Cyber-Marine

Newsletter 2 | June 2022

Welcome to Cyber-Marine newsletter number 2. Despite disruption due to Covid, collaboration between the different institutions in the team is stronger than ever, we're getting increasing involvement from industry, and research is progressing well. In this newsletter we're highlighting our students. We have 3 PhD students and 2 post-doctoral fellows supported by Cyber-Marine. We also supported an honours student and had two undergraduate students working on the programme over the summer break.

Research update

The first comprehensive tissue sample sets have been prepared from our exemplar organisms and in-depth chemical analysis is being carried out at Plant and Food Research (PFR) and Callaghan Innovation (CI).

The same samples are being analysed by laser spectroscopic techniques at University of Otago (UoO), with the algorithms to relate the multiple sets of data being written at Victoria University of Wellington (VUW).

Work is progressing on unit operations for processing steps within multi-product cascades at CI and PFR. Specifically, on supercritical carbon dioxide and dimethyl-ether extractions at CI, on aqueous extraction at PFR, and on chemical modifications to create new products at PFR, CI and Deakin University in Australia.

Cyber-Marine Industry Forum

Our first Cyber-Marine Industry Forum was held on 6th May. It was a hugely successful day with great presentations from researchers and industry partners.

If you missed the forum or would like to have another look at the talks, a recording of the presentations can be found here:
https://plantandfood.zoom.us/rec/share/jNbad-dFi0ezcI5st6JNtkD-I8XgVthlFLrWUYjgNqjiB2g8gyh-QrssgMpHYYyf.2ydBdggHa0Bl_tCy

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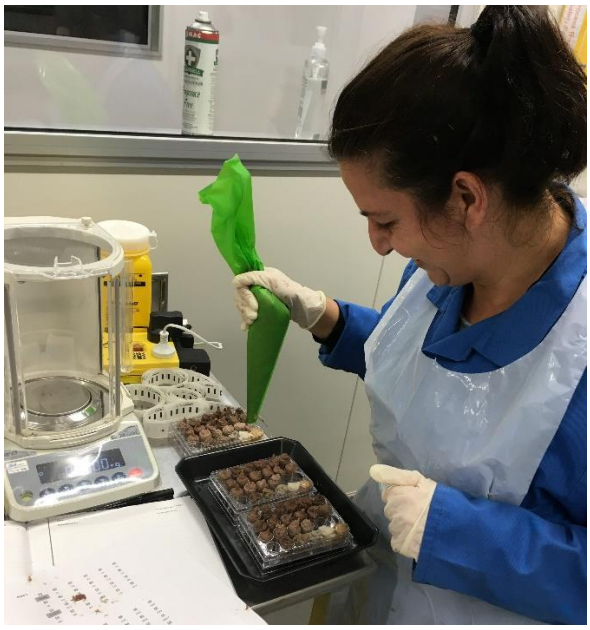

Looks like chocolates but really isn't. Asli Card (PFR) preparing fish and mussel homogenate samples for chemical and spectroscopic analysis at PFR, CI and UoO.

Meet our students

Sudarshan Dhakal: Deakin University

Sudarshan is researching glycolipids of marine origin as a part of his PhD project. His aim is to develop methods to efficiently extract and characterise glycolipids present in marine biomass, and harness their potential for a range of industrial applications. He is focusing on development of valuable marine-derived products with cosmeceutical and pharmaceutical applications.

Sudarshan completed an undergraduate degree in Agricultural Sciences in Nepal, and a postgraduate degree in Biotechnology at Deakin University, Australia. His masters' research focused on the extraction and characterisation of xanthones from mangosteen fruit waste. Sudarshan's agri-food background, and masters' project in organic waste recycling, made him realise the tremendous potential for the biomass left over from food production to be transformed into valuable products because of its

intriguing molecular diversity. His passion grew in working at the interface of analytical chemistry and bioprocessing for solving problems in food industry by applying circular economy and sustainability principles.

With his PhD research, he hopes to find an innovative approach to get value from underutilized marine derived molecular classes specifically glycolipids of commercial significance.

Alex Leonard: University of Otago

Alex started her PhD project with the Centre for Bioengineering and Nanomedicine at the UoO in December 2021. Alex's project focuses on chemically altering fish collagen to allow 3D printing of scaffolds for soft tissue engineering applications. The collagen will be cross-linked to create mechanical properties that support cell growth and attachment onto the scaffold. Precise conjugation techniques called 'click chemistry' will be used to attach vascular endothelial growth factors to the scaffold to facilitate the differentiation of cell culture into tissue, and drive the development of blood vessels. Her aim is to create a thicker engineered tissue construct that has adequate vascularisation, an on-going challenge in tissue engineering.

Jesse Wood: Victoria University of Wellington

Jesse Wood has a BE (Hons) in Software Engineering with the first-class Honours at VUW. He was awarded a Victoria Excellence Scholarship, a summer research scholarship, and two MacDiarmid Institute Discovery Awards. He is an NZ Māori student and has been awarded a Te Herenga Waka Māori Doctoral Scholarship and MBIE PhD scholarship. He started his PhD in artificial intelligence and machine learning in March 2022 within Cyber-Marine, and is co-supervised by Bing Xue, Hoai Bach Nguyen and Mengjie Zhang at VUW and Daniel Killeen at PFR.

Jesse's PhD thesis will be focused on the use of machine learning and evolutionary computation techniques to develop new algorithms for building intelligent and optimised green manufacturing for marine co-products. He will use genetic programming and deep learning to automatically generate interpretable models for multi-objective decision making to maximise the economic values, and minimise the cost and time during the process. Transfer learning and domain adaptation will be used to build models across different species of fish co-products.

Jesse's PhD project complements his BE(Hons) research project which evaluated an ensemble of machine learning techniques to improve the classification of fish species from the current Gas Chromatography-Mass Spectrometry (GC-MS) techniques to identify marine lipids which produces high dimensional low sample size data. His project focused on the interpretability of the model through visualisation, comparisons, and analyses. This project was also part of the Cyber-Marine Research Programme. Jesse investigated Support Vector Machines, ReleifF and PSO feature selection, Decision Tree and Convolutional Neural Networks which showed promising results. Linear Support Vector Classification outperformed all other methods achieving near perfect classification accuracy on unseen data.

Demelza Robinson: Victoria University of Wellington

Demelza has a BSc (Hons) in Computer Science from VUW, specialising in AI and machine learning (AIML). Before being involved in Cyber-Marine she carried out research using AIML techniques for chemical and material science under the co-supervision of the MacDiarmid Institute and the AIML Group at VUW, providing her with experience at the interface between chemistry and computer science. Demelza carried this experience through into her honours project in Cyber-Marine. Her projects used horticultural data to mimic the marine chemical data expected to be generated in Cyber-Marine so that a start could be made on new approaches to data analysis.

Demelza's BSc (Hons) Research Project focussed on developing two new learning/adaptive approaches through the use of evolutionary computation (EC) techniques for horticultural nutrient assessment. She developed a new genetic algorithm (GA) method for automatically selecting pre-processing techniques to bypass manual pre-processing. Then, she created a genetic programming method for automatically building interpretable regression models that remove the requirement for partial least squares regression (PLSR). Her results show great potential in the application of EC techniques in this area.

Demelza undertook a Summer Research Scholarship project in 2021/2022 aiming to further refine her GA-PLSR approach and develop a new genetic programming (GP) method to construct symbolic regression models that are more interpretable than currently used PLSR models, and can generate results in a single process.

Georgia Patching: Summer student - Massey University, Pūhoro STEM

Georgia (Ngāti Kauwhata) recently graduated with a degree in Nutrition from Massey University. She joined the PFR team in Nelson for a summer studentship, in collaboration with the Pūhoro STEM academy. For her studentship Georgia undertook a project investigating a novel green strategy for extracting oils from greenshell mussel and hoki, using a variety of surfactants.

Sam Bonthron: Trinder Engineering and Plant & Food Research Nelson

Sam is in the final year of his Bachelor of Mechanical Engineering Degree at the University of Canterbury. In 2021/2022 he undertook a summer internship based at the professional design office at Trinder Engineering and PFR.

Sam's project focussed on developing a highly specialised inspection window for monitoring viscous biological feed-streams. His design and prototype had to to comply with strict physical, fluid flow, optical, hygiene and performance requirements.

Sam's prototype development will enable the acquisition of Near Infra-Red (NIR) and Raman spectra from back-scattered laser light. These specialized measurements will be used to monitor process performance and determine accurate slurry composition.

Meet our Post Docs

Elley Rudebeck: Deakin University

Elley's project aims to use green chemistry principles to synthesise functional glycolipids with interesting physical and biological properties. She will use lipids extracted from our exemplar species as a raw material for synthesis.

Elley is a postdoctoral researcher at Deakin University in Geelong (AUS). Her role in the Cyber-Marine programme is to investigate marine glycolipids. Glycolipids are a class of lipids that have received recent interest for their surfactant/emulsifying properties and bioactivity.

Bach Hoai Nguyen: Victoria University of Wellington

Bach Hoai Nguyen has a BSc, a BSc (Hons) and a PhD in Computer Science (artificial intelligence) from VUW. He was Postdoctoral Research Fellow at VUW from November 2019 to March 2022 and joined the Cyber-Marine programme in 2021. Bach works on pre-processing of the cyber-marine chemical data, as well as co-supervising Honours, Summer and PhD students. He was appointed as a Lecturer in Artificial Intelligence in April 2022, and continues to work on the Cyber-Marine programme, collaborating with Bing Xue and Mengjie Zhang and the chemists at PFR, CI and UoO.

Jeremy Rooney: University of Otago

Jeremy Rooney has been working as a postdoctoral researcher at the University of Otago on Cyber-marine since August 2021. His expertise is in analytical and polymer chemistry with his PhD project focused on developing a low temperature curing waterborne coating system for New Zealand Steel's coil coating line under Prof. Keith Gordon. Comprehensive skills in vibrational spectroscopy and multivariate analyses, from his PhD experience, are invaluable to the goals of Cyber-marine, particularly the distinction between fish homogenate streams and lipid interactions in deep eutectic solvents.

Coming up…

A meeting of our Science Excellence Advisory Group is planned for June-July.

Jolin Morel (CI) is presenting work from Cyber-Marine at the NZIFST (Institute for Food Science and Technology) Conference 5-7th July in Rotorua. ‘Creating value from marine by-products using supercritical and subcritical solvents’ J. Morel, O. Catchpole, T.Moreno, K. Lagutin, A. MacKenzie, T.Fenton

In June Daniel Killeen will visit Cyber-Marine collaborators at Nofima in Norway. Key contacts include Jens-Peter Wold, an expert in in-line spectroscopic analysis and Runar Solstad, an expert in bioprocessing and marine co-products

Recent Publications and Conference Presentations

Demelza Robinson, Qi Chen, Bing Xue, Daniel Killen, Keith C Gordon and Mengjie Zhang. "A New Genetic Algorithm for Automated Spectral Pre-processing in Nutrient Assessment". Proceeding of the 25th European Conference on Applications of Evolutionary Computation (EvoApplications 2022). Lecture Notes in Computer Science. Vol. 13224. Madrid, Spain. 20-22 April 2022. Pages 283-298.

Demelza Robinson, Qi Chen, Bing Xue, Daniel Killeen, Sara Miller, Keith Gordon, Indrawati Oey and Mengjie Zhang. "Genetic Algorithm for Feature and Latent Variable Selection for Nutrient Assessment in Horticultural Products." IEEE Congress on Evolutionary Computation (CEC 2021). Krakow, Poland, 28 June - 1 July 2021. Pages 272-279.