

Tobacco- inhabiting *Myzus* Aphids in the Southeastern United States: Who Are They, and What do We do About Them?

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***Myzus* Aphids in North Carolina**

- **Seven, possibly 8 species of *Myzus* in NC**
- **Only form of real economic significance is *Myzus persicae* complex, the green peach aphid**
- **Only one other member of subgenus *Nectarosiphon* found in area (*M. certus*, on *Viola*, rare)**

Aphids In North Carolina

Tobacco

- *Myzus* aphids are potentially the most important pests of tobacco in North Carolina
- Virtually all NC (and SE US) populations are apparently parthenogenetic year-round
- Tobacco-inhabiting aphids are dimorphic for color; an association between the red form and resistance to organophosphorous insecticides is well established

Aphids in Tobacco And Other Plants

- ***Myzus* aphids are also important in several other crops in the SE US:**
 - Cole crops (cabbage, broccoli, etc.)
 - Mustard greens
 - White potato
 - Tomato
 - A host of wild plant species, importantly, many feral Brassicaceous and Solanaceous species





The image shows two tobacco leaf samples side-by-side. The sample on the left is dark brown and heavily distorted, with a white label that reads 'APHIDS'. The sample on the right is a lighter, golden-brown color and appears much smoother and more regular in shape, with a white label that reads 'NO APHIDS'.

APHIDS

NO
APHIDS

Tobacco-inhabiting Myzus: Who are They?

Myzus persicae?

Myzus nicotianae?

Genetic Variation in the *Myzus persicae* Complex: Methods

- **Gene sequencing**
 - Mitochondrial cytochrome oxidase II (COII)
 - Elongation factor -1 alpha (EF- 1 α)
- **RAPD-PCR**
- **Cuticular Hydrocarbons (GC-MS)**
- **Host preference**

Tobacco Collections

| <u>Location</u> | <u>Color morph</u> | <u>Type</u> | <u>Analysis</u> |
|--------------------------------|--------------------|-------------|-----------------|
| Hartford Co., CT | orange-red | burley | R, S |
| Ashe Co., NC | red | burley | R |
| Duplin Co., NC | green, red | flue-cured | R |
| Franklin Co., NC | red | flue-cured | G |
| Granville Co., NC | dark green, red | flue-cured | R |
| Johnston Co., NC | green, red | flue-cured | G, HP, R, S |
| Wake Co., NC (Clayton) | green, red | flue-cured | R |
| Wake Co., NC (Raleigh) | red | flue-cured | G |
| Darlington Co., SC | dark green, red | flue-cured | R |
| Dillon Co., SC | green, red | flue-cured | R |
| Horry Co., SC | green, red | flue-cured | R, S |
| Marion Co., SC (Centenary) | green, red | flue-cured | R |
| Marion Co., SC (Nichols) | green, red | flue-cured | R |
| Campbell Co., VA (Brookneal) | red | flue-cured | R |
| Campbell Co., VA (Gladys) | red | flue-cured | R |
| Nottoway Co., VA (Blackstone) | green, dark red | flue-cured | R, S |
| Nottoway Co., VA (Ellett Farm) | green, red | flue-cured | R |
| Chiba Pref., Jap. | dark red | flue-cured | R, S |

* **G = GC-MS, HP = host preference, R = RAPD-PCR, S = gene sequence**

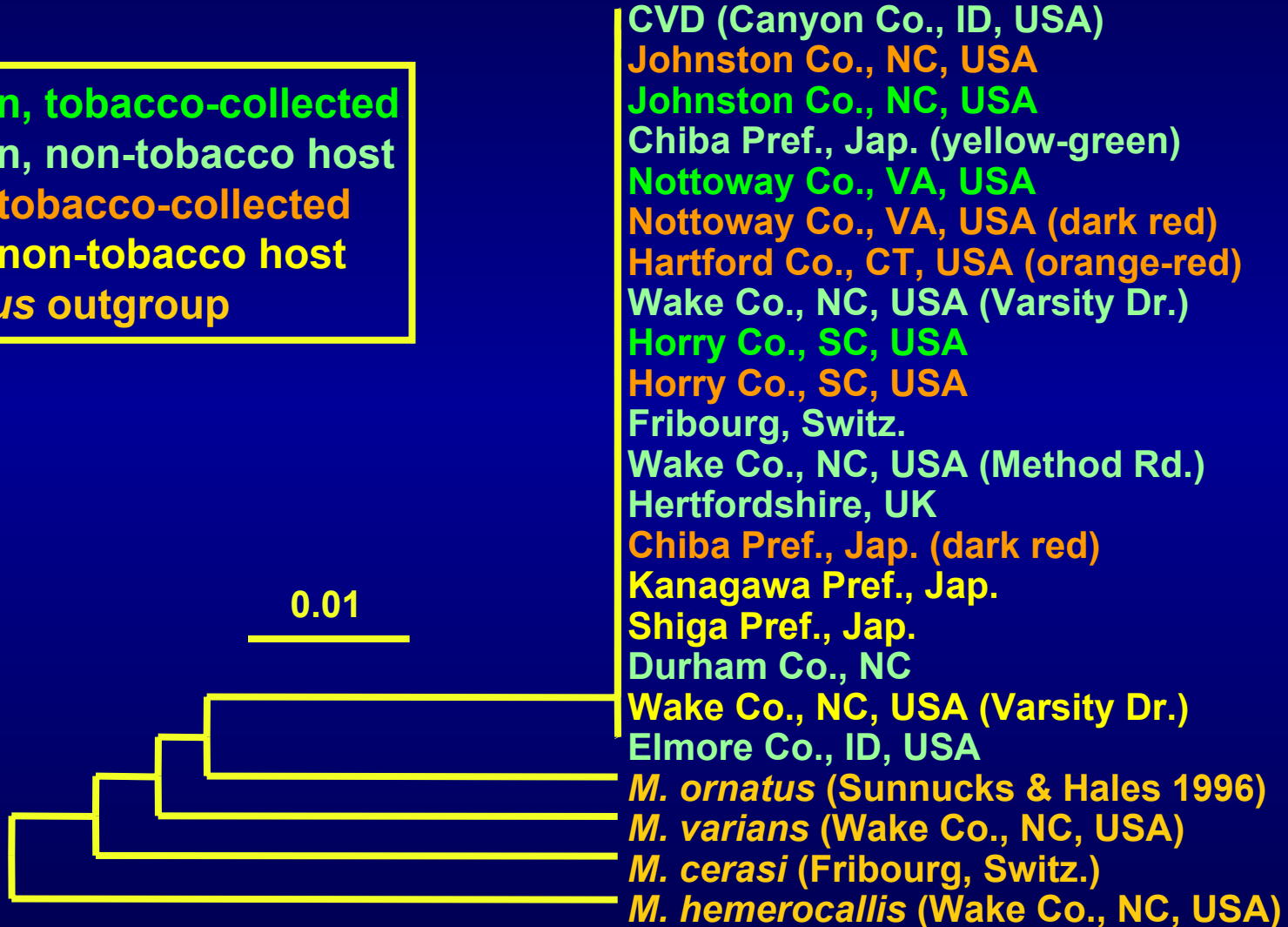
Non-Tobacco Collections

| <u>Location</u> | <u>Color morph</u> | <u>Host plant</u> | <u>Analysis</u> |
|------------------------------|------------------------|--------------------------------|-----------------|
| Elmore Co., ID | pale green | <i>Capsicum annuum</i> | R, S |
| Durham Co., NC | pale green | <i>Capsicum annuum</i> | G, S |
| Wake Co., NC (Dan Allen Dr.) | pale green/pink | <i>Hibiscus rosa</i> | G, R |
| Wake Co., NC (Method Rd.) | pale green | <i>Physalis angulata</i> | G, R, S |
| Wake Co., NC (Varsity Dr.) | pale green, pink | <i>Celosia argentea</i> | R, S |
| Washington Co., VA | pale green | <i>Solanum dulcamara</i> | G, HP |
| Chiba Pref., Jap. | yellow-green | <i>Brassica campestris</i> | R, S |
| Kanagawa Pref., Jap. | red | <i>Brassica campestris</i> | R, S |
| Shiga Pref., Jap. | red | <i>Brassica campestris</i> | R, S |
| Fribourg, Switz. | pale green | <i>Capsella bursa-pastoris</i> | R, S |
| Hertfordshire, U.K. | pale green | <i>Solanum tuberosum</i> | R, S |
| <hr/> | | | |
| Wake Co., NC | <i>M. varians</i> | <i>Clematis</i> sp. | R, S |
| Wake Co., NC | <i>M. hemerocallis</i> | <i>Hemerocallis fulva</i> | R, S |
| Fribourg, Switz. | <i>M. cerasi</i> | <i>Prunus cerasus</i> | R, S |

* **G = GC-MS, HP = host preference, R = RAPD-PCR, S = gene sequence**

COII Tree (UPGMA)

- green, tobacco-collected
- green, non-tobacco host
- red, tobacco-collected
- red, non-tobacco host
- *Myzus* outgroup

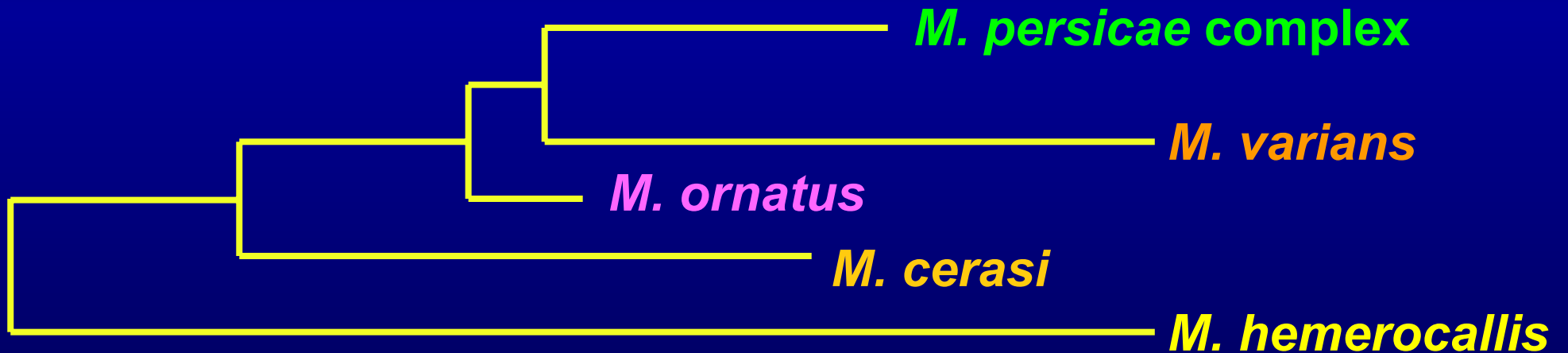


EF-1 α Tree (UPGMA)

- green, tobacco-collected
- green, non-tobacco host
- red, tobacco-collected
- red, non-tobacco host
- *Myzus* outgroup



Parsimony Tree (Combined COII & EF-1 α Data Sets)



Uncorrected Pairwise Genetic Distances (COLI, Below Diagonal; EF-1 \forall , Above Diagonal)

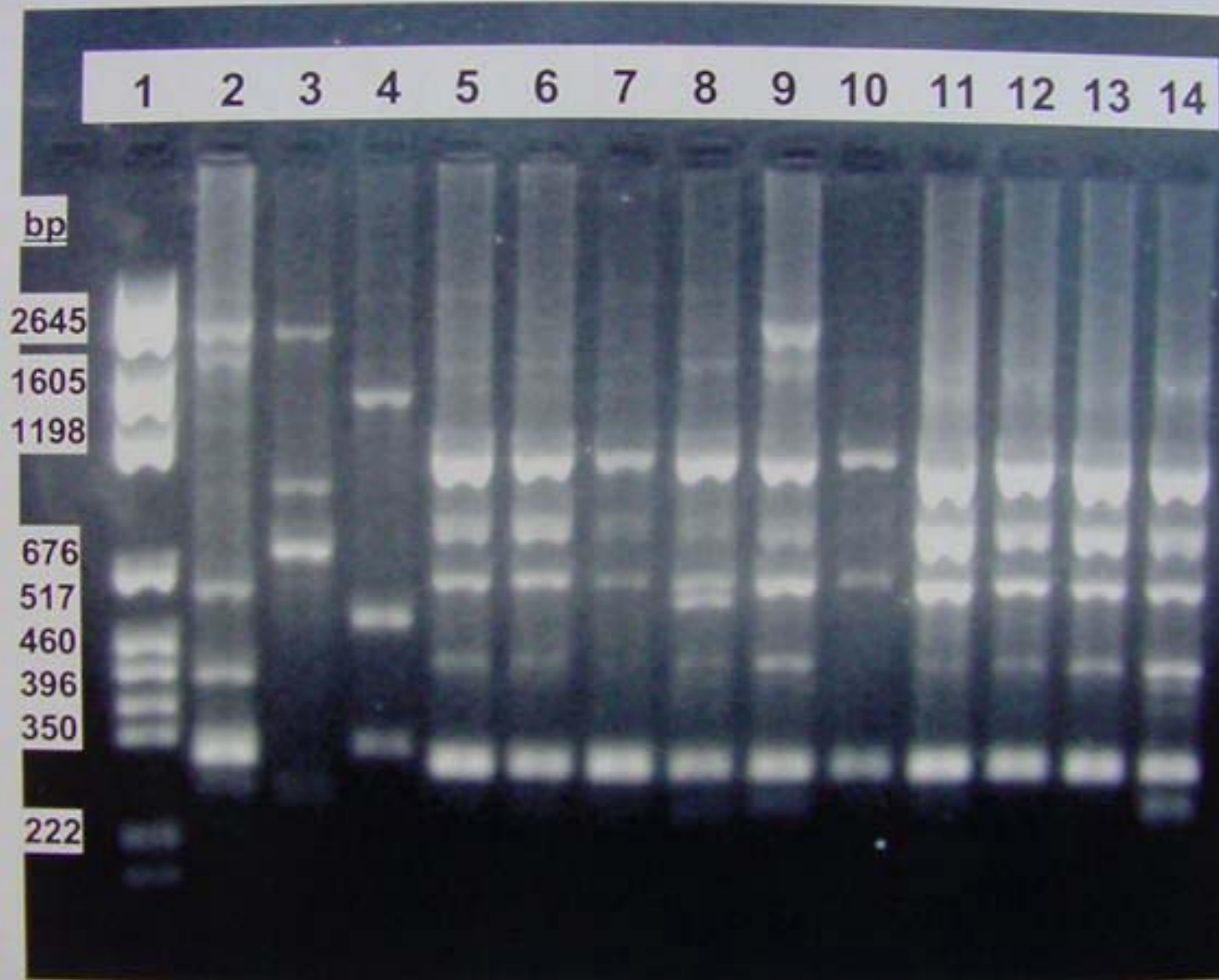
| | <i>M.p.</i> | <i>M.n.</i> | <i>M.c.</i> | <i>M.h.</i> | <i>M.v.</i> | |
|----------------------------------|-------------|-------------|-------------|-------------|-------------|-----|
| <i>M. persicae</i> (consensus) | - | 0.0 | 5.8 | 11.4 | 4.9 | --- |
| <i>M. nicotianae</i> (consensus) | 0.0 | - | 5.8 | 11.4 | 4.9 | --- |
| <i>M. cerasi</i> | 4.9 | 4.9 | - | 12.4 | 7.1 | --- |
| <i>M. hemerocallis</i> | 5.6 | 5.6 | 5.5 | - | 11.9 | --- |
| <i>M. varians</i> | 4.3 | 4.3 | 5.2 | 5.6 | - | --- |
| <i>M. ornatus</i> | 3.9 | 3.9 | 4.4 | 6.0 | 4.7 | - |

Approximate Dates of Divergence (Mya) Assuming the Mitochondrial Clock of Brower (1994)

| | <i>M.p.</i> | <i>M.c.</i> | <i>M.h.</i> | <i>M.v.</i> |
|----------------------------|-------------|-------------|-------------|-------------|
| <i>M. persicae</i> complex | - | | | |
| <i>M. cerasi</i> | 2.1 | - | | |
| <i>M. hemerocallis</i> | 2.4 | 2.4 | - | |
| <i>M. varians</i> | 1.9 | 2.3 | 2.4 | - |
| <i>M. ornatus</i> | 1.7 | 1.9 | 2.6 | 2.0 |

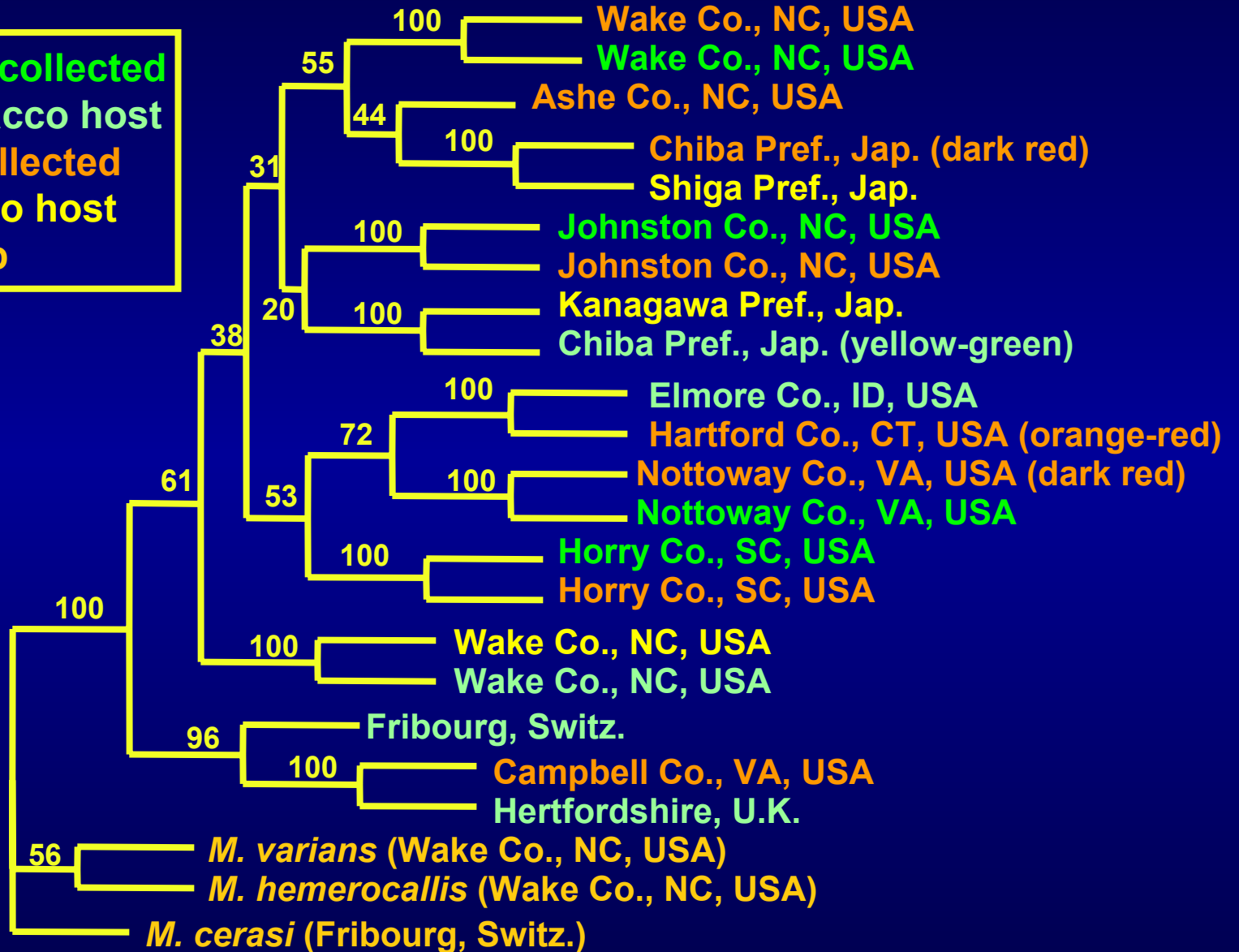
RAPDS Primers and Number of Bands Amplified By Each

| Primer | Sequence | Total bands | Polymorphic bands | Polymorphic bands within complex |
|--------|-------------------|-------------|-------------------|----------------------------------|
| OPA-02 | 5' -TGCCGAGCTG-3' | 21 | 19 | 7 |
| OPA-07 | 5' -GAAACGGGTG-3' | 19 | 18 | 7 |
| OPA-09 | 5' -GGGTAACGCC-3' | 12 | 11 | 4 |
| OPA-12 | 5' -TCGGCGATAG-3' | 14 | 14 | 4 |
| OPA-15 | 5' -TTCCGAACCC-3' | 15 | 15 | 5 |
| OPA-16 | 5' -AGCCAGCGAA-3' | 17 | 17 | 12 |
| OPA-18 | 5' -AGGTGACCGT-3' | 20 | 20 | 13 |
| OPA-19 | 5' -CAAACGTCCG-3' | 18 | 17 | 4 |
| OPA-20 | 5' -GTTGCGATCC-3' | 12 | 12 | 5 |



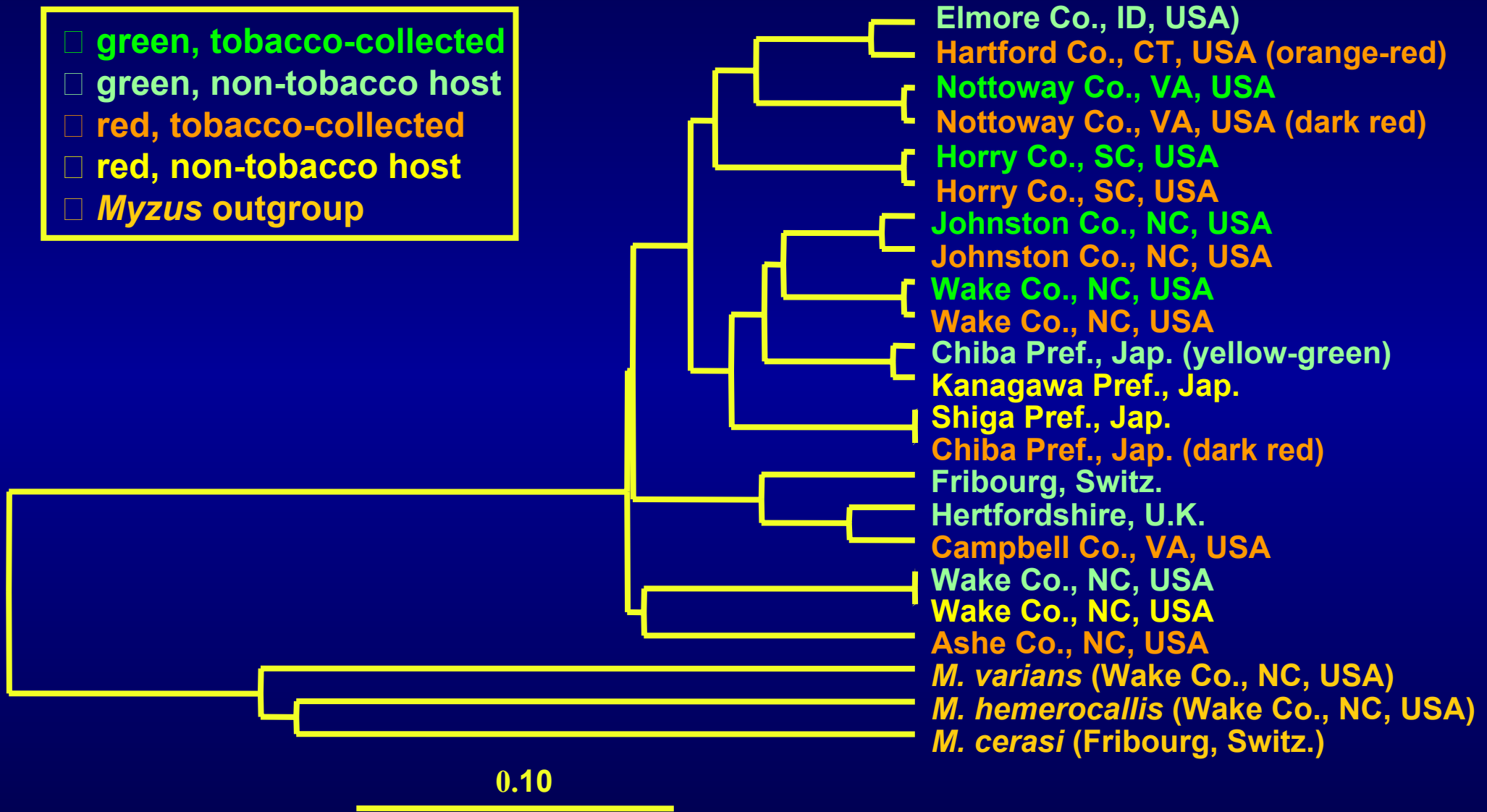
RAPDS Tree (Neighbor-Joining)

- green, tobacco-collected
- green, non-tobacco host
- red, tobacco-collected
- red, non-tobacco host
- *Myzus* outgroup



RAPDS Tree (UPGMA)

- green, tobacco-collected
- green, non-tobacco host
- red, tobacco-collected
- red, non-tobacco host
- *Myzus* outgroup

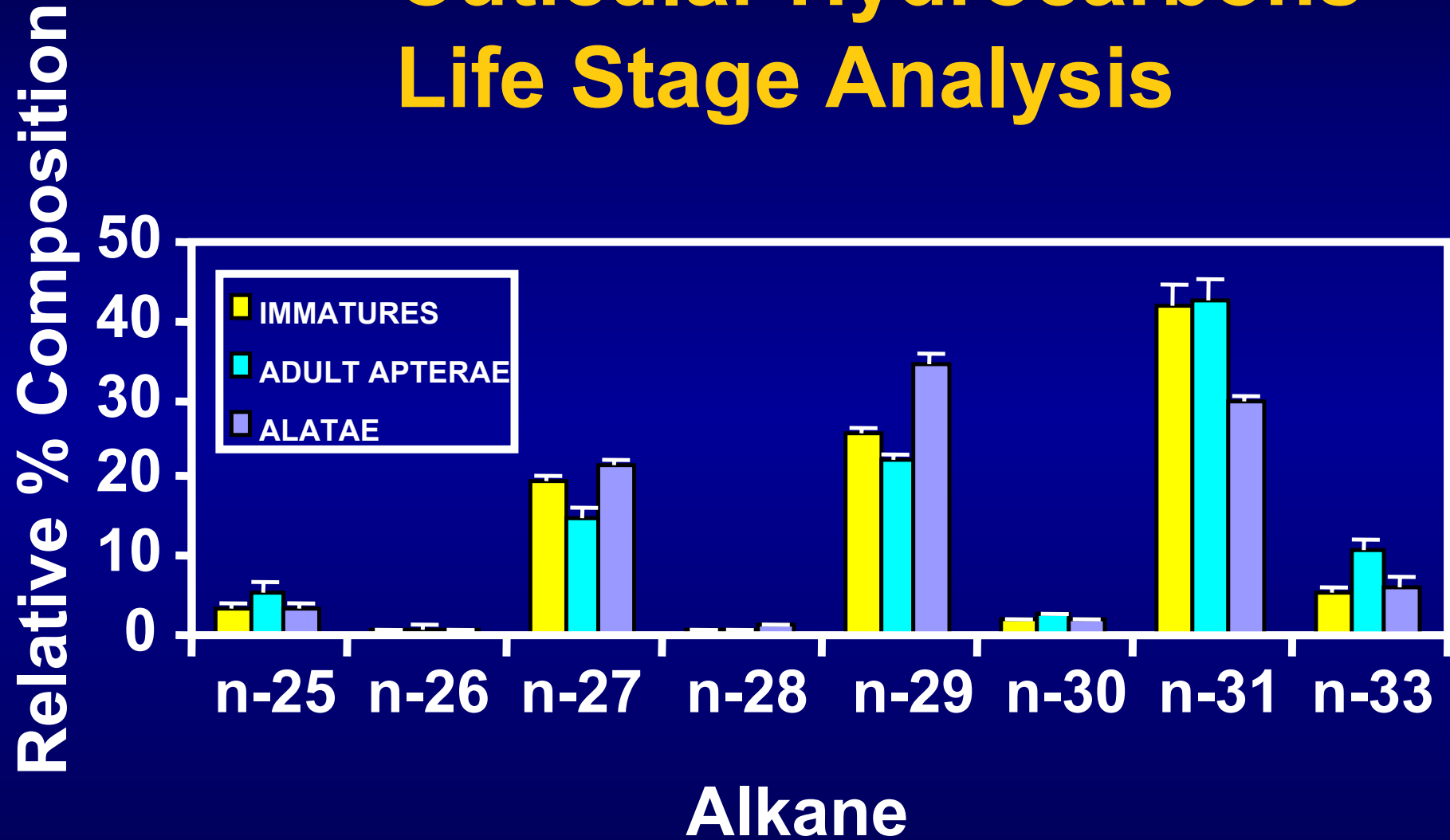


Hydrocarbons Identified By GC-MS

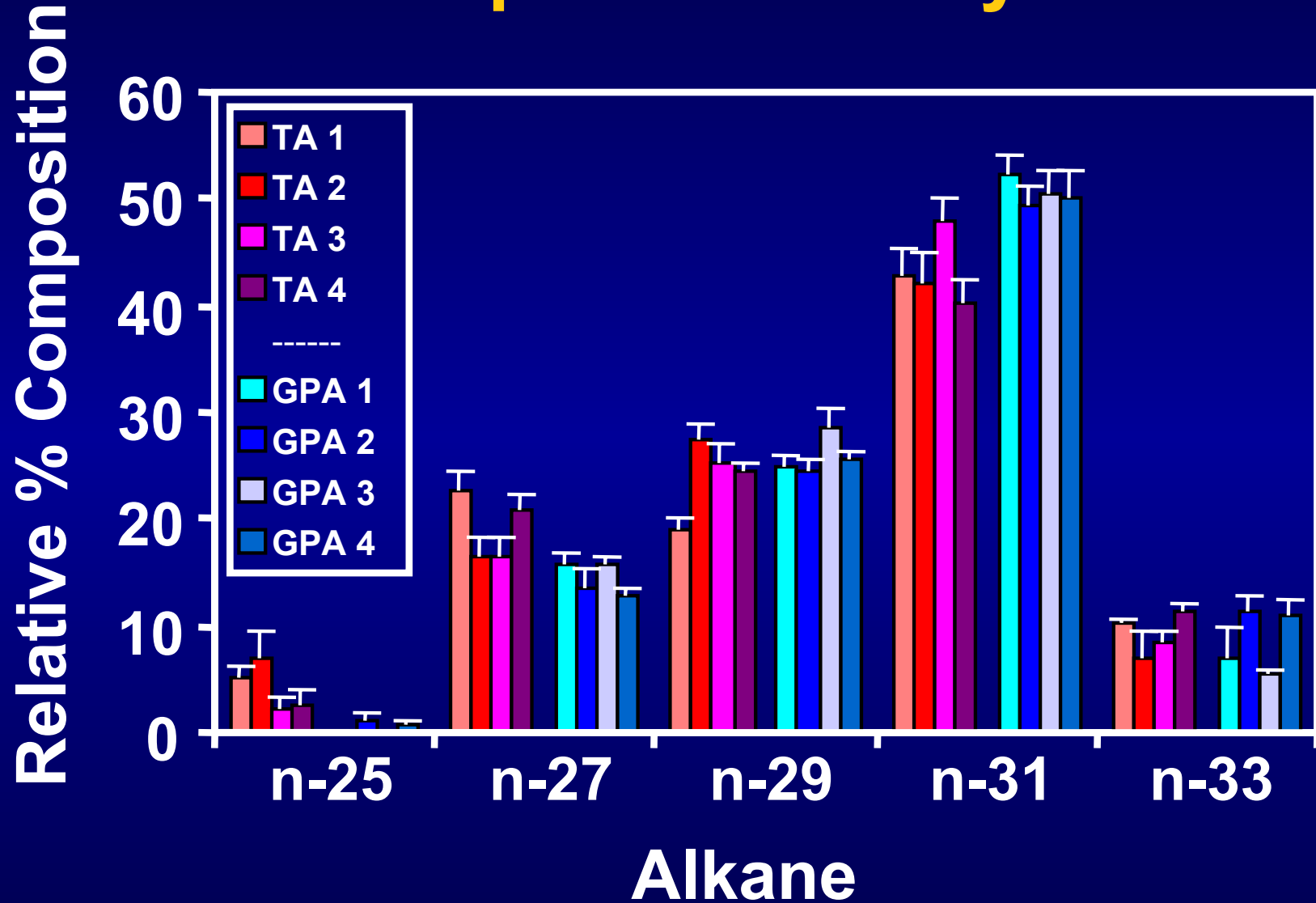
| Retention time (min) | ECL* | Hydrocarbon | Molecular ion (m/z) |
|----------------------|------|--------------------------|---------------------|
| 12.66 | 25 | <i>n</i> -Pentacosane | 352 |
| 13.58 | 26 | <i>n</i> -Hexacosane | 366 |
| 14.49 | 27 | <i>n</i> -Heptacosane | 380 |
| 15.36 | 28 | <i>n</i> -Octacosane | 394 |
| 16.22 | 29 | <i>n</i> -Nonacosane | 408 |
| 17.03 | 30 | <i>n</i> -Tricontane | 422 |
| 17.84 | 31 | <i>n</i> -Hentriacontane | 436 |
| 19.37 | 33 | <i>n</i> -Tritriacontane | 464 |

*Equivalent chain length

Cuticular Hydrocarbons- Life Stage Analysis



Population Analysis



Response to Hosts

Percent choosing collard when offered a choice between collard and:

| | <u>Mustard</u> | <u>Lettuce</u> | <u>Tobacco</u> |
|---------------------|----------------|----------------|----------------|
| Green Tobacco Aphid | 16.3a | 15.0ab | 16.3a |
| Red Tobacco Aphid | 14.1a | 7.5b | 22.1a |
| Green Peach Aphid | 13.6a | 19.5a | 17.6a |

Percent choosing lettuce when offered a choice between lettuce and:

| | <u>Mustard</u> | <u>Collard</u> | <u>Tobacco</u> |
|---------------------|----------------|----------------|----------------|
| Green Tobacco Aphid | 32.1a | 60.6a | 41.2a |
| Red Tobacco Aphid | 45.2a | 73.9a | 40.2a |
| Green Peach Aphid | 46.7a | 48.3b | 39.9a |

Percent choosing mustard when offered a choice between mustard and:

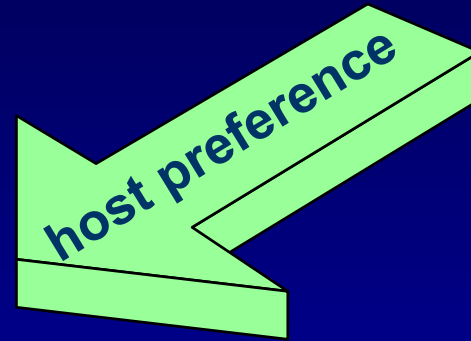
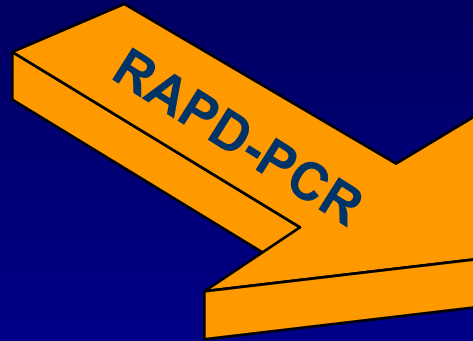
| | <u>Lettuce</u> | <u>Collard</u> | <u>Tobacco</u> |
|---------------------|----------------|----------------|----------------|
| Green Tobacco Aphid | 49.4a | 67.8a | 50.5a |
| Red Tobacco Aphid | 37.1a | 58.5a | 49.5a |
| Green Peach Aphid | 35.8a | 64.3a | 53.0a |

Percent choosing tobacco when offered a choice between tobacco and:

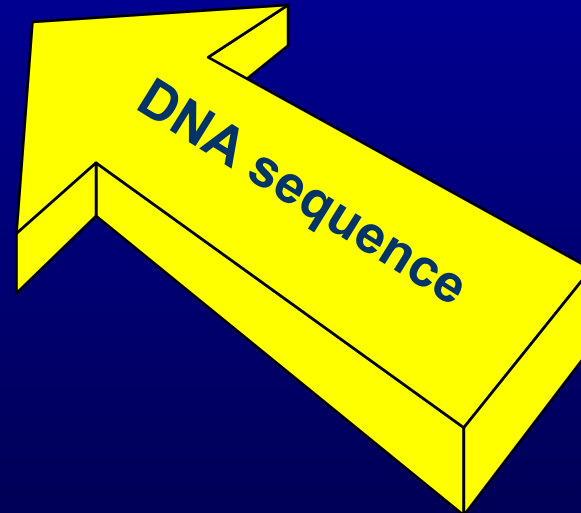
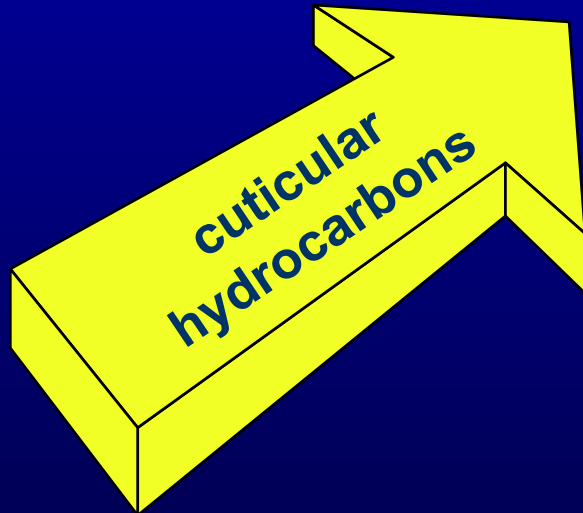
| | <u>Lettuce</u> | <u>Collard</u> | <u>Mustard</u> |
|---------------------|----------------|----------------|----------------|
| Green Tobacco Aphid | 37.2a | 67.5a | 36.0a |
| Red Tobacco Aphid | 43.7a | 60.6a | 32.6a |
| Green Peach Aphid | 46.4a | 67.6a | 37.5a |

Means within a column followed by same letter are not significantly different at $P = 0.05$ by Least Squared Means

Conclusion



M. nicotianae* = *M. persicae



Managing Aphids in North Carolina Tobacco

Managing Aphids on Tobacco: Biology

- **Aphids overwinter on alternate hosts, especially wild Brassicas**
- **Movement of alates in spring generally occurs shortly after tobacco transplant**
- **Asexual reproduction**
- **Live-bearing**

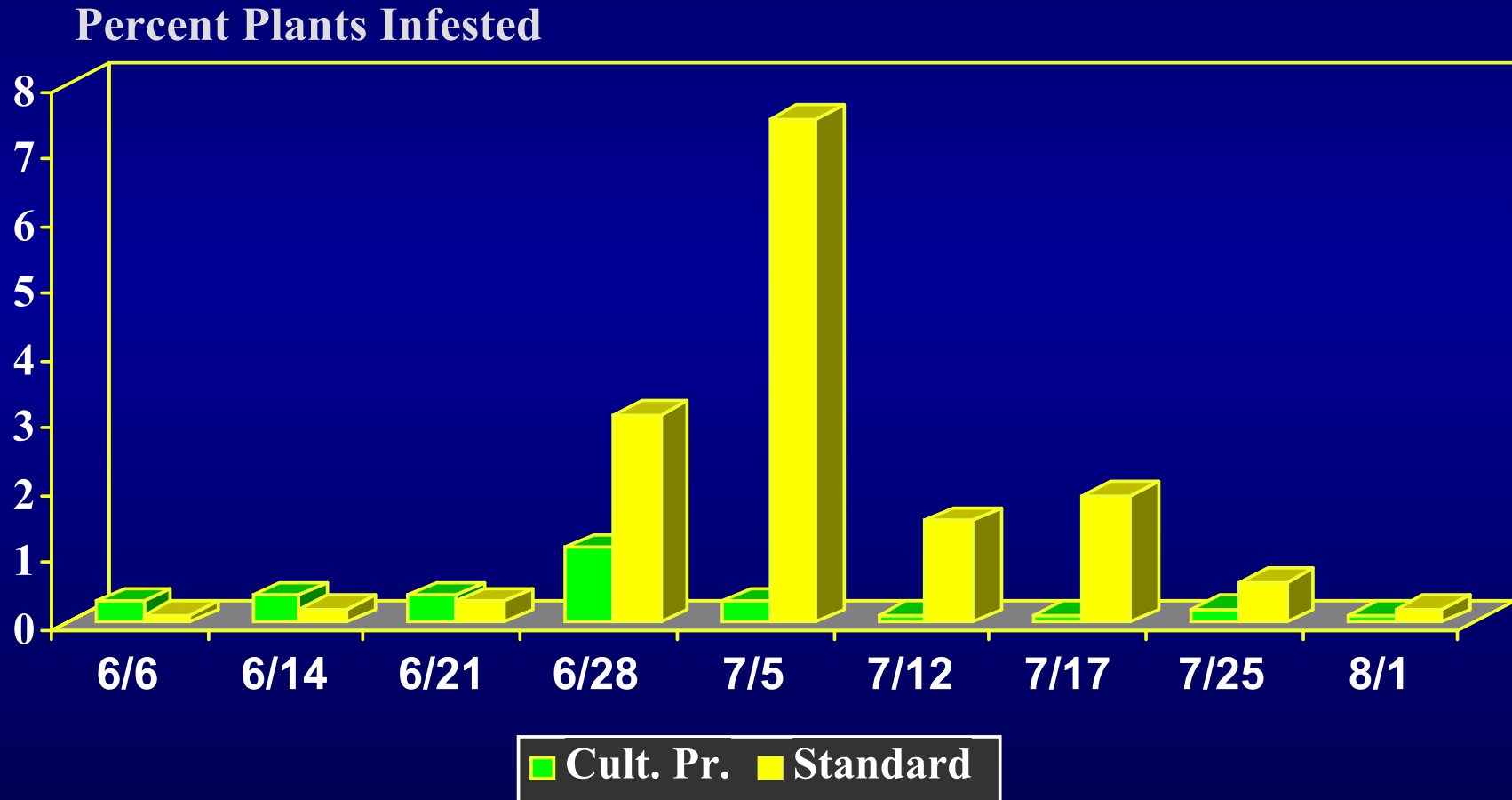
Managing Aphids on Tobacco: Biology

- **Many generations on tobacco**
- **Generation time ca. 7 days under typical summer conditions**
- **Population doubling time as short as 2.2 days**
- **Data suggests that both continual colonization and, to lesser extent, within field movement contribute to growing infestations**

Cultural Practices for Aphid Management

- **Control aphids in plant bed or greenhouse**
- **Consider early planting**
- **Don't exceed recommended nitrogen**
- **Top early (50% early button)**

EFFECT OF CULTURAL PRACTICES ON APHIDS - JOHNSTON CO. - 1991



Aphid Management Program

Consider a soil-applied systemic

Neonicotinoid resistance concerns?

SYSTEMIC INSECTICIDES

2002

| | APHID | FLEA BEETLE |
|--------------|-------|-------------|
| Imidacloprid | +++ | +++ |
| Disulfoton | | ++ |
| Carbofuran | | +++ |
| Acephate | + | +++ |
| Thiomethoxam | +++ | +++ |
| Aldicarb | +++ | ++ |

Aphid Management Program

- Don't wait too long to begin treatment if needed
- Threshold = 10% of plants infested



Aphid Management Program

- Choose effective insecticides
- Use maximum rates for heavy infestations

APHID CONTROL

2002

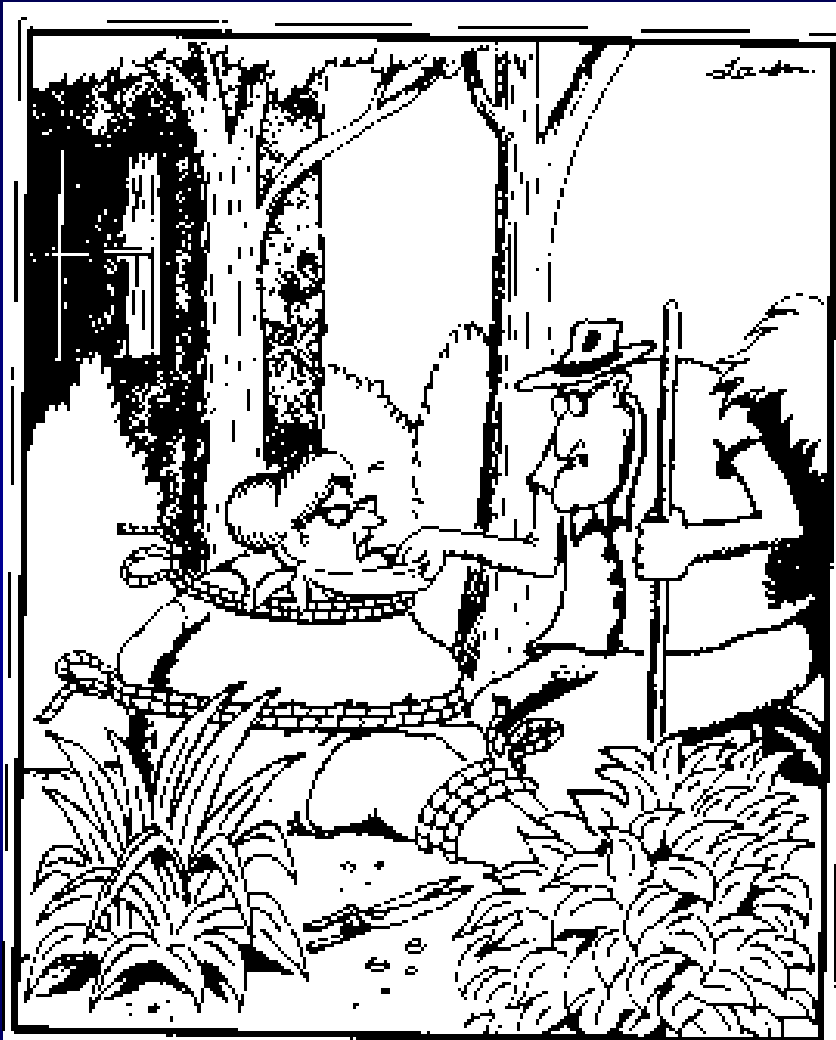
| | |
|---------------------|-------------|
| Thiomethoxam | ++++ |
| Acephate | ++++ |
| Imidacloprid | ++++ |
| Pymetrozine | +++ |
| Endosulfan | +++ |
| Methomyl | + |

Aphid Management Program

- **Use proper application**
- **Wait at least 3 days before judging control**
- **Switch to another recommended material if control is poor**
- **Continue to watch fields - aphids can rebound**

Beneficials and Aphid Management in Tobacco

- **Often, a large variety of beneficials are present in North Carolina tobacco fields**
- **Tobacco appears to confront many beneficials with a very inhospitable environment**
- **Aphid movement into tobacco fields is often on such a scale that beneficials present are overwhelmed**
- **Aphids may be beneficial at low numbers as alternate forage for predators of lepidopterous eggs**



**“Aphids! Aphids, Clyde! ...
Aphids are loose in the garden!”**