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The Delaware Bay Oyster and the MSX Problem

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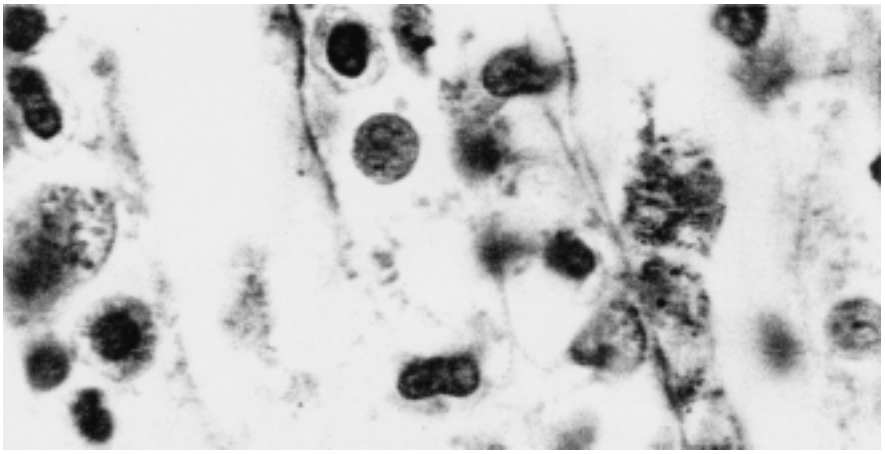
For hundreds of years, the eastern oyster *(Crassostrea virginica)* has been a vital contribution to the people living along the shores of the Delaware Bay. The Lenape Indians used its shell to make cutting and scraping tools. Oyster meat provided struggling European and British settlers with an important source of protein. Once established, pioneers used oyster shells to help pave their first roads. Throughout the years, people of the Delaware Bay relied on the oyster to be there when they needed it.

But more recently, the situation has changed. Since 1957, epidemics of a single-celled parasite called MSX have swept through the Delaware Bay, in some years killing a significant portion of the oyster populations. Historically, MSX is responsible for millions of dollars of damage to the oyster industry on both sides of the bay, and has forced oystermen to leave the water or turn to other types of fishing.

What is MSX? How do MSX epidemics get started? How can the oyster industry minimize losses to MSX? The strategies for coping with the MSX problem in the Delaware Bay involve researchers, oystermen, and state agencies.

The Natural History of MSX

MSX was unknown to scientists and fishermen until 1957, when biologists, studying massive oyster mortalities in the lower Delaware Bay, found the microscopic parasites in many dead oysters. The researchers assigned the name MSX (multi-nucleated sphere X) to the parasite because it contains between one and 60 nuclei in its amoeba-like body (called a plasmodium). In 1966, biologists at Rutgers University classified the new protozoan as *Minchinia nelsoni.* It has recently been reclassified as *Haplosporidium nelsoni.*



MSX plasmodium in oyster tissue. *Photo courtesy Virginia Institute Marine Science.*

Biologists can only speculate about the way MSX harms the oyster. They do know that the plasmodium enters the oyster through its gills, and then takes up residence in the oyster's digestive system. An overall weakening of the oyster follows, often resulting in death.

It's difficult for researchers to identify an MSX-infected oyster. Shellfish pathologists must conduct extensive laboratory tests before they can confirm an infection. One reassurance to seafood consumers: an MSX-infected oyster is harmless when eaten.

The MSX plasmodium typically begins its major infective period late in June, and often continues into fall. Infected oysters may begin to die as early as July or August, while populations with more resistance to MSX may not show the effects until September or November.

The plasmodium can exist in a dormant state during the winter while the oyster hibernates. In early summer, as water temperatures rise to 20° Celsius (68°F), the parasite becomes active again, and may kill more oysters.

Some biologists believe that MSX spends part of its life cycle in

one or more host species that have not yet been identified. Researchers have rarely found oysters that harbor the spore form of MSX, and have never observed direct oyster-to-oyster transmission of the parasite in a laboratory setting. This implies that the plasmodium must leave the oyster at some time to enter and develop as a spore in another host. If researchers could identify this unknown host species, they could gain a valuable tool for combating MSX epidemics.

As is the case with many wild populations, oysters gradually develop a degree of resistance to MSX over many generations by the process of natural selection. The parasite weeds out more susceptible individuals from the population, and leaves oysters with stronger genetic resistance to MSX to pass on this resistance to their offspring.

Factors Affecting MSX

Probably the most perplexing question in the MSX problem is this: What triggers the epidemics? Although MSX is often present in the Delaware Bay, oyster populations are not devastated each year. Researchers have yet to establish a single cause for MSX outbreaks, but they have identified a number of contributing factors. For example, there is a definite correlation between high-salinity water and MSX deaths. When summer salinities over the oyster beds are below 10 parts per thousand (ppt), oysters may become superficially-infected by MSX, but they usually withstand the infection and few oysters die. As salinities rise, however, so does the mortality rate.

New Jersey researchers have found that since 1961, an average of 5% to 10% of the oyster population have died from MSX each year in areas where salinity was below 20 ppt. In areas of higher salinity, MSX killed an average of 25% of the oyster population.

Unfortunately, MSX activity and oyster deaths are not predictable from year-to-year based on salinity alone. Temperature, availability of the suspected alternate host, and fisheries management may also influence the ultimate extent of MSX devastation.

Delaware oystermen at dockside. *Photo courtesy of DNREC.*

The Extent of the MSX Problem

After World War II, the advent of power dredging dramatically increased the oyster catch from the Delaware Bay. As a result, Delaware's natural oyster seed beds were seriously depleted by 1952. In addition, oystermen were not returning oyster shell to the bay. The old shells serve as a substrate for the attachment of larval oysters, called spat. Spat found fewer and fewer areas to settle and grow. Oystermen started transplanting seed oysters from the Chesapeake Bay and other areas to supplement their declining seed beds. Because of this added stock, Delaware waters produced up to four million pounds of oyster meat per year during the 1950s.

In the spring of 1957, oysters began to die on leased grounds in

the lower Delaware Bay. By 1959, the MSX epidemic had spread through the already-weakened seed beds and reached almost all oyster-producing areas within the bay. Oyster populations on grounds in the lower bay suffered as much as 90% to 95% mortality. From 50% to 70% of the oysters on upper bay seed beds died. By 1961, Delaware's oyster landings dropped to 33,000 pounds. Only oysters in areas of lowest salinity, such as tidal rivers, avoided death from MSX. A resource worth $2.7 million in 1954 was worth only $18,000 in 1961.

Those oystermen who could remain in the declining industry had to alter many time-honored practices. Traditionally, oyster spat settled in the lower-salinity upper bay and grew for a relatively short time on seed beds. Prior to the advent of power dredging, oystermen harvested these seed oysters in the spring and transplanted them onto oyster grounds that they leased from the state in the lower bay. The lower bay provides a combination of higher salinity and increased food that make for quicker oyster growth. After several years on the leased grounds, the oysters were finally harvested.

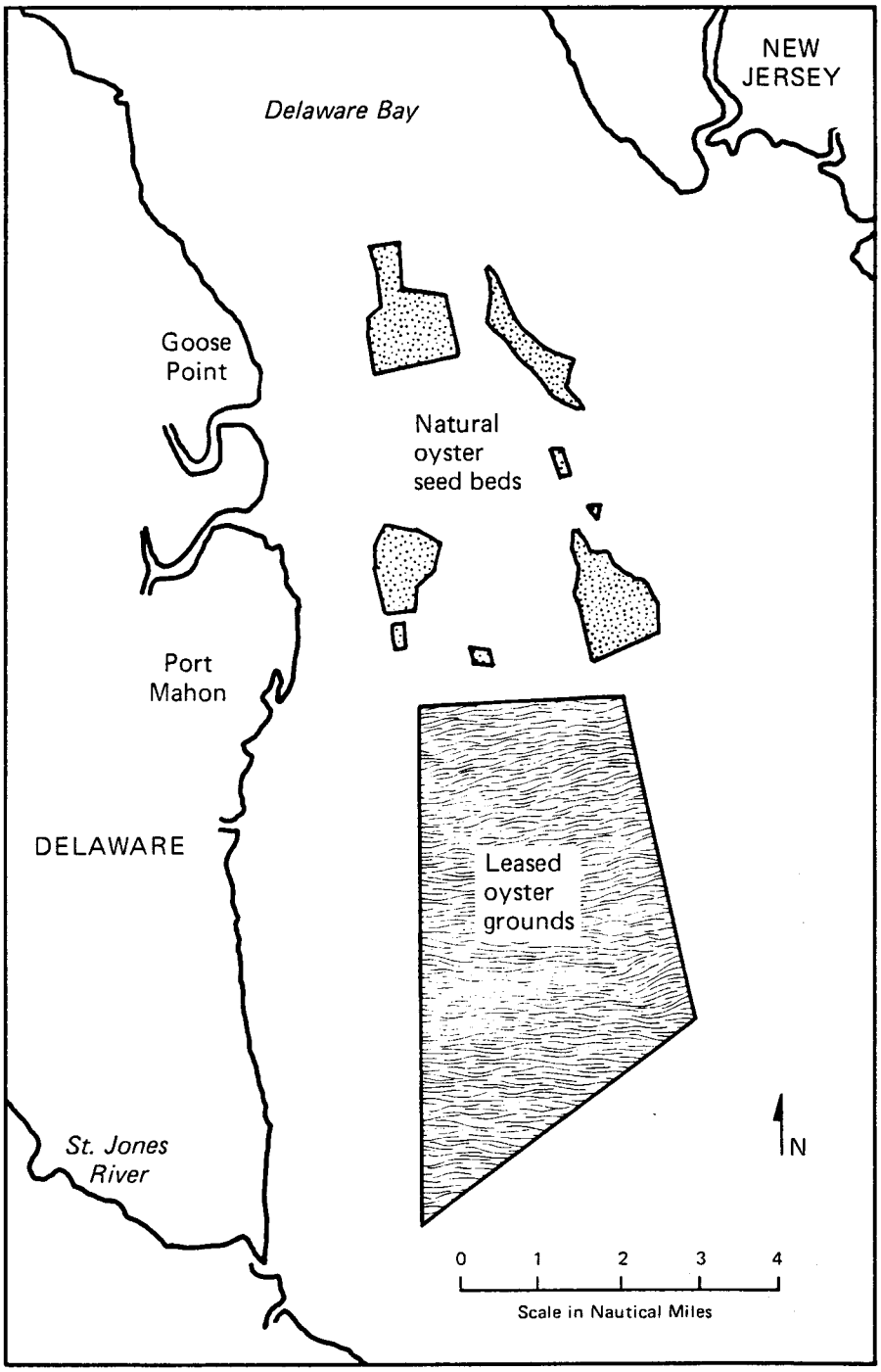
But because MSX-related deaths are higher in the lower bay, the oystermen must now leave seed oysters on the upper bay seed beds for almost the entire growing period. They transplant only the largest seed oysters to the lower bay oyster grounds, and allow them to grow there for just one season before harvesting.

Keeping the oysters on the upper bay seed beds for this extended period has a potential danger. Since these oysters have limited contact with MSX, there is little natural selection to rid the population of more susceptible individuals. Over time, the population will develop little resistance to MSX. Should salinities in the bay shift, as happens periodically due to changes in rainfall, these oyster populations could be damaged by MSX.

Dealing with the MSX Problem

Following the onset of the MSX problem in the 1960s, the Delaware State Department of Natural Resources and Environmental Control (DNREC) became more active in regulating and managing the state's oyster resources. It increased the size of seed beds in middle-salinity areas of the bay, using over five million bushels of waste surf clam shells. These seed beds provide limited exposure to MSX, and have better growing conditions than upper bay seed beds. Following the initial heavy MSX mortalities, DNREC planted several hundred bushels of adult oysters on depleted

Delaware Bay oyster beds and leased grounds. *Adapted from 1962 and 1974 State of Delaware charts.*



seed beds to help attract spat, and to act as brood stock. Researchers continue to sample these beds each fall for growth, survival, recruitment of new oysters, and MSX infection. The outlook is encouraging.

Another practice that may help lessen the amount of damage created by MSX was first noted in the spring of 1980. Delaware oystermen were transplanting seed oysters in May, one month before the major MSX infective period, while oystermen in New Jersey transplanted oysters into late June. By November of 1980, New Jersey oystermen had lost over 50% of their oysters to MSX. By the same time, Delaware oystermen lost 15% of their oysters to all combined causes.

Workers at both the Delaware and New Jersey Fish and Wildlife Agencies now believe that an earlier seed season may enable the oysters to become better established in their new environment, and thereby withstand MSX infection more successfully. As a result, both New Jersey and Delaware oystermen now schedule seed transplantation for May.

On the whole, Delaware Bay oysters appear to be getting stronger, due to the combined effects of natural selection and management practices. Delaware harvested over 639,450 pounds of oysters in 1980, an increase of almost 20 fold since 1961.

The Future of the Delaware Bay Oyster

But until more is known about MSX, the Delaware Bay oyster population will still be subject to devastation by the parasite. Research into the suspected alternate host is being pursued by researchers at Rutgers University, and both the New Jersey state agencies and the Delaware Department of Natural Resources and Environmental Control are improving their oyster management strategies. DNREC plans to expand its MSX study to include late summer sampling, to get a more accurate profile of MSX's early infective period. DNREC is also working closely with Delaware oystermen to optimize oyster harvests.

The Delaware Bay states aren't alone in the MSX problem. MSX is also a problem in the Chesapeake Bay, and institutions in Virginia and Maryland are actively researching MSX biology and pathology. With help from this research, the eastern oyster will continue to contribute to the livelihood of the Delaware Bay area.

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