

## CLIMATE CHANGE AND DEEP-SEA CORALS

BY JOHN GUINOTTE

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**WILL CLIMATE CHANGE HAVE NEGATIVE EFFECTS ON DEEP-SEA CORALS?** *The answer is uncertain as very few manipulative experiments have been conducted to test how deep-sea corals react to changes in temperature, salinity, seawater chemistry (pH), water motion (currents), and food availability. It is likely that the effects of climate change will not be positive for deep-sea corals, because they are highly specialized and have evolved under very stable (cold, dark, nutrient-rich) conditions. Temperature, salinity, seawater chemistry, and light availability control calcification rates in shallow, tropical reef systems and with the exception of light (because deep-sea corals lack algal symbionts), these factors are probably important controls on deep-sea coral calcification as well.*

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### TEMPERATURE

Global sea temperatures are rising both in surface waters and in the deep sea due to an influx of anthropogenic carbon dioxide to the atmosphere. Since the Industrial Revolution, there has been a documented increase in shallow water coral bleaching events, and in many cases, massive coral mortality has followed. Deep-sea corals cannot bleach, since they lack symbiotic algae, but rising temperatures will probably influence their calcification rates, physiology, and biochemistry. Deep-sea corals grow very slowly (4 to 25 mm/yr or less, see Tsao, this issue; Freiwald et al., 2004), an order of magnitude slower than tropical corals. This difference is probably due to the cold temperatures in which deep-sea corals live (about 4° to 13°C). Preliminary findings suggest *Lophelia pertusa* respiration rates increase when the coral is exposed to higher ambient temperatures, but the synergistic effects of increased respiration and temperature on calcification are not known.

### SALINITY

Climate change is altering the salinity of the world's oceans. Increased evaporation in tropical waters has led to more saline conditions in lower latitudes, whereas glacial ice melt in polar waters has led to less saline conditions in higher latitudes. Deep-sea corals tolerate salinity in the range of about 32 to 39 ppt (Freiwald et al., 2004) so any climate-induced change in salinity that puts deep-sea corals outside this optimal range will probably be detrimental. Physiological responses to salinities outside this optimal range are not known and warrant further study.

### SEAWATER CHEMISTRY (pH)

Seawater chemistry and the calcium carbonate saturation state of the world's oceans are changing with the addition of fossil fuel CO<sub>2</sub> to the atmosphere (Feely et al., 2004). This influx of CO<sub>2</sub> is causing the world's oceans to become more acidic, which is bad news for corals and other marine organisms

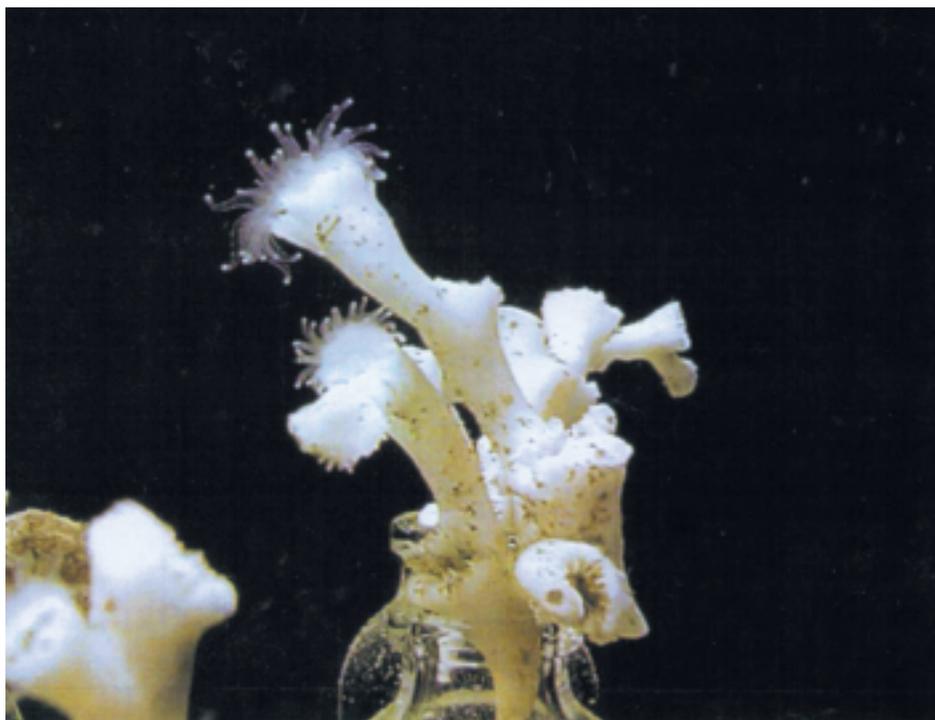
that use calcium carbonate to build their skeletons and protective shells. Although little is known about the effects of decreasing carbonate saturation state on deep-sea corals, lab experiments have conclusively shown that lowering carbonate ion concentration reduces calcification rates in tropical reef builders by 7 to 40 percent (Marubini et al., 2003; Langdon et al., 2000; Gattuso et al., 1999). In fact, all marine calcifying organisms tested to date have shown a similar negative response. As the world's oceans become less saturated over time, corals are expected to build weaker skeletons (a process similar to osteoporosis in humans) and/or to experience slower growth rates. If saturation state is as important to deep-sea coral calcification as it is to shallow reef builders, then this is an important issue.

### FOOD AVAILABILITY

Very little information exists on the food sources of deep-sea corals. It is probable that they depend on suspended organic matter and zooplankton for nourishment (Freiwald et al., 2004). Since corals are sessile filter-feeding organisms, they can obtain nourishment either from organic matter falling from the surface or via currents that bring organic matter and zooplankton to the coral. Deep-sea corals occur in waters that have higher than average surface primary productivity, indicating that food falling from the surface is important to their survival. Many species of plankton (e.g., coccolithophores and foraminiferans) build calcium carbonate shells and are sensitive to the seawater chemistry changes previously noted. If ecosystem changes due to climate change reduce surface productivity, food sources for deep-sea corals will probably also be reduced.

### WATER MOTION (CURRENTS)

The majority of deep-sea coral ecosystems are found in relatively high-energy areas and are exposed to steady currents.



Close-up of *Lophelia pertusa*.

Freshwater inputs to high-latitude waters are expected to increase as global temperatures continue to rise. The influx of freshwater causes seawater density changes, which slows down water circulation and may reduce upwelling and/or alter the trajectory of present-day current patterns. Since deep-sea corals are sessile organisms that depend on currents to bring them nourishment, any change in the direction and/or velocity of currents could have a significant impact on their distribution. Projections for changes in water circulation are uncertain at best, but if the Atlantic conveyor slows down as predicted, it will probably have negative consequences for deep-sea corals.

### SUMMARY

Deep-sea coral ecosystems have probably not experienced a combination of stresses of the types described above for a very long time. The synergistic effects of these stresses occurring in concert are uncertain, but changes in the environmental factors identified above will probably have serious implications for deep-sea coral ecosystems. In situ monitoring and lab experiments are needed to help us understand and quantify how these changes might affect deep-sea coral ecosystems.

**JOHN GUINOTTE** is Marine Biogeographer/GIS Analyst at Marine Conservation Biology Institute (MCBI). He is a Ph.D. candidate in James Cook University's School of Tropical Environment Studies and Geography, and has authored several peer-reviewed papers on climate-related threats to coral ecosystems.

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### PHOTO CREDIT:

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