“Facing Challenges”
Old, New, & Emerging Diseases
Hawaii Island

Lisa Keith
USDA/ARS, Hilo, HI
Tropical Fruit Growers Conference 2017
OUTLINE:
1) DIAGNOSED PATHOGENS
2) MYSTERIES OF THE PAST
3) NEW MYSTERIES
4) ROD
Teamwork!

The Growers

- Lionel Sugiyama
- Nicholle Konanui
- Tracie Matsumoto
- Russell Kai
- Carol Mayo Riley
- Tsuyoshi Tsumura
- Claire Arakawa
- Jason Okamoto
- Amy Strauss
- Darsen Aoki
- Donna Ota
- Ryan Domingo

- Wade Heller
- Blaine Luiz
- Marc Hughes
- Eva Brill
- Cortney Dougherty
- Flint Hughes
- J.B. Friday
- Brian Bushe
- Roxana Myers
- Cathy Mello
- Jon Suzuki
- Jonathan Horrell
Old, New, & Emerging Diseases
Hawaii Island

1) Diagnosed pathogens
2) Mysteries of the past
3) New mysteries
4) ROD
Rambutan Corky Bark

Dolabra sp.
Pathogenicity Tests

No wound

Wound by scalpel

Wound by cork borer
Langsat Corky Bark

- Conidia
- Isolate on PDA
- Fungal Fruiting Body

*Dolabra* sp.
Stem Canker/Corky Bark Disease

- *Dolabra nepheliae*
- Originally described from Malaysia
- Also known on pulasan in Australia, lychee and rambutan in Puerto Rico
- Classified by FAO as a ‘minor disease’
- Potential damage of this disease
- Mechanisms of control
Fungal Diseases of Longan

Pestalotiopsis sp.
Phomopsis sp.
Colletotrichum sp.
Disease Incidence

- **Biew Kiew**
  - Fruit fly damage – 30.0%
  - *Pestalotiopsis* – 46.7%
  - *Phomopsis* - 10.0%
  - *Colletotrichum* - 3.3%
  - *Lasmenia* – 3.3%

- **Egami**
  - Fruit fly damage - 38.9%
  - *Pestalotiopsis* - 22.2%
  - *Phomopsis* - 11.1%
In Vitro Fungicide Assays, % Inhibition

- **Trilogy®**
  - *Pestalotiopsis*, 26%
  - *Phomopsis*, 14%
- **Abound®**
  - *Pestalotiopsis*, 44%
  - *Phomopsis*, 30%
- **Serenade®**
  - 100% effective at all concentrations tested
Scab Disease of Guava

*Pestalotiopsis* spp.
Symptoms of (A) leaf blight, (B) stem canker and (C) tip dieback of *Garcinia mangostana* caused by a *Pestalotiopsis* sp.
Macadamia Quick Decline

• Prove Pathogenicity: Symptoms and Signs
• Strategies for controlling MQD

*Phytophthora tropicalis*

*Nectria sp.*

Ambrosia beetle frass

*Sap bleeding*

*Phytophthora tropicalis*
MQD Treatment Methods: Lab

Water

Fosphite

% decrease in leaf spot size of 69.5%
MQD
Treatment Methods:
Field

• Arborjet System
Old, New, & Emerging Diseases
Hawaii Island

1) Diagnosed pathogens
2) Mysteries of the past
3) New mysteries
4) ROD
Rambutan Quick Decline

- **Rapid/quick decline of tree**
- **Lateral branch**
  - X-section w/ discoloration
- **Ambrosia beetle damage**
- **Fusarium sp. recovered from two discolored areas (blue arrows)**
- **Phytophthora sp. isolated from soil**
Pulasan Quick Decline

Quick decline, rapid browning of leaves and Ambrosia beetle damage

X-section with discoloration (lower section)

Fusarium sp. recovered from discolored area
Longan Slow Decline

Moderate to severe leaf chlorosis, necrosis, leaf twisting, and leaf drop

Fusarium sp. & Phytophthora sp. were recovered
Old, New, & Emerging Diseases Hawaii Island

1) Diagnosed pathogens
2) Mysteries of the past
3) New mysteries
   1) Guava Wilt
   2) Longan Dieback
   3) Lychee Dieback
   4) Macadamia Quick Decline II
4) ROD
Guava Wilt

Leafspot, wilting of lower branches, and defoliation

HPSI 67 'Rica'
Guava Wilt

Greyish brown leafspot, expanding to entire leaf and defoliation; Isolation of *Colletotrichum* sp. (pathogenicity testing in progress)
Guava Wilt

Wilting of lower branch and leaves

Question: pathogen related, herbicide overspray, or a combination of both?
Longan – Dieback Complex (?)

Tree 1

Chlorotic leaves and leaf drop

6 months later
100% leaf browning
with 70% defoliation
Longan – Dieback Complex (?)

Discoloring of sapwood in upper limb; limb above and left of uprooted stump

Bark removed, exposing discolored hardwood; Beetle tunneling evident

Recovered: *Lasiodiplodia theobromae*

Prove pathogenicity
Longan – Dieback Complex (?)

Tree 2

Within 6 months of leaves turning chlorotic, leaves had completely turned brown, with over 70% to 80% defoliation; tree died

Cut stump with beetle tunneling

Uprooted stump, orange interior with blackened decayed areas

Recovered: Campylocarpon sp.
Lychee – Dieback

- Partially dead – 40% dead
- 100% brown and dead
Lychee – Dieback

Numerous Ambrosia beetle tunneling of branches and base of tree

Recovered oomycete fungi from surrounding soil
Macadamia Quick Decline – Old and New
Macadamia Quick Decline – Old and New

Trunk bleeding and frass
Macadamia Quick Decline – Old and New

MQD Original – *P. tropicalis*

MQD II – *P. heveae*
Old, New, & Emerging Diseases
Hawaii Island

1) Diagnosed pathogens
2) Mysteries of the past
3) New mysteries
4) ROD
ʻŌhiʻa, *Metrosideros polymorpha*, Myrtaceae

- Dominant tree in 80% of Hawaiian forests
- Both primary succession and old-growth species
- Forms almost pure stands; Morphologically diverse
- Important for watershed, wildlife, and cultural values
Rapid ‘Ōhi’a Death

- Causing widespread mortality of ‘Ōhi’a (*M. polymorpha*) on Hawai‘i Island
- Characterized by canopy browning, wilt, death, and defoliation
- Caused by two new wound colonizing fungi of *Ceratocystis*
C. fimbriata and spp.

- Wide geographical distribution and host range (woody and herbaceous plants)

- Fungus-Host → 250 records world-wide including 31 plant species and 14 plant families

- Wound parasites; disrupt water movement; cankers; necrosis of inner bark; discoloration of sapwood; wilt and canker stain pathogen; death

- Important Tree Diseases (not found in Hawai‘i):
  - C. fimbriata s.l. – Sweet potato, Mango, Eucalyptus, Taro, Cacao, Citrus spp., Coffee, Rubber tree, Prunus spp., Fig, Poplar, Acacia spp. & Kiwi........ at least 40 genera in 35 countries
  - C. manginecans - Mango sudden decline (Oman and Pakistan)
  - C. platani - Canker stain disease of sycamore (Europe)
  - C. fagacearum - Oak wilt (USA)
  - C. smalleyi – Hickory canker (USA)
Ceratocystis Isolates in Hawai‘i
(‘Invasive Species’)

- **Sweet potato pathogen**: In HI >75 years; Only infects sweet potatoes; Worldwide distribution

- **Syngonium pathogen**: Isolated at a BI nursery in 1979/2016; Broadly distributed (Florida, Brazil, Australia); Closely related to strains that affect crops (coffee, cacao) and forest species (eucalyptus, sycamore)

- **Taro pathogen**: First isolated in 1990’s on Oahu and Kaua‘i; minor pathogen on storage roots

- ‘Ōhi‘a pathogens: Two new species isolated from dead and dying ‘Ōhi‘a trees
Isolation, ID & Pathogenicity Tests
Field Symptoms & Signs

Ceratocystis sp. A

Ceratocystis sp. B

RAPID ‘ŌHI‘A DEATH
Fungal Biology/Host Range/Resistance Testing

M. polymorpha varieties and spp.

Ag & Nursery Crops

- London Plane
- Taro
- Syngonium
- Coffee
- Sweet potato

RAPID ‘ŌHI‘A DEATH
USDA, ARS PBARC
Avocado Laurel Wilt

Laurel wilt was first discovered in Georgia in 2002 on the red bay tree, *Persea borbonia* due to the insect *Xyloborus glabratus* and its associated symbiotic fungi, *Raffaelea lauricola*.

The fungus infects and kills other members of Lauraceae including avocado, *Persea americana*.
Laurel Wilt was detected in Miami-Dade county in 2011.
USDA ARS Subtropical Horticulture Research Station in Miami, FL

- Clonal repository for 269 avocado accessions among other tropical/subtropical fruit trees and sugarcane.
- Currently free from the ambrosia beetle and laurel wilt, but expensive prophylactic fungicide treatments are needed yearly.
- Hilo was selected as the backup for this valuable collection, but special measures were necessary to avoid transfer of laurel wilt or avocado sunblotch viroid (ASBVd).

<table>
<thead>
<tr>
<th>Name</th>
<th>Accessions</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Annona</em> spp. (sugar apple)</td>
<td>26</td>
</tr>
<tr>
<td><em>Averrhoa carambola</em> (carambola)</td>
<td>13</td>
</tr>
<tr>
<td><em>Cocos</em> spp. (coconut)</td>
<td>20</td>
</tr>
<tr>
<td><em>Dimocarpus</em> spp. (longan)</td>
<td>10</td>
</tr>
<tr>
<td><em>Ficus</em> spp. (tropical fig)</td>
<td>115</td>
</tr>
<tr>
<td><em>Hevea</em> spp. (natural rubber)</td>
<td>13</td>
</tr>
<tr>
<td><em>Litchi chinensis</em> (lychee)</td>
<td>18</td>
</tr>
<tr>
<td><em>Mangifera</em> spp. (mango)</td>
<td>316</td>
</tr>
<tr>
<td><em>Musa</em> spp. (banana/plantain)</td>
<td>93</td>
</tr>
<tr>
<td>Palmae (palms)</td>
<td>411</td>
</tr>
<tr>
<td><em>Persea americana</em> (avocado)</td>
<td>269</td>
</tr>
<tr>
<td><em>Psidium</em> spp. (guava)</td>
<td>13</td>
</tr>
<tr>
<td><em>Saccharum</em> spp. (sugarcane)</td>
<td>~1300</td>
</tr>
<tr>
<td><em>Theobroma cacao</em> (cacao)</td>
<td>120</td>
</tr>
<tr>
<td>Total</td>
<td>~3300</td>
</tr>
</tbody>
</table>
Transfer of avocado germplasm from Miami to Hilo via Fort Detrick

ARS Miami sends seeds for rootstock and clean scion to the ARS Foreign Disease/Weed Science lab in Fort Detrick, MD.

Plants are tested to be free of Laurel Wilt and Avocado Sun Blotch Viroid.

Clean scion are sent to ARS Hilo and grafted in approved quarantine facility.
Triple-tested avocado accessions grown in Hilo

Each accession is maintained in a 5 gal pot in covered greenhouses and a field planting

Screening by Wade Heller
In addition to Laurel wilt each plant is tested for the presence of Avocado Sun Blotch ASBVd.

ASBVd testing developed at USDA ARS Miami (David Kuhn and Barbara Freeman) and transferred to ARS Hilo (Ryan).
Develop molecular markers to confirm identification of Sharwil avocados

Working with ARS SHRS, Miami (Kuhn and Freeman) to develop Sharwil specific SNP (single nucleotide polymorphism) markers to confirm identity of Sharwil avocado

Conducted in support of Dr. Alyssa Cho’s Sustainable Hawaii Avocado Production for Market Expansion
Research Areas

Objectives

Understanding basic biology via molecular/proteomic approach
To know "how", "where", "when", and "what for" are the several hundred thousand of individual protein species produced in a cell, how they do interact with each other and with other molecules to construct the cellular building, how they do work in order to fit in with programmed growth and development (life cycle), and to interact with their biotic (nutrition) and abiotic environments (climate changes).

Approach

1. To establish proteome profiling & atlas of fruit flies and their interactive parasitoids;
2. To apply the foundational knowledge to interested research areas;
3. To identify and manipulate the interested proteins/genes to develop novel pest control technologies (RNAi) for fruit fly control.

Proteome profiling

Fig. 2. Proteome differences between successive developmental times of 2-24, 48-72, 96-120, or 144-168 h after parasitism