New England Lobster Research Initiative: Lobster Shell Disease

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This paper presents some information and interim results on the New England Lobster Research Initiative. Research projects started in March 2007. Final results will be presented in 2010.

About the New England Lobster Research Initiative

Researchers in the Northeast first noticed shell disease in lobster pounds. The disease appeared as little black spots on lobsters' shells. But in the past several years, a new form of shell disease has emerged where shells have sometimes become severely affected. This new disease is called epizootic shell disease.

Research on lobster health is paramount to understanding the causes and consequences of shell disease on lobster populations and the fishery.

Congress appropriated $3 million to establish a cooperative research program—the New England Lobster Research Initiative—to study the causes and consequences of lobster shell disease. This funding is jointly managed by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NOAA Fisheries Service), the University of Rhode Island (URI), and Rhode Island Sea Grant. The goal of this project is to describe the disease agent and how it works, and to determine the extent and severity of the disease in New England waters.

Fifteen projects were funded that combine the strengths of 11 institutions, two state agencies, and over 35 scientists and graduate students. Having that number of the world's foremost disease researchers working together is shattering the old model of researchers working in isolation. This holistic approach will allow for groundbreaking analysis of a complex problem.

Roxanna Smolowitz examines microbiology of lobster shells. Inset: Allison Tracy, a Princeton student working with Ann Tarrant, prepares samples.

Background

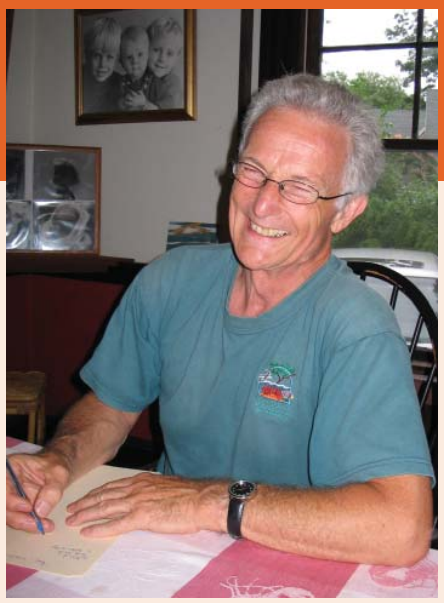
There is no mistaking a lobster with shell disease – there are black spots on the lobster's shell, and the worst cases appear to have shells that are rotting away, in some cases killing the lobster through secondary infection or as a result of other stresses. When researchers look at what is present on these lobsters, they find bacteria. While they know which bacteria are present on shell-diseased lobsters, they are trying to determine which bacteria, or how many, are causing the disease. This is complicated by the fact that researchers have been unable to transfer shell disease from one lobster to another by infecting healthy lobsters.

Also, scientists don't believe the bacteria act alone – the bacteria implicated in shell disease have been present for a long time, but only in recent years have lobsters appeared to become vulnerable to it. There may be several things happening at the same time that are causing this new epizootic shell disease. The researchers involved in the project are looking at various aspects of the lobster, its health, the bacteria and the environment.

For more information about the New England Lobster Research Initiative, contact Kathleen Castro, Rhode Island Sea Grant Sustainable Fisheries Extension Program, at 401.874.5063 or kcastro@uri.edu, or visit seagrant.gso.uri.edu/fisheries/lobster_initiative.

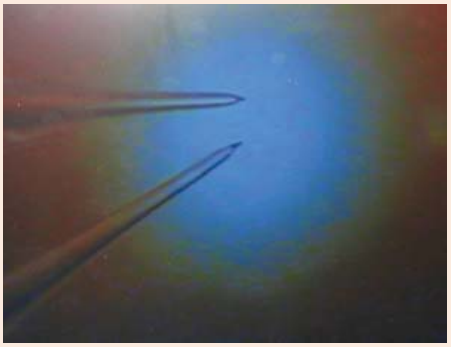
The Projects

Several researchers are looking at the structure of the lobsters' shells to find points of vulnerability, or changes in the shells that would make the animals vulnerable to disease. Michael Tlusty, New England Aquarium's director of research, and his group of researchers are examining the hypothesis that diet and water temperatures are affecting the structure of the shell. Results to date have shown that insufficient diet causes impoundment shell disease. Joseph Kunkel, University of Massachusetts-Amherst biology professor, and his team are looking at detailed shell morphology and chemistry under the hypothesis that something about the interface of the shell and seawater, possibly affected by global climate change and ocean acidification, is weakening the shell. They are searching for weak points on the lobster shell that may be susceptible to invasion by bacteria. Their work seems to indicate the pores of the lobster shells generate a strengthening compound, and that the points on the shell furthest from any of these pores are weak spots, perhaps with the thinnest layer of that strengthening compound. Hans Laufer, University of Connecticut professor emeritus of molecular biology and visiting scientist at the Marine Biological Laboratory at Woods Hole, and his students think chemicals known as alkyphenols, which are found in some plastics and are used



as carriers for pesticides, may reduce shell hardening, perhaps by binding with (and thus reducing the strength of) the calcium that is part of the structure of the shell. To test this, they are also looking at where alkyphenols are found in the body of the lobster to see how these chemicals move through the lobster. Bassem Allam, Stony Brook University assistant professor of marine science, and his team have found that Western Long Island Sound lobsters had comparatively thicker shells than animals from other areas and showed fewer signs of disease.

Other researchers are looking at lobster gene expression: Tim Verslycke and his collaborators from Woods Hole Oceanographic Institution and Mark Fast from Stony Brook University are examining lobsters with the disease to see if they



Joseph Kunkel's work examines possible entry points for bacteria on the shell.

Jelle Atema's behavioral studies indicate differences among populations.

express genes differently (each cell has a full copy of DNA, but different parts of that DNA are "turned on" or expressed as RNA, giving that cell its unique characteristics). Gene expression may provide information about what internal systems of the lobsters are involved in shell disease. For instance, Verslyke's team is examining genes that are involved in immune response, energy metabolism, and hormone regulation. Allam and his group are assessing the status and response of the lobster's immune system. Early results show striking differences between diseased lobsters and those appearing healthy in immune system response and in the microbes active on the shells.

Jelle Atema, Boston University biology professor, and his colleagues are looking at genetics and behavior, to see if they may provide a barrier to shell disease. Shell disease can be limited within populations, does not seem to spread from one population to another, and is also more prevalent in some areas than others. They are looking at whether lobsters

can tell whether other lobsters have shell disease and whether females prefer to mate with lobsters from their own population. Atema and his researchers have found lobsters from different populations are both physically and genetically different, even if those populations live in close proximity to each other.

A further question scientists have is, "Which pathogens are degrading the shell?" Identifying these pathogens is difficult, so three research teams are applying different methods. Andrei Chistoserdov, University of Louisiana associate professor of biology, and his team are looking at how bacteria interact with the shells not only of lobsters but of crabs and shrimp, which also suffer from shell disease, to see if they are affected by the same bacteria as lobsters. They feel that the bacteria of the genus *Aquimarina* might be a candidate as the culprit pathogen. Allam's team is characterizing the composition of the microbial community living on the outside of both healthy and diseased lobsters. Patrick Gillevet, George Mason University associate professor of environmental biocomplexity, is applying a molecular technique called pyrosequencing to identify bacterial communities on the shell and is fine-tuning the identification of potential pathogens.

Lawrence LeBlanc, University of Maine School of Marine Sciences research associate, and his research partners are examining whether environmental contaminants may contribute to lobster shell disease by determining whether specific organic and trace metal contaminants consistently co-occur with shell-diseased lobsters.

Jeffrey Shields, Virginia Institute of Marine Science professor, and his lab are looking at how disease affects mortality and molting. They are also managing the 100 Lobster Study (see below) and developing a complex metadatabase of results.

Ann Tarrant and Tim Verslycke are investigating differences in DNA of lobsters that appear healthy and those that do not.

Above: Hans Laufer and Kathleen Castro discuss Laufer's findings that alkyphenols affect lobster shells. Below: Jeffrey Shields attends a meeting of Lobster Initiative researchers.

100 Lobster Study: A New Approach

Preliminary results indicate that many of the individual factors studied contribute to shell disease. However, it is most likely that multiple overlapping causes in the wild are causing the epizootic shell disease epidemic.

To test this, all the researchers are getting pieces of the same 100 lobsters, with and without shell disease, from the same location in Narragansett Bay, R.I. Researchers will perform their analysis on their samples of blood, shell, or tissue, in the hopes that similarities that show up repeatedly will be significant.

Those 100 lobsters are being provided by the R.I. Department of Environmental Management (DEM) through the ventless trap survey that is part of the initiative being conducted by the DEM and the Maine Department of Marine Resources. Ventless traps, which capture even juvenile lobsters that would escape ordinary lobster traps, are being used from Maine to New York to take lobsters at selected random locations to determine, in part, the scope of the disease at different times during the season.

This dataset will go well beyond the scope of this project and will provide comprehensive information on this valuable crustacean.

Industry Perspective

The lobster industry puts hundreds of millions of dollars into the New England economy via the landings of freshly caught lobsters. There is a tremendous multiplier to this via tourism and restaurants, as well as the direct-support business serving the lobster industry. The industry feels that the collaborative research that has been conducted through the initiative is essential to the success of this project. Industry participation includes supplying the science community with animals for research as well as serving as the eyes on the ground regarding what is going on at specific times and locations during the life cycle of the lobster resource. The research to date has answered many questions, but there are many more that need to be answered in order to negate or diminish the effects this terrible disease has had on the resource and the people who depend on it for their livelihoods.

—Lanny Dellinger, President, Rhode Island Lobstermen's Association