



# Everglades CISMA's Effort to Eliminate Exotic Mangroves

Dennis Giardina (FWC) - Tony Pernas (NPS)



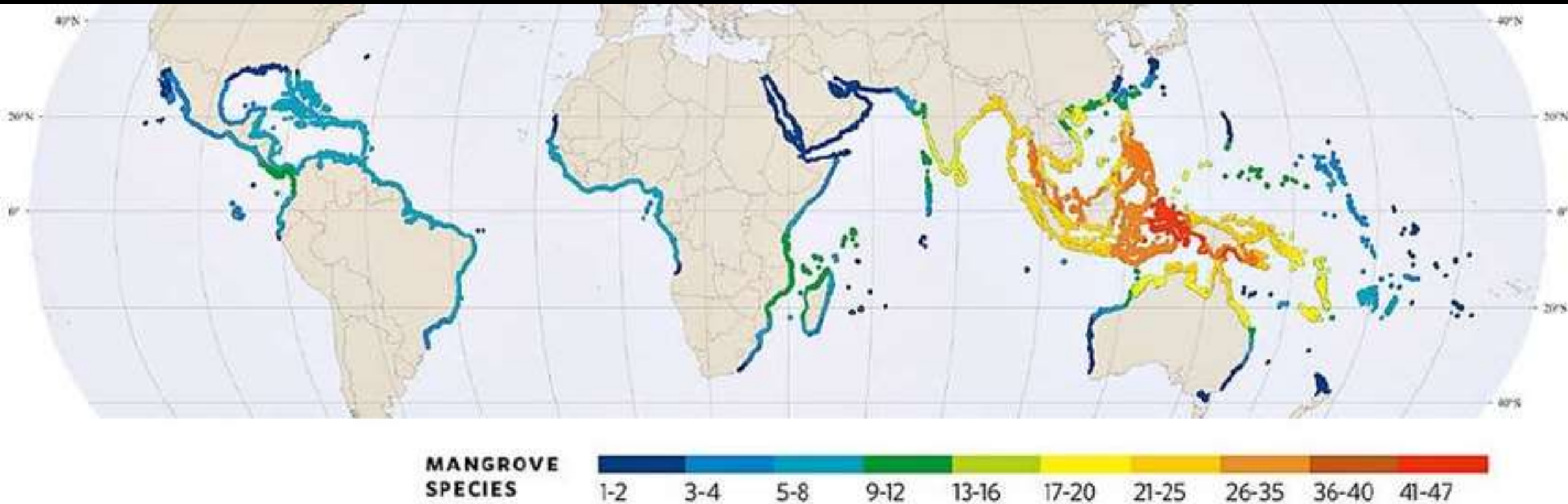
*Bruguiera gymnorrhiza*



*Lumnitzera racemosa*

A mangrove is a tree, shrub, palm or ground fern, generally exceeding one half meter in height that normally grows above mean sea level in the intertidal zone of marine coastal environments and estuarine margins. A mangrove is also the tidal habitat comprising such trees, shrubs, palm and ferns.

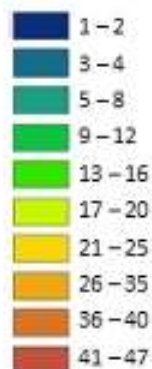
# Worldwide Mangrove Diversity



# Mangrove Species Richness in the Coral Triangle



## Diversity of mangrove species



### DATA SOURCES:

EEZ boundaries: Flanders Marine Institute (VLIZ).

Distribution of Mangroves : Spalding, M., Kainuma, M. and Collins, L. (2010) *World Atlas of Mangroves*. A collaborative project of ITTO, ISME, FAO, UNEP-WCMC, UNESCO-MAB, UNU-INWEH and TNC. Earthscan, London. 319pp. Download from UNEP-WCMC's Ocean Data Viewer <http://data.unep-wcmc.org/datasets/22>.

Diversity of mangrove species: Ibid.

— Coral Triangle scientific boundary (Veron *et al.* 2009)

— Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF) implementation area

- - - Dashed line represents disputed EEZ boundary

### NOTE:

1. Singapore and Brunei are not members of the CTI-CFF;
2. This boundary is based on the Exclusive Economic Zones (EEZ) of the CTI countries. EEZ internal boundaries are not shown;
3. Disputed boundaries exist in this geography;
4. Boundaries are only for illustration and are not legally binding.



# Mangroves of the World (United Nations 2007)

1. *Acanthus ebracteatus*
2. *Acanthus ilicifolius*
3. *Acanthus xiamenensis*
4. *Acrostichum aureum*
5. *Acrostichum speciosum*
6. *Aegialitis annulata*
7. *Aegialitis rotundifolia*
8. *Aegiceras corniculatum*
9. *Aegiceras floridum*
10. *Avicennia alba*
11. *Avicennia bicolor*
12. *Avicennia eucalyptifolia*
13. *Avicennia germinans*
14. *Avicennia integra*
15. *Avicennia lanata*
16. *Avicennia marina*
17. *Avicennia officinalis*
18. *Avicennia rumphiana*
19. *Avicennia schaueriana*
20. *Bruguiera cylindrica*
21. *Bruguiera exaristata*
22. *Bruguiera gymnorhiza*
23. *Bruguiera hainesii*
24. *Bruguiera parviflora*
25. *Bruguiera sexangula*
26. *Camptostemon philippinensis*
27. *Camptostemon schultzei*
28. *Ceriops australis*
29. *Ceriops decandra*
30. *Ceriops somalensis*
31. *Ceriops tagal*
32. *Conocarpus erectus*
33. *Cynometra iripa*
34. *Cynometra ramiflora*
35. *Excoecaria agallocha*
36. *Excoecaria indica*
37. *Heritiera fomes*
38. *Heritiera globosa*
39. *Heritiera kanikensis*
40. *Heritiera littoralis*
41. *Kandelia candel*
42. *Laguncularia racemosa*
43. *Lumnitzera littorea*
44. *Lumnitzera racemosa*
45. *Lumnitzera x rosea*
46. *Nypa fruticans*
47. *Osbornia octodonta*
48. *Pelliciera rhizophorae*
49. *Pemphis acidula*
50. *Rhizophora x annamalayana*
51. *Rhizophora apiculata*
52. *Rhizophora harrisonii*
53. *Rhizophora x lamarckii*
54. *Rhizophora mangle*
55. *Rhizophora mucronata*
56. *Rhizophora racemosa*
57. *Rhizophora samoensis*
58. *Rhizophora x selala*
59. *Rhizophora stylosa*
60. *Scyphiphora hydrophyllacea*
- 61. *Sonneratia alba*
- 62. *Sonneratia apetala*
- 63. *Sonneratia caseolaris*
- 64. *Sonneratia griffithii*
- 65. *Sonneratia x gulngai*
- 66. *Sonneratia hainanensis*
- 67. *Sonneratia ovata*
- 68. *Sonneratia x urama*
- 69. *Xylocarpus granatum*
- 70. *Xylocarpus mekongensis*
- 71. *Xylocarpus rumphii*



# Mangroves of the New World (United Nations 2007)

1. *Acrostichum aureum*
2. *Avicennia bicolor*
3. *Avicennia germinans*
4. *Avicennia schaueriana*
5. *Conocarpus erectus*
6. *Laguncularia racemosa*
7. *Nypa fruticans*
8. *Pelliciera rhizophorae*
9. *Rhizophora harrisonii*
10. *Rhizophora mangle*
11. *Rhizophora racemosa*

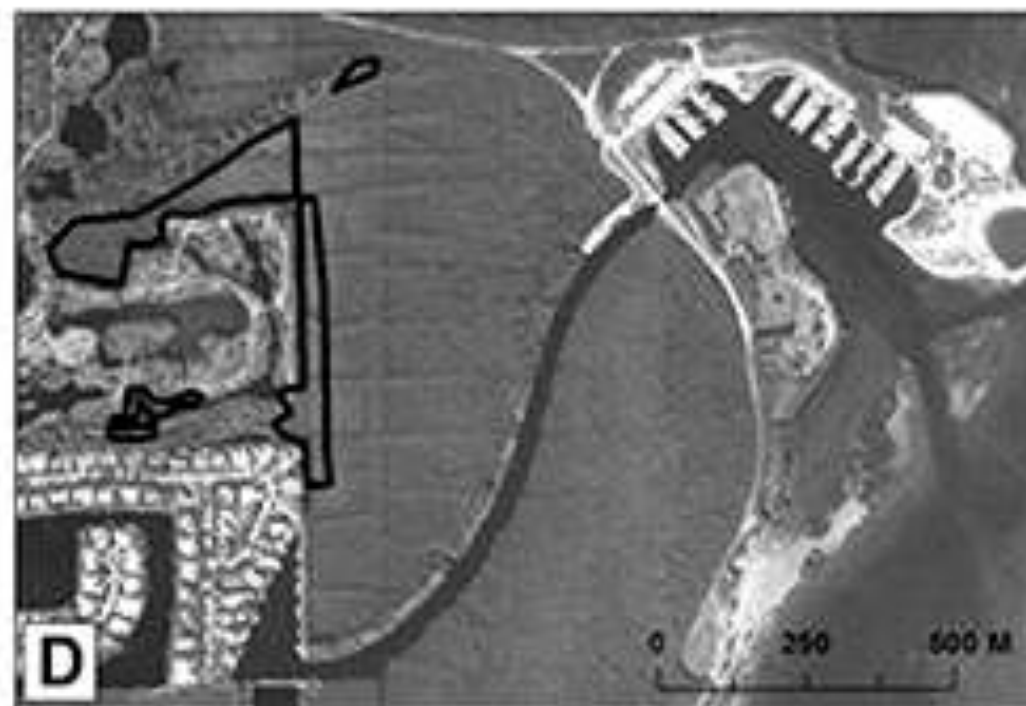


# Are mangroves in the tropical Atlantic ripe for invasion? Exotic mangrove trees in the forests of South Florida

James W. Fourqurean, Thomas J. Smith III, Jennifer Possley, Timothy M. Collins, David Lee, Sandra Namoff

## Abstract

Two species of mangrove trees of Indo-Pacific origin have naturalized in tropical Atlantic mangrove forests in South Florida after they were planted and nurtured in botanic gardens. Two *Bruguiera gymnorhiza* trees that were planted in the intertidal zone in 1940 have given rise to a population of at least 86 trees growing interspersed with native mangrove species *Rhizophora mangle*, *Avicennia germinans* and *Laguncularia racemosa* along 100 m of shoreline; the population is expanding at a rate of 5.6% year<sup>-1</sup>. Molecular genetic analyses confirm very low genetic diversity, as expected from a population founded by two individuals. The maximum number of alleles at any locus was three, and we measured reduced heterozygosity compared to native-range populations. *Lumnitzera racemosa* was introduced multiple times during the 1960s and 1970s, it has spread rapidly into a forest composed of native *R. mangle*, *A. germinans*, *Laguncularia racemosa* and *Conocarpus erectus* and now occupies 60,500 m<sup>2</sup> of mangrove forest with stem densities of 24,735 ha<sup>-1</sup>. We estimate the population growth rate of *Lumnitzera racemosa* to be between 17 and 23% year<sup>-1</sup>. Populations of both species of naturalized mangroves are dominated by young individuals. Given the long life and water-dispersed nature of propagules of the two exotic species, it is likely that they have spread beyond our survey area. We argue that the species-depauperate nature of tropical Atlantic mangrove forests and close taxonomic relatives in the more species-rich Indo-Pacific region result in the susceptibility of tropical Atlantic mangrove forests to invasion by Indo-Pacific mangrove species.





# Mangroves as alien species: the case of Hawaii

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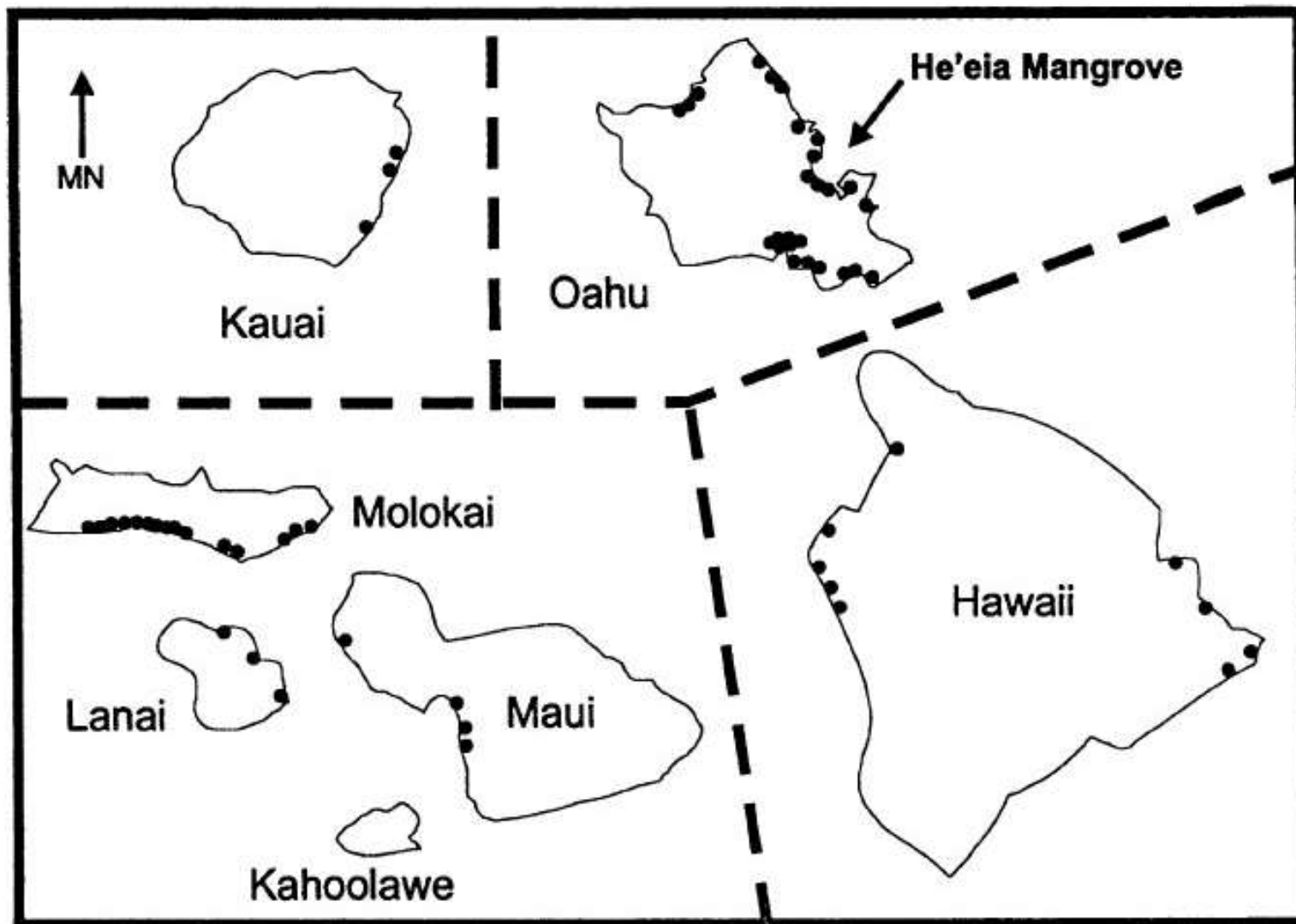
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**Abstract.** Prior to the early 1900s, there were no mangroves in the Hawaiian Archipelago. In 1902, *Rhizophora mangle* was introduced on the island of Molokai, primarily for the purpose of stabilizing coastal mud flats. This species is now well established in Hawaii, and is found on nearly all of the major islands. At least five other species of mangroves or associated species were introduced to Hawaii in the early 1900s, and while none has thrived to the degree of *R. mangle*, at least two have established self-maintaining populations (*Bruguiera gymnorrhiza* and *Conocarpus erectus*). Mangroves are highly regarded in most parts of the tropics for the ecosystem services they provide, but in Hawaii they also have important negative ecological and economic impacts. Known negative impacts include reduction in habitat quality for endangered waterbirds such as the Hawaiian stilt

(*Himantopus mexicanus knudseni*), colonization of habitats to the detriment of native species (e.g. in anchialine pools), overgrowing native Hawaiian archaeological sites, and causing drainage and aesthetic problems. Positive impacts appear to be fewer, but include uses of local importance, such as harvesting *B. gymnorrhiza* flowers for lei-making, as well as some ecological services attributed to mangroves elsewhere, such as sediment retention and organic matter export. From a research perspective, possible benefits of the presence of mangroves in Hawaii include an unusual opportunity to evaluate their functional role in coastal ecosystems and the chance to examine unique or rare species interactions.

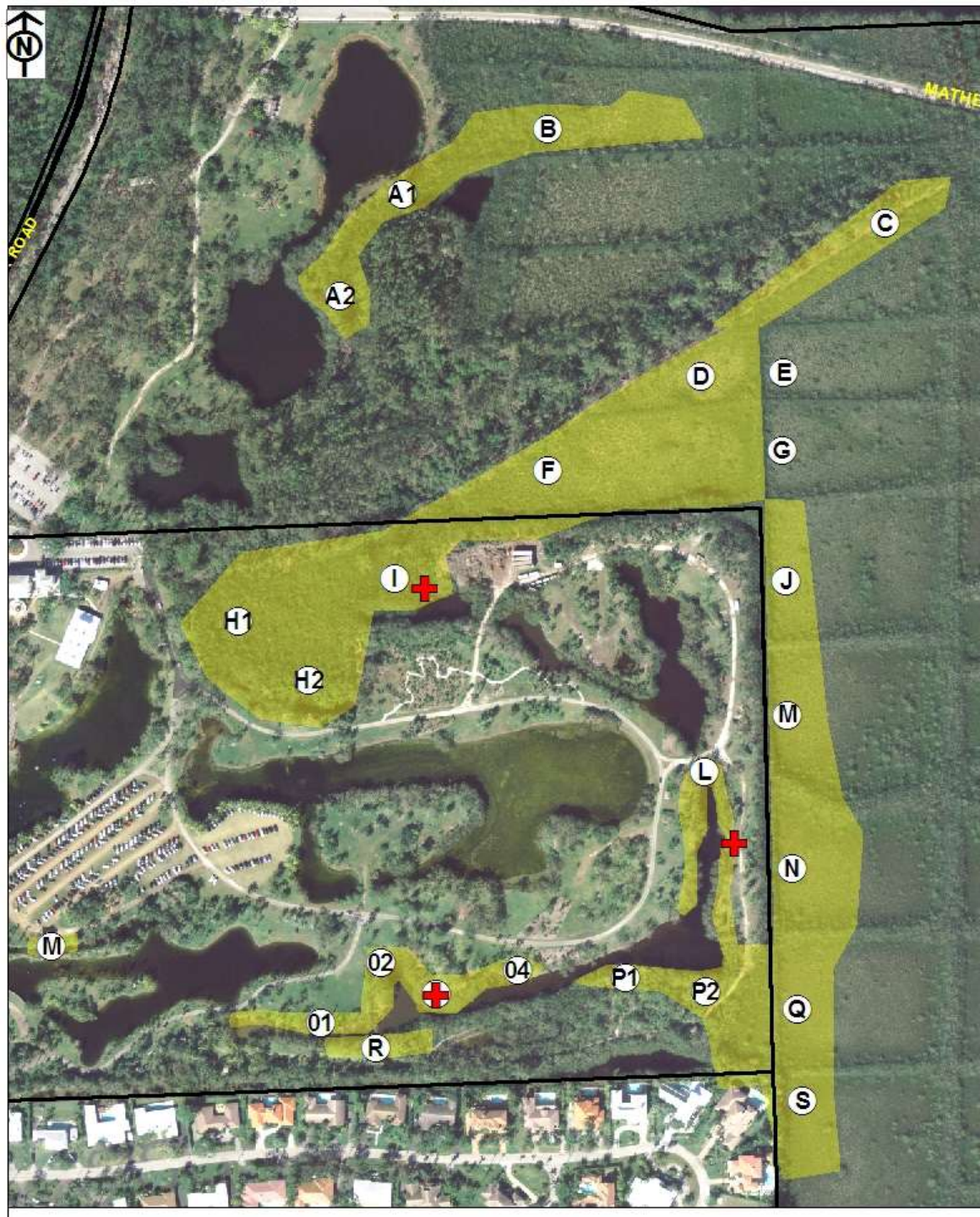
**Key words.** Species introductions, alien species, Hawaii, *Rhizophora mangle*, *Bruguiera gymnorrhiza*, *Conocarpus erectus*, mangroves.

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**Fig. 1.** Approximate locations of known mangrove stands in Hawaii. Map is updated from Wester (1981) with information obtained directly by the author and from consultation with individuals familiar with specific islands.













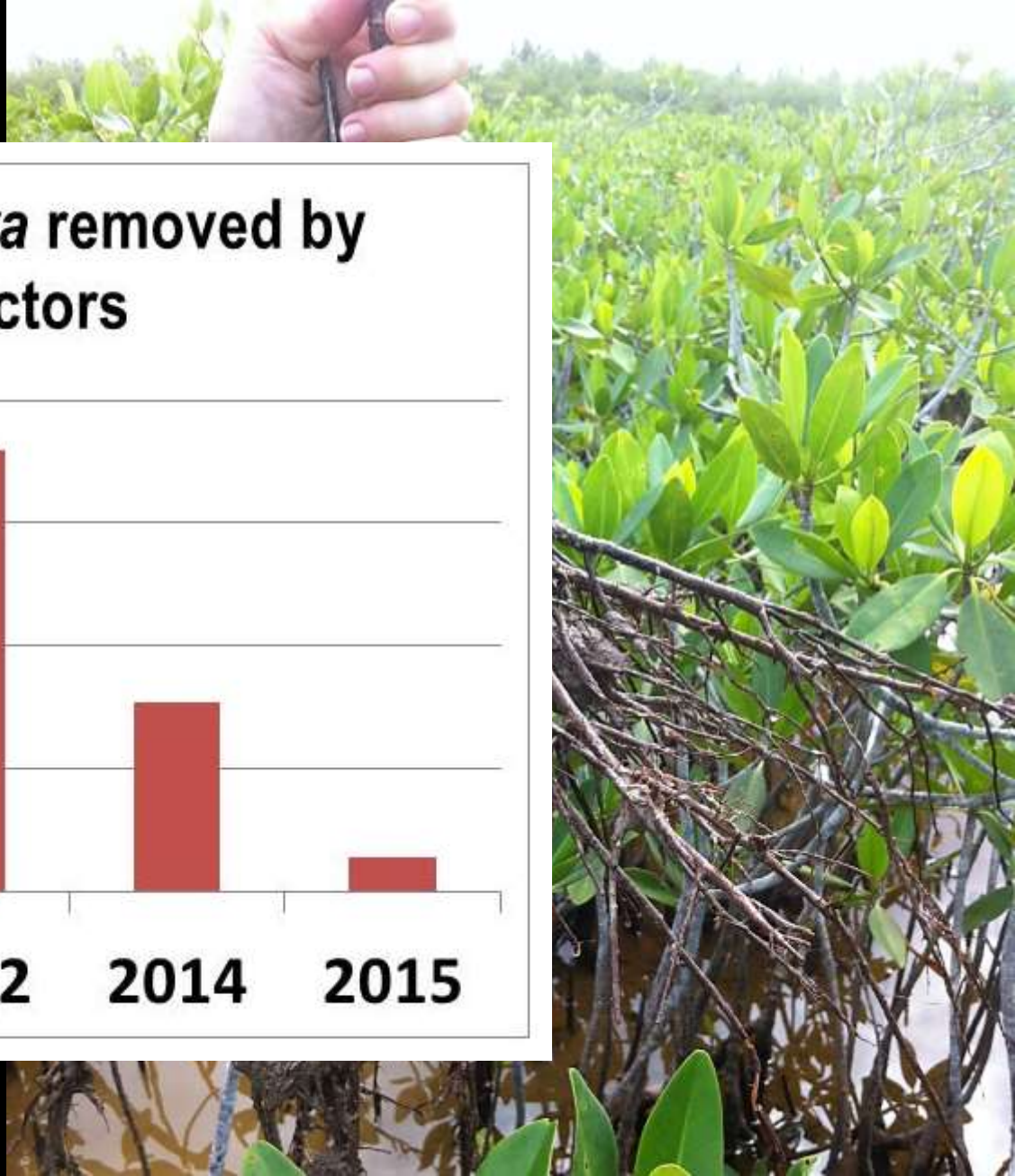
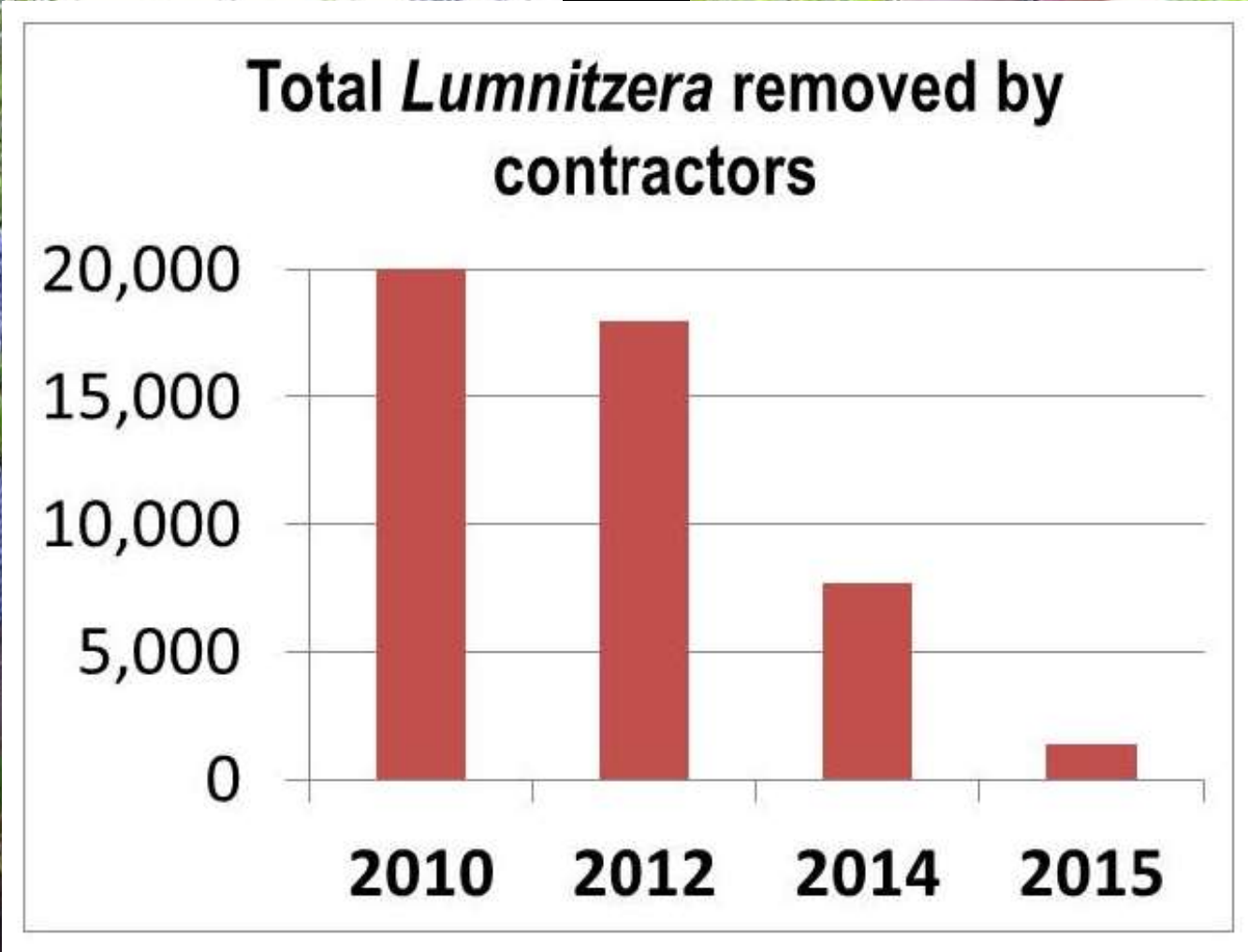












# Range of *Lumnitzera racemosa*



# *Lumnitzera racemosa* in Native Habitat





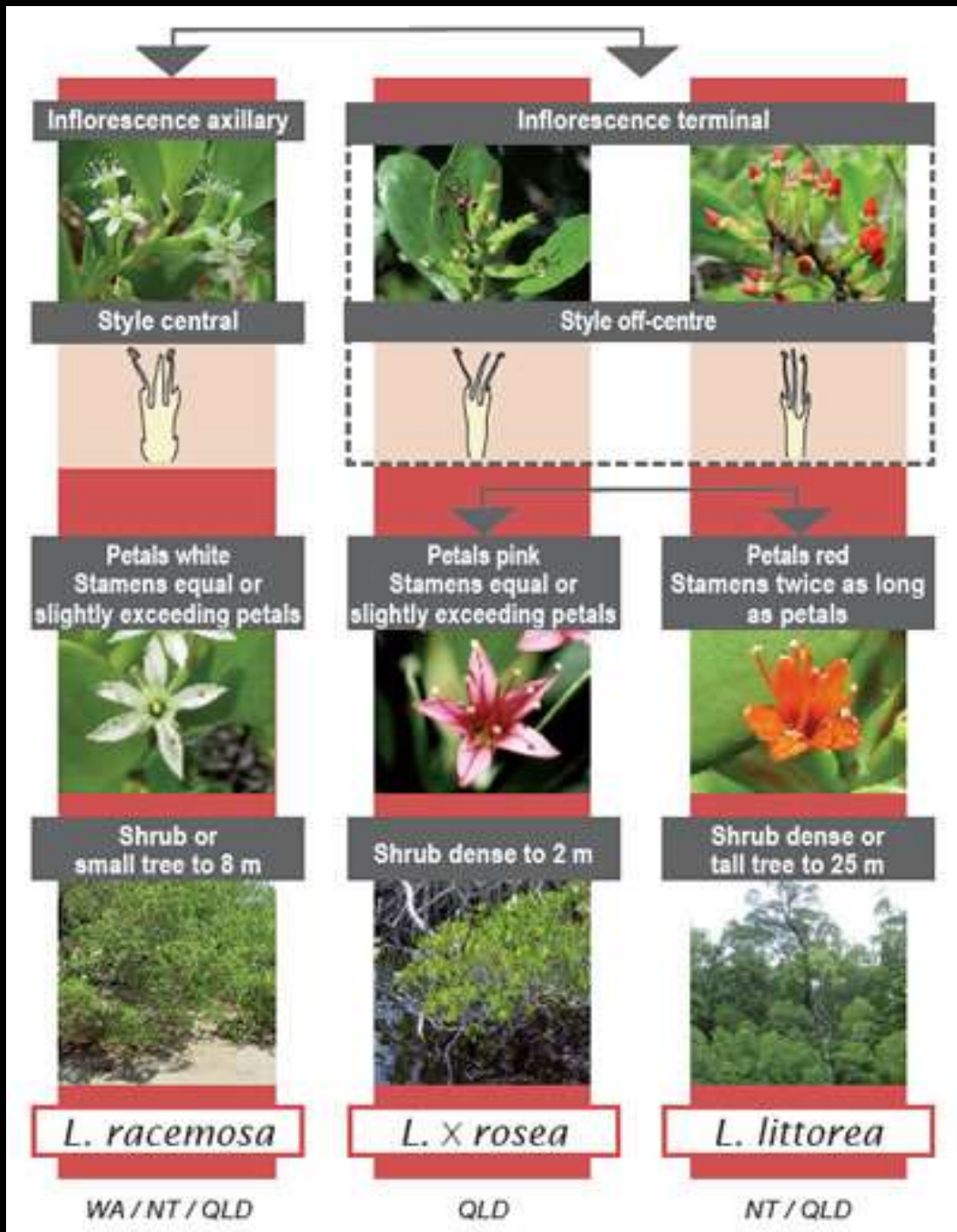














*Lumnitzera littorea*

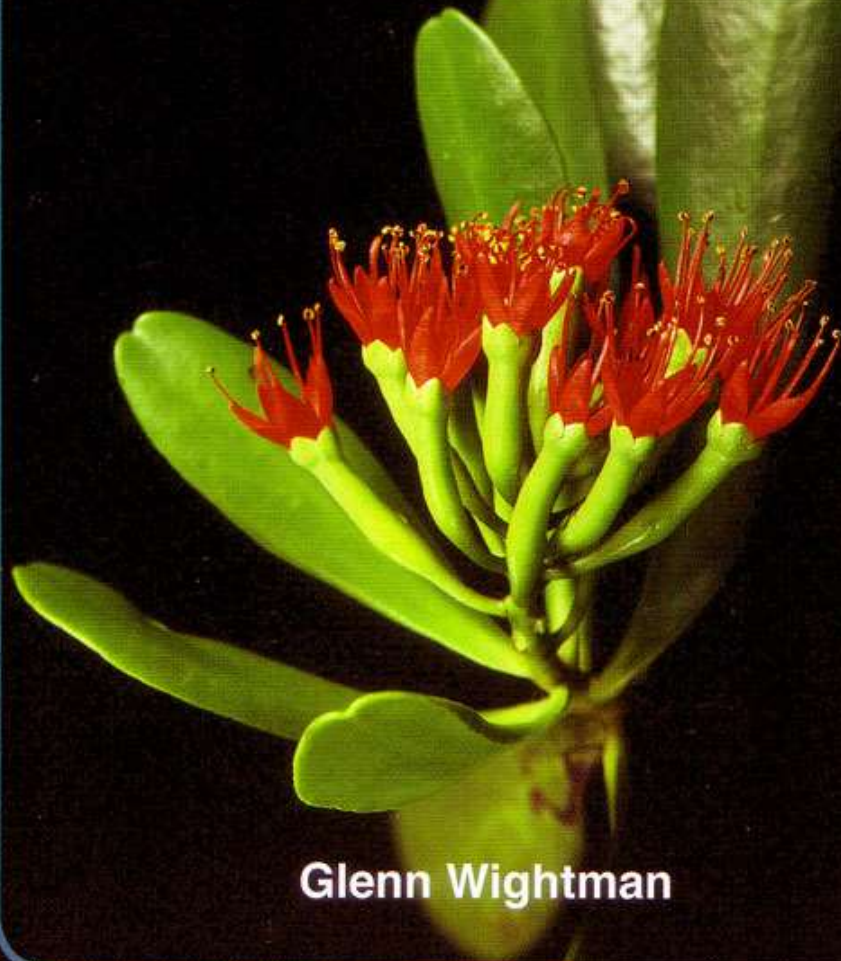






# Mangrove PLANT IDENTIKIT

for north Australia's Top End



Glenn Wightman



Eugene Tang/Tourism Thailand Blog Copyright 2010

*Lumnitzera x rosea*





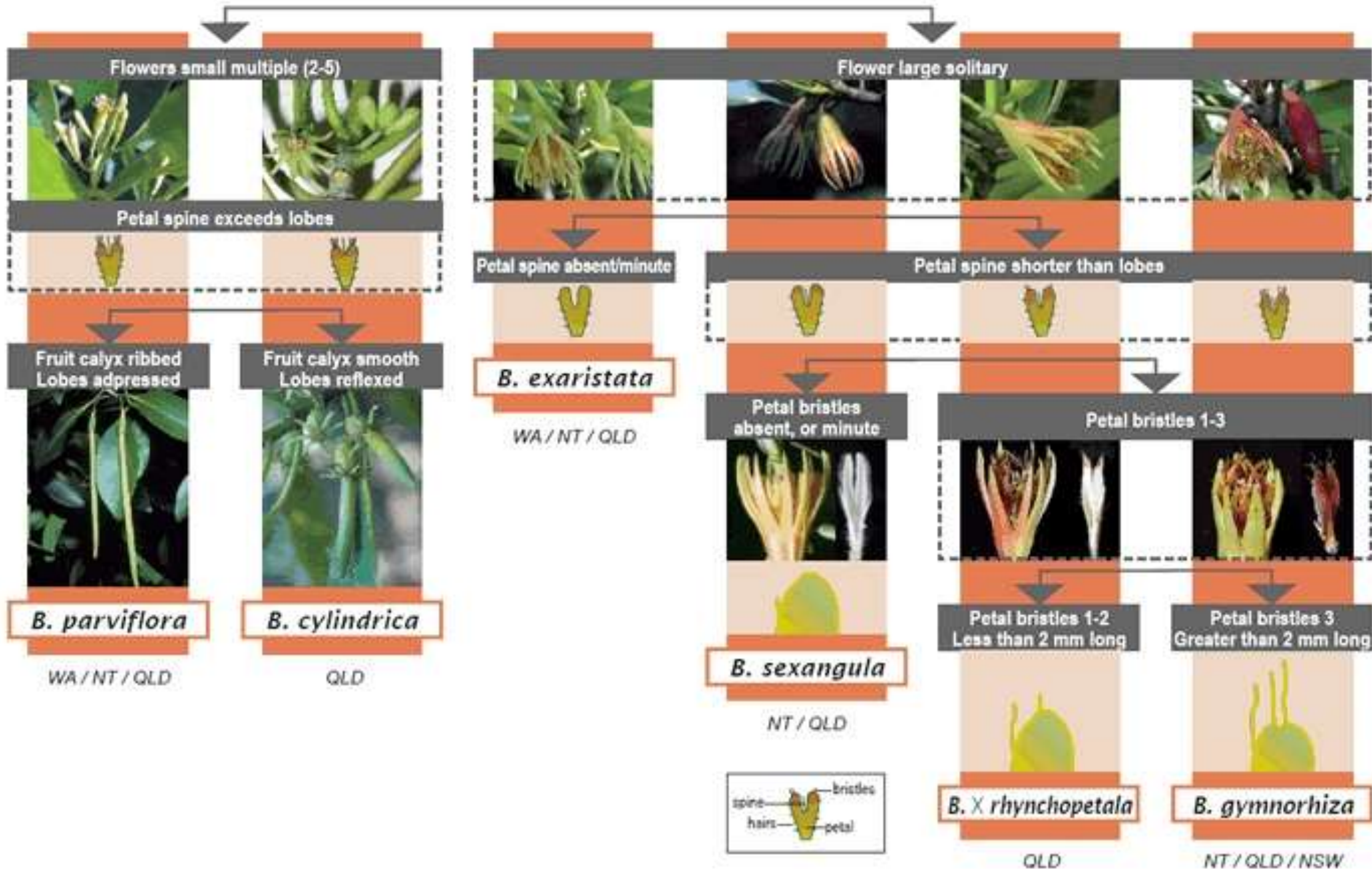


*Bruguiera gymnorhiza*

# Range of *Bruguiera gymnorhiza*

























This Week in Horticulture: Red-flowered mangrove (*Bruguiera gymnorrhiza*):  
A Follow-up Report David Jones, Curator of Living Collections



Shown above is the seven member interagency team who assisted the garden resample and manage the population of red-flowered mangroves thriving in the mangrove preserve, in late May. The piles of green debris next to the group are what remain of *Bruguiera* after measuring and destroying (by uprooting, cutting, and/or herbiciding) all 85 trees, saplings and seedlings found in the preserve.





An aerial satellite photograph of a coastal region. The land is densely packed with buildings and greenery, with a network of roads and waterways. A large body of water, likely a bay or estuary, occupies the right side of the image. Three yellow pushpin markers are placed on the map, each with a corresponding text label in white. The labels are 'New Bruguiera' at the top, 'Kampong Bruguiera' in the middle, and 'Lumnitzera' at the bottom. The water shows some darker patches, possibly indicating mangroves or other aquatic vegetation.

New Bruguiera

Kampong Bruguiera

Lumnitzera

New Bruguiera





John Ricisak, Miami-Dade County



*Bruguiera gymnorhiza*



















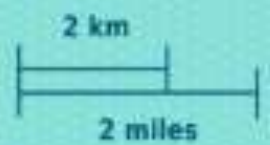
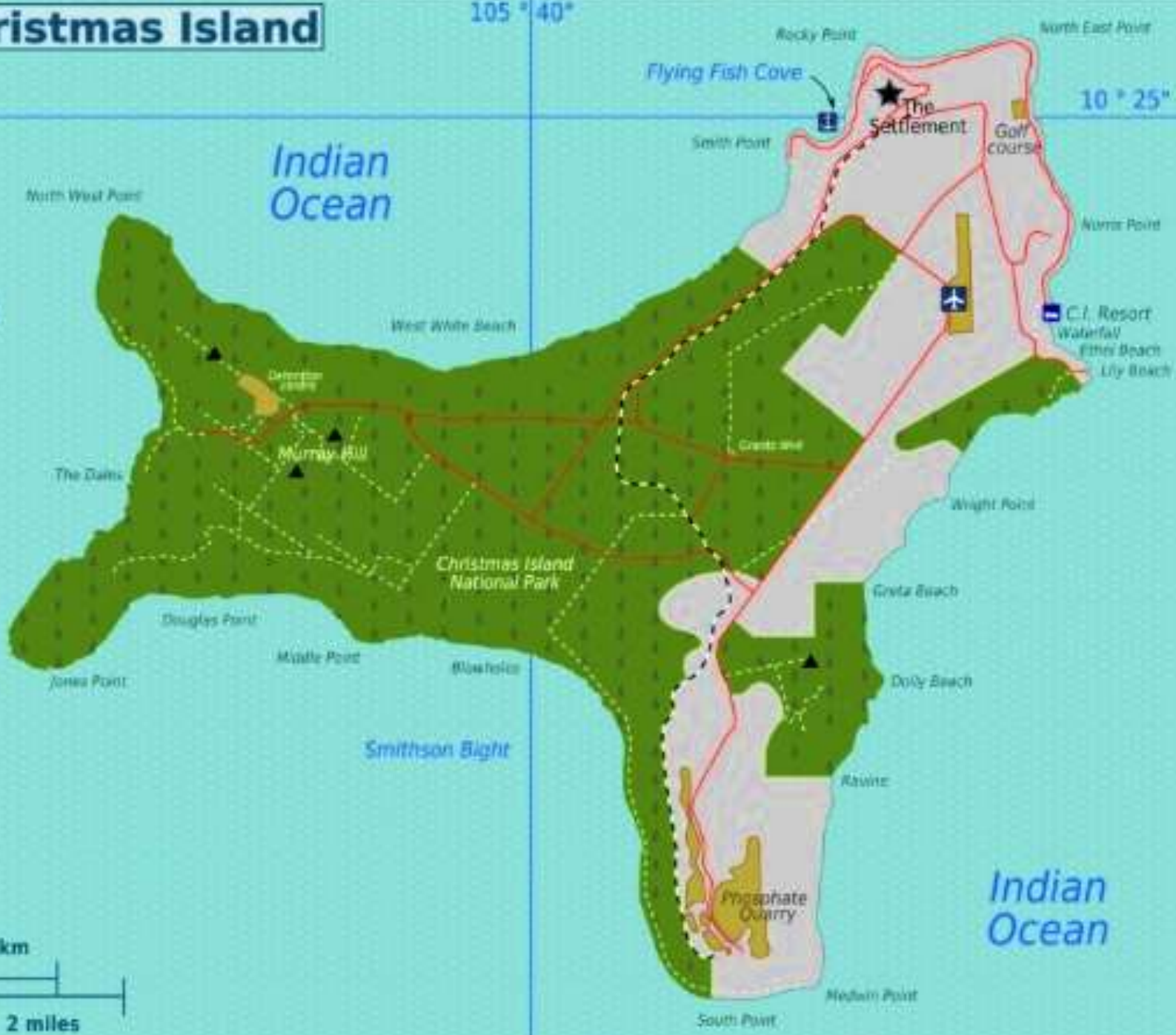
# Hosnies Spring, Christmas Island



# Christmas Island

105° 40'

10° 25'



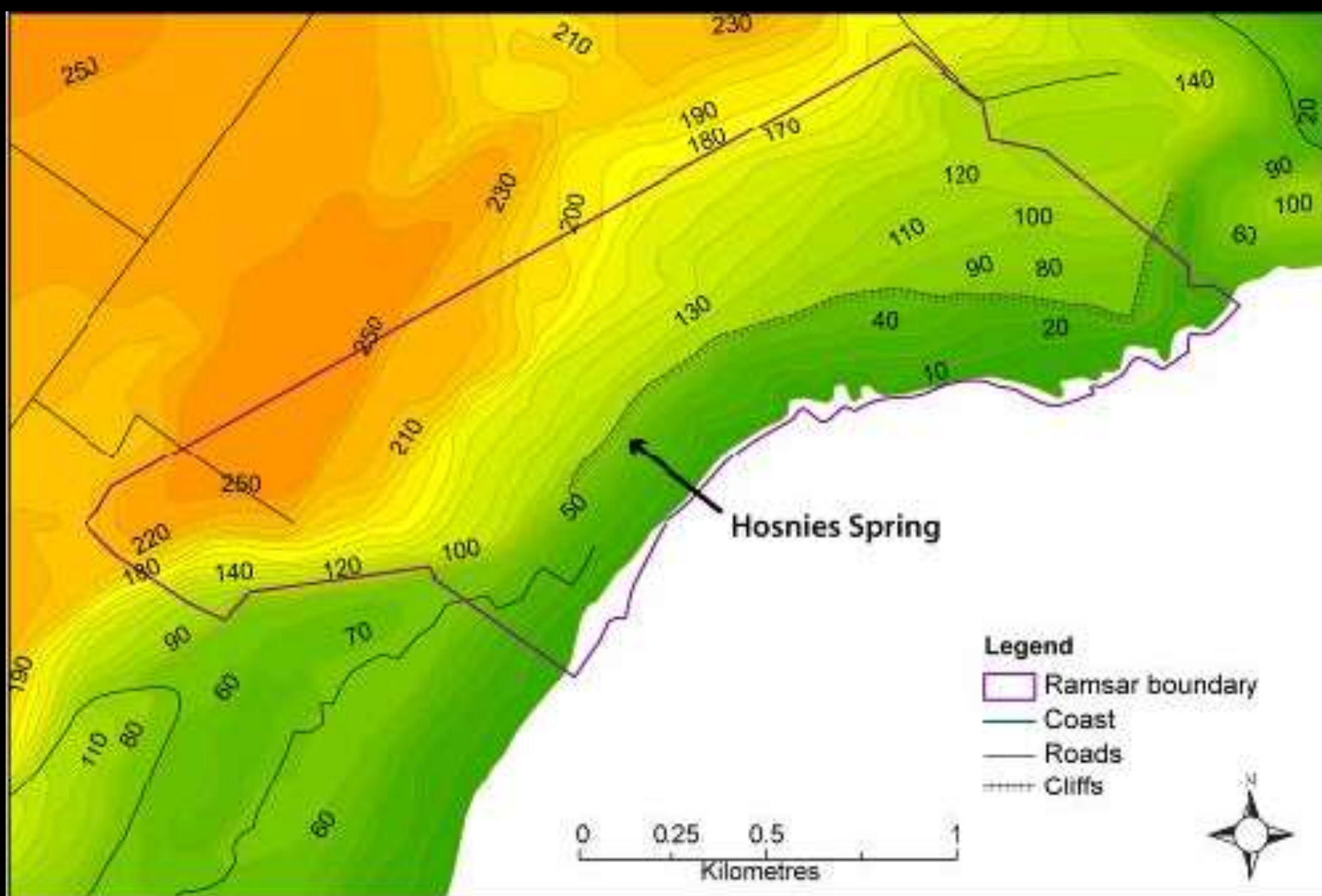
# Hosnies Spring







240,000 ybp

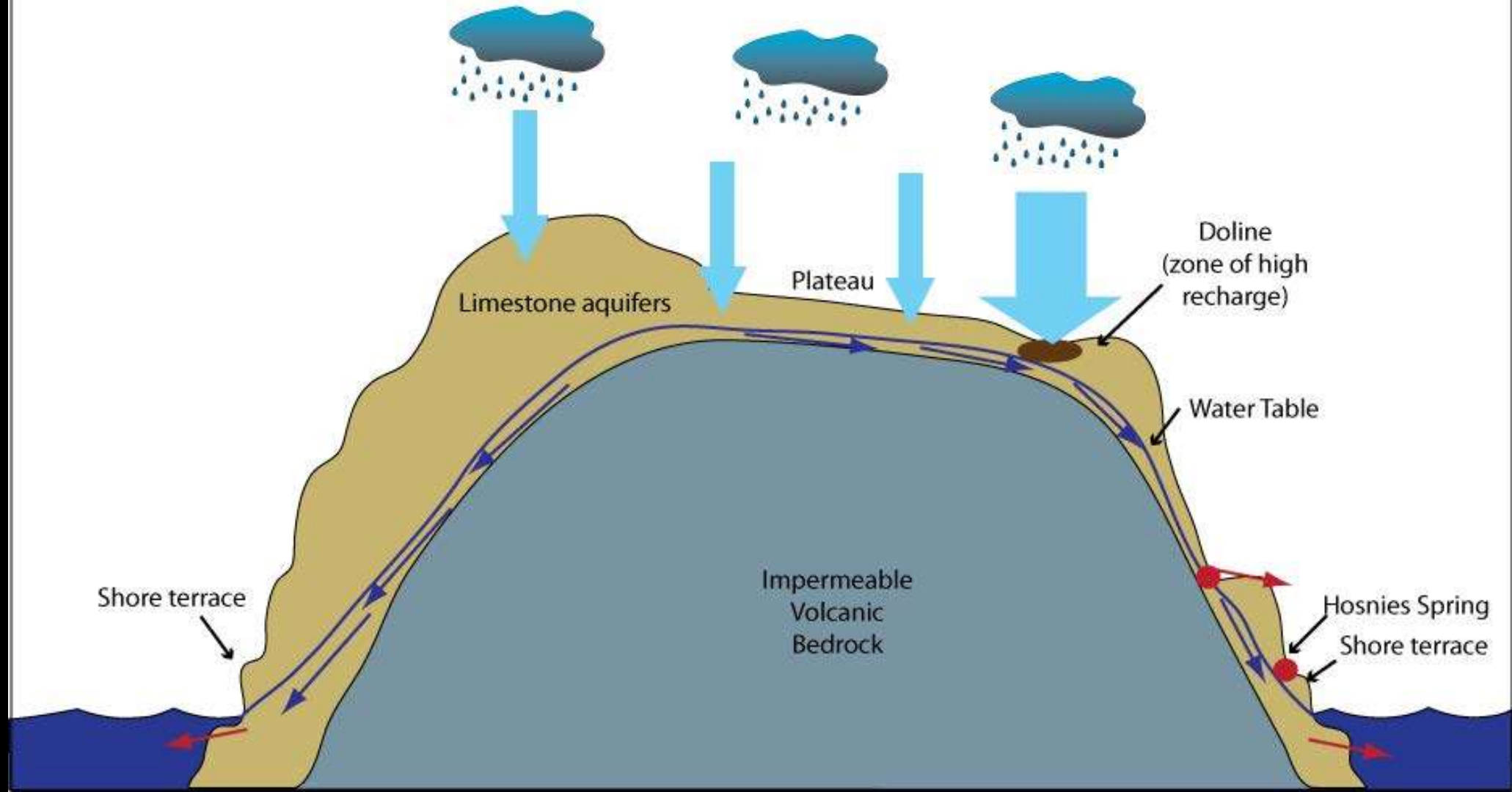


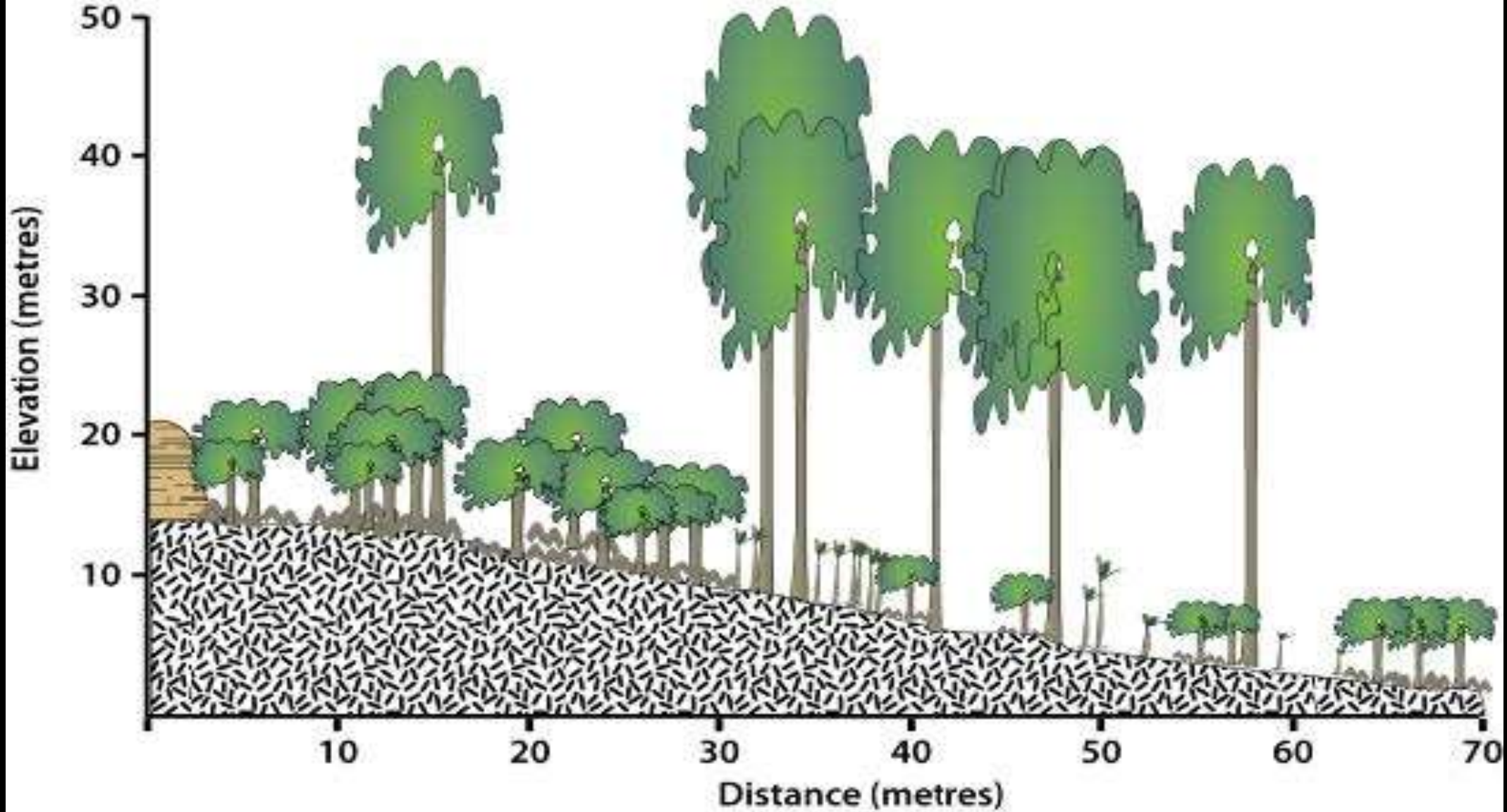
Today





-  Rainfall recharge
-  Groundwater discharge
-  Groundwater flow
-  Springs





-  Bruguiera seedlings
-  Bruguiera
-  Gravel
-  Limestone









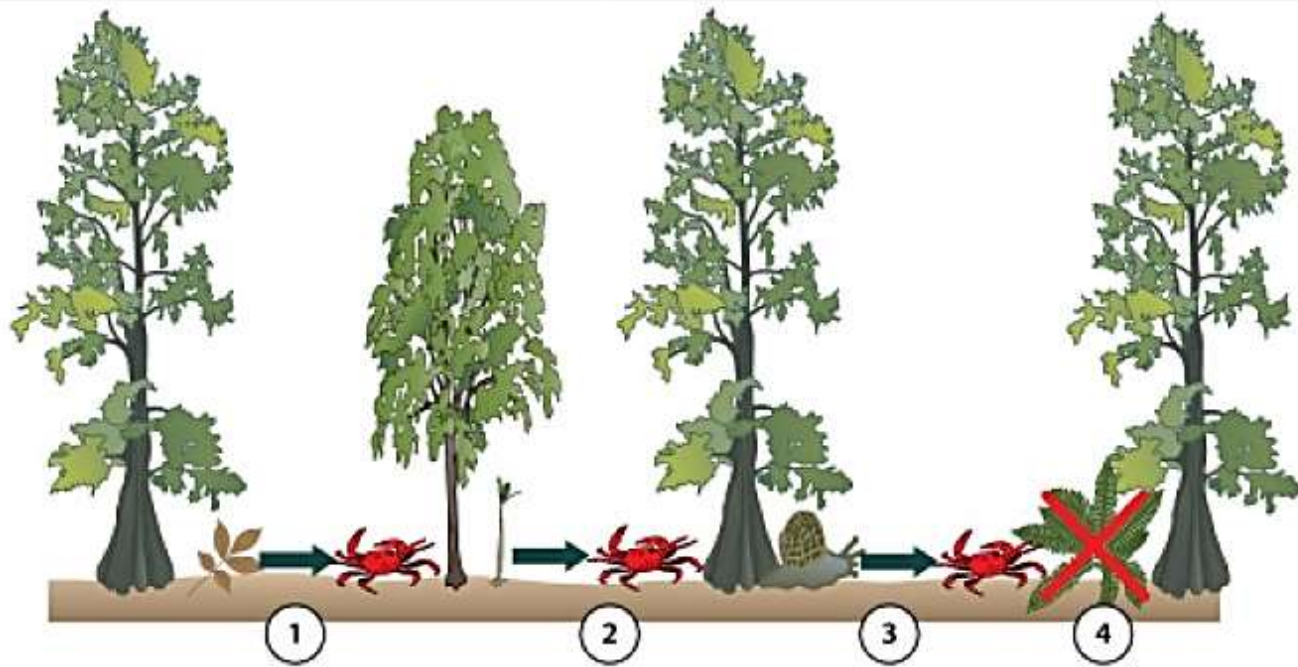










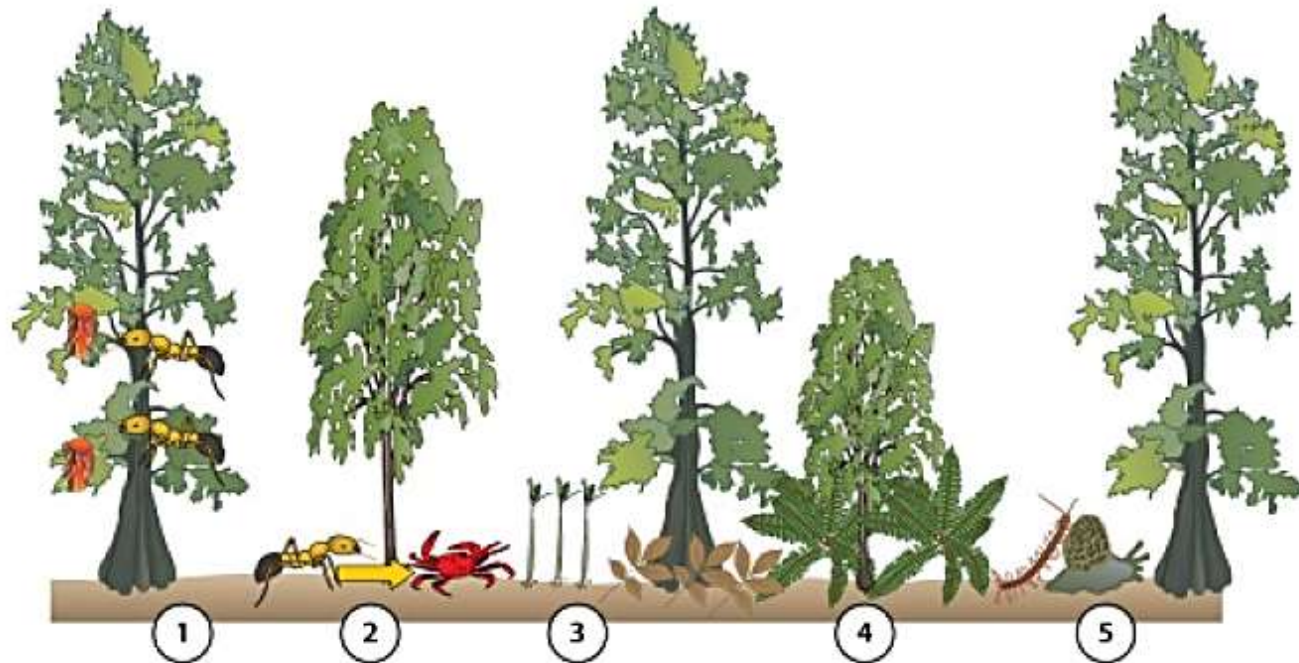






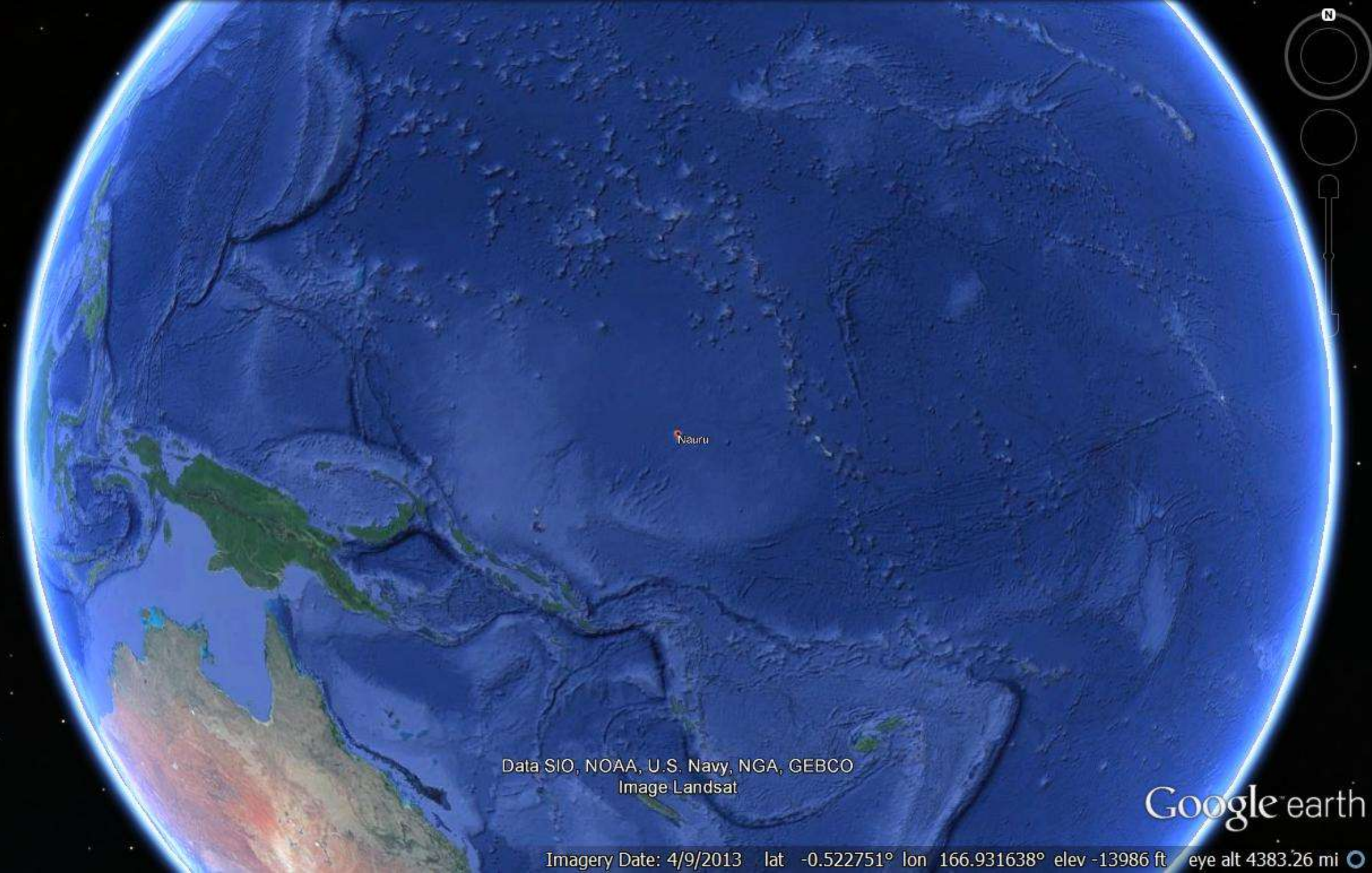
### Model 1: Absence of Yellow crazy ants

1. Red crabs consume live and dead leaf and plant material resulting in low levels of litter  and other detritivores
2. Red crabs consume seeds and seedlings reducing recruitment 
3. Red crabs consume invertebrates including introduced species such as the African land snail 
4. The result of red crab feeding is a simple forest structure with sparse understorey and ground cover. 



### Model 2: Yellow crazy ant super colonies

1. Yellow crazy ants  feed on secretions from scale insects  and form super colonies
2. Yellow crazy ants feed on red crabs and reduce the population
3. In the absence of crab predation, plant recruitment  and leaf litter  increase
4. Increased recruitment results in increased understorey and groundcover. 
5. Increased habitat and food, together with decreased predation, increases numbers of other introduced species such as the African land snail  and giant centipede 



Nauru

Data SIO, NOAA, U.S. Navy, NGA, GEBCO  
Image Landsat

Google earth

Imagery Date: 4/9/2013 lat -0.522751° lon 166.931638° elev -13986 ft eye alt 4383.26 mi







# *Nypa fruticans* the Mangrove Palm





# Native Range of *Nypa fruticans*



# *Nypa fruticans* in Native Habitat













90056012 © Jurgen Freund / NPL / Minden Pictures













2009 © anne jimenez



NIPA FRUTICANS.—WURM.—Blanco.—Miq.

Folia Martiana.

Bot. C. DeCandolle. Arctura.











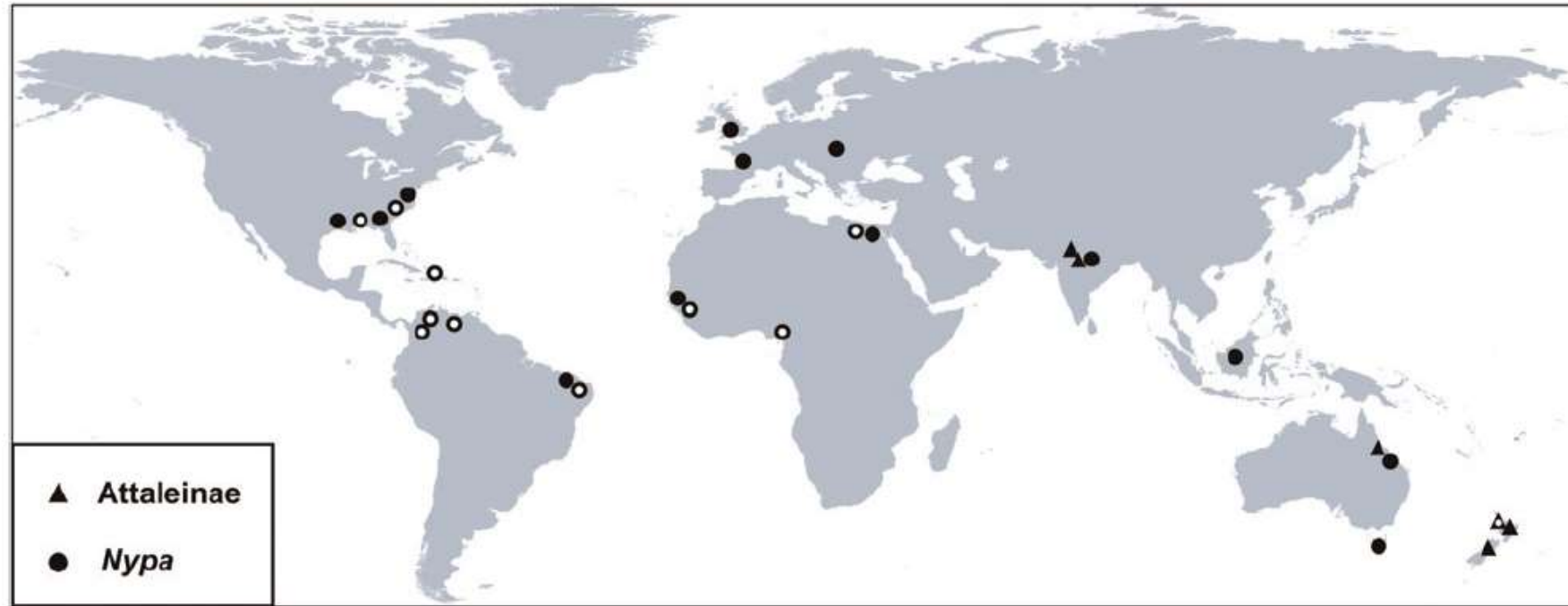


Fig. 7. Previous reports of fossil fruits and pollen of Attaleinae and *Nypa*. The pollen records are indicated by a white dot in the middle of the symbol.

# *Nypa fruticans* in Nigeria and Cameroon

















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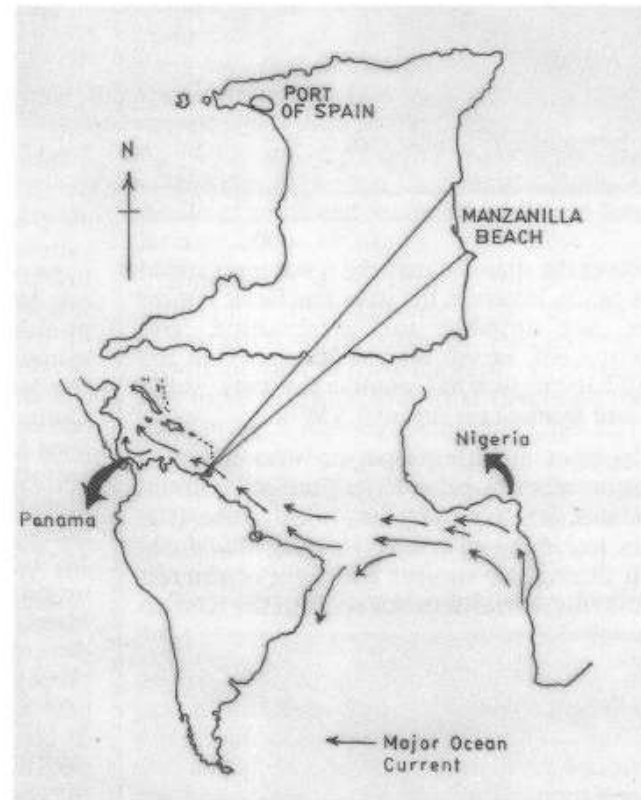




# Germination of *Nypa* *fruticans* in Trinidad

PETER R. BACON

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University of the West Indies,  
St. Augustine, Trinidad  
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1. Map of Trinidad,  
showing collecting  
site.

The first record of germination by beach-stranded propagules of the palm *Nypa* on a Caribbean shore is reported. Dispersal patterns indicate an origin from West Africa, and it is suggested that this might be evidence of the potential for recolonization of the western tropical Atlantic by this species.

# Nypa in the Mangroves of Central America: Introduced or Relict?

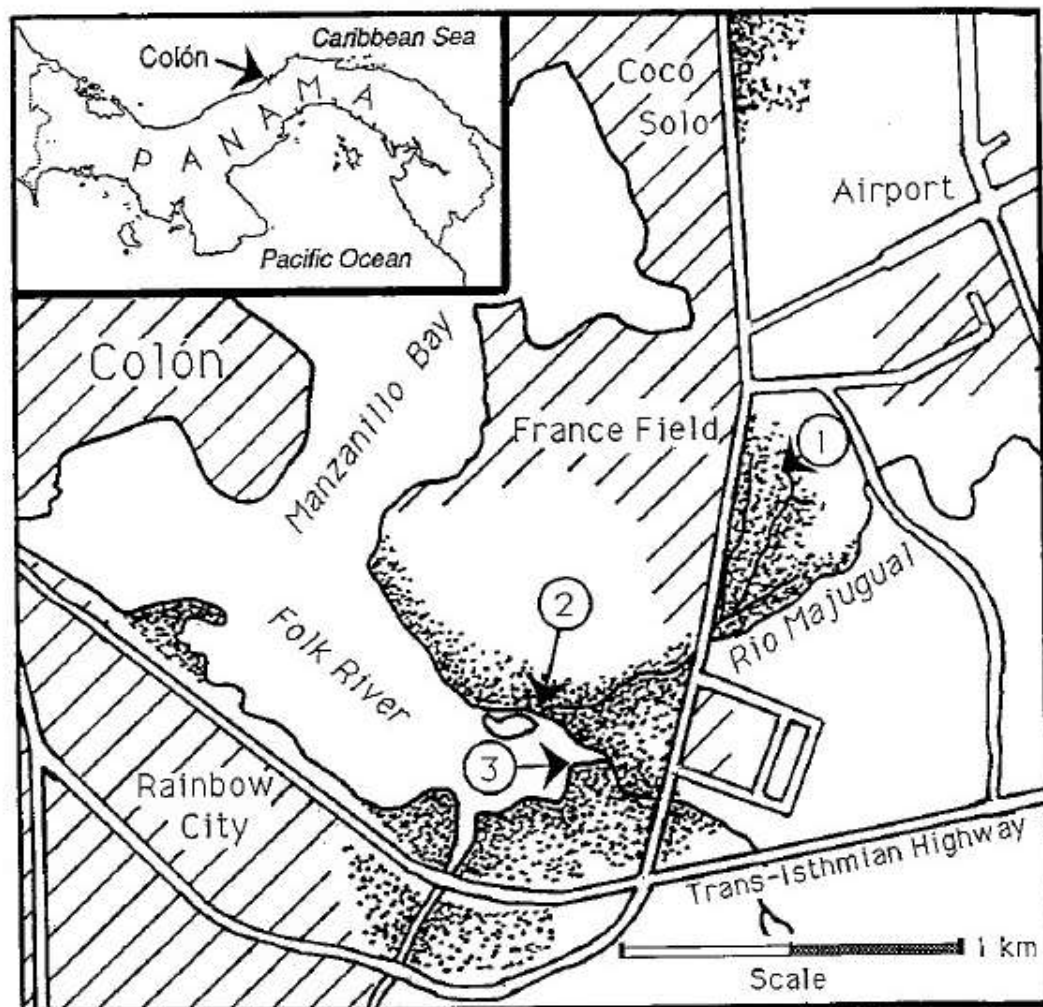
NORMAN C. DUKE

*Smithsonian Tropical Research Institute, Balboa, Republic of Panama*  
(Postal address: Unit 0948, APO AA 34002-0948, USA)

*Nypa fruticans* Wurm. is well-known within the tropical Indo-Western Pacific region as the mangrove palm (Tomlinson 1986). It occurs there in protected, brackish, estuarine locations, and is distributed

scientific interest. The present finding represents the only known occurrence of the palm in the Neotropics.

At the time of discovery, around April-May 1989, many palms were flowering



1. The map locates the small, but well-established population of mangrove palm, *Nypa fruticans*, found in April 1989. The site was alongside a small tidal stream, Rio Majagual, close to Colón on the Caribbean coast of Panama. Mature trees carrying many seeds, and surrounded by numerous seedlings, were found at the upper tidal reach (site 1), while only immature trees were observed downstream from a road bridge, extending to the Folk River estuary (site 2 and 3). The map also shows the proximity of surrounding mangrove forests (stippled) and "built-up" areas (diagonal shading), including major roads and a civil airport.



# *Nypa fruticans* at Fairchild Tropical Botanic Garden



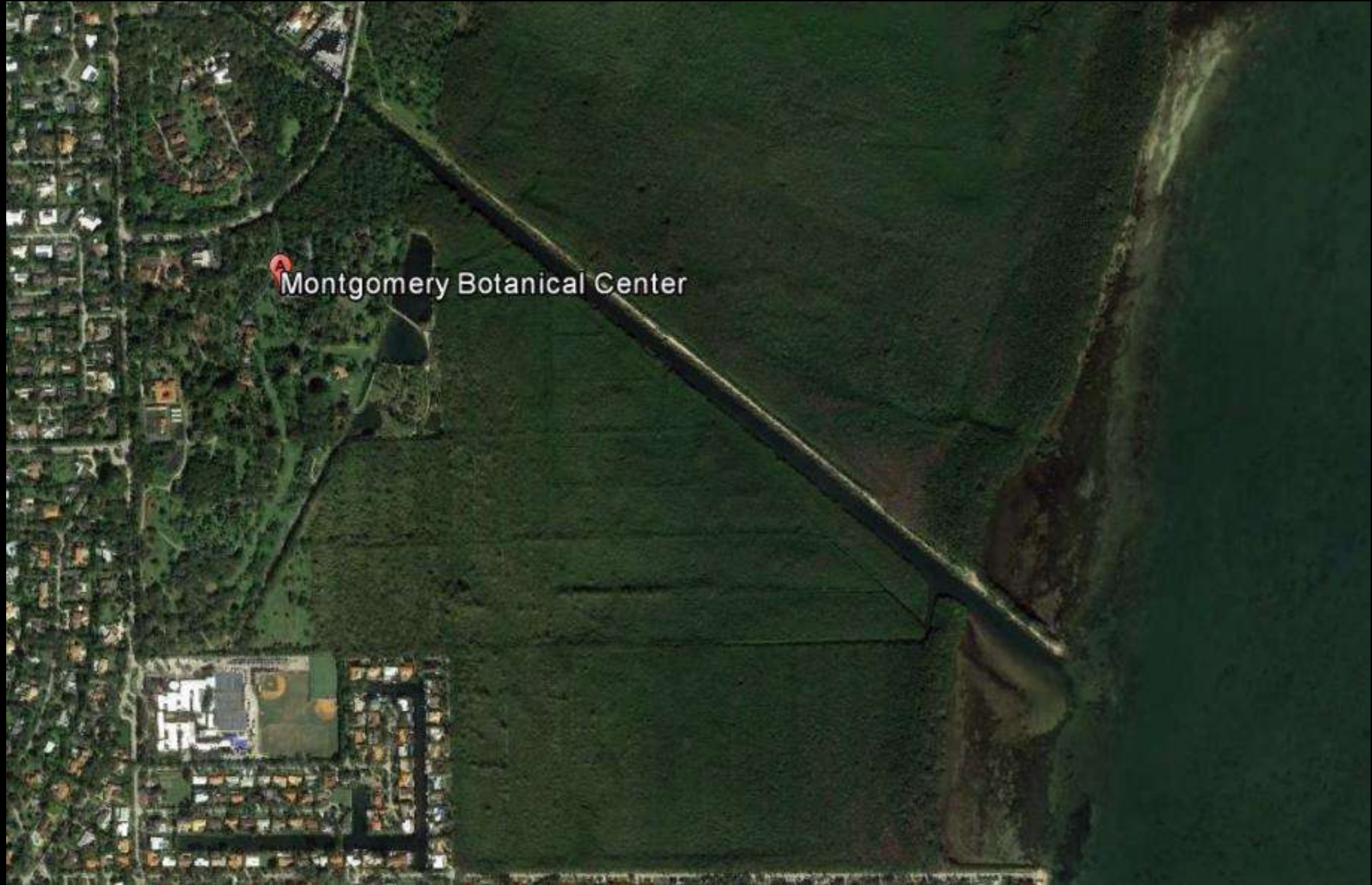








# *Nypa fruticans* at Montgomery Botanical Center













# THE INVASION CURVE

Asset Based Protection  
& Long-term Management

CONTROL COSTS →

↑  
The thousands of  
taxa awaiting  
import for which  
we have little  
basic life history  
info little to go  
on for any sig.  
level of  
management

Eradication

Containment

Species  
absent

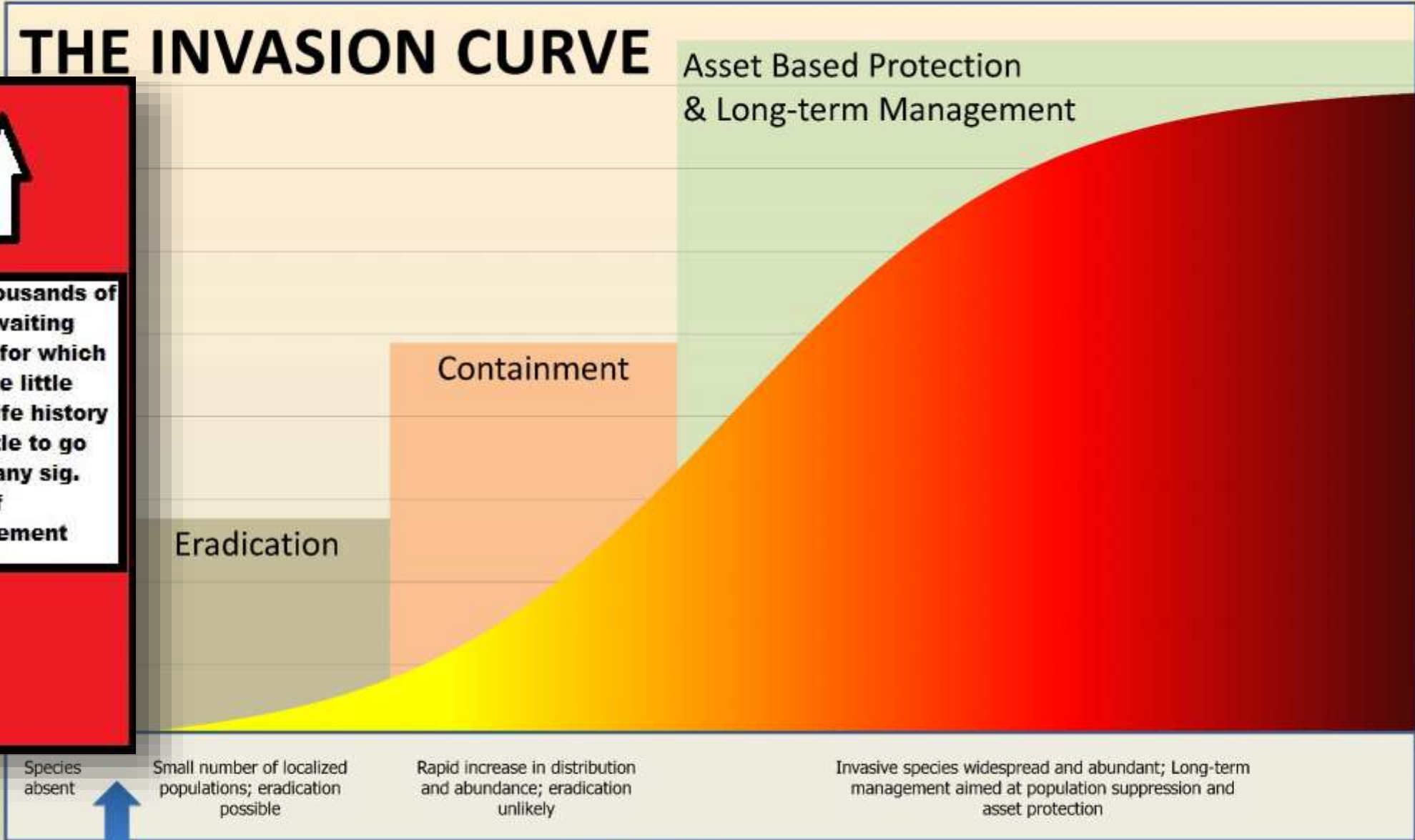
Small number of localized  
populations; eradication  
possible

Rapid increase in distribution  
and abundance; eradication  
unlikely

Invasive species widespread and abundant; Long-term  
management aimed at population suppression and  
asset protection

Introduction

TIME →



# Mangroves

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∴ [Bruguiera gymnorhiza](#)

∴ [Pelliciera rhizophorae](#)

∴ [Rhizophora mangle](#)

∴ [Rhizophora stylosa](#)



[Bruguiera gymnorhiza](#) (Large-Leafed Orange Mangrove)



[Pelliciera rhizophorae](#) (Tea Mangrove)



[Rhizophora mangle](#) (Red Mangrove)



[Rhizophora stylosa](#) (Stilted Mangrove)

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## cultivation



### Abstract

Bruguiera gymnorrhiza can be cultivated easily under simple growing conditions.

### Soil & Fertilizer

One of the most important criterium for a successfull long term cultivation of Bruguiera gymnorrhiza with magnificent growth is to offer the right kind of soil substrate with a numerous amount of the right nutrients. We recommend Mangrove Mud Special with which we have excellent results in growing Bruguiera gymnorrhiza. Mangrove Mud Special is a long term fertilizer that can be used pure or stretched with sand. The less stretched Mangrove Mud Special is the more effective it is and the easier it is to cultivate Bruguiera gymnorrhiza.

### Air temperature

Air temperature should be around 22 to 30°C. Not at any time the temperature should fall below 10°C. Short temperature drops for a few days down to 15°C are normally no problem and can be handled pretty well.

### Water temperature

Water temperature should be around 20 to 28°C. Not at any time the temperature should fall below 10°C. Short temperature drops for a few days down to 15°C are normally no problem for Bruguiera gymnorrhiza and can be handled very well.

### Humidity

Humidity should be around a minimum of 50 percent. The higher humidity is the better it is for Bruguiera gymnorrhiza and its growth. Too low humidity can be a reason for Bruguiera gymnorrhiza to have shriveling shoots which then can not develop properly. In most cases a sprayer helps to increase the local humidity.

### Light

Light plays an important role in keeping Bruguiera gymnorrhiza successfully and is directly related to the growth. Bruguiera gymnorrhiza can be grown successfully by daylight during the whole year but shows its full glory at a daily light period of 10 to 12 hours. An additional or total illumination by an artificial lighting system is recommended, especially in places outside of the thirtieth latitude.

Artificial lights should have a light spectra of about 5000 to 13000 kelvins. Experience has shown that HQI (Metal Halide) or HPS (High Pressure Sodium) lights in the just-called range achieved best results.

T5 fluorescent lamps also achieved good results in growth of Bruguiera

- introduction
- distribution
- cultivation
- roots
- leaves
- flowers
- fruits
- seeds
- trunk
- soil
- growth
- usage

- introduction
- distribution
- cultivation
- roots
- leaves
- flowers
- fruits
- seeds
- trunk
- soil
- growth
- usage



### Growth field

#### Aquarium

Bruguiera gymnorrhiza perfectly can be grown in any kind of aquarium whether seawater aquarium, brackish water aquarium or freshwater aquarium. The implementation of Bruguiera gymnorrhiza into your tank is generally absolutely easy. Bruguiera gymnorrhiza has rapid growth and filters nitrite, nitrate and phosphate pretty good.

#### Mangrove Basin

Cultivation of Bruguiera gymnorrhiza in a mangrove basin is very easy. Socialization with other mangrove species is no problem.

#### Vivarium

Due to the increased humidity in a vivarium Bruguiera gymnorrhiza can be grown perfectly in a vivarium. Keep in mind cutting shoots right on time before the plants get too big.

#### Terrarium

Generally a tropical terrarium offers very good growing conditions for the Oriental Mangrove. Bruguiera gymnorrhiza is a great appearance in such a tropical terrarium, especially near or in the water part of the terrarium. The animals of the terrarium will love the variety. Keep in mind cutting shoots right on time before the plants get too big.

#### Indoor plant / Conservatory

Due the robustness of the Oriental Mangrove, Bruguiera gymnorrhiza is one of the few mangrove species that can be grown as an indoor plant on the window sill or in a conservatory. It is important that the Bruguiera gymnorrhiza is grown from a propagule to make sure that the Oriental Mangrove can adapt to the individual conditions like fluctuating temperatures or daylight hours from first day on. To support the growth during the whole year the temperature can be supported by a heating system and the daylight hours by artificial lights to make sure that the Bruguiera gymnorrhiza receives 10 to 12 hours light daily.

Further details about keeping mangroves are shown detailed and clearly [here](#)

#### Salt

We recommend brackish water with a salinity of 10 to 25 grams not iodized sea salt per liter.

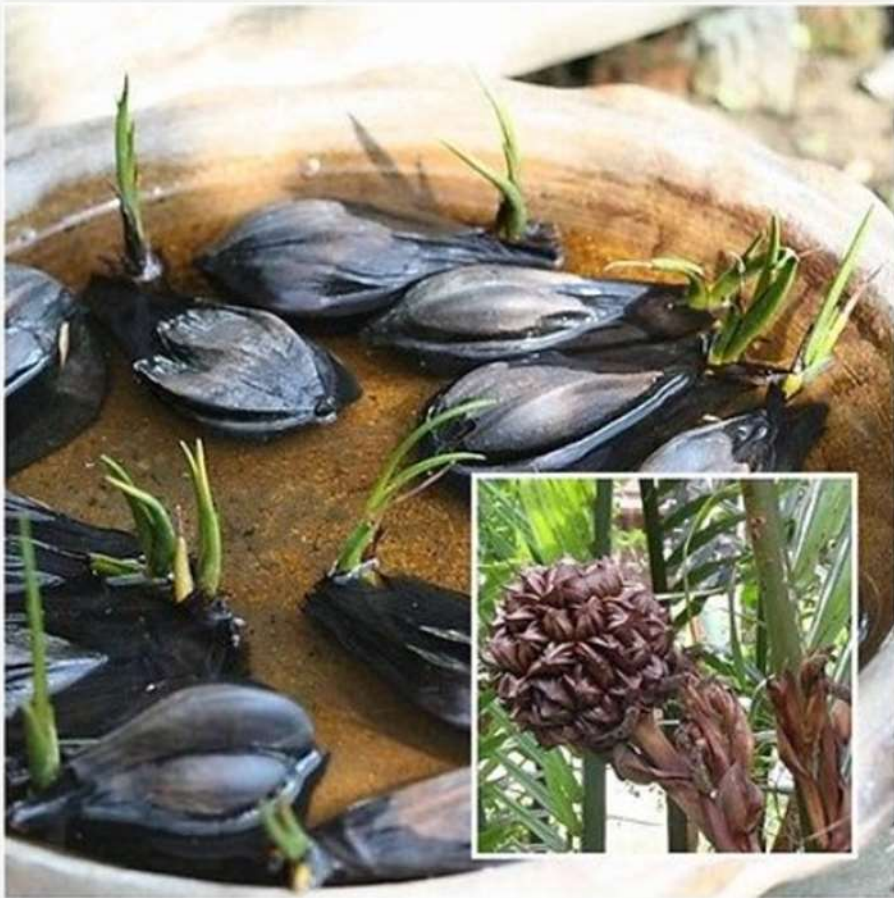
#### Plants

[Bruguiera gymnorrhiza plants](#) are available on our webshop.

#### Propagules

[Bruguiera gymnorrhiza seeds](#) are available on our webshop.





Seller : **seedstogrow** (715 ★) 95.8% Positive feedback

♡ Save this Seller | Contact seller | See other items | Visit store

## Nypa fruticans Wurmb 3 Seedlings Nypa Atap palm Nypa palm Mangrove palm Rare

Condition: --

Quantity:

9 available  
25 sold / [See feedback](#)

Price: **US \$32.89**

**Buy It Now**

**Add to cart**

[Add to watch list](#)

100% buyer satisfaction

25 sold

More than 73% sold

Shipping: **\$30.00** Standard Shipping from outside US | [See details](#)

See details about international shipping here. ?

Item location: Muang, Samutprakarn, Thailand

Ships to: Worldwide [See exclusions](#)

Delivery:  Estimated between **Fri. Nov. 16 and Thu. Dec. 13** ?  
Please note the delivery estimate is **greater than 4 business days.**

Payments:





[vergladesCISMA.org](http://vergladesCISMA.org)