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Re-Emergence of the Harmful Algal Bloom Species Alexandrium Monilatum in the Chesapeake Bay: Assessing Bloom Dynamics and Potential Health Impacts

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Re-emergence of the harmful algal bloom species *Alexandrium monilatum* in the Chesapeake Bay: Assessing bloom dynamics and potential health impacts

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Introduction & Objectives

Introduction

- Since 2007, the harmful algal bloom (HAB) species, *Alexandrium monilatum,* has bloomed almost annually in the southern Chesapeake Bay[1] (Fig. 1 *Left*).
- *Alexandrium monilatum* is a chain-forming dinoflagellate (Fig. 1 *Right*) with a resting cyst stage, which produces the toxin 'goniodomin A'[2].
- *Alexandrium monilatum* blooms are suspected in mass mortalities of oyster larvae (*Crassostrea virginica*) grown for aquaculture and restoration projects in Virginia.
- Preliminary laboratory exposures of larval and adult *C. virginica* to *A. monilatum* resulted in significant morbidity and mortality[1].
- Potential health effects of *Alexandrium monilatum* and its toxin, goniodomin A, on humans are currently unknown.
- Representatives of Virginia's multimillion dollar oyster aquaculture industry have expressed great concern about HAB impacts to their businesses.

Objectives

To more effectively manage *A. monilatum* risks to Virginia, a better understanding of bloom dynamics, spatial and temporal distribution, and impacts on *C. virginica* health, is required.

1. Investigate *Alexandrium monilatum* cyst distributions and densities in bottom sediments in the southwestern portion of the Chesapeake Bay.
2. Develop and conduct *Alexandrium monilatum* toxicity bioassays with Chesapeake Bay isolates using *Crassostrea virginica*.

Figure 1. *Left:* Bloom of *Alexandrium monilatum* at the mouth of Sarah's Creek. *Right:* A chain of *A. monilatum* cells.

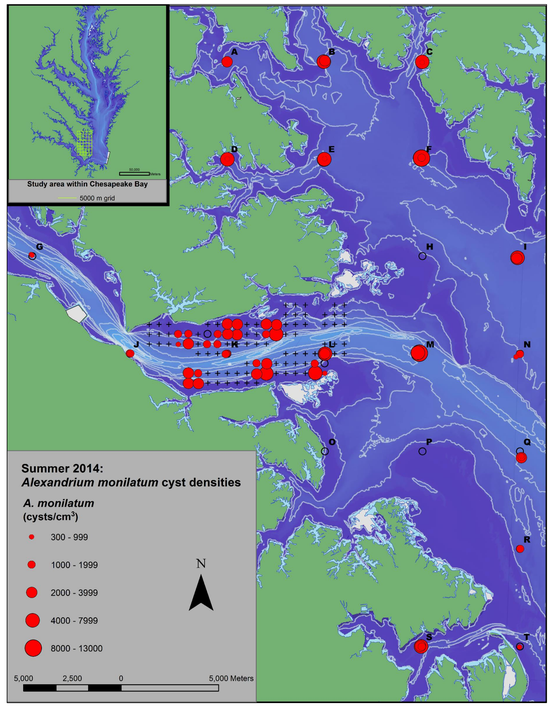


Figure 2. *Alexandrium monilatum* cyst densities in the southwest Chesapeake Bay, summer 2014. The York River runs through sites G, J, K and L.

Alexandrium monilatum Cyst Mapping

Methods

- A systematic grid sampling design was devised for the southwest portion of Chesapeake Bay using ArcMap.
- A 5000 m grid (25X40 km area, see map inset in Fig. 2), established 20 sampling sites (A-T) which were sampled in triplicate (n=60).
- To assess fine scale variation, a 500 m grid was created over the York River. Potential sampling squares at accessible depths were identified; 7 random, non-overlapping squares were sampled at each corner (n=28).
- Summer 2014 (pre-bloom), sediments were collected from selected sites using a Ponar grab and a sample was taken from the sediment surface layer.
- DNA was extracted from sediments and qPCR was used to quantify *A. monilatum* cyst densities using species-specific primers.

Results

- Cyst densities were high where blooms had been recorded in previous years.
- *Alexandrium monilatum* cysts were present at most sites (Fig. 2).

Conclusion

- *Alexandrium monilatum* is prevalent throughout the southwestern portion of the Chesapeake Bay.

Toxicity Bioassays with Oysters

Methods

- Sub-adult triploid *Crassostrea virginica* (~40-70 mm) grown-out on the York River, VA were purchased from a local oyster aquaculturist.
- Oysters were kept unfed in the lab in artificial seawater (~22 ppt) for 4 days prior to the experiment.
- 6 oysters were removed and processed just before the experiment to serve as a baseline for oyster health.
- 30 oysters (6 per treatment) were used in the toxicity bioassay and were exposed to one of five different treatments (0, 250, 500, 2500, 5000 cells/mL) of lab-cultured, live *Alexandrium monilatum* for 48 hours.
- *Alexandrium monilatum* cell counts were performed throughout the bioassay.
- After the bioassay, oysters were shucked and a representative portion was removed for histopathology, the remainder of the oyster tissue was frozen for future toxin analysis.

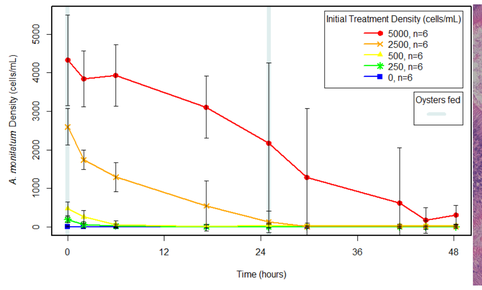
Results

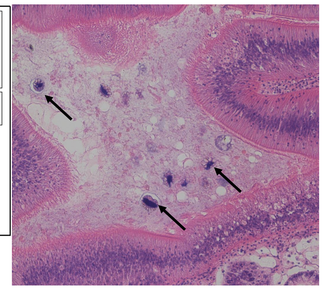
- *Crassostrea virginica* cleared *A. monilatum* from the water column (Fig. 3 *Left*).
- *Crassostrea virginica* exposed to high densities (2500 and 5000 cells/mL) of *A. monilatum* produced more pseudofeces.
- Probable *A. monilatum* cells were found in the stomach (Fig. 3 *Right*), intestines, and gills of one oyster exposed to 5000 cells/mL.
- No mortality or tissue damage was seen in any of the oysters used.

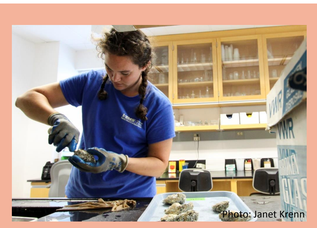
Conclusions

- High densities of *A. monilatum* affect the feeding behavior of sub-adult *C. virginica.*
- Toxicity bioassays need to be run for a longer time period to see if health impacts occur after 48 hours.

Figure 3. *Left:* Time series of removal of *A. monilatum* cells from the water with different initial treatment densities (*A. monilatum* cells/mL). Error bars show standard deviation. *Right:* Stained histological sections of an oyster showing probable *A. monilatum* cells (arrows point to examples) in the stomach.







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References

[1] Reece KS, et al. 2012. Assessing the impacts of emerging harmful algal bloom species on shellfish restoration and aquaculture in Chesapeake Bay. Final report submitted to VA Sea Grant. Award #NA10OAR4170085.

[2] Hsia MH, et al. 2006. Production of goniodomin A by the planktonic, chain-forming dinoflagellate *Alexandrium monilatum* (Howell) Balech isolated from the Gulf Coast of the United States. *Harmful Algae*, 5:290-299.