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Honey bees are known to be highly efficient at exploiting the best available resource plants that bloom within their flight radius due to their excellent recruitment. This is particularly true for mass flowering trees in the tropics. How does this efficient foraging performance of honey bees that were introduced to the neotropics affect native bees, especially the stingless bees (Meliponini)? How much of the available pollen resources are allocated to honey bees and how much to native bees?

To answer these questions, we studied the mass-flowering native Myrtaceae fruit crops gabioba (*Campomanesia pubescens*), cagaita (*Eugenia dysenterica*) and jaboticaba (*Plinia jaboticaba*) in Brazil. We determined the visitor spectrum, the sequence and frequency of flower-visiting bee species during the day, determined the amount of pollen per flower, of pollen collected by individual bee groups and the uncollected pollen at the end of anthesis. In a honey bee exclusion experiment, we measured how much pollen was collected by meliponines in the absence of *Apis mellifera*.

The studied species had pollen-only flowers, synchronized flower opening and pollen presentation at dawn (~04:30 am) and showed "big-bang" flowering. One flower contained on average 180,000 (Cagaita), 270,000 (Jaboticaba) and 920,000 (Gabioba) pollen grains. The consistent order of daily bee visits to flowers on the three species started with crepuscular bees at dawn, followed by honeybees from about sunrise, then stingless bees and solitary bees. Honey bees were by far the most frequent visitors, while crepuscular and diurnal solitary bees were rare. The honey bee visits declined rapidly after about two hours, and overall bee visits ceased around noon. After just one hour of visits, the honeybees alone had removed an average of 82% to 86.6% of the pollen from the three species. Three to 10% of the grains were left in the wilting flowers.

After experimental exclusion of honey bees, native stingless bees collected 76% of the pollen, while their pollen extraction in the presence of honey bees was only 3.7%. This indicates that the overwhelming pollen exploration by honey bees leads to a displacement of native bees by exploitative competition in mass flowering Myrtaceae.

Mass flowering tree crops and the overwhelming efficiency of honey bee pollen exploration – what remains for native bees?



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Apis mellifera



Apis mellifera

Most famous bee species
Most important economically
Most efficient forager
Best competitor ?
Best pollinator ???



Apis mellifera

Not native to the New World

Total success in the
occupation of new territories

Occurs in the whole
Western Hemisphere

Honey bee introduction was
the biggest insect experiment ever

Apis mellifera –
the only highly eusocial species in Europe



Brazilian Stingless Bees ~250 species



Tetragonisca angustula
(Clemens Schlindwein)



Scaura atlantica
(Gabriel Melo)



Ptilotrigona lula
(C.M.F. Camargo)



Lestrimelitta rufipes
(G. Melo)



Partamona pearsoni
(CMF Camargo)



Paratrigona lineata
(Clemens Schlindwein)



Cephalotrigona femorata (Lucian Costa)



Partamona vicina
(Lucaiana Costa)



Melipona quinquefasciata
(Ricardo Camargo)



Nannotrigona punctata
(Luciana Costa)



Melipona flavolineata
(Cristiano Menezes)



Tetragona flavipes
(Ana Laura Dutra)



Trigonisca nataliae
(Luciana Costa)



Partamona combine
(CMF Camargo)

Stingless bees and honey bees are highly social species

Social species have in common:

- Communication, information transfer
- Recruitment of foragers
- Host plant generalists (pollen and nectar)
- Choose best resources in environment
- Switch to lucrative host plants
- Love mass flowering plants (aggregated resources)



We asked:

When invasive honey bees and native stingless bees visit the same host plants – how are floral resources shared?

How many pollen grains are collected by honey bees and how many by native bees?

Myrtaceae fruit crops as model

The Myrtaceae had the following characteristics:

- 1) Pollen-only flowers (countable finite resource)
- 2) Mass flowering species (big-bang flowering, resources aggregated)
- 3) Pollen easily accessible (generalist floral morphology)
- 4) Synchronous flower opening

***Eugenia
dysenterica*
- Cagaita**



Myrtaceae fruit crops as model

Myrtaceae

1 species of Myrtaceae in Europe (*Myrtus communis*)

~1200 described species in Brazil (important elements of the Brazilian flora)

Succulent berries or drupes – fruit crops, important as food for vertebrates

We have selected 3 representative species



What did we do? What did we measure?!

We defined the visitor spectrum (Who visits the flowers?)

We determined when the different bees visit the flowers

How often they visit them (Visitation rate)

What is the pollen fate?

We counted how many pollen grains are available?

We counted how many pollen grains are collected by different bee groups?

Spectrum of flower visitors

Eugenia dysenterica

Bee group	Nr. spp.
<i>Apis mellifera</i>	1
Stingless bees	17
Solitary bees	12
Crepuscular bees	2
Total species nr.	32

Plinia jaboticaba

Bee group	Nr. spp.
<i>Apis mellifera</i>	1
Stingless bees	12
Solitary bees	1
Crepuscular bees	3
Total species nr.	17

Campomanesia pubescens

Bee group	Nr. spp.
<i>Apis mellifera</i>	1
Stingless bees	8
Solitary bees	11
Crepuscular bees	3
Total species nr.	23



Spectrum of flower visitors

Eugenia dysenterica

Bee group	Nr. spp.
<i>Apis mellifera</i>	1
Stingless bees	17
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Plinia jaboticaba

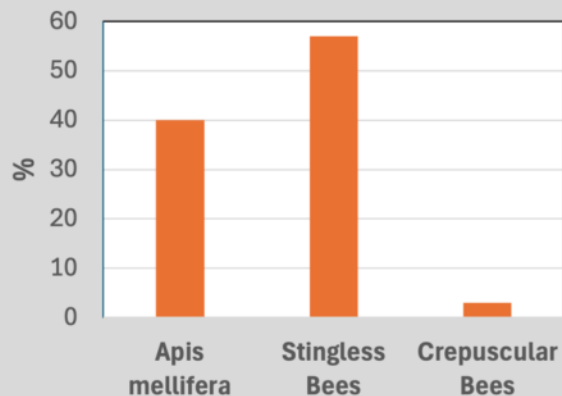
Bee group	Nr. spp.
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Campomanesia pubescens

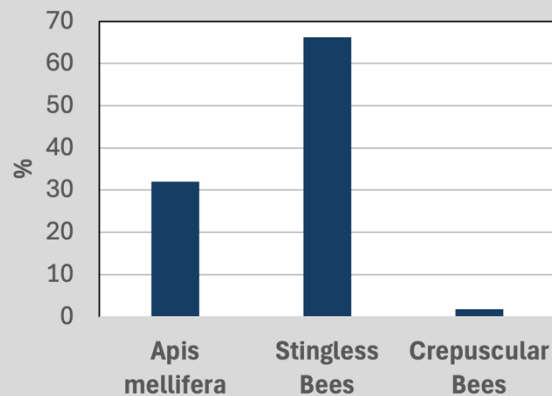
Bee group	Nr. spp.
<i>Apis mellifera</i>	1
Stingless bees	8
Solitary bees	11
Crepuscular bees	3
Total species nr.	23

Abundance

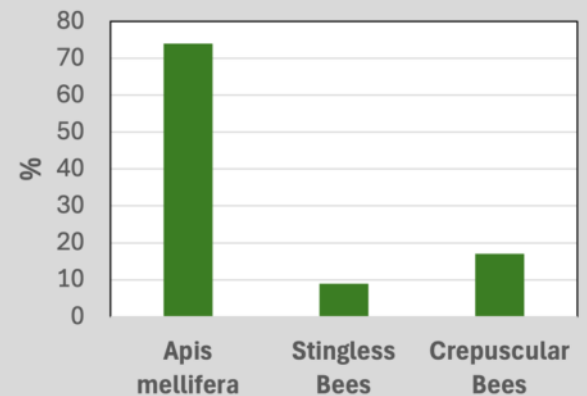
Eugenia dysenterica



Plinia jaboticaba

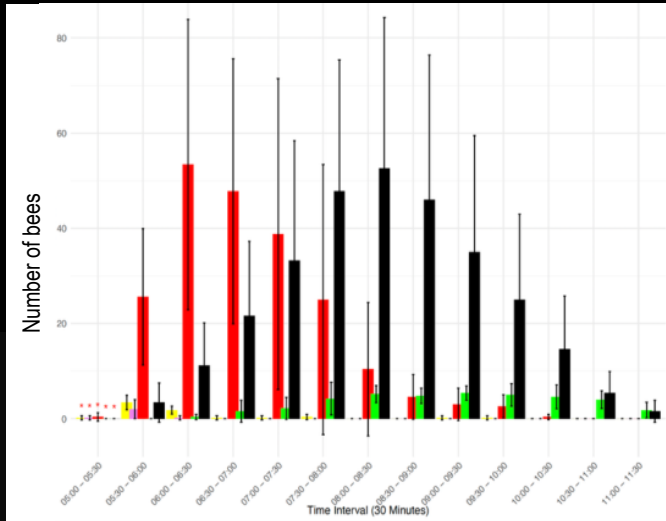


Campomanesia pubescens

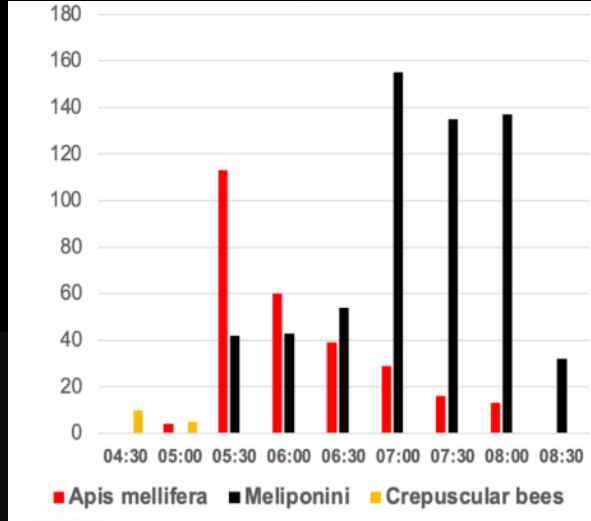


Visitation frequency of bee groups during anthesis

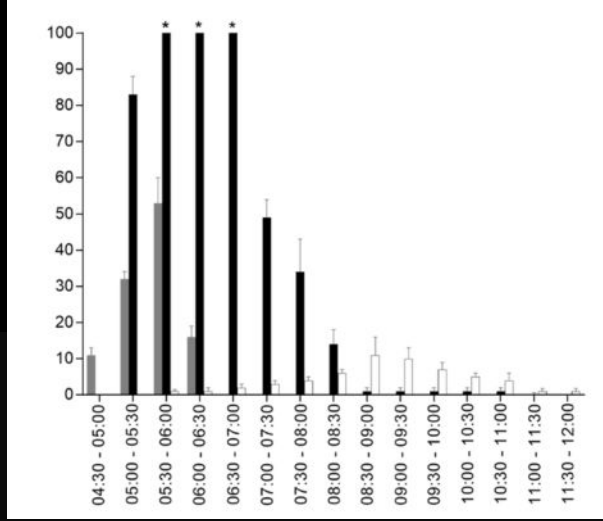
Eugenia dysenterica - Cagaita



Plinia jaboticaba – Jaboticaba Sabará

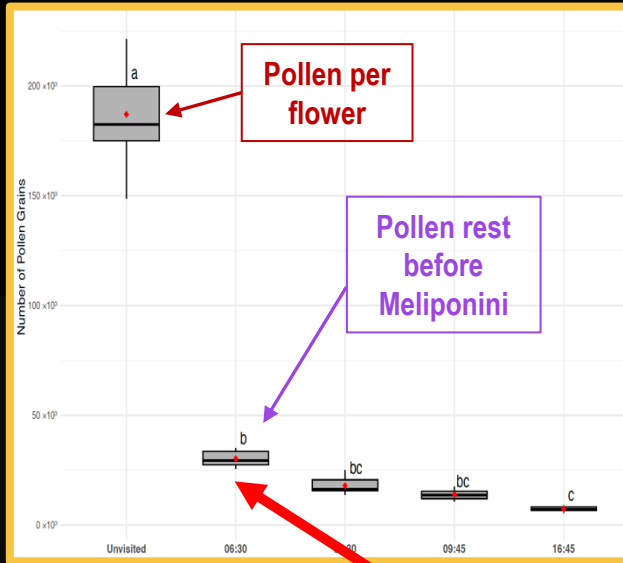


Campomanesia pubescens - Guabirola

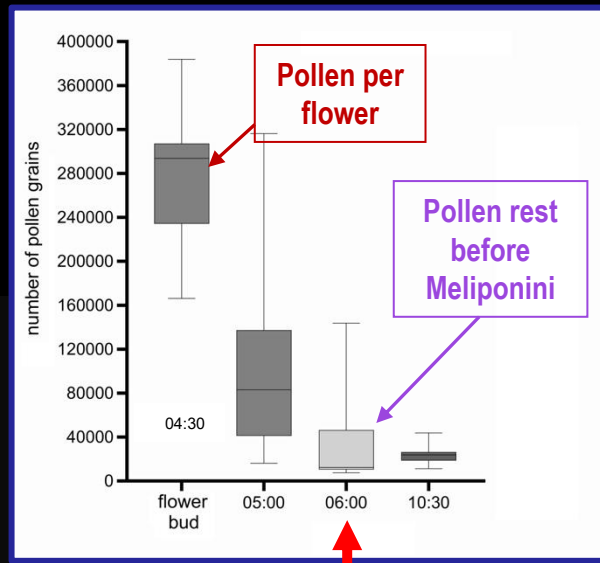


Pollen content per flower during anthesis

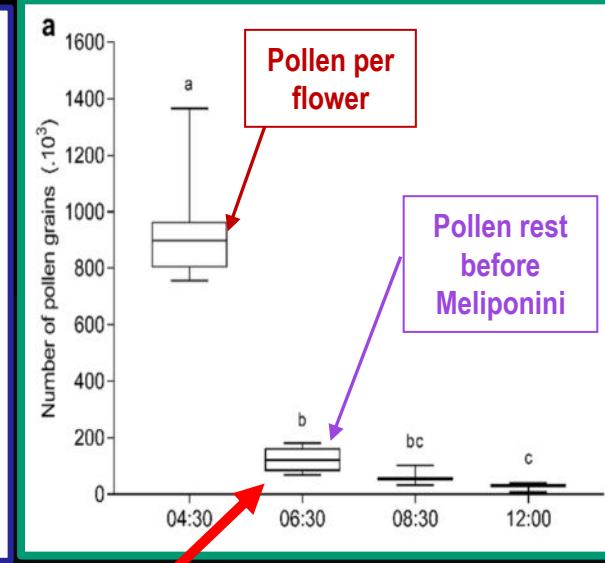
Eugenia dysenterica - Cagaita



Plinia jaboticaba - Jaboticaba-sabar



Campomanesia pubescens - Guabiroba

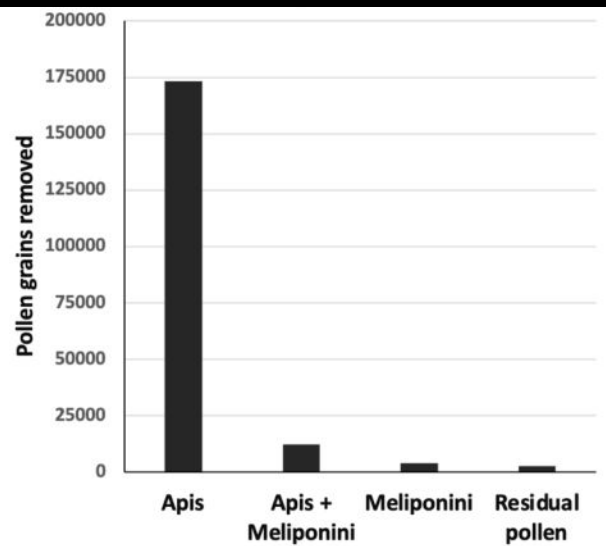


Flowers are emptied
within 1 – 2 hours



Pollen harvest per bee group

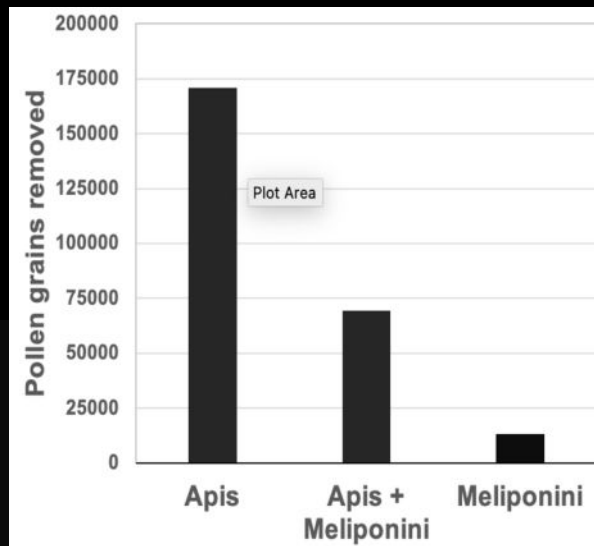
Eugenia dysenterica



Removed Pollen Grains

<i>Apis mellifera</i> :	90.2 %
<i>Apis</i> + Meliponini:	6.0 %
Meliponini	2.1 %

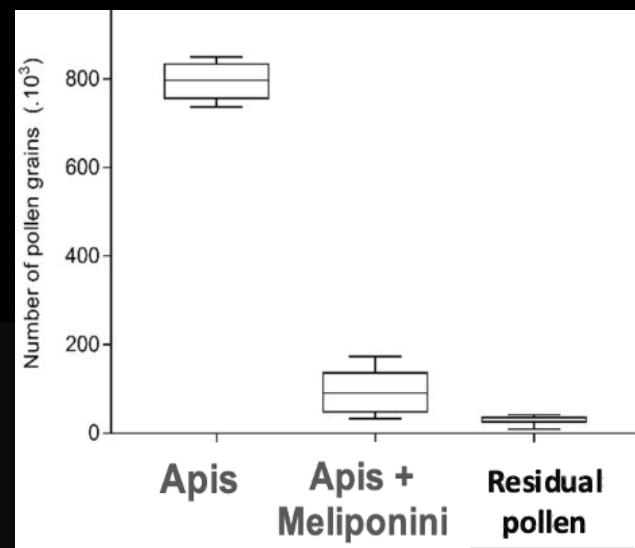
Plinia jaboticaba



Removed Pollen Grains

<i>Apis mellifera</i> :	61.6 %
<i>Apis</i> + Meliponini:	25.1 %
Meliponini:	4.7 %

Campomanesia pubescens



Removed Pollen Grains

<i>Apis mellifera</i> :	86.6 %
<i>Apis</i> + Meliponini:	7.0 %
Meliponini:	4.0 %

Crepuscular bees and diurnal solitary bees are rare and not differentiated



**Honey bees gain 80-90% of the pollen grains
of mass flowering Myrtaceae fruit crops**



Honey bee exclusion experiment

Campomanesia pubescens

Do stingless bees collect the available pollen in the absence of *Apis*?

Flowering branches bagged: mesh size small for honeybees (~ 6mm), but large enough for stingless bees

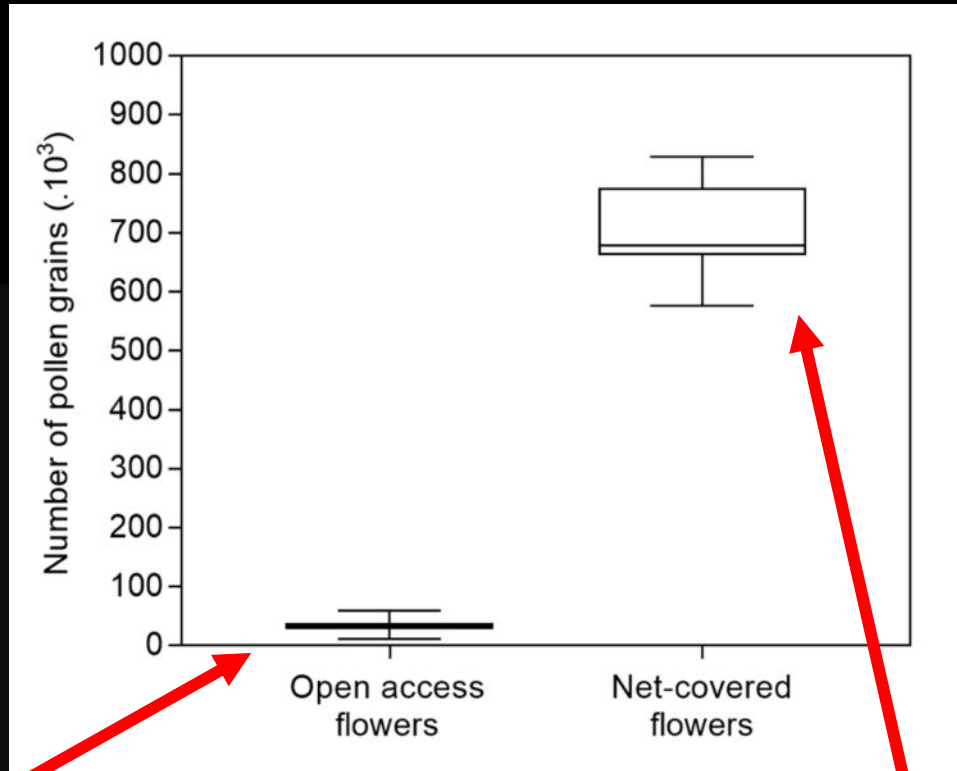
Unbagged branches (accessible for all bees); bagged branches (honey bees excluded)

- Visiting bees were identified and counted
- Pollen removal was measured in unbagged and bagged branches



Honey bee Exclusion Experiment

Campomanesia pubescens



Pollen gain by stingless bees
from open access flowers
(with honey bees)

Pollen gain by stingless bees
from bagged flowers
(honey bees exclude)

Honey bee Exclusion Experiment

Campomanesia pubescens

Result

Pollen gain by stingless bees:

Open accessible flowers (<i>Apis</i> present)	3.7 %
Net-covered flowers (<i>Apis</i> excluded)	76.0 %

Are the invasive honey bees strong competitors for native stingless bees?

YES!

Are the invasive honey bees strong competitors for native stingless bees?

YES!

How many pollen grains are collected by honey bees and how many by native bees?

Honey bees gain 80 - 90% of the pollen from mas-flowering native Myrtaceae fruit crops, Stingless bees < 10 %

In the absence of honey bees, Meliponini harvest ~20 X more pollen than under competition with *Apis mellifera*

How does the efficient foraging performance of the invasive honey bees affect native bees, especially stingless bees?



Due to the long history of honeybee introduction in the New World, this question is difficult to answer

Without honeybees, stingless bees would likely receive most of the pollen from many mass-flowering tropical trees

Possible consequences

Displacement to less profitable floral resources ?

Weaker populations ?

Local or general extinction?

Stronger competition among different stingless bee species?

Native bees on pollen-only crops of Myrtaceae



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