Print

2008 Annual Report: Woods Hole Center for Oceans and Human Health

Mission

To improve the public health through enhancing our understanding of how oceanic processes affect the distribution and persistence of human pathogens and toxin-producing organisms in marine and coastal environments.

Theme

The Woods Hole Center for Oceans and Human Health (WH-COHH) addresses the distribution of biological agents with potential human health consequences in the temperate coastal ocean, including bays, harbors and estuaries. Within this geographic theme, research projects in the Center concentrate on harmful algal blooms, bacterial human pathogens, and parasitic protists, with complementary studies of physical oceanographic conditions and biology of the organisms. The conceptual foundation for the WH-COHH lies at the interface between advanced genomics, population biology, and coastal hydrodynamics.

Background

Established in 2004 through a novel partnership between the National Science Foundation (NSF) and National Institute of Environmental Health Sciences (NIEHS), the WH-COHH brings together researchers with expertise in biomedical, genomic, and oceanographic sciences at Woods Hole Oceanographic Institution (WHOI), the Marine Biological Laboratory (MBL), and the Massachusetts Institute of Technology (MIT). Scientists funded by WH-COHH have been leading studies of harmful algal blooms and of human pathogens in marine systems, addressing the current and future needs of a growing human population.

Center Administration and Research Projects

The Center includes an Administrative Core that ensures integration of the elements of the Center, a Genomics Core Facility that provides state-of –the-art DNA sequencing for the projects, and a Pilot Project Program of small grants for new research ideas. The standing research projects in the Center focus on combining population dynamics and genetics with hydrodynamic (water movement) transport and discovering the refuges within the environments of harmful algal species and human pathogens. The current projects and researchers are:

Enlarge Image

Elizabeth Halliday, a graduate student in the MIT-WHOI Joint Program, takes samples of sand at Wood Neck Beach in Falmouth, Mass., to analyze in the laboratory. Bacteria that are indicators of fecal contamination can live and grow in beach sand, and the DNA from microbes living within this sand will be used to find out how many indicator bacteria are present. Halliday works in Rebecca Gast's laboratory, and her research is supported by the Woods Hole Center for Oceans and Human Health. (Courtesy of Elizabeth Halliday, Woods Hole Oceanographic Institution)

1. *Alexandrium* population biology in the Gulf of Maine: Don Anderson (WHOI) and Deana Erdner (University of Texas Marine Science Institute)
2. Hydrodynamic forcing of *Alexandrium* population biology: Dennis McGillicuddy (WHOI)
3. Human pathogens and coastal ocean processes: Rebecca Gast (WHOI) and Linda Amaral-Zettler (MBL)
4. Microecology and evolution of two marine pathogens: Martin Polz (MIT) and James Lerczak (College of Oceanic and Atmospheric Sciences, Oregon State University)

Recent Highlights

Harmful algal blooms

Drs. Anderson and McGillicuddy successfully forecast the 2008 outbreak of *Alexandrium*, the algae that produce the toxin that causes paralytic shellfish poisoning, using a computer model combined with intensive seafloor surveys for the algae's dormant stage cysts. This is a major breakthrough – the first seasonal prediction of a red tide or HAB (harmful algal bloom) on a regional scale – and validates our understanding of the *A. fundyense* bloom dynamics in the Gulf of Maine, and the sophistication and accuracy of our numerical model. McGillicuddy and Anderson have begun discussions with NOAA officials to use this model in NOAA's Harmful Algal Bloom Forecasting System.

Pathogens

Environmental pathogens pose serious threats to human health, but we lack the means to effectively detect or predict their occurrence. This aspect of the program seeks reasons why virulent variants of these organisms co-occur with non-virulent forms of the same organisms. Pathogenic forms can arise as adaptations to non-human hosts or niches, but we know little about underlying mechanisms.

Drs. Mitchell Sogin and Hilary Morrison at MBL oversee the Core Facility, which provides genetic sequencing for the Center's projects and carries out research to enhance sequencing capability. Detecting microorganisms, including human pathogens, present at low abundance – maybe only a few cells in a milliliter of seawater – demands molecular sampling efforts much greater than those routinely done by laboratories. To address this, we developed a "massively parallel sequencing strategy" that allows us to sample many tens of

thousands of hypervariable regions from specific genes (rRNA genes) at a fraction of the cost of other methods. We anticipate that this technology has the capacity to distinguish between different sources of fecal pollution, and provide a tool for tracking the fate and transport of pathogens in temperate recreational waters and sands (such as beaches.)

Drs. Gast and Amaral-zettler have detected a diverse set of gene sequences from the bacterial genus *Legionella*, including the disease-causing *Legionella pneumophila*, in several marine environments. They also have detected the presence of other human parasites including *Giardia* in Mt. Hope Bay, Mass.

Dr. Polz detected significant populations of *Vibrio cholerae* (the bacterium responsible for cholera) in coastal waters of Massachusetts – including a novel, closely related potential pathogen group with the collective working name " *V. pseudocholerae."* Recently the Centers for Disease Control and Prevention also isolated organisms from this new group, suggesting that *V. pseudocholerae* could be a new potential pathogen. In the environment, *V. cholerae* and *V. pseudocholerae* co-occur but our field observations and preliminary laboratory growth experiments suggest that the two groups grow best at distinct temperatures and salinities. And Maine, New Hampshire, and Massachusetts are considering providing funds for cyst surveys in 2009 and 2010, to be matched with federal funds for ship time. This is strong evidence for the value of the Center's forecasting and outreach efforts.

Pilot Projects
Since the beginning of WHCOHH we have funded Pilot Projects, to broaden the scope and impact of the center. Current pilot projects include:

- Hydrodynamics and Transport Pathways for Fecal Microbial Populations in a Salt Marsh and Barrier Beach System" David Ralston (WHOI),
- Using signature tagged mutagenesis to investigate how pandemic *Vibrio parahaemolyticus* persists in the bacterioplankton" Janelle Thompson (MIT), and
- BMAA, a cyanobacterial neurotoxin, in marine food webs" Carl Lamborg, and Mak Saito (WHOI).
- Pilot project awardees Hauke Kite-Powell and Porter Hoagland (both of the WHOI Marine Policy Center) have been collaborating with the Miami Center to assess economic impact of brevetoxins (neurotoxins from harmful algae) in Florida waters.

Conference
A Gordon Research Conference on Oceans and Human Health was held in summer 2008, co-chaired by WH-COHH Director Dr. John Stegeman, and Miami COHH Director Dr. Lora Fleming. The conference was regarded by many as a significant milestone in establishment of the interdisciplinary field of oceans and human health.

–*John Stegeman, Center Director*

Last updated: July 31, 2009

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