Pest control methods heard through the grapevine

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“California Vine Disease”: First detected in Anaheim in 1884 and in the San Joaquin Valley in 1917

U. S. DEPARTMENT OF AGRICULTURE.
DIVISION OF VEGETABLE PATHOLOGY.
BULLETIN No. 2.

THE

CALIFORNIA VINE DISEASE.

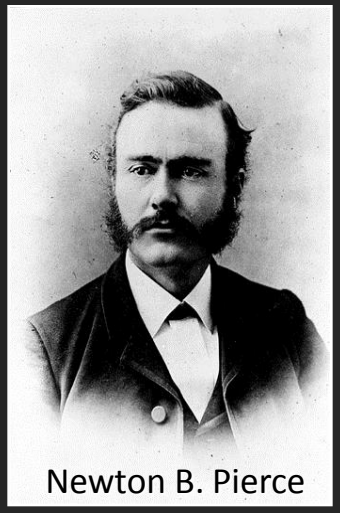
A PRELIMINARY REPORT OF INVESTIGATIONS

BY

NEWTON B. PIERCE,
SPECIAL AGENT.

PUBLISHED BY AUTHORITY OF THE SECRETARY OF AGRICULTURE.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1892.



Newton B. Pierce

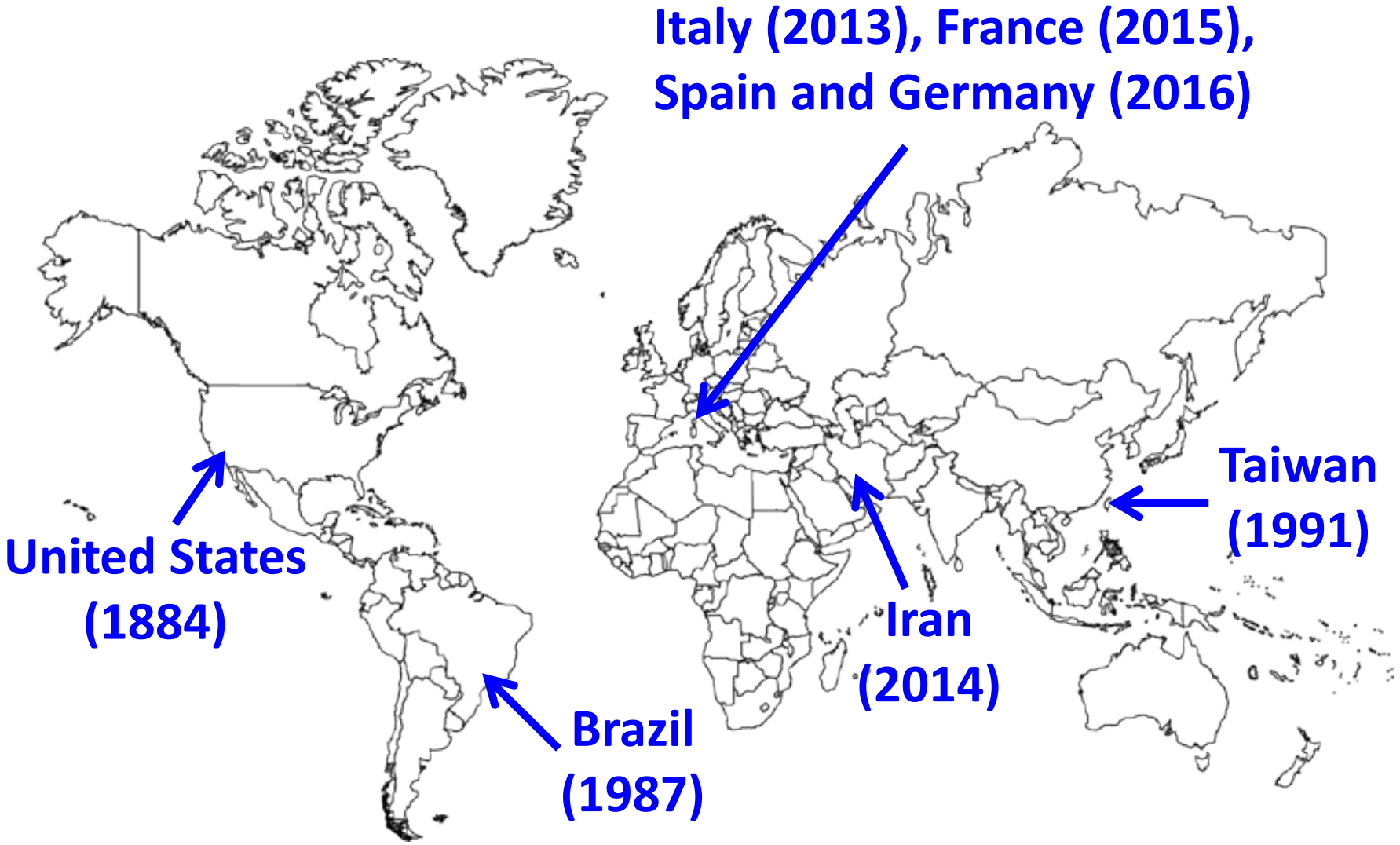
Pierce’s disease costs California US$104 million per year

(Tumber et al. 2014. Calif. Agric. 68, 20-29)

Xylella fastidiosa Wells et al.

Photo: Dennis Margosan, USDA

World Distribution of *Xylella fastidiosa*

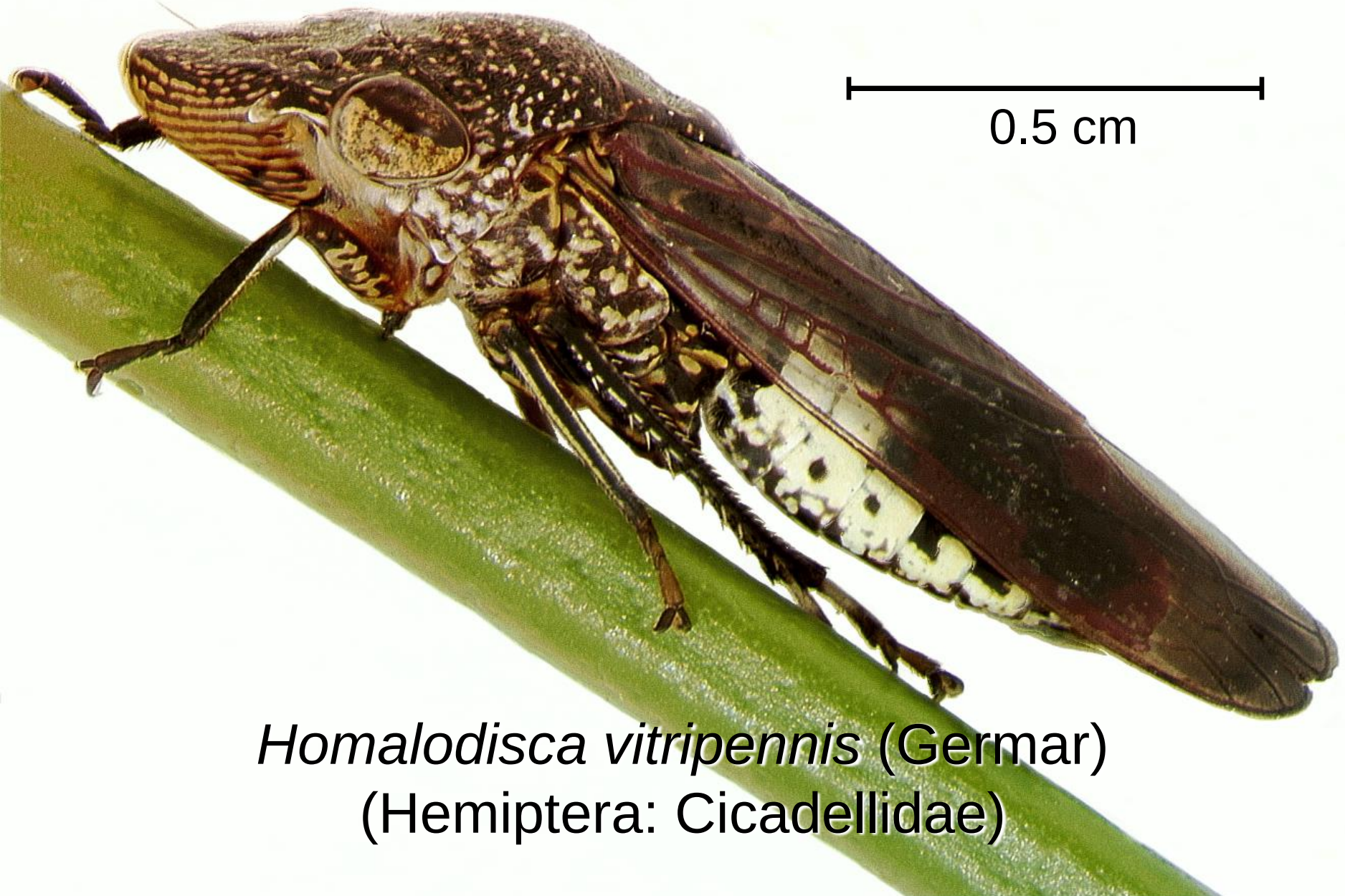


Napa County (North Coast) – Blue-green sharpshooter

Riparian Habitat

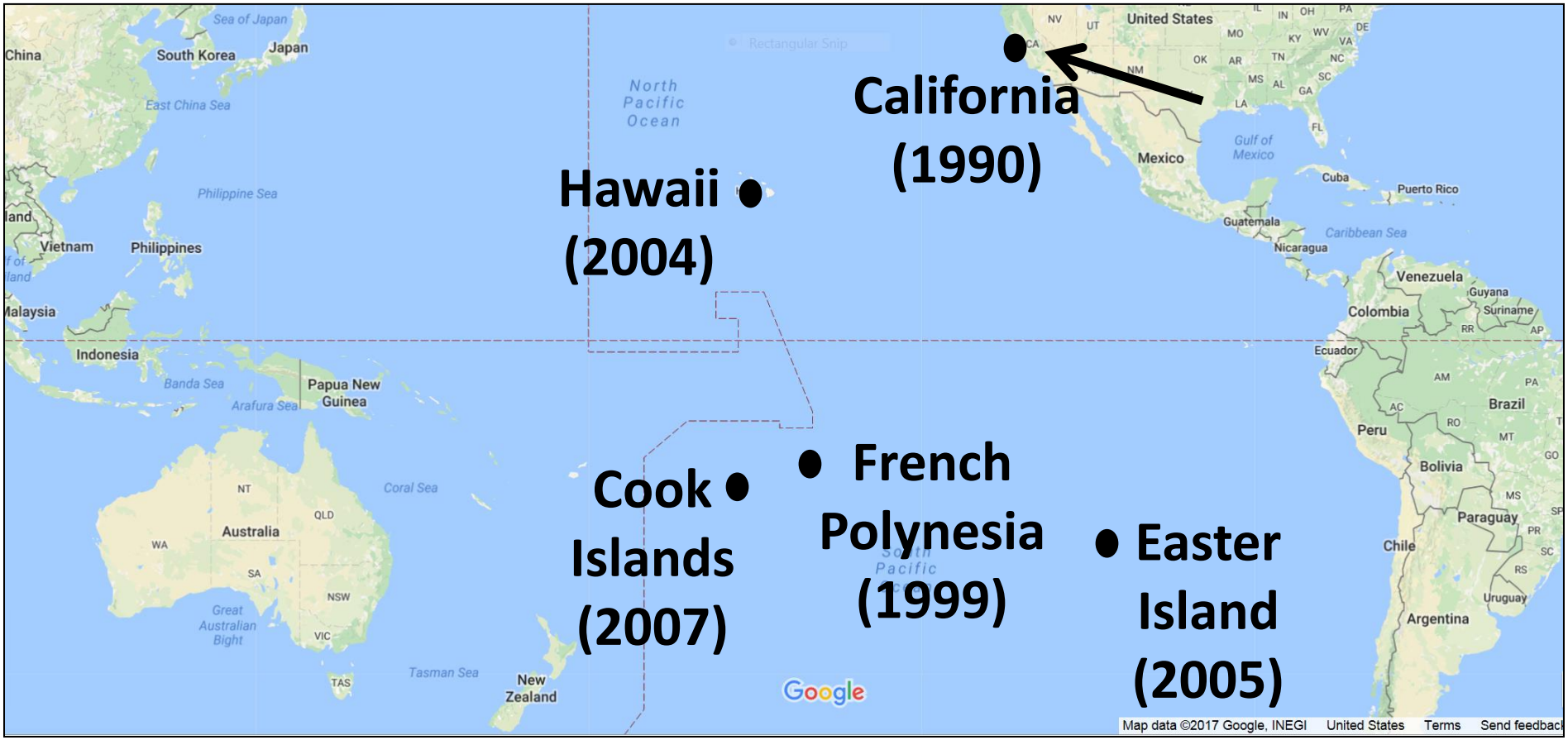
Photo: Jack Clark, UCCE

GLASSY-WINGED SHARPSHOOTER (GWSS)

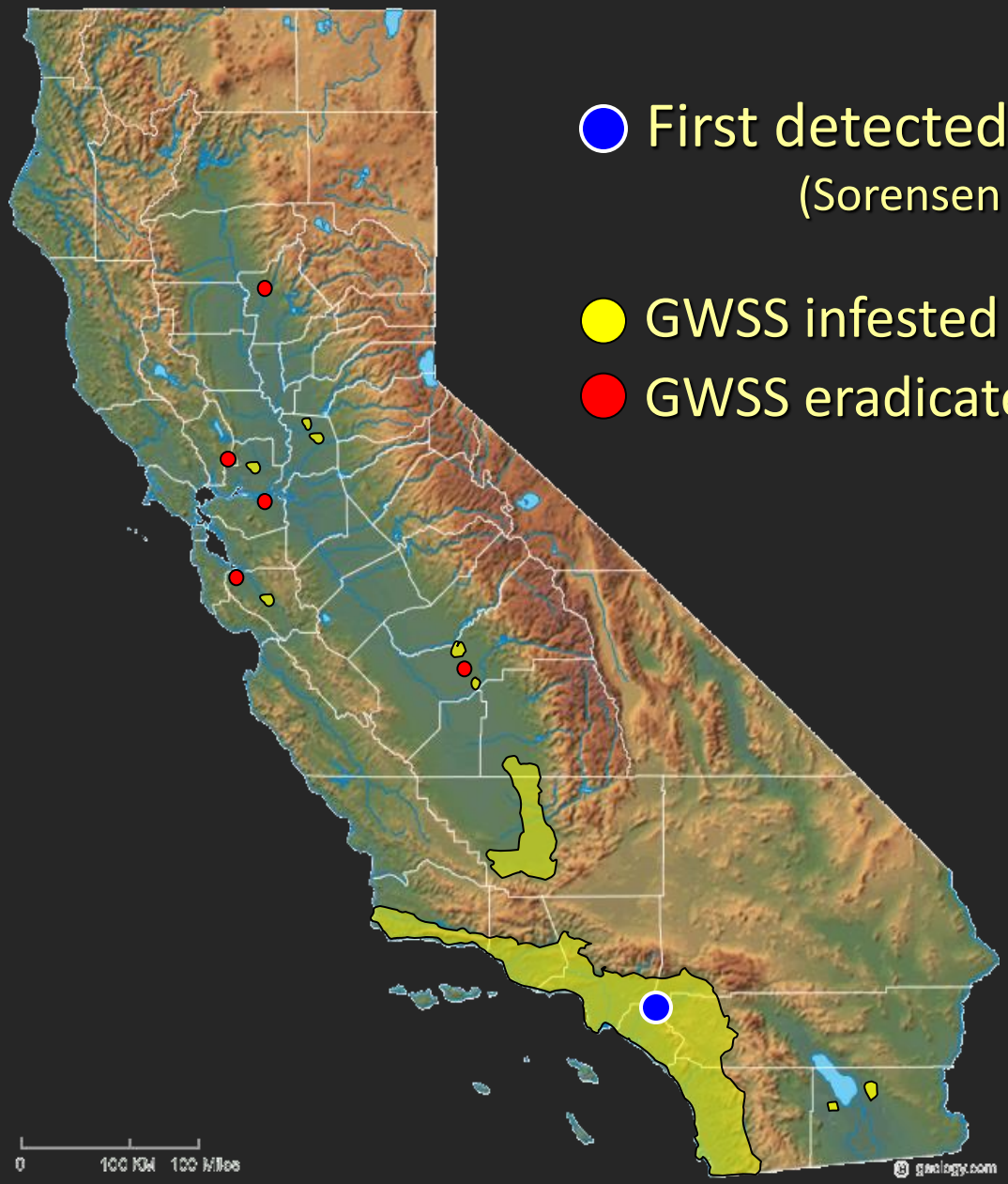


Homalodisca vitripennis (Germar)
(Hemiptera: Cicadellidae)

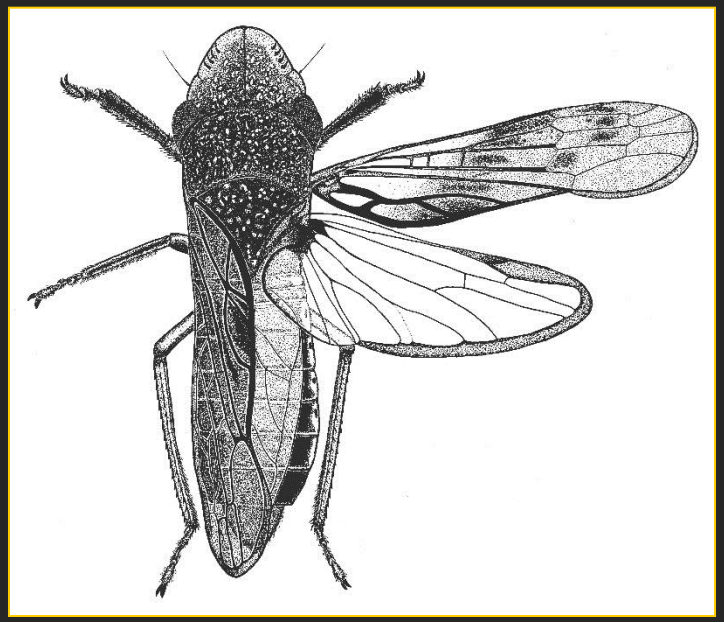
World Distribution of the GWSS



GWSS Distribution in California



- First detected in Irvine in 1990 (Sorensen and Gill 1996)
- GWSS infested area
- GWSS eradicated area (CDFA 2008)



Mymarid egg parasitoids of GWSS

Native

Cosmocomoidea ashmeadi

C. walkerjonesi

Exotic

C. triguttata

C. fasciata

C. morrilli

Anagrus epos

Photos: UC-Riverside, CDFA

GWSS detections by yellow sticky traps in Kern Co. Zone 3 (Southern Central Valley) Jun 21 – July 4, 2015

Tulare County -- Zone 2W
Areawide Management Program
6/21/2015 - 7/4/2015
GWSS per trap (total traps)

no data	(1478)
0	(3607)
1	(23)
2-5	(26)
6-10	(11)
11-25	(4)
26-50	(3)
51-100	(1)
101-150	(0)
151-200	(0)
201-250	(0)
251-300	(0)
over 300	(0)

GWSS regulatory area

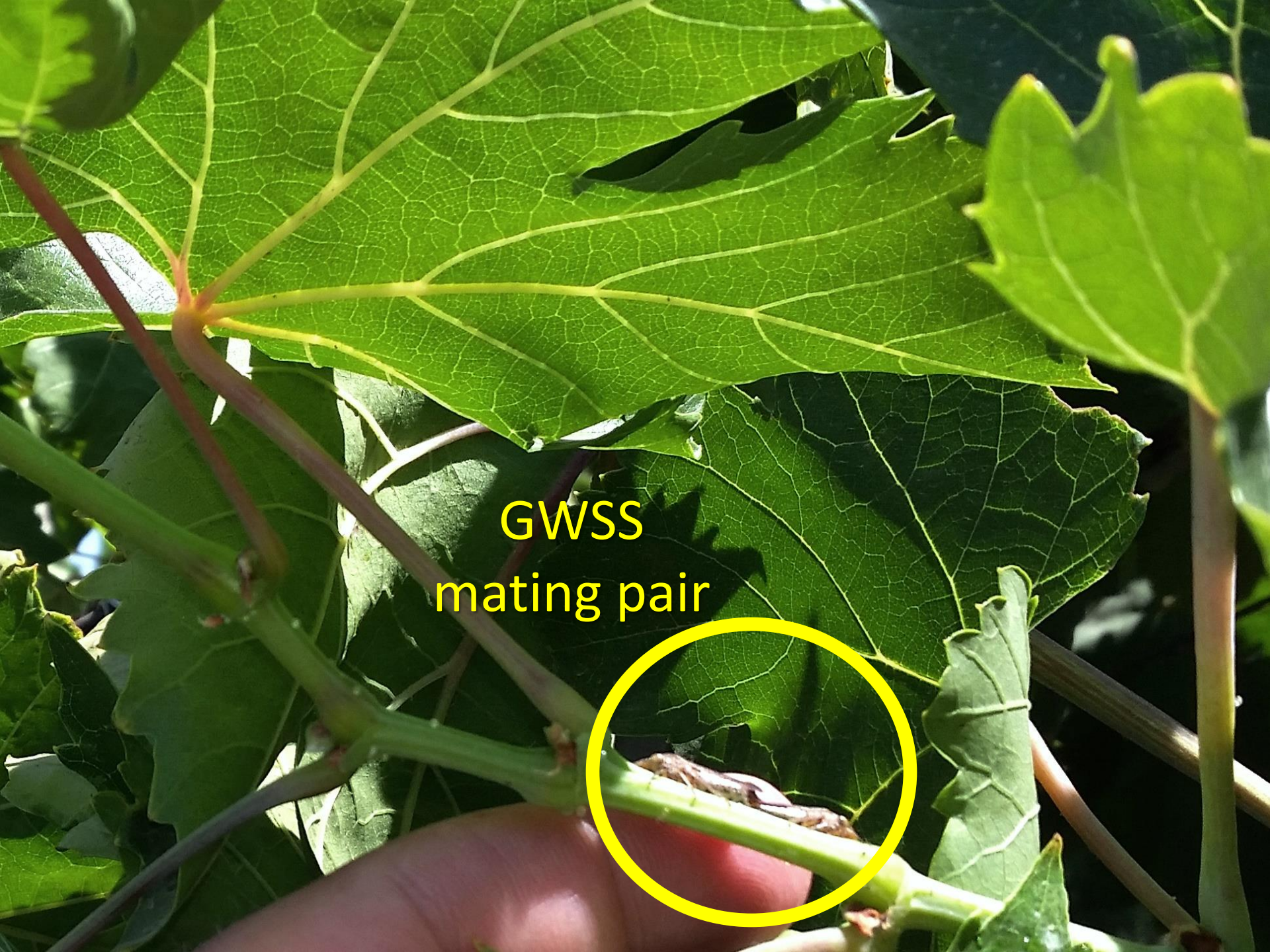
Algoso
Lamont
Arvin
Oil Junction
Cildale
Beale

(CDFA, 2015)

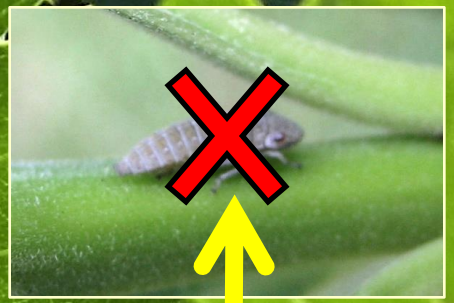
Southern Central Valley, California

Southern Central Valley, California


Change in vector population density
= (birth + immigration) – (death + emigration)

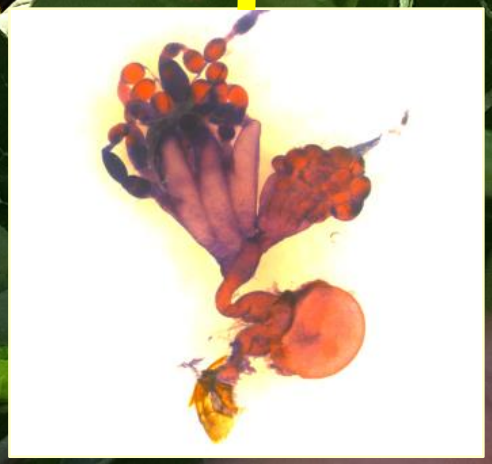

GWSS
mating pair

GWSS Reproduction

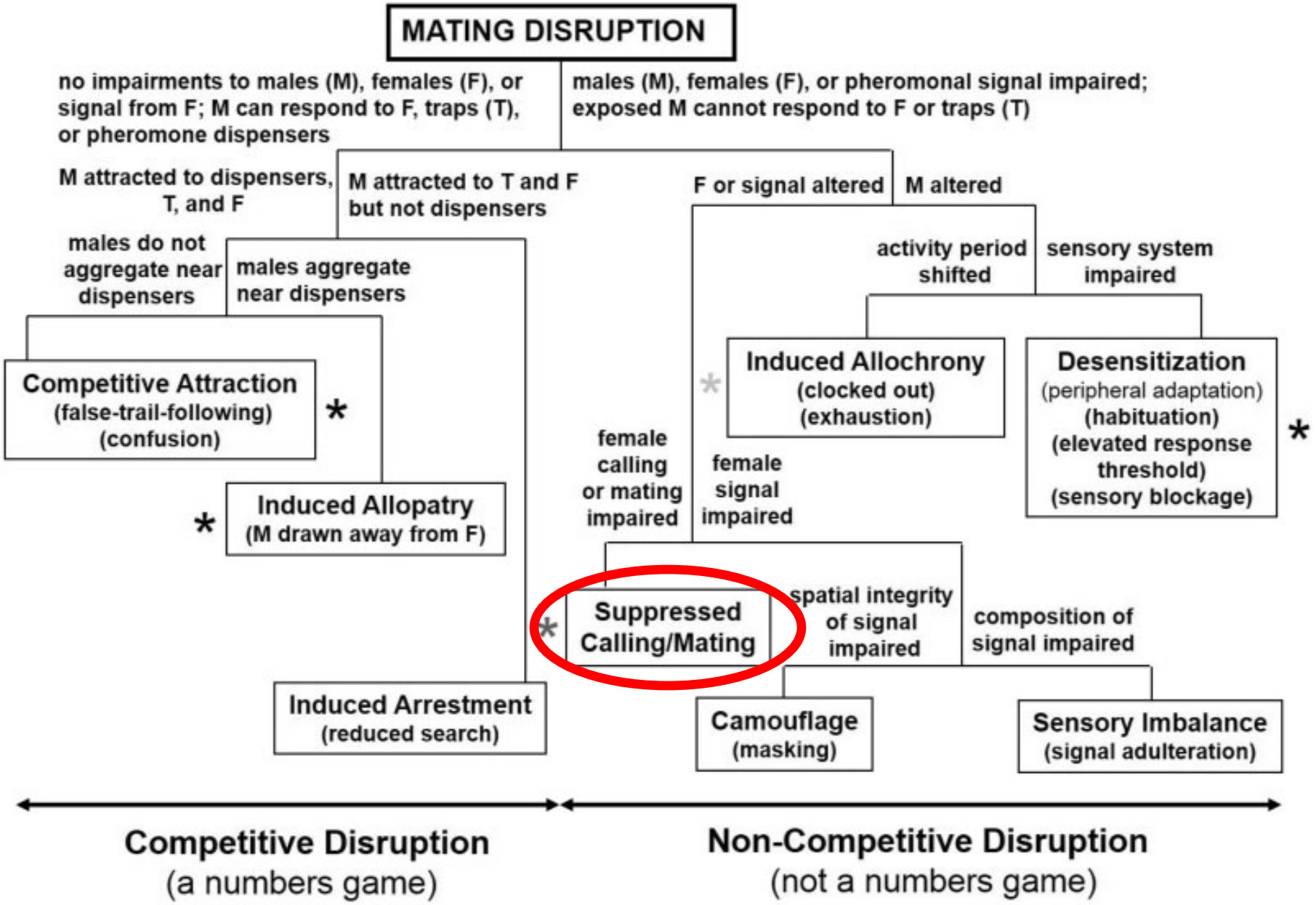


Fertilized eggs

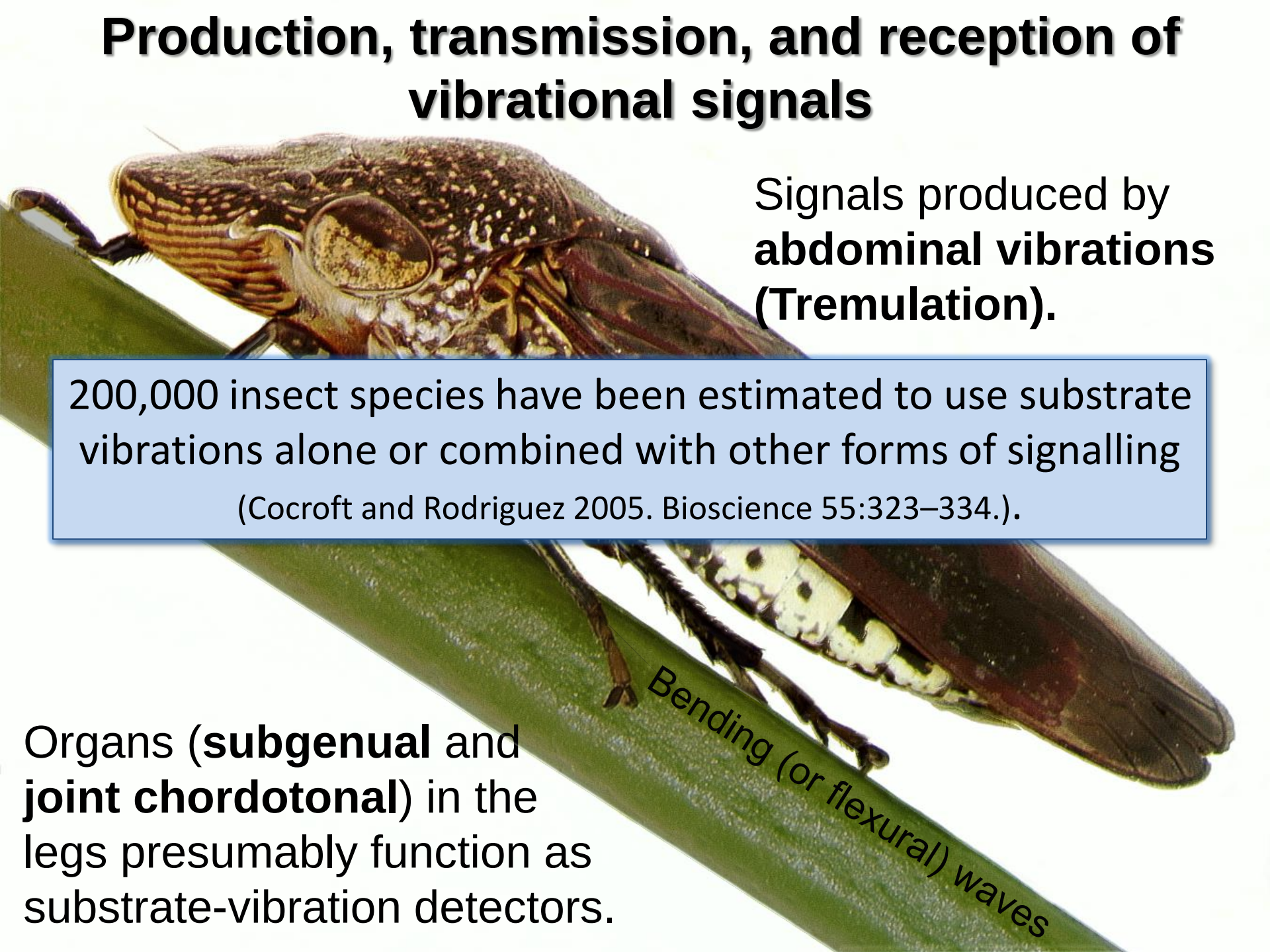
Non-fertilized eggs



Mechanisms of Mating Disruption (Miller and Gut 2015)



Production, transmission, and reception of vibrational signals



Signals produced by **abdominal vibrations (Tremulation).**

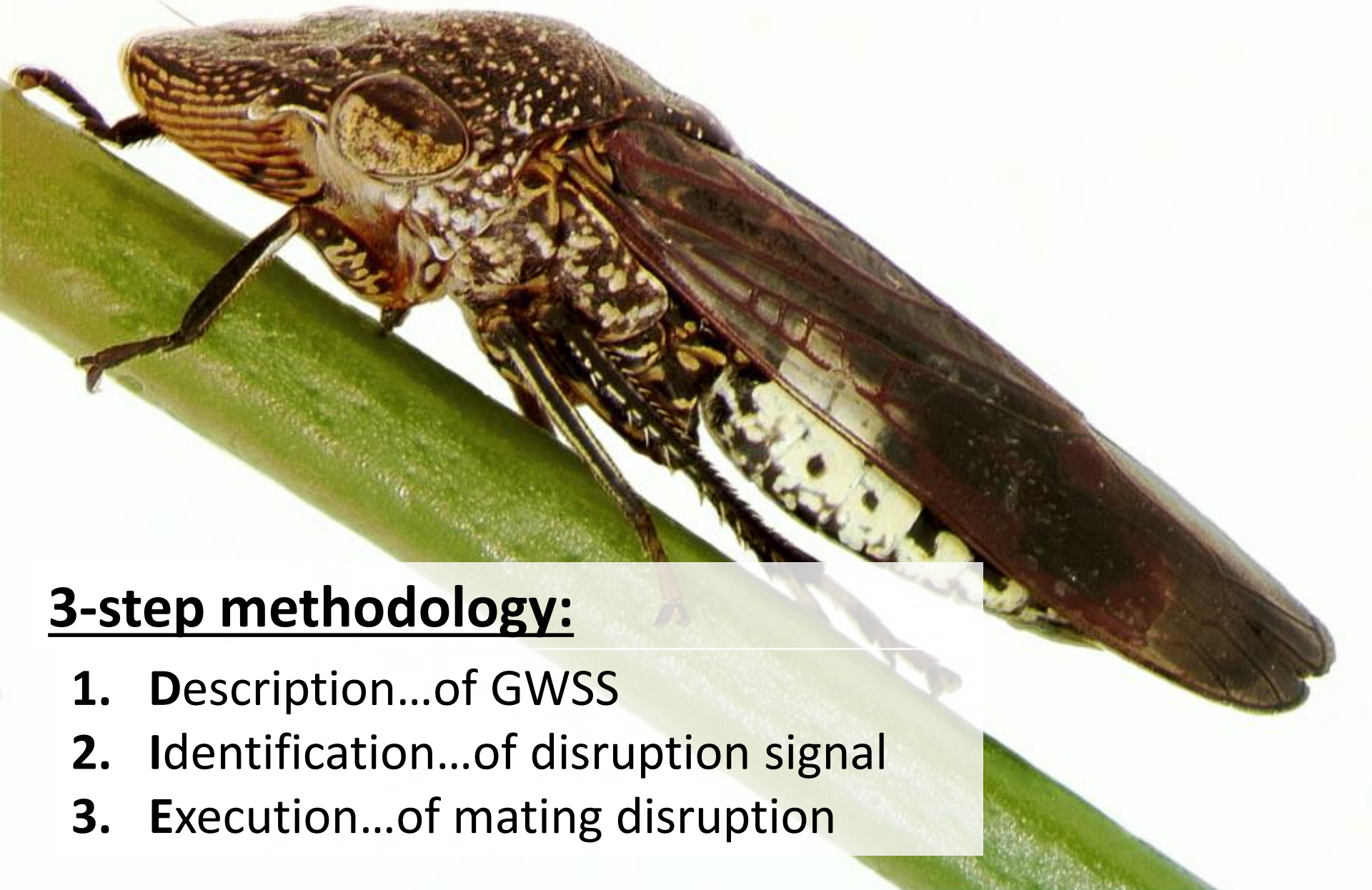
200,000 insect species have been estimated to use substrate vibrations alone or combined with other forms of signalling

(Cocroft and Rodriguez 2005. Bioscience 55:323–334.).

Bending (or flexural) waves

Organs (**subgenual** and **joint chordotonal**) in the legs presumably function as substrate-vibration detectors.

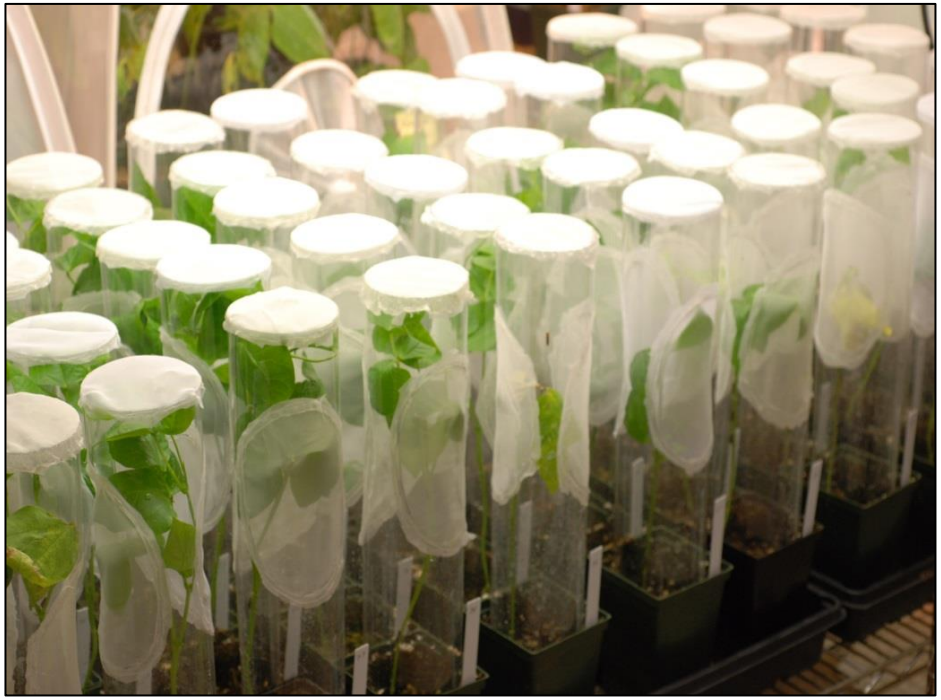
Development of mating disruption methods

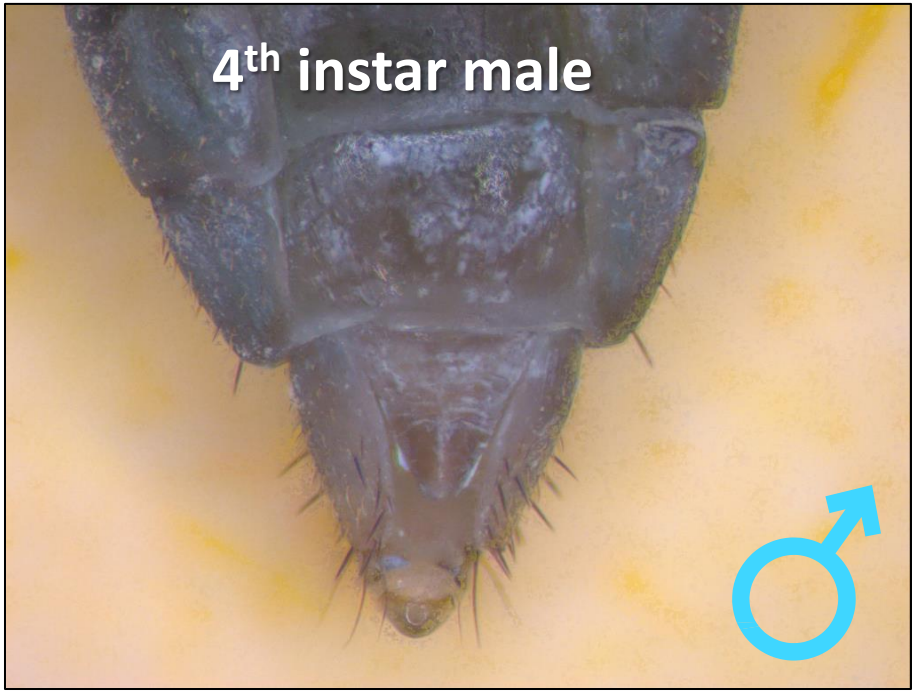


3-step methodology:

1. **D**escription…of GWSS
2. **I**dentification…of disruption signal
3. **E**xecution…of mating disruption


4th instar female

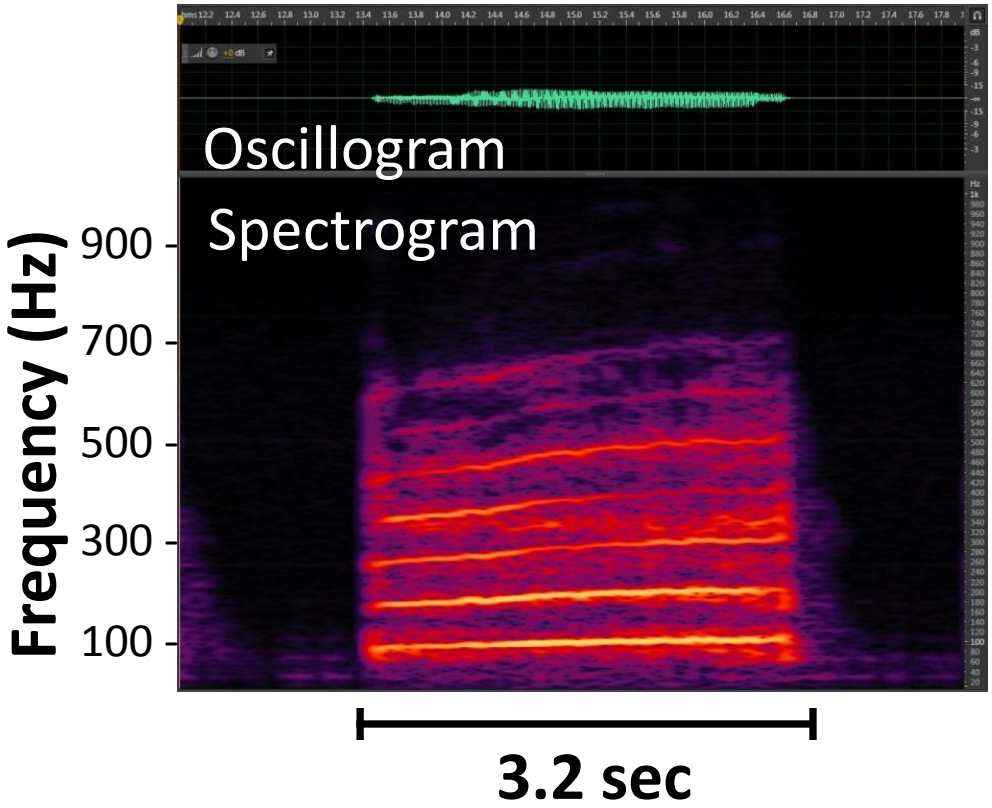



4th instar male

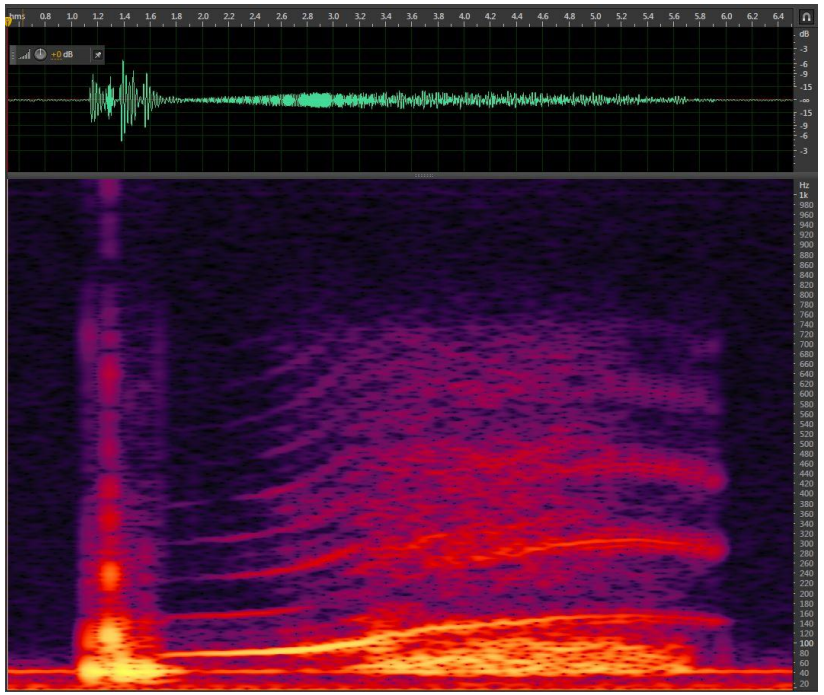

DUET = 1 ♂ + 1 ♀
PLAYBACK
2 MALES + 1 FEMALE

GWSS Signals

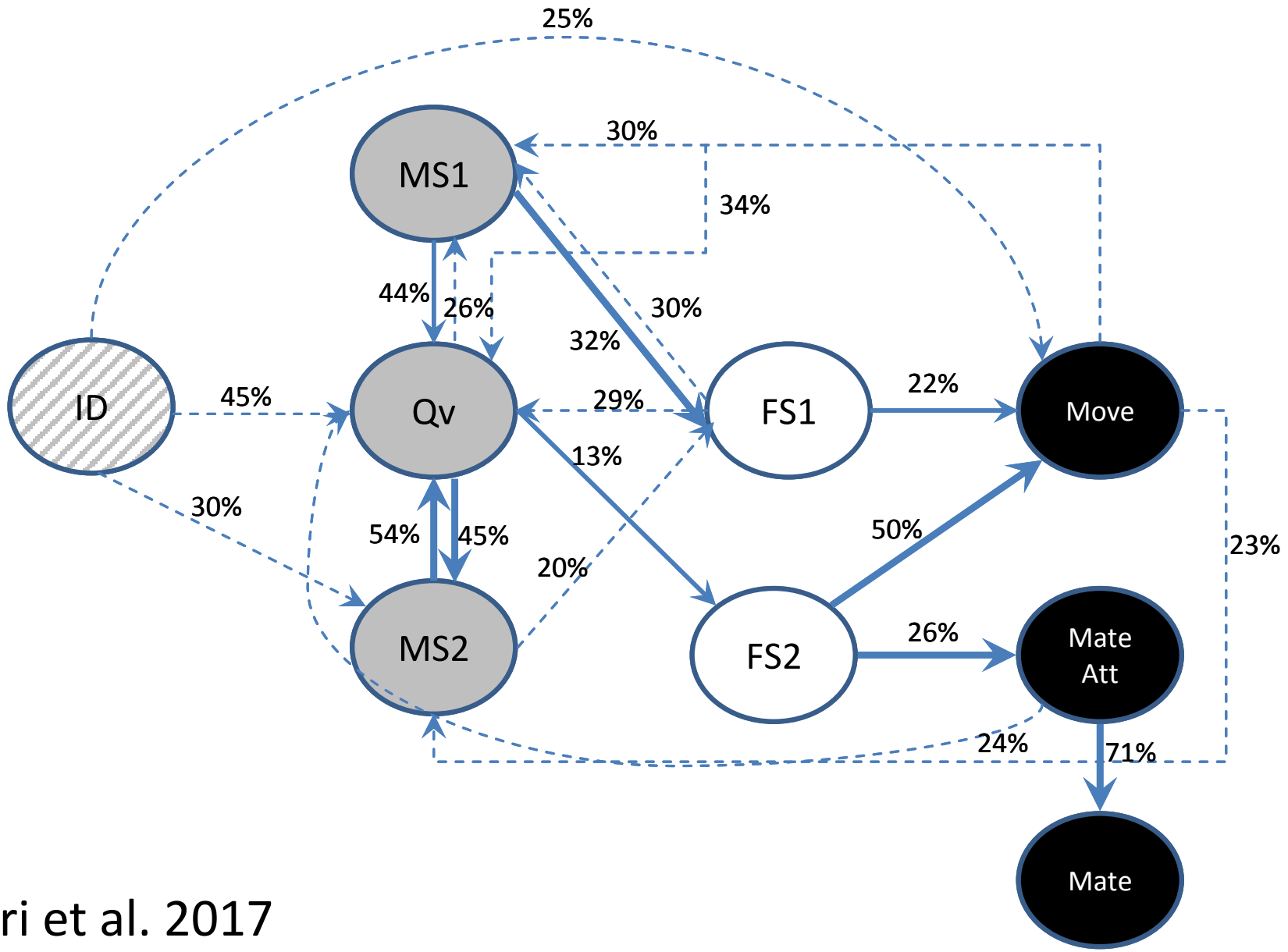
Female



Male

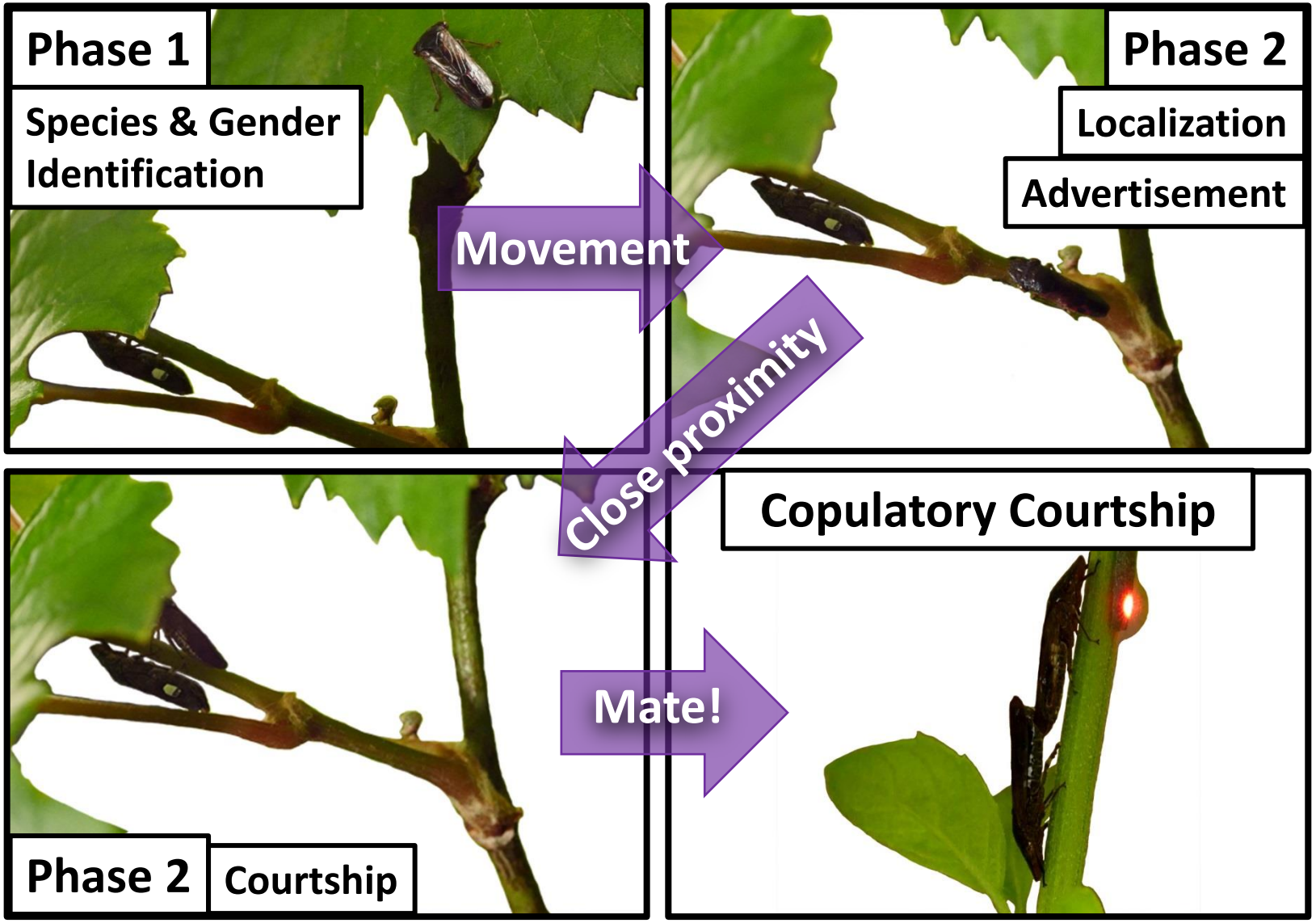


Ethogram of events in GWSS pair formation



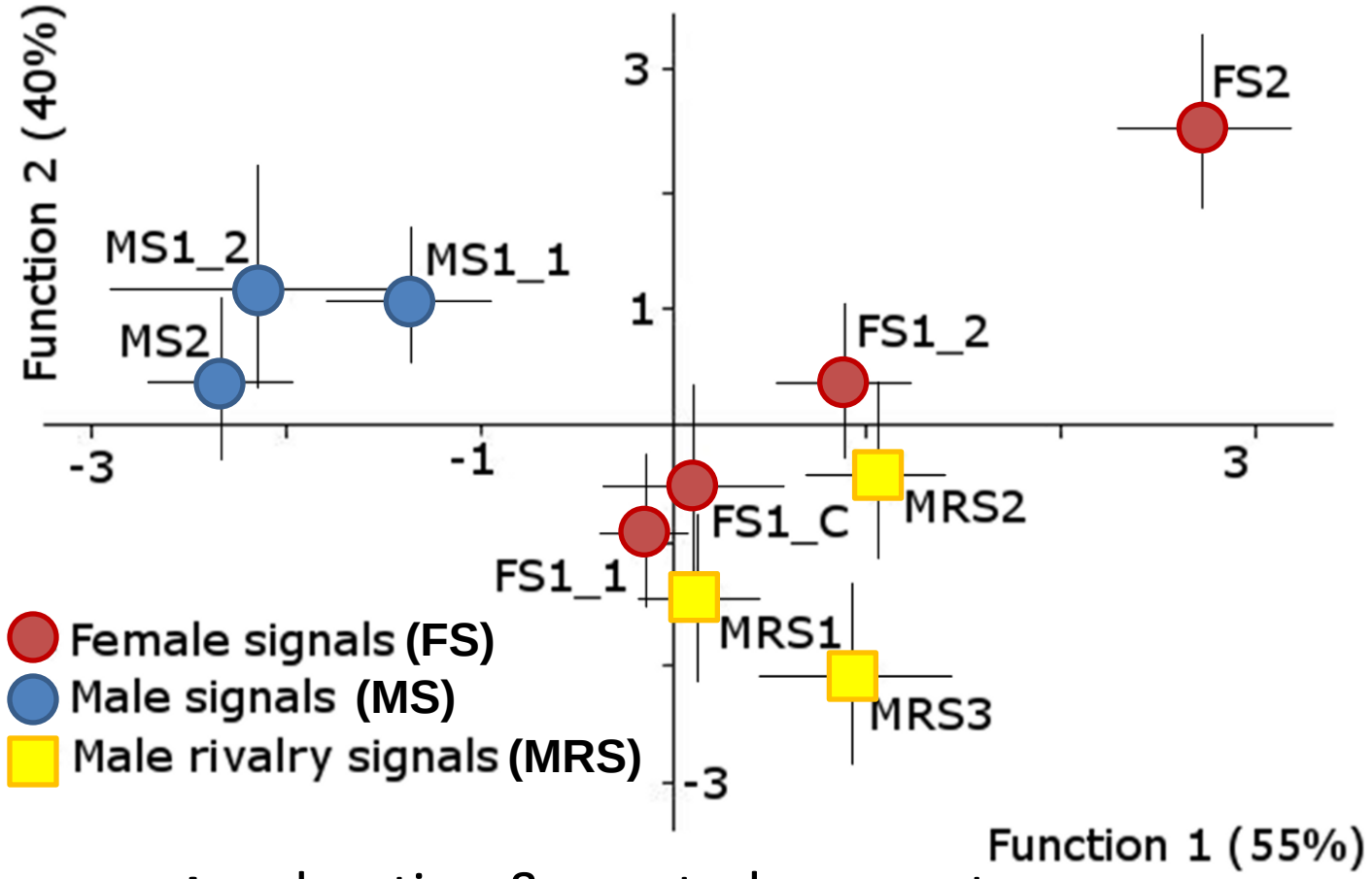
Nieri et al. 2017

Mate Selection Behavior in GWSS



Nieri et al. 2017, Gordon et al. manuscript in preparation.

GWSS Communication: 1. Description

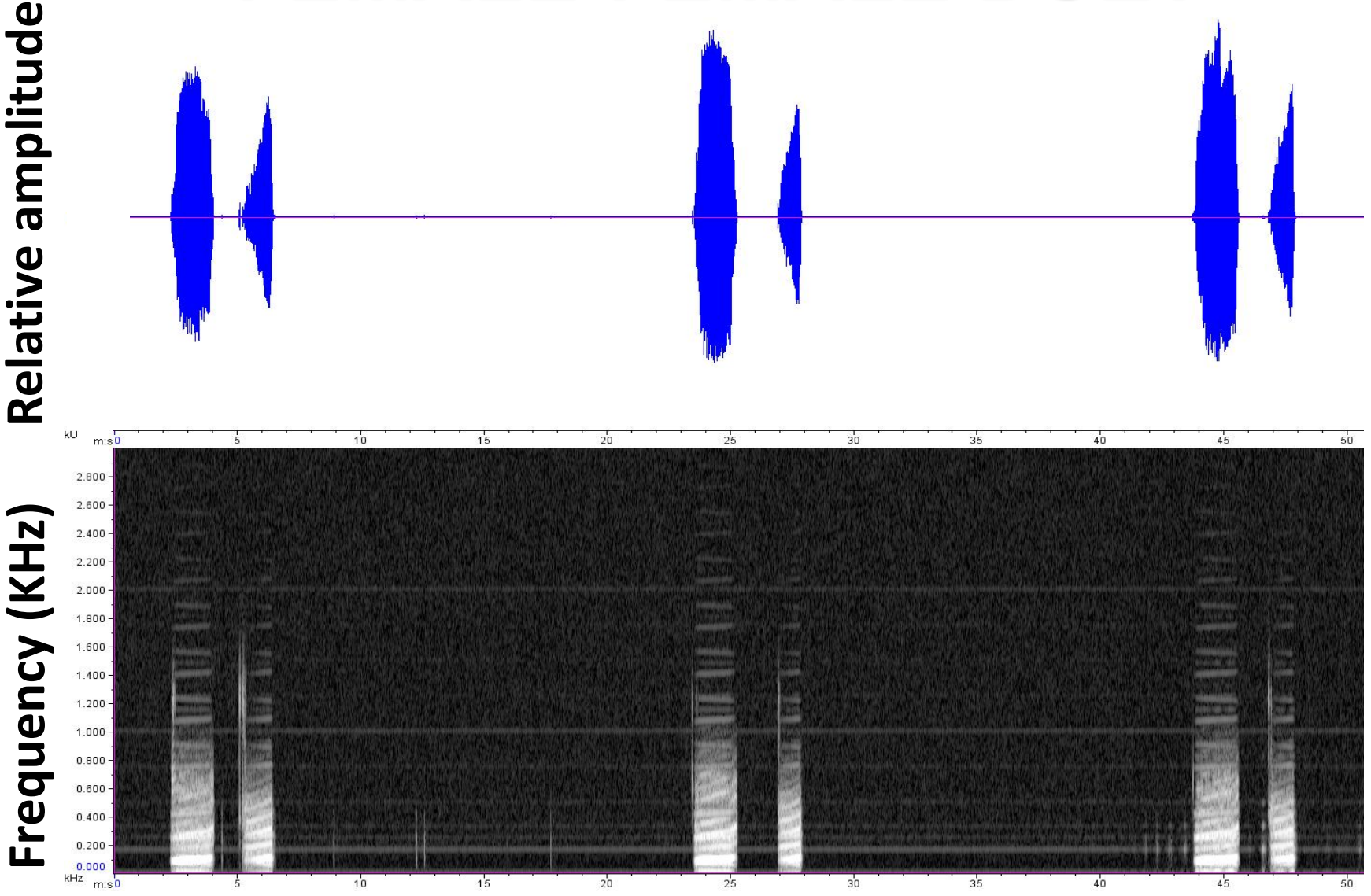


Measurements: duration & spectral parameters
(base frequency, change of frequency within a signal, etc.)

Nieri et al. 2017

GWSS male-male rivalry

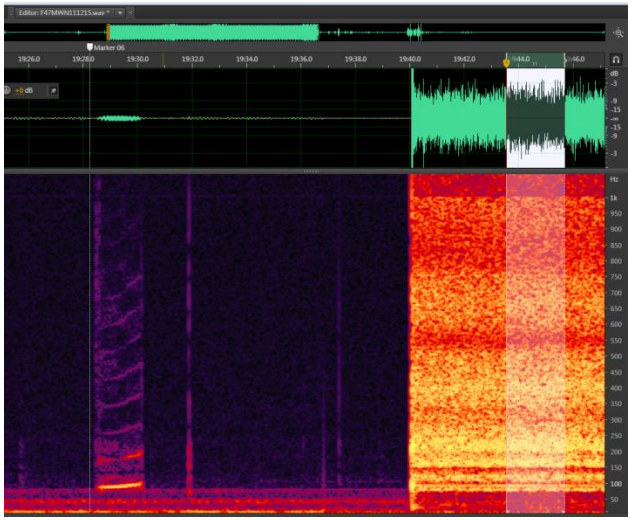
FEMALE-FEMALE DUET

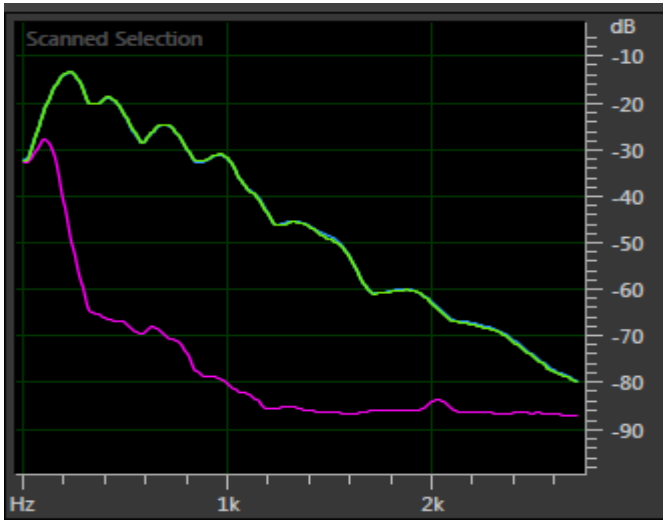


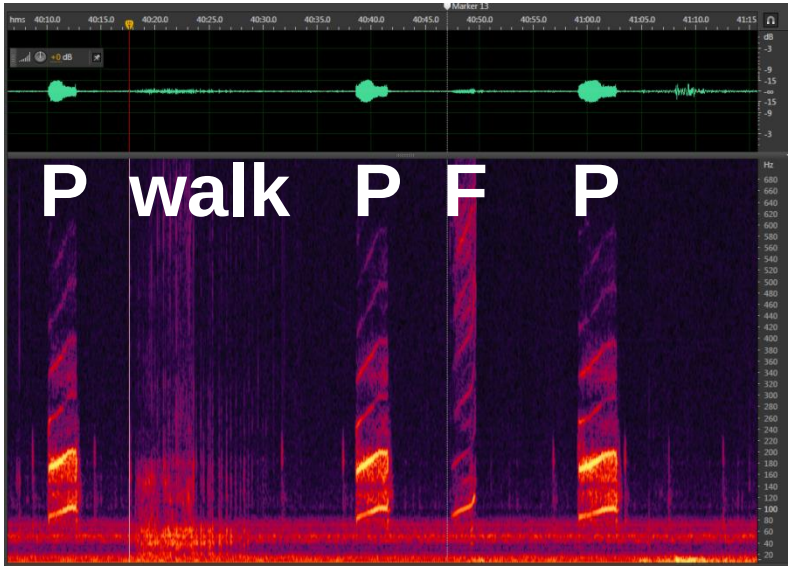
GWSS Communication: 2. Identification

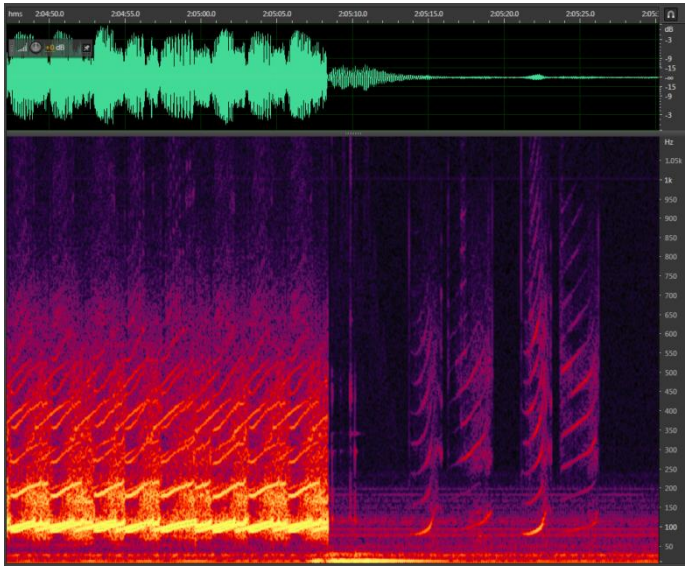
Signals

- White noise
- Female noise
- Female signals

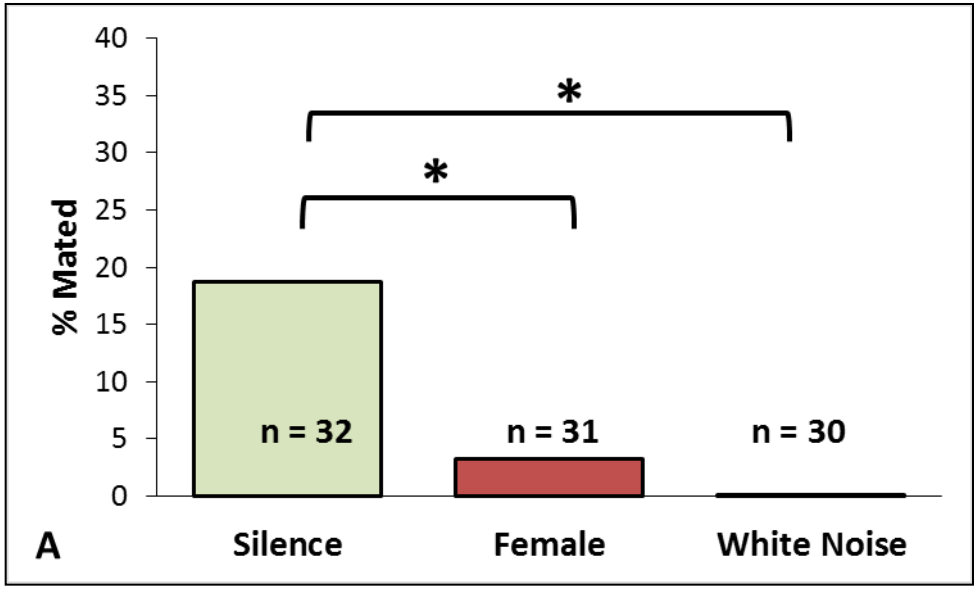


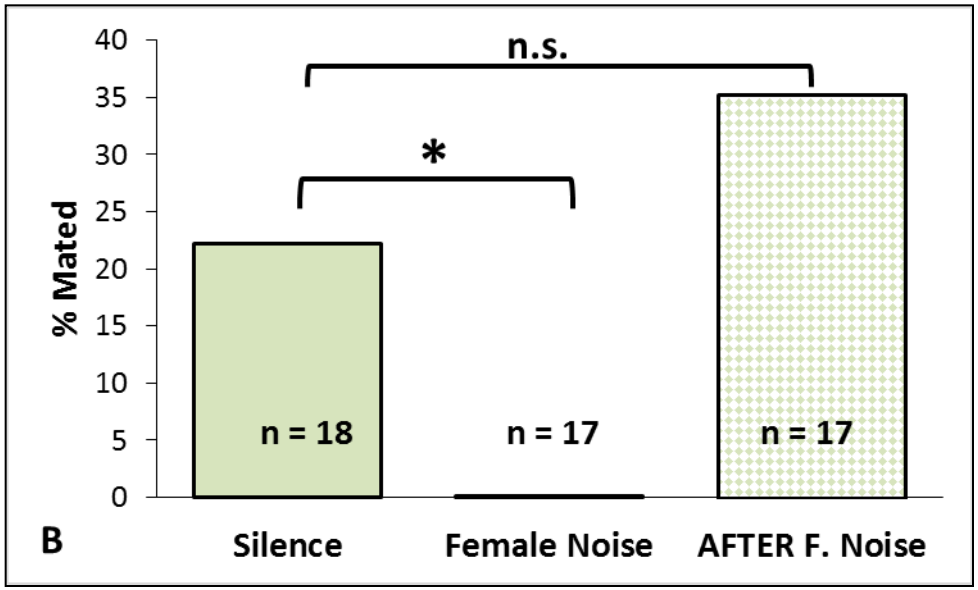






GWSS Communication: 2. Identification



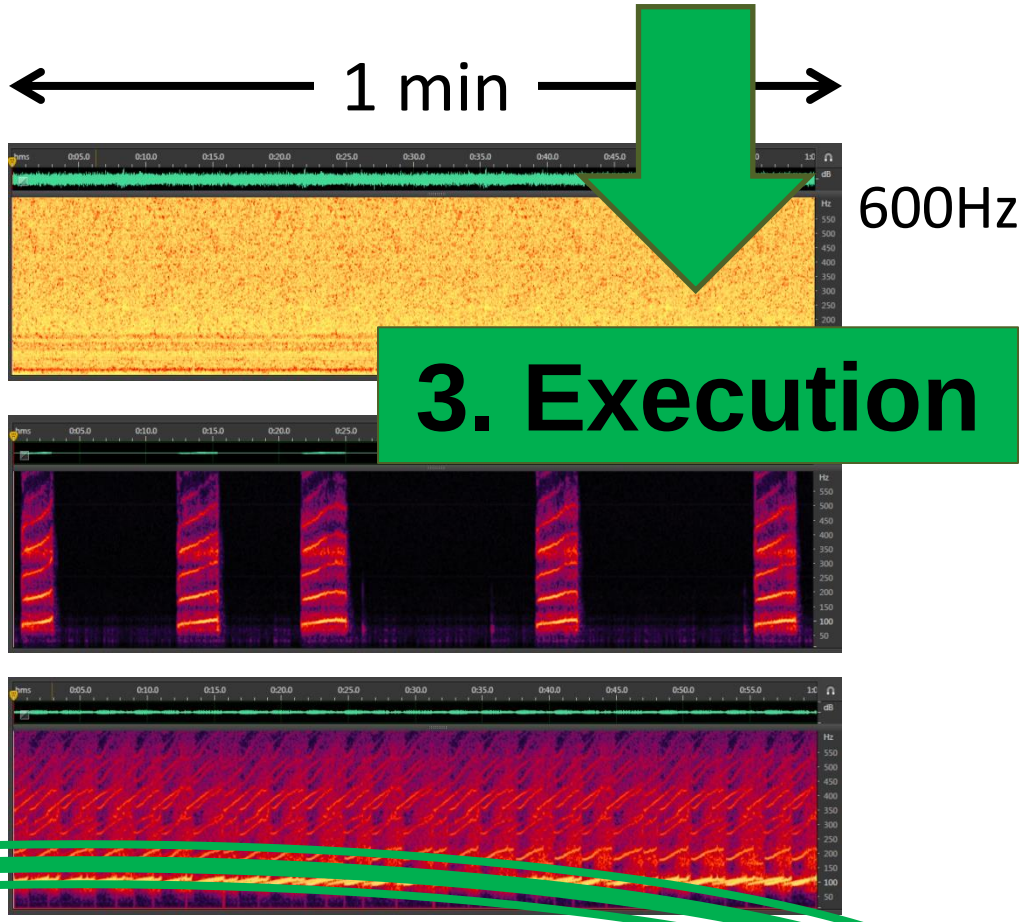


Gordon et al. 2017

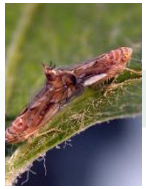
GWSS Communication: 2. Identification

Signals

- White Noise
  - ✓ → High Energy
- Female Signals
  - ✓ → 3% mated
- Female Noise
  - ✓ → High-ish Energy

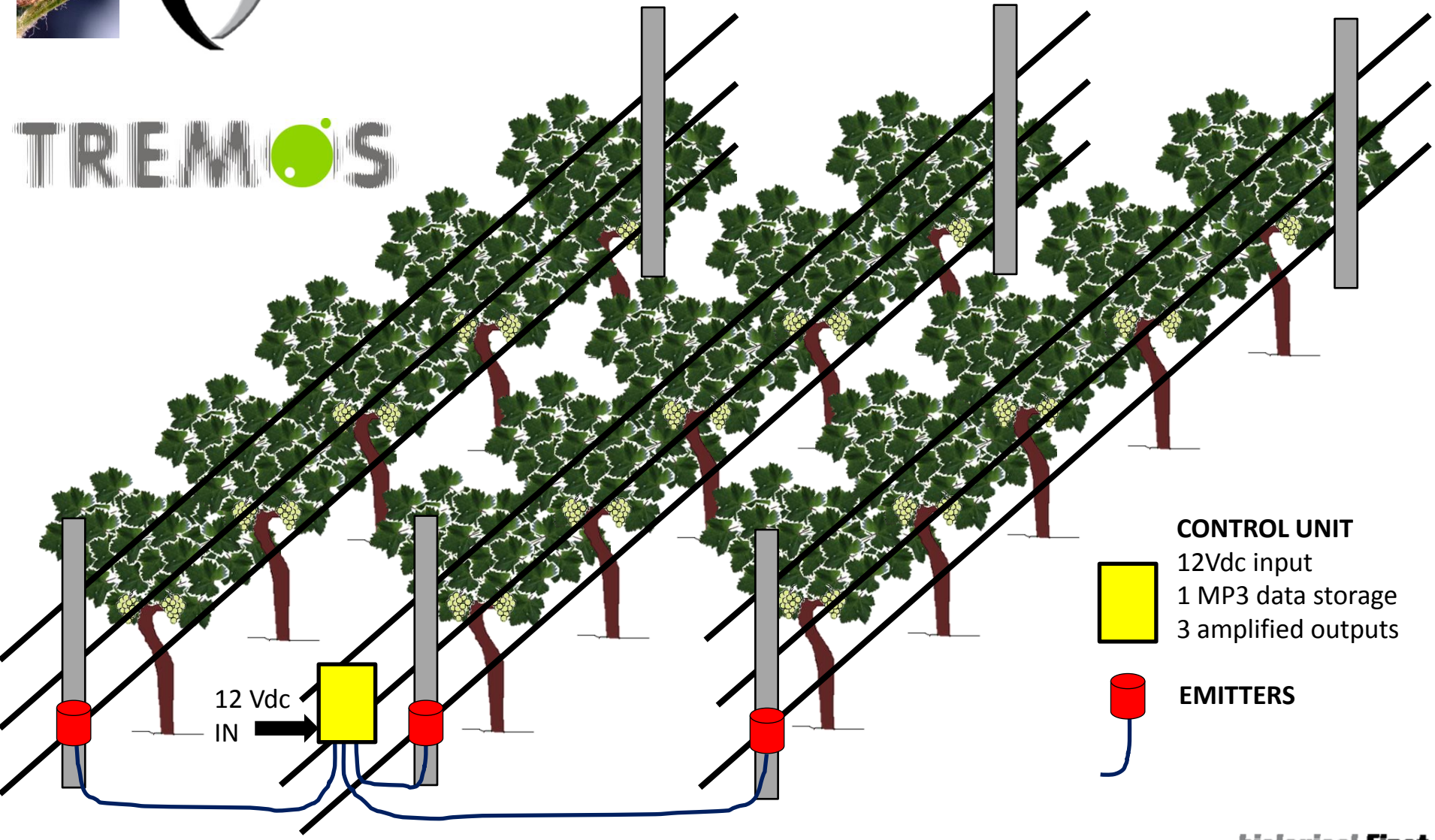


- Female signals with reduced gap between calls.



V2.0 TREMOS Field concept

TREMOS



biological First.

Slide provided by Vittorio Veronelli

GWSS Communication: 3. Execution

GWSS Communication: 3. Execution

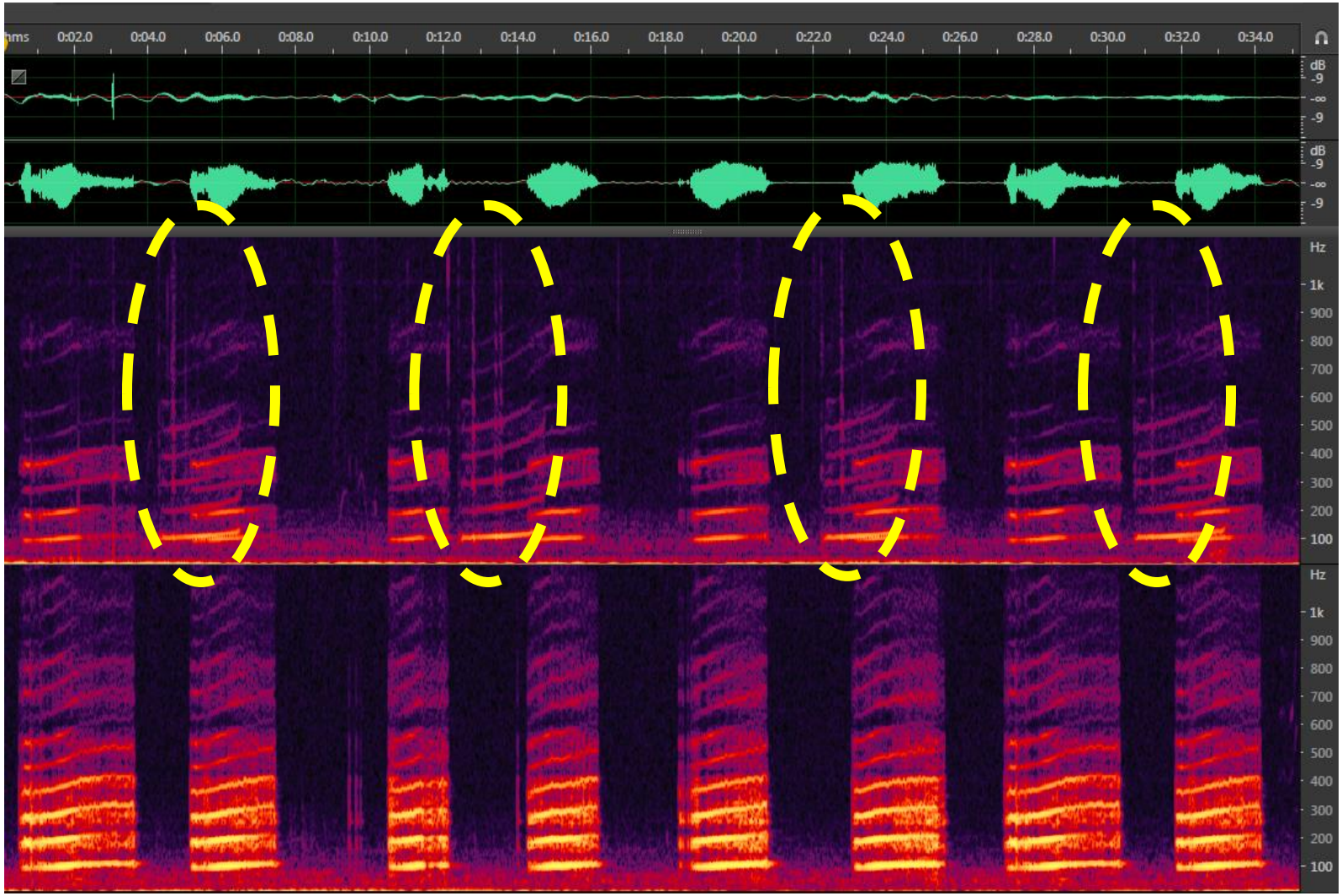
Signal output measured at:

- Wire
- Cane touching wire
- Cane not touching wire
- Trunk
- Cane with insects

GWSS Communication: 3. Execution

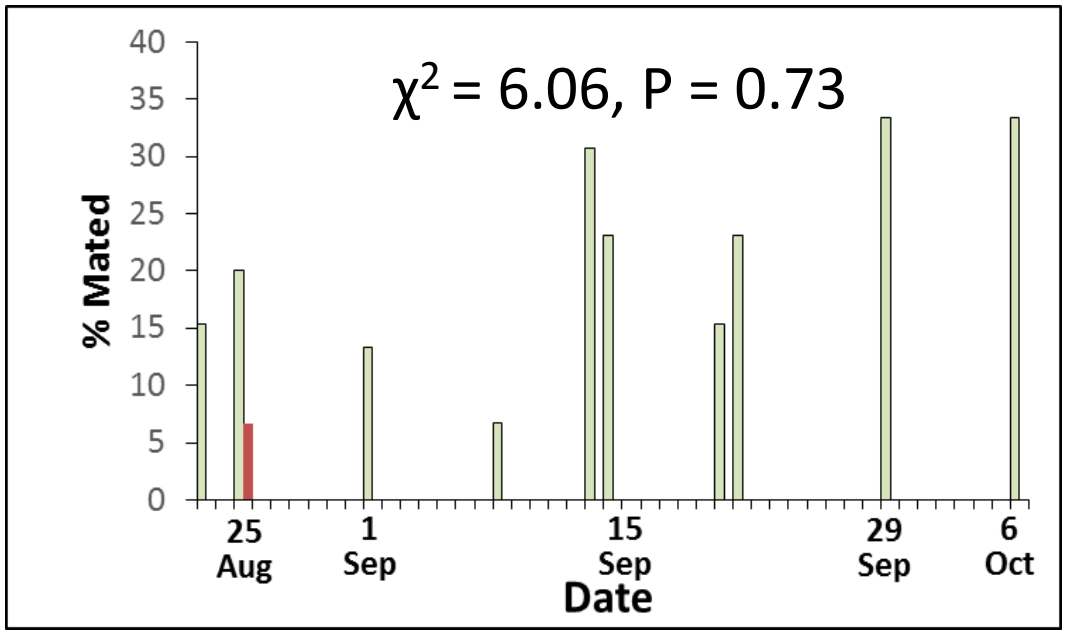
S-3
(~9 m)

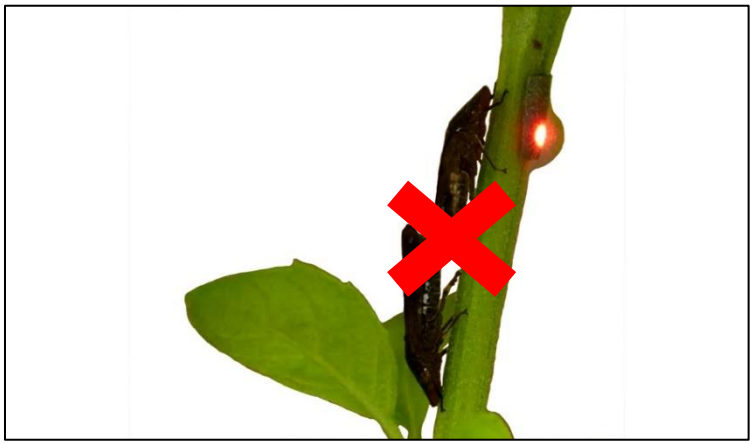
Vine at
emitter



GWSS Communication: 3. Execution

Female signal Silent (control)





TREATMENT	Number of insect pairs	Number of mated pairs	Mean percentage of mated pairs
Silence	134	28	21.5
F26s	134	1	0.6

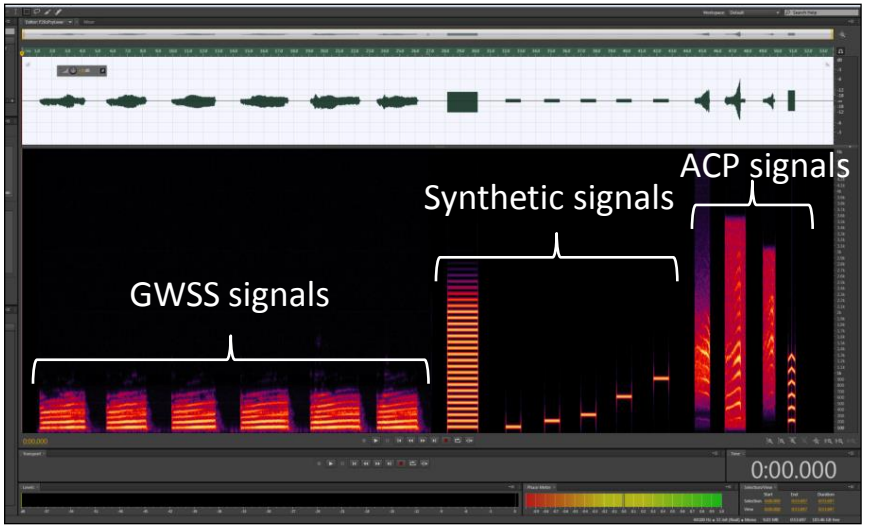
($\chi^2 = 35.15$, P < 0.0001)

GWSS Communication: 3. Execution

Next Steps

- Distance
- Energy
- Vineyard trellis
- Other crops
- Other pests

Vibrational control of GWSS and ACP in citrus orchards



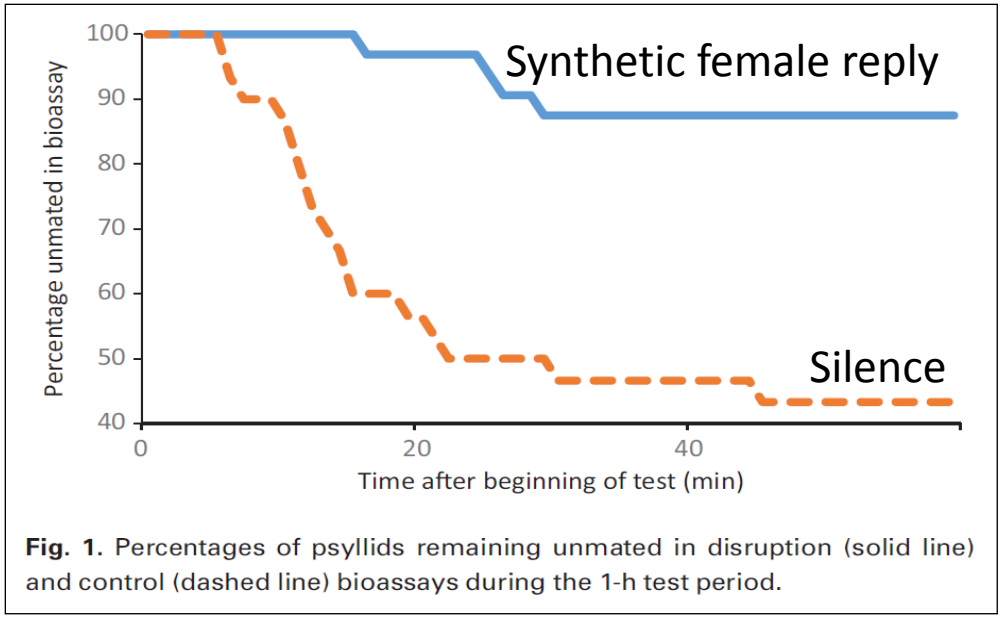


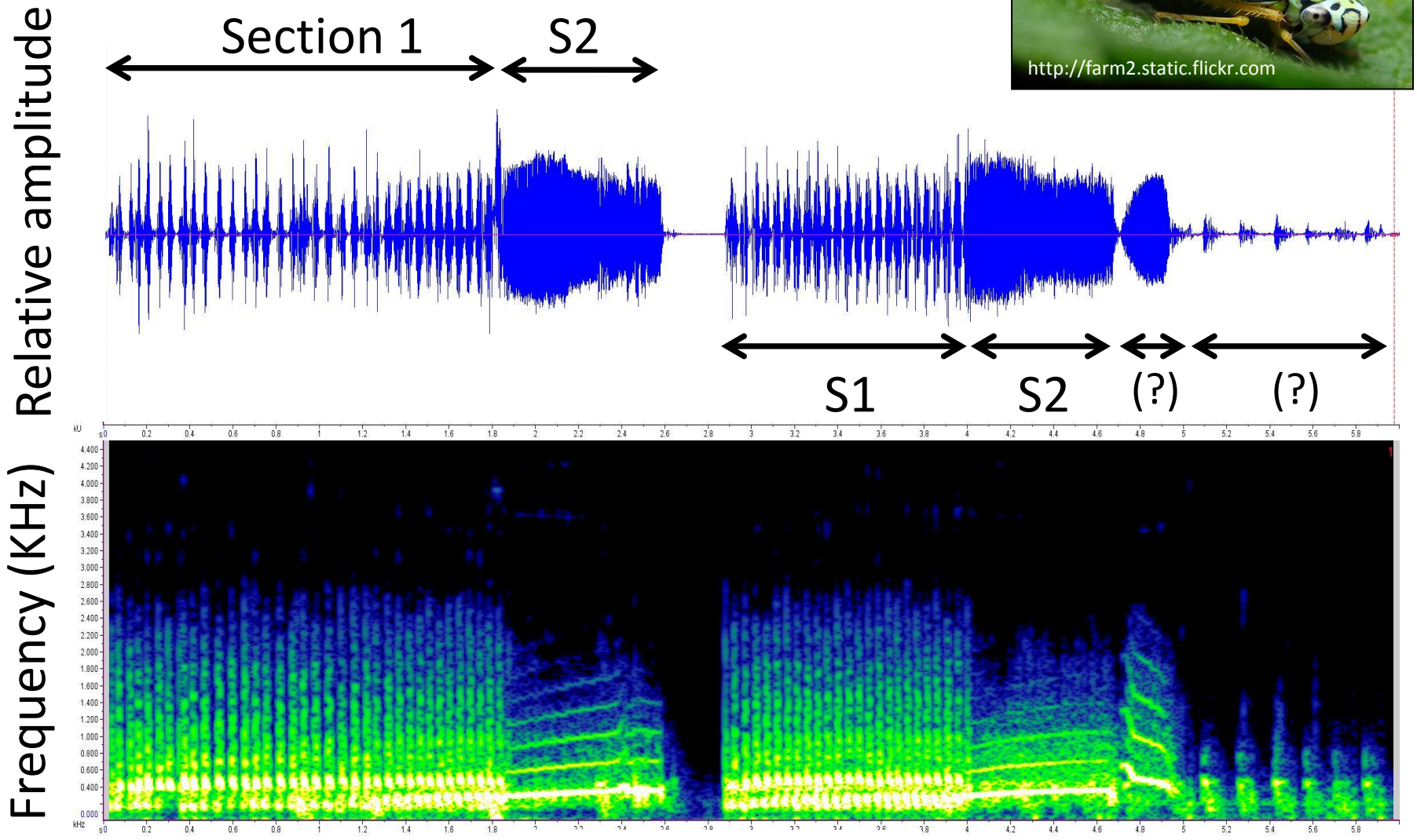
Fig. 1. Percentages of psyllids remaining unmated in disruption (solid line) and control (dashed line) bioassays during the 1-h test period.

(Lujo et al., 2016. J. Econ. Entomol. 109: 2373-2379)

FUTURE WORK:
Identify disruptive signals for other grapevine pests

Blue-green sharpshooter

Graphocephala atropunctata (Signoret)



Summary

- Mating communication of many grapevine pests rely heavily on the exchange of substrate-borne vibrational signals.
- GWSS mating communication signals were described for identification of candidate disruptive signals.
- Disruptive potential of candidate vibrational signals demonstrated in laboratory and validated under field conditions.
- Data support development of vibrational mating disruption as a novel method to control GWSS populations.

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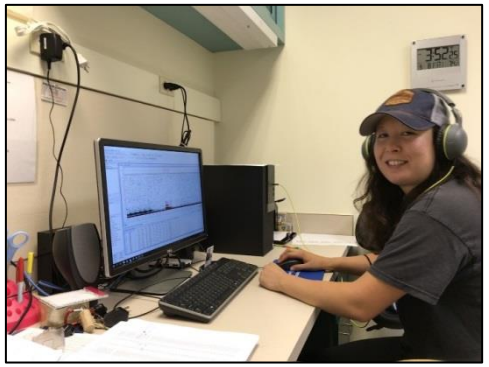

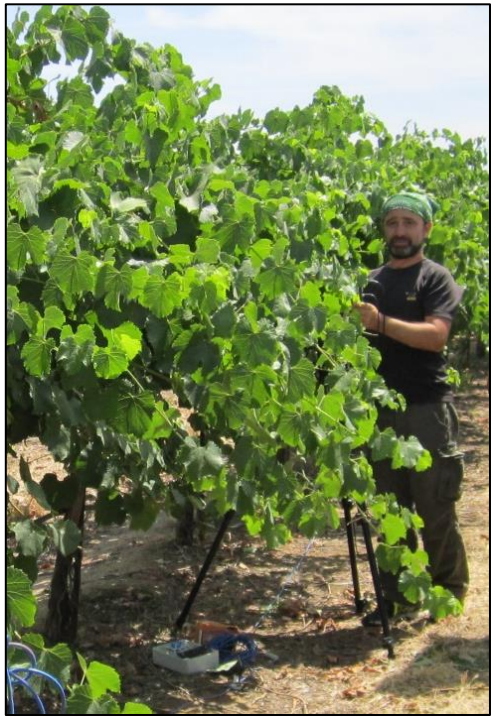

Project title: Identification of Novel Management Strategies for Key Pests and Pathogens of Grapevine with Emphasis on the *Xylella fastidiosa* (*Xf*) Pathosystem. **Project #** 2034-22000-012-00D

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