

An Extension Sea Grant Advisory Program jointly sponsored by:  
 Cooperative Extension Service, University of Massachusetts and  
 Massachusetts Institute of Technology Sea Grant Program

# Marine and Coastal Facts

## New England Red Tide



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If you work or play near the coast, you have probably heard of the poisonous "red tide" which appears from time to time in New England waters from Maine to Cape Cod, and elsewhere in the world. Red tide is a concentration of one-celled organisms—algae—which contain small amounts of a powerful toxin. These algae are eaten by shellfish, which in turn may be eaten by humans. If mollusks such as soft-shelled clams, mussels, or quahogs have stored enough of the toxic substance, paralytic shellfish poisoning (PSP) may result in the unfortunate person who dines on the seafood.

Red tides causing shellfish contamination are known in many countries bordering on the Atlantic and Pacific Oceans. In some places they provoke massive fish and bird kills, and skin and respiratory irritation in swimmers. An Eskimo legend has it that, in 1799, one hundred Aleut hunters died within two hours of eating mussels at a place in Alaska which to this day bears the name Peril Way. West Coast Indian tribes used to post sentries on cliffs to watch for the nighttime glow of bio-luminescence, which is associated with the poisonous algae as well as with some harmless organisms. A tribe in Alaska is said to have invited an unwanted settlement of Russians to a shellfish banquet, which proved to be the settlers' last meal.

### The 1972 Emergency

Red tides have been known in Massachusetts since the autumn of 1972 when a serious outbreak of PSP reached as far south as Cape Cod. State public health officials managed the emergency with the help of experts from Maine and eastern Canada who were old hands in the matter. They banned all clamdigging and commercial harvesting. A statewide media campaign alerted the public to the danger. Field monitoring stations were set up throughout the 2800 acres of harvesting area affected. A potentially tragic

epidemic was avoided (no deaths resulted from the nearly 30 reported cases of PSP) but Massachusetts and the shellfish industry are still battling what seems to have become a permanent enemy.

The tiny but potent algae, a variety of dinoflagellate, have drawn so much attention that two international conferences have been held to examine their lifestyle. Studies in biology, oceanography, and chemistry are underway which may in time provide enough understanding of the algae's characteristics so that eventually outbreaks of red tide can be predicted and possibly controlled.

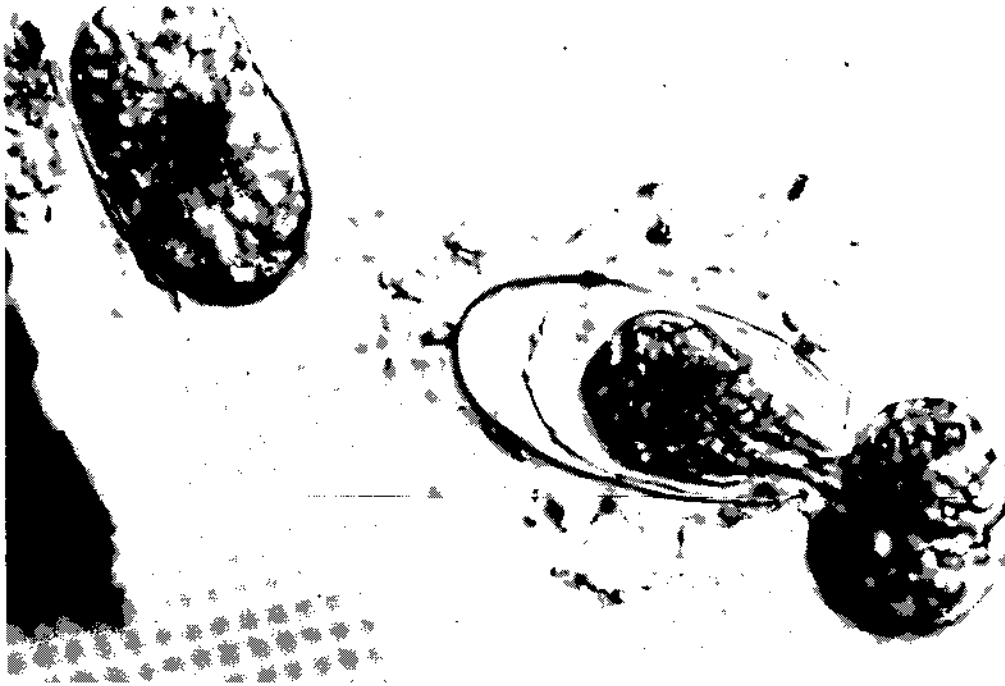
Why are concentrations of these algae called red tides? It takes a million dinoflagellates to color one liter of water red. Unfortunately, the phrase is misleading, as not all poisonous concentrations of algae are dense enough to discolor the water, and conversely, some harmless organisms also can stain the water red if they mass together.

### Weather is a Factor

Many algae bloom, or mass together, on a regular basis, usually in the spring and fall. Changes in water chemistry seem to encourage algal blooms. Dinoflagellates appear to thrive in relatively warm temperatures, low salinity, and certain combinations of nutrients. The weather plays a crucial role in any of several ways. Hurricane Carrie is thought to have been a factor in the 1972 red tide. If other conditions are right, dry, sunny spells may give the organisms a chance to multiply, and storms which stir up the water may serve them a feast of decomposed organic matter, vitamins, and trace metals.

Land runoff transported by rainfall and rivers reduces the salinity of seawater and contributes to the nutrient level. Coastal upwelling induced by waves, tides, and currents causes upsurges of deep, sediment-rich water. Traces of copper are thought to inhibit

(continued)



*Gonyaulax tamarensis* emerging from cyst after completion of dormancy. Cyst in background has not yet germinated. Size: 25 × 55 micrometers. (Photo by D. Wall)

the growth of the algae. However, when copper is bound up chemically by organic material washed into the sea in run-off, the red tide algae can grow more freely.

#### Winter Over on the Bottom

Unlike many one-celled marine organisms, these algae have the ability to swim upwards or downwards to find optimum conditions. Two microscopic tails propel them at a rate of one or two meters an hour. When conditions are unfavorable, the algae enter a temporary resting state in which they do not swim. When winter comes or their bloom is finished, they sink to the ocean floor or to the muddy bottom of a bay or pond where, locked in a hard, protective shell, they enter a dormant cyst stage. Scientists do not yet know what causes the swimming algae to form cysts and sink, and then, a season later, to become motile again and swim to the surface. Laboratory experiments suggest that the cysts break open and release the swimming algae in response to temperature changes. Researchers speculate that the resting cysts serve as seed populations for annually recurring blooms in certain areas, and that the cysts, transported by tidal currents, carry the algae to new locations along the coast.

Mother Nature is not the only force at work. Human activity such as dredging or dumping of sediment, or seeding of shellfish beds with starter samples from other places, may have a bearing on where we find these tough little spores and their swimming counterparts. In Massachusetts we are concerned with two varieties of *Gonyaulax tamarensis*, the red tide dinoflagellate. The first one introduced PSP to Cape Cod in 1972, and the second one, which differs only slightly in appearance, was found four years later at a different location on the Cape. Researchers are probing



this mystery by mapping areas of the coast to determine distribution of the cysts. Studies are also being conducted on the effects of sewage and industrial outfall on the dinoflagellate diet.

#### Testing for Red Tide

In New England, a network of laboratories monitors coastal waters and shellfish samples. In the event of a sudden rise in the shellfish toxin content, these key stations are quickly supplemented by testing points throughout the region. Because it is impossible to tell without scientific equipment whether or not red tide algae are present in the water or in a shellfish catch, clamdiggers and commercial harvesters must rely on postings by local shellfish wardens and on information from the key stations. When algae are found to be present in the water, the traditional mouse test, or bioassay, is performed on suspect samples of shellfish to find out how many "mouse units" of poison they contain (a mouse unit is the amount of PSP it takes to kill a 20-gram mouse in 15 minutes).

As there is no known antidote to the toxin, which attacks the human nervous system, medical treatment of a victim focuses on alleviating the symptoms of gastrointestinal and respiratory dis-

stress. At first, the illness is hard to diagnose because the symptoms resemble drunkenness, the patient exhibiting uncoordinated movements, incoherent speech, a feeling of lightheadedness and nausea. Although some immunity may be built up in people who often eat shellfish containing small amounts of the toxin, an outbreak of PSP could endanger them as well. Historically documented deaths throughout the world total about 300, with about 1,750 nonfatal cases reported. It takes 12 to 24 hours for the toxin to reach its peak effect in the body, after which the crisis is past, leaving no apparent residual effects.

#### The Economic Results

In 1972, the shellfish business in Massachusetts suffered a crippling blow from the closing of the shellfish beds and the damaging publicity about PSP; the National Marine Fisheries Service estimated the loss at more than a million dollars. Other parts of the seafood industry and uncontaminated areas of the coast also suffered because of the halo of public fear surrounding the emergency. Officials were in a double bind: with limited knowledge and experience they could not protect both the industry and the public health at the same time.

Until recently, the only viable response to the threat of PSP was to close down shellfishing with a total embargo, as has been done in Alaska since 1947. This is the traditional response. In the days before America was discovered by Europeans, the Indians in Nova Scotia, even when they were starving, would eat their pet dogs and the bark off trees before they would eat mussels.

So it is an old problem. But lately the situation has much improved. Because scientists and health officials know so much more about the organism, they can manage public policy to reflect the facts.

#### Limited Closings Now

Shellfishing areas are closed only selectively now, as only certain ones are affected, and those for a limited time. Red tide algae tend to recur in the same locations. Thanks to advancing technology and a degree of predictability in the behavior of the organisms, about half the number of key stations established in 1972 are necessary to monitor the coast today, although satellite stations are still set up when a problem is found.

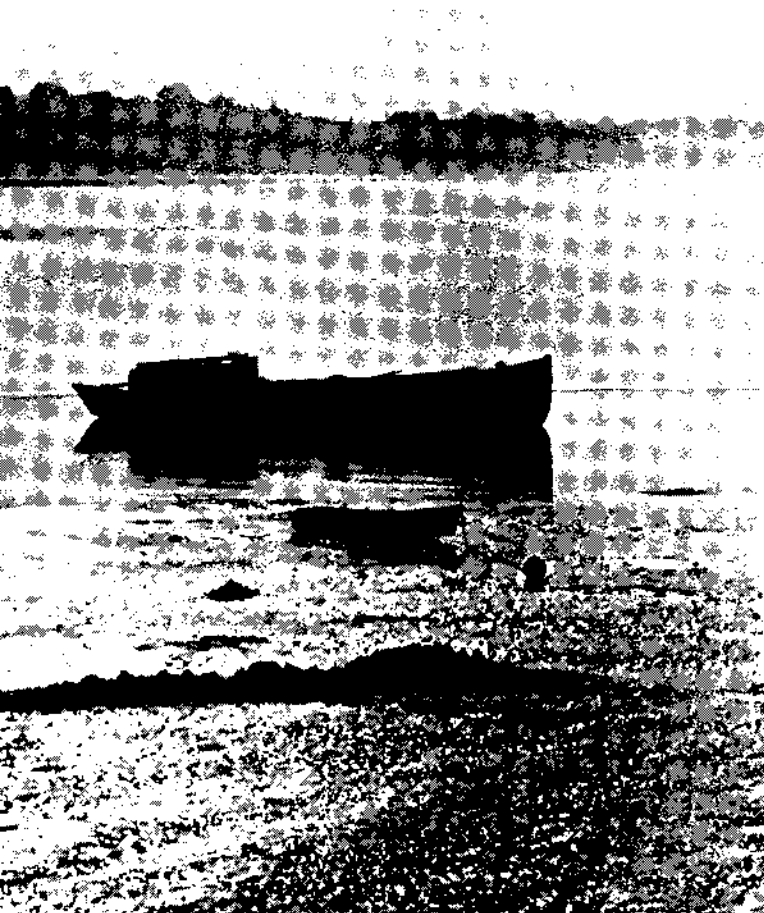
After an outbreak of red tide, shellfish which have ingested the algae purge themselves through their seawater pumping system. Generally, the faster the species pumps, the faster it concentrates the algae from infected seawater, and the faster it detoxifies when the water is free of red tide. Mussels are the fastest pumpers, with softshell clams second.

Boaters, vacationers, and coastal residents should be aware of red tides and should watch for local postings of area closings. Signs are displayed, usually on telephone poles or fenceposts, on the access to the banned area. Violators are fined \$50 to \$300 and/or imprisoned for up to 90 days. Restrictions are also listed

*(continued)*

"Clamming"

*(Photo courtesy of Coastal Zone Management)*



with local Town Offices, where the recreational harvester must go to obtain a license from the shellfish constable. In addition,

The Commonwealth of Massachusetts Department of Environmental Quality Engineering, which has sponsored in part this fact sheet, is responsible for the monitoring, testing and closing of shellfish areas in this state. For more information contact:

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INGENIERIA DE PROTECCION DEL MEDIO AMBIENTE



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DE ACUERDO DE LA LEY DE MASSACHUSETTS ARTICULO 130, SECCION 74A, EL DEPARTAMENTO DE INGENIERIA D PROTECCION DEL MEDIO AMBIENTE HA DETERMINADO QUE LOS MARISCOS EN ESTA ZONA ESTAN CONTAMINADOS CON UN VENENO QUE PARALIZA A LA GENTE. QUEDA PROHIBIDO SACAR MARISCOS DE ESTA ZONA DESDE EL \_\_\_\_\_ HASTA FUTURO AVISO.

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DEPARTMENT OF  
ENVIRONMENTAL QUALITY ENGINEERING



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THE COMMONWEALTH OF MASSACHUSETTS  
DEPARTMENT OF  
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