# Exploration in the South Atlantic Bight: Discovery of New Resources with Pharmaceutical Potential

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***Abstract*-As part of the 2002 NOAA Ocean Exploration Islands in the Stream expedition, our objective was to explore novel sources of marine-derived chemicals that may be applied to the development of pharmaceuticals. Virtually no drug discovery research has targeted the deep-water coral reef communities in this region, and in particular the microbial associates living in these communities. Some of the sites visited have never been dived on previously. This is the first documentation of these habitats and their biodiversity. During a total of 23 dives in the *Johnson-Sea-Link II* submersible, more than 200 benthic macrofauna and sediment samples were collected and analyzed. The abundance and diversity of sponges and octocorals were greater than expected from reports in the literature. Several new species or new records of occurrence of sponges and octocorals were discovered. Chemical profiles of extracts made from specimens of sponges and octocorals indicate that novel compounds are present in many of the samples. NOAA's Ocean Explorer website and HBOI's At-Sea website documented near real-time postings of essays, interviews, photographs, and video from mission scientists, crew, and educators, describing daily dive activities and discoveries. A Professional Development Institute was conducted to familizarize Florida educators with the Ocean Exploration program and curriculum.**

## I. INTRODUCTION

The primary objective of our exploration of the South Atlantic Bight was to discover new sources of marine-derived chemicals that may be applied in the long term to the development of compounds used to study, diagnose or treat human diseases, including cancer, infectious diseases, diseases of the immune system, cardiovascular disease, and central nervous system disorders. The secondary objective of this mission was the documentation of relatively unknown deep-water coral reefs and lithoherms in the South Atlantic Bight.

The general area of study included various little-known, deep-water coral reefs, lithoherms, and live bottom rock reefs within the South Atlantic Bight, including the Florida-Hatteras Slope and western and Blake Plateau off Florida, Georgia, and South Carolina. Except for the Charleston Bump sites, most of the study sites have never been dived on previously or have scant data regarding the benthos. Four general sites were selected for exploration following a thorough analysis of publications and unpublished data from biologists and geologists who have studied the area:

- Stetson's Lophelia Reefs (~32 $^{o}$N, 77$^{o}$30'W), depth ~800-1000 m
- Charleston Bump North and Lophelia Reefs (~32$^{o}$44'N, 78$^{o}$05'W), depth ~200-600 m
- Charleston Bump South (~31$^{o}$38'N, 78$^{o}$46'W), depth ~500 m
- Northeast Florida Lithoherms & Lophelia Reefs (~30$^{o}$30'N, 79$^{o}$45'W), depth ~450-1000 m

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## II. METHODS

Twenty-three dives in the *Johnson-Sea-Link II* submersible were conducted at eleven sites within the four regions listed above. Benthic macrofauna and habitats were documented with approximately 39 hours of videotapes, 160 underwater and 508 shipboard digital still images, and 200 specimens of sponges, octocorals, scleractinian corals, crustaceans, echinoderms, and sediment samples. Taxonomic museum specimens, photographs, and videotapes are archived in HARBOR BRANCH Oceanographic Institution (HBOI), Division of Biomedical Marine Research (DBMR) taxonomic repository. Subsamples of each specimen were preserved for both DNA and RNA extraction and are stored at –80$^{o}$C in DBMR's Molecular Genome Archive. Subsamples were also cryopreserved in glycerol or DMSO for subsequent culture of microorganisms and marine invertebrates, respectively. The remainder of each specimen is stored at –20$^{o}$C in DBMR's frozen sample repository for subsequent biological and chemical evaluation.

## III. KEY FINDINGS AND OUTCOMES

- A 500 ft tall pinnacle was discovered at the Stetson Reef site on the eastern edge of the Blake Plateau. Live colonies of *Lophelia* coral and coral debris cover its flanks, and the crest is a flat plateau at 2200 ft covered with live coral, sponges, gorgonians, and black coral bushes.
- Fathometer transects along a 120 mile stretch at depths of 2400 ft from Jacksonville to south of Cape Canaveral revealed hundreds of 50-500 ft tall *Lophelia* deep-water coral pinnacles. Four submersible dives on these sites discovered an unexpected habitat of coral, sponges, and gorgonians.
- There is a greater abundance and diversity of sponges and octocorals than expected from reports in the literature.
- Several new species or new records of occurrence of sponges and octocorals were discovered.

- Lithistid sponges, common in deep-water communities in the Bahamas, Caribbean, and Gulf of Mexico, are rare along the Florida Hatteras Slope. Instead, hexactinellid sponges are a more common component of the deep-water communities.
- Deep-water lithoherms exist on both sides of the Florida Straits between the Bahamas and Florida; however, the macrofaunal benthic community is strikingly different. For example, stalked crinoids are a dominant component on the Bahamas lithoherms, whereas none were observed at any of the sites at similar depths during this cruise.
- Chemical profiles of extracts made from specimens of sponges and octocorals indicate that novel compounds are present in many of the samples.
- Several species exhibited antimicrobial activity, as determined by shipboard disk diffusion assays against the human pathogens *Bacillus subtilis*, *Pseudomonas aeruginosa*, and *Candida albicans*. No sample showed activity in all bioassays, i.e., selective bioactivity was observed.
- NOAA's Ocean Explorer website and HBOI's At-Sea website documented near real-time postings of essays, interviews, photographs, and video, from mission scientists, crew and educators, describing daily dive activities and discoveries.
- NOAA's National Education Coordinator, HBOI's media lab videographer, and a high school teacher-at-sea provided a strong educational component to the mission, including lesson plan development for grades 6-12, sea-to-shore conference calls with teachers as part of a Professional Development Institute, guided tours during open house for 500 teachers and students, daily dispatches and interviews, and post cruise presentations. A Professional Development Institute was subsequently held at the HBOI campus to familizarize Florida educators with the Ocean Exploration program and curriculum.

## IV. MANAGEMENT IMPLICATIONS

The first deep-water coral Marine Protected Area (MPA) in the world was established in 1984 as the 92 $mi^2$ *Oculina* Habitat of Particular Concern (OHAPC). In 2000, the OHAPC was expanded to ~300 $mi^2$, encompasing this shelf-edge deep-water series of reefs from Fort Pierce to Cape Canaveral, Florida.

The deep-water *Lophelia* coral reefs discovered during this mission are similar in structure and function as the *Oculina* reefs. These were among the first dives ever made to document the habitat and benthic biodiversity on these relatively unknown *Lophelia* coral reefs, especially on the eastern Blake Plateau and the Straits of Florida. The living resource potential is unknown in terms of new fisheries and novel compounds with pharmaceutical potential. Although there are no plans to designate these areas as MPAs, they are an incredibly diverse and irreplaceable resource. Many of the coral structures may be tens of thousands years old as suggested by previous carbon dating of *Lophelia* coral debris. The coral itself is slow growing, only 10-20 mm/year, and is certainly fragile. Any activities involving bottom dredging, trawling, pipeline laying, or oil/gas production could negatively impact these reefs.

## V. FUTURE OUTLOOK

This mission documented newly discovered deep-water reefs within the US Exclusive Economic Zone. Until this mission, little was known about the biology and biodiversity of these diverse habitats. Initial taxonomic analyses indicate that several sponges and gorgonians may be species new to science, and many are certainly range extensions. Further work in collaboration with specialists will be conducted to verify these preliminary determinations.

The work toward drug discovery is just beginning. Each sample was extracted and tested while at sea for its natural product profile using chromatographic techniques. Initial results indicate that many specimens show unusual chemical constituents and biological (antimicrobial) activity. Continued biological and chemical evaluation of the extracts is in progress. Subsamples made from each sample were also frozen and archived for the DBMR Molecular Genome Ark which will provide material for on-going genomic studies. The larger frozen samples will provide material which will be used in on-going bioassays and chemical analyses. The samples collected are certain to contain novel compounds that will show promising biological activities. Funding for these research missions is essential in allowing for the exploration, discovery, understanding and preservation of new habitats which contain resources that have the potential to help mankind through the discovery of new therapeutic agents which can treat existing and newly emerging diseases.

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