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

Coastal strand
Ka’ena Point, Oahu

Dry Forest
Puu Waawaa, Hawaii

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

$P = 0.002$

![Graph showing mean visits per flower per hour across different elevations with significance levels indicated by letters (a, ab, b)].

Elevation (m): 880, 1150, 1370, 1585, 1830, 2440

Mean visits/flower/hr: 1.5, 1.5, 1.5, 2.5, 4.5, 1.5

Significance levels: a, ab, b
Changes in Native Pollinator Importance

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

Proportion of visits at each site


Birds, Mammals, Hymenoptera, Diptera, Leps, Hemipt.
1150m Web
C = 0.24

- Vaccinium calycinum
- Vaccinium reticulatum
- Arundina
- Metrosideros
- Dubautia
- Leptecophylla
- Apis*
- Hylaeus
- Toxomerus*
- Allograpta*
- Calliphorid*
- Other hemiptera
- Ant*
- Bethylidae
- Metallic wasp
- Red abdomen wasp*
- Other diptera
- Hylaeus pubescens
- Tachinid*
- Nysius
- Trupanea
- White eye*
- Hylaeus pubescens
- Amakihi
- Microlep
- Mouse*
- Vespula*
- Moth
- Midge

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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

Upcountry Haleakala, Maui
Expanding Ant Invasion

Paul Krushelnicky, USGS
Study Sites

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

Santalum haleakalae

Geranium cuneatum
Visitation Rate by Plant Species

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

<table>
<thead>
<tr>
<th>Site Location</th>
<th>Geranium</th>
<th>Leptecophylla</th>
<th>Santalum</th>
</tr>
</thead>
<tbody>
<tr>
<td>300m inside invasion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>150m inside invasion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100m outside invasion</td>
<td></td>
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</tbody>
</table>
Hylaeus Abundance (Pan Traps)

Site Location

<table>
<thead>
<tr>
<th>Site Location</th>
<th>Avg. #Hylaeus/trap/day</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>300m inside invasion</td>
<td>a</td>
<td></td>
</tr>
<tr>
<td>150m inside invasion</td>
<td>a</td>
<td></td>
</tr>
<tr>
<td>100m outside invasion</td>
<td>b</td>
<td>0.02</td>
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</tbody>
</table>

P = 0.02
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

Yellow-faced bee
(Hylaeus spp.)
Mahalo!

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Elevation Gradient

Low elevation (880m)

High elevation (2440m)
Leptecophylla tameiameiae (Pūkiawe)

*Arundina graminifolia (Bamboo orchid)

Metrosideros polymorpha ('Ōhi'a)

Vaccinium reticulatum ('Ōhelo)

Hypochoeris radicata (Hairy cat’s ear)

Dubautia scabra

Vaccinium calycinum (Ōhelo)
Flower Visitors

- **Seed bug**
- **Yellow-faced bee** (*Hylaeus spp.*)
- ***Syrphid fly***
- **Amakihi**
- **Apapane**
- ***Japanese white-eye***

Photos:
- K.W. Bridges
- Peter LaTourrette
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