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Harmful Algal Blooms (HABs) - An Overview

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SUMMARY

Harmful algal blooms (HABs) are symptomatic of ecosystem imbalance, often caused by the many environmental changes that demonstrate the expanding global human footprint and climate change. HABs are a major issue in marine, brackish, and freshwater systems worldwide. HAB species include representatives from most major algal and cyanobacterial taxonomic groups, but, despite this diversity, many HAB taxa respond to similar broad environmental stimuli (e.g., nutrients, light) and employ similar growth and defense strategies to maximize growth and minimize losses. In inland waters, attention is focused on dense surface There has also been an apparent rise in blooms of eukaryotic phytoplankton, including invasive marine flagellates, while reports of thick shoreline and benthic mats of chlorophytes, cyanobacteria, and other benthic HABs are likewise increasing. Research has made tremendous advances in our understanding of HAB events, yet they remain poorly understood. Harmful algal blooms are called red tide organisms due to the mark made by the discoloration of seawater surface due to the rapid growth and accumulation of certain microalgae.

INTRODUCTION

Phytoplankton are at the base of the food chain in most freshwater and marine systems. These single-celled photosynthetic algae provide many positive benefits including production of about half the oxygen on the planet, and transformation of sunlight and inorganic elements into the organic material and energy that drives our productive aquatic ecosystems. The dominance of cells of one or several species of phytoplankton can form an algal bloom, either through rapid growth or minimal loss (e.g., grazing, physical advection, or sinking). Though blooms are often harmless or beneficial to the functioning of marine and freshwater ecosystems, there is increasing awareness that blooms can also be indicative of eutrophication, ecosystem disruption, or altered environmental states.

Negative Impacts

Some algal blooms can have negative impacts to the environment, human and aquatic health, and the economy (such as aquaculture, fisheries, and tourism) and are thus termed harmful algal blooms (HABs). HABs negatively affect many freshwater systems and the majority of coastal regions worldwide. There is consensus that the impact of such blooms has grown over the last few decades, causing harm to public health, ecosystem function, fisheries and aquaculture, and recreation/tourism industries. Despite the broad consensus that HAB impacts are increasing, it is challenging to describe the research, management, and mitigation strategies coherently because the term HAB encompasses a wide, and sometimes bewildering, array of species, life histories, ecosystems, and impacts. There is no unifying ecological or evolutionary theme in the organisms considered to form HABs. They span the majority of algal taxonomic groups, including both eukaryotes and prokaryotes; some produce potent toxins, and others cause harm through a variety of other mechanisms. The dinoflagellates account for the majority (75%) of HAB species, but there are HAB representatives from nearly every algal taxon.5

To categorize the many groupings of potentially harmful algae, HABs are often first divided into toxic versus high-biomass blooms. Although they comprise a minority of the phytoplankton assemblage, toxic species can and do have significant impacts on human, marine life, and ecosystem health. In California and along the US West Coast, toxic species are the most frequently encountered HABs; they consist primarily of the dinoflagellate genus Alexandrium (Paralytic Shellfish Poisoning) and the diatom genus Pseudo-nitzschia (Amnesic Shellfish Poisoning and Domoic Acid Poisoning). Less frequently observed, but emerging as serious potential threats, are the dinoflagellates Dinophysis (which can cause Diarrhetic Shellfish Poisoning) and Gonyaulax and Lingulodinium (Yessotoxin producers), whereas the freshwater cyanobacteria Microcystis (Microcystin producer) threatens not only the terrestrial environment but also estuarine

and coastal waters. Other toxic species have been encountered in California, but this relatively short list comprises the majority of significant toxic HAB issues seen to date.

The table below summarizes common HABs and their health effects.

Organism	Water Type	Color	Toxin	Health effects
Alexandrium sp.	Salt	Red or brown	Saxitoxins	Gastrointestinal (nausea, vomiting), and neurological (a floating sensation, headache, or muscle weakness)
Cyanobacteria	Fresh	Blue-green	Cylindrospermopsin	Nausea, vomiting, diarrhea, abdominal tenderness, pain, or acute liver failure
Gambierdiscus	Salt	Orange	Ciguatoxins	Nausea, vomiting, diarrhea, or stomach pain
Karenia brevis	Salt	Red	Brevetoxins	Gastrointestinal illness, muscle cramps, seizures, paralysis Respiratory problems, especially for asthmatics
Pseudo-nitzschia	Salt	Red or brown	Domoic acid	Vomiting, head weaving, nausea, seizures, diarrhea and abdominal cramps, bulging eyes, or headache
Microcystis	Fresh	Blue-green	Microcystin	Gastrointestinal illness, liver damage

In contrast to blooms of toxic species, high-biomass blooms cause negative impacts through the sheer abundance of cells. This can lead to physical disruption of other organisms via gill irritation, viscosity, and gelatinous barriers that lead to gill clogging, production of allelochemicals, and anoxia or hypoxia following the decay of large blooms. Impacts to humans include disruption of desalination systems and drinking water supplies, as well as impacts to tourism due to accumulation of dead organisms, foul smells, foam production, and discoloration of the water.

Red tide formation in marine ecosystem

CONCLUSION

Ranging from microscopic, single-celled organisms to large seaweeds, algae are simple plants that form the base of food webs. Sometimes, however, their roles are more sinister. Under the right conditions, algae may grow out of control and a few of these "blooms" produce toxins that can kill fish, mammals and birds, and may cause human illness or even death in extreme cases. Other algae are nontoxic, but eat up all of the oxygen in the water as they decay, clog the gills of fish and invertebrates, or smother corals and submerged aquatic vegetation. Still others discolor water, form huge, smelly piles on beaches or contaminate drinking water.

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