Testing a New Tool for Monitoring Algal Toxins

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SUMMARY

A new tool for tracking algal toxins is under development. The tool resembles a tea bag filled with sand and, like a tea bag, is soaked in water. The grains in the sac, though, are actually tiny porous resin beads that selectively absorb domoic acid, a naturally occurring neurotoxin that causes amnesic shellfish poisoning in people and brain seizures in marine mammals.

The UC Santa Cruz scientists leading this project envision hanging the "tea bags" off piers and wharfs in California to continuously track algal toxin levels. The idea is similar to what is already being done through the state's sentinel "mussel watch" program, except that the "tea bags" can detect lower levels of toxins and are unaffected by harmful algal blooms and pollution that can kill living organisms.

Ultimately, scientists would like to use ocean-monitoring data in conjunction with the algal tracking technology to forecast algal blooms based on observed environmental conditions.

PROJECT

The man-made "mussel" mentioned above is based on a technology developed in New Zealand, but never tested in the United States, known by the acronym SPATT, short for Solid Phase Absorption Toxin Tracking. The crux of the approach is a collection of tiny resin beads that selectively absorbs target toxins. For the project in question, researchers tested the absorption potential of various resins used in other parts of the world to find one appropriate for monitoring domoic acid. Previous resins, the scientists found, were effective detectors of lipophilic molecules such as saxitoxins, the causative agents of paralytic shellfish poisoning, but not domoic acid, a hydrophilic molecule.

credit unknown

Sea lion affected by domoic acid.

Laboratory experiments were then conducted to measure absorption rates of different resins and the degree to which different toxins are extracted from different resins for a variety of solvents. The idea was to test whether the amount of toxin removed from a resin could provide a concrete measure of the total toxin level in a water sample.

In laboratory experiments, resin beads were shown to be semi-quantitative absorbers of domoic acid, saxitoxin, yessotoxin and microcystin under a range of salinities and seawater samples. Scientists report that more needs to be done to improve toxic extraction, as a function of deployment time, environmental conditions and toxin analysis methods. The bottom line is that the technology is promising but not yet ready for prime time.

Although there are still unresolved issues in using SPATT as a quantitative tool, the technology does provide a relative measure of toxin levels and, for this reason, was deployed at the Santa Cruz Municipal Wharf and integrated into three regional environmental monitoring programs. A 14-month time series of resin and mussel toxin loading is being analyzed to look for links between eutrophication, nutrient pollution and algal bloom formation.

MILESTONES

The Right Resin

In previous overseas deployments, the SPATT resin of choice was DIAION HP20, a polyaromatic styrene-divinylbenzene. In the Sea Grant project, the material was shown to be a poor absorber of hydrophilic molecules such as domoic acid. In laboratory trials, researchers identified a more appropriate resin for toxins of interest in California, the polystyrene-based SEPABEADS SP700. Based on the resin chemistry, they also evaluated SP207 and SP207SS beads, which are made of nearly the same material as the SP700 bead but with different bead sizes.

SP700 resin was shown to absorb 100 percent of domoic acid in seawater within 48 hours; the SP207 and SP207SS absorbed the toxin even faster, but these beads are much more expensive. The HP20 resin, in contrast, absorbed less than 60 percent, independent of the soaking time. The SP700 resin, however, did not release the toxin following the protocols established by the inventors of the technology. Solvents that might improve a resin's "leakiness" were tested to no avail. A new method, based on adjusting the acidity of water samples, has been shown to dramatically improve toxin recovery rates.

Designing a "Tea Bag"

Meiling Roddam/UC Santa Cruz

The sachets contain resin beads that absorb algal toxins.

To conduct field tests, scientists designed a nylon-mesh bag for the resin beads and "activated" the beads by soaking them in methanol for three days, followed by rinsing and a 10-minute sonication (acoustically vibrating the beads) to speed removal of the toxin in de-ionized water. Activated resin bags were stored in de-ionized water at 4°C until used.

At the Santa Cruz Municipal Wharf, the bags were secured, with an embroidery hoop and zip tie, to a weighted rope suspended at about the same level as nearby sentinel mussels.

FINDINGS

Perhaps the most important finding from the study is that the SPATT methodology with modifications may provide a new option for passively monitoring harmful algal bloom toxins.

APPLICATIONS

SPATT algal toxin monitoring has been integrated into the California Program for Regional Enhanced Monitoring of Phyco-Toxins (Cal-PReEMPT), a component of the NOAA Monitoring and Event Response for Harmful Algal Blooms Research Program (MERHAB). It is also now a component of the Central and Northern California Ocean Observing System (CeNCOOS). The technology is also being used by the California Department of Fish and Game, as part of an effort to monitor nutrient, pollution and pathogen loading potentially affecting wildlife, such as the Southern sea otter, in Monterey Bay. The California Department of Public Health, which oversees the state's "mussel watch" program, is collaborating with researchers to evaluate the time-series data.

The HP20 resin has been deployed in freshwater habitats in Central California to look for sources of microcystin toxins, which are implicated in sea otter and dog deaths in the region.

COLLABORATORS

California Department of Fish and Game
California Department of Public Health
NOAA MERHAB Program

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PUBLICATIONS

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