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Phantom midge mandibles in lake sediments as bioindicators of historic fish absence in Minnesota's shallow lakes

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Research Question

Is *Chaoborus americanus* a useful bioindicator of contemporary and historical fish absence in Minnesota's shallow lakes?

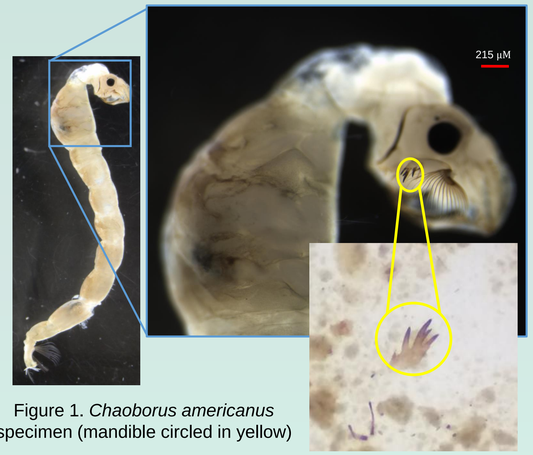

Figure 1. *Chaoborus americanus* specimen (mandible circled in yellow)

Background

- The phantom midge *Chaoborus americanus* (Diptera: Chaoboridae) is restricted to fishless habitats due to their vulnerability to fish predation (Von Ende, 1979, Schilling et al. 2009)
- Their chitinous mandibles are preserved in pond sediments, making this species an excellent bioindicator of historical fish absence in waterbodies with unknown fish colonization history (Lamontagne and Schindler, 1994; Schilling et al. 2008)
- Our research is part of a larger project using paleolimnological techniques to understand historical regime shifts (from clear to turbid states) in shallow lakes in the Prairie Pothole Region (PPR) of Minnesota (Hobbs et al. 2016)
- As part of the larger study, fish and macroinvertebrate communities were sampled and sediment cores were collected from a large set of study lakes in the PPR (Hobbs et al. 2016)
- We are interested in examining the role that fish colonization/extinction has played in triggering regime shifts in shallow lakes
- Our current research objective is to test methods for detecting fish presence/absence developed in Maine (Schilling et al. 2008, 2009) to see if they are applicable to lakes in the PPR

Methods

Objective 1: Examine contemporary lake Chaoborus assemblages relative to fish presence/absence

- We searched macroinvertebrate samples collected in 69 shallow lakes for *Chaoborus*
- We identified each specimen to species using a taxonomic key (Uutala, 1990)

Objective 2: Examine Chaoborus remains in top sediments relative to fish presence/absence

- We are searching for *Chaoborus* subfossil remains in top sediment from cores taken in 15 of the 69 study lakes in Objective 1
- Here, we report data from 6 lakes, as we are still processing sediment
- Freeze dried sediment [~2g per lake] was rehydrated by mixing with deionized water
- Hydrated sediment was heated for deflocculation and then divided into scintillation vials labeled with information about the lake of origin
- We searched for *Chaoborus* mandibles in small aliquots of rehydrated sediment in a Bogorov counting chamber (Figure 2) under a dissecting scope at ~25x magnification
- Mandibles were extracted using a 200 µL micropipette and were mounted on slides using DPX mounting media
- Mandibles were identified under a dissecting scope at 115x magnification to species using a taxonomic key (Uutala, 1990)

Figure 2. Bogorov counting chamber with sediment

Results

Objective 1 Results

- *Chaoborus* were found in macroinvertebrate samples collected in 10/69 lakes
- *C. americanus* was collected only in fishless lakes (Figure 3)

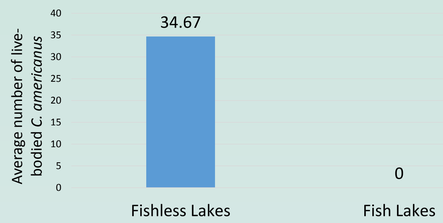

Figure 3 Average abundance of *C. americanus* in macroinvertebrate samples by lake type

Objective 2 Results

- *C. americanus* mandibles were found in both fishless and fish containing lake sediments (Figure 4)

Figure 4 Total *Chaoborus* abundance in lake sediments by species and lake type**

**note no statistical analysis could be done due to small sample size

Discussion

- Our contemporary *Chaoborus* assemblage results indicate that *C. americanus* is restricted to fishless lakes and is a useful indicator of fish absence. This corresponds to a similar study in Maine (Schilling et al. 2009)
- Our sediment results do not confirm that *C. americanus* presence strictly corresponds to fish absence
- This could be due to sediment mixing, especially in top-sediments, or to low numbers of *C. americanus* persisting in lakes with fish
- These results are preliminary as our data collection is on-going

Next Steps

- Search for mandibles in sediments from nine remaining study lakes
- Collect additional sediment from study lakes to increase our sample size
- Compare our sediment results to contemporary *Chaoborus* assemblages to determine the accuracy of our methodology
- If presence/absence of *C. americanus* in lake sediments is not useful, employ logistic regression analysis to model likelihoods of lakes being fishless relative to the abundance of mandibles in a sediment sample
- Search for mandibles down-core to relate historical fish presence/absence to lake state (clear vs. turbid)
- Continue to document microplastics as this may develop into a future study (Figure 5)

Microplastics

Figure 5 Microplastic tallies for two of our study lakes showing number of microplastics per gram of sediment

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