iCASE Project / AY 2026 -2027

Exploring biodiversity for biocatalysis solutions

Project Reference: ICS-SYN-CJ26

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Co-supervisor: Professor Florian Hollfelder (Biochemistry)

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Industrial Partner: Syngenta

Main BBSRC strategic theme: Bioscience for sustainable agriculture and food

Secondary BBSRC strategic theme: Transformative technologies

Project outline:

The enormous functional diversity encoded in genomes has a range of potential applications critical for a healthy and sustainable future for humanity. The myriad uses of enzymes include replacing industrial chemical processes with sustainable, biocompatible yet efficient enzyme-catalysed processes (=biocatalysis) will reduce the carbon footprint and pollution produced by the chemical industry, facilitate recycling and make drug and chemical production more efficient. The availability of high-quality genomes across the tree of life has expanded dramatically, but our understanding of these genomes is limited by genome annotation which traditionally infers function based on sequence similarity. Methods are needed to experimentally annotate gene function.

This proposal brings together expertise in ultra high throughput (UHT) microfluidics and enzyme biology (Prof Florian Hollfelder) and insect genomics and pest species biology and genetics (Prof Chris Jiggins). The droplet microfluidics approach allows functional tests to be carried out on gene repertoires at a throughput of 10^7 per day. The assays are low cost because they are conducted in picoliter volumes (>10,000-fold cheaper than liquid handling in microplates). The Hollfelder group has recently developed directed evolution approaches that combine error-prone PCR with high throughput assays and deep sequencing to screen large numbers of variants to discover sites that confer improved activity. When combined with AI machine learning this can generate significant improvements in catalytic activity, including identification of novel epistatic combinations of sequence changes (DOI: 10.1101/2024.04.08.588565). We propose to explore natural biodiversity for biocatalysis reactions that are relevant to Syngenta. This project is both feasible and based on well-established technology, but also highly novel in its application to explore ecologically diverse arthropods.

1) Develop fluorogenic assays to be used in high throughput screening for enzymatic reactions relevant to Syngenta
2) Establish high complexity gene libraries from UK arthropod diversity and screen for activities studied in 1)
3) Conduct directed evolution using microfluidics, high throughput long read sequencing combined with machine learning to improve catalytic activities.

The project will establish a pipeline to valorise biodiversity and identify biocatalysts for chemical industries.