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Investigation Red Tide Effects on Human Health

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Abstract: This investigation was conducted to determine the effect of red tide on human health. Algae or phytoplankton are single-celled photosynthetic organisms that make up the lowest trophic level of aquatic ecosystems. Of the thousands of species of marine algae, a small number are known to produce chemicals that are toxic to other organisms including fish, birds, marine mammals and human. Bloom algae due to change of water by pigment is called red tide. One pathway common to several marine algal toxins is by human consumption of contaminated shellfish. Four distinct types of human shellfish poisoning have been identified. These are descriptively named paralytic shellfish poisoning (PSP), amnesic shellfish poisoning (ASP), neurotoxic shellfish poisoning (NSP) and diarrheic shellfish poisoning (DSP). Death is possible, although not extremely common, in the most severe cases of PSP and ASP.

Key words: Red Tide · Human Health · ASP · PSP

INTRODUCTION

Oceans contain more than 5000 species of planktonic microscopic algae, the phytoplankton, which forms the base of the marine food chain and produces roughly 50% of the oxygen we inhale [1]. Phytoplankton is microscopic, single-celled plants which use sunlight as the primary energy source for growth [2]. Also called algae, these primary producers make up the foundation of the food web and are the eventual food source of higher forms of life that feed on them either directly or indirectly. Of the thousands of species of marine phytoplankton, roughly a few dozen are known to produce chemicals that are highly toxic to other animals, including humans [3]. Worldwide there are about 60,000 cases of illnesses related to red tides reported, with a mortality rate of 0.15%. But it is estimated, that the majority of cases are not reported [4]. Bivalve shellfish such as oysters, clams and mussels feed exclusively on phytoplankton that they filter from seawater. Shellfish are usually unaffected by toxic algae themselves but can accumulate toxins in their tissue to levels that can be lethal to humans [2]. Four distinct types of shellfish poisonings have been identified ASP, NSP, PSP and DSP, CFP linked with Consumption fish [2].

1-1- ASP: Amnesic shellfish poisoning (ASP) is the only red tide-related intoxication due to diatoms. There have been identified four species of the genera *Pseudo-nitzschia* that produce the ASP-causing domoic acids. *Pseudo-nitzschia* spp. are widely distributed across the world in sea waters of both warm and cold climates. There are seasonal variations in phytoplankton blooms with numbers increasing in spring and autumn when there is heavy rainfall and an abundance of nutrients [5]. In addition, low wind and reduced water currents allow phytoplankton to accumulate in warmer surface waters, whilst periods of sunshine allow these ‘standing stocks’ to undergo rapid growth and form blooms [6]. Numerous strains of *P. nitzschia* are known to produce domoic acid including *P. multiseries, P. pseudodelicatissima* and *P. australis* [7]. However, production of domoic acid varies greatly with strain and is thought to be increased in response to environmental stresses, such as temperature change [8]. Although warmer sea temperatures (14-17°C) tend to be associated with increased domoic acid production [9], some strains have adapted to growth in cooler waters e.g. *P. seriata* produces high concentrations of domoic acid at 4°C [10]. Domoic acid has been shown to accumulate in a wide variety o f shellfish species such as types of cockles,

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crabs, furrow shell, mussels, razor clams and scallops [11]. Shellfish accumulate domoic acid either by direct filtration of the plankton or by feeding directly on contaminated organisms and thus, concentrations are highest in the digestive glands compared with other tissues. Rates of accumulation vary between different species of shellfish [7].

The symptoms of ASP include gastrointestinal effects like those of CFP and neurological problems like dizziness, disorientation, lethargy, seizures and permanent loss of short-term memory [2]. In one severe case, the individual still had selective memory loss five years after the incident [12]. Poisoning symptoms appears rapidly, from 15 minute to 38 hours from mussels' ingestion. After close to two days, some neurological alteration appears, presenting a different degree of severity [1]. In 1998, domoic acid was implicated in the death of over 400 sea lions off the central California coast [2].

Causative organisms of ASP: *Pseudo-nitzschia australis* and *Pseudonitzschia pungens*

1-2- DSP: Diarrhetic shellfish poisoning (DSP) was first described in the 1980s [13], it is caused by the contamination of shellfish with toxins originating in dinoagellates that are predominantly within the genera *Dinophysis* and *Prorocentrum* and has since been reported to occur worldwide [14]. Okadaic acid is the toxin responsible for DSP [13]. Symptoms usually occur 30 minutes to 12 hours after eating contaminated shellfish and include some form of gastrointestinal distress [2].

Approximately 90% of the cases experience diarrhea and other symptoms may include nausea, vomiting, abdominal cramps and chills [15]. The syndromes are gastrointestinal like vomiting and diarrhea and generally resolve within 2-3 days [16]. DSP was first reported in the Netherlands in the 1960s and cases of DSP have since gained prevalence in Europe, Japan and South America [2]. In one of the largest outbreaks, over 5000 people experienced DSP in Spain in 1981 [15].

Causative organisms of DSP: *Dinophysis Prorocentrum*, *Dinophysis fortii*, *Dinophysis acuminate*, *Dinophysis norvegica* and *Dinophysis acuta*

1-3- PSP: This syndrome is caused by saxitoxins, a group of toxins including about 20 different molecules. Saxitoxins was one of the first marine toxins recognized as responsible for human intoxications, the first report dating up to 1798, even if PSP symptoms were attributed to saxitoxins only after 1920. Saxitoxins are responsible for about 2000 human cases/year, with a mortality rate ranging from 15 to 50% [17].

The name of the toxin comes from the mollusk in which it was firstly identified, *Saxidomus giganteus*. It is produced by both temperate and tropical dinoflagellates of the genera Alexandrium, Gymnodium and Pyrodinium [16].

This is one of the few toxins which are produced by both marine and fresh water (cyanobacteria) organisms [1]. The effects of PSP are primarily neurological and very fast acting, with the onset of symptoms occurring 5 to 30 minutes after the ingestion of the contaminated shellfish. It usually starts as a tingling numbness in and around the mouth that spreads to the face and neck [2]. Other symptoms may include headache, nausea, vomiting, giddiness, dizziness and loss of sight. Very severe cases result in complete paralysis and death from respiratory failure unless artificial respiratory support is administered [2]. In non-lethal cases, the victim begins to gradually recover after about 12 hours and has no effects lasting longer than a few days [18]. PSP can be a serious public health problem, however, was demonstrated in Guatemala in a 1987 outbreak in which 187 cases with 26 deaths resulted from the ingestion of a clam soup [15].

Causative organisms of PSP: *Alexandrium excavatum*, *Alexandrium monilata*, *Alexandrium tamarense*, *Gymnodinium catenatum* and *Pyrodinium bahamense*

1-4-NSP: Neurotoxic Shellfish Poisoning or (NSP) Causes by Gymnodium breve, which differs from other dinoflagellates because it is an unarmored dinoflagellates; the lack of an external shell make this microalga easily lysed in turbulent waters The lyses allows the toxin to be released in water, making aerosol and droplets potentially toxics [19]. Typical symptoms of NSP include gastrointestinal symptoms like nausea and diarrhea as well as neurological symptoms like paresthesias [20]. In contrast to PSP and CFP, the mortality rate of NSP for humans is very low [20]. Recovery is usually complete within a few days [18]. Two different poisoning have been identified in humans: “indirect” intoxication by ingestion of contaminated mussels and poisoning for direct contact. In the first one symptom are both neurological and gastro-intestinal and appear within 1-3 hours after mussels' ingestion [1]. Neurological syndrome includes paresthesia of area around the mouth, the face and throat, muscular ache, ataxia, inversion of thermal perception, bradycardia, midriasis. Gastro-intestinal syndrome includes abdominal pain, nausea and diarrhea. Recovery is complete within 24 and 48 hours and no fatality has ever been recorded [1].

Causative organisms of NSP: *Gymnodinium breve* and *Karenia brevis*

1-5-CFP: Ciguatera Fish Poisoning is a well known poisoning linked to fish consumption, which was firstly described in 1555 by sailors in Caribbean areas [1]. Symptoms of CFP are gastrointestinal disturbances as nausea, vomiting and diarrhea as well as neurological symptoms as numbness of the perioral area and extremities, reversal of temperature sensation, muscle and jointaches, headache, blurred vision and paralysis [16].

Although it can affect all ages, certain, higher sensitivity seems to exist for the age range 30-49, interestingly, some occasional episode of toxin transfer through breast feeding was observed [17]. CFP only occurred in tropical areas, but as today the fish is exported worldwide; there are occasionally cases of CFP reported in other parts of the world [16].

Causative organisms of CFP: *Gambierdiscus toxicus*, *Prorocentrum concavum*, *Prorocentrum hoffmannianum*, *Prorocentrum lima*, *Ostreopsis lenticularis*, *Ostreopsis siamensis*, *Coolia monotis, Thecadinium* and *Amphidinium carterae.*

CONCLUSION

Red tide will be increase via human activities and industrial waste, rising temperatures, storms and up welling. Red tides are phenomena that frequently disturb the environments in almost all coastal waters of the world. Increased red tide caused can lead to increase produced toxins. The produced toxins have severe impact on the organisms living in those waters or near them. There are five poisoning linked with red tide but PSP and ASP more than dangerous of them. The objectives of this study were to increase the general scientific knowledge of people with regards to various aspects and impacts of this phenomenon.

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