Ecological Resilience of Peatlands and its Application in Soil Health

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Scientific Questions

• Fate of boreal peatlands?
• Why do non-boreal peatlands exist?
• Carbon sink or source under climate change?

Bakker et al., 1997
Climate change-induced plant succession

Drought + Warming

Moss → Shrub → Tree

Carbon stock

Myers-Smith et al., 2011
What controls C decomposition?

- Generally, low C quality decreases C decomposition

- Not only anoxia, other factors, substrate or buildup chemical resistance must exist to reduce decomposition under drought
Pocosin Bog Study sites in coastal NC
Long-term treatments in field

<table>
<thead>
<tr>
<th>Sites</th>
<th>Water level (cm)</th>
<th>Dominant species</th>
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</table>
| Natural  | 0-60             | Winter: Mature trees: Pond pine (Pinus serotina Michx.), loblolly bay (Gordonia lasianthus (L.) Ellis), fetterbush lyonia (Lyonia lucida (Lam.) K. Koch), and swamp bay (Persea palustris (raf.) Sarg.).
|          | > 100            | Summer: Mature trees: Pond pine (Pinus serotina Michx.), loblolly bay (Gordonia lasianthus (L.) Ellis), fetterbush lyonia (Lyonia lucida (Lam.) K. Koch), and swamp bay (Persea palustris (raf.) Sarg.). |
| Drained  | >50              | Winter: Western brakenfern (Pteridium aquilinum (L.) Kahn) and winged sumac (Rhus copallinum L.)
|          | >120             | Summer: Western brakenfern (Pteridium aquilinum (L.) Kahn) and winged sumac (Rhus copallinum L.)
| Restored | 20-30            | Winter: Shrub: inkberry (Ilex glabra(L.)A. Gray), large gallberry (Ilex coriacea(Pursh) Chapm.), fetterbush lyonia (Lyonia lucida (Lam.) K. Koch) and laurel greenbrier (Smilax laurifolia L.).
|          | >60              | Summer: Shrub: inkberry (Ilex glabra(L.)A. Gray), large gallberry (Ilex coriacea(Pursh) Chapm.), fetterbush lyonia (Lyonia lucida (Lam.) K. Koch) and laurel greenbrier (Smilax laurifolia L.). |
Field and Lab Experiments

Gas chamber
- Soil Monolith
- Collar (ø 9.55 cm)
- Water Level
- Perforation
- Fritted Filter
- 3-way Valve
- Leachate
Phenolic inhibitory effect is defined as a negative value of Pearson’s r between soil respiration and soluble phenolics in the surface soil.

* Lower water level, higher phenolic inhibitory effect

\[ r = 0.8965 \]
\[ p = 0.015 \]
Phenolics inhibit SR

\[ r = 0.833 \]
\[ p < 0.0001 \]
* Highest available and total phenolics found in shrub leaves
Summary 1

Short-term drought

Peat decomposition

Long-term moderate drought

Phenol oxidase

Phenolics

Plant community

Slow-growing microbes with low carbon turnover rate in shrub peatlands

Wang et al., under review
Peatlands can adapt to climate change by **gradually shifting microbial & plant communities to maintain essential carbon sequestration functions and processes.**

* Phenolics linked plant-microbe symbioses
Can we enhance phenolic or phytochemical linkage in farmlands?

- Right crops, right fertilizer, right inoculants, right-plant-induced chemicals?
Phytochemical Linkage to Health of Soil, Plant, Animal and Human

- How human activities and climate change have changed the linkage in natural ecosystem and farmlands wetlands?
- How can we fix and enhance this linkage to improve ecosystem sustainability and resilience?
An example—Organic Farming

- Phenolic acids 19%
- Flavenones 69%
- Stilbenes 28%
- Flavones 26%
- Flavonols 50%
- Anthocyanins 51%
- Cadmium -48%

Questions?

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