Exploring Pollination Webs in the Hawaiian Islands

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Importance of Pollinators

• Essential for plant reproduction in 80-90% of flowering plant species

• Facing global risk of decline
  – Habitat loss and introduction of non-native competitors and predators
  – Islands particularly susceptible to pollinator loss
  – Little known about pollinators of Hawaiian plants
Community Approach

• Quantifying plant-pollinator interactions for majority of flowering plants in a community
  
  – Interactions between alien and native species
  – Which plants share pollinators/ which pollinators share plants?
  – Distribution of generalists and specialists

Data from Pat Aldrich, UH-Manoa Ph.D. candidate
Pollination web at Pu‘u Wa‘awa‘a
Projects

Sub-alpine scrub
Haleakala, Maui

Dry Forest
Puu Waawaa, Hawaii

Coastal strand
Ka’ena Point, Oahu

Early succession rainforest
Mauna Loa, Hawaii

Elevation Gradient
Mauna Loa, Hawaii

Later succession rainforest
Mauna Loa, Hawaii
Comparative Roles of Native and Alien Species

- Changes in pollination webs along an elevation gradient (Hawaii)

- Indirect effects of invasive ants on plant reproduction (Maui)
Variation in Pollinator Webs Across an Elevation Gradient
Methods

• Observed plants during 10-min intervals

*Approx. 400 person hrs total over one year
Specific Questions

• How does elevation effect:
  – 1) Visitation rates
  – 2) Visitor composition
    • Proportion of native and non-native pollinators
Mean Visitation Rates Across Sites

$P = 0.002$

Mean visits/flwr/hr vs. Elevation (m)

Elevation (m)

880 1150 1370 1585 1830 2440

Mean visits/flwr/hr

a ab b
Changes in Native Pollinator Importance

\[ R^2 = 0.67 \]
\[ P = 0.05 \]
Differences in Visitor Composition

Flower visitors
1830m Web
C = 0.42

Vaccinium reticulatum
Coprosma
Hypochoeris
Metrosideros
Vaccinium reticulatum
Coprosma
Hypochoeris
Metrosideros
Conclusions

• Middle elevations communities more complex and plants receive more visits
  – What are the factors driving this pattern?

• Native pollinators increasingly more important at higher elevations
Pollinator-Mediated Indirect Effects

- Predator
- Pollinator
- Plant

Upcountry Haleakala, Maui
Expanding Ant Invasion

Paul Krushelnicky, USGS
Study Sites

- 300 m inside invasion
- 150 m inside invasion
- 100 m outside invasion
- Invasion Front
Leptecophylla tameiameiae

Santalum haleakalae

Geranium cuneatum
Visitation Rate by Plant Species

Plant: $P < 0.0001$
Site: $P = 0.07$
Plant x Site: $P = 0.007$

### Visitation Rate

- **300m inside invasion**
  - Geranium
  - Leptecophyilla
  - Santalum

- **150m inside invasion**
  - Geranium
  - Leptecophyilla
  - Santalum

- **100m outside invasion**
  - Geranium
  - Leptecophyilla
  - Santalum
Visitor Composition

100m Outside Ant Invasion

150m Inside Ant Invasion

300m Inside Ant Invasion

Graph showing the number of visits made by each taxon at different distances from the ant invasion.

- Ants
- Trupanea
- Odynerus
- Calliphorid
- Other fly
- Hylaeus
- Apis
- Large moth
- Allograpta
- Eristalis
- Geranium
- Leptecophylla
- Santalum
Hylaeus Abundance (Pan Traps)

Site Location

Avg. #Hylaeus/trap/day

P = 0.02

300m inside invasion
150m inside invasion
100m outside invasion

0 0.5 1 1.5 2 2.5 3 3.5

300m inside invasion 150m inside invasion 100m outside invasion
Haleakala Conclusions
Conclusions

• Native pollinators:
  – Extremely important at mid and high elevations
  – May not be easily replaced by non-native pollinators

• Non-native insect predators:
  – Reduce native bee populations
  – Indirectly effect plants by reducing flower visits
Mahalo!

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Elevation Gradient

Low elevation (880m) vs. High elevation (2440m)
Leptecophylla tameiameiae
(Pūkiawe)

*Hypochoeris radicata
(Hairy cat’s ear)

*Arundina graminifolia
(Bamboo orchid)

Metrosideros polymorpha
(‘Ōhi’a)

Dubautia scabra

Vaccinium reticulatum
(‘Ōhelo)

Vaccinium calycinum
(‘Ōhelo)
Flower Visitors

- Seed bug
- Yellow-faced bee (*Hylaeus spp.)*
- *Syrphid fly*
- Amakihi
  ©Arnold Gum 2005
- Apapane
  Photo: Peter LaTourrette
- *Japanese white-eye*
  Photo: K.W. Bridges
- *Honeybee*