

# Advances in ocean biological observations: sustained system for deep-ocean meroplankton

## Invited talks and abstracts

### Theme I. Knowledge advances in deep-sea larval diversity and distribution: key challenges and priorities

Deep-sea larval diversity, dynamics and distribution - What would we like to know? What do we know and how did we learn it? What are we missing and why?

Craig Young, University of Oregon, USA

**Abstract.** (not available)

### Theme II. Recent developments in plankton observation: technology and approaches

#### Ocean observing: new technology and approaches

James Birch, Monterey Bay Aquarium Research Institute, USA

**Abstract.** Researchers are increasingly using autonomous platforms to characterize ocean processes. Conceptually, studying processes that change both spatially and temporally seems relatively straightforward. One needs to sample in many locations synoptically over time, or follow a coherent water mass and sample it repeatedly. However, implementing either approach presents many challenges. For example, acquiring samples over days to weeks far from shore, without human intervention, requires seamless autonomy, navigation and communications. We are addressing these challenges by developing a new generation of robotic systems that are primarily aimed at studies of microbial-mediated processes. We have taken lessons learned from our second-generation Environmental Sample Processor (2G-ESP), a robotic microbiology “lab-in-a-can” and have re-engineered the system for use on a Tethys-class Long Range AUV (LRAUV). The new instrument is called the third-generation ESP (3G-ESP), and its integration with the LRAUV provides mobility and a persistent presence not seen before in microbial oceanography. These capabilities were tested when the ESP/LRAUV system was recently deployed in a collaborative effort with the University of Hawaii SCOPE program with operational support provided by the Schmidt Ocean Institute’s R/V Falkor. The target of this investigation was the deep chlorophyll maximum (DCM; ~100m depth), a depth quite amenable to study

by the LRAUV. The DCM is home to microbes that are responsible for producing 30-50% of the atmosphere's oxygen content, and that are critical players in the 'biological pump' that removes carbon from the atmosphere and delivers it to the deep sea. Capturing the dynamics of the DCM can be very laborious and difficult using traditional CTD rosette casts from ships. This presentation culminates with a demonstration of the first coordinated use of LRAUVs, a new generation ESP, and Liquid Robotics' Wave Glider to study the DCM within a large cyclonic eddy north of the island of Maui, Hawaii in March/April, 2018. One LRAUV equipped with an ESP was directed to track an isotherm associated with the DCM peak and collect samples every three hours for 4 days. At the same time a second LRAUV acoustically tracked the sampling vehicle and provided contextual reconnaissance of the waters surrounding the isotherm- locked ESP/LRAUV, verifying a remarkable match between the chlorophyll maximum and where the LRAUV/ESP was collecting samples. The Wave Glider was used to track the LRAUV/ESP acoustically as an aid to shipboard operations. The coordinated use of mobile, robotic assets equipped with sample collection/processing devices offers never-before-seen ocean exploration and research capabilities. These results show the potential of mobile, ecogenomic sensors in the ocean sciences, and now the challenge is to now move these assets into the various areas of meroplankton research (e.g., deeper waters, larger volume capabilities, longer durations).

## Theme III. Data integration and oceanographic modelling

### Modelling deep-sea currents and impacts for dispersal of larvae

Jonathan Gula, LOPS, University of Brest, France

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**Abstract.** Over mid-ocean ridges, the interaction between the currents and the topography gives rise to complex flows, which drive the transport properties of biogeochemical constituents, and especially those associated with hydrothermal vents, thus impacting associated ecosystems. The circulation in the rift valley along the Azores sector of the North Mid-Atlantic Ridge is characterized, using a combination of in-situ data from several surveys and realistic high-resolution modelling. It confirms the presence of a mean deep current with an up-valley branch intensified along the right inner flank of the valley (looking downstream), and a weaker down-valley branch flowing at shallower depth along the opposite flank. We also show that the deep currents exhibit significant variability and can be locally intense, with typical values greater than 10 cm/s. Most of the variability is triggered by mesoscale and submesoscale turbulence. There is, in particular, an intense submesoscale regime of oceanic turbulence over the ridge, contrasting with open-ocean – i.e., far from topographic features – regimes of turbulence. Impacts of submesoscale and tidal currents on larval dispersion and connectivity among vent populations are investigated by releasing neutrally buoyant Lagrangian particles at the Lucky Strike hydrothermal vent. Submesoscale currents are found to significantly increase both the horizontal and vertical dispersion of particles at O(1-10) km and O(1-10) days. Tidal currents and internal tides roughly

double the vertical dispersion. The combined effects of the tidal and submesoscale currents and finer scales of topography significantly impact simulations of larval paths and connectivity between vent communities on the MAR at biologically-relevant time scales.

## **Overarching issues: Synergies and added value of a sustained observation system for meroplankton**

### **Deep-sea meroplankton and conservation in the deep-sea: the design and implementation of marine protected areas**

**Anna Metaxas, Department of Oceanography, Dalhousie University, Canada**

**Abstract.** The Convention on Biological Diversity has provided criteria for the design of Marine Protected Areas (MPAs) and networks of MPAs (MPAn) some of which require an understanding of processes in early life history (e.g. connectivity). MPAn in some form are increasingly being implemented or designed for deep-sea ecosystems in national and international jurisdictions, such as in southwest Australia, OSPAR, in BBNJ agreement and by the International Seabed Authority for the Area. However, while connectivity is considered a critical design element for all MPAn, its implementation to date has been extremely limited. Additionally, the types of connectivity considered by marine managers are different than those considered by scientists, which are mainly demographic and genetic connectivity. Our current measures of demographic connectivity are in fact estimates of dispersal computed using measures of transport, behaviour, spawning times and settlement locations most of which could be obtained either experimentally or with modelling. However, accurate estimates of planktonic larval duration and mortality are very difficult to obtain. Genetic connectivity can be estimated if population structure can be resolved at fine temporal resolutions. Various techniques exist to then use these estimates for the development of metrics that can be used for the design of MPAn. Overall, the data needs for conservation are similar to those needed to address fundamental ecological questions, but the data outputs differ between the two.

### **EMSO Azores Deep-sea Observatory - 9 years of operations**

**Jozée Sarrazin, Ifremer, France**

& P.-M. Sarradin<sup>1</sup>, J. Legrand<sup>1</sup>, M. Matabos<sup>1</sup>, A. Godfroy<sup>1</sup>, M. Cannat<sup>2</sup>, W. Crawford<sup>2</sup>, R. Daniel<sup>2</sup>, V. Ballu<sup>3</sup>, V. Chavagnac<sup>4</sup>, C. Rommevaux<sup>5</sup>, G. Rouillet<sup>6</sup>, A. Colaço<sup>7</sup> and the MoMARSAT team

<sup>1</sup>Ifremer, France; <sup>2</sup>Institut de Physique du Globe de Paris, France; <sup>3</sup>Littoral Environnement et Sociétés, France; <sup>4</sup>Géosciences Environnement Toulouse, France; <sup>5</sup>Institut Méditerranéen d'Océanologie, France; <sup>6</sup>LOPS, University of Brest, France; <sup>7</sup>IMAR, University of Azores, Portugal

**Abstract.** (not available)

## How can Ocean Networks Canada's NEPTUNE observatory support future monitoring of meroplankton communities in the NE Pacific?

**Fabio De Leo, Ocean Networks Canada & Department of Biology, University of Victoria, Canada**

**Abstract.** This presentation aimed to provide an overview of Ocean Networks Canada's deep-sea observing infrastructure in the NE Pacific and to explore opportunities for future sustained monitoring of meroplankton communities. The NEPTUNE regional cabled observatory is strategically installed along the small tectonic plate of Juan de Fuca, covering a range of deep-sea environments such as hydrothermal vents (Endeavour Ridge), abyssal plains (Cascadia Basin), submarine canyons (Barkley Canyon) and methane seeps (Clayoquot Slope and Barkley Hydrates), and spanning only across a few 100s of Km. In addition, all these ecosystems are bathed in low oxygen waters of the NE Pacific Oxygen Minimum Zone. All of this combined makes ONC's NEPTUNE observatory a great candidate location for future sustained observations of meroplankton in conjunction with the already ongoing monitoring of deep-sea benthic communities. ONC Senior Scientist Fabio De Leo outlined a pathway for collaborations and for the writing of research proposals in order to: 1) in the short-term (1-4 years) autonomously deploy passive larval tube traps in all NEPTUNE nodes, and 2) in the medium to long-term (>5 years) deploy state-of-the-art high-volume seawater pumps, rotating tube traps and in-situ plankton imaging systems connected to the cabled network and aiming real-time adaptive sampling. The presentation also covered preliminary results of an emerging research program to monitor pelagic biodiversity (predominantly gelatinous plankton) using ROV video imaging in all NEPTUNE's active monitoring sites.