Workshop Report

ASSESSING THE POTENTIAL OF ANCIENT DNA IN MARINE SEDIMENTS

Organised by Dr Linda Armbrecht (Macquarie University) and A/Prof Leanne Armand (Australian National University) 9-11 October 2017
SUMMARY OF THE WORKSHOP

Macquarie University hosted a workshop to examine the potential for ancient DNA to illuminate the past, present and future of ocean-climate processes (9th-11th October, see program in appendix). The workshop was led by Dr Linda Armbrecht and attracted participants from around Australia as well as Japan and Switzerland. ARC Laureate Fellow Professor Alan Cooper (Australian Centre for Ancient DNA) opened the workshop and catalysed two and a half days of open discussion about advances in technology, limitations, pitfalls and potential opportunities. Advances in the fields of ancient DNA and forensics have a lot to offer researchers applying ‘omics techniques to understand living systems, including eDNA approaches for biosecurity. A/Prof Leanne Armand (ANU, Director ANZIC) outlined the unprecedented opportunity for 'biosphere frontier’ projects to participate in the IODP program, including upcoming voyages and accessing an existing repository of sediment samples.

A consensus emerged that there were significant opportunities to combine geobiology and ‘omics techniques, however, baseline data and experiments were required to establish the in situ rates of DNA degradation in different sediments, and use established techniques to verify the ancient versus living source of extracted DNA. Exploring the deep ocean seafloor has parallels with prospecting for life on distant planets. Contamination and ‘background DNA’ from living organisms in the sediment was a major concern that emerged repeatedly. We heard of the importance of rigorously identifying and eliminating the sources of contamination, even in contemporary DNA research. An outcome of the workshop was the establishment of a network to begin to coordinate research in efforts in this area. Participants are developing a paper ‘Are we contaminating the deep biosphere?’ to highlight the issues, from sample collection to informatics analyses, that will outline a pathway forward and catalyse collaboration in this emerging field of research.

WORKSHOP LEADERS:

Dr Linda Armbrecht and A/Prof Leanne Armand.

PARTICIPANTS AND SPEAKERS:

External:
- Dr Franck Lejzerowicz (University of Geneva, Switzerland)
- Prof Alan Cooper (Australian Centre of Ancient DNA (ACAD), University of Adelaide)
- Dr Laura Weyrich (ACAD)
- Dr Jennifer Young (Advanced DNA, Identification and Forensic Facility (ADIFF), University of Adelaide)
- Ms Nicole Foster (ADIFF)
- A/Prof Yohey Suzuki (University of Tokyo, Japan)
- A/Prof Marco Cooelen (Curtin University, Perth)
- Dr Michael Stat (Curtin University, Perth)
- Dr John Moreau (The University of Melbourne)
- A/Prof Leanne Armand (ANZIC Program Scientist)

Macquarie University:
- Prof. Simon George (MQMarine Director, Department of Earth and Planetary Sciences (EPS))
- Dr Martin Ostrowski (MQMarine Deputy-Director, Department of Molecular Sciences)
- Prof Ian Paulsen (Department of Molecular Science)
- Prof Martin Kennedy (Department of Earth and Planetary Sciences)
- Dr Stefan Loehr (Department of Earth and Planetary Sciences)
- Dr Karita Negandhi (Department of Earth and Planetary Sciences)
- Ms Amaranta Focardi (Department of Molecular Science)
- Dr Linda Armbrecht (Department of Biological Sciences)

FUNDING

This workshop was kindly supported by $14,300 from Macquarie University ($3,300 from the Dept. of Biological Sciences, $5,000 from the Faculty of Science and Engineering, $6,000 MQ Marine).
## PROGRAM:

### MONDAY, 09.10.2017  
**E7A LEVEL 8 FUNCTION AREA**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Presentation Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:15</td>
<td>Arrival &amp; Coffee</td>
<td></td>
</tr>
<tr>
<td>09:30</td>
<td>Dr Linda Armbrecht (Biological/Earth and Planetary Sciences, MQ)</td>
<td>Welcome &amp; Aims</td>
</tr>
<tr>
<td>10:00</td>
<td>Prof Alan Cooper (Australian Centre of Ancient DNA, University of Adelaide)</td>
<td>Problems and potential solutions for work with various marine sediment samples</td>
</tr>
<tr>
<td>10:30</td>
<td>Dr Franck Lejzerowicz (University of Geneva, Switzerland)</td>
<td>Ancient DNA from deep-sea subsurface sediments was once at the surface: the Foraminifera yardstick</td>
</tr>
<tr>
<td>11:00</td>
<td>Break</td>
<td></td>
</tr>
<tr>
<td>11:30</td>
<td>A/Prof Marco Coolen (Curtin University, Perth)</td>
<td>A 52 kyr dead and living geobiologic record of paleoproductivity and oxygen minimum zone (OMZ) strength in the Arabian Sea</td>
</tr>
<tr>
<td>12:00</td>
<td>Prof Simon George (MQ Marine Director, Earth and Planetary Sciences)</td>
<td>The MQ Marine Research Centre – an overview</td>
</tr>
<tr>
<td>12:15</td>
<td>Dr Martin Ostrowski (MQ Marine Deputy-Director, Molecular Sciences)</td>
<td>Facilities and resources at MQ</td>
</tr>
<tr>
<td>12:30</td>
<td>Lunch</td>
<td></td>
</tr>
<tr>
<td>14:00</td>
<td>Louise Fleck (Director, Research Office, MQ)</td>
<td>Centre of Excellence (CoE)/Cooperative Research Centres (CRC) Overview</td>
</tr>
<tr>
<td>14:30</td>
<td>Dr Jennifer Young (Advanced DNA, Identification and Forensic Facility (ADIFF), University of Adelaide)</td>
<td>Environmental DNA analysis: key considerations from sampling to sequencing</td>
</tr>
<tr>
<td>14:45</td>
<td>Dr Karita Negandhi (Earth and Planetary Sciences, MQ)</td>
<td>aDNA for predicting atmospheric carbon flux</td>
</tr>
<tr>
<td>15:00</td>
<td>Discussion</td>
<td></td>
</tr>
<tr>
<td>15:30</td>
<td>Tea Break</td>
<td></td>
</tr>
<tr>
<td>16:00</td>
<td>Discussion</td>
<td></td>
</tr>
<tr>
<td>16:45</td>
<td>Linda Armbrecht &amp; Leanne Armand</td>
<td>Outline for Day 2</td>
</tr>
<tr>
<td>17:00</td>
<td>End of Day 1</td>
<td></td>
</tr>
<tr>
<td>18:30</td>
<td>Dinner</td>
<td>The Ranch Hotel</td>
</tr>
</tbody>
</table>

### TUESDAY, 10.10.2017  
**E7A LEVEL 8 FUNCTION AREA**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
<th>Presentation Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:15</td>
<td>Arrival &amp; Coffee</td>
<td></td>
</tr>
<tr>
<td>09:30</td>
<td>Prof Ian Paulsen (Molecular Sciences, MQ)</td>
<td>Effects of uranium on sediment microbes</td>
</tr>
<tr>
<td>10:00</td>
<td>Dr L Weyrich (Australian Centre of Ancient DNA, University of Adelaide)</td>
<td>Contaminant DNA impacts in paleomicrobiological studies</td>
</tr>
<tr>
<td>10:30</td>
<td>A/Prof Yohey Suzuki (University of Tokyo, Japan)</td>
<td>Methane is a key reagent for preservation of eukaryotic aDNA in marine sediments</td>
</tr>
<tr>
<td>11:00</td>
<td>Break</td>
<td></td>
</tr>
<tr>
<td>11:30</td>
<td>A/Prof Leanne Armand (ANZIC Program Scientist, Australian National University)</td>
<td>Infrastructure and opportunities presented by the Australia-New Zealand International Ocean Discovery Program (ANZIC)</td>
</tr>
<tr>
<td>12:00</td>
<td>Dr John Moreau (The University of Melbourne)</td>
<td>Seawater recirculation through oceanic basalt sustains a sediment community of sulfate-reducing bacteria</td>
</tr>
<tr>
<td>Time</td>
<td>Session/Activity</td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>12:30</td>
<td>Dr Michael Stat (Curtin University) Characterising biodiversity with degraded DNA</td>
<td></td>
</tr>
<tr>
<td>13:00</td>
<td>Lunch ECR Session 2</td>
<td></td>
</tr>
<tr>
<td>14:00</td>
<td>Ms Nicole Foster (ADIFF, University of Adelaide) Changing community composition of coastal and marine vascular plants—towards an independent evidence base on coastal environmental change through time</td>
<td></td>
</tr>
<tr>
<td>14:15</td>
<td>Ms Amaranta Focardi (Molecular Sciences, MQ) Viruses identification in sediment: Potential application of flow cytometry and cell sorting</td>
<td></td>
</tr>
<tr>
<td>14:30</td>
<td>Dr Linda Armbrecht (Biological/Earth and Planetary Sciences, MQ) Reconstructing past phytoplankton communities by using ancient DNA</td>
<td></td>
</tr>
<tr>
<td>14:45</td>
<td>Discussion</td>
<td></td>
</tr>
<tr>
<td>15:30</td>
<td>Tea Break</td>
<td></td>
</tr>
<tr>
<td>16:00</td>
<td>Discussion</td>
<td></td>
</tr>
<tr>
<td>16:45</td>
<td>Linda Armbrecht &amp; Leanne Armand Summary</td>
<td></td>
</tr>
<tr>
<td>17:00</td>
<td>End of Day 2</td>
<td></td>
</tr>
<tr>
<td>18:00</td>
<td>Dinner BBQ at Staff Café</td>
<td></td>
</tr>
</tbody>
</table>

**WEDNESDAY 11.10.2017 E7A G.23**

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>09:15</td>
<td>Arrival &amp; Coffee</td>
</tr>
<tr>
<td>09:30</td>
<td>Review/CoE/future workshop development and drafting</td>
</tr>
<tr>
<td>13:00</td>
<td>End of Workshop</td>
</tr>
</tbody>
</table>
SPEAKERS AND PRESENTATIONS

KEYNOTE SESSION:

Prof Alan Cooper

Australian Centre of Ancient DNA, University of Adelaide  
alan.cooper@adelaide.edu.au

Prof Alan Cooper has played a central role in the development of the field of ancient DNA, starting with his PhD research in Allan Wilson’s UC Berkeley laboratory with Svante Paabo in 1989. He created the Henry Wellcome Ancient Biomolecules Centre at the University of Oxford, and was Professor of Ancient Biomolecules from 2001-2005. He then established the Australian Centre for Ancient DNA (ACAD) at the University of Adelaide as an Australian Research Council Federation Fellow (2005-2010), and has since been an ARC Future Fellow (2011-2014) and is now an ARC Laureate Fellow (2015-2019). In 2016, he was named the South Australian Scientist of the Year.

He currently leads the Aboriginal Heritage Project in collaboration with the South Australian Museum and Aboriginal Families and Communities around Australia, which aims to create the first map of Aboriginal Australia, allowing people of Aboriginal descent to trace their heritage back beyond recent records.

Prof Cooper’s research interests include the use of ancient genetic data and analytical approaches to study key evolutionary processes – including genomic responses to past climate and environmental changes, extinction events, human evolution and migration, molecular evolution, microbiomes and disease – across a broad range of time and space. His multi-disciplinary focus integrates data from genomics, bioinformatics, zoology, archaeology, microbiology, forensics, palaeontology, physical dating methods, and climate records and he has led many large international multi-author studies which have resulted in major advances and high profile publications (27 in Science and Nature). He has published over 230 peer reviewed papers which have been cited over 17,000 times. His h-index is 55 (Web of Science) or 69 (Google Scholar).

Presentation title: Problems and potential solutions for work with various marine sediment samples

Dr Franck Lejzerowicz

University of Geneva, Switzerland  
Franck.Lejzerowicz@unige.ch

Master 1 (Université de Metz - France): Ecotoxicology, Biodiversity, Environment. Microbial ecology, ecotoxicology, molecular biology, immunology.
(FUTURE:) Postdoc (University of San Diego): Metagenomic analysis, Bioinformatics, Deep-Sea Science. Biomonitoring deep-sea mining exploitation of polymetallic-nodule areas: bioinformatic developments for ecological analyses of large metagenomic data

Presentation title: Ancient DNA from deep-sea subsurface sediments was once at the surface: the Foraminifera yardstick
**Abstract:** Foraminifera is a good model to explore marine ancient DNA and could be used for paleontological applications. Metabarcoding research based on Foraminifera proved successful at recovering ancient DNA from deep-sea subsurface sediments, and although the signal it conveys may not match that of classical micropaleontological data, the presence of sub-ancient allochthonous foraminiferal DNA can be used for the detection of paleotsunamis and to reconstruct the macroecological patterns of the plankton diversity. Sequencing and enrichment methods are progressing but the accuracy of ancient foraminiferal DNA as a new proxy for extended paleontological surveys depends on how are addressed both experimental challenges and conceptual frameworks.

**A/Prof Marco Coolen**

Curtin University, Perth  
marco.coolen@curtin.edu.au

Associate Professor Marco Coolen has received his BSc and MSc in Biology from Wageningen (Agricultural) University, the Netherlands in 1992 and 1995. He obtained a PhD in Paleomicrobiology at the Carl-von-Ossietszky University in Oldenburg, Germany in 2001. Marco was a postdoctoral investigator at the Marine Biogeochemistry Department, Royal Netherlands Institute for Sea Research (Royal NIOZ; 2001-2005), the Netherlands and a research faculty member in the Department of Marine Chemistry and Geochemistry at the Woods Hole Oceanographic Institution (WHOI), USA until 2015. His main research interests are reconstructing ecosystem responses to climatic and anthropogenic perturbations using geobiologic records. In addition, he is interested in studying the microbial fate of organic matter, which is of importance to our understanding of past and present carbon cycling. In 2015, Coolen was appointed as Assoc. Professor in Geomicrobiology and Deputy Director of WA Organic and Isotope Geochemistry (www.wa-oigc) at Curtin University, Perth, WA where he is continuing this line of research.

**Presentation title: A 52 kyr dead and living geobiologic record of paleoproductivity and oxygen minimum zone (OMZ) strength in the Arabian Sea**


1Western Australia Organic and Isotope Geochemistry Centre, Department of Chemistry, Curtin University, Bentley, WA 6102, Australia.  
2GeoBio-Center, Ludwig-Maximilians-Universita¨t Mu¨nchen, 80333 Munich, Germany.  
3State Key Laboratory of Estuarine and Coastal Research, East China Normal University, Shanghai, 200062, China.  
4AZTI – Marine Research, Herrera Kaia, Portualdea z/g – 20110 Pasaia (Gipuzkoa), Spain.  
5AZTI-Tecnalia, Marine Research Division, Txatxarramendi ugartea z/g, 48395 Sukarrieta (Bizkaia), Spain.  
6Department of Marine Chemistry and Geochemistry, and 7Department of Geology and Geophysics, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA.

**Abstract:** The analysis of preserved genetic signatures of past aquatic and terrestrial life in sedimentary records is recently gaining popularity as a novel proxy to reconstruct ecosystem interactions with past climate variability or more recent human perturbations. A major benefit of sedimentary paleogenomics is that life can be reconstructed from the relatively recent past even in the absence of preserved microfossils or when these species do not produce diagnostic lipid biomarkers. Past phytoplankton, zooplankton, and catchment vegetation have mainly been targeted for paleogenomics studies since these organisms are most likely no longer metabolically active or alive in anoxic and dark sediments. Therefore, their preserved genetic signatures represent the most genuine archive of past ecosystem changes. However, the DNA of dead organisms does not undergo repair and the general perception is that sedimentary DNA of truly dead organisms will be completely degraded within several 100’s kyrs after deposition. Past photosynthetic bacteria (e.g. cyanobacteria and green sulfur bacteria) have also been used to reconstruct paleoenvironmental conditions, but little is known about to what extent heterotrophic and possibly active subsurface bacteria form genetic archives of past biogeochemical cycling processes and paleoenvironmental conditions.
Selection of microorganisms in marine sediment is shaped by energy-yielding electron acceptors for respiration that are depleted in vertical succession. However, some taxa have been reported to reflect past depositional conditions suggesting they have experienced weak selection after burial. In sediments underlying the Arabian Sea oxygen minimum zone (OMZ), we performed the first metagenomic profiling of sedimentary DNA at centennial-scale resolution in the context of a multi-proxy palaeoclimate reconstruction. While vertical distributions of sulfate reducing bacteria and methanogens indicate energy-based selection typical of anoxic marine sediments, 5-15% of taxa per sample exhibit depth-independent stratigraphies indicative of paleoenvironmental selection over relatively short geological timescales. Despite being vertically separated, indicator taxa deposited under OMZ conditions were more similar to one another than those deposited in bioturbated intervals under intervening higher oxygen. The genomic potential for denitrification also correlated with palaeo-OMZ proxies, independent of sediment depth and available nitrate and nitrite. However, metagenomes revealed mixed acid and Entner-Doudoroff fermentation pathways encoded by many of the same denitrifier groups. Fermentation thus may explain the subsistence of these facultatively anaerobic microbes whose stratigraphy follows changing paleoceanographic conditions. At least for certain taxa, our analysis provides evidence of their paleoenvironmental selection over the last glacial-interglacial cycle. Significant shifts in past protist communities in response to paleoproductivity and OMZ strength were also observed. Dinoflagellates, Cercozoa, and Prasinophyceae were among the significant indicator taxa during productive and OMZ conditions, while benthic Centroheliozoans and the low-nutrient alga *Chlorella* predominated under reduced paleoproductivity and OMZ strength. This shows that both truly ancient protists and possibly slow growing but alive subsurface microbial communities with intact genomes can inform about the paleodepositional environment in marine sedimentary records.

**SENIOR RESEARCHER SESSION:**

**Prof Ian Paulsen**

Molecular Sciences, MQ  
ian.paulsen@mq.edu.au

Professor Ian Paulsen is a Distinguished Professor at Macquarie University and Deputy Director of the Macquarie Biomolecular Discovery and Design Centre. Ian is an ARC Laureate Fellow and an ISI Highly Cited Researcher with more than 250 publications. He received a PhD from Monash University and was an NHMRC C.J. Martin Fellow at the University of California at San Diego. He then took a faculty position at the Institute for Genomic Research (TIGR), where he led many microbial genome sequencing projects. Ian returned to Australia in 2007 as a Professor at Macquarie University and received a Life Science Research Award from the NSW Office of Science and Medical Research. He is the founder and Director of the new Synthetic Biology Laboratory at Macquarie University.

**Presentation title:** *Effects of uranium on sediment microbes*

**Dr Laura Weyrich**

Australian Centre of Ancient DNA, University of Adelaide  
laura.weyrich@adelaide.edu.au

Dr Weyrich received a PhD in Microbiology and Bioethics from Penn State, studying how respiratory infections alter the microbiome. Since 2012, she established a research team at the University of Adelaide that uses calcified dental plaque to reconstruct ancient human oral microorganisms, and was the first to reconstruct the microbiome of an extinct species, Neandertals. Her team is reconstructing the evolutionary history of human oral microbiome on six continents, obtaining insight into how the lifestyles and diets of our ancestors impact our health today.

**Presentation title:** *Contaminant DNA impacts in paleomicrobiological studies*

**Abstract:** Ancient DNA analysis of microorganisms present in soil and the environment
can unlock clues about past changes in climate, biodiversity, and species habitats. However, there are many potential pitfalls in the analysis of ancient bacterial DNA. Contamination from modern DNA from both known and unknown sources can critically impact the interpretation of downstream results. Methods to reduce contaminant introductions, identify and record contaminants throughout laboratory analysis, and analytical programs to account for contamination now exist and will be discussed within the context of ancient bacterial DNA analysis.

A/Prof Yohey Suzuki

University of Tokyo, Japan

PhD (2002) from the University of Wisconsin-Madison (a special degree of Geomicrobiology)
Associate Professor at Earth and Planetary Science Department, The University of Tokyo (2011-present)

Presentation title: Methane is a key reagent for preservation of eukaryotic aDNA in marine sediments

Abstract: Marine sediments are recognized as one of excellent archives of aDNA, when overlying seawater is anoxic. If not, aDNA is quickly degraded by aerobic microorganisms within a top 10 cm of bioturbated sediments. Although the majority of marine sediments is overlain by oxygenated seawater, methane seeping fuels anaerobic oxidation of methane coupled sulfate reduction in marine sediments, which leads to the establishment of strongly sulfidic conditions even at the sediment-water interface. We investigated the preservation of aDNA in marine sediments in areas associated with shallow methane hydrate deposits in Japan Sea.

Related publications

A/Prof Leanne Armand

ANZIC Program Scientist, Australian National University

A/Prof. Leanne Armand completed her PhD in 1998 at the Australian National University under the guidance of Prof. Patrick DeDeckker and the late Dr Jean-Jacques Pichon (Univ. Bordeaux I, France). Subsequently, she held post-doctoral positions at the Antarctic Climate and Ecosystem CRC in Hobart, Tasmania. While there she was the first Australian awarded an European Union Incoming Marie Curie Fellowship (FP6, 2005-07), which she undertook at the University of Marseille, France, in collaboration with Prof. Bernard Quéguiner. In 2007, A/Prof. Armand was awarded the Australian Academy of Science's Dorothy Hill award for her excellence in palaeoceanographic research and also the Bigelow Laboratory's Rose-Provasoli award. She was a Climate Futures Centre of Research Excellence (CoRE) appointee at the Department of Biological Sciences at Macquarie University (2009-2017). In 2017, she was the Chief Scientist of the very successful
palaeoceanographic mission to the Sabrina Coast, East Antarctica, on Australia's new research vessel the RV Investigator. She was the Chief Proponent and Director of the national Collaborative Australian Postgraduate Sea Training Alliance Network (CAPSTAN) initiative (until September 2017), with the Marine National Facility's RV Investigator. As of September 2017, A/Prof. Armand is the Program Scientist of the Australia-New Zealand IODP Consortium (ANZIC) since September 2017, based at the Australian National University, Canberra.

In this workshop, Leanne will talk about the infrastructure and opportunities presented by the Australia-New Zealand International Ocean Discovery Program (ANZIC).

Dr John Moreau
The University of Melbourne

As a geomicrobiologist, Dr Moreau conducts cross-disciplinary research in geochemistry, mineralogy and environmental microbiology on questions that address the impact of microbes on geological materials and processes. His work includes the study of microbial interactions with heavy metals, the evolution of sulfate-reducing bacteria, and the activity of the deep subsurface microbial biosphere. Dr Moreau employs a range of research approaches involving electron microscopy, advanced chromatography and spectroscopy and genomics. He obtained his PhD from the Department of Earth and Planetary Science at the University of California, Berkeley, in 2006, and served as a U.S. National Research Council Postdoctoral Fellow with the U.S. Geological Survey from 2006-2008, prior to taking up his current appointment.

Presentation title
Seawater recirculation through oceanic basalt sustains a sediment community of sulfate-reducing bacteria

Dr Michael Stat
Curtin University, Perth

Dr Michael Stat is interested in using genetic techniques to address questions on the biodiversity, biogeography and adaptation of marine organisms. He is particularly interested in using environmental DNA (eDNA) to assess biodiversity through space and time, and in the adaptation of symbioses.

Presentation title: Characterising biodiversity with degraded DNA

Abstract: This talk will present on the utility of using degraded DNA (eDNA and aDNA) for examining past and present biodiversity. Degraded DNA can be extracted from a variety of different substrates such as water and sediment, and when combined with DNA metabarcoding, a method that simultaneously sequences millions of DNA fragments, can provide a wealth of information on the biota present in an ecosystem. A number of projects will be showcased as well as critical steps in designing metabarcoding workflows that should be considered.
MQ INFRASTRUCTURE SESSION

Louise Fleck
Director, Research Office, MQ
louise.fleck@mq.edu.au

Louise Fleck, Director of the Macquarie University Research Office since 2009, began her career in research management in 1998 and has worked at several universities in Sydney. A qualified lawyer, she is a board member of the CRC Association and of the Australasian Research Management Society, and recently chaired an ARC working group examining the operation of the Linkage Projects scheme.

Louise will present on funding possibilities within the Centre of Excellence (CoE) and Cooperative Research Centre (CRC) frameworks.

Prof Simon George

MQ Marine Director, Earth and Planetary Sciences, Macquarie University
simon.george@mq.edu.au

Simon George was awarded a BSc (Hons) degree in geology from St Andrews University in Scotland in 1985 and then worked as a mudlogger. He obtained his PhD (1990) in organic geochemistry at the University of Newcastle-upon-Tyne, England, for his work on the influence of igneous activity on petroleum generation and accumulation. From 1991–2006 he worked for CSIRO in Sydney, Australia. When he left he was a Senior Principal Research Scientist leading research into the molecular geochemistry of petroleum and petroleum source rocks. He moved to Macquarie University in 2006, where he is now Professor of organic geochemistry, working especially on research areas to do with the geochemical record of the early evolution of life, petroleum geochemistry, marine geoscience, and bioremediation in cold climates. In 2014–2015 he was the Acting Head of Department, Earth and Planetary Sciences and since 2015 is the director of the Macquarie University Marine Research Centre.

Simon’s presentation will focus on the background, infrastructure and support provided by the Macquarie University Marine Research Centre (MQMarine). The structure and achievements of MQMarine will be outlined, as well as future goals of the Centre.

Dr Martin Ostrowski

MQ Marine Deputy-Director, Molecular Sciences, Macquarie University
martin.ostrowski@mq.edu.au

Dr Martin Ostrowski, is a CBMS Research Fellow employed by Ian Paulsen’s ARC Laureate Fellowship (2015-2020). Martin’s research is focussed on elucidating the roles of microorganisms in the key biogeochemical cycles that sustain the biosphere. Dr Ostrowski is the primary contact between the Dept. of Molecular Sciences (MolSci) and the national and international Oceanographic research community. He is a CI on an ARC Discovery Project ($532k, 2015-2018) independently of Paulsen. He represents MolSci as a Deputy-Director of the new Macquarie Centre for Marine Research. He also represents Macquarie within the Integrated Marine Observing System (IMOS) by co-leading the inclusion of trait-based microbial genomics as core indicators of ecosystem health at all National Reference Stations. This program has just received $1m in support from Bioplatforms Australia.

In this workshop, Martin will present on facilities and resources available at Macquarie University that provide a platform to ancient DNA research.
**EARLY CAREER RESEARCHER SESSION:**

**Dr Jennifer Young**

Advanced DNA, Identification and Forensic Facility (ADIFF), University of Adelaide  
jennifer.young@adelaide.edu.au

Dr Jennifer Young completed her PhD in Forensic Soil DNA Analysis at the Australian Centre for Ancient DNA, University of Adelaide and has since applied advanced DNA sequencing techniques to characterize biodiversity within various environmental samples including soils, sediments, scats and gut contents. Dr Young is currently the Senior Laboratory Coordinator of the newly established Advanced DNA Identification and Forensic Facility (ADIFF), at the University of Adelaide. ADIFF is a specialise network of forensic experts who apply cutting edge DNA technology, and sophisticated chemical analysis, to a broad range of biological samples to answer questions related to crime, missing persons, biosecurity and conservation.

**Presentation title**  
*Environmental DNA analysis: key considerations from sampling to sequencing*

**Abstract**

Dr Young will provide an overview of the general environmental DNA analysis workflow and highlight key considerations required to generate robust and reliable biodiversity data from sediments. Dr Young will discuss the pros and cons of different molecular approaches, and introduce the technique developed at ADIFF to allow better characterisation of marine plants with high ecological value, and thus improve interpretation of biodiversity changes through time.

**Dr Karita Negandhi**

Earth and Planetary Sciences, Macquarie University  
karita.negandhi@mq.edu.au

Karita is a postdoctoral research fellow at Macquarie University. Here she is undertaking work investigating greenhouse gas emissions (eddy co-variance) and microbial communities during the tidal reinstatement of a coastal wetland. She also carries CH4 monitoring and modelling approaches at coal seam gas sites. She received her PhD from University of Quebec, where she spent two summers in the Arctic identifying the influence of thaw pond geomorphology on their microbial populations and resulting greenhouse gas emissions. Before this she received a MSc. from Nova Southeastern University looking at bacteria associated within reef sponges and a BSc. in marine biology from Florida Institute of Technology.

**Presentation title:** *aDNA for predicting atmospheric carbon flux*

K. Negandhi, G. C Edwards, N. Saintilani, J. Kelleway, K. Rogers, M. Kennedy

**Abstract:** Australia’s coastal seal level history is similar to that of Antarctica and parts of Arctic, where it was previously underwater during the Holocene. Therefore, as the sea level has decreased, its coastal ecosystems have evolved from seagrass, mangrove, to saltmarsh. These three coastal ecosystems have different carbon uptake rates, with mangroves being the highest. Within the modern day setting of a saltmarsh subjected to tidal flooding, simulating sea level rise, a change in the microbial community was detectable along with an uptake of greenhouse gases (CH4 and CO2). With sediment cores within Australian saltmarshes showing the preservation of mangrove roots they could provide an ideal setting for the extraction of microbial aDNA (ancient DNA) to help estimate past carbon fluxes. Additionally, this environmental setting ideally provides nearby present-day
mangrove environments as a nice control to verify the application of new microbial aDNA technologies and measuring associated carbon flux.

Ms Nicole Foster

Advanced DNA, Identification and Forensic Facility (ADIFF), University of Adelaide
nicole.foster@adelaide.edu.au

My name is Nicole Foster I am a student at the University of Adelaide currently undertaking my PhD in Sciences within the school of Genetics and Evolution. I have previously completed a Bachelor of Science (Advanced) at the University of Adelaide in 2015 majoring in Botany and Ecology, and a Bachelor of Sciences Honours (Earth and Environmental) in 2016. I was also employed as a research assistant at the University of Adelaide from 2015-2017 conducting stress experiments and working on population genetic research on various species of seagrass.

Supervisors: Prof Michelle Waycott, Prof Bronwyn Gillanders, Dr Alice Jones (University of Adelaide)

Presentation Title: Changing community composition of coastal and marine vascular plants—towards an independent evidence base on coastal environmental change through time

Abstract: Coastal ecosystems, both natural and disturbed, contain biological communities that have undergone profound changes in response to increasing human influence. The ability to define anthropogenic impacts on these environments and to then be able to forecast responses to future climate change is highly sought after. Evaluating coastal environmental change through time will enable us to determine how environments have changed in association with human occupancy of our coastal environments. Traditional methods used to look back in time have so far been limited to direct observations of plant fragments in sediment cores, along with historical reconstruction based on observations from satellite and aerial photography and fossil/subfossil and fossilised pollen evidence. New methods to evaluate changes in species presence in communities are available as a result of advancements in DNA technology. For my PhD research we are developing a toolkit for utilising historical plant samples from coastal and nearshore marine sediments to improve our ability to document change. Coastal and nearshore marine plants have also been poorly characterised in the fossil record due to the paucity of fossil evidence globally and for seagrasses a lack of a pollen fossil record due to their inability to be preserved. A comprehensive reference library with a multigene region approach is being adopted. This will also serve to build a high resolution reference library for all studies using NGS tools to determine species identity in coastal and marine plants in temperate Australian ecosystems.

Ms Amaranta Focardi

Molecular Sciences, Macquarie University
amaranta.forcardi@hdr.mq.edu.au

Amaranta Focardi is a PhD student in in ARC Laureate Fellow Prof. Ian Paulsen's Group at Macquarie University. Her PhD project focuses on the impact of viral lysis and microzooplankton grazing on picocyanobacteria mortality with implication for the Carbon cycle. She is also interested in the identification of phage – resistance mechanisms in *Synechococcus*.

Presentation title
Viruses identification in sediment: Potential application of flow cytometry and cell sorting.
Abstract
Accounting for the highest abundance in the marine environments, viruses have a considerable influence on the ecology and the biogeochemical cycles of the ocean. Viral-induced mortality can influence the flux of nutrient in the oceanic microbial food-webs and also alter the species composition through horizontal gene transfer. Viruses in marine sediment are estimated to exceed the one in the water column, but are still difficult to count and to identify. To overcome this problem, high throughput analysis using flow cytometry and cell sorting could be adopted for a time-efficient counting method and to recollect the viral fraction from marine sediment.

Dr Linda Armbrecht
Biological Sciences, Earth and Planetary Sciences, Macquarie University
linda.armbrecht@mq.edu.au

Dr Linda Armbrecht completed her Bachelor degree in 'Biology of Organisms' at the University of Osnabrueck, Germany, and her Masters in 'Marine Biology' at the University of Bremen and the Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany. She conducted PhD in the Marine and Coastal Phytoplankton Lab, Department of Biological Sciences, Macquarie University, Sydney, Australia (supervised by A/Prof. L. Armand), where she established the first annual phytoplankton time-series survey in the tropical-temperate transition zone (Coffs Harbour, NSW, ~30°S). Her current postdoctoral research at Macquarie University focuses on merging morphological and genetic techniques to reconstruct past phytoplankton communities in the Nankai Trough subduction zone, Japan, using sediment cores acquired during Integrated Ocean Drilling Program (IODP) Exp. 316, Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE). In 2018, Linda will be complementing this Northern Hemisphere research with investigations on sediment cores from East Antarctica, collected during the Sabrina Seafloor Survey 2017, for which she will be based at the Australian National University, Canberra.

Presentation title
Reconstructing past phytoplankton communities by using ancient DNA

Abstract
Phytoplankton are unicellular microalgae living in the surface layers of the ocean and important as they conduct half the primary production on our Earth. When phytoplankton die they sink to the seafloor, transporting the carbon incorporated at the surface with them. This so-called ‘biological carbon pump’ is species-specific, thus a good knowledge about phytoplankton species composition and their photosynthetic performance is crucial in times of ongoing environmental change.

This research merges morphological and genetic techniques to reconstruct past phytoplankton communities and investigate their relationship with the paleoenvironment. The samples underlying this project originate from the Nankai Trough subduction zone, Japan, acquired during Integrated Ocean Drilling Program (IODP) Exp. 316, Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE), and from the Totten Glacier region in East Antarctica, acquired during the Sabrina Seafloor Survey, RV Investigator, 2017. The focus is on eukaryotic phytoplankton, therefore, morphological analysis by microscopy concentrates on microfossils (especially diatoms) and ancient DNA analysis using the taxonomic marker regions 18S rRNA V9 and V4, and 16S cpDNA. Additionally, rbcL, the gene encoding RubisCO (Ribulose-1,5-Bisphosphate Carboxylase/Oxygenase; key enzyme in phytoplankton involved in atmospheric and oceanic carbon cycling, which acts as a proxy for atmospheric CO2 concentrations) is targeted to examine changes in photosynthetic activity over geological times.

Preliminary results will be shown for both the Japanese and Antarctic samples and challenges specific to this research discussed.