; can grow many meters high but usually in savannas because it is burned down every several years the palm does not get more than three meters and rarely over four meters high. In Livingston, along edges of creeks and lagoons this palm can be a bit higher.

Photo by: Nicholas Hellmuth, FLAAR Mesoamérica, Jan. 10, 2022. Parque Nacional Laguna del Tigre, Reserva de la Biosfera Maya Peten, Guatemala.

Camera: iPhone 13 Pro Max.



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

Many different grasses, vines, shrubs, and trees grow in a savanna. In our reports on savannas of Parque Nacional Yaxha, Nakum and Naranjo we list a helpful sample of the plants that were flowering during our site visits to each savanna. But the defining characteristic are the following:

- **In PNYNN, Peten:** *Crescentia cujete* (calabash tree).
- **In PNLT, Peten:** nance, *Crescentia cujete*, and oak trees (never any pine in these parks)
- **3km outside northeast corner of Tikal:** oak, pine, nance, morro, sawgrass (Chan et al 2003: 29)
- **In Belize:** *Curatella americana* (sandpaper tree), *Crescentia cujete* and *Byrsonima crassifolia* (craboo in Belize, nance in Guatemala). (Balick, Nee and Atha 200: 18).

So far no sandpaper trees have been found in PNYNN nor PNLT. This is curious since we have found and photographed *Curatella americana* in the hillside savannas a few kilometers from Rabinal, Baja Verapaz. Those hilltops have pine trees.

Oak trees are along the transition zone around the Spider Lily Savanna of PNLT but we need to check whether oak is present also in the other savannas of PNLT. No oak yet found in PNYNN, but has been noted by Fialko 2001 for outside Tikal, in a unique pine tree forest (no documentation whether it's a closed forest, an open grassland forest or what). No satellite view shows this area clearly and there are no panorama photos of high resolution available.

Lundell's 1930's field work in savannas of Peten was more near La Libertad; no botanist that we know of has written about the vegetation of the Savanna East of Nakum or the Savanna West of Naranjo-Sa'al. And no professor or researcher that we are aware of has ever visited the two savannas northwest of the west end of Lake Yaxha (Savanna of 3 Fern Species and adjacent Rectangular Savanna).

We also estimate that no botanist, ecologist, or other professor has visited the southeastern areas of PNLT. However the CONAP team of PNLT knew the tasistal area from their park patrol hikes. The Savanna West of Naranjo-Sa'al is known to everyone there since it is only a few hundred meters from the west edge of the acropolises of Naranjo-Sa'al. But the savanna was originally considered a part of the nearby tintal bajo. We (FLAAR, USA and FLAAR Mesoamerica, Guatemala) divided the area into:

- Bajo La Pita, south of the transition zone into Savanna to the north. All the south part of Bajo la Pita is a true traditional bajo. But none of the northern part is a bajo whatsoever (at most, transitional).
- Savanna West of Naranjo-Sa'al, transitions from the Bajo La Pita at the south into a transitional zone.
- Transitions into grassland savanna in the middle: several *Crescentia cujete* and one cluster of tasiste that survived the incineration by fires.
- Transition of the savanna of low grass into cibal sawgrass area with higher and cutting grass.
- Transition into jimbal, spiny bamboo, *Guadua longifolia*, at the far north. The karst hills rise around the northern side.

Where has *Acoelorrhaphe wrightii* been found in the PNYNN and PNLT?

So far no tasiste palm has been found outside a grassland savanna in PNYNN. For PNLT tasiste palm is inside Tasistal-Savanna #14 and in Spider Lily Savanna (so in savannas and tasistal areas). In the extensive area south of the southeastern part of PNLT, there are lots of tasiste palm clusters in disturbed areas (chopped down in past years). We estimate that in recent decades this entire area was a tasistel with occasional grassland savannas (that also had the palm, but with the clumps not clustered next to each other). We are preparing a separate report on the tasiste areas in the hacienda/finca area.

Neither *Crescentia cujete* nor *Acoelorrhaphe wrightii* are listed in the incomplete tree list for Yaxha by Dix and Dix 1992 cited by the Plan Maestro 2006-2010 nor the following Plan Maestro. This is why FLAAR (USA) and FLAAR Mesoamerica (Guatemala) accomplished a dozen field trips to this extensive park area during August 2018 through July 2019.

Now we are back and finding even more plants. So the next Plan Maestro can have a significantly improved list (keeping in mind there are between 180 and 220 species of tres and between 1,800 and 2,200 species of plants, mushroom and lichenes in an area as large as this park). To find, photograph, research 100% would require significant outside funding. But even with a tight budge in 2018-2019, we still found lots of biodiverse ecosystems, plants, mushrooms, and lichenes not documented previously.

There are no large grassland savannas in Parque Nacional Tikal; the several small grassland areas have not yet had their trees listed (to my knowledge). Local guides or park rangers should know whether tasiste is present anywhere in this large park; but so far no report features *Acoelorrhaphe wrightii* palma de pantano in Tikal.

Acoelorrhaphe wrightii in Belize

Acoelorrhaphe wrightii has been found all over Belize. The savannas of Belize are the best documented savannas of the entire area of Mesoamerica. There are so many savannas in Belize that they occupy a substantial percent of total land área.

Photo by: Nicholas Hellmuth, FLAAR Mesoamérica, Aug. 5, 2021. Parque Nacional Laguna del Tigre, Reserva de la Biosfera Maya Peten, Guatemala.

Camera: iPhone 13 Pro Max.

Botanical Description of *Acoelorrhaphe wrightii* by Standley and Steyermark (1958)

Notable that in 1958 these botanists call the palm *Paurotis wrightii;* yet in 1936, the same botanist (Standley) focused on the name *Acoelorrhaphe Wrightii* (that today would be written with no capital letter for the species). The genus consists of a single species and by most recent authors has been treated under the generic name *Acoelorraphe* Wendland. For comments on the correct name see Bailey and Moore listed above.

Paurotis wrightii (Griseb.& Wendl.) Britton ex Britton & Schafer, N. Amer. Trees 141.1908. Copernicia Wrightii Griseb. & Wendl. ex Griseb. Cat. Pl. Cuba 220. 1866. *Acoelorraphe Wrightii* Beccari, Webbia 2: 109. 1907. *Brahea psilocalyx* Burret, Notizbl. Bot. Gart. Berlin 11: 1037. 1934 (type from Manatee Lagoon, British Honduras, M. E. Peck 241)- *A. pinetorum* Bartlett, Carnegie Inst. Wash. Publ. 461: 33. 1935 (type from pine woods near Belize, British Honduras, H. H. Bartlett11201}. Palma. Figure 47. Moist or wet pinewoods, sometimes in Manicaria swamps, or about or in savannas, 200 meters or lower; Alta Verapaz; Izabal; probably also in Peten. Southern Mexico to Honduras; Cuba; southern Florida.

A rather small palm, the trunk slender, 3-8 meters high, 6-10 cm. in diameter, the plants usually forming colonies; leaf sheaths rufous-brown, glabrous, lustrous, dividing into numerous fibers; petioles 125 cm. long or shorter, usually coarsely dentate on the margins with brown incurved teeth; leaf blades grass-green above, dull pale green or silvery beneath, orbicular in outline, with about 40 segments on each side, almost glabrous or minutely whitish-pubescent; inflorescences ascending to erect, the spadix about a meter long, with about 9 spathes, the lowest spathe reddish, semicylindric, about 14 cm. long, glabrate, but when young floccose-pilose, especially on the margins; primary branches of the spadix 25 cm. long or less, the branchlets white-tomentose, only the ultimate ones floriferous, 5-12 cm. long; calyx segments pale brown, 1 mm. long, carnose, free and membranaceous at the apex, multifimbriate; corolla pale brown when dry, white-lineate, the petals fleshy, glabrous, 1.7 mm. long; fruit 7-8 mm. long and 6-8 mm. in diameter.

In British Honduras called "Honduras pimenta" and "Hairy Tom palmetto." No good reasons have been given for separating the British Honduras palm from that of Cuba and Florida. Bartlett says that *Acoelorraphe pinetorum* differs from *A. Wrightii* "in a number of Minute but definite floral characteristics that are sufficient to give it specific tatus," but these must be minute indeed, since he gives no hint of what they may be. Apparently the British Honduras palm's chief claim to recognition as a separate species is its range; but range, despite its frequent invocation, is not a specific character.

(Standley and Steyermark 1958: 277-279).

Notice that the two leading botanists of that century, Paul Standley and Julian Steyermark, had not seen this palm in Peten (because botanists had not hiked the many kilometers through the bajos, crossed crocodile-filled rivers, and then hiked into botanical areas never before studied. I am also surprised botanist and ethnobotanist Cyrus Lundell did not list any of the synonyms for this palm, despite having studied many savannas. Perhaps tasiste palms are not in the karst savannas that he did study. Surprising since tasiste palms are in the pine-oak savannas of Belize. Lundell even has a chapter on CENTRAL PETÉN SAVANNA COUNTRY. His research area was around La Libertad (along the road from San Benito/Flores to Sayaxche/Rio la Pasion). Lundell lists 10 palms, but none fit the description of tasiste (1937: 160-161). Soil scientist can perhaps document whether tasiste palm needs the mud cover of a savanna in the Reserva de la Biosfera Maya (PNLT, PNYNN and elsewhere) and that the karst-associated soil of savannas around La Libertad are not what tasiste prefers. Need to ask these questions for the pine savannas around the karst area of Poptun (where Lundell did not work).

Is *Acoelorrhaphe wrightii* from the Maya Highlands or from the Maya Lowlands (or both)?

Only the Maya Lowlands; and needs lots of moisture from being next to a river or at least from seasonally inundations during the annual rainy season.

In which States of Mexico is *Acoelorrhaphe wrightii* listed by Villaseñor

On page 616 Villaseñor lists *Acoelorrhaphe wrightii* as being in CAM, CHIS, QROO, TAB, TAMS, VER, YUC. Chiapas, Tabasco and Campeche border Peten (Belize is on the east side of Peten and also has *Acoelorrhaphe wrightii* in savannas). Would be interesting to learn whether tasiste palms in Mexico are only in savannas or also along the edges of rivers, bays, lagoons, inlets of the Caribbean Sea.

Do *Acoelorrhaphe wrightii* trees also grow in home gardens?

You would need a lot of water to have this palm in your home garden; and most home owners prefer more spectacular size or shape. Although has edible parts, most people are not aware of this fact.

Are any parts of *Acoelorrhaphe wrightii* edible?

In Belize: Loc Use: FOOD, MED, CNST, PRD. (Balick, Nee and Atha 2000: 194).

The seeds are edible, especially as medicine against prostate cancer. I have this cancer and take two tasiste pills each day.

The stalk is also edible; we show and discuss this in Part II (where a local guide showed us how to prepare and eat this palm stalk.

David Arrivillaga, our photographer, actually eating it.

Photo by: Nicholas Hellmuth, FLAAR Mesoamérica, Jan 20, 2022. Parque Nacional Laguna del Tigre, Reserva de la Biosfera Maya Peten, Guatemala

Camera: iPhone 13 Pro Max.

The interior part is edible, from the top meter or so (depends on age of the plant). Young plant is preferred.

The plant will resprout in a few months, so this food is easy to produce.

Would help to study the vitamins, minerals, and other ingredients in this food.

The seeds are also edible but there were no seeds that we noticed in January.

Is there potential medicinal usage of *Acoelorrhaphe wrightii* by local people

If you Google *Acoelorrhaphe wrightii,* medicinal you get nine pages of returns (webpages and articles on medicinal uses of this palm).

Are any parts of *Acoelorrhaphe wrightii* trees eaten by mammals?

This is a good question; we need to ask the local people.

A Tasistal means "thousands" of tasiste clumped closely together. A Savanna means open grassland with scattered tasiste palm clumps and with calabash trees

I will need to hike though this savanna with more time to note how many calabash trees are present or not. From arial photos I spotted two possible *Crescentia cujete* trees that had survived the intense fires of this tasistal-savanna. This is why it would help if a considerate individual or foundation could make it possible for us to have a 100 megapixel drone camera:

- Phase One iXM 100 megapixel medium format UAV aerial camera, specially made to be carried by a drone
- DJI M600 drone, specially made to carry the Phase One iXM camera
- Two interchangeable and autofocus RSM camera lenses made specially for this Phase One iXM camera
- software from Capture One (software brand of Phase One) to handle the high resolution files
- Mapping software for the Phase One iXM high resolution camera

Photo by: Nicholas Hellmuth, FLAAR Mesoamérica, Jan 9, 2022. Parque Nacional Laguna del Tigre, Reserva de la Biosfera Maya Peten, Guatemala

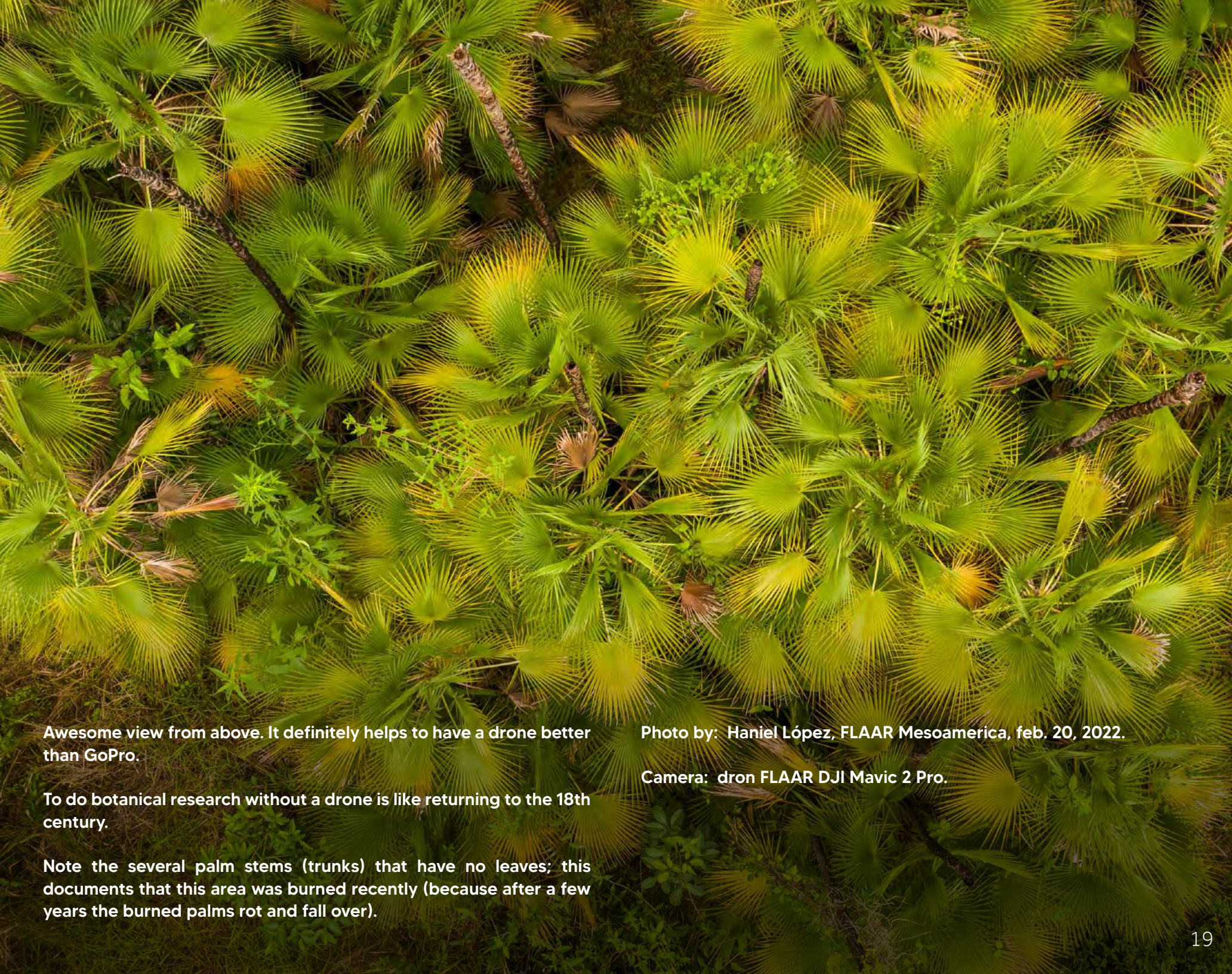
Camera: iPhone 13 Pro Max.

The biggest tasistal that I have seen so far is the one near Arroyo Tasistal. We have already published four FLAAR reports on tasistal ecosystems of these areas. The Tasistal Arroyo Faisan is also large but it was so rainy and so seasonally inundated that we photographed only a small portion. There are also several other tasistal areas to the southeast that no one has yet visited (it takes time to get permission of the land owners).

In the present photo in the southeast part of Parque Nacional Laguna del Tigre, of Tasistal Savanna #14, we see "solid tasiste palms" but of course occasional open areas. Plus other areas occupied by the common bush that thrives especially in the area around the edges.

Photo by: Haniel López, FLAAR Mesoamerica, feb. 20, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.



Awesome view from above. It definitely helps to have a drone better than GoPro.

To do botanical research without a drone is like returning to the 18th century.

Note the several palm stems (trunks) that have no leaves; this documents that this area was burned recently (because after a few years the burned palms rot and fall over).

Photo by: Haniel López, FLAAR Mesoamerica, feb. 20, 2022.

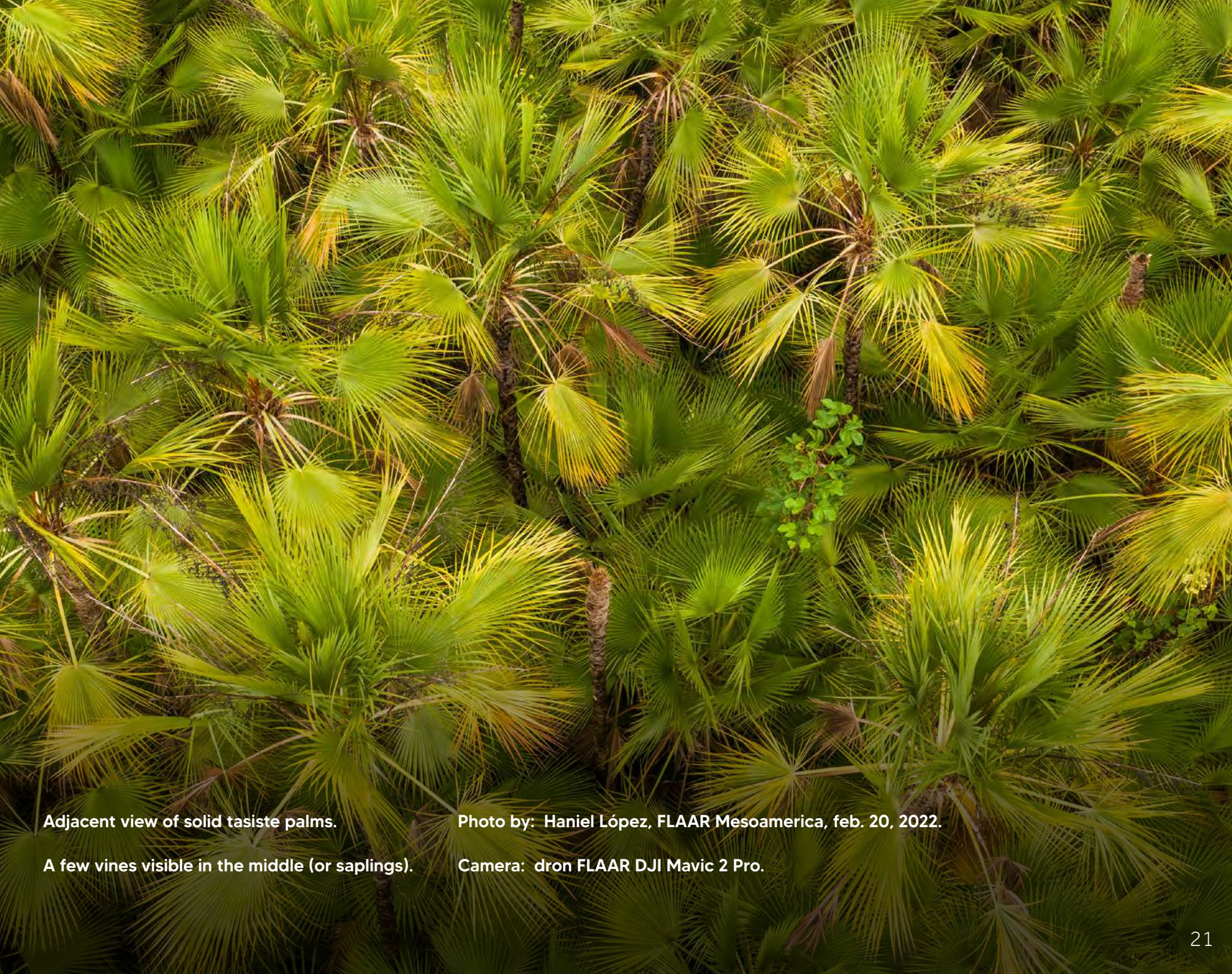
Camera: dron FLAAR DJI Mavic 2 Pro.

Solid tasiste palms.

A few trunks of even higher palms are visible (if you know what they look like). The fact that the dead palms are higher is why all the other palms are lower, because the lower palms grew up when it rains after the fire that incinerated the taller ones during the height of the dry season.

Photo by: Haniel López, FLAAR Mesoamerica, feb. 20, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.



Adjacent view of solid tasiste palms.

A few vines visible in the middle (or saplings).

Photo by: Haniel López, FLAAR Mesoamerica, feb. 20, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

Lots of tall dead palm stems sticking up.

Notice the two levels of palms: the high ones (40% dead leafless stems); the low level is more solid because these have not yet been burned.

This photograph shows saplings or high bushes to the left.

Photo by: Haniel López, FLAAR Mesoamerica, feb. 20, 2022.

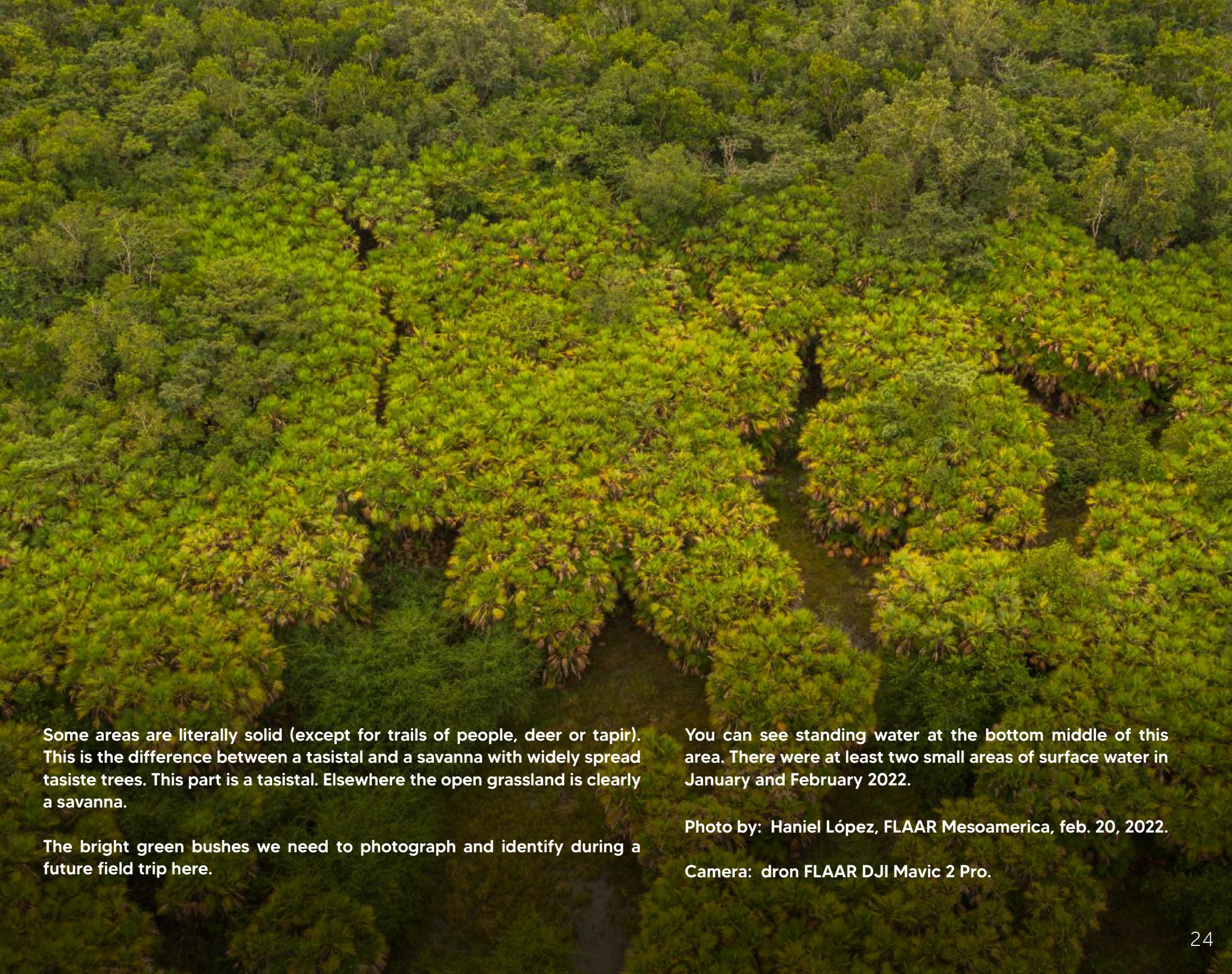
Camera: dron FLAAR DJI Mavic 2 Pro.

Hundreds of palms; I use that count because each individual cluster has usually five to 14 individual palms rising from a single root mass. But in this area there is more grass and more bushes. But this corner is more a tasistal than a savanna. In the Savanna East of Nakum, Savanna of 3 Fern Species and Rectangular Savanna there are no areas with this many palms so close together.

You can see the drone pilot and the helpful local assistants in the middle.

Photo by: Haniel López, FLAAR Mesoamerica, feb. 20, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.



Some areas are literally solid (except for trails of people, deer or tapir). This is the difference between a tasistal and a savanna with widely spread tasiste trees. This part is a tasistal. Elsewhere the open grassland is clearly a savanna.

The bright green bushes we need to photograph and identify during a future field trip here.

You can see standing water at the bottom middle of this area. There were at least two small areas of surface water in January and February 2022.

Photo by: Haniel López, FLAAR Mesoamerica, feb. 20, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

The bottom part is mostly a tasistal; the top left part is a tasistal. The rest is a savanna. We will need to hike through this entire area to see whether there are Crescentia cujete (calabash trees, jicaro/morro trees). Nance trees are the third logo tree of a Peten savanna but they get burned to the ground so often are just ground plants. We will need to check whether oak are present (oak is in the Spider Lily Savanna to the north of this Tasistal-Savanna #14).

Photo by: Haniel López, FLAAR Mesoamerica, feb. 20, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

At top center-right are lots of burned trunks of tasiste palm; one is already fallen over towards the left.

Photo by: Haniel López, FLAAR Mesoamerica, feb. 20, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

You can see the surface water clearly in one area; there is water elsewhere but not as easy to see.

You can see the green bushes around the edge, rarely out in the middle.

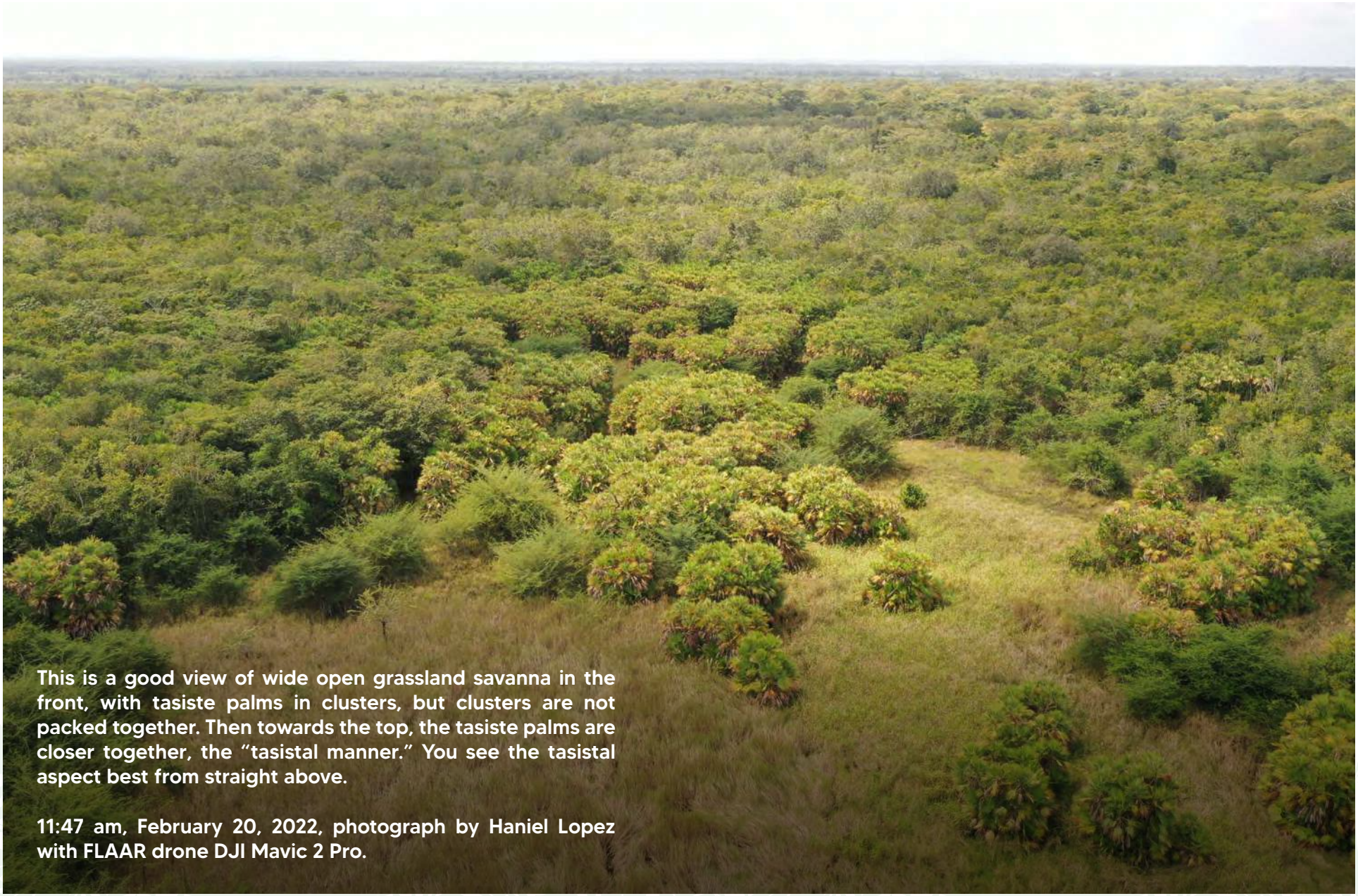
Lots of tasiste palms BEHIND an area of trees; so either the trees invaded the savanna or a fire burned down an area and the palms sprouted up.

At far right there are two tall palms. If these are tasiste they really are far from the edge of the tasiste-savanna.

Photo by: Haniel López, FLAAR Mesoamerica, feb. 20, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

A Savanna means open grassland with scattered tasiste palm clumps and with occasional calabash trees



This is a good view of wide open grassland savanna in the front, with tasiste palms in clusters, but clusters are not packed together. Then towards the top, the tasiste palms are closer together, the "tasistal manner." You see the tasistal aspect best from straight above.

11:47 am, February 20, 2022, photograph by Haniel Lopez with FLAAR drone DJI Mavic 2 Pro.

The open dirt area in the middle may have a few centimeters of water over it.

In the diagonal grassland area the clusters of tasiste palms are typical for a grassland sacanna. But on both sides you can see thicker areas of tasiste palms that are "tasistal solid."

11:48 am, February 20, 2022, photograph by Haniel Lopez with FLAAR drone DJI Mavic 2 Pro.

Here you see the grassland savanna at top left extending down and to the right. But the tasiste palms begin to form larger clumps, and at the end they are almost solid tasiste palm areas. It's the solid palm areas that are a tasistal.

11:49 am, February 20, 2022, photograph by Haniel Lopez with FLAAR drone DJI Mavic 2 Pro.

Areas of solid palm. The diagonal opening at bottom right is probably a trail (otherwise that area would be closed shut by the palms).

At top right you see the grassland area start (with water at the left of the grass, in the middle of the top of the photograph).

11:48 am, February 20, 2022, photograph by Haniel Lopez with FLAAR drone DJI Mavic 2 Pro.

What it's like to walk into a Tasistal

Solid tasistal on both sides but a passageway in between. These are the passageways you see from the aerial photographs.

Photo by Edwin Solares, Canon R5 mirrorless camera, February 20, 2022.

Some tall tasiste palms have survived fires but one in the middle has no more leaves. So that stem is dead; but at its base young palms are rising up. So all the lower leaves heading up to reach the sun are leaves that have sprouted after the most recent fire.

Photo by Edwin Solares, Canon R5 mirrorless camera, February 20, 2022.

Here you see more of the tall stems have lost all their leaves due to recent fire.

Yet the root masses give rise to dozens more palms that will recover the tasistal mass.

Photo by Edwin Solares, Canon R5 mirrorless camera, February 20, 2022.

Standing at the edge of the tasistal area looking out into the open grassland portion of Tasistal-Savanna #14.

iPhone 13 Pro Max panorama by Nicholas Hellmuth, February 20, 2022, 11:51 am.

I could be anywhere in the world; but I prefer to hike into savannas in the Reserva de la Biosfera Maya to document a biodiversity never before photographed in panorama format in full color.

Here all the grass breaks up the tasistal concept; this is more a grassland savanna area with very thick islands of solid tasiste.

A regular savanna (that has no tasistal concentrations) will not have clusters this thick.

iPhone 13 Pro Max panorama by Nicholas Hellmuth, February 20, 2022, 11:52 am.

The tasiste palms are growing thickly next to each other. Several in the middle right background are very tall but a bit whimpy looking since they were damaged by the recent fires. To the left background is the start of the bajo forest that surrounds all the savannas of the southeastern part of Parque Nacional Laguna del Tigre.

iPhone 13 Pro Max panorama by Nicholas Hellmuth, February 20, 2022.

Here you can see burn marks on some of the trunks (stems) of the tasiste palms. The low palms are regenerating after rains came after the most recent fire.

iPhone 13 Pro Max panorama by Nicholas Hellmuth, February 20, 2022.

Fire darkened stems of the tall palms. In the middle you can see the barks on these palms; so not easy to walk through a tasistal area.

The zig-zag aspect in two locations is because the wind is blowing the leaves so they are stuttered in the automatic panorama scan.

iPhone 13 Pro Max panorama by Nicholas Hellmuth, February 20, 2022.

Lots of leaves are dead and hanging down. I estimate that they were damaged by the heat of the fire but since they were green then did not catch on fire. But this is only an estimate. At the right you can see two stems with no fire damage and very healthy leaves heading up to reach sunlight.

iPhone 13 Pro Max panorama by Nicholas Hellmuth, February 20, 2022.

The tasiste at the left of the middle is unburnt so grew since the last fire. In the middle background you can see black scars on the stems of the older palms. The outside covering of the stems has evolved to burn off in a way to protect the inner part of the stem.

This palm would be a great PhD dissertation topic: why are 100% of tasiste palms in the RBM only inside fire-burned savannas? Yet 100% of tasiste palms in the Municipio de Livingston, Izabal, Guatemala are not in any savanna; the Livingston area tasiste are on the shores of rivers and lagoons.

iPhone 13 Pro Max panorama by Nicholas Hellmuth, February 20, 2022.

Crescentia cujete, calabash tree, jicaro

90% of savannas in the Reserva de la Biosfera Maya have calabash trees. These are *Crescentia cujete*. *Crescentia alata* grows in dry areas in other parts of Guatemala. So far in PNLT and PNYNN the only place we find *Crescentia cujete* is in savannas: we have not yet found it in a hillside forest or bajo. If you were to find *Crescentia cujete* outside a savanna it was almost certainly planted there or escaped from a kitchen garden. *Crescentia cujete* and its close relative *Crescentia alata* produce useful products for local Mayan families.

This *Crescentia cujete* tree was photographed by Edwin Solares in the middle of the thick tasistal area of Savanna #14 on February 20, 2022.

Crescentia alata is not listed for Belize whatsoever (Balick, Nee and Atha 2000: 139). *Crescentia cujete* is listed as medicinal, edible, beverage, ritual and for making products (ibid.) (bowls to drink cacao from and musical instruments).

The leading botanists of the 1930's-1970's, Standley and Williams, do not even mention the word savanna for where *Crescentia cujete* is growing wild. This is because they never hiked into any of the savannas of remote parts of PNLT or PNYNN. They also do not mention that *Crescentia cujete* can survive annual fires of the savannas. Nonetheless, their description is helpful:

Crescentia cujete L. Sp. PL 626. 1753. Xigal (Pipil of Salama); jicaro; horn (Quecchi).

Planted in many parts of Guatemala, and apparently native along the Pacific plains, perhaps also in Alta Verapaz, usually brushy plains or in open fields, and at 350 m. or less; Pete"n; Alta Verapaz; Baja Verapaz; Izabal (planted); Santa Rosa; Escuintla; Suchitepequez; Retalhuleu; San Marcos; El Quiche" (probably only in cultivation). Mexico, the West Indies, south through Central America, and south to Peru and Brazil. Cultivated in the Old World tropics.

Small or medium-sized trees, usually 10 m. high or less, with thick trunksand dense rounded crowns; leaves short-petiolate, cuneate-oblanceolate or spathulate, rounded to short-acuminate at the apex, attenuate to the base, minutely glandular-lepidote, sometimes pilose beneath on the nerves, subcoriaceous; calyx 1.5-2.5 cm. long, deeply cleft, glandular-lepidote and with small scattered impressed glands; corolla yellowish white or greenish with dark purple veins, 4.5-7.5 cm. long, glandular-lepidote; fruit very variable in size and shape, often globose and 25 cm. in diameter, frequently much smaller, and often oval.

Called "calabash" and "wild calabash" in British Honduras, also "giiiro," and Maya names are reported as "luch" and "huaz." The wood is light brown or yellowish brown, with fine veining of darker color, without distinctive taste or odor; moderately hard and heavy, tough and strong, the specific gravity 0.60; coarse-textured, with the consistence of elm (Ulmus), fairly easy to work, takes a smooth finish; probably not durable. The wood is used for ox yokes, tool handles, and vehicle parts. Thick crooked limbs often are used in Guatemala for making saddle trees. The trees seem to afford a good habitat for epiphytes, and they often are covered with orchids, bromeliads, and other plants. A syrup made from the pulp of the fruit is a popular remedy for colds, and an infusion of the leaves is sometimes administered for dysentery. The largest fruits, globose in form, upon the tree remind one somewhat of green pumpkins, and a small tree loaded with these huge fruits is an almost unbelievable sight. The dry fruits are a very important article in Guatemala and throughout Central America and Mexico, where they have been used since ancient times as containers for various purposes. Their most general use is for drinking vessels, but the larger ones serve to store all sorts of articles. Sections of the oblong forms are much used in place of spoons. Many of the jicaras, as the cups *Crescentia cujete* L. Sp. PL 626. 1753. Xigal (Pipil of Salama); jicaro; horn (Quecchi).

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[continues on the next page]

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The trees seem to afford a good habitat for epiphytes, and they often are covered with orchids, bromeliads, and other plants. A syrup made from the pulp of the fruit is a popular remedy for colds, and an infusion of the leaves is sometimes administered for dysentery. The largest fruits, globose in form, upon the tree remind one somewhat of green pumpkins, and a small tree loaded with these huge fruits is an almost unbelievable sight. The dry fruits are a very important article in Guatemala and throughout Central America and Mexico, where they have been used since ancient times as containers for various purposes. Their most general use is for drinking vessels, but the larger ones serve to store all sorts of articles. Sections of the oblong forms are much used in place of spoons. Many of the jicaras, as the cups made from the shells are called, are handsomely decorated in colors or by incised designs. Particularly handsome ones are made in the neighboring republic of El Salvador. Oviedo states that the Indians of Costa Rica and Panama had jicaras adorned with gold, "with handles of gold, and so handsome that the most powerful king might drink from them without reproach. These come from the great river of San Juan, which empties into the Gulf of Uraba." Mexico and Guatemala likewise were noted for the handsomely designed jicaras, from which chocolate was drunk. These cups, of course, are rounded on the bottom, so that some support must be given them when set down, either a stand especially made for the purpose or a mere twist of cloth or cotton. The fruits of this species also are eaten by cattle during the dry season, but there is a belief that the fruit often produces abortion. It is difficult to tell just where in Guatemala *C. cujete* is truly native, but it probably is in the Pacific plains, and it and *C. alata* seem to occupy distinct areas of the country. The tree is planted abundantly at low elevations or even somewhat higher because of its local commercial value. The word jicaro appears in such place names as El Jicaro, a village of Guatemala, and El Jicaral (a grove of jicaro trees) in Chiquimula. The place name Jicaltepeque is believed to signify "Jicara mountain." The wood of *Crescentia cujete* and probably also of *C. alata* has been used from Colonial times to the present to make stirrups some of those of the colonial period are beautifully carved and are real objects of art. The wood is easy to carve when still green but when thoroughly seasoned is "like iron" and some now in the collection of Mrs. Louis 0. Williams had perhaps been in use for "hundreds" of years, going back into the colonial period (before 1821). While the wood is occasionally used today in Central America for stirrups no beautifully carved modern ones have been seen. Most stirrups probably originated in Honduras where there has been a long history of making beautifully carved objects of wood.

We suspect that *Crescentia cujete* was widely distributed intropical America in the pre-Columbian era, because of the useful "shell" and may have subsequently evolved into several forms known today. The original area of dispersal is not easily discernible but erratic distribution in Central America may indicate an introduced tree here.

(Standley and Williams 1974: 187-189)

Bushes, Shrubs are also in Savannas and Tasistales

Bright green bushes around most of the tasistal-savanna.

The purpose of the initial was literally to check the trail and do basic initial drone photography to help prepare for a return visit in February or March. The purpose of the drone photos was to prepare all of us to know what to expect and what we need to study up-close (namely all the bushes and occasional vines).

Closer view of the bushes. I am curious whether these prefer savanna areas or grow in any seasonally inundated area where full sun is available.

Photo by: Haniel López, feb. 20, 2022.

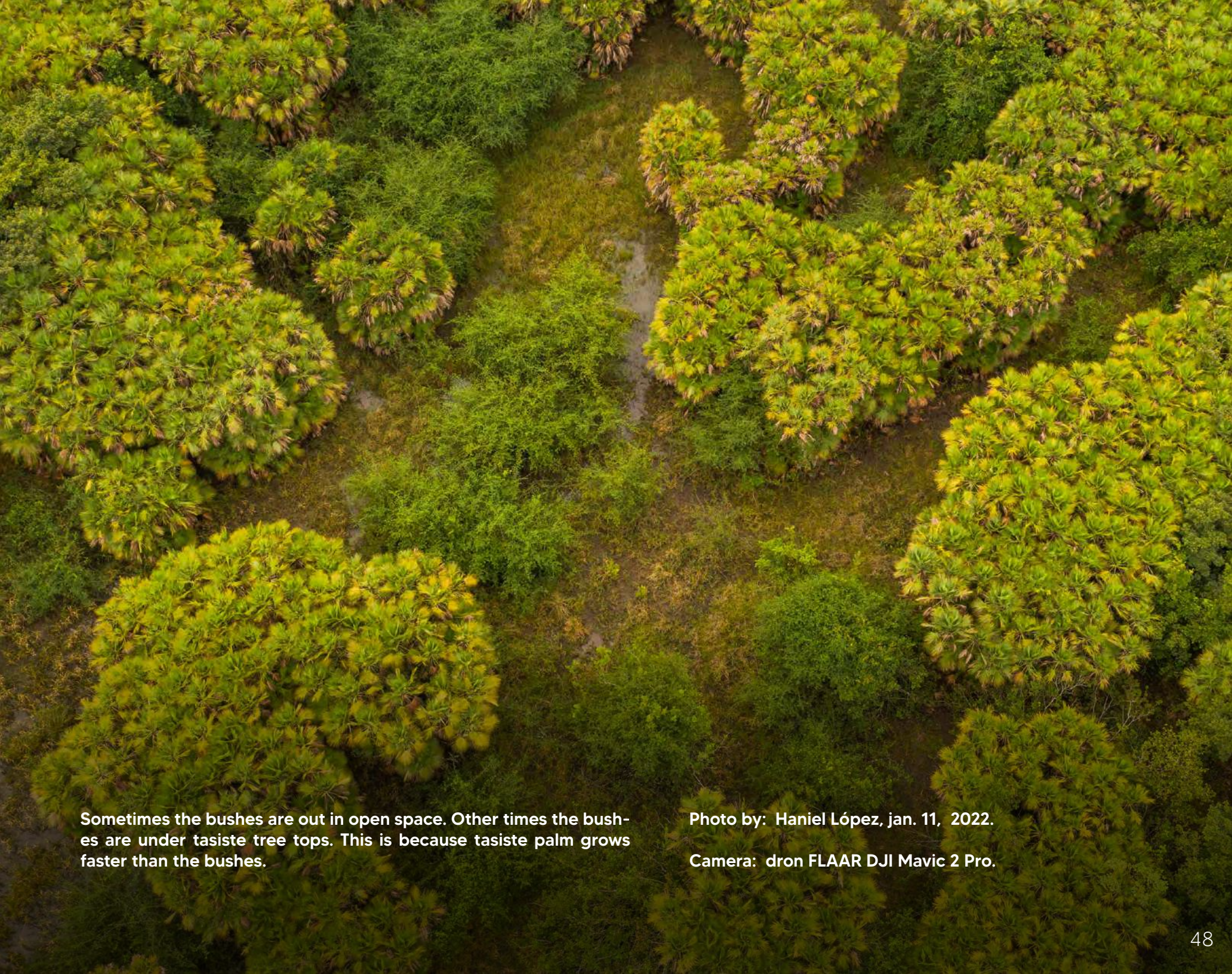
Camera: dron FLAAR DJI Mavic 2 Pro.

Here you can better see the bushes at this end of the tasistal-savanna.

These bushes tend to be around the edges, not in the center.

Photo by: Haniel López, jan. 11, 2022.

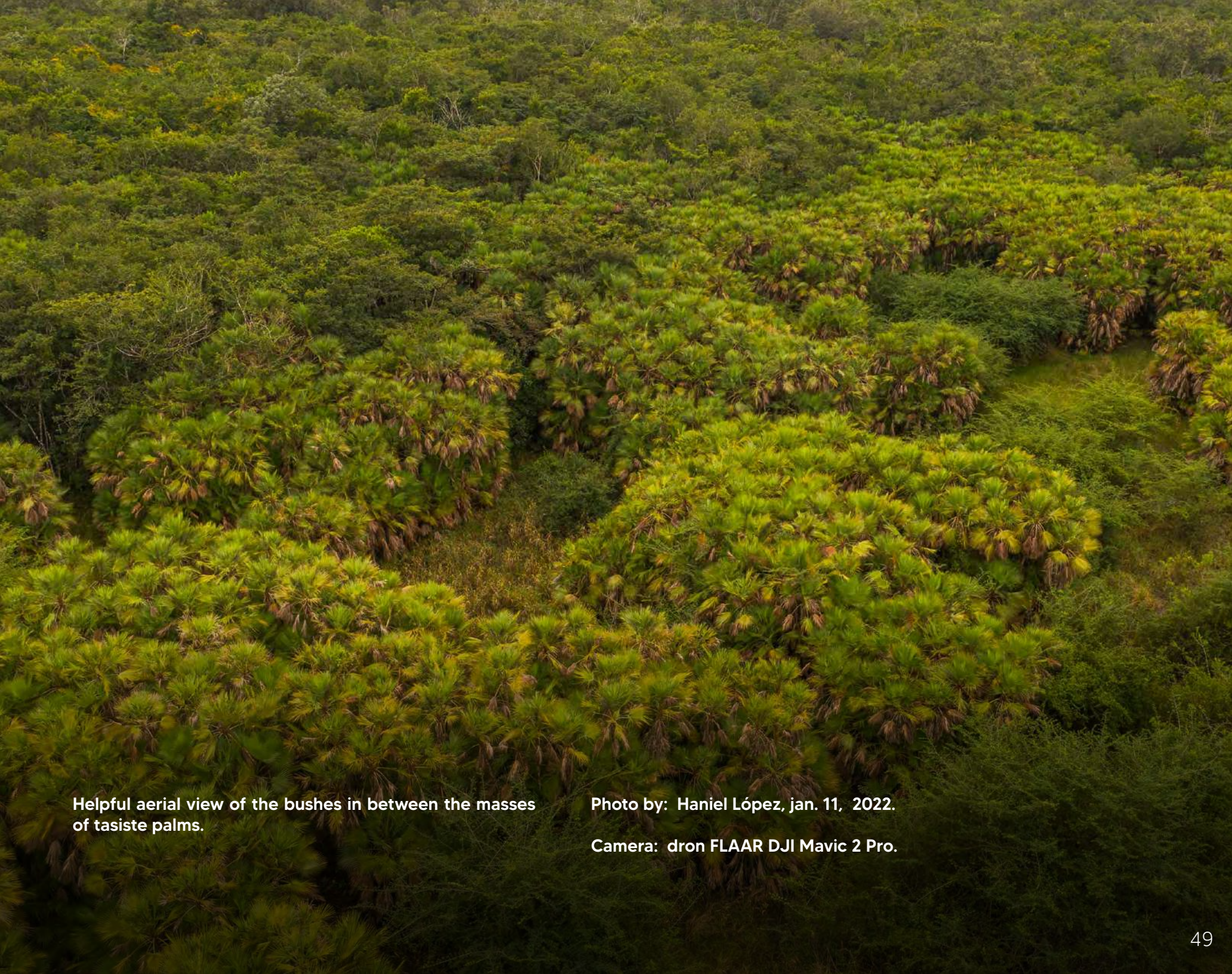
Camera: dron FLAAR DJI Mavic 2 Pro.



Sometimes the bushes are out in open space. Other times the bushes are under tasiste tree tops. This is because tasiste palm grows faster than the bushes.

Photo by: Haniel López, jan. 11, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.



Helpful aerial view of the bushes in between the masses of tasiste palms.

Photo by: Haniel López, jan. 11, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

Different angle view of the bushes in between the masses of tasiste palms.

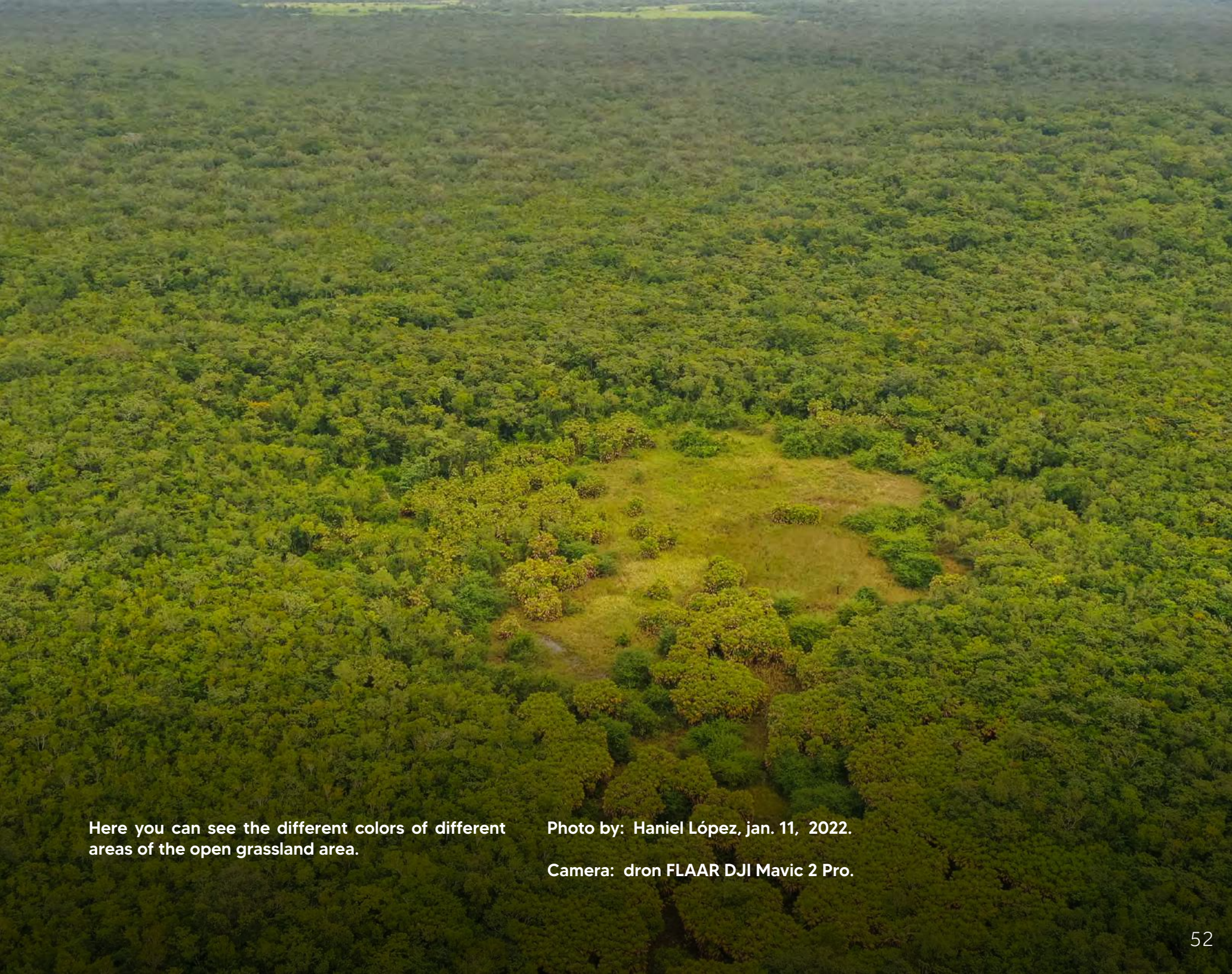
Photo by: Haniel López, jan. 11, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

Surface Grasses are different height, potentially different Species, in different areas of a Savanna

The grass cover varies in color in every savanna. Color depends on amount of water, to what degree the grass was incinerated during the last fire, and other factors. Would help if soil scientists could study the soil in each part of each savanna as a project from their university or research institute. A PhD dissertation would also help.

Would help to have LiDAR to show whether the Maya modified any part of this tasistal-savanna.



Here you can see the different colors of different areas of the open grassland area.

Photo by: Haniel López, jan. 11, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

Color differences in the grasses are very noticeable here.

Photo by: Haniel López, jan. 11, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

The diagonal line is probably where motorcycles have crossed the savanna. I doubt that deer or tapir would make such a straight line. But all the other "trails" are (I estimate) by animals. It would help to put camera-trampa (trail cameras) to learn whether it's deer, tapir, jaguars, and whether crocodiles are wandering around here also (they can hike considerable distances). However there is no pool of water large enough for them to enjoy, so I doubt if there are resident crocodiles here until there is about a meter of water.

Photo by: Haniel López, jan. 11, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

On a 32-inch monitor with at least 4K quality you can see that several species of grasses are here.

Plus in the middle background I see what I estimate are two small *Crescentia cujete* trees. We want to return to this tasiste-savanna with a complete team to take notes on the different plants. The visit of January 11th was to see where the trail went and to photograph the tasiste-savanna to prepare for a follow-up visit.

Photo by: Haniel López, jan. 11, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

Here I can see what I estimate are two *Crescentia cujete* trees that have survived recent fires.

February 20, 2022, 11:46 am, photograph by Haniel Lopez with FLAAR drone DJI Mavic 2 Pro.

Here I was able to see clearly that the light-colored grass is almost certainly a different species than the darker colored grass above it.

Photo by: Haniel López, jan. 11, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

General view of the main grassland area. Two small trees I estimate are Crescentia cujete are near the top edge of the savanna.

You see surface water at the right side.

Photo by: Haniel López, jan. 11, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

View of the different kinds of grasses at a different angle.

Photo by: Haniel López, jan. 11, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

The same two potential *Crescentia cujete* calabash trees are in the middle. Lots of the green shrubs around most of the edges of the savanna.

In the background, lots of orange color above treetops; possibly flowering vines.

Photo by: Haniel López, jan. 11, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

Open grassland portion, with tasistal area at the bottom.

Photo by: Haniel López, jan. 11, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

Animal Trails through the Surface Grasses

Here you can see irregular paths through the grasses. I estimate all of these are by animals. If for people or for a motorcycle they would be straight. Typical savanna clumps of tasiste palms are widely scattered here; this part of Savanna #14 is not a tasistal; it's a savanna with widely scattered clusters of tasiste palms.

11:46 am, February 20, 2022, photograph by Haniel Lopez with FLAAR drone DJI Mavic 2 Pro.

Water on the Surface: Seasonally Inundated

Most of the surface has between perhaps 5 to 11 centimeters of water.

Yet in a dry month of the dry season of the year, the surface will be cracked dry.

This is what “seasonally inundated” means.

Some species of plants die if their roots are seasonally inundated. When you take a boat trip around Lake Yaxha you see hundreds of trees and bushes that have died because the level of the lake has risen and covered the base of these delicate plant species with water.

Other trees love this; tasiste palm is one. In the Caribbean area of Izabal, Guatemala, in the Municipio de Livingston, there are clusters of tasiste palms widely scattered directly along the shores of lakes, lagoons, and rivers. The water level of all these rivers and lakes rises and falls depending on the amount of rain fall. Tasiste palm survives this perfectly.

Aerial photograph by Haniel Lopez (FLAAR Mesoamerica) using FLAAR drone, DJI Mavic 2 Pro. January 11, 2022.

Water water everywhere. Due to the thick grass cover you can’t see all the water.

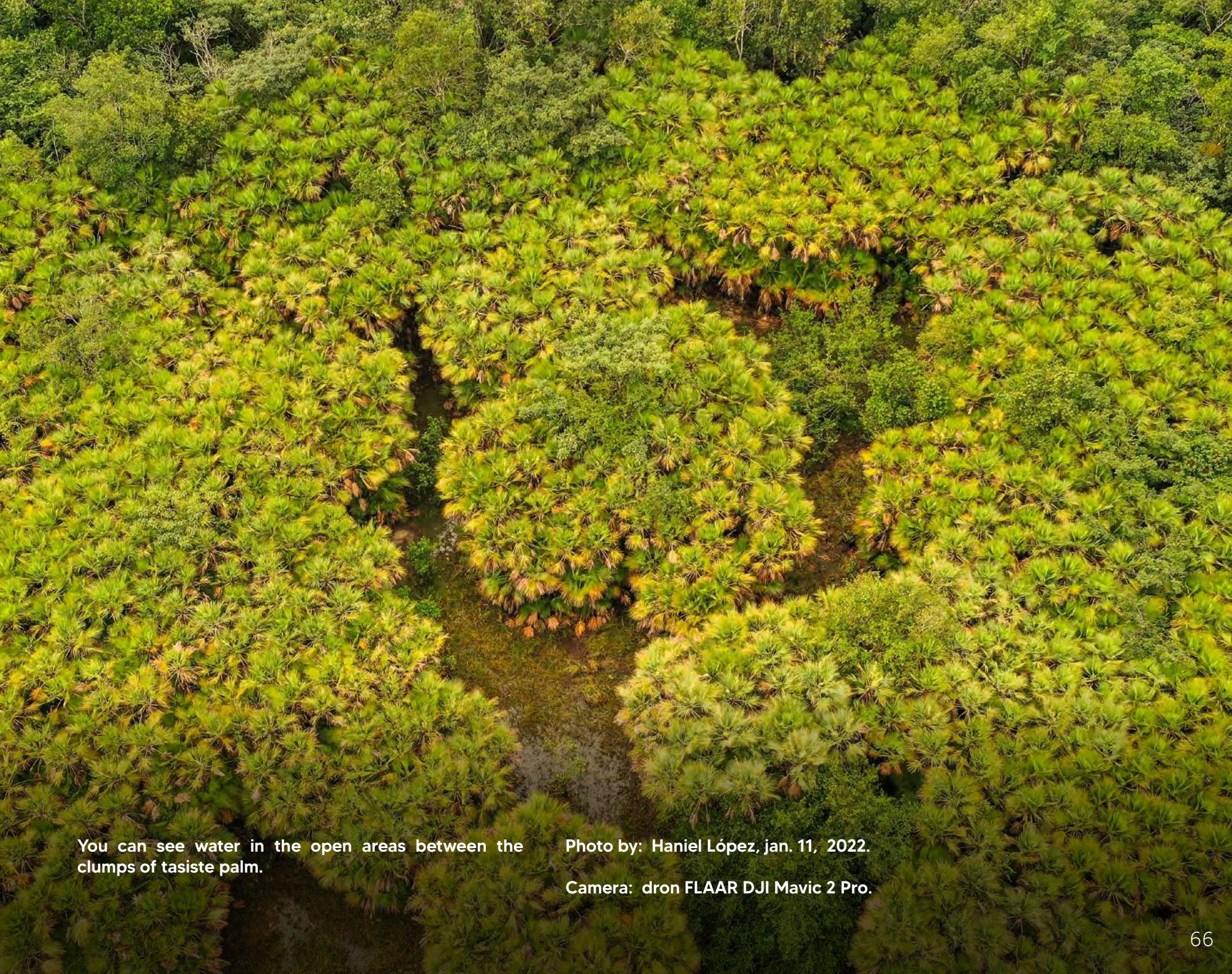
I estimate that tapir love to wade into this water and that peccary love to wallow in the mud.

Aerial photograph by Haniel Lopez (FLAAR Mesoamerica) using FLAAR drone, DJI Mavic 2 Pro. January 11, 2022.

Surface water is clearly visible.

Photo by: Haniel López, jan. 11, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.



You can see water in the open areas between the clumps of tasiste palm.

Photo by: Haniel López, jan. 11, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

Trees and Bushes of Transition Zone between Savanna and surrounding Bajo Forest

When hills surround a bajo, as at the Savanna East of Nakum and Savanna West of Naranjo-Sa'al, most of the tree species of the hillsides do not grow into the savanna: they can't survive the annual fires and probably don't like water over their roots for several months a year. Or, they may not like the kind of soil that is in a savanna. Of course there is often a transition zone but usually with plants other than those on the adjacent hillside or out in the middle of the savanna.

When a savanna is surrounded by a bajo there is no clear border: as you can see in this helpful aerial photograph, the palms merge into the surrounding bajo vegetation and the trees of the bajo come out into the savanna a bit.

The tasiste palms need full sun, so are not likely to sprout inside a bajo.

The savanna is ravaged by fire at least every two or three years (often every single year) so trees of the bajo don't survive these fires.

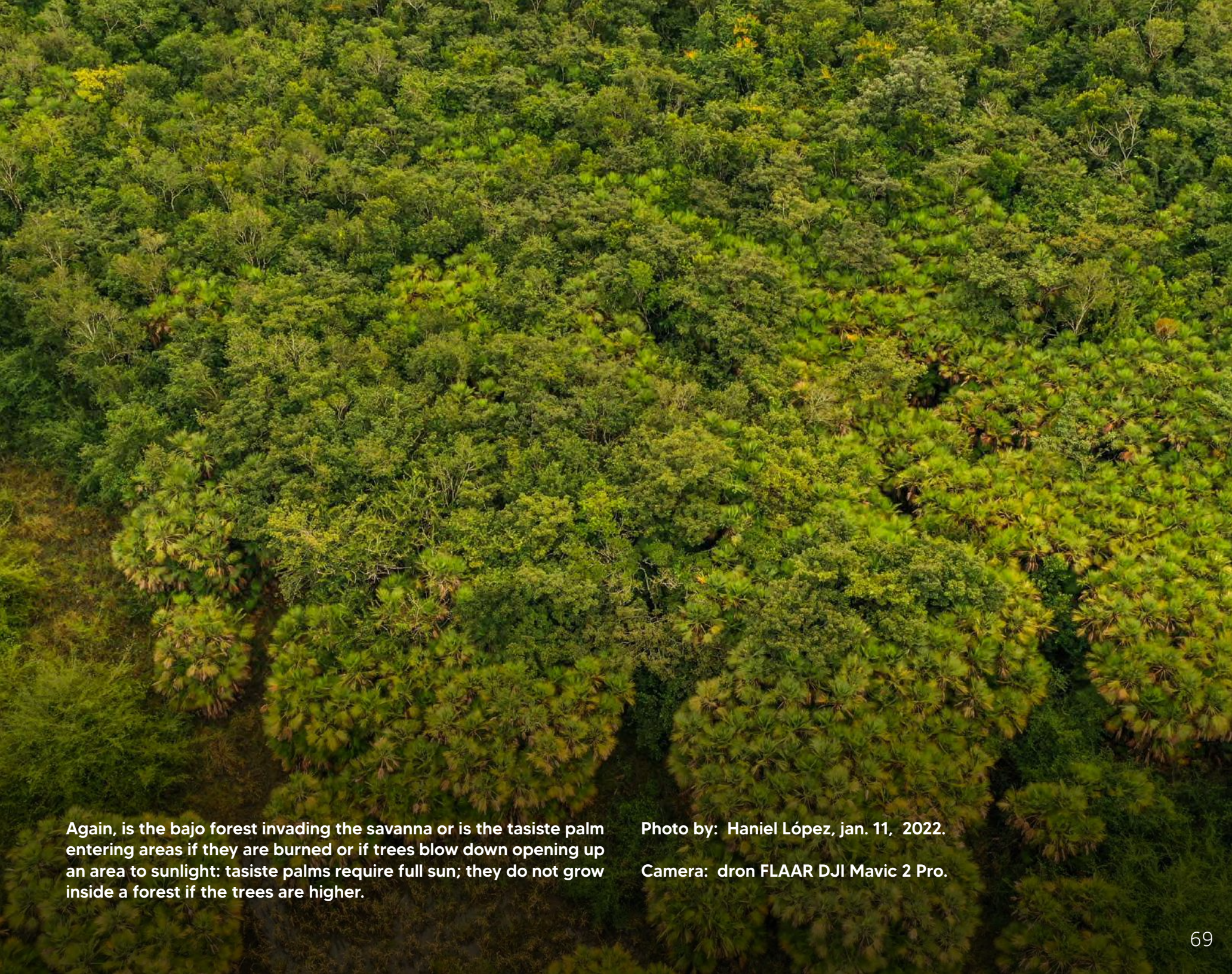
Bajos themselves are often seasonally inundated, so the presence of water out in the savanna does not stop bajo trees from invading the savanna.

Note the zig-zag trails entering the savanna. Probably made by deer or tapir or local people who hunt the deer and tapir.

We do not see birds in most savannas.

Photo by: Haniel López, jan. 11, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.



Again, is the bajo forest invading the savanna or is the tasiste palm entering areas if they are burned or if trees blow down opening up an area to sunlight: tasiste palms require full sun; they do not grow inside a forest if the trees are higher.

Photo by: Haniel López, jan. 11, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

Lots of water visible in area near the outside (top left of the savanna).

Above the water area there is a row of clusters of tasiste right smack next to the bajo forest.

I estimate that the bushes and saplings in front are a typical "encroachment" of vegetation that would lead eventually to much of the savanna returning to bajo tree vegetation (if there were no more burnings).

More to the right you can see the FLAAR Mesoamerica team with helpful local guides. To their left the bajo forest has moved in quite a bit. But a botanist would need to literally map the savanna and identify what kinds of trees are "invading" the savanna, to find out whether there are certain trees that invade first and whether these trees are common in the main surrounding bajo.

In the lower middle you can see the straight diagonal trail (people probably) and the zig-zag trails, probably foraging animals.

Photo by: Haniel López, jan. 11, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

Lots of water visible.

Tasiste palm clusters are smaller when surrounded by other trees. Along the lower right the bushes and saplings have taken over much of this part of the savanna.

Would really help to have year-by-year views to see how the ebb-and-flow of the transition area is affected by weather and fires. But Google sequential satellite photos are such low resolution they are not viable whatsoever to see such details for an area of this moderate size.

Photo by: Haniel López, jan. 11, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

Are tasiste palms expanding into the bajo or is bajo vegetation expanding into the savanna, or is the vegetation of the transitional area really transitional vegetation?

I hope an ecologist, botanist, and soil scientist will each do a PhD dissertation on this topic. I dedicated about 8 years to research for my PhD dissertation (on water-related plants, animals, reptiles, fish, cosmology and iconography in Classic Maya art). This dissertation is still cited four decades later.

So if ecology students, students of botany and soil science will each do a PhD dissertation on the flora of the intermediate zone, their results will be cited for many coming decades.

Parque Nacional Laguna del Tigre is a nice area to do field work; lots of helpful local people who appreciate earning money to support themselves by being guides and research assistants.

Photo by: Haniel López, jan. 11, 2022.

Camera: dron FLAAR DJI Mavic 2 Pro.

Water is deep enough to be visible even where grass is present.

Would help to identify the exuberant bushes and learn whether these are common in any wetland (lakeshore, riverside marsh, etc.) or whether they are primarily in savannas. In other words are these bushes a savanna plant or simply a plant that needs water and full sun.

February 20, 2022, 11:45 am, photograph by Haniel Lopez with FLAAR drone DJI Mavic 2 Pro.

Forest pushing in or savanna palms moving outward? I estimate it's a bit of both but mostly forest pushing in, especially on right side.

February 20, 2022, 11:45 am, photograph by Haniel Lopez with FLAAR drone DJI Mavic 2 Pro.

Cecropia (guarumo) tree is visible in lower right. These are invasive trees for most areas that are regrowing after being chopped down for milpa; but no evidence whatsoever that this area has been choped down in the recent past.

Surrounding the *Cecropia* tree are tasiste palms. So again, who is invading? *Cecropia* or tasiste? I doubt tasiste palms would grow inside a bajo unless giant trees had fallen allowing sun to enter an area.

It is notable that there are forest trees on all sides of the tasiste, so seemingly the fires are not very intense out here at the edge (maybe because not much grass to burn).

February 20, 2022, 11:45 am, photograph by Haniel Lopez with FLAAR drone DJI Mavic 2 Pro.

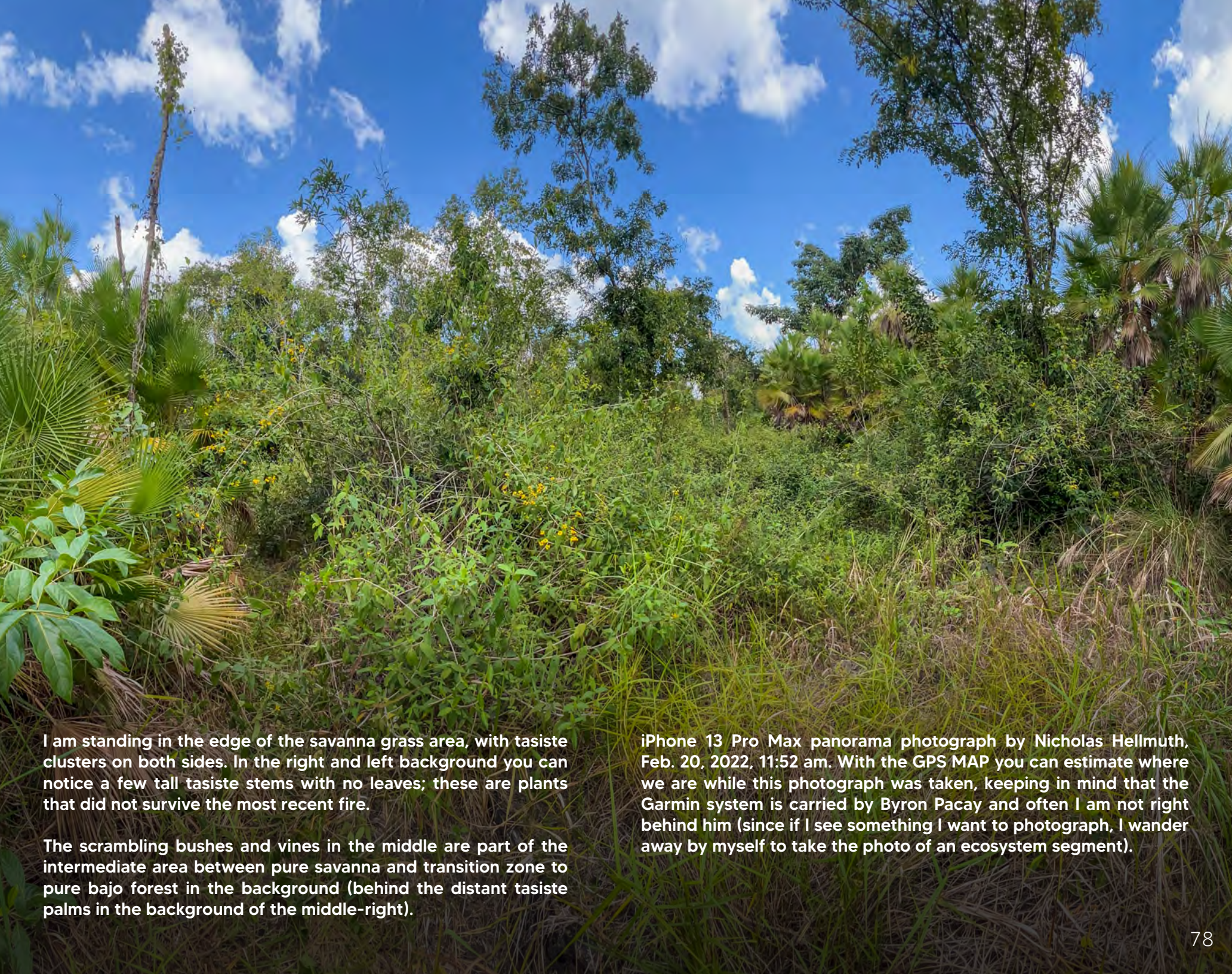
Need to learn whether the yellow flowers in many tree tops are yellow hairbrush sized vine flowers (*Combretum* species) or yellowing leaves?

Lots of palm stems stick up with no leaves; these are the palms "burnt to death" during the fires. But the roots sprout up when rains begin again. Most of the palms survive: their bark gets burned off but the leaves survive or quickly resprout. But a percent get so burned their stems don't resprout at the top. But their root mass resprouts at the bottom.

February 20, 2022, 11:45 am, photograph by Haniel Lopez with FLAAR drone DJI Mavic 2 Pro.

Between the mass of tasiste and the bajo forest there is a several meter area with neither palms nor bajo trees: only bushes and vines.

February 20, 2022, 11:45 am, photograph by Haniel Lopez with FLAAR drone DJI Mavic 2 Pro.



I am standing in the edge of the savanna grass area, with tasiste clusters on both sides. In the right and left background you can notice a few tall tasiste stems with no leaves; these are plants that did not survive the most recent fire.

The scrambling bushes and vines in the middle are part of the intermediate area between pure savanna and transition zone to pure bajo forest in the background (behind the distant tasiste palms in the background of the middle-right).

iPhone 13 Pro Max panorama photograph by Nicholas Hellmuth, Feb. 20, 2022, 11:52 am. With the GPS MAP you can estimate where we are while this photograph was taken, keeping in mind that the Garmin system is carried by Byron Pacay and often I am not right behind him (since if I see something I want to photograph, I wander away by myself to take the photo of an ecosystem segment).

For the next field trip it is crucial to reach all the other dozen savannas that need to be studied

Lots more savannas exist in the far southeast area of Parque Nacional Laguna del Tigre. Some may be outside the PNLT area but at least within the buffer zone of the Reserva de la Biosfera Maya.

We will try to visit these areas in March or April. Our goal is to photograph all 14 savannas of PNLT and also to study all wetlands to the immediate south that may have larger tasistal areas, especially Savannas #24, #25, #26, #30, #31, #32, and #33.

At the top is a row of savannas that we know already (though we need to accomplish additional field trips to document more notes).

Below is Savanna #12, in the shape of the country of India.

To the left are two small savannas, 13 and Tasiste-Savanna 14. Our goal is to accomplish aerial photography of the entire area in this photograph diagonally south as we estimate these may be the largest undisturbed savanna and/or tasistal areas in the entire country of Guatemala.

Tasistal-Savanna #14 is 5% the size of what may be a tasistal-savanna system diagonally to the southeast. The tasistal aspect of Savanna #14 documents that much of the tasistal growing in disturbed abandoned cow pastures. We need to do field work here in February, March, and perhaps April 2022, since this area has already had brechas cut through for surveyors to set aside land to be turned into cattle ranches.

So the forests and tasistal vegetation need to be photographed before they are gone. Obviously this area deserves to be preserved if it is the largest tasistal-savanna in the entire Maya Lowlands. But to preserve it, first we need to show what needs to be protected.

A DJI Mavic 3 would help. DJI Mavic 3 Cine with full package would help even more. These can get us started. If we learn this area is a tasistal, then the medium format, 100 megapixel Phase One aerial UAV camera is crucial.

Haniel Lopez in black, experienced drone pilot and aerial photographer.
Byron Pacay (back middle), GPS map technician.
Rony Chata Soza, CONAP, is the helpful person who knew which trail could get us here.

Leonardo Bo and Jeronimo Cuc, helpful local Q'eqchi' Mayan team who help clear the trail when there are fallen branches in the way. It is essential to get the research/photography team into the research area expeditiously so the daylight hours can be focused on recording the plants and ecosystem. Then you have to hike back to the base camp. If the trails are not open people can trip and hurt themselves and the equipment in their backpacks can be smashed if they trip on a vine or a branch fallen across the trail.

In all cases we try to use trails that already exist.

Aerial photograph by Haniel Lopez (FLAAR Mesoamerica) using FLAAR drone, DJI Mavic 2 Pro. January 11, 2022.

Concluding remarks on Tasistal-Savanna #14

Savanna #10 has several areas of thickly packed tasiste palms, but the rest of the palms in Savanna #10 are just a few clustered together and widely spaced. Tasistal-Savanna #14 is a possible hint of what may be awaiting us in Savannas #24 onward, except that tasistals in that southeastern area could potentially be much larger. But until we can get close enough with drone we can't tell for sure: aerial photos are not high enough resolution other than to hint that the forest may be pure tasistal.

Savanna #14 has several *Crescentia cujete*, calabash trees. Locally they are called either jicaro or morro; I prefer to use jicaro for *Crescentia cujete* and morro for *Crescentia alata*, but the two common names are used interchangeably by most people.

Savanna #14 has open grassland. So all together Savanna #14 is an educational place to visit.

Photo by: Nicholas Hellmuth, FLAAR Mesoamérica, Feb. 20, 2022. Parque Nacional Laguna del Tigre, Reserva de la Biosfera Maya Peten, Guatemala.

Camera: iPhone 13 Pro Max.

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

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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.

Note: 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.

After searching page by page in plant family ARECACEAE, found Acoelorrhaphe wrightii on top left of page 153: helpful list of uses that are not in most other botanical monographs nor articles.

Not available as a download, so all the more difficult to search (since searching on your computer is the most effective way to initiate botanical research nowadays; this is why our team dedicated several months to scanning Lundell's monograph (since the CIW kindly had no copyright, precisely to help share their non-profitresearch publications).

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2016 Centroamérica Patrimonio Vivo: Reflexiones en torno a la arquitectura histórica en madera de Belice.

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Note: information about the architectonic uses of tasiste on pages 30-32

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EDELMAN, S. M.

2017 Morphology, Architecture and Growth of a Clonal Palm, *Acoelorrhaphe wrightii*. Florida International University FIU Digital Commons. 172 pages

Easy download.

ESTRADA-BELLI, Francisco and **David B. WAHL**

2010 Prehistoric Human-Environment Interactions in the Southern Maya Lowlands: The Holmul Region Case Final Report to the National Science Foundation.

Figure 21 is a wonderful photograph; first, it is large enough (half page size). Second it is adequately exposed. But most important of all, this helpful photo shows lots of *Acoelorrhaphe wrightii* around what I estimate is a single *Crescentia cujete* tree. What is notable is that these palms are NOT in clumps: there are lots of them; they are near each other, but none have their trunks touching each other (their leaves, yes, but not their trunks).

The caption of this photograph (captions are not under the illustrations but are in order before the illustrations start): 21. Fire scarring of woody taxa (*Crescentia cujete* and *Acoelorrhaphe wrightii* shown here) on the periphery of the wetland surrounding Laguna Yaloch (no page numbers in this part of the report).

So this helpful field work is further documentation that *Acoelorrhaphe wrightii* prospers in wetlands. Thus it was sheer luck that April through December 2018 and January-February of 2019 were so dry that we could drive to Nakum in August through December (almost every month but one) and both January and February (though our 4WD pickup truck was rented, so it was not fully equipped for deep-rut roads like this route; this route is destroyed by sports-4WD macho-vehicles whose wide and excessively high tires leave deep deep ruts.

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Note: After botanist Cyrus Lundell worked in the La Libertad area of Peten and published his findings in 1937 and 1938, he moved elsewhere. And then decades later he worked for botanical entities in USA. All his 1930's research is published in a single monograph, The Vegetation of Peten. But all his 1940's-1960's botanical field work is scattered and splattered. It would be a monumental contribution to the botanical knowledge of the Mayan areas if all his botanical research for Peten and adjacent Belize could be scanned and turned into a single e-resource. Crucial is to have this research copy-and-pastable (so you can cite it in your own research). Crucial also is to have the scans spelling corrected. Our team at FLAAR Mesoamerica dedicated several weeks to scanning every page of The Vegetation of Peten and two months to spell-checking and hand-correcting every word. But we do not have access to the original articles of Lundell of the 1940's, 1950's, 1960's,etc.

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2018 Arboles de Calakmul. ECCOSUR, Chiapas. 245 pages.

Note: 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.

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

Note: 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.

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

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

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Available online: www.puleston.org/writings-dissertation.html But no pagination, and no copy-and-paste facility.

PULESTON, Dennis

2015 Settlement and Subsistence in Tikal The assembled work of Dennis E. Puleston (Field research 1961-1972). Paris Monographs in America Archaeology 43, BAR International Series 2757. 187 pages.

Note: This is his wife's reorganization of his 1973 PhD. No tasiste, no nance could I find. *Crescentia cujete* is only mentioned as a usable plant, seemingly based on Lundell's 1938 list rather than Puleston finding it in a savanna. In other words, there is no list in this Puleston opus that suggests he studied or made lists of savanna habitats. And there are no photographs of any savanna. Indeed the word savanna is not in his index. This is because the focus of all 1960's-1970's Maya field work was in traditional archaeology and in hilltop settlement areas. There were no house mounds in savannas so no interest (in those decades) in studying a savanna.

QUERO, H, and **J. SALVADOR**

2004 Arecaceae de la Peninsula de Yucatan. Etnoflora Yucatense, Fas. 23. Universidad Aut noma de Yucatan.

RICHARDS, J. H.

2018 Germination and juvenile growth of the clonal palm, *Acoelorrhaphe wrightii*, under different water and light treatments: a mesocosm study. Florida International University, Department of Biological Sciences and International Center for Tropical Botany. Feddes Repertorium No. 129. Pages 92–104

Available online, but you have to request the full-text: https://www.researchgate.net/publication/325560109_Germination_and_juvenile_growth_of_the_clonal_palm_Acoelorrhaphe_wrightii_under_different_water_and_light_treatments_a_mesocosm_study

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.

Note: 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).

Can be downloaded on the Internet: www.researchgate.net/publication/291135077_A_classification_

SELVEN Perez, 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, Pet n, Guatemala, pp. 56-60. Conservation International.

Downloadable: www.academia.edu/1347846/A_Biological_Assessment_of_Laguna_del_Tigre_National_Park_Pet%C3%A9n_Guatemala

SMALL, J. K.

1992 The saw-cabbage palm. The history and distribution of *Paurotis wrightii.* J. New York Bot. Gard. 23: 61-70.

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.

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

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

Free download from various web sites. But some versions are easier to copy-and-paste than other versions. All have spelling errors when any Spanish or Mayanword has an accent.

STANDLEY, Paul C. and Louis O. WILLIAMS

1974 Flora of Guatemala. Fieldiana: Botany, Volume 24, Part X, Numbers 3 and 4. Field Museum of Natural History.

VILLASEÑOR, J. L.

2016 Checklist of the native vascular plants of Mexico Revista Mexicana de Biodiversidad 87 (2016) 559–902.

On page 616 lists *Acoelorrhaphe wrightii* as being in CAM, CHIS, QROO, TAB, TAMS, VER, YUC. Chiapas, Tabasco and Campeche border Peten (Belize is on the east side of Peten and also has *Acoelorrhaphe wrightii* in savannas).

WAHL, David B. ESTRADA-BELLI, Francisco and **Lysanna ANDERSON**

2013 Maíz, clima y fuego en la región de Holmul, Petén, Guatemala. En XXVI Simposio de Investigaciones Arqueológicas en Guatemala, 2012 (editado por B. Arroyo y L. Méndez Salinas), pp. 611-621. Museo Nacional de Arqueología y Etnología, Guatemala.

www.asociaciontikal.com/simposio-26-ano-2012-2/049-maiz-clima-y-fuego-en-la-region-de-holmul-peten-guatemala-david-b-wahl-francisco-estrada-belli-y-lysanna-anderson-simposio-26-2012/

ZAMUDIO, Fernando

2005 Conocimiento ecol gico y sistema de manejo maya del lagarto (*Crocodylus moreletii*) en Quintana Roo, México. Thesis.

Available online:
http://aleph.ecosur.mx:8991/exlibris/aleph/a22_1/apache_media/LP95GN64F2PFAJL5CT1MV251BHNSNS.pdf

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.

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

HELLMUTH, Nicholas
Savanna-Tasistal #14 Seasonally Inundated Wetland with solid Tasiste Palm area Acoelorrhaphe wrightii, Palmetto Palm, Part I, Parque Nacional Laguna del Tigre (PNLT), Reserva de la Biosfera Maya (RBM), Peten, 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 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 through 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, plus all the cameras, and recharge 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

We thank Sergio Balam for providing storage space for our camping equipment and supplies when we are finished with that month's week-long field trip and need to drive back to Guatemala City to process all the photos and prepare reports. So it is essential to have a place in the Santa Elena/San Benito area to store things until we return for the next field trip.

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.

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.

ACKNOWLEDGEMENTS TO FLAAR MESOAMÉRICA

The reports are a joint production between the field trip team and the in-house office team. So here we wish to cite the full team:

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 nowadays is getting involved in the oordination and development of Flora and Fauna projects. She is studying environmental engineer from Universidad Rafael Landivar.

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.

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.

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

Rosa Sequen 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.

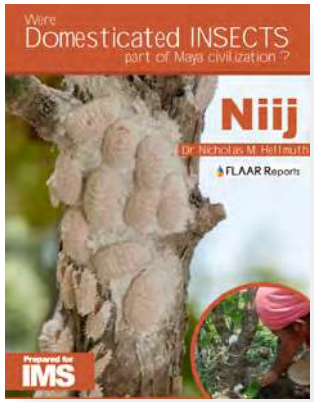
Alexander Gudiel designer who join the editorial design team on December 2020. He will combine the text, pictures and maps into the FLAAR Mesoamerica editorial criteria.

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

Carlos Marroquín is a USAC graphic design student who volunteered to do his professional practice with the Editorial Design Team. We are very grateful with people like him who join our team and bring his knowledge and work.

Sergio Jerez 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).

Other Publications of The Fauna of Guatemala



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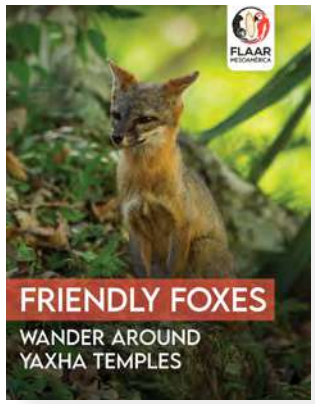

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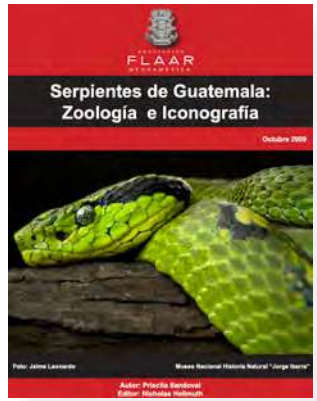

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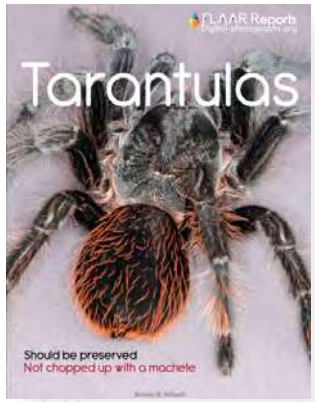

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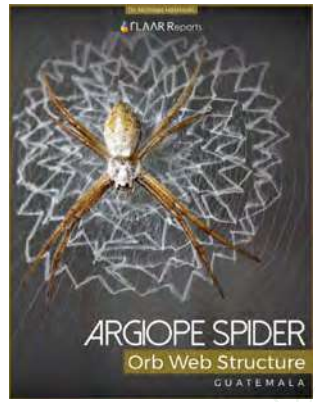

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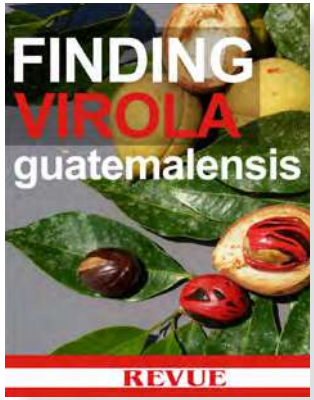

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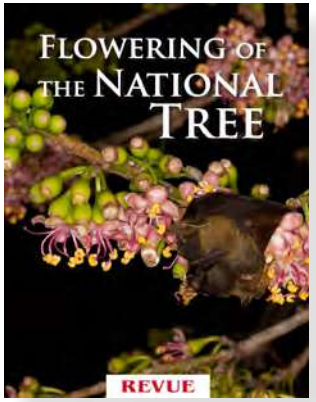

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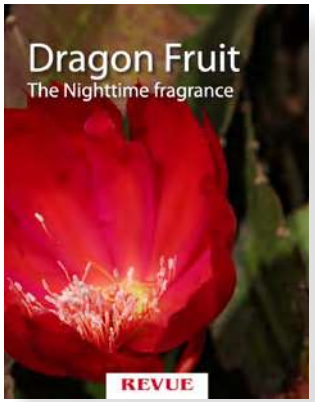

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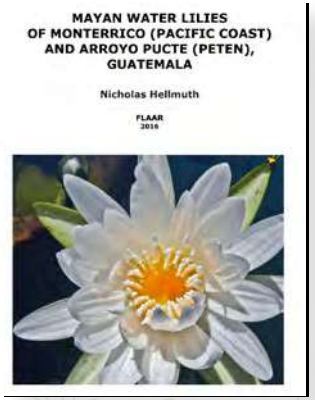

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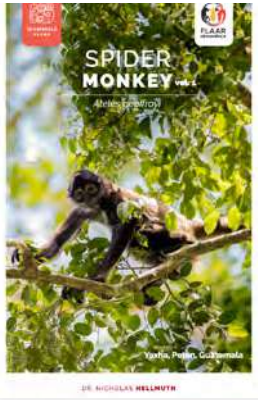

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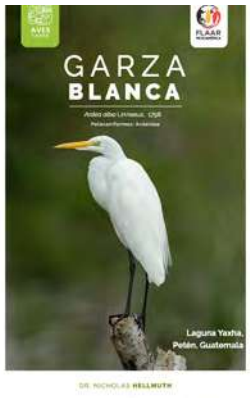

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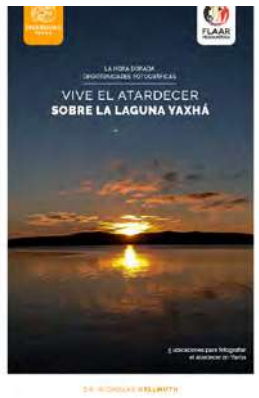

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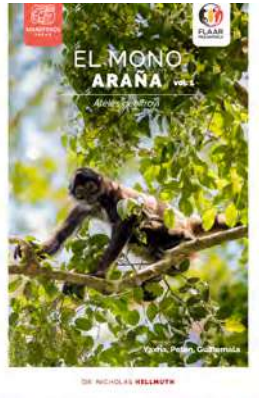

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