## Something Wicked This Way Comes: California's Perennial Problem with Invasive Arthropods



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### California's Invasive Species Problem

- California has a lot of exotic arthropods
  - 1,686 species as of 2010
- Impacts?
  - About 20% (314 spp.) are pests
- Where do they come from?
  - Origin suspected for 992 (~60%) exotic species
    - Invasion bridgeheads (& transcontinental invaders) in USA and Canada (<u>44%</u>)
      - Originated from populations established elsewhere in the USA
    - Direct invaders (56%)
      - Europe = 25%
      - Mexico (2%), Central, and South America (7%) = 9%
      - Asia = 10%
      - Africa = 4%
      - Australia = 5%
      - South Pacific = 3%



#### Dowell et al. 2016. Proc. Cal. Acad. Sci. 63: 63-157

#### **Invader Identities**

- Top orders accounting for ~85% of non-native species are:
  - Hemiptera (32%)
    - Aphididae, Diaspididae, Pseudococcidae, Cicadellidae, Coccidae, & Psyllidae
  - Coleoptera (19%)
    - Curculionidae, Staphylinidae, & Chrysomelidae
  - Lepidoptera (10%)
    - Pyralidae & Tortricidae
  - Acari (8%)
    - Eriophyidae & Tetranychidae
  - Diptera (7%)
    - Cecidomyiidae
  - Hymenoptera (6%)
    - Formicidae
  - Thysanoptera (4%)
    - Thripidae

Sandy Liebhold et al. 2012 – live plant imports are major conduits for introductions of insects and pathogens that attack plants (69% of established pests)

Sap feeders most common group introduced

Front. Ecol. Environ. 10: 135-143

Dowell et al. 2016. Proc. Cal. Acad. Sci. 63: 63-157

### Are Invasions into California Accelerating?

Prior to 1989 CA acquired ~ 6 exotics/yr, one every ~ 60 days

1989-2010 CA acquired ~ 9.7 exotics/yr, one every ~ 40 days

Rate of acquisition has increased by ~62% per year

Dowell et al. 2016. Proc. Cal. Acad. Sci. 63: 63-157

Seebens et al. (2017) analyses indicate that so far there is no observable saturation in the accumulation of non-native species globally, rates of introduction/establishment are not slowing down

This trend is consistent for mainland and islands

Trade is the major driver of introductions of non-native species and is coupled with increasing cultivation of plants in agriculture, botanic, and private gardens

Nature Communications 8: Article No. 14435

# Classical Biological Control: The Premise and Practice

- Why do some new introductions become pests?
  - Enemy release
- The counter attack?
  - Classical or introduction biological control
- What are natural enemies?
  - Predators
  - Parasites
  - Parasitoids
  - Pathogens
  - <u>Herbivores</u>
- Foreign exploration

Co-evolved host specific natural enemies from the native range of the target pest



#### The Response to the First Invasive Arthropod & The Aftermath







Nov. 1888 – March 1889 4 ocean going shipments to SF









The phrase "Biological Control" was first used Prof. Harry Scott Smith in August 1919 at the meeting of Pacific Slope Branch of the American Association of Economic Entomologists at the Mission Inn



To Make a Spotless Orange Biological Control in California

RICHARD C. SAWYER



#### The First Classical Biocontrol Program in the Galapagos Islands



*Icerya* introduced in 1982. By 1996 15/18 islands infested. 80 native/endemic species attacked, 10 were threatened species. Native Lepidoptera and birds threatened. 23% of the Galapagos insect fauna is non-native



2002-2005 2,206 Rodolia released on 10 islands. Immediate establishment rapid population declines on most infested species

26 month follow up study indicated major and permanent declines in *Icerya* densities across all islands and major infested habitats

Zero evidence for non-target impacts

Robust recovery of native & endemic plants infested by *Icerya*, almost complete elimination on some species

Biocontrol extremely successful – blackberry and bird parasitic flies being considered for control



### Good or Bad?: A Question of Perspective?



### Good or Bad?: A Question of Perspective?



### Good or Bad?: A Question of Perspective?









Established in HI in 2010. Significant impacts on naio, *M. sandwicense*, high ecological and cultural importance

#### Leaning In: Proactive Biocontrol

#### OUTLOOK

#### Proactive biological control: A cost-effective management option for invasive pests

Proactive biocontrol could accelerate responses to invasive pests in urban areas — where pesticide use may be unpopular — before they spread to agricultural areas.

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Hoddle et al. (2018) Cal. Ag. https://doi.org/10.3733/ca.2018a0027









# Conclusions

- Incursion and establishment of invasive pests will continue unabated
  - Accelerate?
  - New unexpected threats due to climate change? Drought? Fire?
    - All habitats under siege
      - Aquatic (freshwater and marine)
      - Rangelands
      - Natural areas
      - Agriculture
      - Urban

#### Classical biocontrol

- Very effective and safe when done properly and when it works not a panacea!
- Not all pest targets are amenable some pest groups highly susceptible
- Theory and practice, especially with respect to host range and host specificity of arthropod natural enemies is continuing to improve
- Non-traditional targets need consideration?

# Want More?





#### www.biocontrol.ucr.edu

#### www.cisr.ucr.edu

# Questions?

