Rearing Methods of *Tamarixia radiata* in Gainesville, Florida, and information on its biology.

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International Workshop on *Tamarixia* Species  
McAllen, Texas - February 2, 2010
• 1998 - Asian Citrus Psyllids (ACP) first detected in FL

• Biological control investigated
  - Best host plant determined to be orange jasmine due to higher tolerance for large population of psyllid than citrus.
  - Industry donated orange jasmine plants for project.

• 2005, first U.S. detection of citrus greening on samples of pummelo leaves and fruit.

• 2007 - Orange Jasmine (Murraya paniculata) determined to be host of citrus greening

• Jan 1, 2008 all orange jasmine must be grown in a screen house structure designed to exclude the Asian citrus psyllid.

  These screened structures must be approved by the Division of Plant Industry FL Statue 5B-62.

  Result - no nurseries in FL are growing orange jasmine due to cost of complying with rule.
Sections (TRS) Positive for Huanglongbing (HLB, Citrus Greening) in Florida

Legend

- HLB Positive Sections (2,702)
- US Highways
- Major Cities

Florida Counties
HLB Positive Counties

34 Positive Counties
2,702 Positive Sections

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Production & Rearing Methods of:

- Orange Jasmine, *Murraya paniculata*
- Asian Citrus Psyllid, *Diaphorina citri*
- *Tamarixia radiata*
T. radiata in quarantine

The four T. radiata biotypes are: Florida (a genetic mix from southern Vietnam and Taiwan); Pakistan; Northern Vietnam and China.

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Orange Jasmine: Seed Germination
Vermiculite in incubator @ 90°F for 2 weeks
Orange Jasmine

- Separate individual plants from the root ball
- Place in new pot and add soil
- **Orange Jasmine inside the greenhouse**

  - water every other day, fertilize 1X month with milorganite (1 tsp) + 20-20-20 fertilizer solution
Orange Jasmine

Three months old - three years old

Vegetative propagation?
Major pests of Orange Jasmine in the greenhouse in Gainesville

1. Two spotted spider mite (*Tetranychus urticae*)
2. Cowpea aphid (*Aphis craccivora*)
3. Whitefly (*Aleuroclava jasmini*)

Control – once infested spray with soap/water 5% (3 X / week)
Rearing Methods for Asian Citrus Psyllid
Orange Jasmine with new sprouts.

Prune terminal growth, fertilize and put in greenhouse (2wks) to promote new growth.
Rearing cages for psyllid oviposition.

(80°F + 40-70% RH, 18 hr photoperiod)

- 25-30 plants are put into cage & infested with adult psyllids.
  (infest w/ 3-5k psyllid for 3-4d. 50-70 eggs per sprout)
- Transferred to holding cage for nymph development - 30-40 pots / cage
Young sprouts of Orange Jasmines with ACP eggs (yellow)
- Young nymphs of ACP
Life Stages of Asian Citrus Psyllid

14 days total developmental time from egg hatch

Female life span 6-8 months and can lay 800 eggs/2 months.

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Biology of *Tamarixia radiata*
When psyllid nymphs reach 3-4\textsuperscript{th} instar, colonized plants are transferred into parasite rearing cage + inoculated with 60-80 males/females of Tamarixia.

Females prefer to lay eggs on 4-5\textsuperscript{th} instars, but will attack younger nymphs.
Egg of *T. radidata* deposited between thorax & abdomen

Egg is light yellow and elongate oval.
Young larva of *Tamarixia radiata* on ACP nymph

- Use mouthpart to attach to psyllids integument and feed on the fluid of psyllid.
Mature larva of *T. radiata*

When they become mature (larvae), excrete white filament
Psyllid nymphs: (5th instar)

Filament fuses the psyllid host to plant. Can’t move or fall off.
Mummified nymphs of ACP
Pre-pupa (top) and pupa (bottom) of *T. radiata*
Exit hole of *T. radiata* (closer to head)
T. Radiata adult (female)
Tamarixia radiata

- Egg to adult – (80 F) 10-11 days
- A female may lay 160-300 eggs during her life span of 14-24 days.
- A female may kill more than 500 psyllid nymphs by combination of host feeding (60%) and parasitism (40%).
- Sex ratio varied (4 male: 6 female)
- In rearing conditions, female emerges first
- Life span of parasites fed with honey 25-30 days, unfed lasts 1-2 days.
Parasitoid Collection

Florida Department of Agriculture & Consumer Services, Charles H. Bronson, Commissioner
Division of Plant Industry
- **T. radita** collected by vacuum pump

Have to collect insects singularly with vacuum pump and aspirator. Suitable for small operation, but not mass production.
**T. radiata** collection box (experiment)

Painted black inside

One day before emergence:
A stem of Orange Jasmine / parasitized psyllid and put in box. When parasitoid emerge are attracted to light.

**Only collect ~50% of parasitoids.**
Rearing cage covered with black cloth to collect *T. radita*

- 2d post emergence, cover with black cloth, place vials on tops. 90% of parasites collected.
- 20 plants (+80 parasite) can yield 2,000 – 2,300 parasites.
- Hyper parasitism of *T. radiata*
- Host range study of *T. radiata*
Hyperparasitoids of *Tamarixia radiata* reported in Taiwan

- **Aphelinidae:** *Eacarsia* near *shafeei Marietta leoparchina*
- **Eulophidae:** *Tetrastichus* sp.
- **Encyrtidae:** *Syrphophagus taiwanus*
- **Signiphoridae:** *Chatocerus walkeri*
- **Pteromaridae:** *Pachyneron concolor*

Important - These have been reported in Taiwan, but we have not seen any of these in the state of FL.
Host range of *Tamarixia radiata*

*Tamarixia radiata* is a host specific parasitoid. It has only one reported host: *Diaphorina citri*.

However, these following psyllids were listed as hosts in the literature:

- **Psylla hyaline** - *India Walnut Psyllid*
  (listed by Peter et al. 1990 - checked voucher specimen by LaSalle. 1999)

- **Trioza erytreae** - *African psyllid*
  (listed by Annecke & Cilliers 1963 - voucher specimen checked by Daniel and Moran 1972)

It was determined these weren’t *radiata*, but another *Tamarixia sp*. *Tamarixia* has about 30-40 sp.
**Tamarixia radiata** host range test on indigenous psyllids in Florida 2009

APHIS PPQ requested host range tests before granting permit for release: China, Pakistan, Vietnam

5 species of psyllids were collected in FL from field:

- *Ceropsylla sideroxyli*
- *Hyteropsylla cubana*
- *Glycaspis brimblecombei*
- *Trioza magnobia*
- *Pachypsylla* sp.

*** In no choice test, no *T. radiata* emerged***
Ceropsylla sideroxyli

Unparasitized psyllid

Parasitized psyllid

This parasite collected in Indian River (Hall/Hibbards)

Exit hole on right parasitized.
**T. Radiata (male & female)**

**Tamarixia spp. (male & female)**

Parasite of *Ceropsylla sideroxyli*

Verified (by Greg Evans, Mike Gate) as Tamarixia sp. of *Ceropsylla Sideroxyli*
Biocontrol Program for Asian Citrus Psyllid

From lab production to mass-rearing insectory

1) Orange Jasmine production in 7,000 sq ft. screen house
2) Psyllid rearing in additional greenhouse
3) Parasites reared in walk-in environmental chambers
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