

Mutualisms: mutually beneficial interactions between pairs or groups of species





Mark Dimmitt 1998

How mutualisms (and other pairwise interactions) function in community settings is still largely unknown.

How might apparently “uninvolved” organisms alter mutualism?



- Goggy Davidowitz
- Travis Huxman
- Ruben Alarcón
- Jeff Riffell
- Leif Abrell



Datura wrightii and
Manduca sexta,
Santa Rita Expt.
Range, Arizona

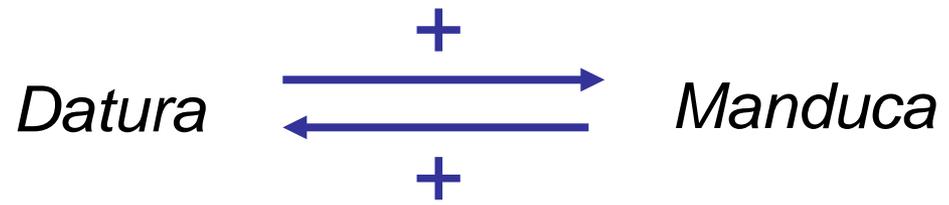
1. Natural history of the *Datura-Manduca* interaction
2. *Agave* as a cryptic partner
3. Is *Agave* good or bad for this mutualism?



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We have documented strong mutual dependence between *Datura* and *Manduca*.



Adults feed on Datura nectar.

They very effectively transfer pollen in the process.



***Manduca* are the major visitors to *Datura* flowers**

20 hours, 31 moths, 174 observed visits during July 2006, Box Canyon

76% *Manduca sexta*



17% *Manduca quinquemaculata*



7% *Hyles lineata*



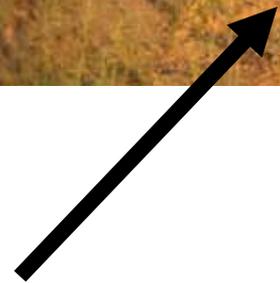


Chip Hedgecock

Females then lay eggs on the undersides of leaves.



Leaves, flowers, and fruits are consumed!



Datura flowers April-November,
but is always scarce;
at times, *exceedingly* scarce
relative to moths.

Might *Manduca* have other nectar resources?



Operated blacklights (UV) & mercury vapor lamps at ~weekly intervals in 2004 & 2005

Identified & sexed all hawkmoths

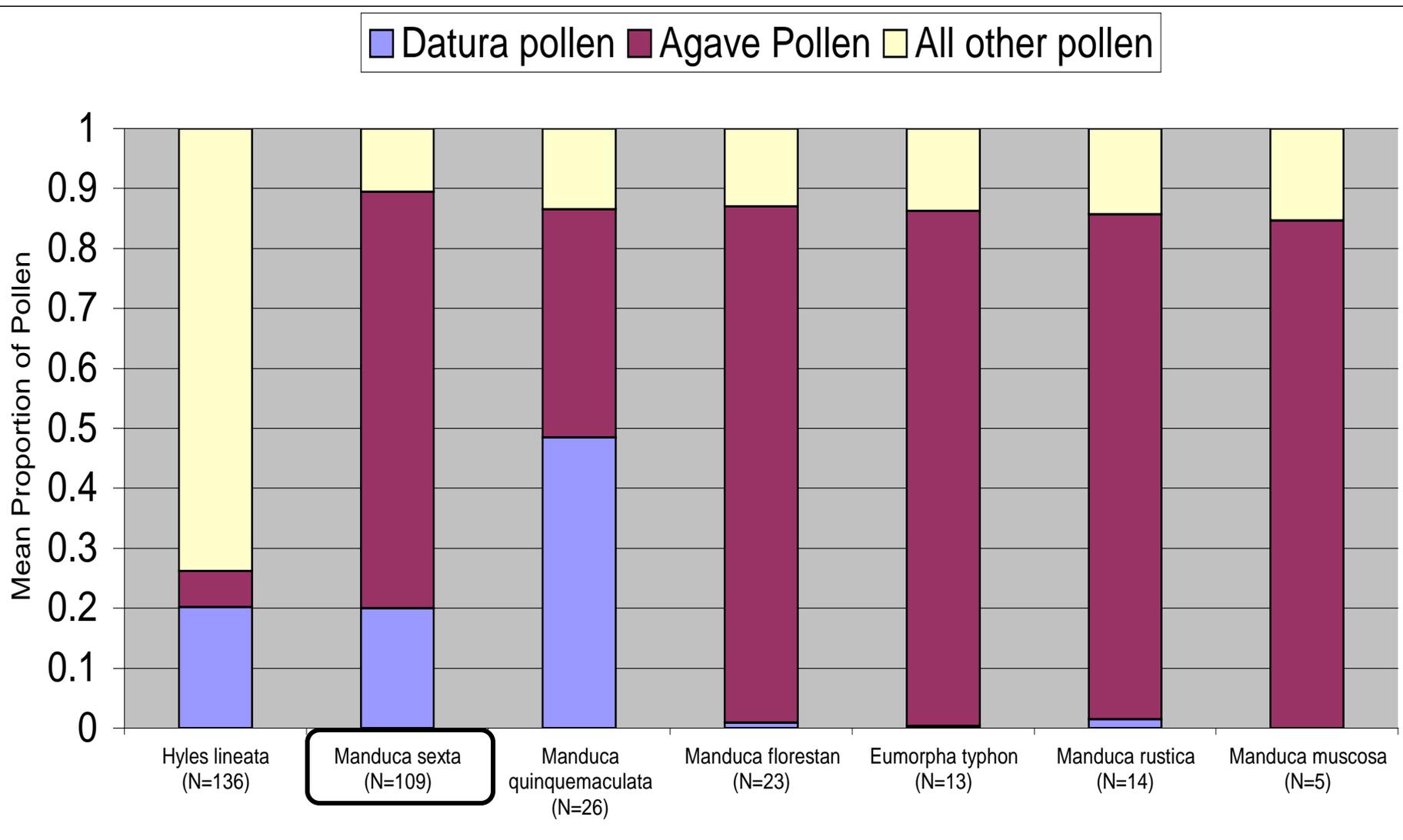
Removed pollen from proboscis with fuschsin jelly

Examined pollen slides



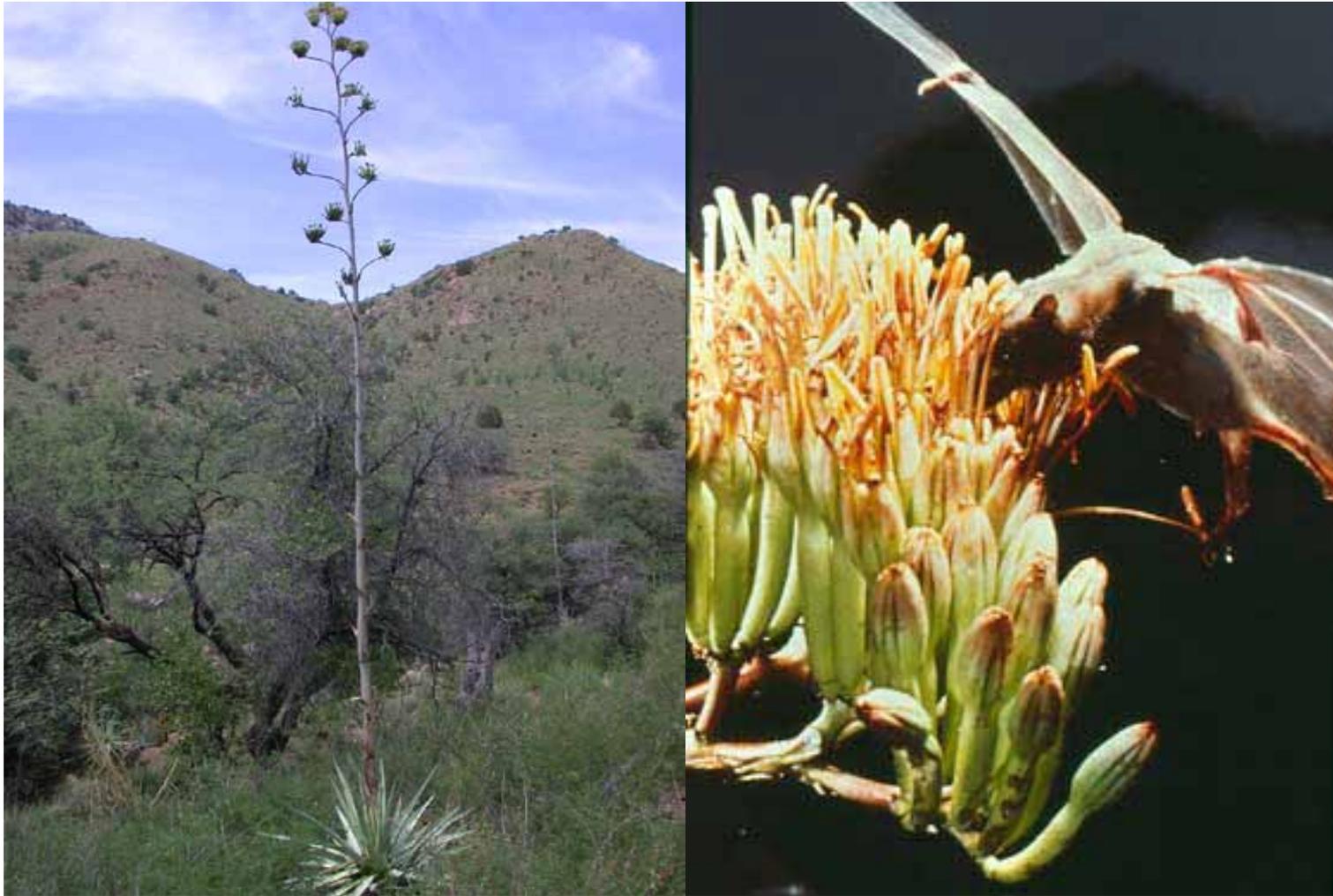
2004 Proboscis Pollen Load

Most hawkmoths carry *Agave palmeri* pollen



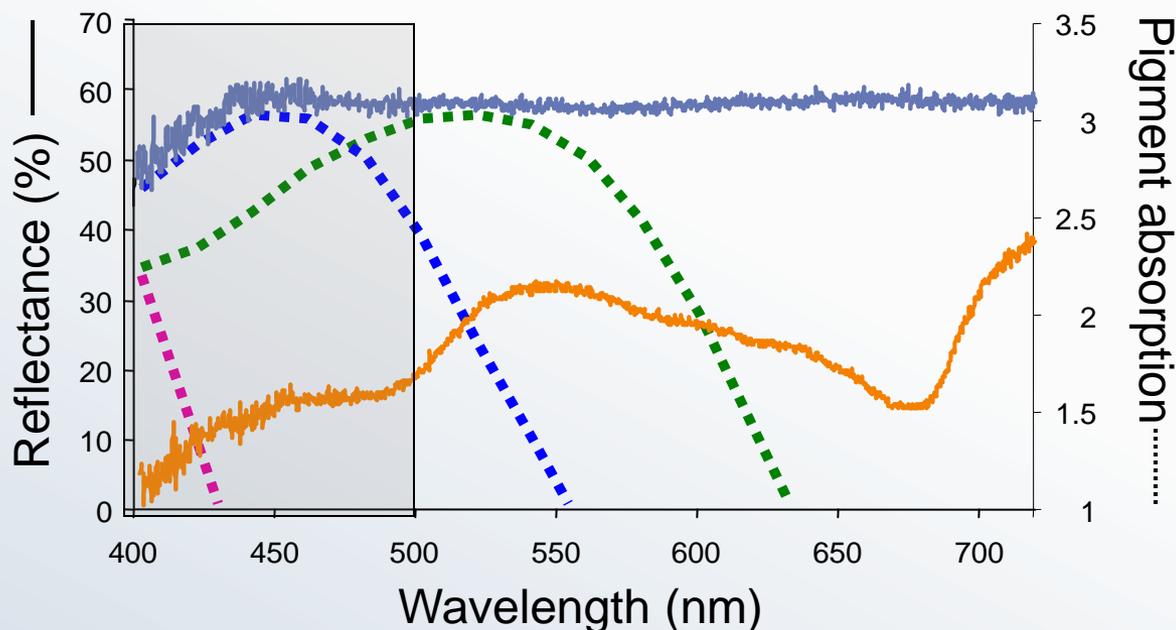
This is surprising.

Agave palmeri is a classic, well-studied bat-pollinated plant.



Datura and Agave differ radically.

1. The flowers look very different to the moths.

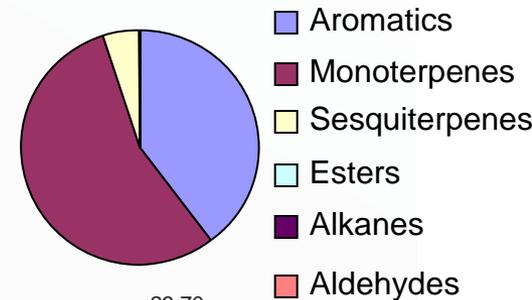
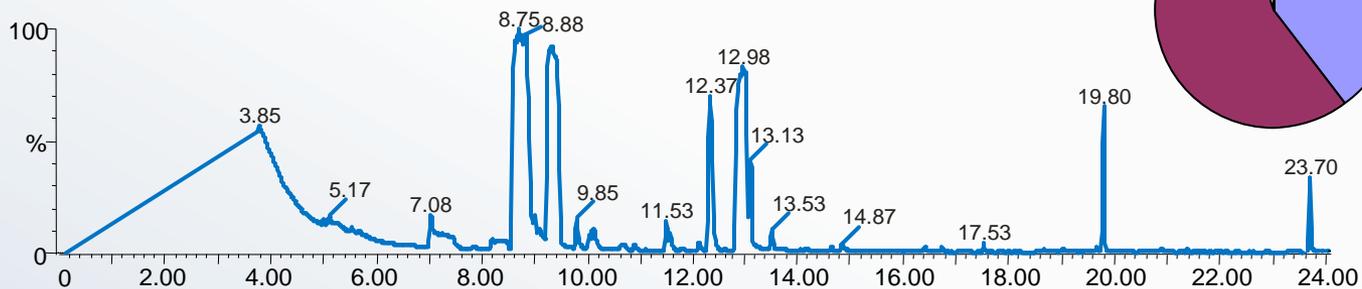


Behaviorally, *Manduca* responds to wavelength between 400-500 nm
Manduca photopigments have peak absorption at 540 nm

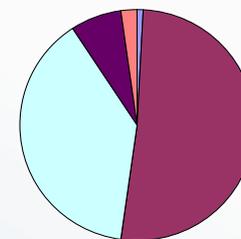
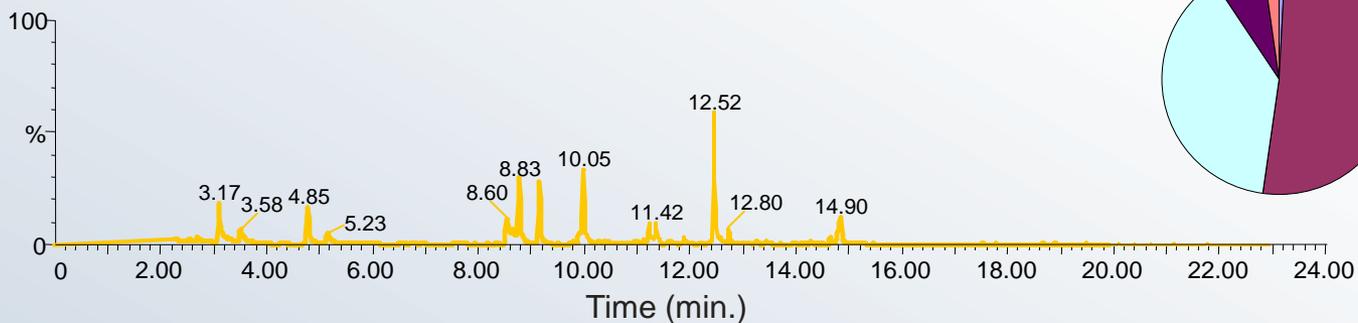
2. Floral volatile compounds differ.



Datura wrightii



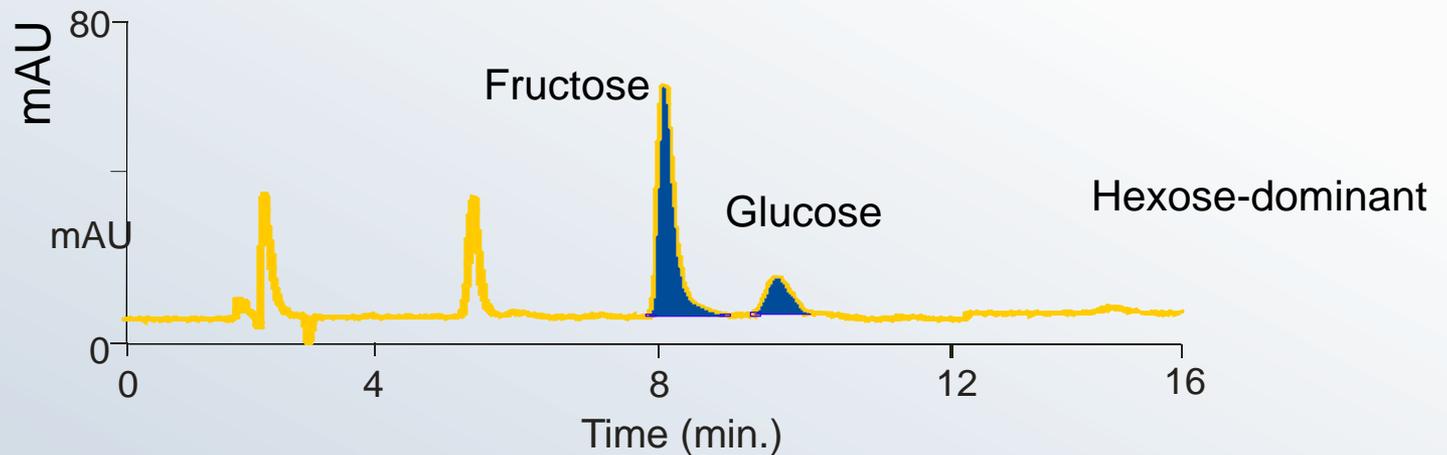
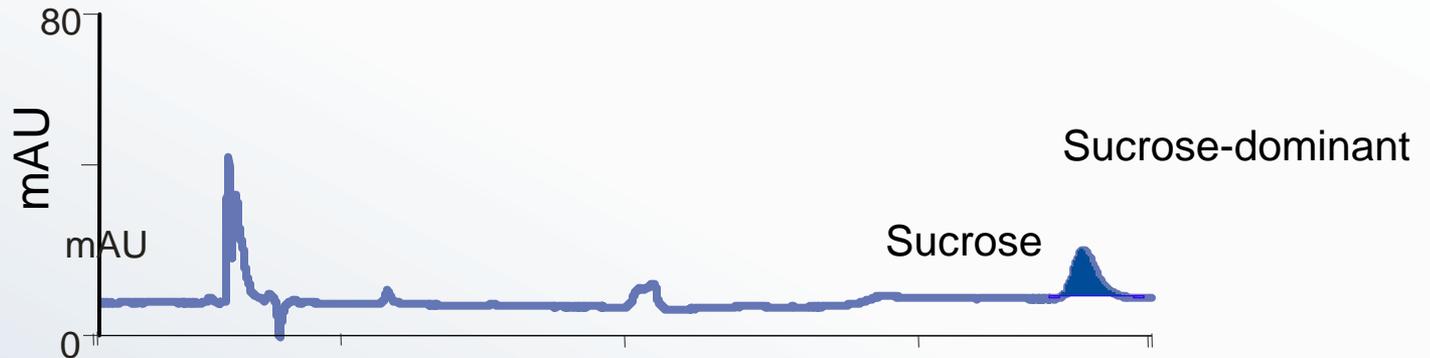
Agave palmeri



GCT chromatograms

3. Nectar composition is very different too.

Per flower, *Agave* has **>6X** higher caloric value than *Datura*!

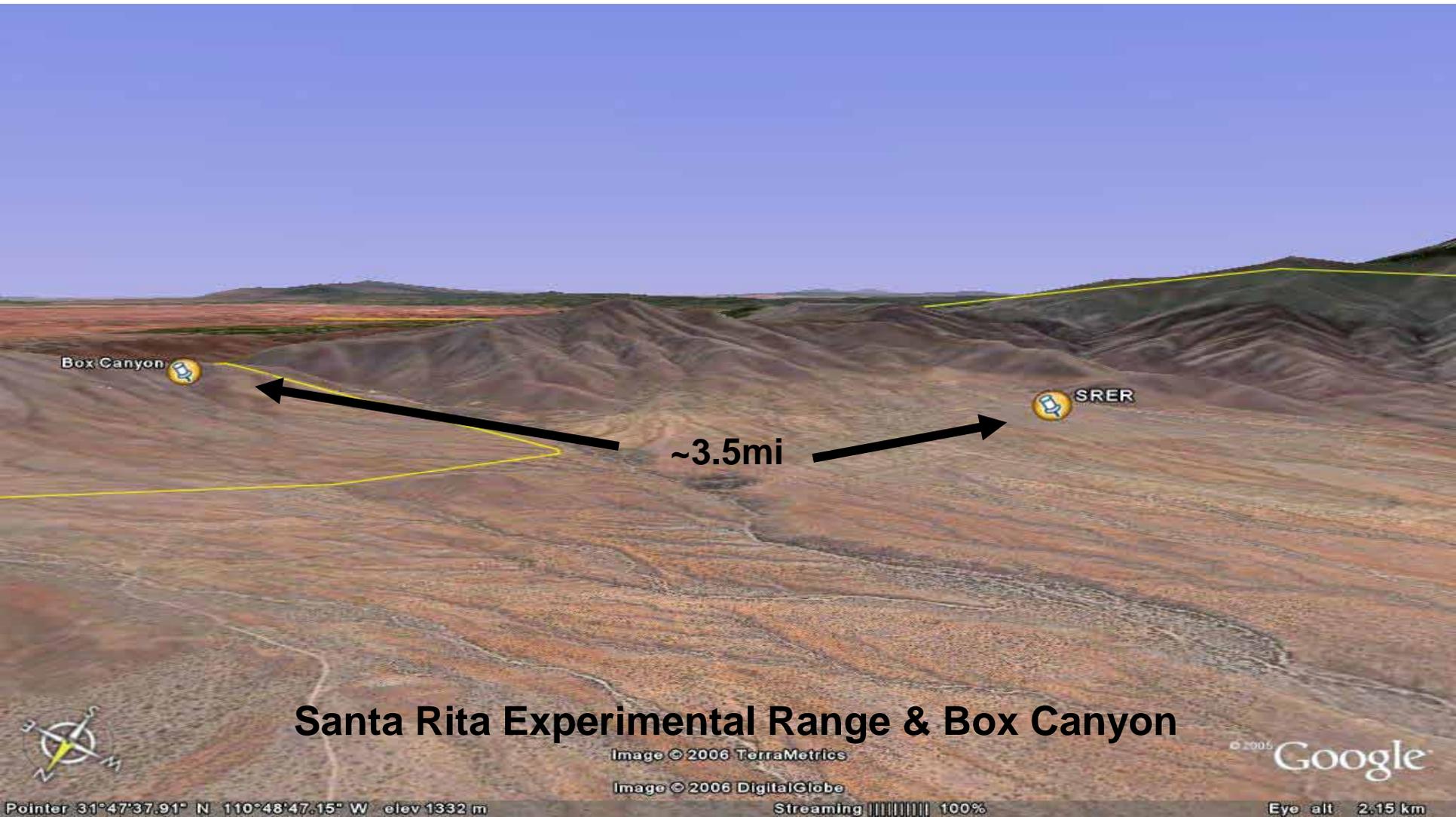




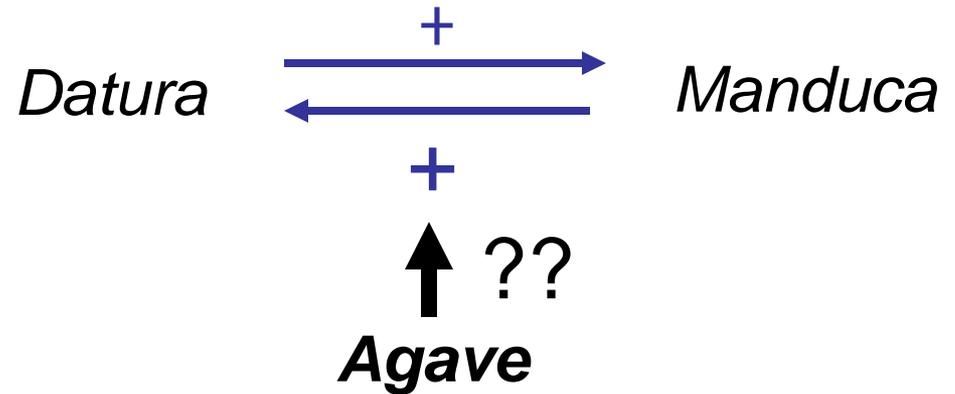
4. Plant heights differ dramatically.



5. Agave & Datura grow in different habitats;
to feed on both,
moths are probably flying back & forth.



What's the influence of this alternate nectar source on the mutualism?



Positive, by facilitating pollinator persistence?
Negative, by distracting moths or interfering with pollination?

Facilitation Hypothesis:



High-calorie snack food

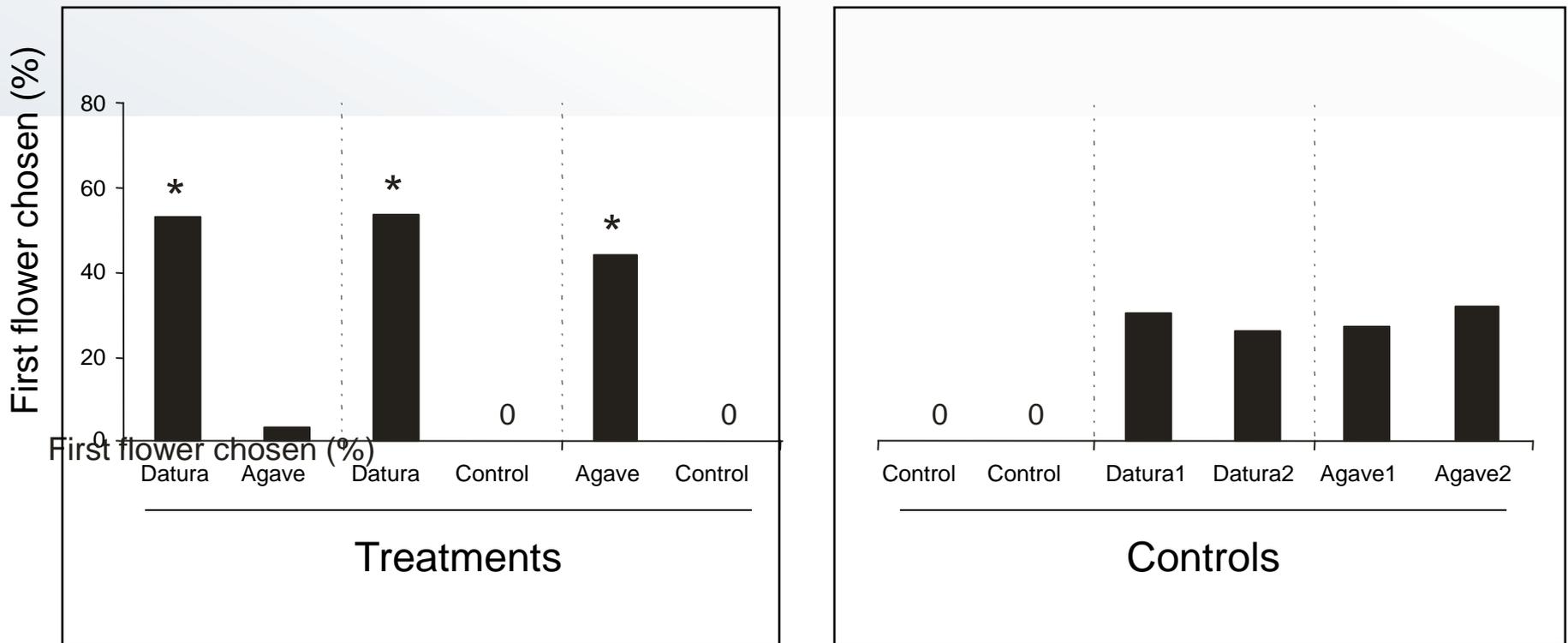


... while waiting
for the preferred
nectar source



Evidence #1:

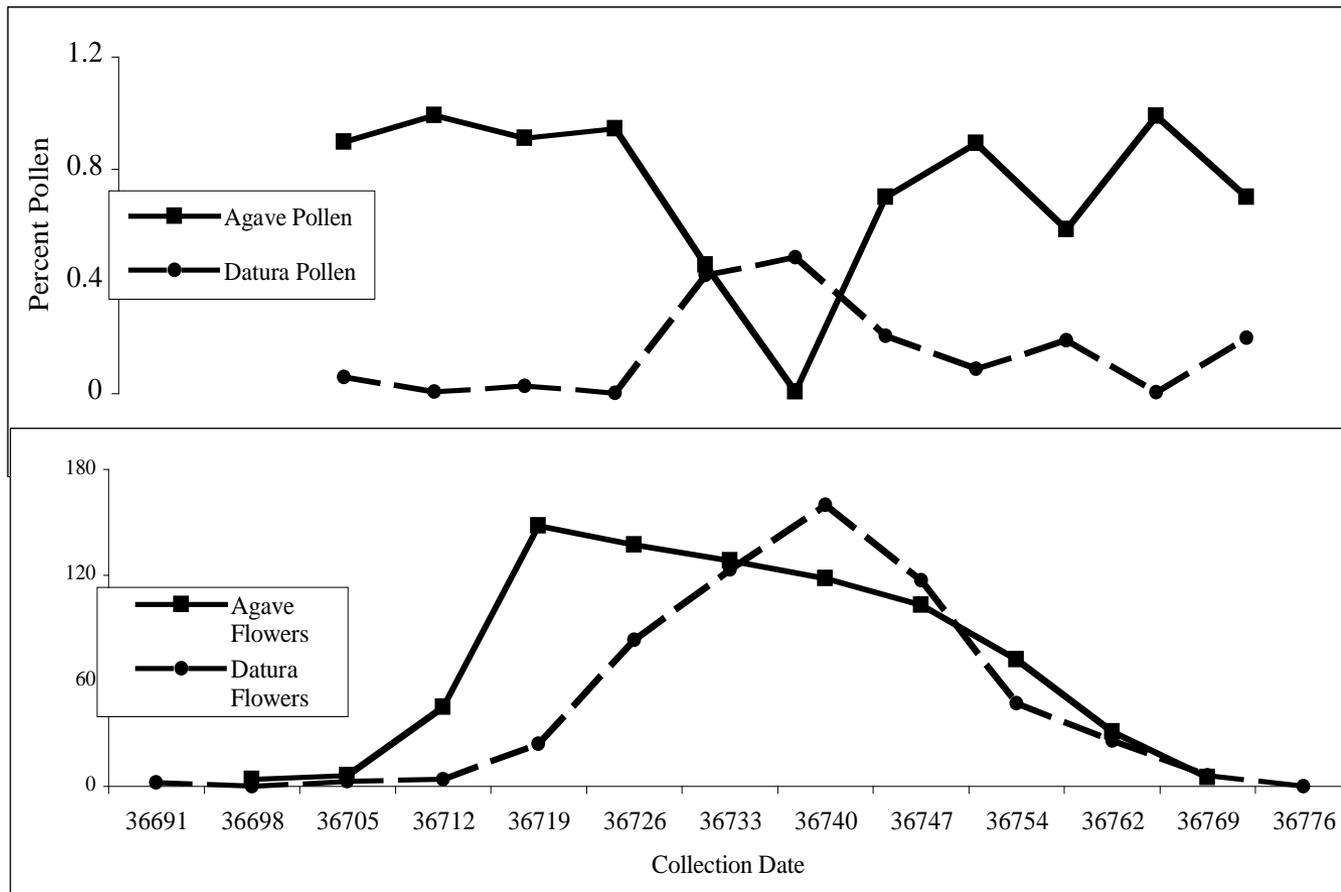
Manduca innately prefers *Datura*, but can learn to incorporate Agave in its diet.



*G-test: $P < 0.05$

Evidence #2:

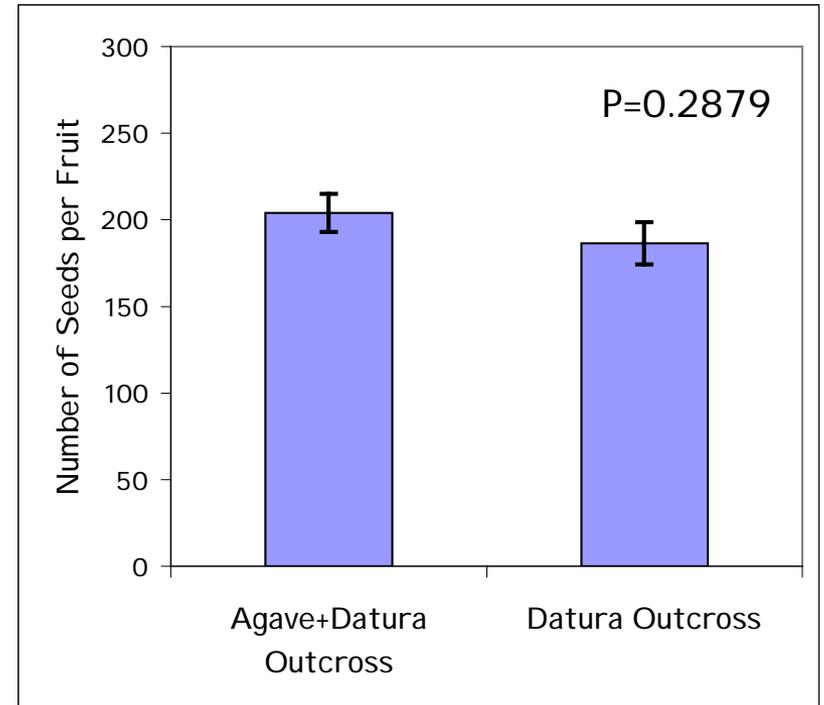
Agave is utilized when *Datura* is scarce; moths shift to *Datura* when it peaks.



BUT: Is *Agave*'s positive effect on the mutualism offset by a cost from pollen deposition?



Brianna Horvath
(UA undergrad)



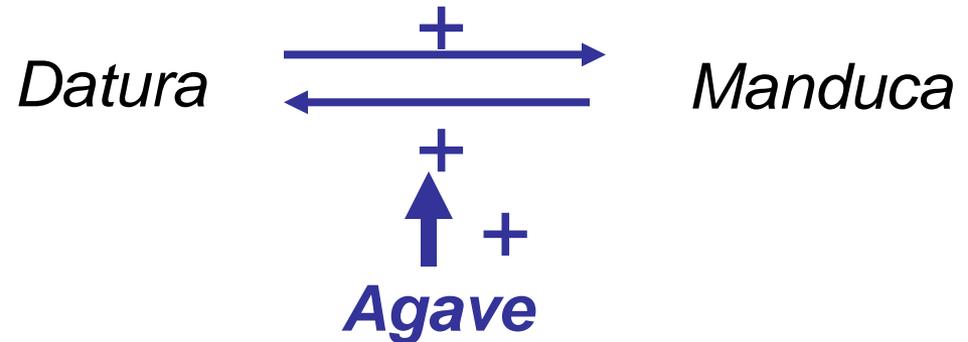
NO negative effect of *Agave* pollen on *Datura* reproduction.

NO evidence for appreciable amounts of *Agave* pollen deposition in the field.



- 100% of flowers receive *Datura* pollen
- 96% of received pollen is *Datura*
 - about 500 *Datura* grains deposited
 - almost no *Agave* deposited!

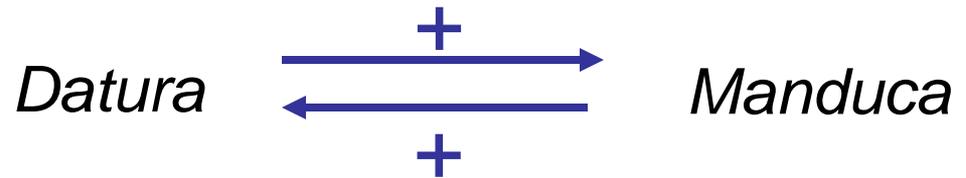
How might apparently “uninvolved” species alter the outcomes of mutualisms?



facilitates pollinator persistence,
doesn't interfere with pollination

Influences of other community members

How might organisms that do not feed upon or compete with mutualists alter the ecology and evolution of mutualists' interaction?



BUT THINGS ARE NEVER AS SIMPLE AS THEY SEEM...





Chip Hedgcock



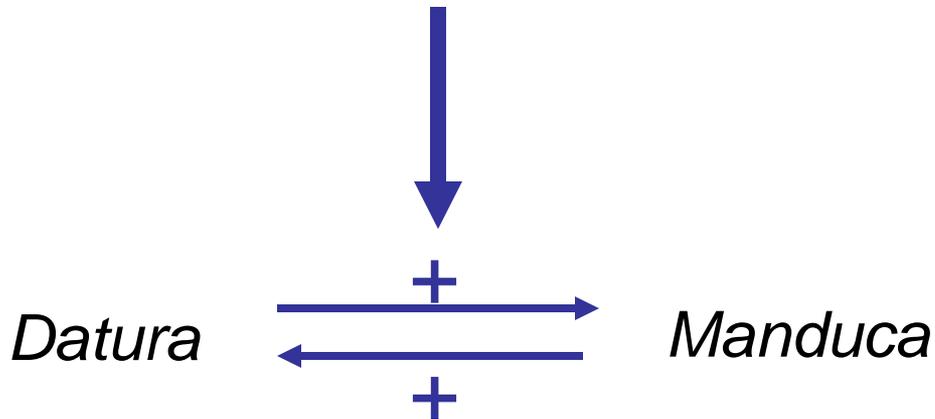
Wendy Marrusich



Agave also facilitates the **herbivory** side of the interaction. 

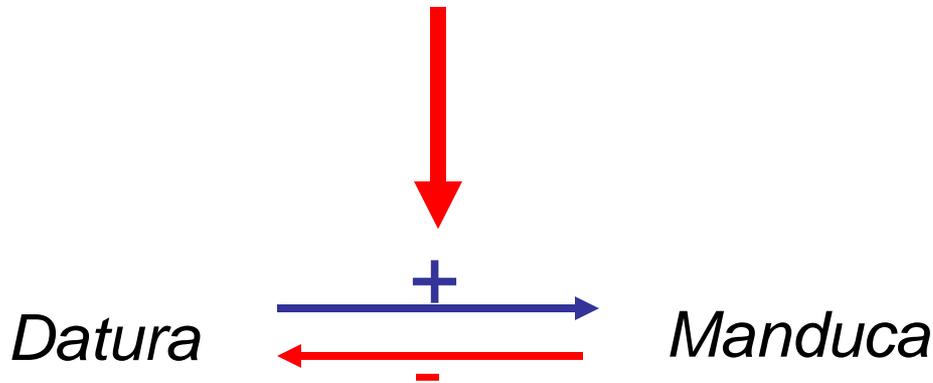
Context-Dependency Hypothesis:

*Agave confers net benefits
when Manduca are very rare...*



Context-Dependency Hypothesis:

... but Agave confers net costs when Manduca are abundant, shifting the Datura-Manduca interaction away from mutualism.



Future research:

What do hawkmoths do where *Agave* is absent, and what will happen to them and to their mutualisms if *Agave* declines?





Multisite and multiyear studies
are the obvious next step.



Thanks to:

- Goggy Davidowitz, Travis Huxman, Ruben Alarcón, Jeff Riffell, Leif Abrell, John Hildebrand
- Santa Rita Expt. Range staff
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- help from a cast of thousands (mostly U. AZ undergrads)
- special thanks: Rob Raguso