Invasive Ambrosia Beetle Conference
The Situation in California
August 12 – 14, 2012

Meeting sponsored by:

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Session 2

Systematics

Systematics of Fusaria Associated With Ambrosia Beetles

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in collaboration with

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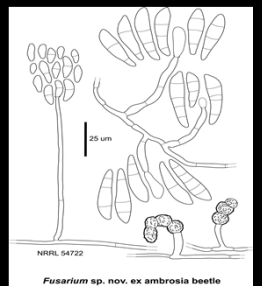
Dave Geiser, Matt Kasson – Penn State Univ., University Park, PA

Alejandro P. Rooney, Allard Cossé – NCAUR-ARS-USDA, Peoria, IL

Takayuki Aoki – MAFF, Tsukuba, JAPAN

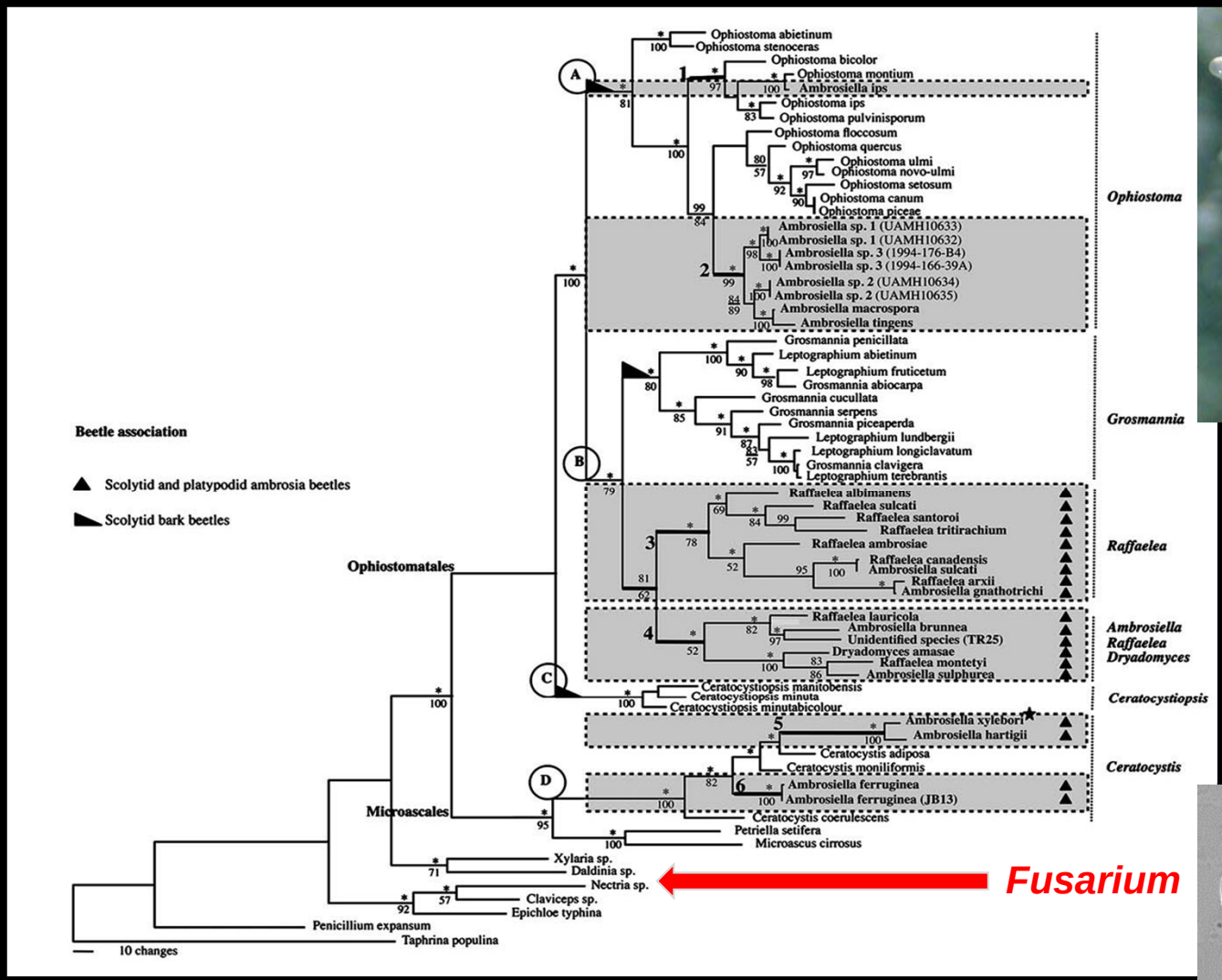
Randy C. Ploetz, Tom White – U. of Florida, Homestead, FL

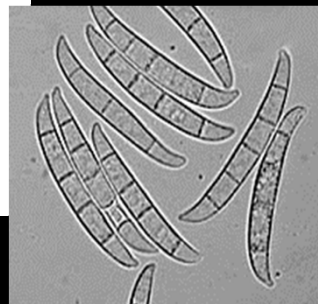


Multigene phylogeny of filamentous ambrosia fungi associated with ambrosia and bark beetles

Sepideh MASSOUMI ALAMOUTI[a], *Clement K. M. TSUI*[b], *Colette BREUIL*[a,*]

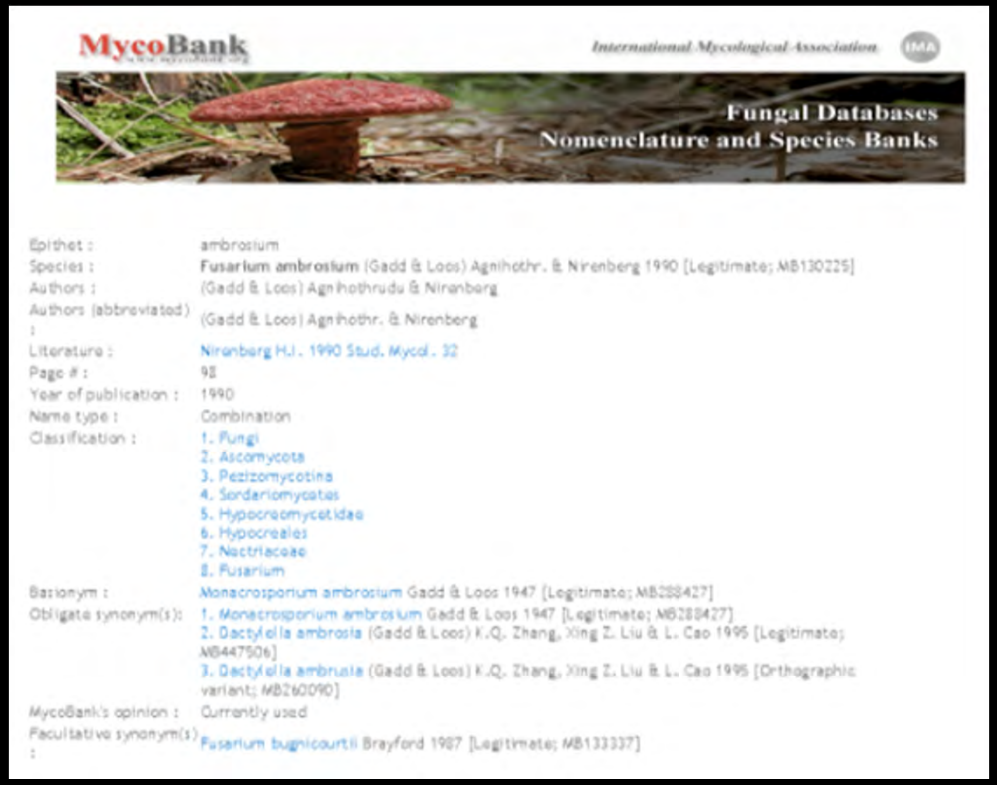
Mycol. Res. 113 (2009)





Fusarium is not a typical ambrosia fungus

Tortured Taxonomic History of *Fusarium ambrosium*



Putative Asian Origin of Ambrosia Fusaria

Fusarium bugnicourtii 1987

Monoacrosporium ambrosium 1947
= *Fusarium ambrosium* 1990

ex galleries of *Euwallacea* (*Xyleborus*) *fornicatus* on tea

Ambrosia Beetle-Associated Fusaria Are Morphologically Similar

THE AMBROSIA FUNGUS OF *XYLEBORUS FORNICATUS* EICH.

By C. H. GADD and C. A. LOOS, *Tea Research Institute of Ceylon*

Text-figs. 1–26. *Minuteporium ambrosium* n.sp.

Trans. Br. mycol. Soc. 89 (3), 347–351 (1987) *Printed in Great Britain*

FUSARIUM BUGNICOURTII SP.NOV., AND ITS RELATIONSHIP TO *F. TUMIDUM* AND *F. TUMIDUM* VAR. *COERULEUM*

By D. BRAYFORD

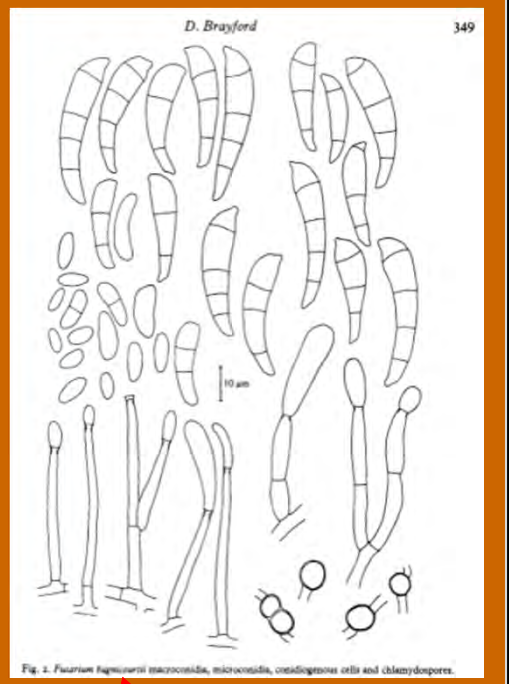


Fig. 2. *Fusarium bugnicourtii* macroconidia, microconidia, conidiogenous cells and chlamydospores.

Table 1. *Sources of F. bugnicourtii strains studied*

IMI	Host	Location	Year
110107	*Hevea brasiliensis*	Sabah, Malaysia	1964
105320	*Theobroma cacao*	Sabah, Malaysia	1964
119156	*T. cacao*	Sabah, Malaysia	1966
240025	*T. cacao*	Sabah, Malaysia	1979
296597	Beetle galleries in *Camellia sinensis* stems	Chinchona, S. India	1985
302711	Galleries of *Xyleborus fornicatus* in *Camellia sinensis* stems	Chinchona, S. India	1986
301160	*Pinus* sp.	Kodnad, India	1985

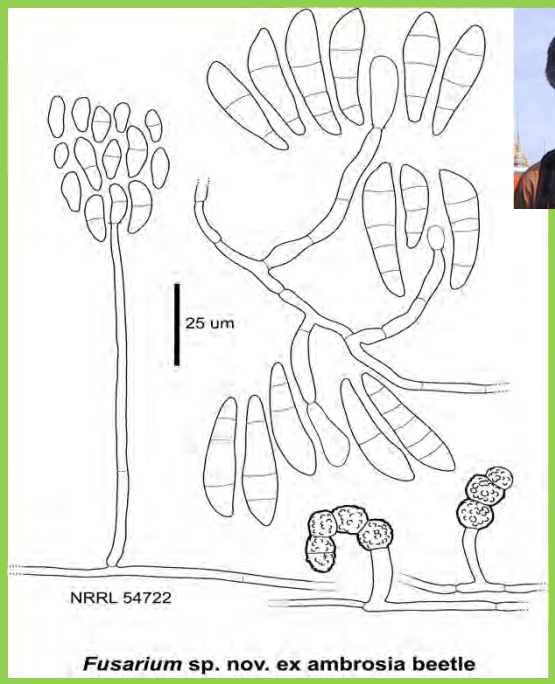
Trans. Br. Mycol. Soc. 1947
ex galleries of
Euwallacea* cf. *fornicatus
in tea (*Camellia sinensis*) stems

Tea in Sri Lanka and India

Phytoparasitica
DOI 10.1007/s12600-012-0223-7

An Asian ambrosia beetle *Euwallacea fornicatus* and its novel symbiotic fungus *Fusarium* sp. pose a serious threat to the Israeli avocado industry

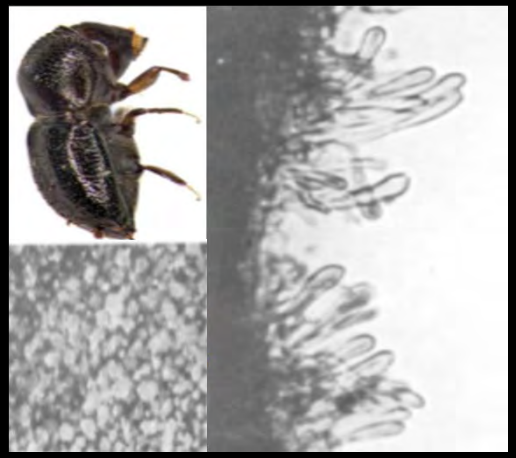
Z. Mendel · A. Protasov · M. Sharon · A. Zveibil · S. Ben Yehuda · K. O'Donnell · R. Rabaglia · M. Wysoki · S. Freeman

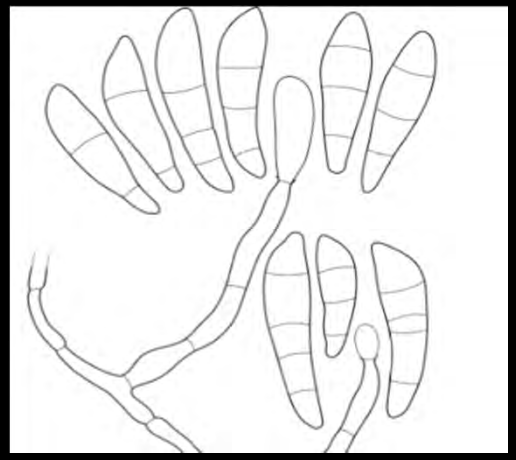


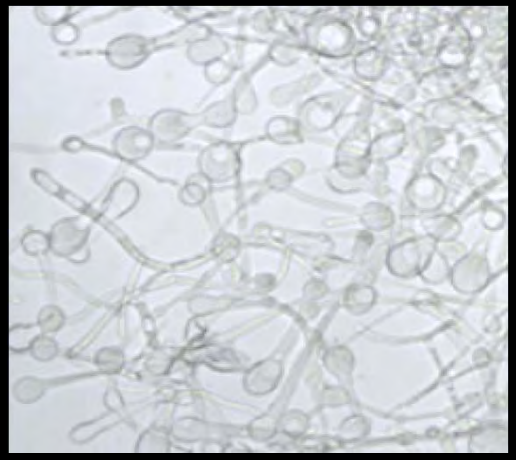
***Fusarium* sp. nov. ex ambrosia beetle**

Avocado in Israel and California

Ambrosia Fusaria Produce Gongylidia-like Conidia



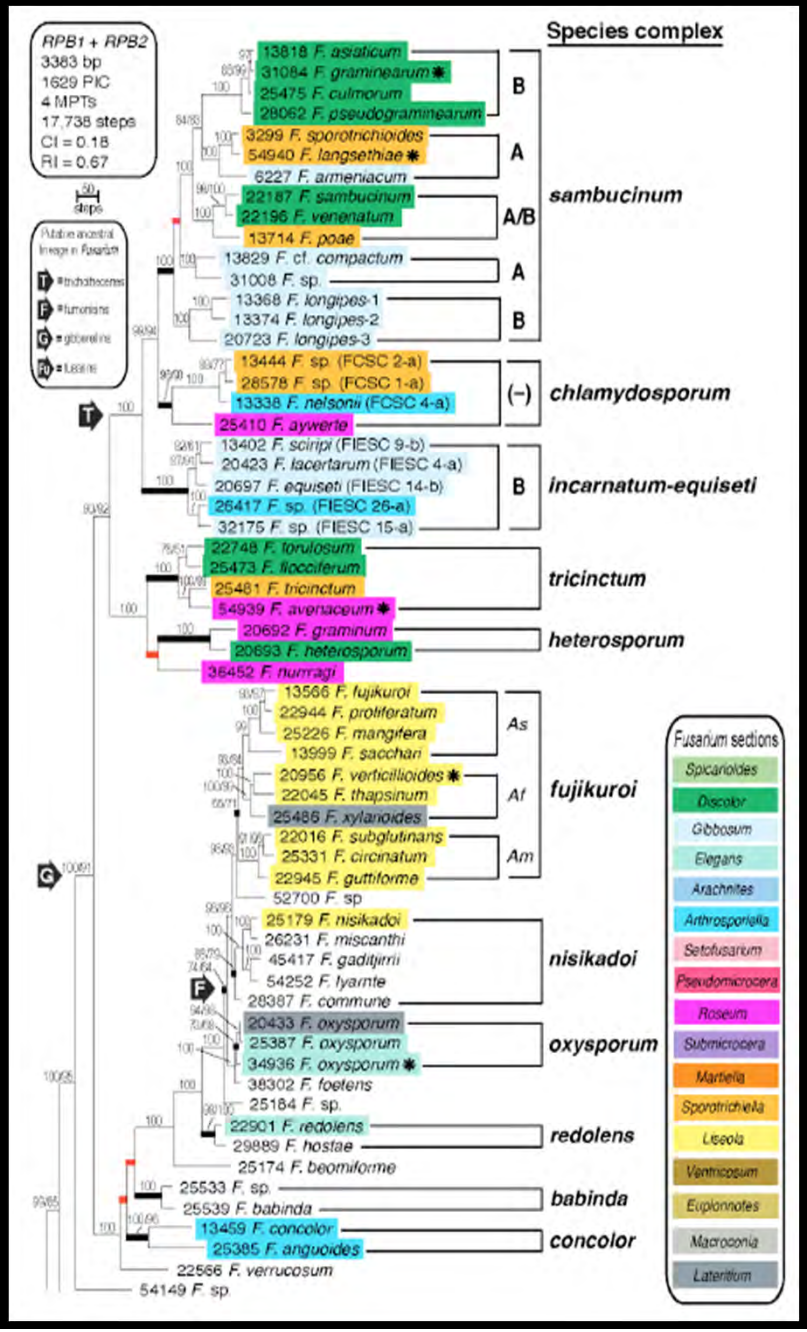




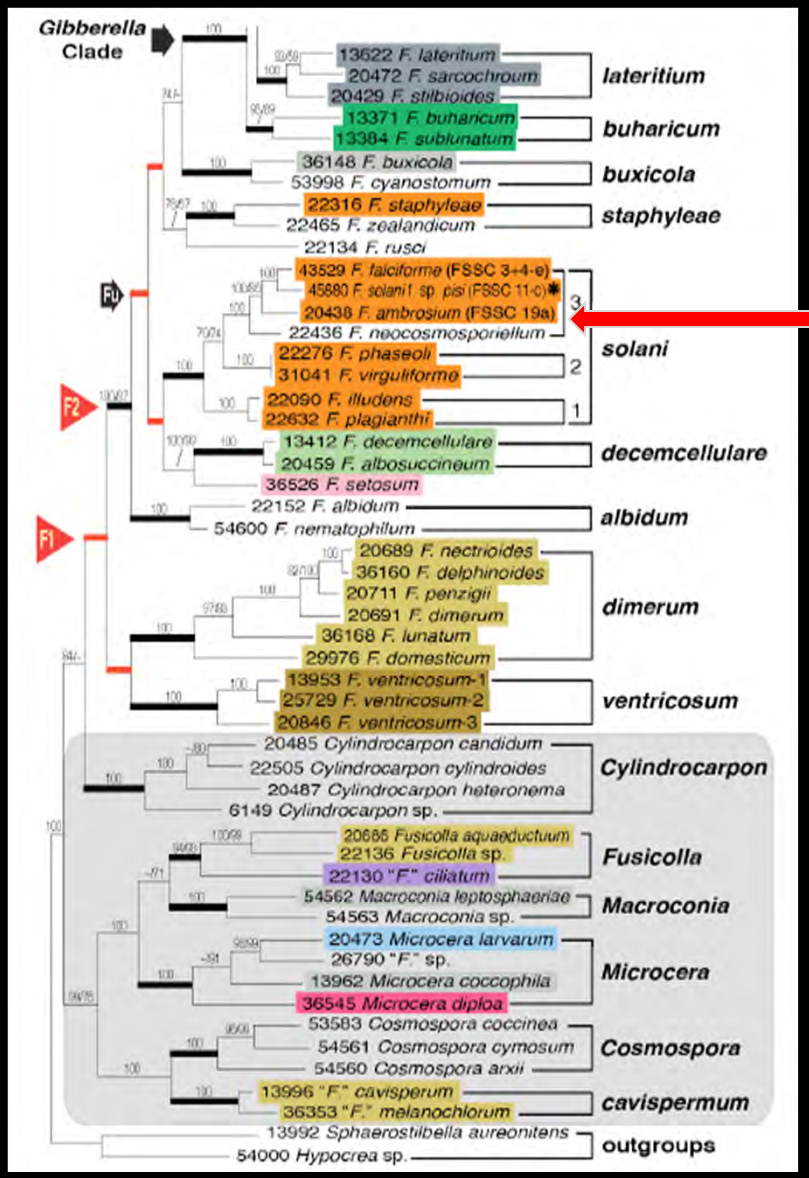
Ambrosia fusaria in gallery of tea

Swollen hyphal tips (= gongylidia) in fungus-growing ant garden

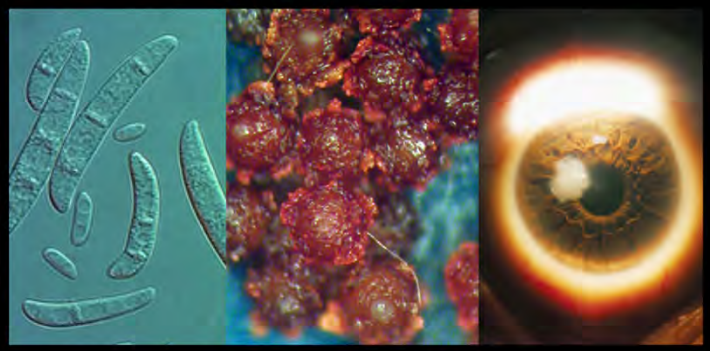
Fusarium Phylogeny



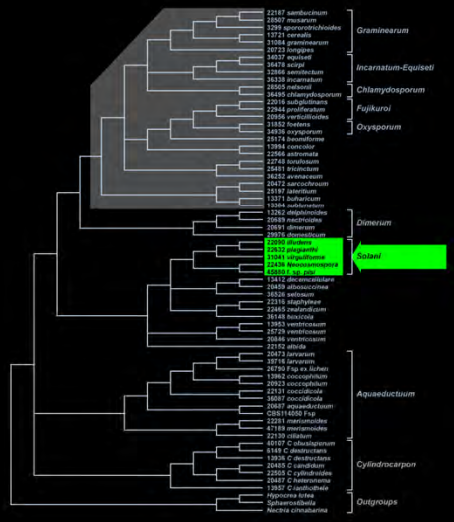
Ambrosia fusaria are members of the *Fusarium solani* species complex

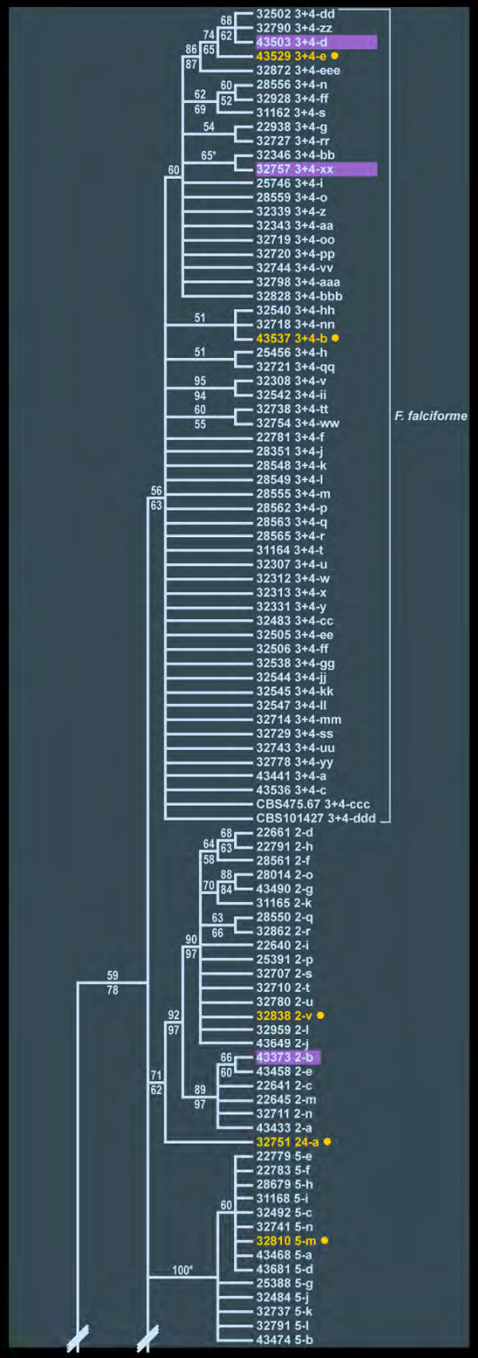


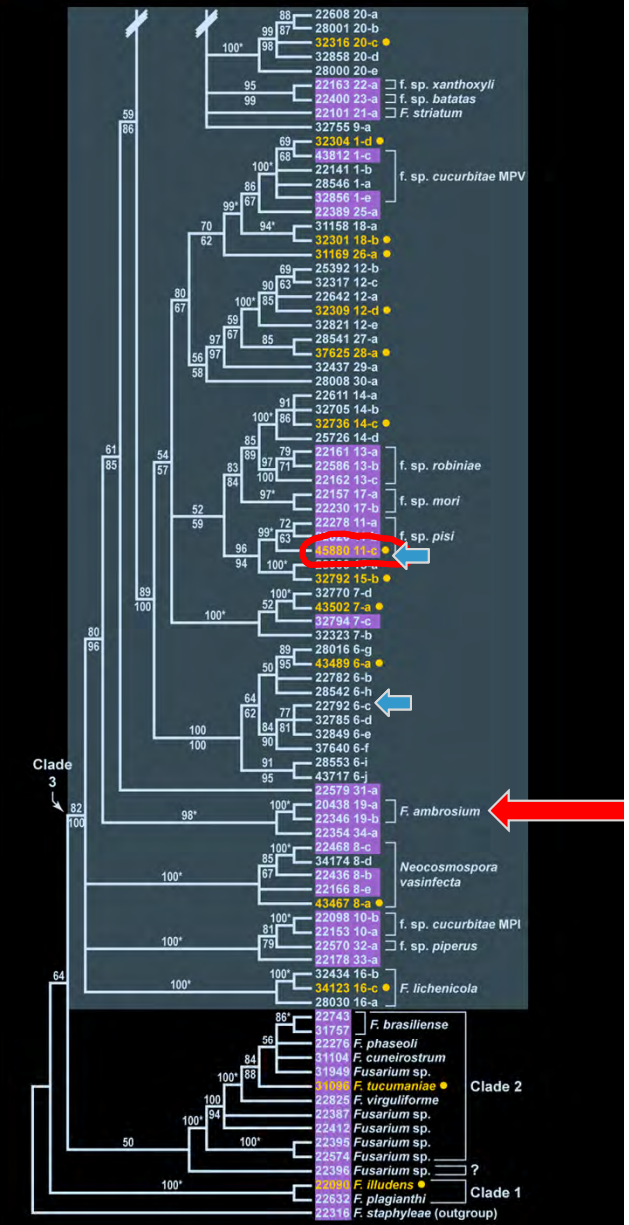
3-Locus Phylogeny of *Fusarium solani* Species Complex



EF-1α, RPB2
ITS + LSU rDNA
3440 bp
2858 steps
CI = 0.46
RI = 0.85

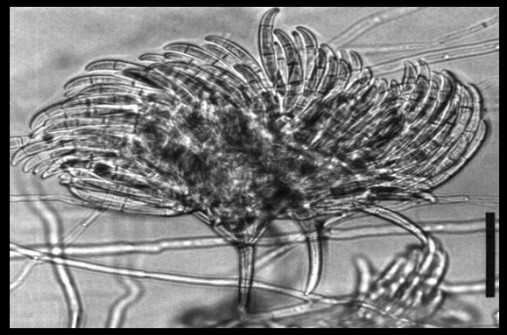




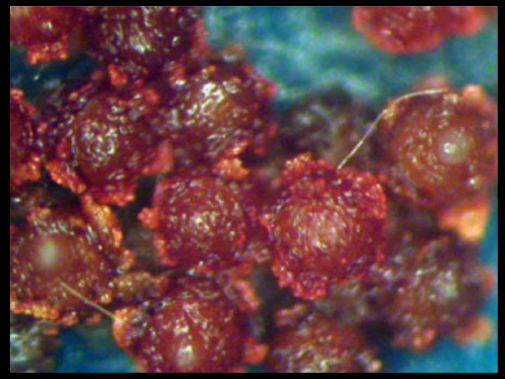


■ = non-clinical source
● = antifungal susceptibility tested

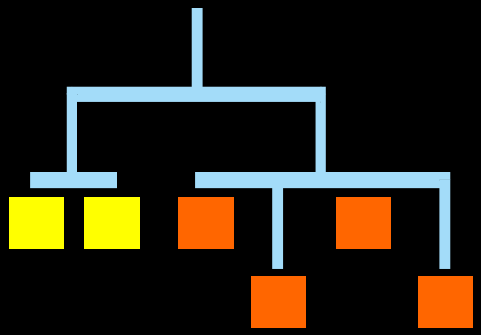
Species Recognition



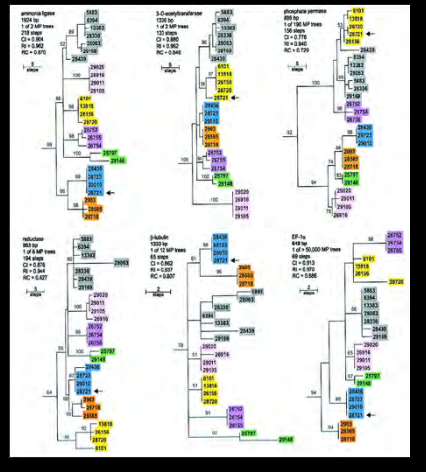
morphological



biological

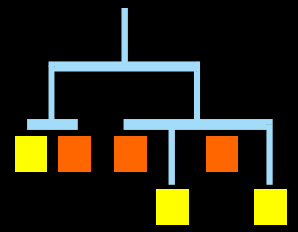


phylogenetic

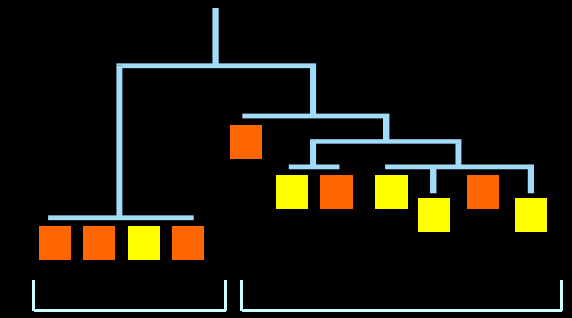


Genealogical Evidence of Speciation

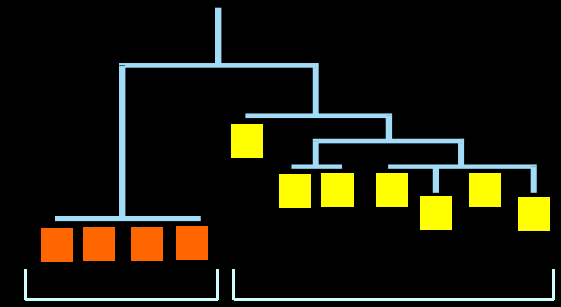
Polymorphism within a species



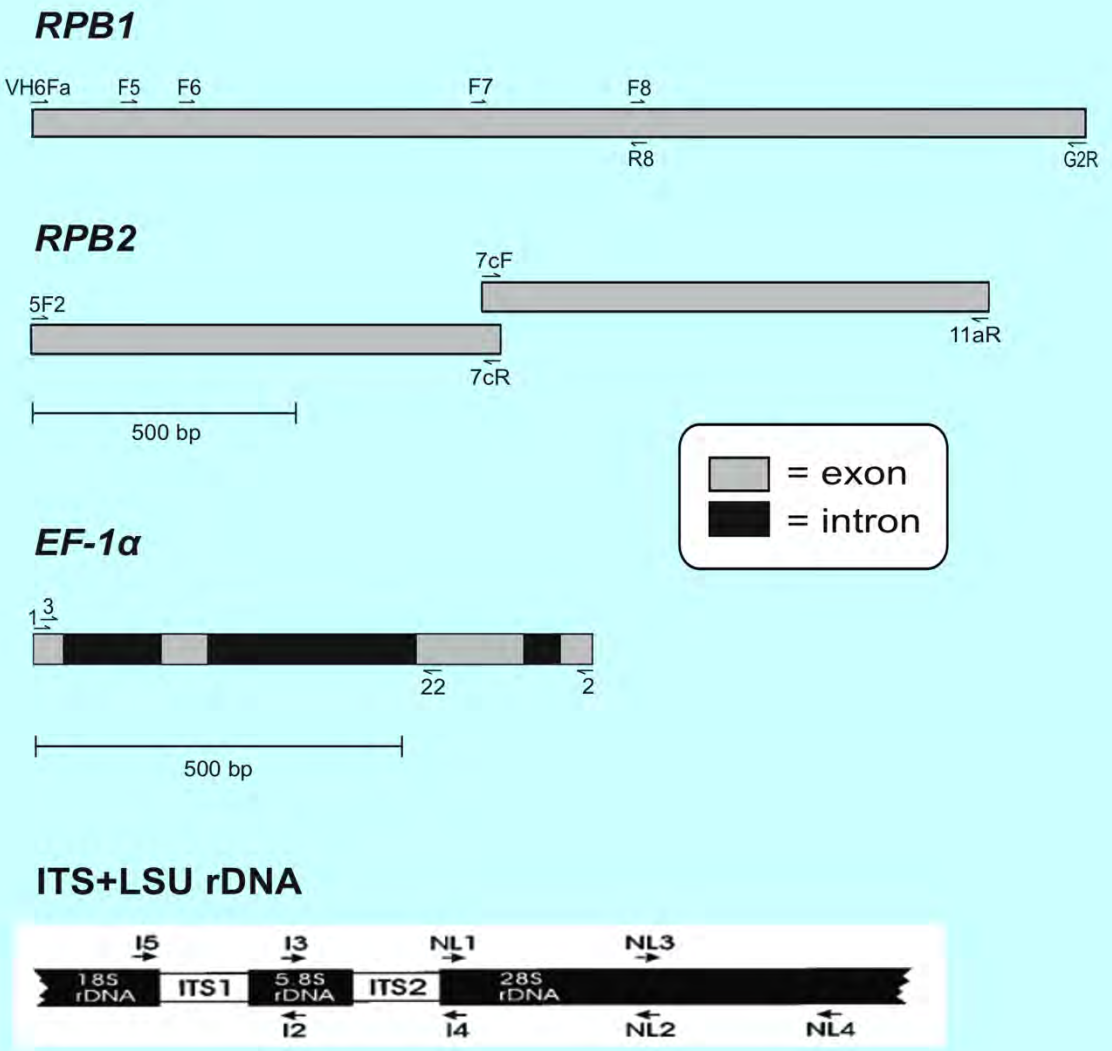
Shared polymorphism immediately following speciation



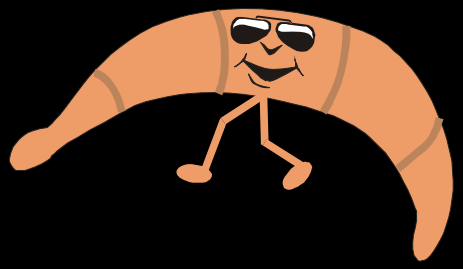
Shared polymorphism lost due to drift in the absence of significant gene flow

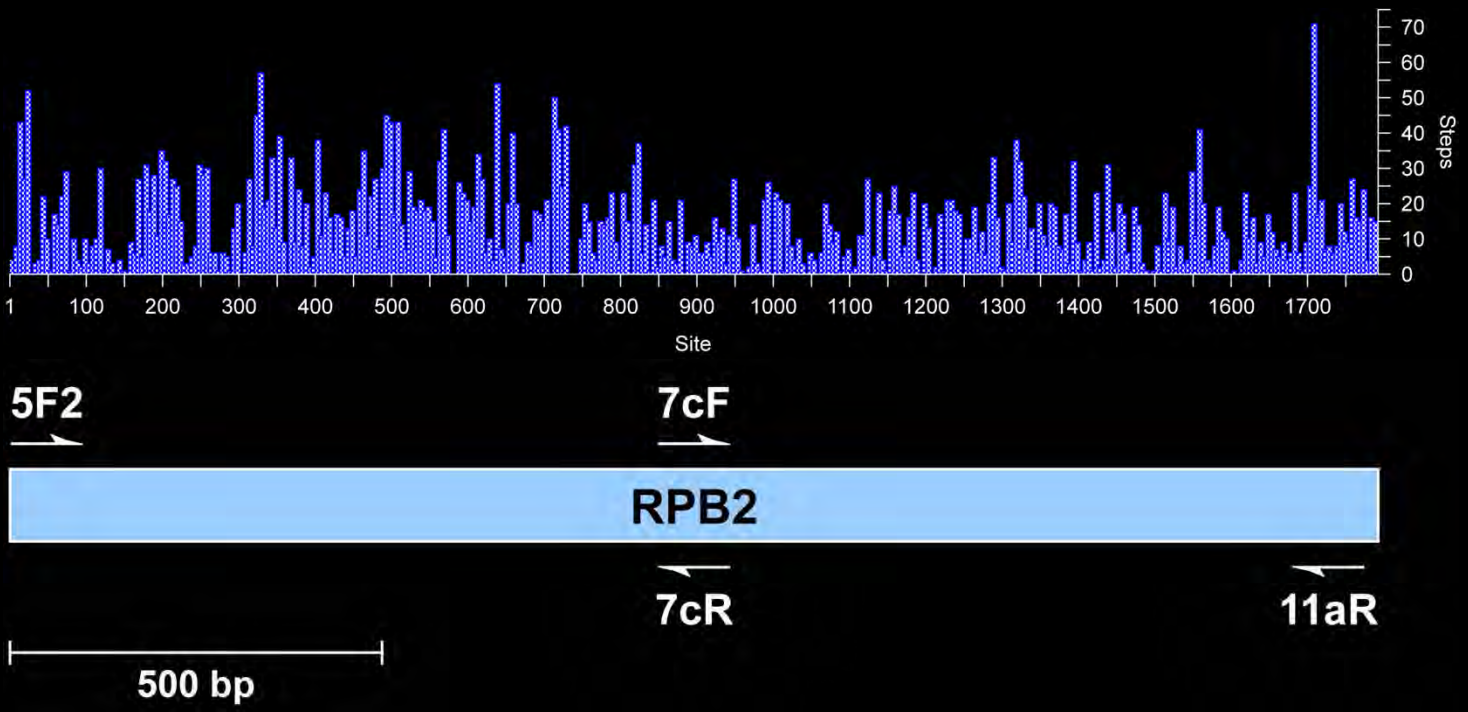


Phylogenetic Species Recognition of Ambrosia Fusaria Within *Fusarium solani* species complex



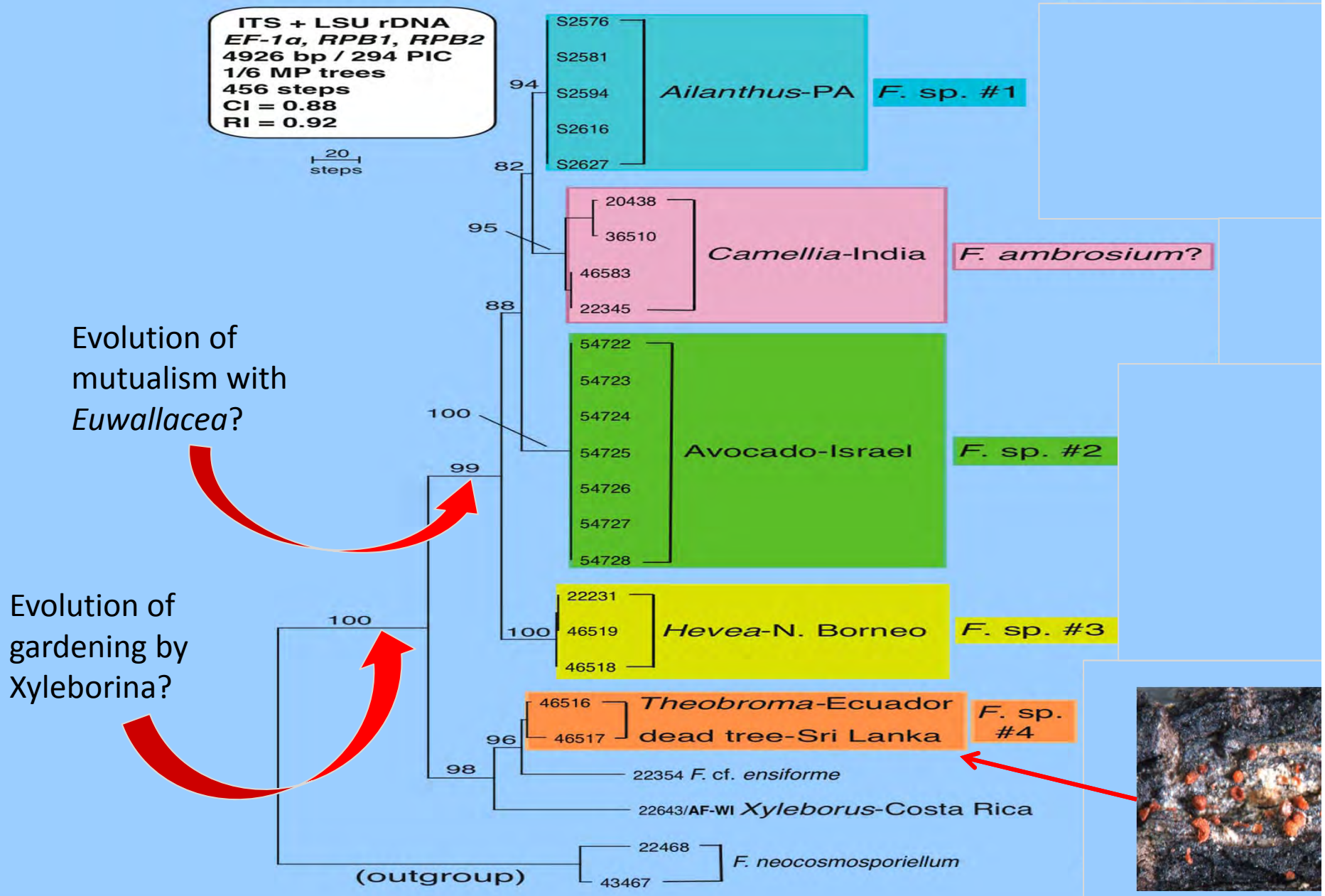
RNA Polymerase II (*RPB2*)



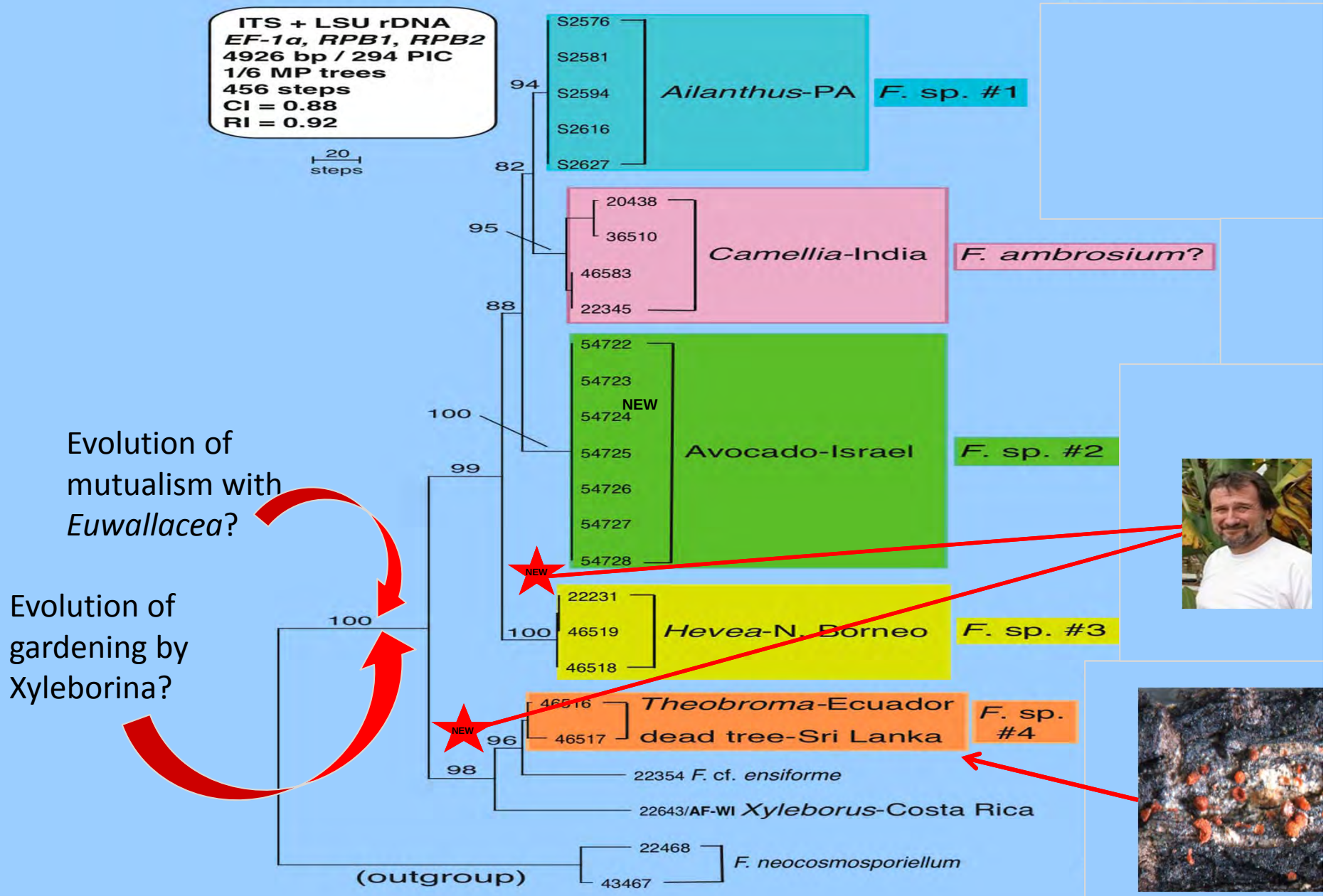


- Easy to PCR amplify as 2 contiguous fragments
- PCR primers work well for DNA sequencing
- Primers work on virtually all fusaria

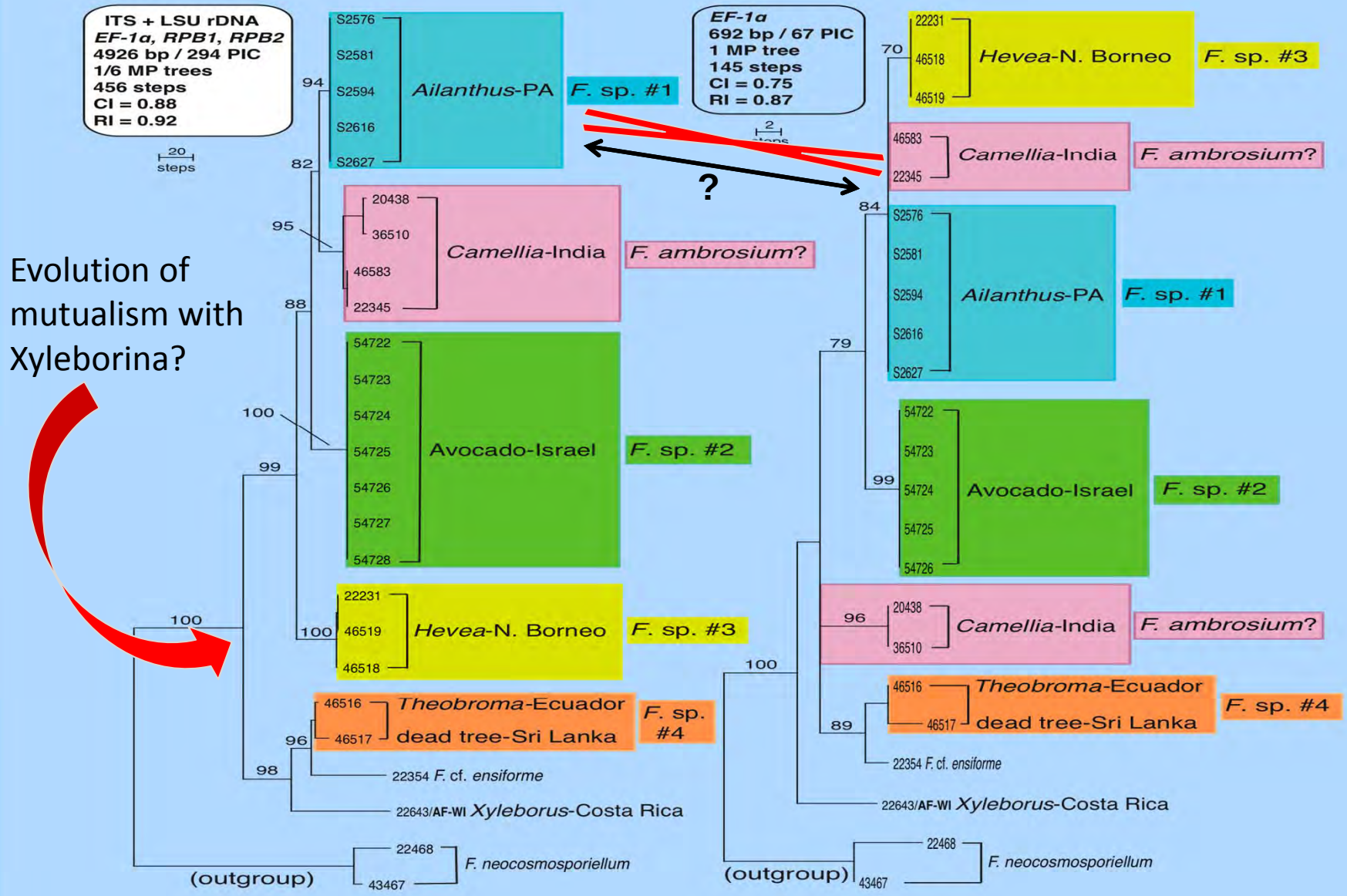
Putative Clade of Ambrosia Fusaria



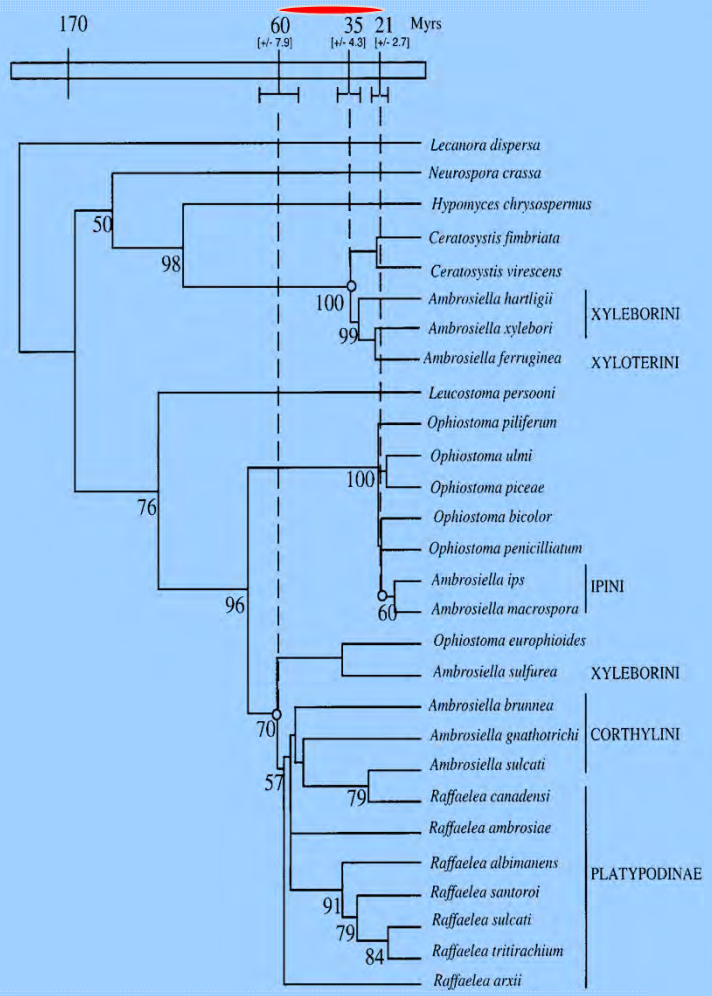
Putative Clade of Ambrosia Fusaria



Putative Clade of Ambrosia Fusaria and Hybridization

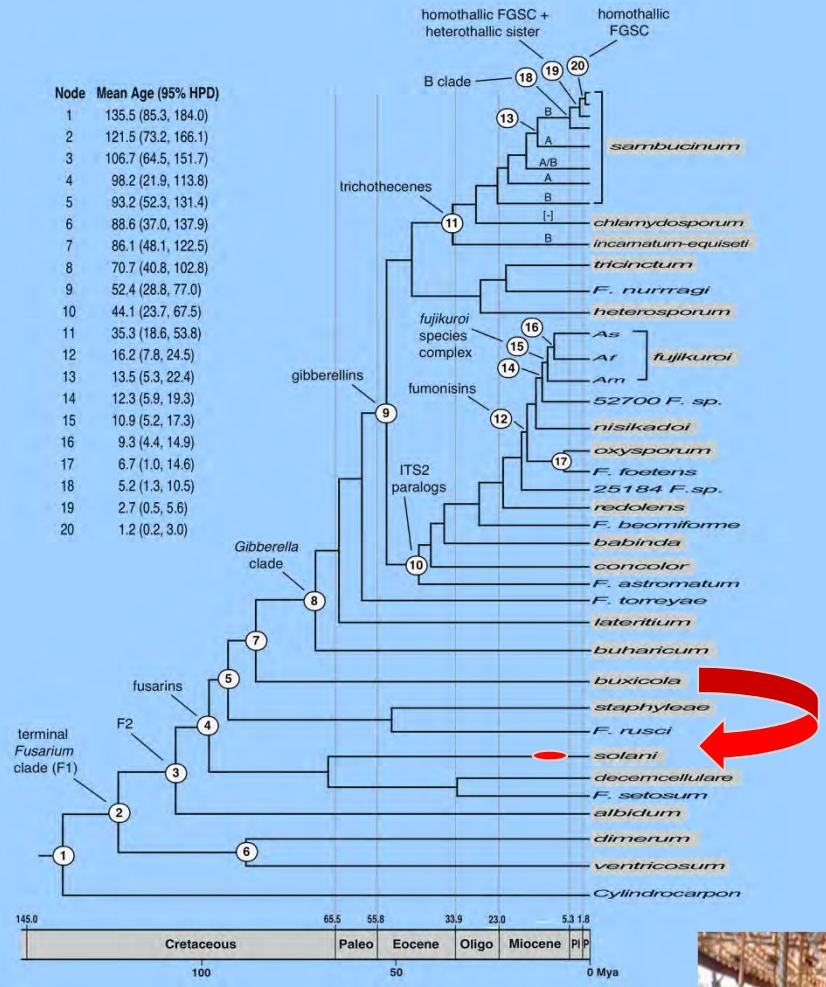


Did Farming of *Fusarium* by *Euwallacea* spp. Evolve Only Once and Relatively Recently?



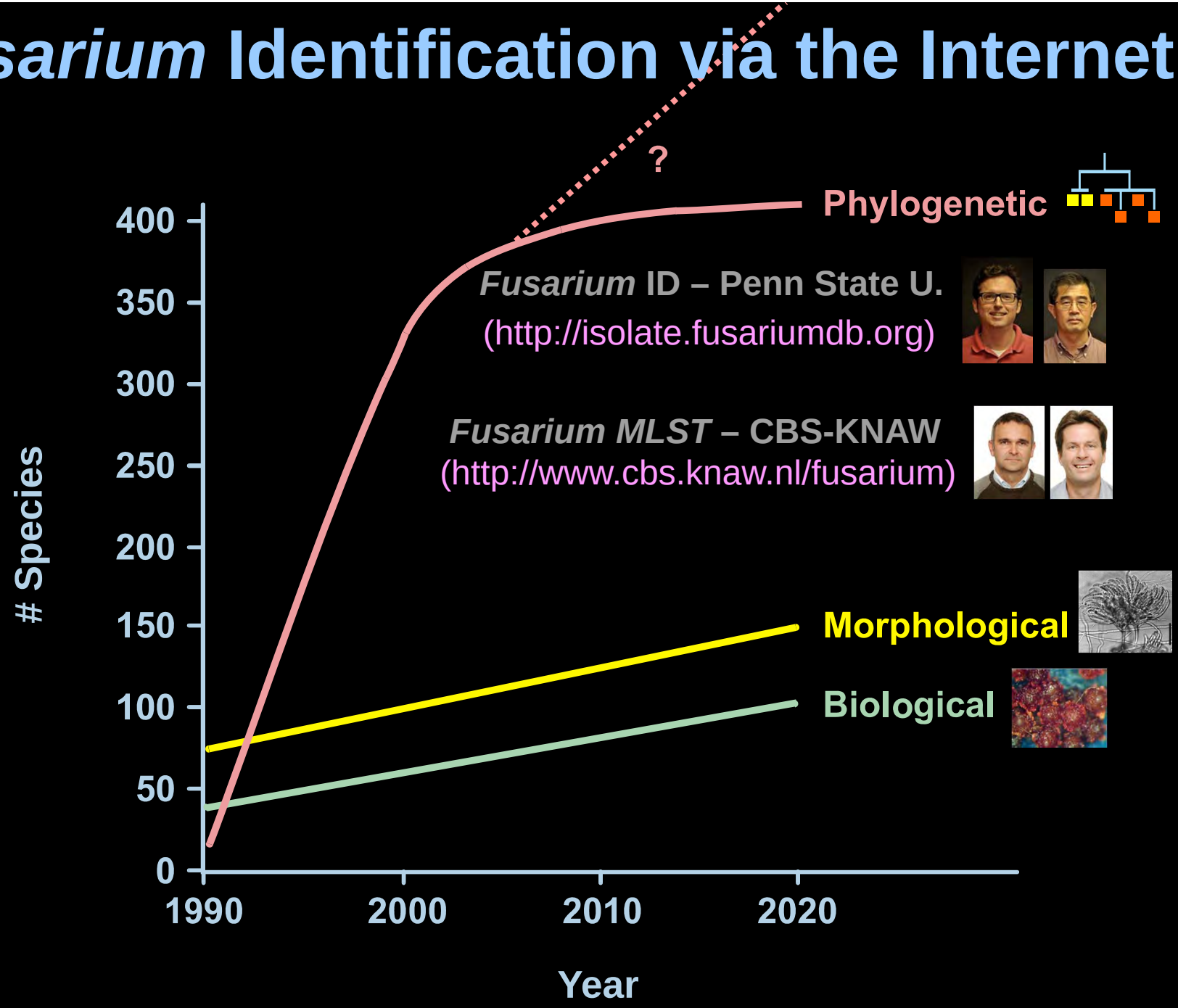
Evolution of Agriculture in Beetles

(Farrell et al. Evolution 2001)

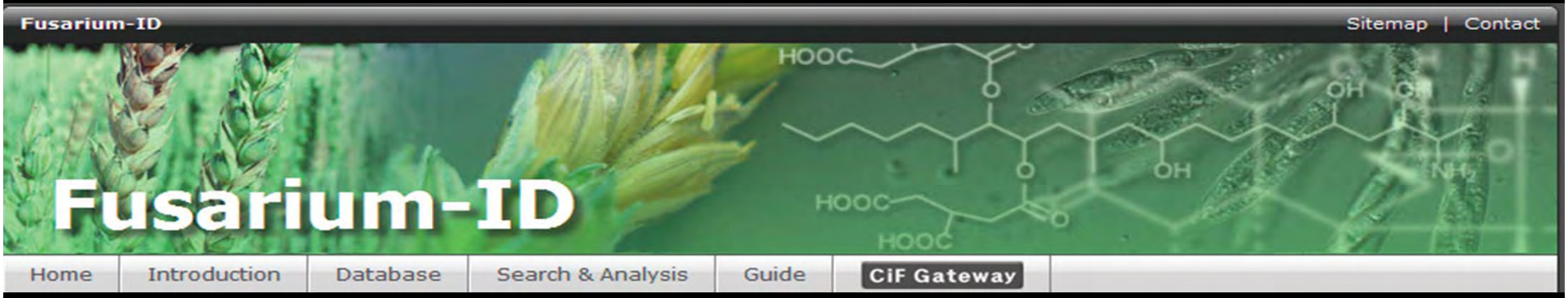


Fusarium time-tree

Fusarium Identification via the Internet



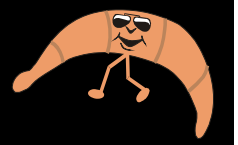
http://isolate.fusariumdb.org



~500 registered users from 50 countries – 500-650 visits/month

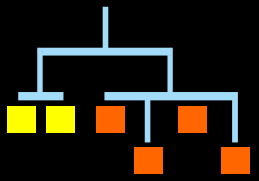
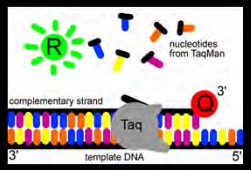
http://www.cbs.knaw.nl/fusarium/DefaultInfo.aspx?Page=Home

Open Theoretical and Practical Questions



- Where and on what hosts did species within *Fusarium ambrosium* clade evolve (What were the invasion routes)?
- Did farming of *Fusarium* by *Euwallacea* evolve only once and relatively recently without reversals (How speciose is this clade)?
- Have *Euwallacea* and *Fusarium* cospeciated (Is transmission strictly vertical)?
- Does each *Fusarium* sp. produce a semiochemical that only attracts one *Euwallacea* sp. (How do attractants affect beetle behavior)?
- Is the reproductive mode within these fusaria strictly clonal (Do they avoid a mutational meltdown via hybridization)?
- How has the transition to mutualism impacted on the *Fusarium* genomes (Do they possess novel lignocellulosic activity)?

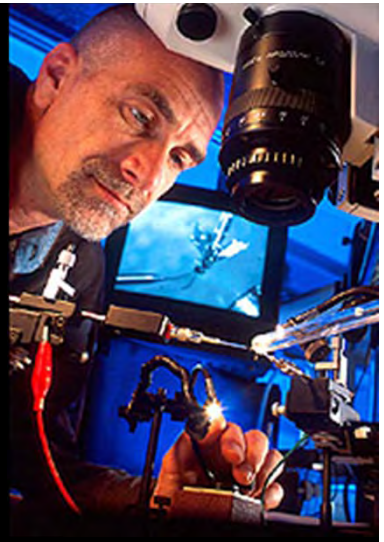
Fusarium: Diversity, Diagnostics and Genomics

- Species limits, reproductive mode and population structure 
- Surveillance via Real Time PCR 

- Surveillance via VNTRs 
- Genomics 

Allard Cossé – NCAUR-USDA, Peoria

Research Approach for Possible Ambrosia Beetle Attractants



- Identify volatiles emitted by *Fusarium* and/or stressed avocado trees, focusing on compounds detected by beetle antennae
- Compare volatile profiles of different *Fusarium* symbionts
- Effect of attractants on ambrosia beetle behavior