Starry Stonewort: Is Your Lake Capable of Hosting the “Connoisseur of Clean Waters”

Presentation and Photos
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Introduction

- Scientific Name: *Nitellopsis obtusa*
- common name: Starry Stonewort
- submerged aquatic macrophyte (Characeae)
- native to Europe
- bio-indicator of healthy aquatic ecosystems
- species first detected as an invasive:
  - North America’s St. Lawrence Seaway in 1978
  - Laurentian Great Lakes in 1983
  - inland lakes of Michigan in 2006

Reference: Schloesser et al. (1986)

Illustration: R. K. Brown
Extant Geographic Distribution

Reference: Soulie-Marsche et al. (2002)
**Empire:** Eukaryota

**Kingdom:** Plantae

**Phylum:** Charophyta

**Class:** Charophyceae

**Order:** Charales

**Family:** Characeae

**Genus:** Nitellopsis

**Species:** Nitellopsis obtusa

Reference: Lewis and McCourt (2004)
Basic Morphology

- highly evolved multi-cellular organism
- small apex coronula
- two to five inferior nodes and internodes
- whorl that consists of five or six thin upwardly radiating branchlets
- length ranges from 24 cm - 2.0 meters

Reference: Bharathan (1983)
Starry Stonewort: The Subject of Numerous Cytological Studies

- inter-node cells 0.4 to 1 mm in diameter and up to 30 cm in length
- ideal in size for manipulation and observation
- considered to be discrete living organisms
- perpetuates cytoplasmic streaming following separation from thallus

Reference: Johnson et al. (2002)
Reproductive Capabilities of Starry Stonewort

- capable of sexual and asexual reproduction
- sexual reproduction occurs through production and fertilization of oospores
- North American colonies all male plants
- asexual reproduction occurs by prolific production of vegetative bulbils
- bulbils capable of surviving for long periods

References: Soulie-Marsche et al. (2002); Bharathan (1983)
Influence of Starry Stonewort on Inland Lake Trophic State Conditions

Charophyte meadows:
- increase water clarity by minimizing re-suspension of particulate matter
- release allelopathic substances
- provide complex habitat for zooplankton
- utilizes and precipitates calcium carbonate causing immobilization of phosphorus, inhibiting primary production

Above, *Nitellopsis obtusa* precipitating calcium carbonate

Reference: Kufel and Kufel, 2002
Invasive macrophyte meadows:

- form dense benthic barriers
- alter or eliminate native submerged aquatic plants
- prevent access to fish spawning substrate
- eliminate optimal growth habitat for fish fry
Impact of Dense Monotypic Starry Stonewort Meadows on Inland Lake Littoral Habitat
Aquatic Plants Capable of Co-Existing with Starry Stonewort Meadows

- *Ceratophyllum demersum* (Coontail)
- *Nymphaea odorata* (White water lily)
- *Utricularia vulgaris* (Common bladderwort)
- *Potamogeton zosteriformis* (Flat-stem pondweed)
Co-occurrence of *Chara vulgaris*

- *Chara vulgaris*
  - Co-Occurs in all Michigan Starry Stonewort colonized lakes
  - Native to Michigan inland lakes
  - Requires high calcium carbonate levels
  - Length positively correlated with high calcium carbonate levels
  - Depth: 2 ft. – 8 ft
  - Requires good water clarity
  - Intermingles with Starry Stonewort in shallow water
Co-occurrence of Eurasian Water Milfoil

- *Myriophyllum spicatum*
- Native to Europe and Asia
- Co-occurs with Starry Stonewort in European Inland Lakes
- Co-occurred in 88% (106/120) of 2012 Starry Stonewort Reported Inland Lakes in Michigan
- Trophic State Index preference equal (CTSI = 35 – 56)
- Starry Stonewort and Eurasian Water Milfoil compete for littoral dominance
Preferred Trophic State of Starry Stonewort

- earlier studies suggested limitation to “cold, clear, calcium carbonate rich waters of low trophic status” (i.e., oligotrophic conditions)

- limited knowledge of trophic state preferences of the species derived in an ancillary manner from study of more frequently observed and sometimes co-occurring charophytes such as Chara tomentosa and Chara globularis

- recent studies emphasize role of submerged macrophytes, particularly charophyte meadows, in promoting water transparency and stabilizing trophic conditions

Reference: Krause (1985)
Carlson Trophic State Index parameter values for 2012 reported inland lakes:

<table>
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<tr>
<th>Carlson Trophic Index Parameters</th>
<th>Secchi Disk Transparency (Meters)</th>
<th>Total Phosphorus (µg/l)</th>
<th>Chlorophyll-a (µg/l)</th>
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<td>Minimum</td>
<td>1.36</td>
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<tr>
<td>Median</td>
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<td>15</td>
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</tbody>
</table>
Inland lakes in Michigan that were vulnerable to colonization by invasive *Nitellopsis obtusa* were largely oligo-mesotrophic to mesotrophic, with the likelihood of successful introduction rapidly declining with trophic state conditions significantly above or below these values providing a barrier to colonization.
Carlson Trophic State Index values for Secchi disk transparency, total phosphorus and chlorophyll-a classified as either oligo-mesotrophic or mesotrophic comprised 94%, 93% and 91% of the group of Michigan inland lakes invaded by Starry stonewort.
Inland Lake Bathymetry v. Secchi Disk Transparency: Important Determinants of Starry Stonewort Colonization Patterns

Round Lake
(Jackson, Lenawee, Washtenaw)

Maximum Depth: 52 Ft.
Secchi Disk Transparency: 11 Ft.
Max. Depth Starry Stonewort: 16 Ft.

Union Lake
(Oakland County)

Maximum Depth: 110 Ft.
Secchi Disk Transparency: 19 Ft.
Max. Depth of Starry Stonewort: 29 Ft.
Inland Lake Bathymetry: An Important Determinant of Starry Stonewort Colonization Patterns
Colonization Potential of Starry Stonewort in Michigan

Oligo-mesotrophic and mesotrophic conditions required for the successful introduction of invasive *Nitellopsis obtusa* are found in approximately 75% of the 6,537 inland lakes in Michigan of ≥ 4 ha in size.

Graphic: MiCorps
Other Important Factors Determining Distribution and Abundance of *Nitellopsis obtusa*

- calcium carbonate levels that often exceed 100 mg/l, equal to levels found in Scandinavia and Russia
- lake shapes, shoreline ratios, bottom contours, and shallow bays capable of supporting large submerged macrophytes communities

Reference: Fuller and Taricska (2011)
### Future Study Opportunities

- Impact of dense *Nitellopsis obtusa* meadows on submerged macrophyte community structure and diversity.
- Influence of dense meadows on macro-invertebrate diversity.
- Potential role of allelopathic chemicals in inhibiting primary production.
- Impact of dense meadows on fish spawning and recruitment.
- Influence of dense meadows on trophic state conditions.
- Affect of global warming on reproduction and growth patterns.
Enhanced ecology-based inter-disciplinary knowledge of charophytes and their respective host aquatic ecosystems may significantly improve efforts to conserve and restore earth’s increasingly vulnerable freshwater ecosystems.

Reference: Coops (2002)


Thank you for your attention!

Questions?