Karenia brevis: ecological effects of red tide essay

Anticipating the blue waters of the Gulf and hoping to enjoy a nice sunny day, but instead it has been ruined by the reddish-brown color that now appears on select areas close to the shore and there are dead fish floating on the surface. Soon after, the overwhelming feelings of a cough, watery eyes, and a runny nose have now taken the place of serenity. This phenomenon is known as “ Florida Red Tide” and is the result of the “ massive multiplication”, or algal blooms of marine dinoflagellates, microscopic, single-celled protists.

Dinoflagellates are usually freshwater and marine, photosynthetic “ algae” and are important components of the phytoplankton. Their blooms appear reddish brown, or pinkish orange due to the high levels of carotenoids, the most common pigments of plastids in dinoflagellates (Reece, 555). One particular dinoflagellate, Karenia brevis, occurs almost annually along the coasts of the Gulf of Mexico and Florida waters. Karenia brevis releases potent neurotoxins called brevetoxins that affect the nervous system of vertebrates, accumulate in shellfish, and can become aerosolized.

The occurrences of “ Florida Red Tide” have resulted in serious and harmful ecological effects such as the air pollution, immense mortalities of invertebrates, mammals, and fish, as well as severe health threats to humans. First to understand the ecological effects of red tide, one must know the underlying factors of this natural phenomenon, neurotoxins. In this case, brevetoxins are the neurotoxins produced by Karenia brevis that are released during a bloom. Not all phytoplankton blooms are harmful, but some species tend to contain blooms that are harmful, and are referred to as “ harmful algal blooms” or (HAB).

Karenia brevis is one of the many species that contain HABs. Karenia brevis algae are thought to have a dormant stage at some point in their life cycle referred to as cysts which settle at the bottom of the ocean floor creating a “ seed bed” effect. When strong currents of warm water flow from Gulf Stream to the shore, they end up disturbing the algae and move the blooms closer to shore and ultimately result in damaging ecological effects (Wikipedia). Marine life is mainly exposed to brevetoxin producing blooms by eating them, breathing them, or simply coming into contact with them.

The blooms of Karenia brevis secretes nine potent polyether brevetoxins (PbTxs) that bind to voltage-gated sodium channels in the neurons that disrupt neurological processes causing the illness “ neurotoxic shellfish poisoning” (Wikipedia). This leads to disruptions in muscle functions, respiratory and cardiac distress. These toxins affect the counter current exchange of fish by entering the bloodstream through their gills causing rapid death to fish in high concentrations.

This rapid cause of death is thought to be due to the lack of muscle coordination, paralysis, convulsions, and respiratory failure. Fish in lower concentrations develop high toxin buildup in their tissues. Brevetoxins can accumulate in shellfish, especially clams, oysters, and coquinas, which filter feed on the algae, as well as fish and marine mammals, that also become poisoned through filter feeding. If toxin levels in shellfish become high enough they can become potent and lead to “ neurotoxic shellfish poisoning” in humans who consume them.

Neurotoxic shellfish poisoning” in humans can lead to severe gastrointestinal and neurologic symptoms. The primary organisms affected by red tide are fish, but in severe cases their have been mortalities of turtles, birds, bottlenose dolphins, whales, and manatees (JSTOR, 717-720). Humans are affected by “ Florida Red Tide” in mainly two ways, one is through the consumption of contaminated shellfish, which we mentioned early, and the other way is through the inhalation of aerosolized brevetoxins.

Karenia brevis cells are very fragile organisms and are broken easily by wave action along the shoreline. When this happens, the brevetoxins are released by Karenia brevis and can be transferred from water to air by wind-powered waves or boat propellers located in high red tide zones (JSTOR, 638-643). As the blooms progress, Karenia brevis can increase to several million per liter of water expanding the effected areas to square miles.

The inhalation of aerosolized brevetoxins causes respiratory irritation, bronchial constriction, coughing, and a burning sensation in the eyes, nose, and throat (JSTOR, 638-643). Many of the respiratory symptoms can be reduced by common medicines like antihistamines, inhaled steroids, or bronchodilators, but only before exposure. Bronchodilators have been known to help with the reversal of respiratory symptoms after exposure. Studies have shown that people with chronic respiratory problems or asthma have a greater proportion of symptoms than those without chronic respiratory ailments.

All these symptoms usually occur after only one hour of exposure to the aerosolized brevetoxins. (JSTOR, 644-649). There is more to be learned about

this natural phenomenon and the damaging ecological effects that come with it. Dinoflagellates play an important role in the conversion of solar energy to chemical energy (photosynthesis), a process significant to the production of oxygen and essential to the survival of most marine animals, yet they also have the unique ability to produce neurotoxins.

This peculiar, but harmful mechanism is still being understood on how the toxins are produced by blooms and what purpose do they serve in ecology. Through understanding and research, red tide can be controlled to help prevent serious ecological effects that include the pollution of air, massive mortalities of fish, marine mammals, invertebrates, and respiratory health problems in humans.