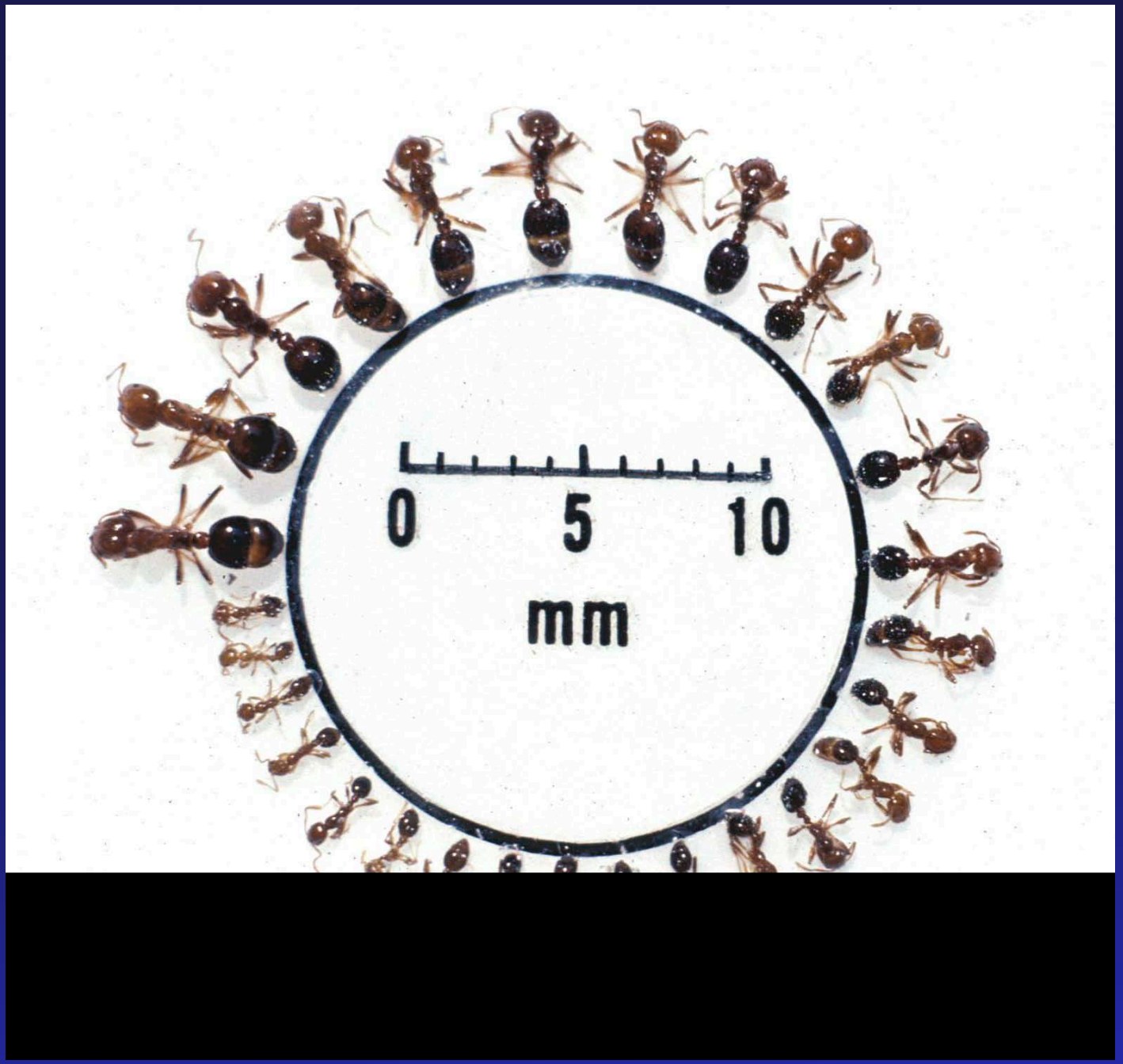
Release and Establishment of Phorid Decapitating Flies for Fire Ant Biocontrol

Sanford D. Porter

USDA-ARS, CMAVE, Gainesville, FL, USA

Red Imported Fire Ant

Solenopsis invicta


0
5
10
mm

Accidentally introduced in the 1930s

Recently found in Australia, Mainland China, Taiwan, Hong Kong, New Zealand

The problem with imported fire ants is that there are so many of them.

Monogyne Populations

Polygyne Populations

Mean fire ant density in Florida Pastures

Measure	Mongyne	Polygyne
Workers	1,500/yd^2	3,000/yd^2
	7 million/acre	14 million/acre
Biomass	13 lb/acre	25 lb/acre

Macom & Porter1996

4-8 Tons of Fire Ants per Mile^2

Negative Impacts

1. Agricultural Crops & Livestock
2. Electrical Equipment
3. Human Health
4. Native Animals

Several Billion US Dollars

of Damage Each Year . . .

. . . Not Counting Damage

to the Environment

Ecological

Rare & Endangered Animals

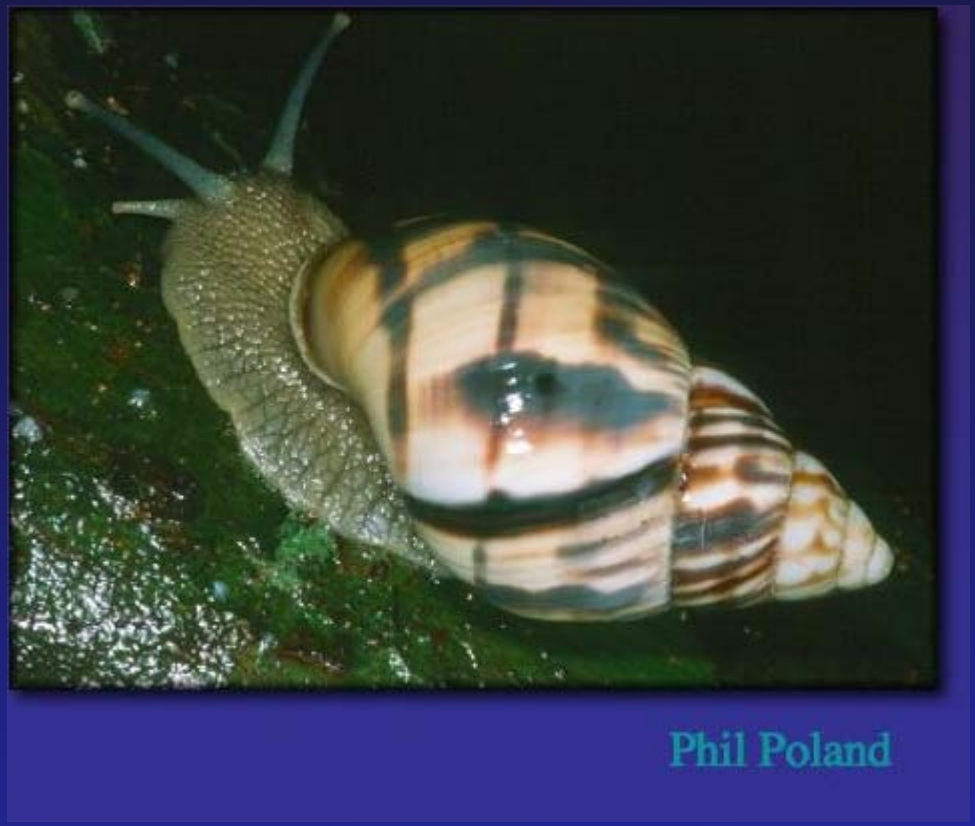
- Least Tern
- Stock Island Tree Snail
- Texas Cave Arthropods
- Schaus Swallowtail Butterflies
- Sea Turtles
- Gopher Tortoises
- Houston Toad

Rare & Endangered Animals

- Least Tern

Rare & Endangered Animals

- Stock Island
  Tree Snail



Rare & Endangered Animals

- Texas Cave Arthropods

Rare & Endangered Animals

- Schaus Swallowtail Butterflies

Rare & Endangered Animals

- Sea Turtles

Rare & Endangered Animals

- Gopher Tortoises

Rare & Endangered Animals

- Houston Toad

Population Level Impacts

- Bobwhite Quail
- Whitetail Deer
- Horned Lizards
- King Snakes
- Waterbird Rookeries
- Native Ants

Population Level Impacts

- Bobwhite Quail

Population Level Impacts

- Whitetail Deer

Population Level Impacts

- Horned Lizards

Population Level Impacts

- King Snakes

Mike Monlezun

Population Level Impacts

- Waterbird Rookeries

Population Level Impacts

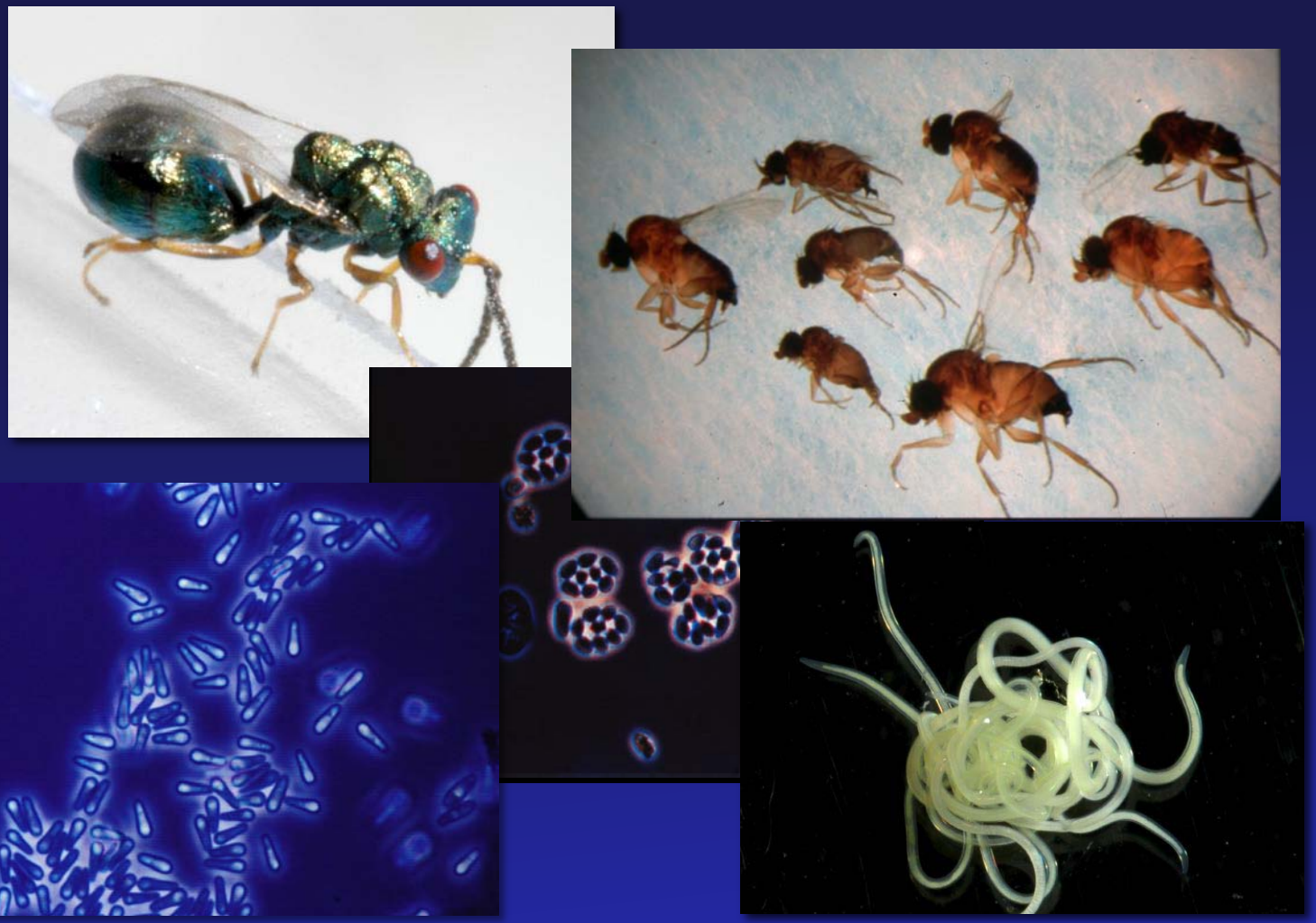
- Native Ants

Chemical Control

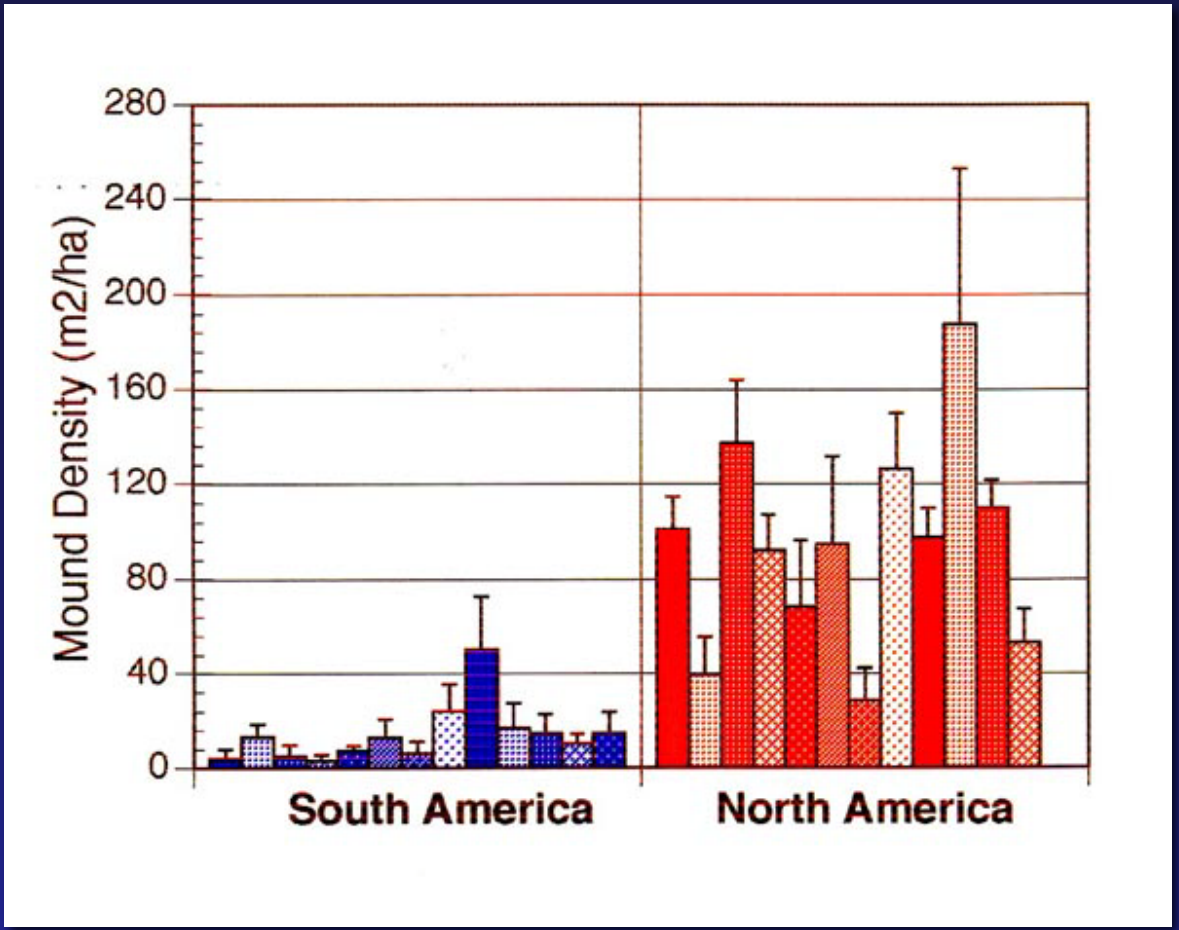
- Too Expensive
- Not Specific

Imported fire ants appear to be good candidates for classical biological control because . . .

(1) Lots of natural enemies in South America compared to the US



(2) Imported fire ants are 5-10 times more abundant in North America



High populations in North America are likely due to escape from natural enemies in South America

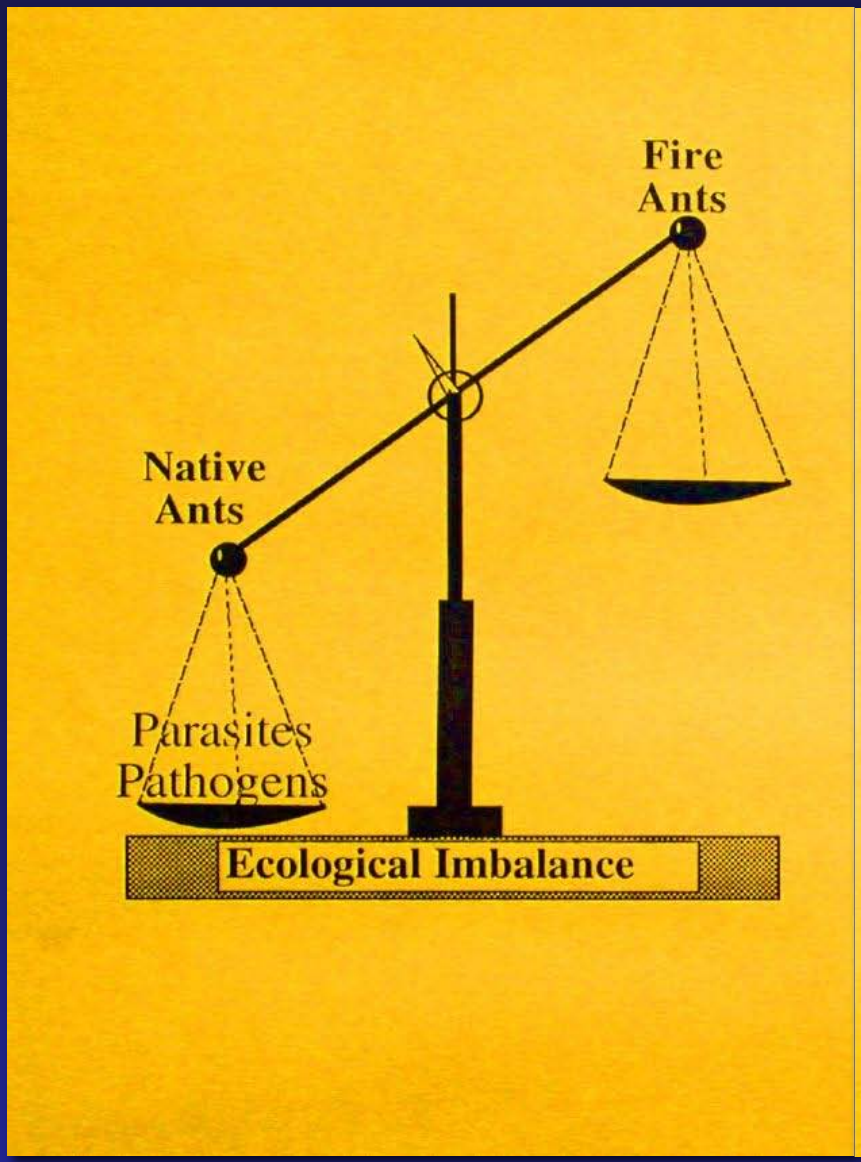
Social insects have never been successfully controlled with biocontrol agents

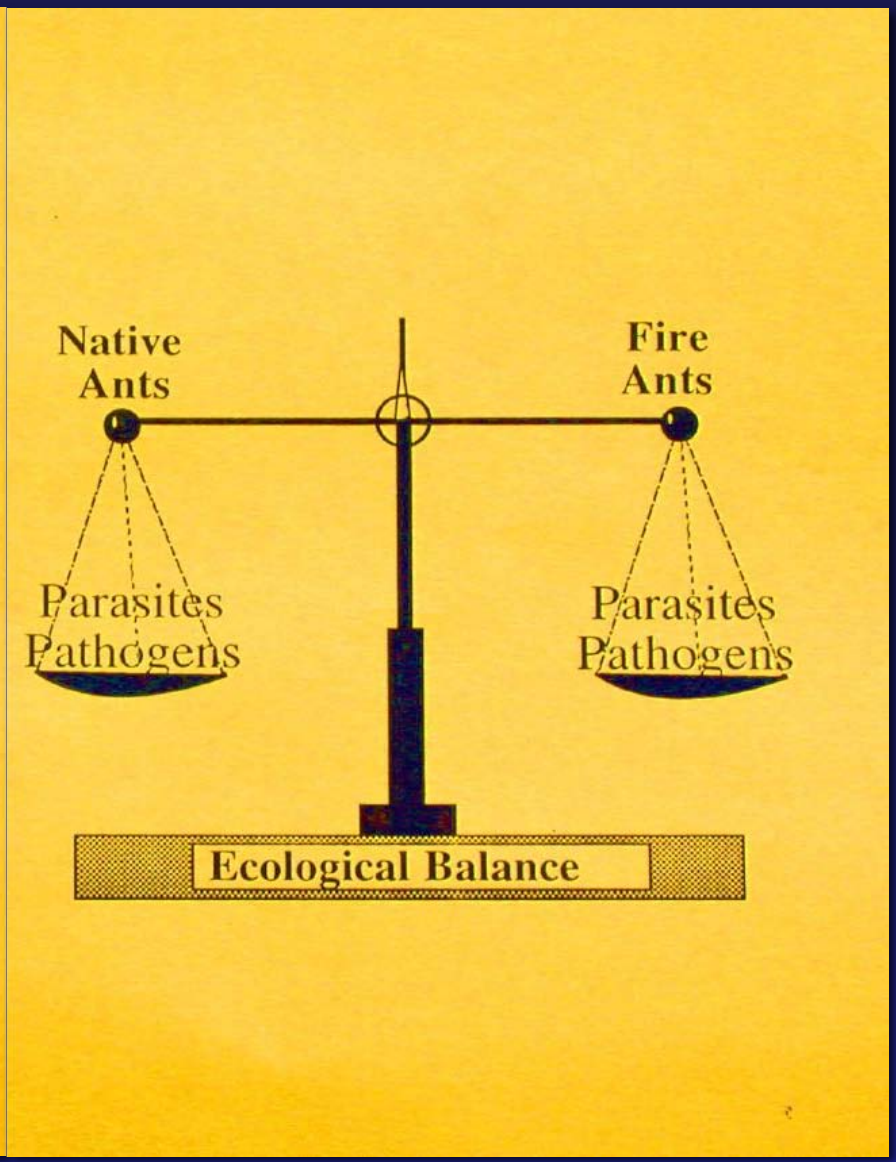
Classical biological control programs are often not successful

Classical biological control programs are often successful

Classical Biocontrol

– is only hope for permanent landscape control imported fire ants


Fire
Ants
Native
Ants
Parasites
Pathogens
Ecological Imbalance


Native
Ants
Fire
Ants
Parasites
Pathogens
Parasites
Pathogens
Ecological Balance

Pathogens

- *Thelohania* microsporidian
- *Vairimorpha* microsporidian
- Fire ant viruses
- other pathogens

Parasites

- Parasitic ant
- Nematode
- Eucharitid wasp
- Phorid decapitating flies

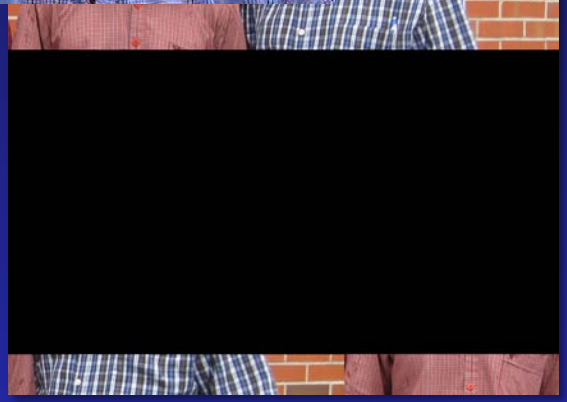
Fire Ant Decapitating Flies


USDA - ARS
SABCL
South American
Biological Control Laboratory






DEPA

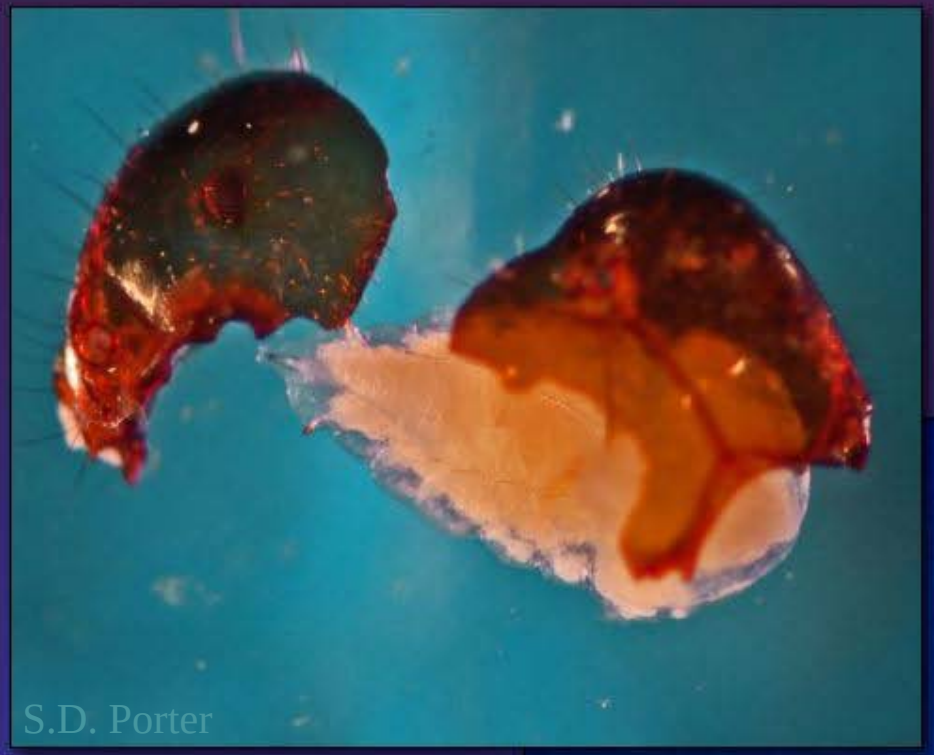
Life History Summary


S.D. Porter


S.D. Porter


F. L. Cônsoli


F. L. Cônsoli


S.D. Porter


S.D. Porter


S.D. Porter


S.D. Porter


S.D. Porter

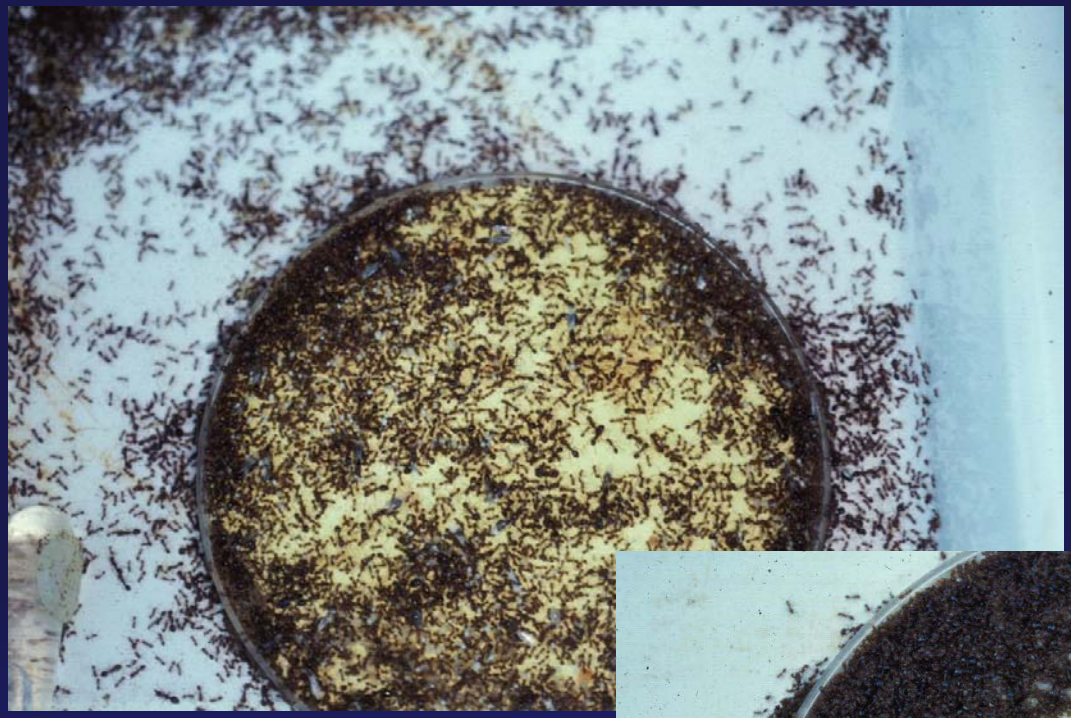

S.D. Porter


S.D. Porter

Ants have evolved several decapitating-fly-specific defensive behaviors.

C-shaped Posture

“Freezing”



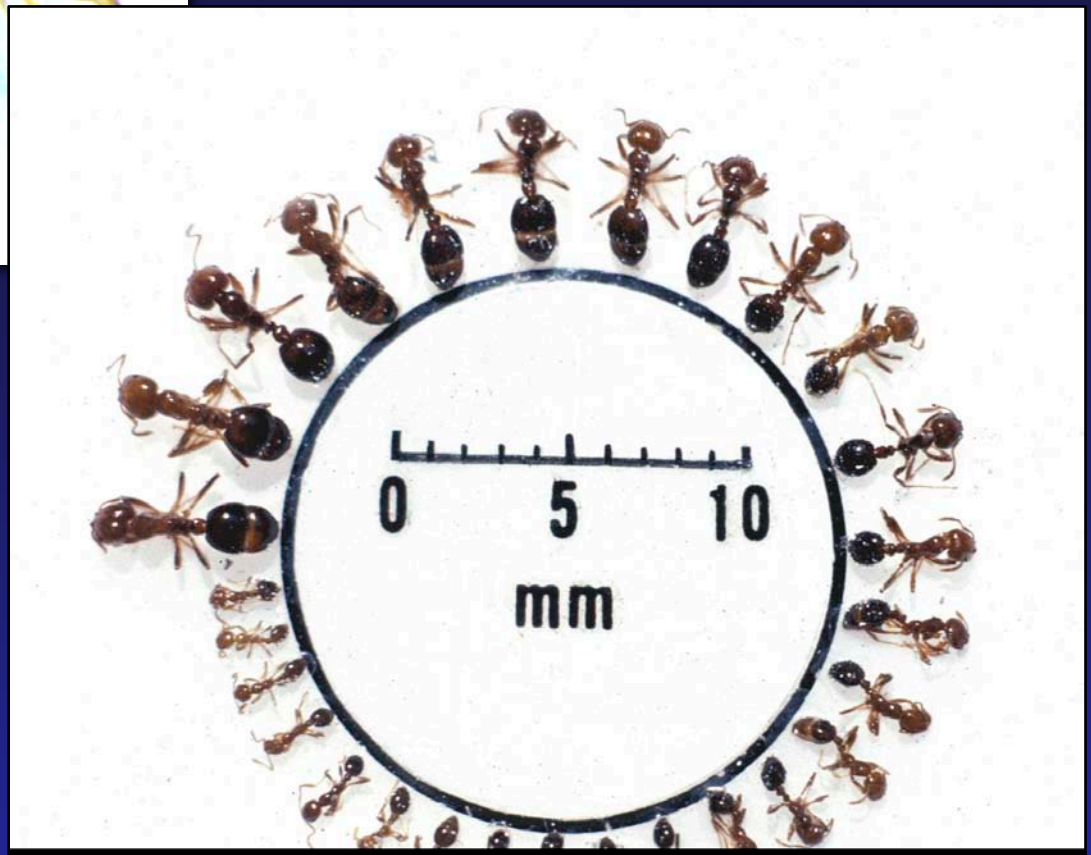
Cease Foraging

Flies

These behaviors could only have evolved if the flies were impacting fire ant populations or sexual production.

How do so many parasites survive on the same host?

S.D. Porter

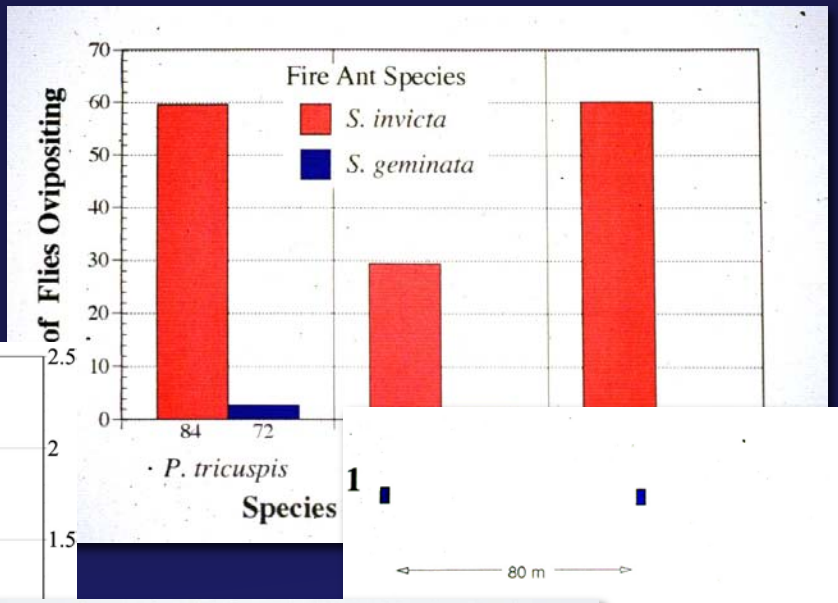


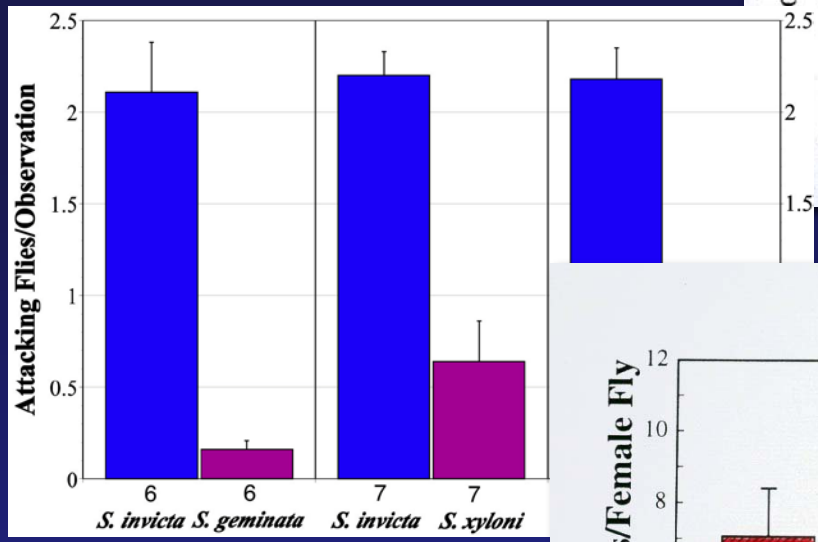
S.D. Porter

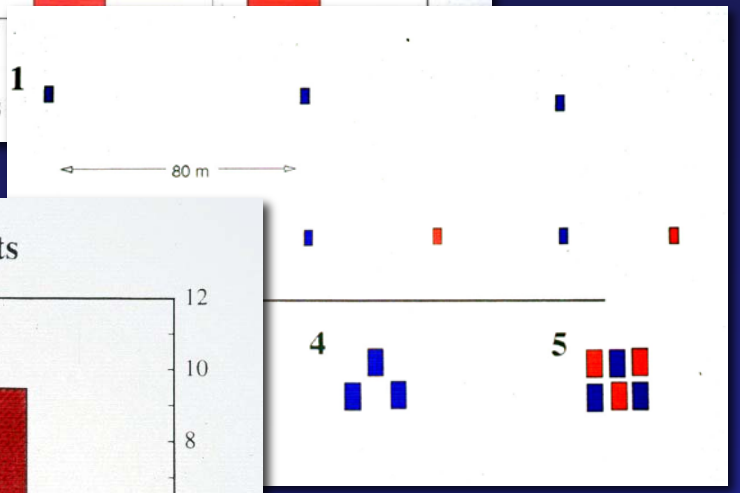
Partition Niche Space by:

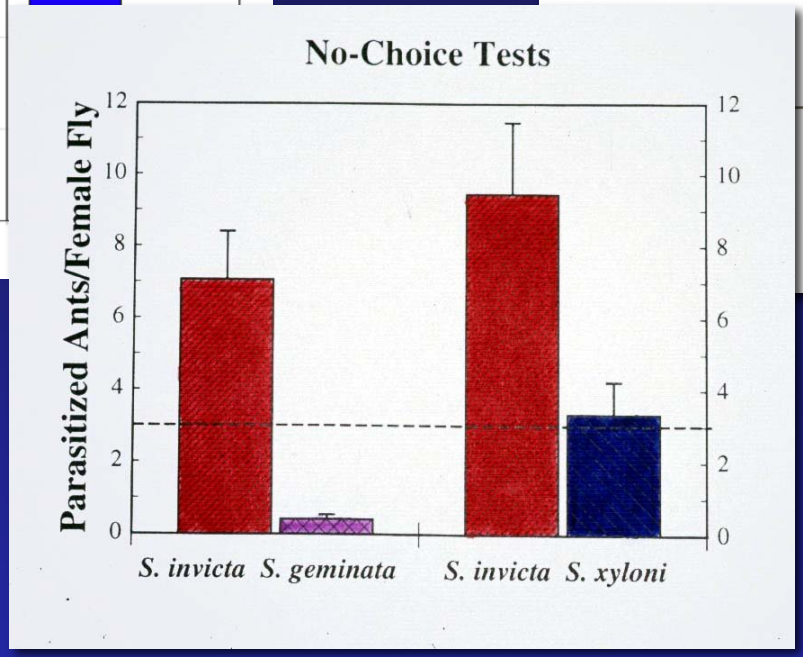
- Size of Host Workers
- Time of Day
- Location of Attacks
- Host Species
- Geography/Climate

Host Specificity

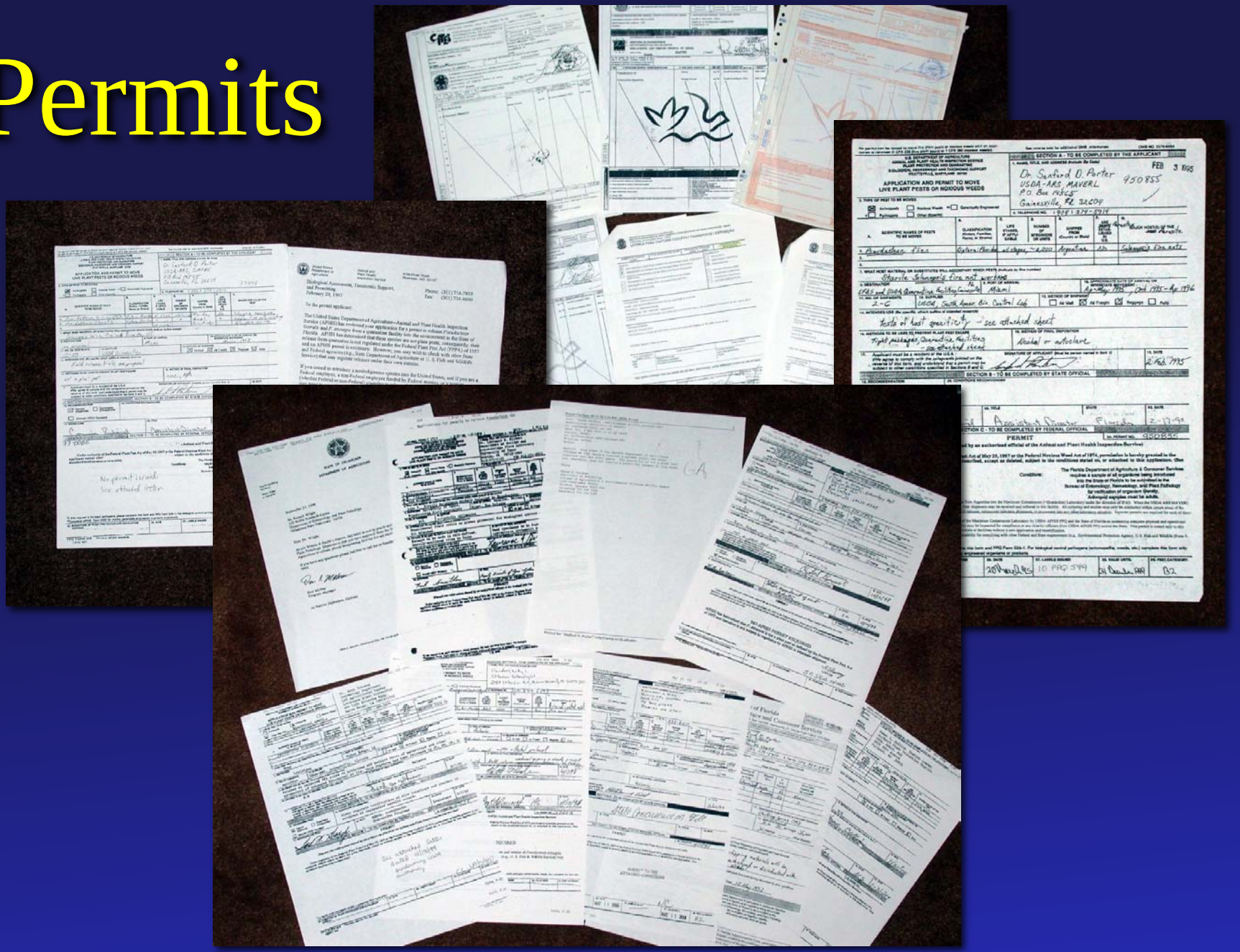








Permits


APPLICATION AND PERMIT TO MOVE
LIVE PLANT PESTS OR NOXIOUS WEEDS
PERMIT

~15 years to release 5 species of flies

- Tests of host specificity and safety together with regulatory approval accounted for about 7-10 years of this time

- While essential, efforts to ensure “Biosafety” come at a considerable cost.

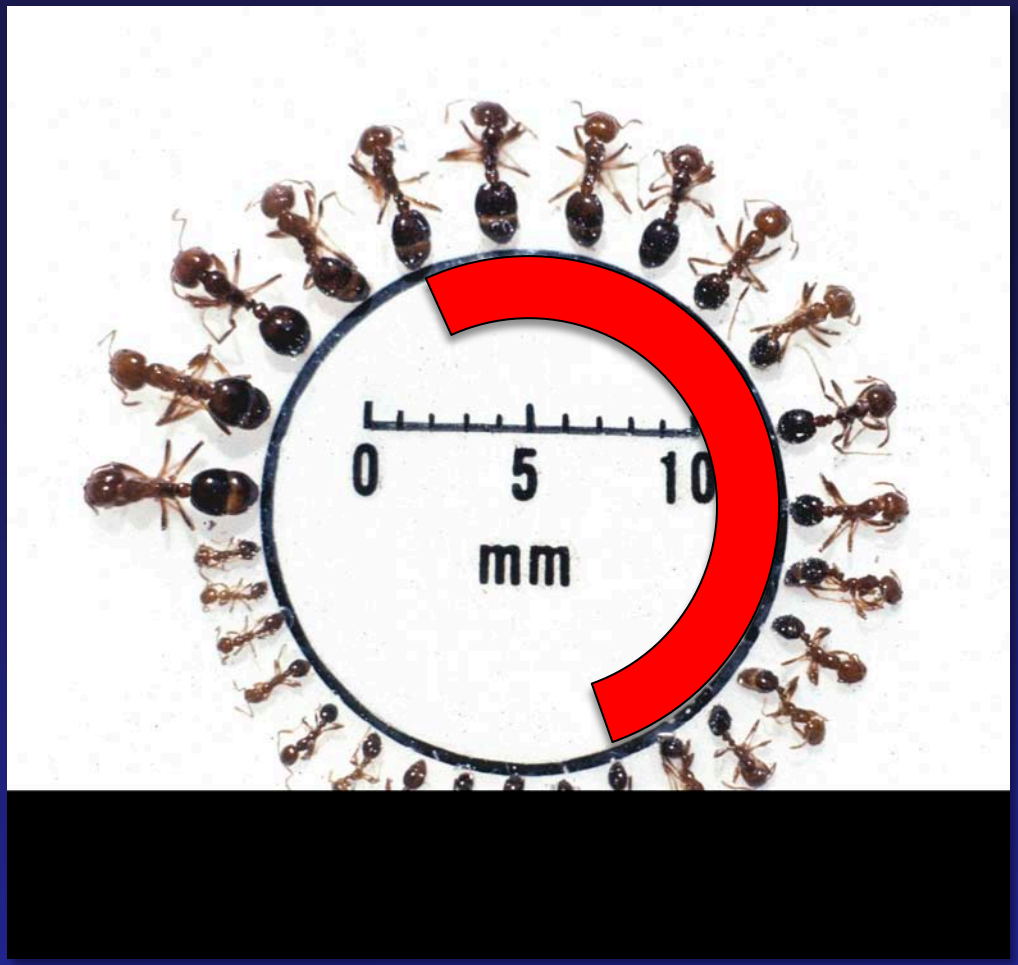
Established

- *Pseudacteon tricuspis*
- *Pseudacteon curvatus*
- *Pseudacteon litoralis*
- *Pseudacteon obtusus*

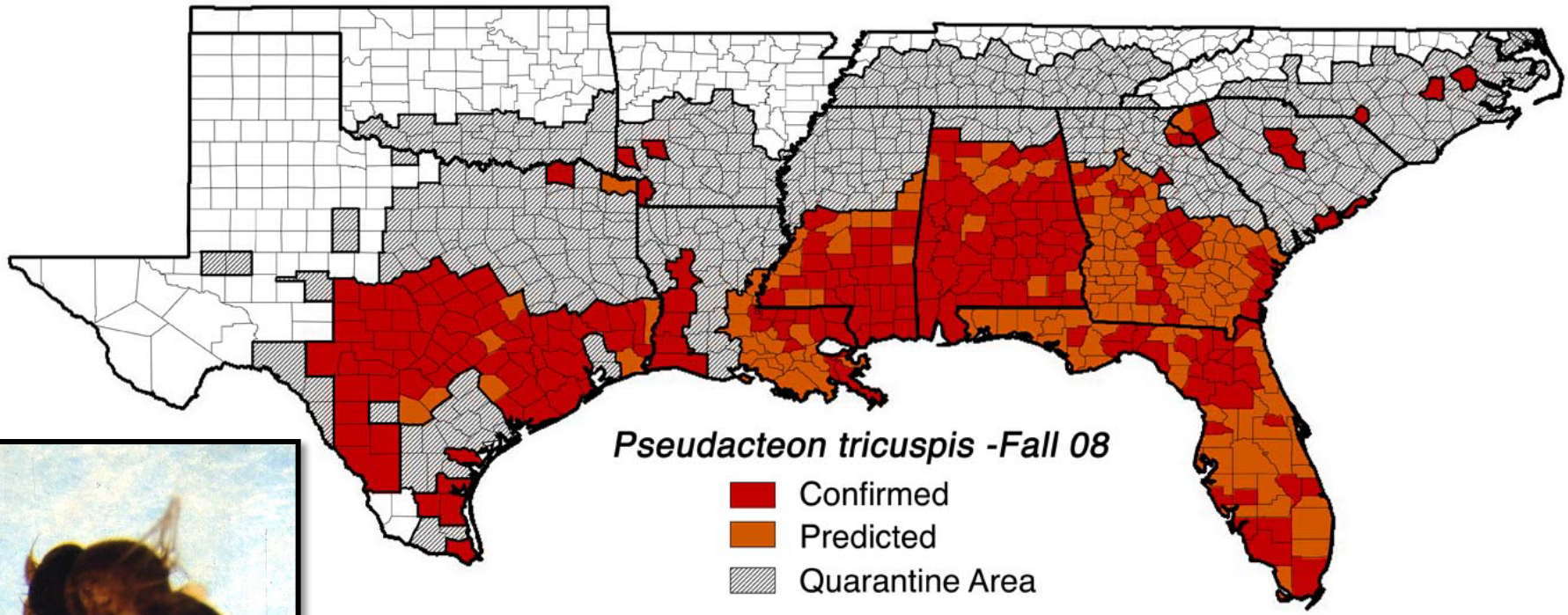
Being Released

- *Pseudacteon cultellatus*

Pseudacteon tricuspis



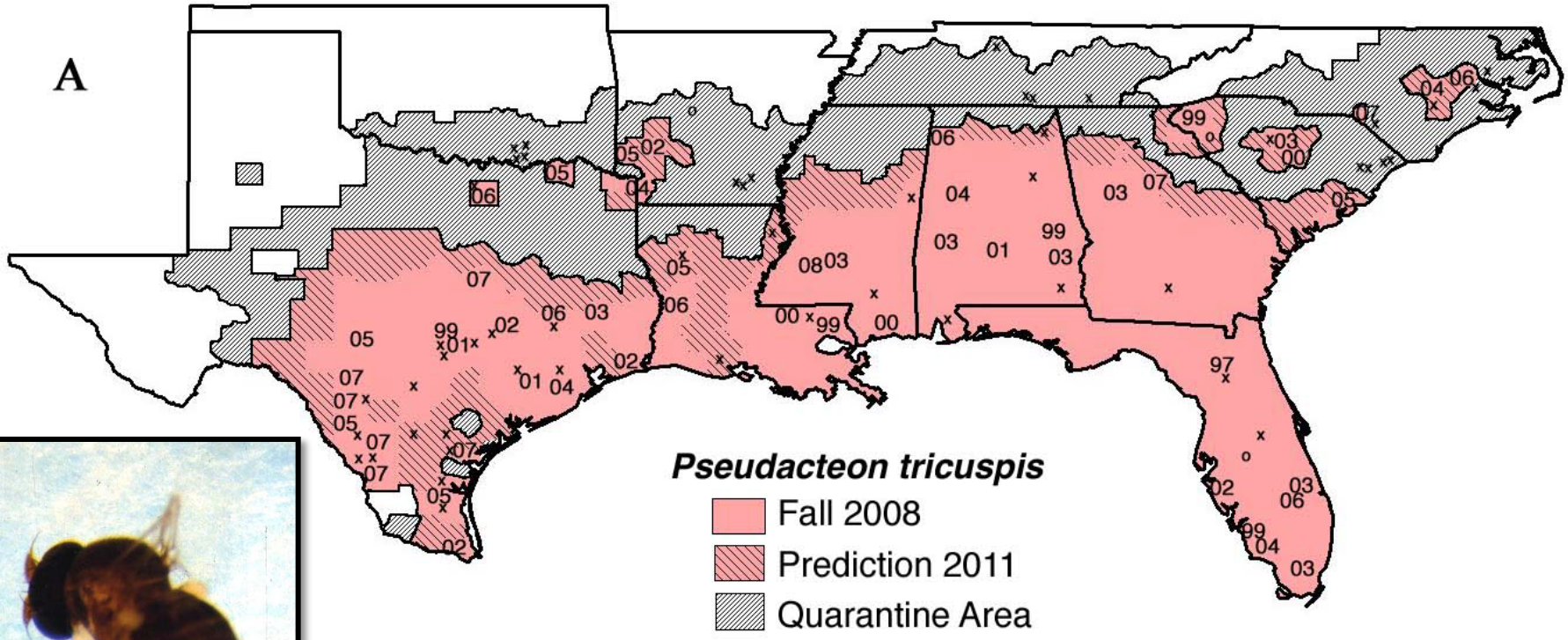
Pseudacteon tricuspis



Callcott et al. 2010

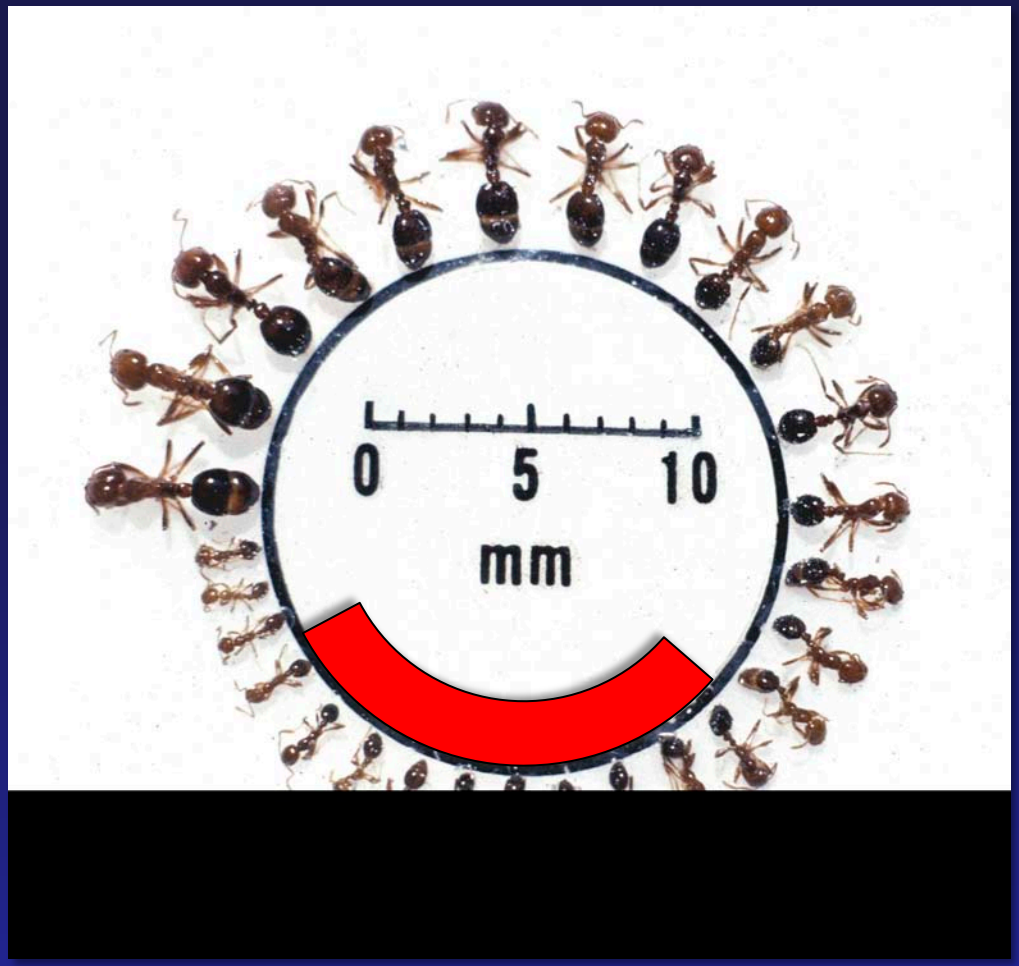
1997-
2007

Pseudacteon tricuspis



Callcott et al. 2010

Pseudacteon curvatus



Two Biotypes:

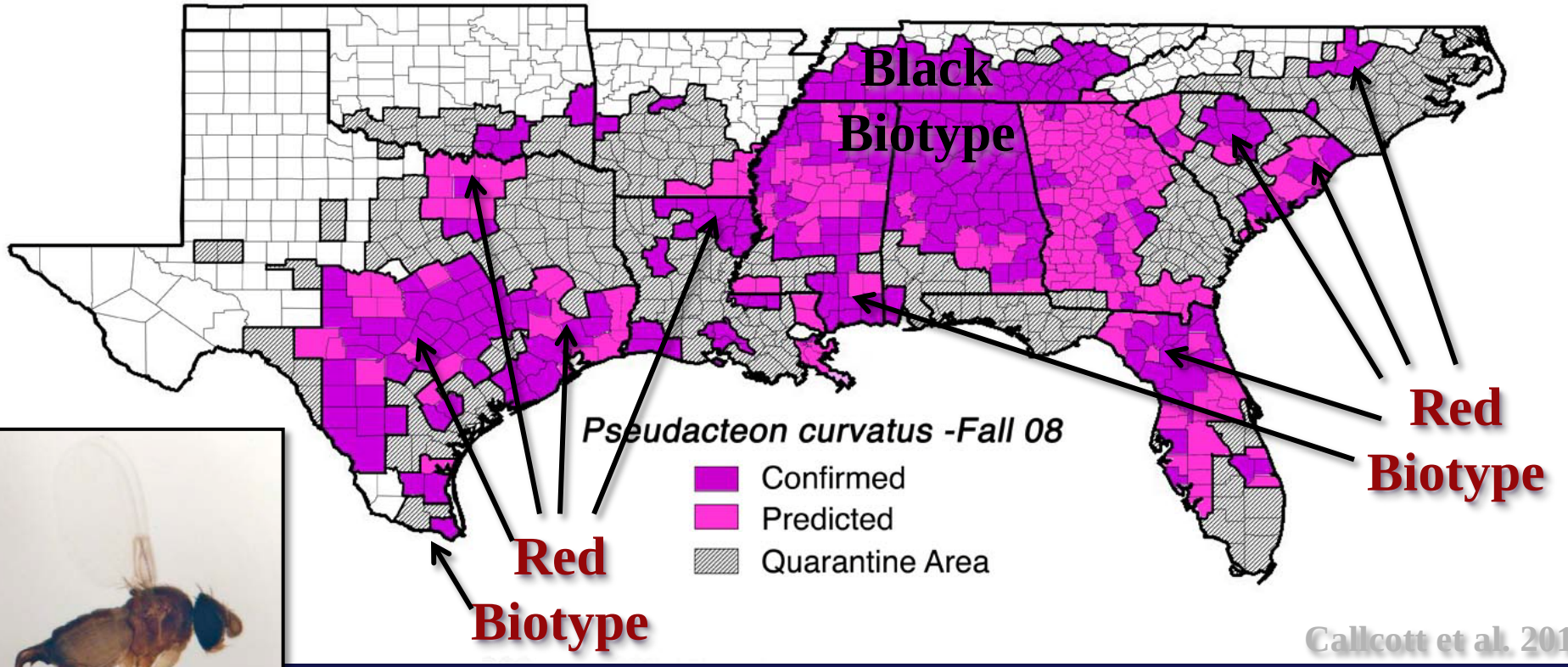
Black Biotype Flies collected from black fire ants (*Solenopis richteri*)

Red Biotype Flies collected from red fire ants (*Solenopsis invicta*).

Black Biotype Flies established every time when released on black and hybrid fire ants, but failed 7 times when released on red fire ants.

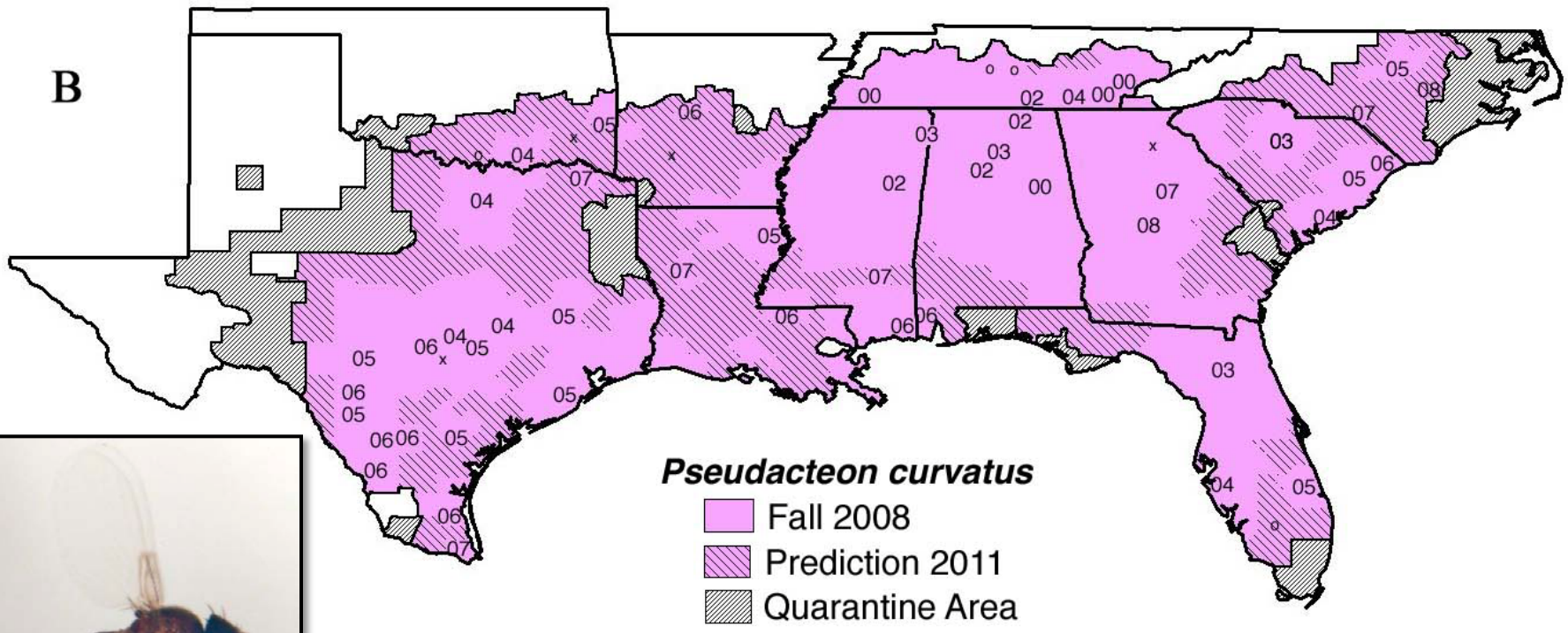
Red Biotype Flies established >90% of the time on red fire ants (n=52).

Pseudacteon curvatus



2000 2003

Pseudacteon curvatus

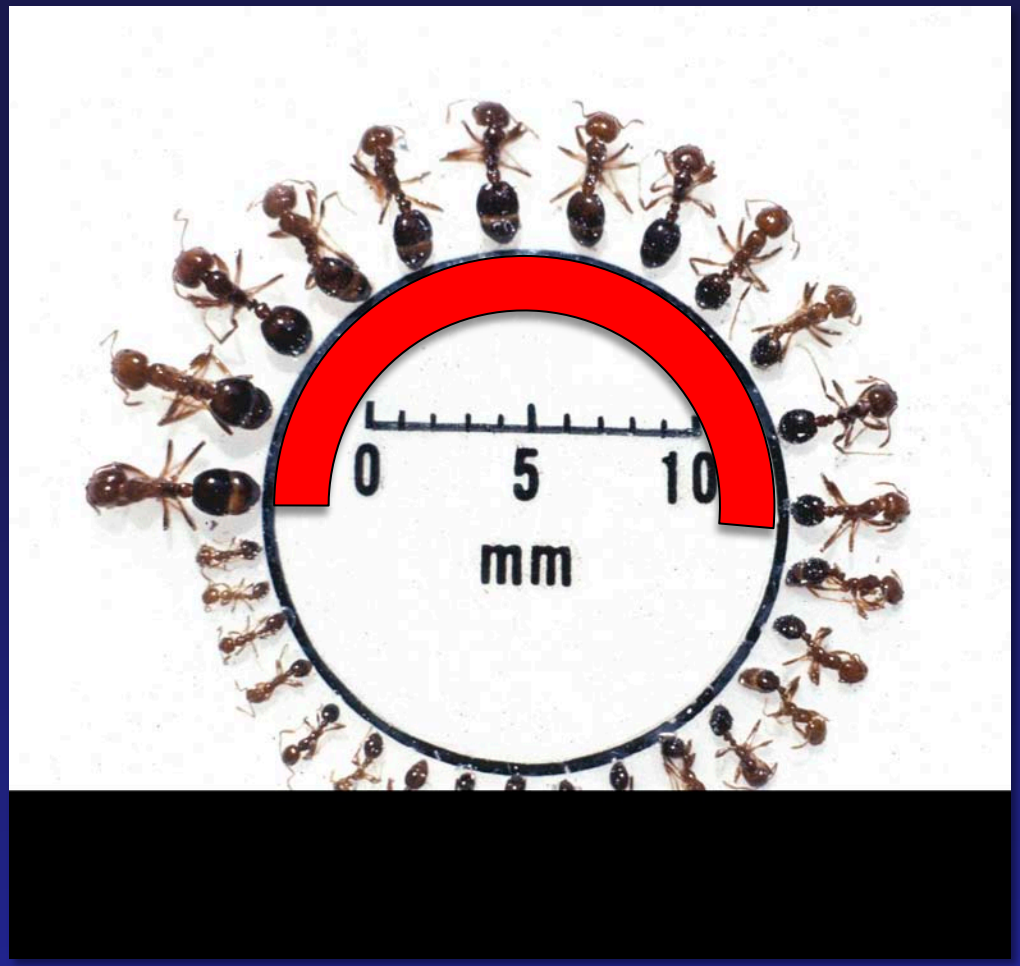


Callcott et al. 2010

Both Biotypes

Densities of *P. curvatus* were about 10x those of *P. tricuspis*

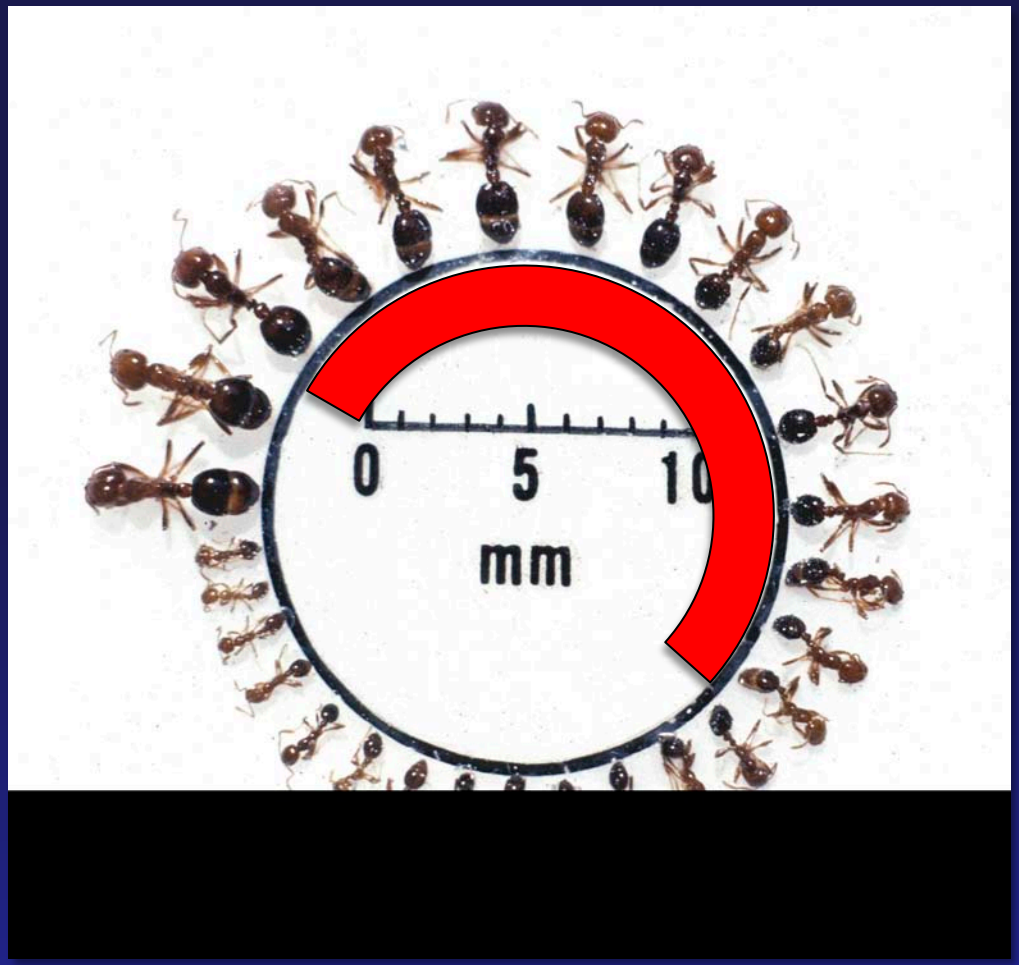
Pseudacteon litoralis



Pseudacteon litoralis

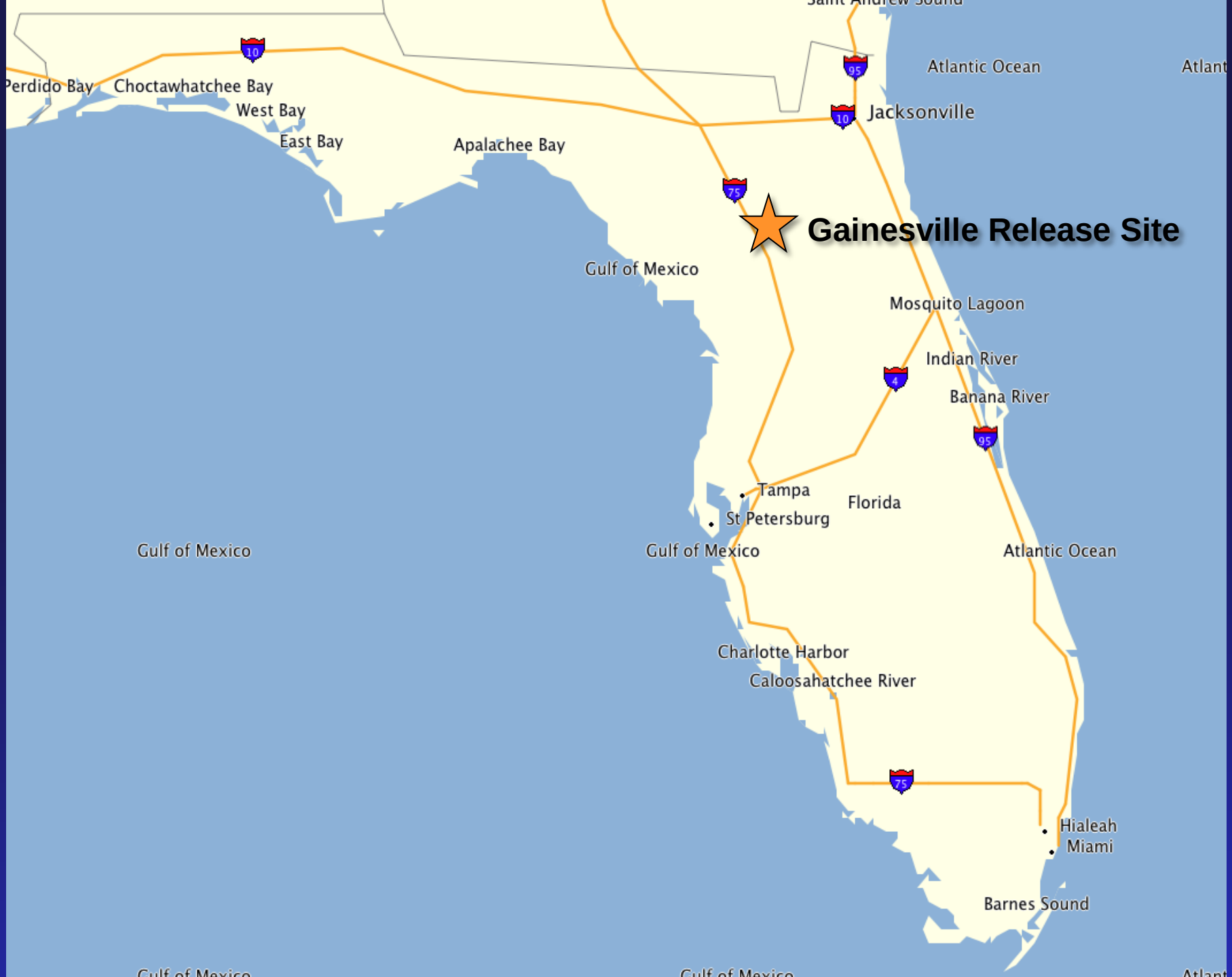
- Released at 9 sites in 3 states
- Only established at
  1 site in Alabama
- Densities in Alabama
  are usually very low

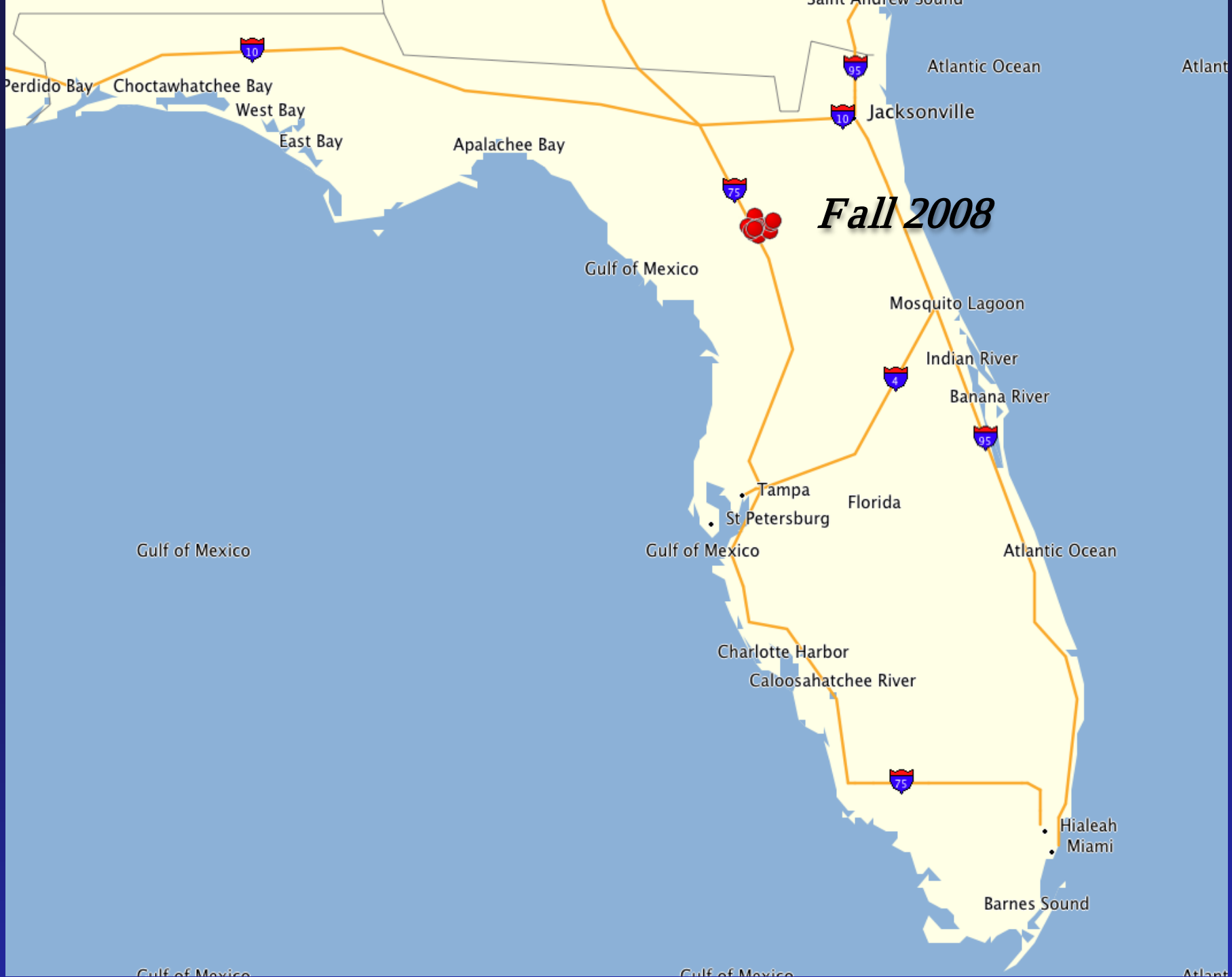
Pseudacteon obtusus

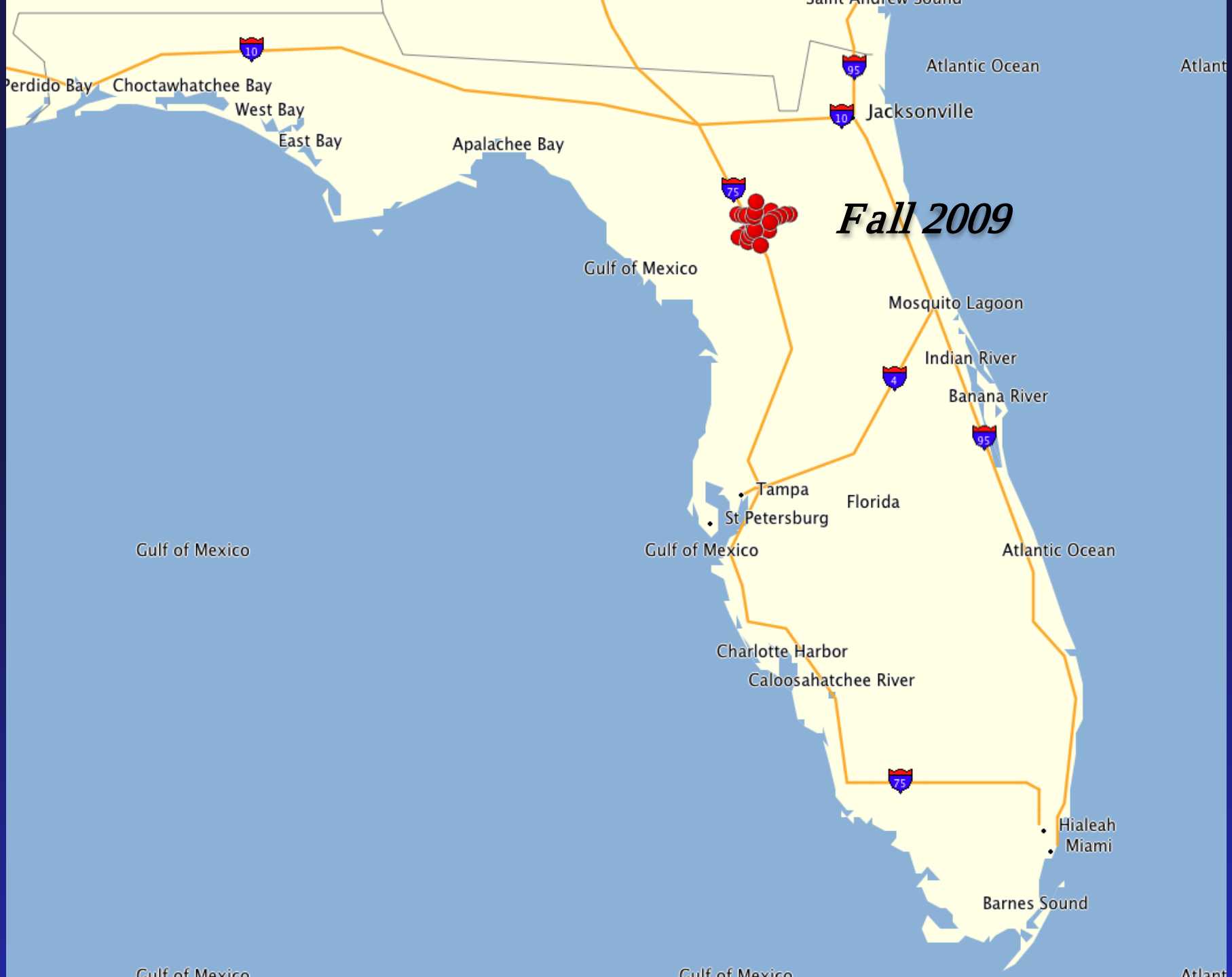


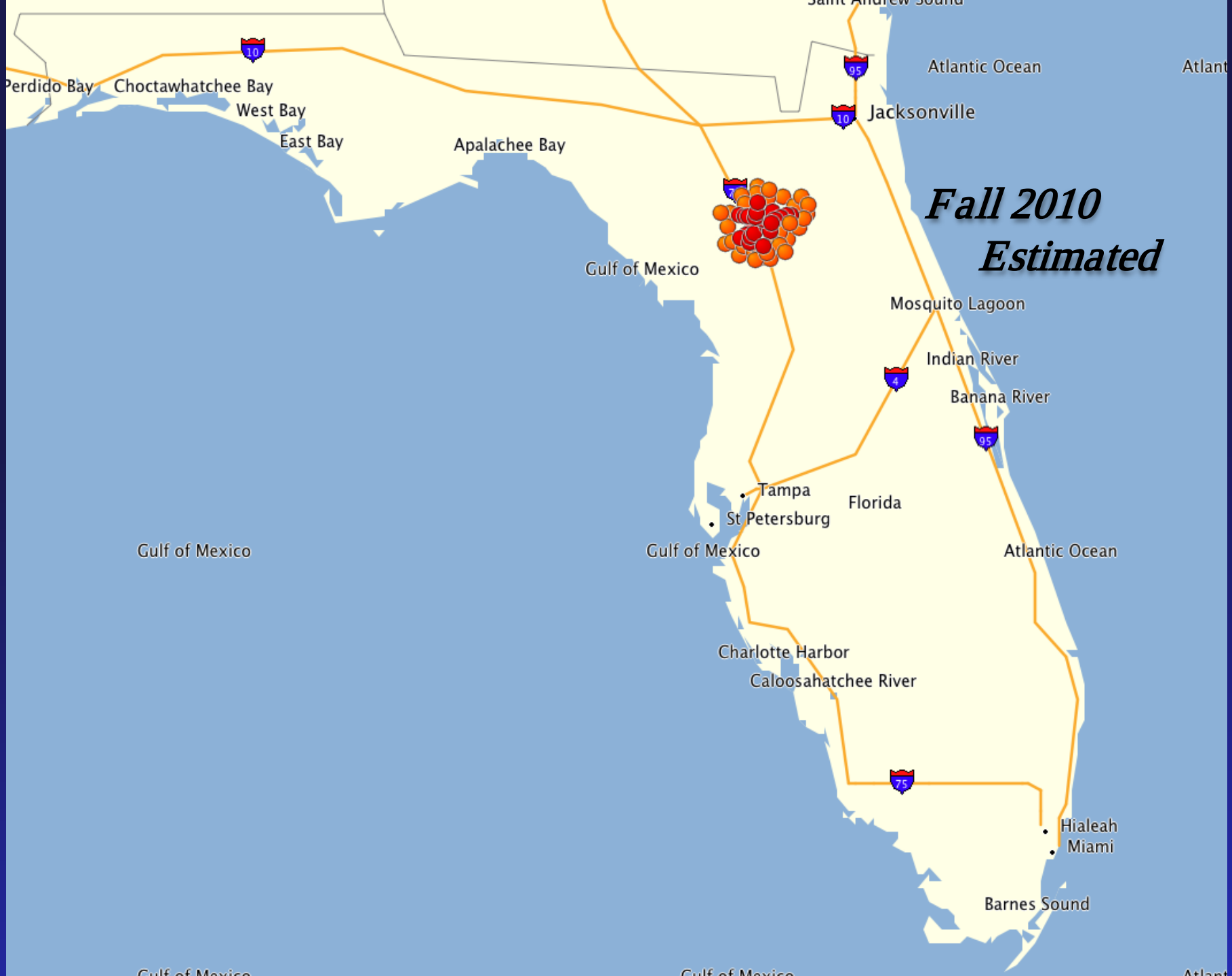
Pseudacteon obtusus

- Established at several sites in Texas and one site Florida

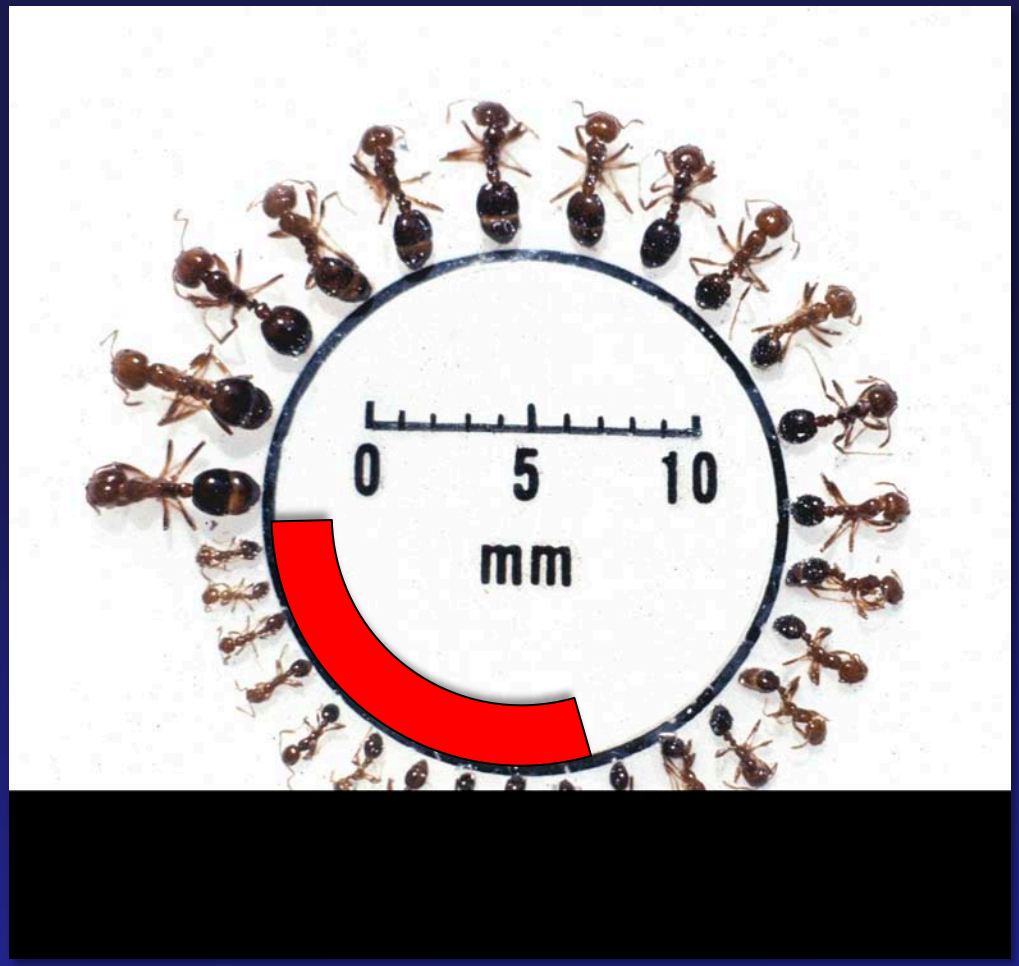

Perdido Bay
Choctawhatchee Bay
West Bay
East Bay
Apalachee Bay
Atlantic Ocean
Jacksonville
Gainesville Release Site
Gulf of Mexico
Mosquito Lagoon
Indian River
Banana River
Tampa
St Petersburg
Florida
Gulf of Mexico
Gulf of Mexico
Atlantic Ocean
Charlotte Harbor
Caloosahatchee River
Hialeah
Miami
Barnes Sound

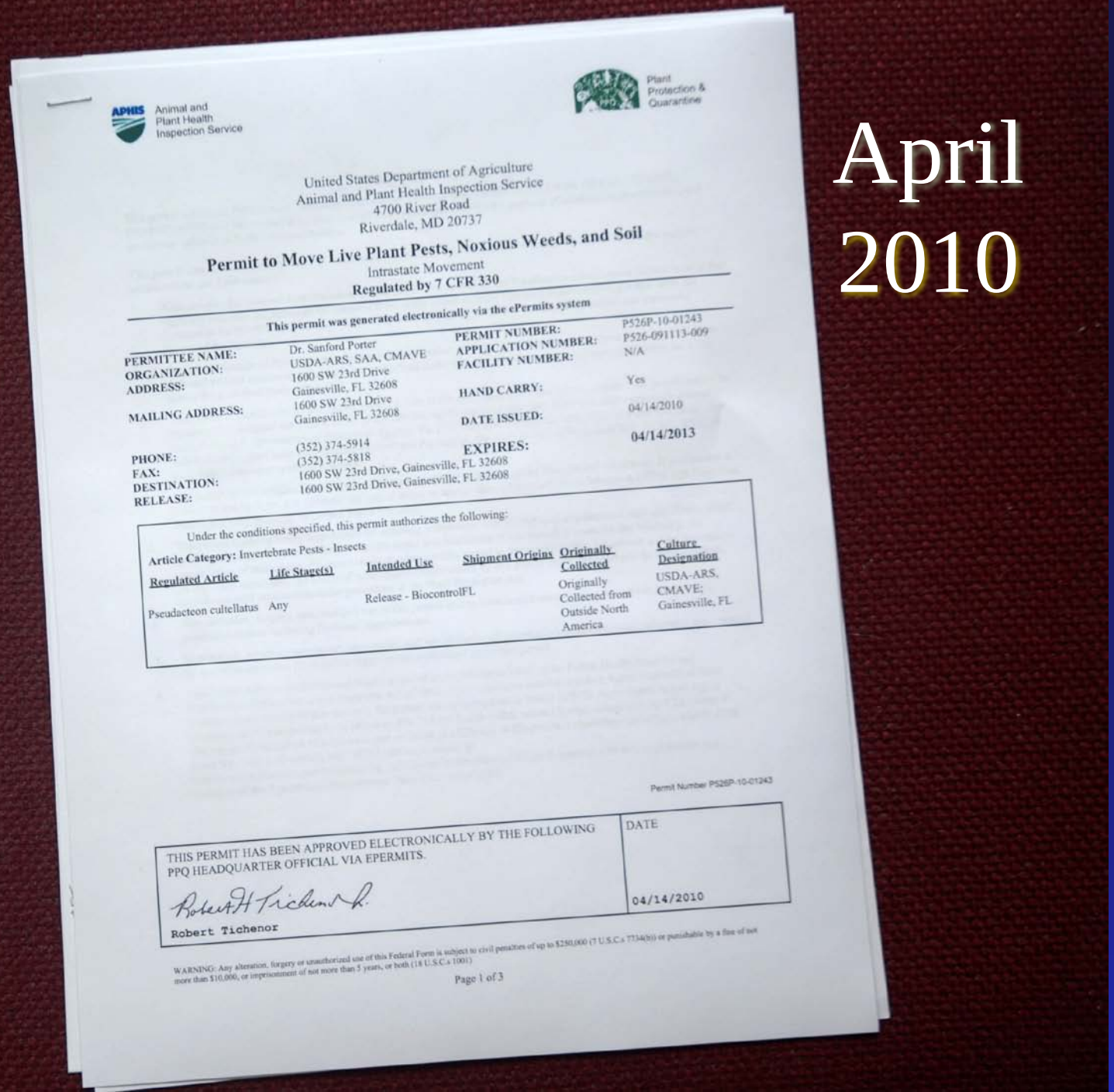

Fall 2008
Perdido Bay
Choctawhatchee Bay
West Bay
East Bay
Apalachee Bay
Gulf of Mexico
Atlantic Ocean
Jacksonville
Mosquito Lagoon
Indian River
Banana River
Tampa
St Petersburg
Florida
Gulf of Mexico
Gulf of Mexico
Atlantic Ocean
Charlotte Harbor
Caloosahatchee River
Hialeah
Miami
Barnes Sound
10
95
10
75
4
95
75


Fall 2009
Atlantic Ocean
Jacksonville
Perdido Bay
Choctawhatchee Bay
West Bay
East Bay
Apalachee Bay
Gulf of Mexico
Mosquito Lagoon
Indian River
Banana River
Tampa
St Petersburg
Florida
Gulf of Mexico
Gulf of Mexico
Atlantic Ocean
Charlotte Harbor
Caloosahatchee River
Hialeah
Miami
Barnes Sound


Fall 2010
Estimated
Perdido Bay
Choctawhatchee Bay
West Bay
East Bay
Apalachee Bay
Atlantic Ocean
Jacksonville
Gulf of Mexico
Mosquito Lagoon
Indian River
Banana River
Tampa
Florida
St Petersburg
Gulf of Mexico
Gulf of Mexico
Atlantic Ocean
Charlotte Harbor
Caloosahatchee River
Hialeah
Miami
Barnes Sound

Pseudacteon cultellatus





APHIS Animal and Plant Health Inspection Service

Plant Protection & Quarantine

United States Department of Agriculture
Animal and Plant Health Inspection Service
4700 River Road
Riverdale, MD 20737

Permit to Move Live Plant Pests, Noxious Weeds, and Soil
Intrastate Movement
Regulated by 7 CFR 330

This permit was generated electronically via the ePermits system

PERMITTEE NAME:	Dr. Sanford Porter	**PERMIT NUMBER:**	P526P-10-01243
ORGANIZATION:	USDA-ARS, SAA, CMAVE	**APPLICATION NUMBER:**	P526-091113-009
ADDRESS:	1600 SW 23rd Drive Gainesville, FL 32608	**FACILITY NUMBER:**	N/A
MAILING ADDRESS:	1600 SW 23rd Drive Gainesville, FL 32608	**HAND CARRY:**	Yes
		DATE ISSUED:	04/14/2010
PHONE:	(352) 374-5914	**EXPIRES:**	**04/14/2013**
FAX:	(352) 374-5818		
DESTINATION:	1600 SW 23rd Drive, Gainesville, FL 32608		
RELEASE:	1600 SW 23rd Drive, Gainesville, FL 32608		

Under the conditions specified, this permit authorizes the following:

Article Category: Invertebrate Pests - Insects

Regulated Article	Life Stage(s)	Intended Use	Shipment Origins	Originally Collected	Culture Designation
Pseudacteon cultellatus	Any	Release - BiocontrolFL		Originally Collected from Outside North America	USDA-ARS, CMAVE; Gainesville, FL

Permit Number P526P-10-01243

THIS PERMIT HAS BEEN APPROVED ELECTRONICALLY BY THE FOLLOWING PPQ HEADQUARTER OFFICIAL VIA EPERMITS.

Robert H Tichenor

Robert Tichenor

DATE 04/14/2010

WARNING: Any alteration, forgery or unauthorized use of this Federal Form is subject to civil penalties of up to $250,000 (7 U.S.C.s 7734(b)) or punishable by a fine of not more than $10,000, or imprisonment of not more than 5 years, or both (18 U.S.C.s 1001)

Page 1 of 3

April 2010

Pseudacteon cultellatus

- Two spring releases appear to have failed
- Fall releases are in progress

Determining the impacts of decapitating flies on imported fire ants is a work in progress

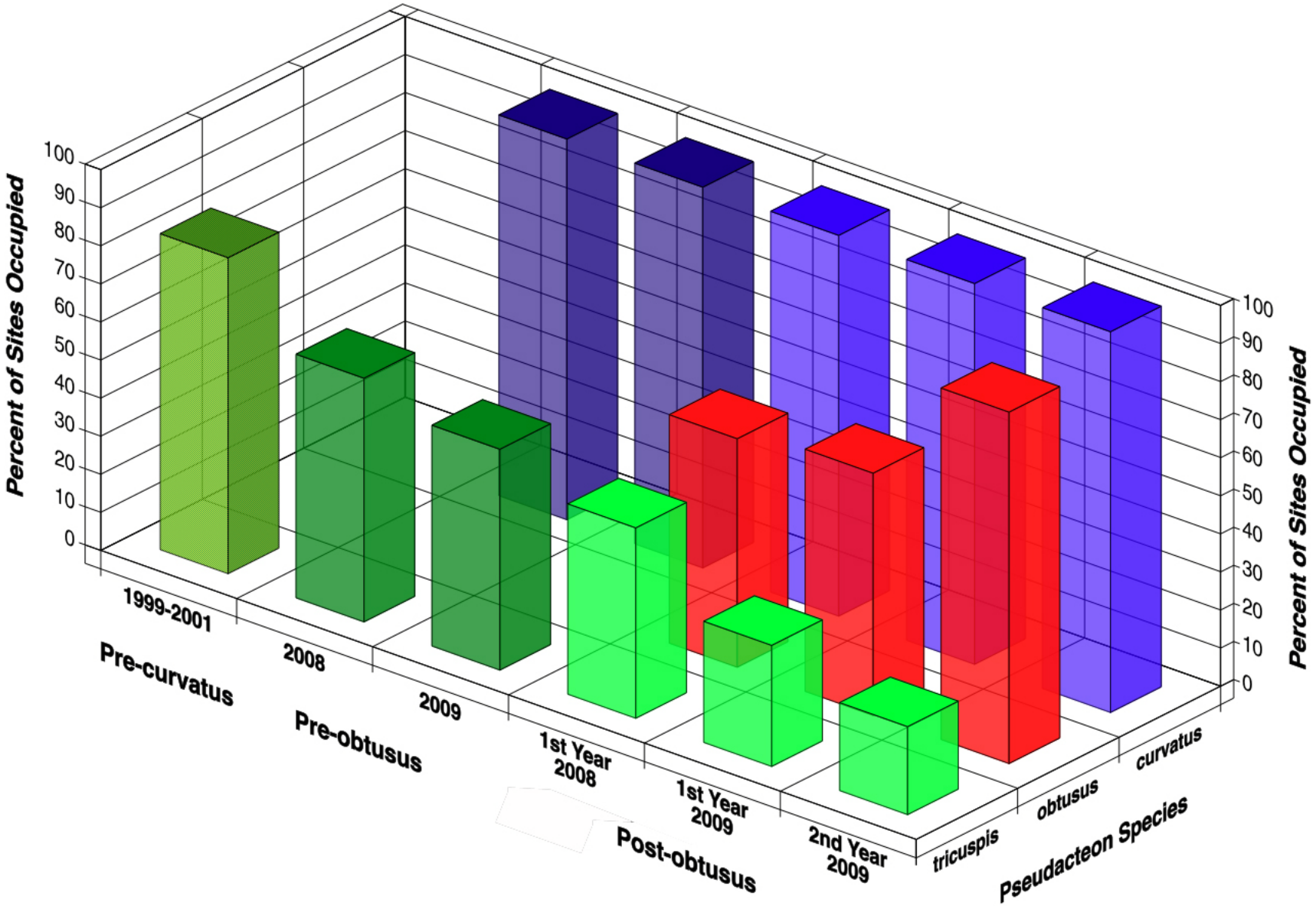
Impacts of Flies on Fire ants

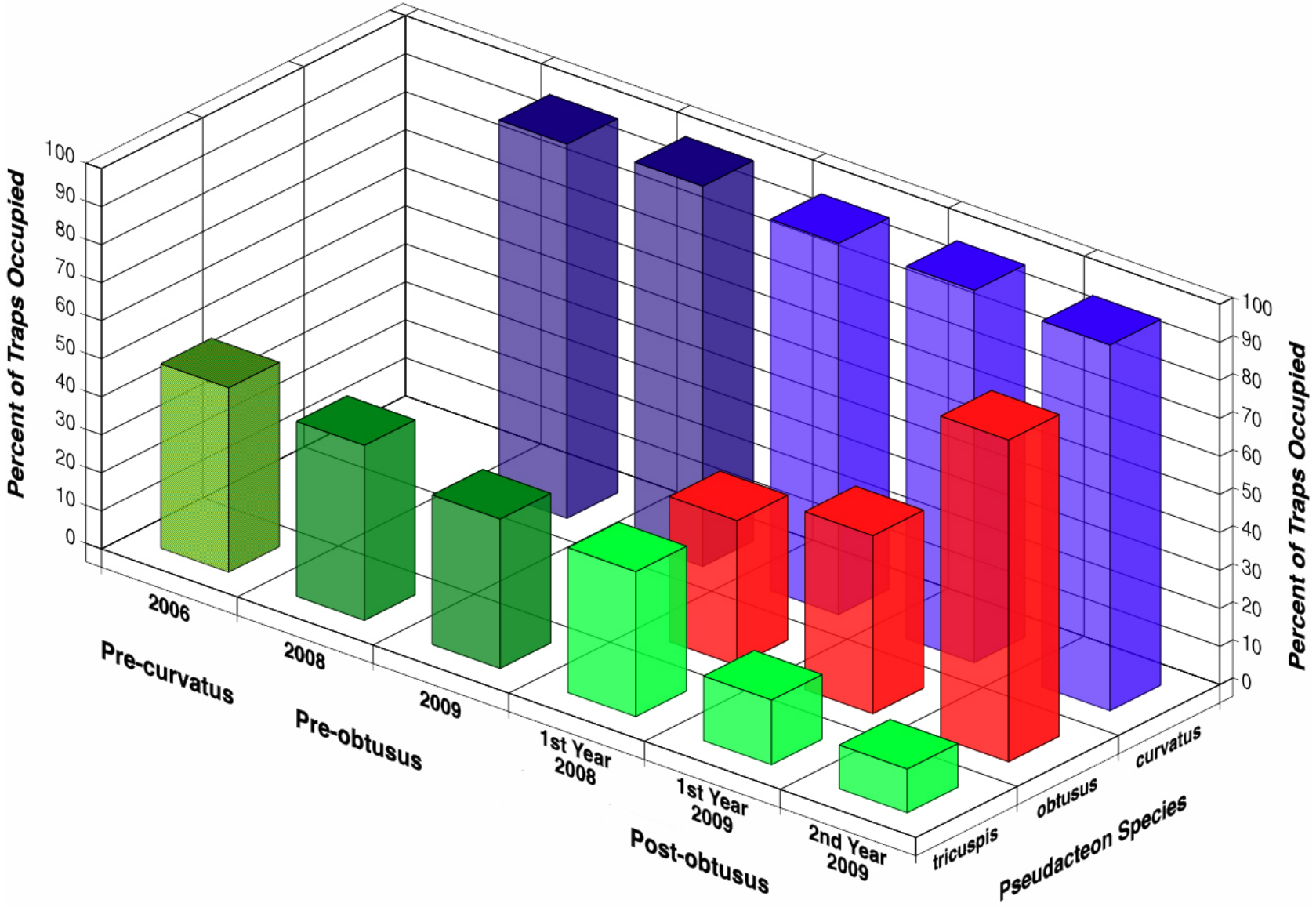
1. Impacts are not trivial– sufficient to cause the evolution host-specific defense behaviors
2. Impacts of first species (*P. tricuspis*) were not detectable above the 10-30% sensitivity of our surveys
3. *Pseudacteon* flies are potential vectors of a microsporidian pathogen
4. Historical compairison of fire ant populations with decapitating fly releases

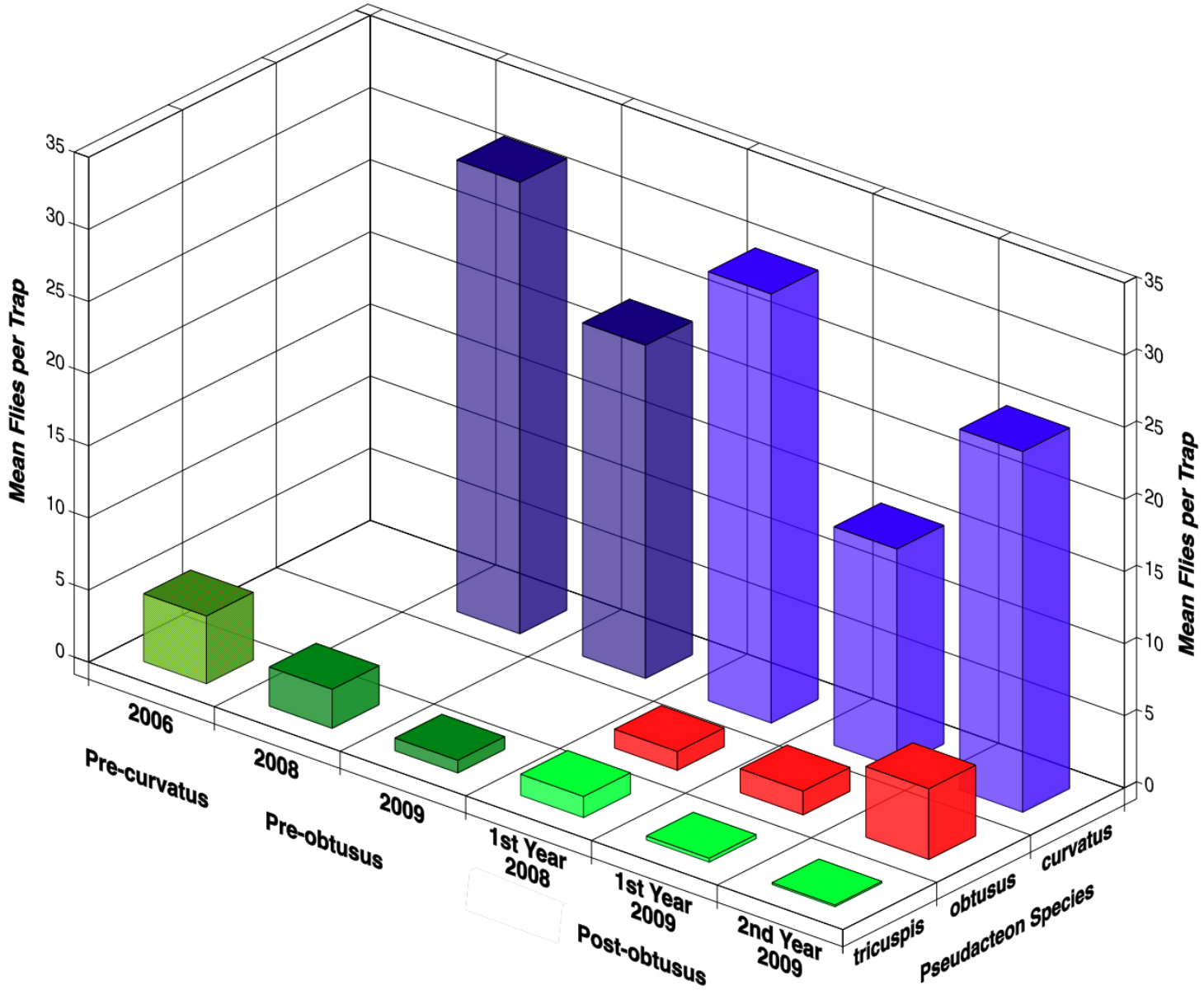
- Curious decline in the abundance of polygyne fire ants in Florida and my colleagues in Texas report a similar change.

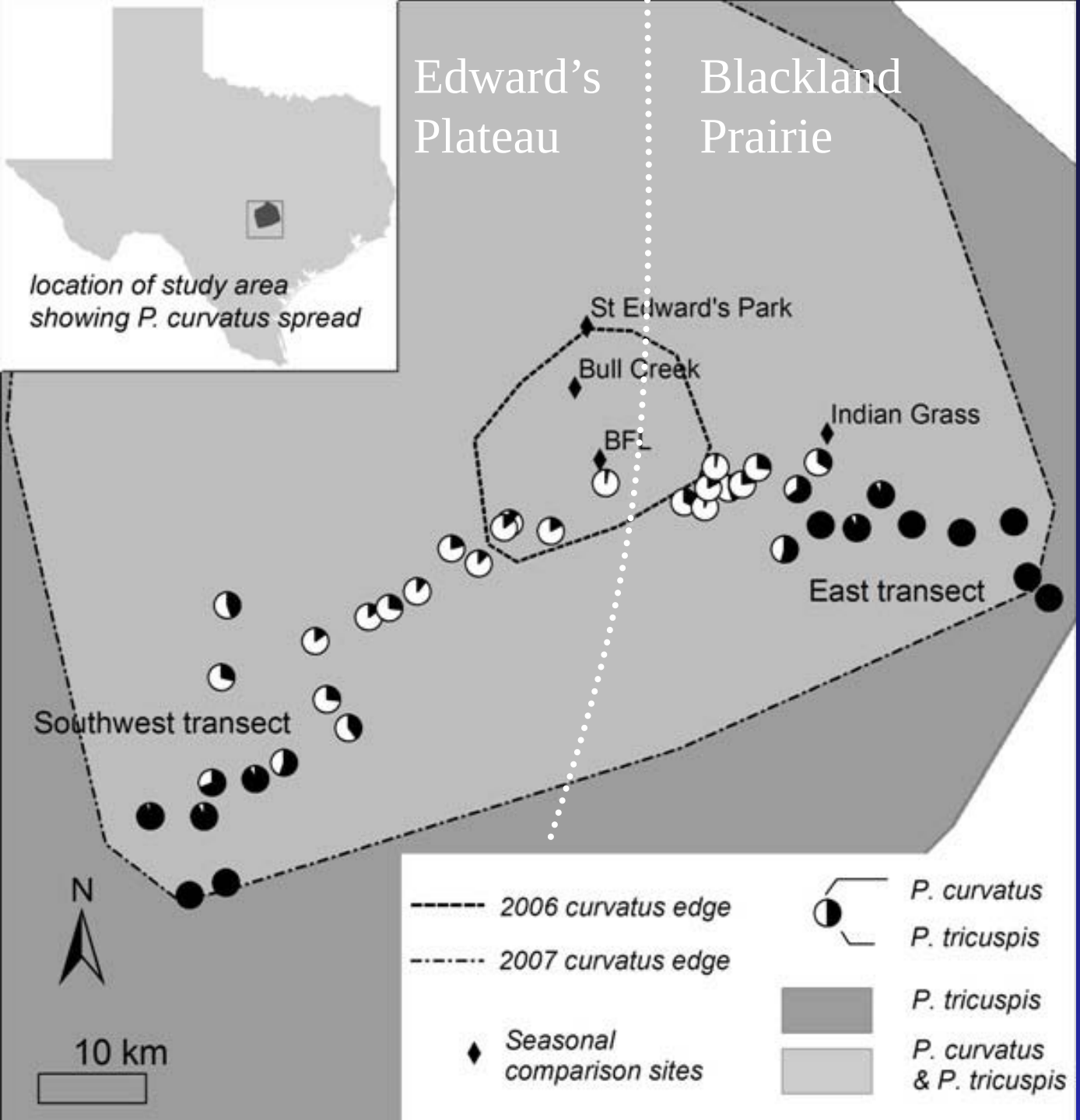
- Spring 2011, I plan to begin resurveying old study sites to see how populations have changed since decapitating flies were released

Interspecific Competition

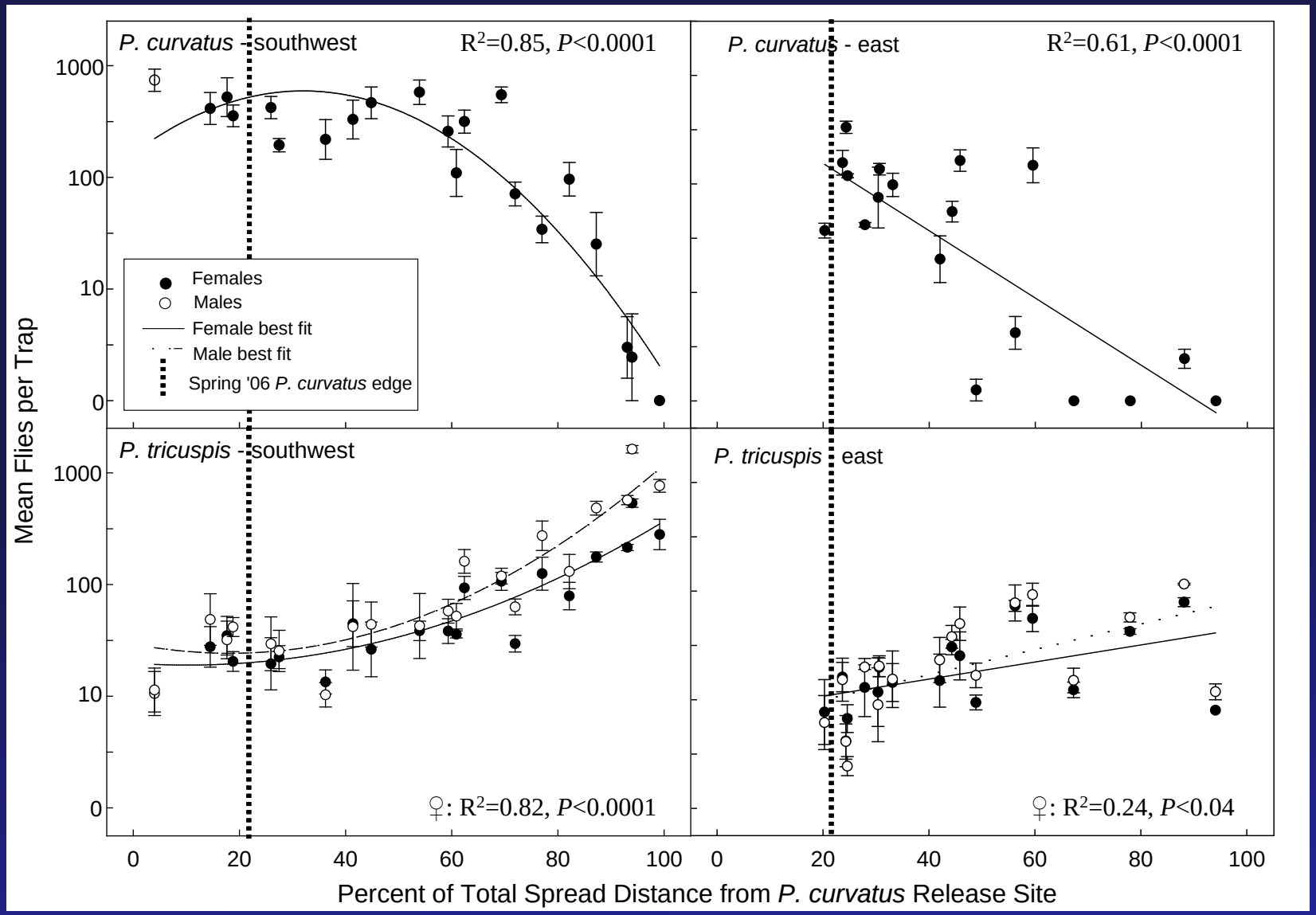

Percent of Sites Occupied
100
90
80
70
60
50
40
30
20
10
0
1999-2001
2008
2009
1st Year 2008
1st Year 2009
2nd Year 2009
Pre-curvatus
Pre-obtusus
Post-obtusus
tricuspis
obtusus
curvatus
Pseudacteon Species


Percent of Traps Occupied
100
90
80
70
60
50
40
30
20
10
0
2006
2008
2009
1st Year 2008
1st Year 2009
2nd Year 2009
Pre-curvatus
Pre-obtusus
Post-obtusus
tricuspis
obtusus
curvatus
Pseudacteon Species
Percent of Traps Occupied


Mean Flies per Trap
0
5
10
15
20
25
30
35
2006
2008
2009
1st Year 2008
1st Year 2009
2nd Year 2009
Pre-curvatus
Pre-obtusus
Post-obtusus
tricuspis
obtusus
curvatus
Pseudacteon Species
Mean Flies per Trap



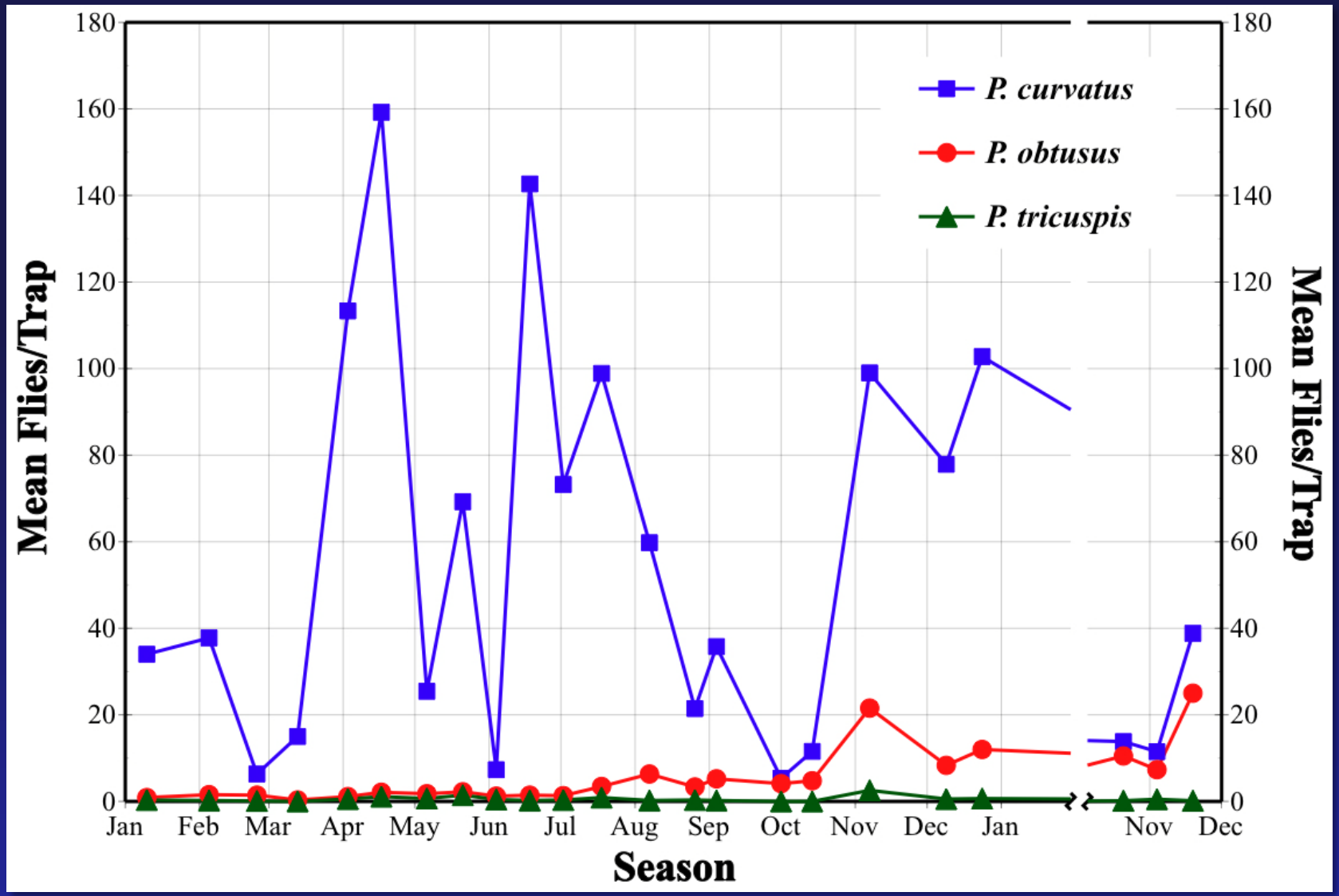
LeBrun, Plowes, and Gilbert. 2009: Ecology.



- *P. tricuspis* populations reduced 97.5%

LeBrun, Plowes, and Gilbert. 2009: Ecology.

Seasonal Abundance Study



P. curvatus - 91%

P. obtusus - 8%

P. tricuspis - 1%

P. curvatus - 91%

P. obtusus - 8%

P. tricuspis - 1%

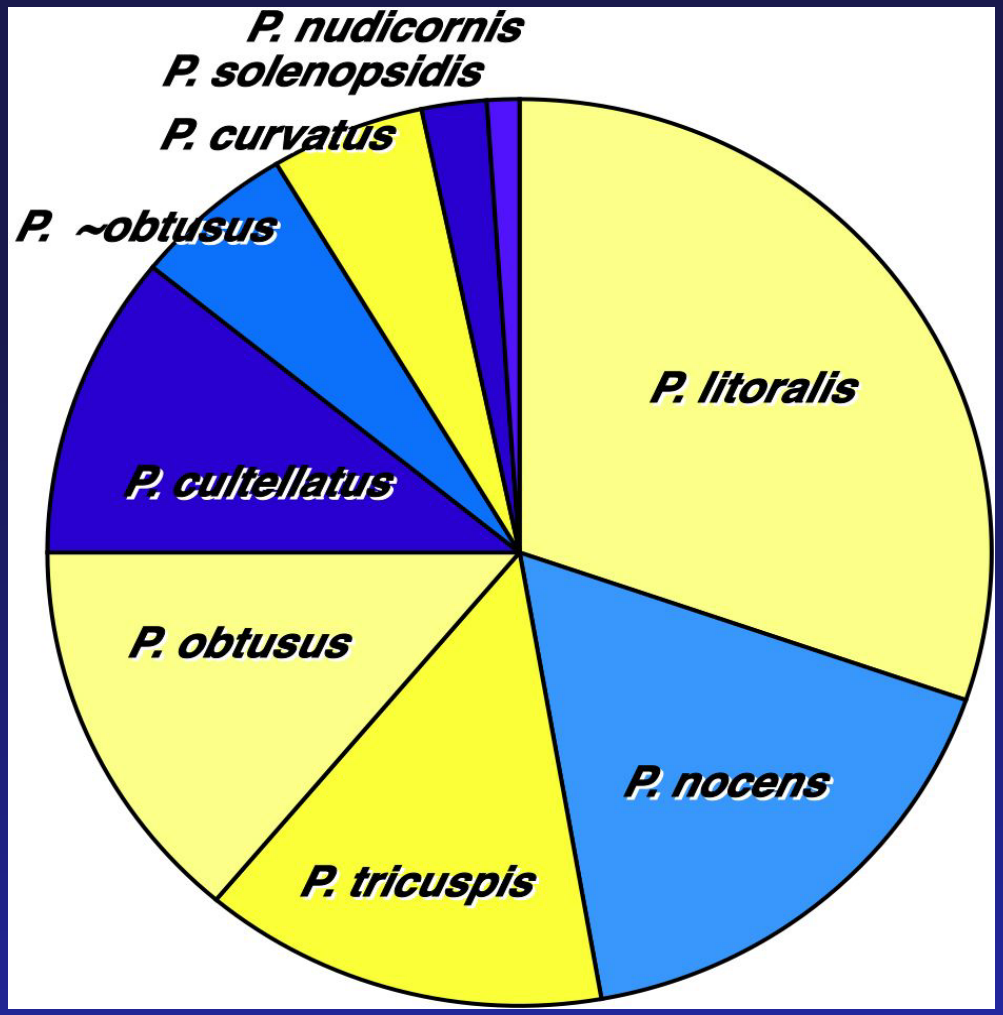
P. litoralis - 0%

Why did we waste time and resources releasing *P. tricuspis* if it was going to do so poorly in competition with *P. curvatus and P. obtusus*?

P. obtusus did not occur in the region of Brazil where *P. tricuspis* was initially collected.

Would more study have helped me choose more wisely?

Relative abundance of decapitating flies on *S. invicta* in northern Argentina



Florida

cur >>obt >>tri >> lit

Argentina

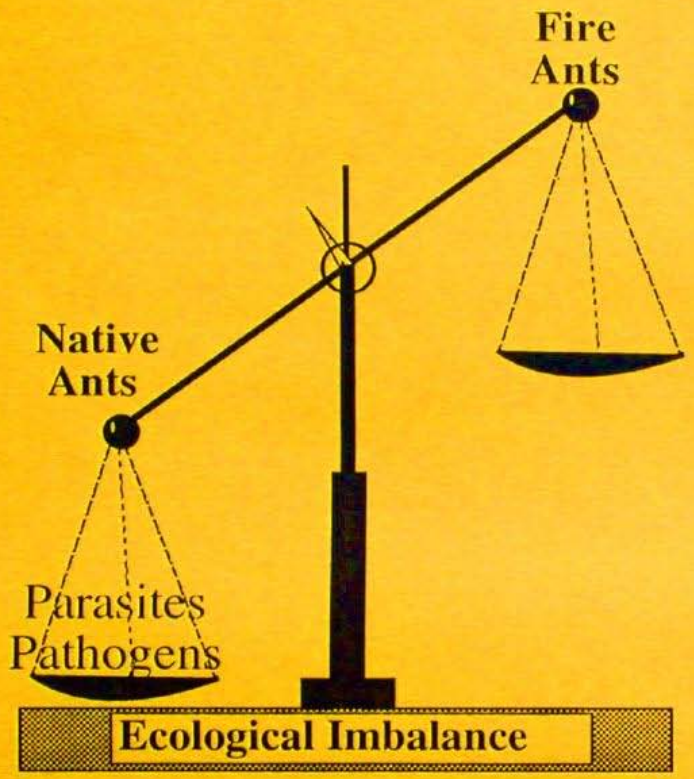
lit >tri ~ obt > cur

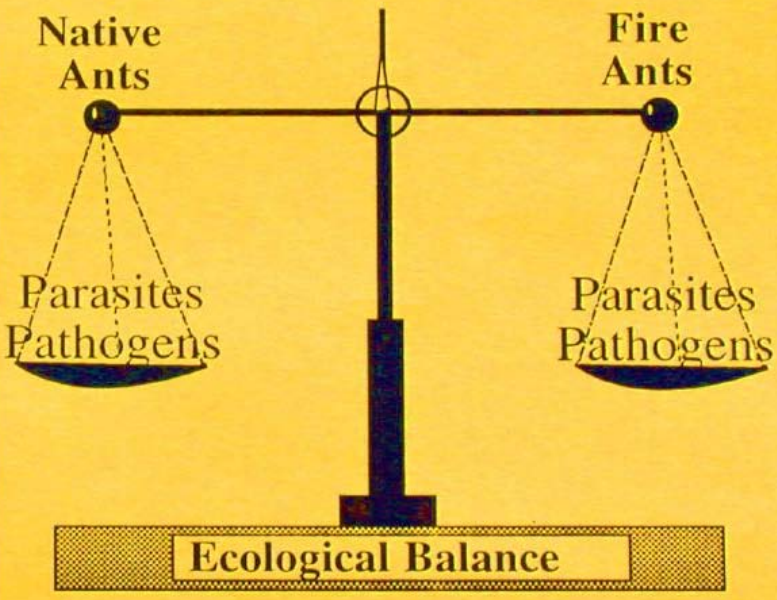
The relative abundance of fly species in the home range did a very poor job of predicting abundance in the introduced range.

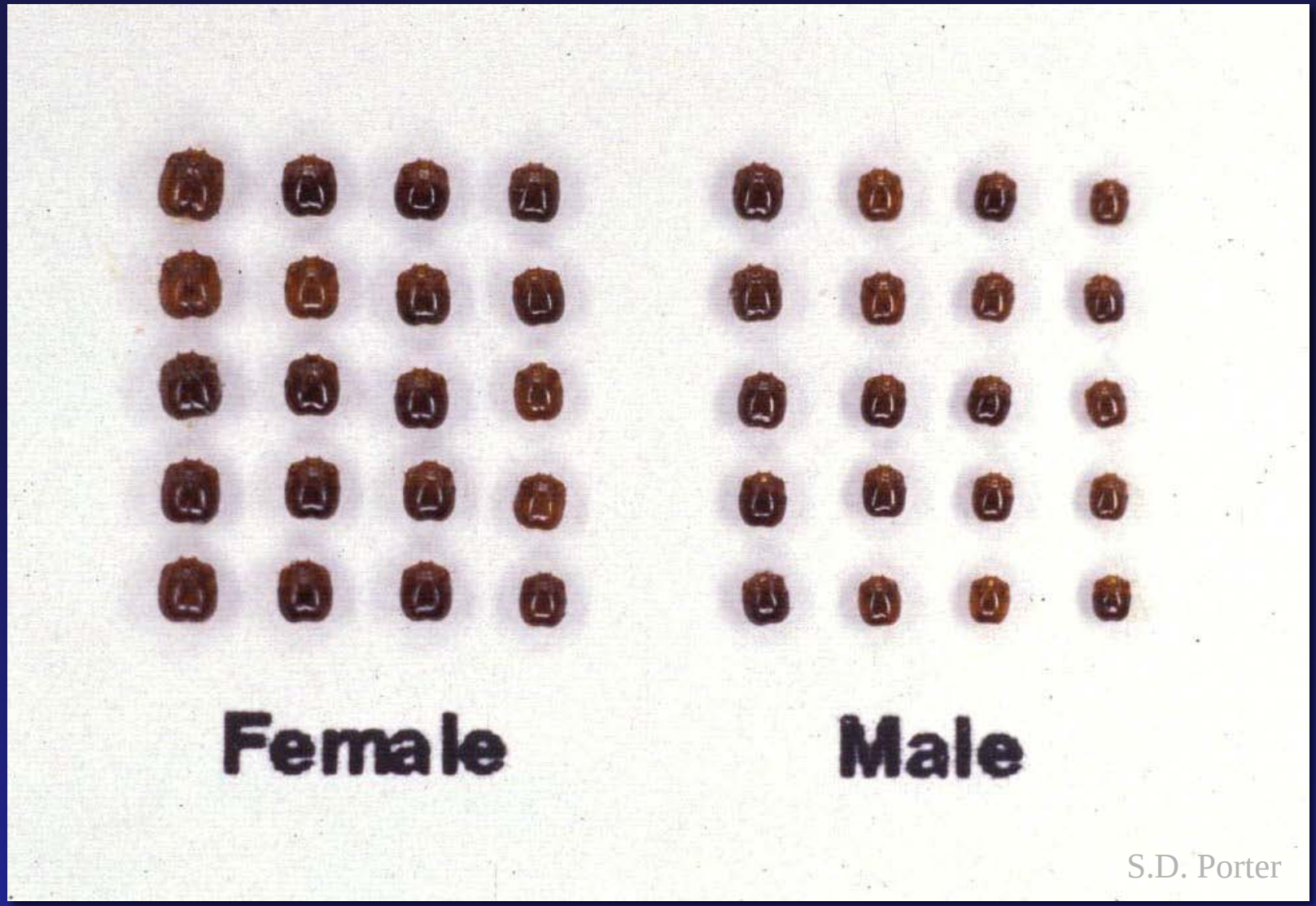
Summary:

- 4 species established, 1 in progress
- Strong evidence for interspecific competition among different species of decapitating flies
- Poor ability to predict which species will do best after introduction
- Assessment of impacts still in progress

Each new natural enemy will increase the magnitude and breadth of the impact.


Fire
Ants
Native
Ants
Parasites
Pathogens
Ecological Imbalance


Native
Ants
Fire
Ants
Parasites
Pathogens
Parasites
Pathogens
Ecological Balance


Female
Male
S.D. Porter