MNF Voyage Highlights

Voyage #:	IN2021_T01
Voyage title:	Brisbane to Darwin Transit
Mobilisation:	Brisbane, Wednesday, 9 June 2021
Depart:	Brisbane, 1800 Thursday, 10 June 2021
Return:	Darwin, 1300 Wednesday, 23 June 2021
Demobilisation:	Darwin, Wednesday, 23 June 2021
Voyage Manager:	Rob Palmer
Chief Scientist:	Dr Viena Puigcorbé
Affiliation:	Edith Cowan University
Principal Investigators:	Dr Sophie Leterme
Project name:	Microplastics in the food chain: impact on the microbial and planktonic organisms
Affiliation:	Flinders University
Principal Investigators:	Dr Viena Puigcorbé
Project name:	Linking the Biological Carbon Pump flux to microbial colonisation of sinking particles in the Coral Sea
Affiliation:	Edith Cowan University
Principal Investigators:	Dr Allison McInnes
Project name:	Flow cytometric classification of the phytoplankton community across Australia's top end
Affiliation:	University of Melbourne
Principal Investigators:	Dr Matt Gordon
Project name:	Dinoflagellates & broader planktonic assemblage observation
Affiliation:	Defence Science & Technology Group
Principal Investigators:	Dr Tom Trull
Project name:	BGC-Argo Float Deployment
Affiliation:	CSIRO

Principal Investigators:	Dr Grahame Rosolen
Project name:	Cosmic Ray Measurements
Affiliation:	CSIRO
Principal Investigators:	Craig Neill
Project name:	Carbon Sampling
Affiliation:	CSIRO

Voyage Highlights

The Chief Scientist

Viena Puigcorbé is an adjunct postdoctoral research fellow at Edith Cowan University (Perth) and has recently received a La Caixa Junior Leader Fellowship to join the Institut de Ciències del Mar-CSIC (Barcelona, Spain). Viena has spent the last 10 years conducting oceanographic research, including >15 months at sea across diverse oceanic regions, from the ice-sheets of the Arctic and the Southern Oceans to the tropical Atlantic. She collaborates with diverse research groups working in a wide range of expertise, which has allowed her to develop a multidisciplinary and dynamic research profile and a strong network of international collaborators. Her background in biogeochemistry and the use of naturally-occurring radionuclides as tracers of particle export in the open ocean, combined with her recent training in microbial ecology, are the base for her new line of research, where she aims to contribute to better understand the crucial role that marine microbes play in marine biogeochemical cycles, specifically, to study how particle-attached microbial communities impact the carbon export efficiency at a global scale.

Title

Linking the Biological Carbon Pump flux to microbial colonisation of sinking particles in the Coral Sea

Purpose

The voyage consisted of one supplementary project and six piggy-back projects with the following objectives:

1. **Leterme**: To assess the amount of microplastics present in blue waters around Australia, to identify their impact on microorganisms at the base of the oceanic food chain and understand how they are distributed and move in oceans around Australia
2. **Puigcorbé**: Evaluate the role that microbes play on the carbon flux attenuation in the Coral Sea
3. **McInnes**: Evaluate the ability of spectral cytometry to describe the phytoplankton community in near realtime.
4. **Gordon**: Conduct observations of dinoflagellates and broader planktonic assemblages in deep and shallow water sites in tropical Australia.
5. **Trull**: Deploy a Biogeochemical Argo Float in the Coral Sea
6. **Rosolen**: Detect cosmic ray flux at sea level over a range of latitudes between Brisbane & Darwin.
7. **Neill**: Conduct carbon sampling as an intercomparison exercise

In addition, a mapping survey was prepared for Parks Australia in the West Cape York Marine Park should extra time be available.

Contribution to the nation

Leterme: By 2025, marine industries are expected to contribute > $100 billion each year to Australia's overall economy. This is not inclusive of the financial worth of essential ecosystem services from the marine environment, such as carbon dioxide absorption, nutrient cycling and coastal protection. Marine ecosystems are affected by plastic intrusion, which impacts how these systems support our economy. Previous studies of microplastics in Australian blue waters were restricted predominately to surface waters. Research shows that plastics (generally buoyant in saltwater) act in a similar way as marine snow; in that as they age, fragments of plastic slowly sink down to the sediment. Currently we do not understand the vertical distributions of plastics in Australian waters. This is important as many animals feed, and aquaculture farms operate, below surface waters.

In addition to this, studies have been restricted to plastic fragments that are greater than 0.3 mm in size. However, smaller fragments impact the microscopic organisms of the ocean that form the basis of aquatic food webs. The plastic alters the feeding habits and reproductive rates and success of zooplankton, which can disrupt larger marine organisms. Due to the restriction of sampling size at 0.3 mm the quantity of plastics in Australian marine waters has been severally underestimated. Our project aims to assess large and small microplastics down to the size of 0.45 µm (0.00045 mm) present around Australia.

The microplastics project onboard voyage IN2021_T01 aims to quantify the amount of plastic present in Australian blue waters, both vertically and at the surface. We will provide increased knowledge on the planktonic communities in Australian waters, and we will assess the amount of microplastic ingested by zooplankton species at the time of sampling. This will allow us to predict how much is carried up the food chain and potentially ingested by fish. The data collected on this voyage will be supplemented with data collected on several additional voyages spanning into the future. The plastic quantifications will be paird with water property data collected on the voyage to develop a comprehensive model of how plastics move in ocean features and inform us of potential hotspots of plastic aggregations on our coastlines.

Puigcorbé: Earth's carbon cycling, and this climate, critically depends on ocean carbon sequestration, which is largely mediated by microbes. The project aims to establish a comprehensive view of how microbes developing on organic particles impact the efficiency of carbon export from the surface waters. The warm and nutrient-poor waters of the Coral Sea present an excellent opportunity to study the linkages between surface productivity and particulate export fluxes under oceanographic conditions similar to those expected in a future warmer ocean. This research shall provide valuable data to constrain biogeochemical models and projections of the ocean carbon cycle under climate change conditions. We will enhance the international collaboration and competitiveness of Australian research by partnering across world-leading teams in this field at a time when the role of marine microbial communities is of global interest and linking it to the marine carbon cycling has the potential to foster new insights that increase its societal relevance.

McInnes: The spectral cytometry technique could revolutionise oceanography by allowing oceanographers to sample the phytoplankton community in small volumes in near real-time allowing for sampling to take place on ecologically significant time and space scales. Further it will allow

experimental manipulation of natural phytoplankton communities and evaluation of the impacts on components of the phytoplankton communities (as opposed to bulk community evaluation).

Gordon: Dinoflagellates are important primary producers in marine ecosystems. In fact, they are often referred to as the rainforests of the oceans, producing around 50% of our planets oxygen. Since they reproduce quickly and live for only a short time, they can also be good indicators of how healthy a marine system is. Some dinoflagellates are also known to be toxic to both humans and marine species such as fish and oysters, especially when they occur in high abundances known as blooms. The dinoflagellates are therefore of interest to Australias population on a number of fronts.

Rosolen: These measurements provide a greater understanding of the role of the atmosphere in the attenuation of cosmic rays. Cosmic rays originate from space weather events including solar flares, coronal mass ejections and supernova explosions. Some of these cosmic rays are directed towards the earth and interact with the earth's magnetic field and atmosphere. The cosmic ray flux varies with altitude and is strongest at higher latitudes due to the concentration of the earth magnetic field. The other contribution from these experiments is to provide the opportunity for an indigenous student to participate in scientific research involving configuring scientific instrumentation, data gathering and data analysis.

As a result of this voyage

1. We have a better understanding of
   - Quantity of plastics and zooplankton communities in selected sites on QLD and NT coast and their vertical distributions
   - How much plastic is ingested by zooplankton
   - Understanding of plastic quantities 5 mm through to 0.005 mm
2. We have found
   - Samples are still being processed; however, we have knowledge on the surface and subsurface currents to assist with model development.
3. We have conducted preliminary research to support a larger project that was granted but could not go ahead due to covid restriction.
4. We will evaluate the carbon export fluxes and carbon export efficiency in the Coral
5. We will assess the changes of the microbial community structure in particles from surface to mesopelagic waters in the Coral Sea
6. We have obtained new data from an understudied area and the results will nourish the global efforts dedicated to give insights into the great microbial diversity
7. We have a regularly spaced dataset to evaluate the phytoplankton community with the new cytometer to determine it's effectiveness.
8. We have completed a mapping survey in West Cape Yorke Marine Park.
9. We have commenced a program that looks at the occurrence and distribution of dinoflagellates within Australian waters. By using a set of standardised sampling procedures, changes in population structure over time can be used to indicate ocean health and potentially give warning of harmful blooms.

10. We have found that there is a variation of cosmic ray flux with latitude and have a better understanding of the magnitude of this variation. The sweep of latitudes on this voyage and the time to transit enabled statistically significant cosmic ray measurements to be made at the full range of latitudes covered during the voyage.

Next steps

Leterme:

- To process the collected samples in the laboratory back at Flinders University
- Disseminate results through publications
- Future outputs available by contacting Sophie Leterme sophie.leterme@flinders.eu.au

Puigcorbé: We will analize the samples collected and have final results a year after the voyage. We will use these results to apply for larger projects, with more sea time, to allow a better spatial coverage and a more comprehensive study of the carbon export in the area.

The results from this project will be disseminated by high-quality peer-reviewed publications in leading jurnals and all the data produced will be made public and will be available through national databases The academic community and stakeholders will also be engaged by presenting the results at conferences and workshops.

General public will be reached by participating in popular science talks and through press releases, media articles and social-media, when appropriated.

McInnes: We will evaluate the samples collected within the next month. We will compare these results to our standard cultures that we have run to determine if we can estimate strain level classification of the phytoplankton communities present. We will compare these findings with previous voyages through the region. We will apply for a piggy back berty on the Perth-Hobart transit to evaluate how the instrument works at sea.

Gordon: Samples have been disseminated to our collaborative partners for analysis, the results of which will provide information for ongoing internal research and feed into the production of external peer reviewed articles. Interested parties can contact relevant team members using the contact form at https://www.dst.defence.gov.au/contact-us .

Rosolen: The next steps are to examine ways of incorporating cosmic ray detector instrumentation into a place on the vessel that is suited to obtaining cosmic ray data that is not influenced by the structural components of the vessel itself. The main challenge is to devise an arrangement of the hardware whereby the detector element is outside and yet the detector electronics are housed in a weatherproof enclosure with access to continuous electrical power.