Workshop on Ocean Biology Observatories

Mestre, Italy

16-18 September 2009

International Council for Science
SCOR
Scientific Committee on Oceanic Research

CENSUS OF MARINE LIFE

Goal of Workshop: Bring together biologists, observing community, and technological community to develop ocean biology observatories that could address the grand challenges of observing ocean life and its response to global change.

Definition of an ocean biology observatory: The definition will be broad, including a sustained, integrated system created from a broad range of platforms that can support existing and emerging technologies for observing marine life and its interaction with the ocean and broader Earth system. The observatory components will include platforms, instrumentation, data management and analysis. Observatories could include fixed-point moorings (cabled or autonomous), animals as oceanographers, measurements from Volunteer Observing Ships, AUVs/ROVs/HOVs, drifters, CPRs, Ocean Tracking Network, and satellites, among other platforms and technologies.

Product from workshop: The workshop will result in a detailed workshop report, a summary paper and, potentially, papers submitted to a special issue of *Public Library of Science (PLoS) One.* The draft structure of the workshop report follows.

1. Introduction
2. Summary of the discussions for each working group
    a. Observational approaches to ocean acidification and oxygen depletion
    b. Observational approaches to community structure, from microbes to zooplankton
    c. Observational approaches to distribution and movement of marine organisms in relation to physical/chemical structures
    d. Observational approaches to changes in trophic structures
    e. Observational approaches to changes in benthic dynamics
3. Workshop summary and recommendations
    a. How can different observational approaches be integrated and what advantages would be gained?
    b. What kinds of intercalibrations and validations are needed among sensors of the same type, as well as different approaches?
    c. How can these activities be funded, particularly sustained observations?
    d. How can data be integrated, delivered, and visualized?

Each breakout group should produce a written report for section 2 above that will address

- Background and context for observing approaches related to the group's topic
- Need for systematic long-term measurements over large scales
- What are the priority observations to address this issue?
- Where should the observations be made and at what frequency and duration?
- Observational technologies now available and on the horizon, and gaps in available sensors to address the need

Funding for Workshop
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Program

<u>16 September (Wednesday)</u>

9:00 a.m. Introduction – Alex Rogers

9:30 a.m. **Plenary Session 1 (Moderator: Alex Rogers)**
What parameters do we need to observe to understand the response of ocean biology to global change and the impacts of biological changes on the Earth system? What collection of observations is needed?

9:30 a.m. Modeling and observations: How do they interact (parameterization to data assimilation)? - *Katja Fennel*, Dalhousie University and *Philippe Cury*, IRD, France

11:00 a.m. Morning Break

11:30 a.m. Thresholds/tipping points/regime shifts/forecasting extreme events – *Francisco Chavez*, Monterey Bay Aquarium Research Institute

12:15 a.m. Introduction to Breakout Groups

<u>Breakout Groups</u>

1. Observational approaches to ocean acidification and oxygen depletion (Chair: *John Volkman*, Rapporteur: *Scott Bainbridge*)
2. Observational approaches to community structure, from microbes to zooplankton (Chair: *Bengt Karlson*, Rapporteur: *Rubens Lopes*)
3. Observational approaches to distribution and movement of marine organisms in relation to physical/chemical structures (Chair: *Dan Costa*, Rapporteur: *Ron O'Dor*)
4. Observational approaches to changes in trophic structures (chair: *Hans Paerl*, Rapporteur: *Bob Gisiner*)
5. Observational approaches to changes in benthic dynamics (Chair: *Alex Rogers*, Rapporteur: *Kate Larkin*)

12:45 p.m. Lunch

1:45 p.m. **Breakout Session 1**

3:30 p.m. Afternoon Break

4:00 p.m. Resume Breakout Session

6:00 p.m. Adjourn for the day
Reception and Poster Session at Hotel

17 September (Thursday)

9:00 a.m. **Plenary Session 2 (Moderator: Skip McKinnell**)
What are the global change issues that we need to address and the observational approaches required? –

9:00 a.m. Observational approaches to ocean acidification – *Andrew Dickson*, Scripps Institution of Oceanography

9:30 a.m. Observational approaches to oxygen depletion – *Denis Gilbert*, Fisheries & Oceans Canada

10:00 a.m. Observational approaches to community structure, from microbes to zooplankton – *Kendra Daly*, University of South Florida

10:30 a.m. Observational approaches to distribution and movement of marine organisms and changes in ocean properties – *Barbara Block*, Stanford University

11:00 a.m. Morning Break

11:30 a.m. Observational approaches to vertical movements of predators and prey in relation to physical/chemical structures – *Martin Biuw*, Norwegian Polar Institute

12:00 p.m. Observational approaches to changes in benthic dynamics – *Paul Snelgrove*, Memorial University

12:30 p.m. What is the marginal benefit of putting in place ocean biology observatories? What chance is there for ocean biological observatories to make a difference? – *Steve Rintoul*, CSIRO, Australia

1:00 p.m. Lunch

2:00 p.m. **Breakout Session 2**

4:00 p.m. Afternoon Break

4:30 p.m. Resume Breakout Session

6:00 p.m. Adjourn for the Day

18 September (Friday)

9:00 a.m. **Plenary Panel discussion (Moderator: John Gunn**)

10:00 a.m. Reports back from yesterday's breakout sessions

11:00 a.m. Morning Break

11:30 p.m. **Plenary Discussion**
What are the common features among the reports from the six working groups?

1:00 p.m. Lunch

1:30 p.m. **Breakout Session 3**

- How can different observational approaches be integrated and what advantages would be gained?
- What kinds of intercalibrations and validations are needed among sensors of the same type, as well as different approaches?
- How can these activities be funded, particularly sustained observations?
- How can data be integrated, delivered, and visualized?

3:30 p.m. Afternoon Break

4:00 p.m. Final Report Back from Breakout Groups

5:30 p.m. **Closing**
Schedule and action items for production of special issue and science and implementation plan

Poster Abstracts

CHALLENGES TO UNDERSTANDING THE DYNAMICS OF HARMFUL PHYTOPLANKTON BLOOMS

Berdalet, Elisa[1], Mireia L. Artigas[1], Oliver Ross[2], Jaume Piera[2] and Marta Estrada[1]

Some proliferations of microalgae, known as "Harmful Algal Blooms" (HABs) cause world-wide problems with significant ecological, economic, social and human health consequences, constraining the sustainable development of valuable marine resources. The mechanisms underlying the population dynamics of species causing HABs are complex because they result from the interplay of a spectrum of physico-chemical and biological factors to which the organisms respond with a variety of strategies.

Improvements have been made regarding the development of both conceptual models to explain HAB dynamics and of technologies allowing to track physico-chemical variables in real time and with high spatial resolution. However, two major challenges remain: 1) the early and fast detection of harmful organisms, in particular of those able to cause toxicity events when present at low biomass, for which remote sensing techniques are not useful; and 2) the measurement of relevant biological parameters, especially growth, encystment, mortality, grazing, and swimming speed, with a spatio-temporal resolution matching that available for the physico-chemical variables.

We are facing these challenges at our study site in Alfacs Bay (Ebre Delta, NW Mediterranean) where we conducted a two-year series of biological and physical measurements that allowed us to establish several basic scenarios leading to different types of HAB events. We have also identified key questions that require further sampling strategies and new measurement tools. We hope that the interaction with participants at this workshop will provide us with some valuable ideas in order to develop new and improved instrument designs.

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COMBINING OCEAN BIOLOGY OBSERVING SYSTEMS TO MONITOR ECOSYSTEM VARIABILITY IN THE SOUTH GEORGIA REGION OF THE SOUTHERN OCEAN

Fielding, Sophie; Claire Waluda; Simeon Hill; Dirk Briggs; Peter Enderlein; Eugene Murphy; Phillip Trathan; and Jonathan Watkins

The region around South Georgia, situated on the Scotia Arc in the eastward flowing Antarctic Circumpolar Current, is an oasis of primary and secondary productivity and consequently an area of high economic and scientific value. The British Antarctic Survey undertakes a substantial long-term monitoring programme to assess the effect of both man-made and natural variability on the structure and function of the South Georgia ecosystem. It utilises a number of observing platforms spanning from hydrography to higher trophic levels: instrumented moorings, collecting temperature, salinity and krill abundance; ship-based sampling, examining krill abundance and distribution; instrumented animals, describing foraging behaviour and

performance; higher predator success metrics (part of the CCAMLR Ecosystem Monitoring Programme), based on diet, mass and breeding success for key birds and Antarctic fur seals.

Examined individually, these observations indicate the dynamics of key ecosystem components. Combined, they show a marine pelagic ecosystem characterised by considerable inter-annual variability which is linked to large-scale climate variability, mediated by local oceanographic and atmospheric conditions. The multiple and long-term nature of the observations enable us to link climate anomalies in 2008 with extreme anomalies in the multiple South Georgia ecosystem indicators in 2009. These included high sea surface and air temperatures, low krill density and low foraging success in a number of krill predators. These observations indicate that Antarctic krill are a major mediator and intensifier of the bottom-up effects of climate on this ecosystem.

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CONDOR PROJECT: AN OBSERVATORY FOR STUDYING AND MONITORING AZOREAN SEAMOUNT ECOSYSTEMS

Giacomello, Eva; Ana Colaço; and Gui Menezes

Seamounts are some of the most ubiquitous topographic features on Earth and play an important role in the marine realm. They are common topographic features in the Azores archipelago EEZ and are extremely important ecosystems in the region, not only at the biological level but also at the economic and, indirectly, at the social level. Shallow seamounts act as hotspots of marine life in the Azores, having an aggregation effect on some marine predators, as some species of fish, marine mammals and marine birds.

CONDOR project is a case-study to increase the knowledge of oceanographic and biological processes occurring at seamounts, enhancing the quality of advice for the management of seamount areas and promoting general public awareness on marine conservation and sustainable development. It will facilitate the testing of observational technology and the involvement of students and stakeholders.

Given its location and characteristics, and on the basis of results which will be obtained from the present pilot project, the Condor seamount observatory is envisaged to become a long term observatory on Azorean seamounts ecosystems.

The CONDOR project ("CONDOR - Observatory for long-term study and monitoring of Azorean seamount ecosystems") is coordinated by the Department of Oceanography and Fisheries of the University of the Azores and it is supported by a grant from Iceland, Liechtenstein and Norway through the EEA Financial Mechanism (contract number PT0040).

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MULTIDISCIPLINARY TIME-SERIES FROM FIXED-POINT DEEP OCEAN OBSERVATORIES: RESULTS AND SCIENCE MISSIONS FROM THE EUROSITES NETWORK

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There is an ever-growing demand for high quality, real-time marine datasets of climatically relevant parameters. *In situ* fixed-point observatories are one key infrastructure within a global ocean observing network to achieve this goal. EuroSITES is a European FP7 Collaborative Project (2008-2011) which will integrate and enhance 9 existing deep (>1000 m) ocean observatories across Europe. The aims and objectives of the network will be presented along with details of specific science missions and integration activities. Results from high resolution multidisciplinary datasets will be presented that offer vital insights into the seasonal and inter-annual variability of oceanic processes. Particular attention will also be given to biogeochemical time-series and frontier sensor developments including the measurement of deep ocean oxygen consumption and pH. Contribution to OceanSITES and GEOSS and links with other relevant projects and initiatives in an international context including ESONET, EMSO PP, EPOCA, ACOBAR, HERMES, HERMIONE, CoralFISH, OOI and NEPTUNE will also be presented.

NOAA CORAL REEF ECOSYSTEM INTEGRATED OBSERVING SYSTEM (CREIOS): A COLLABORATIVE ECOSYSTEM-BASED OBSERVING SYSTEM

Morgan, Jessica A.[1,6]; C. Mark Eakin[1]; Russell E. Brainard[2]; Donald W. Collins[3]; James C. Hendee[4]; Mark E. Monaco[5]; and Katherine D. Andrews[6]

The U.S. National Oceanic and Atmospheric Administration (NOAA) Coral Reef Conservation Program (CRCP) Coral Reef Ecosystem Integrated Observing System (CREIOS) conducts mapping and monitoring of coral reefs, their biota, and their environments in U.S. coral jurisdictions. CREIOS is a multi-agency effort by NOAA scientists in partnership with Federal, State, Territory, Commonwealth, and local coastal management agencies, universities, non-governmental organizations, and international entities. CREIOS provides an ecosystem-based component to U.S. regional coastal ocean observing systems. The CREIOS goal is to understand the condition of coral reef ecosystems in order to assist stakeholders in making ecosystem-based management decisions to conserve coral reef resources. Reef mapping and benthic habitat characterization provide a detailed picture of the physical and biological structure of coral reef communities, while periodic biological, physical, and chemical monitoring provide direct field observations of the condition of critical reef ecosystems, and continuous automated monitoring (*in situ* instrumentation and satellite-based) provides key environmental factors affecting reef condition. Mapping and monitoring activities are integrated to accurately document the status and changes in the habitats, depth ranges, geomorphologic zones, and reef types present in coral reef environments. All of the integrated mapping and monitoring studies are conducted in consultation with local natural resource management institutions and also through CRCP's coral reef ecosystem monitoring grants to State, Territory, and Commonwealth partners. CREIOS data and integrated information products provide support for a variety of management actions, including Marine Protected Area design and evaluation, and assessing the impacts of overfishing, land-based sources of pollution, and climate change.

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FERRYMON: UNATTENDED FERRY-BASED WATER QUALITY MONITORING TO EVALUATUATE HUMAN AND CLIMATICALLY-DRIVEN ECOLOGICAL CHANGE IN THE PAMLICO SOUND SYSTEM, NORTH CAROLINA, USA

Paerl, Hans W.[1]; Rodney Guajardo[1]; Alan R. Joyner[1]; Benjamin L. Peierls[1]; Karen L. Rossignol[1]; and Joseph S. Ramus[2]

FerryMon is an autonomous ferry-base observational program that has been monitoring water quality of the USA's second largest estuarine complex, North Carolina's Albemarle-Pamlico Sound System since 2000. Water quality parameters of interest include salinity, turbidity, pH, temperature, nutrients, chlorophyll *a* and a suite of photopigments indicative of specific algal taxonomic groups. Recently (2008) real-time multispectral fluorescence photopigment detection/quantification has been added and CO_2 sensing equipment will be added in late 2009. In addition to establishing a baseline from which to evaluate change in water quality of the open sound and its largest sub-estuary, the Neuse River Estuary, data are being used to evaluate human and climatically-driven ecological changes to the system. The influence of a recent rise in hurricane and tropical storm activity, as well as an extended drought and unusually high spring rainfall period, possibly reflecting changes in climatic regimes affecting the US mid-Atlantic region, are shown and evaluated in the context of their short- and long-term effects on hydrologic properties and water quality. FerryMon has been integrated with the WATERS Network and the Consortium of Universities for Advancement of Hydrologic Science (CUAHSI) to enable these data sets to be accessed through the CUAHSI's Data Access System for Hydrology (DASH). FerryMon's developing data set will enable scientists, teachers and students to access and analyze the long-term temporal and spatial responses and trends of this ecologically- and economically-important system as it is impacted by natural and anthropogenic stressors.

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SAMPLING STRATEGIES: THE ROLE OF *LOTHIR* (LONG-TERM & HIGH-RESOLUTION) OBSERVATORIES IN THE CHARACTERIZATION OF BIOLOGICAL OCEAN PROCESSES

Piera, Jaume[1]; Oliver Ross[1]; and Elisa Berdalet[2]

The understanding of any biological-physical interaction requires the characterization of the environmental changes derived from the transport mechanisms and the response of organisms to these changes. Field data observations are the common data input for such type of characterization. One of the first questions to solve in any observation planning is the number of samples and the sampling rate required for an effective analysis of the field data. Several authors have pointed out the importance of adapting the sampling strategy to the observed process (Stommel, 1963) or the effects of undersampling the ocean (Munk, 1983; Dickey, 2002).

New ocean technologies are being effectively used to improve ocean sampling deficiencies using inter-disciplinary, multiplatform sampling strategies. In the last years, several initiatives around the world, such as NEPTUNE, MARS, VENUS ARENA, MVCO or OBSEA, have promoted the installation of underwater networks to increase the variety and numbers of sampled variables and thus to fill in the gaps of the time-space continuum of interdisciplinary ocean observations. In parallel, there also mobile platforms such as TAOSF (Podnar et al, 2008) to optimize high-resolution spatial coverture.

The present contribution, which is directed toward both modelers and observationalists, reviews emerging interdisciplinary observational capabilities and their optimal utilization, and particularly address the benefits of *lothir* (long-term & high-resolution) observatories to multiscale characterization of the different processes that are taking place in the ocean.

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DETECTION OF OCEAN BIO-PHYSICAL INTERACTIONS USING HYPERSPECTRAL OPTICAL METHODS

Ross, Oliver N.[1]; Elena Torrecilla[1]; Jaume Piera[1]; and Elisa Berdalet[2]

Observation is critical to science. The gathering of high-resolution biological information fundamentally relies on non-intrusive optical measurements. The theoretical framework to describe the propagation of light in the ocean is the radiative transfer theory. Optical properties of sea water are classified into inherent and apparent optical properties and are related via the radiative transfer equation. Traditionally, many studies focused on the development of bio-optical algorithms linking measurable optical properties to the primary pigment in phytoplankton, chlorophyll *a*, and on the detection of phenomena such as harmful algal blooms. The rapid maturing of optical instrumentation has led to significant technological advances such as the recent development of hyperspectral sensors which provide a very powerful tool with ample spectral information to improve the identification of water column constituents, including a variety of phytoplankton species and functional groups, enabling scientists to obtain non-intrusive continuous high-resolution measurements at small-scales to observe the dynamics of underwater ecosystems *in situ* and *in vivo.* However, there is an urgent need to further develop the underlying theoretical frameworks and analytical methods in order to be able to use these new technologies to their full potential. In our project we aim to develop new analytical methods for the detection and identification of phytoplankton functional groups and species, including the characterisation of dynamical processes such as growth, photoacclimation and turbulent transport. This will provide scientists with a model that covers both the forcing side and the response of the system.

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OceanBit: an International Coastal Ocean Observing and Forecasting System based in the Balearic Islands

Ruiz, Javier[1]; and Joaquín Tintoré[2]

OceanBit is a new Coastal Observing and Forecasting System, a new facility of facilities, open to international access. It is a multi-platform distributed and integrated facility that will provide streams of oceanographic data and modelling services in support to operational oceanography in a European and international frame, therefore also contributing to the needs of marine and coastal research in a global change context. Operational Oceanography is here understood in a wide sense, including both the systematic, long-term routine measurements of the seas and their interpretation and dissemination and also the sustained supply of multidisciplinary data to cover the needs of a wide range of scientific research priorities. OceanBit will be composed of three major subsystems: (1) an observing sub-system, (2) a forecasting and data assimilation sub-system and (3) a data management, visualization and dissemination sub-system. OceanBit components will be therefore constituted by a sustained, spatially distributed, heterogeneous, potentially relocatable and dynamically adaptive observing network that will be integrated through data management and numerical methodologies to exploit the synergies between both the observational network (moorings network, surface velocity drifters, ARGO profilers, HF radar, gliders, AUVÂ's, R/VÂ's, VOS, etc.) per se and between the observational network and the numerical models (physical-waves and currents at different scales- and biogeochemical coupling) and assimilation tools, with the aim to provide a complete and integrated description of the physical and biogeochemical properties of the marine environment. OceanBit Consortium is presently on the implementation design phase. Activities will be formally starting during 2010 and will continue in operation for an initial period of 10 years.

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THE MOMAR-D- PROJECT: A CHALLENGE TO MONITOR IN REAL TIME THE LUCKY STRIKE HYDROTHERMAL VENT FIELD

Sarradin, P.M.[1]; A. Colaço[2]; M. Cannat[3]; J. Blandin[1]; J. Sarrazin[1]; and the project participants.

Hydrothermal circulation at mid-ocean ridges is a fundamental process that impacts the transfer of energy and matter from the interior of the Earth to the crust, hydrosphere and biosphere. The unique faunal communities that develop near these vents are sustained by chemosynthetic microorganisms that use the hot fluids chemicals as a source of energy. Environmental instability resulting from active mid-ocean ridge processes can create changes in the flux, composition and temperature of emitted hydrothermal fluids and influencing the hydrothermal communities.

The MoMAR (Monitoring the Mid-Atlantic Ridge) project was initiated 10 years ago by the InterRidge Program to promote and coordinate long-term multidisciplinary monitoring of hydrothermal vents at MAR. It aims at studying vent environmental dynamics from geophysics to microbiology. More recently, the MoMAR area has been chosen as one of the 11 key sites of

the ESONET NoE. The MoMAR-D project was selected by ESONET as a demonstration mission to deploy and manage a multidisciplinary observing system at Lucky Strike during one year. This large hydrothermal field is located in the centre of one of the most volcanically active segment of the MAR. This monitoring offers a high probability of capturing evidence for volcanic events, observing interactions between faulting, magmatism; hydrothermal circulations and, evaluating their impacts on the ecosystem. Two Sea Monitoring Nodes (Blandin & Rolin. 2005) will be acoustically linked to a surface buoy, ensuring satellite communication to a land base station. The first node will be dedicated to large scale geophysical studies, the second, to edifice scale studies such as ecology and chemical fluxes. The infrastructure should be deployed in 2010 during the MoMARSAT cruise.

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MONITORING COMMUNITY AND ENVIRONMENTAL DYNAMICS ON THE DEEP-SEA FLOOR THROUGH TWO OBSERVATORY APPROACHES

Sarrazin, J.[1]; Y. Auffret[1]; J. Blandin[1]; J.Y. Coail[1]; L. Delauney[1]; S. Dentrecolas[2]; P. Dorval[1]; J. Dupont[1]; L. Dussud[1]; A. Ferrant[1]; G. Guyader[1]; C. Le Gall[1]; J. Legrand[1]; D. Leroux[1]; P. Léon[2]; J.P. Lévèque[2]; P. Rodier[1]; R. Vuillemin[1]; and P.M. Sarradin[1]

The goal of seafloor observatories is to develop multidisciplinary long-term experiments for observations and monitoring of seafloor active processes through the supply of communication means and power to scientific instruments. The success of these future observatories is dependant upon the development of new autonomous scientific tools, suited for long-term deployment.

Two ecological modules, coupling up video imagery and environmental monitoring, have been developed to meet our scientific objectives. The major difference between the two systems is that TEMPO will be connected to an uncabled observatory with acoustic data transmission on the Mid-Atlantic Ridge while TEMPO-mini is dedicated to the Neptune Canada cabled observatory in the Pacific Ocean. Both systems have been successfully deployed to test their long-term reliability and preliminary data (video imagery and environmental variations) will be presented. In the near future (2010), the two modules will be implemented into two multidisciplinary integrated observatories on the Lucky Strike and Endeavour vent fields.

Time-series studies in these remote ecosystems will give fundamental insights about the reaction of the benthos to different environmental events, community succession as well as on the role of biological interactions on community dynamics. Furthermore, long-term experiments on the deep-sea floor will constitute the basis for the management and protection of these remote “hot spots”.

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PLANKTON DISTRIBUTION AT THREE HOT AREAS FROM THE NORTHEASTERN COAST OF EGYPT

Shams El Din, N.G. and Abdel Aziz, N. E. M.

The spatial and temporal distribution of plankton was investigated at three sectors of the northeastern coast of Egypt during winter, spring and summer 2008. Samples were taken from fixed stations at each sector. A maximum density of $1.2x10^6$ unit.l^{-1} for phytoplankton and 5700 ind.m^{-3} for zooplankton. Chlorophyceae and Bacillariophyceae represented the most important groups whereas the others contributed by very low percentages. On the other hand, Copepoda represent the most important zooplankton group followed by Mollusca and Protozoa. More than 208 phytoplankton species and 193 zooplankton species in addition to larval stages of different groups were identified during the whole period, but only a few of them appeared at significant densities. The predominant species were *Chlorella vulgaris, carteria sp.* and *Pseudo-Nitzschia spp.,* whereas the leader zooplankton species were *Paracalnus parvus, Oithona nana,* and *Lamellibranch veliger* of Mollusca. Some species were recorded for the first time in this area. Spring was the lowest plankton density: phytoplankton (248 cells.$^{l-1}$) and zooplankton (2500 ind.m^{-3}) at Rosette Sector. The specific diversity of plankton community is generally quite high. About 7 to 77 phytoplankton species and 13 to 58 zooplankton species per station have been counted. Cluster analysis expressed the similarity between stations of each sector, while Shannon diversity Index was used to indicate the population biodiversity. The exposure of the three sectors to different types of pollutants causes great variability of phytoplankton production, hence the two factors affecting the spatial distribution and abundance of zooplankton.
Keywords: Phytoplankton, zooplankton, hot areas, Egypt

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HAUSGARTEN - THE ARCTIC DEEP-SEA OBSERVATORY

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In order to detect and track the impact of large-scale environmental changes in the transition zone between the northern North Atlantic and the central Arctic Ocean, the German Alfred Wegener Institute for Polar and Marine Research (AWI) established the deep-sea long-term observatory HAUSGARTEN west of Svalbard. The observatory includes 16 permanent sampling sites along a depth transect (at 1000 - 5500 m water depth) and along a latitudinal transect covering approximately 125 km and following the 2500 m isobaths. Multidisciplinary research activities at HAUSGARTEN cover almost all compartments of the marine ecosystem from the pelagic zone to the benthic realm, with some focus on benthic processes.

Time-series studies at the HAUSGARTEN already exhibited some trends. At the moment, we do not know whether these already indicate lasting alterations of the system or simply reflect natural multi-year variability, e.g. in relation to variations in the Arctic Oscillation. Our temperature records at 2500 m depth covering the years 2000 through 2008 exhibited an overall slight temperature increase. Analyses of various biogenic sediment compounds between the summers of 2000 and 2006 revealed a generally decreasing flux of phytodetrital matter to the seafloor, and subsequently, a decreasing trend in sediment-bound organic matter and the total

microbial biomass in the sediments. An ongoing trend in decreasing organic matter input would certainly affect the entire deep-sea ecosystem.

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BIOLOGICAL EXPERIMENTS AT THE DEEP-SEA LONG-TERM OBSERVATORY HAUSGARTEN

Soltwedel, Thomas[1]; Christiane Hasemann[1]; Corinna Kanzog[2]; Ingo Schewe[1]; and Michael Klages

Controlled field experimentation in marine ecology is well established for shallow water habitats. Due to technical and logistical difficulties, experimental work in deep waters is still in its infancy. Prerequisite for experimental approaches at the deep seafloor is the availability of free-falling devices and remotely operated vehicles. Especially the repeated access on a deep-diving ROV allowed us to conduct unique short- and long-term experiments at the deep-sea long-term observatory HAUSGARTEN.

The small benthic biota (range: bacteria to meiofauna) is in focus of our experimental work. Their reaction to sporadic food supplies was studied by spreading algae suspensions over isolated areas of the sediments, and by the deployment of colonization trays containing natural or artificial sediments enriched by various organic matters. Bundles of dead fish as well as a small whale carcass were set out at the seafloor to simulate “large food-falls”. Large cages with solid top lids were installed to prevent the settling of POC over distinct areas (“starvation experiment”). Smaller, “open” cages were deployed to exclude disturbances created by larger benthic organisms from certain spots at the seafloor. Plough-like disturber units were used to repeatedly perturbate the upper sediment layers at different frequencies, in that way mimicking enhanced megafauna bioturbation. A flume, 8.5 m in length and 50x50 cm in cross-section, has been installed to increase current velocities at the seabed, thereby also reducing POC sedimentation.

Results from the outlined experiments will help to elucidate how the small benthic biota interacts with each other and with their changing environment.

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