

Census of Marine Life Annual Report to SCOR

July 2006

The Census of Marine Life (CoML) was formally established in 2000 and became an Affiliated Program of SCOR in 2002. In 2010, this international research program will release its first report on the status of knowledge of marine biodiversity, so 2006 marked an important transition toward integration, synthesis and visualization of the information now actively being collected by our 14 Ocean Realm Field Projects and three cross-cutting initiatives in historical studies (HMAP – History of Marine Animal Populations), modeling and prediction (FMAP – Future of Marine Animal Populations), and data management and accessibility (OBIS – Ocean Biogeographic Information System). The following report provides an update on the program's status and plans in 2006.

Scientific Accomplishments

The last of the global-scale Realm Projects were initiated in 2005. By the end of 2006, all of them will have begun work in the field. Some highlights from CoML expeditions and research analyses include the following.

Species discoveries

On a cruise to New Zealand's Graveyard seamount complex in May 2006, the CoML seamounts project (CenSeam) used a combination of video/still photography, as well as sample collection, they examined seamount community composition at depths in excess of 1km. Discoveries include a potentially new species of carnivorous sponge.

CenSeam scientist Bertrand Richer de Forges published the discovery of a new species of shrimp. Its name is *Neoglyphea neocaledonica*. The Glypheides were well known from the Jurassic and Cretaceous periods and were supposed to be extinct at the Eocene (about 50 million years ago). Bertrand compares this discovery, for invertebrate scientists, to that of the second species of coelacanth in Indonesia some years ago. That species was also thought to be extinct 50 million years ago.

A cruise associated with both the continental margins (COMARGE) and chemosynthetic ecosystems (ChEss) projects, led to the discovery a new species of crab. Described by Enrique MacPherson, William Jones and Michel Segonzac, the crab *Kiwa hirsuta* belongs to the new family Kiwaidae and was found during an expedition to the Easter Island Microplate.

New insights into marine animal distribution and diversity

An international team of researchers, led by Monty Priede (University of Aberdeen), from the CoML Mid-Atlantic Ridge project (MAR-ECO), revealed in a paper to the *Proceedings of the Royal Society* that sharks have failed to colonize at depths greater than 3,000 meters. These findings means that the deepest oceans of the world appear to be shark free, though scientists do not yet know why. One possible reason may be lack of food.

The International Census of Marine Microbes (ICoMM) initiated an experiment to determine whether or not extensive sampling of orthologous microbial genes would provide more accurate estimates of microbial diversity and relative representations of different phylotypes in the deep oceans. They collected ~120,000 tag sequences for samples isolated from the North Atlantic Deep Waters (NADW) and the oxygen minimum zone (OMZ) at the same coordinates, as well as diffuse flow samples from Axial seamount off the coast of Oregon, and discovered that bacterial diversity in the sea is orders of magnitude greater than anyone has ever expected, much greater than previous estimates based upon conventional molecular techniques.

A case study from the History of Marine Animal Populations (HMAP) project tracked human impact on coastal marine ecosystems from Roman time to the present and reported in *Science* that the decline of global estuaries and coastal seas has accelerated in the last 150-300 years. The study quantified the magnitude and causes of ecological change in 12 estuaries and coastal seas, including Massachusetts Bay, Delaware Bay, Chesapeake Bay, Pamlico Sound, Galveston Bay, Francisco Bay, Western Baltic Sea, Wadden Sea, Northern Adriatic Sea, Southern Gulf of St. Lawrence, Outer Bay of Fundy, and Moreton Bay. The researchers, led by Heike Lotze (Dalhousie University), combined palaeontological, archaeological, historical, and ecological records tracing changes in important species, habitats, water quality parameters, and species invasions. To date, this is the most comprehensive quantitative assessment of the state of estuaries and coastal ecosystems ever conducted.

Novel technologies and approaches

The CoML zooplankton project (CMarZ) completed a 20-day cruise to the deep Sargasso Sea. Scientists trawled rarely explored tropical ocean depths between the southeast U.S. coast and the Mid-Atlantic Ridge to survey and record the variety and abundance of zooplankton. Though relatively few in number compared with the uppermost ocean layer, scientists were amazed by the variety of tiny animals found at depths of 1 to 5 km. Among thousands of specimens captured, 220 were DNA sequenced at sea, revealing a number of new species. The scientists, who have spent decades learning to distinguish species within a particular group, sorted through samples in a kind of assembly line. DNA sequencing at this scale had not before been attempted at sea.

A partnership between CoML and the U.S. National Oceanographic Partnership Program (NOPP) has funded work to further test and develop a ground-breaking new technology to view fish populations under water at the shelf-scale. Gulf of Maine Area program (GoMA) researchers, led by Nicholas Makris (MIT), have developed a remote sensor system that makes it possible to track large fish populations over a 10,000 square kilometer area. This new technology can track shoal movements to lead to new insights in behavior and could also help determine whether fish populations are shrinking.

The CoML tagging and tracking technologies developed in the Pacific through the Tagging of Pacific Pelagics (TOPP) and Pacific Ocean Shelf Tracking (POST) projects are being expanded to other global oceans under the newly established Ocean Tracking Network. The OTN is planning a highly interconnected network spanning 14 ocean regions, including the Arctic and

Southern Oceans, the Indian Ocean (East, West), the Atlantic (NE, NW, SE, SW), the Mediterranean, and the Pacific (NE, NW, SE, SW and Mid-ocean), giving scientists and resource managers a highly detailed picture of marine conditions and the migrations of fish and ocean animals throughout the world.

Contributions to the community

The Ocean Biogeographic Information System (OBIS) is currently serving 9.7 million data records covering 67,000 species from 122 databases. Five new geographical searches are available, including Exclusive Economic Zones (EEZs), International Hydrographic Organization (IHO) Seas, Large Marine Ecosystem (LME) provinces, Longhurst maps, and United Nations Food and Agriculture (FAO) fishing grounds. OBIS is the flagship project and a leader of a new interdisciplinary area of research called "Ocean Biodiversity Informatics" (OBI), which is subject of a recent nine-article theme session in the *Marine Ecology Progress Series*.

Researchers from the ChEss project published the second edition of *Handbook of Deep-Sea Hydrothermal Vent Fauna* (Desbruyères, Segonzac & Bright, Eds.). This extensively expanded edition gives an overview of our current knowledge on the animals living at hydrothermal vents.

Members of the Future of Marine Animal Populations (FMAP) team, led by Camilo Mora and Ransom Myers (Dalhousie University) worked with OBIS and other sources to build a database of Marine Protected Areas (MPAs) for coral reefs in 102 countries, including satellite imagery of reefs worldwide. They then surveyed more than 1,000 MPA managers and scientists to determine the conservation performance of MPAs, taking into account such factors as MPA size and distances to neighboring protected areas. Their analysis assessed protection afforded to coral reefs from such threats as resource extraction, poaching, pollution, coastal development and overfishing. They found that less than 2% of coral reefs worldwide are within MPAs that have adequate regulations on extraction, poaching and other major threats to these ecosystems.

Program Governance and Administration

With the addition of Dr. Song Sun of China in December 2005, the international CoML Scientific Steering Committee (SSC) now has 16 members:

- Dr. J. Frederick Grassle (*Chair*), Rutgers University, USA
- Dr. Victor Ariel Gallardo (*Vice Chair*), University of Concepcion, Chile
- Dr. Ian Poiner (*Vice Chair*), Australian Institute for Marine Science, Australia
- Dr. Vera Alexander, University of Alaska Fairbanks, USA
- Dr. D. James Baker, Academy of Natural Sciences (Retired), USA
- Dr. Patricio Bernal, Intergovernmental Oceanographic Commission, France
- Dr. Dorairajasingam Chandramohan, National Institute of Oceanography (Retired), India
- Dr. David Farmer, University of Rhode Island, USA
- Dr. Serge Garcia, Food and Agriculture Organization, Italy
- Dr. Carlo Heip, Netherlands Institute of Ecology, The Netherlands
- Dr. Poul Holm, Roskilde University, Denmark
- Dr. Yoshihisa Shirayama, Kyoto University, Japan
- Dr. Myriam Sibuet, Ifremer (Retired), France

Dr. Michael Sinclair, Bedford Institute of Oceanography, Canada
Dr. Song Sun, Institute of Oceanology, China
Dr. Meryl J. Williams, Future Harvest Alliance Office, Malaysia

The program also has ten National and Regional Implementation Committees (NRICs) that are building local programs that address national research priorities. The intention is that, after the first CoML report in 2010, the NRIC programs will continue to promote CoML's proven technologies and approaches to surveying marine biodiversity in research and monitoring programs and ocean and coastal observation systems. National committees are located in Australia, Canada, China, Japan, and the United States. Regional committees are located in the Caribbean, Europe, the Indian Ocean, South America, and Sub-Saharan Africa.

CoML's international Secretariat is located at the Consortium for Oceanographic Research and Education in Washington, DC. In April 2006, it received renewed funding to continue administering the program for another two years.

The program, to date, has secured approximately \$164 million for scientific research, outreach and education, and project management. These funds come from traditional sources, including both governments and private organizations. This amount, however, does not reflect the crucial resources received through ship-time, personnel and other in-kind support.

Plans for 2007-2009

The CoML, under the guidance of its SSC, has now successfully established and implemented its complete suite of international projects and other planned activities. Most of these projects are already sampling in the field and, by the end of 2006, all of them will have embarked on at least one cruise. These projects will continue to perform research in the field through 2008, after which time focus will transition to analysis and synthesis of information.

For the SSC and Secretariat, the work plan for the next few years emphasizes program growth through increased participation and partnerships, globalization of the field program to achieve representative global coverage, information integration and synthesis, and identification of the key questions to be addressed in the 2010 report. Much of this work will be done through the increased involvement of the NRICs, as their success is the key to sustained research for marine biodiversity after the culmination of the "first" census. The strategy will also involve increased partnerships with a variety of stakeholders and potential user groups that need marine biodiversity information for resource management, conservation, industry practices, and education.

Recognizing the breadth of potential user groups in both government and private realms, the SSC wishes to ensure that the information and insights of CoML will address a variety of needs and issues. It has established a working group, led by Paul Snelgrove (Memorial University of Newfoundland), to develop the framework of the 2010 report in consultation with CoML projects and the user community. This report will also recommend a plan for future research by identifying remaining knowable gaps in information.

Relationship to other SCOR activities

CoML has ongoing collaboration with the SCOR Panel on New Technologies for Observing Marine Life. This Panel makes recommendations to the CoML projects regarding technologies that are applicable to their research and more broadly communicates the benefits and potential of novel technologies for studying marine life. This committee next meets in October in Japan, in conjunction with meetings of the CoML SSC and near shore biodiversity (NaGISA) project.

In December of this year, CoML will participate in the SCOR-organized meeting to build synergy between major international ocean research and observation projects and programs. This is a follow-up meeting to the one held in September 2004, in which CoML also participated. CoML is a supporter of these forums for communication between the large ocean science programs because it reduces redundancy in activities and increases the spirit of and knowledge of opportunities about collaboration, thus making more efficient use of limited resources. CoML endorses efforts to strengthen the community through better data management and interoperability between systems, ocean observing technologies, and the development of a cruise database. In July 2006, several CoML projects with ongoing work in the Southern Ocean participated in a meeting on coordination of a Southern Ocean Observing System, in conjunction with the SCAR annual meeting. This was a result of the recommendations made at the 2004 SCOR meeting of ocean research programs.

CoML hopes to have a strong presence at the SCOR 50th Anniversary meeting in 2008. Fred Grassle, Chair of the CoML International SSC, is a member of the planning committee. In 2007 the SSC will establish a new committee on “biodiversity 2020,” comprised of young, innovative scientists who will likely play large roles in ocean sciences in the next decade. A member of this committee might be a good spokesperson for a creative, cutting-edge theme session on where ocean sciences are heading in the future.

There is natural cross-over between CoML’s and SCOR’s through their vast networks of scientists. CoML shares active personnel with both SCOR-sponsored programs IMBER and GLOBEC. Ann Bucklin, Principal Investigator of the CoML Zooplankton project (CMarZ) and leader of CoML’s integrative initiative in DNA barcoding, is a member of the IMBER SSC. Dave Karl, a member of the CoML marine microbes (ICoMM) project, is on the joint IMBER-GLOBEC working group for “end-to-end food webs.” The former chair and current member of the CoML South American regional committee, Ruben Escribano, is a member of the GLOBEC SSC. Additional personnel from CMarZ, MAR-ECO, and the Gulf of Maine projects are active in GLOBEC activities. GLOBEC’s CLIOTOP program has expressed interest in collaboration with CoML’s CMarZ, TOPP, OBIS-SEAMAP, MAR-ECO and FMAP projects.

Additionally, many of the individual CoML projects have partnerships with other programs of interest to SCOR. The ChEss project collaborates with InterRidge, a SCOR Affiliated Program, on cruises, workshops and database development. The CoML projects in the Arctic and Antarctic, ArcOD and CAML, respectively, are leading projects for biology in the upcoming International Polar Year (IPY). CoML as a whole is seeking greater participation and input into GOOS, particularly through OBIS, POST, TOPP, and the Gulf of Maine project.