

International Census of Marine Microbes (ICoMM)

Mitchell L. Sogin

Josephine Bay Paul Center for Comparative Molecular Biology and Evolution, The Marine Biological Laboratory at Woods Hole, 7 MLB Street, Woods Hole MA 02543 USA

Phone: (508) 289-7246 FAX: (508) 457-4727 E-mail: sogin@mbl.edu

Jan W. de Leeuw

The Royal Netherlands Institute for Sea Research (NIOZ), P.O. Box 59, 1790 AB Den Burg Texel, The Netherlands

Phone: (+31)(0) 222-369471 FAX: (+31)(0) 222-319674 E-mail: deleeuw@nioz.nl

Linda Amaral-Zettler

Secretariat

Education and Outreach Network Liaison

Josephine Bay Paul Center for Comparative Molecular Biology and Evolution, The Marine Biological Laboratory at Woods Hole, 7 MLB Street, Woods Hole MA 02543 USA

Phone: (508) 289-7259 FAX: (508) 457-4727 E-mail: amaral@mbl.edu

<http://icomm.mbl.edu>

1. 2006 ACCOMPLISHMENTS & SCIENTIFIC HIGHLIGHTS

Upon the recommendation of the ICoMM Benthic Systems working group, the ICoMM Scientific Organizing committee formed an Informatics and Data Management Working group that met in Woods Hole in September of 2005 to discuss the structure and input and output services needed for MICROBIS. The participants of this meeting generated a working group summary report with major recommendations that is available for download on the ICoMM website (icomm.mbl.edu).

In February, 2006 ICoMM held a poster session at the Ocean Sciences Meeting in Hawaii entitled: The Mesopelagic and Bathypelagic Realms of the Ocean: Microbial Activity and DOM Cycling. ICoMM Scientific Organizing Committee member Gerhard Herndl served as chair of this session.

In March, 2006 ICoMM helped host a roundtable discussion on visualizing microbes held in Cambridge of this year and included members of MIT's media lab, Civil Engineering department, CoML and ICoMM representatives and others.

In May, 2006 ICoMM participated in the Consortium for the Barcode of Life meeting in which Mitchell Sogin revealed ICoMM's strategy for a barcode of microbial life focused on the V6 hypervariable region of the small-subunit rRNA molecule.

In June, 2006 ICoMM participated in the North Pond Integrated Ocean Drilling Program meeting held at the Woods Hole Oceanographic Institution. ICoMM also provided some financial support for participants attending this meeting.

Also in June, 2006 ICoMM hosted its first Annual meeting at the NH Leeuwenhorst Noordwijkerhout, The Netherlands (June 13-15, 2006) that included 52 participants from 13 countries representing

members of existing ICoMM working groups, members of the ICoMM Scientific Advisory Council and members of the international marine microbiology community who have expressed an interest in the ICoMM initiative.

In July, ICoMM received a 1.5 million dollar grant from the W. F. Keck Foundation to purchase a pyrosequencing machine to enable an initial census of marine microbes.

In August, ICoMM Principal Investigator Mitchell Sogin and colleagues published a manuscript in PNAS entitled, "Microbial diversity in the deep sea and the underexplored "rare biosphere"" that was recently voted No 1 in ALL BIOLOGY in Faculty of 1000's Current Top 10 list www.f1000biology.com and was rated one of our 20 most-read papers online during the month of August, 2006 (www.pnas.org/reports/mfr1.dtl <http://www.pnas.org/reports/mfr1.dtl>.)

In August, ICoMM was featured in a round table session entitled "Towards a Census of Marine Microorganisms," at the International Symposium on Microbial Ecology this August in Vienna, Austria. The session was chaired by ICoMM Scientific Organizing Committee Member Lucas Stal, ICoMM PI Mitchell Sogin served as a panelist.

2. SOCIETAL BENEFITS, IMPACT & APPLICATIONS

Human health issues are tied closely to the health of the ocean and the microbial life that it supports. Examples of this include the presence and persistence of viruses in the ocean, emergence of harmful algal blooms and new pathogens, and eutrophication. The metabolic capabilities of marine microbes are important to a number of biotechnology applications including production of industrial products, alternative energy sources, novel bioactive compounds that may have applications in pharmaceuticals and remediation. The recent ICoMM discovery that members of the rare biosphere represent highly diverse members of the marine microbial community may have important consequences for pathogen presence and detection, invasive species and loss of biodiversity.

3. WORK PLANNED FOR 2007

MICROBIS

Beginning in the Fall of 2006, ICoMM will start compiling Legacy data. This will be accomplished via a coordinated effort between the existing ICoMM Secretariat, ICoMM IT specialists and a newly hired data manager that will work in a coordinated fashion. By December 2007, ICoMM plans to establish geodata (wfs/wms) connections with other research groups. The data management team will address the following priorities:

- 1) Identification and capture of published legacy data that is available in GenBank.
- 2) Contact of potential data providers, data acquisition and establishment of a database of marine microbiologists.
- 3) Identification of "at risk" datasets, capture of the corresponding content of the remote data set and recreating or mirroring the functionality of the sites serving that data.
- 4) Assistance in linking geographical information to an archive of DNA samples where available (see below).

5) Working with OBIS to facilitate the substitution of GenBank numbers for Genus and Species identifiers.

The Royal Netherlands Institute for Sea Research has plans to set up a DNA sample database, i.e. a database of samples (with extensive contextual information) obtained during cruises and from which the DNA has been extracted and stored. This data base will operate via a NIOZ-server but will be linked to MICROBIS. Such a database will be highly interoperable with a few other databases which are presently being developed (i.e. the cruise meta database, historical, present and future, informing the client which RV went or is going when and where and who is or was the PI/ship operator to contact for measurements, samples, berths, etc.) or have already been developed (i.e. that is a SeaDataNet database regarding CSR's, the Ship Cruise Reports which have to be produced within one or two weeks after a cruise and contain the metadata of samples taken, measurements made, on-board experiments performed, etc.; this database exists for Europe and will be globally extended) as well as the IODE database of all the detailed data produced from those samples and measurements assembled through the NODCs (the National Ocean Data Centers). Hence, these 4 databases together will give a complete overview of cruises as such, metadata directly available after the cruises and real data later on and the DNA sample repository.

On October 3-5, 2006, ICoMM will participate in the First Annual International Conference of Metagenomics sponsored by the Calit2, UCSD, the J. Craig Venter Institute, CAMERA and the Moore Foundation. During this meeting ICoMM representatives will interact with members of the CAMERA initiative to address the input and output services recommended by ICoMM's Informatics and Data Management working group. In addition, the following individuals that are actively participating in the Metagenomics Meeting have the following affiliations with ICoMM:

Conference speaker **Frank Oliver Glöckner**/ Max Planck Institute for Marine, is a member of the ICoMM Technology Working Group and Informatics and Data Management Working Group, and participated in the ICoMM 1st annual meeting this past June in The Netherlands.

Terry Gaasterland is member of the CAMERA initiative and participated in the Informatics and Data Management Working Group Meeting in Woods Hole.

Francisco Rodriguez-Valera/ Universidad Miguel Hernández is a member of the ICoMM Scientific Advisory Council and participated in the ICoMM 1st annual meeting this past June in The Netherlands.

Victor Markowitz/ Lawrence Berkeley National Lab participated in the Informatics and Data Management Working Group Meeting in Woods Hole in September 2005.

Alexandra Z. Worden/ University of Miami (FL) attended the ICoMM Open Ocean and Coastal Systems workshop in Hawaii and participated in the Informatics and Data Management Working Group Meeting in Woods Hole.

LIPIDS Database

The Lipids group within ICoMM has developed links to major initiatives: the lipid database will be further developed in close cooperation with Lipid Maps, Lipid Metabolites And Pathways Strategy (<http://www.lipidmaps.org/>).

454 Methodology Development

In the Fall 2006, the MBL will obtain its first pyrosequencing machine. The following is a summary of samples that have been targeted for 454 sequencing in the Keck proposal:

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|---------------------------|--|
| July 2006 -June 2007 | Study of 250 TRANSAT samples |
| July 2006- June 2008 | Process 8 samples/month – Station ALOHA |
| December 2006- March 2007 | Analysis of Western Marianas and Loihi samples collected in fall, 2006 |
| December 2006- June 2008 | Deep subsurface and COHH samples |
| December 2006- June 2008 | Other field sites endorsed by ICoMM |

Meetings/Sessions

September 24-28 2006: ICoMM will participate in 14th Annual International Meeting on Microbial Genomics in Lake Arrowhead, CA. Dr. Julie Huber will be speaking.

October 3-5th 2006: ICoMM will participate in the “Exploring Subseafloor Life With the Integrated Ocean Drilling Program” in Vancouver, British Columbia, Canada. Dr. Mitchell Sogin is on the organizing committee and is an invited speaker.

November 2-5th 2006: ICoMM will participate in the 7th Asia Pacific Marine Biotechnology Conference on November 2-5th in Kochi, India. Dr. Linda Amaral-Zettler will be representing ICoMM.

February 2007: ASLO meeting in New Mexico; ICoMM will help to sponsor the “Plankton in Art” workshop.

May 2007, An ICoMM session is under consideration at the American Society for Microbiology meeting in Toronto. The topic would be “The Rare Biosphere: Implications and Study”.

Cruises:

ICoMM will participate in an upcoming **CReefs** cruise slated for October 6th-26th to the French Frigate Shoals. ICoMM affiliate, Dr. Monica Medina from the University of California Merced will be sending her student Emmanuel Irizzary Soto to collect samples for marine protist diversity.

As part of an **NSF funded Iron Microbial Observatory** lead by ICoMM Benthic Systems Working Group Chair, Katrina Edwards, ICoMM affiliate Dr. Julie Huber will be participating in a cruise to the Loihi Seamount 18.92° N 155.27° W, 30 km southeast of the big island of Hawaii. The cruise will take place on the R/V Melville on October 24th-November 11th. This work focuses on determining the microbial diversity and genomic content of the subseafloor microbial community at geographically and geochemically distinct deep-sea hydrothermal seamounts. Julie will apply V6 454 tag sequencing technology to some of the samples collected during this trip. ICoMM relevant questions to be addressed during this cruise include: What is the distribution and relative abundance of microbial lineages in the subseafloor environment? Is there a core set of lineages or genes specific to the subseafloor environment?

ICoMM Scientific Organizing Committee member Gerhard Herndl will lead a research cruise on the **R/V Pelagia** from mid Nov to mid Dec 06 to the (sub)tropical North Atlantic with a focus on the meso- and bathypelagic waters. Samples will be taken for bacterial and archaeal abundance and production, community composition using ARISA and cloning and sequencing & CARD-FISH. CARD-FISH combined with microautoradiography and calibrated via bulk community measurements

is used to determine the uptake rates of specific bacterial and archaeal populations. Moreover, high pressure sampling and incubation systems are used to measure the metabolic activity of specific populations and the bulk prokaryotic community under in situ pressure conditions and to compare them with the activity measured under decompressed conditions. Another research cruise is planned to the same region in Nov-Dec 07.

Pending Grant Submissions:

Gerhard Herndl is preparing a proposal to the **European Science Foundation** in the frame of EuroCores. The focus of this proposal is to identify prokaryotic diversity hot-spots in the deep ocean. The proposal will also have a compartment with a focus on protists and viruses in the deep ocean. The study area is the North Atlantic and 5 different European research institutes are involved.

Mitchell Sogin is preparing a proposal for the **National Institutes of Environmental Health Sciences** to establish baseline microbial diversity surveys of marine environments impacted by human activities.

Mitchell Sogin is also preparing a research proposal on the Microbial “Rare Biosphere” to the **Sloan Foundation**.

Linda Amaral-Zettler is pursuing a proposal to the **National Science Foundation** with colleagues from the Woods Hole Oceanographic Institution to establish a GK-12 program in the greater Woods Hole Community that will foster Census of Marine Life goals and promote the Ocean Literacy Campaign.

4. EDUCATION & OUTREACH

In October 2005, Dr. David Patterson held a Protistology workshop that provided training in marine protist taxonomy and integration with the NSF EUTREE ATOL Project.

The largest outreach activity to report on is the media event prepared by the CoML education and outreach headquarters in relation to the PNAS publication spearheaded by ICoMM PI Mitchell Sogin and colleagues. The latest coverage summary now includes 220 media websites across 24 countries and in nine languages. This response qualified the story as one of the top five Terry Collins helped produce over 10 years, just slightly smaller than the 2003 Census launch.

In January 2006, ICoMM contributed \$4000 towards the Austral Summer Institute held in Chile and organized by Dr. Victor Gallardo.

In March of this year, children’s book writer Karen Romano Young approached the ICoMM secretariat about using an image of an Acantharian for a book that she was working on. Across the Wide Ocean: The What, Where, and Why of Navigation by Humans and Animals at Sea -- by Karen Romano Young, will be published by Greenwillow (an imprint of HarperCollins) in May, 2007.

Also in March, 2006, ICoMM helped organize a luncheon to address the topic of “Visualizing Microbes”. Dr. Jan Rines from URI is working with CoML outreach and education liaison (Sara Hickox), ICoMM Secretariat (Linda Amaral-Zettler) and ICoMM SOC member David

Patterson to submit a proposal to the Sloan Foundation that will bring together Contemporary Media Specialists, Art and Science Experts, and Microscopic Imaging Technical Experts to discuss better ways of bringing microbes into the public view.

At the June meeting in Noordwijkerhout, invitees of representative South American countries and ICoMM representatives met to discuss the formation of a Latin American/Caribbean regional node of ICoMM. The group consisted of the following representatives: Linda Amaral-Zettler (USA: ICoMM), Carola Espinoza (Chile) Victor Ariel Gallardo (Chile), Martha Gómez (Colombia), Francisco Rodríguez-Valera (Spain:ICoMM), and Rodolfo Paranhos (Brazil). Felipe Artigas (France:Chile) was the organizer but was unable to attend the meeting due to health issues. ICoMM will be providing some financial support for a series of meetings to establish a South American and Caribbean ICoMM regional node. Dr. Mitchell Sogin plans to attend one of planning meetings set for 2007.

Also at the June ICoMM meeting, invitees from China expressed interest in establishing a Chinese regional node of ICoMM. Drs. Xiao Tian and Shining Zhou have been in contact with CoML NRIC Prof. Sun Song to advise on the next steps to take. These included/ will include: 1. Introducing the International Census of Marine Microbes and its goals to marine microbiologists in China at the “Marine Sciences Symposium, Chinese Academy of Sciences” on July 28-31 in Qingdao and at the “2nd Marine Microbiology Symposium in China” on August 2-6 in Dalian. 2. Convening a meeting of an ICoMM-Chinese Working Group in October, 2006 in Qingdao, China to develop a strategy for attracting Chinese marine microbial scientists to ICoMM and establishing how Chinese scientists can contribute to the ICoMM effort. 3. At a suitable time in the future, Dr. Linda Amaral-Zettler (ICoMM Secretariat) will visit China to give a presentation on ICoMM and facilitate interactions with China ICoMM .

5. GEOGRAPHIC EXPANSION

We hope that the recent appointment of Dr. D. Chandramohan to the ICoMM Scientific Advisory Council will help expand the geographic scope of our project. Dr. Chandramohan has agreed to assist in this endeavor by giving talks to colleagues at venues not yet visited by ICoMM constituents. Likewise we have relied upon the efforts of Dr. Victor Gallardo (Chile) and Prof. Sun Song (China) to assist in ICoMM globalization efforts. As with the emerging South American and Chinese regional nodes we anticipate development of other regional ICoMM nodes (India, Canada, etc.). ICoMM participation in the Asia-Pacific Marine Biotechnology Conference will hopefully facilitate this effort. We have also begun a dialog with Robin Rigby at NaGISA to collect samples for microbial analyses.

6. PARTNERSHIPS & COLLABORATION

a. Partnerships

| Organization Name | Point-of-Contact | Nature of Relationship |
|---------------------------------------|---------------------------------|---|
| NASA Astrobiology Program | Mitchell Sogin | NAI participants involved in ICoMM activities |
| Seamount Biogeosciences Network (SBN) | Mitchell Sogin/ Katrina Edwards | Senior Personnel |
| NSF | Matthew Kane | Meeting to discuss funding opportunities for ICoMM effort |

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| CIAR (Canadian Institute for Advanced Research) | David Patterson | Banff Microbial Diversity Workshop Participant |
| WHCOHH (Woods Hole Center for Oceans and Human Health) | Linda Amaral-Zettler | Program Co-I |
| NSF NSDL (National Science Digital Library) program/ Microbial Life Digital Library | David Patterson | PI |
| NSF Microbial Observatory in the Cariaco Basin | David Patterson | Co-I |
| TreeBase/CIPRES (Cyberinfrastructure for Phylogenetic Research) | William Piel/David Patterson | ICoMM IDM member/ ICoMM Scientific Organizing Committee |
| MARBEF (Marine Biodiversity and Ecosystem Functioning) /EUROBIS | Edward vanden Berghe/ Carlo Heip | ICoMM IDM member |
| Joint Genomes Institute (JGI) | Victor M. Markowitz | ICoMM IDM member |
| MARBEF Responsive Mode Project | Gerhard Herndl/ Lucas Stal | ICoMM Scientific Organizing Committee members |
| OBIS | Vishwas Chavan | ICoMM IDM member |
| Scripps Institution of Oceanography | Terry Gaasterland | ICoMM IDM member |
| Woods Hole Oceanographic Institution | Katrina Edwards | ICoMM IDM member; Benthic Systems Working Group Chair |
| Micro-Mar | Francisco Rodriguez-Valera | ICoMM IDM member; SAC member |
| TIGR | William Nelson | ICoMM IDM member |
| Sapelo Island Microbial Observatory /LTER | Wade Sheldon | ICoMM IDM member |
| ARB | Frank Oliver Gloeckner | ICoMM IDM member; ICoMM Technology Working Group |
| JGOFS (Joint Global Ocean Flux Study) | Cyndy Chandler | ICoMM IDM member |
| uBIO (Universal Biological Indexer and Organizer) | David Remsen | ICoMM IDM member |
| DIVERSA | Eric Mathur | ICoMM Technology Working Group |
| Ocean Drilling Program (ODP) | Steve D'Hondt | NAI member; ICoMM Benthic Systems Working Group member |
| Culture Collection of Marine Protists (CCMP) | Robert Andersen | ICoMM SAC member |
| JAMSTEC (Japan's Marine Science and Technology Center) | Koki Horikoshi | ICoMM SAC member |
| POGO (Partnership for Observation of the Global Ocean) | Jan W. de Leeuw | Meeting participant |
| MIRACLE (Microbial Marine Community Diversity: from Culture to Function) | Francisco Rodriguez-Valera/ Lucas Stal | ICoMM IDM member; SAC member/ ICoMM Scientific Organizing Committee member |
| BASICS (Bacterial single-cell approaches to the relationship between diversity and function in the Sea) | Gerhard Herndl | ICoMM Scientific Organizing Committee member |
| SOLAS (Surface Ocean-Lower Atmosphere Study) | Gerhard Herndl | ICoMM Scientific Organizing Committee member |
| SCOR Working Group to Investigate the Role of Viruses in Marine Ecosystems | Gerhard Herndl | ICoMM Scientific Organizing Committee member |
| EuroDEEP (Ecosystem Functioning and Biodiversity in the Deep Sea) | Gerhard Herndl | ICoMM Scientific Organizing Committee member |
| EU Network of Excellence | Lucas Stal | ICoMM Scientific Organizing |

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|--|------------------------|--|
| EurOceans | | Committee member |
| NSF EUTREE ATOL project | David Patterson | ICoMM Scientific Organizing Committee |
| SeaLifebase | David Patterson | ICoMM Scientific Organizing Committee |
| Genome Standards Consortium | Frank Oliver Gloeckner | ICoMM IDM member; Benthic Systems Working group member |
| Marine Microbes Gordon Research Conference | Phil Neal | ICoMM IT specialist |

b. Links to Other CoML Ocean Realm Projects

| Project Name | Cross-Over Person(s) | Nature of Relationship |
|--------------|--------------------------------|---|
| CMarZ | Robert Groman | ICoMM IDM working group member |
| ChEss | Paul Tyler/ Eva Ramirez-Llodra | ICoMM Benthic Systems Workshop Hosts |
| ChEss | Antje Boetius | ICoMM SAC member |
| GoMA | Linda Amaral-Zettler | GoMA working group participant |
| GoMA | Bill Li | ICoMM Open Ocean and Coastal Systems Working Group member; GoMA working group participant |
| OBIS | Vishwas Chavan | ICoMM IDM member |
| CReefs | Meegan Meows | CReefs Cruise |
| NaGISA | Robin Rigby | Sample collection |
| CMarZ | Columban de Vargas | CMarZ/ICoMM working group TBA |
| CeDAMAR | Jan Pawlowski | CMarZ/ICoMM working group TBA |
| CAML | Alison Murray | ICoMM Annual Mtg participant |
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c. Links to CoML National and Regional Implementation Committees (NRICs)

| NRIC | Liaison or Cross-over personnel | Nature of Relationship |
|--------------------|---------------------------------|--|
| Australia | | |
| Canada | Connie Lovejoy | ICoMM 1 st annual meeting participant |
| Caribbean | | |
| China | Sun Song | ICoMM –China contact |
| Europe | Jan de Leeuw | ICoMM - CoPI |
| Indian Ocean | D. Chandramohan | ICoMM – Scientific Advisory Council Member |
| Japan | Koki Horikoshi | ICoMM Scientific Advisory Council Appointed member |
| South America | Victor Gallardo | ICoMM – South America Contact |
| Sub-Saharan Africa | | |
| USA | | |

d. Liaisons to CoML Cross-Cutting Groups

| Project Name | Liaison Name & Institution | Nature of the Relationship |
|---------------------|---|---|
| OBIS | Phil Neal/MBL | OBIS liaison |
| HMAP | TBD | None to date |
| FMAP | TBD | Future meeting participant (Robust Estimation of Rare Species: Trends and Spatial Distribution. March 2007) |
| SCOR Tech Panel | Gerhard Herndl/NIOZ | 454 consultant |
| E&O | Linda Amaral Zettler/MBL | Outreach Liaison |
| Barcoding | Mitchell Sogin/Linda Amaral Zettler/MBL | Meeting participants/Development of microbial barcode |

e. Effectiveness of the Partnerships and collaborations

The CoML NRICs, the CoML E&O office and interactions with other Ocean Realm Projects have lead to very fruitful outcomes for ICoMM. ICoMM recently benefited very greatly from the coordinated outreach efforts of the CoML E&O office in the media event surrounding the Sogin et al PNAS manuscript on the rare biosphere. The benefit of the CoML NRICS was already illustrated above.