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Desert Mutualisms

Linking plant and insect physiology in the *Datura wrightii*- *Manduca sexta* interaction

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Manduca sexta (Sphingidae)

- Large geographic range.
- But host use is locally specialized. In S AZ, only 2 hosts.
- Nectar plants are also locally specialized.

Datura wrightii (Solanaceae)

- Ubiquitous native perennial.

- Hawkmoth pollination "syndrome."

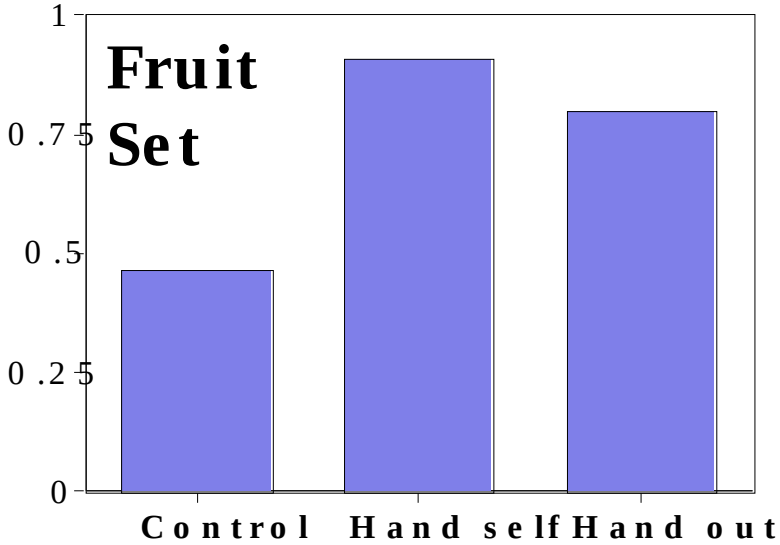
M. sexta females lay eggs after nectaring/pollinating.

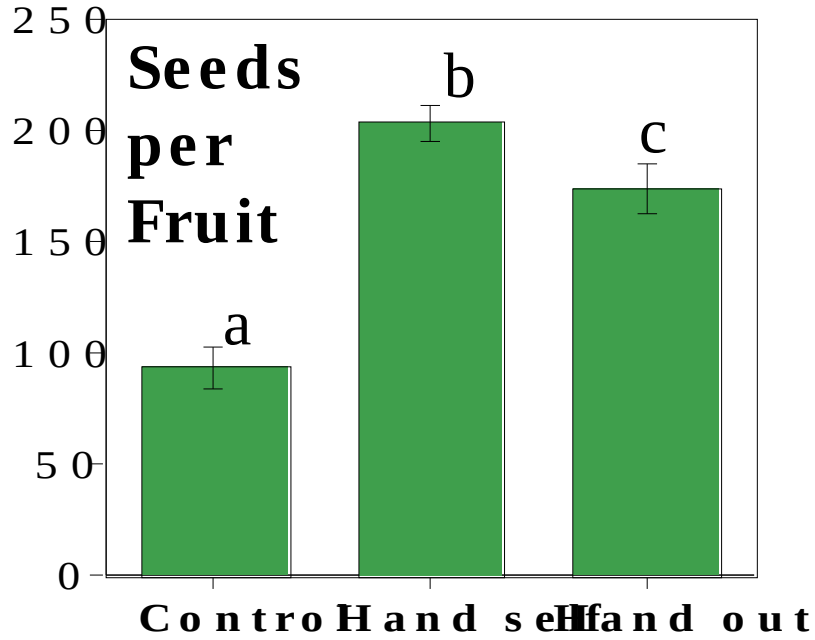
Caterpillars feed on leaves, flowers, and fruits.

Is this a mutualism? An antagonism? Both? Neither?

Hand-pollination experiments

Does *Datura* require pollinators for reproduction?

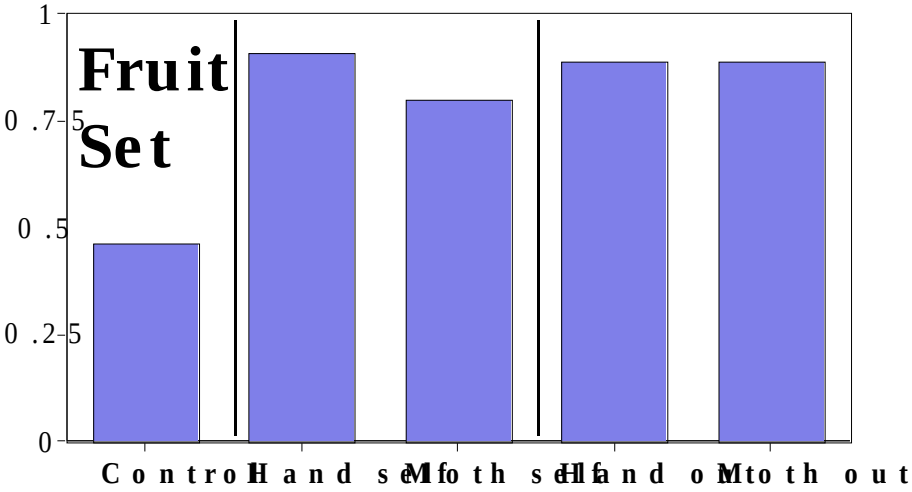


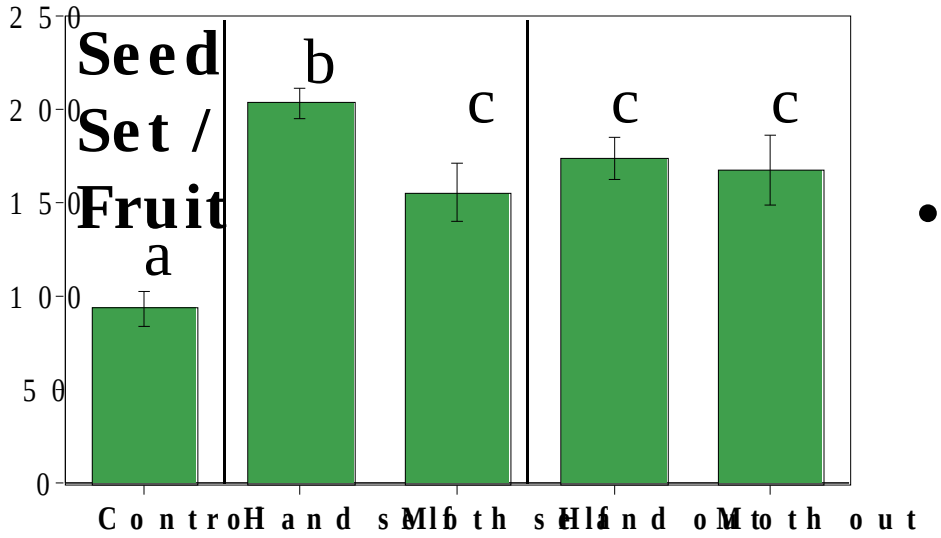


- *D. wrightii* is highly self-compatible.
- Unvisited flowers often reproduce successfully.
- <u>But</u> visits double fruit set and seed set.

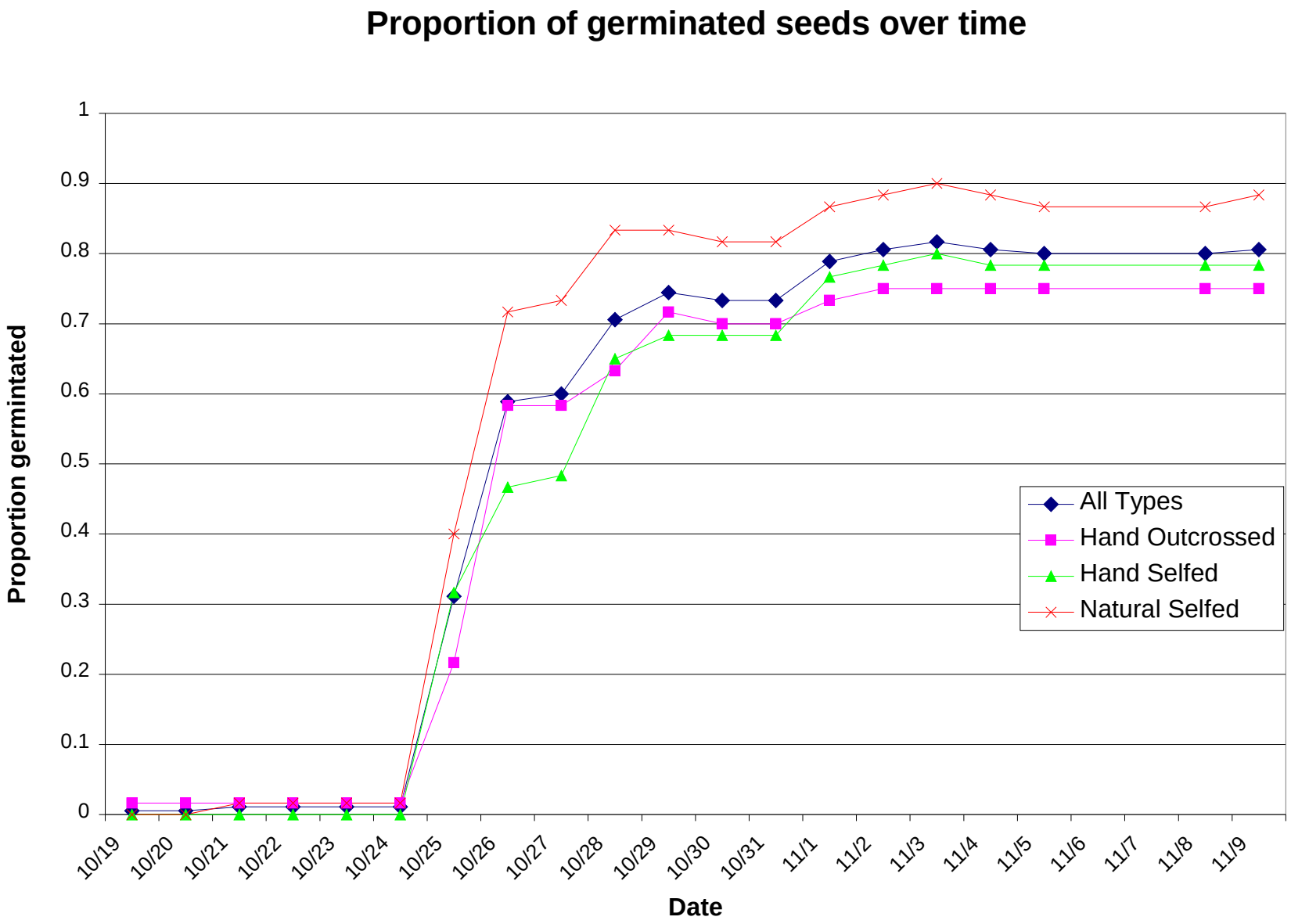
Cage pollination experiments

Is *Manduca* an effective pollinator of *Datura*?





- Caged *M. sexta* pollinate about as well as hardworking biologists can.
- *M. sexta* has the <u>potential</u> to be an important *D. wrightii* mutualist in nature.


Proportion of germinated seeds over time
Proportion germintated
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
10/19
10/20
10/21
10/22
10/23
10/24
10/25
10/26
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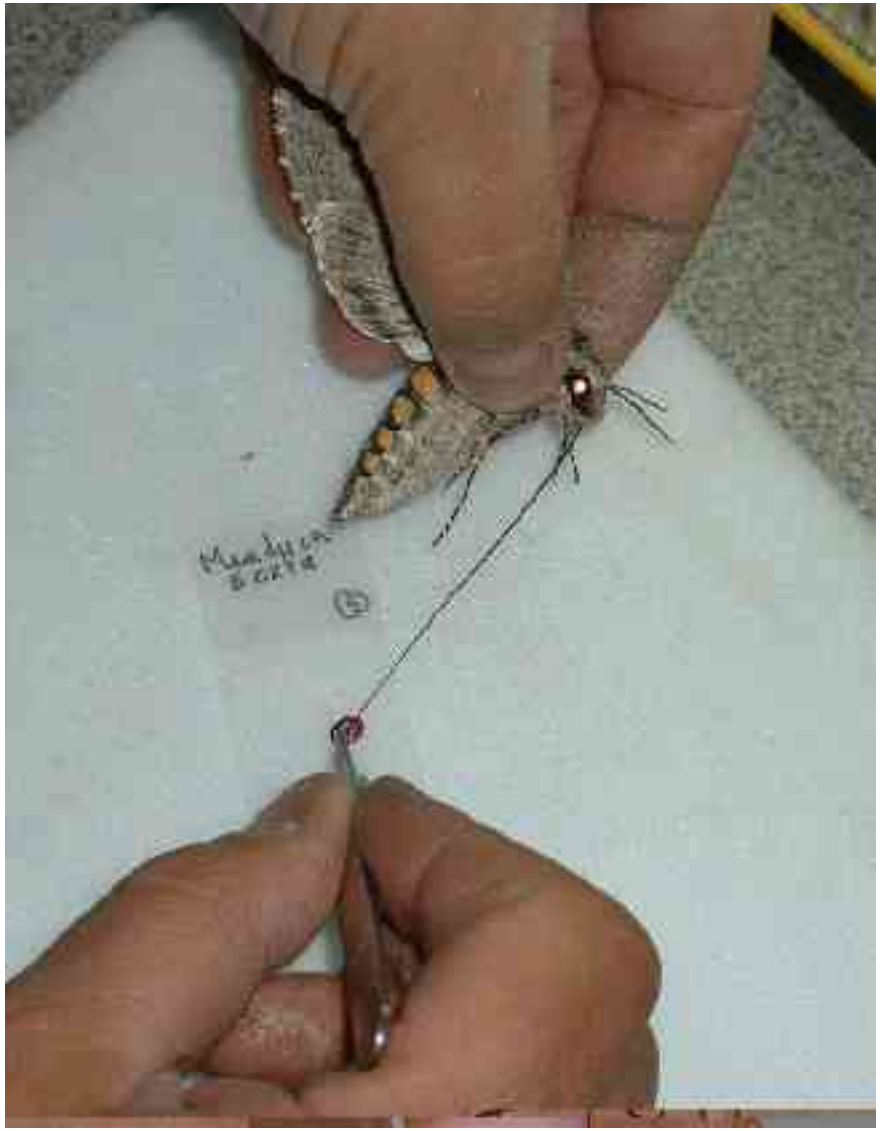
10/28
10/29
10/30
10/31
11/1
11/2
11/3
11/4
11/5
11/6
11/7
11/8
11/9
Date
All Types
Hand Outcrossed
Hand Selfed
Natural Selfed

Implications for *Datura*: Pollination

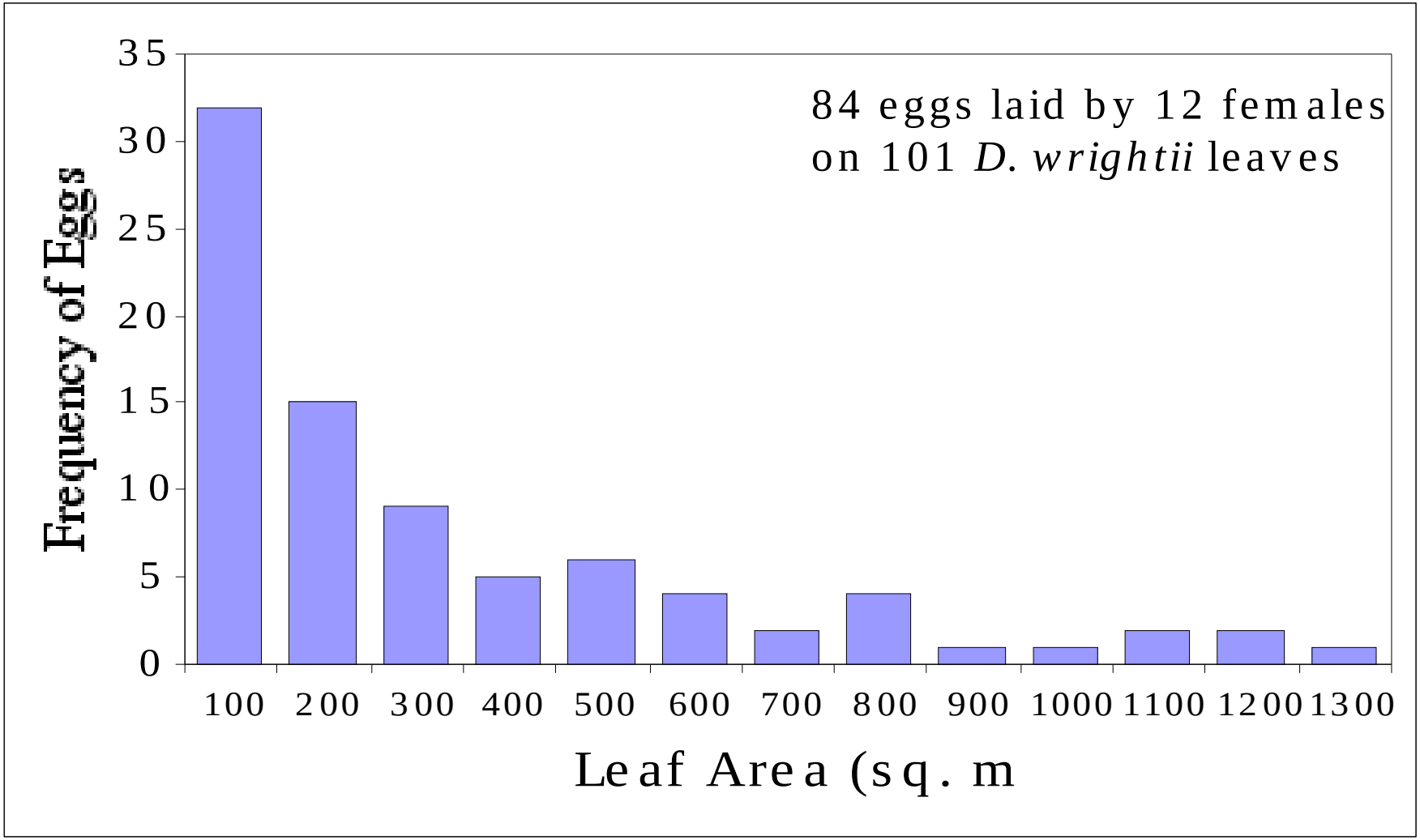
- *M. sexta* visits are beneficial, but reproductive success is surprisingly high when no pollinators visit at all.
- This is interesting in light of *D. wrightii*'s massive investment in flowers and nectar (65 μl/ fl, 25% sucrose equivalents).

(Nature.)

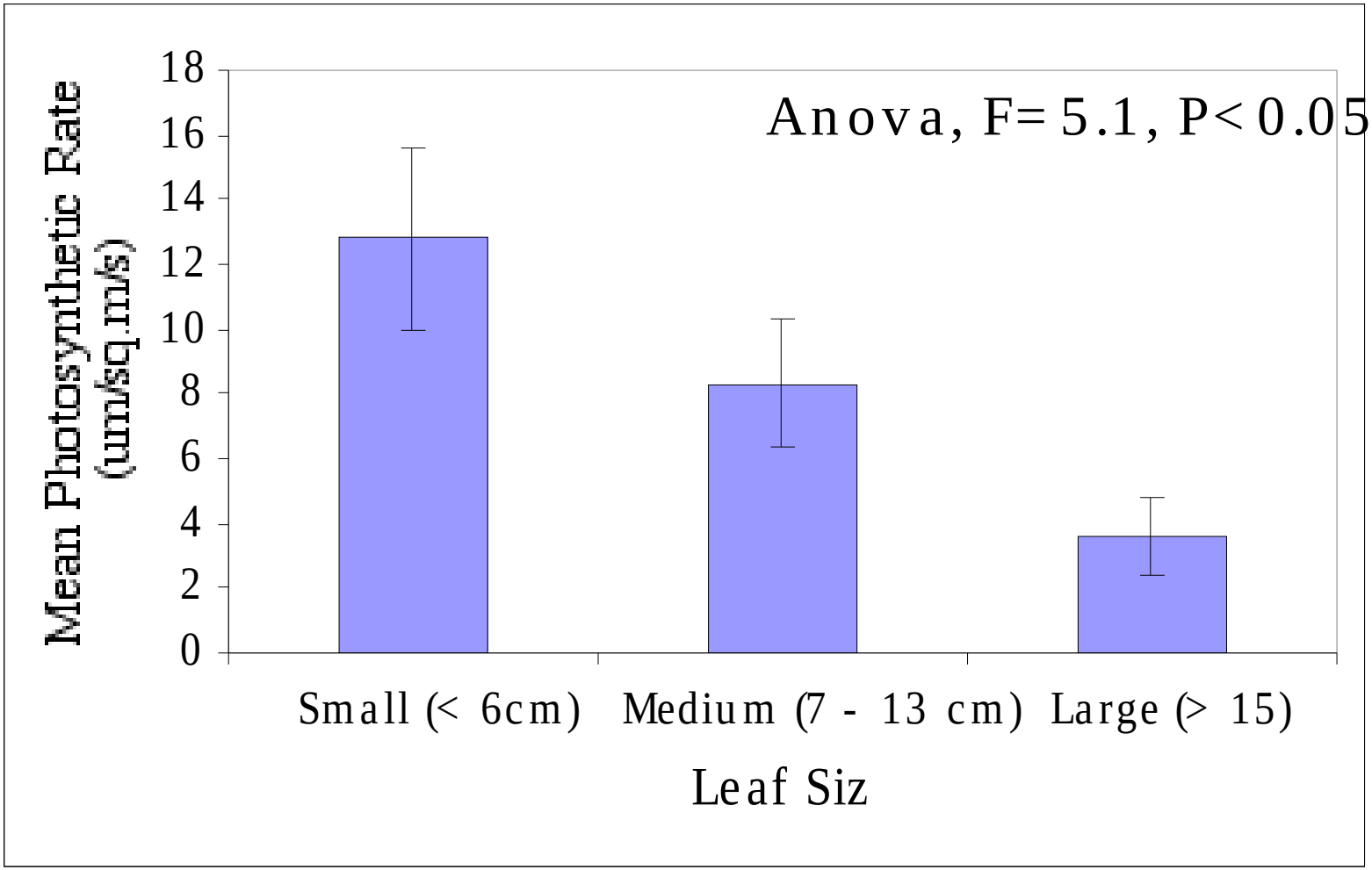


Manduca does more to *Datura* than just pollinate it!

M. sexta lay more eggs on small leaves.



The leaves *M. sexta* prefer contribute disproportionately to photosynthesis.



Are these activities costly to the plant?

- Females lay 3-400 eggs each.
- One 5th-instar larva can <u>defoliate</u> a plant!

sounds bad, but ....

- Less than 1% of eggs survive to 5th instar. (Mira & Bernays 2002)

Implications for *Datura*: Herbivory

The cost of *M. sexta* herbivory is <u>potentially</u> huge, but may only <u>actually</u> be huge when high numbers of eggs are laid.

Plant provides Insect:		Insect provides Plant:	
+ Nectar for adults	→	Pollination	+
+ Tissue for larvae	→	Herbivory	-

What is the net effect for the plant?
How can the plant maximize benefits?

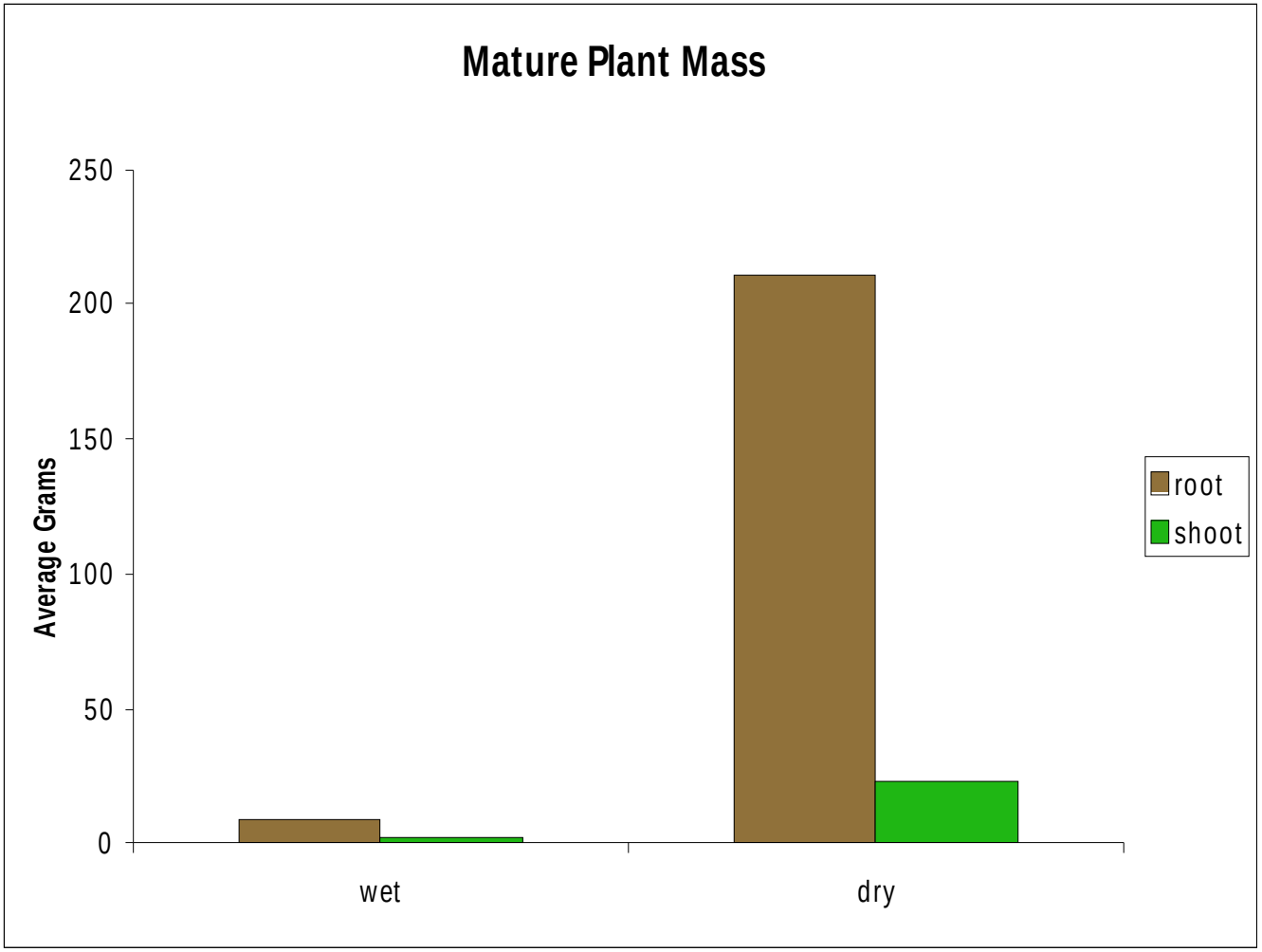
Two important things we learned this summer:

1. Other herbivores cannot be ignored.

A community rather than a pairwise approach is appropriate.

But: two important things we learned this summer:

2. *D. wrightii* has a massive taproot!



Most of *D. wrightii* biomass is actually underground.

Regrowth from herbivore damage is exceedingly rapid.

Some unexpected early conclusions:

- Pollination benefits are relatively low.

- Costs of herbivory, & of investment in floral attractants and rewards, may be relatively low as well.

How might costs and benefits be mediated in annual vs. perennial *Datura* species?

D. wrightii
(perennial)

D. discolor
(annual)

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