SESSION E

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Dr. Amy Costa - EVALUATING THE POTENTIAL OF ATLANTIC OYSTERS *Crassostrea virginicas* TO BIOACCUMULATE CONTAMINANTS OF EMERGING CONCERN IN COASTAL EMBAYMENTS

DIVERSE EVIDENCE FOR A PRIMARY ROLE OF HEMOCYTES IN OYSTER SHELL CONSTRUCTION.

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The primary requirement for calcification in any marine invertebrate, including the Eastern oyster, *Crassotrea virginica*, is the existence of a specialized compartment in which reaction conditions favor calcium carbonate formation. To meet these conditions, this space must be regulated with respect to supply of calcium and bicarbonate ions and must be capable of maintaining a suitably-alkaline pH through removal of hydrogen ions generated during calcite and aragonite crystallization. In oysters, a class of circulating hemocytes that contain this intracellular mineralization compartment has been discovered. These motile, adherent, mineralizing hemocytes migrate to the mineralization front, attach to a substrate produced by the mantle epithelium, and deposit crystals. Accordingly, shell formation is a cellular-driven process that is physiologically regulated and controlled. Several independent lines of evidence support this emerging model of bivalve biomineralization: 1) microscopic imaging shows intracellular calcium carbonate crystallization within hemocytes and participation of hemocytes in shell repair, 2) oysters regulate intracellular pH of hemocytes, but do not regulate extracellular (serum) pH, 3) genomic data for the Pacific oyster show expression of chitin synthase and fibronection genes during the earliest stage of larval shell formation and the existence of mineralizing exosomes, and 4) specialized granular hemocytes (putative ‘osteoclasts’) are induced by shell damage. Further confirmation of this new model of shell building, coupled with recent results showing that carbon in shell minerals has an isotopic signature matching phytoplankton food rather than surrounding seawater, will help to assess potential resilience of oysters to acidifying environments.

DROUGHT INCREASES CONSUMER PRESSURE ON OYSTER REEFS *CRASSOSTREA VIRGINICA* IN FL, USA.

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Coastal economies and ecosystems historically depended on oyster reefs, but this habitat has declined globally by 85% because of anthropogenic activities. In a Florida estuary, we investigated the cause of newly reported losses of oysters. We found that the oyster reefs have deteriorated from north to south and that this deterioration was positively correlated with the abundance of carnivorous conchs and water salinity. In experiments across these gradients, oysters survived regardless of salinity if conchs were excluded. After determining that conchs were the proximal cause of oyster loss, we tested whether elevated water salinity was linked to conch abundance either by increasing conch growth and survivorship or by decreasing the abundance of a predator of conchs. In field experiments, we failed to detect spatial variation in predation on conchs or in conch growth and survivorship. A laboratory experiment, however, demonstrated the role of salinity by showing that conch larvae failed to survive at low salinities. Because this estuary's salinity increased in 2006 in response to reduced inputs of freshwater, the ultimate cause of oyster decline is an increase in salinity. According to records from 2002 to 2012, oyster harvests have remained steady in the northernmost estuaries of this ecoregion (characterized by high reef biomass, low salinity, and low conch abundance) but have declined in the southernmost estuaries (characterized by lower reef biomass, increases in salinity, and increases in conch abundance). Oyster conservation in this ecoregion, may be undermined by drought-induced increases in salinity causing an increased abundance of carnivorous conchs.

A COMPARISON OF THE EFFECTS OF HURRICANE AGNES IN 1972

IN THREE MAJOR OYSTERING LOCATIONS

by

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ABSTRACT: Hurricane Agnes in June, 1972, was the costliest one to strike the U. S. east coast up to that year. Extending from Florida to New York, Agnes featured heavy rains that caused some rivers to crest at least 15 feet (about 5 m) above normal. Destructive floods in the Chesapeake Bay watershed, Pennsylvania and other areas ruined agricultural crops and many homes and other properties. Agnes had huge effects on the oyster industry, but they differed sharply from one another in the three major oyster-producing areas, namely, Long Island Sound, Delaware Bay, and Chesapeake Bay. In Connecticut, Agnes affected oyster setting. Persistent winds from the north, rather than from their usual southerly direction, blew the large water mass containing oyster larvae off its shore, away from the oyster beds, and across Long Island Sound to the bays on the north side of Long Island. Oyster sets were negligible in Connecticut, but some occurred in the Long Island bays. In Delaware Bay, effects of the hurricane led to a heavy oyster set on the beds that was far more intense than it had been for many years. The likely reason for this was that the fresh waters killed the predacious ghost anemones, Diadumene leucolena and mud crabs. The shells received more spat and their survival from crab predation was high. In Chesapeake Bay, a large quantity of sediment was deposited on the bottom, especially in its northern region, and most waters became too fresh for oysters to reproduce. For instance, in Virginia, the James River that had yielded about two million bushels of seed oysters each year, became too fresh to produce an oyster set. In sum, the Connecticut and Chesapeake Bay oyster industries suffered from near failure of the 1972 year-class of seed to appear, whereas the Delaware Bay oyster industry gained a large 1972 crop of seed, larger than usual.

TITLE: Norovirus detection in oysters and human feces

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The number of food poisoning cases by norovirus is greatest among all food poisoning cases. Norovirus infections have been regarded as a cold associated with gastroenteritis and have been treated as such because most infections occur during winter, exhibiting not only diarrhea and vomiting but fever. When the existence of norovirus has been identified, eating raw oysters has often been indicated as a cause. Later, with the progress of investigation of causes, the infection has been found to have actually spread much more through human-to-human infection and contact with food, door knobs, etc., via manual contact with infected persons than through eating oysters. Nevertheless, because it has been incorrectly believed that norovirus infection is caused by eating oysters, not a few workplaces today, such as restaurants and hotels, forbid workers and their families from eating oysters.

Our company conducts norovirus testing of oysters using sensitive gene amplification (PCR) to verify the safety of oysters so that they can be eaten safely. The positive rate of our oysters for norovirus from October 2009 through September 2014 was 7.1%, which consisted of 24% positive for gene group 1 (G1), 57% positive for gene group 2 (G2), and 19% positive for both G1 and G2. Moreover, the positive rate for oyster norovirus in the feces of asymptomatic humans from January 2009 through December 2014 was 5.4%, which consisted of 10.0% positive for G1, 89.4% positive for G2, and 0.6% positive for both G1 and G2. The detection percentages of the gene group from oysters and that from humans are expected to be the same because norovirus develops only in the human intestine, but the actual values are in fact much different, mainly because of the sensitivity of the test method because norovirus amounts from humans are much greater than those from oysters. The oyster norovirus test can be said to be almost established when the sensitivity and the specificity of the norovirus from oysters are improved to reach a percentage similar to that from humans. We have continued to improve the test method with the intention that oysters that passed the norovirus test be eaten raw safely. We endeavor to improve the test method further so that oysters, a food with high nutritive value, will be used increasingly in dietary life worldwide.

Massachusetts Oyster Aquaculture Management and Statistics

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In 2014 Massachusetts wholesale seafood dealers reported purchasing over 34 million oysters from Massachusetts commercial fishermen and aquaculturists commanding a value of approximately $20 million paid directly to local harvesters. This represents an almost 29 million oyster increase in reported landings between 2005 and 2014 making oysters the Commonwealth's fastest growing fishery and one of the most valuable in-state commercial fisheries. Almost ninety-five percent of the 34 million oysters commercially harvested in 2014 came from the 351 *MarineFisheries* permitted aquaculture operations in Massachusetts. These aquaculture operations have an average size of just under three acres and employ a wide variety of oyster culture and harvest techniques, each best suited to the location and environmental conditions on site. 85% of Massachusetts's oyster production comes from six communities on the Cape, South Shore, and Islands (Duxbury, Barnstable, Wellfleet, Edgartown, Wareham, and Dennis) with an additional 22 coastal municipalities making up the difference. This talk is an overview of the current distribution of the permitted aquaculture operations in Massachusetts, recent oyster landings statistics, and an overview of *MarineFisheries'* oyster aquaculture management program.

DISEASE-RESISTANCE AND IMPROVED PERFORMANCE FOR GENETICALLY IMPROVED AND CROSS-BRED EASTERN OYSTERS *Crassostrea virginica.* RESULTS FROM A DECADE OF FIELD TRIALS IN NEW ENGLAND.

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Substantial effort has been expended over the past five decades to develop genetically improved lines of eastern oysters (*Crassostrea virginica*) and has resulted in the production of several lines that demonstrate enhanced survival under specific disease pressures. In two field trials, we investigated the relative performance of the Rutgers University NEH, University of Maine UMFS, and Clinton lines, and interline hybrids when grown at sites across New England. Line performance in both trials was highly site-specific; while there were significant differences in growth between sites, there was only subtle growth variation among lines. In contrast, line performance was heavily dependent on survival which was, in turn, dependent on disease pressure and line-specific disease resistance at each of our grow-out sites. Hybrid lines displayed very little, if any, improvement in growth relative to parental lines, and inherited varying degrees of disease resistance depending on the particular disease pressure experienced at a site. The differences in line performance are indicative of a high degree of genotype by environment interaction for survival and yield among the parental and hybrid lines. The prevalence of such interactions suggest that regional breeding programs should take advantage of the superior characteristics of the extant lines, but will need to consider alternatives to mass selection in order to build a breeding program that benefits growers and hatcheries throughout the region.

EVALUATING THE POTENTIAL OF ATLANTIC OYSTERS *Crassostrea virginicas* TO BIOACCUMULATE CONTAMINANTS OF EMERGING CONCERN IN COASTAL EMBAYMENTS

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Recent studies have detected contaminants of emerging concern (CECs) in ground water, ponds, and coastal embayments. It is unclear what toxicological significance is posed by their occurrence. In the fall of 2014, the Center for Coastal Studies (CCS) in collaboration with 14 other organizations investigated uptake and bioaccumulation of 70 CECs including pharmaceuticals, personal care products and hormones in Atlantic oysters (*Crassostrea virginicas*) in 6 coastal embayments in Massachusetts and compared tissue concentrations to concentrations in passive samplers. The results of this study provide information about the potential for bioavailability of these contaminants in the environment and incorporation into the food chain helping researchers define the environmental impact of CECs.