Climate change: reducing the ocean carbon sink

In temperate and cold oceans and lakes, the spring bloom of phytoplankton provides essential food for sealife including zooplankton and fish. According to recent research from Germany, climate change is likely to affect the spring phytoplankton bloom in these habitats, and could have negative effects on both fish stocks and the ocean’s ability to act as a carbon sink.

Phytoplankton are the vital starting point of most food chains for marine and freshwater creatures and, like plants, obtain energy from the sun via photosynthesis. Phytoplankton live in the well-lit surface layer of oceans, seas and lakes where there is sufficient light for photosynthesis. Through photosynthesis, phytoplankton generate around half of the oxygen present in the Earth’s atmosphere.

Experiments with phytoplankton in the laboratory were used to explore the effects of light levels and temperature on phytoplankton blooms. By varying temperature and light levels the researchers were able to mimic the different seasons. Both light and temperature are factors which affect the spring bloom. The findings indicate that the amount of light determines the timing of the spring bloom: light must reach a certain level each day for the spring bloom to begin. The greater access there is to light, e.g. if the water lies still and undisturbed, the earlier the spring bloom begins in the year. Wind is responsible for disturbing water, and as future wind patterns under a changing climate are uncertain, so too are the timings of future spring blooms.

Higher temperatures did not affect when the phytoplankton bloomed. However, they did affect the size of the phytoplankton, which had smaller cells under warmer conditions.

The decline in size of phytoplankton has key implications for the ocean’s ability to sequester carbon. As there is less phytoplankton available for other organisms to eat, there is a consequent effect on the ‘biological carbon pump’, whereby some atmospheric carbon is dissolved in water and consumed by phytoplankton during photosynthesis. Other marine animals then process this carbon when they eat the phytoplankton, and later rerelease it into the atmosphere through organic mass, for example their excrement or corpses when they die. However, about a tenth of this organic mass sinks to deeper waters, where the carbon remains for thousands of years, or even geologic timescales if it is deposited on the seabed.

The amount of CO₂ that the biological carbon pump can take in is limited by light and nutrients rather than the amount of CO₂ in the atmosphere. Therefore, a scenario where global warming reduces the size of phytoplankton - leading to less CO₂ sequestered in the ocean - could potentially make the ocean a less effective carbon sink.

A separate European research programme, CarboOcean¹, is investigating the world’s oceans to assess their remaining potential to absorb CO₂, as well as the consequences of possible saturation.

1. CarboOcean is funded under the European Commission’s Sixth Framework Programme. See: http://www.carbocean.org/


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