AN AQUATIC PHARMACY: THE BIOMEDICAL POTENTIAL OF THE DEEP SEA

BY SARA MAXWELL

DEEP-SEA ORGANISMS HAVE UNIQUE ADAPTATIONS *that enable them to survive in cold, dark, and highly pressurized environments. As a result of these unique environments, deep-sea species often produce chemical compounds not found in their shallow-water or tropical counterparts that aid in their defense and survival in the deep sea. Compounds that protect corals and sponges from predation can also protect humans from a variety of ailments such as cancer, Alzheimer's disease, and even pain (Newman and Cragg, 2004).*

Two compounds isolated from deep-sea sponges are in human clinical trials, and several other promising compounds and applications, resulting from research on deep-sea sponges and corals, are in early stages of development:

- **Discodermolide.** Scientists from Harbor Branch Oceanographic Institution isolated discodermolide from the sponge *Discodermia dissolute* found off the coast of the Bahamas in water over 460 feet (140 m) deep. Discodermolide recently completed the early stages of clinical trials and is one of the most exciting compounds to date because it may treat cancers which were resistant to other drugs (Ter Haar et al., 1996).
- **E7389.** This compound comes from the sponge *Lissodendoryx* sp., which lives in New Zealand waters at depths of 330 feet (100 m). E7389 is being tested for the treatment of lung cancer and other cancers and is currently undergoing the early stages of clinical trials (Newman and Cragg, 2004).
- **Dictyostatin-1.** Harbor Branch scientists collected a sponge from the order Lithistida (family Corallistadae) at 1,450 feet (442 m) off the northern coast of Jamaica. Dictyostatin-1 was isolated from this sponge and may be more effective than the very successful anti-cancer drug Taxol (Isbrucher et al., 2003). Harbor Branch researchers are continuing work on this promising substance.
- **Topsentin.** This is one of the only deep-sea compounds that researchers are currently investigating for non-cancer related treatments. Isolated from the sponge *Spongosporites ruetzleri*, which lives at depths of 990-1,980 feet (300-600 m), this compound shows promise as an anti-inflammatory agent to treat arthritis and skin irritations, as well as for the treatment of Alzheimer's disease and to prevent colon cancer (National Research Council, 2002).
- **Bone Grafts.** Doctors have used shallow tropical corals as bone grafts for more than 10 years, but deep-sea species have not been used. Ehrlich and colleagues, however, were recently able to successfully synthesize bone analogs from bamboo corals (family Isididae). Found at depths of more than 3,280 feet (1,000 m), these corals have a skeletal structure and dimensions that are almost identical to bone (Ehrlich et al., 2003).
- **Collagen.** Bamboo corals also contain gorgonin, which closely resembles collagen, an important component of bone. Collagen can be used for controlled release of medicines, as scaffolding for tissue rebuilding and for a variety of other applications. Scientists hope that by understanding how corals form gorgonin, they can create a synthetic collagen-like material under the low temperature and pressure environments that bamboo corals naturally inhabit (Swatschek et al., 2002).

The deep sea will continue to be a valuable resource for human medical applications. Destructive fishing practices such as bottom trawling, oil and gas exploration, and other threats to this aquatic pharmacy are endangering this resource before its full life-saving potential can be realized.

SARA MAXWELL is Conservation Scientist with Marine Conservation Biology Institute (MCBI). She received a bachelor's degree in Wildlife Ecology and Conservation from University of Florida and will begin a Ph.D. program at University of California at Santa Cruz in 2005 to study migratory patterns of large pelagic animals in relation to seamount ecosystems.

REFERENCES AND FURTHER READING

Ehrlich, H., P. Etnoyer, H. Meissner, T. Hanke, R. Born, D. Scharnweber, and H. Worch (2003). "Nanoimage and Biomimetic Potential of Some Isididae Corals." *Erlanger Geologische Abhandlungen* 4:34.

The deep-water sponge Discodermia is now in clinical trials for the treatment of cancer.

Isbrucher, R.A., J. Cummins, S.A. Pomponi, R.E. Longley, and A.E. Wright (2003). "Tubulin Polymerizing Activity of Dictyostatin-1, A Polyketide of Marine Sponge Origin." *Biochemical Pharmacology* 66: 75-82.

National Research Council (2002). *Marine Biotechnology in the Twenty-First Century: Problems, Promise, and Products*. National Academy Press: Washington, D.C. 118 pgs. Online at <http://www.nap.edu/books/0309083427/html/>

Newman, D.J. and G.M. Cragg (2004). "Marine Natural Products and Related Compounds in Clinical and Advanced Preclinical Trials." *Journal of Natural Products* 67: 1216-1238.

Swatschek, D., W. Schatton, J. Kellerman, W.E.G. Muller, and J. Kreuter (2002). Marine Sponge Collagen: Isolation, Characterization and Effects on the Skin Parameters Surface pH, Moisture and Sebum." *European Journal of Pharmaceutics and Biopharmaceutics* 53: 107-113.

Ter Haar, E., R.J. Kowalski, E. Hamel, C.M. Lin, R.E. Longley, S.P. Gunasekera, H.S. Rosenkran, and B.W. Day (1996). "Discodermolide, A Cytotoxic Marine Agent that Stabilizes Microtubules More Potently than Taxol." *Biochemistry* 35: 243-250.

PHOTO CREDIT:

Page 32: Courtesy of NOAA Office of Ocean Exploration

Pharmaceutical. Therapy Group. Number of countries worldwide in which pharmaceuticals have been found in the aquatic environment. Diclofenac Carbamazepine Ibuprofen Sulfamethoxazole Naproxen Estrone 17-Î²-Estradiol 17-Î±-Ethinylestradiol Trimethoprim Paracetamol Clofibric acid Ciprofloxacin Ofloxacin Estriol Norfloxacin Acetylsalicylic acid.Â use of the parasiticide ivermectin on dung decay, dung insect popula-tions, and aquatic invertebrates. To assess the environmental risks, predicted (or measured) concentrations of pharmaceuticals in the environment are compared with Predicted No-Effect Concentrations (PNEC), which are Âderived from standardized laboratory experiments with model organisms such as algae, daphnia, fish, or plants. The Deep-Sea Medicines 2003 Expedition collected specimens to continue work on the development of lasonolides as new treatments for cancer. Image courtesy NOAA OE. http://oceanexplorer.noaa.gov/explorations/03bio/logs/ sept10/media/lasonolide1.html. Lessons from the Deep: Exploring the Gulf of Mexicoâ€™s Deep-Sea Ecosystems How Diverse is That? - Grades 9-12 (Life Science).Â An Aquatic Pharmacy: The Biomedical Potential of the Deep Sea. Current 21(4):31-32; available online at http://www. mcbi.org/what/what_pdfs/Current_Magazine/Pharmacy.pdf. http://www.woodrow.org/teachers/bi/1993/ â€“ Background and activities from the 1993 Woodrow Wilson Biology Institute on biotechnology.