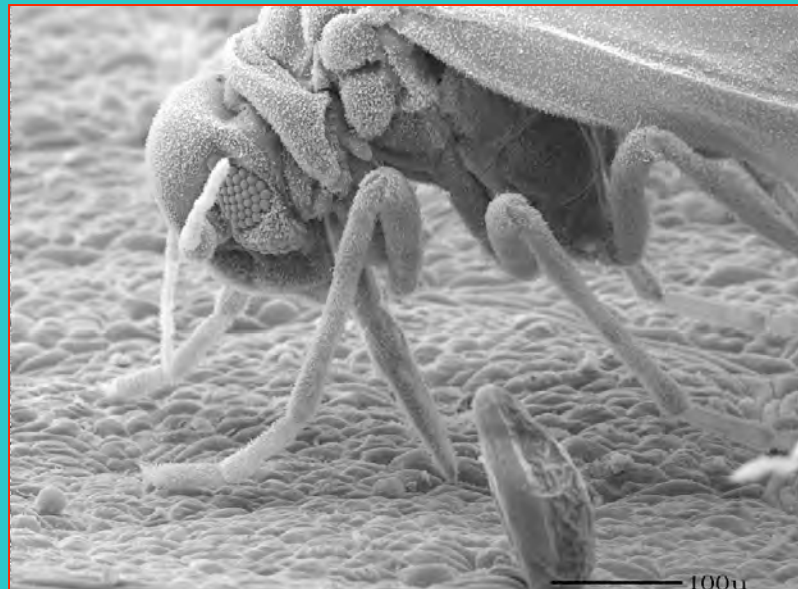


Origin of the Q biotype and global view of the genetics of the whitefly *Bemisia tabaci*

J.K. Brown

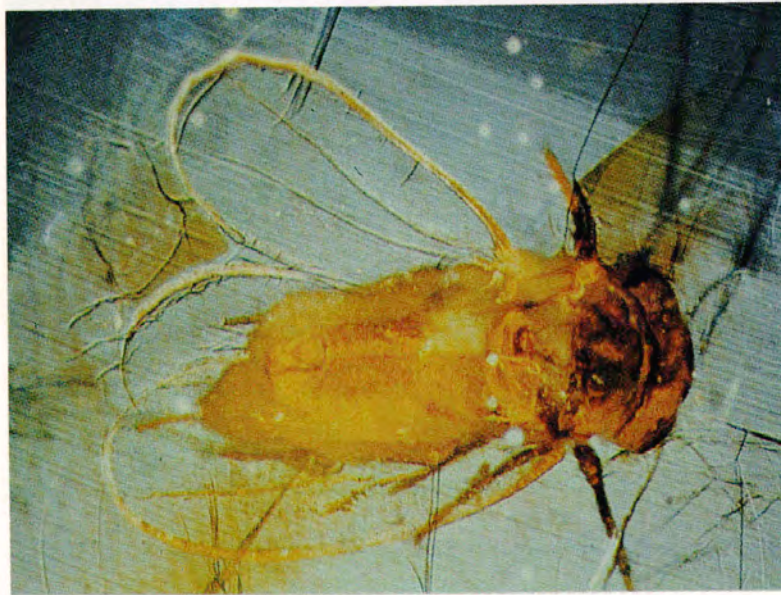
Department of Plant Sciences
The University of Arizona, Tucson



Courtesy, T. Freeman

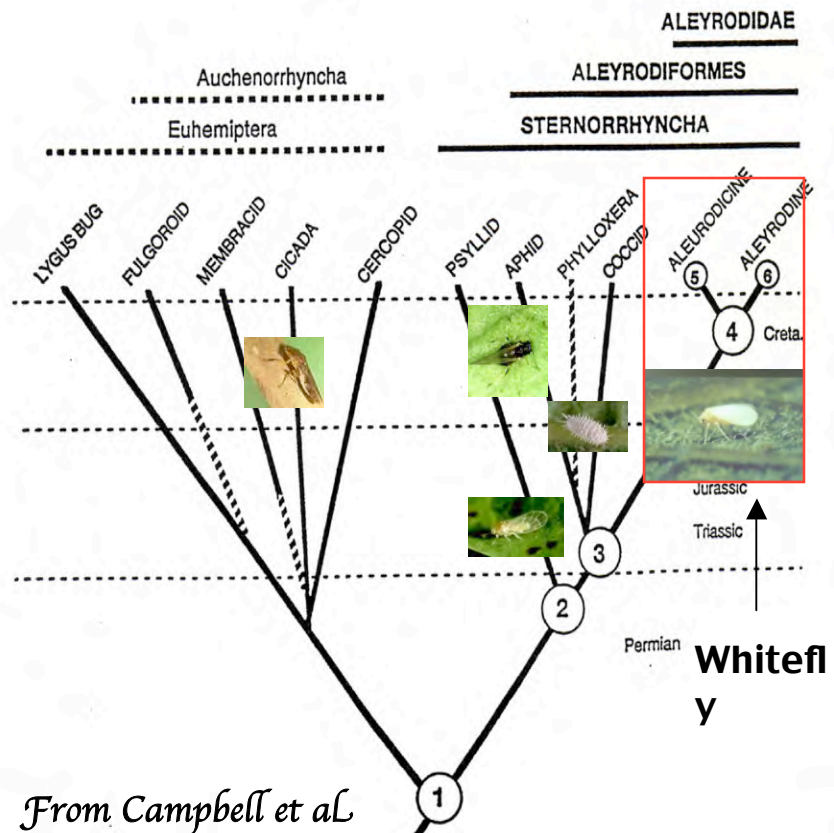
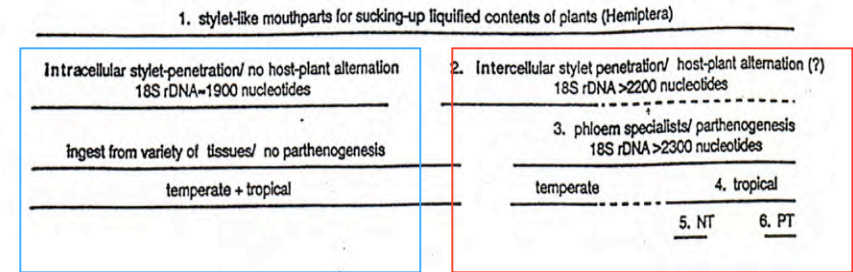
Bemisia tabaci Gennadius [Aleyrodidae]

- Homopteran–tropical origin
- Phloem specialist
intercellular stylet penetration
- Haplodiploidy (2n female/1n male)



Primitive whitefly *Bernaea neocomica*
Schlee in Lebanese amber: 120 to 130 MY
BP

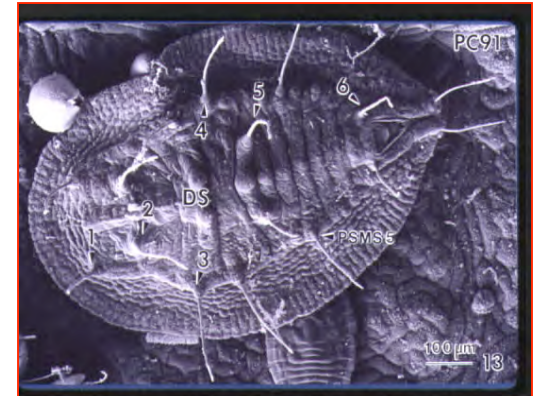
[Stuttgart Natural History Museum Collection]





Adult

Pupal stage
/4th Instar



Bemisia tabaci (Genn.)

- Worldwide, most important whitefly vector of plant viruses: irrigated cropping systems subtropics/tropics (local & invasive).
- Only whitefly vector of the genus: *Begomovirus*.
- Cryptic species = rich in biological variants-lacks distinguishing morphological (4th instar) characteristics.
- Synonymized from numerous species and variants by Russell, 1957 (morphological plasticity=host responsiveness [Mound; Basu and Mohanty, 1970's])
- Evidence for phenotypic (Bird, others 1950's) & genotypic variants.
- **Species group/complex** (A group of closely related species, usually w/ partially overlapping ranges: discontinuous gene flow) **or group of species** (no gene flow)

Concept of biologically distinct populations or 'races'

Now know - different behaviors influence outbreaks, virus spread, & diversification

Bird (1957) recognized *Jatropha* race was 'host-restricted'; Low fecundity

Sida race was polyphagous; moderate to high fecundity

Proposed 'race concept'

Costa and Russell (1975) *B. tabaci* - Brazil did not colonize cassava (center of origin)

Cassava-associated populations - Africa (Burban et al., 1991) (transmitted ACMV, others)

= added to Bird's 'race' hypothesis

AZ-A and B biotypes recognized after introduction of B biotype 1987-88 (Costa & Brown, 1990)

Jatropha



Dr.
Julio
Bird



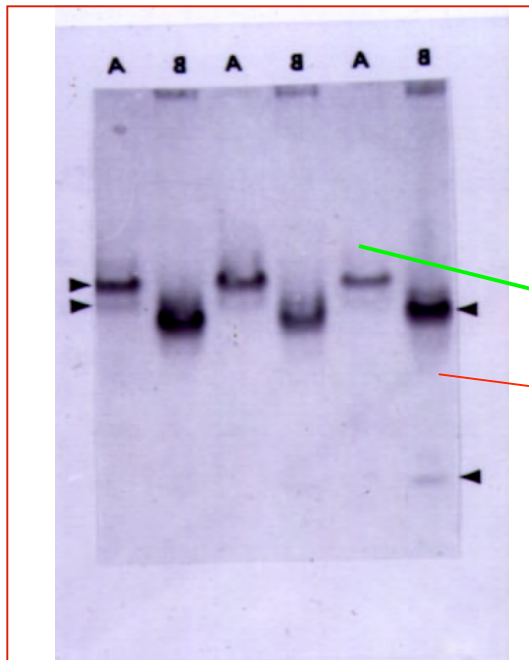
Sida



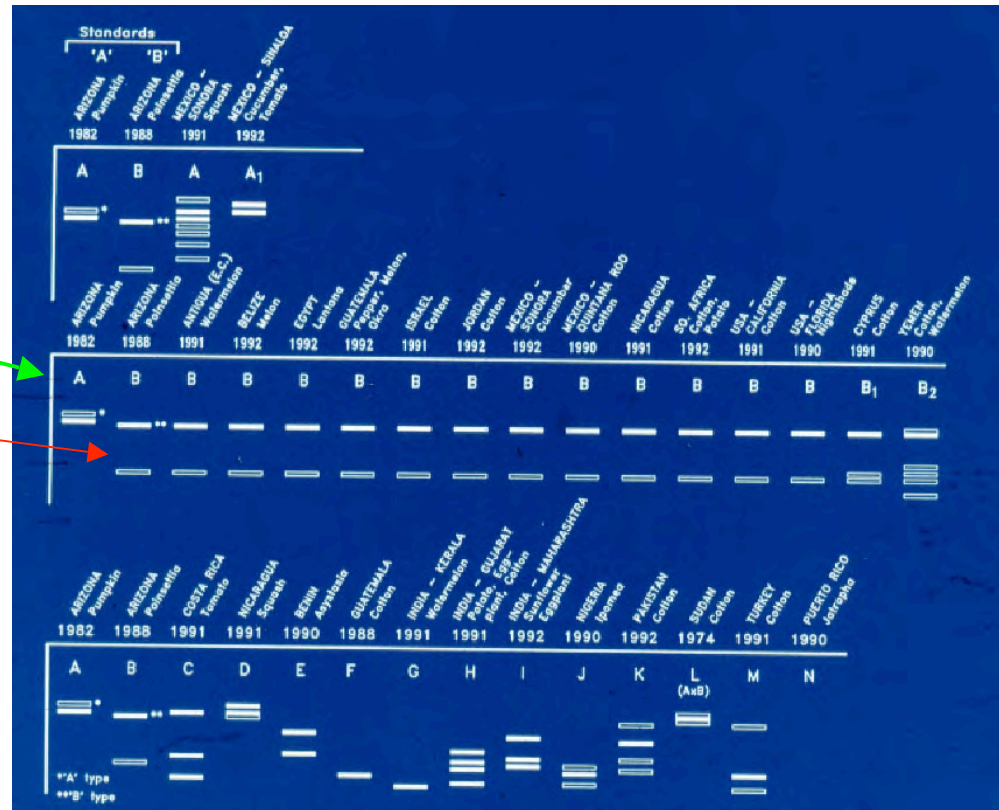
First evidence for genetic polymorphisms

(Burban et al., 1992; Costa and Brown, 1991-USA; Wool et al., 1989-Israel-Colombia)

- B biotype introduced to US & Caribbean, Central & So America & worldwide;
- Polyphagous, high fecundity, insecticide resistant; could transmit NW viruses
- Esterase patterns revealed genetic polymorphism b/t local 'A type' and invasive 'B' type + SSL symptoms in *Cucurbita* spp.
- Then ... genetically diverse worldwide populations



Protein polymorphisms



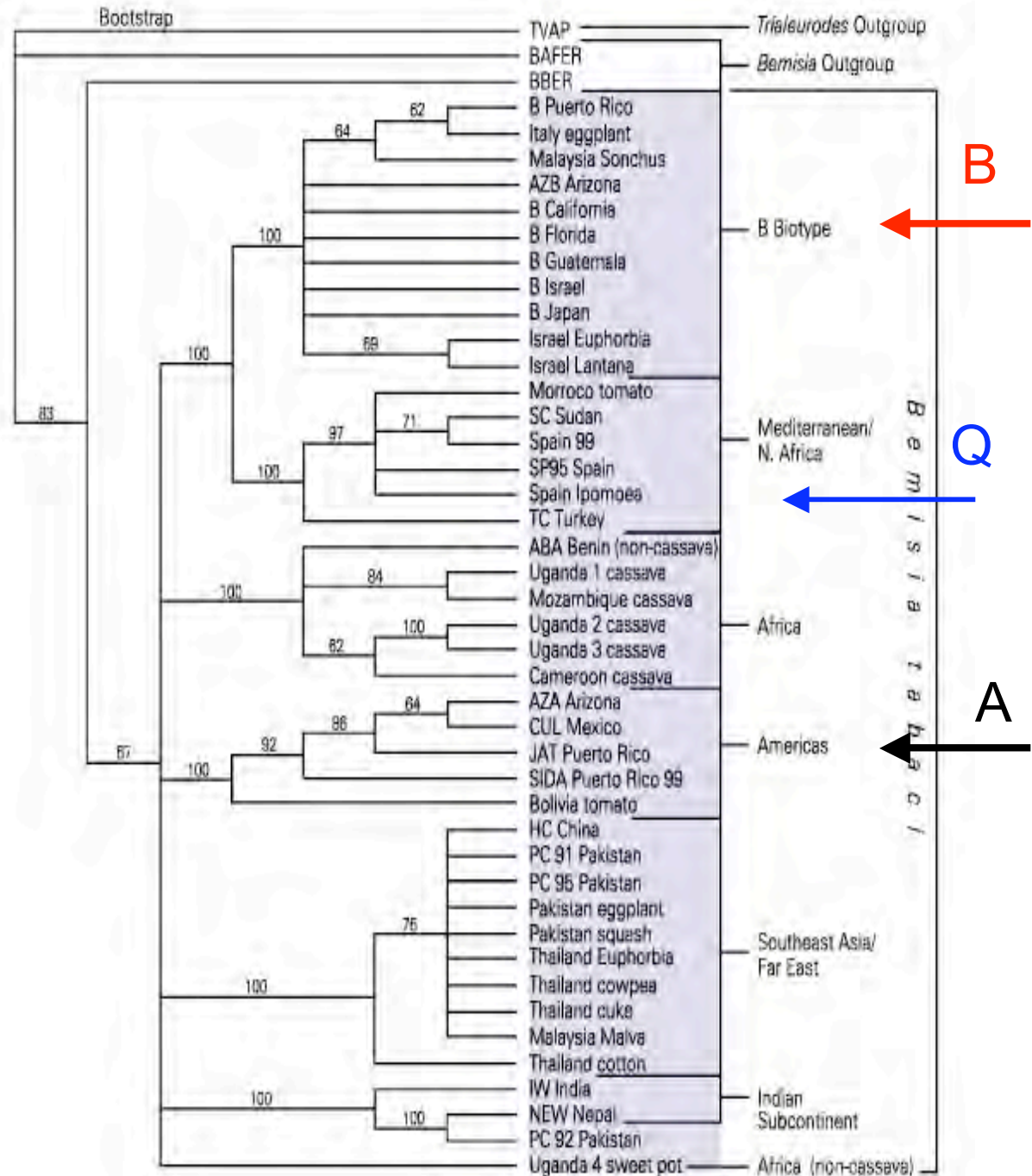
MT COI sequence analysis

-- Seven+
phylogeographical
groups

-- **B biotype-Old
World**; A-New World

Hypotheses

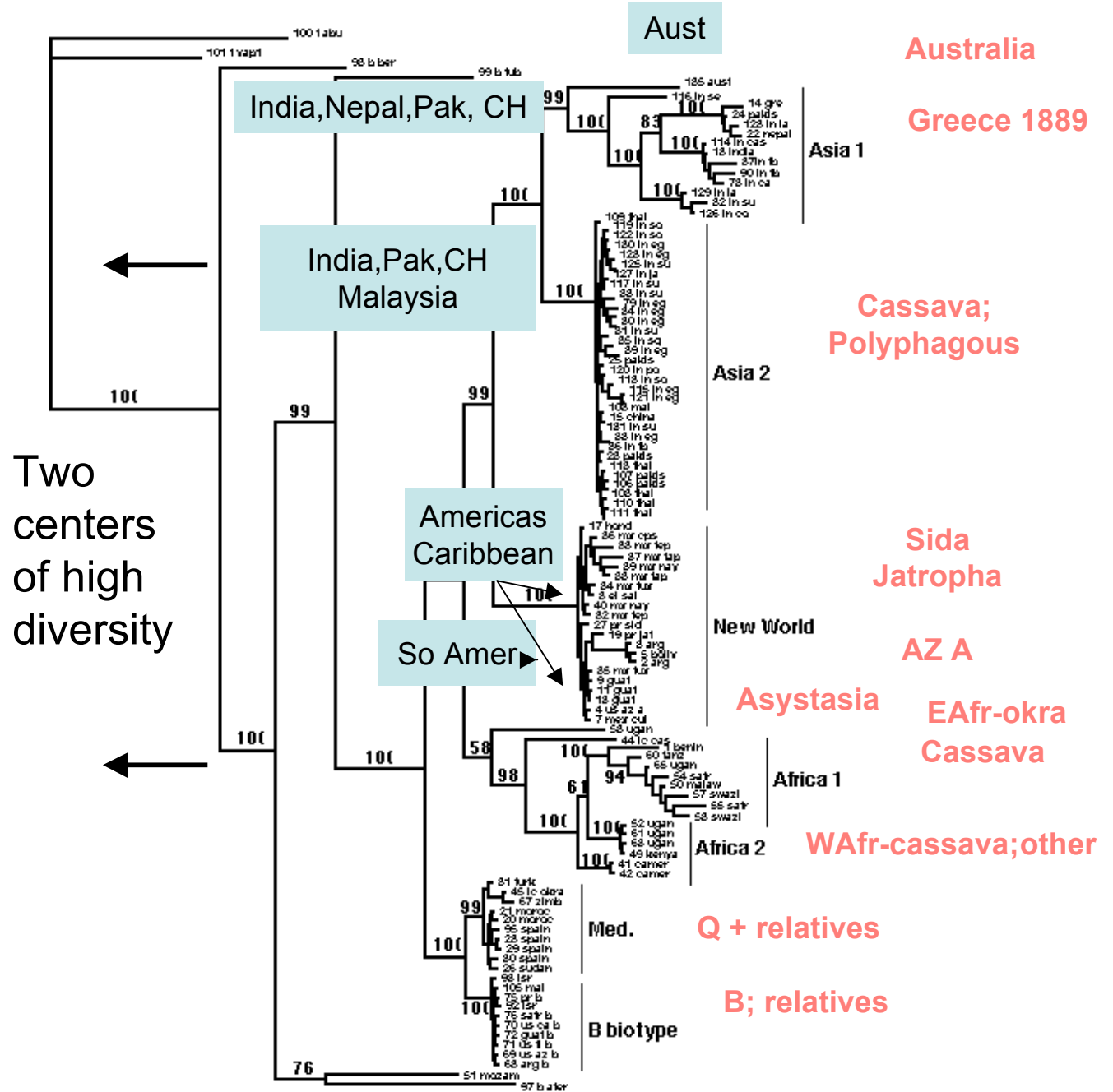
B. tabaci is a species
group .. or
a number of separate
species?
(Gene flow?)



More populations worldwide

Haplotypes of the *B. tabaci* numerous

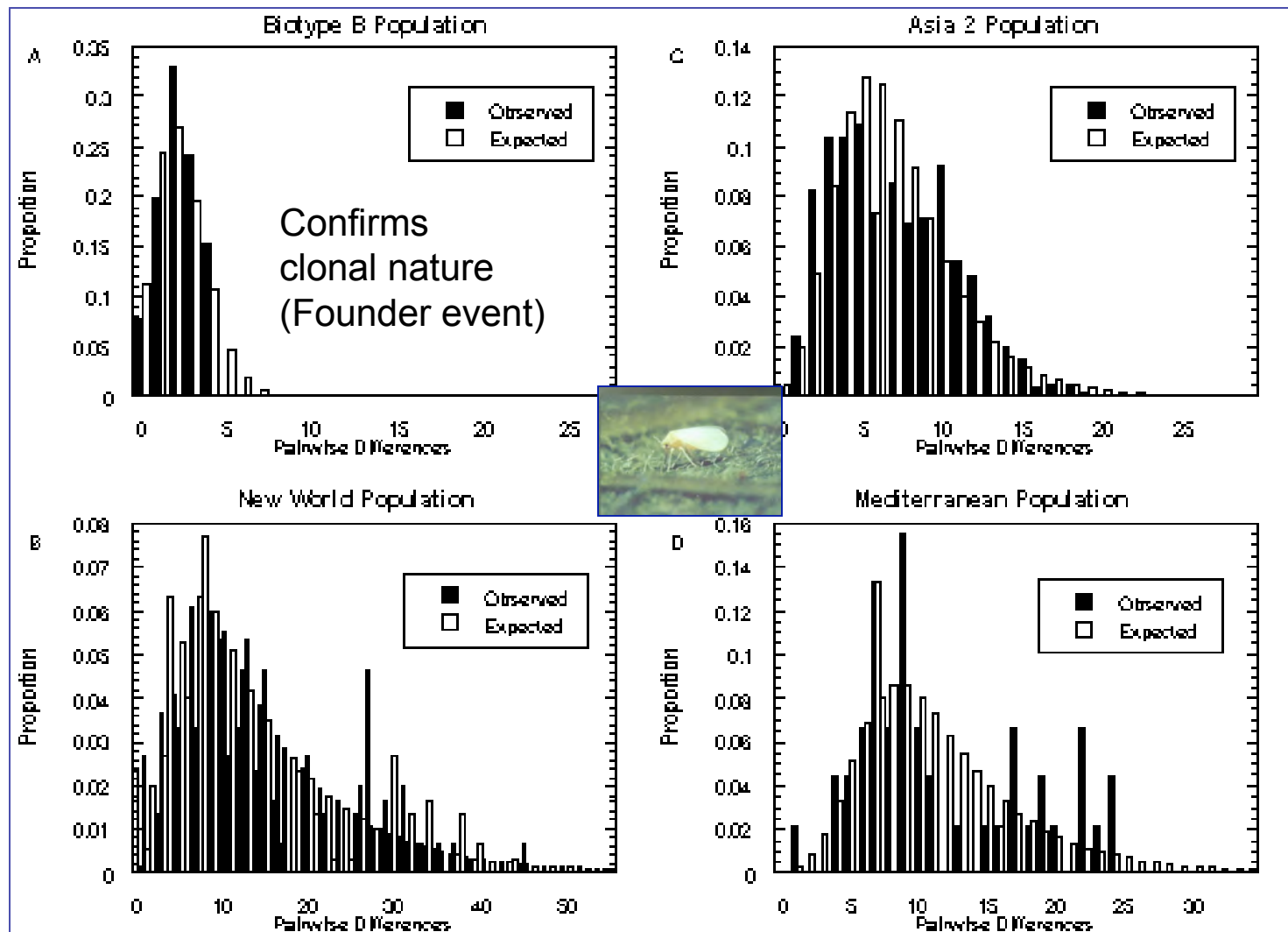
Distributed phylogeographically, (except extant introduced species)



Between clade comparisons

Clade	% nt identity	% nt divergence
New World n = 8	91.4 - 99.0	1.0 - 8.6
Indian Subcontinent/ Far East n = 7	82.8 - 98.6	1.4 - 17.2
N. Africa- Middle East- Mediterranean Region n = 13	81.9 - 97.2	2.8 - 18.1
Sub-Saharan Africa (w/o ABA, IC cassava) n = 42	88.9 - 99.7	0.3 - 11.1
Sub-Saharan Africa N = 44	80.3 - 99.7	0.3 - 19.7
Outgroups		
<i>T. vaporariorum</i> x All <i>B. tabaci</i>	71.3 - 76.5	23.5 - 28.7
<i>B. afer</i> x All <i>B. tabaci</i>	71.6	28.4

Population growth curves (Rogers, 1997) based on pair wise differences suggest different population histories



(Brown & French, in preparation)

Greece 1889 holotype (upsurgent local or invasive population?)

Analysis of mtCOI sequences for the Greece population indicated it clustered with a Asia I (specifically, India)

Suggests that it originated in India? from where it was introduced to Greece as an 'invasive species'. [Note: the Italian T biotype has affinity with Indian clade]



Historical Notes

Origin of the B biotype (N. Africa/Medit/MidEast clade)

The B biotype traceable to the Sahel region of E Africa: Sudan, Ethiopia, Eretria, Uganda (arid, seasonal rainfall/food;dispersal phenotype). Transported to Israel 1970's (SSL, 1975); resistance to pyrethroids
Transported on ornamentals to Europe, Americas/Caribbean, and worldwide. Named as a separate species (*B. argentifolii*); but it constitutes one variant!



Origin of the Q biotype (2005 introduced into US MEX, Japan,China) Mediterranean clade; Resistar neonicotinoids widely used to control the 'B'; Q



A number of biotypes (~20) are now recognized based on behavioral & genetic differences

Host, geographical, environmental specialization

- Geographic range: limited geographical/host range, widely distributed**
- Host range: monophagous, narrow, highly polyphagous**

Vector Competency

- Variation in transmission competency suggests virus-vector co-adaptation (concordant phylogeography viral CP/mtCOI)**

Other Biotic Characters

- Dispersal behavior: short and long distance**
- Insecticide resistance - highly variable and plastic**
- Fecundity: ~50 to 300+ offspring**

Molecular studies

- Highly divergent >24% mt COI (mt16S, ITS1-similar groups)**
- Phylogeographical distribution**
- Identical primary symbiont (homopteran paradigm-single infection/species)**

Unanswered Questions

What will the next invasive biotype be and why? Can we predict this?

What is the underlying mechanism driving biotype formation, invasiveness, adaptability, fitness?

When does displacement occur versus sympatric populations?

How important are insecticides to selection?

How important is hybridization to invasiveness, fitness?

Are hybrids more fit than parents?

Is *B. tabaci* a group of species or a species group?

If so, between clades or within clades?

What are the 'species' barriers?

Dr. Julio Bird
Univ. of Puerto Rico



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