

Differential Effects of Neonicotinoid Exposure on Metabolic Rates Across Life Stages in the Monarch Butterfly (*Danaus plexippus*)

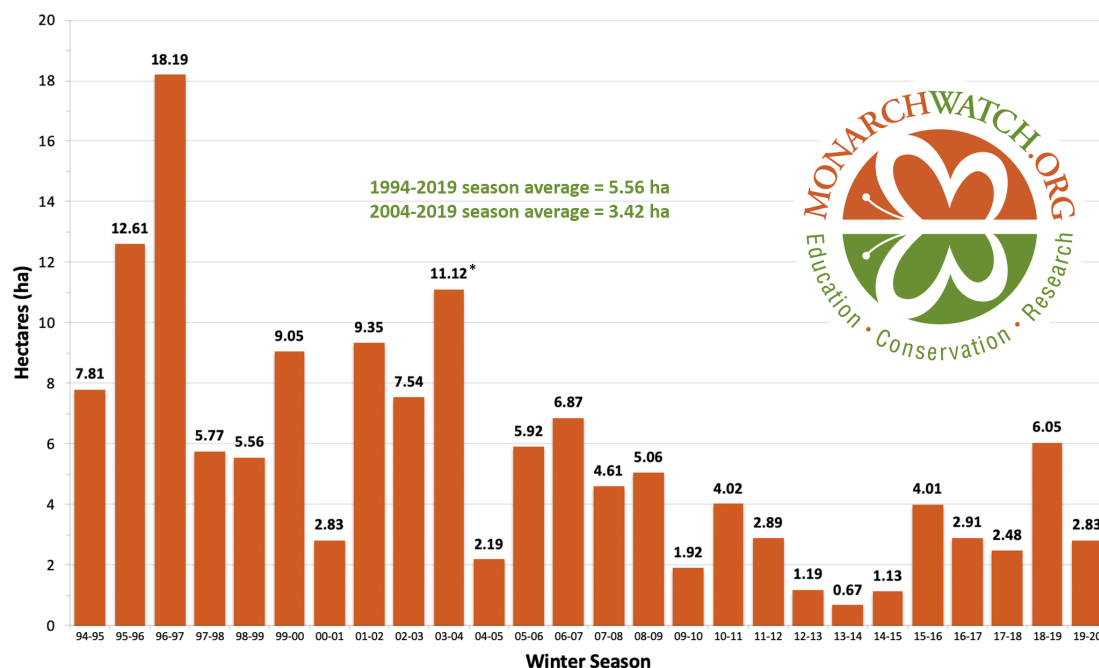


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Advisors: Dr.'s Jared Ali and
Rudolf Schilder



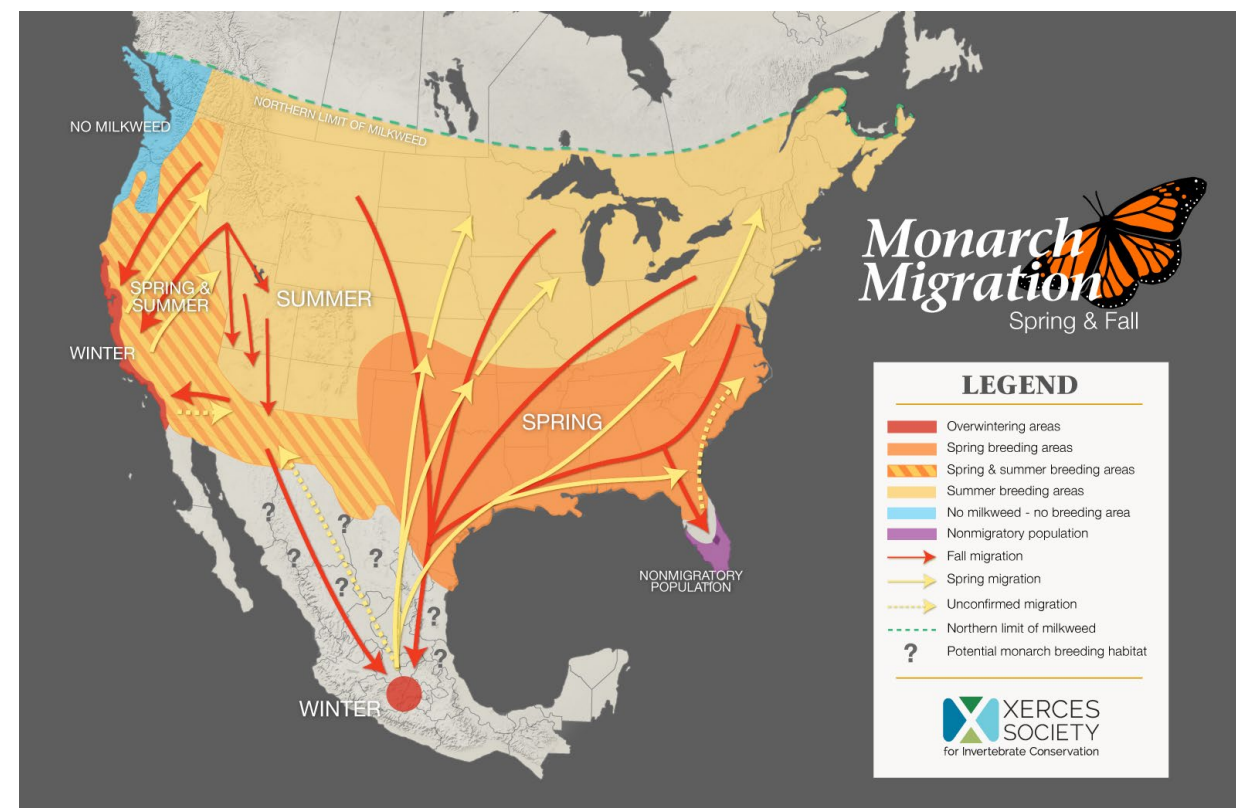
Monarch Populations in Decline

Total Area Occupied by Monarch Colonies at Overwintering Sites in Mexico



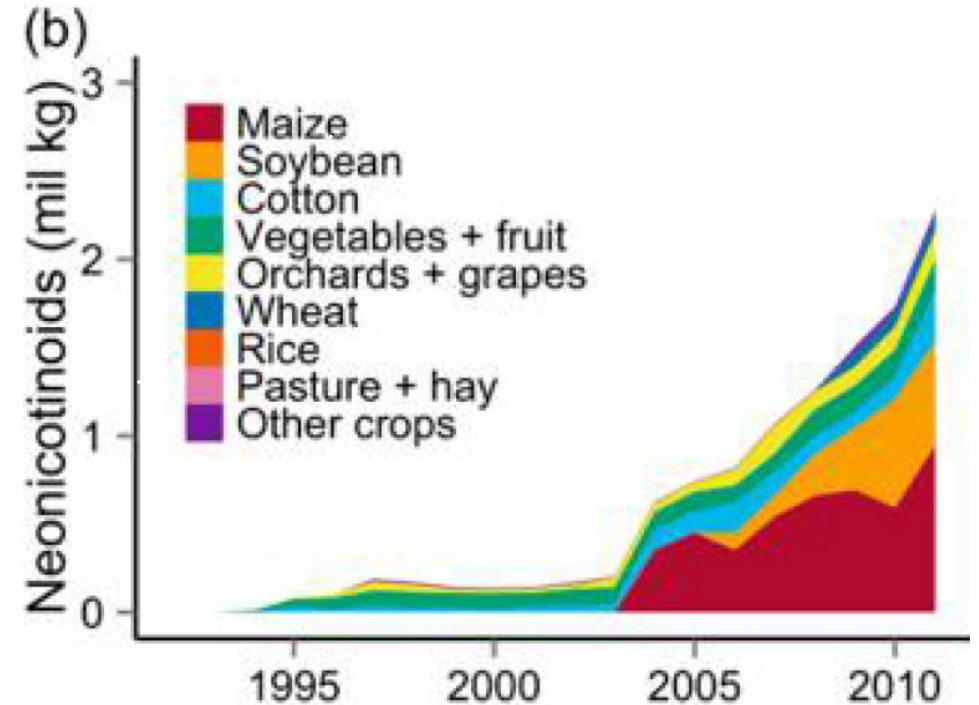
Data for 1994-2003 collected by personnel of the Monarch Butterfly Biosphere Reserve (MBBR) of the National Commission of Natural Protected Areas (CONANP) in Mexico. Data for 2004-2019 collected by World Wildlife Fund Mexico in coordination with the Directorate of the MBBR.

* Represents colony sizes measured in November of 2003 before the colonies consolidated. Measures obtained in January 2004 indicated the population was much smaller, possibly 8-9 hectares. CT



Neonicotinoids

- Introduced in mid-1990s and are now the most widely used insecticide class in the U.S.
- Seed coat treatments in corn, soy, and cotton make up majority of usage in the U.S.
- On avg. ~5% of seed coat active ingredient assimilates into target crop



Neonicotinoids and Monarchs

- Milkweed (*Asclepias spp.*) plants in agricultural landscapes are contaminated with neonicotinoids
- Neonicotinoid usage is negatively correlated with monarch abundance
- Monarchs may preferentially lay eggs on neonicotinoid-contaminated milkweed plants



<https://images.app.goo.gl/uguiqwnKgflsGzqx6>

Research Objective

Assess the lifelong physiological repercussions of larval exposure to neonicotinoid-contaminated milkweed plants

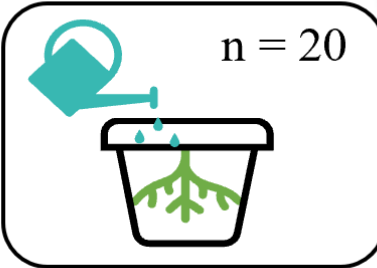
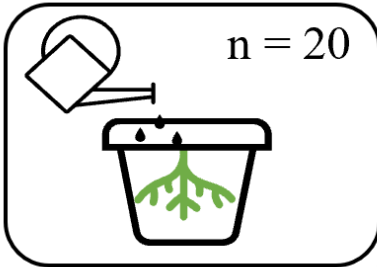
- Using resting and flight metabolic rates (measured in CO_2 exchange rates) as proxies for physiological function
- Using clothianidin (a widely used neonicotinoid)



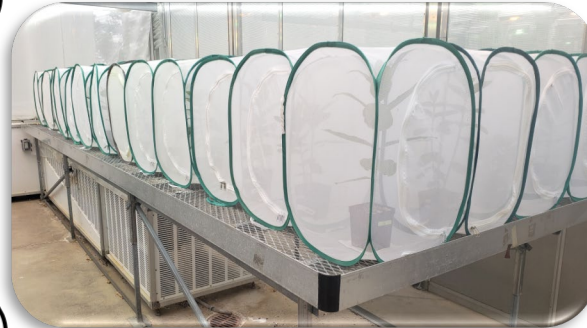
Larval Exposure Methods and Respirometry



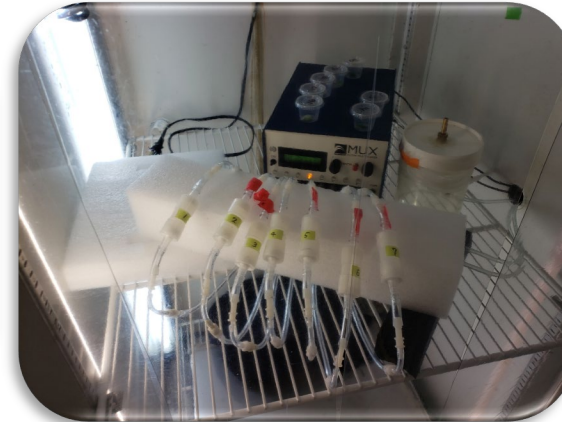
5-month
common
milkweed
plant clipped



Control or 25 ppb
clothianidin
treatments applied

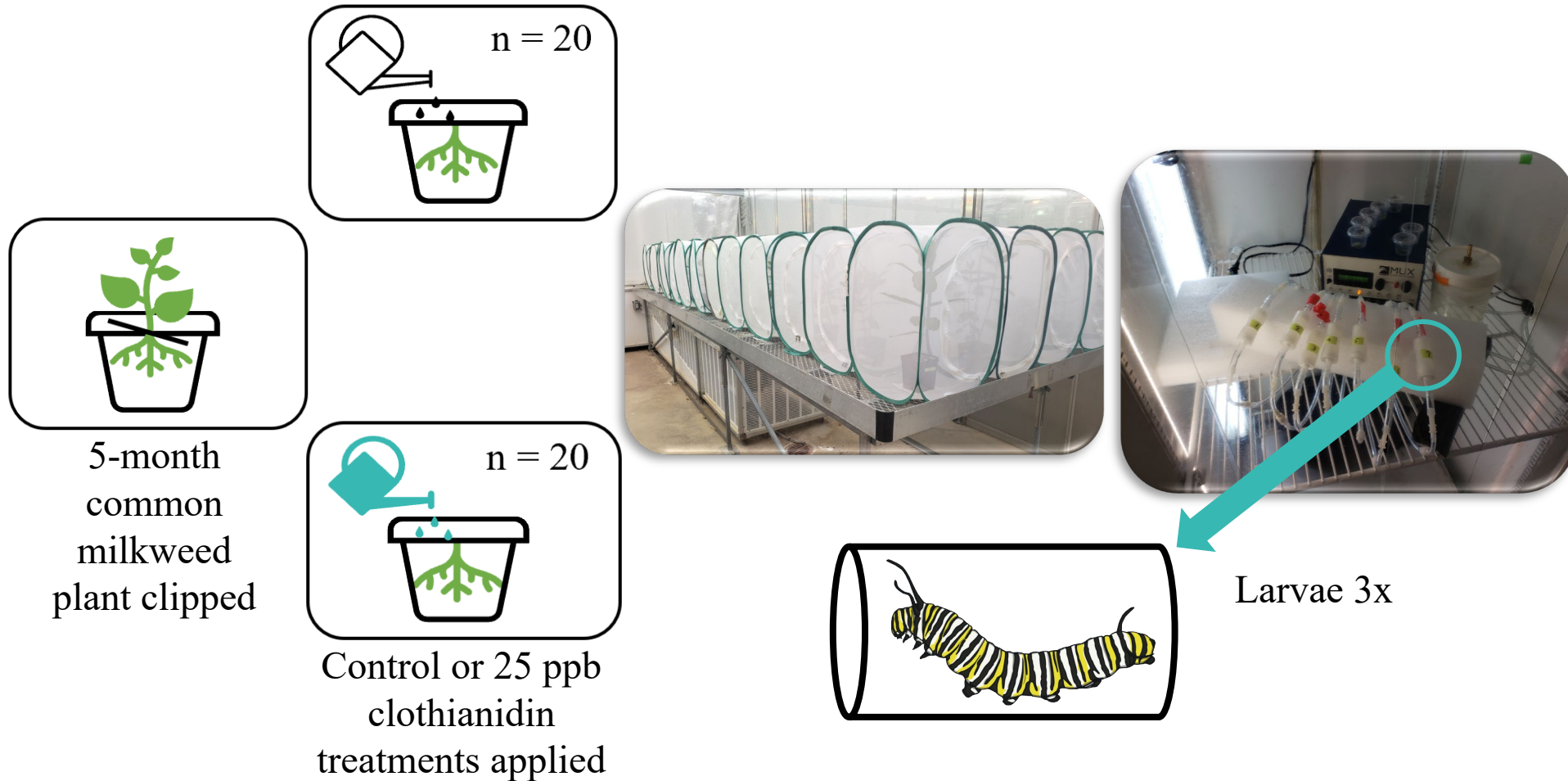


Larvae feed on
plants

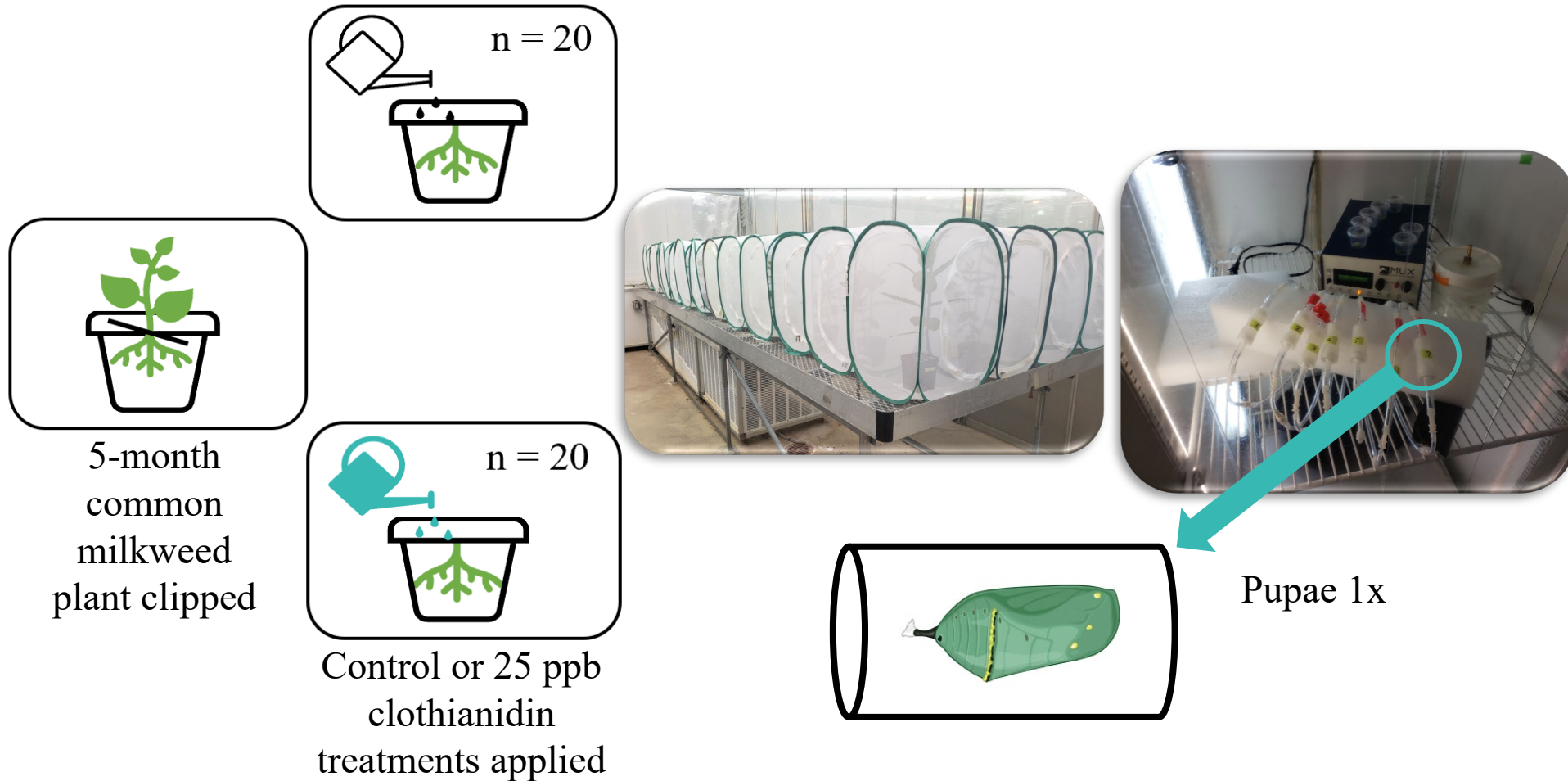


Larval and pupal
respirometry

Larval Exposure Methods and Respirometry



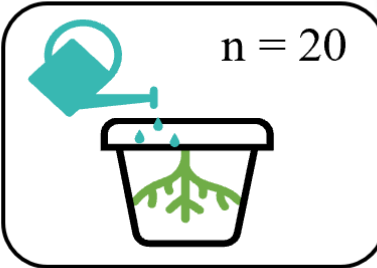
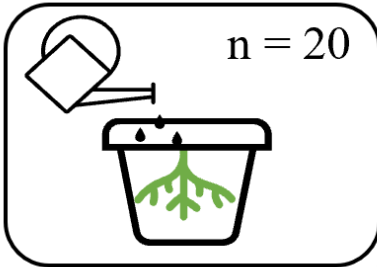
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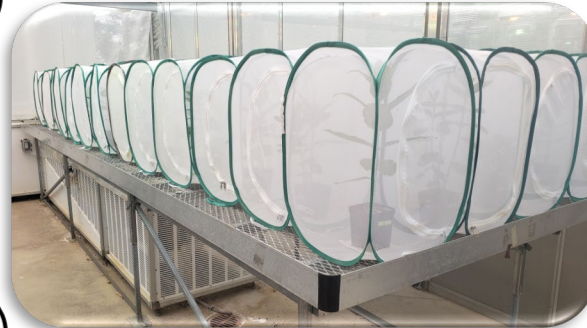
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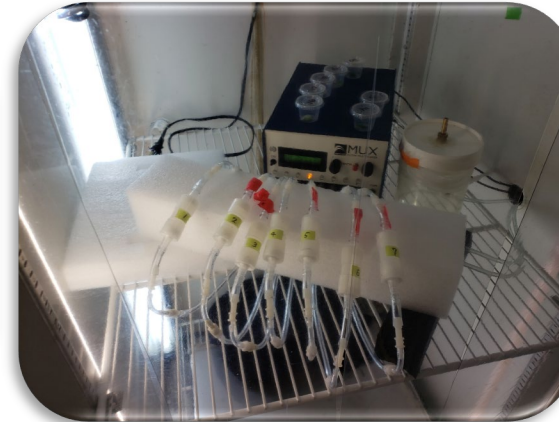
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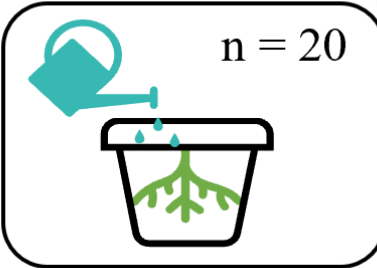
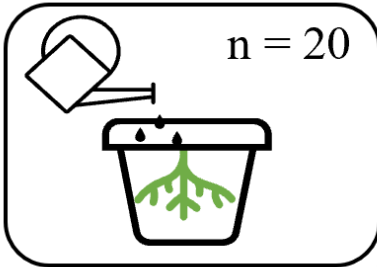


Adult
respirometry

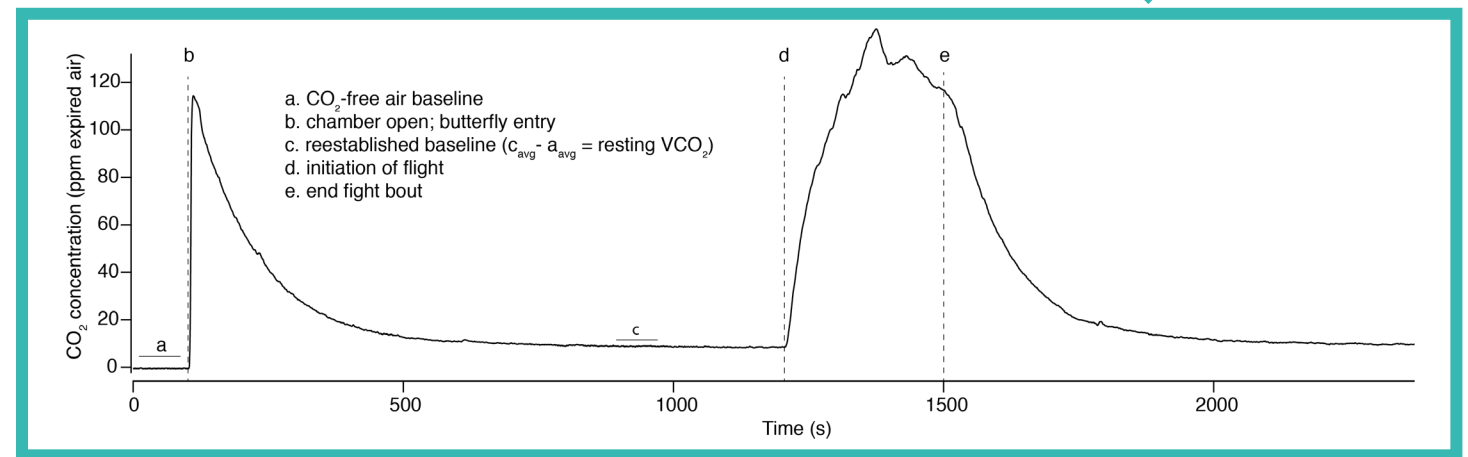
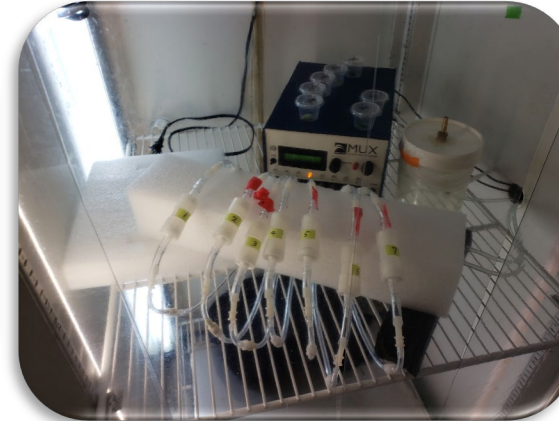
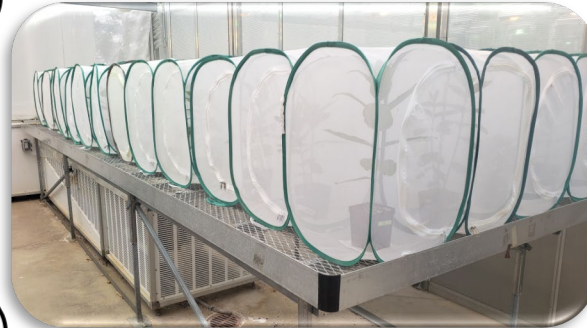
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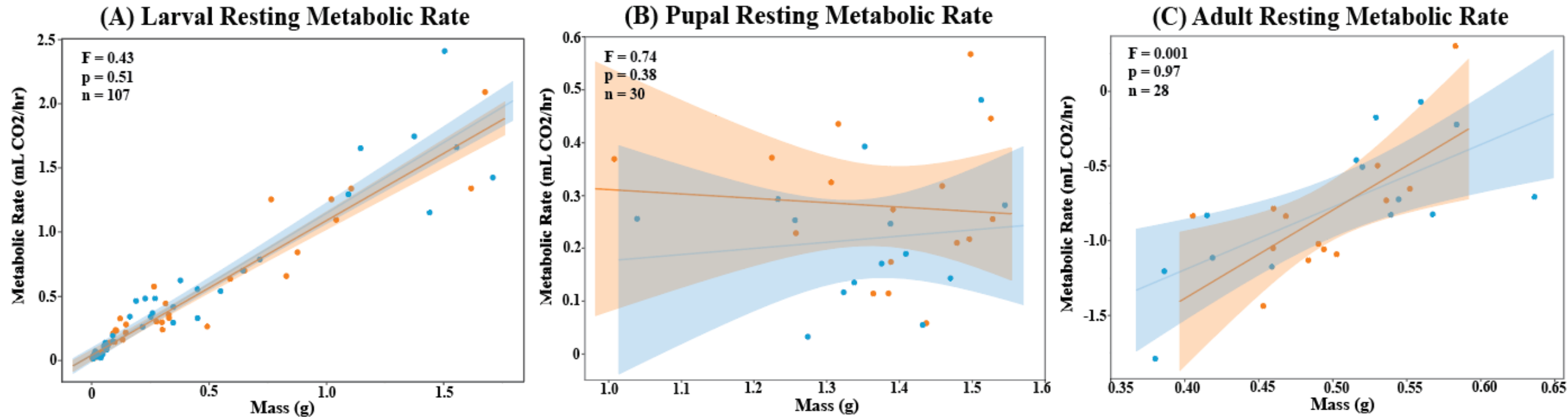


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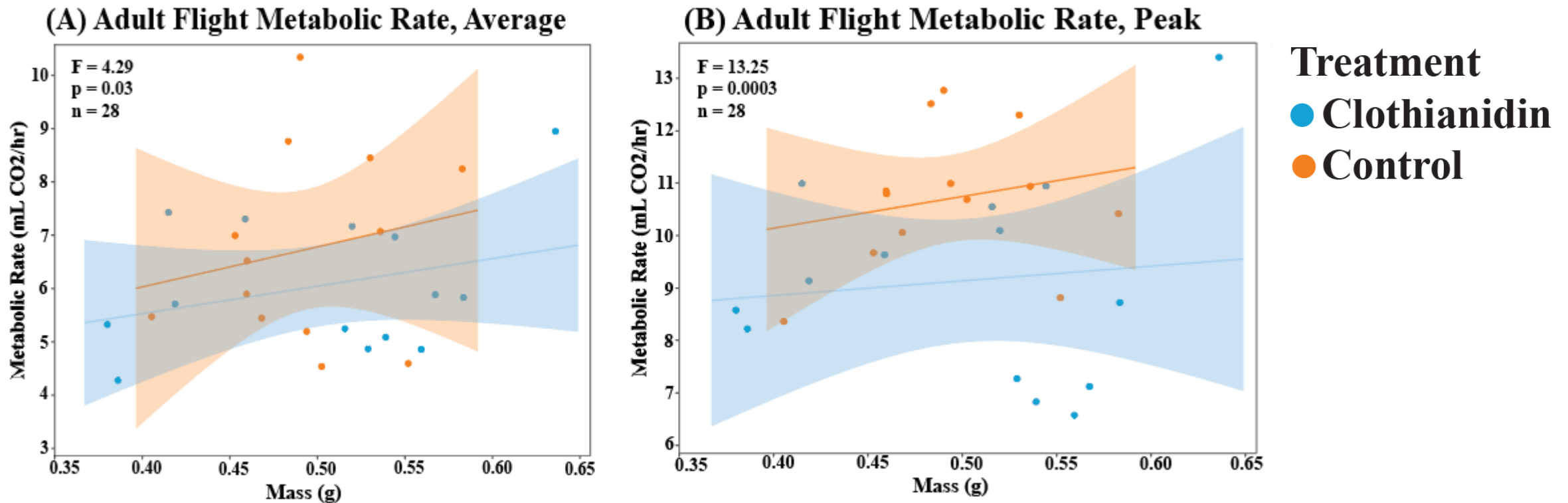


No effect of larval clothianidin exposure on resting metabolic rates at any life stage

Treatment
● Clothianidin
● Control



Significant reduction in both average and peak flight metabolic rates of adults exposed to clothianidin as larvae



What Does this Mean for Flight Performance?

High flight metabolic rate associated with greater flight ability

- Reduced flight metabolic rate and flight performance in monarchs could affect:
 - Mating success
 - Foraging capability
 - Migratory capacity
 - Predator avoidance



Funding

