

# Cyber-Marine

Newsletter 3 | June 2023

Welcome to Cyber-Marine newsletter number 3. We're coming up to the 3-year mark in our 5-year research programme and things are getting increasingly exciting. The team is working closely together as we progress with technologies for multi-product processing cascades and the rapid analytical approaches that underpin them.

## Research update

There are two key challenges in Cyber-Marine. The first is how to understand and react to raw material variability in real time, so that our 'future factory' can utilise any fish species and whatever tissue might arrive for processing. We want to deliver optimised value from the products and no waste.

Extensive sampling over multiple seasons of all tissues in our exemplar species (hoki, mackerel and Greenshell™ Mussel) is almost complete. Huge thanks must go to our industry partners (Sealord, Talley's, MacLab, Pelco, Aroma), who have provided us with such high-quality raw material. The tissues have been extracted and tested at Plant & Food Research (PFR) and Callaghan Innovation (CI), with particular emphasis on specialist phospholipid chemistry by the team at CI. The same samples have been analysed by Raman, FTIR and NIR spectroscopy at PFR and the University of Otago. We now have enormous amounts of in-depth chemical compositional data and the matching laser spectra. Chemical analysis gives very detailed information but is unavoidably slow. Laser spectroscopy can give instantaneous results but the complex spectra have to be correlated to the original chemical data to allow practical application. Analysing and correlating this amount of data requires considerable person and computer time, so it needs to be automated. This is where the Data Science and AI team at Victoria University of Wellington come in. They have made considerable progress in developing the computer algorithms we need to derive instantaneous compositional information from the spectra.

The second major challenge is how to develop sustainable and coordinated processing for marine

products, bringing together existing technologies and new approaches that will maximise recovered value whilst minimising energy consumption. A key aspect has been solving how to protect the valuable lipids, particularly phospholipids, from enzyme attack prior to extraction, whilst preserving other non-lipid bioactives. This has been very challenging, but we now have a range of unit operations that can do this. We have developed non-destructive treatments to control the enzymes and two supercritical processes that can extract phospholipids in good yield. The aim is to be able to present our industry partners with a range of short- and longer-term processing options for the major component streams (e.g. collagen, polar and non-polar lipids, other specific protein fractions, and minerals). We envisage that the processes could be tailored to match a particular multi-product focus and utilise existing as well as future processing equipment in a staged approach.

In the second part of the processing objective, we are looking at new products that can be made from the extracted components. At Deakin University (Geelong, Australia), the team is investigating glycolipids, valuable compounds with uses in products such as nutraceuticals and cosmetics. The first hurdle has been to develop rapid analytical methods for the molecules. Glycolipids are not found in high concentrations in marine animals, but there is potential to synthesise variants with targeted functionalities, using the polyunsaturated lipids isolated from our marine animals as the base molecules. Elsewhere in this objective we are looking at new ways to combine components to allow delivery of stabilised marine bioactive compounds to the skin.

Going forward, the new focus for the combined team is to pull all the research together to create working factory prototypes. We need to demonstrate in our concept factory that we can analyse composition in real time, to incorporate the different processing operations, and produce a complete range of products with information on yields, attributes and quality. As a first step, Talley's have generously allowed us to use their rendering plant for trials, along with donating the time of highly experienced renderer Ray Forscutt. A rendering plant is not a Cyber-Marine factory but contains some of the same equipment. This trial has been hugely informative for researchers in understanding bulk handling of fish by-products and

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the use of large-scale processing machinery. This will be carried through into design of our prototypes.

## Recognition for Cyber-Marine researchers

We have a fantastic team of world-class researchers. It's wonderful to see this recognised.

### Honour for Callaghan Innovation scientist

In March 2023, **Dr Owen Catchpole** was made a Fellow of the Royal Society Te Apārangi, an honour that recognises distinction in research, scholarship and knowledge advancement. Owen is the first scientist to be made a Fellow in the 10-year history of Callaghan Innovation. Further information and a great plug for Cyber-Marine can be found here: [Business.Scoop » Distinguished Honour For Callaghan Innovation Scientist](#)



*Dr Owen Catchpole, elected as a fellow of the Royal Society Te Apārangi*

### Awards for the Victoria University of Wellington Research Team

**Dr Qi Chen**, data science researcher in Cyber-Marine, has been awarded the Early Career Research Excellence Award by Victoria University of Wellington. She has been appointed as a senior lecturer in Artificial Intelligence in the School of Engineering and Computer Science [Qi Chen Profile | Te Herenga Waka — Victoria University of Wellington \(wgtu.ac.nz\)](#).

**Professor Bing Xue** was elected as Fellow of Engineering New Zealand. This recognises her significant contributions to Information and Communications Technology (ICT) and to Women in Engineering. Bing was also awarded the IEEE Computational Intelligence Society Outstanding Early Career Award for contributions to the development and application of evolutionary machine learning. [NZCS: IEEE CIS Early Career Award: Bing Xue](#) [This year's fellows | Engineering NZ](#)



*Professor Bing Xue*

**Professor Mengjie Zhang** received an award for Outstanding Contribution to Evolutionary Computation in Europe by the SPECIES society.

## Cyber-Marine students

**Sudarshan Dhakal**, PhD student at Deakin University, has successfully achieved 1-year confirmation of his research programme. Sudarshan did a fantastic job of presenting his research on the analysis of glycolipids.

**Jesse Wood**, PhD student at Victoria University of Wellington, presented at the 35th Australasian Joint Conference in Artificial Intelligence 2022, Perth, WA, Australia, 5–8 December 2022. He presented his work on harnessing machine learning to identify different fish species in mixed samples.

**Yun Zhou** began his work in Cyber-Marine as a researcher and has recently decided to start PhD studies at Victoria University of Wellington. His work will determine how well the chemical composition can be predicted using vibrational spectroscopy. A key research question is whether predictions are significantly improved if multiple spectroscopy techniques are combined, compared with using each technique independently.

**Alex Leonard**, PhD student at University of Otago, presented her work on applications of fish collagen in biomaterials at the 28<sup>th</sup> Annual Conference of the Australasian Society for Biomaterials and Tissue Engineering, Christchurch, New Zealand, 12–14 April 2023.

## Cyber-Marine out in the world

**Techweek 2023** (10–20 May) is an annual, nationwide series of events, showcasing and celebrating New Zealand's technology and innovation sectors. The intention behind Techweek is to foster national growth by providing opportunities for connection and collaboration. **Dr Kirill Lagutin** (Callaghan Innovation) spoke about the work in Cyber-Marine as part of a panel discussion "AI innovation in Aotearoa: today and

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tomorrow" at the Tomorrow Expo in Tāmaki Makaurau Auckland. **Professor Keith Gordon** (University of Otago) spoke at Techweek in both Auckland and Palmerston North on "Advanced analytical techniques using Raman spectroscopy to guide the enhancement of novel foods".

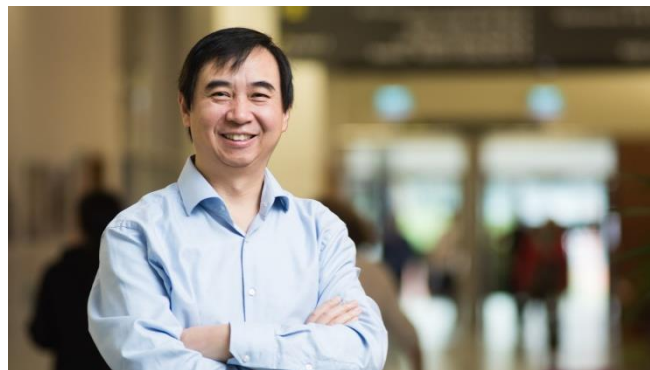


*Kirill Lagutin (Callaghan Innovation) taking part in a panel discussion at TechWeek 2023*

**Dr Daniel Killeen** (Plant & Food Research) will deliver an invited presentation at Queenstown Research Week in August. His talk at the "Kai mō Aotearoa – Food Science" satellite meeting will give an overview of progress on the Cyber-Marine 'Smart Factory', and a sneak peek at some of the seasonal compositional data and vibrational spectroscopy modelling undertaken thus far.

**Dr Jeremy Rooney** and **Professor Keith Gordon** (University of Otago) will attend the International Conference on Advanced Vibrational Spectroscopy (ICAVS 12) in Krakow, Poland, 27 August – 1 September.

Workshop and Opening of **Te Whiri Kawe: The Centre for Data Science and Artificial Intelligence** at Victoria University of Wellington, 13 June 2023. Cyber-Marine's own **Professor Mengjie Zhang** is the new Director of the Centre, based at the Kelburn campus. The Centre brings together expertise and innovation in data science, artificial intelligence, and machine learning from faculties across the University and joins with external collaborators with the aim of solving real-world problems. It will be an essential part of making Cyber-Marine both a scientific and practical success. [Launch of Te Whiri Kawe—Centre for Data Science and Artificial Intelligence | Wellington Faculty of Engineering | Victoria University of Wellington \(wgtn.ac.nz\)](#)



*Professor Mengjie Zhang (photo from [Te Whiri Kawe—A Centre for Data Science and Artificial Intelligence soon to launch | Wellington Faculty of Engineering | Victoria University of Wellington \(wgtn.ac.nz\)](#))*

## Recent publications and conference presentations

Wood J, Nguyen BH, Xue B, Zhang M, and Killeen D. "Automated fish classification using unprocessed fatty acid chromatographic data: A machine learning approach." In AI 2022: Advances in Artificial Intelligence: 35th Australasian Joint Conference in Artificial Intelligence 2022, Perth, WA, Australia, 5–8 December 2022, Proceedings, pp. 516-529. Cham: Springer International Publishing, 2022 [https://doi.org/10.1007/978-3-031-22695-3\\_36](https://doi.org/10.1007/978-3-031-22695-3_36)

Ahmed F, Gordon KC, Killeen DP, and Fraser-Miller SJ. (2023). *Detection and quantification of adulteration in krill oil with Raman and infrared spectroscopic methods*. *Molecules*, 28(9), 3695. <https://doi.org/10.3390/molecules28093695>

Ahmed F, Killeen DP, Gordon KC, and Fraser-Miller SJ. (2022). *Rapid quantitation of adulterants in premium marine oils by Raman and IR spectroscopy: A data fusion approach*. *Molecules*, 27(14), 4534. <https://doi.org/10.3390/molecules27144534>

Morel J, Catchpole O, Moreno T, Lagutin K, MacKenzie A, and Fenton T. "Extraction of lipids and phospholipids from marine biomasses using subcritical and supercritical fluids", at the 19th European Meeting on Supercritical Fluids, Budapest, Hungary, 21–24 May 2023.

Leonard A, Cumming MH, Cabral JD, and Ali MA. "Characterising the impacts of established sterilisation techniques on two marine fish skin collagen extracts for biomedical use", at the 28<sup>th</sup> Annual Conference of the Australasian Society for Biomaterials and Tissue Engineering, Christchurch, New Zealand, 12–14 April 2023.

If you have any feedback or would like to talk more about Cyber-Marine, please contact Sue Marshall: [susan.marshall@plantandfood.co.nz](mailto:susan.marshall@plantandfood.co.nz)

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