Volume 21 • Number 4 • 2005

DEEP-SEA CORALS ARE LONG-LIVED HISTORIANS

BY FAN TSAO

UNDERWATER "CORAL FORESTS" *have more in common with ancient terrestrial forests than you might think. Red-tree coral (*Primnoa resedaeformis*) colonies that now offer refuge for fishes in Alaskan waters began to grow when Emily Dickinson and Walt Whitman were writing poems, and before Theodore Roosevelt became President more than 100 years ago (Andrews et al., 2002). The oldest known deep-water corals, gold corals (*Gerardia *spp.) growing off Florida, can live up to 1,800 years, making them older than most trees other than giant sequoias and bristlecone pines (Druffel et al., 1995). Living in a low-temperature and low-disturbance environment, all deep-sea corals are slow growing and long lived. Even those that don't survive for millennia can live to two, five, even 10 times the human lifespan. In coral reefs along the Southeastern U.S.,* Lophelia pertusa *that began growing 700 years ago still thrive at the top of the reef, while dead coral rubble nearby is more than 20,000 years old.*

The rate at which individual corals and their colonies grow depends on a variety of factors, including food supply. The same species can grow at different rates in different locations. The red-tree coral in Alaska, for instance, grows about two centimeters per year, about 10 times as fast as the same species in the Atlantic (Andrews et al., 2002). At this rate, it still took one colony in Alaska 112 years to reach a height of two meters. Growth rate also varies from one species to another. The growth rate of *Desmophyllum cristagalli*, a scleractinian coral, ranges from 0.1 to 3.1 mm/year (Cheng et al., 2000), and *Oculina varicosa* and *L. pertusa* both extend approximately 1.6 cm each year (Reed, 2002).

Like trees, deep-sea corals form growth rings. The pattern of these concentric bands is affected by the coral's physiological rhythm, food supply, sediment influx, and other factors. The generation of growth rings tends to have an annual pattern (Figure 1), but some corals also form sub-annual bands. Counting the rings under a scanning electron microscope is one of the methods used to determine the age of a coral. Other methods include: analyzing the ratios of stable isotopes of such elements as carbon and oxygen, examining the amount of radioactive carbon in the coral, and assessing the ratio of radioactive isotopes of lead, thorium, uranium, or radium in the coral specimen. Scientists generally use a combination of these techniques to age the specimen and validate the age. Depending on the characteristics of the coral, some techniques work better than others. For example, the growth ring counting method is more suitable for dating bamboo coral than other gorgonian corals because bamboo coral has low organic content and hence does not interact with the fixatives used in this method, and this yields a clearer result (Sanchez, 2004).

Over the long life of a coral, its growth pattern also records information on how ocean chemistry and even global climate have changed. Methods to read these archives are still being perfected, but exciting progress has been reported in recent years. Researchers analyzed *D. cristagalli* fossils collected off Newfoundland and found a sudden change in one specimen's isotopic composition over its lifetime as well as a major difference between this specimen and other specimens that lived at different times, but in the same region. This pattern is a signal of a rapid climate change–the initiation of the Younger Dryas cooling event–a mini ice-age which took place 13,000 years ago (Smith et al., 1997). As scientists continue to develop techniques to accurately determine the age and growth rate of deep-sea corals and to interpret the changes in corals throughout their lives, corals will help reconstruct high-resolution time series of growth, temperature, and ocean chemistry at great depths beneath the sea.

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REFERENCES AND FURTHER READING

Andrews, A.H., E.E. Cordes, M.M. Mahoney, K. Munk, K.H. Coale, G.M. Cailliet, and J. Heifetz (2002). "Age, Growth and Radiometric Age Validation of a Deep-Sea, Habitat-Forming Gorgonian (*Primnoa resedaeformis*) from the Gulf of Alaska." *Hydrobiologia* 471(1-3):101-110.

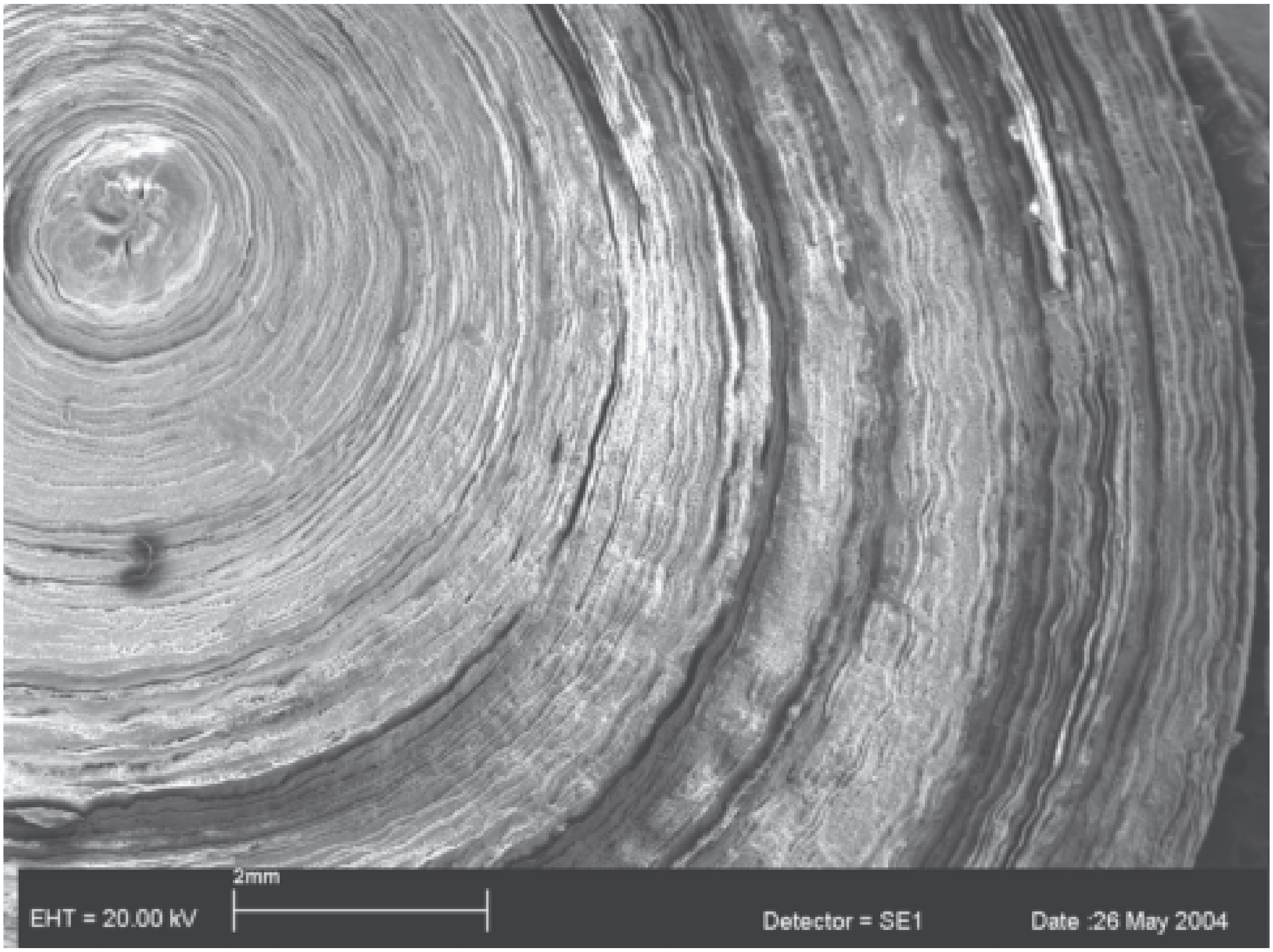

Figure 1. Growth rings of bamboo coral (family Isididae).

Cheng, H., J. Adkins, R.L. Edwards, and E.A. Boyle (2000). "U-Th Dating of Deep-Sea Corals." *Geochimica Et Cosmochimica Acta* 64:2401-2416.

Druffel, E.R.M., S. Griffin, A. Witter, N. Erlie, J. Southon, M. Kashgarian, and J. Vogel (1995). "Gerardia: Bristlecone Pine of the Deep-Sea?" *Geochemica et Cosmochimica Acta*. 59.

Reed, J.K. (2002). "Comparison of Deep-Water Coral Reefs and Lithoherms off Southeastern U.S.A." *Hydrobiologia* 471(1-3):57-69.

Risk, M. J., J.M. Heikoop, M. G. Snow, and R. Beukens (2002) "Lifespans and Growth Patterns of Two Deep-Sea Corals: *Primnoa resedaeformis* and *Desmophyllum cristagalli*." *Hydrobiologia* 471(1–3):125-131.

Sanchez, J., D. Tracey, H. Neil, and P. Marriott (2004). "Coral Rings in the Deep Ocean: Using SEM to date New Zealand's Bamboo Corals." *Water and Atmosphere* 12(4):22-23.

Smith, J.E., M.J. Risk, H.P. Schwarcz, and T.A. McConnaughey (1997). "Rapid Climate Change in the North Atlantic During the Younger Dryas Recorded by Deep-Sea Corals." *Nature* 386:818-820.

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