

## Toxins in algae linked to neurological diseases

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Cox

As another algae bloom continues to settle in across Florida Bay this year, new research findings linking cyanobacteria — commonly known as blue-green algae — and chronic neurological diseases like amyotrophic lateral sclerosis, or ALS, and Alzheimer’s disease are gaining widespread attention.

A new documentary about toxic algae and the growing body of scientific evidence that ties it to neurological diseases, “Toxic Puzzle,” presents the work of Paul Alan Cox, biologist and founder of a Wyoming-based group that has been searching for a cure for ALS, or Lou Gehrig’s disease, over the past decade.

Key to that search for Cox and others has been establishing a link between the toxin BMAA, found in cyanobacteria, and the risk that high levels of exposure to the toxin could be a factor in the development of ALS, which results in the progressive loss of voluntary muscle action.

Links between algae and ALS have been documented for years. A 2011 Dartmouth University study found that New Englanders within a half-mile of waters with frequent algal blooms were 2.5 times more likely to develop ALS than those with normal exposure.

Walter Bradley, chairman emeritus of the University of Miami School of Medicine's neurology department, committed to the quest to establish a connection between toxic algae and ALS after a patient from Florida Keys died of the disease in 2004.

He points to new studies that demonstrate a high exposure to BMAA in monkeys and the subsequent development of neurofibrillary tangles and deposits that are found in ALS, Alzheimer's and Parkinson's patients. The first link between cyanobacteria and those neurological diseases was found among a population in the Pacific U.S. territory Guam, who Cox first studied nearly 20 years ago.

"BMAA can produce, in an animal model, the changes that were seen in the patients who were dying in Guam," Bradley said. "They produced the pathological changes of the Guam patients who were dying of (the) ALS Parkinsonism Dementia Complex."

That's a big step forward, as the monkey research illustrates that high BMAA exposure likely poses a risk for higher rates of the development of diseases in that dementia complex, based on the physical changes in the brains of the monkeys that exposure to high levels of BMAA produced.

But that doesn't mean that BMAA exposure alone causes neurological disease to develop, according to Bradley, who also points out that the changes in the monkeys' brains were more similar to Alzheimer's sufferers than those with ALS.

"I think we've come to realize that cyanobacteria will not be the only cause of ALS," he said. "The basic scientific research has shown that the toxin BMAA is not the only chemical that is produced by cyanobacteria; there are other chemicals of similar molecular weight that are also toxic, and they will add to the toxicity of BMAA."

Cyanobacteria, the blue-green algae that has become a regular occurrence on Florida Bay, contains over 1,000 toxins, many with acute effects, while others, like BMAA and other toxins with similar molecular structures, are becoming more strongly linked with chronic effects as research continues.

When BMAA intermingles with other toxins of a similar structure, its toxicity can strengthen, so while isolating BMAA and testing its effects on the brains of monkeys was a significant breakthrough for Cox and his team at the time, Bradley says that an array of similar toxins require further study.

"We haven't really, to date, gone very far into the exact analysis of which of these chemicals is responsible for ALS," he said. "Research has also demonstrated that these toxins can add one to the other, so that one plus one equals three."

Though Bradley says more research is necessary to determine the cause-and-effect relationship between algal toxins and neurological disease, he insists that enough of a connection has been established that state agencies should start warning the public about the link.

He thinks the approach of the Florida Department of Health has been wrong when it comes to the dissemination of information about toxic algae and its links to neurological diseases.

"The way the Florida Department of Health has gone about the more chronic effects of these toxins is really not appropriate," Bradley said, "because they say (not to) believe what people are saying about BMAA and the toxins from cyanobacteria being responsible for ALS or other neurodegenerations."

A publication found on the Department of Health website states that "no proven connection has been found between cyanobacteria and ALS" and refers to the Guam patients as a "very unusual and limited population" whose exposure to BMAA was "very high."

The department also states that "no animal model has demonstrated that BMAA exposure results in ALS-like neuropathy."

That may change as new scientific research perhaps uncovers stronger connections between toxic algae and neurological diseases. In the meantime, Bradley says that the department has a responsibility to alert the public about all of the possible toxic effects of pervasive algal blooms.

"The evidence is gradually increasing that the poisons resulting from cyanobacteria blooms can produce neurological damage," Bradley said. "I don't think they've come around to that at all."

Cox, Bradley and others working to uncover a connection are ultimately searching for effective treatment and a cure for ALS, Alzheimer's and a range of similar diseases. The amino acid L-serine, which has shown early promise as a potential part of treatment for those diseases, is currently moving through the early phases of clinical trials, though Bradley says that the experimental treatment "seemed to produce a slowing of the progression of the disease in the highest doses we were giving the patients."

"Toxic Puzzle," narrated by actor Harrison Ford, follows Cox to a village in Japan where such neurological diseases are unknown to the population, giving him and fellow researchers hope that studying why villagers there are apparently immune to neurological diseases common elsewhere may lead to a better understanding of the relationship between those diseases and the environmental elements that might help cause them.

Though progress continues, it's slow moving, though the documentary may draw attention and funding to the research on the connection between algal toxins and highly debilitating, chronic diseases like ALS and Alzheimer's.

Bradley says he and Dartmouth neurologist Elijah Stommel, who administered the 2011 study on New Englanders close to algae-plagued waters, were recently awarded a grant from the Centers for Disease Control to study the potential effects of cyanobacteria and other toxins.

That grant will also cover a study of the effects of chemicals released from incinerators and landfills, possibly in the hopes of gathering an idea of the full range of the environmental toxins that may lead to dementia complex diseases.

Bradley also says that while the work is moving at a more gradual pace than he'd like, steady progress is being made.

"It is slower than we'd like, but it is moving forward," Bradley said. "We're all working as hard as we can on this."

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