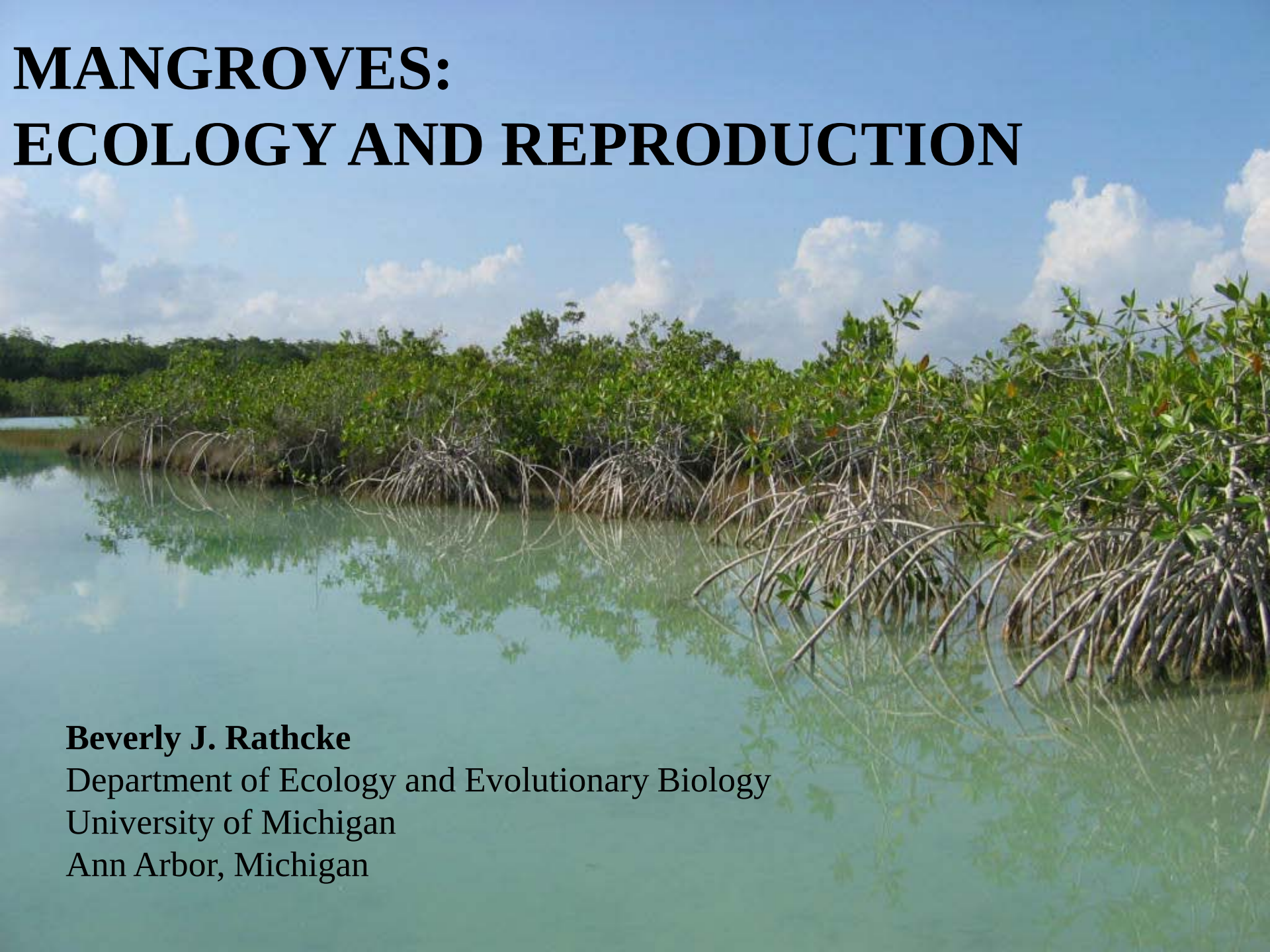
MANGROVES: ECOLOGY AND REPRODUCTION



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Ecological Value of Mangroves

Mangroves are:

1. Land builders and protectors – they collect debris and detritus and protect land from hurricanes
2. Filtration systems for water
3. Feeding, breeding, and nursery grounds for fish, shellfish, birds, and other marine life
4. One of the world's most productive ecosystems

Red mangrove has been called the "most valuable plant" for islands and coastlands

“The only people who go
into mangrove swamps
are scientists and escaped convicts.”

-E. O. Wilson

MANGROVES: 3 major species in neotropics

RED MANGROVE

Rhizophora mangle (Rhizophoraceae)

BLACK MANGROVE

Avicennia germinans (Avicenniaceae or Verbenaceae)

WHITE MANGROVE

Laguncularia racemosa (Combretaceae)

Mangroves are unrelated species that live along the edges of ocean; they do NOT need salt—they tolerate salt—salt reduces competition with other plants

About 50 species worldwide; in 16 families

Mangrove reproduction

The breeding and mating systems and seed dispersal will determine:

- degree of genetic variation
- ability to respond to environmental change
- ability to colonize new areas after disturbances

important to consider in restoration

MANGROVE ZONATION: classic view

RED MANGROVE

Rhizophora mangle (Rhizophoraceae)

water edge

BLACK MANGROVE

Avicennia germinans (Avicenniaceae)

mid-zone: between red and white

WHITE MANGROVE

Laguncularia racemosa (Combretaceae)

landward edge

Local distribution is determined by

fruit dispersal

tidal height, water and soil salinities, and soil aeration


RED MANGROVE – ocean edge
prop roots – provide oxygen
ground roots exclude salt
Xcalak

Red Mangrove distribution

Florida

Bahamas

West Indies

tropical America

West Africa

the Pacific Islands

6 + pantropical species of *Rhizophora*

Red Mangrove (*Rhizophora mangle*)

Typical trees can grow 25 m tall

Dwarf forms
< 1 m tall

Suboptimal conditions
Drier transitional areas

Sandy Point
Abaco, Bahamas

Red Mangrove reproduction

Each flower has
male and female function
(hermaphroditic)

Can self-pollinate in the bud
Self-fertilize
Self-compatible

Many Florida populations are complete selfers (Proffitt, Travis, Devlin)

Do not need pollinators to produce fruit
Wind-dispersed pollen; But many insects visit, especially bees

RED MANGROVE mutants

Selfing reveals deleterious mutations

inbreeding depression

The mutant offspring are yellow, red or albino

and will not survive

Normal offspring are green

Sandy Point, Abaco, Bahamas

Mexico?

Red Mangrove is viviparous

(live-bearing) the seed germinates and the radicle of the embryo grows out of the fruit while still on the parent plant forming a propagule; c. 1/3 of mangrove species show vivipary

Red Mangrove:

propagules (seedlings) float vertically
no seed “bank” but propagules can float and be viable up to a year

20-30 cm long

BLACK MANGROVE

intermediate zone between Red and White mangroves

Black Mangrove distribution

Florida to Texas
Bermuda
Bahamas
West Indies
Mexico
Central America
to Peru and Brazil

A single genus
with 11 species
in Avicenniaceae

Avicennia germinans

Black Mangrove
Avicennia germinans

Intermediate zone

between Red and White mangrove

Excrete salt on leaves

Excreted salt on Black Mangroge leaf

Black Mangrove: pneumatophores (breathing roots--provide oxygen)


Black Mangrove flowers
Sian Ka’an

Black Mangrove: A*vicennia germinans*

Flowers are hermaphroditic (male and female)

Probably are self-incompatible (?) and outcrossing

Require a pollinator for fruit set

Pollinators: butterflies, bees, other insects

mangrove honey

Black Mangrove fruits

viviparous (cryptovivipary)

the embryo develops while on the parent but does not penetrate the fruit coat

Fruits – 2-3 cm long

water dispersed

no seed “bank”


WHITE MANGROVE
Laguncularia racemosa
COMBRETACEAE
Puerto Escondido

White Mangrove distribution

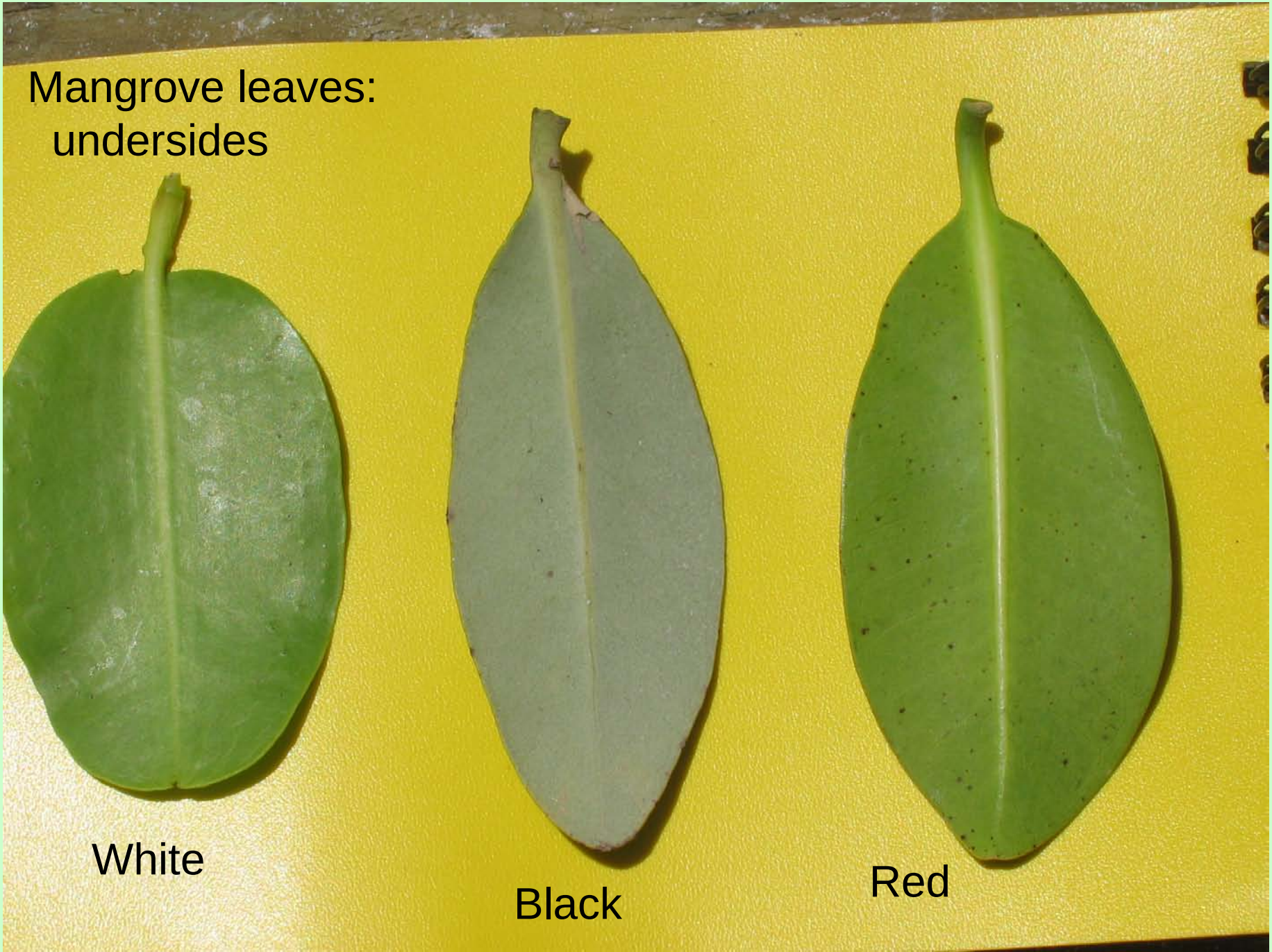
- Florida
- Bahamas
- West Indies
- Mexico through Central America to South America
- Tropical West Africa

Laguncularia:

- A monotypic genus

White Mangrove: landward edge

above low tide; can produce pneumatophores if inundated


Mangrove leaves:
undersides
White
Black
Red

White Mangrove

These are NOT salt glands

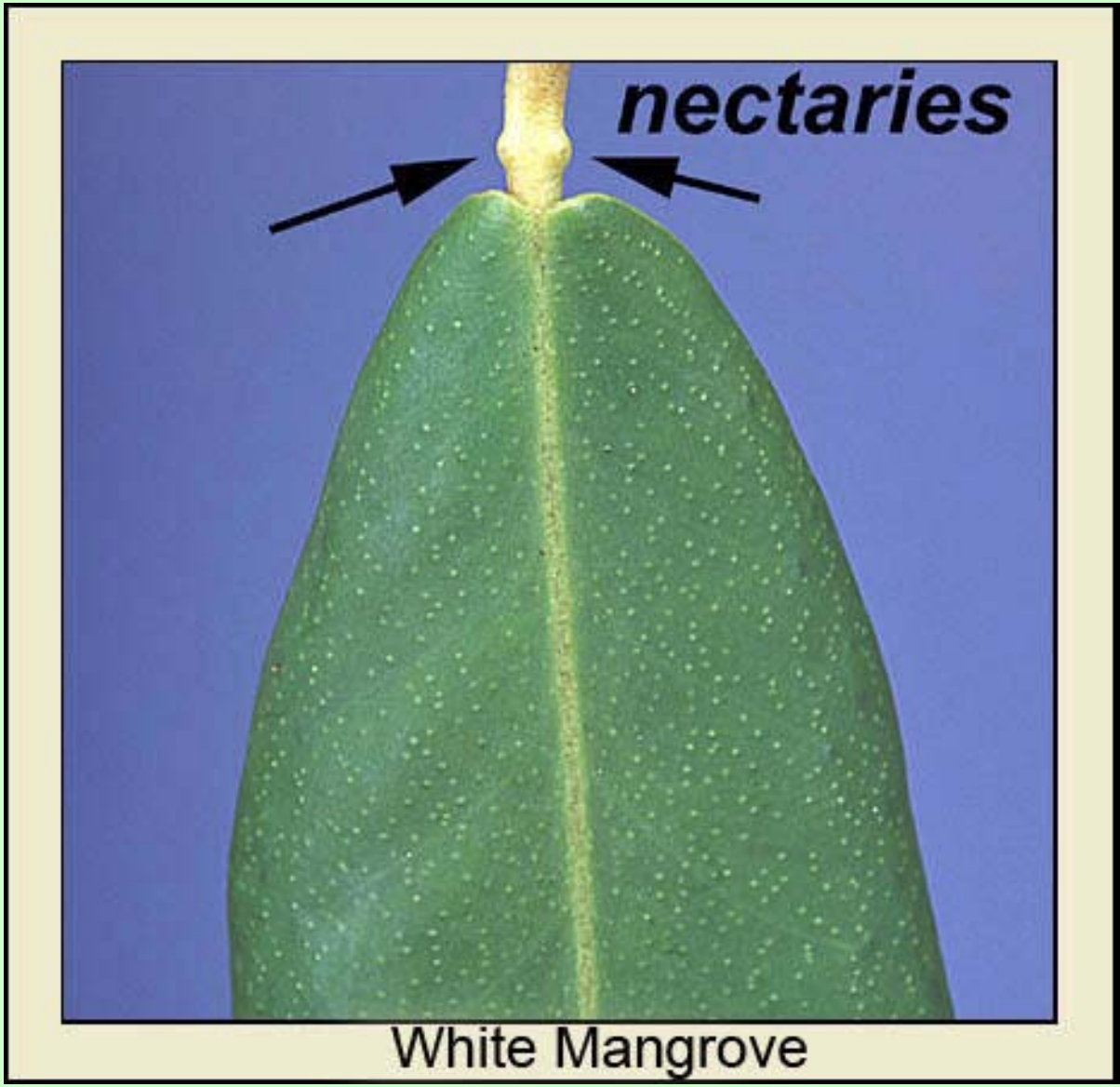
They are extra-floral nectaries

Leaves accumulate and excrete salt

Nectar produced by new leaves only

Ants and wasps visit

PROTECTORS?
kill herbivores



White Mangrove

White Mangrove fruits

SEMI-VIVIPAROUS

Seed can germinate inside fruit during dispersal, but not while attached to the parent plant

Fruit – 1 cm long

Water-dispersed

No seed “bank”

WHITE MANGROVE

breeding system: 2 kinds of flowers

on different plants

Zihuatanejo

White Mangrove

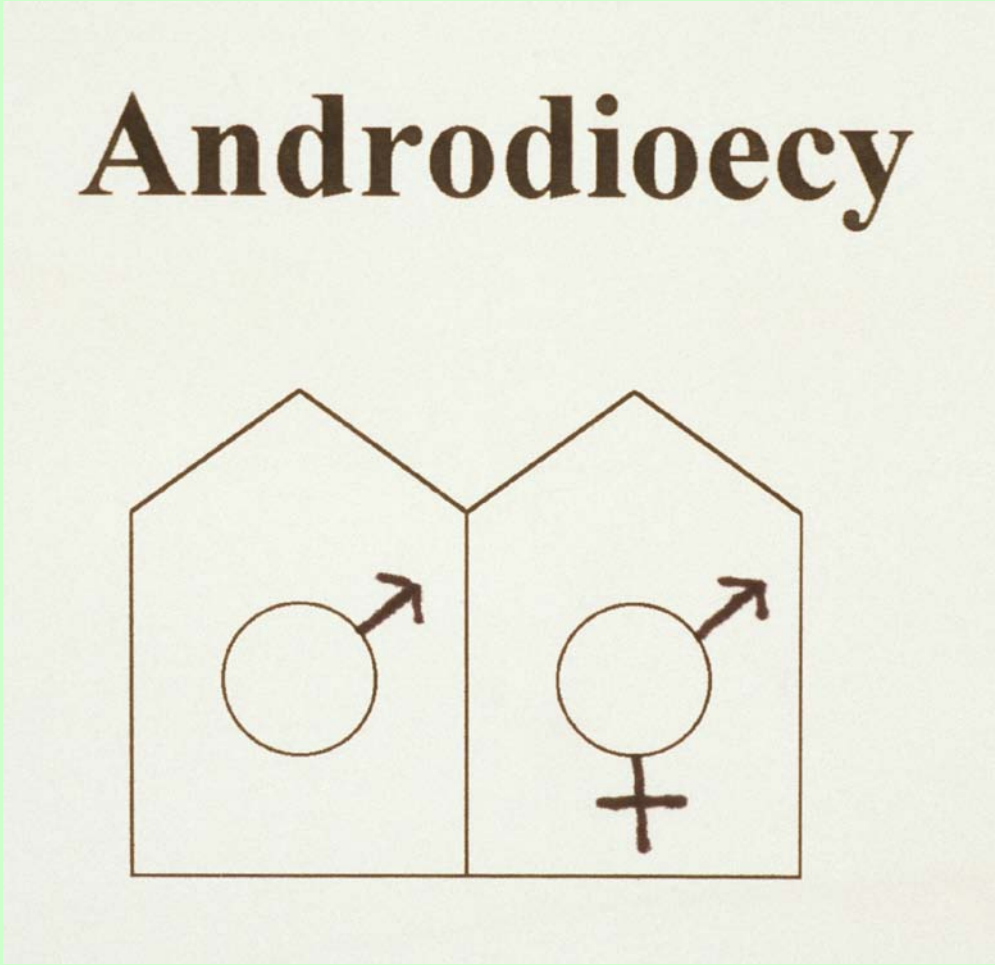
male

hermaphrodite

The surprise: White Mangrove is androdioecious

male plants and hermaphroditic plants (with hermaphroditic flowers—have male and female function)

an extremely rare breeding system; only 9 other plant species to date have been shown to be androdioecious



White Mangrove pollination tests

Hermaphrodites have
viable pollen
have both male and female function

can self-pollinate
can self-fertilize
are self-compatible

Androdioecy: why is this a breeding system so rare?

How can males persist in a population of hermaphroditic plants?

Males need twice the fitness of the male function of hermaphrodites to persist.

Male frequency should be < 50% (dioecy)

Male frequency should vary with the relative fitness of males

(Evolutionary Stable Strategy model—Lloyd 1986)

.

Not all White Mangrove populations have males; some have only hermaphroditic plants

Bahamas:

	N	% males
San Salvador	281	12 % (0-22%)
Eleuthera	409	0
Exumas	134	0
New Providence	284	0
Cat Island	168	0
Andros	21	0
Abaco	262	0

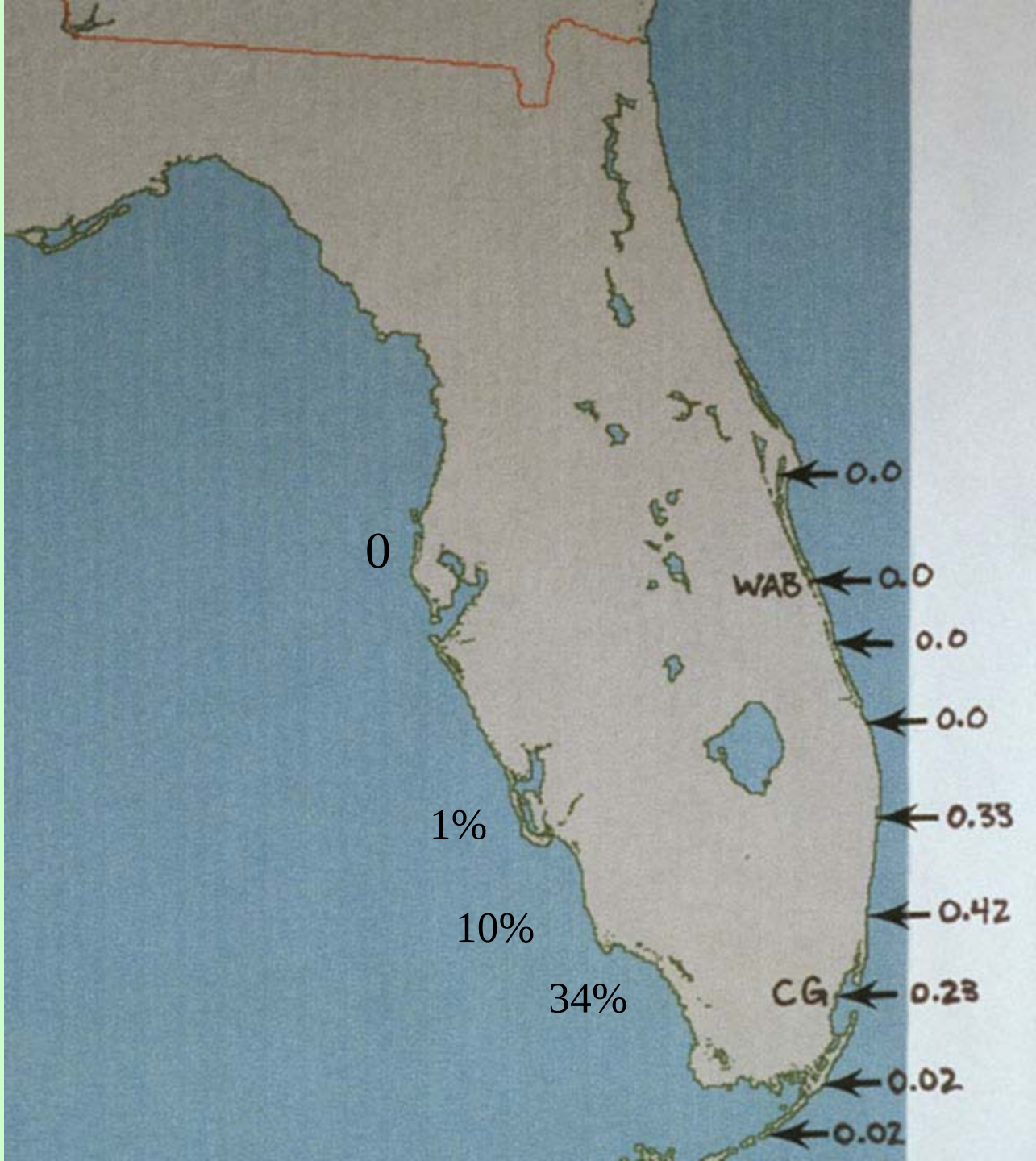
White Mangrove Male Frequency in Florida

East coast: Abrupt shift to no males north of Boca Raton; hermphroditic plants only

Male frequency varies southward

West coast:
Male frequency declines northward

Carol Landry's thesis research



PRINCIPAL FLOWER VISITORS to White Mangrove – Carol Landry

East Coast

N. Florida *(NO males)*	**S. Florida** *(males)*
Large bees and wasps Honeybees	Small bees and wasps
stay w/in plants	move between plants
greater selfing	greater outcrossing

Pollinators may be important in maintaining androdioecy

because they can determine outcrossing and mating opportunities for males

White Mangrove?

White mangrove in Mexico?

androdioecious

surprise: high male frequencies!

	N	% males
• Tulum	90	75 %
• Sian Ka'an	26	77 %
• Xcalak	14	71 %
• Celustun	19	79 %

MACHO IN MEXICO!

WHITE MANGROVE IN W. MEXICO

also high male frequencies!

Pacific coast (N – S)

	N	% males
San Blas	173	58 %
Boca de Naranja	16	76 %
La Pineta	79	85 %
Los Ayalas	110	85 %
Zihautanejo lagoon	134	47 %
park	20	50 %
Pie de la Cuestra	44	57 %
Puerto Escondido	18	78%

Why so many males in Mexico?

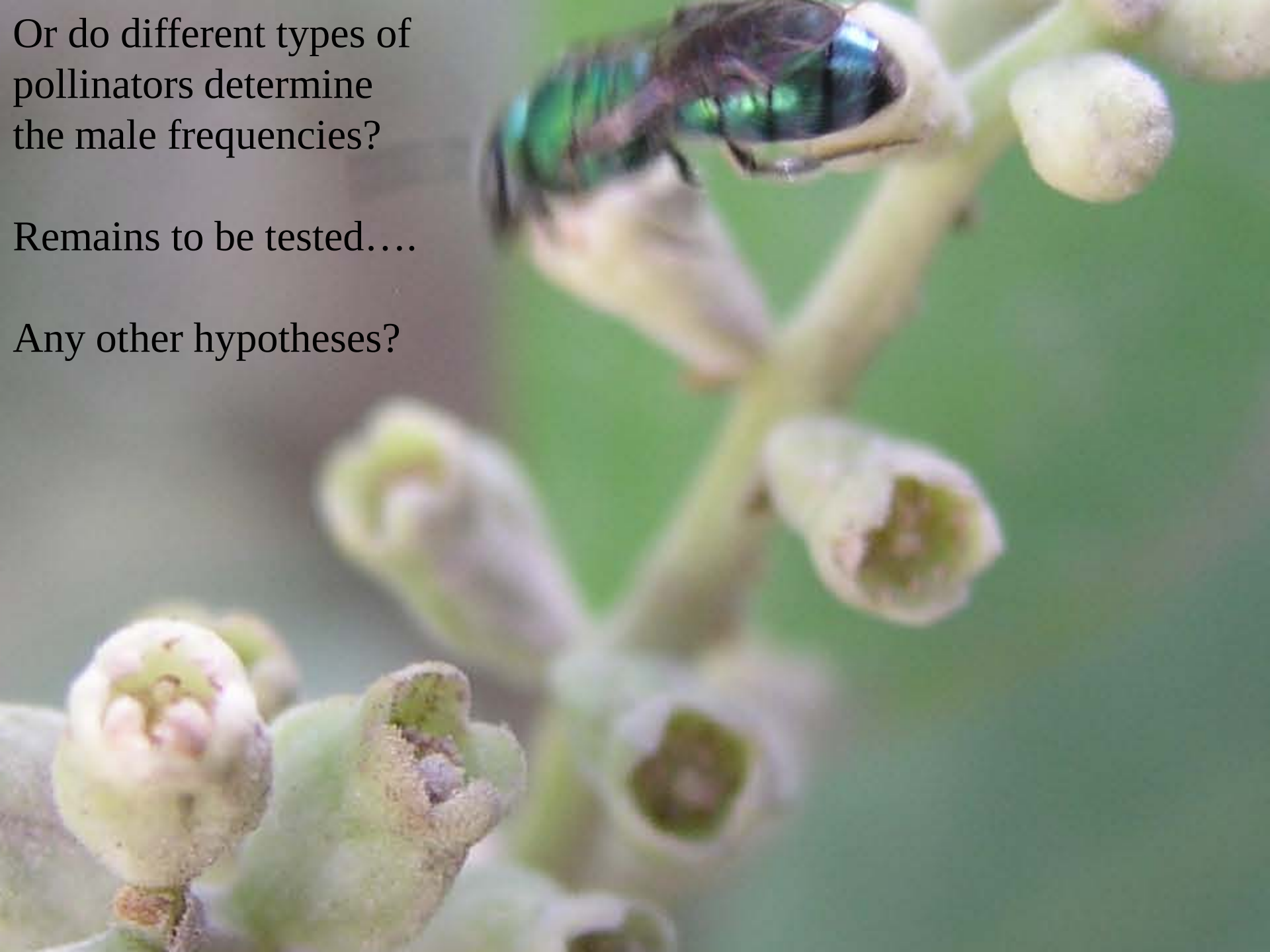
HYPOTHESIS: *Do males live longer?*

	N	% males
Los Ayalas		
• All shrubs	110	85%
• Smaller shrubs	16	50%
• Boca de Naranja		
• Large trees	8	100%
• Smaller shrubs	13	62%

Or do different types of pollinators determine the male frequencies?

Remains to be tested….

Any other hypotheses?



If pollinator behavior is important in maintaining males….

Will introduced honeybees eliminate males in androdioecious populations?

They tend to stay within a plant and cause self-pollination

Males may have lower mating opportunities

Mangrove reproduction

The breeding and mating systems and seed dispersal will determine:

degree of genetic variation (RM<WM<BM)

ability to respond to environmental change—selfing could be disadvantageous (lack of genetic variation)

ability to colonize new areas after disturbances-selfing could be advantageous (no need for mates; a single plant could start a new population)

important to consider in restoration

populations vary in their breeding and mating systems