Host range and natural history of *Gadirtha fusca*; The Second Biological Control Agent of Chinese tallow tree (*Triadica sebifera*)

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- Jiangqing Ding, Yi Wang, Wei Huang, Jialiang Zhang - Chinese Academy of Sciences, Wuhan & Kaifeng, China
- Matt Purcell, CSIRO, Australia
Tallow distribution in China

- Distributed in China south of the Yellow river to Hong Kong
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- Cultivated sp.
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- Possibly 200 spp of herbivore pests that are potential biological control agents
Tallow's distribution US

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• The dominant woody sp in many forests & wetlands
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• Expanding range, $200-$400 million to control over next 20 yrs
Tallow’s distribution US

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- The dominant woody species in many forests & wetlands
- Infestations impact endangered Whooping crane and Attwater’s prairie chicken
- Expanding range, $200-$400 million to control over next 20 yrs
- Biological control - safe, sustainable, cost-effective
Cost of tallow control

- COE Jacksonville district tallow control costs
- Annual cost for herbicide control 2013-2018
Euphorbiaceae phylogeny & test list

- 3 subfamilies in US: Euphorbioideae, Acalyphoideae, Crotonoideae
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- There are 60 genera in US (including Phyllanthaceae & Putranjivaceae)
Euphorbiaceae phylogeny & test list

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- 5 federal and 17 state (FL & TX) listed spp (Argythamnia, Croton, Drypetes, Euphorbia, Heterosavia, Hippomane, Manihot, Phyllanthus, Tragia)
Tallow biological control agents

*Heterapoderopsis bicallosicollis*
Tallow biological control agents

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*Gadirtha fusca*
Tallow biological control agents

- **Heterapoderopsis bicallosicollis**
- **Bikasha collaris**
- **Gadirtha fusca**
- **Sauris sp.**
Tallow biological control agents

- Heterapoderopsis bicallosicollis
- Bikasha collaris
- Gadirtha fusca
- Sauris sp.
Schizomyia chinensis on Tallow insects being developed

- 700 galls collected
- 200 larvae emerged
New Tallow biological control agents

- Da Miao, Hubei province
- *Dichomeris cymatodes*
- (Lepidoptera: Gelechiidae)
- India to China
- Reported from tallow
- DNA analysis
Defoliating caterpillar on Tallow

- *Gadirtha* a small genus, India, China, Japan, Australia
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- Narrow host range from Chinese
- Larval host range tested in China (46 spp lab; 32 spp field tested)
Origin of *Gadirtha fusca* collections

- Discovered in Anhui, Guangdong, Guangxi, Hunan, and Jiangxi provinces
- Molecular analysis to determine if same species
Diversity of *Gadirtha fusca*

- 2015 surveys found two color morphs
- Reared separately
- Conducted COI barcoding
Identification of *Gadirtha fusca*

*Gadirtha fusca* represented by a single clade indicating all one species - 0.3% genetic divergence
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Other *Gadirtha* spp had > 5.0% genetic divergence

Wheeler et al 2018a
Defoliating caterpillar on Tallow

4 days for egg hatch

Complete development 25-30 days

15.4 days as larva

10.8 days pupa to adult

5 instars
Host testing protocol

• No–choice starvation test. Assess physiological host range of neonates
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• Dual-choice test – simultaneously offers neonates a choice between non-target and weed
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- No-choice starvation test. Assess physiological host range of neonates.
- Dual-choice test – simultaneously offers neonates a choice between non-target and weed.
- Multi-generation – determines if the neonates can sustain a population on non-target for three generations. No-choice.
**No-choice test on Tallow**

- No-choice test 78 spp *G. fusca* larvae
- All larvae died within 3 days on non-target spp except:

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Dual-Choice test results

- Dual-choice test of *Gadirtha fusca* larvae on non-target 4 spp.
- Larvae nibbled *G. lucida* only.
Dual-Choice test results

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![Bar chart showing larval feeding comparisons among different plant species](chart.png)

- **Euphorbia milii** yellow: $F_{1,8} = 2083.2; P < 0.0001$
- **Euphorbia milii** red: $F_{1,8} = 330.65; P < 0.0001$
- **Euphorbia hyssopifolia**: $F_{1,8} = 519.18; P < 0.0001$
- **Euphorbia hypericifolia**: $F_{1,8} = 88.08; P < 0.0001$
- **Gymnanthes lucida**: $F_{1,8} = 941.53; P < 0.0001$
Multiple generation test

- *Gadirtha fusca*
- Multiple generation testing larvae on non-target 4 spp:
- No survival after 2 generations on *G. lucida*

Wheeler et al. 2018b
Non-target *E. hypericifolia* (graceful sandmat)

Native to southern Florida, Caribbean
Overlap throughout invaded range
Non-target *E. hyssopifolia* (hyssopleaf sandmat)

Native to southern Florida, Caribbean
Overlap throughout invaded range
Non-target *G. lucida* (oysterwood)

Native to southern Florida, Caribbean
Little overlap throughout invaded range
Non-target *E. milii* (crown of thorns, christplant)

Ornamental in south Florida
Little overlap with tallow’s invaded range
Defoliating caterpillar on Tallow

- *Gadirtha fusca*
- Larvae safe & very damaging
- RCR = 0.9 mg/mg/d

Leaves fed to one late instar larva

Leaf damage of one larva after 2 days (135 cm²)
Defoliating caterpillar on Tallow

- *Gadirtha fusca*
- How much damage will larvae cause in an experimental setting?
- Infested saplings ~ 50 cm tall
- 0, 1, 5 larvae
- 2 generations
- about 15 d feeding/generation
Defoliating caterpillar on Tallow

- *Gadirtha fusca*
- Five larvae reduced total biomass by half
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Defoliating caterpillar on Tallow

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- AG biomass 40% of control
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- BG biomass 60% of control
Summary Gadirtha fusca testing

All larvae died on 78 test spp, except

• Gymnathes lucida
• Euphorbia hypericifolia
• Euphorbia hyssopifolia
• Euphorbia milii (red)
Summary *Gadirtha fusca* testing

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Summary *Gadirtha fusca* testing

- 5 larvae/sapling reduced leaf biomass to 5%

**Dual-choice results**

**Multi-gen results**
Acknowledgments