Rapid Global Invasion by *Quadrastichus erythrinae* (Eulophidae), the Erythrina Gall Wasp and the Hawaii Biological Control Success

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Erythrina sandwicensis

- Deciduous tree
- Keystone species of Hawaiian low land dry forest
- Important species in Hawaiian culture
- Many threats during the last decades: ungulates, invasive weeds, fire, pests
Erythrina Gall Wasp (EGW), *Quadrastichus erythrinae* Kim

- First documented in 2003 in the Mascarene Islands and Taiwan.

- Described in 2004 from specimens from Singapore, Mauritius, and Reunion.

- India, American Samoa, China, Thailand, Guam, Philippines, Japan, Hawaii, Florida and Mariana Islands.
Incursion of EGW into Hawaii

Initially found on Oahu in April 2005
Erythrina Gall Wasp

1.5 mm

1.0 mm
Control Methods

- Mechanical control
- Chemical control (Xu et al. 2006)
- Biological control
Origin of the invasive EGW

- Where did it come from?
- Is the invasive EGW a single species or have multiple GW with similar ecology caused this invasion?
- What are its natural enemies?

Locate source population to focus biocontrol exploration efforts.
Survey across much of the range of *Erythrina* in Sub-Saharan Africa.

Sequence DNA of wasps across native and introduced range.

A single species, *Q. erythrinae*, involved in dramatic host range expansion.

Complete lack of polymorphism in all invasive populations sampled.

Exact origin still undetermined. Almost certainly East Africa.

Rubinoff et al. 2009
First Q. erythrinae Invasion?
Natural enemies of EGW collected from Africa

*Eurytoma erythrinae*  
*Aprostocetus nitens*
Eurytoma erythrinae (Eurytomidae)

Incubation period of egg: 3 d
Larval stage: 11 d
Pupal stage: 4 d
Mean adult longevity: 40.4 ± 2.2 d

Egg
Pupa
Eurytomid larva
Feeds on multiple EGW larvae
Risk Assessment Evaluation

Insect Hosts Selected

- **Trioza sp.**
  - Psyllidae

- **Josephiella microcarpae**
  - Agaonidae

- **Ophelimus sp.**
  - Eulophidae

- **Procecidochares alani**
  - Tephritidae

- **Procecidochares utilis**
  - Tephritidae

- **Eutreta xanthochaeta**
  - Tephritidae

- **Tectococcus ovatus**
  - Eriococcidae
Pre and Post Release Monitoring

- Infestation rate on young shoots
- Captive emergence from galled material
- Tracking young shoots and inflorescences
- Dissecting galled material
Infestation rate on young shoots

- Infestation level on 20 side shoots / tree
- Infestation level based on a four point scale
- Pre-release : 6 months
- Post-release: 18 months
A. Infestation level 0: no galls, B. Infestation level 1: 1-33% of tissue galled
C. Infestation level 2: 34-66% of tissue galled, D. > 66% of tissue galled
Captive emergence from galled material

- Galled material sorted by infestation rate
- Material held in ventilated containers
- Dry weight of galled material
- EGW and *E. erythrinae* counted
Leaves – Infestation rate 2

- **EGW**
- **Eurytoma erythrinae**

release

# individuals / g dry galled material

Jun/08  Sep/08  Dec/08  Mar/09  Jun/09  Sep/09  Dec/09  Mar/10  Jun/10  Sep/10
Tracking young shoots and inflorescences

- Young shoots and inflorescences tagged at infestation level zero or one
- Infestation level rated till dormancy or seed production
- Photo of shoots and inflorescences
Infestation level

% young shoots tagged

pre-release 2008
post-release 2009
post-release 2010

Infestation level

0 1 2 3
Dissection of galled material

- 100 galls dissected
- Records of healthy EGW larvae, EGW with probing marks, EGW with larvae of *E. erythrinae*
- EGW larval mortality:
  - EGW larvae with probing marks + EGW with *E. erythrinae* larvae
EGW larval mortality

% Larval mortality

Dec/08  Mar/09  Jun/09  Sep/09  Dec/09  Mar/10  Jun/10  Sep/10
Unknown Eupelmid in the Field

85% of Eupelmids found in dissections – feeding on EGW
Conclusions

- *Eurytoma* established immediately, emergence from galls detected within 2-6 months after release.
- Infestation rates in leaves, petioles and stems decreased significantly post release.
- Infestation rate in inflorescences still relatively high at some sites.
- Unknown wasp – generalist hyperparasitoid may be impacting *Eurytoma*?
Further considerations

- Need for augmentative releases during flowering at some sites?
- Need for a second biocontrol agent?
- Impact of other pests on recovery of *E. sandwicensis*
Acknowledgments

 USDA T-STAR; HISC; Ti-Isle R&D for funding
 Rob Hauff, Cynthia King – DLNR-DOFAW
 Naomi Hoffman - Honolulu Botanical Gardens
 David Orr - Waimea Arboretum
 Dr. David Burney - NTBG
 The Outdoor Circle
 Roshan Manandhar, Amber Tateno, Robert Morgan