

Shot Hole Borers - Fusarium Dieback Host Range, Biology and Control Strategies in Native Vegetation

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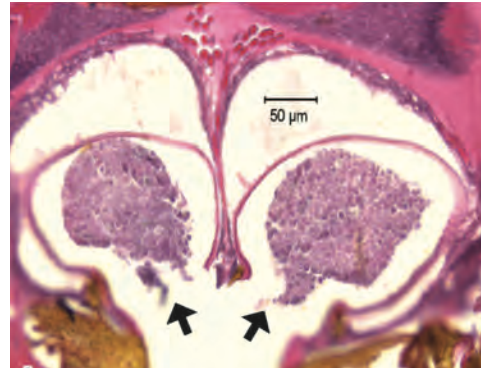
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Polyphagous and Kuroshio Shot Hole Borers and their symbiotic fungi



Mycangia

Figure: Matthew Kasson



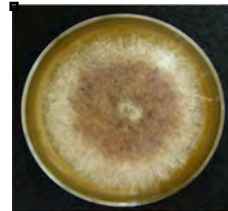
Polyphagous and Kuroshio Shot Hole Borers and their symbiotic fungi



A.Eskalen

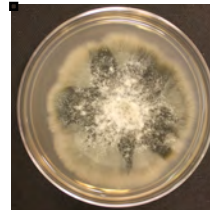
Los Angeles Co
Orange Co
San Bernardino Co
Riverside Co
Ventura Co.

Polyphagous
Shot Hole
Borer
PSHB



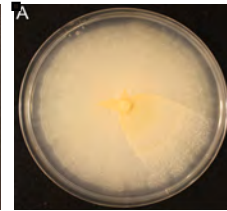
Fusarium
euwallaceae

(Freeman et al.2013)



Graphium
euwallaceae

(Lynch et al. 2015)



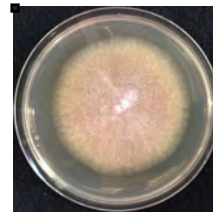
Paracremonium
pembeum

(Lynch et al. 2015)

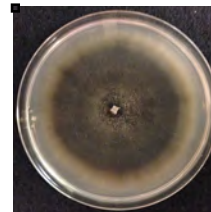


San Diego Co
Orange Co

Kuroshio
Shot Hole
Borer
KSHB



Fusarium sp.
(New species)



Graphium sp.
(New species)

Beetle attack, introduction of fungi and tree response



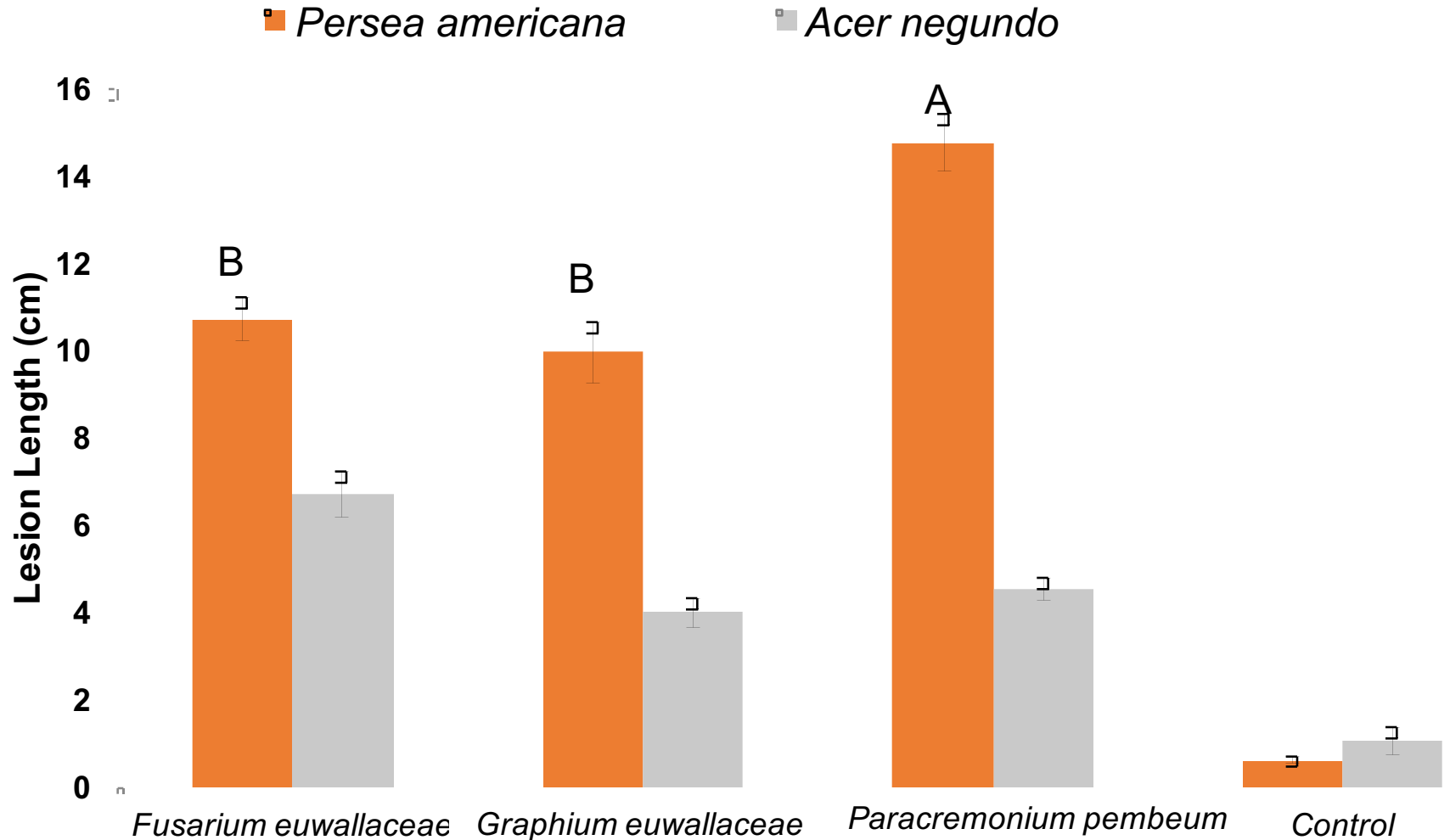
Branch Dieback and Tree Wilt



Coast Live Oak (*Quercus agrifolia*)

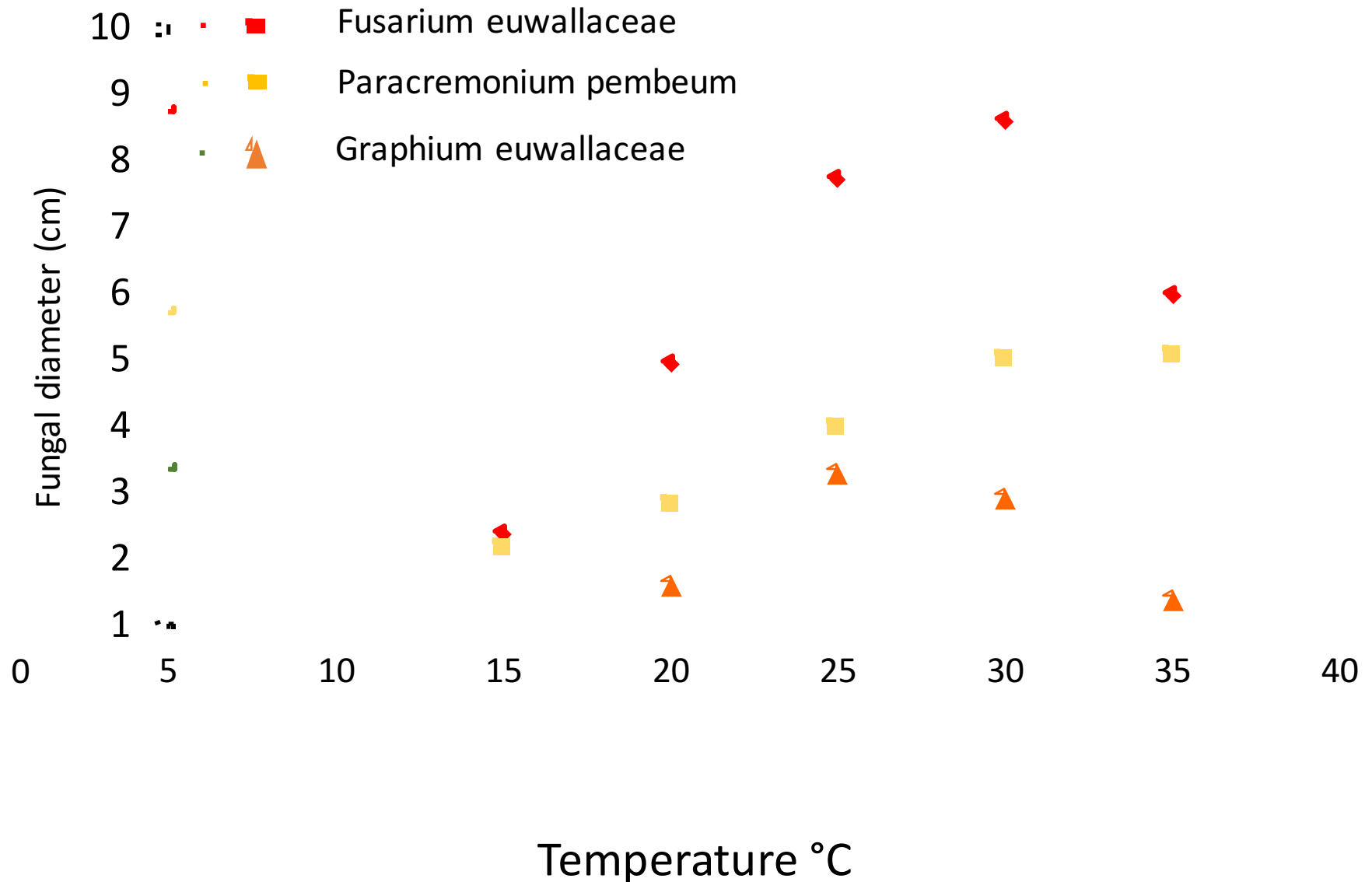


Koch's Postulates – Pathogenicity test

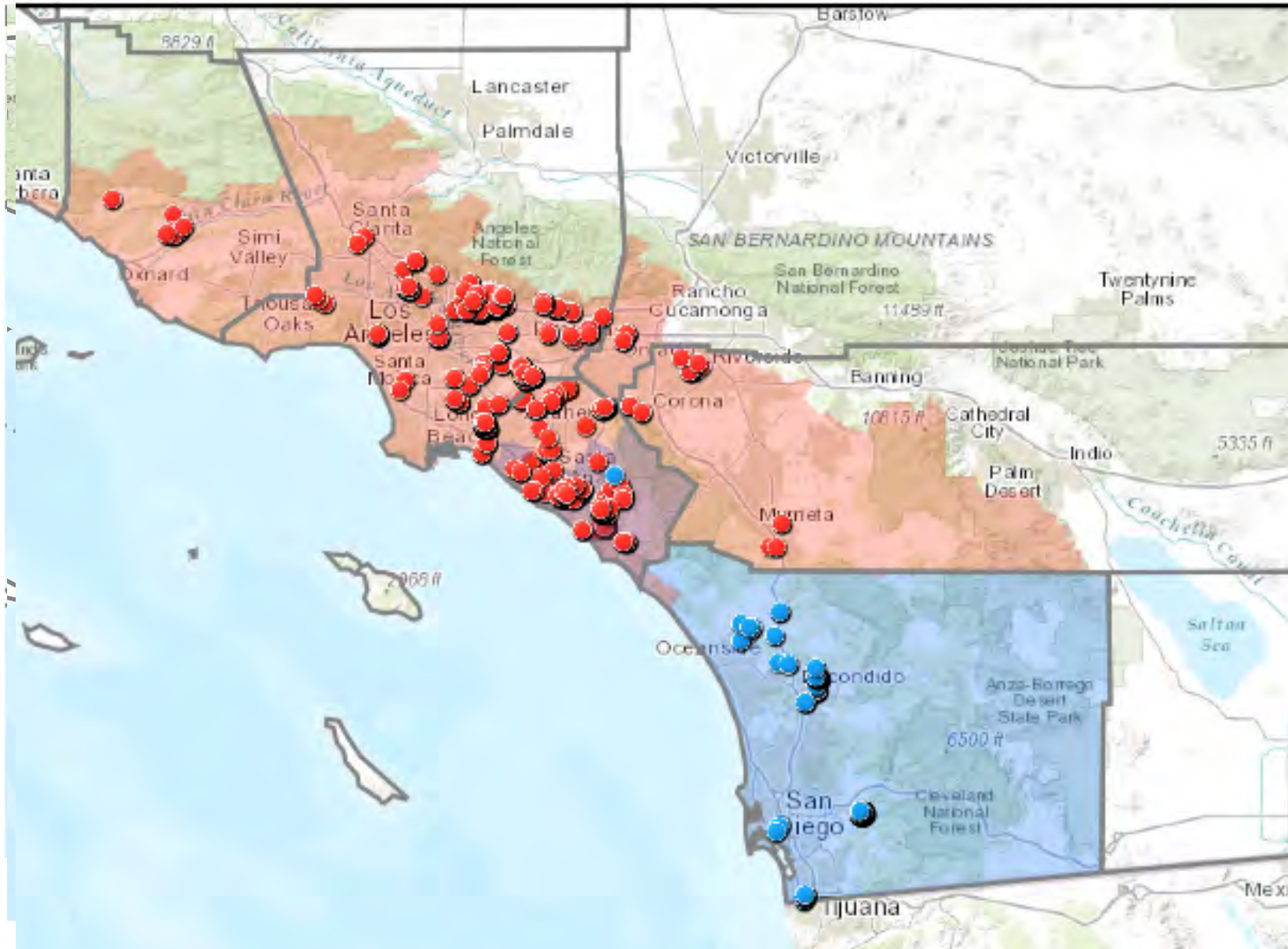


Mean lesion lengths on avocado and box elder shoots inoculated with isolates of *Fusarium euwallaceae*, *Graphium euwallaceae* and *Paracremonium pembeum*. Vertical lines represent standard error of the mean according to Fisher protected Least significant difference (LSD) mean separation test at $\alpha = 0.05$.

Growth rate of symbiotic fungi in different temperature



Historical spread of SHB/FD in California



2012

2013

2014

2015

2016

Host Range of Shot Hole Borers and Fusarium Dieback in CA

	2012	2016
Tree Species Attacked by Beetle	286	303
Tree Species Infected by Fungus	117	138
Agricultural Crops	13	13
California Native Tree Species	11	19
Number of Tree Families	62	64
Number of Reproductive Hosts	19	41

Ref: Eskalen, A., Stouthamer, R., Lynch, S.C., Rugman-Jones, P., Twizeyimana, M., Gonzalez, A., Thibault, T. 2013. Host Range of Fusarium Dieback and its Ambrosia Beetle (Coleoptera: Scolytinae) Vector in Southern California. *Plant Disease*.In 97:7, 938-951

- Box elder (*Acer negundo*)*
- Big leaf maple (*Acer macrophyllum*)*
- Evergreen Maple (*Acer paxii*)
- Trident maple (*Acer buergerianum*)
- Japanese maple (*Acer palmatum*)
- Castorbean (*Ricinus communis*)
- California Sycamore (*Platanus racemosa*)*
- Mexican sycamore (*Platanus mexicana*)
- Red Willow (*Salix laevigata*)*
- Avocado (*Persea americana*)
- Mimosa (*Albizia julibrissin*)
- English Oak (*Quercus robur*)
- Coast live oak (*Quercus agrifolia*)*
- London plane (*Platanus x acerifolia*)
- Cottonwood (*Populus fremontii*)*
- Black cottonwood (*Populus trichocarpa*)*
- White Alder (*Alnus rhombifolia*)*
- Titoki (*Alectryon excelsus*)
- Engelmann Oak (*Quercus engelmannii*)*
- Cork Oak (*Quercus suber*)
- Valley oak (*Quercus lobata*)*
- Coral tree (*Erythrina corallodendron*)
- Blue palo verde (*Cercidium floridum*)*
- Palo verde (*Parkinsonia aculeata*)
- Moreton Bay Chestnut (*Castanospermum australe*)
- Brea (*Cercidium sonora*)
- Mesquite (*Prosopis articulata*)*
- Weeping willow (*Salix babylonica*)
- Chinese holly (*Ilex cornuta*)
- Camelia (*Camellia semiserrata*)
- Acacia (*Acacia* spp.)
- Liquidambar (*Liquidambar styraciflua*)
- Red Flowering Gum (*Eucalyptus ficifolia*)
- Japanese wisteria (*Wisteria floribunda*)
- Goodding's black willow (*Salix gooddingii*)*
- Tree of heaven (*Ailanthus altissima*)
- Kurrajong (*Brachychiton populneus*)
- Black mission fig (*Ficus carica*)
- Japanese beech (*Fagus crenata*)
- Dense logwood (*Xylosma congestum*)
- Mule Fat (*Baccharis salicifolia*)*

***Native species to California**

Symptoms of SHB/FD on different hosts



Coast live oak



Liquidambar



California Sycamore



Excelsa



Coast live oak



Avocado



English Oak



Castor bean

Size of the plant attacked by the beetle



Avocado



Sycamore

KSHB in Tijuana River Valley in San Diego



Mortality on Willow Species (*Salix* spp.)

Distribution of Arroyo Willow



Mortality on Willow Species (*Salix* spp.)

KSHB in San Luis Rey Watershed in Bonsall



San Joaquin Marsh Wildlife Sanctuary Orange County



A. Eskalen



Red Willow

A. Eskalen



Red Willow

A. Eskalen



Cottonwood

A. Eskalen

San Ana River Riparian Areas in Riverside County



Collaborators

California Avocado Commission

U.S. Forest Service, OC Parks, UC Irvine, UC ANR, USDA Farm Bill, Arborjet, Mauguet, USDA Forest Service, Cal-Fire, Huntington botanical garden and LA arboretum

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Mathew Hand, PCA
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<http://eskalenlab.ucr.edu>