Collier Soil and Water Conservation District

Gulf of Mexico Algae Shield Themselves with Toxins When Hungry

A photograph of the algae *Karenia brevis*. The plant, responsible for toxic red tide in the Gulf of Mexico, is so small you need a microscope to see it.

A species of algae, responsible for red tide plaguing Gulf coast communities, protects itself by becoming highly toxic when it's hungry and vulnerable to being eaten by predators, say scientists from National Oceanic and Atmospheric Administration National Centers for Coastal Ocean Science and North Carolina State University.

Florida red tide (*Karenia brevis*) reacts to low levels of nutrients—particularly phosphorus—by using its remaining energy to make itself several times more toxic than it usually is, in order to guard itself from microorganisms that would eat it in its weakened state.

Karenia brevis needs three components to form a bloom. The first is biology—the organism must be present in the water. The second is the correct chemistry—nutrients that it needs to grow. And the third component is the right physical conditions—in order to concentrate and transport the microscopic algae.

Many algae species cause red tides all over the world. Yet, the organism that causes Florida's red tide is found almost exclusively in the Gulf of Mexico from Mexico to Florida. Florida red tides can be transported around the Gulf of Mexico as coastal waters move with winds and currents and become two to seven times more toxic when levels of phosphorus, a major algal nutrient found in fertilizers and human waste, are low. Like wearing a suit of armor, producing highly toxic cells allows the algae to defend themselves against opportunistic waterborne grazers like zooplankton.

Karenia brevis produces brevetoxins that can affect the central nervous system of fish and other vertebrates, causing these animals to die. Wave action can break open *Karenia brevis* cells and release these toxins into the air, leading to respiratory irritation. For people with severe or chronic respiratory conditions, such as emphysema or asthma, red tide can cause serious illness. The red tide toxins can also accumulate in molluscan filter-feeders such as oysters and clams, which can lead to Neurotoxic Shellfish Poisoning in people who consume contaminated shellfish.

Are red tides new to Florida?

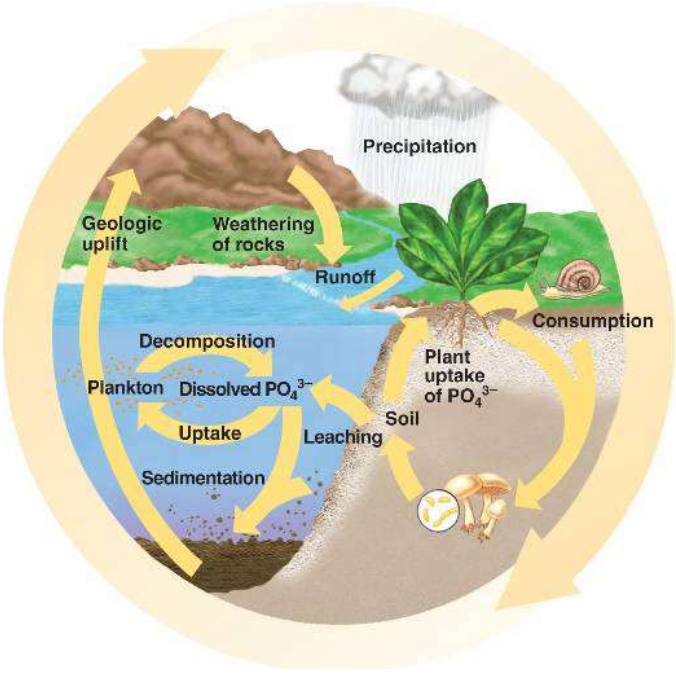
No. Red tides were documented in the southern Gulf of Mexico as far back as the 1700s and along Florida's Gulf coast in the 1840s. Fish kills near Tampa Bay were even mentioned in the records of Spanish explorers.

The Phosphorus Cycle

Phosphorus enters the environment from rocks or deposits laid down on the earth many years ago. The phosphate rock, in its commercially available form, is called apatite. Other deposits may be from fossilized bone or bird droppings called guano. Weathering and erosion of rocks gradually release phosphorus as phosphate ions which are soluble in water. Land plants need phosphate as a fertilizer or nutrient.

Phosphate is incorporated into many molecules essential for life such as ATP, adenosine triphosphate, which is important in the storage and use of energy. It is also in the backbone of DNA and RNA which is involved with coding for genetics.

When plant materials and waste products decay through bacterial action, the phosphate is released and returned to the environment for reuse.



Much of the phosphate eventually is washed into the water from erosion and leaching. Again water plants and algae utilize the phosphate as a nutrient. Studies have shown that phosphate is the limiting agent in the growth of plants and algae. If not enough is present, the plants are slow growing or stunted. If too much phosphate is present, excess growth may occur, particularly in algae.

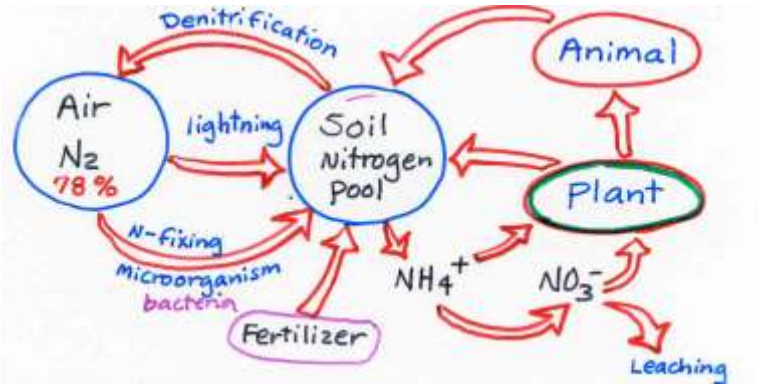
A large percentage of the phosphate in water is precipitated from the water as iron phosphate which is insoluble. If the phosphate is in shallow sediments, it may be readily recycled back into the water for further reuse. In deeper sediments in water, it is available for use only as part of a general uplifting of rock formations for the cycle to repeat itself.

Nitrogen Fixation

Nitrogen Fixation is a process of combining atmospheric nitrogen with other elements to form useful compounds. There are only a few ways in which nitrogen, which is relatively inert, can be combined with other elements. Nitrogen is essential to living things and, because most organisms cannot use nitrogen that is not combined with other elements, nitrogen fixation is important to the continuation of life on earth. Fixed, or combined, nitrogen is also necessary for the manufacture of many substances, including explosives and commercial fertilizers.

In nature, nitrogen is fixed by some micro-organisms and by lightning. This natural fixation plays an important role in the nitrogen cycle. In the 20th century, humans learned to fix nitrogen in large quantities to supplement the amount of nitrogen fixed naturally. Synthetic processes of nitrogen fixation include the electric arc process, the cyanamide process and the Haber process.

Natural Nitrogen Fixation



In a way that is not yet completely understood, nitrogen-fixing bacteria and algae use nitrogen gas to make ammonium compounds. These compounds are absorbed by plants. Two main groups of microorganisms carry out nitrogen fixation. The more common of the two groups is made up of organisms living in soil and water—a few species of bacteria (chiefly of the genera Azotobacter and Clostridium) and some blue-green algae.

The second group, consisting of bacteria of the genus Rhizobium, lives in plants, primarily legumes such as peas, clover, and alfalfa. The bacteria cause the roots of legumes to form root nodules (swellings) in which the organisms live. The plants supply the bacteria with food. In return, the bacteria secrete ammonium compounds that are absorbed and used by the legumes and by other plants that are grown in the same soil.

Lightning plays a minor part in the fixation of atmospheric nitrogen. The extreme heat of a lightning flash causes nitrogen to combine with oxygen of the air to form nitrogen oxides. The oxides combine with moisture in the air. The fixed nitrogen is carried by rain to the earth, where, in the form of nitrates, it is used by plants.

There are many unknowns about both nitrogen and phosphorus but we are certain that no one should be able to target using fertilizer as the sole or main reason for algal activity in the Gulf of Mexico. We're also confident that where native plants are used, you don't need fertilizer.