Indirect Effects of Current Velocity on Algal Abundance Through Interactions with *Ceratopsyche* Larvae

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Introduction:

Stream current velocity has been shown to affect the distribution of benthic organisms in direct and indirect ways:

- Current can directly affect algal abundance by influencing the attachment of algal cells and nutrient exchange rates (Larson *et al.*, 2012).
- Current velocity influences the distribution of benthic organisms, such as *Ceratopsyche* caddisfly larvae (Edler *et al.*, 2004).
- *Ceratopsyche* caddisfly larvae can affect the abundance of algae by use of it in construction of their protective retreat (Torres-Ruiz *et al.*, 2010).
- In this way, current velocity may affect algal abundance indirectly, through its effects on *Ceratopsyche* larvae distribution.

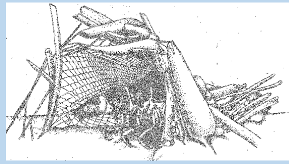

Figure 1: *Ceratopsyche* caddisfly larva emerging from its retreat to feed on particles strained from the water by its net (after McCafferty, 1983). Larvae may incorporate algal filaments into their retreats and algae may grow over the structure.

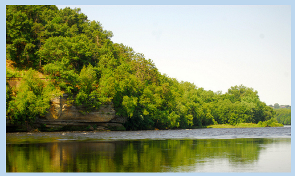

Figure 2: The study site on the Chippewa River near the confluence with Little Niagara Creek by Putnam Park.

Hypotheses:

If the indirect relationship between current velocity, *Ceratopsyche* and algal abundance was important, we would see:

1) A positive correlation between current velocity and *Ceratopsyche* density.
2) A negative correlation between *Ceratopsyche* density and algal abundance.
3) A negative correlation between current velocity and algal abundance.

Figure 3: Algae, *Ceratopsyche* larvae and other macroinvertebrates were sampled at locations where current velocity was measured.

Methods:

- Sampling was performed in the Chippewa River near the confluence of Little Niagara Creek in Eau Claire, WI.
- 45 Surber samples were taken across a 5-100 cm s^{-1} current velocity gradient.
- Benthic algae, *Ceratopsyche* larvae, and other members of the benthic community were sampled across the gradient.
- Density of the *Ceratopsyche* larvae, algae biomass and benthic species richness were determined.
- Data were analyzed using linear regression and structural equation modeling (SEM).

Figure 4: Algae was picked out of the samples, dried, and weighed so the biomass could be calculated.

Results:

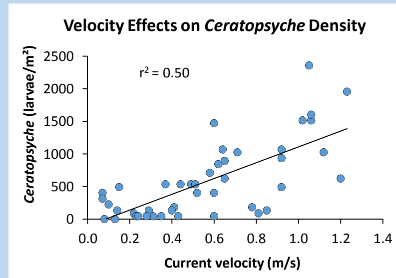

Figure 5: Current velocity had a positive effect on *Ceratopsyche* density ($F = 37.98$, $p < 0.001$), which was consistent with what I had hypothesized.

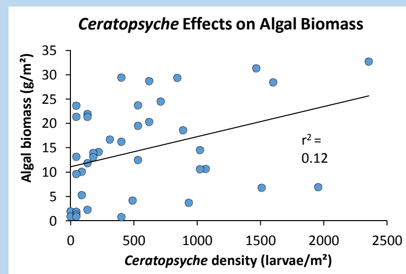

Figure 6: *Ceratopsyche* density had a positive relationship with algal biomass ($F = 6.11$, $p = 0.018$), which was contrary to my hypothesis. *Ceratopsyche* apparently does not displace algae, but rather facilitates its growth and/or accumulation (e.g., by incorporating into larval retreats and/or through nutrient enrichment).

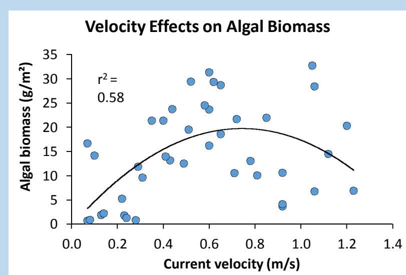

Figure 7: Algal biomass showed a positive relationship to current for velocities < 0.7 m/s ($F = 32.14$, $p < 0.001$); however, faster current speeds reduced algae. This may be a consequence of increased algal sloughing at higher velocities.

Conclusions:

Current velocity affected both algal abundance and *Ceratopsyche* density, partially supporting my hypotheses.

The relationship between current velocity and algae may indicate that there is a critical velocity at which algal abundance is most positively affected (Larson *et al.*, 2012).

Algae may be having a more positive effect on *Ceratopsyche* density than previously thought.

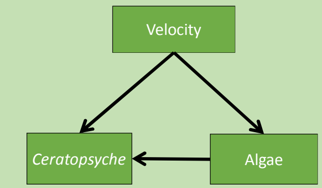

Figure 8: The structural equation model (SEM) showed that algal biomass had more of an effect on *Ceratopsyche* density than the other way around.

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