Variation in susceptibility of tanoak to \textit{Phytophthora ramorum} at the population and species levels

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INTRODUCTION

Tanoak (\textit{Lithocarpus densiflora}) is among the hosts most heavily impacted by sudden oak death, one of a complex of diseases caused by the introduced forest pathogen \textit{Phytophthora ramorum}. However, a patchy disease distribution at both the landscape and population scale, as well as observed variation in lesion development within single populations, suggest that variance in susceptibility may play a role in disease dynamics. We report on a preliminary study of resistance to infection by \textit{P. ramorum} in tanoak sampled across the tree’s geographic range.

MATERIALS & METHODS

5 populations, 30 trees/population, 10 inoculations/tree, 1 sham inoculation/tree

Inoculated with \textit{P. ramorum} isolate Pr57 (source D. Rizzo, isolated from \textit{L. densiflora} in Santa Clara Co., CA), grown 2 weeks on V8 agar at 20°C

Detached-leaf assay: 5 mm diameter agar plug cut from colony edge and impaled on cut petiole. Incubation in moist chambers in a single incubator at 18-20°C for 9 days; leaves moistened and chambers rotated every 3 days.

Lesions measured using the software ASSESS (APS Press)

RESULTS

Across individuals:

All individuals were susceptible to infection. Lesion area, averaged over the ten inoculations per tree, ranged from 17.97 mm$^2$ to 92.75 mm$^2$, with a median of 39.28 mm$^2$. Standard deviations ranged from 5.00 mm$^2$ to 49.71 mm$^2$, with a median of 7.78 mm$^2$.

Across populations:

Population means for lesion area ranged from 31.58 mm$^2$ to 61.53 mm$^2$, with an average standard error of the mean of 0.96 mm$^2$.


![Fig. 1. Tanoak mortality in Monterey Co., CA.](image1)

![Fig. 2. Location of study populations. Green shading represents tanoak habitat, which extends north beyond area shown into Oregon. Cut branches were sampled from all populations within a span of 4 days, and stored in water at 12°C. Prior to inoculation, all branches were brought to ambient temperature over 24 hr. Leaves from all populations were inoculated in random order on the same day.](image2)

![Fig. 3. Lesions extended using the software ASSESS (APS Press) Chambers rotated every 3 days.](image3)

![Fig. 4. Mean leaf lesion area among populations. Letters represent means significantly different at \( P < 0.05 \) by Tukey’s HSD. Analyses were performed on log-transformed data in JMP.](image4)

CONCLUSIONS

There was significant variation in susceptibility to \textit{P. ramorum} in tanoak at both the individual and population levels. There was a six-fold difference between the most and least susceptible trees, and a two-fold difference among the most and least susceptible populations. The observed variance should help further understanding of disease dynamics. \textit{Phytophthora ramorum} sporulates on the petioles and midribs of infected leaves. Thus, the size of these sporulating lesions, whether due to genetic or environmental causes, may contribute significantly to the inoculum load in a given region. Furthermore, less susceptible trees may be more likely to survive an infestation, with positive effects on the wildlife and ectomycorrhizal fungal communities they support.

The northernmost population was least susceptible, echoing a pattern observed in bay laurel (\textit{Umbellularia californica}). Trees from more northerly populations of bay laurel develop smaller lesions than southern trees when inoculated with \textit{P. ramorum} [1]. The similar pattern in tanoak suggests that environmental conditions may be responsible for lower susceptibility, and again, promises to further understanding of disease dynamics and forest risk factors.

FUTURE STUDY

A common garden study across these five population will be undertaken to determine which portion of the observed variation in susceptibility is due to heritable genetic differences, as opposed to environmental or other effects.

Surviving tanoak in heavily-diseased areas will be assayed to determine whether outcome in the field is correlated with laboratory-measured susceptibility. While leaf lesion size is correlated with stem lesion size (the cause of mortality in infected tanoak) in experimental systems, it is unknown if the differences in susceptibility we observe are great enough to change disease outcomes.

Surviving trees in heavily-diseased areas will be assayed against local and distant isolates of \textit{P. ramorum} to determine if local adaptation is playing a role in the evolution of host resistance or pathogen virulence.

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REFERENCE