ROLE OF PHYTOPLANKTON PARASITES IN FOOD WEBS OF THE COLUMBIA RIVER ESTUARY

Michelle A. Maier, Joseph A. Needoba, and Tawnya D. Peterson

Oregon Health & Science University, Institute of Environmental Health, Center for Coastal Margin Observation & Prediction, Portland, Oregon

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Beaver Army Terminal

Columbia River Estuary

Pacific Ocean

Astoria, OR

Longview, WA

Vancouver, WA

Portland, OR

Kilometers

0 5 10 20 30 40

NSF

CMOP
Columbia River exhibits phytoplankton blooms dominated by diatoms captured by in situ sensors
Abundance of fungal parasites on phytoplankton (‘chytrids’)
Chytrids in aquatic systems

- Saprotrophs
- Parasites

Forrest Brem

Asterionella formosa

Chytrid sporangium

10 µm —

http://www.bio.utexas.edu/faculty/sjasper/Bio301M/fungiplants.html
Parasitic chytrids of phytoplankton

- Parasitism can lead to spring bloom decline in lake ecosystems (Ibelings et al., 2004)
- Few chytrids reported and studied in river systems
- Chytrids may play an unrecognized role in the food web by efficiently shunting carbon from large diatoms to zooplankton.
Role of chytrids in carbon cycling

Doggett & Porter, 1996

Chytrid zoospores

Grazed

www.micromagus.net/microscopes/pondlife_cladocera.html

Kagami et al., 2007

Percent Survival

Food Treatment

Asterionella

Asterionella + Zygorhizidium

Zygorhizidium

(14 %) (83 %) (100 %)

(Percent Survival)

Daphnia body length (µm)
1. Describe the seasonal dynamics of chytrid infections on diatoms in the Columbia River → 2009-2013
   • Prevalence of infection → Enumerate sporangia
   • Zoospore abundance → Specific qPCR assay
2. Estimate the contribution of chytrid parasites in the Columbia River food web → Convert abundances to particulate organic carbon
Spring blooms dominated by *A. formosa*
Highest infection prevalence in spring

*Asterionella* comprises ~50% of infected biomass
Estimation of zoospores in the Columbia River

Kagami et al. 2007

<table>
<thead>
<tr>
<th></th>
<th>zoospore</th>
<th>carbon (pg cell$^{-1}$)</th>
<th>10.7 ± 1.7</th>
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<tbody>
<tr>
<td></td>
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<td>nitrogen (pg cell$^{-1}$)</td>
<td>0.60 ± 0.1</td>
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<td></td>
<td></td>
<td>phosphorus (pg cell$^{-1}$)</td>
<td>2.40 ± 0.0</td>
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<td></td>
<td></td>
<td>C : N ratio</td>
<td>18.4 ± 1.3</td>
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<td></td>
<td></td>
<td>C : P ratio</td>
<td>4.45 ± 0.7</td>
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~15% of *A. formosa* carbon biomass available in the form of zoospores.
A. formosa accounts for up to 65% of large diatom carbon biomass (124 µg C L\(^{-1}\))

\(\sim 40\%\) of A. formosa cells infected (46 µg C L\(^{-1}\))

\(\sim 15\%\) of A. formosa carbon biomass available in the form of zoospores (17.1 µg C L\(^{-1}\))

Turchin 2003; http://www.micromagus.net/microscopes/pondlife_cladocera.html
Key Findings

• Increased water retention time & decreased turbidity compared to natural river flows has allowed diatoms to bloom & potentially opened a niche for chytrid parasites
  – Multiple diatom species found infected in the Columbia River in spring & summer

• Infections do not reach epidemic proportions
  – 30-40% of dominant diatom infected each spring
  – Chytrids may prevent spring blooms from reaching maximum potential
  – Spring freshet leads to the decline of host diatoms & parasites

• The base of the food web is complex
  – Chytrids may provide an unrecognized route for the transfer of organic matter into local food webs
  – Up to 30% of the phytoplankton biomass infected in spring
  – At least 15% of *A. formosa* carbon biomass released into zoospores, however, quantification of all chytrid species/strains may be greater
Future directions

• Quantify additional parasitic chytrid zoospores in the Columbia River

• Evaluate grazing of zoospores by dominant zooplankton
  – Assess zoospore reinfections on diatoms in the presence of grazers

• Describe environmental parameters that influence chytrid infectivity in the Columbia River