Rapid Bacterial and Fungal Successional Dynamics in First Year after Chaparral Wildfire

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Funding Sources
Chaparral is a Mediterranean shrubland adapted to wildfires.

- 34,398 Km²
- ~9% of CA
- 70% of Federal land

Keeley, J.E. and F.W. Davis. 2006

Holy Fire, 2018, ~93 Km²
Secondary succession (change over time) is well understood in Chaparral vegetation but unknown for bacteria or fungi.

Importance of Microbes
- Drive nutrient cycling
- Stabilize soils
- Plant regeneration (mycorrhizal fungi)
Experimental Design: 2018 Holy Fire

Sampled 9 time points ranging from 2.5 weeks to 1-year post-fire.

16S
ITS2
Metagenomes

Pulido-Chavez et al Mol. Ecol. 2023
Fire reduced bacterial richness by 46% and fungal by 68%
Fire altered bacterial and fungal composition

![Bacteria NMDS plot](image1)

**Treatment**
- Burned
- Unburned

**Time Since Fire (days)**
- 17
- 25
- 34
- 67
- 95
- 131
- 187
- 286
- 376

![Fungi NMDS plot](image2)

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Pulido-Chavez et al. *Molecular Ecology* 2023
Unburned microbial communities show little to no dominance and low turnover

Pulido-Chavez et al Molecular Ecology 2023
Burned communities dominated by a few pyrophilous bacteria

\textit{Massilia}
Copiotrophic
Fast growing

\textit{Paenibacillus}
\textit{& Bacillus}
Heat-resistant
Endospores

\textit{Noviherbaspirillum}
Degrade
polyaromatic hydrocarbon, charcoal component

\textbf{Pulido-Chavez et al.}
\textit{Molecular Ecology} 2023
Burned communities dominated by a few pyrophilous fungi

**Geminibasidium**
Heat-resistant and xerotolerant

**Pyronema**
Heat-resistant sclerotia

**Aspergillus**
Fast growing

**Penicillium**
Fast growing

**Coprinellus**
Decomposer

Pulido-Chavez et al
*Molecular Ecology* 2023
Burned communities dominated by a few pyrophilous microbes with distinct tradeoffs in abundance and traits

Pulido-Chavez et al. Molecular Ecology 2023
First detailed view of secondary succession Chaparral microbiomes

- **High severity fire**
  - 0-25 days: thermotolerators
  - 25-187 days: fast growers
  - 187 days-1 year: Resource acquisition

Diagram showing the succession stages post fire with various fungal and microbial species depicted.
Summary

1. Wildfire significantly reduced bacterial & fungal richness

2. Burned bacterial and fungal communities experience rapid turnover rates likely driven by traits

3. Wildfire affected carbon and nitrogen cycling functions and increased aromatic degradation genes

4. Certain pyrophilous microbes positively respond to fire
   Bacteria: Massilia, Bacillus, Paenibacillus, Noviherbaspirillium
   Fungi: Geminibasidium, Pyronema, Penicillium, Aspergillus
Next steps – biophysical assays & genomics

• Cultured >400 isolated of bacteria and fungi from burned soils
• Biophysical assays & genomics to assess traits of pyrophilous bacteria and fungi