

HAS THERE BEEN A GLOBAL EXPANSION OF ALGAL BLOOMS? IF SO, IS THERE A CONNECTION WITH HUMAN ACTIVITIES?

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Bloom Definition

Opinions varied as to what is the most important aspect to stress in developing a definition of an "algal bloom." The need was emphasized for two types of definitions -- a definition for scientific purposes based on environmental and ecological grounds and a definition for the purposes of human affairs based on the impact of blooms on public health, fisheries and aquaculture. The ecological definition would consider population variance, i.e., differences from "normal" levels of species abundance. This would require long-term monitoring to define "normal" levels. In regard to considering the harmful effects of algal blooms as part of a definition, it was noted that there are of course good blooms as well as bad. It was suggested that toxic algal blooms fall into three categories: eutrophication dependent, toxicity associated with low cell numbers (as for *Dinophysis* blooms), and toxicity associated with large numbers of cells but not obviously with nutrient enrichment of coastal waters.

Global Increase

The question was considered whether it is possible to conclude at this time if there has been a global increase in the frequency and intensity of algal blooms around the world. Although it is generally suspected that toxic and noxious algal blooms have been increasing in frequency and intensity worldwide over the past 20 years or so, it was agreed that it is not possible to conclude this with certainty on a global level because the long-term data on the abundance of algae in the sea are insufficient in scales of both time and space. It will take a long time to be able to answer this question. An appropriate time frame for monitoring algal blooms appears to be in the range of 5 to 10 years at a minimum. The need for internationally coordinated efforts was emphasized. The obvious links with present plans for internationally coordinated studies of global climate change were noted. The usefulness of reviewing historical data in terms of delineating past trends was mentioned by several people. Past meteorological records can also provide a considerable amount of information relative to algal abundance.

The need was identified for the scientific community to reach agreement on how to approach the problem of algal blooms on an international level. Efforts can be directed at two aspects of the problem -- long-term monitoring and short-term mechanisms. There was considerable feeling that we should direct attention to solving bloom problems (short-term mechanisms) because of the tremendous impact of blooms on public health, fisheries and aquaculture. The causes and mechanisms of blooms may differ as there seem to be two major types of blooms, those in which nutrient additions to coastal systems are obviously implicated (for example, in Tolo Harbour (Hong Kong), in the Seto Inland Sea (Japan), and in the Aegean Sea in the vicinity of sewage outfalls) and those blooms that are not obviously associated with coastal enrichment (for example, *Alexandrium*, *Pyrodinium*, *Dinophysis*, etc.). It was suggested that although our knowledge of specific features of algal blooms is increasing (such as nutrient uptake and association with hydrographic fronts) we should focus interdisciplinary attention (biology, chemistry, physics) on particular blooms to develop a full understanding of the short-

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term mechanisms of bloom formation, transport and dissipation. It was stressed that there is an immediate need to coalesce the best available information around the world to help in managing bloom events and their effects.

Discussion followed on how to develop funding for long-term projects on algal blooms. International organizations may be of assistance here. Perhaps half of any such funding could be used for conducting long-term monitoring work and half for conducting short-term studies on bloom mechanisms and amelioration of bloom effects. Establishing capital investments and using the interest accruing from them for conducting long-term monitoring of blooms was also suggested.

Global Spreading

The question was posed whether a global spreading of algal blooms is now occurring. The circumstantial evidence is building to suggest strongly that some algal organisms have recently been introduced from certain parts of the world to others, either within the same region or in different regions suggesting trans-oceanic spreading. Ocean currents are viewed as the chief natural cause of spreading. Regarding man's involvement in the spreading of marine microalgae, it appears feasible that ballast water may be a prime mechanism for long-distance transport of algae, including those responsible for toxic and noxious blooms. Evidence is increasing that marine microalgae can survive long-distance transport in the ballast tanks of ships. Controls and regulations pertaining to the discharge of ballast water by commercial shipping are now being adopted in Australia. Another possible mechanism of algal spreading related to man's activities is the relay of shellfish stock from one region to another. Viable vegetative cells and cysts in and on the shellfish may be introduced to new waters in this manner.

Man's Involvement

Circumstantial evidence points to man's involvement in the increase in frequency, intensity and global distribution of some algal bloom events. This is especially so in the case of coastal blooms associated with nutrient enrichment from municipal and industrial activities. The association of other human activities with increased bloom occurrence is suspected, as for example with ballast water, shellfish transport, aquaculture activities themselves (self-pollution), and with more general environmental alterations on a global scale.

Statement of Concern

It was agreed that the workshop prepare a statement of concern to bring to the attention of international organizations. The following general statement was prepared and approved. It was transmitted to the Intergovernmental Oceanographic Commission (IOC) in Paris.

"Scientists attending the 4th International Conference on Toxic Marine Phytoplankton in Lund, Sweden, conclude that there is a potential that global expansion of algal bloom problems is now occurring.

"While in the traditional scientific sense, the term 'algal bloom' refers to a deviation from 'normal' abundance, this term is increasingly being equated with harmful algal phenomena affecting public health, fisheries and aquaculture.

"The conference participants reached a consensus that some human activities may be involved in increasing the intensity and global distribution of blooms and recommended that international research efforts be undertaken to evaluate the possibility of global expansion of algal blooms and man's involvement in this phenomenon."

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