BARCODING MARINE LIFE

Report of a meeting organized by the Census of Marine Life in conjunction with the Consortium for the Barcode of Life

Amsterdam, 15-17 May 2006

Ann Bucklin1, David E. Schindel2, Paul Hebert3 and Bob Ward4

Introduction

The Census of Marine Life (CoML) is an international initiative dedicated to documenting the diversity, distribution and abundance of past and present life in the world's oceans, and to predicting the future state of marine life. CoML operates through a number of activities, including an ambitious set of field projects. “DNA barcoding” is a technique that several CoML field projects are using to assist their efforts to identify and document marine species. DNA barcoding uses a short gene sequence from a standard position in the genome as a diagnostic tool for species identification. The goal of this 2 ½ day meeting was to disseminate information on DNA barcoding to the leaders of CoML field projects, and to build collaborations between CoML and the DNA barcoding community.

The Consortium for the Barcode of Life (CBOL) is an international initiative hosted by the National Museum of Natural History, Smithsonian Institution. CBOL has more than 125 Member Organizations from 40 countries, and it is devoted to promoting DNA barcoding as a global standard for species identification. The workshop agenda was developed as a collaborative effort between CoML and CBOL.

Acknowledgments

Funding for this meeting was provided by the Alfred P. Sloan Foundation of New York. CBOL provided support for the participation of leaders from the barcoding community, and administrative support during the organizational stages leading up to the meeting. The University of Connecticut provided... The Scientific Committee on Oceanic Research (SCOR) provided support for several attendees. Local arrangements and meeting space were provided by the Netherlands Royal Academy of Arts & Sciences.

Workshop Structure and Content

The workshop included four sections:

- A public symposium which introduced DNA barcoding, CBOL, and the application of barcoding to taxonomic research and applied problems such as marine invasive species. A presentation on biodiversity research in India sensitized workshop attendees.

---

1 Director, Department of Marine Sciences, Marine Sciences and Technology Center, University of Connecticut - Avery Point, 1080 Shennecossett Road, Groton, CT 06340
2 Executive Secretary, Consortium for the Barcode of Life, National Museum of Natural History, Smithsonian Institution, Washington, DC
3 Department of Integrative Biology, University of Guelph, Guelph ON N1G 2W1 Canada
4 CSIRO Marine and Atmospheric Research, Hobart, Tasmania 7001, Australia
5 See meeting agenda, Appendix 1. Presentations linked to the agenda are available at http://www.barcoding.si.edu/coml_agenda_2006.htm
participants to the concerns of developing countries that are approached by international initiatives;

- A seminar on the DNA barcoding technique and the design and implementation of barcoding research projects. Participants discussed data standards for barcode data, strategies for obtaining and curating voucher specimens, laboratory protocols for extracting and amplifying DNA and obtaining sequences, intellectual property rights, and other topics related to the conduct of large-scale barcoding projects. The BOLD data system at the University of Guelph was described. BOLD is the workbench being used by all CBOL initiatives to assemble barcode data records for later transfer to GenBank;

- A series of 13 presentations on CoML’s field projects and a presentation on CoML’s Ocean Biogeographic Information System (OBIS), with special emphasis on the potential for adding value through barcoding. Two presentations on marine projects in the Assembling the Tree of Life (AToL) initiative and a presentation on Diversitas explored potential linkages to the Barcode of Life Initiative; and

- A whole-group discussion on the potential for synergy between the Barcode Initiative and CoML, some potential goals for the collaboration, and the resources and processes that would be needed to attain these goals.

**Meeting Results**

Participants agreed that adding DNA barcoding to CoML activities would enhance their impact significantly. Barcode data could be linked to data records in OBIS, which would increase the value of records generated by CoML field projects. Occurrences of species in other locations could then be compared genetically to earlier observations. Potential new species could also be compared with known species using standardized barcode data, thereby confirming or refuting differences. In these ways, barcode data could make CoML data records the basis for a more integrated, objective and repeatable analysis of marine biodiversity.

The participants agreed that setting the following goal for 2010 would be worthwhile:

- Establish a “reference library” of DNA barcodes for as many of the 200,000 known marine species as possible. For each species, representative voucher specimens would be obtained from:
  1. Existing collections and museum holdings. These specimens have the advantage of already being identified, for the most part. The disadvantage is that the DNA of many of these specimens is degraded, either because of original fixation in formalin and/or the aging process; and
  2. Recent and future CoML expeditions. These specimens provide intact DNA as well as fresh tissue that can be preserved in cryogenic repositories. Using these specimens as barcode vouchers will require identification by taxonomic specialists in that group.

Participants discussed the challenges associated with reaching this goal, and they identified a number of action items that should be undertaken:

A. **Increase awareness of DNA Barcoding.** Develop an educational process on the potential value of DNA barcoding to CoML. This process should target the science
community, collectors, end-users (e.g., government agencies, industry, conservation
groups), CoML scientists and other scientists such as AToL. This process should also
enhance collaboration among CoML scientists.

B. **Establish a data infrastructure for marine barcodes.** CBOL has established data
standards for barcode records in GenBank, EMBL and DDBJ, with GPS locality data
and linkages to databases of taxonomic names and on-line museum catalogs. CoML
projects will need to encourage the managers of existing and new specimen
collections to digitize their specimen records and put them online, so they can be
linked to barcode records.

C. **Agree on the standard barcode region to be used in marine groups.** The
mitochondrial COI region is being used for most animal groups but it does not work
for some marine taxa. CBOL anticipates that there will be barcode regions other than
COI and is creating a protocol for reviewing proposals to formally adopt others.
CoML projects should learn more about this process and submit proposals for suitable
barcode regions in groups where COI doesn’t work.

D. **Consider costs and benefits.** Most CoML projects have not been designed and
costed to include comprehensive programs of specimen curation and barcoding. They
will need to consider the costs and benefits of adding a barcoding component.
Alternatively, they could seek partnerships with taxonomic research programs that
would benefit from the specimens collected by CoML projects and would obtain
barcode data that could be linked back into OBIS.

E. **Expand linkages between CoML field projects and specimen repositories.** CoML
needs to develop and promote a tradition of specimen vouchering. Museums and
other kinds of collections, especially those that are CBOL Member Organizations,
should be approached about becoming repositories for new collections produced by
CoML field projects.

F. **Create barcoding and curatorial protocols for use by CoML field projects.** As
the culture of specimen vouchering grows and linkages to specimen repositories
develop, CoML projects will need to adopt standard curatorial practices. CBOL and
the museum community could produce and distribute updated protocols for specimen
collection, processing and analysis. These protocols would ensure preservation of
tissue and DNA for molecular analysis as well as smooth transfer of information
about specimens. CBOL’s DNA working group might also be helpful in compiling
laboratory protocols and in making them available to CoML participants. Some
protocols have already been developed and are posted on the BOLD website. Other
protocols have been developed by individual programs, and they need to be
assembled and updated.

G. **Conduct barcoding workshops** that would introduce barcoding to CoML projects
and create working partnerships with barcoding labs; and

H. **Develop sequencing capacity in developing countries.** CoML projects in
developing countries will have less access to sequencing facilities. There needs to be
an outreach effort to these countries that will result in training and capacity-building
related to DNA sequencing.
The workshop participants articulated the following Next Steps that should be proposed to CoML’s Scientific Steering Committee:

1. Adopt CBOL’s data standards, policies, and protocols;
2. Develop and agree upon standard formats for visualization of specimens and data;
3. Design strategies for archiving tissue and/or DNA extracts resulting from CoML field projects;
4. Establish partnerships with large museums that would be willing to act as repositories of barcode voucher specimens collected by CoML projects;
5. Establish partnerships with other relevant organizations (e.g., Ocean Genome Legacy) and institutions.
6. Develop and distribute integrated “workbench software” to track specimens from collection, through barcoding, to species page production.
7. Identify barcoding “service centers” for each taxon or guild; consider distributed versus centralized barcoding facilities.
8. Try to influence equipment manufacturers in ways helpful to barcoding;
9. better at-sea sequencing;
10. Identify bottlenecks in CBOL protocol chain; address most serious bottlenecks.
APPENDIX 1: Meeting Agenda

DNA Barcoding for CoML Workshop
The Netherlands Royal Academy of Arts & Sciences
The Trippenhuis, No. 29 Kloveniersburgwal, Amsterdam

Monday, May 15th  PUBLIC SYMPOSIUM

1:00 pm Welcome
1:30 pm DNA Barcoding in Broad View
   - Paul Hebert (University of Guelph, Canada)
2:00 pm DNA Barcoding: the CBOL Perspective
   - Freek Bakker (National Herbarium, the Netherlands)
2:30 pm Taxonomy and Species Discovery
   - James Hanken (Harvard University, USA)
3:00 pm Coffee Break
3:30 pm FISH-BOL: the Fish Barcode of Life Campaign
   - Bob Ward (CSIRO, Australia)
4:00 pm Barcoding for CoML: Assessing Zooplankton Diversity
   - Ann Bucklin (University of Connecticut, USA)
4:30 pm Using DNA Barcodes to Study Marine Invasions
   - Jon Geller (Moss Landing Marine Laboratories, USA)
5:00 pm Capacity Development and Education for the Barcode of Life: Meeting the Demand for Knowledge and Skills.
   - D. Chandramohan (National Inst. of Oceanography, India)
5:30 pm Summary
6:00 pm Adjourn
6:30 pm Welcome Reception
Tuesday, May 16th 

**BARCODING PROTOCOLS and PRACTICES**

9:00 am Overview of the barcoding protocol chain  
- David Schindel (CBOL)

9:30 am Data management & data standards for barcoding  
Moderator: Bob Hanner (FISH-BOL, CBOL)  
- CBOL and NCBI data requirements and standards (Bob Hanner)

10:00 am Specimen sources, collection, and shipping  
Moderator: Lee Weigt (Smithsonian)

10:30 am Fixing, preserving and curating specimens  
Moderator: Christoffer Schander (MAR-ECO)  
- The formalin question (Christoffer Schander)

11:00 am Coffee break

11:30 am Molecular protocols  
Moderator: Keith Crandall (ATOL)  
- Ribosomal genes as barcodes for microbial eukaryotes (Jan Pawlowski)  
- Tag sequencing approaches for barcoding (Mitch Sogin)  
- Exhaustive analysis of zooplankton mtCOI genes (Ryuji Machida)  
- Multiple mitochondrial pseudogenes from a copepod (Ryuji Machida)

12:30 pm Lunch

2:00 pm Taxonomic issues: identifying, naming, describing species  
Moderator: Rob de Salle (CBOL)  
- Character-based diagnosis of species boundaries (Rob de Salle)  
- Contributions from GBIF (Larry Speers)

2:30 pm Data analysis and display  
Moderator: Endre Willassen (CoML)  
- Identifying genes in cyberspace – Endre Willassen  
- DNA-Surveillance tool – Shane Lavery

3:00 pm Infrastructure, coordination, and capacity-building  
Moderator: Nancy Knowlton (CoML)  
- Approaches to implementing a CoML barcoding effort (Nancy Knowlton)  
- Outreach needs for barcoding marine life (James Woods)  
- The MOOREA approach (Chris Meyer)  
- Cephalopod Steering Committee (Bob Ward & Victoria Wadley)  
- Zooplankton sampling for barcoding in Antarctic / South China Seas (Sun Song)  
- Status and challenges of barcoding fish in Africa (Ernst Swartz)

3:30 pm Coffee break

4:00 pm Open discussion  
Moderators: Paul Hebert (CBOL) & Ann Bucklin (CoML)

5:30 pm Summation: David Schindel (CBOL)

6:00 pm Adjourn
**Wednesday, May 17th  BARCODING FOR CoML**

9:00 am DNA barcoding: opportunities for CoML (Jesse Ausubel)
9:30 am Barcoding for CoML: current activities and future plans
   - ArcOD – Rolf Gradinger
   - CAML – Victoria Wadley
   - GOMA – Lew Incze
   - NaGISA – Yoshihisa Shirayama
   - CREEFS – Nancy Knowlton
   - MAR-ECO – Endre Willasen
   - POST – David Welch
   - OBIS – Catherine Duckett

11:00 am Coffee break
   - CeDAMAR – Pedro Martinez
   - CoMarge – Lenaick Menot
   - CenSeam – Malcolm Clark
   - ChEss - Cindy van Dover
   - ICOMM – Mitch Sogin
   - CMarZ – Ann Bucklin

12:30 pm Lunch
2:00 pm Coordination with other programs and projects
   - ATOL / decapods – Keith Crandall
   - ATOL / cnidarians – Allen Collins
   - DIVERSITAS – Carlo Heip

3:30 pm Coffee break
3:45 pm Goals for accomplishments for 2007 and 2010
4:30 pm Next steps and action items
5:30 pm Adjourn
## APPENDIX 2: Meeting Participants

<table>
<thead>
<tr>
<th>Full Name</th>
<th>Company</th>
<th>Country/Region</th>
<th>Representing</th>
<th>E-mail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linda Amaral-Zettler</td>
<td>Marine Biological Laboratory</td>
<td>USA</td>
<td>ICoMM</td>
<td><a href="mailto:amaral@mbl.edu">amaral@mbl.edu</a></td>
</tr>
<tr>
<td>Pedro Martinez Arbizu</td>
<td>Natural History MuseumSenckenburg</td>
<td>Germany</td>
<td>CeDAMAR</td>
<td><a href="mailto:pmartinez@senckenberg.de">pmartinez@senckenberg.de</a></td>
</tr>
<tr>
<td>Juan Diaz de Astarloa</td>
<td>Universidad Nacional de Mar del Plata</td>
<td>Argentina</td>
<td>FISH-BOL</td>
<td><a href="mailto:astarloa@mdp.edu.ar">astarloa@mdp.edu.ar</a></td>
</tr>
<tr>
<td>Jesse Ausubel</td>
<td>Alfred P. Sloan Foundation</td>
<td>USA</td>
<td>Sloan Foundation</td>
<td><a href="mailto:ausubel@mail.rockefeller.edu">ausubel@mail.rockefeller.edu</a></td>
</tr>
<tr>
<td>Freek Bakker</td>
<td>National Herbarium Nederland - Univ.</td>
<td>Netherlands</td>
<td>FISH-BOL</td>
<td><a href="mailto:freek.bakker@wur.nl">freek.bakker@wur.nl</a></td>
</tr>
<tr>
<td>Eldredge Bermingham</td>
<td>Smithsonian Tropical Rsch. Inst</td>
<td>Panama</td>
<td>FISH-BOL</td>
<td><a href="mailto:BERMINGE@si.edu">BERMINGE@si.edu</a></td>
</tr>
<tr>
<td>Bodil Bluhm</td>
<td>University of Alaska Fairbanks, UAF</td>
<td>USA</td>
<td>ArcOD</td>
<td><a href="mailto:bluhm@ims.uaf.edu">bluhm@ims.uaf.edu</a></td>
</tr>
<tr>
<td>Malcolm Brown</td>
<td>CSIRO</td>
<td>Australia</td>
<td>ArcOD</td>
<td><a href="mailto:malcolm.brown@csiro.au">malcolm.brown@csiro.au</a></td>
</tr>
<tr>
<td>Ann Bucklin</td>
<td>University of Connecticut - Avery Point</td>
<td>USA</td>
<td>CMarZ</td>
<td><a href="mailto:ann.bucklin@uconn.edu">ann.bucklin@uconn.edu</a></td>
</tr>
<tr>
<td>D. Chandramohan</td>
<td>India</td>
<td>New Zealand</td>
<td>CenSeam</td>
<td><a href="mailto:m.clark@niwaco.nz">m.clark@niwaco.nz</a></td>
</tr>
<tr>
<td>Malcolm Clark</td>
<td>National Institute of Water and Atmospheric Research, NIWA</td>
<td>New Zealand</td>
<td>CenSeam</td>
<td><a href="mailto:m.clark@niwaco.nz">m.clark@niwaco.nz</a></td>
</tr>
<tr>
<td>Allen Collins</td>
<td>National Systematics Lab</td>
<td>USA</td>
<td>FISH-BOL</td>
<td><a href="mailto:COLLINSA@si.edu">COLLINSA@si.edu</a></td>
</tr>
<tr>
<td>Filipe Costa</td>
<td>School of Biological Sciences</td>
<td>UK</td>
<td>FISH-BOL</td>
<td><a href="mailto:fjc@fct.unl.pt">fjc@fct.unl.pt</a></td>
</tr>
<tr>
<td>Keith Crandall</td>
<td>Brigham Young University</td>
<td>USA</td>
<td>FISH-BOL</td>
<td><a href="mailto:keith_crandall@byu.edu">keith_crandall@byu.edu</a></td>
</tr>
<tr>
<td>Robert DeSalle</td>
<td>American Museum of Natural History</td>
<td>USA</td>
<td></td>
<td><a href="mailto:desalle@amnh.org">desalle@amnh.org</a></td>
</tr>
<tr>
<td>Daniel L Distel</td>
<td>Ocean Genome Legacy Foundation</td>
<td>USA</td>
<td>OGL</td>
<td><a href="mailto:distel@OGLF.org">distel@OGLF.org</a></td>
</tr>
<tr>
<td>Catherine Duckett</td>
<td>Rutgers University</td>
<td>USA</td>
<td>OBIS</td>
<td><a href="mailto:duckett@marine.rutgers.edu">duckett@marine.rutgers.edu</a></td>
</tr>
<tr>
<td>Annelise Fleddum</td>
<td>University of Oslo; Biological Institute</td>
<td>Norway</td>
<td></td>
<td><a href="mailto:fleddum@bio.uio.no">fleddum@bio.uio.no</a></td>
</tr>
<tr>
<td>Jon Geller</td>
<td>Moss Landing Marine Laboratories</td>
<td>USA</td>
<td></td>
<td><a href="mailto:geller@mlml.calstate.edu">geller@mlml.calstate.edu</a></td>
</tr>
<tr>
<td>Rolf Gradinger</td>
<td>University of Alaska Fairbanks, UAF</td>
<td>USA</td>
<td>ArcOD</td>
<td><a href="mailto:rgradinger@ims.uaf.edu">rgradinger@ims.uaf.edu</a></td>
</tr>
<tr>
<td>James Hanken</td>
<td>Museum of Comparative Zoology, MA</td>
<td>USA</td>
<td>CBOL</td>
<td><a href="mailto:hanken@oeb.harvard.edu">hanken@oeb.harvard.edu</a></td>
</tr>
<tr>
<td>Robert Hanner</td>
<td>University of Guelph</td>
<td>Canada</td>
<td>FISH-BOL</td>
<td><a href="mailto:rhattan@uoguelph.ca">rhattan@uoguelph.ca</a></td>
</tr>
<tr>
<td>Shunping He</td>
<td>Institute of Hydrobiology, Chinese Academy of Sciences</td>
<td>China</td>
<td>FISH-BOL</td>
<td><a href="mailto:clad@ihb.ac.cn">clad@ihb.ac.cn</a></td>
</tr>
<tr>
<td>Paul Hebert</td>
<td>University of Guelph</td>
<td>Canada</td>
<td>FISH-BOL</td>
<td><a href="mailto:phebert@uoguelph.ca">phebert@uoguelph.ca</a></td>
</tr>
<tr>
<td>Name</td>
<td>Affiliation</td>
<td>Country</td>
<td>Project</td>
<td>Email</td>
</tr>
<tr>
<td>-----------------------</td>
<td>--------------------------------------------------</td>
<td>---------</td>
<td>---------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>Carlo Heip</td>
<td>Netherlands Institute of Ecology</td>
<td>Netherlands</td>
<td>DIVERSITAS</td>
<td><a href="mailto:c.heip@nioo.knaw.nl">c.heip@nioo.knaw.nl</a></td>
</tr>
<tr>
<td>Graham Hosie</td>
<td>Australian Antarctic Division, AAD</td>
<td>Australia</td>
<td>CAML</td>
<td><a href="mailto:graham.hosie@aad.gov.au">graham.hosie@aad.gov.au</a></td>
</tr>
<tr>
<td>Lewis Incze</td>
<td>Bioscience Research Institute</td>
<td>USA</td>
<td>GoMA</td>
<td><a href="mailto:linzcze@usm.maine.edu">linzcze@usm.maine.edu</a></td>
</tr>
<tr>
<td>Robert Jennings</td>
<td>Marine Sciences, UConn</td>
<td>USA</td>
<td>CMarZ</td>
<td><a href="mailto:robert.jennings@uconn.edu">robert.jennings@uconn.edu</a></td>
</tr>
<tr>
<td>Nancy Knowlton</td>
<td>Scripps Institution of Oceanography</td>
<td>USA</td>
<td>CReefs</td>
<td><a href="mailto:nknowlton@ucsd.edu">nknowlton@ucsd.edu</a></td>
</tr>
<tr>
<td>Wazir Singh Lakra</td>
<td>Fish Genetics and Biotechnology, CIFE</td>
<td>India</td>
<td>FISH-BOL</td>
<td><a href="mailto:lakraws@hotmail.com">lakraws@hotmail.com</a></td>
</tr>
<tr>
<td>Ryuji Machida</td>
<td>Ocean Research Institute, University of Tokyo</td>
<td>Japan</td>
<td>CMarZ</td>
<td><a href="mailto:ryuji@ori.u-tokyo.ac.jp">ryuji@ori.u-tokyo.ac.jp</a></td>
</tr>
<tr>
<td>Richard Mayden</td>
<td>Saint Louis University</td>
<td>USA</td>
<td>FISH-BOL</td>
<td><a href="mailto:maydenrl@slu.edu">maydenrl@slu.edu</a></td>
</tr>
<tr>
<td>Lenaick Menot</td>
<td>DRO/Department Environment Profund</td>
<td>France</td>
<td>CoMargE</td>
<td><a href="mailto:lanaick.menot@ifremer.fr">lanaick.menot@ifremer.fr</a></td>
</tr>
<tr>
<td>Chris Meyer</td>
<td>Florida Museum of Natural History</td>
<td>USA</td>
<td></td>
<td><a href="mailto:cmeyer@fmnh.ufl.edu">cmeyer@fmnh.ufl.edu</a></td>
</tr>
<tr>
<td>Peter Ng</td>
<td>National University of Singapore (NUS)</td>
<td>Singapore</td>
<td>FISH-BOL</td>
<td><a href="mailto:dbsngkl@nus.edu.sg">dbsngkl@nus.edu.sg</a></td>
</tr>
<tr>
<td>Jan Pawlowski</td>
<td>University of Geneva</td>
<td>Switzerland</td>
<td>CeDAMAR</td>
<td><a href="mailto:jan.pawlowski@zoo.unige.ch">jan.pawlowski@zoo.unige.ch</a></td>
</tr>
<tr>
<td>Annelies Pierrot-Bults</td>
<td>Zoological Museum Amsterdam</td>
<td>Netherlands</td>
<td>CMarZ</td>
<td><a href="mailto:pierrot@science.uva.nl">pierrot@science.uva.nl</a></td>
</tr>
<tr>
<td>Christoffer Schander</td>
<td>University of Bergen</td>
<td>Norway</td>
<td>MAR-ECO</td>
<td><a href="mailto:christoffer.schander@bio.uib.no">christoffer.schander@bio.uib.no</a></td>
</tr>
<tr>
<td>David Schindel</td>
<td>Consortium for the Barcode of Life</td>
<td>USA</td>
<td>CBOL</td>
<td><a href="mailto:schindeldl@si.edu">schindeldl@si.edu</a></td>
</tr>
<tr>
<td>Kwang-Tsao Shao</td>
<td>Research Center for Biodiversity, Academia Sinica (RCBAS)</td>
<td>Taiwan</td>
<td>FISH-BOL</td>
<td><a href="mailto:zoskt@gate.sinica.edu.tw">zoskt@gate.sinica.edu.tw</a></td>
</tr>
<tr>
<td>Yoshiihsa Shirayama</td>
<td>Seto Marine Biological Laboratory</td>
<td>Japan</td>
<td>NaGISA</td>
<td><a href="mailto:yshira@bigfoot.com">yshira@bigfoot.com</a></td>
</tr>
<tr>
<td>Peter Smith</td>
<td>NIWA</td>
<td>New Zealand</td>
<td>FISH-BOL</td>
<td><a href="mailto:p.smith@niwa.co.nz">p.smith@niwa.co.nz</a></td>
</tr>
<tr>
<td>Mitchell Sogin</td>
<td>Marine Biological Laboratory</td>
<td>USA</td>
<td>ICoMM</td>
<td><a href="mailto:sogin@mbl.edu">sogin@mbl.edu</a></td>
</tr>
<tr>
<td>Sun Song</td>
<td>Institute of Oceanology, Chinese Academy of Sciences</td>
<td>China</td>
<td>CMarZ</td>
<td><a href="mailto:sunsong@ms.qdio.ac.cn">sunsong@ms.qdio.ac.cn</a></td>
</tr>
<tr>
<td>Lawrence Speers</td>
<td>GBIF</td>
<td>Denmark</td>
<td>GBIF</td>
<td><a href="mailto:lspeers@gbif.org">lspeers@gbif.org</a></td>
</tr>
<tr>
<td>Ernst Swartz</td>
<td>Institute for Aquatic Biodiversity</td>
<td>South Africa</td>
<td>FISH-BOL</td>
<td><a href="mailto:e.swartz@ru.ac.za">e.swartz@ru.ac.za</a></td>
</tr>
<tr>
<td>Ed Urban</td>
<td>Scientific Committee on Oceanic Research, SCOR</td>
<td>USA</td>
<td>SCOR</td>
<td><a href="mailto:scor@jhu.edu">scor@jhu.edu</a></td>
</tr>
<tr>
<td>Cindy Van Dover</td>
<td>William and Mary</td>
<td>USA</td>
<td>ChEss</td>
<td><a href="mailto:cleveland@wm.edu">cleveland@wm.edu</a></td>
</tr>
<tr>
<td>Colomban de Vargas</td>
<td>Rutgers University, Institute of Marine and Coastal Sciences</td>
<td>USA</td>
<td>CMarZ</td>
<td><a href="mailto:vargas@imcs.rutgers.edu">vargas@imcs.rutgers.edu</a></td>
</tr>
<tr>
<td>Victoria Wadley</td>
<td>Australian Antarctic Division</td>
<td>Australia</td>
<td>CAML</td>
<td><a href="mailto:victoria.wadley@aad.gov.au">victoria.wadley@aad.gov.au</a></td>
</tr>
<tr>
<td>Bob Ward</td>
<td>CSIRO Marine and Atmospheric Research,</td>
<td>Australia</td>
<td>SCOR</td>
<td><a href="mailto:Bob.Ward@csiro.au">Bob.Ward@csiro.au</a></td>
</tr>
<tr>
<td>hobart</td>
<td>lee weigt</td>
<td>smithsonian institution</td>
<td>usa</td>
<td><a href="mailto:weigtl@si.edu">weigtl@si.edu</a></td>
</tr>
<tr>
<td>-----------------</td>
<td>-----------</td>
<td>-------------------------</td>
<td>-----</td>
<td>---------------</td>
</tr>
<tr>
<td>david welch</td>
<td>david welch</td>
<td>kintama research corp, malaspina university</td>
<td>canada</td>
<td>post</td>
</tr>
<tr>
<td>peter wiebe</td>
<td>peter wiebe</td>
<td>woods hole oceanographic institution</td>
<td>usa</td>
<td>cmarz</td>
</tr>
<tr>
<td>endre willassen</td>
<td>endre willassen</td>
<td>bergen museum</td>
<td>norway</td>
<td>mar-eco</td>
</tr>
<tr>
<td>james wood</td>
<td>james wood</td>
<td>bermuda biological station for research</td>
<td>bermuda</td>
<td></td>
</tr>
</tbody>
</table>