Microbial Processes at Ocean Station ALOHA

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2015 Balzan Prize for Oceanography

Balzan GPC Advisers: Enric Banda, Charles Godfray
Main Researchers: Sara Ferrón, Benedetto Barone
Affiliated Institutions: Ocean Station ALOHA (A Long-term Oligotrophic Habitat Assessment)
Period: 2016-2018
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David M. Karl is Professor of Oceanography at the School of Ocean and Earth Science and Technology at the University of Hawaii at Manoa and Director of the University of Hawaii's Center for Microbial Oceanography: Research and Education. Ocean Station ALOHA (A Long-term Oligotrophic Habitat Assessment) is a novel oceanographic research site located approximately 100 km north of Oahu, Hawaii, in the North Pacific Subtropical Gyre, one of Earth's largest habitats. On approximately monthly intervals since October 1988, interdisciplinary teams of scientists from institutions worldwide have studied the biology, physiology and ecology of microorganisms, from genomes to biomes. Research at Ocean Station ALOHA has helped to define the new and exciting discipline of Microbial Oceanography. The numerous scientific discoveries from Ocean Station ALOHA, including novel microorganisms, unprecedented metabolic pathways and complex interactions, have transformed our understanding of microbial life in the sea. The uncertain nature of future climate change and the potential impacts on the structure and function of marine ecosystems demand a comprehensive description and understanding of the sea around us. Sustained research of marine microbes is vital, so continued field observations and experimentation at Ocean Station ALOHA is both timely and important. Two outstanding early career scientists, Sara Ferrón and Benedetto Barone, will receive financial support from the Balzan Prize fund to take them past this important training period for their future careers in science, help them develop new leadership and research skills, as well as gain additional self-confidence and independence.

Microbial Oceanography is a new discipline that integrates the principles of marine microbiology, microbial ecology, and oceanography to study the role of microorganisms in the biogeochemical dynamics of natural marine ecosystems. A general goal of Microbial Oceanography is to observe and understand microbial life in the sea well enough to make accurate ecological predictions, for example, of the impact of climate variability on microbial processes in the global ocean. By analogy to a living cell, the ocean has a collective metabolism that is based largely on its dynamic genetic blueprint, with expressed phenotypes that control fluxes of energy and matter. The microbial processes that underlie this collective metabolism are influenced by environmental forcing and are governed by the laws of physics and chemistry.

A major contemporary challenge in Microbial Oceanography revolves around the pathways and rates of energy and matter transformations, ranging from solar energy capture to major element cycles, especially carbon (C), nitrogen (N), oxygen (O), and phosphorus (P). Several new observational and analytical techniques, in part developed or refined in Karl's laboratory over the past two decades, provide novel opportunities to move the field forward. Ferrón and Barone will participate in these ongoing studies at Ocean Station ALOHA. Sara Ferrón's (PhD 2009, University of Cádiz, Spain) current research interests include marine primary production and the oceanic carbon cycle, biogeochemical cycling and sea-to-atmosphere exchange of biogenic gases, including carbon dioxide, methane and nitrous oxide. She has recently devised novel methods for the measurement of gross primary production, net community production and community respiration, and has applied these methods to estimate the net metabolic state of the sea. Karl's research project funds will provide partial support for Dr. Ferrón to continue her research on marine primary production using a novel approach to measure the production of $^{18}O2$ from ^{18}O-labeled H_2O in field experiments. She will also use the Balzan Prize support to help plan and execute a set of novel at-sea deliberate tracer release experiments (using inorganic nutrients and the inert gas sulfur hexafluoride), hopefuly to be conducted at Ocean Station ALOHA in 2017 or 2018. David Karl will be her primary supervisor throughout the duration of this project.

Benedetto Barone's (PhD 2010, Università degli studi di Napoli "Federico II" and Stazione Zoologica Anton Dohrn, Italy) current research interests include marine primary productivity, biogeochemistry and physical-biological modeling of marine ecosystems. He has recently been involved in field research at Ocean Station ALOHA using bio-optical methods to study the dynamics of marine phytoplankton. In the past

decade, several novel autonomous observational and sampling systems have become available to improve our understanding of the controls on the spatial and temporal variability of microbial processes in the sea. At Ocean Station ALOHA, autonomous Seagliders capable of measuring temperature, salinity, oxygen, chlorophyll and optical backscatter caused by suspended particulate matter, including living phytoplankton cells, have been deployed to map daily changes in oxygen (caused by photosynthesis and respiration) and in particulate matter distributions. A recent (2014) 2-month Seaglider mission has yielded results of great interest and importance in studies of the oceanic carbon cycle. Karl's Balzan Prize funds will provide support for a new University of Hawaii based Balzan Research Fellow, and Barone would be the inaugural recipient of this prestigious fellowship, which will provide full-time support for a period not to exceed three years. During his fellowship, Barone will continue his ongoing analysis of four years of past Seaglider missions at Ocean Station ALOHA, and plan, execute and analyze data from new missions. Within the next year, new remote sensing and sampling systems will also be acquired, including a fleet of three purpose-built, long-range (1,000 km) autonomous underwater vehicles (AUV), and a commercially available Waveglider. These new assets, along with the Seaglider fleet will provide an unprecedented view of spatial and temporal variability in the oligotrophic North Pacific Subtropical Gyre, and an outstanding training opportunity for an ambitious and creative early career scientist. David Karl will be the primary supervisor throughout the duration of this project.