CONNECTIONS

Bioplatforms Australia Newsletter | July 2015

SEARCHING FOR THE CANARIES OF THE MARINE WORLD

Bioplatforms Australia has instigated a pioneering investigation into the life-sustaining microbes that inhabit our oceans and their potential as an indicator of marine life health.

Marine microbes play a critical role in the health of our oceans. Making up the bulk of ocean biomass, they directly control the majority of the ocean's energy production and are ultimately responsible for regulating the marine food-web. They are also very sensitive indicators of both natural and man-made changes within the marine environment. Just as canaries were sent down coal mines to detect toxic gases, aquatic microbes can also serve as an early warning system for ocean health.

Despite their importance to the global climate and marine based industries, little is known about the dynamic nature of marine microorganisms and the complex interactions that sustain marine ecosystems. While they are important first responders to ocean changes, marine microbes are more than mere alarm systems with the ability to either augment or buffer the negative influences of human and natural impacts.

Sampling for this ambitious project will cover the microbial communities of seawater, sediment, sponge and sea grass utilising the extensive capability of Australia's Integrated Marine Observing System (IMOS). Bioplatforms Australia's genomics network will perform DNA sequencing to provide new data on how these microbial communities change over time offering enormous scope to develop indicators of ecosystem health and disturbance. Research outputs will also feed into key marine-based industries including tourism, fisheries and oil and gas.

This nationally collaborative project involves scientists from the Australian Institute of Marine Science, CSIRO, Curtin University, Edith Cowan University, Macquarie University, Sydney Institute of Marine Science, University of NSW, University of Queensland and University of Technology, Sydney and will employ the Australia's brand new, $120 million research vessel Investigator for some of the sampling work.

The combined advances in 'omics technologies, cell imaging and computational and bioinformatics capacity only now makes this endeavour possible. With

Bioplatforms Australia's support, the project will generate the large-scale datasets scientists require to understand fundamental marine processes and provide new benefits for ocean health and Australia's marine industries.

CORAL DATASETS PROPEL PROTECTION EFFORTS FOR GREAT BARRIER REEF

Bioplatforms Australia's datasets of Great Barrier Reef coral genomics are a cornerstone of new research seeking to accelerate reef resilience and adaptation to climate stresses.

A new collaborative project led by Professor Mark Ragan of the University of Queensland will characterise the genetic impact variations in water quality and temperature have on coral holobionts. The research will generate genomic data on the short-term response of corals in the face of environmental changes as well as their potential for genetic adaptation. The ultimate aim is to develop more-powerful tools for monitoring the Great Barrier Reef and innovative solutions to halting, or reversing, its present decline.

Since 1987, close to 50 per cent of the hard coral cover of the Great Barrier Reef has disappeared with most lost since 2006. Besides adding around $6 billion to our economy through tourism and fisheries, the Great Barrier Reef is an amazing example of biodiversity and a valuable ecosystem worthy of protection.

The project is clearly on the path that transforms research into management quality data. Early on, the research team will leverage the genomic datasets of Great Barrier Reef corals, symbionts and associated microbial communities to pinpoint biological responses along two environmental gradients, one dominated by nutrients, sedimentation and heavy metals, the other by variation in surface water temperature. They will then utilise these data to identify health biomarkers that can be used for new diagnostic tools and assays which can input into better predictive models of the reef's health status, stress and resilience. Access to real-time data will enable more effective conservation and management decisions.

The project, funded by the Queensland Government, brings together institutional members of the existing ReFuGe 2020 Consortium including the Great Barrier Reef Foundation, James Cook University, the Australian Institute of Marine Science, the University of Queensland, the Great Barrier Reef Marine Park Authority and the Australian National University. As a ReFuGe partner, Bioplatforms Australia is also supporting a genetic-based approach to improving the health and adaptation of coral reefs. Since 2012, our facilities have sequenced genomes for 10 corals, three algal symbionts and the microbial communities that support coral growth and health and will continue to provide sequencing services for this project.

The additional datasets generated by this new project will shed further light on the genetic underpinnings of the

Great Barrier Reef's tolerance to rapid environmental change and accelerate the potential for real time analysis and better solutions for a healthier reef.

PROTEOMICS ENABLES GROUND BREAKING DIAGNOSTIC TEST

The world's first proteomics-derived predictive test for diabetic kidney disease represents a global breakthrough in the diagnosis and treatment of the disease.

The commercial arm of Bioplatforms Australia network partner, Proteomics International, has produced and validated PromarkerD, the world's first diagnostic test for diabetic kidney disease (DKD) offering enormous potential for medical benefits and cost savings.

The ability to accurately predict the onset of DKD via a simple blood test and then provide appropriate clinical treatment to prevent its onset has the potential for global health care savings in the billions. In Australia alone, health costs and productivity losses attributed to diabetes is estimated at $10.3 billion annually. Of the approximately 1.7 million Australians who have chronic kidney disease, 1.5 million are not even aware they have it.

In an exciting example of the potential for proteomics to identify new drugs and diagnostics, the test was developed using mass spectrometry-based proteomics technology to compare the differences in the protein makeup of people with and without the disease. The test is able to measure specific biomarkers in the blood of diabetes patients to determine their likelihood of contracting DKD.

PromarkerD was developed and validated in a clinical study of 576 diabetes patients in Western Australia between 2010 and 2014. It has considerable commercial potential given the International Diabetes Foundation estimates that 382 million people currently have diabetes worldwide and the CDC estimates 35 per cent of diabetic adults have chronic kidney disease.

METABOLOMICS JOINS THE BATTLE AGAINST SUGAR CANE DISEASE

Metabolomics techniques have been called upon to combat the growing threat of Yellow Canopy Syndrome (YCS) which is reducing the yields of sugar cane crops and causing considerable concern for the Australian sugar industry.

YCS is a baffling condition that causes sugar cane plants to progressively yellow until the crop is incapable of producing and storing sugar in their stems resulting in lower plant yields. The industry-owned company, Sugar Research Australia (SRA) has invested almost $4 million into finding the cause of YCS so that it can develop management strategies to combat the condition. So far, their efforts have ruled out herbicide use, poor root growth

and environmental stress. SRA has now turned to biological factors and teamed up with Associate Professor Ute Roessner and Dr Daniel Dias from Bioplatforms Australia's metabolomics node at the University of Melbourne to investigate internal mechanisms within the sugar cane plant.

To try and pinpoint the factors that cause YCS, the SRA - University of Melbourne collaboration is comparing the metabolite patterns of affected leaves, stems and sap with those that are healthy. The team hope to identify metabolomic changes associated with the development of YCS and will integrate metabolite data with other physiological and genomic data to better understand the influencing mechanisms. The work involves complex analysis of dozens of plant hormones, hundreds of biochemicals and over 200,000 different genes within sugar cane plants.

While this industry-based project was instigated by the YCS crisis, the SRA is now interested in applying the University of Melbourne's metabolomics and lipidomics expertise to more deeply understand sugar cane response to genetic and environmental stimuli.

RECONSTRUCTING AUSTRALIA'S HERITAGE THROUGH A GENETIC MAP OF INDIGENOUS AUSTRALIA

Genomics techniques used to analyse ancient DNA will help reconstruct Australia's lost genetic and cultural past.

The Australian Centre for Ancient DNA and the South Australian Museum are working with aboriginal communities to develop the first map of Indigenous Australia using a remarkable collection of around

7,000 hair samples. DNA from the hair samples will allow Aboriginal families and communities to trace their ancestry and is also the last practical means to reconstruct the unique human history of Australia prior to the arrival of Europeans.

The hair samples were collected with permission from Aboriginal and Torres Strait Islanders during anthropological expeditions from 1926 to 1963. Some of the samples were collected prior to the significant disruption to Aboriginal communities and before and during child removal policies. As a result, this resource provides one of the only practical and feasible means of tracing Aboriginal ancestry where oral or written records may fail. It also represents the first steps in revealing Australia's 50,000 years of human history and will complement the large collection of other records of Indigenous peoples held by the South Australian Museum.

Led by Professor Alan Cooper, a team of archaeologists, linguists, ethicists, and South Australian Museum staff have built links with Aboriginal communities to obtain consent for the investigations and to inform them of the research, outcomes and the records that exist of their ancestors.

The project will utilise advanced DNA sequencing techniques to construct mitochondrial genomes and Y chromosome sequences from the hair samples allowing researchers to build

lineage maps that will help indigenous peoples trace their immediate family and ancient heritage. This will be particularly important for those who were dispossessed from their families or were not told of their heritage due to the social constraints of the time. Sequencing results will be included in a genetic database which will have considerable potential to facilitate the repatriation of cultural items and human remains held in museums around the world which cannot currently be identified. The database may also assist in future health studies for Indigenous people by providing insights into patterns of disease and resistance.

NEW GENETIC DATABASE AIMS TO SAVE KOALAS

The Australian Museum will employ data from the newly sequenced koala genome in the mission to combat koala diseases and declining populations.

The newly sequenced koala transcriptome has been critical in understanding koala immunity and accelerating the development of vaccines for debilitating koala diseases that are seriously impacting their numbers. The koala transcriptome will now be used in a new investigation on the genetic diversity of koalas in the

MELANOMA RESEARCH TAKES ANOTHER STEP TOWARDS EARLY DETECTION

A new collaborative research program has received $14 million to study the molecular determinants of the risk, progression and treatment of melanoma cancer.

mission to protect this iconic species from further population declines. Dr Rebecca Johnson from the Australian Museum will lead the development of new genetic assay for koalas that will deliver an unprecedented level of detail on the genetic diversity of both wild and captive koala populations.

Data from this rapid and relatively cheap genetic assessment will enable deeper studies of koala disease responses, their mating system, the impact of habitat fragmentation and the dynamics of koala populations. These data will be broadly shared and are expected to provide new tools for conservation management,

captive breeding decisions and koala research. The genetic assay will also measure the koala retrovirus and chlamydial infection status of koalas which will help conservation decisions and be particularly useful for breeding programs. The Australian Museum will also use the project to create a genetic tissue bank using sampled koalas as a foundation for the first Australia-wide genetic repository of koala material.

The genetic database and tissue repository will significantly improve the ability of wildlife managers and zoos to manage wild and captive koala populations and will provide an ongoing resource to answer key koala survival questions into the future.

The collaborative project that brings together researchers from Macquarie University, the Melanoma Institute, the University of Sydney, the Centenary Institute, the Westmead Millennium Institute and QIMR Berghofer will investigate why melanoma develops hoping to identify risk genes as well as molecular markers of prognosis. Finding gene faults responsible for melanoma could lead to targeted screening and advance new treatments to treat and cure the disease.
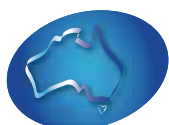
Bioplatforms Australia was instrumental in generating the datasets that have enabled a large-scale genomic analysis of melanoma tumours. These datasets have been fundamental in the research efforts seeking early detection and prevention of one of Australia's deadliest cancers and will continue to be a cornerstone of this research.

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