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WHAT YOU SHOULD KNOW ABOUT *PFIESTERIA PISCICIDA*

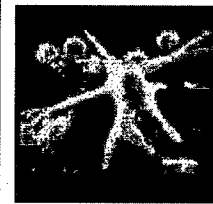
WHAT IS *PFIESTERIA* ?

Pfiesteria piscicida (fee-STEER-ee-uh pis-kuh-SEED-uh) is a toxic dinoflagellate that has been associated with fish lesions and fish kills in coastal waters from Delaware to North Carolina. A natural part of the marine environment, dinoflagellates are microscopic, free-swimming, single-celled organisms, usually classified as a type of alga. The vast majority of dinoflagellates are not toxic. Although many dinoflagellates are plant-like and obtain energy by photosynthesis, others, including *Pfiesteria*, are more animal-like and acquire some or all of their energy by eating other organisms.

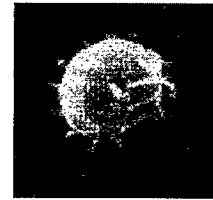
Discovered in 1988 by researchers at North Carolina State University, *Pfiesteria piscicida* is now known to have a highly complex life-cycle with 24 reported forms, a few of which can produce toxins. Three typical forms are shown on the right. A few other toxic dinoflagellate species with characteristics similar to *Pfiesteria* have been identified but not yet named. These are referred to as "*Pfiesteria*-like organisms," and they occur from Delaware to the Gulf of Mexico.

HOW DOES *PFIESTERIA* AFFECT FISH ?

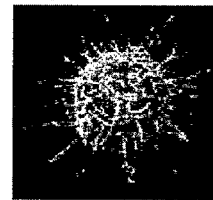
Pfiesteria normally exists in non-toxic forms, feeding on algae and bacteria in the water and in sediments of tidal rivers and estuaries. Scientists believe that *Pfiesteria* only becomes toxic in the presence of fish, particularly schooling fish like Atlantic menhaden, triggered by their secretions or excrement in the water. At that point, *Pfiesteria* cells shift forms and begin emitting a powerful toxin that stuns the fish, making them lethargic. Other toxins are believed to break down fish skin tissue, opening bleeding sores or lesions. The toxins or subsequent lesions are frequently fatal to the fish. Fish may also die without developing lesions. As fish are incapacitated, the *Pfiesteria* cells feed on their tissues and blood. *Pfiesteria* is NOT an infectious agent like some bacteria, viruses, and fungi. Thus, fish are NOT killed by an infection of *Pfiesteria*, but rather by the toxins it releases, or by secondary infections that attack the fish once the toxins have caused lesions to develop.



amoeboid form



flagellated form



encysted form

Three forms of
Pfiesteria piscicida.
Photos courtesy of the
Aquatic Botany
Laboratory, North
Carolina State
University.

IS *PFIESTERIA* THE ONLY CAUSE OF FISH LESIONS AND FISH KILLS ?

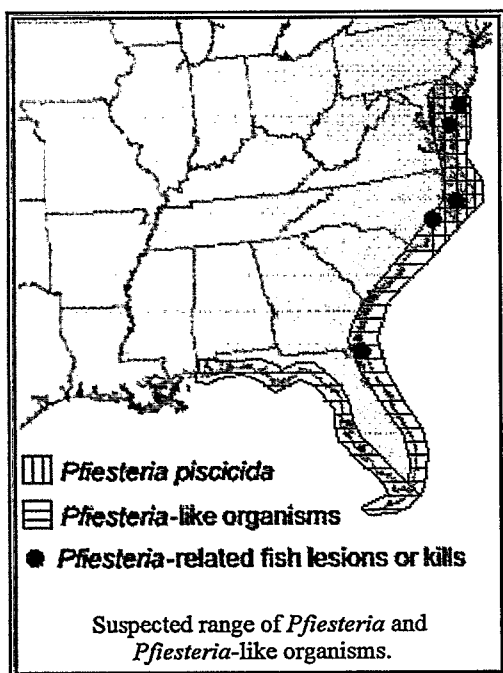
A lesion is any sore, wound, or area of diseased tissue. There are many possible causes for fish lesions other than *Pfiesteria* and *Pfiesteria*-like organisms. These include physical injury in nets or traps, bites by other fish or birds, chemical pollutants, generally poor water quality, and infectious disease agents such as certain viruses, bacteria, and fungi. A fish kill is a situation in which many fish -- more than a few dozen -- die over a short period of time -- hours or days. *Pfiesteria* and *Pfiesteria*-like organisms are only one cause of fish kills on the southeast and Gulf coasts. Other causes include a lack of dissolved oxygen in the water, sudden changes in factors such as salinity or temperature, sewage or chemical spills, blooms of other kinds of harmful or toxic algae, infectious disease agents, and other environmental changes.

HOW LONG DO TOXIC *PFIESTERIA* OUTBREAKS LAST ?

Toxic outbreaks of *Pfiesteria* are typically very short, no more than a few hours. After such an event, *Pfiesteria* cells change back into non-toxic forms very quickly, and the *Pfiesteria* toxins in the water break down within a few hours. However, once fish are weakened by the toxins, *Pfiesteria*-related fish lesions or fish kills may persist for days or possibly weeks.

WHERE HAS *PFIESTERIA* BEEN FOUND ?

Pfiesteria piscicida is known to occur in brackish coastal waters from the Delaware Bay to North Carolina. Other *Pfiesteria*-like organisms occur along the southeast coast from Delaware to the Gulf of Mexico. These organisms are believed to be native, not introduced species, and are probably common inhabitants of estuarine waters within their range. These microbes have not been found in freshwater lakes, streams, or other inland waters.



Pfiesteria piscicida has been implicated as a cause of major fish kills at many sites along the North Carolina coast, particularly the New River and the Albemarle-Pamlico estuarine system, which includes the Neuse and Tar-Pamlico Rivers. Millions of fish have died from *Pfiesteria* in North Carolina. In 1997, *Pfiesteria* or *Pfiesteria*-like organisms killed thousands of fish in several Eastern Shore tributaries of the Chesapeake Bay, including the Chicamacomico and Manokin Rivers and King's Creek in Maryland, and the lower Pocomoke River in Maryland and Virginia. *Pfiesteria piscicida* is the probable cause for a 1987 fish kill in Delaware's Indian River. Fish kills in coastal aquaculture operations in Maryland and North Carolina have also been linked to *Pfiesteria* and *Pfiesteria*-like organisms. Lesioned fish found in association with *Pfiesteria* or *Pfiesteria*-like organisms have been documented in several Maryland and Virginia tributaries of the Chesapeake Bay, in many coastal areas of North Carolina, and in the St. John's River in Florida.

WHAT CAUSES TOXIC *PFIESTERIA* OUTBREAKS ?

The exact conditions that cause toxic outbreaks of *Pfiesteria* to develop are not fully understood. Scientists generally agree that a high density of fish must be present to trigger the shift of *Pfiesteria* cells into toxic forms. However, other factors may contribute to toxic *Pfiesteria* outbreaks by promoting the growth of *Pfiesteria* populations in coastal waters. These factors include warm, brackish, poorly flushed waters and high levels of nutrients.

Nutrients such as nitrogen and phosphorus are thought to encourage the growth of *Pfiesteria* populations by stimulating the growth of algae that *Pfiesteria* feeds on when in its non-toxic forms. Some evidence suggests that nutrients may also directly stimulate the growth of *Pfiesteria*, but more research is needed to show this conclusively. At this time, the precise role that nutrients and other factors may play in promoting toxic outbreaks of *Pfiesteria* is not clear, and is an area of active research.

Excess nutrients are common pollutants in coastal waters. Chief sources of nutrient pollution in coastal areas are sewage treatment plants, septic tanks, polluted runoff from suburban landscapes and agricultural operations, and air pollutants that settle on the land and water.

WHAT IS BEING DONE ABOUT *PFIESTERIA* ?

State and federal agencies are working closely with local governments and academic institutions to address the problems posed by *Pfiesteria*. Federal agencies involved in the effort include the U.S. Environmental Protection Agency, the National Oceanic and Atmospheric Administration, the Centers for Disease Control and Prevention, the National Institute of Environmental Health Sciences, the Food and Drug Administration, the U.S. Geological Survey, and the U.S. Department of Agriculture. Together with state departments of health and natural resources, these agencies are working to:

- Manage the risk of human health effects by monitoring and rapid response through river closures and public health advisories.
- Direct funding and technical expertise to *Pfiesteria*-related research and monitoring.
- Make current and accurate information widely available to the public.
- Understand and address the causes of *Pfiesteria* outbreaks, especially the possible role of excess nutrients.

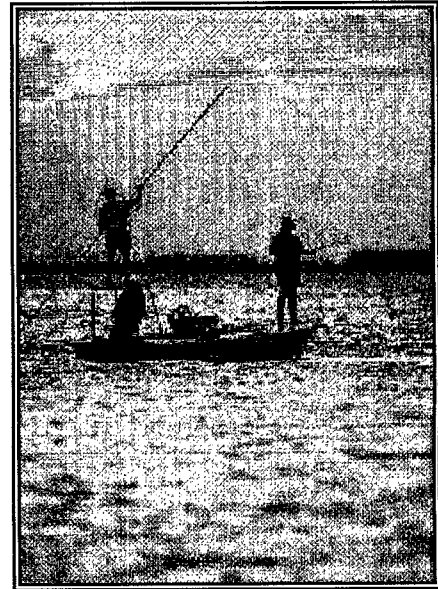
WHOM SHOULD I CONTACT TO REPORT FISH LESIONS, FISH KILLS, OR POSSIBLE HUMAN EXPOSURE TO *PFIESTERIA* ?

A few fish with lesions or even a few dead fish are not cause for alarm. However, if you notice a significant number of fish -- more than a few dozen -- that are dead, dying, behaving abnormally, exhibiting lesions, or showing other signs of disease, please contact your state's department of environment or natural resources. If you experience health problems after being exposed to fish, water, or air at the site of a fish kill or suspected toxic *Pfiesteria* outbreak, contact your physician and your state or local public health agency at once. Several states have set up *Pfiesteria* hotlines, listed on the following page.

IS IT SAFE TO SWIM AND BOAT IN COASTAL WATERS ?

Swimming, boating, and other recreational activities in coastal waters are generally safe. To be on the safe side, the following common-sense precautions are recommended:

- Comply with state closures of water bodies and public health advisories. Do not go into or near the water in areas that are closed by the state.
- If you notice significant numbers of fish that are dead or that exhibit lesions or other signs of disease, avoid contact with the fish and water, and promptly report the incident to your state's environment or natural resource agency.



IS *PFIESTERIA* A "HARMFUL ALGAL BLOOM" ?

HOW IS IT RELATED TO RED AND BROWN TIDES ?

Most species of algae are not harmful. Algae are the energy producers at the base of the ocean's food web, upon which all other marine organisms depend. However, a few species of algae and other microbes can become harmful to marine life and to people under certain conditions. Scientists call such events "harmful algal blooms." Brown tides, toxic *Pfiesteria* outbreaks, and some kinds of red tides are all considered types of harmful algal blooms. Some harmful algal blooms, like toxic *Pfiesteria* outbreaks, can cause detrimental effects when the microbes are at low concentrations in the water and cannot be visibly detected. In other cases, like certain red and brown tides, harmful effects occur when the algae reach high concentrations that discolor the water. However, not all algal blooms that discolor the water are harmful -- many red tides appear to have no negative effects on marine life, people, or the environment.

Some kinds of algal blooms are harmful because the algae produce one or more toxins that poison fish or shellfish, and can pose human health risks when people come in contact with affected waters. These toxic algal blooms may also kill seabirds and other animals indirectly as the toxins are passed up the food chain. Certain kinds of these toxic algal blooms can cause human health problems via contaminated seafood, like Ciguatera Fish Poisoning, Amnesic Shellfish Poisoning, and Paralytic Shellfish Poisoning. However, there is no evidence that *Pfiesteria*-related illnesses are associated with eating fish or shellfish.

Most algal blooms are not toxic, but they are still considered harmful if they reduce the amount of light or oxygen in the water, consequently killing sea grasses, fish or other marine life. Blooms of macro algae -- seaweed -- can also be harmful if they damage underwater habitats such as coral reefs or sea grass beds.

CAN *PFIESTERIA* CAUSE HUMAN HEALTH PROBLEMS ?

Pfiesteria is not a virus, fungus, or bacterium. It is not contagious or infectious, and cannot be "caught" like a cold or flu. Any human health problems associated with the microbe stem from its release of toxins into river and estuarine waters.

Preliminary evidence suggests that exposure to *Pfiesteria* toxins in the air, water, or fish at the site of an outbreak can cause skin irritation as well as short-term memory loss, confusion, and other cognitive impairments in people. It has been shown that similar human health effects can be caused by exposure to *Pfiesteria* toxins in a laboratory setting. However, there is no evidence that illnesses related to *Pfiesteria* are associated with eating fish or shellfish. To date, only *Pfiesteria piscicida* has been linked to human health problems; other *Pfiesteria*-like organisms have not been shown to cause human illness.

As of October, 1997, 146 people had reported possible *Pfiesteria*-related health problems, including researchers working with the toxins in the laboratory, commercial fishermen, a water-skier, and officials working in the field during a fish kill. Symptoms reported by these individuals include skin irritation; memory loss and other cognitive impairments; nausea and vomiting; and respiratory, kidney, liver, vision, and immune system problems. Recent studies suggest that some of these symptoms may be temporary. Establishing a definite link between generalized symptoms and the microbe is difficult, but health officials are studying the situation carefully.

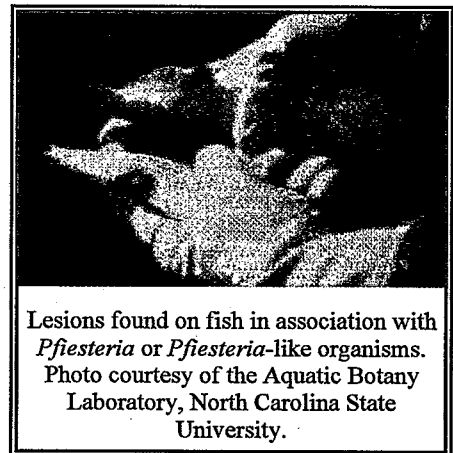
IS IT SAFE TO EAT SEAFOOD ?

YES. In general, it IS safe to eat seafood.

- There has never been a case of illness from eating fish or shellfish exposed to *Pfiesteria*.
- There is no evidence of *Pfiesteria*-contaminated fish or shellfish on the market.
- All seafood products and processing facilities are required by law to have programs to ensure the safety of the fish and shellfish they sell. Seafood from restaurants, supermarkets, and other retailers is considered safe.
- There is no evidence that illnesses related to *Pfiesteria* are associated with eating fish or shellfish.

To be on the safe side, the following common-sense precautions are recommended:

- Comply with state closures of water bodies and public health advisories. Do not harvest or consume fish or shellfish from areas that are closed by the state.
- Do not handle or consume fish that you have harvested that are dead or dying; that exhibit sores, peeling, lesions, or other signs of disease; or that were acting abnormally when caught.
- If you notice significant numbers of fish that are dead or that exhibit lesions or other signs of disease, avoid contact with the fish and water, and promptly report the incident to your state's environment or natural resource agency.



Lesions found on fish in association with *Pfiesteria* or *Pfiesteria*-like organisms. Photo courtesy of the Aquatic Botany Laboratory, North Carolina State University.

WHERE CAN I GET MORE INFORMATION ABOUT *PFIESTERIA* ?

State *Pfiesteria*, Fish Kill, or Related Health Effects Hotlines:

Delaware	1-800-523-3336	North Carolina	1-888-823-6915
Maryland	1-888-584-3110	Florida	1-800-636-0511
Virginia	1-888-238-6154		

On the Internet:

Federal:

U.S. Environmental Protection Agency
<http://www.epa.gov/owow/estuaries/pfiesteria/>
National Oceanic and Atmospheric Administration, Coastal Ocean Program
<http://www.cop.noaa.gov/pfiesteria>
USDA National Agricultural Library
<http://www.nal.usda.gov/wqic/pfiest.html>
National Office for Marine Biotoxins and Harmful Algal Blooms
<http://www.redtide.who.edu/hab/>
U.S. Geological Survey
<http://www.usgs.gov/outreach/fishlesions/>

State:

Delaware Department of Natural Resources and Environmental Control
<http://www.dnrec.state.de.us/tpff1.htm>
Maryland Department of Natural Resources
<http://www.dnr.state.md.us/fishhealth.html>
Virginia Department of Health
<http://www.vdh.state.va.us/misc/alert.htm>
North Carolina Department of Environment and Natural Resources
<http://www.ehn.state.nc.us/EHNR/files/pfies.htm>
North Carolina Department of Health and Human Services
<http://www.dhr.state.nc.us/DHR/docs/pfanswer.htm>
Florida Department of Environmental Protection
<http://www.ces.fau.edu/library/info/Pfiesteria/Pfiesteria.html>
Coastal States Organization
<http://www.sso.org/cso/>
Association of State and Interstate Water Pollution Control Administrators
<http://www.asiwpca.org/>

Academic Institutions:

University of Maryland Sea Grant- Fish Health in the Chesapeake Bay
<http://www.mdsg.umd.edu:80/fish-health/>
Virginia Institute of Marine Science
<http://www.vims.edu/welcome/news/pfiesteria/>
North Carolina State University Aquatic Botany Laboratory
http://www2.ncsu.edu/unity/lockers/project/aquatic_botany/pfiest.html
North Carolina Sea Grant- *Pfiesteria* Research Results
http://www2.ncsu.edu/ncsu/CIL/sea_grant/pfiest.html