Soil Lichens of the NJ Pinelands

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October 21st 2015
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Talk Outline

1. Lichens in general
2. Lichens of NJ Pinelands – introduction
3. Lichen communities of NJ Pinelands
4. Lichen influence on forest soils
5. Lichen: why should you care?
Lichen: composite organism made of a fungal species, photosynthesizing organisms and bacteria coexisting in a *symbiotic* relationship.
Lichen-associated bacteria are ubiquitous and phylogenetically and functionally diverse,
Lichens represent huge diversity of form, color, chemistry

- 14,000 species
- 29 new species discovered in N.A. since 2014
Lichens are well documented in NJ Pinelands...

- **1881 Britton**
  - 209 lichens in Flora of NJ
- **1926 Harshberger**
  - 11 Pinelands plant communities with lichens
- **1955 Moul and Buell**
  - Prescribed burns in NJ Pinelands favor growth of moss/lichen
- **2001 Brodo:**
  - Lichens of North America – anyone can find & study lichen
- **2006 Lendemer:**
  - 190 species in Wharton State Forest alone
  - Lichen flora of NJ has more southern species at north edge of range than northern species at south end

... so why should we continue to study NJ lichen populations?

Lichen populations decrease as human populations increase

- Example: New York City (Brodo, 1968)
- Long Island lichen diversity increases w/ distance from NYC


Example: NJ lichen diversity increases w/ distance to NJ TPK
... because lichens may be indicators of ecological stress

Lichen communities may reveal subtle habitat differences that are not apparent in vascular plant communities.

*Chaenotheca hygrophila*
Different lichen communities develop along a disturbance gradient

1. Highly used sand roads = no lichen:

2. Roads w/ low intensity use:
   - Tar lichen (*Placynthiella sp.*)
   - Pebble lichen (*Leimonis erratica*)
Different lichen communities develop along a disturbance gradient

3. Stable and undisturbed roadsides, forests
Thorn lichen (*Cladonia uncialis*)
Reindeer lichen (*Cladonia subtenuis*)

4. Protected areas with open canopies
*Cladonia subtenuis*
*Cladonia submitis*
Lichens are widespread in forest communities

(Ahti and Oksanen, 1990)

What ecological importance do lichens have in forests?
Lichens can be important for grazing animals in the tundra.

Heggberget et al., 2002
Lichens can be important for soil formation.

- Lichens can tolerate the high light intensity, low water availability, and low nutrient availability on bare rock.

- After lichens establish, they make the surface more permeable for water, more able to retain organic matter, and more accessible to plant roots.

Chen, Bloom, Beyer, 2000; Catena 39:121-146
Lichens can be important for erosion prevention and moisture retention in deserts

What functional importance do lichens have in temperate forests?

Belknap et al., 2005

Patton's Tracks Mohave: http://www.ecoseeds.com/ juicy.gossip.four.html
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Lichen mats all seem similar (but so do forests from far away)

Research Question 1:
How do lichen mats differ across the NJ pinelands?

Prediction:
Lichen mats differ according to land use differences
Study 1: Are lichen communities different across NJ?

- NLT Crossley Preserve – Tom’s River
- FAA Radio Tower – Warren Grove
- Wharton State Forest – Hammonton
- Makepeace Lake WMA – Hamilton Township
- Manumuskin River Preserve – Millville

Crossley Preserve

- Natural Land Trust preserve, Edge of Extensive development, North end of Pinelands
Warren grove
FAA Tower

- East edge of Pinelands, sparse population, near bombing range
Wharton State forest
Pleasant Mills Church

Heart of pinelands (Wharton State Forest, near Nescochague Creek, Batsto village, and Blueberry Fields.)
Makepeace Lake

- 10,000 acre NJDEP Wildlife Management Area, Former Cranberry Bogs,
Manumuskin river preserve

- Manumuskin River Preserve
Community study method

- Two 50m transects at each site
- 1m² quadrats
- assessed % cover of:
  - Lichens
  - Plants
  - Moss
  - Bare ground
Results: 9 species make up most of the lichen mats across NJ.
Many kinds of “reindeer lichen” on soils

- **Dull light green, branches bent mostly one way**
  - *Cladonia rangiferina*
- **Dull light green, branches going all directions.**
  - Branching in 2s, stalks under .7 m wide
    - *Cladonia subtenuis*
  - Branching in 3s/4s, .5-.8 mm wide,
    - *Cladonia arbuscula*
  - Branching in 3s/4s, wrinkled stalks .7-2mm wide
    - *Cladonia submitis*
- **Shiny, yellow-green**
  - Densely branched cushions with holes between branches
    - *Cladonia uncialis*
  - Flattened mats of slender branches, .5-1.5 mm wide
    - *Cladonia dimorphoclada*
- **Brown-green w/ lots of small side branches**
  - *Cladonia atlantica*
Comparison of lichen communities at 5 Pinelands sites
Why is manumuskin community different?

- All have sandy soils
- Well drained, low nutrient, low PH
- Lakewood Sand, Woodmansie sand, Lakehurst Sand, Evesboro Sand

L-R: © Mark Schoneveld, PPA; http://theeastheadwest.blogspot.com/2010/08/along-south-jersey-roads.html, Mark Betz, the Jersey I know
Manumuskin R.P. has more organic matter and more soil moisture

Soil properties: Summer 2013
Sampling Details: Arthropods

- Soil sampling using Tullgren Extractor in Dighton Lab
- Organisms identified to morphogroups

Oribatids:
- Ex:Eulechna
- Ph: Phthiracaroida
- Op: Oppioidea
- Or: Dark oribatid

Predators:
- Mc: Mesostigmata
- Pr: Prostigmata
- Po: Predator - other

Other:
- Other: Spider
- Other: Pseudoscorpion

Collembolans:
- Co: Collembola

Figure 4. Tullgren Extractor
Soils under lichens at Manumuskin R.P. lichens harbor higher densities of microarthropods

Soil animal abundance under lichen mats
Conclusions:
lichen mats are influenced more by moisture and soil organic matter than by land use

• Where lichen mats grow, they seem to be robust to historic disturbances.
  – But this disturbance gradient was small (lichens don’t grow at all in ATV tracks).
    • New question: what intensity of disturbance can the lichens survive?
• Natural Land Trust’s Manumuskin River Preserve has distinct lichen mats distinct from those in the rest of NJ. They have different lichens, the soils have more organic matter and support more predatory mites.
  • New question: What drives this difference? Geography? Soil type? Air moisture? If so, are other sites on the Delaware bay similar to Manumuskin?
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Study 2: How do soil lichens influence soil properties?
Lichens may be influential in:

– soil moisture retention

(Chamizo et al., 2013)
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- soil nutrient patterns
  (Knops et al., 1996)
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- provision of arthropod habitat
  (Root et al., 2007)
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- soil moisture retention
  
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- soil nutrient patterns
  
  (Knops et al., 1996)

- provision of arthropod habitat
  
  (Root et al., 2007)

- Soil microbial community activity
  
  (Sedia and Ehrenfeld, 2006)
How do soil lichens influence soil properties?

Brendan Byrne State Forest

Wharton State Forest
Transplant study

- 0.5m² Transplant blocks established Jan 2012 at 2 forests
- Soil homogenized, plants removed, 500g litter added
- Soils sampled to 5cm w/ 5cm diam soil core

4 litter types:
- lichen
- bare
- pine
- mixed
No significant lichen influence on soil moisture: lichen influence takes time to accumulate.
After 1.5 years, lichens decrease phosphorus availability

Soil phosphorus concentrations with different aboveground treatments

Soil Phosphate ug/g dry wt. of soil

PO₄²⁻

Forest

Treatment
- bare
- lichen
- mixed
- pine

Bryne
Wharton

*
Significant predatory mite difference in fall 2014
No significant influence of soil cover on enzyme activity
Conclusion: 
Study 2

LICHEN vs. BARE

Lichen Influence takes >1.5 years to manifest, and depends on initial soil conditions
Lichens: Next steps

- How do insect-mediated changes in forests alter lichen communities?
- How do lichen communities recover after fires?
Lichens: why should you care?

• Lichens are part of the suite of organisms that make the Pinelands unique
• Areas with diverse lichens might superficially look similar to other habitats, but the lichens indicate subtle habitat differences
Lichens: Next steps

- How many lichen hotspots are there in the Pine Barrens?
- How does the NJ Pinelands flora compare to the flora of other pinelands?
Thanks!

• Dighton Lab, Dennis Gray & Ken Clark
• J. Russel Juleg & Special Pinelands Plant Class
• Andrews Foray & Walter Bien
• Rutgers Pinelands Research Station
• Pinelands Commission
• James Lendemer