DRAFT Theme Session D – Census of Marine Life: Community and Species Diversity in Marine benthic habitats from the coastal zone to the deep sea

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At the ICES ASC in 2002, a special session was devoted the Census of Marine Life (CoML). Since then, the Census has substantially advanced its aims of understanding the diversity, abundance, and distribution of marine organisms. There have been major developments in all components of its programme, with many new results and exciting discoveries. It is timely to focus on a narrower component of the overall Census, benthic ecosystems from the coastal zone to the deep sea. CoML field projects involving diversity and species richness of benthic communities include Natural Geography on Shore Areas (NaGISA), Gulf of Maine Area Project (GOMA), Global Census of Coral Reef Ecosystems (GCCRE), Continental Margin Ecosystems on a Worldwide Scale (CoMargE), Census of Diversity of Abyssal Marine Life (CeDAMar), Mid-Atlantic Ridge Ecosystems (MAR-ECO), Biogeography of Deep-Water Chemosynthetic Ecosystems (CHESS), Global Census of Marine Life on Seamounts (CenSeam), Arctic Ocean Diversity (ArcOD), and the Census of Antarctic Marine Life (CAML).

The theme Session encouraged papers of a synthesis nature, in which patterns of species and community diversity may be predicted based on environmental parameters, and emerging conceptual developments relating diversity to productivity and disturbance. A Census objective is to produce a synthesis of the biogeography of the benthic habitats and their associated communities for the global oceans by 2010. The Theme Session was an opportunity to initiate discussions on this challenge. Results of research on this theme, but not formally within the above listed CoML field projects were encouraged.

The Session included a number of papers which evaluated the degree to which spatial patterns in benthic assemblages and species distributions can be predicted based on environmental parameters. Six papers addressed large spatial scales. In the Gulf of Mexico study (a component of CoMargE) (D: 05) it was concluded that the observed biodiversity patterns over large spatial scales are determined by variability in vertical fluxes in food depositions. Depth was also an important factor. The objectives and questions addressed by Comarge were also presented by the CoMl Comarge coordinator. The uniqueness of the deep sea and the need for valuable taxonomic and ecological data on distinct types of margin habitats were highlighted. There is a need to understand how habitat heterogeneity is influenced by hydrodynamic, chemical, and geological processes, and how this heterogeneity affects the diversity (and interacts with the gradients of latitude, depth, and ocean basin).

In D:11, a synthesis of the biodiversity patterns of the continental shelf of the Great Barrier Reef region explored relationships between species diversity and the physical environment (eg., large scale data sets such as satellite remote sensing, oceanographic model output, sediments and bathymetry). D:02 provided a synthesis of spatial and temporal trend in species richness in the North Sea, using the trawl survey data (1977-2005) in the North Sea. Climate change, fishing pressure and possibly changes in sampling procedures (and improved identification of species) were concluded to be important in the interpretation of this rich data set. D:10 addressed the community and species biodiversity in benthic fauna of the Barents Sea, including interesting comparisons with earlier analyses carried out by Russian biogeographers. Seventeen of the taxa were found to adequately represent the variation of the sampled communities, and may serve as indicators of the impacts of future climatic changes on benthic communities. D:03 provided a synthesis of the distributions of elasmobranch species along the shelf and slope area off northwest Africa, including comparisons of recent observations with those of the 1970s and 1980s. No significant differences were reported, and

new life history features were noted. D:08 provided a global synthesis of biodiversity issues on seamounts, including estimates of the number of seamounts, the degree of endemism of species on seamounts, and the fragility of seamounts benthic communities to disturbance by trawling.

Three papers addressed spatial patterns of benthic species and communities at smaller spatial scales (within banks). D:04 used video surveys to map distributions of surficial substrates and to support scallop fisheries management off northeast USA. D:01 used bottom type and water depth information to predict by-catch species in a sea scallop fishery off Nova Scotia. D:13 provided detailed observations of hotspots of benthic biodiversity on Georges Bank, and evaluated the relative roles of groundfish and scallop fishing on the observed spatial patterns. All three papers highlighted the importance of scale in predicting spatial patterns of species and assemblage distributions.

There was a good discussion on the degree to which spatial patterns in benthic biodiversity in shelf, slope and deep-sea areas can be characterized. Detailed information concerning the nature of substrata is becoming available by using close to sea-bottom multi-beam systems and side-scan sonars operated at different high frequencies. Oceanographic models of bottom currents and surface estimates of primary productivity using ocean colour data from satellites might also help to predict shelf and upper slope spatial patterns in benthic biodiversity. While it was recognised that there is scope for predicting spatial patterns of benthic biodiversity, parallel efforts need to focus on analyses that allow the organisms to inform us of their preferential habitats. Enhancement of empirical observations of distributions of species and assemblages in relation to environmental parameters, in particular in slope and deep seas environments was considered to be a high priority (given the degree to which they were presently under-sampled).

The three final papers addressed processes that control the distributions of species and populations at a range of spatial scales. D:19 used the north-Atlantic data on species distributions in the Ocean Biogeographic Information Systems (OBIS) to evaluate the origins of benthic species of the northeast and northwest Atlantic on geological time scales. It was concluded that dispersal (from the northeast to the northwest) following glaciation events about 20,000 years ago is the most important process in the origin of present patterns of species on the northwest Atlantic. D:09 provided a synthesis of the patterns of decapod species in the Euro-Asiatic Seas of the Arctic Ocean. The patterns were related to temperature and salinity distributions, and the low degree of endemic Arctic decapod species summarised. D:12 evaluated the degree to which patterns of dispersal at relatively small spatial scales can be evaluated from genetic and life history observations. Paradoxically it was noted that the mode of reproduction (species with and without free living larval stages) was not a determinant of dispersal capacity.

The general discussion following the papers focussed initially on the utility of OBIS to address research questions on changes in species distributions on geological time scales. Overall it was concluded that OBIS is becoming an increasingly useful research tool to address diverse biodiversity issues. There was also a short discussion on possible interpretations of why the only decapod groups to have endemic species in the Arctic is Caridea.

Three posters illustrated the role of integrated studies and cooperation 1) by creating links between scientists within countries belonging to EuroCoML (D:17), 2) by new approaches for mapping benthic invertebrates assemblages in well-studied coastal areas with an adequate protocol of trawl sampling and video surveys to describe the structure of macro epibenthic invertebrates assemblages and to determine which environmental variables best explained the observed patterns in the assemblages. (D:15) 3) by the exceptional collection of 1260

cephalopods along the mid Atlantic Ridge (MAR-ECO) which show an increase of diversity from North to South. (D:16)

As a follow-up to the theme session, participants met for a discussion on conceptual issues in benthic ecology that are of interest to several of the field projects of CoML. The synthesis of the research activities of the Census will be completed in 2010, thus it was timely to initiate discussions on such issues. The potential role of ICES, and of a putative SCOR WG, in the synthesis activities were also discussed. The discussion identified "hot topics" that are tractable within a 3 to 5 year time frame, as well as technical issues that require attention across projects within the Census.

Conclusions

Theme Session D was considered by the participants to be very timely. It provided a focus on benthic biodiversity, an emerging research area of high priority for ICES given the key role of addressing benthic disturbance by anthroprogenic activities within ecosystem-based management (EBM), and the rapid advances that are being made in this research field due to technological innovations (eg. Multi-beam sonar, optical equipment, oceanographic modelling of bottom currents, focussed sampling of fauna, and controlled video surveys). It appears that progressively the strategy of sea operations in the deep sea allows quantitative approaches like that in coastal waters. A crisis in the study of biodiversity appears today because all the traditional taxonomists are retiring, and are not being replaced by taxonomists able to work in close relationship with molecular biologists. There is a particular need for taxonomists to work on deep sea biodiversity studies.

The papers were all of high quality, and in most cases were based on the synthesis of extensive multi-disciplinary data sets. The discussions were animated and follow-up actions are in the process of being defined. It was unfortunate, however, that not all of the ten CoML field projects of relevance to benthic biodiversity were included in the session.