Tropical plankton exodus by 2100

19:00 25 October 2012 by **Michael Marshall**
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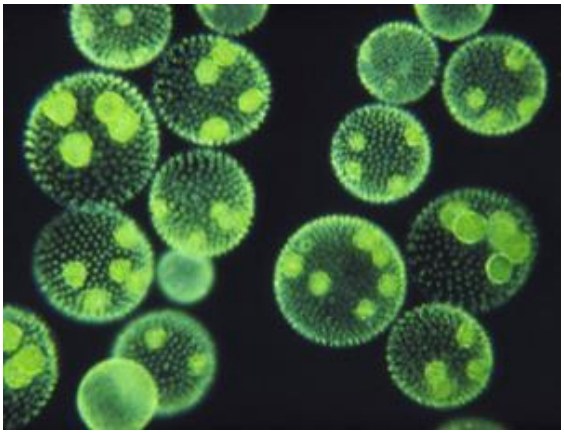

Feeling the heat *(Image: Oxford Scientific/Getty)*

Hordes of microscopic plants could be driven out of tropical oceans over the course of this century by rising temperatures. One-third of tropical phytoplankton species may be forced to move or die. The consequences for fisheries could be severe.

As Earth's climate warms over the coming decades, thanks to rising levels of greenhouse gases, the oceans will warm. But what does that mean for marine life? Many ocean-going animals ultimately depend on phytoplankton, microscopic plants that form the basis of the food chain, so if phytoplankton take a hit the rest of the ecosystem suffers.

To find out how they will contend with higher temperatures, Mridul Thomas of Michigan State University in Hickory Corners and colleagues compiled decades of data on the temperature tolerances of phytoplankton. Each species grows best at a particular temperature, and their growth rates fall off rapidly if they are warmed further.

Thomas compared the different species' optimum temperatures with the average temperatures in the oceans where they live. "The optimum temperature of the phytoplankton is very closely related to the mean temperature of the environment they were isolated from," Thomas says. "Phytoplankton have adapted to their current environmental temperatures."

But some species were better adapted than others. Most temperate species lived in waters a few degrees cooler than their optimum temperatures, so could presumably cope with rises. But tropical species were often living right at the optimum, or even slightly above it – making them vulnerable.

Phytoplankton on the move

The team ran a climate model to simulate ocean temperatures in the 2090s, and used the results to estimate how the phytoplankton's habitats would change. One third of tropical species were forced towards the poles where they have better chances of survival. "You see this big drop in diversity in the tropical oceans,"

Thomas says.

It's not clear how ecosystems will change in practice, says Thomas. In theory, the remaining phytoplankton species could become more common, in which case animals like fish will still have plenty to eat.

Experience suggests otherwise, says Stephen Simpson of the University of Exeter in the UK, who believes species diversity will be hit hard and the bottom of the food chain severely diminished.

Simpson has shown that the intense 1998 El Niño, which dramatically warmed the Pacific, made the oceans of French Polynesia less productive. Adult fish starved and could not reproduce, so fish populations crashed (*Global Change Biology*, DOI: 10.1111/j.1365-2486.2010.02355.x). Other studies suggest that warmer oceans reduce phytoplankton populations, and that even short-term heatwaves may permanently change ecosystems.

"If this becomes the norm for the tropics, crucial ecosystems will deteriorate and fisheries will fail, with devastating impacts for many of the poorest nations," Simpson says.

Evolution to the rescue?

There are two ways the tropical phytoplankton could survive. They may be able to cling on closer to the poles, but to do so they will have to outcompete native species. Many tropical organisms are already moving polewards, but they are a threat to polar species.

Alternatively, the phytoplankton might stay put and evolve to cope with higher temperatures. Phytoplankton reproduce fast, so in theory they should be able to evolve rapidly. But there is little information on how fast that might be.

Last year Emma Huertas of the Andalucía Institute of Marine Sciences in Puerto Real, Spain, tried to find out. She forced 12 phytoplankton species to live under gradually increasing temperatures. There were stark differences, with some species adapting fairly rapidly and others struggling (*Proceedings of the Royal Society B*, DOI: 10.1098/rspb.2011.0160). "Genetics will ultimately determine survival," Huertas says.

Whatever the fate of individual phytoplankton species, the tropical ecosystems where they live will change. "The one unknown we cling to for hope is that evolutionary adaptation and innovation will generate species capable of living alongside us in our increasingly modified world," says Simpson.

Journal reference: *Science*, DOI: 10.1126/science.1224836

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