C-MORE Highlights 2008

Award No:
CCF-0424599

Project Title:
Center for Microbial Oceanography: Research and Education (C-MORE)

Investigators:
David Karl, Sallie Chisholm, Edward DeLong, Jonathan Zehr

Institution:
University of Hawaii, Lead Partner

Massachusetts Institute of Technology

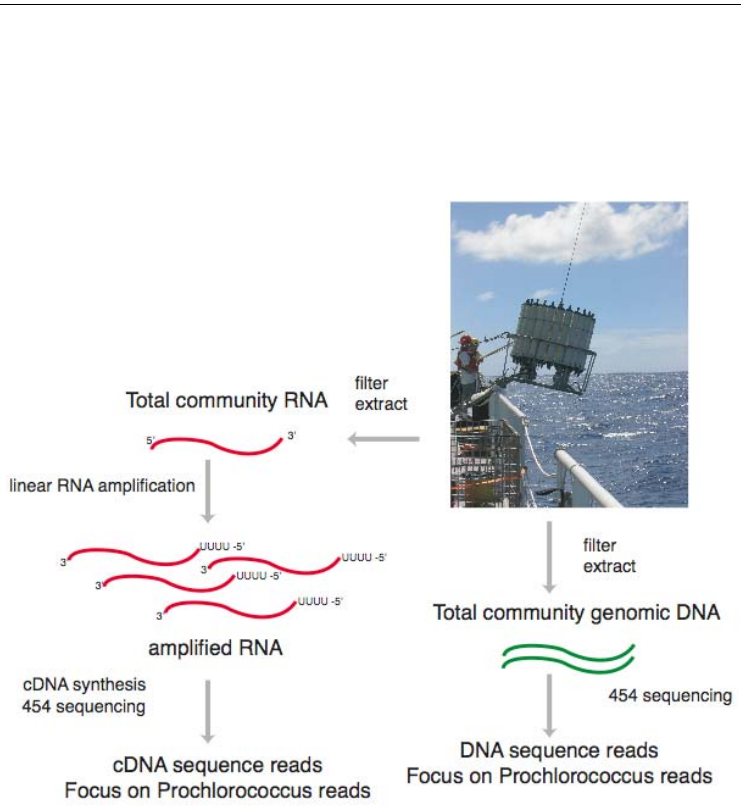
Marine Advanced Technology Education (MATE) Center at Monterey Peninsula College

Oregon State University

University of California at Santa Cruz

Woods Hole Oceanographic Institution

Monterey Bay Aquarium Research Institute



Website:
http://cmore.soest.hawaii.edu/

Description of Graphic Image:
Flow chart showing the main steps of metatranscriptomic analysis of the whole microbial community in the ocean. Linear amplification of the extracted RNA is the key point of the method. Our interests are focused on the subset of sequences that belong to *Prochlorococcus* because the large number of sequenced *Prochlorococcus* genomes facilitates the analysis of environmental gene expression.

Project Description and Outcome - *Provide a paragraph or two that provides background on the project, results of the project, the scientific uniqueness; and the project's impact (societal or industrial). Also, provide content that supports your selection of the outcome goals listed below.*

We developed a metatranscriptomics method that allowed us, for the first time, to look at patterns of gene expression of whole microbial communities in the environment. We then analyzed expressed genes in a naturally occurring microbial community using samples from station ALOHA (Hawaii). Genes associated with key metabolic pathways in open ocean microbial species, including genes involved in photosynthesis, carbon fixation, and nitrogen acquisition, and a number of genes encoding hypothetical proteins, were found to be highly represented in the cDNA pool.

Prochlorococcus is an ideal system on which to focus metatranscriptomic analysis in the environment because genes from *Prochlorococcus* are highly represented in the metagenomic database, and because extensive genomic and transcriptomic data from culture studies are available. Interestingly, *Prochlorococcus* genes present in the variable regions of *Prochlorococcus* genomes were among the most highly expressed in the natural environment, suggesting these genes encode proteins central to cellular processes of specific ecotypes.

Applying this technique to the study of environmental samples from C-MORE will dramatically increase our knowledge of how *Prochlorococcus* and other important microorganisms adapt to natural conditions in the ocean. We will gain knowledge of the functions of previously unknown proteins and we will develop a broader picture of the physiology of bacterial communities in their natural environments.

This technique will have applications in any environmental study whose goal is to analyze gene expression in whole microbial communities. Linking these data to metagenomic analyses will provide a more complete picture of how microbial communities adapt and survive under real-life environmental conditions.

Managing Program Officer: Matthew D. Kane

C-MORE Highlights (Education & Diversity)

Award No: CCF-0424599	
Project Title: Center for Microbial Oceanography: Research and Education (C-MORE)	
Investigators: David Karl, Sallie Chisholm, Edward DeLong, Jonathan Zehr	
Institution: University of Hawaii, Lead Partner Massachusetts Institute of Technology Oregon State University University of California at Santa Cruz Woods Hole Oceanographic Institution Monterey Bay Aquarium Research Institute	
Website: http://cmore.soest.hawaii.edu/	**Description of Graphic Image: High School Biology teacher Jenny Hoof (left), Science Department Head Mari Taira (center) and undergraduate RaeAnne Cobb-Adams aboard a five-day research cruise.**

Project Description and Outcome - *Provide a paragraph or two that provides background on the project, results of the project, the scientific uniqueness; and the project's impact (societal or industrial). Also, provide content that supports your selection of the outcome goals listed below.*

C-MORE's Education office opened in February 2007. Its key goals are to promote public awareness of microbial oceanography, provide the best possible training for the next generation of microbial oceanographers, and to increase the number of underrepresented minorities (esp. Native Hawaiians and Pacific Islanders) in the ocean and earth sciences and related disciplines. Recent and upcoming highlights include:

- Providing teachers and undergraduate students with experiences at sea, including a dedicated two-day R/V Kilo Moana cruise in which researchers partner with educators (June 2008)
- Developing an undergraduate science internship program for Native Hawaiians and Pacific Islanders
- Working with aquariums and discovery centers in Hawaii to promote microbial oceanography to the general public
- Co-founding the Ocean Literacy Alliance– Hawaii to foster collaboration and minimize duplication of efforts among Hawaii's ocean science educators. (November 2007)
- Leading professional workshops in microbial oceanography for teachers and students in Hawaii (April-May 2008) and Oregon (July 2008)
- Providing professional development opportunities for C-MORE graduate students and postdocs, including exchanges among C-MORE partner institutions to learn research techniques, attending workshops and conferences, and involving these young scientists in educational endeavors.

C-MORE Education Office programs are targeted at engaging Native Hawaiians, Pacific Islanders and other underrepresented students in ocean and earth science and related fields. We work to expand the scientific literacy of all citizens, particularly in the area of microbial oceanography .

Many of our education programs are research-based and advance both C-MORE's education and research missions. For example, our undergraduate and graduate students work closely with C-MORE Investigators on cutting-edge, multidisciplinary research.

Managing Program Officer: Matthew D. Kane

C-MORE Highlights

Award No: CCF-0424599	
Project Title: Center for Microbial Oceanography: Research and Education (C-MORE)	
Investigators: David Karl, Sallie Chisholm, Edward DeLong, Jonathan Zehr	
Institution: University of Hawaii, Lead Partner Massachusetts Institute of Technology Marine Advanced Technology Education (MATE) Center at Monterey Peninsula College Oregon State University University of California at Santa Cruz Woods Hole Oceanographic Institution Monterey Bay Aquarium Research Institute	
Website: http://cmore.soest.hawaii.edu/ http://www.mbari.org/ESP/espdeepmovie.htm	**Description of Graphic Image:** The C-MORE logo represents its mission to foster the integration of science discovery, technological advancement, and communication of knowledge through education and outreach.

Project Description and Outcome - *Provide a paragraph or two that provides background on the project, results of the project, the scientific uniqueness; and the project's impact (societal or industrial). Also, provide content that supports your selection of the outcome goals listed below.*

The development and application of biological sensors is central to numerous research and resource management activities such as those envisioned under the Ocean Observatories, Integrated Ocean Observing System, and Centers for Oceans and Human Health. Methods to detect genetic materials indicative of specific organisms or metabolic processes are commonly employed in support of those initiatives. Armed with such tools, ocean researchers are addressing fundamental questions concerning the flow of elements and energy through the oceans, and to assess changes in ecosystem structure and function that may occur due to natural and human mediated environmental fluctuations. Traditionally, this is a science that demands acquisition of biological samples and analysis in specially equipped laboratories. But that is fast changing. New in-water sensing technologies aim to alleviate that requirement in large part. The Environmental Sample Processor (ESP; http://www.mbari.org/esp/) is an experimental device designed for that challenge. Development and use of the device is funded in part by the NSF (OCE0314222, CCF424599), NASA (NNG06GB34G) and private entities (Packard and Moore Foundations).

Development of new ocean sensing technologies is of broad interest to educators and as well as the general public. One way to meet that need is to utilize short animations that can be served on the web to illustrate relevant concepts and principles, and to show how such tools can be used in the future. This was done for the ESP, to convey a sense of what the instrument is and how it might be applied in service to basic research and to meet everyday societal needs. The animation is served on the web at http://www.mbari.org/ESP/espdeepmovie.htm

Communicating the importance and relevance of such developments is critical to attract the next generation of students and entrain them into professional science careers, as well as to make the public aware of the value and purpose of C-MORE science.

The develop of instrumented, automated in situ instrumentation for microbial research is almost certain to transform the field of microbial oceanography, just as sensors have transformed chemical and physical oceanography.

Managing Program Officer: Matthew D. Kane