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Spreading Shell Rot Disease "Eating" New England Lobsters

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"UGLINESS is the measure of imperfection," said author H.G. Wells in 1905. He was talking about machinery, not lobsters with shell disease, but if Wells were alive today he might find the statement apropos. In New England today, ugliness in lobsters can be a measure of ill health. Lobsters in the eastern Long Island Sound, Narragansett Bay, and further north in Buzzards Bay (and the Gulf of Maine), are increasingly becoming infected by shell disease that may not only make them look hideous, but may cause mortality as well. In shell-diseased lobsters, bacteria eat into, and sometimes through, their hard outer shells, leaving disfiguring lesions.

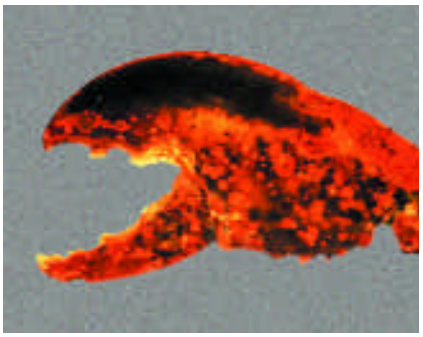
Okay, some folks don't find them aesthetically appealing under any circumstance. Even some lobstermen call them "bugs". However, a nice red lobber, fresh from a steaming pot with a side of fresh butter, sure looks beautiful to seafood lovers. The American lobster has risen to the status of King of the crustaceans in the dining room, and definitely has mascot status in New England. A new role for the homely decapod (10-footed) creature may be that of indicator species. An indicator species points to the health of the ecosystem in which it lives, analogous to the canary in the coal mine.

Prior to 1996, lobster shell disease, also called "shell rot", was a minor problem in the New England fishery. Now, however, an average between 25 and 30% of the lobster population in eastern Long Island Sound and southern New England (excluding Maine) are infected, according to Tom Angell of the Rhode Island Department of Environmental Management. Now, the disease seems to be both more severe to the animals and more aggressive in its spread, say researchers Roxanna Smolowitz (Marine Biological Laboratory, Woods Hole) and Andrei Chistoserdov (Louisiana State University). Both are participating in the Long Island Sound Lobster Research Initiative. They say the disease is now "epizootic", the animal equivalent of "epidemic". In severe cases, bacteria eat totally through the layers of shell into the lobster's inner flesh. The manifestation is now more frequently severe erosion of the lobster carapace, rather than the minor pitting, or "black spots" reported in years past. While the disease doesn't affect human consumers, as far as we know, the affected lobsters are unappealing and thus difficult to market whole.

"If half my body was ulcerated like that, I'd be in a hospital with IV's and other life support systems on"

–R. Smolowitz, MBL

Lobstermen in Canada and Maine are watching nervously as the disease spreads relentlessly northward. In Rhode Island, the Rhode Island Sea Grant Program held its third Lobster Shell Disease Workshop in February 2005, at the University of Rhode Island's Bay Campus. Organizer Kathy Castro, Director, Rhode Island Sea Grant Fisheries Extension Program felt that the Long Island Sound researchers and experts from elsewhere in New England might provide some insights for the Rhode Island fishery.



UConn Pathobiology/R. French

The black pitted areas eroding this lobster claw are evidence of severe shell disease.

During the day-long session, experts shared observations and brainstormed about the disease.

Bob Glenn, Massachusetts Division of Marine Fisheries, reported that in Massachusetts, currently, 80% of all shell-diseased lobsters reported were female. Why there is a gender bias is part of the mystery. About 30% of all egg-bearing females were shell-diseased. Mortality of female lobsters tripled between 1995 and 2002, added Mark Gibson, Rhode Island Fish and Wildlife. Most mortalities, he said, were reported between May and July; fewer later in July. July is a major molting period for the lobsters, which bolsters observations that some lobsters are able to "molt out" of the disease.

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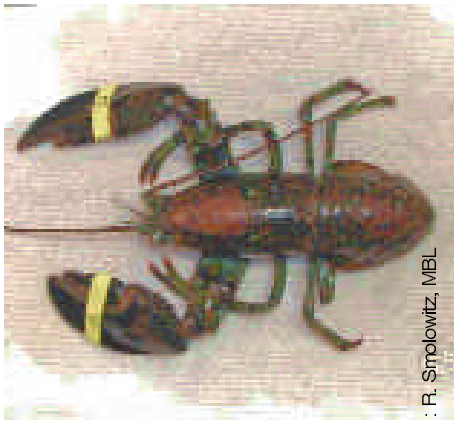
Smolowitz, a veterinary pathologist, describes the disease as first affecting the dorsal rostrum (top of front), then progressing to the claws and carapace. "We know for sure now that the disease comes from the outside in, not from the inside out" she said. Bacteria begin to eat into the top surface of the lobster carapace; consuming proteins and tissue as it progresses deeper, leaving "pillars" that are part of the crystalline lattice of chitin that forms the shell. What's left was described as resembling a windowpane. The animal undergoes melanization surrounding the lesion, "like putting up a brick wall", as a defense mechanism. The ulcerization may breach the "wall" and continue on if molting doesn't solve the problem, progressing from layer to layer through the shell. "Once it gets in, it's simply a big hole" said Smolowitz,

"At the leading edge of the bacterial infection, other small organisms such as nematodes and protozoans come in, " she said. "The rest are along for the ride." Smolowitz and Chistoserdov have observed "carpets" of bacteria on the lobsters. They have shown that it's not just one species of bacteria, as previously thought, but rather colonies of multiple species. Using probes and a gel to perform RNA analyses, they have identified four common bacteria types involved in shell disease.

Like other recent breakthroughs in the lobster disease investigations, the findings only raise more questions. Why is the disease more virulent now? Is it enhanced by warmer temperatures? Could the strains of bacteria have become more pathogenic? Has there been a decrease in ciliate predators that normally feed on bacteria? Has the amount of calcium deposited in the lobster shells decreased? One difficulty with the findings is that healthy animals, to date, cannot be reinfected with the bacteria believed to be



A lobster suffering from severe shell disease.

responsible, to scientifically prove cause-and-effect. They don't know why.

If only all lobsters were lucky enough to literally shed their troubles. "We don't see the lobsters with the really deep lesions shedding," said David Jordan, a Rhode Island lobsterman. "The poor buggers try and try to shed, and they just can't do it." If the lesions have eaten through the shells into the tissue below, the shell is stuck to the soft flesh and the lobster is pretty much doomed.

> "The poor buggers try and try to shed, and they just can't do it."
> *–Dave Jordan, RI lobsterman*

"In the 30 years I've been working with lobsters, nothing has given me as much concern as this recent phenomenon" remarked Stan Cobb (Professor of Biological Sciences) at the University of Rhode Island meeting. "The severity is the difference." Severe cases are those in which 50% or more of the carapace is infected.

John Fish, a lobsterman for forty years, remarked that the impacted nearshore fishery is much closer to pollution. "We never saw shell disease like this until the (*North Cape*) oil spill happened in 1996," said Mike Marchetti, president of the Rhode Island Lobstermen's Association. An estimated 15 to 70 million lobsters were lost from Narragansett Bay following that spill. However, that event doesn't seem to explain the rise in shell disease in other New England areas.

Early on, lobstermen reported a strange phenomenon–"eggers", or female, egg-bearing lobsters, prematurely shedding their shells and thus losing their eggs. Ordinarily the molt would not occur until the eggs had been released for hatching. New research from the Long Island Sound lobster research initiative, and a Connecticut Sea Grant research project, shows that the two phenomena, shell disease, and premature molting by eggers, are related.

Hans Laufer, Professor emeritus of Molecular and Cell Biology at the University of Connecticut, found that molting lobsters had much higher levels of the hormone ecdysone, as did shell-diseased lobsters. Since shell-diseased lobsters were producing much higher levels of the hormone that regulates molting, as a response to either the damaged shell or the disease itself, it could explain the phenomenon of female lobsters prematurely shedding while still carrying eggs.

Laufer tried an experiment using equipment many of us have in our hobby nooks–a Dremel® tool. Laufer carefully abraded the carapaces of crayfish, a relative of the lobster, using the tool. He was careful to keep the abrasions very superficial and clean, like a light sandpapering, to avoid infection by bacteria. The abraded crayfish promptly molted, demonstrating that out-of-synch molting is a natural response to damage to the shell,

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rather than a response to the bacteria in the infection. Indeed, crayfish carrying eggs in the abrasion experiment lost their eggs along with their shells.

Looking at lobster tissues in the laboratory, Laufer was surprised to find very high levels of alkylphenols, estrogenic chemicals used in the manufacture of plastics and rubber, in lobster tissues. They are antioxidants with phenolic resins, and also result from the breakdown of many manufactured products. Intrigued by this finding, Laufer also examined sediment samples from Martha's Vineyard and Great Bay, New Jersey. The sediments had high levels of these same endocrine-disrupting chemicals.

Laufer believes that the alkylphenols were not present because of some greedy, midnight illegal dumper, but that they simply came through water treatment plants unscathed. So, "we," the producers, users, and discarders of plastic and rubber products, and the wastewater treatment methods we use, may be part of the shell disease problem. While Laufer stresses that the work is very preliminary, he believes that there may be a tie between these chemicals and susceptibility to shell disease. Smolowitz added that alkylphenols disrupt the lobsters' melanization process.

Another fascinating twist to the story is that, apparently, lobsters contaminated with alkylphenols inshore can migrate offshore and may cleanse themselves over time. When Laufer compared shell-diseased inshore animals with those from the healthier offshore populations of Hudson Canyon, he was surprised to find that some of the "clean" eggers were carrying contaminated eggs! This implies that the females were contaminated when they migrated to warmer inshore waters to reproduce, but were cleansed later in the cooler offshore waters, yet were unable to decontaminate their eggs.

> **"The lobster is reinventing itself right now"**
> *–Kathy Castro, URI*
> *Rhode Island Sea Grant Fisheries Extension Program*

Skeptics point out that alkylphenols have been around for decades, and that this aggressive outbreak of shell disease is recent. Some studies indicate that plastics manufacture and use has increased exponentially after its inception, and of course, the more people, the more product, and the more alkylphenols, out there. They are found in industrial detergents, surfactants, paints, textiles, curing agents, food cans, pipes, and petroleum recovery products (used to clean up oil spills). Lobstermen wondered if the latter could possibly explain the suspected oil spill connection.

However, the areas considered to be shell-disease "hot spots", such as Buzzards Bay, are not those closest to major industrial activity. "Proximity to industrial sources doesn't necessarily relate to pollution levels" cautioned one participant at the Rhode Island meeting. Oceanographers know that materials in the water can travel long distances via currents and eddies before they end up in the sediments elsewhere. The contamination could be as much a function of the product disposal as its manufacture. "It's encouraging that we're now looking at whole aquatic ecosystems, and not just the individual lobster in it." said Smolowitz.

Hans Laufer, Professor emeritus of Molecular and Cell Biology at the University of Connecticut,has discovered alkylphenol pollutants in lobster tissues and coastal sediments.

Many of the experts decried the changes that lobsters are undergoing in their physiology, due to both overfishing and disease. "Bubba", the late hefty 23-pound lobster that recently made news headlines, would not have been uncommon in New England waters a few short decades ago. There are records of 30, 40, and even 50-pounders caught aplenty in New England. Lobsters take seven years to reach legal size, and although they may be capable of living for a century, that would be extremely unusual today. Most are caught soon after maturity.

"The lobster is reinventing itself right now" said Castro. "What happens when a long-lived species becomes short-lived? Probably they are more vulnerable to regime changes," she continued.

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"Lobsters are experiencing changes in size, frequency of molts and other physiological processes. They can't have much energy left for egg production."

What's it like for an animal to be continuously fighting off disease? "If half my body was ulcerated like that, I'd be in a hospital with IV's and other life support systems on" said Smolowitz.

"We're starting to get answers, but there are still pieces missing from the puzzle" said Castro. There is a positive note, says Nancy Balcom, Connecticut Sea Grant's Extension leader. The Atlantic States Marine Fisheries Council is considering expanding the Long Island Sound Lobster Research Initiative, which was specifically targeted to Long Island Sound, to include other New England states. The change could facilitate better monitoring and more research for lobsters. So–perhaps a ray of hope for the ugly "bugs", after all.

–PVP

Peg Van Patten is *Wrack Lines* editor and Communications Director for Connecticut Sea Grant at UConn.