



2016-2018 Projects

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Quantifying the role of mycorrhizal fungi in soil organic matter dynamics in boreal forest soils

Håvard Kauserad, University of Oslo; Lina Nybakken and Mikael Ohlson, NMBU and Peter Kennedy, University of Minnesota

Abstract:

This project will investigate how plant-associated symbiotic fungi influence the storage of carbon in boreal forest soils. The work will specifically focus on how changes in soil fertility and climatic conditions influence the decomposition of dead fungal and plant biomass, which represent major sources of carbon inputs into soils. Researchers at the three universities will collaborate on a set of field-based observational and experimental studies located in both Norway and the United States. The research will leverage experimental infrastructure already present in both countries and involve scientists with synergistic expertise in fungal and plant ecology, ecosystem biogeochemistry, molecular microbial identification, and bioinformatics. Collectively, the project will provide fundamental new insights into the role of plant-associated symbiotic fungi in carbon sequestration processes and how changes in resource availability and environmental conditions may mediate the below-ground response of boreal forest ecosystems to climate change.



Structural characterization of the *Shewanella oneidensis* 5' nucleotidase UshA

Jeffrey Gralnick, University of Minnesota and Hans-Petter Hersleth, University of Oslo

Abstract:

The development of effective and sustainable technologies to clean our environment and provide alternative energy is critical for the future of our society. One promising technology aimed at providing solutions toward these priority areas involves utilization of bacteria. *Shewanella oneidensis* is a bacterial species capable of breathing a diverse array of extracellular substrates, including environmental contaminants and electrodes. Breathing extracellular environmental contaminants, including uranium and chromium, renders the substrate insoluble, allowing for reduced movement through waterways and easier remediation. Additionally, the process of breathing electrodes can potentially be harnessed as a sustainable energy source. The general mechanism of *S. oneidensis* breathing extracellular substrates has been characterized. However, to enhance our ability to implement these technologies we must first understand precise biochemical and genetic mechanisms related to the cell's ability to carry out these reactions. As such, this proposal aims to characterize the structure of *S. oneidensis* UshA, a key protein involved in breathing extracellular substrates. Through collaboration between groups located at the University of Minnesota and the University of Oslo, we will characterize the general structure of UshA and identify critical amino acid residues for UshA activity using both genetic and biochemical methods. Our findings will provide a foundation for development of *S. oneidensis*-based applications concerning environmental and energy challenges facing our society.



Advancing a novel mouse model to study APOBEC-catalyzed DNA damage and its misrepair as a major source of mutation in cancer

Hilde Nilsen, University of Oslo and Reuben Harris, University of Minnesota

Abstract:

Many mutations must occur for a normal cell to become cancerous and for primary tumors to become aggressive and life threatening. Apart from obvious environmental and dietary sources, very little is known about the molecular origins of most cancer-causing mutations. The Harris laboratory at the University of Minnesota recently identified a DNA mutating enzyme called APOBEC that provides mutational fuel in the majority of breast cancers. The Nilsen laboratory at the University of Oslo is expert in the DNA repair enzymes that normally work to counteract such mutational activity. Here, we are working together to develop a new animal model for cancer research by determining whether mice with APOBEC and defective DNA repair enzymes show an elevated incidence of cancer. If so, such animals may be instrumental for future pre-clinical studies of new cancer drugs.



The role of selective autophagy in the pathogenesis of neurodegenerative diseases

Thomas Neufeld, University of Minnesota and Anne Simonsen, University of Oslo

Abstract:

Neurodegenerative diseases such as Alzheimer's and Parkinson's disease are associated with the accumulation of aggregated proteins within neuronal cell bodies. Healthy cells are able to eliminate such aggregates through a digestive process called autophagy, involving engulfment of cellular material into membrane — bound vesicles. Activation of autophagy in animal models of neurodegenerative diseases has been shown to improve outcomes. However, the mechanisms by which autophagy selectively removes protein aggregates and damaged organelles is poorly understood. The proposed studies are aimed at identifying and characterizing the factors that participate in selective autophagy and prevent neurodegeneration, using two approaches. Cell based imaging assays will be used to test the requirement for a collection of membrane — associated signaling proteins in sequestering protein aggregates and organelles through selective autophagy. In parallel, the effect of these proteins on neurodegeneration will be tested in established animal models of neurodegeneration using the fruit fly *Drosophila melanogaster*. These complementary strategies are designed to improve our understanding of intrinsic cellular defense mechanisms against neurodegeneration, and to identify potential therapeutic targets.



Plague ecosystem resilience to Intervention (PERI): A One Health approach

Christian Stenseth and Boris Schmid, University of Oslo and Marlene Zuk and Susan Jones, University of Minnesota

Abstract:

Fuelled by a changing global climate, the rate at which new infectious diseases emerge is reaching unprecedented levels and is becoming an increasing threat to the globalized human population – a situation that has recently been called one of the most formidable ecological problems of our time. Against this backdrop, we propose a project focusing on the most devastating pandemic disease in human history, namely plague (*Yersinia pestis*) – an ancient infection in wild rodents that periodically spills over into human populations. Using a multi-disciplinary team of Norwegian and American scientists, the objective of the project is to evaluate which ecosystem-scale plague interventions have been effective, and why, in order to guide future prevention of plague outbreaks. The proposed project concentrates on the plague wildlife reservoir control program of the Soviet Union, and the Russian Federation (1930s – 2000s). This Anti-Plague System was responsible for monitoring an estimated 2.2 million km² area of semi-arid deserts, steppes and montane grasslands that harbored a large variety of plague-infected wildlife rodents. Applying modern scientific methods to evaluate the interventions on the 43 natural plague foci in Russia and its former federated states offers a unique opportunity to retrospectively study the effectiveness of these ecosystem-scale interventions at a time when there is a growing interest in employing similar disease interventions elsewhere. There is a great potential here for opening up important avenues for research, by studying some of the largest man-made interventions ever undertaken in resilient disease ecosystems.



Real-time robotic sensing and manipulation for fruit picking

Pal Johan From, NMBU and James Luby and Volkan Isler, University of Minnesota

Abstract:

Specialty crop farmers such as apple, peach and berry farmers rely on seasonal workers to pick fruit. Availability and cost of employing seasonal workers is a concern for producers across the world. For example, in the United States, it is estimated that “the apple harvest workforce is short about 20 percent.” This is a proposal to develop a general-purpose robotic system capable of picking fruit to address this shortage. Robotic technology has revolutionized automation in structured environments such as factory floors. Today, robots are used in manufacturing a wide range of products ranging from cars to consumer electronics. Outside the factory floor, however, the use of robots has been limited due to the unknown and dynamic nature of the environment and challenges in sensing, navigation and manipulation. Fruit-picking is an especially challenging task for robots because high value fruit must be picked without being damaged. The robots must be rugged enough to operate on farms yet precise enough to handle fruit gently. Sensing algorithms must be capable of detecting all fruits in the environment and in all environmental conditions. To overcome these challenges, we propose to develop a sensing system capable of reconstructing a precise model of the farm on-the-fly and a robotic manipulator capable of picking fruits using this model. These components will be integrated into a mobile robotic base and tested in two challenging fruit picking settings: an apple orchard in Minnesota and a berry farm in Norway.