Quercus chrysolepis supports sporulation of *Phytophthora ramorum*

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Overview:

►Canyon live oak (*Quercus chrysolepis*), an important tree in many California woodlands, was originally found to be susceptible to leaf and twig infection by *Phytophthora ramorum* (Murphy & Rizzo 2003; Fig. 1C).

►Recently, we discovered that canyon live oak also suffers trunk infections by *P. ramorum*, often resulting in mortality (Aram et al. 2011, Fig. 1B & D).

►Foliar infections are considered primary source of *P. ramorum* inoculum in California forests (Davidson et al. 2008).

►Tanoak (*Notholithocarpus densiflorus*) is susceptible to fatal trunk infections, but is capable of supporting sporulation on its foliage and twigs.

►In contrast, infection and sporulation on foliage of California oaks, like *Quercus agrifolia*, appears to be negligible; trunk infections on these oaks depend on proximity to other hosts supporting pathogen sporulation.

►To determine the sporulation potential of *Q. chrysolepis* foliage and twigs, we inoculated detached branches of this species along with those from *N. densiflorus* and *Q. agrifolia* for comparison.

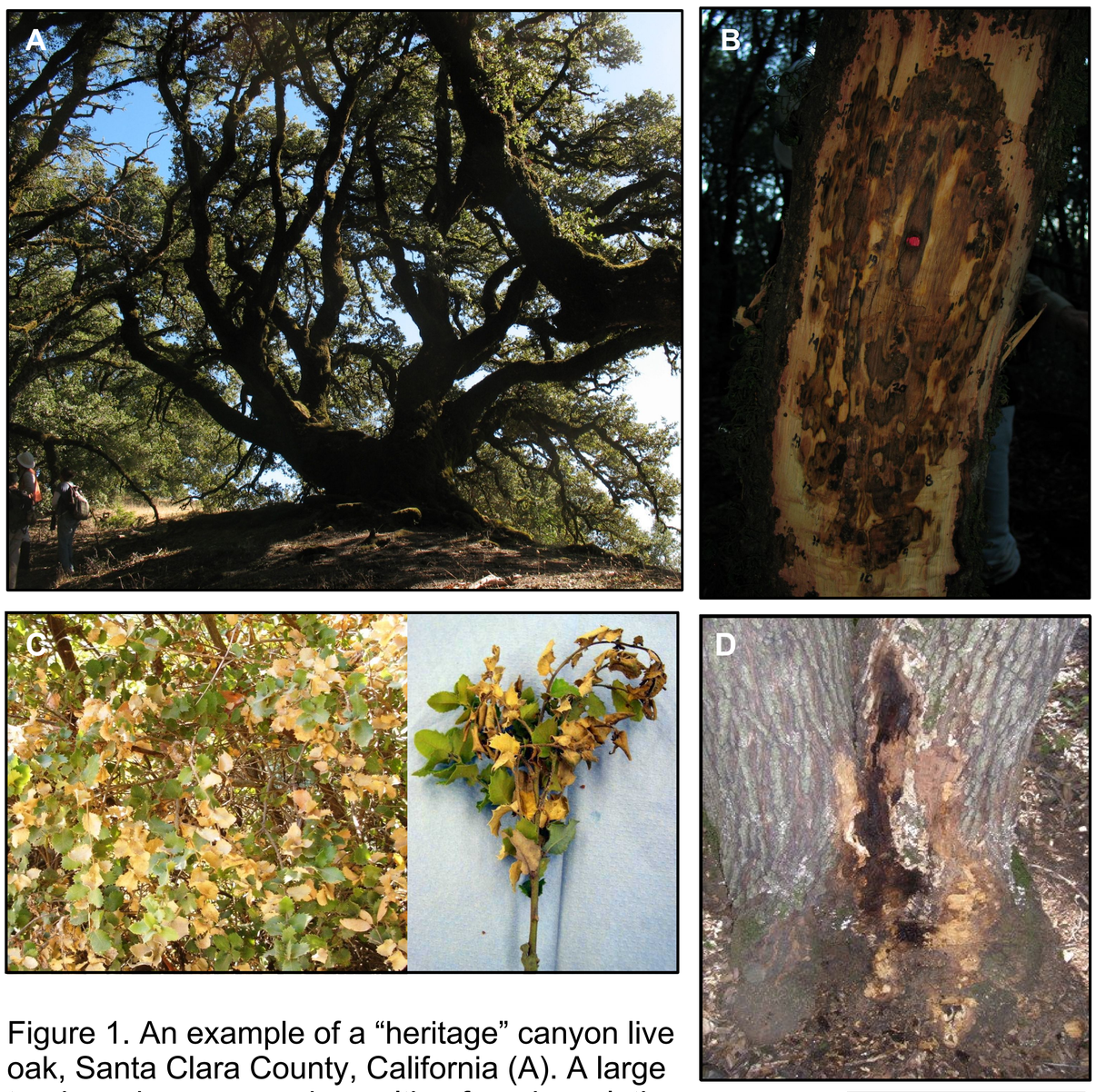

Figure 1. An example of a “heritage” canyon live oak, Santa Clara County, California (A). A large trunk canker, exposed, resulting from inoculation with *P. ramorum* (B). Leaf blight & twig die-back symptoms (C). A late-stage natural canker (D). *P. ramorum* cultured from *Q. chrysolepis* tissue (E).

Methods:

- 10-20 cm terminal branches were collected from 10 trees of each species.
- Sourced from UC Davis campus and arboretum, and nature preserves in California.

- From each tree, ten branches were inoculated; one was retained as non-inoculated control.
- Branches were inoculated by dipping in zoospore suspension ($2x10^4$ per ml) for 30 seconds.
- Incubated on a plastic grate in clear moist chambers at 18°C with 8 hours light daily.

- Destructively sampled after 14 days by removing 5 mm dia. discs from necrotic regions of leaves, petioles and stems.
- Excised tissue was placed into 1.5mL deionized water in microcentrifuge tubes and vortexed for 30s to dislodge sporangia. Tissue was removed and the suspension preserved with a drop of lactophenol with cotton blue (5% w/v).

- Frequency of sporangia in each suspension was determined by counting subsamples of known volume with the aid of a microscope at 50x magnification. Results were averaged and the number of sporangia per leaf disc, petiole & stem length were estimated.

- To compare the effect of host species on the sporulation in each host tissue (leaves, shoots, or petioles), Kruskall-Wallis test was performed because these data did not satisfy the normality and homogeneity of variance requirements of ANOVA. Species means were compared by Dunn's multiple comparison procedure using ranks sums at P = 0.05.

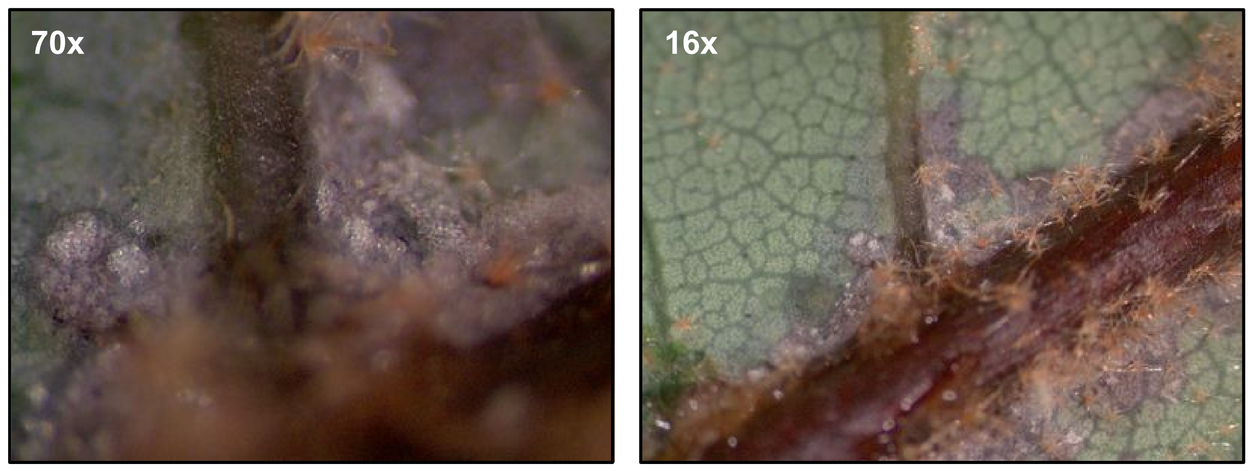

Figure 2. *P. ramorum* sporangia were produced on all species tested, typically erupting from necrotic areas that predominated along leaf veins. *Q. chrysolepis* shown.

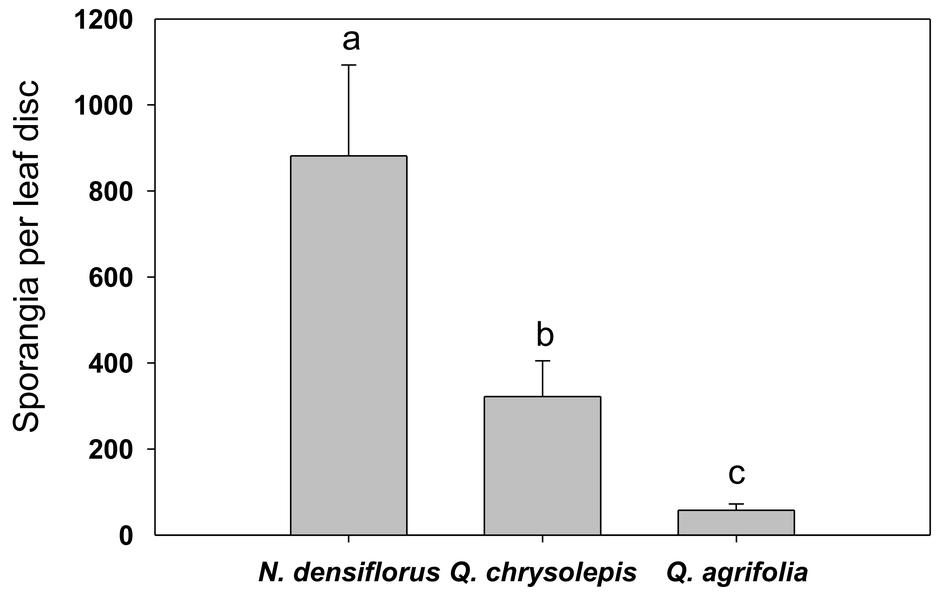

Figure 3. *Q. chrysolepis* leaves supported sporangia production, but significantly lower than *N. densiflorus;* both species produced significantly higher numbers of sporangia than *Q. agrifolia*. Bars represent standard error. Columns with different letters are significantly different (P = 0.05) according to non parametric Dunn´s test.

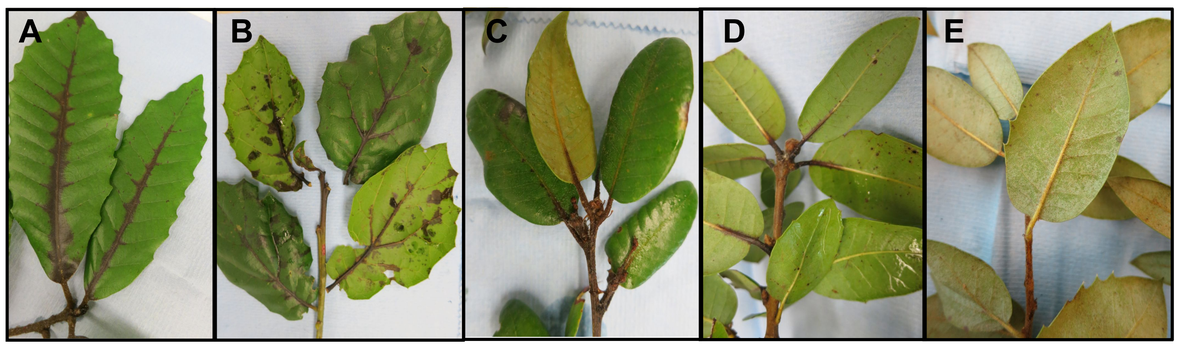

Figure 4. Most inoculated *N. densiflorus* (A), *Q. agrifolia* (B) and *Q. chrysolepis* (C & D) branches developed necrotic lesions, mainly along leaf mid-veins, petioles and stem apex. *P. ramorum* was re-isolated from most symptomatic tissue. Non-inoculated branches did not show necrosis (E), nor were sporangia or *P. ramorum* recovered from them.

Discussion:

► Tanoak and California bay laurel (*Umbellularia californica*) are highly conducive to *P. ramorum* sporulation & therefore drive epidemics in North American forests; these results confirm that canyon live oak is not as conducive.

►However, *P. ramorum* reproduced more on this species than on coast live oak.

►While most *P. ramorum*-susceptible oaks in California are red oaks (section *Lobatae*), and white oaks (section *Quercus*) appear to be resistant, canyon live oak is in the intermediate section (*Protobalanus*), and therefore presents a potentially new pathology.

►To date, *P. ramorum*-caused shoot and trunk infections have not been concurrently observed on canyon live oak. Trunk infections have only been observed on large trees in proximity with bay laurel, while shoot infections were observed on smaller trees under an infected overstory. It is uncertain that sporulation from infected shoots could favor trunk infections, as occurs with tanoak.

►Finally, infected leaves of *Q. chrysolepis* and *Q. agrifolia* were prone to abscission, while those of *N. densiflorus* remained firmly attached. This could further reduce the potential inoculum load such infections could produce.

References:

Aram, K., Swiecki, T., Bernhardt, E., and Rizzo, D.M. 2011. Canyon live oak (*Quercus chrysolepis*) is susceptible to bole infection by *Phytophthora ramorum*. Phytopathology 101:S8

Davidson, J. M., Patterson, H. A., and Rizzo, D. M. 2008. Sources of inoculum for *Phytophthora ramorum* in a redwood forest. Phytopathology 98:860-866.

Murphy, S.K., and Rizzo, DM. 2003. First Report of *Phytophthora ramorum* on Canyon Live Oak in California. Plant Dis. 87: 315

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