BOX 7 | Deep-Sea Corals on Seamounts

By Peter J. Etnoyer

Deep-sea corals are solitary and colonial suspension-feeding cnidarians commonly associated with seamounts around the world. They are important components of seamount ecology, providing food and refuge for numerous associated species of fish, crabs, shrimp, and sea stars at depths where few other habitat formers live (50–6000 m). Deep-sea corals are a rich assemblage in their own right, a paraphyletic taxonomic group (derived from several ancestors) of more than 3300 species of azooxanthellate stony corals (Figure 1; Scleractinia) and soft corals (Figure 2; Octocorallia) (Cairns, 2007).

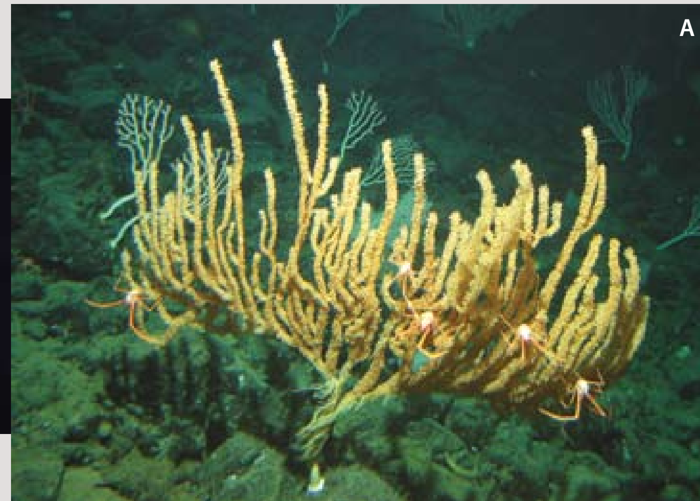
Deep-sea corals thrive on seamounts because hard substrate is highly available, water flows are accelerated, and productivity is high. The composition of the assemblage varies by depth and region. Gorgonian octocorals and black corals are major habitat formers on seamounts in the Pacific Ocean. *Lophelia pertusa* is a major habitat former in the Atlantic. *Lophelia* bioherms rival shallow tropical coral reefs in terms of their size (several square kilometers) and associated diversity. More than 2000 invertebrate species are associated with deep *Lophelia* reefs (André Freiwald, University of Erlangen, *pers. comm.*, December 2009).

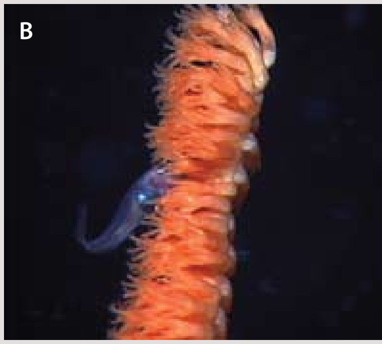
Destructive fishing gear, such as bottom trawls, longlines, pots, and traps, imperil these long-lived, fragile habitats. Trawl nets bring centuries old *Paragorgia* sp. colonies to the surface as "bycatch" for orange roughy fisheries. Longline fisheries snap and topple gorgonian colonies, causing their demise. Some precious corals (*Corallium* sp.) and bamboo corals (e.g., *Keratoisis* sp.) are harvested directly for the jewelry and curio trades.

Fisheries are imperiling survivorship of deep corals, but coral growth is also affected by climate change. Changes in water chemistry associated with ocean acidification may reduce calcification rates in skeletons that already grow slowly (Cohen and Holcomb, 2009). Both stony and soft coral types have calcitic parts vulnerable to changes in pH. Climate change can also affect deep corals' food supply through changes in the plankton community and its transport to the benthos.

Peter J. Etnoyer *(peter.etnoyer@noaa.gov) is Schmidt Research Vessel Institute Research Fellow, Harte Research Institute for Gulf of Mexico Studies, Texas A&M University–Corpus Christi, Corpus Christi, TX, USA. His current address is National Oceanic and Atmospheric Administration, Charleston, SC, USA*

Figure 1. Three stony corals. Deep scleractinia take a variety of forms and colors, with about 650 species known to science and more discovered every year. (A) *Lophelia pertusa* is a constructional scleractinian coral, capable of forming bioherms that are kilometers in length and breadth. The image depicts a *Lophelia* thicket in the Gulf of Mexico. *Lophelia* grow as shallow as 40-m depth in cold Atlantic fjords, but occurrences in the North Atlantic are typically at 300–800-m depth. (B) This *Enallopsammia profunda* is at approximately 1600-m depth on Manning Seamount in the Northwest Atlantic. The growth form has a yellow color and a sea fan shape. (C) *Desmophyllum* sp. is a solitary, nonconstructional cup coral used in long-term climate studies. In this image, the corallum of several large polyps are fused at the base. Each corallum is the about the size of a fist. *(A) Image courtesy Mountains in the Sea Research Group, University of Rhode Island-Institute for Archeological Oceanography, Institute for Exploration, and NOAA (B) Image courtesy Lophelia II: Reefs, Rigs, and Wrecks 2009 Expedition (C) Image courtesy Smithsonian Institution's National Museum of Natural History Database of Antarctic and Subantarctic Marine Invertebrates*





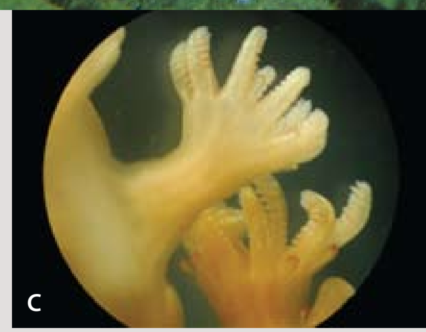


Figure 2. An *Isidella* octocoral, at three scales of magnification: (A) living colony, 100 cm, (B) branch tip, 10 cm, and (C) polyps, 2–3 mm. (A) *Isidella tentaculum* is one of several new species of octocoral recovered from Gulf of Alaska seamounts in 2002 and 2004 (Etnoyer, 2008). The living holotype (~1-m across) is shown at 775-m depth with six *Gastrotychus iaspus* crabs on Dickins Seamount. (B) A liparid snailfish clinging to the large, closely spaced polyps of *Isidella tentaculum* at 705-m depth on Warwick Seamount. Close inspection reveals small white eggs at the base of the polyps, along the right side of the branch. (C) A close-up of *Isidella tentaculum* polyps showing eight pinnate tentacles. The polyps are nonretractile, and unarmored, so they are easy prey for gastropods and sea stars. The calcitic sclerites are barely visible, protruding between the tentacles, and imbedded in the tissue. *(A) Image courtesy of NOAA, WHOI, the Alvin Group, and Gulf of Alaska Seamount Expedition 2004 Science Party (B) Image courtesy of NOAA, WHOI, the Alvin Group, and Gulf of Alaska Seamount Expedition 2002 Science Party (C) Image courtesy Peter Etnoyer*

Deep-sea coral research is helping to highlight the importance of climate change in the deep ocean. Many coral species have laminar growth patterns, with growth rings, like trees. The colonies are paleo-archives of water mass history and ocean water temperature, recording glaciation cycles (Robinson et al., 2007) and global ocean overturning events (Adkins et al., 2008) on monthly, decadal, and millennial time scales.

A *Leiopathes* black coral from Cross Seamount in the Pacific Ocean is the "world's oldest animal" at 4,200 years of age (Roark et al., 2009). Gold corals (*Gerardia* sp.) are the "bristlecone pines of the sea" and can grow as old as 2,000 years (Druffel et al., 1997). Cup corals like *Desmophyllum* sp. are centuries old. These corals are helping to reveal the ocean's past.

Deep-sea corals represent an important intersection of science, management, and outreach for people around the world. Their scientific utility is remarkable, but their natural living beauty and color is even more striking. Deep-sea corals are flagship species for an ecosystem in need of conservation, capturing the interest and attention of the general public worldwide.

REFERENCES

Adkins, J.F., H. Cheng, E.A. Boyle, E.R.M. Druffel, and R.L. Edwards. 2008. Deep-sea coral evidence for rapid change in ventilation of the deep North Atlantic 15,400 years ago. *Science* 280(5364):725–728, doi:0.1126/science.280.5364.725.

Cairns, S.D. 2007. Deep-water corals: An overview with special reference to diversity and distribution of deep-water scleractinian corals. *Bulletin of Marine Science* 81(3):311–322.

Cohen, A.L., and M. Holcomb. 2009. Why corals care about ocean acidification: Uncovering the mechanism. *Oceanography* 22(4):118–127.

Druffel, E.R.M., S. Griffin, A. Witter, E. Nelson, J. Southon, M. Kashgarian, and J. Vogel. 1995. Gerardia: Bristlecone Pine of the deep-sea? *Geochimica et Cosmochimica Acta* 59(23):5,031–5,036.

Etnoyer, P.J. 2008. A new species of *Isidella* bamboo coral (Octocorallia: Alcyonacea: Isididae) from Northeast Pacific seamounts. *Proceedings of the Biological Society of Washington* 121(4):541–553.

Roark, E., T. Guilderson, R. Dunbar, S. Fallon, and D. Mucciarone. 2009. Extreme longevity in proteinaceous deep-sea corals. *Proceedings of the National Academy of Sciences of the United States of America* 106(13):5,204–5,208, doi:10.1073/pnas.0810875106.

Robinson, L.F., J.F. Adkins, D.S. Scheirer, D.P. Fernandez, A. Gagnon, and R.G. Waller. 2007. Deep-sea scleractinian coral age and depth distributions in the Northwest Atlantic for the last 225,000 years. *Bulletin of Marine Science* 81(3):371–391.