The Laurel Wilt and Other Ambrosia Fungi, Similarities to the Dutch Elm Disease Cycle, and Management Implications

Thomas Harrington

Department of Plant Pathology
Iowa State University, USA


M. C. Thomas

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UGA1

Coleoptera: Scolytidae

Most are bark beetles

adults lay eggs in galleries in the inner bark (phloem)

only a few associated with vascular wilt-type fungi

Ophiostoma ulmi and O. novo-ulmi

Dutch elm disease

Leptographium wageneri

Black stain root disease on conifers

Some attack twigs, fruit or seeds

Many are ambrosia beetles

adults lay eggs in xylem (wood)

adults carry special “ambrosia” fungi

often in specialized sacs = mycangia

anamorphs of *Ophiostoma* or *Ceratocystis*

The definitive work on evolution in the Scolytidae:

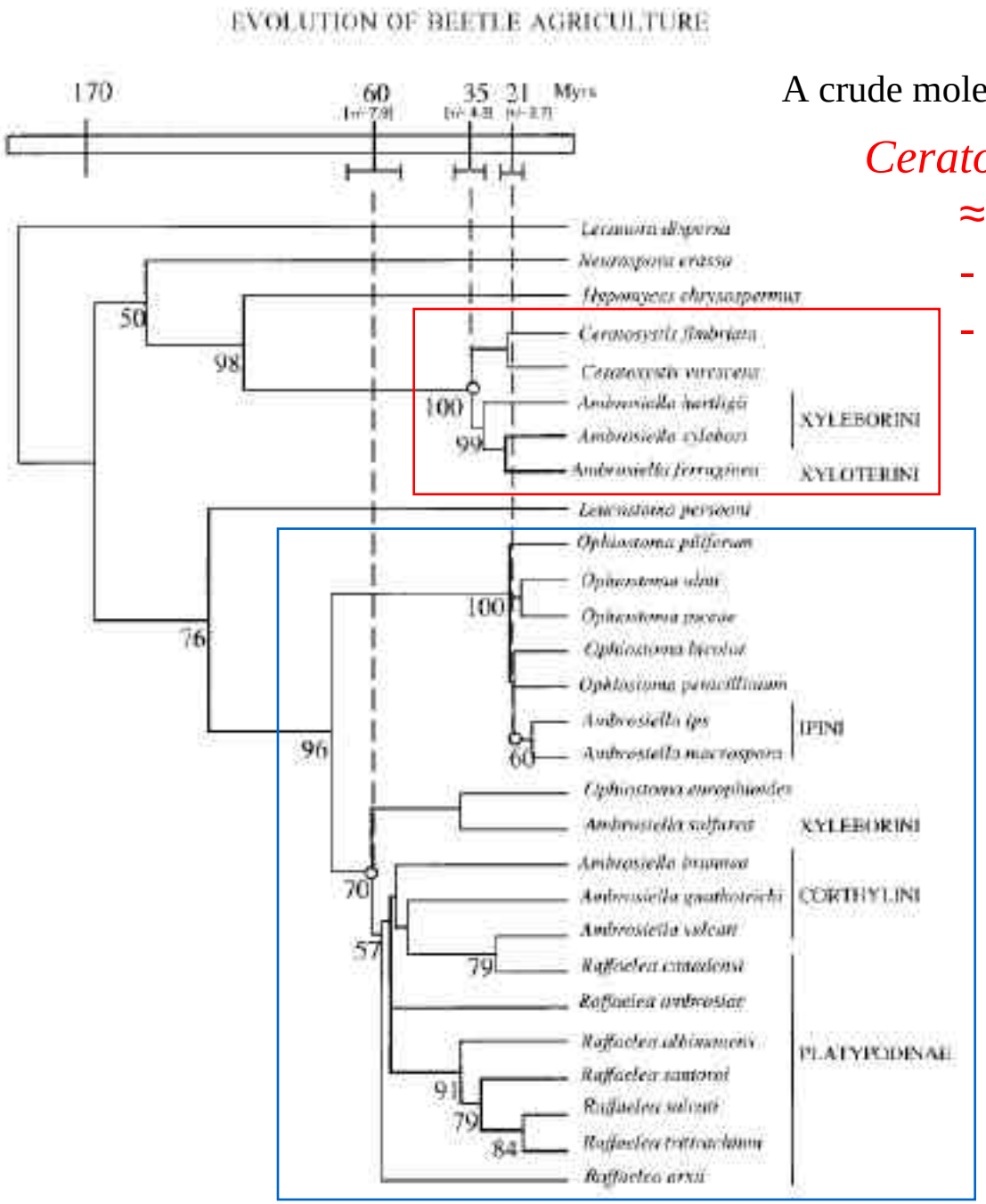
Evolution, 55(10), 2001, pp. 2011–2027

THE EVOLUTION OF AGRICULTURE IN BEETLES (CURCULIONIDAE: SCOLYTINAE AND PLATYPODINAE)

BRIAN D. FARRELL,[1,2] ANDREA S. SEQUEIRA,[1] BRIAN C. O'MEARA,[1] BENJAMIN B. NORMARK,[1,3] JEFFREY H. CHUNG,[1,4] AND BJARTE H. JORDAL[1,5]

Earliest Scolytidae were likely conifer inhabiting bark beetles, after the dominance of *Auracaria,* about 67-93 million years ago

There were at least seven shifts to the ambrosia-xylem habit in the Scolytidae, mostly associated with shifts to hardwoods



A crude molecular clock for Scolytid Associates

Ceratocystis

≈ 35 million years old

- all plant pathogens
- few species associated with Scolytids, a derived trait

Ophiostoma

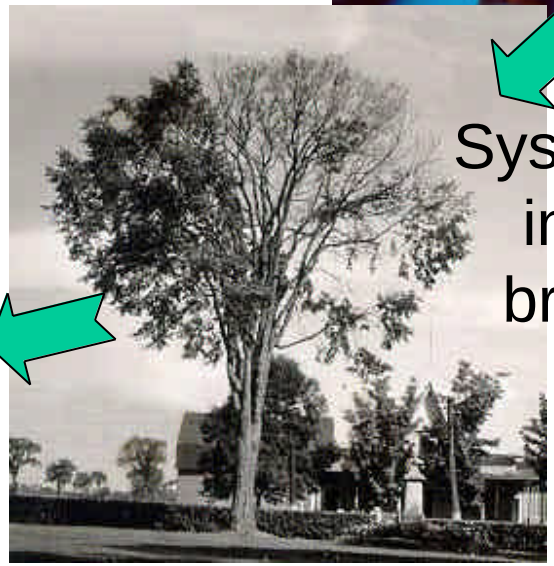
≈ 70 million years old, arising about the time of the ascendancy of bark beetles

- almost all saprophytes
- mostly associates of bark and ambrosia beetles

Dutch Elm Disease Disease Cycle

Transmission through twig crotch feeding (maturation feeding)

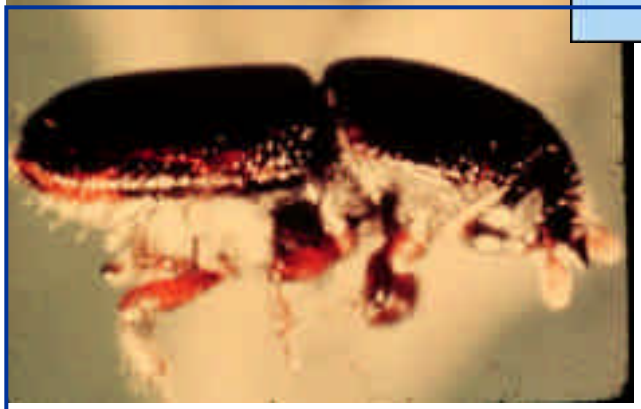
Systemic movement in tree provides breeding material



Acquisition of fungal spores in pupal chambers

Two important vectors of *Ophiostoma novo-ulmi* in North America
Both vectors well-established before pathogens arrived

Hylugopinus rufipes
North American
elm bark beetle
- inefficient vector
- throughout natural range of elm
- tolerates cold winters



Scolytus multistriatus
Lesser European
elm bark beetle
- efficient vector
- throughout most of North America, except North
- does not survive cold winters well
(Dutch elm disease management is easier in cold climates)

New Vector Arrives:

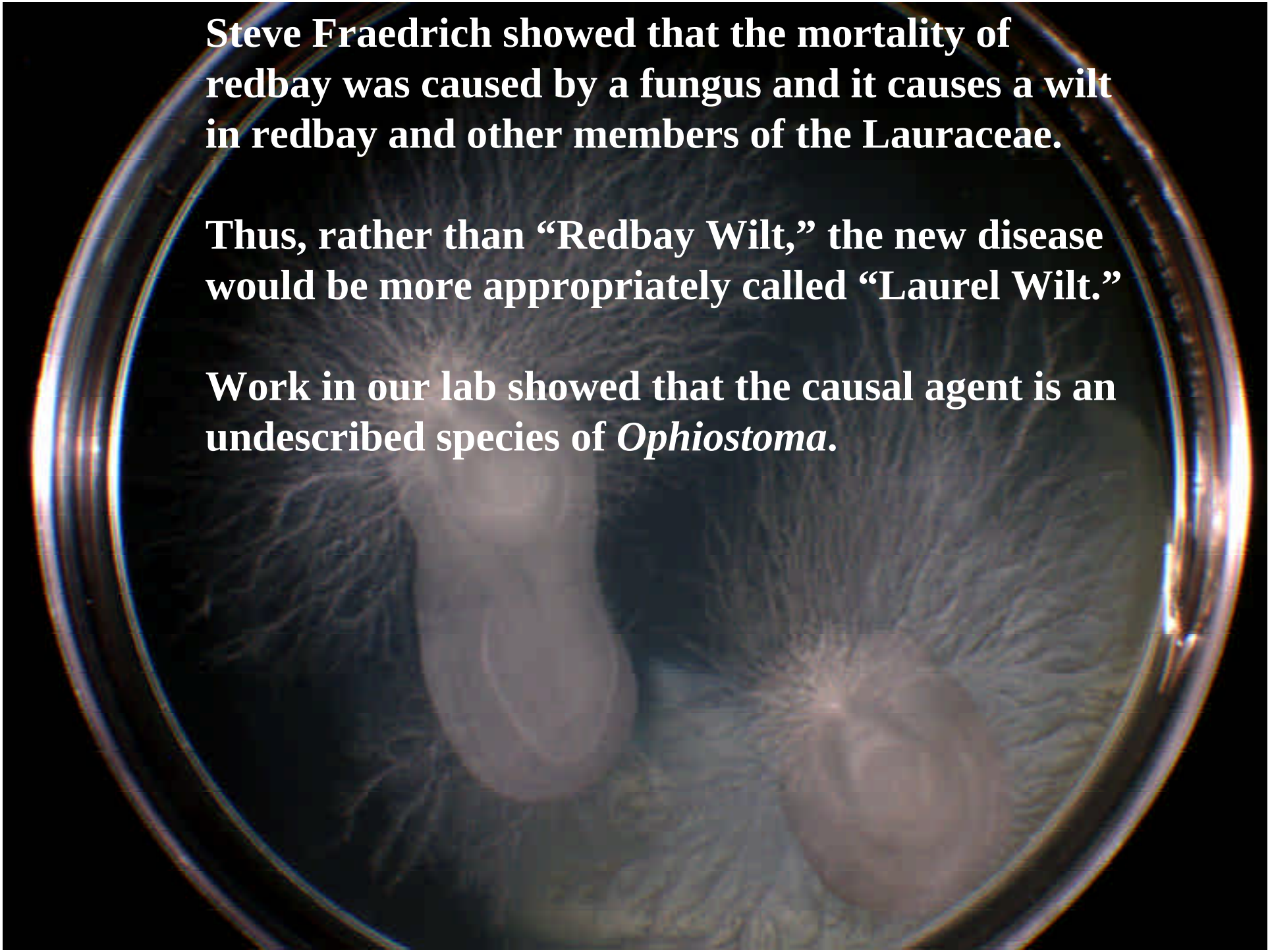
Scolytus schevyrewi
Banded Asian Elm Bark Beetle

- native to Asia, as far north as Mongolia
- introduced in 2002 to Utah and Colorado
  on crating material
- now as far east as West Virginia
-appears to be replacing *Scolytus multistriatus*
-carries *Ophiostoma novo-ulmi* and will likely prove a major vector

Laurel Wilt

Our New
Dutch Elm
Disease


Moves systemically,
a vascular wilt disease,
like Dutch elm disease



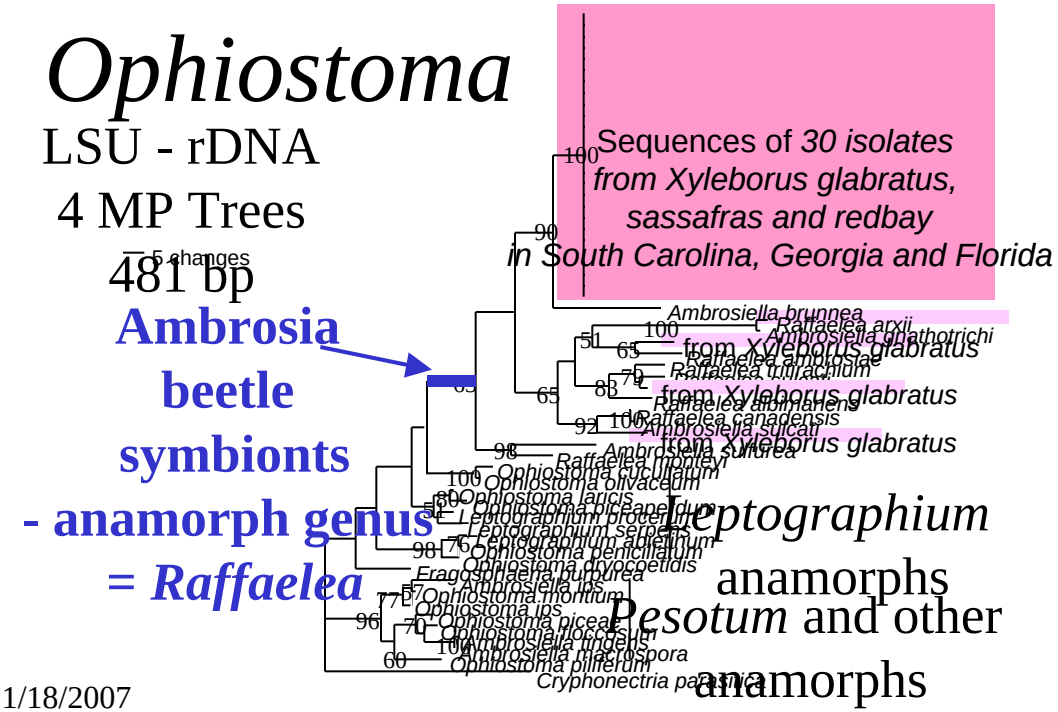
Steve Fraedrich showed that the mortality of redbay was caused by a fungus and it causes a wilt in redbay and other members of the Lauraceae.

Thus, rather than "Redbay Wilt," the new disease would be more appropriately called "Laurel Wilt."

Work in our lab showed that the causal agent is an undescribed species of *Ophiostoma*.

The pathogen tolerates cycloheximide, like other species of *Ophiostoma*, and rDNA sequences show that it is closely related to other Ophiostoma-like fungi that are symbionts of ambrosia beetles.

The fungus does not form a sexual state, and thus the rules of nomenclature do not allow describing it as a species of *Ophiostoma*. Rather, the new species will be described as a species of *Raffaelea*, a genus of ambrosia beetle symbionts within the genus *Ophiostoma*.



Thus far, the only known vector of the *Raffaelea* sp. is *Xyleborus glabratus*

Xyleborus glabratus - Redbay Ambrosia Beetle

Southeast Asia

On members of the Lauraceae and other aromatic trees

Cinnamon tree, camphor, and others

(In the Americas - bay, laurel, avocado, etc.)

Xyleborus glabratus and other ambrosia beetles attack and lay eggs in redbay trees with laurel wilt.

Other species of *Xyleborus* are known to carry their fungal symbionts in mandibular mycangia.

Mike Ulyshen and Jim Hanula sectioned *X. glabratus* females and found the paired mandibular with what appeared to be budding spores.

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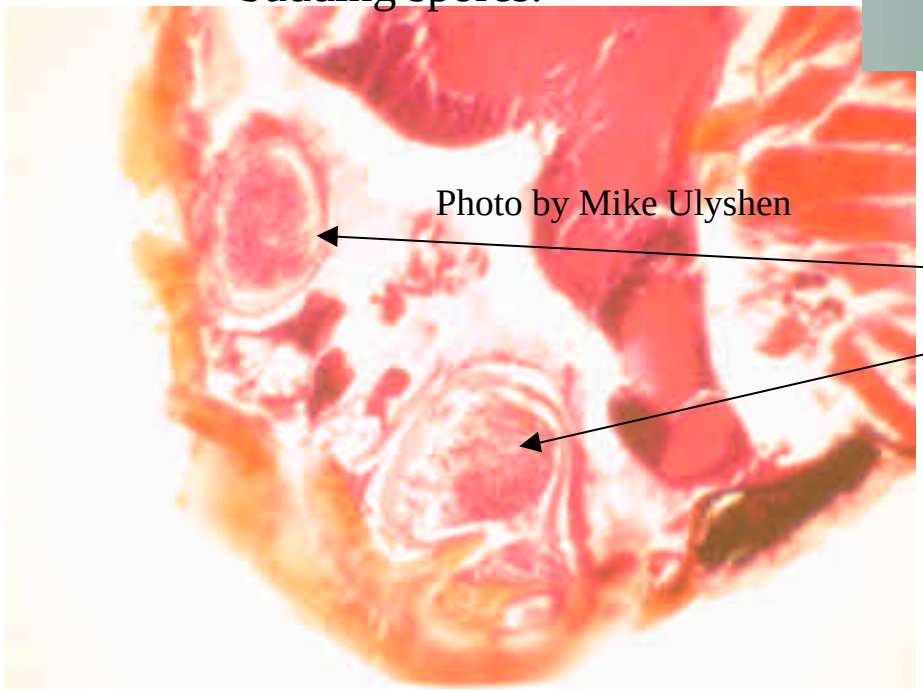
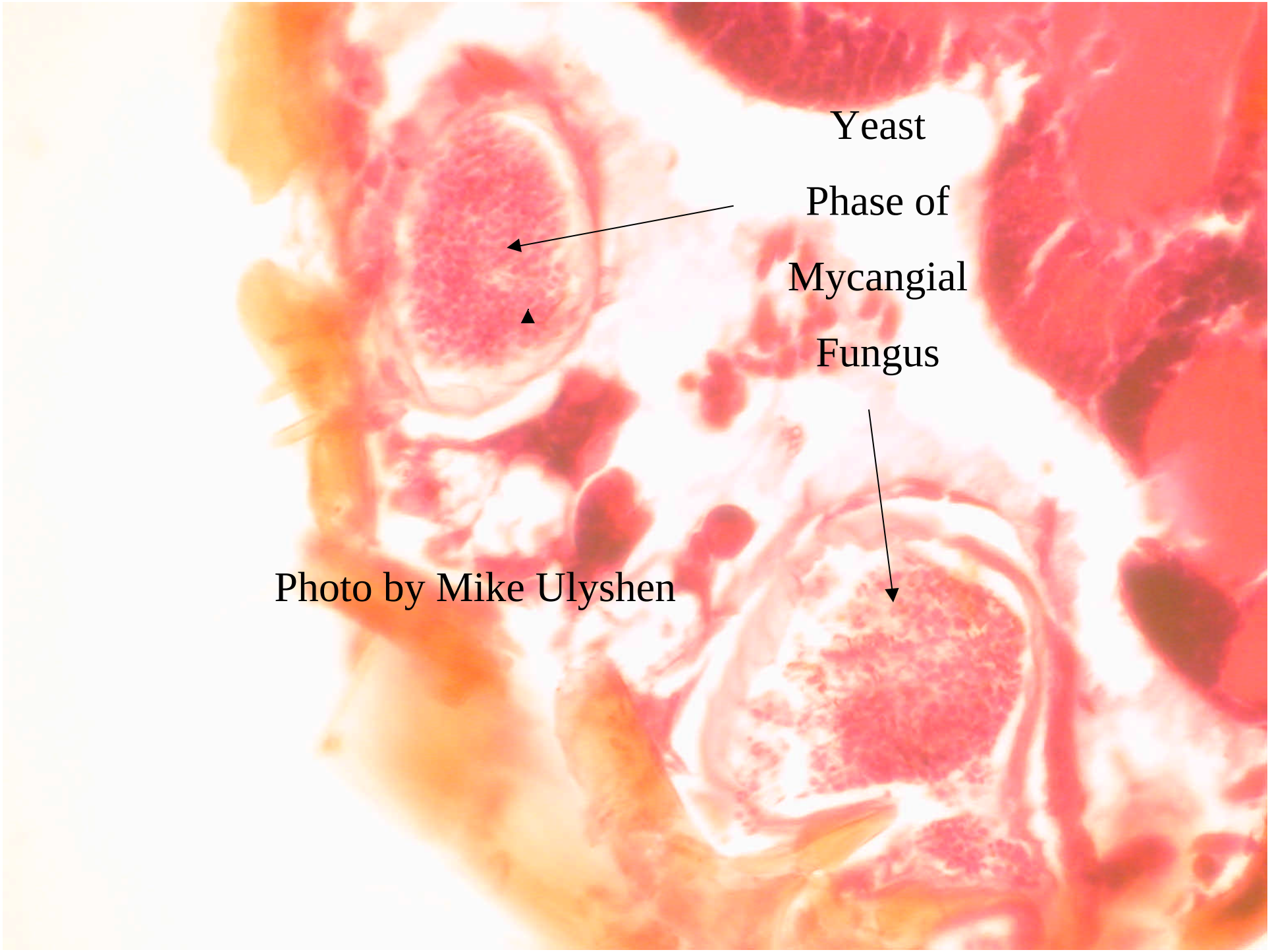
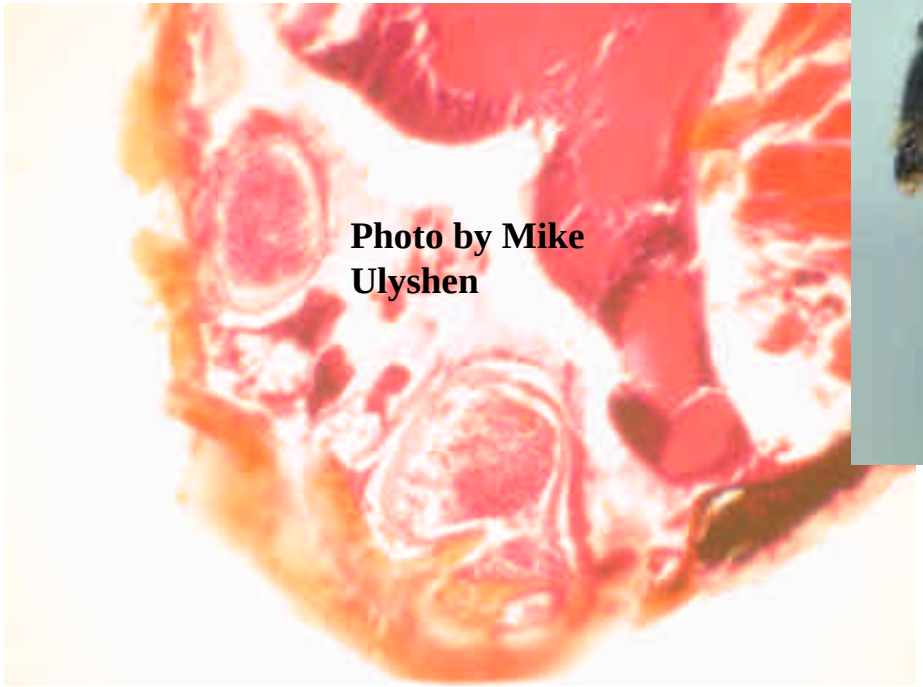


Mandibular Mycangia


Yeast
Phase of
Mycangial
Fungus
Photo by Mike Ulyshen

Steve Fraederich collected *X. glabratus* females and did dilution plating from individual beetles, and we quantified the fungi present.



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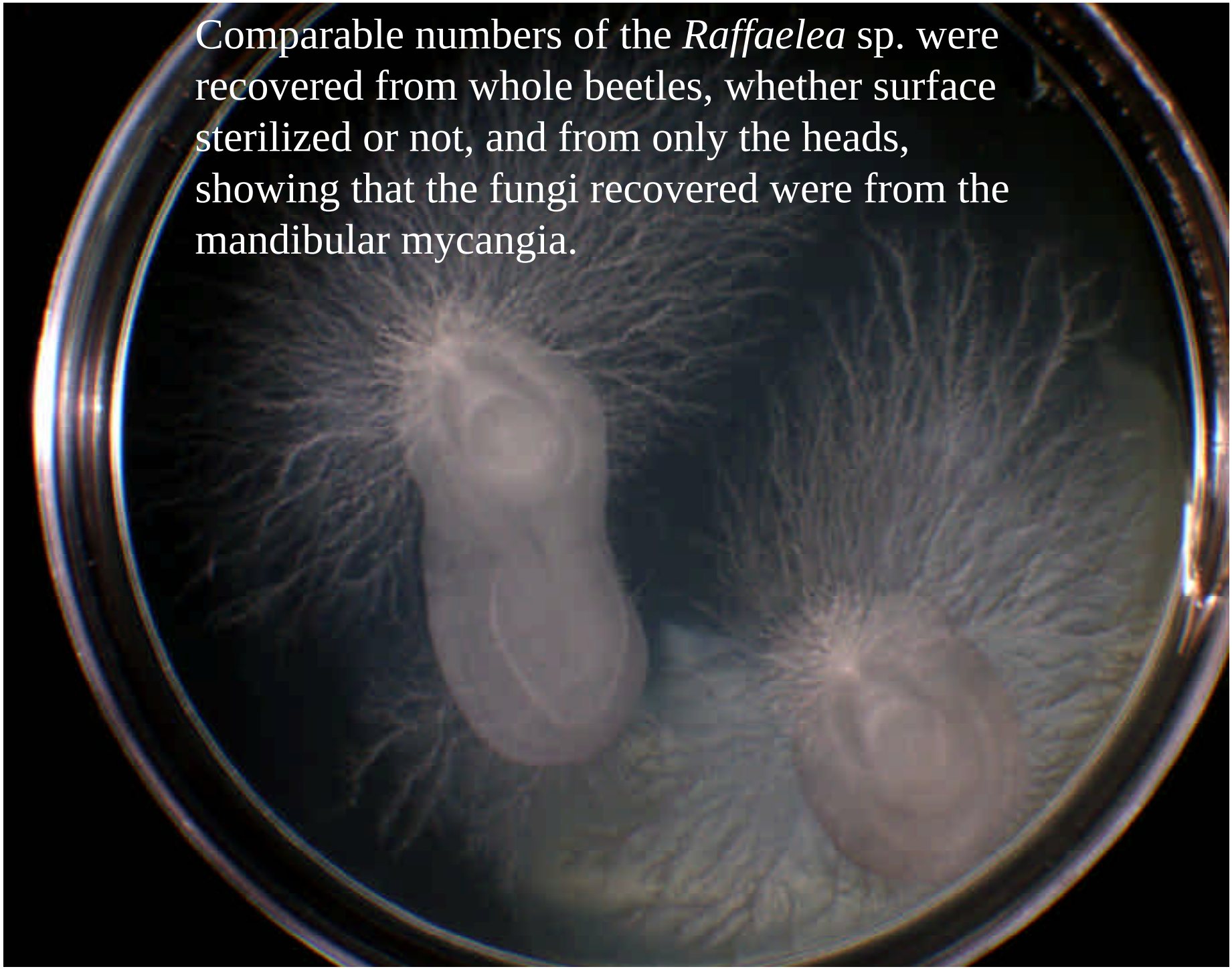
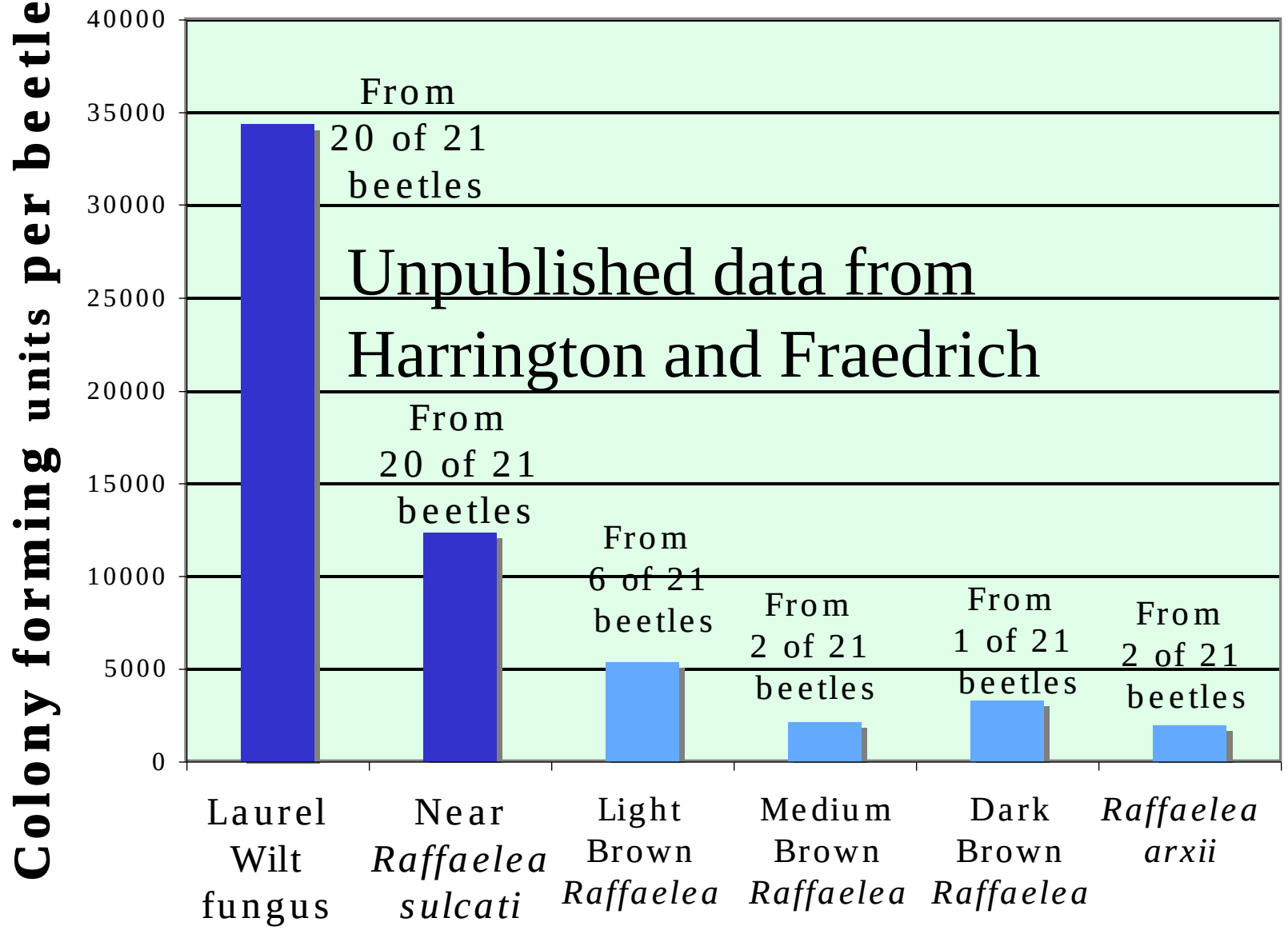


Comparable numbers of the *Raffaelea* sp. were recovered from whole beetles, whether surface sterilized or not, and from only the heads, showing that the fungi recovered were from the mandibular mycangia.


Other species of *Raffaelea* species were also recovered, including one near an unnamed species from South Africa and near a named species of ambrosia beetle symbiont, *R. sulcati*

Isolations from *X. glabratus* mycangia



1/18/2007

Initial infections in healthy redbay seem t
due to aborted tunneling by *Xyleborus glabratus* healthy trees.

Empty tunnels in small branches of redbay, with vascular discoloration emanating from the tunnels.

Vascular discoloration moving down from infections in smaller branch

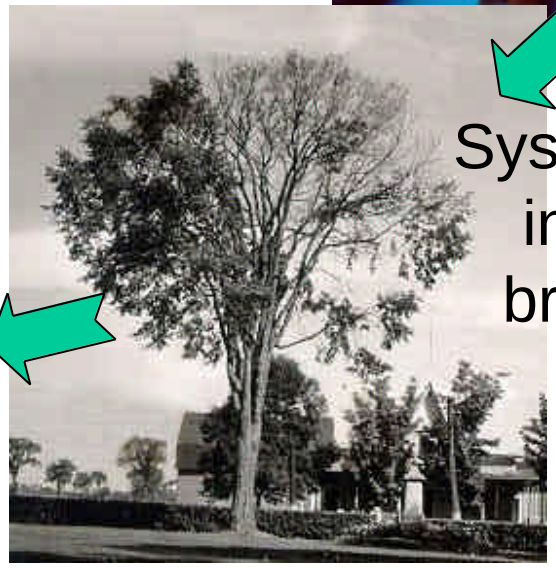
Vascular discoloration in main stem, but before egg-laying attacks by ambrosia beetles


Aborted tunnels by *X. glabratus* appear to be the important infection courts in healthy trees
Wilted trees provide breeding material for the beetles.

Disease cycle of laurel wilt similar to that of DED

Transmission through twig crotch feeding (maturation feeding)

Systemic movement in tree provides breeding material



Acquisition of fungal spores in pupal chambers

Dutch Elm Disease Management in the North America

vs. laurel wilt ?

Eradication of vectors not a possibility

vs limited distribution of *Xyleborus glabratus*?

Reduce numbers of vectors that breed in diseased trees

Replace mycangial fungus of *X. glabratus*?

Insecticides sprayed on foliage to eliminate maturation feeding

Protect high value trees with insecticides sprays?

Systemic fungicides to protect trees

Alamo or arbotech for high value trees?

Severing root grafts

Stump treatment of survival in roots?

Some Research Needs

Can the spread of *X. glabratus* be slowed?

- sanitation (all redbay suitable for brood, not just symptomatic)
- lures

Host range of pathogen

Host range of *X. glabratus for attacks and brood*

Competition and benefit to beetle of the *Raffaelea* species

Can other ambrosia beetles introduce pathogen to live trees?

Will systemic fungicides protect trees?

Will stump sprouts harbor fungus?

Can a mycovirus disease control the pathogen?

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Photo by Mike Ulyshen