Aleyrodid Pupa Workshop

Beliz on Cocos nucifera
11-III-1996
Dr. Jon Martin 6770

Limes Malaysia
Oct 10, 1948 H. D. Smith
S.E.L.

ridges

thoracic cleft

longitudinal pair of ridges

Slide from the NHM, London (Dr. Jon Martin).
Image by PPQ San Francisco (J. Dooley)
Presented by John Dooley, PPQ
South San Francisco

John.w.dooley@aphis.usda.gov

650-876-9093 (office) & 650-876-0915 (fax)

• Training at The following Locations:
  USDA, APHIS, PPQ
  Plant Inspection Station
  11840 South La Cienega Blvd.
  Hawthorn, CA 90250
  (310) 725-1918-19 (phone) (310) 725-1922 (fax)
Purpose of Training

The purpose is to learn to identify the 4th stage (puparial stage only) to species of more common species that are intercepted in quarantine or domestically in the Western Region and Hawaii.

Therefore, an introduction into the identification of the prepupal stages (2nd & 3rd) will initially be discussed. Note prepupal stages cannot be identified beyond subfamily.
Aleyrodids Covered

The Aleyrodids consist of only two subfamilies: Aleurodicinae and Aleyrodinae. The species listed below will be covered in detail in order to identify them accurately. Other species may be covered by request after these are addressed. The prepupal stages consist of the egg, crawler, stage 2 & stage 3 nymphs.
Aleyrodids Covered: crawlers

The crawler stage is mobile with

- Well developed, 3 segmented legs
- Two to three-segmented antenna with the apical segment very thin and elongated extending beyond margin
- Cannot identify beyond family
The 2\textsuperscript{nd} & 3\textsuperscript{rd} stage nymphs are sessile and easily confused with the puparial stage:

- Reduced operculum and lingula
- Legs and antenna are reduced to one segment
- Legs normally oriented toward margin not down or toward median

1-2 segmented legs oriented marginally
Aleurodicticinae Subfamily

The following species will be discussed and those with an “*” are known to be important agricultural pests:

- **Aleurodicus**: *A. cocolobae* (Quaintance & Baker), *A. destructor* (Mackie)*, *A. dispersus* (Russell)*, *A. dugesii* (Cockerell)*, *A. rugioperculatus* (Martin)*

- **Dialeurodicus**: *D. niger* (Bondar) & *D. tessellatus* (Quaintance & Baker)

- **Metaleurodicus**: *M. cardini* (Back)

- **Paraleyrodes**: *P. bondari* (Martin), *P. minei* Iaccarino, *P. perseae* (Quaintance), and *P. pseudonaranjae* (Martin).
Aleyrodinae Subfamily

• The following species will be discussed and those with an “*” are known to be important agricultural pests:

  – **Aleurocanthus**: *A. citripervdus* (Quaintance & Baker)*, *A. husaini* (Corbett)*, *A. spiniferus* (Quaintance)*, *A. spinosus* (Kuwana)*, *A. t-signatus* (Martin), *A. woglumi* Ashby*

  – **Aleurocerus**: *A. musae* Russell & *A. palmae* Russell

  – **Aleuroclava**: *A. aucubae* (Kuwana), *A. jasmini* (Takahashi), *A. psidii* (Singh)

  – **Aleuroglandulus**: *A. subtilis* Bondar (includes *A. malangae*)

  – **Aleurolobus**: *A. marlatti* (Quaintance & Baker)*, *A. olivinus* (Silvestri)*, *A. subrotundus* (Silvestri)

  – **Aleuroparadoxus**: *A. iridescens* (Bemis) & *A. illicicola*
Aleyrodinae Subfamily Con’t

- **Aleuropleurocelus**: *A. abnormis* (Quaintance), *A. ceanothi* (Sampson), *A. nigrans* (Bemis)
- **Aleurothrixus**: *A. antidesmae* (Takahashi), *A. flocossus* (Maskell)*
- **Aleurotrachelus**: *A. atratus* (Bondar), *A. trachoides* (Back)*
- **Aleurovitreus**
- **Aleyrodes**: *A. proletella*, *A. lonicera*
- **Bemisia**: *B. afer* (Priesner & Hosny)*, *B. giffardi* (Kotinsky)*, *B. tabaci* (Gennadius)*
- **Crenidorsum**: *C. aroidephagus* Martin et al
- **Dialeurodes**: *D. citri* (Ashmead)*, *D. kirkaldii* (Kotinsky)*
Aleyrodinae Subfamily Con’t

– **Dialeuropora**: *D. 10-punctata*

– **Orchamoplatus**: *O. mammaeferus* (Quaintance & Baker)*

– **Paraleurolobus**: *P. chamaedoreae* Russell

– **Rusostigma**

– **Singhiella**: *S. citrifolii* (Morgan)*

– **Siphoninus**: *S. phillyreae* Goux


– **Trialeurodes**: *T. abutiloneus* (Haldeman), *floridensis* (Quaintance), *T. lauri* (Signoret), *T. vaporariorum* (Westwood)*, *T. variabilis* (Quaintance) *T. vitrinellus* (Cockerell)
Aleurodicinae vs. Aleyrodinae

**Aleurodicinae:**
Terminal appendage: claw (none for *Nipaleyrodes* & *Stenaleyrodes*; right image)

**Aleurodinae**
Terminal appendage: adhesive pad
Aleurodicinae vs. Aleyrodinae

Aleurodicinae
Setal pairs on lingula:
2 pairs (4 setae)

Compound pores:
absent or present

Aleyrodinae
Setal pairs on lingula:
1 pair (2 setae)

Compound pores: absent (do not confuse with large disc pores (as in *Dialeuropora*)
Aleurodicinae

1. Compound pores absent ........................................... \textit{Dialeurodicus}

   This genus has a pear-shaped appearance consisting of several species. The most common is \textit{D. tessellatus} and the only species with a reticulated derm.

1’. Compound pores present ..................................................2

- Cone-shaped:
  - Aleurodicus
  - Lecanoideus

- Dagger or spike-shaped:
  - Azuraleurodicus
  - Bakerius

- Rod-shaped splines:
  - Paraleyrodes
Aleurodicinae

2 Five or six pairs of abdominal compound pores; if five pairs only present, then first abdominal pore only reduced; if six pairs, then with anterior two pores reduced; compound pores usually with splines (rod-shaped structures emerging from central lumen of compound pores) and annuli (inner and outer ring of cells within the compound pores that may be round to flower-petal shape); lingula always exserted, protruding outside of the vasiform orifice towards to caudal margin (may or may not terminate at or beyond the caudal margin) ........................ Paraleyrodes

2'. Four to six pairs of compound pores present .............................. 3
Aleurodicinae

3 Four pairs of abdominal compound pores; central process absent or rudimentary; dorsal loculate (star-shaped) disc pores; lingula exserted, extends beyond posterior border of vasiform orifice .......................................................... Metaleurodicus cardini (Back)

3 With four or six pairs of abdominal compound pores; loculate pores absent but sometimes with other specialized pores (reniform, double- & wide-rimmed); lingula always exserted ................................. Aleurodicus
Aleyrodinae

1 With spines or siphon-like tubes ......................................................2

1’ Spines or siphon-like tubes absent .................................................4

2 With spines ..................................................................................Aleurocanthus

2’ With siphon tubes either scattered dorsally or paired ......................3
Aleyrodinae

3  Siphon tubes numerous & scattered ........ *Siphoninus phillyreae* Goux

3’ 2 pairs of Siphon tubes ........ *Aleurothrixus antidesmae* Takahashi
Aleyrodinae

4  With a submarginal row of papillae, tubercles or specialized glands ........... 5

4’ Submarginal row of papillae, tubercles or glands absent; if present, not in a submarginal row ................................................................. 7

5  Barrel-shaped glands only; tracheal clefts dentate ............... *Orchamoplatus*

5’ Papillae or tubercles present, shape otherwise; tracheal clefts otherwise ..... 6
Aleyrodinae

6 With a submarginal row of tubercles; thoracic tracheal cleft platelike; anal cleft furrow present; shape insinuate; lingula simple (left image) ..........................

............................................................... Aleuroclava jasmini Takahashi

6' With a submarginal row of papillae; tracheal clefts not or slightly differentiated, not platelike; anal cleft furrow absent; lingula lobed (above left image)...........................Trialeurodes
Aleyrodinae

7  With a horn-like structure above the vasiform orifice; puparia dark colored

\[ \textit{Aleurocerus} \]

7’ Horn-like structure absent (may be broken off); puparia light or dark .......... 8

8  Pupal case light colored; with large discoidal pores (left image) or submedian pairs of glands (right image) ................................................................. 9

8’ Pupa case dark colored; large pores or glands absent ................................. 10
Aleyrodinae

9  Puparia light colored; with 2 pairs of large submedian thoracic glands; thoracic and caudal clefts dentate with numerous teeth

------------------------------------------------------------------------------------------------------------------------------- Aleuroglandulus striatus

9’ Puparia light colored; with 5 pairs of large subdorsal discoidal pores; thoracic clefts plate-like ................................................... Dialeuroplora 10-punctata Takahashi

10 Dorsal or ventral margin reflexed (turned up) ventrally or deflexed (turned down) dorsally ............................................................................................................ 11

10’ Margin not deflexed or reflexed; subdorsal or subventral sutures absent or present .................................................................................................................. 12
Aleyrodinae

11  Pupal case light colored; margin reflexed ................. *Aleurovitreus*

11’ Pupal case dark colored; margin reflexed ........... *Aleuropleurocelus*

12  Subdorsal suture absent (ventral suture may be present) ............ 13

12’ Subdorsal suture present ............................................................... 21
Aleyrodinae

13  Submarginal row of glands, papillae, or tubercles present ...........14

13’ Without a submarginal row of structures ..................................16

14  With a submarginal row of barrel-shaped glands ........ Orchamoplatius

14’ With a submarginal row of papillae/tubercles ......................... 15
Aleyrodinae

15  Thoracic tracheal cleft present with plate, single row of papillae ..........

.................................................................

Aleuroclava jasmini Takahashi

15’  Thoracic tracheal margin undifferentiated; single to multiple submarginal rows of papillae .................................................................

.................................................................

Trialeurodes

- narrow marginal crenulations & papillae

- Cuba in Quarantine at Miami
  28 April 1995
  SEL 95 6208

- Philadeiphus sp.
  12 September 1985
  Det: R. Gill
  85116-41

- Slide from California Dept. Food & Agriculture Image by PPG, San Francisco (J.Deoley)
Aleyrodinae

16 Vasiform orifice acutely triangular shape containing an inserted spinulose acutely elongated lingula; some with a pronounced caudal furrow; and completely exposed with a trapezoidal operculum covering only the anterior half of the vasiform orifice .................................................................17

16' Lingula otherwise .................................................................................................................. 18
Aleyrodinae

17  Two elongate submedian parallel ridges from thorax to vasiform orifice  

........................................................................................................ Bemisia giffardi (Kotinsky)

17’ Without elongate ridges; if present, not parallel and terminates before level of 

vasiform orifice .................................................................................. Bemisia spp

18  Tracheal cleft present with pore, plate, or teeth; tracheal furrows present 

(unmarked or marked with reticulations, pores)  .......................................................... 19

18’ Without obvious tracheal pore or plate ......................... Aleyrodes spp.
Aleyrodinae

19  Tracheal pore greatly invaginated and reticulated ........ Rusostigma

19’ Tracheal pores shallow, otherwise ................. Other Dialeurodini ..20

20  Faint cranial suture present ................................. Dialeurodes

20’ Faint cranial suture absent ......................... Singhiella citrifolii (Morgan)
Aleyrodinae

21   Suture disjuncted ................................................................. \textit{Aleurothrixus}

21'  Suture radially concentric, or paired ......................................................... 22
Aleyrodinae

22  Suture as paired structures, unjoined structures, sometimes limited to thoracic areas and anterior abdominal segments .......................... Aleurotrachelus

22’ Suture radially concentric from cephalothorax; joined or interrupted below or at the level of the vasiform orifice ................................................................. 23
Aleyrodinae

23 Tracheal clefts usually defined as dentate (with 3 or more teeth each that are smaller than marginal teeth); eyespots present or absent; with caudal ridges; caudal ridge interrupts concentric fold ... *Aleurolobus*

23' Characters otherwise with concentric fold .......................................................... 24

24 Thoracic cleft with plate; caudal furrow present ........................................... *Aleuroclava*

24' Thoracic cleft undifferentiated; caudal furrow absent .................................... 25
Aleyrodinae

25 Marginal teeth with a submarginal row of glands that give the appearance of the margin with a double row; puparium always dark ....... *Aleurocerus*

25’ Margin dentate with one row of teeth; puparium normally dark, sometimes light colored .................................................. *Tetraleurodes*
Glossary

• **Adhesion pads** are cushion-like structures that form the apical terminal appendage of the legs.
  – They are present only in the immature form of the Aleyrodinae subfamily of whiteflies (left image below).

• **Agglomerate pores** are a type of compound pores for the purposes of this key consisting of sub circular to oval large pore-like structures with a clear margin containing a central cluster of small pore-like or papillae (rt two images).
  – according to Quaintance (1917) "consist of a clear marginal area and a central area composed of numerous small papillae or rod-like pores, giving this area the appearance of a brush."
  – according to Caballero, "simple pore arranged in a restricted circle, giving the appearance of a compound pore; there is a large, chitin process in the center..."
Glossary

- **Annulus** (plural, annuli), occurring in the Genus *Paraleyrodes*, refers to the structure in compound pores composed of a ring of facets or "spinneret" cells that resemble variable shaped facets or cells (left image below).

- **Disc (discoidal)** pore is a minute, circular, pore without locules (spinneret cells) or central processes occurring on the sub medial, sub dorsal or sub marginal dorsal surface (above right image).

- **Double-rimmed simple pore** is a circular pore along the sub margin with a light, central portion encircled by a dark rim which is also encircled the same but lighter rim (image below).
Glossary

- **Central processes** are structures, if present, that rise from the center (central lumen) of a compound pore in the form of splines (rods), cones, spikes or other shapes.

- **Cordate vasiform orifice** refers to the "heart-like" shape of the orifice.

- **Claws** are hook-like structures that form the apical terminal appendage of the leg.
  - They are present as a single claw in the immature stages (except the egg and crawler stages), of the Aleurodicinae subfamily of whiteflies (absent only in the *Nipaleyyrodes* & *Stenaleyyrodes*).
Glossary

• **Compound pore** (for the purposes of this key) are the following:
  – Small to large invaginated gland with none to several distinct spinneret cells (or loculi) arranged in a circular fashion at the lumen (central base) at its base. A central process may be absent or emerge from the central lumen in the form of splines (rods), cones, spikes or other shapes.

  • **Splines**: rod-like structures extending from the central lumen of the compound pore occurring only in *Paraleyrodes*

  – Small circular or sub circular glands enclosing a cluster of pitting or papillae-like structures, also known as agglomerate compound pores.

  – Caveat: do not confuse with large simple discoidal pores found in *Dialeuropora*. 
Glossary

**Compound Style Pores**

- **agglomerate**
  - Leonardius
  - Synaleurodicus

- **cone shape**
  - Aleurodicus
  - Lecanoideus

- **dagger shape**
  - Azuraleurodicus
  - Bakerius

- **splines (rod shape)**
  - Paraleyrodes

- **whip or spine shape**
  - Eudialeurodicus

- **no central processes**
  - Metaleurodicus

- **reduced processes**
  - Eudialeurodicus
  - Metaleurodicus

- **solitary**

- **no central processes**
  - Aleuronudus
  - Octaleurodicus

Images: Slide from Systematic Entomology Lab., Image by PPQ (John Dooley).
Glossary

- Derm may be corrugated, smooth, reticulated, rugose, or tessellated.
  - Rugose cuticle (portion roughened)
    - *Aleurodicus rugioperculatus* (top right image)
    - The submargin to the subdorsal area distinctly roughened or reticulated.
    - *A. talamancensis* sp. nov. is known for the submedian corrugated area.
  
  - Corrugated operculum surface (wrinkled)
    - *Aleurodicus rugioperculatus* (top right image)
    - *A. niveus* sp. nov. has the operculum partially rugose.

  - Tessellated cuticle (forming cellular type derm pattern)
    - *Dialeurodicus tessellatus* (lower right image)
Glossary

• **lingula** is the dorsal organ that is attached within the vasiform orifice with a pointed, paddle, or tongue shaped appearance; considered an organ to remove fecal material.
  
  – It may be contained within (*inserted*), or extend beyond the orifice (*exserted*).

• **Loculate** pores are simple discoidal pores that show cells (divisions) within the pore and giving the star-shaped appearance.
Glossary

- **Operculum** is the plate or lid-like structure that partly or completely covers the vasiform orifice. Dorsal surface usually is smooth, but in some species rugose or corrugated.

- **Pores-Octagonal**: compound sub circular complex pores with the central area taking the shape of a star (allegedly 8 points).

- **Pore-Reniform septate** is a simple kidney shaped pore with a raised or flush.
• **Pore-Septate** pore is a circular or sub circular, slightly tuberculate and faintly porous pore with a rim much darker than the center and a bar-like line extending bisecting the pore.

• **Pore-Septate double-rimmed** pore is similar to the simple pore but has a septate (divided) orifice as well as an outer and inner rim.

• **Pore- Wide rim** pore is a circular or sub circular, sometimes sub marginal, with the rim as wide or wider than the center's diameter.

• **Splines**: rod-like structures protruding from the central lumen of a compound pore occurring only in Paraleyrodes.
Glossary

Shapes-Puparium:

1. **Asymmetric**: lateral halves of the pupal case different

2. **Boat shape**: typical shape for the genus *Aleuropleurocelus* appearing as the bow and stern of a boat

3. **Insinuate** (pear-shaped)

**Splines**: rod-like structures extending from the central lumen of the compound pore occurring only in *Paraleyrodes*
Glossary

- **Suture- Disjuncted**: appears broken or fragmented but is joined from the cephalon to below the vasiform orifice (not a uniform arc-two left images).

- **Suture- radially concentric**: the subdorsal suture separating the dorsum from the venter and uniformly forms an arc somewhat equidistant from the margin (right images).
  - Joined below vasiform orifice
  - Interrupted below vasiform orifice

*Images show examples of suture types.*
• Terminal (apical) appendages of the legs consists of either an adhesion pad or a claw:

  – The apical terminal appendages of the Aleurodicinae subfamily consists of a claw (hook-like) structures for stages 2 through 5. The only exceptions are the genera *Nipaleyrodes* & *Stenaleyrodes* which lacks the claw.

  – The apical terminal appendages of the Aleyrodinae subfamily consists of an "adhesion pad" (cushion-like and usually hyaline) structures for only the immature stages. Claws replace the pads in the adult stage.

• **Vasiform orifice** is the dorsal anal opening on the last abdominal segment; covered by the plate-like operculum enclosing partly or completely the lingula.
Thanks

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