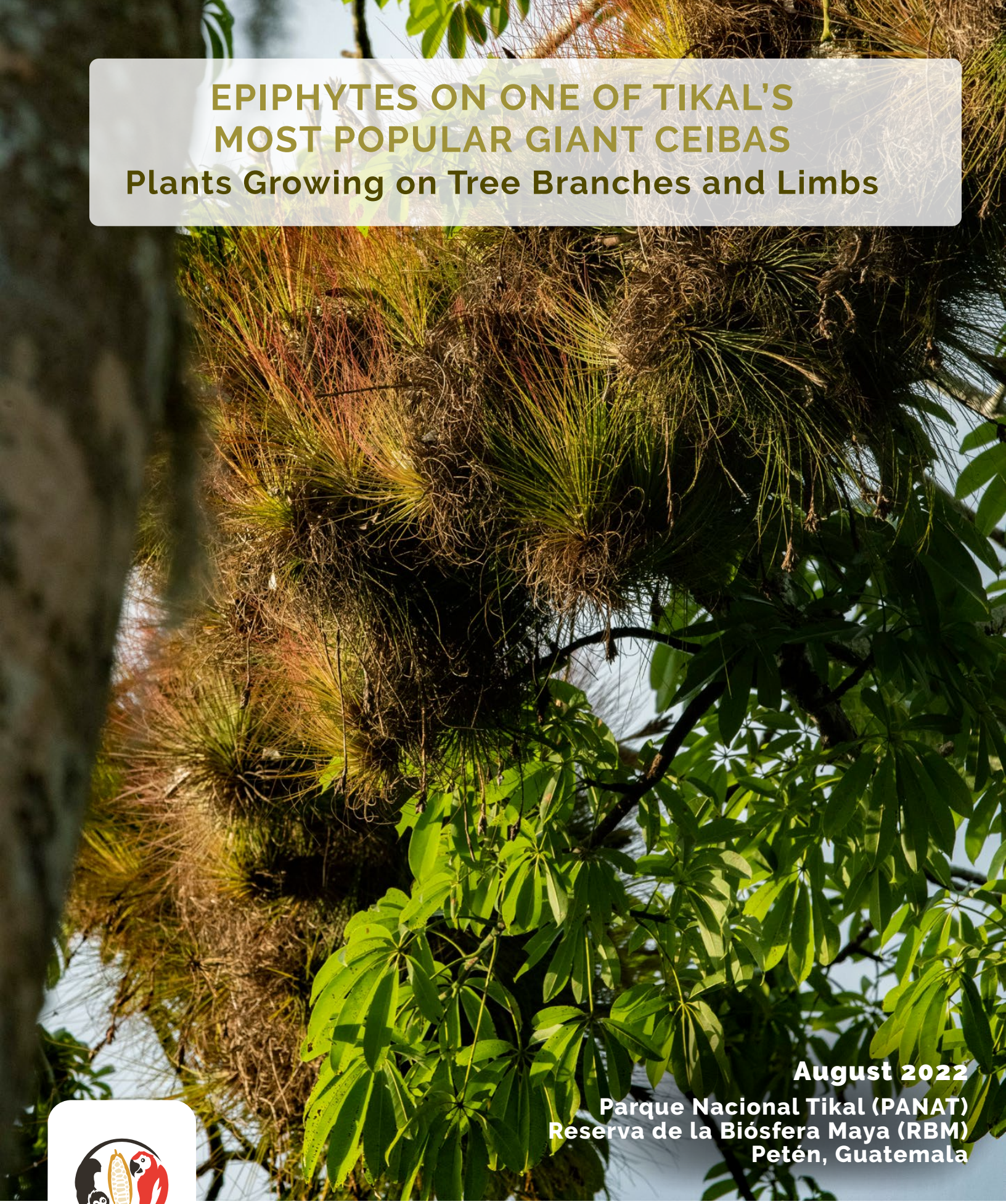
EPIPHYTES ON ONE OF TIKAL'S MOST POPULAR GIANT CEIBAS

Plants Growing on Tree Branches and Limbs



August 2022

Parque Nacional Tikal (PANAT)
Reserva de la Biósfera Maya (RBM)
Petén, Guatemala

FLAAR MESOAMÉRICA

NICHOLAS HELLMUTH & SERGIO D'ANGELO JEREZ

FLAAR (USA) AND FLAAR MESOAMÉRICA (GUATEMALA)

APPRECIATION FOR FACILITATING THE RESEARCH PROJECTS

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Discussion on aspects of PANAT that can assist the Tikal Park administrators
Ing. Dimas Pérez Rivera, Sub-Administrador, Parque Nacional Tikal

Assistance for knowledge of plants and animals of PANAT
Gelbert Aldana
Esdras García

Guides and equipment porters from El Remate and Uaxactun
Carlos Enrique Núñez
Roberto García Leonel
Barillas Núñez

We appreciate a donation during November 2021 and a follow-up donation in June 2022 to help cover the costs of FLAAR research projects specifically to assist and support the current FLAAR project of exploring remote areas to find and document flora and fauna in the Reserva de la Biósfera Maya (RBM), Petén, Guatemala.

This donation is from a family in Chicago in honor of the decades of botanical field work of botanist Dr John D. Dwyer, who worked in many areas of Mesoamerica, including Petén.

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 Biósfera Maya (RBM) of Guatemala. Parque Nacional Yaxha, Nakum and Naranjo (PNYNN) and Parque Nacional Laguna del Tigre are the first two parts of the over 5 million acres of the RBM where we have initiated field work in 2021 and 2022. In July 2022 we initiated field work in cooperation and coordination with the biologists of PANAT at Tikal to study epiphytic plants (orchids, bromeliads, cacti, ferns that grow high up in tres) plus other biology topics of mutual interest and importance to document. Photographs are donated to the park administrators. Contact sheets are being prepared to also donate to CONAP.

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CREDITS

The helpful individuals listed below are part of the FLAAR Mesoamerica research and field work team together with report preparation team.

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We thank Roxana Ortiz for offering to provide lodging for our research team at the Tikal Inn for our field trips starting in October 2022. Since we are not receiving payments for our field work, our budget appreciates complimentary lodging.

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 functional Internet is available at the Hotel Tikal Inn.

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COVER PHOTOGRAPHY

Photograph by: Nicholas Hellmuth FLAAR Mesoamerica, Jul. 20, 2022.
Camera: Sony Alpha A7C. Settings: 1/1,250; sec; f/9; ISO 4,000.

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Introduction to our field work
on Tikal National Park (PANAT)

Mario Vásquez (CONAP co-administrator of PNYNN) told us about an informal group of cooperating parks, nature reserves and biotopes in the south-central part of the RBM. So one by one we initiated visits to photograph and publish FLAAR Reports on:

- Parque Nacional Yaxhá, Nakum y Naranjo (PNYNN)
- Bio Itzá
- Biotopo Protegido San Miguel la Palotada El Zotz
- Cerro Cahui, overlooking Lake Petén Itzá

And now in July 2022 we had a meeting at Tikal to discuss how we could cooperate and coordinate with the park, so now we have added photography of PANAT to the group of cooperating parks.

- Parque Nacional Tikal (PANAT)

Upon receiving a message from the park biology/ecology team that they were available to speak with us in late July 2022, we drove about 560 kilometers to Tikal to meet with three of the biologists. They mentioned their interests in: as many photos of epiphytes as possible.

We mentioned that we too are definitely interested in epiphytic bromeliads, epiphytic cacti, epiphytic orchids, and anything and everything else that grows up and down tree trunks and across the limbs and branches. So one of our first focuses at PANAT was to try out our 800mm prime telephoto lense to see to what degree we could capture nice views of the masses of epiphytes along the limbs.

PANAT and FLAAR Mesoamerica each have a lot of additional focus points of flora, fauna and ecosystems at PANAT that we will coordinate and cooperate with them to accomplish. This CONAP project with FLAAR is not a traditional outside project; instead it is literally cooperation and coordination.

We also found and photographed a lot of tree trunk and treetop epiphytes in the Mundo Perdido area and also in the area at one side of Temple V. Much of the field trip was focused on macro photography of stingless bee entry-exit wax tubes and on gigantic larvae of butterflies (that stay plastered to tree trunks).

My Personal Experience with this *Ceiba pentandra* tree

I've known this *Ceiba pentandra* tree for decades but this is the first time I had an 800mm prime telephoto lens available. Plus lead photographer Edwin Solares (FLAAR Mesoamerica) has been provided a Sony FE 200-600mm f/5.6-6.3 G OSS zoom-telephoto lens so he can capture images up to 600mm. Normally we don't acquire zoom lenses but this lens for the Sony is excellent and has in-lens stabilization.

Photograph by: Edwin Solares FLAAR Mesoamerica, Jul. 20, 2022.
Camera: Sony Alpha A7C with lens FE 200-600mm f/5.6-6.3 G OSS. Settings: 1/1,250; sec; f/9; ISO 4,000

Full Botanical Names

The tree is a *Ceiba pentandra* (L.) Gaertn. The most common and abundant bromeliad is *Tillandsia juncea* (Ruiz & Pav.) Poir.

Additionally, we were able to photograph at least nine different epiphyte species, from which we could identify six genera from six different families. We were not able to identify the genus of two orchids and one fern. Neither could we identify the individual species of the *Clusia* and *Rhipsalis* specimens that were growing happily among the rest of the epiphytes.

Here we include the botanical names and synonyms for each of the species we got to identify.

FAMILY	SPECIES (FULL BOTANICAL NAME)	SYNONYMS (RETRIEVED FROM TROPICOS.ORG AND THEPLANTLIST.ORG)
Araceae	*Anthurium schlechtendalii* Kunth	*Anthurium brachygonatum* Schott *Anthurium fortinense* Engl. *Anthurium hookeri Schott* [Illegitimate] *Anthurium kunthianum* Liebm. *Anthurium mexicanum* Liebm. *Anthurium schlechtendalii* subsp. *schlechtendalii* *Anthurium tetragonum* Hook. ex Schott *Anthurium tetragonum* var. yucatanense Engl. *Anthurium tikalense* Lundell *Pothos schlechtendalii* (Kunth) M.Martens & Galeotti
Bromeliaceae	*Tillandsia juncea* (Ruiz & Pav.) Poir.	*Acanthospora juncea* (Ruiz & Pav.) Spreng. *Bonapartea juncea* Haw. *Bonapartea juncea* Ruiz & Pav. *Misandra juncea* (Ruiz & Pav.) F. Dietr. *Platystachys juncea* (Ruiz & Pav.) Beer *Tillandsia juncifolia* Regel *Tillandsia pulchra* Hook. *Tillandsia quadrangularis* M. Martens & Galeotti

FAMILY	SPECIES (FULL BOTANICAL NAME)	SYNONYMS (RETRIEVED FROM TROPICOS.ORG AND THEPLANTLIST.ORG)
	Tillandsia usneoides (L.) L.	*Anthurium brachygonatum* Schott *Anthurium fortinense* Engl. *Anthurium hookeri Schott* [Illegitimate] *Anthurium kunthianum* Liebm. *Anthurium mexicanum* Liebm. *Anthurium schlechtendalii* subsp. *schlechtendalii* *Anthurium tetragonum* Hook. ex Schott *Anthurium tetragonum* var. yucatanense Engl. *Anthurium tikalense* Lundell *Pothos schlechtendalii* (Kunth) M.Martens & Galeotti
Bromeliaceae	*Tillandsia juncea* (Ruiz & Pav.) Poir.	*Dendropogon usneoides* (L.) Raf. *Renealmia usneoides* L. *Strepsia usneoides* (L.) Nutt. ex Steud. *Tillandsia crinita* Willd. ex Beer *Tillandsia filiformis* Lodd., Cat. ex Schult.f. ***Tillandsia pendula* hort. Louvain ex Schult.f. *Tillandsia trichoides* Kunth *Tillandsia usneoides* fo. *cretacea* Mez *Tillandsia usneoides* var. *cretacea* (Mez) DC. *Tillandsia usneoides* fo. *crispa* André *Tillandsia usneoides* fo. *ferruginea* André *Tillandsia usneoides* var. *ferruginea* (André) Mez *Tillandsia usneoides* var. *ferruginea* (André) A. Cast. *Tillandsia usneoides* fo. *filiformis* André *Tillandsia usneoides* var. *filiformis* (André) Mez *Tillandsia usneoides* fo. *genuina* André *Tillandsia usneoides* fo. *longissima* André *Tillandsia usneoides* var. *longissima* (André) Mez *Tillandsia usneoides* fo. *major* André *Tillandsia usneoides* fo. *robusta* E. Morren ex Mez *Tillandsia usneoides* var. *robusta* (E. Morren ex Mez) Mez

FAMILY	SPECIES (FULL BOTANICAL NAME)	SYNONYMS (RETRIEVED FROM TROPICOS.ORG AND THEPLANTLIST.ORG)
Cactaceae	*Epiphyllum phyllanthus* (L.) Haw.	*Cactus phyllanthus* L. *Cereus phyllanthus* (L.) DC. *Epiphyllum gaillardae* Britton & Rose *Epiphyllum hookeri* Haw. *Epiphyllum phyllanthus* var. *boliviense* (F.A.C. Weber) Backeb. *Epiphyllum phyllanthus* var. *hookeri* (Haw.) Kimnach *Epiphyllum phyllanthus* var. *paraguayense* (F.A.C. Weber) Backeb. *Epiphyllum phyllanthus* var. *phyllanthus* *Epiphyllum phyllanthus* var. *schnetteri* Peukert *Epiphyllum pittieri* (F.A.C. Weber) Britton & Rose *Epiphyllum rubrocoronatum* (Kimnach) Dodson & A.H. Gentry *Hariota macrocarpa* (Miq.) Kuntze *Opuntia phyllanthus* (L.) Mill. *Phyllocactus gaillardae* (Britton & Rose) Vaupel *Phyllocactus phyllanthus* (L.) Link *Phyllocactus phyllanthus* (L.) Salm-Dyck *Phyllocactus phyllanthus* var. *boliviensis* F.A.C. Weber *Phyllocactus phyllanthus* var. *paraguayensis* F.A.C. Weber *Rhipsalis macrocarpa* Miq. *Rhipsalis phyllanthus* K. Schum.
	Selenicereus undatus (Haw.) D.R. Hunt	*Cereus guatemalensis* (Eichler) A.Berger [Illegitimate] *Cereus tricostatus* Rol.-Goss. *Cereus trigonus* var. *guatemalensis* Eichlam *Cereus undatus* Haw. *Cereus undulatus* D.Dietr. *Hylocereus guatemalensis* (Eichlam) Britton & Rose *Hylocereus tricostatus* (Rol.-Goss.) Britton & Rose *Hylocereus undatus* (Haw.) Britton & Rose

Local names for *Tillandsia juncea* and all epiphytes on this ceiba

These are some of the local names we found online that are used in Guatemala to refer to these species. Take into account that we include those names for every species we identified plus the two plants that we could only identify by genus, which means that the names for the latter could apply to different species in each corresponding genus.

SPECIES	COMMON NAMES	MAYAN NAMES
Anthurium schlechtendalii	Hoja de piedra, nido de pájaro, quequesquillo, colmenero.	Baatún, Ucutzh box.
Tillandsia juncea		
Tillandsia usneoides	Musgo, barba de viejo, paxte.	Tzin-i en Huehuetenango, umeex nohoch uinic en Petén.
Epiphyllum phyllanthus		
Selenicereus undatus	Pitahaya	chacuob," "zacuob," "uob," "uoo" and "uo.
Rhipsalis	Bejuco de quebradura.	Tatache is a registered maya name for a Rhipsalis species in Petén.
Clusia	Hoja de tortilla, matapalo, lengua de venado in Petén. Manzanita de ratón, quiebramuelas, sello, memela, manzana rosa de mico, palma rosa, lima real, cerbatana in other departments of Guatemala.	Hubuche, chunup in Petén. Jubub or jubup in Alta Verapaz.

All names were retrieved and compilated from samples of individual species from GBIF (https://www.gbif.org).

In addition, these are some of the common names that are used for the same species in the neighboring states of Mexico (all retrieved from GBIF):

SPECIES	BELIZE
Anthurium schlechtendalii	Baatun, bobtun, hoja de pescado, hoja de piedra, hoja de sabila, kilbal chak, lengua de ciervo, mazorca, pata de gallo, pol box, raíz de piedra, tio tamal, x kilbalchak, kilbal chaak, hoja de viento, zuzuyub.
Tillandsia juncea	Bromelia, which is a generic name for bromeliads. Gallitos and tencho.
Tillandsia usneoides	Barba española, bromelia, gallitos, heno, pañal de niño, Raxo, Spanish moss, Sosquil-chaac, Leno, Musgo, Barba de viejo, Paxtle de cerro, Paste, Cola de zorro, Paxte, pashte, Paxtle, Pastle, soski-chak.
Epiphyllum phyllanthus	Flor de baile, Xpitajalla cuc, Diego de la noche, Lagarto shupa, Lemo, Pitajalla, Pitaya.
Selenicereus undatus	Chac, chacomb, chacoub, dama de la noche, jacube, junco, junco tapatío, orejona, pitahaya, pitahaya orejona, pitajaya, pitaya, pitaya orejona, pitaya reina de la noche, pitayo trepador, reina de la noche, tasajo, tasayo, zacomb, zacoub pitahaya, pitaya, luhuoxit tot, chac, chacomb, chacoub, dama de la noche, jacube, junco, junco tapatío, orejona, pitahaya orejona, pitajaya, pitaya orejona, pitaya reina de la noche, pitayo trepador, reina de la noche, tasajo, tasayo, zacomb, zacoub.
Rhipsalis	Caballero, cactus muérdago, diciplinilla, ingerto, injerto, jiotilla, lágrimas de San Pedro, mazorquita, niguilla, nigülla, nopalillo mal ojo, tatache, tripa de diablo, dedos de muerto.
Clusia sp.	Memelita, upu kutkuy ay, Chunuup, Memela, Copel, Quiebra muelas, flor de canela, flor de venadillo, matapalo, memelita, oreja de burro, oreja de coyote, oreja de león, oreja de lobo, oreja de ratón, oreja de venado, palo de águila, siempreviva, Una tzoy, Kajan ché, Chu' nup', Mata palo, Mandreagua, Membrillo, Kopó, Kuanispakua, B. pikin té, Cajanshé, Oreja de toro, Olivo chino, Oreja de tigre, Zoit, Churam, Matapalo, Chunup, memelita, churup, flor de canela, flor de venadillo, matapalo, oreja de burro, oreja de coyote, oreja de león, oreja de lobo, oreja de ratón, oreja de venado, palo de águila, siempreviva, pikin te, mamey silvestre, uvero.

In addition, other names recorded by Espejo et al. (2010) for *Tillandsia juncea* are gallitos, pasto toojuuk, tencho and zoluche.

Habit for each epiphyte

With only few exceptions, all these plants have an epiphytic habit. Although both *Anthurium schlechtendalii* and *Clusia* can develop this habit as well, *A. schlechtendalii* has also been described as an epilithic or terrestrial herb, while some *Clusia* species might also be considered scandent shrubs, hemiepiphytes, climbing trees, and terrestrial trees. On the other hand, *Selenicereus undatus* has been described as an epiphyte, an hemiepiphyte, a climbing or sprawling succulent, and both a rupicolous and a terrestrial plant.

In what Ecosystem(s) can you find these epiphytes?

According to World Flora Online (http://worldfloraonline.org), *Anthurium schlechtendalii* can be found in evergreen forests, rainforests (Stevens, *et al.* 2001), and humid forests (Woodson and Scary 1980). *Tillandsia juncea*, on evergreen jungles (Davidse, *et al.* 1994) and evergreen forests (Stevens *et al*. 2001). *Tillandsia usneoides*, on tall evergreen jungles and humid submontane forests (Davidse *et al.* 1994); also in very humid evergreen forests (Stevens *et al*. 2001). *Epiphyllum phyllanthus*, on humid forests (ibid.). *Selenicereus undatus,* is described to be found on the edges of dry broadleaf evergreen formations and woodlands (scrublands) (Leon Levy Native Plant Preserve 2020). *Rhipsalis* species, on humid and very humid forests (Stevens *et al*. 2001).

Clusia species, at last, are described by Standley and Williams (1961) to be found mostly on wet or moist forests or thickets. These forests might be either mixed or pine forests.

All epiphytes described
by Standley and co-authors

With only one exception, Standley and his coauthors described all these epiphytes as follows:

> ***Anthurium Schlechtendalii*** Kunth, Enum. Pl. 3: 75. 1841.
> Epiphytic in moist forest, 1200-1500 meters; Huehuetenango (Paso del Boqueron, along Rio Trapichillo below La Libertad, Stey- ermark 51171); San Marcos (above Finca El Porvenir, Volcan Taju- mulco, Steyermark 37078}. Southern Mexico; El Salvador; Costa Rica; Panama.
>
> Plants epiphytic or sometimes growing on rocks, rather large and coarse, the caudex very short and thick; petioles subtetragonous, less than one-fourth as long as the blade, usually very short, sometimes as much as 15 cm. long and 1-1.5 cm. thick, with a short node somewhat longer than broad; leaf blades obovate-oblong or oblanceolate-oblong, commonly 50-60 cm. long and 15-20 cm. wide, sometimes smaller or larger, acute or acuminate, coriaceous when dried, gradually narrowed from about the middle to the narrow cuneate base, the costa stout and prominent, sometimes 1 cm. thick at the base, the primary lateral nerves about 14 on each side, stout and prominent, not forming a distinct collective nerve, ascending at an angle of about 45 degrees; peduncles shorter than the leaves, often very short, sometimes 60 cm. long, stout or slender; spathe reflexed, 10-25 cm. long or more, 2 cm. wide near the base, pale green or sometimes tinged with red or purple, long-attenuate, more or less decurrent at the base; spadix 10-25 cm. long, often 1 cm. or more in diameter at the base, attenuate upward, reddish or greenish, in fruit 2 cm. thick.

(Standley and Steyermark 1958: 317).

Tillandsia juncea (R. & P.) Poir. in Lam. Encyc. Suppl. 5: 309. 1817. *Bonapartea juncea* R. & P. Fl. Peruv. 3: 38, pi. 262. 1802. *Tillandsia quadrangularis* Mart. & Gal. Bull. Acad. Brux. 10, pt. 1:

119. 1843. T. juncifolia Regel, Gartenflora 23: 321, pi. 811. 1874. *T. setacea* sensu Baker, Jour. Bot. 25: 241. 1887, not Sw. 1797. Cola de gallo (Chimaltenango) ; Gallito (Santa Rosa). Figure 106.

Saxicolous or epiphytic in oak or pine forest, 200-2000 meters; Peten; Zacapa; Jalapa; Santa Rosa; Guatemala; Sacatepéquez; Chimaltenango; Huehuetenango. Florida (Mez!); Greater Antilles; southern Mexico to Panama; Trinidad and Colombia to Peru and Bolivia. Plant 2-4 dm. high, stemless but often bearing scaly rhizomes; leaves densely fasciculate, minutely lepidote, blades linear-subulate; inflorescence densely digitate- compound or rarely simple with polystichous flowers; primary bracts with sheaths shorter than the spikes; spikes stout, up to 4 cm. long; floral bracts densely imbricate, broadly ovate, exceeding the sepals, carinate, densely lepidote; sepals 15-20 mm. long, the posterior ones connate; petals violet, 4 cm. long; stamens exserted.

(Standley and Steyermark 1958: 451-452).

Tillandsia usneoides L. Sp. Pl. ed. 2. 411. 1762. *Renealmia usneoides* L. Sp. Pl. 287. 1753. *Dendropogon usneoides* Raf. Fl. Tellur. 4: 25. 1838. *Strepsia usneoides* Steud. Nomencl. Bot. ed. 2. 2: 645. 1841. Musgo (Escuintla, Chimaltenango) ; Tzin-i (Huehuete- nango). Figure 118.

Hanging from trees, often in dense masses, 50-1650 meters; Petén; Alta Verapaz; Baja Verapaz; Santa Rosa; Escuintla; Guate- mala; Chimaltenango; Retalhuleu; Quiche"; Huehuetenango; Totoni- capan; San Marcos. Virginia to Texas along the coast and south to central Argentina and Chile.

Plant forming slender branching strands up to 8 meters long; roots usually lacking; stem less than 1 mm. thick, sympodial; internodes 3-6 cm. long with only the extreme base covered by leaves, curved, leaves 5 cm. long, densely lepidote, blades filiform; scape absent; inflorescence 1-flowered; floral bract short, ovate, lepidote; sepals acute, 7 mm. long, thin, glabrous; petals narrow, 9-11 mm. long, pale green or blue; stamens deeply included, exceeding the pistil.

(Standley and Steyermark 1958: 468).

Hylocereus undatus (Haworth) Britt. & Rose in Britton, Fl. Bermuda 256. 1918; Cactaceae 2: 187, t. SO, f. 263. 1920. *Cereus undatus* Haworth, Phil. Mag. 7: 110. 1830. *Cereus trigonus* var. guatemalensis Eichlam, Monatsschr. Kakteenk. 21: 68. 1911. *Hylocereus guatemalensis* Britt. & Rose, Cactaceae 2: 184, /. 261. 1920. Pitahaya; pitaya; pitajaya dulce.

Epiphytic or terrestrial in thickets, hedges, on rocks or rock walls, at 2,000 meters or usually much less; Pete"n; El Progreso; Jalapa; Zacapa; Jutiapa; Santa Rosa; Escuintla; Guatemala; Sacatepe"quez; Retalhuleu; Solola; Quiche". Mexico, El Salvador and the West In- dies to South America; often cultivated in other parts of the world. Figure 34.

Plants terrestrial or epiphytic, when terrestrial often with arching or recurved stems, when epiphytic more or less scandent and emitting aerial roots; ribs of the stem generally 3, broad, thin, green or glaucous green, the margins undulate,corneous; areoles 2-4 cm. apart; the spines 1-4, usually subconic or more numer- ous and slender on young plants; flowers as much as 30 cm. long, the outer seg- ments whitish, yellowish green, or tinged with rose, acuminate, the inner segments white, lanceolate to oblanceolate, acute or acuminate; style elongated, to 25 cm. long, usually yellow or yellowish, lobes of the stigma to 25; fruit 6-12 cm. long, usually deep red when mature, covered with large foliaceous scales; seeds small, numerous and black.

(Standley and Williams 1962: 206-208).

RHIPSALIS Gaertner

Slender epiphytes, usually pendent from the branches of trees, often much branched and forming dense clumps; stems terete, angulate, or complanate and leaf -like; leaves none or represented by minute bracts; areoles borne on the mar- gins in flat-stemmed plants, along the ridges or irregularly scattered in other forms, small, usually bearing hairs, wool, bristles, and flowers, never spines; flowers small, usually solitary, nocturnal or diurnal; perianth segments distinct, few, sometimes only 5, usually spreading, sometimes reflexed; stamens few or numerous, slender, erect, inserted in 1-2 rows on the outer margin of the disc; style erect, the stigma lobes 3 or more, usually slender and spreading; ovary small, sometimes depressed or sunken in the stem; fruit globose or oblong, juicy, white or colored, generally naked, sometimes bearing a few scales; seeds small, few or numerous.

A genus of about 50 or perhaps more not very clearly defined species, all American and tropical with the exception of a few species which are to be found from West Africa across to Madagascar, and on islands of the Indian Ocean as far as Ceylon. These may have been transported from America by birds or other agents.
Other species are described from Mexico and Central America.

(Standley and Williams 1962: 226-227).

CLUSIA L.

Glabrous trees or shrubs, often epiphytic and sometimes strangling their hosts by their epiphytic roots, sometimes woody vines, the sap yellow, viscid, resinous, turning black when dried, dioecious or polygamodioecious; leaves opposite, usually coriaceous, usually with numerous parallel lateral nerves; inflorescences more or less ternately branched, rarely 1-flowered, articulate at the nodes; flowers small or large, unisexual or rarely perfect; bractlets often numerous decussate pairs be- low the flower and resembling sepals; sepals 4-6, rounded; petals 4-10, free or somewhat connate at the base; stamens usually numerous in the staminate flower, free or connate, variable in form, number, and dehiscence, often accompanied by staminodia, usually covered with a viscid resinous sap; pistillate flower with vari- ously formed staminodia; ovary 4-15-celled, with as many sessile or subsessile, radiate stigmas; ovules anatropous, numerous, arillate, fruit a thick-walled, leath- ery or fleshy capsule, septicidally dehiscent. Species about 145, in tropical America, 2 species in New Cale- donia and 1 in Madagascar. Several additional ones are found in southern Central America. It is difficult to present a satisfactory account of the Guatemalan species. Although many specimens are available, not all are in proper condition for study, and there is complete material of few species. To make matters worse, while some of the species seem to be very uniform in all their characters, others are highly variable and inconstant.

(Standley and Williams 1961: 39-40).

Epiphyllym phyllanthus was the only species of these epiphytes that was not included in *Flora of Guatemala* by Standley and co authors. Woodson and Schery describe it in the *Flora of Panama* as follows:

Succulent epiphytic shrubs, the primary stem joints terete, elongate, about 5 mm. thick when young, probably thicker when old, the secondary stem joints narrowly oblong-elliptic to linear-elliptic, usually obtuse to rounded at the tip, cuneately decurrent into a terete subpetiolar base, 3-5 dm. long, 2-8 cm. wide, rather narrowly serrate, thick and callose-marginate in dessication, the areoles 3-5 cm. distant, naked or indefinitely papillate, borne superficially upon the upper broad margin of the serrations. Flowers nocturnal, very elongate and slender, white (…)the perianth tube about 18-25 cm. long, narrowly tubular, about 3 mm. in di- ameter at the base, abruptly dilated into an extremely short conic throat about 8 mm. broad at the orifice, bearing very few distant and inconspicuous external bracts, the perianth segments very narrowly oblong-elliptic, acuminate, spreading, the inner about 3-4 cm. long, the ovary oblongoid, inconspicuously tuberculate. Berry oblong-turbinate, truncate, somewhat tuberculate-angulate, about 7-8 cm. long and 2 cm. broad, bright red when ripe.

(Woodson and Schery 1980).

Photograph by: Nicholas Hellmuth, FLAAR Mesoamerica, Jul. 20, 2022.
Camera: Nikon D810, 800mm prime telephoto lens. Settings: 1/200; sec; f/14; ISO 2,500.

Photograph by: Nicholas Hellmuth, FLAAR Mesoamerica, Jul. 20, 2022.
Camera: Nikon D810, 800mm prime telephoto lens. Settings: 1/200; sec; f/14; ISO 2,500.

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

Given that epiphytes' seeds can be propagated by wind, they can grow in different ecosystems, which contain very different plant communities. In that sense, only geographical accidents and the lack of proper humidity may interfere with their distribution. But even so, if the seeds are dispersed by birds, they would still be able to develop in very different ecosystems, among totally different plant communities and host species. For that reason, it is not as easy to determine which other plants and trees can be found in the same habitat. There are simply too many and the habitats may vary significantly.

However, these are some other epiphytes that we have found in the Maya Biosphere Reserve, and for instance, they could be considered as plants to be found in the same habitat.

The families:

- Orchidaceae (we are currently working on a list of orchids from the Maya Biosphere Reserve, and so far, we have counted around 80 epiphytic species).
- Polipodaceae (many different species as well).
- Araceae (not as many species because aroids tend to be rather climbing than strictly epiphytic, but several species could be found in the same habitat).

These genera:

- *Selenicereus* (*S. testudo* is rather a common plant among the Reserve. We have also found *S. grandiflorus* subsp. *donkelaarii* on one of the savannas from Laguna del Tigre National Park)
- *Peperomia*
- *Tillandsia* (many different species, including *T. brachycaulos, T. festucoides*, and *T. bulbosa*)
- *Psittacanthus*
- *Ficus*
- *Catopsis*
- *Aechmea*

Epiphytic Cacti

Photograph by: Nicholas Hellmuth, FLAAR Mesoamerica, Jul. 20, 2022.
Camera: Nikon D810, 800mm prime telephoto lens. Settings: 1/200; sec; f/14; ISO 2,500.

Other areas of Tikal have lots more Spanish moss; we will show this in separate upcoming FLAAR Reports on epiphytic flora of PANAT.

The camera is focused on the Spanish moss so the branch that sticks out at the right is out of focus.
The plant growing just above the spanish moss is Rhipsalis (en cursiva) which looks almost like green twigs.

Photograph by: Nicholas Hellmuth, FLAAR Mesoamerica, Jul. 20, 2022.
Camera: Nikon D810, 800mm prime telephoto lens. Settings: 1/200; sec; f/14; ISO 2,500.

A few strands of *Tillandsia usneoides* Spanish moss are visible at top left and bottom left. Some 3-dimensional lichen can be seen on the branches at the right. Here is where we need a digiscope system to capture the 3D lichen in better detail.

Photograph by: Nicholas Hellmuth, FLAAR Mesoamerica, Jul. 20, 2022.
Camera: Nikon D810, 800mm prime telephoto lens. Settings: 1/200; sec; f/14; ISO 2,500.

Same photo as the previous one, but cropped down to the two areas of 3D lichen. If an individual, company, or research association could provide FLAAR (USA) or FLAAR Mesoamerica (Guatemala) with funds to obtain a Zeiss, Leica, Nikon or Swarovski digiscope with Novoflex attachment for our digital camera then we could photograph the 3D lichen as it we were up in the tree with a macro camera lens.

Photograph by: Nicholas Hellmuth, FLAAR Mesoamerica, Jul. 20, 2022.
Camera: Nikon D810, 800mm prime telephoto lens. Settings: 1/200; sec; f/14; ISO 2,500.

Some of the masses of romeliads are on horizontal limbs

Photograph by: Nicholas Hellmuth, FLAAR Mesoamerica, Jul. 20, 2022.
Camera: Nikon D810, 800mm prime telephoto lens. Settings: 1/200; sec; f/14; ISO 2,500.

Photograph by: Nicholas Hellmuth, FLAAR Mesoamerica, Jul. 20, 2022.
Camera: Nikon D810, 800mm prime telephoto lens. Settings: 1/200; sec; f/14; ISO 2,500.

Photograph by: Nicholas Hellmuth, FLAAR Mesoamerica, Jul. 20, 2022.
Camera: Nikon D810, 800mm prime telephoto lens. Settings: 1/200; sec; f/14; ISO 2,500.

Photograph by: Nicholas Hellmuth, FLAAR Mesoamerica, Jul. 20, 2022.
Camera: Nikon D810, 800mm prime telephoto lens. Settings: 1/200; sec; f/14; ISO 2,500.

Other of the masses of same bromeliads are on vertical branches and limbs

Photograph by: Nicholas Hellmuth, FLAAR Mesoamerica, Jul. 20, 2022.
Camera: Nikon D810, 800mm prime telephoto lens. Settings: 1/200; sec; f/14; ISO 2,500.

The previous photo shows the bromeliads clinging primarily to the "top" of the branch; the present photo shows this same plant clinging all 360-dgrees around the branch.

Photograph by: Nicholas Hellmuth, FLAAR Mesoamerica, Jul. 20, 2022.
Camera: Nikon D810, 800mm prime telephoto lens. Settings: 1/200; sec; f/14; ISO 2,500.

Where have these epiphytes been found throughout Guatemala?

SPECIES	TIKAL NATIONAL PARK	YAXHA, NAKUM Y NARANJO NATIONAL PARK	OTHER AREAS OF PETÉN	OTHER DEPARTMENTS OF GUATEMALA
Anthurium schlechtendalii	Some herbarium samples have been collected in the park. We have also photographed it at the Mundo Pérdido complex, inside the park, and at the south side of temple VI snacking area. It can certainly be found abundantly along the rest of the main archaeological structures of the park.	Guatemala's Biodiversity Portal doesn't showcase any collection that has been made here, but we have found it and photographed it at the campamento Yaxhá, and near Grupo Malher.	Herbaria samples have been collected in Dolores, Uaxactún, Paso Caballos, La Libertad, Santa Teresa (at Río Subin), 4 km east of El Rosario (near Sayaxché), and Puerto Chimono, at Laguna Petexbatún.	It has been collected in San Marcos, Huehuetenango, Zacapa, Chiquimula, Quiche, Alta Verapaz and Izabal.
Tillandsia juncea	Samples were collected in 1961.	No available data on Guatamala's Biodiversity Portal.	Besides being collected in Tikal, it was collected in Saxactún.	Santa Rosa, Huehuetenango, Guatemala, Sololá, Zacapa, and Quetzaltenango.
Tillandsia usneoides	Yes, it has been collected in the Park.	Yes, it has been collected in the Park	At Laguna Petexbatún, La Libertad (at archaeological site La Joyanca).	Retalhuleu, Izabal, San Marcos, Guatemala, Zacapa, Chimaltenango, Huehuetenango, Baja Verapaz, Sacatepéquez, Santa Rosa, El Progreso, Quiché, Sololá,
Epiphyllum phyllanthus	Herbaria samples have been collected in the Park.	We have photographed it inside the park.	According to Véliz (2008), it has been collected at Tikal, Flores; the archaeological site La Joyanca, La Libertad; Sarstum, San Luis Petén; and Laguneta Amatillo, Sierra del Lacandón.	Suchitepequez, Escuintla, Jalapa, Alta Verapaz, Izabal, Solola, and Quetzaltenango. According to Véliz (2008), also in Quiché and Huehuetenango
Selenicereus undatus	No data online but we have photographed the species in the Park.	No data online but we have photographed the species in the Park.	Although neither Véliz (2008) or any collection according to Guatemala's Biodiveristy Portal report other locations in Petén for this species, it is almost certain that it can be found elsewhere in Petén.	Sololá, Sacatepéquez, San Marcos, Jutiapa, Escuintla, Guatemala, El Progreso, and Quiché. According to Véliz (2008), also in Chimaltenango.

Information retrieved from herbaria data from Guatemala's Biodiversity Portal (https://biodiversidad.gt) and Véliz (2008).

Tillandsia juncea and all epiphytes in Belize and the neighboring states of Mexico

The following table shows where in Belize and neibhboring states of Mexico do every epiphyte has been reported or collected:

SPECIES	BELIZE	CHIAPAS	TABASCO	CAMPECHE	QUINTANA ROO
Anthurium schlechtendalii	Yes	Yes	Yes	Yes	Yes
Tillandsia juncea	Yes	Yes	No	Yes	Yes
Tillandsia usneoides	Yes	Yes	Yes	Yes	Yes
Epiphyllum phyllanthus	Yes	Yes	Yes	Yes	Yes
Selenicereus undatus	No	Yes	Yes	No	Yes

Information retrieved from herbaria data from GBIF.

Are these epiphytes from the Highlands or from the Lowlands (or both)?

Most of these epiphytes are both from the highlands and the lowlands. Again, given that their seeds can be dispersed by wind and birds, they are not necessarily restricted to a particular altitude.

World Range for each epiphyte

SPECIES	WORLD RANGE
Anthurium schlechtendalii	México to Nicaragua.
Tillandsia juncea	México, Central América, Antilles, South America (up to Bolivia).
Tillandsia usneoides	South of United States, México, Central America, Antilles and South America (up to Uruguay and Argentina).
Epiphyllum phyllanthus	Sout of Mexico, to Paraguay and Argentina.
Selenicereus undatus	México to Nicaragua, Cuba and Jamaica.

Which of these epiphytes also grow in home gardens?

Many *Tillandsias* are popular as house plants. In fact, they are known as "air plants" due to the fact that they don`t need soil to develop. In that sense, both *T. juncea* and *T. usneoides* can be shopped online in many countries. However, not in Guatemala, but that is because people here are not used to shop plants online. People will rather visit a plant shop or nursery. Having said that, *T. juncea* might be difficult to find on sale, but rather possible. *T. usneoides* could be more easily found, and since it is available in fruit markets for the Holiday season, it is not rare that some people might grow it as an ornamental in their own garden.

Many epiphytic cactus are also popular as ornamental plants. For that reason, it wouldn`t be unusual that people might have *Epiphyllum phyllanthus* in their gardens. Such species as *E. phyllanthus*, that have big and showy flowers, are known by some people as galán de noche or queen of the night. At the same time, people also like to grow pitahaya (*Selenicereus undatus*) as a garden plant, both for its showy flowers and edible fruits.

Anthurium schelchtendalii is another popular ornamental plant. Not only do people in the most humid regions of Guatemala use it to decorate their gardens, but it is also a rather common garden plant in Guatemala City, where there is not as much humidity. Other *Anthurium* bird nest species, including some exotic ones, are used as well.

Lastly, regarding *Rhipsalis* and *Clusia* species it is worth mentioning that both are ornamental plants used in other countries. But not in Guatemala. *Rhipsalis* is a popular house plant in many countries in the northern hemisphere, and some *Clusia* species are used in landscaping. In Guatemala, you may find exotic species from the same genera that are used as ornamental, but definitely not the native ones.

Practical uses of *Tillandsia juncea* for the Lacandon Maya of Chiapas

It appears that one of the most popular uses for tillandsias is as ornamentations for the Holiday season. For instance, Mondragón (2008) included *T. juncea* in a list of tillandsias that could be found in the markets of Oaxaca during December. Similarily, *T. guatemalensis* is a popular bromeliad that is broadely sold by peddlers in Guatemala during the same month. In that sense, they might be used as Christmas decoration or as ornaments for Nativity scenes. In this regard, *T. usneoides* is another tillandsia that is widely commercialized for the same reason.

Moreover, T. usneoides appears to be another underutilized plant with a significant amount of different uses. Estrella-Parra et al. (2019) cite all of the following practical uses for this species:

> The first hint of the use of *Tillandsia* happened by *T. usneoides* fibers, which were found in the pottery-making societies of North America before our era (Smith & Trinkley, 2006; Gilmore, 2015).
>
> In the early 20th century in Louisiana, Florida USA, T. usneoides was used in the winter by farmers when the pastures were scarce, whose often chop downed trees and allow the cattle to feed on the moss (Halligan, 1909).
>
> *T. usneoides* was suggested as a product very versatile in USA (Schorger, 1927), as for tanning hides (Hall & Tuttle, 1918), and as a possible source for a hard-natural wax and for processing of upholstering fibers (Feurt & Fox, 1953a; Feurt & Fox, 1955). Besides, the waste material from the processing of threads for the upholstery industry was suggested as a source of estrogens for cattle, to improve meat quality and the efficiency of feed utilization (Feurt & Fox, 1953b). *T. usneoides* was also used to eliminate the bitter taste of citrus for use in animal feed (Sokoloff & Redd, 1951).
> Also, in Peru, *T. usneoides* was used to wrapping fruit and fragile objects, as well as filling pillows and mattresses (Pierce, 2000).

(...)

Also, *T. usneoides* is used as a decorative arrangement in buildings (Wickham, 2013), as ornamental plants in vertical type support, as air purification indoors (Kim, 2011a; Kim, 2011b) as well as green plant curtain (Yu et al., 2009).

Tillandsia genus possesses importance also in the cosmetic industry. Aerial part extracts of *T. usneoides, T. cyanea, T. tectorum, T. ionantha,* and *T. stricta* improve rough skin and keeping moisture (Ohara & Hori, 2001; Shoji et al., 2003; Kurokawa et al., 2004; Yokozeki, 2010). Moreover, from T. usneoides has been developed an anti-aging cosmetic, which promotes the keratinocyte differentiation in the skin (Kwon et al., 2013; Jung et al., 2015).

T. usneoides and *T. recurvata* also can have utility as atmospheric indicators (Wherry and Capen, 1928). Brazil and Mexico reported the efficiency of *T. usneoides* for this purpose (Cardoso-Gustavson et al., 2016; Castañeda et al., 2016).

(Estrella-Parra et al. 2019).

In addition, the Natural Resources Conservation Service of the USDA (2003) described the following uses:

> Ethnobotanic: Various Native American tribes, including the Houma and the Seminole, have used Spanish moss for a variety of purposes. When the outer coating of the plant is cleaned away, tough, black, curly inner fibers are exposed. These strong fibers were useful in many ways. The fibers were woven into a course cloth that was used for bedding, floor mats and horse blankets. The fibers could be twisted into cordage that was used as rope. The ropes were used to lash together the poles that composed the framework of housing. The dried fibers were used to remove scum in cooking. The process used to strip off the outer coating is still used today. It consists of placing bundles of the green moss into a shallow pond for six weeks, long enough for the outer coat to rot away. Dry Spanish moss was used for fire arrows. The moss was wrapped around the base of the shaft, lit on fire and then shot from the bow. The moss was also an ingredient in the clay that was used to plaster the insides of houses. Fresh Spanish moss was gathered, soaked in water and stuffed into dugout canoes to keep them from drying out and splitting. The Natchez tribe of Louisiana played a game that used fist-size balls that were stuffed with Spanish moss. The plant was boiled to make a tea for chills and fever. There is evidence that Spanish moss was used over 3,000 years ago to make fire-tempered pottery. Although the moss burned away during the firing, the distinctive pattern of the fibers is still evident in the clay pottery. Spanish moss is still used today by many Native American tribes. For example, the Houma and the Koasati use Spanish moss in the construction and decoration of small dolls.
>
> (Natural Resources Conservation Service of the USDA 2003).

The National Park Service of the United States (n.d.) published a plant profile on *T. usneoides*, which includes the following uses:

> It was noted by Francis Moore, one of the more famous Frederica colonist, in 1736 that the Native Americans used dried moss for wadding in black powder muskets and as tinder for starting fires. The moss could also be spun into rope, used to stuff pillows, mattresses, furniture, and as a binding agent in bousillage style construction.
> The moss was often woven into baskets, horse blankets, and primitive clothing. A more modern use of Spanish Moss was in the early 20th century, when Henry Ford used it to stuff the seats of the Model T Fords.
>
> (National Park Service of the United States, n.d.).

Lastly, Weerawong et al. proposed that this species could also be used as biomass:

> The heating value and moisture content of Spanish moss is close to the rice husk, bagasse, wood chip, and straw. The component in view of C, H, O, N, and S is also close to general biomass (…)
>
> The Spanish moss can be used as biomass but the property of growth retardant must be concerned. The Spanish moss should be used as supplementary biomass but not expected to be the major part for the power plant.
>
> (Weerawong et al. 2016).

It is interesting that so many uses by people living both present and past in the United States, can be found online, but that there is no information easily available on how the Maya used this plant. For that reason, it would be really helpful to conduct more research and to check physical bibliography on this topic.

Are any of these epiphytes edible?

Yes, both *Selenicereus undatus* and *Epiphyllum phyllanthus* have edible fruits. *S. undatus* or pitahaya, is in fact a popular fruit.

Photograph by: Edwin Solares FLAAR Mesoamerica, Jul. 20, 2022.
Camera: Sony Alpha A7C with lens FE 200-600mm f/5.6-6.3 G OSS. Settings: 1/1,250; sec; f/9; ISO 4,000

Is there potential medicinal usage of any of these epiphytes by local people?

Yes. Various authors have claimed the medicinal properties of *T. usneoides.* Here are some examples cited by Estrella-Parra et al.:

> In Mexican traditional medicine, there are more than 30 *Tillandsia* plants reported (Table No. 1), being the most critical *T. recurvata* and *T. usneoides*, which are used for cough, bronchitis, rheumatism, ulcers, and hemorrhoids, among other (Bennett, 2000; Acebey et al., 2006; Grijalva, 2006; De Fátima et al., 2008; Zamora, 2009; Hornung-Leoni, 2011; Mondragón et al., 2011).
>
> In South Louisiana, USA, people use the decoction of *T. usneoides* in diabetes mellitus control (Keller et al., 1981) and for hemorrhoid treatment (Agra et al., 2008).
>
> "Persona tapeada", hemorrhoids, dandruff, digestive ailments due to overeating, body inflammation, antiepileptic and astringent, gastritis, throat placenta, accelerate childbirth, infant epilepsy, astringent, antipyretic, cough, hernias, measles, ulcers, arthritis, lung conditions, Liver, kidney, heart, contraceptive (Zamora, 2009; Bennett, 2000; Sandoval-Bucio et al., 2004; Acebey et al., 2006; Grijalva, 2006; De Fátima et al., 2008; Mondragón et al., 2011).
>
> Witherup et al. (1995) confirmed the use of *T. usneoides* against diabetes (…)

(Estrella-Parra et al. 2019).

Anthurium schelchtendalii has also been claimed to have medicinal properties. In fact, it is thougth that it had an important significance for prehispanic cultures. Studnička (2020) compiled the following information on this topic:

> *A. schlechtendalii* Kunth, a species widely distributed in Central America, especially in Belize and Guatemala. This species is of ethnobotanical significance in the Maya tradition. It was known as a healing plant by the Maya people in pre-Columbian times as well as at present (Balick & Arvigo 2015, Hitzinger 2016).

(Studnička 2020).

Abu et al. (2022) found out that A. schelchtendalii has anti-cancer activity in-vitro:

> It is used for many medicinal purposes for the treatment of severe and chronic inflammatory conditions. Cross examination of the plant regarding its anti-neoplastic properties has been done because its molecular targets of anti- inflammatory are common for both pathologic conditions. A polar extract of the Maya healing plant, *Anthurium schlechtendalii* (Arecea), leaves and roots exhibited strong anti-cancer activity in vitro, and the freeze-dried (not air dried) roots of *A. schlechtendalii* also exhibited strong growth inhibitory and apoptosis-inducing properties for leukemia and breast cancer
>
> (Abu et al. 2022).

As last point, at least one species of *Rhipsalis* is known to be used in traditional medicine. Bautista-San Juan et al. (2017) affirn that *R. baccifera* is used in Mexico to treat health problems such as hair loss, diabetes, and fractures.

Photograph by: Edwin Solares FLAAR Mesoamerica, Jul. 20, 2022.
Camera: Sony Alpha A7C with lens FE 200-600mm f/5.6-6.3 G OSS. Settings: 1/1,250; sec; f/9; ISO 4,000

Ecology aspects of these epiphytes

The following chart includes some facts regarding how these plants are related to other organisms. For example, it shows if any mammal feeds from any part of these plants, and which are the pollinators for each species. In that sense, this chart may illustrate how a single ceiba tree constitutes an important niche for numerous species and allows various ecological relationships between different organisms.

SPECIES	HABITAT FORMATION	POLLINATORS	FEEDING
Anthurium schlechtendalii	Due to its morphology which is specialized to gatter leaf litter (a dense epigeous root mass and broad leaves disposed in a rosette), it creates habitat for leaf litter insects.	The main pollinators are coleopterans (beetles) from the families: Curculionidae, Phalacridae, Chrysomelidae, Bruchidae and Anthicidae, which feed from the pollen and the estigmatic drops of the spadix.	We have photographed gray foxes (*Urocyon cinereoargenteus)* feeding from the ripe fruits. Orthoptera, Lepidoptera (larvae) and sap feeders (Homoptera and Hemiptera) may feed from the leaves or the sap.
Tillandsia juncea	This species might form habitat for other epiphytes by promoting the conditions for their germination and stabilization. Moreover, the Collembola significant diversity that inhabits in populations of this species has been documented in Mexico.	Hummingbirds	
Tillandsia usneoides	This is a plant with significant ecological importance due to the habitat it creates for other species. It also constitutes habitat for arthropods. Some studies have documented the diversity of spiders, mites and thysanopterans living in it. At least three species of bats have been found sleeping in spider moss. Many birds use the plant as nest material, including orioles, the yellow-throated warbler and northern parulas. Frogs, lizards and snakes may also inhabit this plant. Additionaly, there is one spider species that is said to only be found in this plant: *Pelegrina tillandsia.*		
Epiphyllum phyllanthus		Its pollinators include bats, hummingbirds, moths, and bees	
Selenicereus undatus		Bats, hawkmoths and bees.	It is most probable that different mammals eat the fruits, including bats.
Rhipsalis sp.			Fruits might be eaten by birds and bats.
Clusia sp.	Symbiosis with micorrhyzal fungi has been studied by several authors.	Bees. Studies have found that *Clusia* species constitute a significant source of propolis.	Bees use the látex from wounds (or they even create wounds for this purpose) to construct their nests. Since it is considered that birds may disperse the seeds, then it means that birds feed from the fuits.

Concluding Discussion and Summary
on the epiphytes on this Ceiba

It certainly is very interesting how many different plants can grow in a single ceiba, and moreover the diversity that they can sustain. *Tillandsia juncea* grows so densely that almost wraps every limb of this ceiba, and surely this creates the conditions that other plants need to germinate and develop, rather than growing directly on the bark of the tree (although many of them are capable of that too).

In addition, it is impressive how many uses these epiphytes have, so this single ceiba could provide food, fibers, and medicine to humans, and other organisms. The amount of different uses that *T. usneoides* has is incredible. Yet, it is intriguing that it is so underutilized right now.

In the future we will continue to improve our list of epiphytes that grow in Tikal National Park as well as other areas of the RBM. It will be helpful if other scientists, students, and personel of the corresponding entities could better document the epiphyte diversity of the RBM and further explore how these could be used, as well as conserved. After all, all these epiphytes, the way they colonize huge trees, their diversity and the impact they create in the scenery is a characteristic feature of the RBM that is worth taking care of. By better studying and knowing their diversity, they could surely be better conserved.

Photograph by: Edwin Solares FLAAR Mesoamerica, Jul. 20, 2022.
Camera: Sony Alpha A7C with lens FE 200-600mm f/5.6-6.3 G OSS. Settings: 1/1,250; sec; f/9; ISO 4,000

APPENDIX A

How can you take a non-distorted photo of a giant tall tree with today's Technology?

I estimate that this is one of the most photographed *Ceiba pentandra* trees in all Guatemala. Definitely this is the most popular Ceiba tree in Peten. About 50% of the Ceiba, Tikal returns on Google show the top, since most tourists have never seen so many epiphytes in their own home área. About 35% of the potos show the huge buttress roots that supports the giant trunk. About 15% try to show the entire tree, but since most ancient tall trees are leaning over, most potos show the tree leasing over.

I wanted to capture a view of this *Ceiba pentandra* with the trunk as straight as posible and showing the entire treetop area from below.

To do this I did a vertical panorama: set your iPhone 13 Pro Max into Pano mode, turn your phone horizontal, point the arrow upwards, and raise the telephone parallel to the trunk as far as your arms can to this. When you reach the height of your arms, hold your arms steady and rotate the camera in a curve to photograph the treetops.

The iPhone 13 Pro Max then corrects the distortion and gives you an amazing result that we show here, "the entire tree".

Surely other telephones can do this, or if you are further away you can simply use a wide-angle lens. There are indeed several potos showing the whole tree that are not too distorted.

The photographs of our field trips we will donate to the park and to CONAP. They can be used without paperwork but please be sure to clearly list the park and the photographer and courtesy of FLAAR Mesoamerica.

We feel proud to have provided a nice new fresh digital photo to show the world the natural beauty of Tikal, and then with all our other photos to show the epiphytic bromeliads and cactus up on the tree limbs. I estimate these are the first views of the epiphytes with an 800mm prime telephoto lens.

Photograph by: Nicholas Hellmuth, FLAAR Mesoamerica, Jul. 20, 2022.
Camera: iPhone 13 Pro Max.

APPENDIX B

How was it posible to photograph epiphytic plants so high up in a giant tree?

One of the goals of the first field trip visit to PANAT was to show the park biologists the range of our camera equipment so they could see what kids of flora and fauna we can photograph for them. Since I have known this giant *Ceiba pentandra* tree for decades, I realized that anything less than an 800mm prime telephoto lens would not be adequate. So already several years ago we acquired a Nikon AF-S FX NIKKOR 800mm f/5.6E FL ED. Note that this is twice the cost of the newer Nikon AF-S FX NIKKOR 800mm f/5.6E FL ED lens for mirrorless Nikon cameras. We are using Sony mirrorless and Canon mirrorless but Nikon does not yet have enough experience in mirrorless technology.

We used an 800mm prime Nikkor telephoto lens. I try to avoid zoom lenses. We also avoid after- market brands. In past years colleagues who wanted to sabe money and thus got a Sigma telephoto lens have told us that Sigma equivalents are often not as good as the original Nikkor or Canon lenses.

We use only Gitzo tripods and for a heavy lens only Wimberley WH-200 Gimball Tripod Head II. For regular photography we use Gitzo tripods and an antiquated Arca-Swiss Monoball big-ball tripod of decades ago. No subsequent Arca-Swiss tripod head was any good (they newer models were over- engineered and failed to function out in the real world). Arca-Swiss "repaired" the head and it then failed to function after a few days. Arca-Swiss never admitted that the tripod head was over- engineered. And Arca-Swiss never offered to return my purchase Price. In the meantime I have bought two more of the much older original Monoball and am happy with them. But I would not recommend any new model of anything made by Arca-Swiss.

Photography assistant Norma is controlling the Wimberley WH-200 Gimball Tripod Head II which Hellmuth is trying to focus on a few centimeters of epiphytic bromeliads high above.

Photograph by: Edwin Solares, FLAAR Mesoamerica, Jul. 20, 2022. Camera: iPhone 13 Pro Max.

100% of our lenses have circular polarizing filters. We never remove these.

We did not even try to use normal camera flash because the tree limbs were too far above. On a future field trip we will take our ProPhoto flash equipment. Originally we bought a BronColor flash because we noticed the experience of this Swiss Company at Photokina several years ago. But the BronColor flash turned out to be only for a photo studio: NOT for taking on a field trip. It literally "fell apart" and could not be used after just one or two field trips. We sent it back asking for a refund but they repaired it instead and did not return our money. We have not even attempted to use it for over 2 years since it was so fragile. In other words, we do NOT recommend BronColor equipment.

The ProPhoto flash withstood a field trip to really remote part of Peten, to Biotopo El Zotz and worked acceptably (considering that we had never used equipment of this complexity before). So on an upcoming field trip we will try to ProPhoto.

Since this was our first field trip to PANAT within the 5-year 2021-2025 CONAP Project of cooperation and coordination with FLAAR Mesoamerica, we did not bring the drone or drone pilot. A drone would make it posible to photograph the tree from above and from the side. We have now registered the drone with the park and will only use it in the future where there are no bird nests or birds, and where there are no Mayan ruins below: in other words, the drone will only before flora and ecosystems in selected and approved áreas. All aerial potos will be donated to the park.

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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.

Permissons

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.

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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.

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.

BACKCOVER PHOTOGRAPH
Photograph by: Edwin Solares.
FLAAR Mesoamerica, Jul. 20, 2022.
Camera: Sony Alpha A7C. Settings: 1/125 sec; f/6,3; ISO 125.

ACKNOWLEDGEMENTS TO FLAAR MESOAMÉRICA

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

FLAAR MESOAMÉRICA

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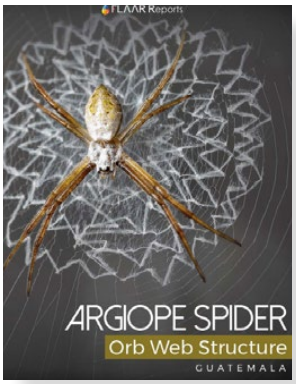
RESERVA DE LA BIÓSFERA MAYA - RBM -
DEPARTAMENTO DE PETÉN, GUATEMALA

Mapa elaborado por: Carlos D. Marroquín

Google Maps 2022; Asociación de Comunidades Forestales de Petén - ACOFOP - 2011; Wikimedia Commons 2019

Other publications of
the fauna of Guatemala



Argiope Spider
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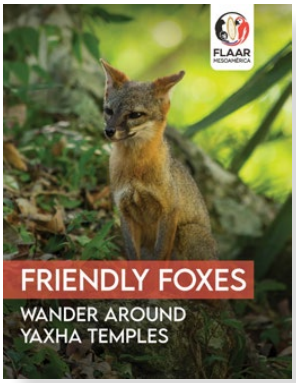

Friendly Foxes
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Reincersión de dos crías de Coatíes
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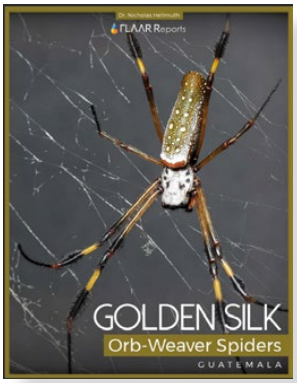

Golden Silk Orb-Weaver Spiders
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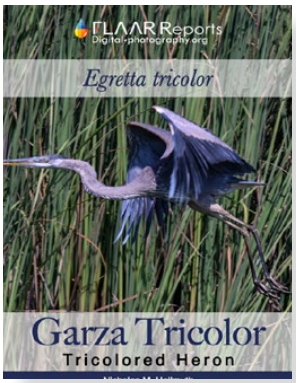

Garza Tricolor
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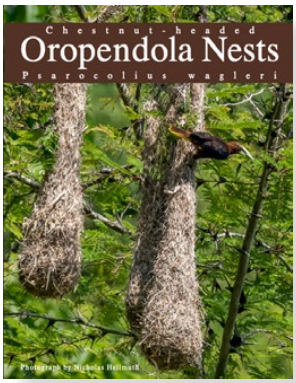

Oropendola Nests
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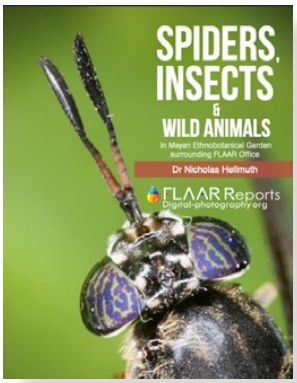

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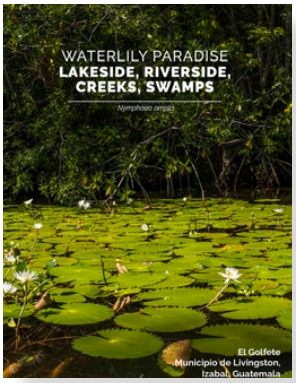
www.maya-ethnozoology.org.

Other publications of
the flora of Guatemala



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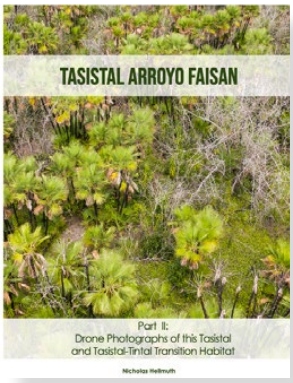

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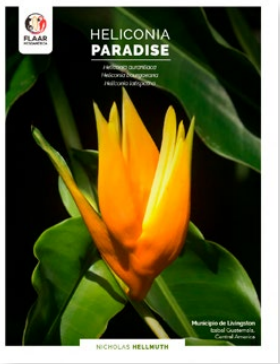

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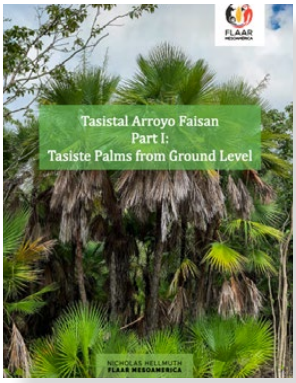

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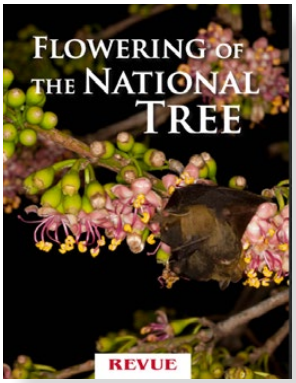

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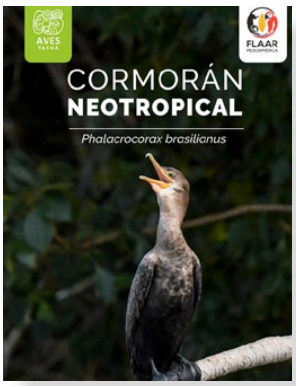

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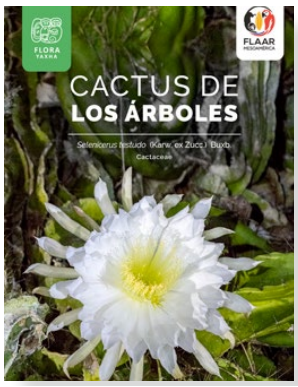

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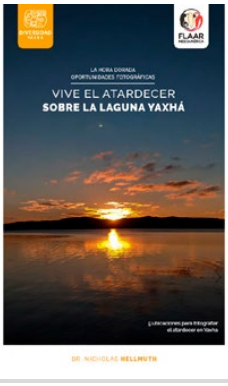

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