



# *Tiny,* **Silent Killers!**

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In spite of being essential to man's existence in many ways, phytoplankton, a group of microscopic plants, catch our attention only when they create havoc in the seas around us. The 'Red tide', one such bizarre and enigmatic event caused by these tiny organisms, has become a problem of global concern today.

**P**ICK up a drop of water from the vast ocean, observe it under a microscope, and you will be welcomed to an incredible world. You will find tiny microscopic organisms, both animal and plant kind, together called 'plankton' waving at you. But they have a very restricted movement (the word 'plankton' is derived from Greek, meaning wanderer), if at all they have any. They just drift; even modest water currents push them around. A few who can swim barely cover 10-15 metres a day.

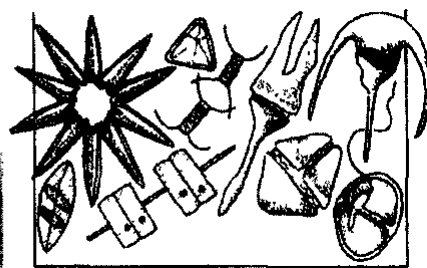
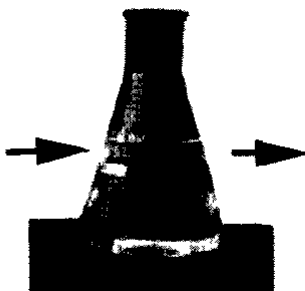
In that little drop you will find several spectacular forms, opalescent ovular with tiny holes, pill-box-like chains with protruding spines, plated-and-grooved "spaceships" with flickering flagella. Those packed with bright green to brown pigments are plant plankton or 'phytoplankton' or 'microalgae'. Believe it or not, 80% of the oxygen that we breathe comes from these tiny plant bodies.

Generally, in the top 200 meters of the ocean waters you will find great activity. Also called the 'euphotic' or 'sunlit zone', here the sunlight turns on the photosynthetic machinery of millions of phytoplankton. As a result, we get about 80-120 billion tons of organic carbon annually, amazingly double the quantity of what land plants provide. You may measure the individual phytoplankton in microns (1,000 micron equals 1 mm), but how

does their size matter? They are rightly referred to as 'grasses of the sea' or 'pastures of the ocean', the first morsels in the long food chain. In short, they play a key role for our survival.

But their saga does not end there. Look at other connected actions of equal significance—for example, scavenging the atmospheric carbon dioxide. As primary producers or autotrophs, phytoplankton cells with their sunlight charged pigment 'chlorophyll' use carbon dioxide dissolved in water and fix organic carbon by photosynthesis.

**PHYTOPLANKTON:**  
Invisible to the visible (from sea to microscope)



## Feature Article

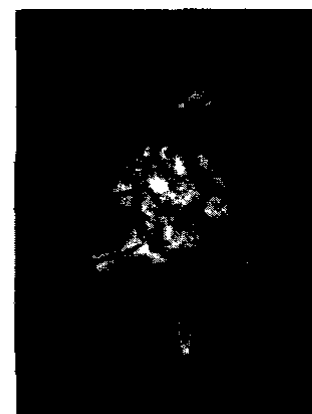
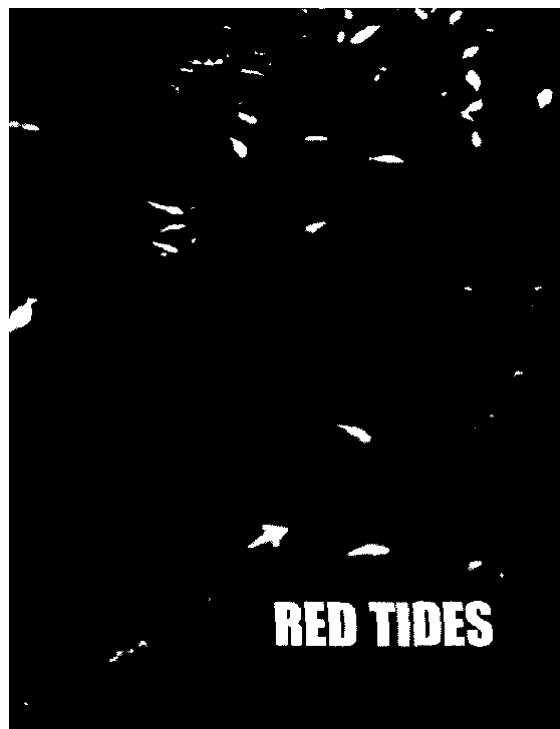
This triggers absorption of atmospheric CO<sub>2</sub> into the upper ocean layers. Some carbon from CO<sub>2</sub> is also transported to the deep ocean, as a few phytoplankton species producing calcite shells or tests sink a few kilometers down to the seafloor when they die and remain stored for long. This complex carbon-transporting ocean process is a critical mechanism in preventing what we now call as 'greenhouse' effect.

Now imagine a scenario wherein the present trend of pumping out greenhouse gases continues and the ocean's photosynthetic machinery, or what we call 'biological pump', is not functioning as expected. Then it is feared that by the turn of the century, the global temperature would rise by 50 C, which will not only change rainfall pattern but also lead to a sea level rise inundating the low-lying coastal areas. Let's pray this doesn't happen and the biological pumps do not fail. We need to thank these tiny microalgae for their fine balancing act in not allowing the prevalence of an atmosphere upon us of only carbon dioxide and a small amount of nitrogen, an atmospheric pressure 60 times higher than the present, and air temperatures around 3000°C, similar to that on the planet Venus.

Apart from those mega natural processes critical for survival of human beings, these phytoplankton species have other potential uses too. Scientists are exploring how phytoplankton species can be innovatively converted into high industrial value, food and pharmaceutical products. Some compounds with anti-cancer properties, for use in the much-needed generation of antibiotics, and as nutritional supplements and cosmetics have been isolated from some species.

Biotechnologists are zeroing in on new commercial opportunities in health products such as additives to infant milk formulas. This is because some species contain long chain polyunsaturated fatty acids, which are common in human breast milk. Phytoplankton species also have a vast potential for cleaning up oil spills and industrial effluents, and as additives to stock feeds to boost the health and fertility of livestock. Phytoplankton 'starter' cultures are in use for mass-producing as food for juvenile forms of farmed species of prawns, oysters, mussels, trout, clams and abalone.

## RED TIDES, KILLER TIDES: Dinoflagellates and diatoms like *Chaetoceros* sp. are often associated with the occurrence of the killer algal blooms



### When Phytoplanktons Turn into Devils

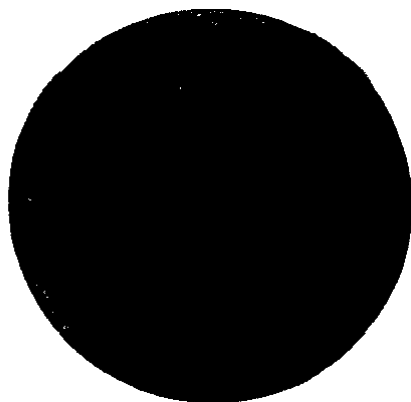
At times, the same phytoplankton species with great potential use and applications turn into quiet killers. The population of some species skyrockets forming dense blooms discoloring the vast expanse of ocean waters (other aquatic bodies too), at times even jeopardizing human life. The bloom can spread in a matter of days, and disappear just as rapidly. They are popularly known as 'Red tides' and now with better knowledge are categorized into toxic, non-toxic and noxious groups.

'Red tides' have been known throughout recorded history, but the growing trend of occurrence globally in estuaries, coastal waters and even open oceans in recent decades have been causing global concern particularly

when these blooms are of toxic species.

Of the several thousand species identified, about 80 are known to be harmful. Diatoms and Dinoflagellates are two dominant groups with harmful species. Diatoms comprise about 2000 marine species and Dinoflagellates about 1,700. Many are free living but some are either symbiotic or parasitic.

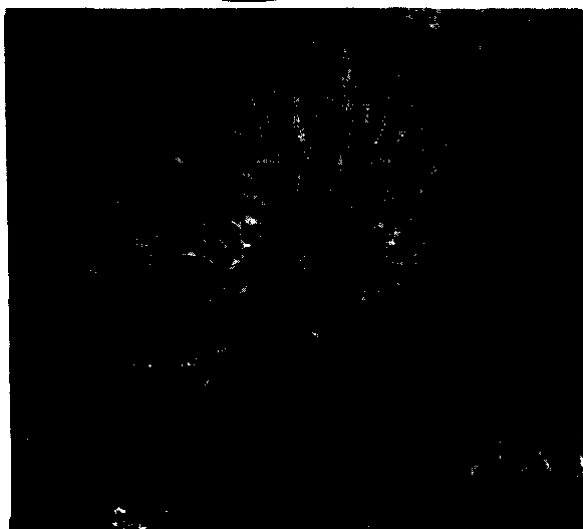
They inflict harm in many ways. The decay of bloom can cause deoxygenation of waters (anoxia) leading to death of fish and invertebrates. Some species when abundant secrete polymers into their surroundings, which can render the water so viscous that fish have difficulty in pumping it through their gills. Others like the diatom *Chaetoceros* sp., which are spiny, irritate fish gills leading to mucus reduction, gill damage, and reduced gaseous exchange.



But the real danger comes from the toxic forms. Often their toxins enter the *food chain of clams, mussels, oysters and scallops* feeding on them. The toxin is retained in their tissues. Typically shellfish themselves are only marginally affected, but a single clam can sometimes accumulate enough toxins to kill a human being. Shellfish accumulate four types of toxins which result in paralytic shellfish poisoning, diarrhetic shellfish poisoning, neurotoxic shellfish poisoning and amnesic shellfish poisoning well known by acronyms PSP, DSP, NSP and ASP.

Consequences of these toxins are many and variable such as tingling and numbness of mouth, lips, and fingers, muscle weakness and in acute cases, respiratory paralysis and

**SEA SPARKLER:** *Noctiluca scintillans* (above), commonly called 'sea sparkle' is a single celled dinoflagellate and is known for its large size and light emission. *Noctiluca* forms an extensive green or some times orange-red bloom; (below) *Coscinodiscus.sp.*, another contributor to algal blooms.



death, stomach pain, muscle aches, dizziness, anxiety, disorientation, stomach cramps, temporary or permanent loss of memory, etc. These toxins generally are not affected by freezing or cooking and there are no antidotes.

### Blooming Blooms

Today many parts of the world are suffering from the harmful consequences of Red tides. Virtually every coastal country is threatened by multiple harmful or toxic algal species, which earlier were restricted to the waters of Europe, North America, and Japan, Blooms can cover small areas of the size of a coastal pond or as large as 1000 square miles.

Researchers are unsure why phytoplanktons produce toxins. It may be to incapacitate predators or make themselves taste bad to avoid predation or they may be just performing an essential biochemical function. Illness and deaths are rare in developed countries where monitoring programmes detect contaminated fish and shellfish before they reach market. But it is not so everywhere and therefore toxic blooms are taking a heavy toll. Fish and shellfish losses total tens of millions of dollars every year. While the wild fish can swim away from blooms, penned fish are trapped.

The spread of harmful algal blooms (HABs) has been due to various reasons. The foremost, though not always, is said to be due to the unprecedented growth of human activities in coastal watersheds including agriculture, aquaculture, industry, and recreation which drastically increase the amount of fertilizer flow into coastal waters, thus triggering algal blooms.

The currents, tides or other water movements facilitate dispersal of organisms and nutrient enrichment. 'Cyst', the dormant form of plankton, may become active or get transported through ballast waters of cargo ships, or through shellfish stocks. Though non-toxic blooms have been commonly reported from Indian waters cases of HABs are on the rise since 1981 in different coastal states, warranting a regular monitoring and network of institutions for research and awareness creation.

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Some known cases of toxic/harmful blooms from Indian waters

Year	Occurrence Site
1981	Paralytic Shellfish Poisoning (PSP) in Tamil Nadu; 85 hospitalized, 3 died due to the consumption of bloom-affected mussel <i>Merefrax casta</i>
1983	PSP in Mangalore, Karnataka but causative species not identified
1996	A bloom of potent PSP species <i>Gymnodinium catenatum</i> in Mangalore, Karnataka but did not reach toxic level!
1997	PSP in 3 villages of Kerala, 3 died, over 500 hospitalised following consumption of mussel, <i>Perna indica</i>
2001	A toxic algal bloom in Goa waters by hitherto unreported dinoflagellate <i>Cochlodinium polykrikoides</i> , fish mortality observed, cause not confirmed
2004	A bloom in 3-4 villages along Kerala coast, 200 hospitalized and large number of fish kills reported

## Feature Article

The US is one of the most badly affected by the scourge of the algal blooms. The HAB is estimated to cost them at least 50 million dollars annually. This includes the death of wild and farmed fish, shellfish and coral reefs; closure of harvestable shellfish and fish stocks; reductions in seafood sales, including its avoidance, monitoring, impacts on tourism and related businesses and medical treatment of exposed populations.

### Watch What You Eat

The consumption of shellfish (e.g. mussels, clams) is one of the most common ways of algal toxins reaching and affecting humans. In US, the state management is responsible for monitoring toxin level in shellfish and accordingly closes or allows its harvest from shellfish beds. Marketable shellfish are generally considered to be safe, but in spite of these precautions, there are known illnesses.

One dramatic example is from 1990, when six US fishermen almost died from eating mussels during a fishing trip. After a hard day of fishing, the fishermen settled down in the ship's galley to eat a pot of steamed mussels that they had incidentally caught in their nets. The Captain, who had joined the meal later than the rest of the crew, witnessed his fellow fishermen become incapacitated due to the paralytic effects of the toxin. He himself also became ill, but was capable of sending an urgent radio message to the US Coast Guard.

The Coast Guard airlifted the men to the nearest hospital.

### Combating Deadly Blooms an example to follow

It all began in 1950s with two mid-coast groups deciding to investigate the nature of local water pollution problems by monitoring in partnership with the University of Maine Cooperative Extension (UMCE), Department of Marine Resources (DMR) and the Department of Environmental Protection (DEP) in United States. This take-charge model of environmental stewardship soon expanded statewide as more communities saw that they too could make a difference by preventing or remediating pollution problems in their coastal areas.

A primary concern was to reopen shellfish growing areas. DMR recognized this untapped, person-power resource and began calling on local volunteers to assist with collecting water samples for analysis, identification of pollution sources and get more acres of shellfish flats open for harvesting. This effort opened up for harvest over 60,000 acres of clam-flats. Over the years the capacity to detect harmful algal blooms (HAB's) has been enhanced. To date this volunteer driven program has 25 monitoring groups with approximately 80 volunteers covering 40 sampling locations along the 5000 miles of Main coast.

Extensive surveillance programs are in place in many countries to monitor

Red Tides: Toxic blooms are taking a heavy toll worldwide.



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blooms. Knowing the locations of these blooms is very valuable to fishermen and marine biologists, because fish and other marine animals tend to collect near fresh blooms. Satellite remote sensing has been playing an important role in all such studies. For several years since the launch of satellites by various countries, phytoplankton studies based on ocean color sensing has been vigorously pursued for different applications. Different instruments are being used onboard satellites to detect and measure chlorophyll and other pigments.

The vital role that phytoplankton play, both as moderator of climate and as the base of the oceanic food web, certainly requires us to understand them better. It's high time that we stop enraging them by continuously attacking their home—the oceans. If we continue in the same manner, not only would the hapless ocean inmates suffer terrible consequences, but also what could follow next could be even more dangerous—a reduction in our own oxygen supply.

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