Physicochemical controls on suitable habitat and distribution of *Didymosphenia geminata* in the mid-Atlantic region

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Outline

• What is didymo?

• Current distribution in mid-Atlantic

• Physicochemical controls

• The Pine Creek experience
  – Temporal/spatial dynamics

• Future Research
What is didymo?

- *Didymosphenia geminata* – ‘rock snot’
- Single celled diatom algae
- External cell wall composed of silica
- Can produce stalks for attachment to substrate *(the nuisance part)*
Ecology

• Does not do well in eutrophic conditions
  – (“Didymo paradox”)

– Green algae bloom in eutrophic conditions
– Didymo response to eutrophic conditions
– Didymo coverage negatively correlated with dissolved P
  • stalk length increased 250% after 2 weeks of nutrient deprivation!

Cullis et al. 2012;
Sundareshwar et al. 2011;
Kilroy and Bothwell, 2012
Didymo – Habitat Preferences

- Flow regulated areas (tailwaters)
  - Prevents scouring
- Large, rocky substrate
- Temperature range: 32-73°F
  - Highest didymo biomass where temp is below 64°F (18°C)
- Abundant ambient light
- pH values above neutral
- Low dissolved Phosphorus concentrations
  - oligotrophic

World-wide distribution of records for D. geminata. Recent nuisance blooms in orange.

source Whitton et al., 2009
Current distribution

• Large nuisance blooms uncommon in native range historically
  – has recently been expanding range and bloom intensity within native range

• Previously, didymo was believed to be introduced largely because it kept showing up in high recreation areas (e.g. trout streams, tailwaters, etc..)

• Paradigm shifting research suggest didymo is more historically widespread than originally thought, just becoming a nuisance due to changing environmental conditions
  – Role of climate change and “oligotrophication”
  – Could be acting invasively in native range

• Not clear if didymo is native or introduced in mid-Atlantic

Lavery et al., 2014; Bothwell et al., 2014; Taylor and Bothwell, 2014
Didymo Impacts

• Impacts to base trophic levels/benthic habitat/periphyton nutritional content
  – Displacement of native algae/ increase pollution tolerance

= Effects on nutrient cycling and ecosystem function
  -implications for higher trophic levels (e.g. macros, fish)

• Impacts to macroinvertebrates
  – Macro diversity ; Scrapers, etc. living on course substrates ; EPT taxa
  – Chironomids and Oligochaets (pollution tolerant)

= Reduced assemblage diversity; taxonomic and functional homogenization

• Impacts to fish
  – Potential for didymo to smother trout redds, decreasing recruitment
  – Significant declines (50%) of brown trout population in S.D.
    • loss of EPT prey; impacts on the spawning success of brown trout
    • Reduced viability of eggs in redds

Reid and Torres 2014; Larson 2007; Richardson et. al. 2013; Ladrera et al. 2014; Kilroy et al. 2009; Bickel and Closs 2008; James and Chipps 2010
Didymo impacts

• Recreation:
Where is didymo in the mid-Atlantic?
• compiled 2451 records
  – 397 positive
  – 14 watersheds
- Blooms restricted to upper portion.
- Large bloom event in 2012 throughout >100 mile reach

East Branch Dyberry Creek - 1 obs May 2012
- 1 location

Pine Creek - 1st obs June 2013
- will be discussed in depth

Trout Run - 1st obs April 2015 (eDNA)
- not present on substrate

Youghiogheny River - 1st obs May 2012
- 2012 survey 49 mile reach

Didymo Present  Didymo Not Detected  State Boundary

SOURCE: Periphyton taxonomic data: ANSP, SRBC, DRBC, MDDNR, USEPA, iMap Invasives (PA and NY), PATLIB, Potapova (2010), Keller and Hilderbrand (2015), and RD Volkmar;
DISCLAIMER: Use of Map for Any Purpose on “As Is” Basis, No Warranties Provided; SRBC (1555b) 03-28-2016
Savage River
- 1st obs 2009

N. Br. Potomac
- 1st obs 2011

Gunpowder Falls
- 1st obs Jan 2008
- 16 mile reach below Prettyboy

Big Hunting Creek
- 1st obs winter 2012
- not detected in 2014 (eDNA & visual surveys)
What is controlling distribution?

• Bothwell et al. (2014):

“Once the suite of physical (higher light, low turbidity, stable substratum and flow) and chemical (specific pH range, minimum Ca and Si, maximum Na and Cl) prerequisites are met, we have shown that it is the concentration of soluble available P [SRP] that explains the timing and spatial distribution of blooms where D. geminata cells are present.”

Didymo on substrate of West Branch Pine Creek, June 2014
• compiled 35,607 SRP records
  – 2,576 in NY
  – 12,017 in PA
  – 21,014 in MD

• >1 obs in 358/725 HUC10 watersheds (49%)

• SRP <10 µg/l (didymo)

• SRP <5 in PA non-tailwaters
The Pine Creek Experience

18 June 2013

16 October 2013

Credit: Aaron Henning
The Pine Creek Experience

- 112 algal records
- 3 in close proximity to 1st discovery
- No evidence of didymo prior to 2013
since 2013
– 84 samples
– 25 confirmed didymo
– didymo on substrate from West Branch Pine Creek at Crippen Run downstream to Tiadaghton access in the Pine Creek gorge
– cells detected in water column as far down as Ramsey
repeated sampling using eDNA and microscopy did not detect presence of didymo:

- Ninemile Run
- Genesee Forks
- Phoenix Run
- Long Run
- Elk Run
- Marsh Creek
- Babb Creek
- Cedar Run
- Slate Run
- Blockhouse Creek
- Little Pine Creek

Keller and Hilderbrand, 2015
The Pine Creek Experience

- cell density highest in nutrient poor section high in watershed

- SRP inputs cause decrease in cell density moving downstream
The Pine Creek Experience

- SRBC RWQMN station
  - 70.6 mi²
  - 4th order
  - 0.63% slope
  - Median 6/3/10 - 12/31/15:
    - pH: 6.99
    - Temp: 10.1 °C
    - SpCond: 45 µs/cm
    - DO: 10.79 mg/l
    - Turbidity: 1.6 NTU
The Pine Creek Experience

- Standing Crop Index (visual assessment of didymo cover)
  - association with continuously monitored variables
The Pine Creek Experience

Hydrograph of modeled flow at West Branch Pine Creek
Future Research

• Determine native/non-native status of didymo
  – Paleolimnological analysis of sedimentary diatom assemblages in riverine impoundments in NY, PA, & MD

• Fill presence/absence data gaps throughout mid-Atlantic

• Refine quantitative relationships between didymo presence/bloom formation and physicochemical variables

Continue to decontaminate field gear!
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Questions?

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Link to report on PA didymo research:
http://seagrant.psu.edu/topics/invasive-species/research/didymosphenia-geminata-pennsylvania-investigation-current-and

Didymo on bedrock in upper Pine Creek, June 2014