

## Genetic architecture of adaptive differentiation in evolving host races of the soapberry bug, *Jadera haematoloma*

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### Introduction

- 2 races of Soapberry Bug *Jadera haematoloma* occur on two hosts
  - 100 generations diverged
- Habitat
  - Native plants *Cardiospermum corindum*
  - Introduced plants *Koelerutaria elegans*
- Cross-rearing of ancestral and derived bugs on native or introduced hosts
- 3 Traits measured
  - Length of mouthparts
  - Body size
  - Development time
- Estimated 3 rates for each trait
  - Evolutionary path
    - Compares 2 races when reared on introduced host
  - Current Ecological Contrast
    - Compared each race when reared on natal host
  - Evolved Trade-off
    - Compares 2 races when reared on native host

### Results

- Additive genetic variance large for mouthpart length: 60%
- Other traits:
  - Interaction of dominance, maternal effects, epistasis
- Rearing host plant affected genetic architecture
  - No relationship with evolution rate
- Selection resulted in additive and nonadditive race differentiation

### Rates of Evolution

- Beak length
  - Derived race beak length significantly shorter in when reared on native plants
  - Introduced host bugs beak length reduced from 70% to 50% of body length
  - Similar evolved path and current ecological contrast values= introduced host hasn't impeded or facilitated adaptation to that host (yet beaks shorter)
  - Rate of change 3000-7000 darwins/0.01-0.035 haldanes
- Thorax width
  - No significant difference between races
  - Beak length differences are independent of body size
  - Current ecological contrast is a host effect rather than evolutionary change
- Development time
  - Means:
    - Ancestral race on native host  $35 \pm 0.6$  days
    - Derived race on introduced host  $34 \pm 0.9$  days

- Each race requires 20-25% longer to develop on non-natal host plant
- Little differentiation with current ecological contrast
- Beak length
  - Shortest in DxD line, longest AxA line
  - Greater on native vs non-native host in all lines
  - Variation beyond additive due to epistasis on introduced host, no definitive effects for native host
  - Crossing ancestral (long beak) X derived (short beak) = beak longer than ancestral
- Thorax width
  - Varied less than 2% in first experimental generation
  - Hybrid means differed from purebreds on both hosts
  - Weak additive effects (7-9%)
- Development time
  - Ancestral line took longer to develop
  - Introduced host seeds are available less time of the year
  - Additive control strong on introduced host
  - No distinct effects for native host

### **And the beak shall inherit—evolution in response to invasion**

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### **Introduction**

- 2 races of Soapberry Bug *Leptocoris tagalicus* occur on two hosts
  - 100 generations diverged (1965 introduction of invasive plant)
  - Native plant *Alectryon tomentosus*
  - Introduced plant *Cardiospermum grandiflorum*
- Hypothesis: Will a host plant switch to a larger fruit promote an *increase* in beak length?
  - Beak length differences between bugs on native and alien host are the result of evolution
    - Observational Studies
    - Breeding experiment
  - The derived population on the alien balloon vine has evolved the ability to better reach the plant's seeds
    - Feeding trial
- Observational study looked at 857 live specimens (native and invasive), and 30 museum specimens
  - 3 Traits measured
    - Beak length
    - Body width
    - Body length
- Reciprocal rearing experiments
  - Evolutionary path
    - Compares 2 races when reared on natal and non-natal host

- Measured beak length in response to cross-rearing experiments
- Feeding trial
  - 12 replicates
    - 6 with soapberry bugs collected from native woolly rambutan
    - 6 with soapberry bugs collected from invasive balloon vine
  - Insects placed in separate cages
    - Observed for seed choice
    - Counted feeding scars

## Results

- Observational study
  - Average female beak lengths in 10 of the 12 populations on balloon vine were greater than in all 10 populations on the native host (similar results for males)
  - Host effect on beak length independent of body size measures
  - Variation in beak length not attributable to differences among populations within each host species
  - In females, beak length after 1965 averaged almost 10% longer, while the body size measures were static (similar trend for males)
- Cross-rearing Experiment
  - Host-associated differences in beak length are genetically based
  - Beak length was consistently greater in the bugs collected from balloon vine than from the native host
  - Maternal host effects varied significantly between the populations
  - Rearing host effects also varied significantly
  - Host species had opposite effects on beak length
- Feeding Trial
  - Females collected and reared from the balloon vine sites fed on  $42 \pm 8\%$  of the seeds over the week
  - Females from woolly rambutan fed on only  $24 \pm 10\%$  of such seeds

## Discussion

- Modern insects are more capable of attacking balloon vine than those from the past
- Bugs that came from balloon vines attacked them 1.8X more
- Soapberry bugs were present at all fruiting balloon vines
- Insects show host preference
- Weak evidence of environmental effects, strong evidence of genetic effects