Discovery of algae's toxic hunting habits could help curb fish kills

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A microbe commonly found in the Chesapeake Bay and other waterways emits a poison not just to protect itself but to stun and immobilize the prey it plans to eat, a team of researchers from four universities has discovered. The findings about algae linked to massive fish kills could lead to new ways to slow the growth of these tiny but toxic marine creatures.

The researchers studied the behavior of the algal cell *Karlodinium veneficum*, known as a dinoflagellate and found in estuaries worldwide. Each year millions of dollars are spent on measures to control dinoflagellates around the globe. This particular species is known to release a substance called karlotoxin, which is extremely damaging to the gills of fish. *Karlodinium veneficum* has been known to form large algal blooms in the Chesapeake and elsewhere, triggering an immediate harmful impact on aquatic life, including fish kills.

"This new research opens the door to reducing bloom frequency and intensity by reducing the availability of its prey," said Allen Place of the Institute of Marine and Environmental Technology at the University of Maryland Center for Environmental Science. "As we reduce the nutrient load feeding *Karlodinium*'s prey and bring back the bay's most prolific filter feeder, the Eastern oyster, we could essentially limit *Karlodinium*'s ability to bloom."

Place, in whose laboratory karlotoxin was discovered and characterized, was a co-author of the new study, published this week in the online Early

Edition of the Proceedings of the National Academy of Sciences. Other researchers involved in the study came from the University of Minnesota, The Johns Hopkins University and the University of Hawaii.

"This is a major environmental problem, but we didn't know why these microbes were producing the toxins in the first place," said Joseph Katz, the William F. Ward Sr. Professor in the Department of Mechanical Engineering at Johns Hopkins and a co-author of the paper. "Some people thought they were just using the toxins to scare away other predators and protect themselves. But with this new research, we've provided clear evidence that this species of *K. veneficum* is using the toxin to stun and capture its prey."

Historically, scientists have found it difficult to study the behavior of these tiny animals because the single-cell creatures can quickly swim out of a microscope's shallow field of focus. But in recent years this problem has been solved through the use of digital holographic microscopy, which can capture three-dimensional images of the troublesome microbes. The technique was pioneered by Katz.

In a study published in 2007, Katz, Place and Jian Sheng, who was Katz's doctoral student, were part of a team that reported the use of digital holographic microscopy to view the swimming behavior of *K. veneficum* and *Pfiesteria piscicida*. At the time, it appeared that *K. veneficum* slowed down into a "stealth mode" in order to ambush its prey while *P. piscicida* sped up to capture prey.

For the new paper, in which Sheng is lead author, the researchers used the same technique to more closely study the relationship between *K. veneficum* and its prey, a common, single-celled algal cell called a cryptophyte. They found that *K. veneficum* microbes release toxins to stun and immobilize their prey prior to ingestion, probably to increase the success rate of their hunt and to promote their growth.

This significantly shifts the understanding about what permits harmful algal blooms to form and grow, the researchers said. Instead of being a self-defense mechanism, the microbes' production of poison appears to be more closely related to growth through the ingestion of a "pre-packaged" food source, the cryptophyte cell, they concluded.

"In the paper, we have answered why these complicated [toxic] molecules are made in nature in the first place and identify a possible alternative mechanism causing massive bloom," said Sheng, who is now a faculty member in the University of Minnesota's Department of Aerospace Engineering and Mechanics.

More information: The journal article maybe viewed online here: www.pnas.org/content/early/201 … 254107.full.pdf+html .

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