

# **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

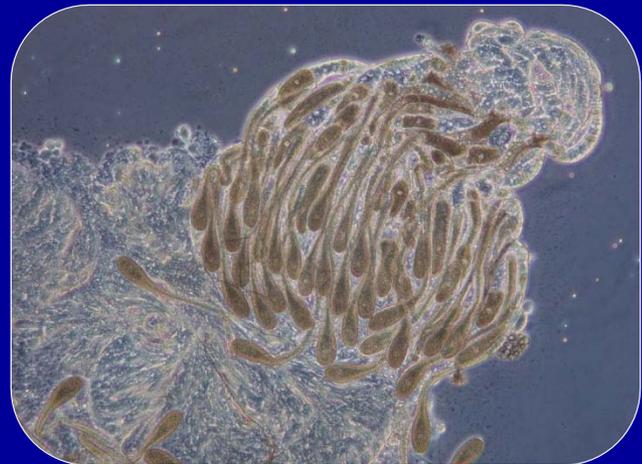
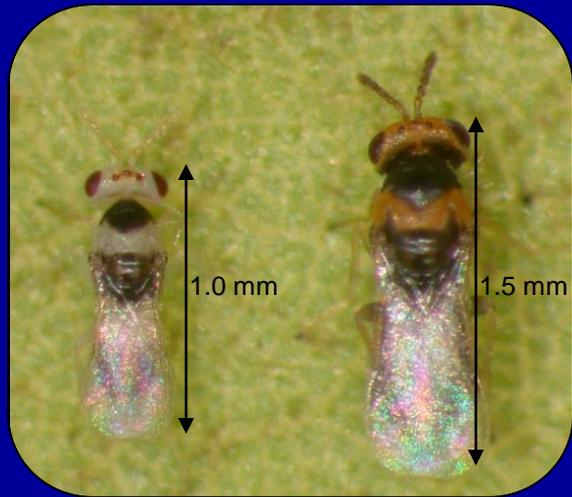
- ✿ First documented in 2003 in the Mascarene Islands and Taiwan.
- ✿ Described in 2004 from specimens from Singapore, Mauritius, and Reunion.
- ✿ India, American Samoa, China, Thailand, Guam, Philippines, Japan, Hawaii, Florida and Mariana Islands.

# Incursion of EGW into Hawaii

✿ Initially found on Oahu in April 2005



# Erythrina Gall Wasp







# Control Methods

🌸 Mechanical control

🌸 Chemical control (Xu et al. 2006)

🌸 Biological control



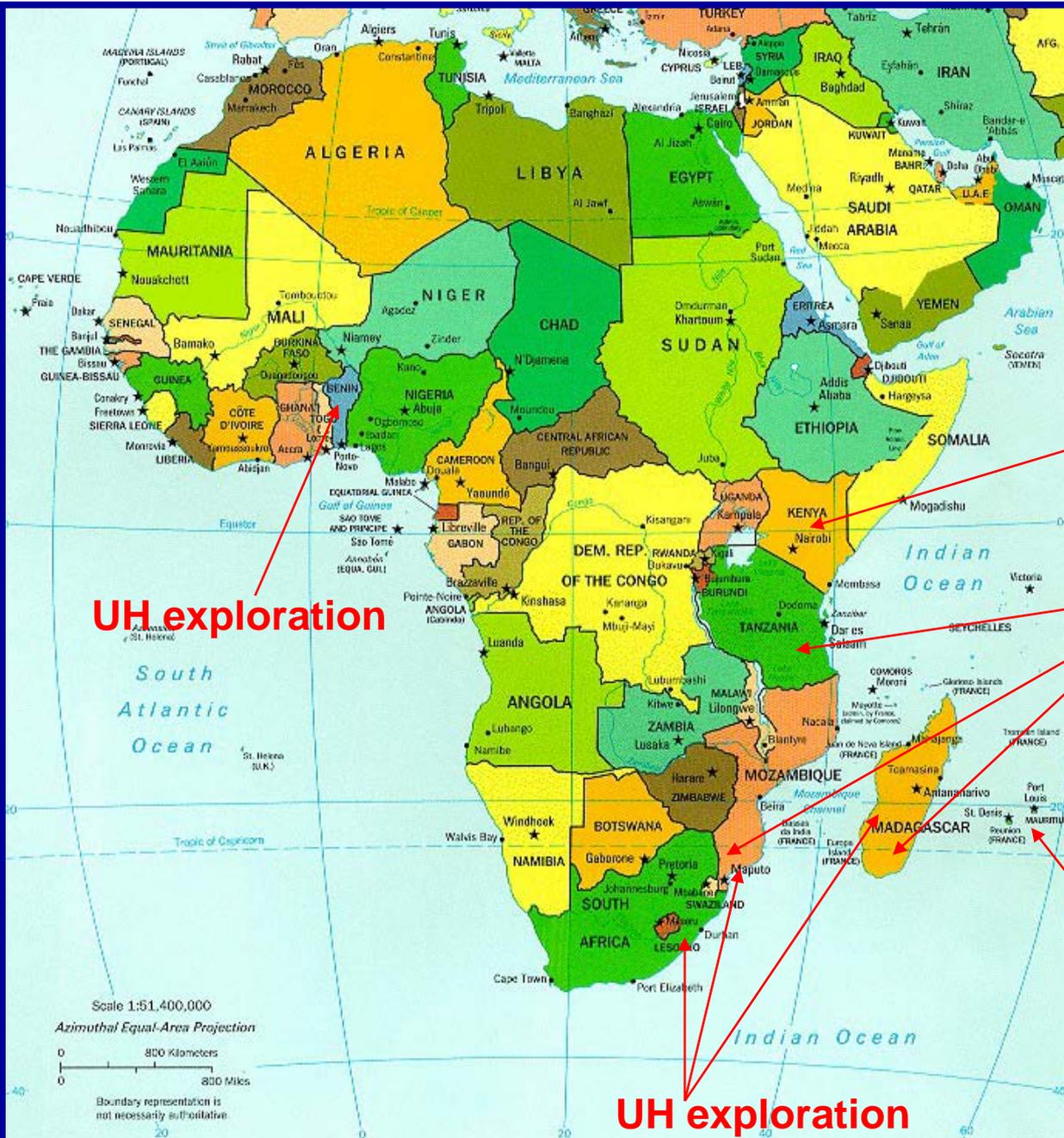
# Origin of the invasive EGW

- ❁ 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.

# Origin of the invasive EGW

- ✿ 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.



UH exploration

ICIPE

HDaA

First *Q. erythrinae* Invasion?

UH exploration

# Natural enemies of EGW collected from Africa



*Eurytoma erythrinae*



*Aprostocetus nitens*

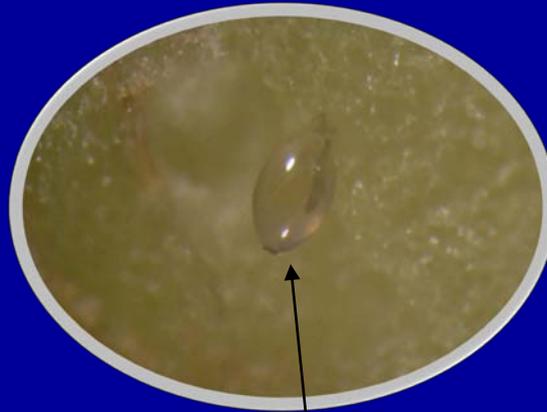
# *Eurytoma erythrinae* (Eurytomidae)

Incubation period of egg: 3 d

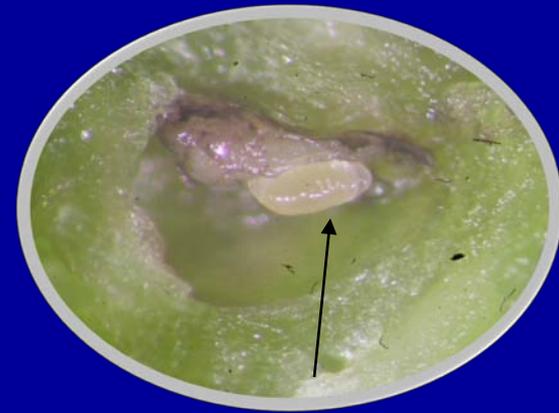
Larval stage: 11 d

Pupal stage: 4 d

Mean adult longevity:  $40.4 \pm 2.2$  d



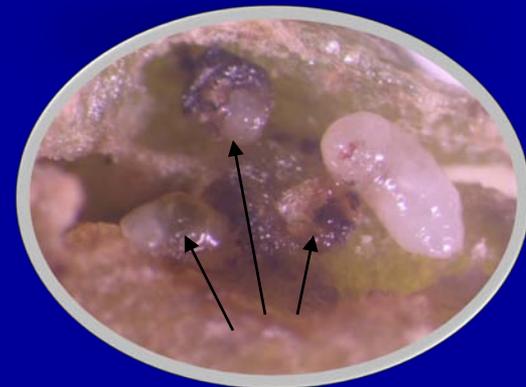
Egg



Eurytomid larva



Pupa



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



# Monitoring sites



# Pre and Post Release Monitoring

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

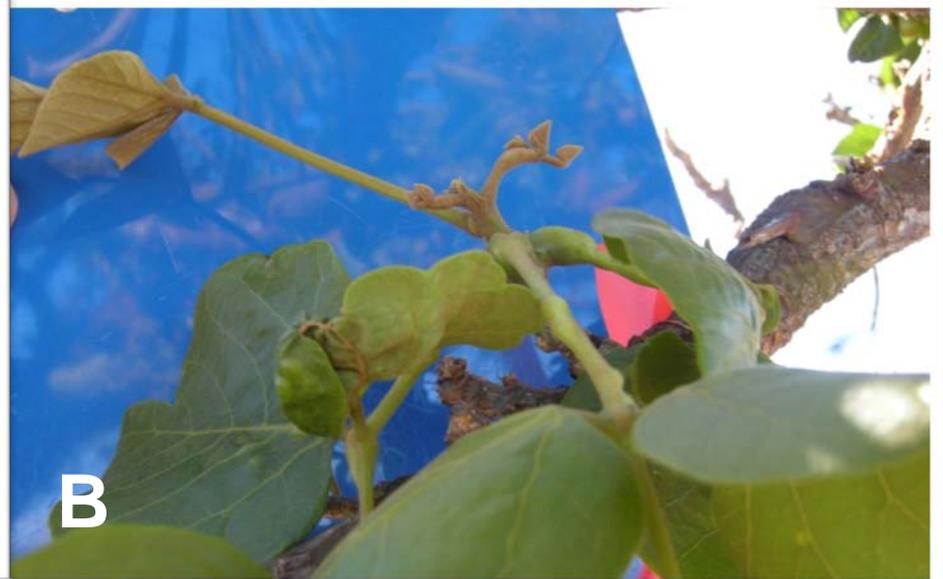
# Infestation rate on young shoots

🌸 Infestation level on 20 side shoots / tree

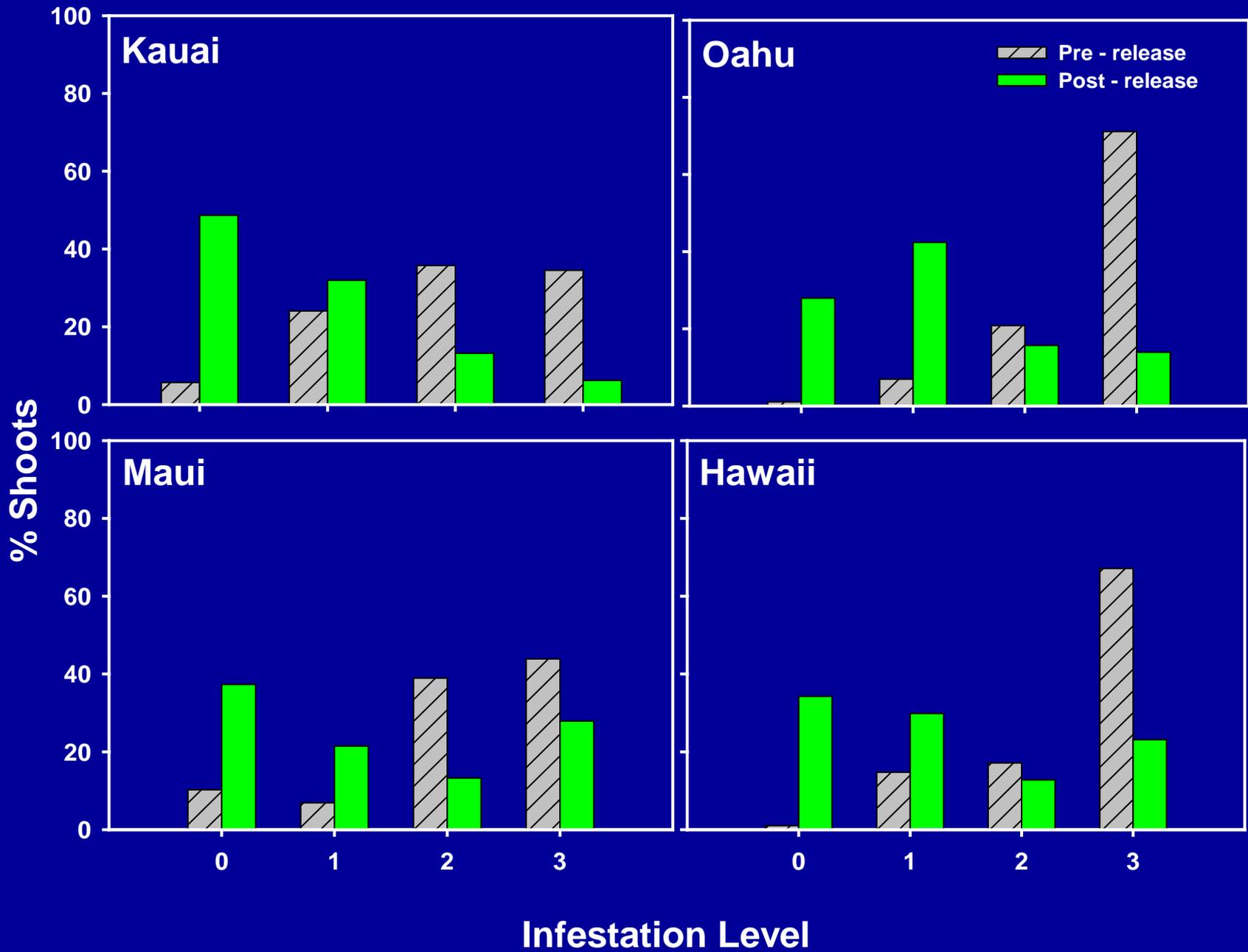
🌸 Infestation level based on a four point scale

🌸 Pre-release : 6 months

🌸 Post-release: 18 months



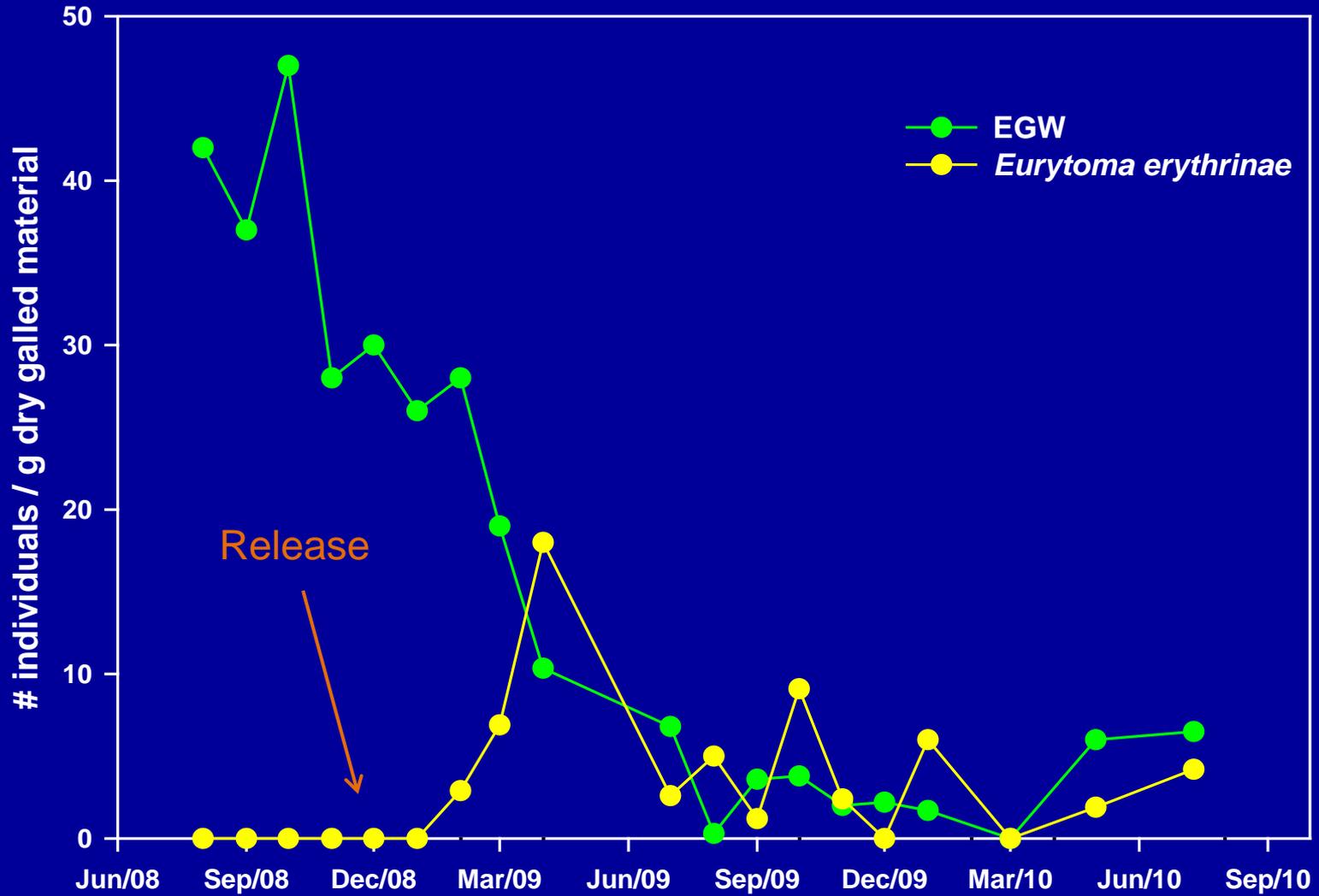
A. Infestation level 0: no galls, B. Infestation level 1: 1-33% of tissue galled  
C. Infestation level 2: 34-66% of tissue galled, D. > 66% of tissue galled



# Captive emergence from galled material

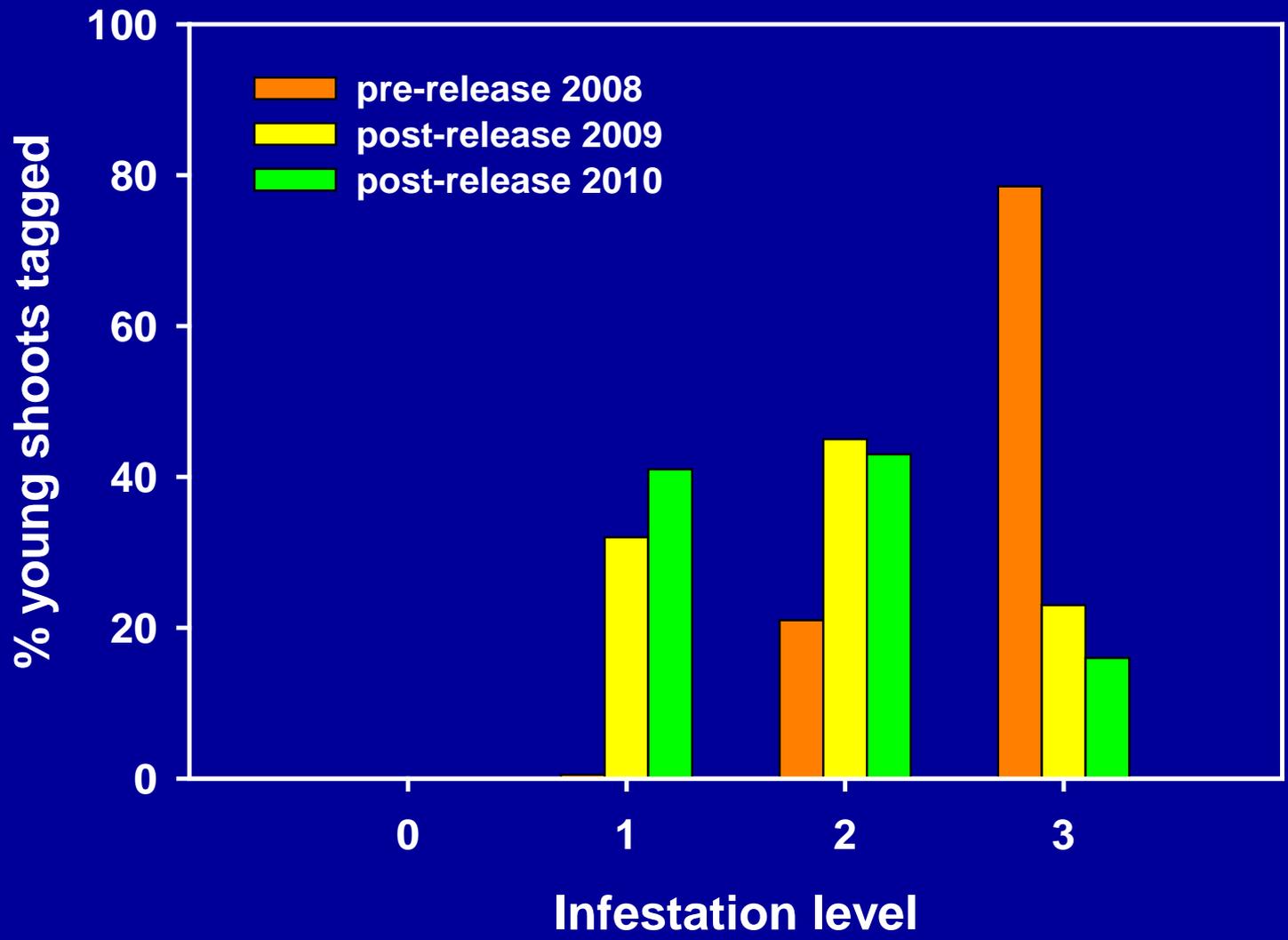
- ✿ Galled material sorted by infestation rate
- ✿ Material held in ventilated containers
- ✿ Dry weight of galled material
- ✿ EGW and *E. erythrinae* counted

# Leaves – Infestation rate 2



# 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



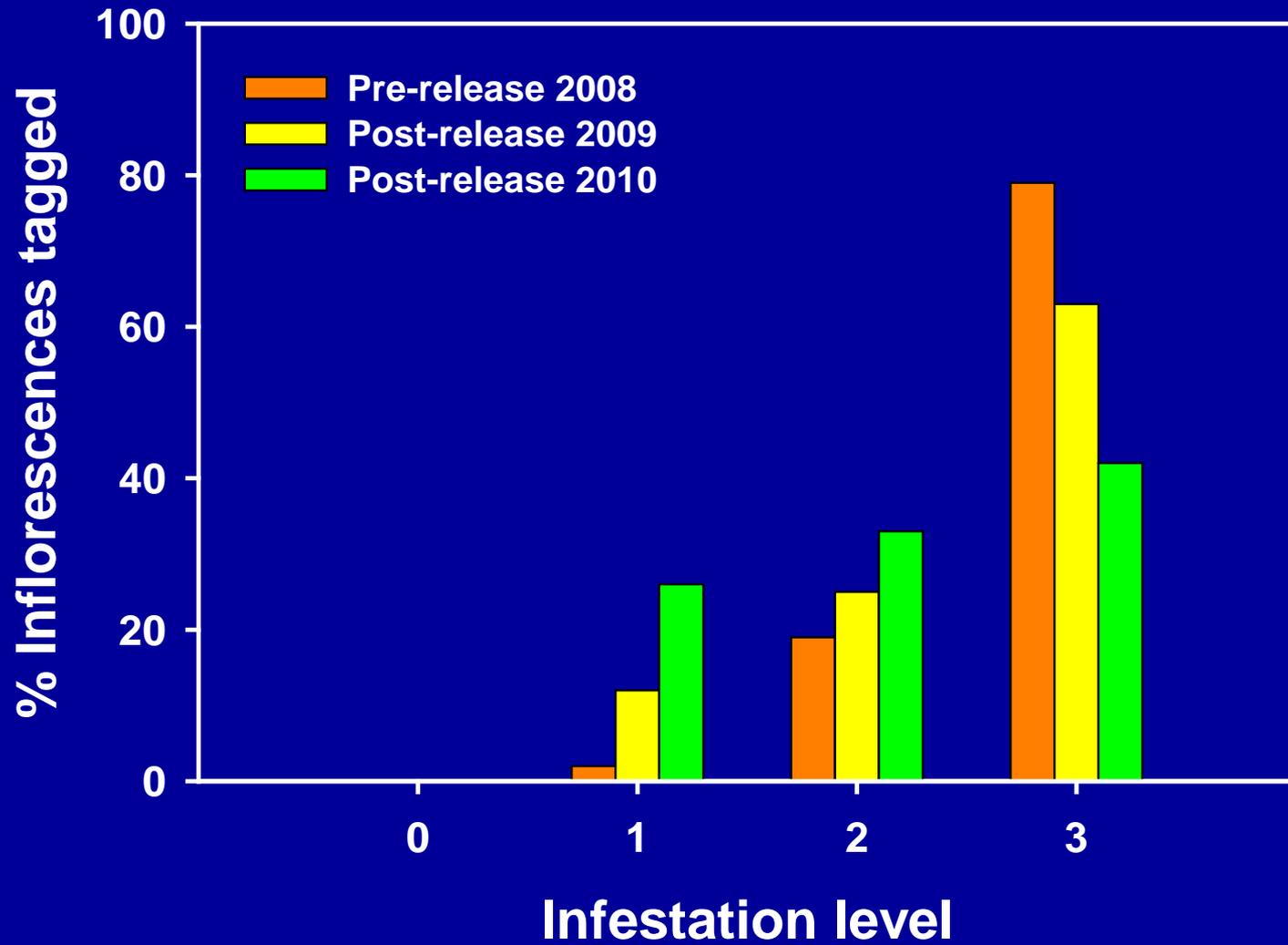


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12/16/2008









# Dissection of galled material

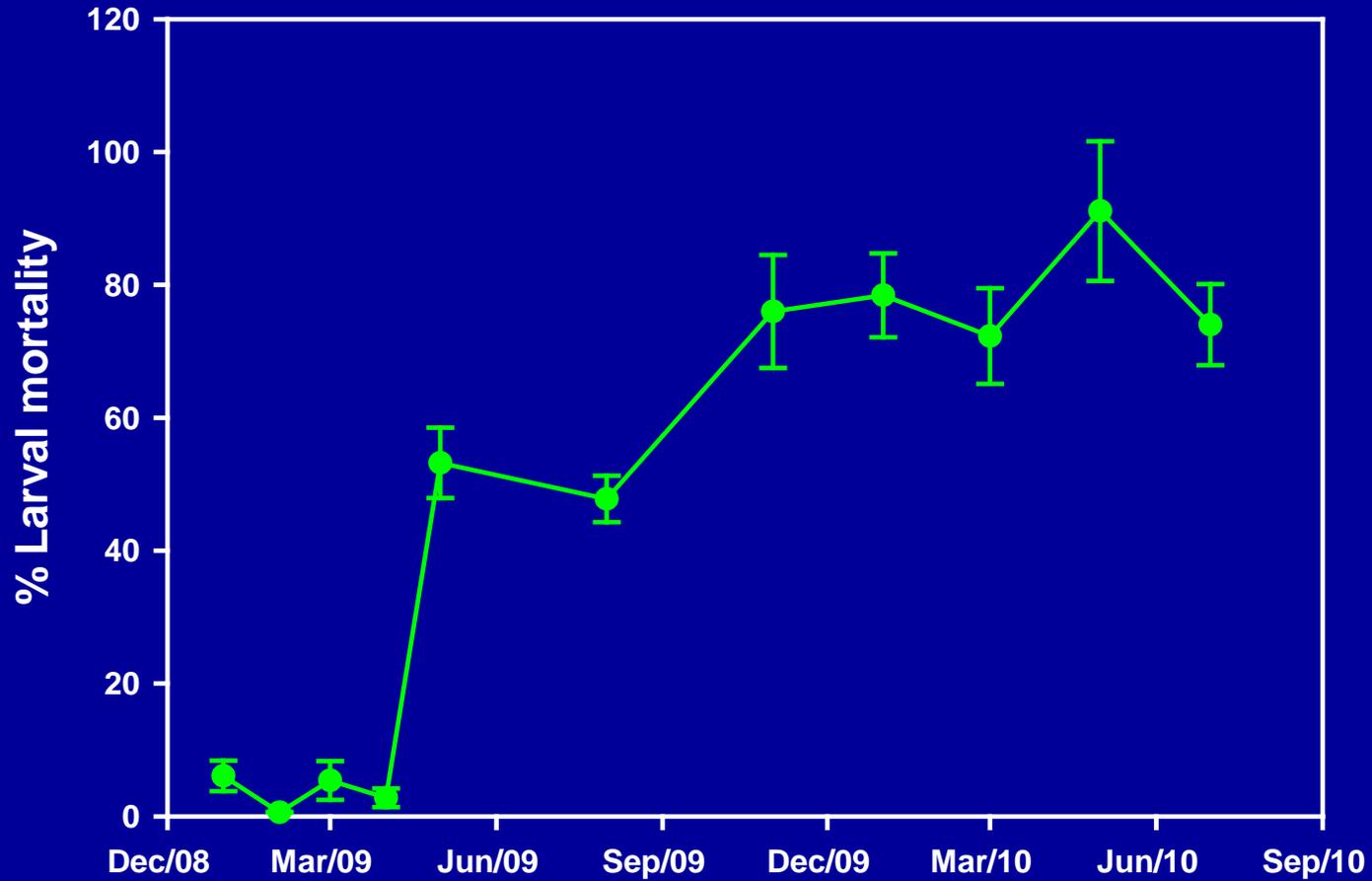
✿ 100 galls dissected

✿ 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



# 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

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