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Pharmacokinetics and Efficacy of Oxytetracycline in RLP-Infected Abalone

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University of Washington; University of California, Davis; California Department of Fish and Game; University of Birmingham

Summary

Sea Grant research has led to the development of a cure for an abalone wasting disease that destroyed about \$1.5-million worth of farmed abalone product at two California farms during the 1997–98 El Niño. The antibiotic therapy is now being used to help in the restoration of endangered wild white abalone on the U.S. West Coast.

Further Sea Grant research will enhance the commercial viability of the therapy.

Project

Researchers led by Carolyn Friedman of the School of Aquatic and Fishery Sciences at the University of Washington in Seattle have shown that a common oral antibiotic (oxytetracycline) cures withering syndrome, a disease that has decimated both farmed and wild abalones.

She and colleagues are now trying to find the lowest effective dose of oxytetracycline and to administer this as a single dose added to abalone feed. This would not only lower the cost of administering treatment but also reduce the “clearing time” of the drug in abalone tissues.

Because of a quirk in abalone physiology, abalones preferentially accumulate oxytetracycline in their digestive gland. (Why is a topic for future research.) As a result, it takes an inordinately long time for antibiotic levels to fall below the FDA’s human health standard, which allows the meat to be sold for human consumption.

Abalone Disease

Withering syndrome is a highly

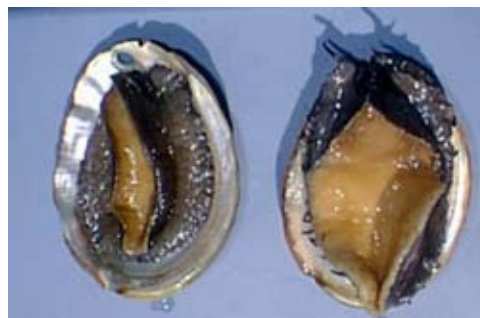
contagious bacterial infection caused by a rickettsia-like pathogen. (Rickettsial bacteria cause Rocky Mountain spotted fever and typhus fever.) The withering syndrome bacterium is shed in abalone feces and is believed to enter animals while they feed.

In abalone with full-blown withering syndrome, the most obvious symptom of distress is severe atrophy of the foot muscle, the mollusk’s primary edible portion. A wild abalone uses its foot to adhere to substrate and locomote, like a giant snail. A diseased animal can do neither effectively and probably will die.

As with other microbial diseases, abalones can carry the disease-causing pathogen without showing any symptoms of infection. Warmer ocean temperatures, however, accelerate the pathogen’s transmission, causing a precipitous rise in incidences of full-blown withering syndrome in previously asymptomatic animals.

Hurdle to Commercial Use of Therapy

Experiments have shown that, following a 20-day antibiotic treatment, it takes about nine months for antibiotic residues to drop below the FDA standard. For abalones approaching harvest, this translates into nine months of extra culture time—a significant increase in the cost of rearing an animal that otherwise would reach market size in three to four years. Even the single-dose treatment in the scientists’ experiments requires a three- to four-month clearing time.



(Left) Abalone suffering from withering disease and (right) healthy animal. Photo James Moore, CDFG

“The fact that we can now give abalone a medicine and they will get better is really exciting,” said George Trevelyan, director of research and development at The Abalone Farm in Cayucos, California. “But, it would be even better if the drug cleared from the abalones much faster. A single-dose treatment would be pretty major for us,” he said.

A commercially viable cure for withering syndrome would be a huge boon for abalone farms along the rugged Central California coast between Santa Barbara and San Mateo. The 1997–98 El Niño was the nightmare example of the region’s vulnerability to oceanic warming and hence disease. That year, an outbreak of withering syndrome resulted in major losses of valuable product at two of the state’s largest farms, one being The Abalone Farm. “We saw our largest, most valuable abalone wither away,” Trevelyan said.

Applications to Abalone Conservation

Not just cultured but also wild abalones are vulnerable to withering



Professor Carolyn Friedman is working on a cure for abalone withering syndrome. Photo courtesy University of Washington, Seattle

syndrome, particularly black abalones in the southern part of their range. Populations of this intertidal species were reduced by more than 90 percent in some areas in the '80s and '90s. Biologists at NOAA Fisheries are now evaluating whether the black abalone should be granted protection under the Endangered Species Act. If so, it would be the second abalone species with federal endangered species protection, the other being the deep-water white abalone, the first marine invertebrate on the endangered list.

Despite their precarious status today, black and white abalones were once abundant and targets of lucrative fisheries. The Abalone Farm and other culture facilities raise red abalone, the largest of California's seven native species, also once a wild-capture commercial fishery.

The use of antibiotics is usually

relegated to cultured animals, not as a tool for assisting wild populations. The situation for California's wild white abalone, however, is so dire that what is being learned during the recent research is being applied to conservation efforts.

James Moore, a senior fish pathologist at the California Department of Fish and Game and a co-investigator on ongoing and recent California Sea Grant projects, said that the recovery plan for white abalone includes a captive-rearing program in which progeny from wild-caught brood stock are outplanted in the wild.

The fact that abalones accumulate oxytetracycline in their digestive gland may have benefits for wild conservation, Moore said. The withering syndrome bacterium attacks digestive tissues. The antibiotic is thus retained precisely where its activity is needed most. An accumulation of antibiotic may extend protection from the disease for some months.

Tom McCormick, who is leading NOAA Fisheries' white abalone captive rearing program and is a co-investigator on another Sea Grant abalone project, is now examining the efficacy of oxytetracycline in controlling mortality of white abalone. The Abalone Farm has donated some of its medicinal noodles that are being fed to captive-reared specimens in the controlled environment of a laboratory.

"Withering syndrome is endemic to all of Southern California," Moore said. "But the few brood stock we collected were from very deep waters and were found to be free of the withering syndrome agent. We don't

want to outplant infected animals." Feeding abalones optimal doses of antibiotic before they are released in the wild may help in this effort, he said.

Trainee

Eric Rosenblum

Publications

E.S. Rosenblum, M.R. Viant, B.M. Braid, J.D. Moore, C.S. Friedman and R.S. Tjeerdema. 2005. Characterizing the Metabolic Actions of Natural Stresses in the California Red Abalone, *Haliotis rufescens* using 1H NMR Metabolomics. *Metabolomics* 1:199-209.

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