

2010 SCIENCE GRADUATE STUDIES DAY ABSTRACTS

Keynote speaker

Dr John VanLeeuwen (Atlantic Veterinary College, UPEI):

Epidemiological investigations: Finding answers to real world health questions close and not so close to home

It is expected that livestock numbers will have to double in the next 50 years to meet increasing demand for animal protein world-wide. However, if farming practices continue as they are, then environmental impacts from livestock farming on our land, water and air will also double. To avoid the doubling of these environmental impacts, we have 2 main options: we can either modify farming practices to reduce the environmental impacts, or increase the productivity of existing farm animals so that livestock numbers do not need to double. Over my career, I have endeavoured to carve out two productive lines of research: 1) infectious diseases epidemiology of cattle; and 2) ecosystem health epidemiology, along with the interactions between these two lines. Improving productivity through infectious disease control would have direct economic benefits to farmers, and environmental sustainability would have long-term indirect benefits to farmers. This presentation will provide a smattering of some of the research projects that I have been involved in across Canada and in Kenya in these 2 lines of research.

Student presentations (ordered according to schedule)

Douglas Marchbank:

Synthesis of a Library of Novel Fuscoidin Analogues and Screening for Selective Anti-inflammatory Activity

Over the past 30 years, scientists have become interested in exploring the natural products of organisms found in varied marine environments. The huge phylogenetic diversity is expected to contain numerous undiscovered natural products, many of these exhibiting bioactivity of relevance to human health.¹ For instance, a Caribbean gorgonian *Eunicea fusca* produces an arabinose glycoside Fuscoidin B which has great potential as an anti-inflammatory as it selectively inhibits 5-lipoxygenase activity, and is inactive towards targets of other inflammatory drugs such as cyclooxygenase (COX) enzymes.² Given the deleterious side effects of COX inhibitors, natural products that inhibit such "new" targets of the inflammatory cascade are worth developing. Furthermore, the potency of fuscoidin B is comparable to indomethacin, a currently marketed anti-inflammatory drug.³ Fuscol, the aglycone of fuscoidin B, can also be extracted from *Eunicea fusca* and is readily available in gram quantities; therefore, this project aims to develop and optimize the glycosylation of fuscol to generate fuscoidin B. A library of fuscoidin analogues with different carbohydrate moieties will also be synthesized from the fuscol aglycone precursor. Once this library has been properly characterized, each derivative will be evaluated for selective anti-inflammatory activity in the 5-lipoxygenase assay as well as other assays for such enzymes as COX.

Supervisor: Dr Russ Kerr (Chemistry), Collaborator: Dr Fabrice Berrue (NRC).

References: ¹ J.W. Blunt; et al, *Nat. Prod. Rep.* **2007**, *24*, 31-86. ² J. Shin and W. Fenical, *J. Org. Chem.* **1991**, *56*, 3153-3158. ³ P.B. Jacobson and R.S. Jacobs, *J. Pharm. Exp. Ther.* **1992**, *262*, 866-873.

Meghan Marriott:

Maritime lady beetles, insect collections, and the story they have to tell.

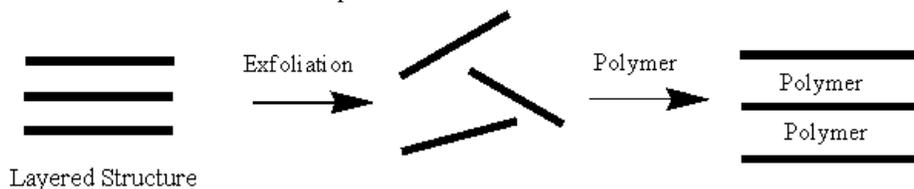
Over the past century five non-native Coccinellinae have become common and widespread in Canada, with earliest records in 1912 (*Coccinella u. undecimpunctata* Linnaeus) and most recent in 1988 (*Harmonia axyridis* (Pallas)). The introduction of non-native lady beetles as biological control agents has met with some success, but there are now concerns about potential non-target effects on native lady beetle populations. We databased Coccinellinae specimens from eastern Canadian collections (Newfoundland to Ontario) in order to determine if the arrival of non-native species coincides with the decline of native species using collection records.

Supervisor: Dr Donna Giberson (Biology).

Iskandar Saada:

Novel nanocomposite materials for lithium ion batteries

Intercalation chemistry of layered structures is utilized to develop nanocomposite materials with potential applications in lithium ion batteries. The layered systems of interest are iron (III) oxychloride, and sodium-hectorite. The objective of the research is to introduce solid polymer electrolytes into these layered systems. The polymers of interest are poly[oligo(ethylene glycol)oxalate] (POEGO), poly [oxymethylene-(oxyethylene)] (POMOE), and poly[bis-(methoxyethoxyethoxy) phosphazene] (MEEP). The nanocomposites are expected to possess enhanced mechanical properties and conductivity. The following systematic diagram illustrates the synthetic methodology for the formation of the nanocomposites:



Supervisor: Dr Rabin Bissessur (Chemistry).

Tyler Pickering:

Invasive green crabs: A new shellfish predator to Prince Edward Island shorelines

The invasive European green crabs (*Carcinus maenas*) are emerging as important shellfish predators to Prince Edward Island shorelines and may threaten the sustainability of the province's American oyster (*Crassostrea virginica*) fishery and aquaculture industry. To identify potential strategies aimed at reducing green crab related mortality of oysters, the size of oysters most vulnerable to green crab predation must be properly identified. I addressed this question by running a series of field inclusion experiments in an estuarine area adjacent to North River, PEI. Specifically, I used floating Vexar oyster bags to measure crab predation rates and size preferences of small (30-45 mm carapace width), medium (45-55 mm), and large (55-75 mm) green crabs feeding on small (5-15 mm shell length), medium (15-25 mm), large (25-35 mm), and extra-large (35-50 mm) oysters. The experiments lasted five days, but in order to identify the timing of the most intense foraging, records of oyster mortality were obtained on a daily bases. In general, little to no predation occurred on extra-large oysters, and large crabs preyed more heavily, but in similar proportion, on all other oyster sizes compared to small and medium crabs. Meanwhile, small oysters were the most vulnerable to predation followed by medium and large oysters. The results suggest that green crab predation on American oysters is dependent on both oyster size and crab size, with larger crabs presenting a greater risk to smaller oysters. Ultimately, oysters appeared to reach a partial size refuge from green crab predation at ~35 mm SL. I discuss these results in the light of the oyster industry and the ongoing spread of green crabs along PEI's southern shore.

Supervisor: Dr Pedro Quijon (Biology).

Shawn MacDougall:

Fluorescence-based trace detection of pesticides using supramolecular hosts, UV photolysis, and synchronous scanning

Traditional methods of pesticide detection used on Prince Edward Island (PEI) are very expensive and time consuming. These methods are typically only useful after harm has been done to the environment, and cannot be used in prevention. A new method for rapid, on-site detection of these pesticides would not only be of value financially, it could also prove to be essential in preventative measures, for example by monitoring streams. Fluorescence, the light emitted by electronically excited molecules, is a highly sensitive technique for detecting and measuring the concentration of molecules in solution. Most pesticides used on Prince Edward Island show only weak native fluorescence in water. However by forming a supramolecular host:guest inclusion complex, in which the pesticide "guest" becomes included within the internal cavity of an organic host molecule, this fluorescence is increased for many guest molecules. In some cases, this enhancement of the fluorescence might be sufficiently large enough to allow for the development of a fluorescence-based trace analysis technique with sensitivity in the required ppb level. In this project, native and modified cyclodextrins and their effect on the fluorescence of a series of pesticides used on PEI, specifically carbofuran, carbaryl and chlorothalonil along with five others, is measured with results varying from 670 parts per trillion for carbaryl to 69 ppb for Chlorothalonil. In addition, UV photolysis of

certain pesticides can also lead to enhanced fluorescence such as azoxystrobin and imidacloprid, and thus also be a technique used in the trace detection of pesticides. This occurs via creation of a more highly fluorescent molecule from a previously non- fluorescent or weakly fluorescent pesticide. Synchronous scanning, a method of measuring fluorescence by scanning both excitation and emission wavelengths simultaneously, which resulting narrower measured emission bands is also examined in detail in order to separate fluorescent bands of similar emission wavelengths, and thus simultaneously measure a set of two or more pesticides in solution. Overall, the main goal of this work is to develop a sensitive, enhanced fluorescence based trace analysis technique for pesticides, which could eventually be carried out using a portable fluorimeter, so that samples could be analyzed on site, in a matter of minutes, rather than in a lab over a period of days.

Supervisor: Dr Brian Wagner (Chemistry).

Bob Deziel:

The effects of cranberry phytochemicals on the behaviour of human prostate cancer cells in vitro.

The most common cancer for Canadian men to develop is prostate cancer, with over 25,000 estimated diagnosed cases occurring in 2009. Notwithstanding the prevalence of prostate cancer in Canada, many East Asian nations have much lower rates of prostate cancer, leading some researchers to suggest both genetic and environmental factors involved with the development of this malignancy. Due to this epidemiological research it has been suggested that certain environmental factors, most notably diet, have effects on the development and progression of prostate cancer. Recent research has focused on naturally derived compounds from fruits, vegetables, and certain spices on the development and growth of prostate cancer in both an *in vitro* and *in vivo* setting. In this study we demonstrate the effects of a class of compounds derived from the American Cranberry, proanthocyanidins (PACs), on human prostate cancer cells *in vitro*, focusing on its effects on the expression of matrix metalloproteinases, or MMPs. Cranberry PACs lowered the viability of DU145 cells at a concentration of 25 µg/ml by 30% after 6 hours of treatment. Treatment of DU145 cells with cranberry PACs resulted in an inhibition of both MMPs 2 and 9 in a dose and time-dependent manner. PACs increased the expression of TIMP-2, a known inhibitor of MMP activity, and decreased the expression of EMMPRIN, an inducer of MMP expression. PACs decreased the expression of PI-3 kinase and AKT proteins, and increased the phosphorylation of both p38 and ERK1/2. Cranberry PACs also decreased the translocation of the NF-κB p65 protein to the nucleus. This study demonstrates that cranberry phytochemicals can affect the behaviour of human prostate cancer cells, and that additional research into the anti-cancer effects of these compounds is warranted.

Supervisor: Dr Rob Hurta (Biology) & Katherine Gottschall-Pass (FNS). Collaborator: Dr Catherine A. Neto (Chemistry and Biochemistry, University of Massachusetts-Dartmouth).

Evans Monyoncho:

The Search for Renewable Energy: Research and role of Lithium rechargeable battery towards sustainable green energy.

As the world's demand for energy increases, the dependence on non-renewable energy sources such as crude oil is unsustainable. To address this issue, we must explore all possible alternatives for renewable and green energy such as solar, wind, and zero emission powered engines. Solar and wind are the best sources of green energy, but are intermittent. This calls for means to harvest green energy when available and its storage for continuous and future use. Rechargeable batteries act as portable storage devices. Therefore, there is a desire to improve battery properties such as capacity, energy density, and recyclability, as well as to incorporate environmentally benign materials in their design. Lithium ion batteries are currently the best candidate under consideration. This presentation will cover my current project in designing cathode materials which can be used in lithium ion batteries to improve the above mentioned properties.

Supervisor: Dr Rabin Bissessur (Chemistry).

Mitchell R. MacMillan:

Sandy Beach Ecology: The effects of erosion rate and beach type on invertebrate community structure.

Sea level rise influences the rate of shoreline erosion and constitutes one of the many factors causing spatial change among sandy beach habitats. Prince Edward Island's north shore is particularly vulnerable to surges and storms, with shoreline erosion rates as high as 330 linear cm/yr being recorded in the last decade. Since sandy beach invertebrates associated to exposed sandy beaches are assumed to be primarily controlled by species specific

responses to swash climate and sediment characteristics, they should respond to physical changes such as those linked to erosion. I was prompted to document their community structure, and hypothesized that areas exposed to different levels of erosion will exhibit different intertidal characteristics and consequently, different faunistic densities and distributions. I sampled 12 sandy beaches associated to three main types of backside formation: dunes, till and sandstone. At each beach I collected 5 core samples along 4 transects perpendicular to the shore from high to low tide (20 samples per beach). I measured slope and identified erosion levels based on proximity to Parks Canada's erosion monitoring stations. Densities were calculated as individuals/linear meter, with the highest overall densities found in a couple of sandy beaches associated with dunes. I found a significant relationship between erosion level and density that was best described by a power function. Unexpectedly, the relationship was positive, suggesting that beaches with higher erosion rates hold higher total densities as well. I discuss these results in the light of the effects that physical disturbance is expected to exert over sandy beach invertebrate densities.

Supervisor: Dr Pedro Quijon (Biology).

Simon Berger:

Drug Discovery from Psychrophilic and Psychrotolerant bacteria from Malpeque Bay

Marine environments are proving to be great sources of novel groups of bacteria with new bioactive Natural Products (NPs). There has been a large amount of research on cold adapted bacteria but the focus has been predominantly on cold-adapted enzymes. The current research project aims to develop cold-adapted bacteria, psychrophilic and psychrotolerant bacteria for their potential as a source of anti-microbial, anti-cancer, anti-inflammatory and anti-diabetic agents. Waters in the Gulf of Saint Lawrence have large annual temperature fluctuations, especially Malpeque Bay which has enormous annual thermal changes from -1 to 25°C.¹ This body of water has received no known natural products investigation, making it highly likely that the water column and sediment samples will contain complex and novel microbes. These microbes will in turn likely produce and provide new sources of novel bioactive NPs.

Supervisor: Dr Russ Kerr (Chemistry), Collaborators: Dr B. Haltli & Dr F. Berrue (NRC).

Reference: Fisheries and Oceans Canada. Area 4Tj. 12M. Accessed at: http://www.mar.dfo-mpo.gc.ca/science/ocean/coastal_temperature/coastal_temperature.html

Meghan Smith:

The development of prepulse inhibition deficits in rats treated neonatally with domoic acid, and the effect of Haloperidol

Schizophrenia is a common and devastating mental illness that affects approximately 1-1.5% of the world's population. It is generally characterized by "positive" symptoms such as hallucinations and delusions; and by "negative" symptoms such as blunted affect and decreased social functioning. Animal models of schizophrenia have been developed in order to better understand the disorder and help develop better drugs to treat it. Good animal models of schizophrenia are expected to display "predictive validity", meaning that they will react to drugs in the same manner as humans with schizophrenia. To test the predictive validity of the neonatal domoate-treated rodent model of schizophrenia, the subjects were tested in prepulse inhibition (a "gold standard" behavioural test used in schizophrenia research, which has been previously shown to be deficient in this model.) starting on post-natal day 30, and again every 30 days until post-natal day 150, in order to determine the age at which deficits arose. Following behavioural testing, the subjects were dosed orally with either 2.0 mg/kg of haloperidol, a common typical antipsychotic, or a placebo for 21 days. The subjects were then tested in prepulse inhibition on the last day of dosing, and then again following a 48-hour washout period, to see if the haloperidol had any effect on the subject's performance. Results revealing a developmental change and a differential reaction to haloperidol will be discussed.

Supervisor: Dr Tracy Doucette (Biology).

Adam Proud:

The Origins of the Secondary Coulomb Hole

In quantum chemistry, in order to completely describe the properties of a system, we must exactly solve the Schrodinger equation. However, for most systems, an exact solution is not possible and we must use approximations to obtain the energy and other important properties of these systems. One common approach is the Hartree-Fock method. In the HF method, one approximates the electronic repulsion on one electron as that generated by a mean

electric field formed by all of the other electrons in the system. Not allowing individual electrons to “see” one another leads to the omission of what is known as electron correlation energy. Thus when we introduce correlation into these systems, on average the electrons push further apart. However, recent research has shown that at large interelectronic separations, correlation actually brings electrons closer together leading to what is known as the secondary Coulomb hole. We have developed a novel probability distribution, the IntEx density, to provide more information about the nature of this effect. Additionally, by studying fictional systems that either do not contain nuclei (two electrons in a box) or with nuclei containing harmonic potentials (Hooke’s Law atom), we hope to narrow down the source of this secondary hole.

Supervisor: Dr Jason Pearson (Chemistry).