



FLOATING HEART WATER SNOWFLAKE

Nymphoides indica Vol. 1

El Golfete
Livingston, Izabal

NICHOLAS **HELLMUTH**

LIVINGSTON

Plants



FLOATING HEART WATER SNOWFLAKE



MAY 2020

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Photograph by: María Alejandra Gutiérrez. FLAAR Mesoamerica. March, 2020. Camera: SONY DSC-RX10M4. Lens Sony 90mm Macro G OSS. Settings: 1/250, f/13, ISO 3200.

Title Page Photograph *Nymphoides indica*

Photograph by: María Alejandra Gutiérrez. FLAAR Mesoamerica. March, 2020. Camera: SONY DSC-RX10M4 Lens Sony 90mm Macro G OSS. Settings: 1/250, f/13, ISO 3200.

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INTRODUCTION

I have enjoyed doing field research in swamps, rivers, and other wetland habitats of Guatemala for decades. I have spent literally years doing field trips twice every year studying *Nymphaea ampla*, the large white waterlily, all over Guatemala: parallel to the Pacific Ocean, deep in western Peten (Rio San Pedro) and multiple field trips over two decades in Arroyo Pucte, a tributary of Rio La Pasion. Never in any of these decades did I stop to study or photograph the smaller waterlily species of *Nymphoides indica*.

Yet during our mid-March 2020 field trip to rivers, creeks, lakes, lagoons, and inlets in the Municipio de Livingston, we saw entire “fields” of flowers of *Nymphoides indica*. Often these tiny but bright white furry-fuzzy edged water flowers were mixed next to the larger white waterlily. In other areas a kilometer away the *Nymphoides indica* were by themselves. So I finally woke up to realize that *Nymphoides indica* is a potentially common riverside, lakeside, creek-side, swamp-side flower of the El Golfete area of the Rio Dulce area of Izabal.



Check our previous report:

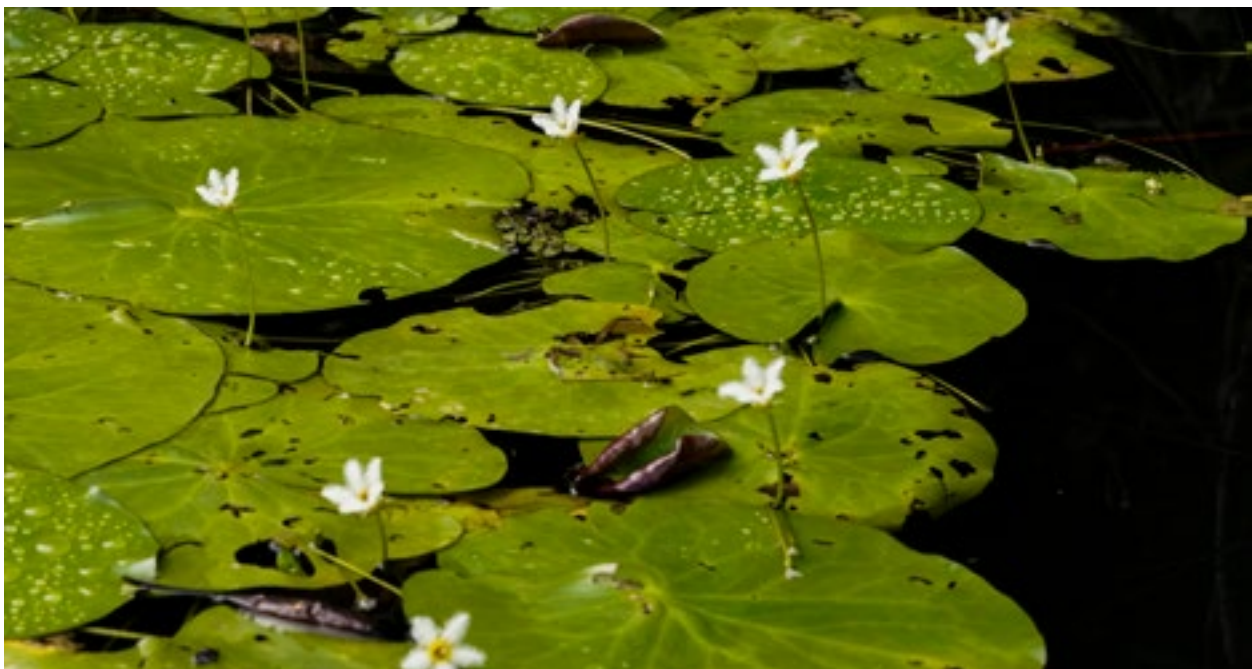
Waterlilies Paradise
Lakeside, Riverside, Creeks,
Swamps, *Nymphaea ampla*.



So back in my research office I dedicated hour after hour, of my typical 12 to 14 hour work days, to learning about *Nymphoides indica*. I quickly noticed that I was not the only individual who has not noticed and not listed this plant previously. So one goal of this present FLAAR report is to inspire botanists and students to search every lake, river, and humid area of Peten and elsewhere in Izabal to see where else *Nymphoides indica* is present, and equally important, in which rivers and lakes is this water plant not present.

These small flowers of *Nymphoides indica* are among the most photogenic flowers of this size that I have yet found in Guatemala. The furry fuzzy outline of each petal, in different sunlight angles, is really great to see in a digital photograph. Since in 50+ years of exploring diverse parts of rivers, creeks, lakes, and lagoons I have never seen this many extensive areas literally covered with *Nymphoides indica*, it is clear that the El Golfete areas of the Municipio de Livingston are worth visiting.

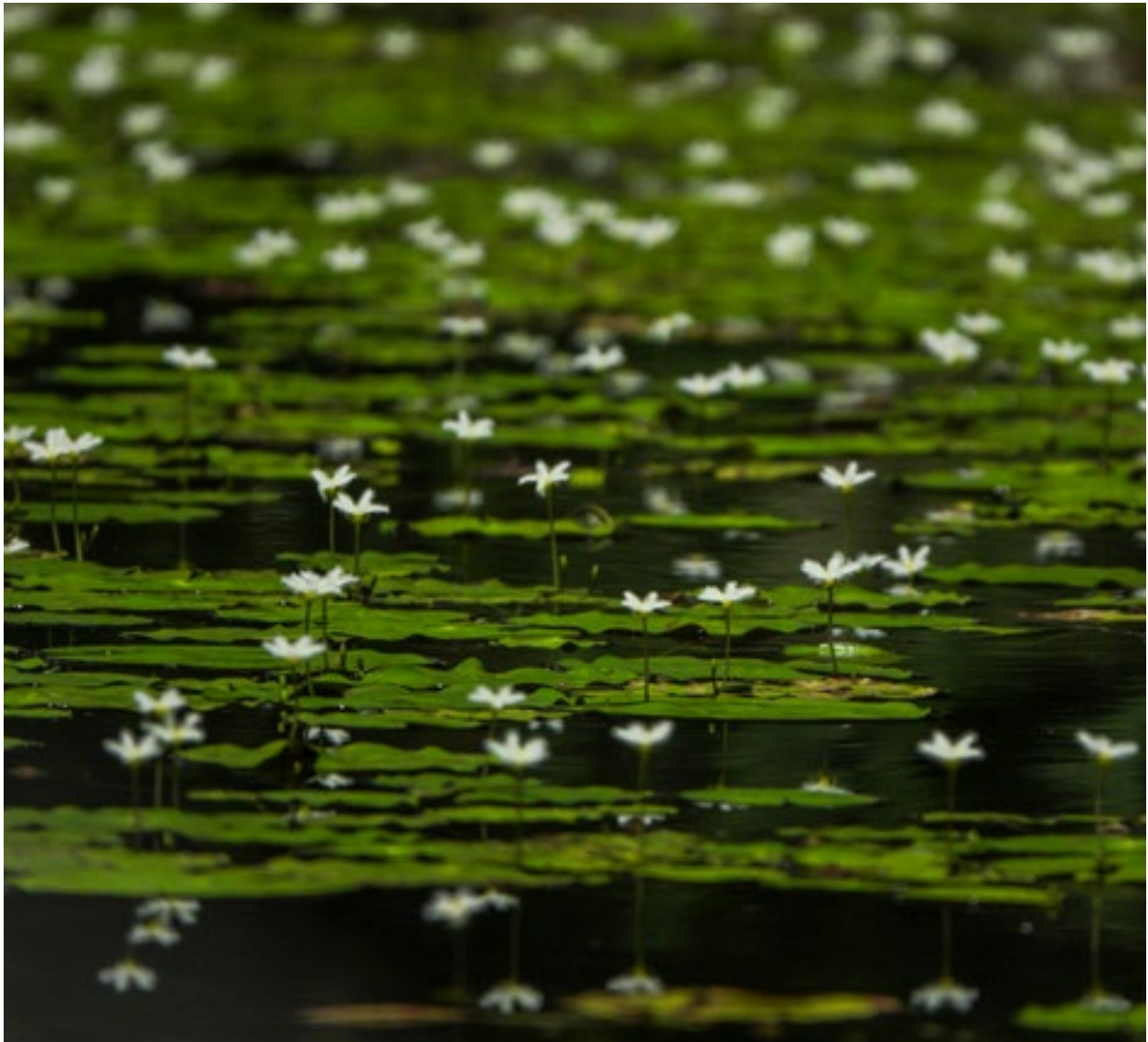
If you are planning a visit to these “waterlily islands” be sure you have arranged a boat that is specifically for exploring these shore areas. The “water taxis” take you near these areas but their job is to get you from Rio Dulce bridge to the village of Livingston. We would recommend to stay in one of the hotels that faces the El Golfete or is near the water lily area and then either kayak around them or have a local lancha and patient boat captain. So far all the masses of *Nymphoides indica* that we found were in the eastern half of El Golfete.



Nymphoides indica founded at the riverside, El Golfete.
Photograph by: María Alejandra Gutiérrez, FLAAR Mesoamerica. March 14, 2020.
Camera: SONY DSC-RX10M4. Settings: 1/250, f/13, ISO.3200.

Three of us photographed these flowers. We each have a different kind of camera, different lens, and different personal style (such as what angle we do the photography from).

I must admit that the common name, *Floating Heart*, was unexpected. And having grown up first in snowy winters of Detroit, Michigan, and then St. Louis, Missouri, I do indeed know what a snowflake looks like. So now I can sense why someone somewhere gave these flowers the name of *Water Snowflake*. I have been very motivated to research, write, and publish this interesting water plant. And definitely look forward to returning to the Municipio de Livingston to accomplish additional research on of *Nymphoides indica*.



Nymphoides indica. founded at the riverside, El Golfete.

Photograph by: María Alejandra Gutiérrez, FLAAR Mesoamerica. March 14, 2020.

Camera: SONY DSC-RX10M4. Lens: Sony 8.8-220mm f/2.4-4. Settings: 1/6400, f/4, ISO.500.

FULL BOTANICAL NAME AND HABIT

Nymphoides indica (L.) Kuntze, Family Menyanthaceae.

Habit: Herb, aquatic.



Nymphoides indica. El Golfete, Livingston.
Photograph by: María Alejandra Gutiérrez, FLAAR Mesoamerica. March 14, 2020.
Camera: SONY a7R IV. Lens: Sony 90mm Macro G OSS. Settings: 1/250, f/13, ISO.3200.

LOCAL NAMES FOR *NYPHOIDES INDICA*

Common names in English are “floating heart” and “water snowflake”.

(<https://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=242>).

Called “cebolla de agua”, “corazón de agua” for the area of Cerro San Gil (south side of El Golfete) (CONAP 2008: 152). “Pancillo” (for Rio Usumacinta, Tabasco, Ochoa et al 2018: 6).

Nombres comunes: Hoja de sol, trigueña y pancillo (Tabasco), estrella de agua y camalotillo (Veracruz). (Lot et al. 2015: 192).

Hoja de sol = leaf of the sun.

Corazón de agua = literally, heart of water; figuratively floating heart.

Trigueña is a color, a word used for skin color or hair color.

Pancillo means a small item of bread (or bread-like material). Would be interesting to know if the word pancillo is because the roots were still eaten 1000 years ago by the Mayan people of Tabasco?

Cebolla de agua literal meaning is onion of water (again, perhaps a residue of this plant's roots being eaten a thousand years ago?).

Camalotillo is usually used for the invasive species of the lavender-flowered genus *Eichhornia*. So I am surprised that camalotillo is also used for the totally different white-colored native waterlily. Yet, when you Google “camalotillo” you do not get *Eichhornia* you get photographs of *Nymphoides indica*.



Nymphoides indica. El Golfete, Livingston. Photograph by: David Arrivillaga, FLAAR Mesoamerica. March 14, 2020. Camera: NIKON D5 Lens: 35mm f/1.4. Settings: 1/640, f/9, ISO 640

As typical in Spanish language, any one word can have totally unrelated meanings. So the word camalotillo also is for a still another completely different plant, *Paspalum plicatulum*.



Nymphoides indica..El Golfete, Livingston. A foreign honeybee hanging around seeking for nectar.
Photograph by: David Arrivillaga, FLAAR Mesoamerica. March 14, 2020.
Camera: NIKON D5 Lens:Nikon 28-300mm VR Settings: 1/500, f/11, ISO 640

SYNONYMS FOR *NYPHOIDES INDICA*

About 80% of the botanical monographs and articles written up to about the year 2008 use the plant name *Nymphoides humboldtiana*. This is a synonym, thus no longer accepted. But you need to know the history of the names so you can recognize when the plant they are describing or the plant they list for their research area is really *Nymphoides indica*. Here is a list of all 23 synonyms.

Limnanthemum esquirolii H. Lév.

Limnanthemum humboldtianum
(Kunth) Griseb.

Limnanthemum humboldtianum var.
parviflorum Griseb.

Limnanthemum indicum (L.) Griseb.

Limnanthemum indicum (L.) Thwaites

Limnanthemum thunbergianum Griseb.

Menyanthes brasilica Vell.

Menyanthes indica L.

Menyanthes petioliflora Stokes

Nymphoides humboldtiana (Kunth)

Kuntze

Nymphoides thunbergiana (Griseb.)

Kuntze



Nymphoides indica, with ***Nymphaea ampla***. El Golfete, Livingston.
Photograph by: Nicholas Hellmuth, FLAAR Mesoamerica. March 14, 2020.
Camera: NIKON D810 Lens: Nikon AF-Micro-NIKKOR 200mm IF-ED tele-macro.
Settings: 1/320, f/13, ISO 500

Villarsia communis A.St.-Hil.

Villarsia glandulosa Griff.

Villarsia humboldtiana Kunth

Villarsia indica (L.) Vent.

Villarsia nymphaeifolia Fraser

Villarsia platiphylla A.St.-Hil.

Villarsia rheedei Kostel.

Villarsia simsii G.Don

Villarsia swartzii G.Don

Villarsia trachysperma F.Muell.

(www.theplantlist.org/tpl/record/kew-2385097).

Most botanical lists of the 1900's and even into the early 2000's use the name *Nymphoides humboldtiana*. So if you search for information, you also need to search for which reports mention this name. Or it is easiest just to look for the Genus *Nymphoides*.



Nymphoides indica at the riverside, El Golfete, Livingston.

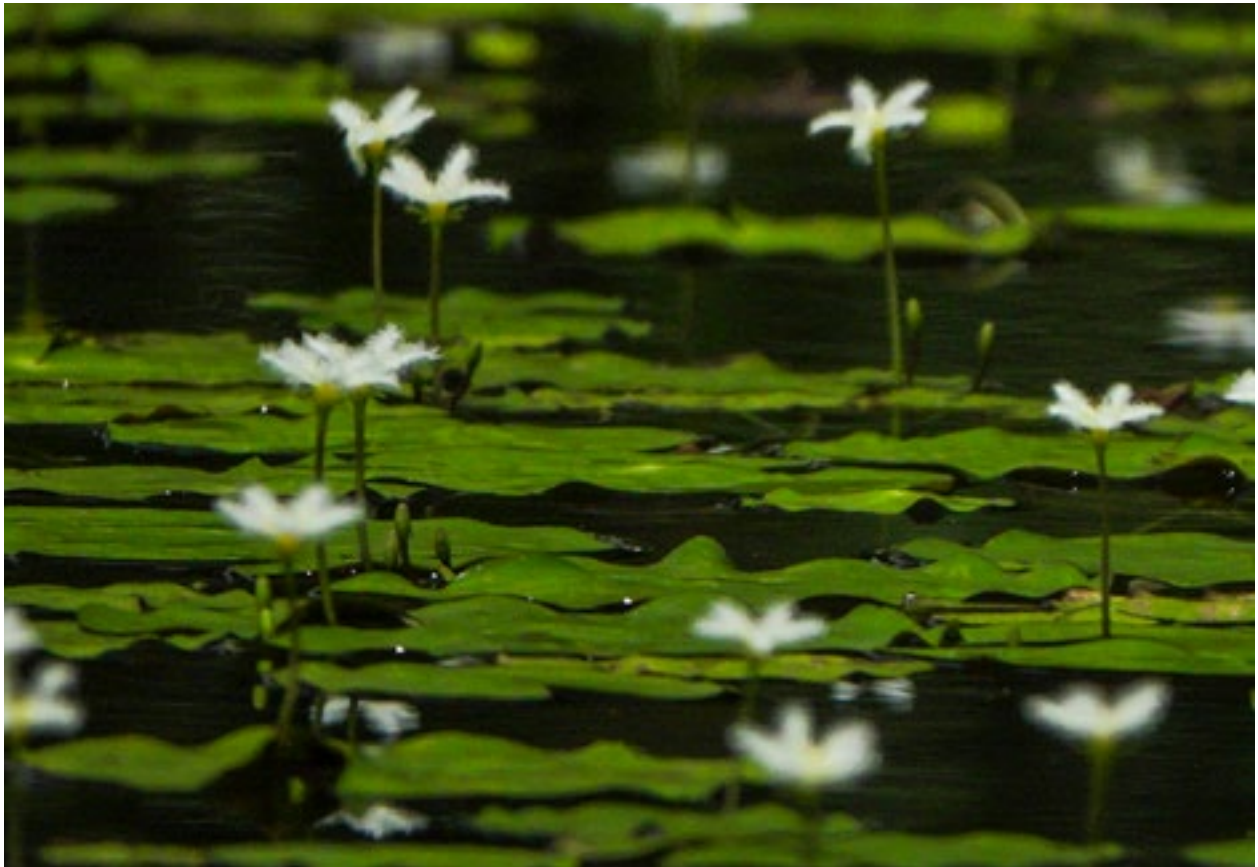
Photograph by: David Arrivillaga, FLAAR Mesoamerica. March 14, 2020. Camera: NIKON D5 .
Lens: 35mm f/1.4. Settings: 1/640, f/9, ISO 640

CLOSE RELATIVE(S) FOR *N. INDICA*

No other species of Genus *Nymphoides* are found in Guatemala or nearby countries. That's what you see in Flora of Guatemala. But *Nymphoides fallax* Ornduff is listed for Chiapas and Quintana Roo (but not for Tabasco or Campeche) (Mora et al. 2013: 590).

Nymphoides fallax is also listed in other botanical reports (Aguilar et al. 2003: 68). *Nymphoides fallax* Ornduff is an accepted name with no synonyms. *Nymphoides fallax* has yellow flowers. *Nymphoides indica* has white flowers.

Nymphoides fallax is listed for Chiapas and "Above Malacatancito, Huehuetenango, Guatemala" (<http://enciclovida.mx/especies/165662-nymphoides-fallax>). There are dozens, scores, of botanical articles written on *Nymphoides fallax*.



Nymphoides indica at the riverside, El Golfete, Livingston.

Photograph by: María Alejandra Gutiérrez, FLAAR Mesoamerica. March 14, 2020.

Camera: SONY DSC-RX10M4. Lens: 8.8-220mm f/2.4-4. Settings: 1/6400, f/4, ISO 500.

NYMPHOIDES INDICA IS NOT DOCUMENTED FROM PARQUE NACIONAL TIKAL

The extensive park area around Tikal has several aguadas, but not much running water (since Rio Holmul is a series of dry river bed much of the year, with an occasional pond a few hundred dry meters from the next pool in the seasonal riverbed).

I would make a guess that *Nymphoides indica* prefers water of a meter or more depth, and water that is at least occasionally flowing. But I would not have a heart attack if I learned that *Nymphoides indica* is indeed in an aguada in or near Tikal. But I tend to expect *Nymphoides indica* to be present on the shore of a lake or shore of a river that is flowing all year.



Nymphoides indica, waterlilies, El Golfete, Livingston
Photograph by: María Alejandra Gutiérrez, FLAAR Mesoamerica. March 14, 2020.
Camera: SONY DSC-RX10M4. Lens: 8.8-220mm f/2.4-4. Settings: 1/1600, f/8, ISO.500.

SAME FOR YAXHA NAKUM NARANJO, THIS *NYMPHOIDES INDICA* IS MISSING FROM EARLIER LISTS

The list of plants for Yaxha by Dix and Dix 1992 is helpful for trees and for their specialty of orchids and bromeliads but does not even list *Nymphaea ampla* even though the name for the second largest lake in the park (Lago Sacnab) is translated as White Water Lily Lake. The other Dix research, on wetlands of Guatemala, openly admits they have no information for Lake Yaxha.

Neither *Nymphoides indica* (L.) Kuntze, nor Family Menyanthaceae is in the list of Reyes, Can, *et al.* n.d. But the synonym *Nymphoides humboldtiana* is in her longer list. She also suggests *Nymphoides humboldtiana* is an introduced species (Reyes et al. 2009: 46).

Their report we have found so far in three different editions; each typed up in different style. One is short; other(s) are longer. All are helpful, but full-page photographs would add more information; and discussion and description of each individual plant in a several page spread (with lots of high-resolution photographs at a size where you can also see what plants are nearby).



Nymphoides indica. El Golfete, Livingston
Photograph by: David Arrivillaga FLAAR Mesoamerica. March 14, 2020. Camera: NIKON D5.
Lens: Nikon 28-300mm VR. Settings: 1/500, f/11, ISO.640.

BRIEF DESCRIPTION OF A SYNONYM **BY STANDLEY AND RECORD (1936)**

Only an older name, now a synonym, *Limnanthemum Humboldtianum* (HBK.) Griseb is in this antiquated book on the plants of Belize. Virtually no botanical information of use whatsoever (Standley and Record 1936: 321), other than that this plant is indeed findable in Belize:

MENYANTHACEAE. Buckbean Family

LIMNANTHEMUM Gmel.

Limnanthemum Humboldtianum (HBK.) Griseb. An aquatic plant.



Nymphoides indica. El Golfete, Livingston

Photograph by: María Alejandra Gutiérrez, FLAAR Mesoamerica. March 14, 2020.

Camera: SONY DSC-RX10M4 Lens: Sony 8.8-220mm f/2.4-4. Settings: 1/1600, f/8, ISO.500.

BOTANICAL DESCRIPTION OF *NYMPHOIDES HUMBERTIANUM* BY STANDLEY AND WILLIAMS (1969)

Nymphoides humboldtianum (HBK.) Kuntze, Rev. Gen. PL

2: 429. 1891. *Villarsia humboldtiana* HBK. Nov. Gen. & Sp. 3: 187.

1818. *Limnanthemum humboldtianum* Griseb. Gen. & Sp. Gent. 347.

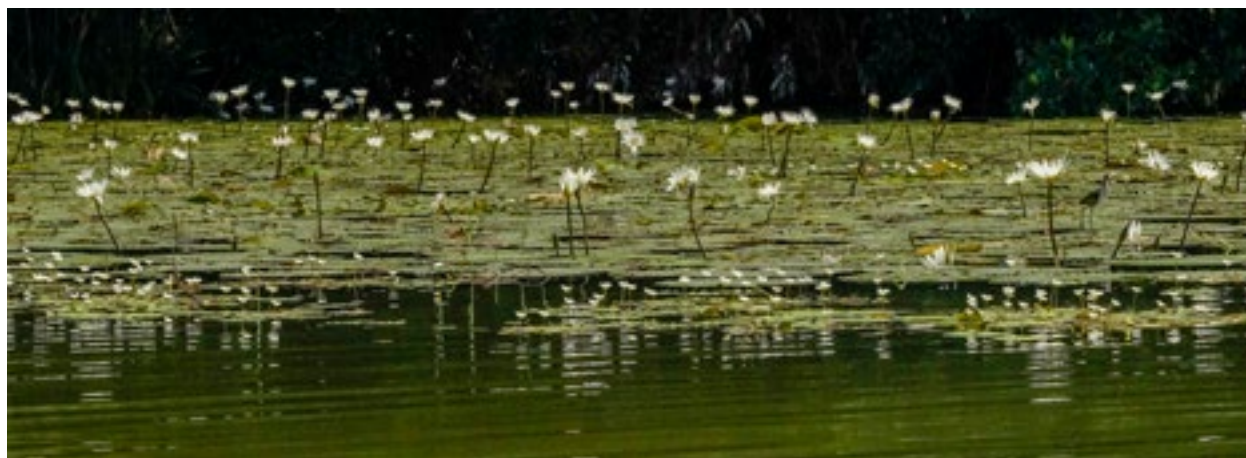
1838. Cebolla de agua; Corazon de agua.

Floating on ponds or lakes or sometimes submerged or on mud, 2,000 m. or less; Peten; Izabal; Chiquimula; Jalapa; Jutiapa; Santa Rosa; Esquintla; Quiche; Huehuetenango; probably also in other departments. Mexico; British Honduras to Panama. West Indies. South America.

Plants glabrous, with elongate rootstocks, fleshy, the stems stout, often spongy, mostly 40 cm. long or shorter; leaves solitary, orbicular or orbicular-reniform, 3-12 cm. broad, deeply cordate at the base; flowers white or yellow, in a sessile umbel at the base of the petiole, the pedicels few or numerous, very unequal, 3-10 cm. long, deflexed in fruit; calyx segments linear-lanceolate, 8 mm. long; corolla lobes fimbriate, twice as long as the calyx, recurved; capsule somewhat shorter than the calyx; seeds numerous, smooth, globose.

The plants sometimes are found upon mud, where the water has receded. The leaves are often purplish beneath. In Guatemalan plants the flowers are either white or yellow. The plants of this alliance sometimes are placed in a separate family Menyanthaceae.

(Standley and Williams 1969: 326 and 328; Fig. 89 on page 327).



Nymphoides indica and ***Nymphaea ampla***. El Golfete, Livingston

Photograph by: María Alejandra Gutiérrez, FLAAR Mesoamerica. March 14, 2020. Camera: SONY a7R IV
Lens: Sony gomm Macro G OSS. Settings: 1/1600, f/13, ISO.3200.

In the 1960's these botanists placed this water plant in the family NYMPHOIDES.

This monograph has nice botanical drawing of details (Fig. 89, page 327), but no image of the front of the flower from above, so no indication whatsoever of the fuzzy edges that make it look like a snowflake.

100% of the flowers we saw in every part of Municipio de Livingston were white. None were yellow. Standley and Williams, back in the 1960's, did not realize that the species with yellow flowers is a separate species: *Nymphoides fallax* Ornduff.



Nymphoides indica. El Golfete, Livingston

Photograph by: David Arrivillaga, FLAAR Mesoamerica. March 14, 2020.

Camera: NIKON D5. Lens: 35mm f/1.4. Settings: 1/640, f/9, ISO 64.

IS *NYMPHOIDES INDICA* NATIVE OR INTRODUCED?

There is no indication by Standley and Williams that *Nymphoides indica* is a plant from South America that has been introduced. However, a botanical report on plants of the wetlands of Tikal through Yaxha suggests that *Nymphoides indica* is as non-native as is the obvious *Eichornia crassipes* and *Pistia stratiotes* (Reyes 2009: 46).

Pistia stratiotes is water lettuce and is found in most aguadas, and stagnant water areas of Peten and nearby. We found lots of this in Parque Nacional Yaxha Nakum Naranjo. Some (but not all) botanists suggest that *Pistia stratiotes* was introduced but I have not yet seen convincing botanical documentation for either opinion (yes it was introduced for sure; yet it was already pan-tropical long ago). *Eichornia crassipes* is more convincingly originally from South America and escaped from gardens in Mesoamerica many decades ago.



Nymphoides indica. El Golfete, Livingston.

Photograph by: David Arrivillaga, FLAAR Mesoamerica. March 14, 2020. Camera: NIKON D5.
Lens: Nikon 28-300mm VR Settings: 1/500, f/11, ISO 640

COVERAGE OF *NYMPHOIDES INDICA* IN OTHER PERTINENT BOOKS

The book *Inventario Nacional de los Humedales de Guatemala* has nothing from plant family Menyanthaceae and thus no species of *Nymphoides* whatsoever. This book failed to have documentation for Laguna Yaxha (page 67). For Laguna Sacnab not one single water plant is mentioned other than *Typha* (p. 54). Rio Ixtinto does not seem to exist in their three-page list of other rivers (pages here have no numbers).

Despite the title *National Inventory of Water-related Areas of Guatemala*, not one single solitary river or creek near Rio Dulce is mentioned: Tapon Creek is missing, Lagunita Creek is Missing. Even Rio Chocón Machacas is missing.

Fortunately, Arroyo Pucté is included (a river far far away, Sayaxche is closer than La Libertad, a tributary of Rio la Pasion). Here the author even lists *Utricularia*, *Najas wrightiana*, *Nymphaea ampla*, *Ludwigia* spp., *Habenaria* spp. (141). The list of flora for Rio Dulce is so totally absent I literally don't know what to say (p. 79).



Nymphoides indica. El Golfete, Livingston.

Photograph by: María Alejandra Gutiérrez, FLAAR Mesoamerica. March 14, 2020..

Camera: SONY a7R IV. Lens: Sony gomm Macro G OSS Settings: 1/250, f/13, ISO 3200

Fortunately USAC has dozens of outstanding theses and many capable botanists. CONAP has talent and dedication. This monograph has a good start for a list of rivers and lakes (would help if it could be also in ABC order in an index). But the report on wetlands of Tikal through Yaxha is so much better as are all the independent reports on the Rio Sarstún area, Biotope Chocón Machacas, etc.

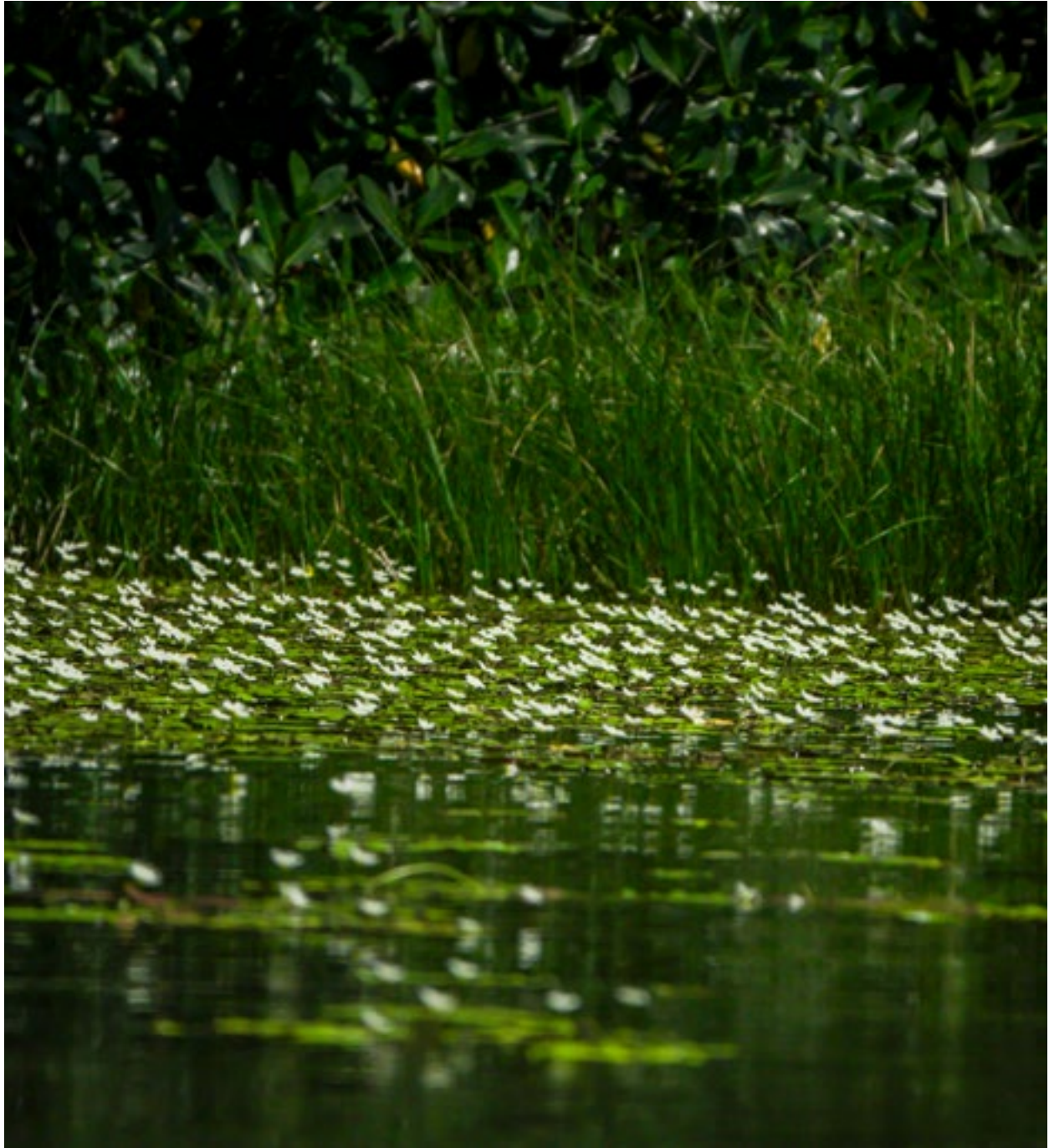
Our motivation for preparing this present report is to show the potential of El Golfete and surrounding areas for studies of water plants. But this is best done *insitu*, on field trips, and staying in the area with the assistance of local guides.



Nymphoides indica. El Golfete, Livingston.
Photograph by: David Arrivillaga, FLAAR Mesoamerica. March 14, 2020. Camera: Nikon D5.
Lens: 35mm f/1.4. Settings: 1/800, f/8, ISO 640.

WHERE HAS *NYMPHOIDES INDICA* BEEN **FOUND IN PETEN, NOT FAR FROM IZABAL?**

It is unlikely that *Nymphoides indica* is only in Izabal. So as soon as the university herbaria of Guatemala are hopefully reopened after the Coronavirus pandemic, we can find where else this plant has been collected in Guatemala.

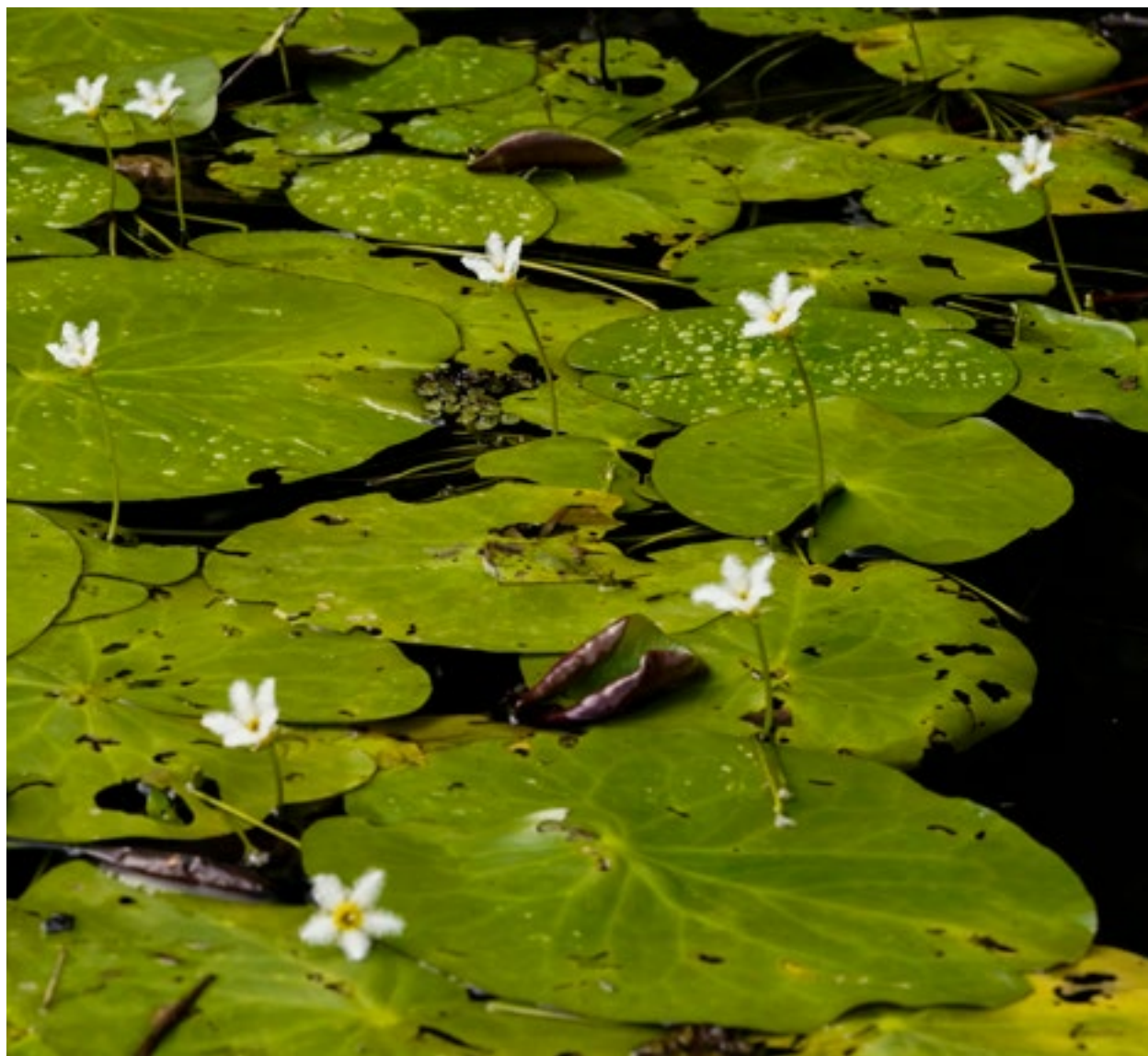


Nymphoides indica..El Golfete, Livingston.
Photograph by: María Alejandra Gutiérrez, FLAAR Mesoamerica. March 14, 2020.
Camera: SONY DSC-RX10M4. Settings: 1/800, f/8, ISO 640.

WHERE HAS *NYMPHOIDES INDICA* **BEEN FOUND IN ALTA VERAPAZ?**

So far not many water plant records for Alta Verapaz. But the records for Rio Polochic (far inland from Bocas de Polochic), the records for Rio Cahabon would be helpful.

Surely there are documents for Lachoa (Laguna Lachuá) that can be studied to learn more about whether *Nymphoides indica* is present there.



Nymphoides indica..El Golfete, Livingston.

Photograph by: María Alejandra Gutiérrez, FLAAR Mesoamerica. March 14, 2020. Camera: SONY a7R IV.
Lens: Sony 90mm Macro G OSS. Settings: 1/250, f/13, ISO 3200.

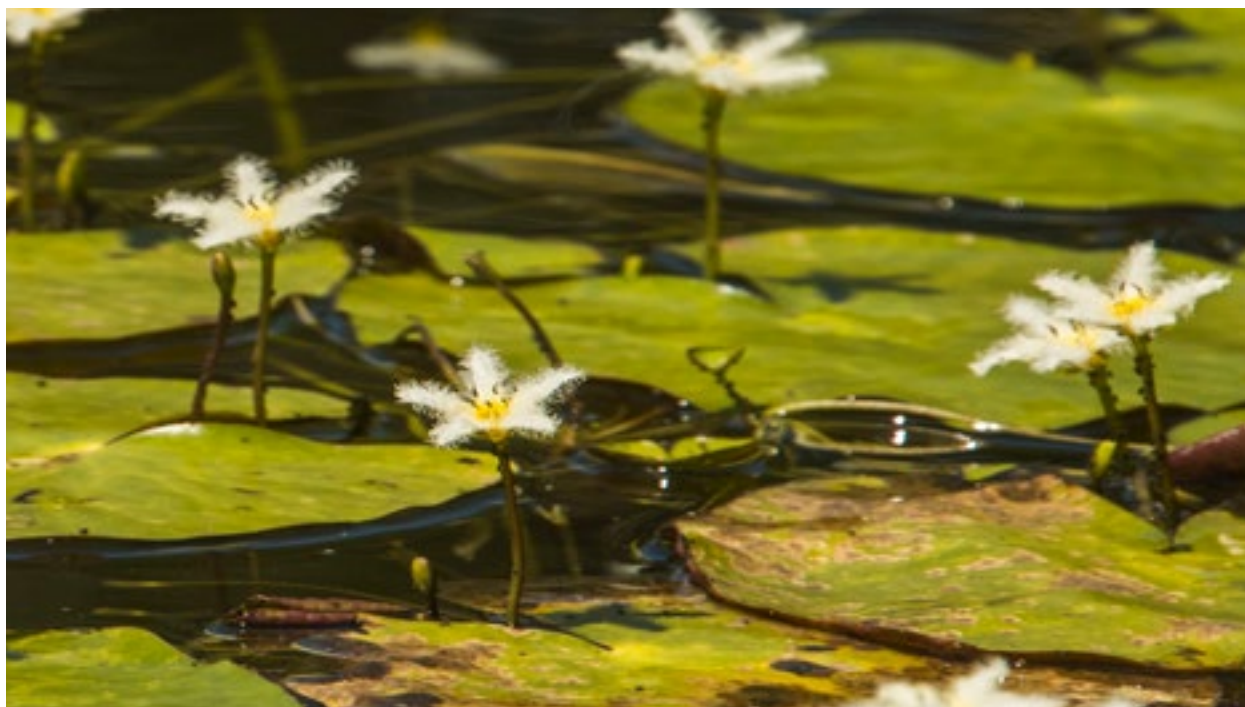
WHERE ELSE HAS *NYMPHOIDES INDICA* BEEN FOUND IN GUATEMALA?

The Neotropical Plant Portal Collection data base shows:

- Vicinity of Malacatancito, Dept. Huehuetenango
- Amatitlán, Laguna de Calderas, Volcán de Pacaya
- Jutiapa, Agua Blanca, Laguna Obrejuela, Agua Blanca, 5 km al S de la cabecera. 14.45 -89.64, 878m. (<https://serv.biokic.asu.edu/neotrop/plantae/collections/list.php>).

The specimen listed for Malacatancito should probably be identified as *Nymphoides fallax* Ornduff because another botanical web site lists this same location for this "yellow-flowered species " (<http://enciclovida.mx/especies/165662-nymphoides-fallax>).

As soon as the Coronavirus pandemic is over, and university herbaria are open again, we will check to see where else this water plant has been documented in Guatemala.

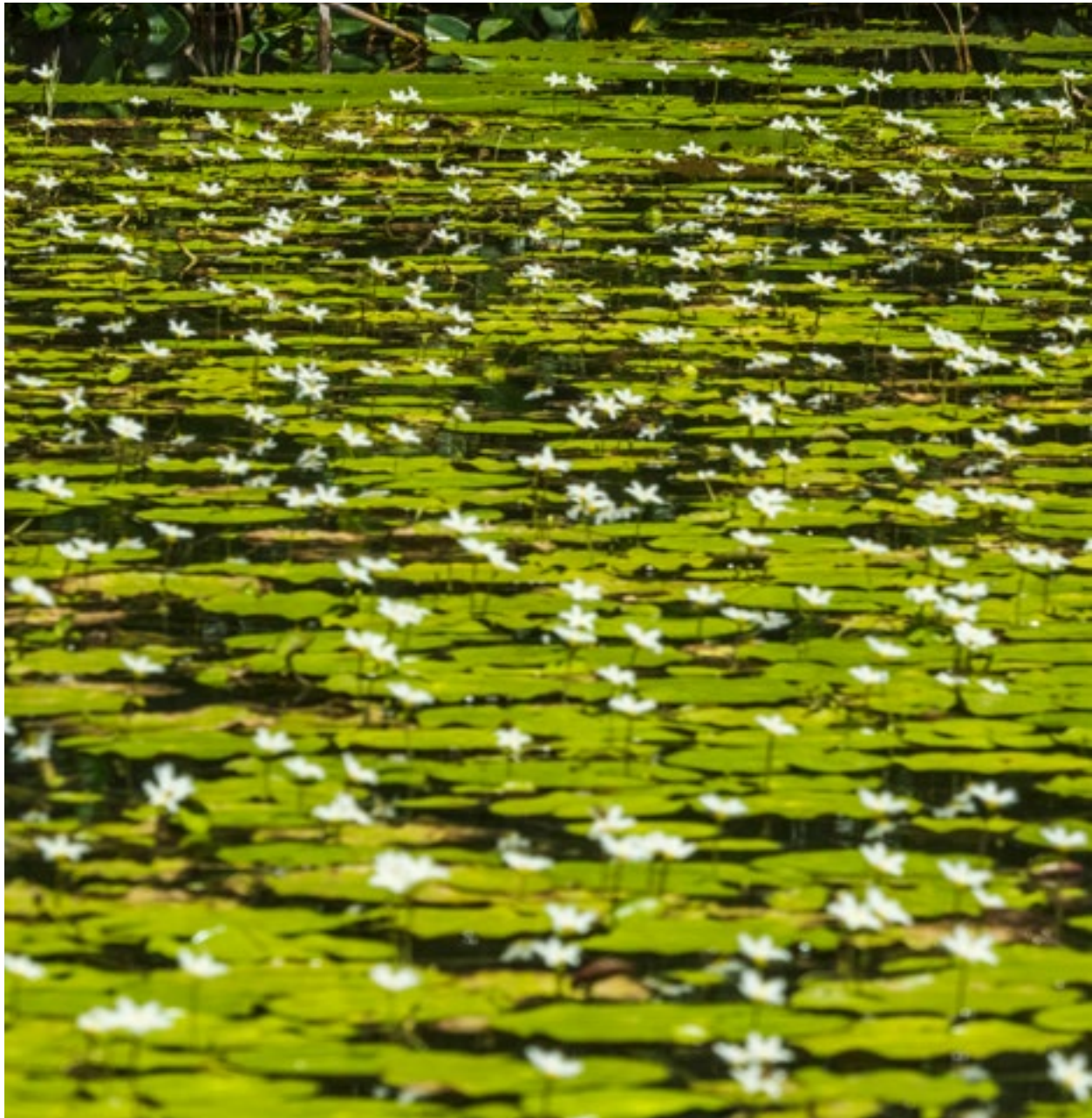


Nymphoides indica..El Golfete, Livingston.

Photograph by: David Arrivillaga, FLAAR Mesoamerica. March 14, 2020. Camera: Nikon D5. Lens: Nikon 28-300mm VR. Settings: 1/500, f/11, ISO 640.

NYMPHOIDES INDICA IN CHIAPAS

The yellow-flowered species, *Nymphoides fallax* Ornduff, is listed for Chiapas (<http://enciclovida.mx/especies/165662-nymphoides-fallax> and <http://abm.ojs.inecol.mx/index.php/abm/article/view/50/97>)



Nymphoides indica..El Golfete, Livingston.

Photograph by: David Arrivillaga, FLAAR Mesoamerica. March 14, 2020. Camera: Nikon D810.

Lens: Nikon AF-Micro-NIKKOR 200mm IF-ED tele-macro. Settings: 1/320, f/14, ISO 640.

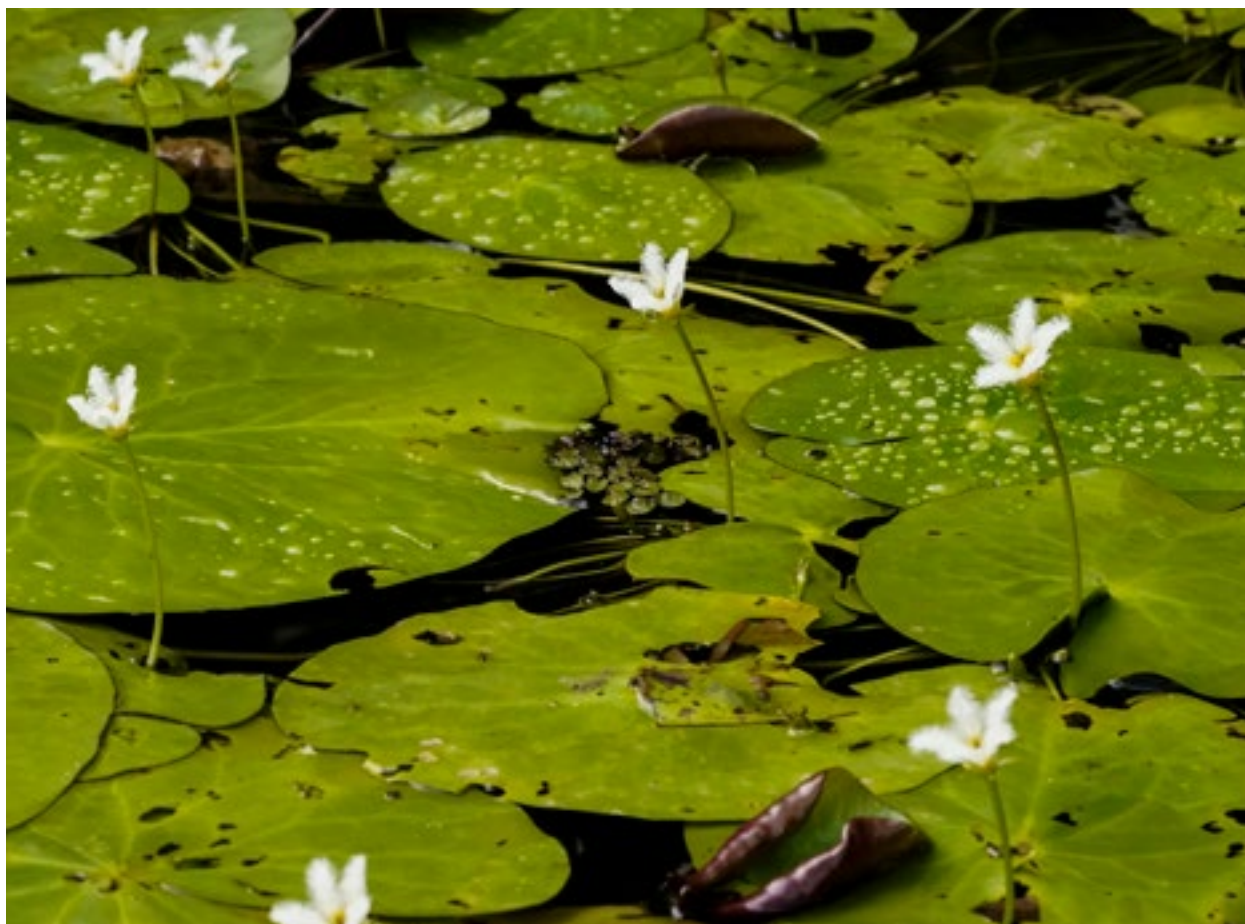
NYMPHOIDES INDICA IN TABASCO

Not listed for Tabasco in www.cicy.mx/sitios/flora%20digital/ficha_virtual.php?especie=1832

So would be essential to review all modern ecological studies and see whether *Nymphoides indica* is missing from the wetlands of Tabasco. Due to the biodiversity of the flood plains of Tabasco, surely there are a lot of water plants here. And, after several days of additional library research, I found Tabasco listed for *Nymphoides indica*:

Nymphoides indica (L.) Kuntze (1, 2) CAMPECHE, CHIAPAS, COL, GRO, HGO, JAL, MICH, NAY, QRO, QUINTANA ROO, TABASCO, TAMS, VER, even YUCCATAN.

(<http://abm.ojs.inecol.mx/index.php/abm/article/view/50/97>).



Nymphoides indica..El Golfete, Livingston.

Photograph by: María Alejandra Gutiérrez, FLAAR Mesoamerica. March 14, 2020. Camera: SONY a7R IV.
Lens: Sony 90mm Macro G OSS. Settings: 1/250, f/13, ISO 3200.

NYMPHOIDES INDICA **IN CAMPECHE**

Present. www.cicy.mx/sitios/flora%20digital/ficha_virtual.php?especie=1832



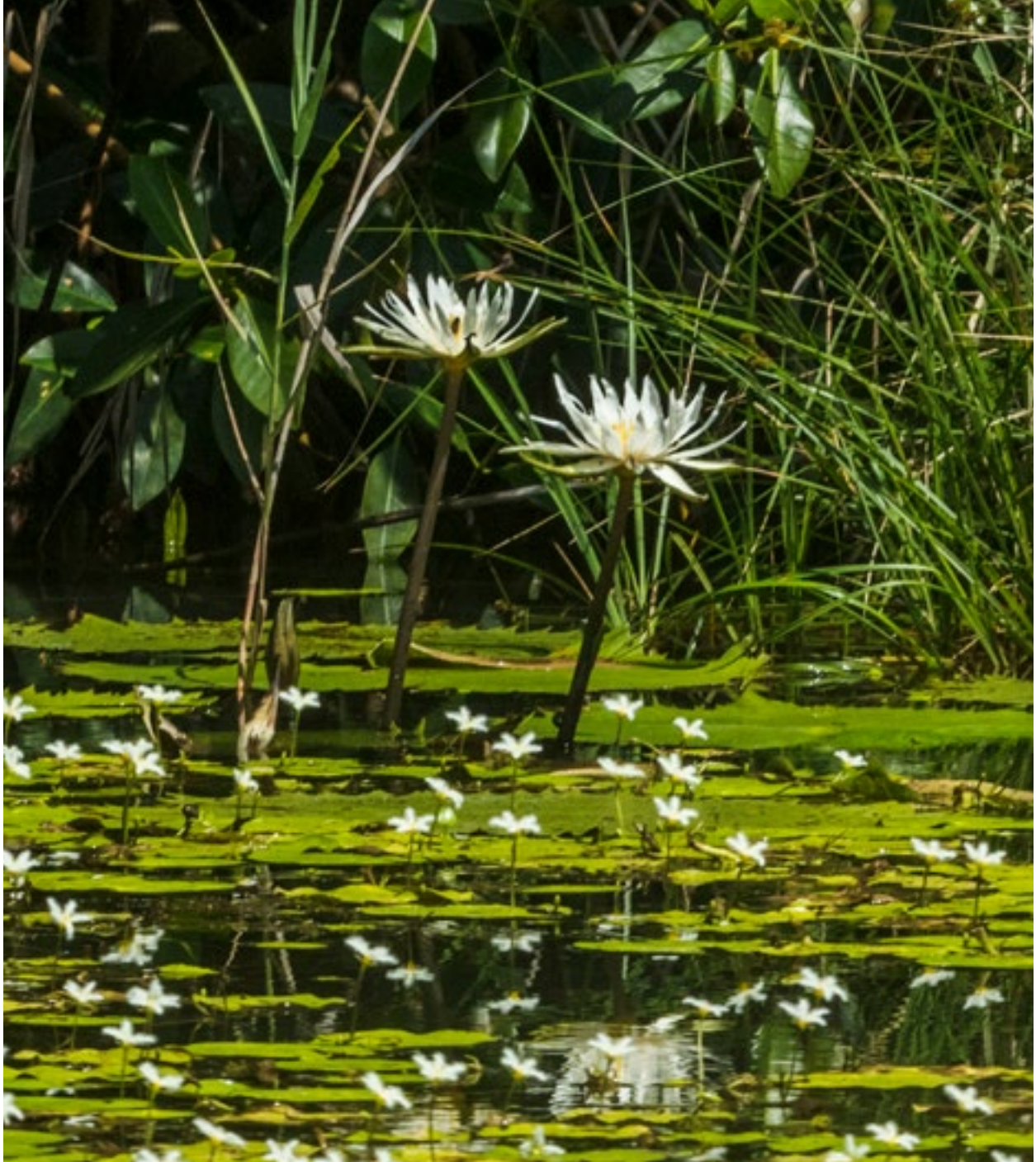
Nymphoides indica. El Golfete, Livingston.

Photograph by: María Alejandra Gutiérrez, FLAAR Mesoamerica. March 14, 2020.

Camera: SONY a7R IV. Lens: Sony 90mm Macro G OSS. Settings: 1/250, f/13, ISO 3200.

NYMPHOIDES INDICA IN QUINTANA ROO

Also present, www.cicy.mx/sitios/flora%20digital/ficha_virtual.php?especie=1832, and also in Yucatan.



Nymphoides indica with *Nymphaea ampla* at the back, El Golfete, Livingston.
Photograph by: David Arrivillaga, FLAAR Mesoamerica. March 14, 2020. Camera: NIKON D810.
Lens: Nikon AF-Micro-NIKKOR 200mm IF-ED tele-macro. Settings: 1/320, f/14, ISO 640.

NYMPHOIDES INDICA IN BELIZE

Yes, this plant is documented for Belize (Balick, Nee and Atha 2000: 129). There are dozens of REA reports that can show where. But as with all such reports, and with 90% of Master Plans, the plants are in a tabulated list. Lacking is information of what plants are associated with what other plants; how deep is the water, etc. since our initial field trips to El Golfete area is to do initial exploration, we are still in our first step. But we can definitely already show, with photographs, what other water lilies are present, etc. I love plant lists, but it helps to have additional information.



Nymphoides indica. El Golfete, Livingston.

Photograph by: María Alejandra Gutiérrez, FLAAR Mesoamerica. March 14, 2020.

Camera: SONY DSC-RX10M4 Lens: Sony 8.8-220mm f/2.4-4. Settings: 1/6400, f/4, ISO 500.

IN WHAT ECOSYSTEM(S) CAN YOU FIND **NATIVE *NYMPHOIDES INDICA*?**

As mentioned above, the problem is that most botanical web sites and reports (and PhD dissertations on areas) simply have *Nymphoides* in their list. Rarely is any mention of how it grows or anything else about it. One helpful exception is for the Pantanos de Centla Biosphere Reserve, Tabasco, from ParksWatch (2003:4) (an entity which was very active in Mesoamerica in past decades but seems no longer to be functioning?). An even more useful descriptions is by the botanists below:

The aquatic communities are subdivided into three major vegetation types:

1. Emergent aquatic vegetation Characterized by pure stands of cattails (*Typha latifolia*) which generally grow between 1 to 3 m tall, sawgrass (*Cladium jamaicense*) and jointed flat sedge (*Cyperus articulatus*). Within the reserve, this plant community is impacted by the expansion of agricultural activities, water retention, and wildfires;
2. Floating aquatic vegetation This type of vegetation is concentrated in boggy lake environments where it exists with cattails. Species include: water hyacinth (*Eichornia crassipes*), common duckweed (*Lemna minor*), dotleaf waterlily (*Nymphaea ampla*, *N. odorata*) and water snowflake (*Nymphoides humboldtiana*), among others;
3. Submerged aquatic vegetation The primary species are coontails (*Ceratophyllum demersum*) spineless hornwort, (*C. echinatum*) and bladderwort (*Utricularia* sp.) and they are found in the swamps and marshes. This type of vegetation is the least studied within the reserve, and it seems to be diminishing (Lot y Novelo 1988; Sol et al. 1993).



Nymphoides indica. El Golfete, Livingston.
Photograph by: David Arrivillaga, FLAAR Mesoamerica. March 14, 2020. Camera: NIKON D5.
Lens: Nikon 35mm f/1.4. Settings: 1/640, f/9, ISO 640.

I can add that so far that many of the *Nymphoides indica* plants were in water that I estimate is at least about 2 meters deep. Others were in water for sure over 1 meter deep. We know this since I had chest-high wading boot-trousers (so I can get into the water and do macro photography at water level). But even near the shore the water was too deep (and the mud would have allowed me and my camera to sink below my shoulders...).

Plus, there are *Nymphaea* plants physically adjacent in many areas. We have not yet studied *Lemna minor* but that is definitely on our "Need to Find, Photograph & Document" list for our next field trip to the Municipio de Livingston areas of biodiverse lakes, lagoons, inlets, rivers, creeks, and shore area swamps.



Nymphoides indica. El Golfete, Livingston.

Photograph by: David Arrivillaga, FLAAR Mesoamerica. March 14, 2020. Camera: NIKON D810.
Lens: Nikon AF-Micro-NIKKOR 200mm IF-ED tele-macro. Settings: 1/320, f/14, ISO 640.

DOES *NYMPHOIDES INDICA* ALSO GROW IN HOME GARDENS?

This plant is a plant for modern gardens but is not present in Mayan home gardens today, despite the fact that it is potentially edible. Since waterlilies require pools of water they are not appropriate for a kitchen garden in most hillside house areas.



Nymphoides indica with *Nymphaea ampla* at the back, El Golfete, Livingston.
Photograph by: David Arrivillaga, FLAAR Mesoamerica. March 14, 2020. Camera: NIKON D810.
Lens: Nikon AF-Micro-NIKKOR 200mm IF-ED tele-macro. Settings: 1/400, f/14, ISO 1250.

USES OF *NYMPHOIDES INDICA*

La raíz es comestible. Se saca la raíz, se limpia, luego se cocina. Tiene sabor como a batata es muy rica, se prepara como la batata, hirviendo en agua. (Polini 2018: 104)

First, there needs to be documentation (from pollen or whatever) that *Nymphoides indica* was present in the Maya Lowlands in the Classic period. As soon as we know for sure that this plant was in Mesoamerica before the arrival of non-local plants from the 16th century onward, then we should add *Nymphoides indica* to the list of edible roots available to feed the “millions” of Classic Maya imagined by LiDAR.



Nymphoides indica. El Golfete, Livingston.
Photograph by: David Arrivillaga, FLAAR Mesoamerica. March 14, 2020.
Camera: NIKON D5. Lens: Nikon 28-300mm VR. Settings: 1/500, f/11, ISO 640.

MODERATE POTENTIAL MEDICINAL USAGE OF *NYPHOIDES INDICA* BY LOCAL PEOPLE

Nymphoides indica is one of over 600 native plants of Guatemala that has potential medical usage. The medical aspects would best be a separate report.

i!

If you have many extra hours and days just to research edible and medicinal uses of *Nymphoides indica* you will quickly find lots of articles about these aspects of this plant in India. Lots of plants are brought from Mesoamerica and from South America to India, Africa, and Asia that have potential use. Though Polini mentions just the root as being edible, in India they focus on eating the leaf petiole ([Jain et al. 2011: Table 1](#)).



Nymphoides indica. El Golfete, Livingston.

Photograph by: David Arrivillaga, FLAAR Mesoamerica. March 14, 2020. Camera: NIKON D5. Lens: 35mm f/1.4 VR. Settings: 1/800, f/8, ISO 640.

WHEN DOES *NYPHOIDES INDICA* FLOWER?

We found *Nymphoides indica* in flower in mid-March 2020. We had not studied this plant on the February field trip. In February and also in March *Nymphaea alba* was flowering both months. I estimate this white waterlily flowers most of the year. But *Nymphoides indica* seems to flower only half of the year.

For Campeche *Nymphoides indica* flowers and fruits:

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
FLOWER	X		X				X	X	X			
FRUIT								X	X	X		

www.cicy.mx/sitios/flora%20digital/ficha_virtual.php?especie=1832

As is no surprise, each different botanical web site will list different months for flowering. It is not helpful to dump 14 different parts of Mexico together; Campeche, Chiapas, Colima, Guerrero, Hidalgo, Jalisco, Michoacán, Nayarit, Queretaro, Quintana Roo, Tabasco, Tamaulipas, Veracruz, Yucatán. So these dates are better than nothing but not guaranteed for any one location since the weather, temperature, rainfall is totally different in each state of Mexico.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
FLOR	X		X	X	X	X		X	X			
FRUIT	X		X		X			X	X			

(Lot et al. 2015: 193)

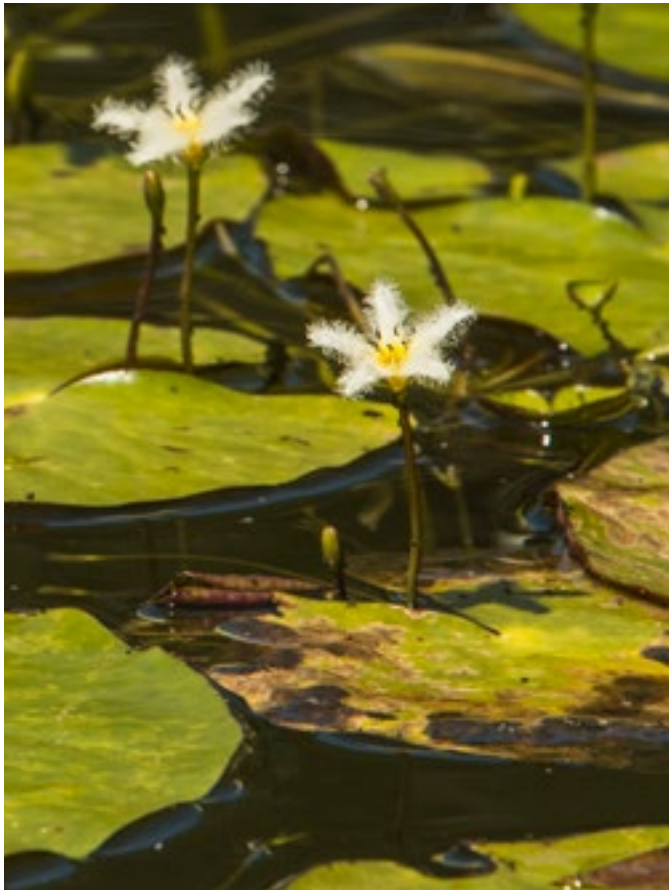
www.gob.mx/cms/uploads/attachment/file/102190/Gu_a_PIH-min.pdf

We prefer to document the dates for flowering one-area-at-a-time.

WHAT ARE THE PRIMARY POLLINATORS OF *NYPHOIDES INDICA* FLOWERS?

The Nymphonids genus includes plants that have an **entomophily pollination**, which is a way to reproduce the seeds plant. It means that the pollen, from flower to flower, needs to be distributed by insects who visit them to eat nectar or pollen itself. The main two animals who visit the flowers are from the Hymenoptera and Coleoptera order.

Nowadays, there are information gaps about the way and agents that pollinate certain groups of plants. That is why there's a need for more information and observations of the plant, it's habits, environment and the family and order they belong to in order to know which animal species pollinate waterlilies.



The Hymenoptera order includes insects as wasps, bees, ants, and sawflies. The Coleoptera order includes beetles and weevils. So, you must be prepared to look for some of these insects hanging around the waterlily's flowers and pollen

Nymphoides indica. El Golfete, Livingston.
 Photograph by: David Arrivillaga, FLAAR Mesoamerica
 March 14, 2020. Camera: NIKON D5.
 Lens: Nikon 28-300mm VR. Settings: 1/500, f/11, ISO 640.

NEXT STEPS, TO HAVE AVAILABLE MORE **DOCUMENTATION ON *NYPHOIDES INDICA***

First step is to show on a map where we have found:

Nymphoides indica growing by itself.

Nymphoides indica growing side by side with *Nymphaea ampla*.

Nymphaea ampla growing with no *Nymphoides indica* anywhere near.

But no maps are easy to find that have the names of each inlet, each swamp, each open area between to adjacent lagoons. So we need to have adequate maps of the entire Municipio of Livingston. Since they do not exist (at least in two months we have not found any on the Internet, we would prefer to make coordinate with the Municipio de Livingston and create these maps. To initiate this, we need the aerial maps from IGN (Instituto Geográfico Nacional) in digital format (.tif or high-resolution JPEG format). Google Maps does not provide the names of the inlets, the lagunitas, the creeks that abound along the north and south parts of El Golfete. Same with the area below Rio Sarstoon over to Tapon Creek. These creeks are not named on Google Maps.



Nymphoides indica. El Golfete, Livingston.

Photograph by: Juan Pablo Fumagalli, FLAAR Mesoamerica March 14, 2020.

Camera: Google Pixel 3XL

To find even a fraction of these creek names you need to locate between 20 and 50 different reports (so one to three on each nature reserve) to try to find the names of everything. So our goal is to have access to the IGN aerial maps digitally, and then have our team of designers put the names on each area. For example, which of the many islands filled with birds in El Golfete is “Bird Island.”

The printed IGN traditional maps of segments of the Municipio de Livingston are also needed, since these hopefully have at least the names on the larger creeks, rivers, and inlets. Next is to find local people who know the name of each creek and inlet and aldea, and go with them in a boat, and place the names on the map. Then present this map to IGN and to the Municipio de Livingston.

This map can also help INGUAT create more details in their two maps (of “Livingston” and of “Rio Dulce”). To attract more visitors it definitely would help for INGUAT to create a map of the area from Lagunita Creek nature preserve down to Tapon Creek nature preserve (and down to the town of Livingston).

Also, that other rivers and shores of lagoons elsewhere along the sides of El Golfete have this *Nymphoides indica* water plant? We have a lot more areas to explore on future field trips.



Nymphoides indica. El Golfete, Livingston.

Photograph by: Nicholas Helmuth, FLAAR Mesoamerica March 14, 2020. Camera: NIKON D810.
Lens: Nikon AF-Micro-NIKKOR 200mm IF-ED tele-macro. Settings: 1/320, f/13, ISO 500.

For botanists it would help to have more field work to document in which habitats do you get both *Nymphaea alba* physically adjacent to *Nymphoides indica*. And where do you find just one or just the other (but only a few hundred meters from other other). What allows the two to grow next to each other only in some habitats; what causes one only (and the other not)? And while studying habitat, would help to make a tabulation of every riverside, lakeside, or wetlands where one or the other (or both) are present in the entire country of Guatemala. And then, why is the yellow-flowered species (*Nymphoides fallax*) not in Peten or Izabal but is possibly in Huehuetenango? These are suggestions to biology and ecology students for a thesis.

Next step is to find, photograph, and map all the reeds, grasses and other plants that are nearby the *Nymphaea alba* and *Nymphoides indica*. For example, what water plants of the family Lemnaceae can be found in the rivers, lagoons, creeks, of the Municipio de Livingston. The aquatic plant duckweed, *Lemna minor* L., is potentially edible. So is *Wolffia brasiliensis*. Which of these two water plants is also in the Izabal wetlands?

And to photograph all aspects of the underwater aspects of plants we definitely need an underwater camera.

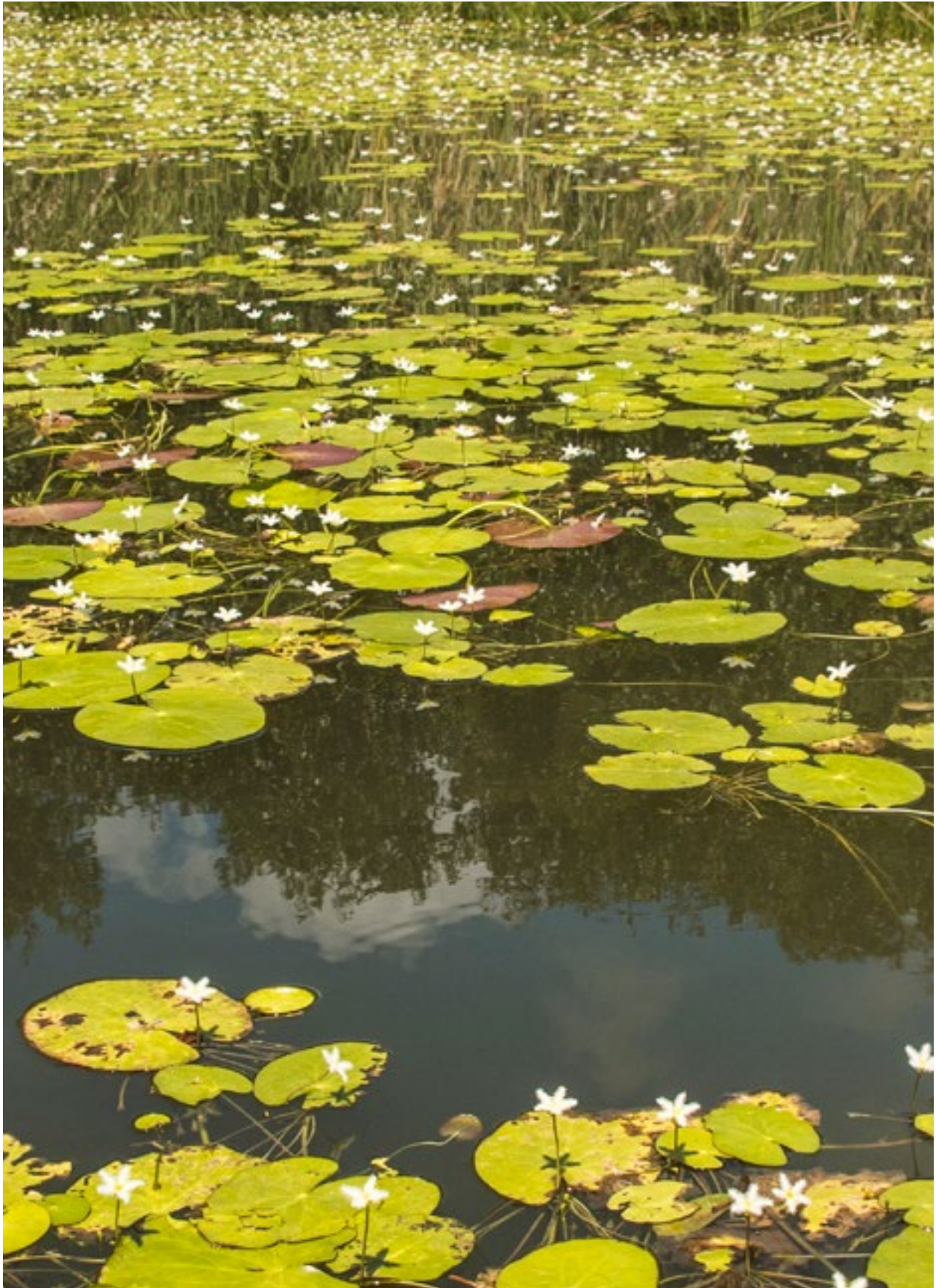
And, since two parts of *Nymphoides indica* are potentially edible, what are the nutrients in each part?



Nymphoides indica. El Golfete, Livingston.

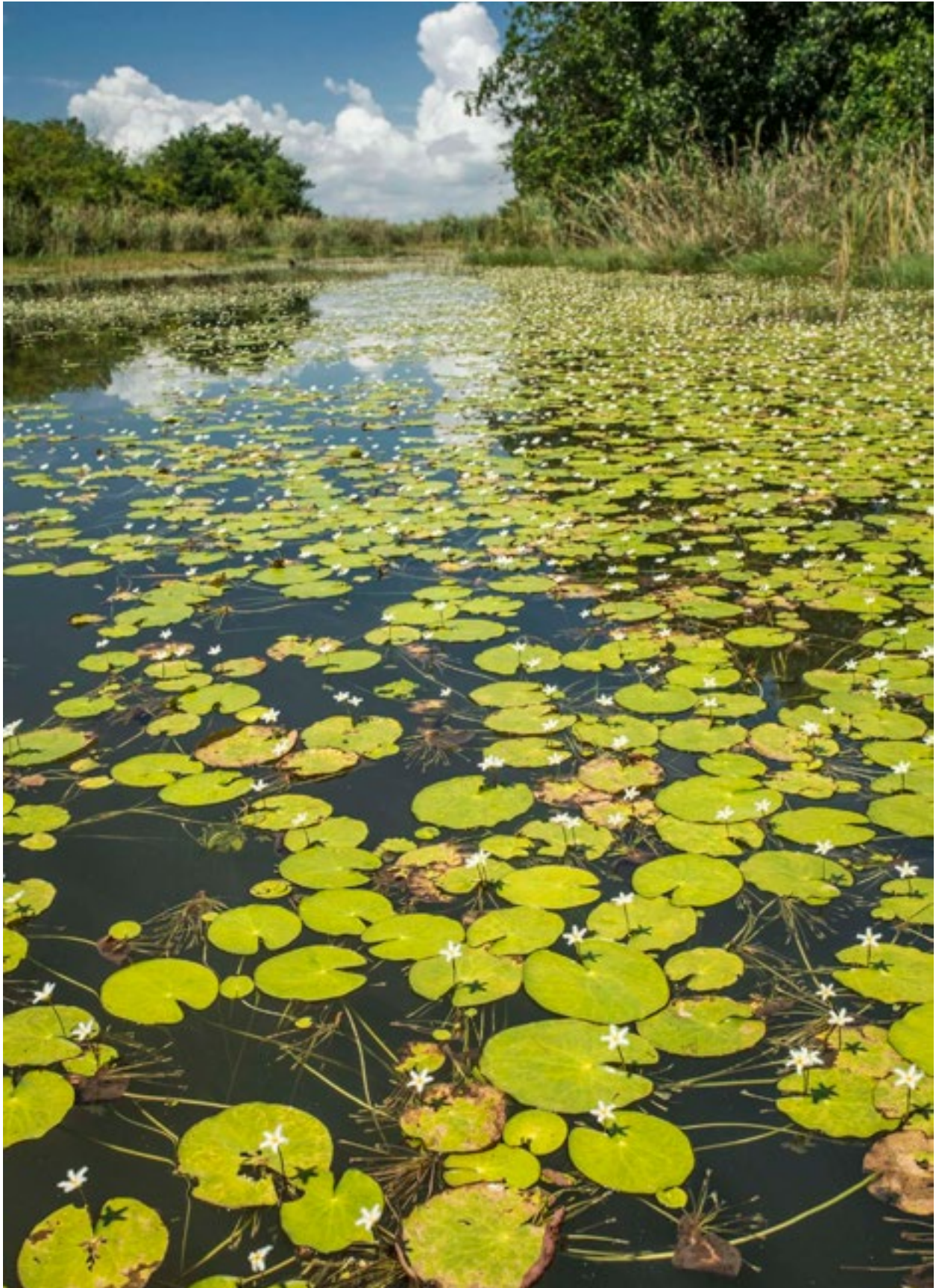
Photograph by: María Alejandra Gutiérrez, FLAAR Mesoamerica March 14, 2020.

Camera: SONY DSC-RX10M4. Lens: 8.8-220mm f/2.4-4. Settings: 1/600, f/8, ISO 500.



Nymphaoides indica. El Golfete, Livingston.

Photograph by: David Arrivillaga, FLAAR Mesoamerica March 14, 2020. Camera: NIKON D5.
Lens: Nikon 28-300mm VR. Settings: 1/640, f/9, ISO 640.



Nymphoides indica. El Golfete, Livingston.
Photograph by: David Arrivillaga, FLAAR Mesoamerica March 14, 2020. Camera: NIKON D5,
Lens: Nikon 35mm f/1.4. Settings: 1/640, f/9, ISO 640.

CONCLUDING DISCUSSION AND SUMMARY ON *NYPHOIDES INDICA*

With a name like floating heart and water snowflake this flower will become one that visitors will enjoy seeing, photographing, and sharing with their friends. I am frankly so enthusiastic about this plant that I look forward to studying the western portion of Municipio de Livingston (from the highway bridge west to end of the Municipio, and from the highway bridge east to the middle of El Golfete (since we have already explored the eastern half of El Golfete).

With the potential to become an edible food to help overcome diabetes 2 and excess dependence on sugar and salty plastic-packaged foods, *Nymphoides indica* definitely deserves more research. If this plant can be documented from pollen cores in the rivers and lakes of Municipio de Livingston, and then in other lakes and lagoons in Peten and Alta Verapaz and Huehuetenango (the lowlands part adjacent to Chiapas, Mexico) these results will allow raising *Nymphoides indica* to the level of a helpful source of edible plants for the Classic Maya.

By visiting El Golfete every single month for an initial 12 months we can document in which months it flowers. And of course in which months do all the other water plants flower on the surface, especially *Lemna minor* and *Wolffia brasiliensis* (if they are present, but surely one or the other will be findable). Both are potentially edible. It is very helpful to find edible plants that don't require chopping down trees.



Nymphoides indica. founded at the riverside
Photograph by: María Alejandra Gutiérrez, FLAAR Mesoamerica. March 14, 2020.
Camera: SONY a7R IV. Lens: Sony 90mm Macro G OSS. Settings: 1/250, f/13, ISO.3200.

Another reason for the importance of continuing research on water plants is to show the world that these plants are more healthy when there is less runoff of toxic pesticides and herbicides that are sprayed on both milpas and commercial plantations.

The biodiversity of the rivers, creeks, lakes, lagoons, and inlets of Izabal are remarkable. These are definitely places worth visiting, and try to have more time available in your schedule to have a knowledgeable local guide. The water taxi boat shuttle is an important and essential service in this area. But to be able to see the size, shape, colors of all the orchids, bromeliads, and flowering water plants, it helps if you find a hotel along the shore to spend the night. Then in the afternoon you can have a boat from the hotel take you to the “hidden inlets.” We had one guide that cleverly made his own decisions of where to take us. He know more places than I did. And he knew where he could take his boat physically into, and through, the mangrove swamps from the main area to the “hidden back areas” (where there were a lot more exotic flowering plants).



Nymphoides indica. El Golfete, Livingston.

Photograph by: María Alejandra Gutiérrez, FLAAR Mesoamerica March 14, 2020.

Camera: SONY a7R IV. Lens: Sony 90mm Macro G OSS. Settings: 1/250, f/13, ISO 3200

You can also kayak yourself to these areas but we recommend always kayaking with a travel companion (so each of you can assist the other in you turn over).

For taking photographs of the flowers we use Nikon D5, Nikon D810, Canon EOS 1D X Mark II, plus the two most sophisticated mirrorless full-frame Sony models, plus one high-end point-and-shoot Sony camera. I find my iPhone Xs significantly better than any Samsung or any other brand, for panoramas, videos, and general photographs. For macros the Google Pixel 3XL is great (but so far no mobile phone camera can take 1:1 macros as can a full-frame camera with 1:1 macro lens). And the Canon MP-E 65mm Macro f/2.8 lens is essential if you wish to photograph the eye of an insect or the inside of a flower.



Nymphoides indica. El Golfete, Livingston.

Photograph by: María Alejandra Gutiérrez, FLAAR Mesoamerica March 14, 2020.

Camera: SONY a7R IV. Lens: Sony 90mm Macro G OSS. Settings: 1/250, f/13, ISO 3200.

Although this initial field work on *Nymphoides indica* was an initial exploration, we hope our photographs and library research documentation from the dedicated team of FLAAR (USA) and FLAAR Mesoamerica (Guatemala), coordinated with the helpful team from the Municipio of Livingston and local guides, can assist you to realize what is waiting for you in the El Golfete part of Guatemala, Central America.



Road to Isla de las Flores, on the boat heading towards the Isla de las Flores, El Golfete area of Rio Dulce, Livingston. A photogenic boat trip to find and photograph thousands and thousands of waterlilies two species of waterlilies. To photograph the gorgeous flowering plants here it helps to have high-resolution cameras and prime telephoto lenses (not cheap off-brand lenses). Here is David at the top and Maria Alejandra at the bottom. In between is Q'eqchi' plant scout Don Chus. March 14, 2020. FLAAR Mesoamerica Team. Camera: Google Pixel 3XL



ACKNOWLEDGMENTS FOR LIVINGSTON

We thank Ing. Daniel Esaú Pinto Peña Livingston mayor (Izabal, Guatemala) for the cooperation provided by him and the team of the Municipio de Livingston. Also thank him for accompanying us to Nito Maya during our first field trip and has kindly made time to visit with our team on each of the initial field trips.

We thank Edwin Mármol Quiñonez, Coordinación de Cooperación de Livingston (Izabal, Guatemala), and his son Leonel. He kindly accompanied us every day of the first field trip to the Municipio of Livingston.

We appreciate the cooperation of Juana Lourdes Wallace Ramírez, Asistente Administrativo, Coordinación de Cooperación de Livingston, for organizing the day-by-day transportation and logistics for our team. Lourdes also accompanies us each day of each field trip, including long hikes and deep into caves.

The local guides, the boat captain and boat assistants, the local drivers are helpful because they know the local area. We appreciate that they share their experiences with us; in return we also mention to them the aspects of the different plants that we find on the shore or along the trails.

We will donate all photographs that we take in the Municipio of Livingston to the Municipio. These can be used by the Municipio at no fee; credit to the individual photographer and to FLAAR Mesoamerica is appreciated when an image is used.





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 Maria Setina is the office manager, overseeing all the diverse projects around the world (since FLAAR-REPORTS research on advanced wide-format digital inkjet printers is a worldwide project for over 20 years. We also utilize the inkjet prints to produce educational banners to donate to schools. On a banner we can show an entire ecosystem at a size even larger than in a coffee table art book.

Vivian Díaz 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). We then utilize our experience to also produce books on ecological rescue concepts for educational projects in local schools in remote areas of Guatemala.

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

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

Andrea Sánchez is a designer who helps prepare the master-plan for aspects of our publications.

Ximena Arriaga is a designer who puts together the text and photographs to create the actual report.

Jaqueline Gonzalez 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).

Maria Alejandra Gutierrez 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. And then preparing reports in PDF format.

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

Juan Carlos Hernandez 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 Nuñez 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 Aviles is an illustrator for MayanToons a FLAAR Mesoamerica division which is in charge of preparing material for kids as coloring books, activity books, games, animated videos, mayan Q'eqchi' children, also for schools at Peten, Yahxa and Izabal in Livingston.

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

LIVINGSTON: THE CARIBBEAN BIODIVERSITY WONDERLAND OF GUATEMALA

Izabal, one of the regional departments of Guatemala that offers a variety of recreational activities, is home to numerous nature parks and diverse natural landscapes. There are white sandy beaches a short boat trip away, with tall jungle-covered mountains in the background, and the Mesoamerican Reef System in the Caribbean Sea on the horizon in front of you. Mangrove swamps, seagrass, islands, cenotes, caves, karst geology canyons and streams of crystal clear water abound along the Rio Dulce and Lake Izabal coast or inland. All this together makes Livingston one of the destinations for tourists wanting to do bird-watching, explore caves, get healthy exercise hiking through trails in the rainforest. In addition to the incredible flora and fauna that the municipality offers, three different cultures coexist in the ecosystem (Mayan Q'eqchi', Garifuna and Ladinos).

In order to conserve the biodiversity found in the municipality and that continues to be of benefit to the ecosystem, it is necessary to have an updated record of the species that inhabit here and thus be able to detect changes in the species population. Thanks to the efforts of different institutions focused on environmental improvement projects at various sites in Livingston (FUNDAECO (Río Sarstun), CONAP (Río Dulce), CECON-USAC (Chocón-Machacas), ARNPG (more than ten private reserves), among many others) there are records of species of flora, fauna and ecosystems of this municipality of Izabal.

Using this information in the most efficient way and using the potential of digital technology, the database for the municipality can be supplemented with photographic records of flora, fauna, and ecosystems. The FLAAR Mesoamerica team, in cooperation with the municipal authorities, have begun to produce this educational material using the photographic records generated during the cooperation project to account for the flora, fauna and ecosystems that can be seen in Livingston. This will be accomplished in order to provide information to the schools, families and institutions already working to protect the environment.

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.





FLAAR Mesoamerica (**Foundation for Latin American Anthropological Research**), is a nonprofit Guatemalan institution founded under the direction and enthusiasm of Biologist Eduardo Sacayon and Dr. Nicholas Hellmuth, a specialist of Classic Mayan iconography and architecture who then evolved his research to focus on edible and utilitarian plants, with the aim of wanting to see our country be recognized throughout the world for its biodiversity of plants, cultures, and natural resources. Likewise, our work has arisen from the interest and support of the board directors of FLAAR Mesoamerica, its president, Eduardo Sacayón, its vice president Flor de María Setina, the secretary Rodrigo Girón, the treasurer Oscar Lambourg and his member Elsa Morales.

One of our main objectives at FLAAR Mesoamerica is to increase consciousness about caring and protecting Mesoamerican natural diversity. By utilizing high-resolution photography, we can better showcase the remarkable flora and fauna of Guatemala. These photographs, and the accompanying information, will awake the admiration and desire in those who follow our work. Thus, the FLAAR Mesoamerica teams create educational material about the biodiversity that deserves recognition and protection.

The work done at FLAAR Mesoamerica consists of the methodological compilation of facts about nature, flora, fauna, history, and cultures of Mesoamerica, and disseminate it to the largest audience both in Guatemala and around the world. We also are inspired to provide for all our readers plenty of annotated suggestions of lots of other reports, articles, thesis, dissertations, and web sites via our bibliographies of suggested additional reading. Our focus is generate materials that are easy to read, educational, reliable, and visually pleasing by using lots of full-color photographs -just like this report!

We also prepare illustrated books and animations for primary school children and Mayan families in Guatemala to have access to information about the need to protect the fragile ecosystems and flora and fauna throughout this Central American republic.

We are open to work with, share, and, expand our accomplishments with other organizations, institutions, or companies that share our vision.

You can find more of our work throughout the different digital platforms of our directory:



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www.digital-photography.org
www.maya-ethnozology.org
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REFERENCES CITED AND SUGGESTED READING ON *NYMPHOIDES INDICA*

Most Helpful Article:

MARTÍNEZ, Mahinda and Maricela GÓMEZ Sánchez

2006 Descripción anatómica vegetativa de dos especies de *Nymphoides* (Menyanthaceae).
Revista Mexicana de Biodiversidad 77: 81-87, 2006.

AGUILAR, Abigail, LÓPEZ-Villafranco, María Edith and Santiago XOLALPA-Molina

2003 Los tratamientos populares y el personal de salud. Mexico.

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

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

BALICK, Michael J. and Rosita ARVIGO

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

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

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

CONAP

2008 Resolucion 401/2008. CONAP, Guatemala.

COOK, Suzanne

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

I use this book for every single solitary plant I am studying. But of course no one book has
everything since each ecosystem has some plants but not every plant of Mesoamerica.
So no *Nymphoides indica* nor relatives.

Sold online: www.springer.com/la/book/9781461491101

ESTRADA Loreto, Feliciano

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

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

DIX, Margareth and Juan F. FERNANDEZ

2001 Inventario Nacional de los Humedales de Guatemala. UICN-Mesoamérica: CONAP: USAC.

Curiously "published" in San Jose, Costa Rica, although everything in the book is focused on Guatemala.

Has nice list of major lakes and large rivers of Guatemala. but is missing 100% of the rivers and "creeks" of the Izabal area (other than large rivers such as Rio Dulce and Rio Polochic). Also does not have Rio Ixtinto for Peten. Nor even the Rio Holmul. I also expected this monograph to have lists of all the water plants of all the humedales. But after looking hour after hour I see that it is a list of the big lakes and big rivers: it is not a list of ecosystems, habitats, nor water plants whatsoever. Would be great to do a 2nd Edition by adding the missing information.

JAIN A., SUNDRIYAL M., ROSHIBALA S., KOTOKY R., KANJILAL P. B., SINGH, H. B. and R. C. SUNDRIYAL

2011 Dietary use and conservation concern of edible wetland plants at Indo-Burma hotspot: a case study from Northeast India. Journal of Ethnobiology and Ethnomedicine, 7: 29.

Free download: www.ncbi.nlm.nih.gov/pmc/articles/PMC3207871/pdf/1746-4269-7-29.pdf?tool-EBI and <http://europepmc.org/article/PMC/3207871>

LOT, Antonio, OLVERA, Martha, FLORES, Carla and Angélica DIAZ

2015 Guía ilustrada de campo. Plantas Indicadoras de Humedales. UNAM. Mexico.

Free download:

www.gob.mx/cms/uploads/attachment/file/102190/Gu_a_PIH-min.pdf

LUNDELL, Cyrus L.

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

Not one species of *Nymphoides* is findable. No plant of Family Menyanthaceae. Lundell produced priceless botanical information, but he was primarily a tree and shrub person.

But yet he does list *Nymphaea alba* dozens of times since this plant is everywhere and easily visible. And, as a pleasant surprise, Lundell does note both Lemna and Wolffia species (26). These are among the smallest plants of Peten.

LUNDELL, Cyrus L.

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

Nymphoides indica is not listed. Nor are several other water plants that we are also working on. The conquering Spanish forced the Mayan people to produce long-lasting grains so the Spanish could grab a percent that could be sold or shipped or otherwise make profit with. The Spanish could not make any profit with water plants that would rot within two or three days after being harvested.

MARTÍNEZ, Mahinda and Maricela GÓMEZ Sánchez

- 2006 Descripción anatómica vegetativa de dos especies de *Nymphoides* (Menyanthaceae). Revista Mexicana de Biodiversidad 77: 81-87, 2006.

Clear crisp botanical illustration of the entire plant, with names for the roots hanging down from near the surface (the roots that do not yet reach the bottom of the swamp or riverside).

Lots of detailed anatomical information and photographs not available in any other publication.

Free Download:

file:///Users/new/Downloads/Descripcion_anatomica_vegetativa_de_dos_especies_d.pdf

MORA-Olivo, Arturo, VILLASEÑOR, José Luis and Mahinda MARTÍNEZ

- 2013 Las Plantas vasculares acuáticas estrictas y su conservación en México. Acta Botanica Mexicana 103: 27-63 (2013).

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

- 2018 Diversidad de flora acuática y ribereña en la cuenca del río Usumacinta, México. Revista Mexicana de Biodiversidad 89 (Suplem. 2018): 3 – 44.

Free download:

www.scielo.org.mx/pdf/rmbiodiv/v89sdcic/2007-8706-rmbiodiv-89-sdic-3.pdf

PARKSWATCH

- 2003 Park Profile – Mexico, Pantanos de Centla Biosphere Reserve. ParksWatch.

POLINI, Giuseppe

- 2017 Plantas útiles y comestibles del Paraguay (Comer del Monte) (Volume 2) (Spanish Edition).

https://issuu.com/libero9677/docs/plantas_utiles_y_comestibles_del_pa/104

POLINI, Giuseppe

2018 Plantas útiles y comestibles del Paraguay - Región del Chaco.

This chapter on the Internet has a date of 2018. What I estimate is the original book is dated 2017.

REYES-Morales, Elsa María de Fátima, MORALES-Can, Julio Enrique, OLIVA Hernández, Bessie Evelyn and Celia Vanessa DÁVILA-Pérez

2009 Los Cuerpos de Agua de la Región Maya Tikal –Yaxhá: Importancia de la Vegetación Acuática Asociada, Calidad de Agua y Conservación. USAC.

Only *Nymphaea alba* is listed (spelled as *Nymphea alba*). *Nymphoides indica* is not in any list.

Free download:

<https://digi.usac.edu.gt/bvirtual/informes/puirna/INF-2009-047.pdf>

The edition that mentions *Nymphoides indica* is a readable on:

<https://docplayer.es/56051215-Los-cuerpos-de-agua-de-la-region-maya-tikal-yaxha-importancia-de-la-vegetacion-acuatica-asociada-su-conservacion-y-el-valor-desde-el-uso-humano.html>

This edition can be copied-and-pasted (so much easier to cite). There is a shorter edition than the other one. So both should be listed.

SELVEN Pérez, Edgar and Miriam Lorena CASTILLO Villeda

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

STANDLEY, Paul C. and Samuel J. RECORD

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

STANDLEY, Paul C. and Louis O. Williams

1969 Flora of Guatemala. Fieldiana, Botany, Volume 24, Part VIII, Number 4, Field Museum of Natural History.

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://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.

HELPFUL WEB SITES FOR **NYMPHOIDES INDICA**

<http://abm.ojs.inacol.mx/index.php/abm/article/view/50/97>

Lists in which states of Mexico each species of *Nymphoides* can be found.

www.cicy.mx/sitios/flora%20digital/ficha_virtual.php?especie=1832

Information

<https://colombia.inaturalist.org/taxa/165759-Nymphoides-indica>

Photos and map distribution

<https://florabonaerense.blogspot.com/2012/08/estrella-del-agua-nymphoides-indica.html>

Description and photo

<http://tropical.theferns.info/viewtropical.php?id=Nymphoides-indica>

Information

www.randomharvest.co.za/en-us/South-African-Indigenous-Plants/Show-Plant/PlantId/674/Plant/Nymphoides-indica

Information and photos

APPENDIX A

WHERE HAS *NYMPHOIDES INDICA* BEEN STORED IN BOTANICAL HERBARIA THAT ARE LISTED ON THE NEOTROPICAL FLORA DATA BASE

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

You can get all the details and coordinates on this helpful professional botanical web site. It is especially notable that not one single specimen from Izabal is listed. And not one single specimen from Lake Yaxha, Lake Sacnab or any other lake besides Lake Peten Itza.

Yet we found literally thousands of *Nymphoides indica* plants in full bloom in mid-March 2020 in the Municipio de Livingston. In other words, if you are a botanist, or a student looking for a thesis or dissertation, here in Izabal there is plenty of material. And the hotels are just a few minutes away from the creeks, lagoons, lakesides, and swamps.

I estimate there were between five and eight locations. Most had both *Nymphaea ampla* and *Nymphoides indica* near each other. We now need to go back and take notes (to see where *Nymphoides indica* is by itself).

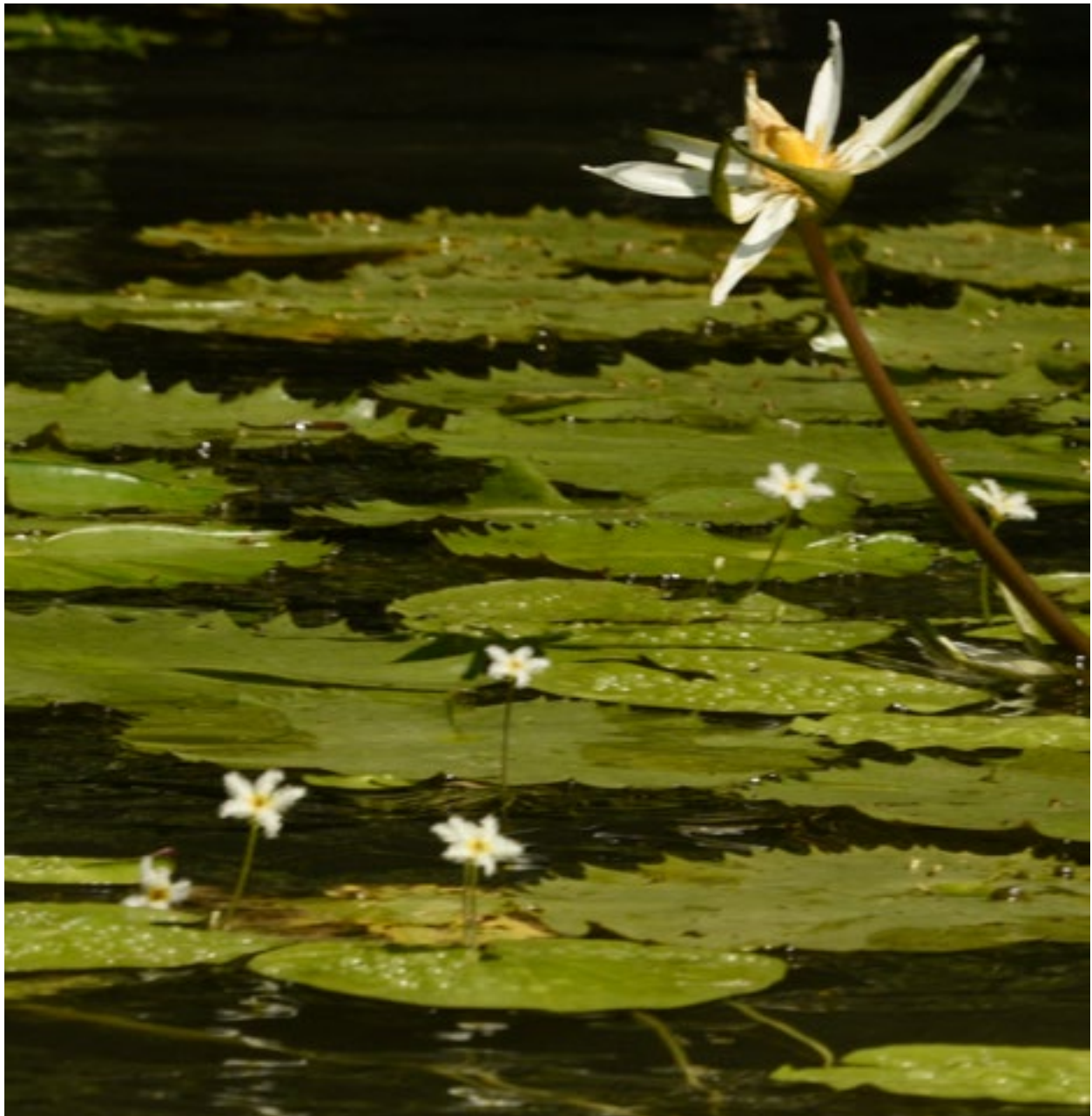


Nymphoides indica. El Golfete, Livingston.

Photograph by: David Arrivillaga, FLAAR Mesoamerica March 14, 2020. Camera: NIKON D5.
Lens: Nikon 28-300mm VR. Settings: 1/500, f/11, ISO 640.

APPENDIX B**WHERE HAS *NYMPHOIDES INDICA* BEEN LOCATED IN GUATEMALA BASED ON HERBARIA OF GUATEMALA (WHICH ARE NOT YET DIGITIZED)**

As soon as the Coronavirus lockdown is opened up, we will check with the helpful herbaria of the various institutes and universities of Guatemala.



Nymphoides indica. El Golfete, Livingston.

Photograph by: David Arrivillaga, FLAAR Mesoamerica March 14, 2020. Camera: NIKON D810.

Lens: Nikon AF-Micro-NIKKOR 200mm IF-ED tele-macro. Settings: 1/320, f/13, ISO 500.

APPENDIX C

MAPS OF RIO DULCE, EL GOLFETE, RIO SARSTUN TIPS FOR BOTANISTS, ZOOLOGISTS, ECOLOGISTS, ECO-ARCHAEOLOGISTS HOW TO FIND MAPS TO PLAN YOUR FIELDWORK

We wish to share our findings with scholars, students, and the interested public. Since Google maps lacks the local Q'eqchi' Mayan names and Garifuna names of most settlements and villages of the Municipio of Livingston, we wish to assist everyone to find a functional map. Fortunately, the Guatemalan Instituto de Geografia Nacional has what you need.

Start with this map:	But at 1:250,000 typically there is no name
Escala	Lagunita Creek or Tapon Creek (nor the
1:250,000	nature preserves in each of these areas). But
PUERTO	this 1:250,000 map is essential to start your
BARRIOS	planning. We find it a great help. Simply
ND 16-1	scan the Lake Izabal, El Golfete and Canyon
SERIES	Rio Dulce segments (which are all next to
E503	each other) with a good desktop scanner
	and put it on your iPad to take with you
	during field work.



The Instituto de Geografia Nacional, Guatemala, has precisely what you need. This is a low-res desktop scanner rendition from a normal office scanner.

NEXT STEP, acquire the 1:50,000 maps. IGN has a catalog page:
Indice de Hojas Topograficas. Escala 1:50,000 y 1:250,000 de la Republica de Guatemala

To be sure you have all the close-up maps of the entire area we suggest seven of them. Our field work is focused on the Municipio de Livingston. Since this is a large area of remarkable biodiversity, this area will keep us busy for many field trips that we aspire to undertake.

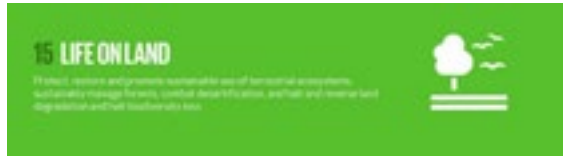
Modesto Mendez 2363 I	Sarstun 2463 IV	
San Antonio Sejá 2363 II	Livingston 2463 III	Puerto Barrios 2463 II
Rio Túnico 2362 I	Castillo San Felipe 2462 IV	

The squares above show you the code and order of each map that you can acquire at IGN, once it reopens. We will try to get them as soon as possible.

NEXT STEP, acquire all the IGN aerial photos. .TIF format if available; otherwise high-resolution JPEG. You don't need LiDAR: you want to see the trees and plants. These aerial photos from circa 2005-2006 are wonderful help.



Nymphoides indica. El Golfete, Livingston.
Photograph by: Juan Pablo Fumagalli , FLAAR Mesoamerica March 14, 2020. Camera: Google Pixel 3XL



The current Alcalde of Livingston, Mr. Daniel Pinto, together with his team of International Cooperation division, Mr. Edwin Mármol, have set the goal of achieving the municipality development in the years 2020-2024 based on the goals and indicators proposed by the 2030 Agenda for Sustainable Development. From this agenda, FLAAR Mesoamerica will collaborate to achieve Sustainable Development Goal (SDG) number 15 "Life on Land".

Throughout this cooperation project, different materials have been prepared, like this Photo Essay, that helps to collect information on species, different ecosystems: terrestrial, wetlands and fresh water biodiversity. This information would also be useful as part of a strategy to protect threatened species and prevent their extinction. The municipality's goals include to promote the sustainable use, conservation and research of the species of flora and fauna of the terrestrial, wetlands and aquatic shore and coastal ecosystems of the Guatemalan Caribbean. Learn more about this project and the SDG indicators at: <https://flaar-mesoamerica.org/rain-forests-rivers-lakes-bays-ocean-caves-canyons-livingston-the-caribbean-biodiversity-wonderland-of-guatemala/>

SERIES OF MUNICIPIO OF LIVINGSTON



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- www.maya-ethnobotany.org
- www.maya-ethnozology.org
- www.maya-archaeology.org
- www.digital-photography.org
- www.FLAAR-Mesoamerica.org

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Hellmuth, N. (2020) Floating Heart Water Snowflake *Nymphoides indica*, Livingston, Izabal. Guatemala: FLAAR Mesoamerica.



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All national parks, nature reserves, and comparable are welcome to have and use our reports at no cost. USAC, UVG, URL, Universidad Rural, INTECAP and other Guatemalan universities, and high schools, and schools, are welcome to post our reports, at no cost.

If you wish our flora and 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, etc. He has also lectured at Rotary Club events, etc. He also writes cartoon books on plants and animals of Guatemala so gives presentations to kindergartens, primary school, high schools, etc. www.MayanToons.org shows our educational material for children.

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 of 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 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 of our office expenses for all the cataloging, processing, and organization of the photos and the field trip data.

For 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.



BACKCOVER PHOTOGRAPH

Nymphoides indica.

Photograph by: Maria Alejandra Gutiérrez.

FLAAR Mesoamerica. March, 2020.

Camera: SONY DSC-RX10M4. Lens: 8.8-220mm

f/2.4-4. Settings: 1/6400, f/4, ISO 500

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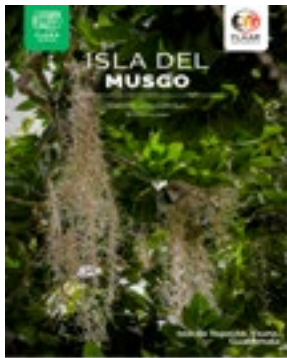
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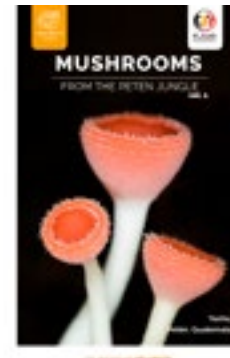
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