

**University of Calgary**  
**Annual Meeting / Rencontre Annuelle**  
**May 25-29 mai 2015**

**Canadian Society of Zoologists**  
 Advancing the study of animals and their environment

**Société Canadienne de Zoologie**  
 Favoriser l'étude des animaux et de leur environnement



**Spring 2015/Printemps 2015**  
**Volume 46 No. 2**

## Meeting Sponsors



**Biological Sciences**  
from biomolecules to the biosphere



The Journal of  
**Experimental  
Biology**  
[jeb.biologists.org](http://jeb.biologists.org)



**Loligo® Systems**



**aurora**  
SCIENTIFIC | Performance.  
Precision.  
Progress.

[www.AuroraScientific.com](http://www.AuroraScientific.com)

---

**Information:** Campus Security: 403-220-5333, [campus.security@ucalgary.ca](mailto:campus.security@ucalgary.ca)

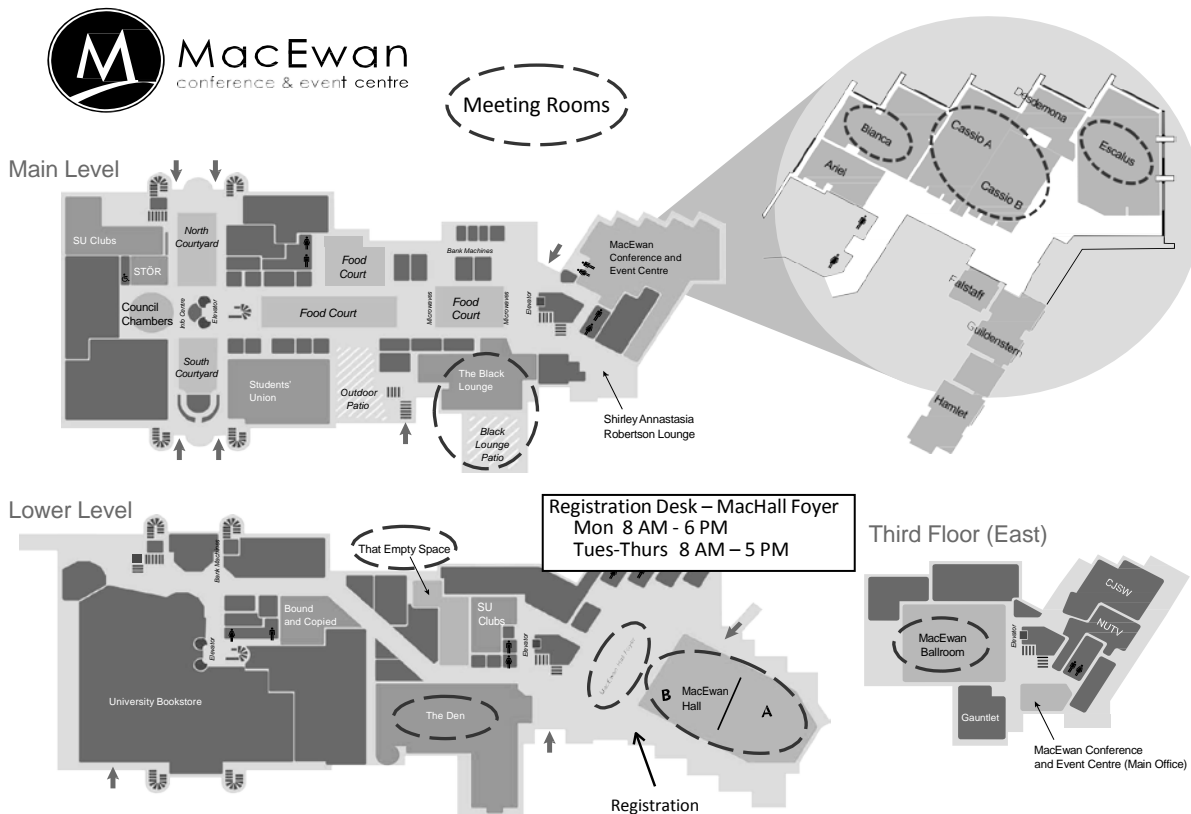
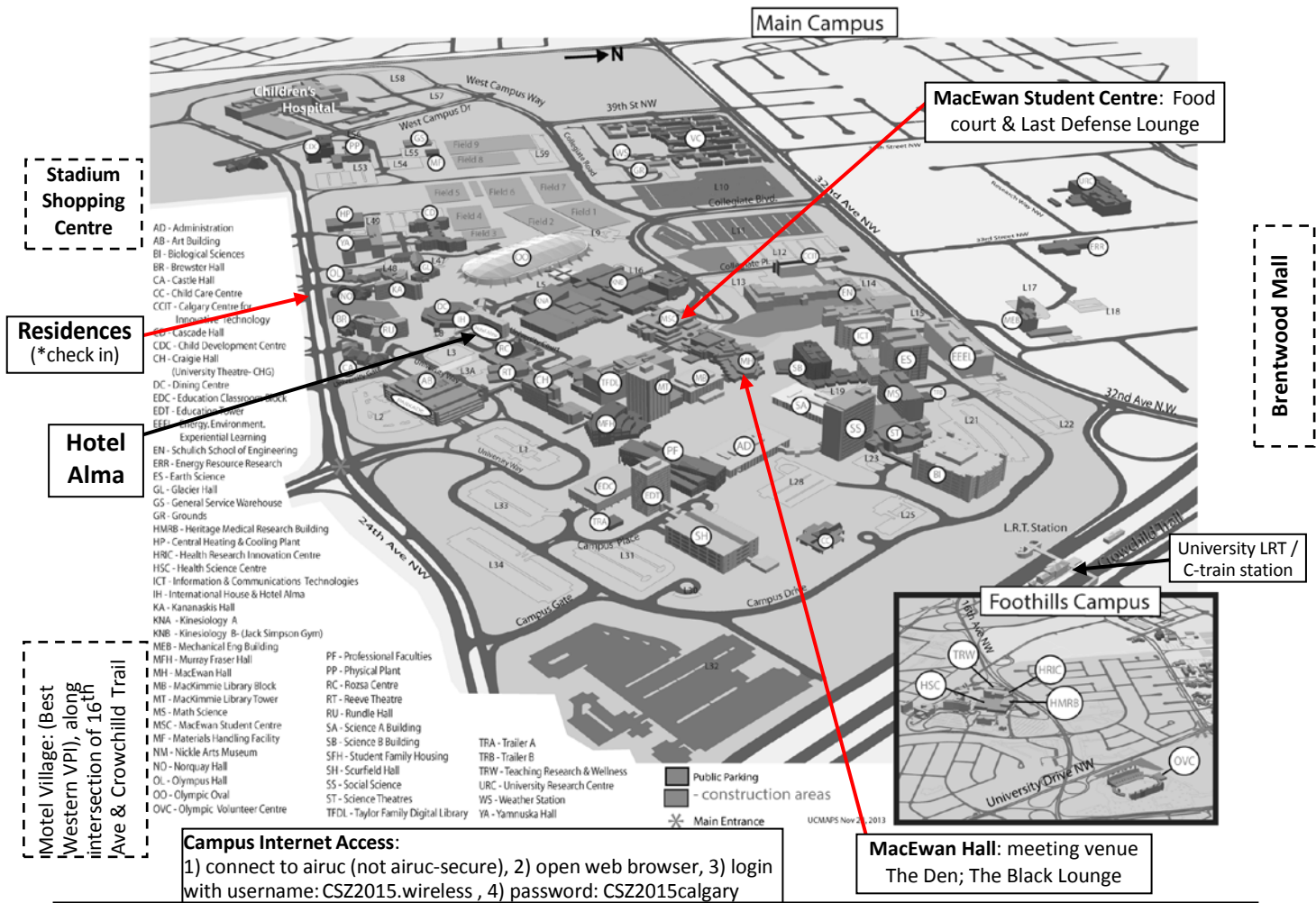
Safewalk is a student-run volunteer service. Twenty four hours a day and seven days a week, Safewalk volunteers are available to walk people safely to their destination on campus. This service is free and available to students, staff and campus visitors. The Safewalk team providing the service is comprised of two volunteers, one male and one female. The volunteers will escort you anywhere on campus (including McMahon Stadium, Health Sciences, Student Family Housing, the Alberta Children's Hospital, and the University LRT station).

**Requesting Safewalk volunteers to walk with you is easy!**

- Call 403-220-5333 (24 hours a day/seven days a week, 365 days a year)
- Use the Help Phones (they are not just for emergencies)
- Approach an on-duty Safewalker and request a walk

**Active Living Centre** – offers an aquatic centre, fitness centre, gymnastic centre, outdoor centre and racket centre. Day passes are available at the Active Living Client Services desk, Kinesiology A 104. See <http://www.ucalgary.ca/activeliving/> for info.









## OFFICERS OF CSZ 2014-2015 CONSEIL DE LA SCZ

**President - Président: Suzie Currie**

Mount Allison University, Biology, 63B York St., Sackville, NB E4L 3G7

Ph: 506-364-2260, [scurrie@mta.ca](mailto:scurrie@mta.ca)

**First Vice President - Premier vice-président: James Staples**

Western University, Biology, 1151 Richmond St., London, ON N6A 5B8

Ph: 506-364-2514, [jfstaple@uwo.ca](mailto:jfstaple@uwo.ca)

**Second Vice President - Deuxième vice-président: Lucy Lee**

Univ. of the Fraser Valley, Faculty of Science, 33844 King Rd., Abbotsford, BC N6A 5B8

Ph: 604-851-6346, [lucy.lee@ufv.ca](mailto:lucy.lee@ufv.ca)

**Past President- Président antérieur: Patrick Walsh**

Univ. Ottawa, Biology, 30 Marie Curie St., Ottawa, ON K1N 6N5

Ph: 613-562-5800x6328, [pwash@uottawa.ca](mailto:pwash@uottawa.ca)

**Secretary – Secrétaire: Helga Guderley**

Université Laval, Département de biologie, Pavillon Alexandre-Vachon, local 4062D

Tél : 418-656-2131 poste 3184, [helga.guderley@bio.ulaval.ca](mailto:helga.guderley@bio.ulaval.ca)

**Treasurer – Trésorier: Allen W. Shostak**

Univ. Alberta, Biological Sciences, CW405 Biological Sciences Building, Edmonton, AB T6G 2E9

Ph: 780-492-1293, [al.shostak@ualberta.ca](mailto:al.shostak@ualberta.ca)

### Councillors – Conseillers

2012 – 2015

Brian Dixon, Univ. Waterloo, Biology, [bdixon@uwaterloo.ca](mailto:bdixon@uwaterloo.ca)

Richard Kinkead, Hopital St-Francois d'Assise, [Richard.Kinkead@crsfa.ulaval.ca](mailto:Richard.Kinkead@crsfa.ulaval.ca)

Russell Wyeth, St Francis Xavier Univ., Biology, [rwyyeth@stfx.ca](mailto:rwyyeth@stfx.ca)

2013 – 2016

Kevin Campbell, Univ. Manitoba, Biological Sci., [campbelk@cc.umanitoba.ca](mailto:campbelk@cc.umanitoba.ca)

Tim Higham, Univ. California – Riverside, Biology, [timothy.higham@ucr.edu](mailto:timothy.higham@ucr.edu)

Allison McDonald, Wilfrid Laurier Univ., Biology, [amcdonald@wlu.ca](mailto:amcdonald@wlu.ca)

2014 – 2017

Bill Milsom, Univ. British Columbia, Zoology, [milsom@zoology.ubc.ca](mailto:milsom@zoology.ubc.ca)

Michael Wilkie, Wilfrid Laurier Univ., Biology, [mwilkie@wlu.ca](mailto:mwilkie@wlu.ca)

Barbara Zielinski, University of Windsor, Biology, [azielin1@uwindsor.ca](mailto:azielin1@uwindsor.ca)

### Student Councillors - Conseillers étudiants

2013 – 2015, Angela Shamchuk, Univ. Alberta, Biological Sciences, [ashamchu@ualberta.ca](mailto:ashamchu@ualberta.ca)

2014 – 2016, Laura Ferguson, Western University, Biology, [lfergus9@uwo.ca](mailto:lfergus9@uwo.ca)

### Post-doc Councillor - Conseillers post-doctoral

2014 – 2015, Matt Pamenter, Univ. British Columbia, Zoology, [pamenter@zoology.ubc.ca](mailto:pamenter@zoology.ubc.ca)

### Section Chairs - Présidents des sections

CMD-MDC: Jessica Theodor, Univ. Calgary, Biological Sci. [jtheodor@ucalgary.ca](mailto:jtheodor@ucalgary.ca)

CPB-PBC: Gary Burness, Trent Univ., Biology, [garyburness@trentu.ca](mailto:garyburness@trentu.ca)

EEE-ÉÉÉ: Greg Pyle, Univ. Lethbridge, Biological Sci. [gregory.pyle@uleth.ca](mailto:gregory.pyle@uleth.ca)

PIE-PIE: Dan Barreda, Univ. Alberta, AFNS, [dan.barreda@ualberta.ca](mailto:dan.barreda@ualberta.ca)

**Ex officio: Archivists - Archivistes: J. Webster** SFU, Biological Sciences, [jwebster@sfu.ca](mailto:jwebster@sfu.ca) & **T. Moon**, UofO, Biology, [tmoon@uottawa.ca](mailto:tmoon@uottawa.ca)

**Webmaster - Gestionnaire du site web: Allen W. Shostak** Univ. Alberta, [al.shostak@ualberta.ca](mailto:al.shostak@ualberta.ca)

BULLETIN Vol 46 No. 2 Spring/Printemps 2015 ISSN 0319-6674

Editor/Rédacteur en chef: Jim McGeer, 519 884-0710, x3537, [jmcgeer@wlu.ca](mailto:jmcgeer@wlu.ca) Translation/Traduction: Richard Kinkead, Céline Audet & J. McGeer.

**BULLETIN OF THE CANADIAN SOCIETY OF ZOOLOGISTS:** The Bulletin is usually published three times a year (winter, spring, and autumn) by the Canadian Society of Zoologists. Members are invited to contribute short articles in either English or French and any information that might be of interest to Canadian zoologists. Send an electronic file. Figures, line drawings and photographs may be included. All manuscripts submitted are subject to review and approval by the Editors before publication. The views and comments expressed by contributors do not necessarily reflect the official policy of the Society.

**BULLETIN DE LA SOCIÉTÉ CANADIENNE DE ZOOLOGIE:** Le Bulletin est publié trois fois par année (hiver, printemps et automne) par la Société canadienne de zoologie. Les membres sont invités à collaborer en envoyant au rédacteur en chef de courts articles en français ou en anglais, ainsi que toute information ou anecdote susceptibles d'intéresser les zoologistes canadiens. Les auteurs devront soumettre une copie sur traitement de texte. Les textes peuvent être accompagnés de dessins originaux ou de photographies. Avant d'être publiés, ils seront révisés et devront être approuvés par le rédacteur. Les opinions et commentaires qui apparaissent dans le Bulletin ne reflètent pas nécessairement les politiques de la SCZ.

The Canadian Society of Zoologists is a diverse and inclusive scientific society that welcomes members of any gender, race, ethnicity, religion and sexual orientation. The society aims to reflect this diversity at all levels, ranging from participation at meetings, to representation on council and committees, to the recipients of its awards. The Canadian Society of Zoologists is proud to promote and support equality for all members interested in zoology.

La Société canadienne de zoologie se veut une société scientifique diversifiée et inclusive qui admet dans ses rangs toute personne intéressée à la zoologie, sans égard au sexe, à l'origine ethnique, la religion ou l'orientation sexuelle. La Société a pour objectif que cette diversité se reflète à tous les niveaux que ce soit au niveau de la participation aux conférences, de la représentation au sein du conseil ou de ses comités qu'à celui des récipiendaires des prix et récompenses. La Société canadienne de zoologie est fière de promouvoir et de supporter l'égalité entre tous ses membres.

# 2015 CSZ Awards / Prix SCZ 2015

## Summary of awards for best poster or oral presentation Sommaire des prix pour meilleure affiche ou présentation orale



William Hoar

### W.S. Hoar Award / Prix W.S. Hoar

The Award is given for the best student paper presented orally at the Annual Conference of the Society, and is intended to encourage and acknowledge excellence in scientific research and communication by students.

Le prix est remis à l'étudiant(e) qui donne la meilleure présentation orale lors du congrès annuel de la Société. Le prix Hoar a pour but d'encourager l'excellence dans les travaux de recherche des étudiant(e)s et la présentation de leurs résultats.

### Hoar finalists / finalistes 2015

<b>Melissa Beck</b> , U. of Lethbridge. ( <a href="#">link to abstract</a> )	<b>Sabine Lague</b> , U. of British Columbia. ( <a href="#">link abstract</a> )
<b>Alexander Clifford</b> , U. of Alberta. ( <a href="#">link to abstract</a> )	<b>Gigi Lau</b> , U. of British Columbia. ( <a href="#">link abstract</a> )
<b>Kathleen Foster</b> , U. California, Riverside. ( <a href="#">abstract</a> )	<b>Scott Seamone</b> , U. of Calgary. ( <a href="#">link abstract</a> )

[Thursday / jeudi 12:30 – 2:00 PM, MacHall A](#)



Helen Battle

### H.I. Battle Award / Prix H.I. Battle

The Helen Battle Award is given for the most outstanding student poster at the Annual Conference of the CSZ. The prize is intended to encourage and acknowledge excellence in scientific research and communication by students.

La SCZ remet annuellement le Prix Helen Battle à l'étudiant(e) ayant présenté la meilleure affiche au congrès annuel. Ce prix veut encourager et reconnaître l'excellence des étudiant(e)s en recherche scientifique et en communication.



Murray Fallis

### A. M. Fallis Award / Prix A. M. Fallis

Award for the best student research given as oral presentation during the AGM in the area of parasitism, immunity and environment.

Prix pour la meilleure présentation orale donnée par un étudiant-chercheur dans le domaine du parasitisme, de l'immunité et de l'environnement au cours du congrès annuel.



Cas Lindsey

### C.C. Lindsey Prize / Prix C.C. Lindsey

The Cas Lindsey Prize is given by the EEE Section. The prize has a monetary value of \$300 and will be presented at the Annual Meeting of the CSZ. It will be awarded for the best student presentation (oral or poster) within the fields of behaviour, ecology or evolution.

Le Prix Cas Lindsey est décerné par la section ÉÉÉ à la rencontre annuelle de la SCZ. Le prix a une valeur monétaire de 300 \$ et est remis pour souligner la meilleure présentation étudiante (orale ou par affiche) qui traite de comportement, d'écologie ou d'évolution.



Brian K. Hall

### B.K. Hall Award / Prix B.K. Hall

The Award is given for the best oral presentation by a student on a topic in comparative morphology and development at the Annual Meeting.

Ce prix souligne la meilleure présentation orale donnée par un(e) étudiant(e) sur un des thèmes couverts par la section Morphologie et développement comparés (MDC) lors du congrès annuel.



George F.  
Holeton

### G.F. Holeton Prize / Prix G.F. Holeton

The George F. Holeton Prize is given for the most outstanding student poster presentation in the Comparative Physiology and Biochemistry (CPB) Section at the Annual Conference of the CSZ. The prize is intended to encourage and acknowledge excellence in scientific research and communication by students.

La section Physiologie et Biochimie Comparées (PBC) remet annuellement le Prix George Holeton pour la meilleure affiche présentée par un étudiant de la section au congrès annuel de la SCZ. Ce prix veut encourager et reconnaître l'excellence des étudiant(e)s en recherche scientifique et en communication.



## F.E.J. Fry Medal / Médaille F.E.J. Fry

Patricia Wright  
University of Guelph

[Fry Medal Lecture/ Conférence Fry](#)  
[Monday/lundi 6PM MacHall A](#)



F.E.J. Fry

**Living on the edge – The physiology of amphibious fish in and out of water.**

**La vie à la limite – physiologie des poissons amphibiens dans et hors de l'eau**

[Link to the Fry Lecture Abstract](#) / [Lien vers Résumé de la conférence Fry](#)

**Biography / biographie:** Pat Wright obtained her B.Sc. from McMaster University and her Ph.D. from the University of British Columbia. After postdoctoral fellowships at the University of Ottawa and the National Institutes of Health, Bethesda, she was hired by the University of Guelph where she is currently a Professor in the Department of Integrative Biology in the College of Biological Science.

Pat Wright heads the Environmental Physiology research group that studies osmoregulation, metabolism and respiration in aquatic ectotherms, with particular interests in early life stages and amphibious fishes. She has supervised 31 graduate students over her career. Pat is on the editorial board of the American Journal of Physiology, Journal of Experimental Biology and Journal of Experimental Zoology. She has served as President of the American Fisheries Society Physiology Section and various roles within the Canadian Society of Zoologists.

Pat Wright a obtenu son baccalauréat en sciences de l'Université McMaster et un doctorat de l'Université de la Colombie-Britannique. Après des stages postdoctoraux à l'Université d'Ottawa et le «National Institutes of Health, Bethesda», elle a été embauchée par l'Université de Guelph, où elle est actuellement professeur au Département de biologie intégrative au Collège des sciences biologiques.

Pat Wright dirige un groupe de recherche qui étudie comment l'environnement peut influencer l'osmorégulation, le métabolisme et la respiration chez les ectothermes aquatiques, en particulier chez les jeunes stades de la vie et les poissons amphibiens. Elle a supervisé 31 étudiants aux cycles supérieurs au cours de sa carrière. Pat est sur le comité de rédaction de «American Journal of Physiology», «Journal of Experimental Biology» et «Journal of Experimental Zoology». Elle a été présidente de l'American Fisheries Society Physiology Section et a rempli divers rôles au sein de la Société canadienne de zoologie.

The Fry Award is given to a Canadian Zoologist who has made an outstanding contribution to knowledge and understanding of an area in zoology.  
La médaille Fry est décernée à un zoologiste canadien qui s'est distingué par son apport aux connaissances et à la compréhension des phénomènes biologiques d'intérêt pour la zoologie.

## T. W. M. Cameron Outstanding Ph.D. Thesis Award Prix T. W. M. Cameron pour une thèse de Ph.D. exceptionnelle



Rajendhran Rajakumar  
McGill University

[Thursday/jeudi 3:55 PM, MacHall A](#)



T.W.M.  
Cameron

**The developmental basis of caste evolution in ants: hormones, genes, and epigenetics.**  
**Base développementale de l'évolution des castes de fourmis: hormones, gènes et épigénétique.**

[Link to Cameron Lecture Abstract](#) / [Lien vers Résumé de la conférence Cameron](#)

**Biography / biographie:** Dr. Rajendhran (Rajee) Rajakumar received his BSc in the department of Biology at Concordia University where he specialized in Cell & Molecular Biology. During his undergrad, he volunteered in the lab of Ehab Abouheif in the department of Biology at McGill University where he fell in love with ants and decided to stay and pursue a PhD. He is currently an NSERC Postdoctoral Fellow at the Genetics Institute of the University of Florida in the lab of Dr. Martin J. Cohn. For almost a decade, Rajee has been inspired by the elegance of ant societies. He has used ants as a model to understand how ecology can act on developmental processes, generating morphological variation and subsequent evolution. Combining fieldwork and phylogenetics with hormonal, developmental genetic and epigenetic experimental approaches, he has tried to tackle questions as diverse as: why recurrent phenotypes appear in nature, and how epigenetic mechanisms generate quantitative trait variation. He is currently pursuing Evo-Devo research in an array of vertebrate systems from

chickens to sharks.

Dr Rajendhran (Rajee) Rajakumar a complété son baccalauréat en sciences au département de biologie de l'Université Concordia avec une spécialisation en biologie cellulaire et moléculaire. Au cours de ses études de premier cycle, il était bénévole dans le laboratoire d'Ehab Abouheif au département de biologie de l'Université McGill où il est tombé en amour avec la recherche sur les fourmis; il a donc décidé d'y demeurer afin de poursuivre son doctorat. Il est présentement boursier postdoctoral du CRSNG au « Genetic Institute » de l'Université de la Floride, dans le laboratoire du Dr Martin J. Cohn. Depuis presque dix ans, Rajee a été inspiré par l'élégance des sociétés de fourmis. Il a utilisé les fourmis comme modèle expérimental afin de comprendre comment l'écologie peut agir sur les processus de développement en générant la variation morphologique et l'évolution qui en découle. Combinant les travaux de terrain et les études phylogénétiques avec des approches expérimentales utilisant les hormones, la génétique du développement et l'épigénétique, il a essayé de s'attaquer à diverses questions; à titre d'exemple, pourquoi est-ce que les phénotypes réapparaissent dans la nature et comment les mécanismes épigénétiques génèrent la variation quantitative dans les caractéristiques? Il poursuit présentement des recherches « Evo-Devo » dans une gamme de systèmes de vertébrés allant des poulets aux requins.

This is an annual award, established by the Canadian Society of Zoologists to recognize the author of an outstanding Ph. D. Thesis in Zoology submitted to a Canadian University. Ce concours annuel a été institué par la Société canadienne de zoologie pour récompenser l'auteur d'une thèse de doctorat en zoologie jugée exceptionnelle et soumise dans une université canadienne.



**R. G. Boutilier New Investigator Award**  
**Prix R. G. Boutilier pour jeune chercheur**

**Keith B. Tierney**  
University of Alberta

[Thursday/jeudi 3:00 PM, MacHall A](#)

**How aquatic vertebrates cope with ever changing environments.**  
**Comment les vertébrés aquatiques se débrouillent dans les environnements**  
**qui changent constamment.**

[Link to Abstract](#) / [Lien vers Résumé de la présentation](#)

**Biography / biographie:**

Dr. Keith Tierney is Associate Professor (July 1<sup>st</sup>) in the Department of Biological Sciences at the University of Alberta. He has a BSc in biology from Simon Fraser where he also did a MSc in fish physiology under Dr. Anthony Farrell. He subsequently completed an MBA (British Columbia) and returned to Simon Fraser for his PhD in aquatic toxicology with Christopher Kennedy. His postdoctoral studies were at U. Windsor with Barbara Zielinski and he has been at U. Alberta since July 2009. His works is in olfactory neuroscience, northern salmon ecophysiology, developmental toxicity of petroleum and related process-affected waters, and avian toxicology. He has funding from NSERC, Alberta Innovates, Canada's Oil Sands Innovation Alliance and others. He supervises five graduate students and as many as ten undergraduates. They work with rainbow trout, Arctic char, goldfish, zebrafish and mallard ducks. He is Editor of the *Canadian Journal of Fisheries and Aquatic Sciences* (July 1<sup>st</sup>) and Treasurer of the *Canadian Society of Zoologists*.

The Bob Boutilier New Investigator Award is to encourage & honour CSZ members within 7 y of receiving their 1st academic/professional appointment. The individual must have made significant contributions to zoology (defined broadly) and to be considered a "rising star" in their field.

Le prix Bob Boutilier pour jeune chercheur vise à encourager et à reconnaître des membres de la SCZ qui ont contribué de manière significative au domaine de la zoologie au cours des 7 premières années de leur premier emploi académique ou professionnel et qui sont considérés comme des « étoiles montantes » dans leur discipline.

Le Dr Keith Tierney est professeur agrégé (1er juillet) au Département des sciences biologiques de l'Université de l'Alberta. Il détient un baccalauréat en biologie de l'Université Simon Fraser, où il a aussi fait une maîtrise en physiologie des poissons sous la direction du Dr Anthony Farrell. Il a ensuite obtenu un MBA (Colombie-Britannique) avant de revenir à Simon Fraser pour son doctorat en toxicologie aquatique sous la supervision de Christopher Kennedy. Ses études postdoctorales ont été complétées à l'Université de Windsor dans le laboratoire du Dr Barbara Zielinski. Il est à l'Université de l'Alberta depuis juillet de 2009. Ses travaux sont en neuroscience de l'olfaction, l'écophysiologie des saumons du nord, toxicité développementale du pétrole et des eaux de processus pétroliers, et la toxicologie aviaire. Il est présentement financé par le CRSNG, Alberta Innovates, Oil Sands Innovation Alliance du Canada et d'autres organismes subventionnaires. Il supervise cinq étudiants diplômés et jusqu'à dix étudiants de premier cycle. Ils travaillent avec la truite arc-en-ciel, l'omble de l'Arctique, le poisson rouge, les danios zébrés et les canards colverts. Il est rédacteur en chef du Journal canadien des sciences halieutiques et aquatiques (1er juillet) et trésorier de la Société canadienne de zoologie.



Bob Boutilier





## R.A. Wardle Award / Prix R.A. Wardle

Brian Dixon,  
University of Waterloo



R.A. Wardle

**From Parasites to Immunity and the Environment and Back Again**  
**Aller des parasites à l'immunité et à l'environnement, et s'en revenir**

[Wednesday/mercredi 2:00 PM, MacHall A](#)

[Link to Wardle Lecture Abstract / Lien vers Résumé de la conférence Wardle](#)

### Biography / biographie:

Research in my laboratory is directed towards characterizing fish immune systems at the molecular level. A detailed knowledge of the molecules used as signals and receptors in the mammalian immune system has allowed more effective control of disease through vaccines and drugs. Despite the large number of immunologically important genes that have been isolated from fish, many are only understood at the DNA and RNA level. A detailed knowledge of how the proteins encoded by those genes function is required to meet the growing need for vaccines and drugs to control diseases in aquaculture. A deeper knowledge of the molecules involved in teleost immune systems also provides insight into the evolution and function of equivalent molecules in mammalian immune systems.

La recherche dans mon laboratoire s'intéresse à la caractérisation des systèmes immunitaires des poissons au niveau moléculaire. Une connaissance détaillée des molécules utilisées comme des signaux et des récepteurs dans le système immunitaire des mammifères a permis un contrôle plus efficace de la maladie par les vaccins et les médicaments. Malgré le grand nombre de gènes immunologiquement importants qui ont été isolés à partir de poissons, beaucoup ne sont compris qu'au niveau de l'ADN et de l'ARN. Une connaissance détaillée de la façon dont les protéines codées par ces fonctions génomiques est nécessaire pour répondre aux besoins croissant pour des vaccins et des médicaments pour contrôler les maladies dans l'aquaculture. Une connaissance plus approfondie des molécules impliquées dans le système immunitaire des téléostéens donne aussi un aperçu de l'évolution et la fonction des molécules équivalentes dans les systèmes immunitaires des mammifères.

The Robert Arnold Wardle Award is presented by the Parasitism, Immunity & Environment Section to an individual in recognition of outstanding contributions to Canadian-based research on the interrelationships at all levels among infectious agents, the response of animals to these agents, and the environment in which these relationships exist.

Le prix Robert Arnold Wardle est décerné par la Section de parasitisme, immunité et environnement à un individu en reconnaissance de contributions exceptionnelles à la recherche canadienne sur les relations, à tous les niveaux, entre les agents infectieux, la réponse des animaux à ces agents, et l'environnement dans lequel ces relations existent.



## L. Margolis Scholarship / La Bourse L. Margolis

Kristin Dinning  
University of New Brunswick.



Leo Margolis

**Biography / biographie:** Kristin received her B.Sc. degree (Marine Biology) from Dalhousie University (supervised by Dr. Anna Metaxas) where she used the "VENUS" undersea observatory to study the seafloor community of Saanich Inlet, B.C. She received her M.Sc. (Biology) at the University of New Brunswick in Saint John (UNBSJ), under the supervision of Dr. Rémy Rochette, studying the settlement behaviour of postlarval lobsters and examining juvenile lobster use of rock-bottom and mud-bottom seafloor. Kristin is currently a Ph.D. student at UNBSJ where she is continuing her research on the early life history of juvenile American lobsters with a focus on habitat use and how lobster survival, growth, and movement behaviour might differ among these habitats and ultimately affect the population dynamics of this species.

Kristin a obtenu son baccalauréat en sciences (biologie marine) de l'Université Dalhousie (supervisée par le Dr Anna Metaxas) où elle a utilisé l'observatoire sous-marin "VENUS" pour étudier la communauté du fond marin de Saanich Inlet, en Colombie-



Britannique. Elle a obtenu sa Maîtrise (Biologie) à l'Université du Nouveau-Brunswick à Saint John (UNBSJ), sous la supervision du Dr Rémy Rochette, où elle a étudié le comportement d'établissement du homard après le stade larvaire et d'examiner l'utilisation des fonds marins rocheux et boueux par homards juvéniles. Kristin est actuellement étudiante au doctorat à l'UNBSJ où elle poursuit ses recherches sur l'histoire des premiers stades de vie de homards américains avec un accent sur l'utilisation de l'habitat et la façon dont la survie, la croissance et le comportement de mouvement peuvent différer entre ces habitats et finalement affecter la dynamique des populations de cette espèce.

This scholarship has been established as a memorial to Dr. Leo Margolis, an internationally preeminent parasitologist and a staunch supporter of the Canadian Society of Zoologists since its inception in 1961. The competition for the scholarship is open to any Canadian who is registered in a graduate studies program at a Canadian university at the time the scholarship is taken up and whose research is in the field of fisheries biology.

Cette bourse a été instituée à la mémoire de Leo Margolis, éminent parasitologiste de réputation internationale et militant fidèle de la Société canadienne de zoologie depuis sa création en 1961. Le concours est ouvert à tous les Canadiens qui sont inscrits à un programme d'études supérieures en biologie des pêches dans une université canadienne au moment où la bourse est acceptée.



## Zoological Education Trust Lecture Conférence Publique du Fonds pour l'Éducation en Zoologie



**Dr. Axel Moehrenschrager**

Director of Conservation & Science Calgary Zoo

***Saving endangered species in Canada and beyond:  
challenges, successes, and hope.***

***La sauvegarde des espèces en voie de disparition au Canada et ailleurs:  
défis, succès et espoir.***

**Tuesday/mardi, 6 PM, MacHall A**

### **Biography / biographie:**

Over the last 25 years, Dr. Axel Moehrenschrager has conducted research or training in Canada and around the world, to develop science-based solutions that will help save endangered species from extinction. Over the last 15 years at the Calgary Zoo, Axel founded the Centre for Conservation Research, which has dedicated undergraduate, graduate, and post-doctoral staff that combine scientific rigour with pragmatic wildlife management to make a real difference for the conservation of species in the wild.

Axel received his Ph.D. from Oxford University's Wildlife Conservation Research Unit, where he remains affiliated today. He is also an Erskine Fellow at the University of Canterbury in Christchurch, New Zealand. Finally, he is an Adjunct Associate Professor at the University of Calgary, Canada and has supervisory status at several other Canadian universities. The work Axel spearheads with Calgary Zoo colleagues centre on two approaches: The 1) The reintroduction of endangered species to the wild; and 2) Community conservation to benefit people and nature. Having been involved with the International Union for the Conservation of Nature (IUCN), Axel became the chair of the IUCN Reintroduction Specialist Group in 2014 which has over 150 global experts in over 40 countries that enable responsible conservation translocations. The Calgary Zoo's Community conservation approach focusses on developing economic solutions for impoverished communities, to make global biodiversity conservation sustainable.

Au cours des 25 dernières années le Dr Axel Moehrenschrager a mené des

recherches ou des formations au Canada et autour du monde afin de développer des solutions scientifiques qui permettront de sauver les espèces menacées d'extinction. Au cours des 15 dernières années au zoo de Calgary, Axel a fondé le Centre de recherche sur la conservation qui dispose de personnel du premier cycle, diplômé et post-doctorat qui sont dédiés et combinent la rigueur scientifique à une gestion pragmatique de la faune afin de faire une différence réelle pour la conservation des espèces dans la nature.

The Zoological Education Trust is dedicated to develop interests in Zoology. At every Annual Meeting, ZET organizes discussion panels and invites well recognized zoologists to talk about new trends in Zoology. The target publics are mainly the youth and the public in general interested in these matters.

Le Fonds pour l'Éducation en Zoologie se veut un incitatif pour développer l'intérêt pour la zoologie. À chaque congrès annuel de la SCZ, le FEZ organise des ateliers de discussion et invite des zoologistes éminents pour discuter des nouvelles tendances en zoologie. Les publics cibles sont principalement les jeunes et le public en général.

Axel a reçu son doctorat du Wildlife Conservation Research Unit de l'Université d'Oxford, où il se reste affilié aujourd'hui. Il est aussi un « Erskine Fellow » à l'Université de Canterbury à Christchurch, Nouvelle-Zélande. Enfin, il est professeur agrégé adjoint à l'Université de Calgary et sert en tant que superviseur dans plusieurs autres universités canadiennes. Les travaux qu'Axel dirige avec des collègues du Zoo de Calgary se concentrent sur deux approches: 1) La réintroduction à l'état sauvage d'espèces en voie de disparition; et 2) la conservation de la Communauté au bénéfice des personnes et de la nature. Ayant été impliqué avec l'Union Internationale pour la Conservation de la Nature (UICN), Axel est devenu président du Groupe de spécialistes de la réintroduction de l'UICN en 2014 qui compte plus de 150 experts internationaux dans plus de 40 pays qui permettent des translocations de conservation qui sont responsables. L'approche de la conservation de la Communauté du zoo de Calgary se concentre sur le développement de solutions économiques pour les communautés pauvres, pour faire de la conservation de la biodiversité mondiale durable.

---



**Public Education Award  
Prix de vulgarisation scientifique**

**Evelyn Boychuk**

***Monarch butterflies threatened by GM crops in U.S., study says.  
Les papillons monarques menacés par des cultures génétiquement  
modifiées selon une étude américaine.***

Publié dans le « Globe and Mail » du mercredi 4 juin 2014.

Published in the Globe and Mail, Wednesday, Jun. 04 2014.

**Biography / biographie:**

Evelyn Boychuk completed her Bachelor of Science degree with a major in Zoology at the University of Calgary. During that time she researched the effects of low oxygen and low temperature on the neurobiology of pond snails. She then completed her Master's of Science in Physiology and Biochemistry at the University of Western Ontario in London, Ontario, in 2013. Her research focused on the physiology of low-temperature tolerance in sub-alpine beetles. Boychuk's goal is to bring her passion for animal biology out of academia and into the public eye.

Evelyn Boychuk a complété son baccalauréat en sciences avec spécialisation en zoologie à l'Université de Calgary où elle a étudié les effets des réductions d'oxygène et de température sur la neurobiologie des lymnéides. En 2013, elle a ensuite complété sa maîtrise en science en physiologie et de biochimie à l'Université de Western Ontario à London en Ontario. Sa recherche a porté sur la physiologie de la tolérance au froid dans coléoptères sous-alpines. L'objectif de Boychuk est d'apporter sa passion pour la biologie des animaux hors du milieu universitaire et dans le domaine public.

This award is intended to recognize excellence in public education about zoology. Ce prix vise à reconnaître l'excellence en vulgarisation scientifique dans le domaine de la zoologie.
--

# 54<sup>th</sup> annual meeting / 54<sup>ième</sup> réunion annuelle

May 25-29 mai 2015 University  
of Calgary

## Organizing committee / Comité organisateur

Doug Syme (Chair)

Jason Anderson

Ralph Cartar

Hamid Habibi

Mary Reid

Campbell Rolian

Tony Russell

Matt Vijayan

## Student volunteers / Volontaires Étudiant

Abeer Alhawsawi

Carol Best

Tasha Cammidge

Chinmayee Das

Erin Faught

Shaelen Konschuh

Analisa Lazaro-Côté

Kady Lyons

Larry Powell

Jordan Roberts

Scott Seamone

Leah Sparrow

Alex Tinius

Cameron Toth

Ava Zare

Chelsey Zurowski

---

### Main meeting venue

MacEwan Hall (MH, centre of map)

### Registration Desk

MacHall Foyer

Mon 8 AM - 6 PM

Tues-Thurs 8 AM – 5 PM

### Campus Internet Access

- 1) connect to airuc (not airuc-secure)
- 2) when opening your web browser you will be asked to log in
- 3) username: CSZ2015.wireless
- 4) password: CSZ2015calgary  
(password is case sensitive)

## **Monday May 25 / lundi, 25 mai**

<b>9:00-2:30</b>	<b>Council Meeting / Réunion du conseil</b>	<i>Escalus</i>
<b>2:30-3:30</b>	<b>Can. J. Zool. Workshop / Atelier du Can. J. Zool.</b> What do editors expect from reviewers: the Goldilocks touch	<i>Bianca</i>
<b>3:30-4:30</b>	<b>NSERC Information Sessions / Session d'Information CRSNG: Research Grants</b> This session is for those interested in the latest news from NSERC regarding research funding. Guillaume Sabourin, NSERC program officer, will be on hand to present information about the programs and field questions.	<i>Cassio</i>
	<b>NSERC Information Sessions / Session d'Information CRSNG: Student / PDF Scholarships</b> This session is for those interested in how to prepare a winning scholarship application. Gillian Cooper, NSERC scholarship program officer, will lead off with information to help you understand the programs that are available and what's on the horizon for the next application cycles. Gillian and several experienced scholarship selection committee members will then be available to take your questions about preparing an application with the best chances of getting into the funded pool. Bring your questions. Pizza, pop, veggies and goodies will be provided	<i>Escalus</i>
<b>4:30-5:30</b>	<b>Diversity in Science Workshop / Atelier la diversité dans science</b> <b>A Healthy Workplace - it's everyone's business.</b> Perspectives from departmental, faculty and institutional diversity and equity committees/offices at the University of Calgary. Session led by Drs. Mary Reid and Lisa Gieg (Dept. of BioSci Equity Committee), Leslie Reid (Fac. of Science Equity and Diversity Committee), and Valerie Pruegger (Director, University of Calgary's Office of Diversity, Equity and Protected Disclosure). These individuals will share their expertise in fostering diversity and equity at the University of Calgary. They bring their experiences as chairs, developers and directors across Departmental, Faculty and Institutional levels of organization. They will touch on the role their offices and committees play at each level of organization, the needs and clientele they serve, resource needs, challenges, triumphs, and a look into the past and future at their various functions. Following a brief presentation from each level of organization, they will open the floor to the audience, so bring your questions and your ideas.	<i>Escalus</i>
<b>5:30-6:00</b>	<b>Break / Pause</b>	
<b>6:00-7:00</b>	<b>Welcome / <a href="#">Fry Lecture Bienvenue / Conférence Fry</a></b>	<i>MacHall A</i>
<b>DR. PATRICIA WRIGHT, UNIVERSITY OF GUELPH</b>		
<a href="#"><u><i>Living on the edge – The physiology of amphibious fish in and out of water</i></u></a> <a href="#"><u><i>La vie à la limite – physiologie des poissons amphibiés dans et hors de l'eau</i></u></a>		
<b>7:00-8:30</b>	<b>Opening Reception / Réception d'ouverture</b> All delegates are invited to a catered reception with a cash bar (that also accepts drink tickets) in the MacHall Foyer.	<i>MacHall Foyer</i>
<b>8:30</b>	<b>Social / Soirée</b>	<i>The Den</i>

**Note:** There are two NSERC information sessions running concurrently in the rooms indicated. The Student/PDF section of the Society is sponsoring the scholarship session with pizza/pop for student/pdf attendees.



## **Tuesday May 26 / mardi, 26 mai**      (Summary / résumé)

<b>8:00-10:00</b>	<b>SESSION A</b>	
	CPB Symposium PBC: Tribute to Dr. Tom Moon	<i>MacHall A</i>
	EEE Symposium ÉÉE: Landscape Disturbances	<i>Escalus</i>
	PIE A1: Pathogens – Disease and Immunity part I	<i>That Empty Space</i>
	CMD A2: Insights from Morphology 1	<i>Cassio</i>
<b>10:00-10:30</b>	<b>Coffee / café</b>	<i>MacHall Foyer</i>
<b>10:30-12:30</b>	<b>SESSION B</b>	
	CPB B1: Thermal Physiology 1	<i>MacHall A</i>
	CPB B2: Materials, mechanics and moving	<i>Cassio</i>
	CPB B3: Tribute to Dr. Tom Moon cont'd	<i>That Empty Space</i>
	EEE B4: student symposium	<i>Escalus</i>
<b>12:30-2:00</b>	<b>AGM lunch / Lunches des AGA</b>	<i>MacHall B</i>
<b>2:00-3:30</b>	<b>SESSION C</b>	
	PIE C1: Pathogens – Disease and Immunity part II	<i>That Empty Space</i>
	CPB C2: Energy and Homeostasis	<i>Cassio</i>
	CPB C3: Ion Regulation I	<i>MacHall A</i>
	CMD C4: Tribute to Dr. Tony Russell	<i>Escalus</i>
<b>3:30-4:00</b>	<b>Coffee / café</b>	<i>MacHall Foyer</i>
<b>4:00-5:30</b>	<b>SESSION D</b>	
	PIE D1: Pathogens – Distrib., Divers., Detect. part I	<i>Escalus</i>
	CPB D2: Stress 1 – Response mechanisms	<i>Cassio</i>
	CPB D3: Ion Regulation II	<i>MacHall A</i>
	CMD D4: Morphology in the 4 <sup>th</sup> dimension	<i>That Empty Space</i>
<b>5:30-6:00</b>	<b>Break / Pause</b>	
<b>6:00-7:00</b>	<b><u><a href="#">ZET Lecture / Conférence ZET</a></u> <u><a href="#">Saving endangered species in Canada and beyond</a></u></b>	<i>MacHall A</i>
<b>7:00-8:30</b>	<b>ZET Reception / Réception ZET</b> The ZET reception is catered, with a cash bar that also accepts drink tickets.	<i>MacHall Foyer</i>
<b>8:30</b>	<b>Social / Soirée</b>	<i>The Den</i>

CPB Symposium / symposium PBC 8:00-10:00 MacHall A

**Endocrine control of metabolism: A tribute to the career of Dr. Thomas W. Moon**  
**Contrôle endocrine du métabolisme: un hommage à la carrière de Dr. Thomas W. Moon**  
 organizers: Patrick Walsh and Paul Craig

Chair / Prèsident: Pat Walsh

CPB SYM 1 8:00-8:30	<b>ELENA FABBRI</b> University of Bologna <b>Adrenergic signalling in teleost fish, a challenging path</b> <i>Signalisation adrénérquique chez les téléostéens, un parcours complexe</i>
CPB SYM 2 8:30-9:00	<b>PATRICIA A WRIGHT</b> University of Guelph <b>Many moons ago: Insights into the biochemical and physiological pathways that enable fish to thrive in extreme environments</b> <i>Aperçus sur les voies biochimiques et physiologiques qui permettent aux poissons de prospérer dans les environnements extrêmes</i>
CPB SYM 3 9:00-9:30	<b>MATT VIJAYAN</b> University of Calgary <b>Stress Steroid and Hepatocyte Metabolism: Moon Legacy and Beyond!</b> <i>Stéroïdes du stress et métabolisme des hépatocytes: legs de Moon et plus encore</i>
CPB SYM 4 9:30-10:00	<b>VICKI L MARLATT, JINYING SUN, RYAN SHERRARD, CHRIS J KENNEDY, JAMES R ELPHICK, CHRISTOPHER J MARTYNIUK</b> Simon Fraser University <b>Exploring estrogen action in teleosts: from molecular to organismal effects</b> <i>Action de l'estrogène chez les poissons téléostéens: effets moléculaires et organismiques</i>

EEE Symposium / symposium ÉÉÉ 8:00-10:00 Escalus

**Large, Landscape-Level Ecological Disturbances**  
**Large perturbations à l'échelle des paysages**  
 organizer: Greg Pyle

Chair / Prèsident: Greg Pyle

EEE SYM 1 8:00-8:30	<b>SHELLEY E ARNOTT, SHAKIRA AZAN, AND ALEX ROSS</b> Queen's University <b>An invasive predator and calcium decline reduce herbivore abundance in Shield lakes</b> <i>Un prédateur envahissant et le déclin du calcium réduisent l'abondance des herbivores dans les lacs du Bouclier canadien</i>
EEE SYM 2 8:30-9:00	<b>JAN J.H. CIBOROWSKI AND A. LEE FOOTE</b> University of Windsor <b>Reclaiming wetlands in the post-mining landscape of the Alberta Oilsands region</b>
EEE SYM 3 9:00-9:30	<b>MICHAEL LANNOO, JAIMIE KLEMISH, ROCHELLE STILES AND JONATHAN SWAN</b> Indiana University <b>Amphibian habitat creation on post-industrial landscapes</b> <i>Création d'habitats pour amphibiens dans les environnements post-industriels</i>
EEE SYM 4 9:30-10:00	<b>HILLARY YOUNG</b> University of California, Santa Barbara <b>Cascading effects of defaunation on zoonotic disease across scales and environmental contexts</b> <i>Effets en cascade de la défaunation sur les maladies zoonotiques à différentes échelles et dans différents contextes environnementaux</i>

**Contributed Sessions A / Sessions de communications A**

**8:00-10:00 PIE A1: That empty space  
Pathogens – Disease and Immunity part I  
Pathogènes – Maladies et immunité, première partie**

Chair / Prèsident: Dan Barreda

PIE A1-1 8:00-8:15	<b>LAURA V FERGUSON</b> and BRENT J SINCLAIR Western University <b>Plasticity drives thermal dependency of host-pathogen interactions</b> <i>La plasticité dirige la dépendance thermique dans les interactions hôte- pathogène</i>
PIE A1-2 8:15-8:30	<b>MICHAEL E. WONG</b> , JEFF J. HAVIXBECK, AJA M. RIEGER, KEITH B. TIERNEY, DAN R. BARREDA University of Alberta <b>The impact of behavioural fever on the modulation of immunity in teleost fish.</b> <i>Impact de la fièvre du comportement sur la modulation de l'immunité chez les poissons téléostéens</i>
PIE A1-3 8:30-8:45	<b>HEATHER COATSWORTH</b> , PAOLA CAICEDO, CLARA OCAMPO, AND CARL LOWENBERGER Simon Fraser University <b>Flipping Phenotype: Using RNAi to knock-down pro-viral genes in <i>Aedes aegypti</i> to prevent dengue transmission</b> <i>Inverser le phénotype: Utilisation du RNAi visant le knock-down des gènes pro- viraux chez Aedes aegypti afin de prévenir la transmission du dengue.</i>
PIE A1-4 8:45-9:00	<b>DUSTIN LILICO</b> , JOSH PEMBERTON, MYRON ZWOZDESKY, DR. JAMES STAFFORD University of Alberta <b>Examining distinct immune receptor-mediated target acquisition and engulfment pathways in fish.</b> <i>Étude sur le ciblage par récepteur immunitaire et les voies d'engouffrement chez les poissons.</i>
PIE A1-5 9:00-9:15	<b>NIKOLINA KOVACEVIC</b> , MARIEL O. HAGEN, JIASONG XIE, AND MIODRAG BELOSEVIC University of Alberta <b>The analysis of the acute phase response during the course of <i>Trypanosoma carassii</i> infection in the goldfish (<i>Carassius auratus</i> L.)</b> <i>Analyse de la réaction aigüe pendant l'infection par Tripanosoma carassii des poissons rouges (Carassius auratus)</i>
PIE A1-6 9:15-9:30	<b>HEATHER COATSWORTH</b> , PAOLA CAICEDO, CLARA OCAMPO, CHRIS COOMB, AND CARL LOWENBERGER Simon Fraser University <b>Resistance Reasoning: The case of resistance by <i>Aedes aegypti</i> to Dengue viruses</b> <i>Résistance de Aedes aegypti aux virus du Dengue.</i>
PIE A1-7 9:30-9:45	<b>JIASONG XIE</b> AND MIODRAG BELOSEVIC University of Alberta <b>Functional characterization of receptor-interacting serine/threonine kinase 2 (RIP2) of the goldfish (<i>Carassius auratus</i> L.)</b> <i>Caractérisation fonctionnelle du "receptor-interacting serine/threonine kinase 2" (RIP2) du poisson rouge (Carassius auratus L.)</i>
PIE A1-8 9:45-10:00	<b>JANET KOPRIVNIKAR</b> AND THERESA M.Y. URICHUK Ryerson University <b>Effects of predator exposure on host anti-parasite behaviour: current vs. past threats</b> <i>Effets de l'exposition aux prédateurs sur le comportement anti-parasite de l'hôte: menaces présentes et passées</i>

**Contributed Sessions A / Sessions de communications A**  
**8:00-9:45 CMD A2: Cassio**

**Insights from Morphology 1**  
**Aperçus de la morphologie, première partie**

Chair / Prèsident: Sally Leys

CMD A2-1 8:00-8:15	<b>TEGAN N BARRY, SEAN M RODGERS, AND HEATHER A JAMNICZKY</b> University of Calgary <b>Phenotypic heterogeneity in marine Threespine Stickleback from Madeira Park, BC</b> <i>Hétérogénéité phénotypique des épinoches à trois épines du Parc Madeira, Colombie Britannique</i>
CMD A2-2 8:15-8:30	<b>KEVIN DUCLOS, THOMAS GRÜNBAUM, RICHARD CLOUTIER, BERNARD ANGERS</b> Université de Montréal <b>A mouthful of variation: skeletal phenotypic variation in clonal hybrids.</b> <i>De la variation plein la bouche: variation phénotypique du squelette des hybrides clonaux</i>
CMD A2-3 8:30-8:45	<b>JAVIER LUQUE AND A. RICH PALMER</b> University of Alberta <b>Unleashing the chimaera: An enigmatic crab from the Cretaceous of Tropical America, and the early evolution of true crabs</b> <i>Un crabe énigmatique du Crétacé des Amériques tropicales et l'évolution initiale des vrais crabs</i>
CMD A2-4 8:45-9:00	<b>A. RICHARD PALMER</b> University of Alberta <b>The role of genes in the development of morphological asymmetry</b> <i>Le rôle des gènes dans le développement de l'asymétrie morphologique</i>
CMD A2-5 9:00-9:15	<b>MATTHEW MORRIS, KATY PETROVICH, HEATHER JAMNICZKY, AND SEAN ROGERS</b> University of Calgary <b>Exploring Jordan's Rule in coastal threespine stickleback</b> <i>Exploration de la loi de Jordan chez les épinoches à trois épines côtières</i>
CMD A2-6 9:15-9:30	<b>AMANDA S KAHN, AND SALLY P LEYS</b> University of Alberta <b>Multiple origins of choanocytes in feeding chambers of sponges</b> <i>Origines multiples des choanocytes dans les chambres d'alimentation des éponges</i>
CMD A2-7 9:30-9:45	<b>NICOLE B WEBSTER AND A. RICHARD PALMER</b> University of Alberta <b>Bridging pattern and process: How do snails grow shell sculpture?</b> <i>Entre motif et mécanisme: comment les escargots sculptent-ils leurs coquilles?</i>



**Contributed Sessions B / Sessions de communications B**  
**10:30-12:30 CPB B1: MacHall A**

**Thermal Physiology 1**  
**Physiologie thermal, première partie**

Chair / Prèsident: Ben Speers-Roesch

CPB B1-1 10:30-10:45	<b>ZHONGQI CHEN</b> , MIKE SNOW, CRAIG S. LAWRENCE, ROBERT H. DEVLIN, ANTHONY P. FARRELL University of British Columbia <b>Thermal performance and tolerance of a warm adapted rainbow trout (<i>Oncorhynchus mykiss</i>) population</b> <i>Performance et tolérance thermale chez les truites arc-en-ciel adaptées aux températures chaudes (<i>Oncorhynchus mykiss</i>)</i>
CPB B1-2 10:45-11:00	<b>MATTHEW GILBERT</b> , KATE FAULDER, KEITH TIERNEY University of Alberta <b>Physiological tolerance of arctic char (<i>Salvelinus alpinus</i>) and rainbow trout (<i>Oncorhynchus mykiss</i>) to diurnal temperature fluctuations.</b> <i>Tolérance physiologique de l'omble arctique (<i>Salvelinus alpinus</i>) et de la truite arc-en-ciel (<i>Oncorhynchus mykiss</i>) aux fluctuations diurnes de température</i>
CPB B1-3 11:00-11:15	<b>JOHN EME</b> , CASEY A. MUELLER, RICHARD G. MANZON, CHRISTOPHER M. SOMERS, DOUGLAS R. BOREHAM, JOANNA Y. WILSON McMaster University <b>Effects of daily, incremental changes in incubation temperature on the metabolism of Lake Whitefish embryos and hatchlings</b> <i>Effets de changements quotidiens progressifs de la température d'incubation sur le métabolisme des embryons et nouveaux-nés chez les grands corégones</i>
CPB B1-4 11:15-11:30	<b>TARA L MCBRYAN</b> , TIMOTHY M. HEALY, KRISTEN HAAKONS, AND PATRICIA M. SCHULTE University of British Columbia <b>The effects of increased temperature on hypoxia tolerance in the Atlantic Killifish, <i>Fundulus heteroclitus</i></b> <i>Effets de la température élevée sur la tolérance à l'hypoxie chez le cyprinodontidé de l'Atlantique <i>Fundulus heteroclitus</i></i>
CPB B1-5 11:30-11:45	<b>ALEXANDER H MCKINNON</b> , BRENT J. SINCLAIR Western University <b>A new model for cool: Inducing freeze tolerance in the spring field cricket, <i>Gryllus veletis</i></b> <i>Comment induire la tolérance au gel chez le grillon printanier <i>Gryllus veletis</i></i>
CPB B1-6 11:45-12:00	<b>KATIE E. MARSHALL</b> AND CHRISTOPHER D.G. HARLEY University of British Columbia <b>Mechanisms of freeze tolerance in the mussel <i>Mytilus trossulus</i></b> <i>Mécanismes de tolérance au gel chez la moule <i>Mytilus trossulus</i></i>
CPB B1-7 12:00-12:15	<b>NASTASHYA WALL</b> AND GRANT B. MCCLELLAND McMaster University <b>Adult plasticity in thermogenesis for low and high altitude deer mice (<i>Peromyscus maniculatus</i>)</b> <i>Plasticité adulte dans la thermogénèse à basse et haute altitude chez les souris sylvestres (<i>Peromyscus maniculatus</i>)</i>
CPB B1-8 12:15-12:30	TIMOTHY M. HEALY, JESSICA L. MCKENZIE AND PATRICIA M. SCHULTE University of British Columbia <b>Are thermal tolerance and hypoxia tolerance functionally correlated traits in fish?</b> <i>Est-ce que la tolérance thermique et la tolérance à l'hypoxie sont corrélées du point de vue de la fonction chez les poissons?</i>

**Contributed Sessions B / Sessions de communications B**  
**10:30-12:30 CPB B2: Cassio**

**Materials, mechanics and moving**  
**Matériaux, mécanique et mouvement**

This session is sponsored through the generous support of Aurora Scientific [www.AuroroScientific.com](http://www.AuroroScientific.com)

Chair / Prèsident: Emily Standen

CPB B2-1 10:30-10:45	<b>SHANNON FERRARO</b> AND DOUGLAS FUDGE University of Guelph <b>Swelling mechanisms of hydrogels in the slime of the Pacific hagfish, <i>Eptatretus stoutii</i></b> <b>Mécanismes d'engorgement des hydrogels dans la bave de la myxine du Pacifique, <i>Eptatretus stoutii</i></b>
CPB B2-2 10:45-11:00	<b>SARAH E M JENKIN</b> , AND WILLIAM K MILSOM The University of British Columbia <b>Active expiration in mammals: When and where does it occur?</b> <b>Expiration active chez les mammifères: quand et où a-t-elle lieu?</b>
CPB B2-3 11:00-11:15	<b>CODY W MANCHESTER</b> AND JOHN R GRAY University of Saskatchewan <b>Flight muscle coordination in collision avoidance of flying locusts. <i>Coordination des muscles du vol dans l'évitement des collisions chez les locustes volants</i></b>
CPB B2-4 11:15-11:30	<b>ANDY TURKO</b> , ROGER CROLL, DOUGLAS FUDGE, FRANK SMITH, MATTHEW STOYEK, AND PATRICIA WRIGHT University of Guelph <b>Aquatic-terrestrial transitions in amphibious fishes mimic astronauts returning to earth</b> <b>Les transitions entre l'eau et la terre chez les poissons amphibies ressemblent aux retours des astronautes sur terre</b>
CPB B2-5 11:30-11:45	<b>MICHELLE N REICHERT</b> AND WILLIAM K MILSOM University of British Columbia <b>Pulmonary mechanics and the work of breathing in the caiman, <i>Caiman yacare</i></b> <b>Mécanique pulmonaire et travail respiratoire du caïman, <i>Caiman yacare</i></b>
CPB B2-6 11:45-12:00	<b>EMILY M. STANDEN</b> , TRINA Y. DU, HANS C.E. LARSSON University of Ottawa <b><i>Polypterus</i> plasticity and what it means for the origin of tetrapods.</b> <b>Plasticité de <i>Polypterus</i> et ce qu'elle nous apprend sur l'origine des tétrapodes</b>
CPB B2-7 12:00-12:15	<b>LINDSAY E. MAY</b> , JAMES D. KIEFFER University of New Brunswick Saint John <b>I can't get a grip: The effect of substrate type on aspects of swimming in shortnose sturgeon (<i>Acipenser brevirostrum</i>)</b> <b>Je n'ai pas de prise: effets du type de substrat sur la nage chez l'esturgeon à museau court (<i>Acipenser brevirostrum</i>)</b>
CPB B2-8 12:15-12:30	<b>JAMES WHALE</b> , ROBERT SHADWICK University of British Columbia <b>Thunniform locomotor strategies across three major taxa</b> <b>Stratégies locomotrices des thunniformes dans trois groupes taxonomiques majeurs</b>

## Contributed Sessions B / Sessions de communications B

**10:30-12:30 CPB B3: That Empty Space**

**Tribute to the career of Dr. Tom Moon cont'd**

**un hommage à la carrière de Dr. Thomas W. Moon, deuxième partie**

Chair / Prèsident: Paul Craig

CPB B3-1 10:30-10:45	<b>PATRICK J. WALSH</b> University of Ottawa <b>Lessons learned during my life as a 'Moonie'.</b> <i>Ce que j'ai appris dans ma vie en tant que 'Moonie'</i>
CPB B3-2 10:45-11:00	<b>WILLIAM DRIEDZIC, KATHY CLOW AND CONNIE SHORT</b> Memorial University of Newfoundland <b>Extracellular glucose can support metabolism in Atlantic cod myocytes but not in heart of hypoglycemic short-horned sculpin.</b> <i>Le glucose extracellulaire peut supporter le métabolisme des myocytes des morues de l'Atlantique mais pas celui du coeur des chabosseaux à épines courtes hypoglycémiques</i>
CPB B3-3 11:00-11:15	<b>KATHLEEN M GILMOUR, MARIE-ÈVE BÉLAIR-BAMBRICK, ALISON HANES, GURPREET SAHMBI AND JENNIFER JEFFREY</b> University of Ottawa <b>Regulation of the stress axis during chronic social stress in rainbow trout</b> <i>Oncorhynchus mykiss</i> <i>Régulation de l'axe du stress pendant le stress social chronique chez la truite arc-en-ciel (Oncorhynchus mykiss)</i>
CPB B3-4 11:15-11:30	<b>JASON R. TREBERG, SHEENA BAHN, LILLIAN WIENS, EMIANKA SOTIRI, PAMELA ZACHARIAS</b> University of Manitoba <b>Temperature influences on hydrogen peroxide metabolism by skeletal muscle mitochondria</b> <i>Influences de la température sur le métabolisme du peroxyde d'hydrogène par les mitochondries de muscle squelettique</i>
CPB B3-5 11:30-11:45	<b>OANA BIRCEANU AND MICHAEL P. WILKIE</b> Wilfrid Laurier University <b>The effects of routine lampricide treatment on the stress physiology of a non-target fish: the rainbow trout (<i>Oncorhynchus mykiss</i>).</b> <i>Effets de traitements fréquents de lampricide sur la physiologie du stress d'un poisson non-recherché: la truite arc-en-ciel (Oncorhynchus mykiss)</i>
CPB B3-6 11:45-12:00	<b>CHRIS M. WOOD AND MARTIN GROSELL</b> University of Miami <b>Electrical aspects of the osmorepiratory compromise in the euryhaline killifish (<i>Fundulus heteroclitus</i>)</b> <i>Aspects électriques du compromis osmorepiratoire chez les cyprinodontidés euryhalines (Fundulus heteroclitus)</i>
CPB B3-7 12:00-12:15	<b>STEVE F PERRY, YUSUKE KUMAI, COSIMA PORTEUS, JACOB POLLACK AND BILL MILSOM</b> University of Ottawa <b>Respiratory responses to high external ammonia in zebrafish (<i>Danio rerio</i>): A possible role for neuroepithelial cells and Rhesus glycoproteins in ammonia sensing.</b> <i>Réponses respiratoires à des taux élevés d'ammoniac chez le poisson zèbre (Danio rerio): un rôle possible des cellules neuro-épithéliennes et des glycoprotéines dans la détection de l'ammoniac</i>
CPB B3-8 12:15-12:30	<b>PAUL CRAIG</b> University of Waterloo <b>Goodnight Moon: Teaching an old dog new tricks about epigenetics and metabolism.</b> <i>Bonne nuit Moon: comment apprendre à un vieux chien de nouveaux trucs sur l'épigénétique et le métabolisme</i>

**Contributed Sessions B / Sessions de communications B  
10:30-12:30 EEE B4: Escalus**

**EEE student symposium  
Symposium étudiant EEE**

Chair / Prèsident: Ralph Carter

EEE B4-1 10:30-10:45	<b>TRAVIS BANNATYNE</b> , NICOLA KOPER AND SUSAN LINGLE University of Winnipeg <b>Do density-dependent shifts in winter habitats of mule deer reflect intraspecific competition for safe terrain?</b> <i>Les changements d'habitats d'hiver qui dépendent de la densité reflètent-ils une compétition intra-spécifique pour des terrains plus sûrs?</i>
EEE B4-2 10:45-11:00	<b>IAN BLACK</b> AND GLENN TATTERSALL Brock University <b>Orientation Bias and Behavioural Thermoregulatory Coordination in <i>Pogona vitticeps</i></b> <i>Préférences dans l'orientation et coordination thermorégulatoire chez <i>Pogona vitticeps</i></i>
EEE B4-3 11:00-11:15	<b>ELLA BOWLES</b> , REBECCA A. JOHNSTON, STEVI L. VANDERZWAN AND SEAN M. ROGERS University of Calgary <b>Genetic basis for body size variation between an anadromous and two derived lacustrine populations of threespine stickleback (<i>Gasterosteus aculeatus</i>) in southwest Alaska</b> <i>Base génétique de la variation dans la taille du corps entre une population anadrome et deux populations dérivées lacustres de l'épinoche à trois épines dans le sud-ouest de l'Alaska</i>
EEE B4-4 11:15-11:30	<b>ZACH DEMPSEY</b> , CAMERON GOATER AND THERESA BURG University of Lethbridge <b>Phylogenetic patterns of mountain snails, <i>Oreohelix</i> spp. in Southern Alberta</b> <i>Motifs phylogénétiques chez les escargots de montagne du genre <i>Oreohelix</i> dans le sud de l'Alberta</i>
11:30-11:45	<b>break/pause</b>
EEE B4-6 11:45-12:00	<b>REBECCA RIZZATO</b> AND N. KIRK HILLIER Acadia University <b>Comparative analysis of pheromone blend divergence in Heliothine moths</b> <i>Analyse comparative de la divergence des mélanges de phéromones chez les papillons de nuit Heliothines</i>
EEE B4-7 12:00-12:15	<b>CORA ANNE ROMANOW</b> , TOBIAS RIEDE, AND SUSAN LINGLE University of Winnipeg <b>Designed to Attract: infant cries and male courtship calls in elk</b> <i>Faits pour attirer: pleurs de nourissons et appels de cour masculins chez les caribous</i>
EEE B4-8 12:15-12:30	<b>BENJAMIN WALTERS</b> , MICHAEL J CLINCHY, NATALIE CHENG, CHRIS GUGLIELMO, AND LIANA ZANETTE University of Western Ontario <b>A tactic to stay alive: anti-predator behavioural responses affect physiology but not flight performance in high risk environments</b> <i>Une tactique pour survivre: les réactions comportementales anti-prédatrices affectent la physiologie mais pas la performance du vol dans les environnements à hauts risques</i>



**Contributed Sessions C / Sessions de communications C**  
**2:00-3:30 PIE C1: That Empty Space**

**Pathogens – Disease and Immunity part II**  
**Pathogènes – Maladies et immunité, deuxième partie**

Chair / Prèsident: James Wasmuth

PIE C1-1 2:00-2:15	<b>ALETHE L. KABORE</b> , EMMANUEL A. PILA AND PATRICK C. HANINGTON University of Alberta <i>Schistosoma mansoni</i> immunological behaviours during <i>Biomphalaria grabata</i> infection <i>Comportement immunologique de Schistosoma mansoni lors d'une infection par Biomphalaria grabata</i>
PIE C1-2 2:15-2:30	<b>MEGHAN KERR</b> , REMINGTON WINTER, MIKE TRITES, EMMA GILLIS, LAURA FERGUSON, AND TODD SMITH Acadia University Interspecific competition among intraerythrocytic blood parasites of the genus <i>Hepatozoon</i> in green frogs, <i>Rana clamitans</i> <i>Compétition inter-spécifique entre les parasites sanguins intra-érythrocytiques du genre Hepatozoon chez les grenouilles vertes, Rana clamitans</i>
PIE C1-3 2:30-2:45	<b>ANNA MANKO</b> , JEAN-PAUL MOTTA, JAMES A. COTTON, JOHN L. WALLACE, ANDRE G. BURET University of Calgary <i>Giardia muris</i> attenuates <i>Citrobacter rodentium</i> -induced colitis <i>Giardia muris</i> atténue la colite induite par <i>Citrobacter rodentium</i>
PIE C1-4 2:45-3:00	<b>CAOIMHE MCPARLAND</b> , GLENYS GIBSON AND TODD SMITH Acadia University Lethal effects of high intensities of <i>Hepatozoon</i> species on the mosquito, <i>Culex territans</i> <i>Effets létaux de hautes intensités d'espèces de Hepatozoon sur le moustique, Culex territans</i>
PIE C1-5 3:00-3:15	<b>REYES JOSE LUIS</b> , LEUNG GABRIELLA, FERNANDO MARIA, LOPES FERNANDO, MANCINI NICOLE, WANG ARTHUR AND MCKAY DEREK University of Calgary Tapeworm antigens block LPS-induced inflammatory mediator production, induce regulatory macrophages and recruit myeloid derived suppressor cells via CCR2 <i>Les antigènes de ténia bloquent la production de médiateur d'inflammation induits par LPS, induisent les macrophages régulateurs et recrutent les cellules myéloïdes suppressives au moyen de CCR2</i>
PIE C1-5 3:15-3:30	<b>EMMANUEL PILA</b> , MAHMOUD TARRABAIN AND PATRICK HANINGTON University of Alberta Involvement of a snail Toll-like receptor in the immune response against schistosome infection <i>Implication d'un récepteur Toll-like dans la réaction immunitaire d'un escargot contre une infection de schistosome</i>

**Contributed Sessions C / Sessions de communications C**  
**2:00-3:45 CPB C2: Cassio**

**Energy and Homeostasis**  
**Énergie et homéostasie**

Chair / Prèsident: Jason Treberg

CPB C2-1 2:00-2:15	<b>ALICIA A CASSIDY</b> , ROXANNE J SAULNIER AND SIMON G LAMARRE Université de Moncton <b>Adjustments in protein metabolism of starved Arctic Charr, <i>Salvelinus alpinus</i></b> <i>Ajustements du métabolisme des protéines chez les ombles chevaliers affamés (<i>Salvelinus alpinus</i>)</i>
CPB C2-2 2:15-2:30	<b>BRENT J SINCLAIR</b> AND KEITH J KING Western University <b>Waterproof from the inside and out: Role of cuticular melanism and lipids on water loss rates in insects</b> <i>Étanches à l'intérieur comme à l'extérieur: le rôle du mélanisme cuticulaire et des lipides dans les taux de perte d'eau des insectes</i>
CPB C2-3 2:30-2:45	<b>JOSHUA G PEMBERTON</b> , JAMES L STAFFORD, AND JOHN P CHANG University of Alberta <b>Biased G Protein-Coupled Receptor Signal Transduction Networks and the Control of Pituitary Cell Function: Lessons from the Goldfish (<i>Carassius auratus</i>)</b> <i>Réseaux de "G protein-coupled receptor signal transduction" biaisés et le contrôle de la fonction des cellules pituitaires: leçons du poisson rouge (<i>Carassius auratus</i>)</i>
CPB C2-4 2:45-3:00	<b>SARAH MCFARLANE</b> AND JAMES F. STAPLES University of Western Ontario <b>Mitochondrial respiration in brown adipose tissue of hibernating 13-lined ground squirrels, <i>Ictidomys tridecemlineatus</i>.</b> <i>Respiration mitochondrienne dans le tissu adipeux brun des spermophiles à treize rayures, <i>Ictidomys tridecemlineatus</i>, en hibernation</i>
CPB C2-5 3:00-3:15	<b>DANIEL MUNRO</b> , SHEENA BANH AND JASON TREBERG University of Manitoba <b>Metabolism of H<sub>2</sub>O<sub>2</sub> by skeletal muscle mitochondria: consumption exceeds production</b> <i>Métabolisme du H<sub>2</sub>O<sub>2</sub> par les mitochondries des muscles squelettiques: la consommation excède la production</i>
CPB C2-6 3:15-3:30	<b>DIVYANG PATEL</b> , AARON ROBERTSON, KYLE SCHALTZ, AND ALLISON E. MCDONALD Wilfrid Laurier University <b>Expression of the alternative oxidase in the yeast <i>Saccharomyces cerevisiae</i>: a high-throughput screening tool for treating mitochondrial diseases.</b> <i>Expression de l'oxidase alternative dans la levure <i>Saccharomyces cerevisiae</i>: un outil de dépistage à haut débit pour traiter les maladies mitochondriales</i>
CPB C2-7 3:30-3:45	<b>KATE MATHERS</b> and JAMES STAPLES University of Western Ontario <b>Regulation of reversible mitochondrial suppression during hibernation</b> <i>Régulation de la suppression mitochondrienne réversible durant l'hibernation</i>

**Contributed Sessions C / Sessions de communications C  
2:00-3:30 CPB C3: MacHall A**

**Ion Regulation I / Régulation ionique, première partie**

Chair / Président: Carol Bucking

CPB C3-1 2:00-2:15	<b>SANDRA FEHSENFELD</b> , DAVID W. TOWLE, ANNA-MARIA MARINI, JYUAN-RU TSAI, DIRK WEIHRAUCH University of Manitoba <b>Characterization of the crustacean Rhesus-like protein (RhCM) and its role in branchial ammonia excretion in the green crab, <i>Carcinus maenas</i></b> <i>Caractérisation de la protéine de type Rhésus (RhCM) des crustacés et son rôle dans l'excrétion d'ammoniac des branchies chez le crabe vert, <i>Carcinus maenas</i></i>
CPB C3-2 2:15-2:30	<b>ALEX QUIJADA-RODRIGUEZ</b> , JASON R. TREBERG AND DIRK WEIHRAUCH University of Manitoba <b>The ribbon leech <i>Nepheolopsis obscura</i> as a model system to investigate cutaneous ammonia transport in freshwater invertebrates</b> <i>La sangsue ruban <i>Nepheolopsis obscura</i> comme modèle pour les études de transport cutané de l'ammoniac chez les invertébrés d'eau douce</i>
CPB C3-3 2:30-2:45	<b>CHRISTOPHE LEMOINE</b> AND PATRICK WALSH University of Ottawa <b>Evolution and distribution of the Urea Transporter (UT) family in vertebrates.</b> <i>Évolution et distribution de la famille des transporteurs d'urée (UT) chez les vertébrés</i>
CPB C3-4 2:45-3:00	<b>MARINA GIACOMIN</b> , B. PELSTER, H. SADAUSKAS HENRIQUE, V. ALMEIDA-VAL, A. LUIS VAL, AND CM WOOD University of British Columbia <b>Ionoregulation versus gas exchange in two Amazonian erythrinid teleosts: increased reliance on the gut during the transition to air breathing</b> <i>Régulation ionique versus échanges de gaz chez deux téléostéens erythrinides de l'Amazonie: dépendance accrue sur les intestins durant la transition à la respiration aérienne</i>
CPB C3-5 3:00-3:15	<b>MICHAEL A SACKVILLE</b> , JONATHAN M WILSON AND COLIN J BRAUNER University of British Columbia <b>Larval lamprey question the origins of chordate gill function.</b> <i>Les larves de lamproies remettent en question l'origine de la fonction des branchies des cordés</i>
CPB C3-5 3:15-3:30	<b>ALEX ZIMMER</b> , PAT WRIGHT, CHRIS WOOD McMaster University <b>The role of ammonia excretion in driving gill ontogeny in early life stage fish</b> <i>Rôle de l'excrétion d'ammoniac dans l'ontogénèse des branchies chez les poissons en stade précoce de l'existence</i>

**Contributed Sessions C / Sessions de communications C  
2:00-3:30 CMD C4: Escalus**

**From head to toe - integrative vertebrate morphology and evolution: a tribute to Tony Russell  
De la tête aux pieds – morphologie intégrée et évolution des vertébrés: un hommage à Tony Russell**

Chair / Président: Tim Higham

CMD C4-1 2:00-2:30	<b>ANTHONY RUSSELL</b> , JOELLE BASKERVILLE, TONY GAMBLE AND TIMOTHY HIGHAM University of Calgary <b>Back to basics: the origin of adhesion in geckos.</b> <i>Retour aux fondamentaux: origine de l'adhésion chez les geckos</i>
CMD C4-2 2:30-2:45	<b>MATT VICKARYOUS</b> , EMILY GILBERT, K. JACYNIAK, ALAINA MACDONLAD, R. MCDONALD & N. SUBRAMANIAN University of Guelph <b>Geckos as a model for the study of scar-free wound healing and regeneration: where biology meets biomedicine.</b> <i>Les geckos comme modèles pour étudier la guérison de blessures sans cicatrices et la régénération: rencontre entre la biologie et la biomédecine.</i>
CMD C4-3 2:45-3:00	<b>HILLARY C. MADDIN</b> , NADINE PIEKARSKI, ELIZABETH SEFTON, JAMES HANKEN Carleton University <b>Re-evaluation of the homology of the bones of the tetrapod cranial vault</b> <i>Réévaluation de l'homologie des os de la voûte crânienne des tétrapodes</i>
CMD C4-4 3:00-3:15	<b>BENEDIKT HALLGRIMSSON</b> , REBECCA GREEN, C. PERCIVAL, JENNIFER FISH, NATHAN YOUNG & RALPH MARCUCIO University of Calgary <b>The Developmental-Genetics of Complex Morphological Traits: Insights from the Vertebrate Face and Skull</b> <i>Génétique du développement des traits complexes: aperçus du crâne et du visage des vertébrés</i>
CMD C4-5 3:15-3:30	<b>AARON M BAUER</b> Villanova University <b>Size, shape, function and phylogeny: evolutionary diversity in the gekkotan skull.</b> <i>Taille, forme, fonction et phylogénie: diversité évolutive du crâne des geckos</i>

## Contributed Sessions D / Sessions de communications D

4:00-5:15 PIE D1: Escalus

### Pathogens – Distribution, Diversity and Detection part I

### Pathogènes – Distribution, diversité et détection, première partie

Chair / Président: Brian Dixon

PIE D1-1 4:00-4:15	<b>CAMERON P. GOATER</b> University of Lethbridge <b>Zombie hosts and their parasite chauffeurs: the behaviour of trematode- infected ants</b> <i>Les hôtes zombies et leurs parasites chauffeurs: comportement des fourmis infectées par des trématodes</i>
PIE D1-2 4:15-4:30	<b>MICHAEL J TRITES AND DANIEL R BARREDA</b> University of Alberta <b>Cleaved transferrin products can serve as an early marker of acute inflammation in goldfish, <i>Carassius auratus</i></b> <i>Les produits de sidérophilines clivés peuvent servir d'indicateurs initiaux d'inflammation aiguë chez les poissons rouges, <i>Carassius auratus</i></i>
PIE D1-3 4:30-4:45	<b>TERIN ROBINSON, PABLO CONEJEROS, SAM MARTIN, MARTIN LYSY and BRIAN DIXON</b> University of Waterloo <b>The use of Major Histocompatibility Gene Haplotypes in Population Genetics: A Cautionary Tale</b> <i>Utilisation des haplotypes de gènes de complexes majeurs d'histocompatibilité dans la génétique des populations: une mise en garde</i>
PIE D1-4 4:45-5:00	<b>JOSHUA SULLIVAN, FLORENCE CHAN, S. CHECKLEY, LISA-MARIE LECLERC, DONALD MCLENNAN &amp; SUSAN KUTZ</b> University of Calgary <b>Evaluation of sampling techniques for terrestrial gastropods at the edge of their range in the Canadian Arctic.</b> <i>Évaluation des techniques d'échantillonnage de gastropodes terrestres à la limite de leur étendue dans l'Arctique canadien</i>
PIE D1-5 5:00-5:15	<b>JAMES D WASMUTH, AUDE GILABERT, DAVID CURRAN AND SIMON HARVEY</b> University of Calgary <b>The evolution of signalling pathways that control the life-cycle transition of parasitic nematodes.</b> <i>Evolution des voies de signalisation contrôlant les transitions du cycle de vie des nématodes parasitiques</i>

## Contributed Sessions D / Sessions de communications D

4:00-5:30 CPB D2: Cassio

### Stress 1 – Response mechanisms Stress 1 – mécanismes de réponses

Chair / Président: Katie Gilmour

CPB D2-1 4:00-4:15	<b>NEAL CALLAGHAN, LOUISE TUNNAH, SUZANNE CURRIE AND TYSON MACCORMACK</b> Mount Allison University <b>AMPK-mediated metabolic regulation during heat stress preconditioning of rainbow trout (<i>O. mykiss</i>).</b> <i>Régulation métabolique médiée par AMPK durant le préconditionnement au stress thermique chez la truite arc-en-ciel (<i>Onchorynchus mykiss</i>)</i>
CPB D2-2 4:15-4:30	<b>ERIN FAUGHT, MATHILAKATH VIJAYAN</b> University of Calgary <b>Rainbow trout exosome: is it involved in the stress response?</b> <i>L'exosome de la truite arc-en-ciel: est-il impliqué dans la réaction au stress?</i>
CPB D2-3 4:30-4:45	<b>DAVID LISSER, ZACHARY LISTER, MICHAEL WILKIE, AND GRAHAM SCOTT</b> Wilfrid Laurier University <b>The role of oxidative stress in the mechanisms of ammonia-induced neurotoxicity in goldfish(<i>Carassius auratus</i>)</b> <i>Rôle du stress oxydatif dans les mécanismes de neurotoxicité induite par ammoniac chez les poissons rouges.</i>
CPB D2-4 4:45-5:00	<b>LANNA M DESANTIS, JEFF BOWMAN, RUDY BOONSTRA AND GARY BURNES</b> Trent University <b>Seasonal differences in stress reactivity in New World flying squirrels: shedding light on physiological function and natural history.</b> <i>Différences saisonnières dans la réactivité au stress chez les écureuils volants de Nouveau Monde: éclaircissement de la fonction physiologique et de l'histoire naturelle</i>
CPB D2-5 5:00-5:15	<b>JULIA C REDFERN, SJ COOKE, RJ LENNOX, MA NANNINI, AR SHIFMAN, DH WAHL, KATHLEEN M GILMOUR</b> University of Ottawa <b>Effects of maternal cortisol treatment on offspring size, behaviour, and responsiveness to stress in wild largemouth bass (<i>Micropterus salmoides</i>).</b> <i>Effets de traitements par cortisol maternel sur la taille de la descendance, le comportement et la réactivité au stress chez les achigans à grande bouche sauvages.</i>
CPB D2-6 5:15-5:30	<b>ROXANNE J SAULNIER, SIMON G LAMARRE</b> Université de Moncton <b>The effects of cortisol on fish protein metabolism.</b> <i>Effets du cortisol sur le métabolisme des protéines chez les poissons</i>



**Contributed Sessions D / Sessions de communications D**  
**4:00-5:30 CPB D3: MacHall A**

**Ion Regulation II / Régulation ionique, deuxième partie**

Chair / Prèsident: Salvatore Blair and Louise Tunnah

CPB D3-1 4:00-4:15	NICHOLAS CHOW, PAIGE ZENIUK, MATTHEW A. GLOVER, MARK R. RHEAULT University of British Columbia <b>The effects of blood feeding on organic cation transporter gene expression in the vector mosquito <i>Aedes aegypti</i>. Effets de l'alimentation sanguine sur l'expression des gènes des transporteurs de cations organiques chez le moustique vecteur <i>Aedes aegypti</i></b>
CPB D3-2 4:15-4:30	QUENTIN HEFFELL, SCOTT KELLY, FERNANDO GALVEZ AND PATRICIA WRIGHT University of Guelph <b>Skin permeability of the amphibious killifish <i>Kryptolebias marmoratus</i> in response to extreme salinity and short-term emersion. Perméabilité cutanée du cyprinodontidé amphibie <i>Kryptolebias marmoratus</i> en réaction à la salinité extrême et à l'émersion à court terme</b>
CPB D3-3 4:30-4:45	JOSHUA D. EMERMAN, GADWYN C. GAN, VICTOR K.S. CHAN, JG RICHARDS, COLIN J. BRAUNER University of British Columbia <b>Just add salt: Does salinity affect growth of salmon? Ajoutez du sel: la salinité affecte-elle la croissance des saumons?</b>
CPB D3-4 4:45-5:00	SALVATORE D BLAIR, DERRICK MATHESON, DANUTA CHAMOT, GREG G GOSS University of Alberta <b>Salinity tolerance of Arctic grayling (<i>Thymallus arcticus</i>): Physiological and Environmental Perspectives. Tolérance à la salinité de l'omble arctique (<i>Thymallus arcticus</i>): perspectives physiologiques et environnementales</b>
CPB D3-5 5:00-5:15	LOUISE TUNNAH, SARA MACKELLAR, TYSON MACCORMACK, A. MORASH, J. SEMMENS & SUZIE CURRIE Mount Allison University <b>How do hypersaline conditions in estuarine nurseries affect the physiology of two Tasmanian shark species? Effets de conditions hypersalines dans les nurseries estuariennes sur la physiologie de deux requins de Tasmanie</b>
CPB D3-6 5:15-5:30	RAYMOND KWONG AND STEVE PERRY University of Ottawa <b>Hydrogen sulfide modulates calcium uptake in larval zebrafish Le sulfure d'hydrogène module l'assimilation de calcium chez les poissons zèbres larvaires</b>

**Contributed Sessions D / Sessions de communications D**  
**4:00-5:30 CMD D4: That Empty Space**

**Local speakers - Morphology in the 4<sup>th</sup> dimension**  
**Conférenciers locaux – Morphologie dans la quatrième dimension**

Chair / Prèsident: Jessica Theodor

CMD D4-1 4:00-4:30	CALEB BROWN Royal Tyrrell Museum of Palaeontology <b>Homology of frill epioassifications of horned-dinosaurs (Ornithischia: Ceratopsidae): new specimens and new data. Homologie de l'épioassification de la frange des dinosaures à corne (Ornithischia: Ceratopsidae): nouveaux spécimens et nouvelles données</b>
CMD D4-2 4:30-4:45	JAMES A. CAMPBELL, MICHAEL J. RYAN University of Calgary <b>A reassessment of the horned dinosaur <i>Judiceratops tigris</i> (Ornithischia: Ceratopsidae) from the Upper Cretaceous (middle Campanian) of Montana, USA. Réévaluation du dinosaure à corne <i>Judiceratops tigris</i> (Ornithischia: Ceratopsidae) du Crétacé Supérieur (campanien moyen) du Montana, É.U.</b>
CMD D4-3 4:45-5:00	DONALD M HENDERSON Royal Tyrrell Museum of Palaeontology <b>Stomach stones for sinking in swimming sauropterygians? Des cailloux dans l'estomac afin de couler chez les sauroptérygiens aquatiques?</b>
CMD D4-4 5:00-5:15	JASON D. PARDO, AND JASON S. ANDERSON University of Calgary <b>Neurocranial morphology of the lysorophian <i>Brachydectes newberryi</i> from the Permian of Kansas and Nebraska: new information from <math>\mu</math>CT Morphologie neurocrânienne du lysorophien <i>Brachydectes newberryi</i> provenant du Permien du Kansas et du Nebraska: nouvelles données de tomographie par ordinateur</b>
CMD D4-5 5:15-5:30	JESSICA THEODOR University of Calgary <b>Ear region morphology in Hypertragulidae. Morphologie de la région de l'oreille chez les Hypertragulidés.</b>

**Zoological Education Trust Lecture**

**Conférence Publique du Fonds pour l'Éducation en Zoologie**

**6:00-7:00 MacHall A**

**DR. AXEL MOEHRENSCHLAGER  
HEAD OF CONSERVATION RESEARCH, CALGARY ZOO**

***Saving endangered species in Canada and beyond:  
challenges, successes, and hope***

***Sauvegarde des espèces en voie de disparition au Canada et ailleurs:  
challenges, succès et espoirs***

All delegates are invited to a catered reception with a cash bar in the MacHall Foyer following the lecture.

## Wednesday May 27 / mercredi, 27 mai (Summary / résumé)

<b>8:00-10:00</b>	<b>SESSION E</b>	
	PIE Symposium PIE: Host-Parasite Interactions	<i>Escalus</i>
	CMD Symposium MDC: Ten Years of the Triple Helix s	<i>MacHall A</i>
	EEE E1: Ecology – Environmental Impacts	<i>That Empty Space</i>
	CPB E2: Metabolism I – blood, gas and acid/base	<i>Cassio</i>
<b>10:00-10:30</b>	<b>Coffee / café</b>	<i>MacHall Foyer</i>
<b>10:30-12:30</b>	<b>SESSION B</b>	
	Teaching workshop / Atelier d'enseignement	<i>Escalus</i>
	PCB F1: Stress 2 – Toxins in the environment	<i>Cassio</i>
	CPB F2: Metabolism II – digestion, absorption, control	<i>That Empty Space</i>
	CMD F3: Student led - visualizing and quantifying	<i>MacHall A</i>
<b>12:30-2:00</b>	PIE Lunch / Lunch PIE	<i>Bianca</i>
	CMD Lunch / Lunch MDC	<i>The Den</i>
<b>2:00-3:00</b>	<b>Wardle Lecture / Conférence Wardle</b>	MacHall A
<b>3:00-3:30</b>	<b>Break / Pause</b>	
<b>3:30-6:00</b>	<b>Poster Session &amp; Pizza / Session d'affiches et Pizza</b> <b>3:30-4:30 EVEN #s    4:30-5:30 ODD #s</b>	MacHall Foyer
<b>6:00-6:30</b>	<b>Break / Pause</b> (poster take-down)	
<b>6:30-7:30</b>	<b>Student / PDF meet / greet</b>	The Den
<b>7:30-9:00</b>	<b>How to be the Best Workshop</b> <b>Atelier comment faire de son mieux</b>	The Den
<b>9:00-</b>	<b>Social / Soirée</b>	Black Lounge*

### Notes:

- The Poster session is catered, with a cash bar that also accepts drink tickets.
- Please note your poster number in the program and attend as indicated.
- Poster should be mounted Wed morning and removed by 6:30PM.
- \*We request that only those participating in the How to be the Best Workshop attend *The Den* during the workshop, to keep noise levels in check. *The Black Lounge* (directly above the Den) will be open starting about 6PM for others wanting to relax in a pub during the workshop.

## PIE Symposium / symposium PIE

8:00-10:00 Escalus

### Host-Parasite Interactions: new paradigms of disease pathogenesis and immunomodulation Intérazions hôtes-parasites: nouveaux paradigmes de la pathogénèse des maladies et de la modulation immunitaire

organizers: Derek McKay and Andre Buret

Chair / Président: Derek McKay and John Gilleard

PIE SYM 1 8:00-8:25	<b>DEREK M MCKAY</b> University of Calgary <b>Exploiting properties of helminth modulation of host immunity to treat inflammatory disease</b> <i>Comment exploiter les propriétés de la modulation de l'immunité de l'hôte par les helminthes pour traiter les maladies inflammatoires</i>
PIE SYM 2 8:25-8:50	<b>MAYARA LUZZI AND CONSTANCE FINNEY</b> University of Calgary <b>What do natural infection models tell us about host-parasite interactions?</b> <i>Que peut-on apprendre des modèles d'infection naturelle au sujet des interactions hôte-parasite?</i>
PIE SYM 3 8:50-9:15	<b>PATRICK C. HANINGTON</b> University of Alberta <b>Immunological determinants of snail-trematode compatibility</b> <i>Déterminants immunologiques de la compatibilité entre escargots et trématodes</i>
PIE SYM 4 9:15-9:40	<b>ROGER PRICHARD</b> McGill University <b>The interplay between immunomodulation and anthelmintics in Host- Parasite Interaction</b> <i>Intérazion entre la modulation immunitaire et les anthelminthiques dans les interactions hôte-parasite</i>
PIE SYM 5 9:40-9:50	<b>JEFFREY J. HAVIXBECK, AJA M. RIEGER, DANIEL R. BARREDA</b> University of Alberta <b>Aeromonas infections induce high levels of soluble CSF-1R expression impacting inflammatory responses of teleost fish. Les infections d'Aeromonas induisent des niveaux élevés d'expression de CSF- 1R soluble et impactent les réactions inflammatoires des poissons téléostéens</b>
PIE SYM 6 9:50-10:00	<b>CHRISTINA B. AMAT, JEAN-PAUL MOTTA, AMOL BHARGAVA, KRIS CHADEE AND ANDRE G. BURET</b> University of Calgary <b>Modulation of host intestinal mucus secretion by <i>Giardia duodenalis</i>. Modulation des sécrétions de mucus intestinal des hôtes par <i>Giardia duodenalis</i></b>

## CMD Symposium / symposium MDC

8:00-10:00 MacHall A

### Ten Years of The Triple Helix: Development, Morphology, Evolution

### Dix ans de triple hélice: développement, morphologie, évolution

organizers: Richard Palmer and Timothy Higham

Chair / Président: Richard Palmer

CMD SYM 1 8:00-8:40	<b>JEAN-BERNARD CARON</b> Royal Ontario Museum <b>Marble Canyon, a new Burgess Shale Shangri-La in Kootenay National Park La formation Marble Canyon, un nouveau Shangri-La de schistes de Burgess dans le Parc National Kootenay</b>
CMD SYM 2 8:40-9:20	<b>SALLY P. LEYS</b> University of Alberta <b>Complexity and loss of complexity in the evolution of early metazoan body plans</b> <i>Complexité et perte de complexité dans l'évolution des plans de corps des anciens métazoaires</i>
CMD SYM 3 9:20-10:00	<b>TIMOTHY E. HIGHAM AND EMILY A. KANE</b> University of California, Riverside <b>Complexity, integration, and innovation: biomechanics meets ecology Complexité, intégration, et innovation: rencontre entre la biomécanique et l'écologie</b>

**Contributed Sessions E / Sessions de communications E**  
**8:00-10:15 EEE E1: That Empty Space**  
**Ecology – Environmental Impacts Écologie – impacts environnementaux**

Chair / Prèsident: Ella Bowles

EEE E1-1 8:00-8:15	<b>BRANDON VARELA AND MERY MARTINEZ</b> Laurentian University <b>Sperm performance in <i>Barbus apleurogramma</i> across oxygen regimes</b> <i>Performance du sperme de <i>Barbus apleurogramma</i> sur plusieurs régimes d'oxygène</i>
EEE E1-2 8:15-8:30	<b>JAGDEEP SEKHON, LANIELLE LAFRAMBOISE AND MARY REID</b> University of Calgary <b>Big, fat and hydrated: survivorship of pine beetles exposed to tree defences of historical and novel host trees.</b> <i>Gros, gras et hydraté: survie des dendroctones de pin ponderosa exposés aux défenses d'arbres hôtes nouveaux et historiques</i>
EEE E1-3 8:30-8:45	<b>BRANDON ALLEN AND SEAN ROGERS</b> University of Calgary <b>Genetic population responses and modified growth patterns among varying active management strategies in Alberta Walleye (<i>Sander vitreus</i>).</b> <i>Réactions génétiques des populations et modifications du profil de croissance dans diverses stratégies de gestion du doré jaune de l'Alberta (<i>Sander vitreus</i>)</i>
EEE E1-4 8:45-9:00	<b>GRANT HARRISON, ANDREA LISTER, MELAINE SIMBA, MIKE PALMER &amp; DEBORAH MACLATCHY</b> Wilfrid Laurier University <b>Health and reproductive status of walleye (<i>Sander vitreus</i>) and lake whitefish (<i>Coregonus clupeaformis</i>) in Tathlina Lake, NT.</b> <i>Santé et état reproductif des dorés jaunes (<i>Sander vitreus</i>) et grand corégones du lac Tathlina, T.N.-O.</i>
EEE E1-5 9:00-9:15	<b>KAREN COGLIATI, JULIA UNREIN, ERIC BILLMAN, ROB CHITWOOD, CAMERON SHARPE, DAVID NOAKES AND CARL SCHRECK</b> Oregon State University <b>Determinants of migratory life history phenotypes in juvenile spring Chinook salmon</b> <i>Déterminants des phénotypes du cycle de vie migratoire chez les saumons Chinook juveniles</i>
EEE E1-6 9:15-9:30	<b>STEV L VANDERZWAN, STEVEN M VAMOSI AND SEAN M ROGERS</b> University of Calgary <b>Ecology of adaptive peak shifts in Alaskan threespine stickleback.</b> <i>Écologie des décalages de pics d'adaptation dans les épinoches à trois épines de l'Alaska</i>
EEE E1-7 9:30-9:45	<b>LEANNA E LACHOWSKY, MARY L REID</b> University of Calgary <b>Maternal state and habitat quality as causes of offspring mortality and sex ratio bias.</b> <i>État maternel et qualité de l'habitat comme causes de mortalité des descendants et biais dans la proportion des sexes</i>
EEE E1-8 9:45-10:00	<b>KERRY PERRAULT, BRANDON VARELA, MERY MARTÍNEZ</b> Laurentian University <b>Sperm variation of <i>Pseudocrenilabrus multicolor victoriae</i> across habitats.</b> <i>Variation du sperme de <i>Pseudocrenilabrus multicolor victoriae</i> en fonction de l'habitat</i>
EEE E1-9 10:00-10:15	<b>KECIA A. KERR, MICHAEL D. JENNIONS &amp; PATRICIA R.Y. BACKWELL</b> The Australian National University <b>Effects of small-scale habitat selection on reproductive activity and female mate preferences in fiddler crabs</b> <i>Effets de la sélection d'habitat à petite échelle sur l'activité reproductrice et le choix des partenaires des femelles du crabe violoniste</i>

Withdrawn

# Contributed Sessions E / Sessions de communications E

8:00-10:00 CPB E2: Cassio

## Metabolism I – Blood, gas and acid/base Métabolisme I – Sang, gaz et acide/base

Chair / Président: Dan Baker and Ryan Shartau

CPB E2-1 8:00-8:15	<b>ANTHONY V. SIGNORE</b> , ANGELA FAGO, ROY E. WEBER AND KEVIN L. CAMPBELL University of Manitoba <b>Evolutionary and functional analysis of Steller's sea cow (<i>Hydrodamalis gigas</i>) hemoglobin provides new insights into temperature adaptation</b> <i>L'analyse évolutive et fonctionnelle de l'hémoglobine de la rhytine de Steller offre de nouveaux aperçus sur l'adaptation à la température</i>
CPB E2-2 8:15-8:30	<b>VELISLAVA TZANEVA</b> AND STEVE F. PERRY University of Ottawa <b>Carbon monoxide (CO) mediated respiratory responses to changing water O<sub>2</sub> levels in the zebrafish larvae, <i>Danio rerio</i>.</b> <i>Réactions respiratoires médiées par le monoxyde de carbone (CO) aux changements dans le niveau d'O<sub>2</sub> dans la larve du poisson zèbre, <i>Danio rerio</i></i>
CPB E2-3 8:30-8:45	<b>YANGFAN ZHANG</b> , FLORIAN MAUDUIT, SVEN M. JORGENSEN, GERRIT TIMMERHAUS, TORSTEIN KRISTENSEN, GUY CLAIREAUX, ANTHONY P. FARRELL, HARALD TAKLE. The University of British Columbia <b>Aerobic swimming performance and its relationship to indicators of metabolic rate and hypoxia tolerance in wild and domestic Atlantic salmon (<i>Salmo salar</i> L.).</b> <i>Performance de nage aérobique et son lien aux indicateurs de taux métabolique et de tolérance à l'hypoxie chez les saumons de l'Atlantique sauvages et domestiques (<i>Salmo salar</i>, L.)</i>
CPB E2-4 8:45-9:00	<b>RYAN B. SHARTAU</b> , ZACHARY F. ZOHL, DANE A. CROSSLEY II AND COLIN J. BRAUNER. University of British Columbia <b>Acid-base regulation during embryonic development in the snapping turtle (<i>Chelydra serpentina</i>)</b> <i>Régulation acide-base durant le développement embryonnaire de la chélydre serpentine (<i>Chelydra serpentina</i>)</i>
CPB E2-5 9:00-9:15	<b>TYSON MACCORMACK</b> , JASON ROBINSON, WILLIAM DRIEDZIC. Mount Allison University <b>Acclimation to hypercapnia alters energy metabolism and cardiac contractility in the Amazonian armored catfish, <i>Pterygoplichthys pardalis</i>.</b> <i>L'acclimation à l'hypercapnie modifie le métabolisme énergétique et la contractilité cardiaque chez le poisson-chat blindé d'Amazonie, <i>Pterygoplichthys pardalis</i></i>
CPB E2-6 9:15-9:30	<b>DANIEL W. BAKER</b> , ALEXANDER M. CLIFFORD, LENORA TURCOTTE, KAYLA MOHNS, ALYSSA M. WEINRAUCH, GREG G. GOSS, JOHN D. MORGAN Vancouver Island University <b>Energetically challenged hagfish compensate for a severe hypercarbia-induced acidosis.</b> <i>Les myxines appauvries en énergie compensent pour une acidose sévère induite par l'hypercapnie</i>
CPB E2-7 9:30-9:45	<b>SARAH L. ALDERMAN</b> , TILL S. HARTE, JONATHAN M. WILSON, ANTHONY P. FARRELL, AND COLIN J. BRAUNER University of Guelph <b>Getting to the heart of plasma-accessible carbonic anhydrase in fish.</b> <i>Comment se rendre au cœur de l'anhydrase carbonique dans le plasma des poissons</i>
CPB E2-8 9:45-10:00	<b>TILL S. HARTE</b> AND COLIN J. BRAUNER University of British Columbia <b>The distribution of plasma accessible carbonic anhydrase and its effect on a unique mechanism of tissue oxygenation in teleosts.</b> <i>Distribution de l'anhydrase carbonique dans le plasma, et son effet sur un mécanisme unique d'oxygénation des tissus chez les téléostes</i>



**Contributed Sessions F / Sessions de communications F**  
**10:30-12:30 CPB F1: Cassio**

**Stress 2 – Toxins in the environment Stress 2 – Toxines dans l'environnement**

Chair / Président: Patrice Couture

CPB F1-1 10:30-10:45	<b>TAMZIN A. BLEWETT</b> and CHRIS M. WOOD McMaster University <b>Salinity alters mechanisms of sub-lethal Ni toxicity in the green shore crab</b> <i>La salinité modifie les mécanismes de toxicité sublétales du nickel chez le crabe vert</i>
CPB F1-2 10:45-11:00	<b>PATRICK T. GAUTHIER</b> , WARREN P. NORWOOD, ELLIE E. PREPAS, GREG G. PYLE Lakehead University <b>Behavioural alterations from exposure to copper, phenanthrene, and copper-phenanthrene mixtures: linking behaviour to acute toxicity mechanisms in the aquatic amphipod, <i>Hyaella azteca</i>.</b> <i>Changements de comportement suite à l'exposition au cuivre, au phénanthrène, et aux mixtures cuivre-phénanthrène: liens entre le comportement et les mécanismes de toxicité aiguë chez l'amphipode aquatique, <i>Hyaella Azteca</i></i>
CPB F1-3 11:00-11:15	<b>CHRISTINA JOHNSTON</b> , LINDSAY CLOTHIER, PETRA HERMANN, LISA GIEG, AND WILLEM WILDERING University of Calgary <b>Model naphthenic acids delay growth and hatching in snail embryos.</b> <i>Les acides naphthéniques modèles retardent la croissance et l'éclosion des embryons de limnées</i>
CPB F1-4 11:15-11:30	<b>ISABELLE FOURNIER</b> et PATRICE COUTURE Institut national de la recherche scientifique, centre eau-terre-environnement <b>Fish are running out of energy in the race against metal contamination and climate change</b> <i>Les poissons sont à court d'énergie dans la course contre la contamination de métaux et le changement climatique</i>
CPB F1-5 11:30-11:45	<b>LAURA DINDIA</b> , O BIRCEANU, A MASSON, V TALEBIAN, BRENDAN MCCONKEY AND MATHILAKATH M. VIJAYAN University of Waterloo <b>Bisphenol A accumulation in oocytes disrupts the liver proteome of rainbow trout in multiple generations.</b> <i>L'accumulation du bisphénol A dans les oocytes perturbe le protéome du foie de la truite arc-en-ciel sur plusieurs générations</i>
CPB F1-6 11:45-12:00	<b>DAVID M JANZ</b> , JITH K THOMAS, ANITA J MASSÉ AND JORGELINA R MUSCATELLO University of Saskatchewan <b>Selenium ecotoxicology in fish and frogs</b> <i>Écotoxicologie du sélénium chez les poissons et les grenouilles</i>
CPB F1-7 12:00-12:15	<b>KADY LYONS</b> , MATT VIJAYAN University of Calgary <b>Stress response in round stingrays exposed to environmental PCBs along the southern California coast</b> <i>Réaction de stress chez les raies pastenagues exposées aux BPCs le long de la côte du sud de la Californie</i>
CPB F1-8 12:15-12:30	<b>KAMAL MOGHRABI</b> , KEVIN KOBES, VISHESH OBEROI, GAGANDEEP S. RAI, FABIOLA D. ROJAS & LUCY E.J. LEE University of the Fraser Valley <b>Evaluating sublethal effects of neonicotinoids in non-target species: effects on fish cell lines</b> <i>Évaluations des effets sub-létaux des néonicotinoïdes sur les espèces non recherchées: effets sur les lignées cellulaires de poissons.</i>

## Contributed Sessions F / Sessions de communications F

**10:30-12:15 CPB F2: That Empty Space**

### Metabolism II – Digestion, absorption and control Métabolisme II – Digestion, absorption et contrôle

Chair / Président: Haneesha Mohan and Azadeh Hatef

CPB F2-1 10:30-10:45	<b>KEVIN CHOI AND JEAN-MICHEL WEBER</b> University of Ottawa <b>Exogenous glucose supply to hyperglycemic fish: Glucose kinetics during carbohydrate overload.</b> <i>Approvisionnement exogène de glucose aux poissons hyperglycémiques: cinétique de glucose durant la surcharge de glucides</i>
CPB F2-2 10:45-11:00	<b>MARINA SUBRAMANIAM; LYNN P. WEBER; JOHN C. CHING; CB ENNS; MD DREW; MATTHEW E. LOEWEN</b> University of Saskatchewan <b>Identification and Characterization of Glucose Transporters in the Gastrointestinal Tract of Rainbow Trout (<i>Oncorhynchus mykiss</i>) and Nile Tilapia (<i>Oreochromis niloticus</i>)</b> <i>Identification et caractérisation des transporteurs de glucose dans le système gastro-intestinal de la truite arc-en-ciel (<i>Oncorhynchus mykiss</i>) et du tilapia du Nil (<i>Oreochromis niloticus</i>)</i>
CPB F2-3 11:00-11:15	<b>ALYSSA M. WEINRAUCH, ALEXANDER M. CLIFFORD, AND GREG G. GOSS</b> University of Alberta <b>Intestinal glucose transport in the Pacific Hagfish, <i>Eptatretus stoutii</i></b> <i>Transport intestinal de glucose chez la myxine du Pacifique, <i>Eptatretus stoutii</i></i>
CPB F2-4 11:15-11:30	<b>ALEX MYRKA</b> University of Toronto Scarborough Campus <b>Comparative analysis of glucose transporter transcription in hummingbirds</b> <i>Analyse comparative de la transcription des transporteurs de glucose chez les oiseaux-mouche</i>
CPB F2-5 11:30-11:45	<b>HANEESHA MOHAN, MICHAELA GASNER, NARESH RAMESH, ANTHONY LE, SIMA MORTAZAVI, VENKAT PASUPULETTI, ROBERT TSUSHIMA, ROLANDO CEDDIA AND SURAJ UNNIAPPAN</b> University of Saskatchewan <b>Characterization of Endogenous Nucleobindin-2/Nesfatin-1 in Rodents.</b> <i>Caractérisation de nucleobindin-2/nesfatin-1 chez les rongeurs</i>
CPB F2-6 11:45-12:00	<b>VISHESH OBEROI, HARDEEP S. SARAN, MANDEEP K. SARAN, KAMAL MOGHRABI, GAGANDEEP S. RAI, FABIOLA D. ROJAS, NIELS C. BOLS &amp; LUCY E.J. LEE</b> University of the Fraser Valley <b>Evaluating bioactivity of blueberry extracts and components with fish cell lines</b> <i>Évaluation de la bioactivité des extraits et composants de bleuets à l'aide de lignées cellulaires de poisson</i>
CPB F2-7 12:00-12:15	<b>AZADEH HATEF AND SURAJ UNNIAPPAN</b> University of Saskatchewan <b>Nesfatin-1 - Kisspeptin Interactions In Murine Hypothalamic Cells (GT1-7)</b> <i>In Vitro</i> <i>Interactions entre Nesfatin-1 et Kisspeptin dans les cellules murines hypothalamiques (GT1-7) in vitro</i>

## Contributed Sessions F / Sessions de communications F

**10:30-12:30 CMD F3: MacHall A**

### CMD student symposium:

**Techniques and technologies for better visualizing and quantifying morphology and development**

***Techniques et technologies pour mieux visualiser et quantifier la morphologie et le développement***

Chair / Prèsident: Larry Powell and Ramon Nagesan

CMD F3-1 10:30-11:00	<b>HEATHER A JAMNICZKY</b> University of Calgary <b>Considering the WHOLE phenotype: emerging approaches to 3D quantitative morphology in eco-evo-devo.</b> <b><i>Prendre en considération le phénotype ENTIER: nouvelles démarches en morphologie quantitative 3D dans le "eco-evo-devo"</i></b>
CMD F3-2 11:00-11:15	<b>DIMITRI A SKANDALIS, JOSEPH W BAHLMAN, BENJAMIN GOLLER, DOUGLAS L ALTSHULER</b> University of British Columbia <b>Hummingbird wing shape from 2-D to 4-D</b> <b><i>Forme de l'aile d'oiseau-mouche de deux à quatre dimensions</i></b>
CMD F3-3 11:15-11:30	<b>SARAH SCHORNO, TIMOTHY M WINEGARD AND DOUGLAS S FUDGE</b> University of Guelph <b>Using focused ion beam scanning electron microscopy (FIB-SEM) to elucidate sub-cellular structures in 3D: The case of hagfish thread cells</b> <b><i>Utilisation de la microscopie électronique à balayage à faisceau d'ions focalisé afin d'élucider les structures sous-cellulaires en 3D: le cas des cellules à fibres des myxines</i></b>
CMD F3-4 11:30-11:45	<b>ZACHARY R. LEWIS, JAMES HANKEN</b> Harvard University <b>A transcriptional and morphological investigation of lung loss in salamanders</b> <b><i>Enquête transcriptionnelle et morphologique de la perte de poumons chez les salamandres</i></b>
CMD F3-5 11:45-12:00	<b>TEGAN N BARRY, SEAN M RODGERS, AND HEATHER A JAMNICZKY</b> University of Calgary <b>Microcomputed Tomography as a tool for fine-tuned phenotypic analysis</b> <b><i>La microtomographie comme outil pour les analyses phénotypiques détaillées</i></b>
CMD F3-6 12:00-12:15	<b>JASON D PARDO, MATT SZOSTAKIWSKYJ AND JASON S ANDERSON</b> University of Calgary <b>Micro-CT can resolve intractable problems in vertebrate paleontology: an example from the early tetrapod braincase.</b> <b><i>La tomographie par microordinateur peut résoudre des problèmes intraitables en paléontologie des vertébrés: exemple de la boîte crânienne d'anciens tétrapodes</i></b>
CMD F3-7 12:15-12:30	<b>MATT SZOSTAKIWSKYJ AND RAMON NAGESAN</b> University of Calgary <b>From Instagram to the classroom: using photogrammetry to visualize anatomy.</b> <b><i>De Instagram à la classe: utilisation de la photogrammétrie afin de visualiser l'anatomie</i></b>

**Sessions F Sessions 10:30-12:30**

**Teaching Workshop / atelier d'enseignement Escalus**

**Healthy Classrooms: Establishing Productive Habitats for Learning**

***Classes en santé: établissement d'habitats productifs pour l'apprentissage***

Chair / Prèsident: Leslie Reid

Creating productive and healthy classroom environments for learning can enhance and improve students' experiences and outcomes. In this workshop, participants will learn about some of the research on learning and classroom environments and how the findings can be applied in their teaching context. Participants will also engage in table discussions, drawing out challenges and solutions to some of the specific characteristics of healthy classrooms most pertinent to them, such as the diversity of learners, large class sizes, effective employment of technology, the challenges imposed by the physical space of the classroom, and social dynamics.

**Robert Arnold Wardle Award / Prix Robert Arnold Wardle**

**2:00-3:00** MacHall A

**DR. BRIAN DIXON, UNIVERSITY OF WATERLOO**

**From Parasites to Immunity and the Environment and Back Again**

**Aller des parasites à l'immunité et à l'environnement, et s'en revenir**

**[Link to Wardle Lecture Abstract](#) / [Lien vers Résumé de la conférence Wardle](#)**

---

**Posters / Affiches**

**3:30- 6:00** MacHall Foyer

**Authors should be present at posters as follows:**

**3:30-4:30 even numbered posters, 4:30-5:30 odd numbered posters**

<b>P1</b>	<b>Effects of diluted bitumen exposure on swimming performance of juvenile sockeye salmon</b> <i>Effets de l'exposition au bitumen dilué sur la performance en nage des saumons sockeye</i> <b>SARAH L. ALDERMAN, FENG LIN, CHRIS J. KENNEDY, ANTHONY P. FARRELL, AND TODD E. GILLIS</b> University of Guelph
<b>P2</b>	<b>Individual variation in the ruffed grouse (<i>Bonasa umbellus</i>) drumming display</b> <i>Variation individuelle dans le signal de tambourinage de la gélinotte huppée (<i>Bonasa umbellus</i>)</i> <b>NICHOLAS P O'NEIL AND ANDREW N IWANIUK</b> University of Lethbridge
<b>P3</b>	<b>Glucagon Like Peptide-1 (GLP-1) Regulation of Nesfatin-1 in Stomach Cells. <i>Régulation de nesfatin-1 par Glucagon like peptide-1 (GLP-1) dans les cellules de l'estomac</i></b> <b>SIMA MORTAZAVI AND SURAJ UNNIAPPAN</b> University of Saskatchewan
<b>P4</b>	<b>Serological survey of pathogens in caribou: a snapshot in time <i>Enquête sérologique des pathogènes du caribou: un instantané temporel</i></b> <b>CARLSSON, AM., CURRY, P., ELKIN, B., RUSSELL D., VEITCH, A., BRANIGAN, M., CROFT, B., CUYLER, C., COTE, S., COOLEY, D., KUTZ, S</b> University of Calgary
<b>P5</b>	<b>Sexual selection across populations in a species with alternative reproductive tactics</b> <i>Sélection sexuelle dans les populations d'une espèce possédant plusieurs tactiques de reproduction</i> <b>KAREN COGLIATI, BRYAN NEFF, SIGAL BALSHINE</b> McMaster University
<b>P6</b>	<b>Local adaptation of fish populations to bituminous toxicants <i>Adaptation locale de populations de poissons aux substances toxiques bitumineuses</i></b> <b>SYLVIA CHOW, AND GREG PYLE</b> The University of Lethbridge
<b>P7</b>	<b>Eyeing a research barrier: development of a walleye retinal epithelial cell line that expresses three classes of tight junction proteins</b> <i>Développement d'une lignée de cellules épithéliales de la rétine du doré jaune exprimant trois classes de protéines de jonction serrée</i> <b>NGUYEN T. K. VO, BRENNAN D. GERLACH, THERESA M. CURTIS, LUCY E. J. LEE AND NIELS C. BOLS</b> University of Waterloo

<b>P8</b>	<p><b>Application of toxicogenomics to assess adverse effects of exposure to environmental contaminant in male fathead minnows</b>  <i>Application de la toxicogénomique afin d'évaluer les effets adverses de l'exposition aux contaminants environnementaux chez les têtes-de-boule mâles</i> AVA ZARE, DARREN HENRY, GORDON CHUA AND HAMID R HABIBI  University of Calgary</p>
<b>P9</b>	<p><b>Modulation by hypoxia-reoxygenation of the toxic effect of copper on mitochondrial electron transport system activity in control and warm-acclimated and rainbow trout</b>  <i>Modulation par réoxygénation d'hypoxie de l'effet toxique du cuivre sur l'activité du système de transport d'électrons des mitochondries chez les truites arc-en-ciel contrôle et acclimatées au chaud</i>  RAVINDER SAPPAL, DON STEVENS AND COLLINS KAMUNDE UPEI</p>
<b>P10</b>	<p><b>The effects of a neonicotinoid pesticide on the looming response of an insect motion detection pathway</b>  <i>Effets d'un pesticide néonicotinoïde sur la réaction de "looming" dans une voie de détection du mouvement d'un insecte</i>  RACHEL PARKINSON, JOHN R. GRAY  University of Saskatchewan</p>
<b>P11</b>	<p><b>The risk of hitchhiking: a story of phoretic mites and their beetles</b>  HAYDEE PERALTA-VAZQUEZ AND MARY REID  University of Calgary</p>
<b>P12</b>	<p><b>Differential remodelling of brown and white adipose tissue in high altitude deer mice (<i>Peromyscus maniculatus</i>)</b>  <i>Remodelage différentiel du tissu adipeux brun et blanc chez la souris sylvestre (<i>Peromyscus maniculatus</i>) de haute altitude</i>  CAYLEIH E. ROBERTSON, TAYLOR B. VALEE, GRANT B. MCCLELLAND  McMaster University</p>
<b>P13</b>	<p><b>Secretion and reabsorption of Na<sup>+</sup> and K<sup>+</sup> by Malpighian tubules of the cabbage looper <i>Trichoplusia ni</i>: a novel role for type II cells. <i>Sécrétion et réabsorption de Na<sup>+</sup> et K<sup>+</sup> par les tubules de Malpighi de la fausse- arpenreuse du chou</i></b>  <i>Trichoplusia ni: nouveau rôle des cellules de type II</i>  MIKE O'DONNELL AND ESAU RUIZ-SANCHEZ  McMaster University</p>
<b>P14</b>	<p><b>Plasma membrane correlates of neuronal aging: probing lipid peroxidation- and PLA2-associated changes in plasma membrane microarchitecture as possible factors in neuronal aging. <i>Corrélat de la membrane plasmique du vieillissement des neurones: étude des changements dans la micro-architecture de la membrane plasmique associés à la peroxydation des lipides et au PLA2 en tant que facteurs responsables du vieillissement des neurones</i></b>  ALEXANDER C PERRY, PETRA M HERMANN AND WILLEM C WILDERING  University of Calgary</p>
<b>P15</b>	<p><b>A comparison of conventional crude oil and dilbit developmental toxicity to zebrafish. <i>Comparaison entre la toxicité développementale du pétrole brut classique et du pétrole de bitumen dilué chez les poissons zèbres</i></b>  DANIELLE PHILIBERT, CARLIE LEWIS, KEITH TIERNEY  University of Alberta</p>
<b>P16</b>	<p><b>Exploring the control of phagocytosis using teleost immunoregulatory receptors</b>  <i>Exploration du contrôle de la phagocytose à l'aide de récepteurs immuno- régulateurs de poissons téléostéens</i>  MYRON ZWOZDESKY, CHENJIE FEI, DUSTIN LILICO, LENA JONES &amp; JAMES STAFFORD  University of Alberta</p>
<b>P17</b>	<p><b>In vivo measurements of intracellular pH in zebrafish H<sup>+</sup>-ATPase rich (HR) cells using ratiometric imaging</b>  <i>Mesures in vivo du pH intra-cellulaire dans les cellules de poisson zèbre riches en H<sup>+</sup>-ATPase à l'aide d'imagerie ratiométrique</i>  HONG MENG YEW AND STEVE F. PERRY  University of Ottawa</p>
<b>P18</b>	<p><b>Response of a locust motion-sensitive neuron to objects deviating away from a collision course in the presence or absence of optic flow</b>  <i>Réaction d'un neurone de détection de mouvement de locuste aux objets déviant d'une collision en présence ou en absence de flux optique</i>  JASMINE M YAKUBOWSKI AND JOHN R GRAY  University of Saskatchewan</p>

P19	<p>The effects of polymer-coated nanoparticles on the phagocytic capacity and viability of immune cells  <i>Effets de nanoparticules enduites de polymères sur la capacité phagocytaire et la viabilité des cellules immunitaires</i>  <b>VAN A. ORTEGA</b>, MARKIAN BAHNIUK, SHARYAR MEMON, LARRY UNSWORTH, JAMES L. STAFFORD and GREG G. GOSS  University of Alberta</p>
P20	<p>Determining the relative impacts of contaminants from natural and industrial sources on aquatic biota in the Lower Athabasca region. <i>Impacts de contaminants provenant de sources naturelles et industrielles sur les biomes aquatiques dans la région du Lower Athabasca</i>  <b>NILO SINNATAMBY</b>, WILLIAM SHOTYK, MARK POESCH  University of Alberta</p>
P21	<p>Effects of anaesthetics during euthanasia on the mechanical properties of compact myocardium from rainbow trout: are anaesthetics contraindicated for euthanasia? <i>Effets des anesthésiants pendant l'euthanasie sur les propriétés mécaniques du myocarde compact des truites arc-en-ciel: les anesthésiants sont-ils contre-indiqués pour l'euthanasie?</i>  <b>JORDAN C ROBERTS</b> AND DOUGLAS A SYME  University of Calgary</p>
P22	<p>Some don't like it hot: Thermal preconditioning in wild, juvenile, Atlantic salmon (<i>Salmo salar</i>)  <i>Certains ne l'aiment pas chaud: préconditionnement thermique chez les saumons de l'Atlantique sauvages juvéniles (Salmo salar)</i>  <b>LOUISE TUNNAH</b>, EMILY COREY, SUZIE CURRIE, TYSON MACCORMACK  Mount Allison University</p>
P23	<p>Reproductive diapause alters stress tolerance in <i>Drosophila suzukii</i>  <i>La diapause reproductive modifie la tolérance au stress chez Drosophila suzukii</i> <b>JANTINA TOXOPEUS</b>, RUTH JAKOBS, LAURA V FERGUSON, TARA D GARIEPY AND BRENT J SINCLAIR  University of Western Ontario</p>
P24	<p>Quantifying activity from thermal imaging videos using an automated script-based approach  <i>Quantification de l'activité basée sur films d'imagerie thermique par utilisation d'une méthode scriptée automatisée</i>  <b>GLENN J. TATTERSALL</b>, RAYMOND M. DANNER, DANIELLE L. LEVESQUE, KRISTEN D. SCHUPPE  Brock University</p>
P25	<p>Solitary chemosensory cells during the life cycle of the sea lamprey, <i>Petromyzon marinus</i>  <i>Cellules chimio-sensorielles solitaires durant le cycle de vie de la lamproie de mer, Petromyzon marinus</i>  <b>TINA E SUNTRES</b>, GHEYLEN DAGHFOUS, RÉJEAN DUBUC, AND BARBA ZIELINSKI  University of Windsor</p>
P26	<p>Tissue Distribution and Functions of a Nucleobindin-1 Encoded Nesfatin-1 Like Peptide (NLP) in Fish  <i>Distribution dans les tissus et fonctions d'un "Nucleobindin-1 Encoded Nesfatin-1 Like Peptide" (NLP) chez les poissons</i>  <b>LAKSHMINARASIMHAN SUNDARRAJAN</b> AND SURAJ UNNIAPPAN  University of Saskatchewan</p>
P27	<p>Sourcing fish chemical alarm cues in fathead minnows (<i>Pimephales promelas</i>)  <i>À la recherche de la source d'indices chimiques d'alerte chez les alevins de têtes-de-boule</i>  <b>DYLAN STEINKEY</b>, ADITYA MANEK, GREGORY PYLE  University of Lethbridge</p>
P28	<p>In-silico investigation of cestode proteomes to predict host mimicking proteins  <i>Enquête in silico des protéomes de cestodes afin de prédire les protéines qui imitent les hôtes</i>  <b>SHRUTI SRIVASTAVA</b>, DEREK M. MCKAY AND JAMES D. WASMUTH  University of Calgary</p>
P29	<p>The evolution of thermal tolerance and preference in marine and freshwater Threespine Stickleback (<i>Gasterosteus aculeatus</i>)  <i>L'évolution de la tolérance et de la préférence thermique chez les épinoches à trois épines (Gasterosteus aculeatus) marines et d'eau douce</i>  <b>SARA J SMITH</b>, ROWAN DH BARRETT, AND SEAN M ROGERS  University of Calgary</p>
P30	<p>Autonomic control of cardiac chronotropy in zebrafish  <i>Contrôle autonome de la chronotrophie cardiaque chez le poisson zèbre</i>  <b>FRANK SMITH</b>, MATT STOEYK AND ROGER CROLL  Dalhousie University</p>

<b>P31</b>	<b>Preliminary analysis of ontogenetic scaling of bite performance within Texas sharks</b> <i>Analyse préliminaire du proportionnement ontogénétique de la performance du mordant parmi les requins du Texas</i> JOSHUA CULLEN AND CHRISTOPHER MARSHALL Texas A&M University
<b>P32</b>	<b>A qPCR diagnostic test to detect Enterobius vermicularis present in wastewater</b> <i>Un test diagnostique par PCR quantitatif pour détecter la présence d'Enterobius vermicularis dans les eaux usées</i> SYDNEY RUDKO, NORMAN NEUMANN, AND PATRICK HANINGTON University of Alberta
<b>P33</b>	<b>Nesfatin-1 Regulation of enteric hormone secretion in mice</b> <i>Régulation par Nesfatin-1 de la sécrétion entérique d'hormones chez les souris</i> NARESH RAMESH, SIMA MORTAZAVI, SURAJ UNNIAPPAN University of Saskatchewan
<b>P34</b>	<b>Mechanisms of brain swelling in the rainbow trout and in the goldfish (Carassius auratus)</b> <i>Mécanismes d'engorgement du cerveau chez la truite arc-en-ciel (Oncorhynchus mykiss) et chez le poisson rouge (Carassius auratus)</i> PHILLIP PHAM-HO AND MICHAEL P. WILKIE Wilfrid Laurier University
<b>P35</b>	<b>Basal and agonist-selective control of pituitary cell signal transduction networks</b> <i>Contrôle de base et sélectif aux agonistes des réseaux de transduction de signaux des cellules pituitaires</i> JOSHUA G PEMBERTON, FEDERICO SACCHI, NICHOLAS P CHURCHILL, MALCOLM LARAQUE, GEORGE KINLEY, ENEZI KHALID, JAMES L STAFFORD, AND JOHN P CHANG University of Alberta
<b>P36</b>	<b>Nesfatin-1 modulates ghrelin and leptin in mouse insulinoma (MIN6) cells</b> <i>Nesfatin-1 contrôle Grhelin et Leptin dans les cellules d'insulinoma (MIN6) de souris</i> PASUPULETI VENKATA KIRAN AND SURAJ UNNIAPPAN University of Saskatchewan
<b>P37</b>	<b>Transcriptional changes in photoreceptor development genes during regeneration after cone ablation in zebrafish</b> <i>Changements de transcription dans les gènes du développement des photorécepteurs pendant la régénération après l'ablation des cônes chez le poisson zèbre</i> A. PHILLIP OEL AND W. TED ALLISON University of Alberta
<b>P38</b>	<b>Effects of targeted blue cone photoreceptor ablation on neighbouring cone subtypes in Danio rerio</b> <i>Effets de l'ablation ciblée de photorécepteurs coniques bleus sur les sous-types de cônes avoisinants chez Danio rerio</i> NICOLE C L NOEL, A PHIL OEL, MICHELE G DUVAL, AND W TED ALLISON. University of Alberta
<b>P39</b>	<b>Multi-parametric analysis of phagocyte antimicrobial responses using imaging flow cytometry</b> <i>Analyse multi-paramétrique des réponses anti-microbiennes des phagocytes par imagerie de cytométrie de flux</i> JUAN A. MORE BAYONA, JEFFREY J. HAVIXBECK, MICHAEL E. WONG, DANIEL R. BARREDA University of Alberta
<b>P40</b>	<b>Sensory bursts in a single motion-sensitive pathway of the locust</b> <i>Rafales sensorielles d'une seule voie de détection du mouvement chez le locuste</i> GLYN A MCMILLAN AND JOHN R GRAY University of Saskatchewan
<b>P41</b>	<b>Age-related changes in nearest neighbour distance: the missing hypothesis</b> <i>Changements relatifs à l'âge dans la distance entre voisins proches: l'hypothèse manquante</i> PETRA MCDOUGALL, KATHREEN RUCKSTUHL University of Calgary
<b>P42</b>	<b>Illuminating cardiac function: optical imaging of voltage dynamics in the zebrafish heart</b> <i>Illuminer la fonction cardiaque: imagerie optique de la dynamique du voltage dans le Coeur du poisson zèbre</i> MATTHEW R. STOEYK, ALEXANDER T. QUINN, ROGER P. CROLL, FRANK M. SMITH Dalhousie University



P43	Arctic grayling ( <i>Thymallus arcticus</i> ) gill morphological plasticity in response to acute salinity exposure <i>Plasticité morphologique des branchies de l'ombre arctique (Thymallus arcticus) en réponse à l'exposition à la salinité aiguë</i> DERRICK MATHESON, SALVATORE D. BLAIR, GREG G. GOSS University of Alberta
P44	Toxicity assessment of structurally diverse model naphthenic acids using <i>Lymnaea stagnalis</i> hatching assay <i>Évaluation de la toxicité des acides naphthéniques de structure diverse par épreuve biologique de l'éclosion chez Lymnea stagnalis</i> KAITLIN MARASCO, TINA JOHNSTON, PETRA HERMAN, GORDON CHUA AND WIC WILDERING University of Calgary
P45	Does exposure to water hardness affect cell yield of freshwater algae ( <i>Raphidocelis subcapitata</i> )? <i>L'exposition à l'eau dure affecte-t-elle le rendement cellulaire des algues d'eau douce (Raphidocelis subcapitata)?</i> ADITYA K. MANEK, DYLAN STEINKEY, CINDY MEAYS, AND GREGORY PYLE
P46	The physiological effects of lowered salinity on two species of juvenile hound sharks in a Tasmanian estuary <i>Effets physiologiques de salinité réduite sur les juvéniles de deux espèces de requins dans un estuaire en Tasmanie</i> SARA MACKELLAR, ANDREA MORASH, JASON SEMMENS, SUZIE CURRIE Mount Allison University
P47	Flight performance in a songbird exposed to elevated dietary methyl-mercury <i>Performance de vol chez un oiseau chanteur exposé à des taux élevés de méthylmercure alimentaire</i> YANJU MA, CRISTINA PEREZ, BRIAN BRANFIREUN AND CHRIS GUGLIELMO University of Western Ontario
P48	Physical and physiological costs of ectoparasitic mites on host flight endurance <i>Coûts physiques et physiologiques des mites ectoparasitaires sur l'endurance de vol des hôtes</i> LIEN T. LUONG, LUDMILA R. PENONI, COLLIN J. HORN, AND MICHAL POLAK University of Alberta
P49	Trophic linkages in aquatic food webs of rivers affected by oil sand development <i>Liens entre réseaux trophiques aquatiques dans les rivières affectées par le développement des sables bitumineux</i> ANDREAS LUEK, NILO SINNATAMBY, MARK POESCH, JOSEPH RASMUSSEN University of Lethbridge
P50	Direct contact of <i>Hymenolepis diminuta</i> activates gut epithelia and predicts host permissiveness <i>Le contact direct avec Hymenolepis diminuta active l'épithélium des intestins et prédit la permissivité de l'hôte</i> FERNANDO LOPES, ARTHUR WANG, JOSE LUIS REYES, DEREK MCKAY University of Calgary
P51	The impact of fluctuating incubation temperatures on embryonic development of Lake whitefish ( <i>Coregonus clupeaformis</i> ). <i>Impact des fluctuations dans la température d'incubation sur le développement des grands corégones (Coregonus clupeaformis)</i> MICHAEL Y.T. LIM, RICHARD MANZON, CHRIS SOMERS, DOUGLAS BOREHAM AND JOANNA Y. WILSON McMaster University
P52	Metabolic alterations in aging neurons: evidence for age-associated shift towards NAD-linked metabolism <i>Altérations métaboliques dans les neurones vieillissant: évidence d'un changement vers le métabolisme lié au NAD</i> JONATHON LEE, KEENAN BOUGHTON, PETRA HERMANN, WILLEM WILDERING University of Calgary
P53	Acute cardiac effects of sublethal injection of benzo-a-pyrene and 5-azacytidin juvenile rainbow trout ( <i>Oncorhynchus mykiss</i> ). <i>Effets cardiaques aigus d'injections sublétales de benzo-a-pyrène et 5-azacytidine les truites arc-en-ciel juvéniles (Oncorhynchus mykiss)</i> FRED LEAL, KATHLEEN MA, LYNN WEBER University of Saskatchewan
P54	Understanding the evolution of eye degeneration using a zebrafish model <i>Comprendre l'évolution de la dégénération de l'oeil en utilisant le poisson zèbre comme modèle</i> JENNIFER L A PYLYPIW, W TED ALLISON University of Alberta

P55	Establishment and characterization of continuous cell cultures from the bone marrow and skin of the African clawed frog ( <i>Xenopus laevis</i> ). <i>Établissement et caractérisation de cultures cellulaires continues dérivées de la moëlle osseuse et de la peau du xénope, Xenopus laevis</i> MAXWELL MARINOS, NGUYEN T.K.VO, STEVEN TEN HOLDER, NIELS C BOLLS AND BARBARA A. KATZENBACK University of Waterloo
P56	An in vitro examination of selenium-cadmium antagonism using primary cultures of rainbow trout ( <i>Oncorhynchus mykiss</i> ) hepatocytes. <i>Examination in vitro de l'antagonisme sélénium-cadmium en utilisant des cultures primaires d'hépatocytes de truite arc-en-ciel (Oncorhynchus mykiss)</i> ANKUR JAMWAL AND SOM NIYOGI University of Saskatchewan
P57	Evolutionary ecology of archigregarines (Apicomplexa) – the earliest parasite relatives of malaria <i>Écologie évolutionnaire des archigregarines (Apicomplexa) – les plus anciens parasites apparentés à la malaria</i> DAVIS IRITANI University of British Columbia
P58	Functional regeneration and plasticity of vision following ablation of specific subtypes of cone photoreceptors in larval zebrafish ( <i>Danio rerio</i> ) <i>Régénération fonctionnelle et plasticité de la vision après l'ablation de sous-types spécifiques de photorécepteurs coniques chez les poissons zèbres larvaires (Danio rerio)</i> GORDON HAGERMAN, A PHIL OEL AND W TED ALLISON University of Alberta
P59	Neuroendocrine control of memory and aging in <i>Lymnea stagnalis</i> <i>Contrôle neuroendocrinien de la mémoire et du vieillissement chez Lymnea stagnalis</i> LIS DE WEERD, PETRA M HERMANN AND WILLEM C WILDERING University of Amsterdam
P60	High-altitude adaptation and metabolic capacities in Andean ducks and geese <i>Adaptation aux hautes altitudes et capacité métabolique chez les canards et oies des Andes</i> NEAL J DAWSON, GRAHAM R SCOTT AND KEVIN G MCCracken McMaster University
P61	Rapid modulation of intracellular calcium by cortisol in rainbow trout hepatocytes <i>Modulation rapide du calcium intra-cellulaire par le cortisol dans les hépatocytes des truites arc-en-ciel</i> CHINMAYEE DAS, WIC WILDERING AND MATHILAKATH M. VIJAYAN University of Calgary
P62	The effect of bone length and shape on bone strength in the Longshanks mouse <i>Effet de la longueur et la forme de l'os sur sa solidité chez la souris Longshanks</i> MIRANDA COSMAN, HAYLEY BRITZ, and CAMPBELL ROLIAN. University of Calgary
P63	Elevated embryo cortisol content affects neurogenesis and locomotor activity in larval zebrafish <i>Un taux élevé de cortisol dans les embryons affecte la neurogénèse et l'activité locomotrice des poissons zèbres larvaires</i> CAROL BEST, MATHILAKATH M. VIJAYAN University of Calgary
P64	Strontium flux and accumulation in juvenile Lake Sturgeon <i>Flux et accumulation de strontium chez les esturgeons de lac juvéniles</i> BEN CARRIERE AND W. GARY ANDERSON University of Manitoba
P65	Pass the salt: Sodium gut loading enhances cold tolerance in the fall field cricket <i>Passe moi le sel: le chargement intestinal de sodium améliore la tolérance au froid chez le grillon automnal</i> JACQUELINE LEBENZON, LAUREN DES MARTEAUX, BRENT J. SINCLAIR Western University
P66	Song organization and variability in Northern House Wrens ( <i>Troglodytes aedon</i> ) <i>Organisation et variabilité des chants du troglodyte familier (Troglodytes aedon)</i> CHINTHAKA KALUTHOTA, AND DREW RENDALL University of Lethbridge
P67	Effects of altered expression of the Keap1/CncC pathway on secretion of organic toxins <i>Effets de l'expression modifiée de la voie Keap1/CncC sur la sécrétion de toxines organiques</i> MARTEN KAAS AND MICHAEL O'DONNELL McMaster University

P68	<b>A comparison of QPCR and multiplex methodologies</b> <i>Comparaison entre PCR quantitative et méthodologies multiplexes</i> <b>LAUREN JONES, ANDREA LISTER, DEBORAH MACLATCHY</b> Wilfrid Laurier University
P69	<b>Tolerance of the sea lamprey olfactory system to copper in roadway runoff water discharges to the Great Lakes</b> <i>Tolérance du système olfactif de la lamproie de mer au cuivre provenant de déversements d'eau de chaussée dans les Grands Lacs</i> <b>JENNA JONES, KARL BOYES, RON PADILLA, JOEL GAGNON, DANIEL H AND BARB ZIELINSKI</b> University of Windsor
P70	<b>Effects of thyroid hormone disruptors in treated wastewater on bullfrog (<i>Rana catesbeiana</i>) tadpole chemosensory function and behavior.</b> <i>Effets des disrupteurs de l'hormone thyroïdienne dans les eaux usées traitées sur la fonction chimiosensorielle et le comportement des têtards de ouaouaron (<i>Rana catesbeiana</i>)</i> <b>JODY HEEREMA, ADITYA MANEK AND GREG PYLE</b> University of Lethbridge
P71	<b>Acid-base regulatory role of different book gill regions of the American horseshoe crab (<i>Limulus polyphemus</i>)</b> <i>Rôles de différentes régions des branchies dans la régulation acide-base chez la limule américaine (<i>Limulus polyphemus</i>)</i> <b>STEPHANIE HANS, HORST ONKEN AND DIRK WEIHRAUCH</b> University of Manitoba
P72	<b>North American vultures differ in their reliance on olfactory cues: neuroanatomical evidence</b> <i>Les vautours de l'Amérique du Nord diffèrent dans leur dépendance sur les signaux olfactifs: évidence neuro-anatomique</i> <b>NATHAN P. GRIGG, JUSTIN M. KRILOW, GARY R. GRAVES, ANDREW N. IWANIUK</b> University of Lethbridge
P73	<b>Regulation of mitochondrial F<sub>1</sub>F<sub>0</sub>-ATPase in the anoxia tolerant turtle, <i>Trachemys scripta</i></b> <i>Régulation de l'ATPase-F<sub>1</sub>F<sub>0</sub> mitochondrial chez la tortue tolérante à l'anoxie, <i>Trachemys scripta</i></i> <b>CRISOSTOMO GOMEZ AND JEFFERY RICHARDS</b> University of British Columbia
P74	<b>The rise and fall of UCP1-mediated non-shivering thermogenesis in eutherian mammals</b> <i>Hausse et baisse de la thermogénèse sans frissons induite par UCP1 chez les mammifères euthériens</i> <b>MICHAEL J GAUDRY, MARTIN JASTROCH, JASON R TREBERG, MARK S SPRINGER AND KEVIN L CAMPBELL</b> University of Manitoba
P75	<b>Chronic pharmaceutical exposure affects sex steroids in adult zebrafish (<i>Danio rerio</i>)</b> <i>L'exposition chronique aux produits pharmaceutiques affecte les stéroïdes sexuels chez les poissons zèbres adultes (<i>Danio rerio</i>)</i> <b>SHAMAILA FRAZ AND JOANNA Y. WILSON</b> McMaster University
P76	<b>Effects of hydraulic fracturing flowback fluid on zebrafish and trout.</b> <i>Effets du liquide de fracturation hydraulique sur le poisson zèbre et la truite</i> <b>ERIK FOLKERTS, YUHE HE, AND GREG GOSS</b> University of Alberta
P77	<b>Characterization of pheromone communication channel in bertha armyworm, <i>Mamestra configurata</i></b> <i>Caractérisation de la voie de communication par phéromone chez le légionnaire bertha, <i>Mamestra configurata</i></i> <b>EDYTA SIEMINSKA, MARTIN A. ERLANDSON, DWAYNE D. HEGEDUS, JOHN R. GRAY</b> University of Saskatchewan
P78	<b>The summer roosting ecology of western small-footed bats (<i>Myotis ciliolabrum</i>) in southeastern Alberta</b> <i>Écologie du perchage estival chez les vespertillons pygmées de l'ouest (<i>Myotis ciliolabrum</i>) du sud-est de l'Alberta</i> <b>STEPHANIE FINDLAY</b> University of Calgary
P79	<b>Song structure and organization in southern House Wrens (<i>Troglodytes aedon</i>)</b> <i>Organisation et structure des chansons chez les troglodytes familiers (<i>Troglodytes aedon</i>)</i> <b>EDNEI B. DOS SANTOS, PAULO LLAMBÍAS &amp; DREW RENDALL</b> University of Lethbridge
P80	<b>Glucose transporter (GLUT) expression in response to feeding and glucose- loading in the North Pacific spiny dogfish (<i>Squalus suckleyi</i>).</b> <i>Expression du transporteur de glucose (GLUT) en réponse au nourrissage et aux injections de glucose chez l'aiguillat commun du Pacifique Nord (<i>Squalus suckleyi</i>)</i> <b>COURTNEY DECK AND PATRICK WALSH</b> University of Ottawa

P81	Identifying xenobiotic metabolism genes in parasitic nematodes <i>Identification des gènes du métabolisme xénobiotique chez les nématodes parasitaires</i> DAVID M. CURRAN, JOHN S. GILLEARD AND JAMES D. WASMUTH University of Calgary
P82	The role of aryl hydrocarbon and pregnane X receptor in CYP3C gene regulation in Zebrafish. <i>Rôle de l'hydrocarbure aryle et du récepteur de pregnane X sur la régulation génétique de CYP3C chez les poissons zèbres</i> LANA SHAYA AND JOANNA Y. WILSON University of McMaster
P83	Direct determination of parasite-induced host mortality in flour beetles infected with <i>Hymenolepis diminuta</i> <i>Détermination directe du taux de mortalité d'origine parasitaire chez les triboliums de la farine infectés avec Hymenolepis diminuta</i> HILARY M H CHIN, LIEN T LUONG AND ALLEN W SHOSTAK University of Alberta
P84	Landscape genetics of Bull Trout ( <i>Salvelinus confluentus</i> ) in Jasper National Park and surrounding Foothills region <i>Génétique des populations de l'omble à tête plate (Salvelinus confluentus) dans le Parc National de Jasper et les régions avoisinantes des Foothills</i> EMMA CARROLL AND STEVEN M. VAMOSI University of Calgary
P85	Regulation of hypothalamic-pituitary-interrenal axis function by serotonin in rainbow trout ( <i>Oncorhynchus mykiss</i> ) <i>Régulation de la fonction de l'axe hypothalamique-pituitaire-interrénal par la sérotonine chez la truite arc-en-ciel (Oncorhynchus mykiss)</i> MARIE-ÈVE BÉLAIR-BAMBRICK, LAURENCE DIONNE-WILSON AND KATHEEN GILMOUR University of Ottawa
P86	The effects of aquatic copper exposure on the acute ventilatory drive of freshwater-acclimated killifish <i>Effets de l'exposition au cuivre aquatique sur les réactions ventilatoires aiguës des fondules habitués à l'eau douce</i> SHERIDAN J C BAKER AND GRANT B MCCLELLAND McMaster University
P87	Cold tolerance of invasive isopod <i>Oniscus asellus</i> in Southwestern Ontario <i>Tolérance au froid chez l'isopode invasif Oniscus asellus dans le sud-ouest de l'Ontario</i> SUSAN ANTHONY AND BRENT SINCLAIR University of Western Ontario
P88	Multi-metal interactions at biological surfaces: Study of Ag, Cd, Cu, Ni, Pb and Zn uptake in the rainbow trout ( <i>O. mykiss</i> ) and the great pond snail ( <i>L. stagnalis</i> ). <i>Interactions multi-métaux en surfaces biologiques: Étude de l'absorption de Ag, Cd, Cu, Ni, Pb and Zn chez la truite arc-en-ciel (O. mykiss) et la grande limnée (L. stagnalis)</i> CRÉMAZY ANNE, KEVIN V BRIX, CHRIS M WOOD University of British Columbia
P89	Acid-base regulation and ammonia excretion in the gills of the cephalopod <i>Octopus vulgaris</i> <i>Régulation acido-basique et excrétion d'ammoniaque dans les branchies du céphalopode Octopus vulgaris</i> DIRK WEIHRAUCH, MARIAN Y. HU <sup>1</sup> , PO-HSUAN SUNG, PUNG-PUNG HWANG AND YUNG-CHE TSENG University of Manitoba
P90	The salinity tolerance of juvenile shortnose sturgeon ( <i>Acipenser brevirostrum</i> ) to full strength seawater <i>Tolérance à la salinité chez les esturgeons à museau court (Acipenser brevirostrum) dans l'eau de mer</i> ADAM DOWNIE AND JAMES KIEFFER University of New Brunswick
P91	Is the salmonid adipose fin a mechanosensory organ? <i>La nageoire adipeuse des salmonidés est-elle un organe mécanosensoriel?</i> JOHN BUCKLAND-NICKS AND ROGER P CROLL St Francis Xavier University
P92	Assessing the health impact of OSPW on embryonic zebrafish ( <i>Danio rerio</i> ). <i>Évaluation de l'impact sur la santé des OSPW chez les embryons de poisson zèbre (Danio rerio)</i> CAMERON G A TOTH, GORDON CHUA, AND HAMID R HABIBI University of Calgary

**How to be the Best / Comment faire de son Mieux**

<b><u>Station</u></b>		<b><u>Expert volunteers</u></b>
1	How to find a job/building your job package	Jeff Richards, Alex Gerson
2	Alternative careers/careers outside academia	Joy Stacey, Sarah House
3	Grant writing tips and tricks	Pat Wright, Sue Edwards
4	Using research to travel the world	Brian Dixon, Sally Leys
5	Publish or perish	Todd Gillis, Katie Gilmour
6	Science communication	Emily Standen, Jessica Theodor
7	Networking tips	Suzie Currie, Barb Zielinski
8	What to expect from a career in academia	Colin Brauner, Greg Pyle
9	Balancing science and family/work-life balance	Helga Guderley, Graham Scott
10	Surviving first years with a faculty position	Brent Sinclair, Jason Treberg
11	Building and maintaining an online presence	Allison McDonald
12	Winning teaching techniques	Rich Palmer, Richelle Monaghan, Trish Schulte

## Thursday May 28 / jeudi, 28 mai (Summary / résumé)

<b>7:30-9:30</b>	<b>SESSION G</b> (yes 7:30, sorry, but there is an enhanced coffee break for you!)	
	LOC Symposium CO: Healthy Ecosystems	<i>MacHall A</i>
	CPB G1: Living in hypoxia	<i>Cassio</i>
	EEE/CPB G2: Learning and Behaviour	<i>Escalus</i>
	CMD G3: Reproduction and Development	<i>That Empty Space</i>
<b>9:30-10:00</b>	<b>Coffee / café</b> (UofC Student Union Sponsored)	<i>MacHall Foyer</i>
<b>10:00-11:30</b>	<b>SESSION H</b>	
	PIE H1: Pathogens – Distrib., Divers., Detect. part II	<i>Escalus</i>
	CPB H2: Thermal Physiology 2	<i>MacHall A</i>
	CPB H3: Stress 3 – Environmental impacts	<i>Cassio</i>
	CMD H4: Insights from Morphology 2	<i>That Empty Space</i>
<b>11:00-12:30</b>	CJZ Lunch / Lunch CJZ (by invitation)	<i>Last Defence Lounge*</i>
	CPB Lunch / Lunch PBC	<i>MacHall B</i>
<b>11:30-12:30</b>	EEE Lunch / Lunch ÉÉE	<i>The Den</i>
<b>12:30-2:30</b>	<a href="#"><u>Hoar Award Presentations / Présentations des Prix Hoar</u></a>	MacHall A
<b>2:30-3:00</b>	Coffee / café	
<b>3:00-3:55</b>	<a href="#"><u>Boutilier Lecture / Conférence Boutilier</u></a>	MacHall A
<b>3:55-4:50</b>	<a href="#"><u>Cameron Lecture / Conférence Cameron</u></a>	MacHall A
<b>4:50-5:30</b>	<b>Break / Pause</b>	
<b>6:30-</b>	<b>Banquet / Silent Auction / Dance</b> <b>Banquet / encaen silencieux / danse</b>	MacHall Ballroom

Notes:

\*This lunch begins before the previous sessions end. The Last Defence Lounge is located at the far (west) end of the MacEwan Student Centre on the third floor (MSC 350). To get there from the meeting rooms, walk to the far end of the food court, up the stairs one flight, then turn left.

**LOC Symposium / symposium LOC**  
**7:30-9:30 MacHall A**  
**Healthy Ecosystems: mechanisms to regulatory decisions**  
**Écosystèmes en santé: des mécanismes aux décisions réglementaires**  
organizers: Matt Vijayan and Hamid Habibi

Chair / Prèsident: Hamid Habibi

LOC SYM 1 7:30-8:00	<b>ALICE HONTELA</b> , LANA MILLER, NICOLE PILGRIM, JEFF DECKER AND JOSEPH RASMUSSEN University of Lethbridge <b>The agony and the ecstasy of selenium: comparative ecophysiology and risk assessment.</b> <i>L'agonie et l'extase du sélénium: écophysiologie comparative et évaluation des risques</i>
LOC SYM 2 8:00-8:30	<b>KAREN KIDD</b> University of New Brunswick <b>What happens in a food web when fish go on the birth control pill? Qu'est-ce qui arrive à un réseau trophique quand les poissons prennent des contraceptifs oraux?</b>
LOC SYM 3 8:30-9:00	<b>BRYAN W. BROOKS</b> Baylor University <b>Fish on Prozac (and Zoloft): Ten years later</b> <i>Des poissons qui prennent du Prozac (et du Zoloft): dix ans plus tard</i>
LOC SYM 4 9:00-9:30	<b>JOHN P. GIESY</b> University of Saskatchewan <b>Toxicological Evaluation of Perfluorooctanesulfonate (PFOS) in the Environment: Anatomy of an Environmental Issue. Evaluation toxicologique de perfluorooctanesulfonate (PFOS) dans l'environnement: anatomie d'un problème environnemental</b>

**Contributed Sessions G / Sessions de communications G**  
**7:30-9:30 CPB G1: Cassio**  
**Living in hypoxia / Vivre en hypoxie**

Chair / Prèsident: Graham Scott and Tammy Rodela

CPB G1-1 7:30-7:45	<b>JULIA M YORK</b> , BEVERLY CHUA, WILLIAM K MILSOM University of British Columbia <b>Pulmonary mechanics and air sac morphology of bar-headed geese.</b> <i>Mécanique pulmonaire et morphologie des sacs d'air chez les oies à tête barrée</i>
CPB G1-2 7:45-8:00	<b>GRAHAM R SCOTT</b> , KEVIN B TATE, CATHERINE M IVY, KEVIN GUO, PARAS PATEL, AND SAJENI MAHALINGAM McMaster University <b>Cardiac performance in hypoxia of high-altitude deer mice.</b> <i>Performance cardiaque pendant l'hypoxie chez les souris sylvestres de haute altitude</i>
CPB G1-3 8:00-8:15	<b>YVONNE A DZAL</b> , MATTHEW E PAMENTER, PAUL A FAURE AND WILLIAM K MILSOM University of British Columbia <b>Huff and puff or shut'er down?: Hypoxia tolerant mammals employ divergent strategies to tolerate hypoxia</b> <i>Les mammifères tolérants à l'hypoxie utilisent différentes stratégies pour tolérer l'hypoxie</i>
CPB G1-4 8:15-8:30	<b>TODD E. GILLIS</b> , MATTHEW D. REGAN, GEORGIE K. COX, TILL S. HARTER, COLIN J. BRAUNER, JEFF G. RICHARDS, AND ANTHONY P. FARRELL University of Guelph <b>Characterizing the metabolic capacity of the anoxic hagfish heart.</b> <i>Caractérisation de la capacité métabolique de coeur de myxine anoxique</i>
CPB G1-5 8:30-8:45	<b>TAMMY RODELA</b> , MARK SCOTT, ROBERT DEVLIN, AND JEFF RICHARDS University of British Columbia <b>Differential gene expression in the brain of diploid and triploid Tzenzaicut rainbow trout (<i>Oncorhynchus mykiss</i>) following hypoxia exposure. Expression différentielle de gènes dans le cerveau des truites arc-en-ciel Tzenzaicut (<i>Oncorhynchus mykiss</i>) après l'exposition à l'hypoxie</b>



CPB G1-6 8:45-9:00	<b>MILICA MANDIC, ANDREW W. THOMPSON, TAMMY M. RODELA AND JEFFREY G. RICHARDS</b> University of British Columbia <b>Functional analysis of HIF and PDH among sculpins that vary in hypoxia tolerance.</b> <i>Analyse fonctionnelle de HIF et PDH chez les chabots variant dans leur tolérance à l'hypoxie</i>
CPB G1-7 9:00-9:15	<b>ORA JOHANSSON, HELEN SADAUSKAS-HENRIQUE, MARINA GIACOMIN, RAMON BAPTISTA, DEREK CAMPOS, WALDIR HEINRICKS, VERA ALMEIDA-VAL, CHRIS WOOD, ADALBERTO VAL</b> University of British Columbia <b>Does Rate of Re-oxygenation Matter to Hypoxic Recovery?</b> <i>Est-ce que le taux de ré-oxygénation influence la récupération hypoxique?</i>
CPB G1-8 9:15-9:30	<b>MATTHEW D REGAN AND JEFFREY G RICHARDS</b> University of British Columbia <b>How do goldfish concurrently use oxygen, anaerobic glycolysis, and metabolic rate depression in increasingly hypoxic environments?</b> <i>Comment les poissons rouges utilisent-ils en même temps l'oxygène, le métabolisme du glucose anaérobique, et la dépression du taux métabolique dans les environnements de plus en plus hypoxiques?</i>

**Contributed Sessions G / Sessions de communications G**  
**7:30-9:30 EEE/CPB G2: Escalus**  
**Learning and Behaviour / Apprentissage et comportement**

Chair / Président: Leanna Lachowsky and Matthew Morris

EEE/CPB G2-1 7:30-7:45	<b>S. RICHELLE MONAGHAN</b> Wilfrid Laurier University <b>Building scaffolds for threshold concepts through mnemonics in biological sciences.</b> <i>Construction d'échafaudages pour les concepts de seuil par le biais de mnémoniques dans les sciences biologiques</i>
EEE/CPB G2-2 7:45-8:00	<b>JUSTIN BRIDGEMAN, GLENN J. TATTERSALL</b> Brock University <b>Reversal learning of a visual task reveals a turning bias in red-footed tortoises</b> <i>L'apprentissage à revers d'une tâche visuelle révèle une préférence de virage chez les tortues charbonnières à pattes rouges</i>
EEE/CPB G2-3 8:00-8:15	<b>JACK GRAY, PAUL DICK</b> University of Saskatchewan <b>Population coding in an insect visual motion detection system</b> <i>Codage de population dans le système de détection visuelle de mouvement d'un insect</i>
EEE/CPB G2-4 8:15-8:30	<b>CAILIN M. ROTHWELL, SEVANNE A. CARPENTER, AND GAYNOR E. SPENCER</b> Brock University <b>Retinoid signaling enhances memory formation in the pond snail <i>Lymnaea stagnalis</i></b> <i>La signalisation par rétinoïdes améliore la formation de la mémoire chez la lymnée <i>Lymnaea stagnalis</i></i>
EEE/CPB G2-5 8:30-8:45	<b>RALPH V. CARTAR</b> University of Calgary <b>Different determinants of foraging performance of nectar and pollen collectors in bumble bees.</b> <i>Différences dans les déterminants de la performance en butinage entre collecteurs de nectar et de pollen chez les bourdons</i>
EEE/CPB G2-6 8:45-9:00	<b>BLAIR DUDECK, MICHAEL CLINCHY, MAREK ALLEN and LIANA ZENETTE</b> Western University <b>Fear compromises parental care and the survival of post-fledged young</b> <i>La peur compromet les soins parentaux et la survie des jeunes à l'envol</i>

EEE/CPB G2-7 9:00-9:15	<b>OLIVIA J. MCMILLAN</b> , DAVID G. STORMER AND FRANCIS JUANES University of British Columbia <b>Effects of summer temperature increase and food deprivation on aggressive behaviour in juvenile ocean-type Chinook salmon (<i>Oncorhynchus tshawytscha</i>)</b> <i>Effets de l'augmentation de la température estivale et de la déprivation alimentaire sur le comportement agressif chez les saumons Chinook juvéniles océaniques (<i>Oncorhynchus tshawytscha</i>)</i>
EEE/CPB G2-8 9:15-9:30	RAY SANWALD, TINGJIA LORENGIANO, BRIAN MCGILL, AND EHAB ABOUHEIF McGill University <b>Climate change signature on slave-raiding behaviour in ants</b> <i>Signature du changement climatique sur le comportement de mise en esclavage chez les fourmis</i>

**Contributed Sessions G / Sessions de communications G**  
**7:30-9:30 CMD G3: That Empty Space**  
**Reproduction and Development / Reproduction et développement**

Chair / Président: Matthew Vickaryous

CMD G3-1 7:30-7:45	<b>MARTA MARCHINI</b> , CARSTEN B. KRUEGER AND CAMPBELL ROLIAN University of Calgary <b>The role of the growth plate in tibia length variation</b> <i>Rôle de la plaque cartilagineuse dans la variation de la longueur du tibia</i>
CMD G3-2 7:45-8:00	<b>ROOHOLLAH ABBASI</b> AND JEFFREY M. MARCUS University of Manitoba <b>A new A/P compartment boundary and organizer in the developing wings of holometabolous insects.</b> <i>Une nouvelle limite de compartiment antéro-postérieur et un nouvel organisateur actifs durant le développement des ailes d'insectes holometaboliques.</i>
CMD G3-3 8:00-8:15	<b>TOMONARI KAJI</b> , A. RICHARD PALMER University of Alberta <b>Direct evidence of developmentally plastic addition and fusion of barnacle leg segments.</b> <i>Preuve directe de l'addition et de la fusion plastiques de segments de bras dans le développement de la balane.</i>
CMD G3-4 8:15-8:30	<b>ANDREAS HEYLAND</b> , ANDREW LIORTI AND JAMIE GIARDINI University of Guelph <b>Calcium metabolism in <i>Daphnia</i>: Ecophysiological responses to freshwater acidification</b> <i>Métabolisme du calcium chez <i>Daphnia</i>: Réponses écophysologiques à l'acidification des eaux fraîches.</i>
CMD G3-5 8:30-8:45	<b>JOHN BUCKLAND-NICKS</b> St Francis Xavier University <b>Unique events in chitonid reproduction.</b> <i>Événements uniques dans la reproduction des chitonidés</i>
CMD G3-6 8:45-9:00	<b>MARYNA P LESOWAY</b> , RACHEL COLLIN, and EHAB ABOUHEIF McGill University <b>Potential roles for apoptosis and MAPK in nutritive embryo development in the calyptraeid gastropods</b> <i>Rôle potentiel de l'apoptose et du MAPK dans le développement des embryons nutritifs des gastropodes calyptraeidés</i>
CMD G3-7 9:00-9:15	<b>KEEGAN LUTEK</b> and ANDREAS HEYLAND University of Guelph <b>Histamine signaling in <i>Strongylocentrotus purpuratus</i> metamorphic competence</b> <i>Signalisation d'histamines dans la compétence métamorphique de <i>Strongylocentrotus purpuratus</i></i>

CMD G3-8 9:15-9:30	<b>CASEY A. MUELLER</b> , JOHN EME, RICHARD MANZON, C SOMERS, DOUGLAS BOREHAM AND JOANNA WILSON McMaster University <b>Effects of increased temperature during critical windows of development on the hatchling phenotype of Lake whitefish (<i>Coregonus clupeaformis</i>).</b> <i>Effets de l'augmentation de la température durant les phases critiques du développement sur le phénotype des alevins du grand corégone (<i>Coregonus clupeaformis</i>)</i>
-----------------------	---

**Contributed Sessions H / Sessions de communications H**  
**10:00-11:30 PIE H1: Escalus**  
**Pathogens – Distribution, Diversity and Detection part II**  
**Pathogènes – Distribution, diversité et détection, deuxième partie**

Chair / Prèsident: James Stafford

PIE H1-1 10:00-10:15	<b>BRENT DIXON</b> , MOMAR NDAO, RASHA MAAL-BARED, SABAH BIDAWID AND JEFFREY FARBER Bureau of Microbial Hazards, Food Directorate, Health Canada <b>The Food and Environmental Parasitology Network (FEPN).</b> <i>Le Réseau de parasitologie alimentaire et environnementale (RPAE)</i>
PIE H1-2 10:15-10:30	<b>STEPHANIE A. REIMER</b> , CAMERON P. GOATER University of Lethbridge <b>Ecological epidemiology of an emerging virus in western tiger salamanders (<i>Ambystoma mavortium</i>) in southwestern Alberta.</b> <i>Épidémiologie écologique d'un virus émergent dans les salamandres tigrées occidentales (<i>Ambystoma mavortium</i>) dans le sud-ouest de l'Alberta</i>
PIE H1-3 10:30-10:45	<b>MICHELLE A. GORDY</b> , LISA KISH, MAHMOUD TERRABAIN, AND PATRICK C. HANINGTON University of Alberta <b>Community-level patterns of snail-trematode associations among lakes in central Alberta</b> <i>Motifs d'associations entre les escargots et les trématodes à l'échelle communautaire dans les lacs du centre de l'Alberta</i>
PIE H1-4 10:45-11:00	<b>NATALIA D PHILLIPS</b> , CAMERON GOATER, DOUGLAS COLWELL AND CLAUDIA SHEEDY University of Lethbridge <b>Comparative responses of cattle, sheep, and goats to larvae of the invasive generalist liver fluke, <i>Dicrocoelium dendriticum</i></b> <i>Réactions comparées des vaches, des moutons et des chèvres aux larves de la petite douve du foie, <i>Dicrocoelium dendriticum</i></i>
PIE H1-5 11:00-11:15	<b>UMER CHAUDHRY</b> , E. M. REDMAN, MUTHUSAMY RAMAN, JOHN S. GILLEARD University of Calgary <b>Genetic evidence for the spread of a benzimidazole resistance mutation from a single origin across southern India in the parasitic nematode <i>Haemonchus contortus</i></b> <i>Évidence génétique de la propagation d'une mutation de résistance au benzimidazole d'origine unique chez le nématode parasitaire, <i>Haemonchus contortus</i>, dans le sud de l'Inde</i>
PIE H1-6 11:15-11:30	<b>BRADLEY VAN PARIDON</b> , DOUGLAS COLWELL, CAMERON GOATER AND JOHN GILLEARD University of Lethbridge <b>Invasion pathway, life-cycle, and host utilization of emerging liver fluke, <i>Dicrocoelium dendriticum</i>, in wildlife and cattle in Cypress Hills, Alberta</b> <i>Voie d'invasion, cycle de vie, et utilisation des hôtes de la petite douve du foie émergente, <i>Dicrocoelium dendriticum</i>, chez les animaux sauvages et le bétail à Cypress Hills, Alberta.</i>

**Contributed Sessions H / Sessions de communications H**  
**10:00-11:30 CPB H2: MacHall A**  
**Thermal Physiology 2 / Physiologie thermal, deuxième partie**

Chair / Prèsident: John Eme

CPB H2-1 10:00-10:15	<b>HAMIDULLAH (HAMID) SAFI AND ANTHONY P. FARRELL</b> University of British Columbia <b>The relationship between aerobic scope and heart rate in a eurythermal fish</b> <i>La relation entre le registre aérobic et la fréquence cardiaque chez un poisson eurythermal</i>
CPB H2-2 10:15-10:30	<b>HYEWON ELLEN JUNG, KEVIN V. BRIX, COLIN J. BRAUNER</b> University of British Columbia <b>The effect of temperature acclimation on aerobic scope, hypoxia tolerance, and maximal thermal tolerance in <i>Cyprinodon variegatus variegatus</i> and <i>Cyprinodon variegatus hubbsi</i></b> <i>Effets de l'acclimatation à la température sur la portée aérobique, la tolérance à l'hypoxie, et la tolérance thermique maximale chez <i>Cyprinodon variegatus variegatus</i> et <i>Cyprinodon variegatus hubbsi</i></i>
CPB H2-3 10:30-10:45	<b>BEN SPEERS-ROESCH AND WILLIAM R DRIEDZIC</b> Memorial University of Newfoundland <b>Mechanisms of winter dormancy in fishes: lessons about the roles of inactivity and metabolic depression from a temperate wrasse, the cunner (<i>Tautogolabrus adspersus</i>)</b> <i>Mécanismes de dormance hivernale chez les poissons: leçons sur le rôle de l'inactivité et de la dépression métabolique d'une vielle tempérée, la tanche- tautogue (<i>Tautogolabrus adspersus</i>)</i>
CPB H2-4 10:45-11:00	<b>JAMES L. MARCHANT, HAMIDULLAH SAFI, CHRISTOPHER M. WILSON, ANTHONY P, FARRELL</b> University of British Columbia <b>Adjustments to cardiac pacemaker ion-channel electrophysiology over a temperature range.</b> <i>Ajustements de l'électrophysiologie des canaux ioniques des pacemakers cardiaques sur une étendue de températures</i>
CPB H2-5 11:00-11:15	<b>ELIZABETH JOHNSTON, ARIANA BONDER AND TODD GILLIS</b> University of Guelph <b>The role of transforming growth factor-beta 1 in connective tissue remodeling during cold acclimation in cultured rainbow trout cardiac fibroblasts</b> <i>Le rôle de "transforming growth factor-beta 1" dans le remodelage des tissus conjonctifs pendant l'acclimatation au froid dans des cultures de fibroblastes cardiaques de truite arc-en-ciel</i>
CPB H2-6 11:15-11:30	<b>PHILLIP R MORRISON, TILL S HARTER, DEREK SOMO, DIEGO BERNAL, CHUGEY A SEPULVEDA, RICHARD W BRILL, PETER G BUSHNELL, JEFFREY G RICHARDS, AND COLIN J BRAUNER</b> University of British Columbia <b>The effect of temperature on whole blood hemoglobin-O<sub>2</sub> affinity in the regionally heterothermic swordfish, and two eurythermal fishes.</b> <i>Effets de la température sur l'affinité à l'oxygène de l'hémoglobine sanguine chez l'espadon hétérothermique et chez deux poissons eurythermiques</i>

**Contributed Sessions H / Sessions de communications H**  
**10:00-11:30 CPB H3: Cassio**  
**Stress 3 – Environmental impacts Stress 3 – Impacts environnementaux**

Chair / Prèsident: Michael Wilkie

CPB H3-1 10:00-10:15	<b>BREDA MULDOON</b> AND NATACHA S. HOGAN University of Saskatchewan <b>The brook stickleback (<i>Culaea inconstans</i>) as a novel bioindicator species for androgenic and estrogenic compounds in aquatic environments.</b> <i>L'épinoche de ruisseau (<i>Culaea inconstans</i>) comme nouvelle espèce bio- indicateur de produits androgéniques et estrogéniques dans les environnements aquatiques</i>
CPB H3-2 10:15-10:30	<b>ADITYA K MANEK</b> , CINDY MEAYS, AND GREGORY PYLE University of Lethbridge <b>The effects of water hardness on the physiological stress response and histopathology of fathead minnows (<i>Pimephales promelas</i>).</b> <i>Effets de la dureté de l'eau sur les réactions physiologiques de stress et l'histopathologie des têtes-de-boule (<i>Pimephales promelas</i>)</i>
CPB H3-3 10:30-10:45	<b>JENNIFER D JEFFREY</b> , KELLY D HANNAN, CALEB T HASLER, ADAM WRIGHT AND CORY D SUSKI University of Illinois at Urbana-Champaign <b>Understanding the physiological response of a freshwater mussel to elevated carbon dioxide levels.</b> <i>Étude sur la réaction physiologique d'une moule d'eau douce à un taux élevé de dioxyde de carbone.</i>
CPB H3-4 10:45-11:00	<b>MEGAN ZAK</b> , LORI MANZON, MATTHEW AGEE, DANIEL STEFANOVIC, DOUG BOREHAM, CHRISTOPHER SOMERS, JOANNA WILSON AND RICHARD G. MANZON University of Regina <b>Intensity of heat shock response is reduced in Lake Whitefish (<i>Coregonus clupeaformis</i>) acclimated to temperatures above or below thermal optimum</b> <i>L'intensité de la réaction au choc thermique est réduite dans les grand corégones (<i>Coregonus clupeaformis</i>) acclimatées aux températures en dessous</i>
CPB H3-5 11:00-11:15	<b>YUEYANG ZHANG</b> , JENNIFER LOUGHERY, CHRIS MARTYNIUK AND JAMES KIEFFER University of New Brunswick <b>The physiological and molecular responses of shortnose sturgeon to thermal stress</b> <i>Réactions physiologiques et moléculaires des esturgeons à museau court au stress thermique</i>
CPB H3-6 11:15-11:30	KATHERINE SESSIONS, D STEFANOVIC, D BOREHAM, C SOMERS, JOANNA WILSON AND RICHARD G. MANZON University of Regina <b>The heat shock response and thermal adaptation in lake whitefish (<i>Coregonus clupeaformis</i>) embryos and fry in response to chronic and acute thermal stress.</b> <i>Réactions de choc thermique et adaptation thermique chez les embryons et alevins de grands corégones (<i>Coregonus clupeaformis</i>) en réponse au stress thermal aigu et chronique. et en dessus de l'optimum thermal.</i>

**Contributed Sessions H / Sessions de communications H**  
**10:00-11:30 CMD H4: That Empty Space**  
**Insights from Morphology 2**  
**Aperçus de la morphologie, deuxième partie**

Chair / Prèsident: Jason Anderson

CMD H4-1 10:00-10:15	<b>JOHN BRUBACHER</b> Canadian Mennonite University <i>Smed-Atlas: A 3D digital histological and cytological resource for the planarian, Schmidtea mediterranea.</i> <i>Smed-Atlas: une ressource digitale 3D histologique et cytologique pour le planaire, Schmidtea mediterranea</i>
CMD H4-2 10:15-10:30	<b>ALEXANDER TINIUS and ANTHONY P. RUSSELL</b> University of Calgary <b>3D geometric morphometric analysis of the scapulocoracoid: associations with ecomorphic categorization of arboreal anoles (Squamata: Dactyloidae) on Caribbean islands.</b> <i>Analyse en morphométrie géométrique 3D de l'os scapulocarcoïde: association avec les catégories écomorphiques des anoles arboréales (Squamata: Dactyloidae) sur les îles des Caraïbes.</i>
CMD H4-3 10:30-10:45	<b>TETSUTO MIYASHITA</b> University of Alberta <b>Evolution of the hypobranchial musculature inside out</b> <i>Évolution de la musculature hypo-branchiale de l'intérieur vers l'extérieur</i>
CMD H4-4 10:45-11:00	<b>KELSEY N GIL, MARGO A LILLIE, ROBERT E SHADWICK</b> University of British Columbia <b>Anatomical specializations for swallowing food in cetaceans</b> <i>Spécialisations anatomiques pour avaler la nourriture chez les cétacés</i>
CMD H4-5 11:00-11:15	<b>CHARISSA FUNG, LANCE G. BARRETT-LENNARD, WILLIAM K. MILSOM</b> University of British Columbia <b>Correlating cranial shape with diet specialization among sympatric Northeast Pacific killer whale (<i>Orcinus orca</i>) ecotypes</b> <i>Corrélations entre la forme du crâne et le régime alimentaire parmi les écotypes sympatriques d'épaulards du nord-est du Pacifique</i>
CMD H4-6 11:15-11:30	<b>WAYNE VOGL, MARGO LILLIE, MARINA PISCITELLI, JEREMY GOLDBOGEN, NICKOLAS PYENSON AND ROBERT SHADWICK</b> University of British Columbia <b>Stretchy nerves withstand deformation associated with lunge feeding in rorqual whales.</b> <i>Des nerfs élastiques résistent à la déformation liée au happement chez les rorquals</i>

## Hoar Award Presentations / Présentations des Prix Hoar

12:30-2:30 MacHall A

Chair / Prèsident: Jim Staples

HOAR -1 12:30-12:50	<b>MELISSA A. BECK</b> , STEFAN W. KIENZLE, CAMERON P. GOATER, DOUGLAS D. COLWELL University of Lethbridge <b>Landscape epidemiology of an invasive generalist parasite (<i>Dicrocoelium dendriticum</i>) in sympatric ungulates in southwestern Canada.</b> <i>Epidémiologie du paysage d'un parasite généraliste envahissant (<i>Dicroelium dendriticum</i>) chez les ongulés sympatriques du sud-ouest du Canada</i>
HOAR -2 12:50-1:10	<b>SCOTT SEAMONE</b> AND DOUGLAS SYME University of Calgary <b>Escape advantage: benthic stingrays can flee in all directions across the substrate</b> <i>Avantage dans l'évasion: les raies benthiques peuvent s'évader dans toutes les directions sur le substrat</i>
HOAR -3 1:10-1:30	<b>ALEXANDER M CLIFFORD</b> , ALYSSA M WEINRAUCH, SUSAN L EDWARDS AND GREG G GOSS University of Alberta <b>Extrabranhial aspects of acid/base and ammonia recovery in Hagfish (<i>Eptatretus stoutii</i>).</b> <i>Aspects extra-branchiaux de la restauration des acides/bases et de l'ammoniac chez la myxine (<i>Eptatretus stoutii</i>)</i>
HOAR -4 1:30-1:50	<b>KATHLEEN FOSTER</b> AND TIMOTHY HIGHAM University of California, Riverside <b>Modulation of muscle function during arboreal locomotion in <i>Anolis</i> lizards</b> <i>Modulation de la fonction musculaire pendant la locomotion arboricole chez les lézards du genre <i>Anolis</i></i>
HOAR -5 1:50-2:10	<b>GIGI YC LAU</b> AND JEFFREY G RICHARDS University of British Columbia <b>Critical role of cytochrome c oxidase in the evolution of hypoxia tolerance</b> <i>Rôle critique de l'oxidase de cytochrome c dans l'évolution de la tolérance à l'hypoxie</i>
HOAR -6 2:10-2:30	<b>SABINE L LAGUE</b> , BEVERLY CHUA, ANTHONY P FARRELL, KEVIN G MCCracken, YUXIANG WANG, AND WILLIAM K MILSOM University of British Columbia <b>Performance and life at high altitude: Different hypoxic ventilatory response strategies in bar-headed geese and Andean geese</b> <i>Performance et vie en haute altitude: Différentes stratégies de réactions ventilatoires hypoxiques chez les oies à tête barrée et les oies des Andes</i>



**Bob Boutilier New Investigator Award / Prix Bob Boutilier pour jeune chercheur**

MacHall A 3:00-3:55

DR. KEITH TIERNEY, UNIVERSITY OF ALBERTA

*How aquatic vertebrates cope with ever changing environments*  
*Adaptations des vertébrés aquatiques aux changements constants de leur environnement*

[Link to Abstract](#) / [Lien vers Résumé de la présentation](#)

---

**The T.W.M. Cameron Outstanding Ph.D. Thesis Award**  
**Le Prix T.W.M. Cameron Pour Une Thèse De Ph.D. Exceptionnelle**

MacHall A 3:55-4:50

DR. RAJENDHRAN RAJAKUMAR, MCGILL UNIVERSITY (currently at U. Florida)

*The developmental basis of caste evolution in ants: hormones, genes, and epigenetics*  
*Base développementale de l'évolution des castes de fourmis: hormones, gènes et épigénétique*

[Link to Cameron Lecture Abstract](#) / [Lien vers Résumé de la conférence Cameron](#)

---

**Friday May 29 / vendredi, 29 mai** (Summary / résumé)

---

**9:30-12:00** Council Meeting / Réunion du conseil

Bianca

---

Notes:

- A continental breakfast and coffee will be provided for Council members.

## Poster Abstracts

*Sorted according to surname of presenting author (underlined)*

**SARAH L. ALDERMAN**, FENG LIN, CHRIS J. KENNEDY, ANTHONY P. FARRELL, AND TODD E. GILLIS

University of Guelph

**Effects of diluted bitumen exposure on swimming performance of juvenile sockeye salmon.**

**Effets de l'exposition au bitumen dilué sur la performance en nage des saumons sockeye**

Diluted bitumen (Dbit) is transported from the Athabasca Oil Sands across the continent by rail and pipeline. In British Columbia, existing and proposed pipelines cross prime freshwater habitats that are critical to the anadromous lifecycle of Pacific salmon species. Developing fish are particularly sensitive to environmental contamination, and cardiotoxicity has been reported in several teleost species exposed to crude oil fractions. Importantly, there have been no studies on how bitumen exposure influences cardiac health, aerobic performance, or migratory ability of sockeye salmon. Therefore, we are evaluating the physiological and performance impacts of Dbit exposure on juvenile sockeye salmon (*Oncorhynchus nerka*). Fish exposed to Dbit (total PAH concentrations of approximately 0, 1, 10, and 100 ppb) for one and four weeks were assessed for swimming performance in a constant acceleration swim test (Umax). Supported by Fisheries and Oceans Canada National Contaminants Advisory Group.

**BEN CARRIERE AND W. GARY ANDERSON**

University of Manitoba

**Strontium flux and accumulation in juvenile Lake Sturgeon**

**Flux et accumulation de strontium chez les esturgeons de lac juvéniles**

Deposition of elements in bony structures of fish have long been used to infer origin, movement and life history events in fish. Similarities in charge and size of the alkaline earth metals strontium and barium with calcium has led to their frequent use as environmental markers. However, empirical studies of these elements are lacking in fish. In the present study we examined flux rate, tissue deposition and turnover of strontium in juvenile Lake Sturgeon, *Acipenser fulvescens*. Using radioactive <sup>85</sup>Sr we found flux was in a strong inward direction, and short-term accumulation was highest in the pectoral fin ray. Following immersion of Lake Sturgeon in the rare isotope <sup>86</sup>Sr we found the isotopic signature remained within the fin ray for at least 510 days. Results demonstrate that isotopic strontium can be used to infer origin of Lake Sturgeon and therefore is a useful technique to mark Lake Sturgeon for conservation stocking purposes.

**SUSAN ANTHONY** AND BRENT SINCLAIR

University of Western Ontario

**Cold tolerance of invasive isopod *Oniscus asellus* in Southwestern Ontario**

**Tolérance au froid chez l'isopode invasif *Oniscus asellus* dans le sud-ouest de l'Ontario**

Temperate ectotherms have evolved strategies to survive the cold. Cold tolerance has been investigated extensively in insects, but relatively little studied in terrestrial crustaceans. We studied cold tolerance of the invasive isopod *Oniscus asellus* which overwinters in leaf litter in southwestern Ontario. In the field, the isopods did not experience sub-zero temperatures until January, after which the temperature ranged from -3.2 to 0°C. *Oniscus asellus* does not enter chill coma when cooled quickly, but it does after one week at -2°C. When rewarmed, these isopods recover activity within 2 min; considerably faster than most insects. The supercooling point (SCP) of *O. asellus* ranges from -6.6 to -3.6°C; and although the isopods are killed by internal ice formation after acute cold exposure (freeze avoidance), 42% died after prolonged cold exposure to temperatures above their SCP. *Oniscus asellus* are relatively cold intolerant, and therefore their northern expansion is likely dependent on buffered microhabitats.

**SHERIDAN J C BAKER** AND GRANT B MCCLELLAND

McMaster University

**The effects of aquatic copper exposure on the acute ventilatory drive of freshwater-acclimated killifish**

**Effets de l'exposition au cuivre aquatique sur les réactions ventilatoires aigües des fondules habitués à l'eau douce**

The physiological stressors of aquatic metal pollution and hypoxia often occur together in natural environments as a result of anthropogenic influences. Both eutrophication and copper pollution have increased in prevalence recently; however little is known about their interactions. This project investigated how both acute and chronic copper exposure affect the acute ventilatory response of a model marine vertebrate, the killifish. Killifish were exposed to 100 µg Cu/L for 96 hours (chronic) or 1 hour (acute) and then acutely exposed to normoxia, or one of three stimulants of ventilation: hypoxia (30 torr O<sub>2</sub>), 100 µM external ammonia, or combined hypoxia and ammonia. Both chronic and acute copper exposure led to a significant reduction in the acute ventilatory response of killifish. This indicates that aquatic copper pollution negatively affects the appropriate physiological responses to both hypoxia and ammonia, exacerbating the impacts of eutrophication and copper pollution on aquatic environments and their inhabitants.

**MARIE-ÈVE BÉLAIR-BAMBRICK**, LAURENCE DIONNE-WILSON AND KATHEEN GILMOUR

University of Ottawa

**Regulation of hypothalamic-pituitary-interrenal axis function by serotonin in rainbow trout (*Oncorhynchus mykiss*)**

**Régulation de la fonction de l'axe hypothalamique-pituitaire-interrénal par la sérotonine chez la truite arc-en-ciel (*Oncorhynchus mykiss*)**

There is evidence of serotonergic regulation of the hypothalamic-pituitary-interrenal (HPI) axis in teleost fish but the mechanisms involved are not clear. We hypothesized that serotonin (5-HT) plays a paracrine role in regulating the HPI axis at the head kidney level in rainbow trout (*Oncorhynchus mykiss*). Head kidney tissue contained detectable levels of 5-HT<sub>1A</sub>, 5-HT<sub>2</sub> and 5-HT<sub>4</sub> receptor mRNA. Cortisol production was significantly increased in head kidney preparations incubated with 5-HT, or with the 5-HT<sub>4</sub> receptor agonist cisapride, and this elevated cortisol production was blocked by the 5-HT<sub>4</sub> receptor antagonist GR125487. Localization of 5-HT and tyrosine hydroxylase (TH) (an enzyme used to identify chromaffin cells) by immunohistochemistry on head kidney sections revealed that 5-HT was present in chromaffin cells, but also in an unidentified population of cells. In conclusion, 5-HT could act in a paracrine fashion at the head kidney level to regulate cortisol production, probably via the 5-HT<sub>4</sub> receptor.

**CAROL BEST**, MATHILAKATH M. VIJAYAN

University of Calgary

**Elevated embryo cortisol content affects neurogenesis and locomotor activity in larval zebrafish.**

**Un taux élevé de cortisol dans les embryons affecte la neurogénèse et l'activité locomotrice des poissons zèbres larvaires.**

Recent studies point to a key role for the stress steroid cortisol in early zebrafish (*Danio rerio*) development. Altered glucocorticoid signalling during development, representing differences in maternal stress and altered embryo cortisol deposition, was shown to disrupt developmental programming. Transcriptomic analysis identified neurogenesis as a potential target for developmental dysfunction associated with disrupted glucocorticoid signalling. We hypothesized that abnormal cortisol exposure during early development affects neurogenesis and early locomotor behaviour in zebrafish. Zygotic cortisol levels were elevated by microinjection into the yolk (1 hpf) to mimic maternal deposition, while waterborne exposure to cortisol (72 hpf) mimicked an early stress response. The expression patterns of transcripts involved in neurogenesis (*orthopedia b*, *neurod4*) were determined by whole-mount *in situ* hybridization. Additionally, cortisol effects on light-responsive larval locomotor behaviour (96 hpf) were also assessed. Altogether, elevated cortisol exposure during early development disrupts neurogenesis and affects larval locomotor activity in zebrafish.

**JOHN BUCKLAND-NICKS** AND ROGER P CROLL

St Francis Xavier University

**Is the salmonid adipose fin a mechanosensory organ?**

**La nageoire adipeuse des salmonidés est-elle un organe mécanosensoriel?**

The adipose fin of salmonids, once widely regarded as vestigial and lacking function, has been shown to be important to the swimming efficiency of juvenile trout. We examined fins with electron microscopy, as well as immunocytochemistry using laser confocal microscopy, revealing a complex neural network throughout the fin. Several nerves enter the base of the fin and anastomose throughout its length forming specific patterns of terminal branches along the edges, as well as sending fine perpendicular branches to the fin surface. In the subdermal space, nerves and astrocyte-like cells are linked to fusiform actinotrichia and other elements of structural collagen, which is reminiscent of some vertebrate mechanoreceptors. Our research provides support for the hypothesis that the adipose fin has a proprioceptive function as a "precaudal flow sensor".

**CARLSSON, AM**; CURRY, P; ELKIN, B; RUSSELL D; VEITCH, A; BRANIGAN, M; CROFT, B; CUYLER, C; COTE, S; COOLEY, D; KUTZ, S

University of Calgary

**Serological survey of pathogens in caribou: a snapshot in time**

**Enquête sérologique des pathogènes du caribou: un instantané temporel**

Caribou are an iconic species sensitive to the accelerated climate warming and anthropogenic disturbances occurring in the Arctic. These disturbances can promote the emergence of disease. However, few baselines on pathogen prevalence are available, hampering our ability to track changes over-time. We used blood samples (n=607) from seven caribou herds, collected between 2007-2014, to test for exposure to pathogens that are zoonotic (*Brucella suis*, *Toxoplasma gondii*), that impact on population productivity (*Neospora caninum*, alphaherpesvirus, paramyxoviruses and pestivirus) and that are emerging (West Nile virus (WNV)). We analyzed results to examine relationships between temporal, spatial and individual trends. Preliminary data show highest seroprevalence for alphaherpesvirus, low seroprevalence to *Brucella*, *N. caninum* and *T. gondii* and no seropositivity to WNV. Exposure varied between regions (West Canada, Quebec and Greenland) and for alphaherpesvirus, pestivirus and parainfluenzavirus findings suggest that adults are at greater risk of exposure than young caribou, especially in the fall.

**Emma Carroll** and Steven M. Vamosi

University of Calgary

**Landscape genetics of Bull Trout (*Salvelinus confluentus*) in Jasper National Park and surrounding Foothills region.**

**Génétique des populations de l'omble à tête plate (*Salvelinus confluentus*) dans le Parc National de Jasper et les régions avoisinantes des Foothills**

Bull trout (*Salvelinus confluentus*) (BLTR), native to the headwaters of the eastern slope of the Rocky Mountains, have specific habitat requirements: cool water with low siltation and overhanging banks. Habitat destruction, stocking of non-native species, and overfishing have caused BLTR population declines in Alberta, which may collectively reduce genetic variability in extant populations. Implementations such as the province-wide “catch-and-release” regulation and angling ban in BLTR spawning areas in Jasper National Park provide an ideal system for developing baseline BLTR population data for the northern extent of their range. From the Upper Athabasca River, five tributaries will be sampled via electrofishing and angling. DNA from BLTR tissue samples will be collected and polymorphic microsatellite loci will be scored to determine the effective population size of populations, as well as genetic structure among populations. We will also explore associations between landscape characteristics, life history and genetic variability.

**HILARY M H CHIN**, LIEN T LUONG AND ALLEN W SHOSTAK

University of Alberta

**Direct determination of parasite-induced host mortality in flour beetles infected with *Hymenolepis diminuta*.**

**Détermination directe du taux de mortalité d'origine parasitaire chez les triboliums de la farine infectés avec *Hymenolepis diminuta***

Flour beetles are intermediate hosts of the rat tapeworm, *Hymenolepis diminuta*, and are important models for ecological and evolutionary studies on host-parasite relationships. Patterns of parasite-induced host mortality are an important component of such studies. Since these beetles desiccate quickly after death and necropsy becomes problematic, parasite-induced mortality is typically estimated indirectly by comparing initial parasite distributions with distributions in survivors. We overcame this by developing a technique to directly determine numbers of *H. diminuta* cysticercoids present within beetles at the time of death. Parasite-infected or sham-exposed beetles were stored in 0%, 1% or 4% diatomaceous earth (DE) to test for interactive effects of these two stressors. Infected beetles had slightly higher survivorship initially than did controls. In 0% and 4% DE, parasitism caused additive mortality after lengthy exposure, and killed hosts in a largely intensity-independent manner. In 1% DE, additive mortality occurred earlier and was intensity-dependent.

**SYLVIA CHOW**, AND GREG PYLE

The University of Lethbridge

**Local Adaptation of Fish Populations to Bituminous Toxicants.**

**Adaptation locale de populations de poissons aux substances toxiques bitumineuses**

Aquatic toxicants related to bituminous oil sands erosion, mining and processing may enter the local watersheds indirectly as nonpoint source toxicants and impact both the surrounding aquatic and terrestrial ecosystem. As part of a laboratory component of a project looking at adaptation to bituminous toxicants, the effects of chronic exposure of fathead minnows (*Pimephales promelas*) to low doses of oil sands process affected water will be examined for 28 days. The objective of this project is to deduce potential short-term adaptive changes in critical swimming speed, respiration, olfaction, and toxicant biomarker response to oil sands process affected waters using a model species. Understanding the effects of chronic exposure to low doses of bituminous toxicants will elucidate potential watershed impacts of the oil sands industry on the local aquatic ecosystem. Such effects will in turn help determine the ecological risk of chronic exposure to bitumen-related toxicants.

**KAREN COGLIATI**, BRYAN NEFF, SIGAL BALSHINE

McMaster University

**Sexual selection across populations in a species with alternative reproductive tactics**

**Sélection sexuelle dans les populations d'une espèce possédant plusieurs tactiques de reproduction**

Although variation in resources is thought to have an impact on mating patterns, few studies have quantified this pattern across spatial scales. We investigated how resource distribution across a species' range affects competition and the strength of sexual selection in plainfin midshipman (*Porichthys notatus*). Male plainfin midshipman can be guarders that compete for nest sites and court females, or sneakers that attempt to steal fertilizations from guarder males. Males from the north population grow larger, suggesting more competition among males in the north. However, we found that variance in body size and in nest availability were similar between populations, suggesting instead a similar degree of male-male competition. Accordingly, we found no significant population differences in reproductive success, male tactic frequencies, paternity, and most measures of the strength of sexual selection. Despite a wide geographic distance, our results show remarkable conservation of mating patterns across different populations of this benthic toadfish.

**MIRANDA COSMAN**, HAYLEY BRITZ, and CAMPBELL ROLIAN.

Department of Anthropology, University of Calgary

**The effect of bone length and shape on bone strength in the Longshanks mouse**

**Effet de la longueur et la forme de l'os sur sa solidité chez la souris Longshanks**

The Rolian lab has been selectively breeding a line of mice (“Longshanks”) to have longer tibiae relative to body mass compared to a control cohort. Previous research has demonstrated that the length increase in the Longshanks tibiae resulted in a negative allometric change in the bone's shape which may lead to reduction in the bone strength. We tested the hypothesis that the strength of the Longshanks tibiae has been reduced due to the shape and length change of the bone. We predicted that the Longshanks tibiae would require lower bending forces to break. Tibiae were dissected from two independent selected

lines (n=56), and a control line (n=29). The bones were tested for strength using a three-point bending apparatus. Results indicated that the tibiae in the Longshanks mice required 20-30% less force to break. This research provides insights into the relationship between bone length and strength under directional selection.

**CRÉMAZY ANNE**, KEVIN V BRIX, CHRIS M WOOD

University of British Columbia

**Multi-metal interactions at biological surfaces: Study of Ag, Cd, Cu, Ni, Pb and Zn uptake in the rainbow trout (*O. mykiss*) and the great pond snail (*L. stagnalis*)**

**Intéactions multi-métaux en surfaces biologiques: Étude de l'absorption de Ag, Cd, Cu, Ni, Pb and Zn chez la truite arc-en-ciel (*O. mykiss*) et la grande limnée (*L. stagnalis*)**

In order to meet certain metabolic needs, freshwater organisms have developed uptake pathways for essential cations (e.g. Cu, Zn, Na and Ca), some of them being also used by nonessential metals (e.g. Ag, Cd and Pb). It is well known that physiological sites are rarely sensitive to only one chemical specie and that multiple metals present in solution can affect each other's uptake. Since metals are almost always found in mixtures in the aquatic environment, it is important to characterize these interactions. We investigated binary mixture effects on the uptake of six metals (Ag, Cd, Cu, Ni, Pb and Zn) in two freshwater species, the rainbow trout (*O. mykiss*) and the great pond snail (*L. stagnalis*). One of our initial assumptions was that antagonistic effects would be observed between metals known to use Ca channels (Cd, Pb and Zn) and between metals known to use Ca channels (Ag and Cu).

**JOSHUA CULLEN** AND CHRISTOPHER MARSHALL

Texas A&M University

**A Preliminary Analysis of Ontogenetic Scaling of Bite Performance Within Texas Sharks**

**Analyse préliminaire du proportionnement ontogénétique de la performance du mordant parmi les requins du Texas**

Numerous shark species have been recorded to undergo a series of dietary and habitat changes during their ontogeny, which may constrain how certain species effectively capture their prey. Bite force production in some sharks has been measured to increase significantly from parturition through juvenile stages due to positive allometry of the jaw adducting mechanism. However, our knowledge regarding these patterns is limited to a few species and size classes. Bonnethead (*Sphyrna tiburo*), blacktip (*Carcharhinus limbatus*), and bull (*Carcharhinus leucas*) sharks are common along the Texas coast and each exhibit different feeding strategies. The goal of this study is to characterize bite performance and its constraints on trophic ecology and dietary shifts to compare these three sympatric species over their entire ontogeny. Bite performance affects overall fitness of an individual and the study of its scaling over ontogeny for multiple species can help to explain differences in diet and ecological niches.

**David M. Curran**, John S. Gilleard, James D. Wasmuth.

University of Calgary

**Identifying xenobiotic metabolism genes in parasitic nematodes.**

**Identification des gènes du métabolisme xénobiotique chez les nématodes parasites**

Parasitic nematodes are estimated to infect one third of the human population - often hindering development - while others infecting livestock cause billions of dollars of economic loss annually. They are typically controlled using drugs, but resistance rapidly arose and has spread throughout the globe. The mechanism of resistance has not been well established in these organisms, but we hypothesize that xenobiotic metabolism is important, as in insects a single cytochrome P450 enzyme is responsible for resistance to DDT. This capability has long been thought absent in parasitic nematodes, but recent sequencing efforts have called these conclusions into doubt. We are using a phylogenomics approach to identify relevant xenobiotic genes in several free-living nematodes, as these genes will be under distinctive selective pressure. These approaches will then be extended to parasitic species, identifying genes that may be involved in drug resistance, and others that may be useful therapeutic targets.

**CHINMAYEE DAS**, WIC WILDERING AND MATHILAKATH M. VIJAYAN

University of Calgary

**Rapid modulation of intracellular calcium by cortisol in rainbow trout hepatocytes**

**Modulation rapide du calcium intra-cellulaire par le cortisol dans les hépatocytes des truites arc-en-ciel**

Recent studies have shown that stress levels of cortisol rapidly alter liver plasma membrane order in rainbow trout (*Oncorhynchus mykiss*). These studies suggest a rapid nongenomic cortisol signaling in trout hepatocytes, but the mechanisms are far from clear. We tested the hypothesis that acute stress levels of cortisol rapidly modulates intracellular calcium levels in trout hepatocytes, as a mechanism for rapid nongenomic signaling. This was tested using Fura-2AM ratiometric calcium imaging. Our results demonstrate that physiological levels of cortisol rapidly alter intracellular calcium levels. This steroid-mediated intracellular calcium changes were modulated by the available intracellular and extracellular calcium stores. Also, the changes in calcium levels seen with cortisol was not modified by exposing cells to either mifepristone (glucocorticoid receptor antagonist) or a membrane impermeable form of the steroid. Altogether, cortisol modulates rapid intracellular calcium levels in trout hepatocytes and this effect is independent of classical glucocorticoid receptor activation.

**NEAL J DAWSON**, GRAHAM R SCOTT AND KEVIN G MCCracken

McMaster University and University of Miami

**High-altitude adaptation and metabolic capacities in Andean ducks and geese.**

**Adaptation aux hautes altitudes et capacité métabolique chez les canards et oies des Andes.**

High-altitude environments are both cold and hypoxic, which requires that highland animals maintain high rates of O<sub>2</sub>-consumption for locomotion and thermogenesis in exceedingly O<sub>2</sub>-thin air. Evolved specializations in respiratory physiology and metabolism have shown to help mitigate challenges at high-altitude in some highland taxa, but we know little about whether parallel strategies evolved across independent highland lineages. This study compared several sister-populations/species of high-and low-altitude waterfowl. We measured the activity of 16 enzymes involved in main pathways of energy metabolism of flight muscle to elucidate possible parallel mechanisms of high-altitude adaptation. Differences between cytochrome-c oxidase, 3-hydroxyacyl-CoA dehydrogenase and lactate dehydrogenase activities were observed between high-and low-altitude populations in ruddy ducks (~100,000 years at high-altitude), but remained unchanged in cinnamon teal ducks (~10,000 years at high-altitude), suggesting possible shifts in aerobic capacities based on the degree of establishment at high-altitude. Other changes in enzyme activities will also be discussed between populations/species.

**LIS DE WEERD**, PETRA M HERMANN AND WILLEM C WILDERING

University of Amsterdam

**Neuroendocrine control of memory and aging in *Lymnaea stagnalis***

**Contrôle neuroendocrinien de la mémoire et du vieillissement chez *Lymnaea stagnalis***

The theory of life history trade-offs that postulates that metabolically costly processes, such as growth and reproduction are traded off against cell survival, provides an evolutionary context for the process of biological aging. Recent findings point to a prominent role of insulin-like peptides (ILPs) in mediating these trade-offs by promoting growth on one hand and causing accelerated aging on the other hand. We seek to understand the biological foundations of neuronal aging and age-related learning impairment using the pond snail *Lymnaea stagnalis* as model system. ILPs have been shown to reverse age-related learning deficiencies in this gastropod. In *Lymnaea*, the balance of reproduction and growth is regulated by the lateral lobes (LL) two accessory lobes that inhibit the release of Molluscan ILPs (MIPs) and schistosomin, an anti-gonadotrope neuropeptide. This study examines the effect of lateral lobes (LL) ablation on memory performance after one-day appetitive conditioning in *Lymnaea stagnalis*.

**COURTNEY DECK** AND PATRICK WALSH

University of Ottawa

**Glucose transporter (GLUT) expression in response to feeding and glucose-loading in the North Pacific spiny dogfish (*Squalus suckleyi*)**

**Expression du transporteur de glucose (GLUT) en réponse au nourrissage et aux injections de glucose chez l'aiguillat commun du Pacifique Nord (*Squalus suckleyi*)**

Elasmobranchs consume extremely low-carbohydrate diets and their tissues have a general preference for ketone bodies as oxidative fuels but at least one tissue, the rectal gland, is glucose-dependent. We previously identified three putative GLUT sequences in elasmobranchs that were phylogenetically similar to GLUTs 1, 3, and 4 and we cloned these in the dogfish to determine expression patterns across different tissues. In this study, we investigated changes in GLUT mRNA levels in the rectal gland, liver, muscle, and intestine in response to feeding, an event that has previously been shown to activate the gland. GLUT mRNA was also measured following glucose injections which served as a contrast to the amino acid load that would result from their high-protein meals. Interestingly, both GLUT1 and GLUT4 mRNA levels changed in the rectal gland whereas only changes in GLUT4 were observed in the other three tissues.

**EDNEI B. DOS SANTOS**, PAULO LLAMBÍAS & DREW RENDALL

University of Lethbridge

**Song structure and organization in southern House Wrens (*Troglodytes aedon*)**

**Organisation et structure des chansons chez les troglodytes familiers (*Troglodytes aedon*)**

House Wrens (*Troglodytes aedon*) have the widest distribution of any songbird in the western hemisphere. At the same time, they show considerable variation in mating system, migratory behaviour and life-history patterns, for example being almost entirely migratory and more frequently polygynous with large clutch sizes in North America but sedentary and substantially monogamous with small clutch sizes in most of South America. House Wrens are thus ideally suited to quantifying adaptive behavioural flexibility and to testing the role played by male song in variable mating systems and in potential geographic sub-structuring of populations. Here we present a first detailed description of song structure and organization in a South American population of House Wrens based on an analysis of 13,000 songs recorded from 22 males breeding in Mendoza, Argentina. We provide a comparison with song patterns and mating systems of a population of House Wren wrens studied concurrently in Alberta, Canada.

**ADAM DOWNIE** AND JAMES KIEFFER

University of New Brunswick & MADSAM Sturgeon Eco-Physiology Lab, Saint John

**The salinity tolerance of juvenile shortnose sturgeon (*Acipenser brevirostrum*) to full strength seawater.**

### **Tolérance à la salinité chez les esturgeons à museau court (*Acipenser brevirostrum*) dans l'eau de mer**

Recent studies have investigated the salinity tolerance of juvenile shortnose sturgeon exposed to brackish water. To date, less research has been done on salinity tolerance and osmoregulation of shortnose sturgeon exposed to full-strength seawater. Recently, our lab has demonstrated that after 24 hours exposed to full-strength seawater, juvenile shortnose sturgeon are tolerating these conditions but are not yet osmoregulating. Therefore, it is possible that 24 hours may not provide enough time to activate the potential mechanisms for osmoregulation at full-strength seawater. The current study investigated how sturgeon survive full-strength seawater over 72 hours (using LT<sub>50</sub> tests), and whether they begin to osmoregulate within a 72 hour period (through the measurement of various blood indices).

### **STEPHANIE FINDLAY**

University of Calgary

### **The summer roosting ecology of western small-footed bats (*Myotis ciliolabrum*) in southeastern Alberta.**

### **Écologie du perchage estival chez les vespertillons pygmées de l'ouest (*Myotis ciliolabrum*) du sud-est de l'Alberta**

I am studying the roosting ecology and behaviour of the western small-footed bats (*Myotis ciliolabrum*) in the prairies in southeastern Alberta. The first season took place in Dinosaur Provincial Park in summer 2014. Using radiotelemetry, I successfully tracked 3 males, 3 non-pregnant females, and 3 lactating females over a period of thirty days. The bats primarily roosted in small erosional mudholes which are common in the sandstone coulees that dominate the park topography. All bats had low roost fidelity, switching roosts every 2 days on average, but exhibited high fidelity for specific coulee valleys. I measured internal roost environmental conditions to compare with the ambient conditions. This study provides the first baseline data regarding this species in this semi-arid region of Alberta. These data can be used to create effective ecological management strategies prior to the arrival of white-nose syndrome, a disease killing bats in eastern North America.

### **ERIK FOLKERTS, YUHE HE, AND GREG GOSS**

University of Alberta

### **Effects of hydraulic fracturing flowback fluid on zebrafish and trout.**

### **Effets du liquide de fracturation hydraulique sur le poisson zèbre et la truite**

Hydraulic fracturing and horizontal drilling practices are becoming a growing component of the Alberta and British Columbia energy sectors. A by-product formed from these practices is a surface returned fracturing proppant mixture called flowback fluid. To date, significant knowledge gaps exist not only on the chemical identity and characteristics of this secondarily formed fracturing flowback fluid, but also on the handling, disposal, and potential hazards posed to the aquatic environment. Profiling the toxigenicity of this fluid on fresh water aquatic vertebrate species (*Oncorhynchus mykiss* and *Danio rerio*), we have found this fluid to have significant toxicological effects at several life stages, affecting survival, development, and specific toxin induced gene expression changes. Future acute and chronic exposure assays will further help to outline potential protocols for remediation efforts should spills or leaks occur. This study is the first in Canada to investigate the effects hydraulic fracturing fluid has on indicator species.

### **SHAMAILA FRAZ AND JOANNA Y. WILSON**

McMaster University

### **Chronic pharmaceutical exposure affects sex steroids in adult zebrafish (*Danio rerio*)**

### **L'exposition chronique aux produits pharmaceutiques affecte les stéroïdes sexuels chez les poissons zèbres adultes (*Danio rerio*)**

Steroid concentrations are important in control of fish reproduction and multiple pharmaceutical compounds appear to alter steroid levels and disrupt reproduction. Exposure of zebrafish to carbamazepine and gemfibrozil has been shown to alter fecundity and increase atretic oocytes; plasma 11-ketotestosterone (KT) concentrations were lowered with carbamazepine exposure. We exposed adult zebrafish to 10µg L<sup>-1</sup> of either carbamazepine or gemfibrozil for 6 weeks. Sex steroids were analysed with ELISA in plasma, whole body and gonadal samples. Estradiol (E2) and KT were measured in plasma, gonad, or whole body samples of both males and females. KT was significantly lower in plasma and whole body, but not testis, of male fish. E2 was significantly lower in ovaries but not in plasma nor whole body homogenates of female fish.

Hence, long term exposure to GEM and CBZ can lead to endocrine disruption and may intervene with normal physiological processes vitally regulated by sex hormones.

### **MICHAEL J GAUDRY, MARTIN JASTROCH, JASON R TREBERG, MARK S SPRINGER AND KEVIN L CAMPBELL**

University of Manitoba

### **The rise and fall of UCP1-mediated non-shivering thermogenesis in eutherian mammals**

### **Hausse et baisse de la thermogénèse sans frissons induite par UCP1 chez les mammifères euthériens**

Mitochondrial uncoupling protein 1 (UCP1) is essential for the non-shivering thermogenic function of brown adipose tissue (BAT). BAT is widely recognized to play a key thermoregulatory role in neonatal, small-bodied, and heterothermic eutherian mammals that enabled their exploitation of thermally taxing environments. Our analysis of 122 extinct and extant vertebrate species challenge these generalizations by revealing independent *UCP1* inactivations within 9 of 18 eutherian orders, a finding corroborated by relaxed *UCP1* selection pressures and lack of discernable BAT in these groups. Molecular dating analyses indicate these pseudogenization events largely coincided with widespread global cooling during the late Eocene-early

Oligocene that promoted sharp increases in body mass, and hence niche expansion and species diversification apparent in the fossil record. Ancient disruptions of this locus further signifies that evolution of extreme cold-tolerance is not uniquely associated with BAT-mediated thermogenesis, thus questioning the physiological importance of *UCP1* across the eutherian radiation.

**CRISOSTOMO GOMEZ** AND JEFFERY RICHARDS

University of British Columbia

**Regulation of mitochondrial  $F_1F_0$ -ATPase in the anoxia tolerant turtle, *Trachemys scripta*.**

**Régulation de l'ATPase- $F_1F_0$  mitochondrial chez la tortue tolérante à l'anoxie, *Trachemys scripta***

The anoxia-tolerant pond slider, *Trachemys scripta*, is capable of surviving months in anoxic mud while overwintering in ice covered-ponds. In most vertebrates, anoxia leads to inner mitochondrial membrane depolarization causing the  $F_1F_0$ -ATPase to run in reverse, hydrolyzing ATP, attempting to restore membrane potential ( $\Delta\Psi$ ). Previous studies have shown, that anoxia exposure in *T. scripta* results in a severe inhibition of  $F_1F_0$ -ATPase activity, which prevents anoxia-induced hydrolysis of ATP. The benefits of reducing  $F_1F_0$ -ATPase activity during anoxia are clear, but the mechanisms responsible for inhibition remain unknown. We predict that the inhibitory protein IF1 is responsible for the reduction in  $F_1F_0$ -ATPase activity. IF1 has been previously shown to inhibit  $F_1F_0$ -ATPase activity when mitochondrial matrix acidifies or  $\Delta\Psi$  depolarizes. We also predict that during long-term anoxia, the  $F_1F_0$ -ATPase is further inhibited by post-translational modifications. Work is underway with *T. scripta* to elucidate any post- translational modifications to  $F_1F_0$ -ATPase when exposed to anoxia.

**Nathan P. Grigg**, Justin M. Krilow, Gary R. Graves, Andrew N. Iwaniuk

University of Lethbridge

**North American vultures differ in their reliance on olfactory cues: neuroanatomical evidence.**

**Les vautours de l'Amérique du Nord diffèrent dans leur dépendance sur les signaux olfactifs: évidence neuro-anatomique**

The size of sensory regions in the brain reflects the importance of sensory modalities to a species behaviour and ecology. Here, we use this brain-behaviour relationship to gain insight into the sensory ecology of black (*Coragyps atratus*) and turkey (*Cathartes aura*) vultures, two closely related species that are thought to vary in their reliance on olfactory cues to find carrion. Brains of both species were sectioned and stained and the size of the olfactory bulbs and visual brain regions quantified. Our results demonstrate that the turkey vulture has significantly larger olfactory bulbs than the black vulture and the largest olfactory bulbs of any extant bird species. Visual regions did not, however, differ between the two species. We conclude that black and turkey vultures share similar visual abilities, but the turkey vulture likely has the most sensitive sense of smell of any bird examined to date.

**GORDON HAGERMAN**, A PHIL OEL AND W TED ALLISON

University of Alberta

**Functional regeneration and plasticity of vision following ablation of specific subtypes of cone photoreceptors in larval zebrafish (*Danio rerio*).**

**Régénération fonctionnelle et plasticité de la vision après l'ablation de sous-types spécifiques de photorécepteurs coniques chez les poissons zèbres larvaires (*Danio rerio*)**

Zebrafish are the preeminent genetic model of regenerating daytime vision because they possess a rich mosaic of cone photoreceptors and an innate ability to regenerate photoreceptors from intrinsic retinal stem cells. Using our novel model of cone photoreceptor specific ablation our aim is to assess functional integration of regenerated photoreceptors and recovery of vision. Our latest model of targeted cell ablation is tailored to death and regeneration of blue or ultraviolet (UV) cone photoreceptors. Our previous work demonstrated the fate of regenerating cones is biased towards the ablated cone subtype. Defects in vision due to cone death were identified using a visually mediated behavioral assay for larval zebrafish (optomotor response). Behavioral recovery time was dependent on the subtype of cone ablated, potentially due to differences in the plasticity of the respective retinal circuitry. Our novel model enables functional study of vision in the context of cone death and regeneration.

**STEPHANIE HANS**, HORST ONKEN AND DIRK WEIHRAUCH

University of Manitoba

**Acid-base regulatory role of different book gill regions of the American horseshoe crab (*Limulus polyphemus*)**

**Rôles de différentes régions des branchies dans la régulation acide-base chez la limule américaine (*Limulus polyphemus*).**

Acid-base homeostasis is of utmost importance to basic physiological processes. In the American horseshoe crab (*Limulus polyphemus*), we showed that in comparison to other tissues, book gills have the highest expression of carbonic anhydrase and Rhesus protein, two genes known to be involved in acid-base regulation. Within the book gills, we found higher expression of these genes in the ventral side of the lamella compared to the dorsal side. Split gill lamella mounted in Ussing chambers showed a higher conductance of the ventral epithelium ( $145.40 \pm 33.95$  mS/cm<sup>2</sup>) than the dorsal side ( $1.40 \pm 1.20$  mS/cm<sup>2</sup>). Transepithelial ammonia transport was observed in the ventral side but was lacking in the dorsal side, and both epithelia increased the pH of the artificial hemolymph to ~8.3. The acid-base regulatory mechanism of this living fossil may be found in other marine invertebrates and could provide interesting insight into the evolution of this process.



**JODY HEEREMA, ADITYA MANEK AND GREG PYLE**

University of Lethbridge

**Effects of thyroid hormone disruptors in treated wastewater on bullfrog (*Rana catesbeiana*) tadpole chemosensory function and behaviour**

**Effets des disrupteurs de l'hormone thyroïdienne dans les eaux usées traitées sur la fonction chimiosensorielle et le comportement des têtards de ouaouaron (*Rana catesbeiana*)**

Endocrine disrupting compounds (EDCs) are present in wastewater effluent at low concentrations, but are still biologically active and can have effects on the endocrine system. Some EDCs are able to disrupt thyroid hormone (TH) synthesis, signalling, and response in vertebrates. Thyroid hormone is extremely important for vertebrates during early life stages for normal growth and development of many organs and tissues, especially the brain. The present study will investigate the effects of EDCs on American bullfrog (*Rana catesbeiana*) tadpoles' chemosensory acuity. Behavioural and electro-olfactogram (EOG) assays will be conducted to characterize chemosensory acuity after exposure to toxicants present in treated wastewater. Identifying chemosensory responses can serve as a strong link to ecological implications of TH disruption, and inform us of the efficacy of current wastewater treatment processes. This presentation will highlight preliminary findings and future directions of this project.

**DAVIS IRITANI**

University of British Columbia

**Evolutionary ecology of archigregarines (Apicomplexa) – the earliest parasite relatives of malaria**

**Écologie évolutive des archigregarines (Apicomplexa) – les plus anciens parasites apparentés à la malaria**

The Apicomplexa is a diverse clade of eukaryotic parasites which includes infamous members such as those that cause malaria, toxoplasmosis, and cryptosporidiosis. Archigregarines form the most basal branch within Apicomplexa and have retained morphologies and host-exploitation strategies inferred to be ancestral to the whole clade. Archigregarines, therefore, present an opportunity to better understand how Apicomplexan character traits have evolved over time. The current knowledge base surrounding archigregarines, however, is weak and most species have not been formally described. Given this dearth of information, understanding archigregarine parasitism initially requires quantification of basic host-parasite variables. Using a Sipunculan worm host naturally infected by three archigregarines species, the current study attempts to address: (1) site specificity of each archigregarine species; (2) niche partitioning within the host; and (3) the adaptive significance of their morphologies. Describing fundamental ecological parameters of the Sipunculan-archigregarine system is an important first step to understanding early Apicomplexan parasitism.

**ANKUR JAMWAL AND SOM NIYOGI**

Department of Biology, University of Saskatchewan – SK.

**An *in vitro* examination of selenium-cadmium antagonism using primary cultures of rainbow trout (*Oncorhynchus mykiss*) hepatocytes**

**Examination *in vitro* de l'antagonisme sélénium-cadmium en utilisant des cultures primaires d'hépatocytes de truite arc-en-ciel (*Oncorhynchus mykiss*)**

The main objective of this study was to evaluate the ameliorative properties of selenium (Se) against cadmium (Cd)-induced oxidative stress in rainbow trout hepatocytes in primary culture. Se is known to have anti-oxidative functions under normal physiological condition, but can turn into a pro-oxidant beyond the threshold concentration. Trout hepatocytes were exposed to 100  $\mu$ M Cd both in the absence and presence of selenite or selenomethionine (25, 50, 100, 250 and 500  $\mu$ M) for 48 hrs. It was observed that both forms of Se, up to a concentration of 100 $\mu$ M, significantly reduce Cd-induced cytotoxicity (measured as cell viability). Reduced cytotoxicity of Cd in the presence of Se was associated with reduced reactive oxygen species production and increased thiol status. Treatment with pharmacological anti-oxidants, such as TEMPO and NAC, also reduced Cd-induced oxidative stress in trout hepatocytes, providing further evidence that Se likely ameliorates Cd toxicity via anti-oxidative mechanisms.

**JENNA JONES, KARL BOYES, RON PADILLA, JOEL GAGNON, DANIEL HEATH, AND BARB ZIELINSKI**

University of Windsor, Department of Biological Sciences, Windsor, Ontario, Canada

**Tolerance of the sea lamprey olfactory system to copper in roadway runoff water discharges to the Great Lakes.**

**Tolérance du système olfactif de la lamproie de mer au cuivre provenant de déversements d'eau de chaussée dans les Grands Lacs**

Heavy Metals, such as copper, are known to inhibit olfaction in many fish species. Copper is abraded from disc brake pads in motor vehicles, is deposited onto roadways, and migrates into runoff and into water-bodies inhabited by fish through runoff. Runoff was sampled in a high traffic corridor and surrounding areas in Windsor, Ontario and was analyzed for total and dissolved metals. Additionally, the effect of copper exposure on the olfactory response and pheromone detection of sea lamprey, *Petromyzon marinus*, which is an invasive species that uses pheromones for spawning migration and reproduction, was determined. Thirdly, the effect of copper exposure on gene transcription was investigated to determine potential modifications resulting from Cu exposure. We observed that low levels of copper found in urban runoff from roadways impairs sea lamprey olfaction, and has the potential to impact pheromone-based abatement strategies in the Great Lakes region.

**LAUREN JONES** ANDREA LISTER DEBORAH MACLATCHY

Wilfrid Laurier University

**A comparison of QPCR and multiplex methodologies**

**Comparaison entre PCR quantitative et méthodologies multiplexes**

Polymerase chain reaction (PCR) is a method in which DNA is amplified according to primers designed for a specific sequence. In multiplex PCR multiple sets of forward and the corresponding reverse primers may be added. To determine the usefulness of multiplex PCR methodology in fish reproductive endocrinology studies, hepatic vitellogenin (VTG) mRNA expression by qPCR and multiplex were compared in two separate studies. First, male fathead minnow (*Pimephales promelas*) were exposed to 10ng/L of EE<sub>2</sub> and control water in a laboratory for a period of 15 days. Secondly, female walleye (*Stizostedion Vitreum*) from Tathlina and Kakisa Lakes in the Northwest Territories were collected across different time points of their spawning cycle. In fathead minnow, hepatic VTG mRNA expression by qPCR was significantly increased 1574 fold following exposure to EE<sub>2</sub>, while walleye hepatic VTG mRNA expression significantly increased 12 fold in pre-spawning compared to post spawning periods.

**MARTEN KAAS** AND MICHAEL O'DONNELL

McMaster University

**Effects of altered expression of the Keap1/CncC pathway on secretion of organic toxins.**

**Effets de l'expression modifiée de la voie Keap1/CncC sur la sécrétion de toxines organiques**

The Keap1-Nrf2 pathway is a major upstream regulator of xenobiotic detoxification. In *Drosophila*, directed activation of the protein complex of Keap1 and CncC (the Nrf2 homolog) in principal and stellate cells of the Malpighian (renal) tubules confers resistance to lethal doses of the pesticide malathion, which is metabolized into organic anions. Dietary exposure to organic anions such as salicylate (10 mM) causes increases in fluid secretion rate and salicylate flux across Malpighian (renal) tubules. Here we used salicylate-selective microelectrodes and Ramsay assays to determine the role of Keap1/CncC in regulating these responses. Fluid secretion rate and salicylate flux across tubules isolated from adults with activated Keap1/CncC are comparable to the values from salicylate-fed controls, suggesting a role for Keap1/CncC in upregulating fluid secretion in response to the presence of dietary organic anions.

**CHINTHAKA KALUTHOTA**, AND DREW RENDALL

University of Lethbridge

**Song organization and variability in Northern House Wrens (*Troglodytes aedon*)**

**Organisation et variabilité des chants du troglodyte familier (*Troglodytes aedon*)**

Northern House Wrens (*Troglodytes aedon*) are noted for complex song, but detailed studies are lacking. We report patterns of syllable and song diversity from 15,600 songs recorded from 15 males, in Southern Alberta, Canada. The population syllable repertoire was 27, most syllables shared by all males but used variably. Songs were a concatenation of multiple syllable types (mean=4), each type produced several times before switching. Repertoires of song types (unique syllable type sequences) were large and ranged to 194 with no evidence of a ceiling. However, 'working repertoires' of commonly produced song types were much smaller (n=25) and singing bouts typically involved repeating a song type many times before switching. Additional constraints in syllable sequencing and song diversity were evident and captured using song templates summarizing common song construction pathways. Ultimately, male house wrens combined tremendous potential syllable and song diversity with a comparatively monotonous short-term singing style.

MAXWELL MARINOS, NGUYEN T.K.VO, STEVEN TEN HOLDER, NIELS C. BOLS AND **BARBARA A. KATZENBACK**

University of Waterloo

**Establishment and characterization of continuous cell cultures from the bone marrow and skin of the African clawed frog (*Xenopus laevis*).**

**Établissement et caractérisation de cultures cellulaires continues dérivées de la moëlle osseuse et de la peau du xénope, *Xenopus laevis***

Continuous cell cultures from the bone marrow (Xela BMW), dorsal skin (Xela skin-D) and ventral skin (Xela skin-V) of the African clawed frog (*Xenopus laevis*) have been established. Xela BMW cells have a stromal-like morphology while Xela skin-D and Xela skin-V cells have an epithelial morphology. All cell cultures were grown in 70% Leibovitz's L-15 medium supplemented with 20% fetal bovine serum at 26°C. The cell growth characteristics, viability and senescence-associated beta-galactosidase activity were assessed under normal growth conditions. The susceptibility of each cell type to infection with the ranavirus, frog virus 3 (FV3) was assessed and changes in cell viability measured. Currently, the availability of amphibian cell lines is limited. Therefore, the continuous cell cultures reported herein will be important for studying amphibian cell physiology, viral pathogenesis and for rapid screening and evaluation of the effects of environmental stressors, including contaminants, on the health of amphibian populations.

**FRED LEAL**, KATHLEEN MA, LYNN WEBER

University of Saskatchewan

**Acute cardiac effects of sublethal injection of benzo-a-pyrene and 5-azacytidine in juvenile rainbow trout (*Oncorhynchus mykiss*)**

**Effets cardiaques aigus d'injections sublétales de benzo-a-pyrène et 5-azacytidine chez les truites arc-en-ciel juvéniles**

**(*Onchorrhynchis mykiss*)**

Benzo-a-pyrene (BaP) is a ubiquitous contaminant, which exerts acute cardiotoxicity in fish and induces persistent effects via epigenetic modifications. 5-Azacytidine (5AZA) inhibits DNA methylation and was used to determine if DNA methylation plays any role in acute BaP cardiac toxicity. Juvenile rainbow trout were injected twice with control vehicle or BaP (0.1, 1mg/kg) with/without 5AZA (2mg/kg), then cardiac ultrasound performed on days 4 and 7 (n=10 fish/group/time). Heart rate increased and duration of blood flow through the atrioventricular and ventriculobulbar valves and caudal aorta decreased with 5AZA alone at Day 4. Velocity of blood flow through atrioventricular valve during atrial diastole decreased with high BaP alone. When 5AZA was administered with BaP, all values were similar to control. All cardiac function values in all groups returned to control levels at Day 7. Thus, no evidence for persistence or potentiation i.e. epigenetic mechanisms playing a role in acute cardiotoxicity was found.

**JACQUELINE LEBENZON**, LAUREN DES MARTEAUX, BRENT J. SINCLAIR

Western University

**Pass the salt: Sodium gut loading enhances cold tolerance in the fall field cricket**

**Passe moi le sel: le chargement intestinal de sodium améliore la tolérance au froid chez le grillon automnal**

In the fall field cricket, *Gryllus pennsylvanicus*, sodium and water follow concentration gradients from the haemolymph to the gut during chill coma. Recovery from coma occurs upon reversal of this ion redistribution. We hypothesized that recovery time will be determined by the  $[Na^+]$  gradient between the haemocoel and gut, because that will determine the number of ions that must be redistributed during recovery.  $CT_{min}$  did not differ among crickets fed high (540 mM), medium (180 mM) or low (8 mM) sodium diets, or those with varying osmolality. Feeding crickets high sodium diets reduced chill coma recovery time, but diet osmolality did not affect recovery time, suggesting that it is the ion (not osmotic concentration *per se*) gradient that determines recovery time. Faster recovery time in crickets with sodium-loaded guts occurs because the reduced haemocoel-gut sodium gradient decreases the amount of ion redistribution required during recovery, thus speeding chill coma recovery.

**JONATHAN LEE**, KEENAN BOUGHTON, PETRA HERMANN, WILLEM WILDERING

University of Calgary

**Metabolic alterations in aging neurons: evidence for age-associated shift towards NAD-linked metabolism.**

**Altérations métaboliques dans les neurones vieillissant: évidence d'un changement vers le métabolisme lié au NAD.**

Age-related neuronal failure is thought to arise from compounding structural damage incurred by an increased presence of highly destructive free radicals. Aging neurons accordingly require a great deal of energy to support maintenance and repair processes. Energy production in neurons is largely dependent on the activity of mitochondria, wherein gradual metabolic failure is synonymous with aging. While the mechanisms that propagate this deterioration are not well known, we provide evidence of a specific functional constraint that increases with age in neuronal mitochondria. Using biomarkers of cellular respiration (NADH, FAD autofluorescence; oxygen consumption), we show in *Lymnaea* that mitochondria may lose the ability to utilize fatty acids for energy as neurons age. Our results suggest that while mitochondria of young neurons likely make use of both carbohydrate (NAD-linked) and fatty acid (FAD-linked) metabolism, their counterparts in aged neurons appear to be more reliant on NAD-linked metabolism.

**MICHAEL Y.T. LIM**, RICHARD MANZON, CHRIS SOMERS, DOUGLAS BOREHAM AND JOANNA Y. WILSON

McMaster University

**The impact of fluctuating incubation temperatures on embryonic development of Lake whitefish (*Coregonus clupeaformis*)**

**Impact des fluctuations dans la température d'incubation sur le développement des grands corégones (*Coregonus clupeaformis*)**

Temperature plays a key role in fish embryo development and optimal temperature ranges vary between species. While most studies incubate fish embryos at constant temperature, in nature, temperature fluctuates both diurnally and seasonally, and may be exacerbated by human activities. Thermal effluent from industrial plants may transiently raise water temperature several degrees above ambient. Temperature fluctuations may impact development, particularly for cold-adapted species such as Lake whitefish. In this study, we have reared Lake whitefish at constant temperatures (2, 5, 8°C), with seasonal temperatures (gradually decreasing/increasing temperature to represent changing seasons), with 3°C fluctuations every other day, and with seasonal temperatures combined with 3°C fluctuations. We compare development (e.g. development stage length, hatch, morphometrics, heart rate) between these groups to clarify the effects of non-constant incubation temperature on Lake whitefish embryos, and the validity of using constant incubation temperature to evaluate temperature sensitivity during development.

**FERNANDO LOPES**, ARTHUR WANG, JOSE LUIS REYES, DEREK MCKAY

University of Calgary

**Direct contact of *Hymenolepis diminuta* activates gut epithelia and predicts host permissiveness**

**Le contact direct avec *Hymenolepis diminuta* active l'épithélium des intestins et prédit la permissivité de l'hôte**

Little is known of the interaction between the rat tapeworm, *H. diminuta*, and the epithelium of its host. Adult *H. diminuta* were collected from IL-4R<sup>-/-</sup> mice and a 2-cm head-neck portion cultured  $\pm$  murine (IEC4), rat (IEC6) or human (T84) epithelial cells. Helminth condition was assessed on a 12-point scale and epithelial cytokines measured by qPCR and ELISA. Helminths

exposed to murine (non-permissive host) enterocytes fared worse than those on T84 cells; rat (natural definitive host) epithelia sustained the healthiest appearing worms. Reciprocally, murine IEC4s exposed to *H. diminuta* showed significant up-regulation of TH2-polarizing cytokines (e.g. interleukin (IL)-25): this was not the case for rat enterocytes, which had little, if any response to *H. diminuta* (assessed by qPCR). Human epithelia displayed a response intermediate between mouse and rat, consistent with case reports of this helminth in immunocompromised individuals. Thus, the epithelium appears critical in directing the host response against *H. diminuta*, determining eradication or establishment of the parasite.

**ANDREAS LUEK**, NILO SINNATAMBY, MARK POESCH, JOSEPH RASMUSSEN

University of Lethbridge

**Trophic linkages in aquatic food webs of rivers affected by oil sand development**

**Liens entre réseaux trophiques aquatiques dans les rivières affectées par le développement des sables bitumineux.**

Long-term fish community surveys show substantial changes in fish health and reduced abundances of key fish species of recreational and commercial interest in the Lower Athabasca River basin. Oil Sands development in the region has been identified as the main driver of environmental change, causing alterations in the hydrology and water chemistry downstream of mined watersheds. While changes in flow regimes can have direct effects on recruitment success, and diminished water quality directly affects fish health, consequences on the trophic structure of aquatic food webs are poorly understood. We utilize aquatic community surveys and employ stable isotope analysis to identify variations in trophic linkages in aquatic food webs in the Lower Athabasca River and its tributaries to understand food-web mediated effects of Oil Sand development. Changes in diversity and abundance at any trophic level can result in cascading effects through the food web, reducing ecosystem productivity and resilience.

**LIEN T. LUONG**, LUDMILA R. PENONI, COLLIN J. HORN, AND MICHAL POLAK

University of Alberta

**Physical and physiological costs of ectoparasitic mites on host flight endurance**

**Coûts physiques et physiologiques des mites ectoparasitaires sur l'endurance de vol des hôtes**

Dispersal is essential for locating mates, new resources, and to escape unfavourable conditions. Ectoparasites in particular can adversely affect host flight performance by diminishing flight aerodynamics and/or by inflicting physiological damage. We conducted experimental flight assays using two fruit fly-mite systems: *Drosophila nigrospiracula* - *Macrocheles subbadius* and *D. hydei* - *M. muscaedomesticae*. The results show that the presence of mites (attached) significantly decreased flight endurance by 57% and 78% compared to uninfected *D. nigrospiracula* and *D. hydei*, respectively. The physiological damage caused by *M. subbadius* was revealed through a 53% decline in flight time among previously infected flies (mites removed just prior to flight assay). Surprisingly, the presumably phoretic *M. muscaedomesticae* also caused a significant 62% decline reduction in flight endurance among previously infected *D. hydei*. These results suggest a strong deleterious effect of ectoparasitic mites on host flight, mediated by a reduction in flight aerodynamics and damage to host physiology.

**YANJU MA**, CRISTINA PEREZ, BRIAN BRANFIREUN AND CHRIS GUGLIELMO

University of Western Ontario

**Flight performance in a songbird exposed to elevated dietary methyl-mercury**

**Performance de vol chez un oiseau chanteur exposé à des taux élevés de méthylmercure alimentaire**

Many songbirds migrate and are exposed to different mercury (Hg) concentrations during their annual cycle, and mounting evidence indicates that environmental Hg exposure may cause reductions in avian fitness. However, how the Hg levels we observe in migratory songbirds affect migration is still unknown. We hypothesize that Hg, as a neurotoxin, negatively affects flight performance in migratory songbirds. We predict that: experimental exposure to dietary Hg that induces realistic blood Hg concentrations for wild birds will reduce take-off and endurance flight performance in a wind tunnel. Our dosing experiment shows that warblers in a hyperphagic, migratory state rapidly bioaccumulate dietary Hg to 10 – 20 fold over 2 weeks. We will manipulate dietary Hg and measure relationships between Hg and take-off speed, flight propensity, voluntary flight duration, number of flight interruptions, and flight energy cost. Our results will fill a knowledge gap in our present understanding of Hg in the environment.

**SARA MACKELLAR**, ANDREA MORASH, JASON SEMMENS, SUZIE CURRIE

Mount Allison University

**The physiological effects of lowered salinity on two species of juvenile hound sharks in a Tasmanian estuary**

**Effets physiologiques de salinité réduite sur les juvéniles de deux espèces de requins dans un estuaire en Tasmanie**

Estuaries serve as protective nursery grounds for many marine sharks, including gummy (*Mustelus antarcticus*) and school sharks (*Galeorhinus galeus*), but are susceptible to salinity changes. Tracking data indicate different movement patterns for these sharks in response to lowered salinity, leading us to hypothesize that they will have distinct physiological responses to hypo-osmotic stress. Juveniles from a Tasmanian nursery were exposed to 70% SW for 48 h, followed by 12 h recovery at 100% SW. We predicted that gummy sharks would experience more physiological stress than school sharks because they behaviourally avoid hypo-saline waters. Our data indicate that both species osmoconform through loss of ions and urea, but in contrast to our prediction, under these hypo-osmotic conditions, school sharks significantly induce heat shock proteins (HSPs), while gummy sharks do not. This robust stress response in the highly migratory school sharks may be adaptive for this species

to deal with variable environments.

**ADITYA K. MANEK**, DYLAN STEINKEY, CINDY MEAYS, AND GREGORY PYLE

Does exposure to water hardness affect cell yield of freshwater algae (*Raphidocelis subcapitata*)?

L'exposition à l'eau dure affecte-t-elle le rendement cellulaire des algues d'eau douce (*Raphidocelis subcapitata*)?

Increasing water hardness as a result of industrial activities has been an issue for freshwaters of British Columbia. Algae are primary producers, widely distributed in aquatic systems and play a very important role in regulating an aquatic food chain. Effects of environmental toxicants on freshwater algal cell density has been widely investigated for toxicological studies in *R. subcapitata*. The main objective of this study was to investigate if exposure to different concentrations of water hardness (15, 30, 60, 120, 240, 480, 960 mg/L as CaCO<sub>3</sub>), at a constant calcium: magnesium ratio affects algal cell density following the EPS 1/RM/25 protocol. Preliminary results suggest that a 72-96 h exposure to extreme water hardness influences survival of algae. Further testing will determine if exposure to water hardness (calcium and magnesium ions under a constant and varying Ca:Mg ratio) have an effect on algal cell yield at specific concentrations of water hardness.

**KAITLIN MARASCO**, TINA JOHNSTON, PETRA HERMAN, GORDON CHUA AND WIC WILDERING

University of Calgary

**Toxicity assessment of structurally diverse model naphthenic acids using *Lymnaea stagnalis* hatching assay.**

**Évaluation de la toxicité des acides naphthéniques de structure diverse par épreuve biologique de l'éclosion chez *Lymnaea stagnalis***

There are several large oil deposits in Alberta, collectively termed the Athabasca oil sands, from which crude bitumen is recovered. The waste, or tailings, generated during this process is collected into tailings ponds, and contains a structurally diverse group of carboxylic acids broadly termed naphthenic acids (NAs) with a wide variety of molecular architectures. Remediation efforts depend on an understanding of the potential toxicity and environmental impact of NAs. Low-molecular weight model NAs have been shown to affect different aspects of the biology of the gastropod *Lymnaea stagnalis*, a pond snail native to Alberta, including a dose-dependent decrease in juvenile hatching. In addition, there is some evidence that variations in molecular structure are an important factor in the relative toxicity of these NAs in this bioassay. In order to efficiently further test these toxicity parameters of numerous samples, we developed a scaled-up hatching assay.

**DERRICK MATHESON**, SALVATORE D. BLAIR, GREG G. GOSS

University of Alberta

**Arctic grayling (*Thymallus arcticus*) gill morphological plasticity in response to acute salinity exposure**

**Plasticité morphologique des branchies de l'ombre arctique (*Thymallus arcticus*) en réponse à l'exposition à la salinité aiguë.**

Arctic grayling (*Thymallus arcticus*) are freshwater salmonids native to North America, but unlike other salmonids, do not undergo smoltification. With expanding oil industry, the threat of incidental saline water release increases the likelihood of acute salinity exposure for grayling. This study compares the impact that exposure to saline water (17ppt) on grayling and trout (*Oncorhynchus mykiss*) gill morphology. Gills were collected from fish exposed to 17 ppt saline water for 0, 24 and 96h. Histological analysis by light microscopy, scanning and transmission electron microscopy was conducted. Our study reveals a significant morphological rearrangement of the gills of grayling as demonstrated by the growth of an interlamellar cell mass (ILCM) by 24 and persisting at 96h. We demonstrate and quantify the appearance of the ILCM as a response to high salinity. We hypothesize that the appearance of the ILCM is a unique defense mechanism in grayling to cope with acute salinity stress.

**PETRA MCDOUGALL**, KATHREEN RUCKSTUHL

University of Calgary

**Age-related changes in nearest neighbour distance: the missing hypothesis.**

**Changements relatifs à l'âge dans la distance entre voisins proches: l'hypothèse manquante**

The distance between neighbouring individuals within a social group varies with age in a number of species (e.g. vervet monkeys, humans, goats, Japanese quail, and zebrafish), but the pattern of change does not appear consistent across species. Previous research suggests that these age-related changes in distance may be linked to changes in predation risk. We tested this hypothesis in a population of free-ranging bighorn sheep (*Ovis canadensis*). Specifically, we predicted that average nearest neighbour distance (NND) would be inversely related to age-specific predation risk. Furthermore, we predicted that females would maintain shorter average NNDs than males. Our results contradicted these predictions: NNDs decreased with age in males and showed no age-related changes in females. Moreover, average NNDs were larger for females than for males. These results suggest that alternative hypotheses are required to further investigate age-related changes in NND.

**GLYN A MCMILLAN** AND JOHN R GRAY

University of Saskatchewan

**Sensory bursts in a single motion-sensitive pathway of the locust.**

**Rafales sensorielles d'une seule voie de détection du mouvement chez le locuste**

In the locust, the descending contralateral movement detector (DCMD) relays information regarding object motion and has lateral projections that synapse with motor neurons involved in flight collision avoidance. While the DCMD response is typically described in terms of rate coding, responses to looming often display observable oscillations in mean firing rates and tight

clustering of spikes in raw traces. Burst coding of sensory information is common in many animals yet no studies have rigorously investigated DCMD bursting. We tested 20 locusts with 30 looming stimuli known to generate behavioural responses and found frequent and shorter inter-spike intervals (ISIs) ranging from 1-8 ms, while longer less frequent ISIs ranged from 40-50 ms. A subsequent burst analysis revealed inter-burst frequencies of ~25 Hz (within the range of the wingbeat frequency of a flying locust). We propose that the DCMD may employ a bimodal coding strategy to relay information regarding looming objects.

**JUAN A. MORE BAYONA**, JEFFREY J. HAVIXBECK, MICHAEL E. WONG, DANIEL R. BARREDA

University of Alberta

**Multi-parametric analysis of phagocyte antimicrobial responses using imaging flow cytometry**

**Analyse multi-paramétrique des réponses anti-microbiennes des phagocytes par imagerie de cytométrie de flux**

In this study, we apply a imaging flow cytometry platform to understanding of phagocyte functions against invading pathogens. Overall, we find marked changes in macrophage viability, activation, proliferation and antimicrobial killing potential. Murine RAW 264.7 macrophages stimulated with *A. veronii*, a well-known pathogen responsible for infections in a range of species including mammals and fishes, maintained viability at 1, 2 and 4 hours. However, after 24 hours incubation, a marked increased of apoptotic cell death was observed. Notably, we also found that *Aeromonas veronii* induced NF-KB translocation, while simultaneously reducing the proliferative capacity of RAW macrophages. Interestingly, downstream of phagocytosis, we found a reduction in the respiratory burst responses of phagocytic cells in comparison to non-phagocytic cells. Importantly, these multiparametric approach is applicable beyond *in vitro* conditions. We provide one example, where the kinetics of acute inflammation are evaluated *in vivo* using a self resolving avian model of zymosan-induced peritonitis.

**SIMA MORTAZAVI** AND SURAJ UNNIAPPAN

University of Saskatchewan

**Glucagon Like Peptide-1 (GLP-1) Regulation of Nesfatin-1 in Stomach Cells.**

**Régulation de nesfatin-1 par Glucagon like peptide-1 (GLP-1) dans les cellules de l'estomac**

Nesfatin-1 is an anorexigenic and insulintropic hormone encoded in the precursor nucleobindin-2 (NUCB2). It is found abundant in the stomach, pancreas, and brain. Glucagon Like Peptide-1 (GLP-1) secreted from intestinal enteroendocrine cells also regulates insulin secretion and metabolism. We hypothesized that intestine is a source of nesfatin-1, and the enteric hormone GLP-1 regulates stomach nesfatin-1 synthesis and release. To test this hypothesis, we used mice tissues, and a stomach cell line that produces nesfatin-1. NUCB2 mRNA and protein are present in both small and large intestines of mice. GLP-1 stimulates nesfatin-1 mRNA expression in a stomach cell line (MGN3-1, derived from mice) at 1 post-incubation. Our results indicate the presence of nesfatin-1 in intestinal cells, and a stimulatory role for GLP-1 in regulating nesfatin-1 *in vitro*. Future studies will focus to unravel the *in vivo* actions of GLP-1 on nesfatin-1, and the mechanisms by which GLP-1 regulates nesfatin-1.

**NICOLE C L NOEL**, A PHIL OEL, MICHELE G DUVAL, AND W TED ALLISON.

University of Alberta

The Effects of Targeted Blue Cone Photoreceptor Ablation on Neighbouring Cone Subtypes in *Danio rerio*.

Effets de l'ablation ciblée de photorécepteurs côniques bleus sur les sous-types de cônes avoisinants chez *Danio rerio*

Zebrafish have the robust ability to replace lost photoreceptors after destruction, though the impact that specific ablation of one photoreceptor subtype has on neighbouring cells has not been well investigated. Our lab has engineered transgenic lines of fish to allow for targeted ablation of cone subtypes via treatment with a prodrug called metronidazole to determine what effects this specific destruction has on neighbouring photoreceptors. We hypothesize that there is no toxic bystander effect when ablating blue cones and that remaining photoreceptors undergo rewiring. Preliminary data shows no significant difference in cell death in non-target cells nor in relative abundance of remaining cones. Photoreceptor axons (telodendria) are being characterized to allow for determination of connectivity changes after ablation. This investigation may give insight into degenerative disease, elucidation of photoreceptor interaction, and determination of factors involved in retinal regeneration for eventual application into stem cell therapies to restore functional daytime vision.

**MIKE O'DONNELL** AND ESAU RUIZ-SANCHEZ

McMaster University

**Secretion and reabsorption of Na<sup>+</sup> and K<sup>+</sup> by Malpighian tubules of the cabbage looper *Trichoplusia ni*: a novel role for type II cells.**

**Sécrétion et réabsorption de Na<sup>+</sup> et K<sup>+</sup> par les tubules de Malpighi de la fausse-arpenteuse du chou *Trichoplusia ni*: nouveau rôle des cellules de type II**

There are six morphologically distinct regions of the excretory system in larval Lepidoptera: rectal complex, rectal lead, ileac plexus, white Malpighian tubule (MT) yellow MT and urinary bladder. Approximately 80% of the cells in the ileac plexus are type I, and the remaining are type II (secondary or stellate cells). We used the scanning ion-selective electrode technique (SIET) to identify regions of Na<sup>+</sup> and K<sup>+</sup> secretion or reabsorption in the intact renal system. Whereas multiple studies have shown that the type II (stellate) cells in dipterans are important sites of Cl<sup>-</sup> secretion, our results indicate that the type II cells in MTs of larval *T. ni* are sites of absorption of K<sup>+</sup> and Na<sup>+</sup>, and that the adjacent type I (principal) cells secrete K<sup>+</sup> and reabsorb Na<sup>+</sup>. SIET

measurements also reveal that both Na<sup>+</sup> and K<sup>+</sup> are absorbed (from gut lumen to haemolymph) across the rectal complex.

**A. PHILLIP OEL** AND W. TED ALLISON

University of Alberta

**Transcriptional changes in photoreceptor development genes during regeneration after cone ablation in zebrafish**

**Changements de transcription dans les gènes du développement des photorécepteurs pendant la régénération après l'ablation des cônes chez le poisson zèbre**

Genes controlling differentiation of developing photoreceptors have been identified in mouse and zebrafish; however, regulation of the teleost ability to robustly regenerate lost photoreceptors remains uncharacterized. We hypothesize that genes that influence photoreceptor development are used to govern regeneration; here, we test whether they are transcriptionally active during regeneration in adult zebrafish retinas. We induced regeneration in adult zebrafish in two ways: intense light exposure, and conditional genetic ablation of either UV or blue light-sensitive cones. The genetic construct confers cell-specific sensitivity to the pro-drug metronidazole (MTZ) added to the fishwater. After injury, we examined the transcriptional activity of several photoreceptor differentiation genes over a time-course by quantitative PCR analysis. Examining gene activity during regeneration allows us to characterize regulation of regeneration; to identify genes critical to the regeneration of cone photoreceptors; and finally, to build a foundation upon which to understand the loss of neuro-regenerative ability in derived vertebrates.

**NICHOLAS P O'NEIL** AND ANDREW N IWANIUK

University of Lethbridge

**Individual variation in the ruffed grouse (*Bonasa umbellus*) drumming display**

**Variation individuelle dans le signal de tambourinage de la gélinotte huppée (*Bonasa umbellus*)**

During the breeding season, male ruffed grouse (*Bonasa umbellus*) produce a unique, non-vocal wing-beat display called 'drumming'. Despite using drumming as a means of censusing grouse population, little is known about how this display is used, if individuals vary or if it contains information about male quality. Here, we use bioacoustic analyses and playback studies to determine how consistent drumming patterns are within individuals, when they drum the most, and how individuals respond to different drumming patterns. Males exhibit little intra-individual variation and high inter-individual variation in the speed at which they drum throughout the season. The time of year and day that males drum appears to be driven primarily by photoperiod with peaks in drumming activity prior to sunrise. Last, the response to playbacks varies greatly among males. Taken together, our data suggests that individual discrimination is possible, but whether males are capable of individual discrimination is unclear.

**VAN A. ORTEGA**, MARKIAN BAHNIUK, SHARYAR MEMON, LARRY UNSWORTH, JAMES L. STAFFORD and GREG G. GOSS

University of Alberta

**The effects of polymer-coated nanoparticles on the phagocytic capacity and viability of immune cells**

**Effets de nanoparticules enduites de polymères sur la capacité phagocytaire et la viabilité des cellules immunitaires** The aim of this study was to determine the effects of polyacrylic acid (PAA) coated metal-oxide NPs on the phagocytic capacity of mast cells, which are resident in mucosal linings of respiratory and gastrointestinal systems and are principle cells for augmenting inflammation and allergies. *Escherichia coli* (*E. coli*) expressing Green Fluorescent Protein (GFP) were used to stimulate phagocytosis in RBL-2H3 cells, as measured by flow cytometry. We found increased cellular phagocytosis of *E. coli* when opsonized with plasma proteins pre-exposed to PAA-NPs. Parallel western blot experiments demonstrated that PAA-NPs bind a variety of human blood proteins important for the activation of immune function. By contrast, pre-exposure of RBL-2H3 cells to increasing concentrations of NPs (1-200 µg/mL) for 1-24 h decreased phagocytic capacity of RBL-2H3 cells indicating that direct cell exposure negatively affects phagocytosis. Using confocal microscopy, fluorescently labeled-PAA-NPs were visualized inside the RBL-2H3 cells and may have contributed to observed increases in RBL-2H3 apoptosis.

**RACHEL PARKINSON**, JOHN R. GRAY

University of Saskatchewan

**The effects of a neonicotinoid pesticide on the looming response of an insect motion detection pathway**

**Effets d'un pesticide néonicotinoïde sur la réaction de "looming" dans une voie de détection du mouvement d'un insecte**

The neonicotinoid pesticide, imidacloprid, is widely used as a control agent in agriculture. It is selectively toxic to insects, binding to insect nicotinic acetylcholine receptors (nAChR) with higher affinity than to the mammalian nAChR. We tested putative sublethal effects of imidacloprid on a behaviourally-relevant neural pathway in locusts (*Locusta migratoria*), which are important agricultural pests. The Descending Contralateral Movement Detector (DCMD) is a motion sensitive neuron in the locust brain that is involved in collision avoidance and escape from predators. Locusts were injected with 200ng (approximately 100ng/g) imidacloprid. Within minutes after injection, DCMD activity was sporadic and did not respond to an approaching object. While responses resumed twenty minutes later, DCMD fired at a lower frequency than before injection. A longer duration of the decay phase of the DCMD response profiles suggests systemic effects on a neural network upstream of the DCMD and impairment of an important motion detection system.

**PASUPULETI VENKATA KIRAN** AND SURAJ UNNIAPPAN

University of Saskatchewan

**Nesfatin-1 Modulates Ghrelin and Leptin in Mouse Insulinoma (MIN6) Cells**

**Nesfatin-1 contrôle Ghrelin et Leptin dans les cellules d'insulinoma (MIN6) de souris**

Gastrointestinal and brain hormones regulate appetite and energy homeostasis. Nesfatin-1 is an 82 amino acid metabolic peptide. It is co-produced with insulin in rodent pancreatic islet beta cells, and stimulates insulin secretion. The main goal of this study was to analyze whether nesfatin-1 affects two insulin regulatory hormones, leptin and ghrelin, to mediate its insulinotropic effects. We used mouse insulinoma (MIN6) cells for *in vitro* studies. mRNAs encoding for leptin and ghrelin are expressed in MIN6 cells. Fluorescence microscopy revealed that MIN6 cells are immunopositive for nesfatin-1, leptin and ghrelin. A very preliminary study found that ghrelin and leptin mRNA in MIN6 cells increased at 1 hour after *in vitro* incubation with synthetic nesfatin-1 (100 nM). Additional *in vitro* and *in vivo* studies are required to determine the precise role of nesfatin-1 on pancreatic islet derived leptin and ghrelin synthesis and secretion.

**JOSHUA G PEMBERTON**, FEDERICO SACCHI, NICHOLAS P CHURCHILL, MALCOLM LARAQUE, GEORGE KINLEY, ENEZI KHALID, JAMES L STAFFORD, AND JOHN P CHANG

University of Alberta

**Basal and Agonist-Selective Control of Pituitary Cell Signal Transduction Networks**

**Contrôle de base et sélectif aux agonistes des réseaux de transduction de signaux des cellules pituitaires**

In all vertebrates, luteinizing hormone (LH) and growth hormone (GH) released from the pituitary gland regulates sexual maturation and somatic growth. As an important part of understanding the coordinate control of reproduction and growth, our research has focused on how activation of intracellular signal transduction regulates LH and GH synthesis as well as release in goldfish, a classical model organism used for studies of neuroendocrine signalling. Results showed that signalling pathways selectively participate in the control of hormone release and synthesis in a time-, pituitary cell type-, and agonist-specific manner; furthermore, changes in total LH and GH availability are often dissociated from their known mRNA expression profiles. Overall, these findings add to our understanding of how basal and agonist-stimulated intracellular signaling within the neuroendocrine system contributes to the coordinate regulation of whole-organism physiology. (Supported by the University of Alberta Dissertation Fellowship, NSERC, AIHS, and Killam Trusts)

**HAYDEE PERALTA-VAZQUEZ** AND MARY REID

University of Calgary

**The risk of hitchhiking: a story of phoretic mites and their beetles.**

Dispersal is a complex and risky condition-dependent endeavor. And from a phoretic species' perspective cost of dispersal might be tied to the success or failure of dispersal of the host. This is particularly relevant for phoretic organisms since they don't have other means of transportation after depletion of a current resource besides relying for carriage on their insect hosts. Using mountain pine beetle (MPB; *Dendroctonus ponderosae*) and its phoretic mites, we aimed to examine whether there is cost for mites associated to the flight behavior of adult beetles using automated flight mills. So far, our results indicate that long-distance dispersal for mites is indeed costly but traveling on good condition beetles could outweigh the cost.

**ALEXANDER C PERRY**, PETRA M HERMANN AND WILLEM C WILDERING

University of Calgary

**Plasma membrane correlates of neuronal aging: probing lipid peroxidation- and PLA2-associated changes in plasma membrane microarchitecture as possible factors in neuronal aging.**

**Corrélatés de la membrane plasmique du vieillissement des neurones: étude des changements dans la micro-architecture de la membrane plasmique associés à la peroxydation des lipides et au PLA2 en tant que facteurs responsables du vieillissement des neurones**

Normal brain aging is typically accompanied by a host of neurobiological changes that manifest themselves in various symptoms, including learning and memory impairment. Using a snail model system of neuronal aging (*Lymnaea stagnalis*) we identified peroxidation of plasma membrane polyunsaturated fatty acids (PUFAs) and concomitant phospholipase A2 (PLA2) activation as key components of the neurophysiological and memory impairment that characterizes aging in this gastropod. The mechanism(s) through which PUFA-peroxidation and PLA2 activation lead to age-associated neurophysiological and behavioural impairment in this model system are currently not known but may include a decline in plasma membrane barrier function due to increasing lipid packing deficits. To examine this hypothesis membrane integrity of neurons of different ages is tested using normally membrane impermeant probes (e.g., propidium iodide). These experiments suggest that subtle age-associated changes in plasma membrane barrier functions are indeed one of the exponents of neuronal aging in this model system.

**PHILLIP PHAM-HO** AND MICHAEL P. WILKIE

Wilfrid Laurier University

**Mechanisms of Brain Swelling in the Rainbow Trout and in the Goldfish (*Carassius auratus*).**

**Mécanismes d'engorgement du cerveau chez la truite arc-en-ciel (*Oncorhynchus mykiss*) et chez le poisson rouge (*Carassius auratus*)**

In fishes, increased internal ammonia results from high external ammonia (HEA) exposure, or following feeding or vigorous



exercise. At toxic levels, ammonia causes increased brain water content and swelling in fishes, but the underlying mechanisms are poorly understood. To test the hypothesis that brain swelling arises from ammonia-induced over-excitation of N-methyl-D-aspartate receptors (NMDAr), trout and goldfish were administered MK801, an NMDAr antagonist, to determine if brain swelling was reduced during HEA exposure. After 48h HEA, plasma ammonia levels increased 10-fold in both trout ( $[Amm]_{H_2O}=1\text{mmolL}^{-1}$ ) and goldfish ( $[Amm]_{H_2O}=5\text{mmolL}^{-1}$ ) resulting in 13% and 15% increases in brain water content, respectively. Administration of MK801 prior to HEA attenuated brain swelling in trout, but not goldfish. We suggest that over-activation of the NMDAr maybe a key event leading to brain swelling in trout, but not goldfish. Measurements of  $Na^+$  and  $K^+$  also indicated that ammonia caused ionic disturbances in the brain of both species.

**DANIELLE PHILIBERT**, CARLIE LEWIS, KEITH TIERNEY  
University of Alberta

#### **A comparison of conventional crude oil and dilbit developmental toxicity to zebrafish**

#### **Comparaison entre la toxicité développementale du pétrole brut classique et du pétrole de bitumen dilué chez les poissons zèbres.**

The toxicity of diluted bitumen oil (dilbit) has been largely understudied, despite widespread transport and potential exposure. This study compared the effects of exposure to low and high concentrations of water accommodated fractions (WAFs; 1/1000 and 1/10 oil to water, respectively) of dilbit and conventional sweet blend crude oil using larval zebrafish. Fish were exposed from 30 min to 7 days post-fertilization (dpf) and scored for survival, incidence of pericardial edema, yolk sac edema, abnormal tail curvature and hatch rate. Heart rate was measured at 2 dpf and basal activity was recorded at 7 dpf. Low concentration WAFs had no effects; high concentration WAFs of both oil types increased pericardial and yolk sac edema, and decreased survival. The survivorship values (7d LC50) indicated that mixed sweet blend crude was more toxic than dilbit, demonstrating that the risks associated with dilbit are less or no different from those of conventional crude.

**JENNIFER L A PYLYPIW**, W TED ALLISON  
University of Alberta

#### **Understanding the evolution of eye degeneration using a zebrafish model**

#### **Comprendre l'évolution de la dégénération de l'oeil en utilisant le poisson zèbre comme modèle.**

The Mexican cavefish, *Astyanax*, has been an important organism to study regressive evolution due to eye loss in cave populations. Regressive Evolution suggests that improvements to other sensory systems are positively selected, and secondary pleiotropic effects lead to eye degeneration. Alternatively, eye degeneration might occur first and subsequent improvement in other senses would be adaptive. We are testing this by characterizing  $gdf6^{-/-}$  microphthalmic zebrafish mutants that lack eyes and thus have no previous evolutionary pressure driving eye reduction. **The latter hypothesis predicts that microphthalmic fish will have increased other sensory abilities and will outcompete normophthalmic fish in dark situations.** Behavioural assays will investigate prey capture efficiency of eyeless  $gdf6^{-/-}$  zebrafish in dark conditions compared to normal fish. Sensory cells near the lips and barbels appear to be more abundant in microphthalmic compared to normophthalmic fish, arguing against the hypothesis that selection for these characters preceded or led to eye degeneration.

**NARESH RAMESH**, SIMA MORTAZAVI, SURAJ UNNIAPPAN  
University of Saskatchewan

#### **Nesfatin-1 Regulation of Enteric Hormone Secretion in Mice**

#### **Régulation par Nesfatin-1 de la sécrétion entérique d'hormones chez les souris**

The hormones secreted by intestinal enteroendocrine cells, GLP-1 and GIP (incretins), CCK and PYY, all regulate insulin secretion. While incretins and CCK are insulinotropic, PYY is insulinostatic. Nesfatin-1 is an anorexigenic and insulinotropic peptide found abundantly in the gut, brain and pancreas. The objective of this research was to test whether nesfatin-1 regulates enteric hormone secretion. NUCB2/nesfatin-1 immunoreactivity was detected in STC-1 (intestinal endocrine) cells and in the small and large intestines of mice, where it was found to be co-localized with CCK, GLP-1 and PYY. STC-1 cells treated dose-dependently with nesfatin-1 increased proglucagon/GLP-1, GIP, and CCK mRNA expression and secretion, while decreased PYY mRNA expression and secretion. These novel results demonstrate a direct action of nesfatin-1 in regulating enteric hormone secretion *in vitro*. The role of intestinal hormones in mediating nesfatin-1's role in regulating energy balance remains to be elucidated.

**JORDAN C ROBERTS** AND DOUGLAS A SYME  
University of Calgary

#### **Effects of anaesthetics during euthanasia on the mechanical properties of compact myocardium from rainbow trout: are anaesthetics contraindicated for euthanasia?**

#### **Effets des anesthésiants pendant l'euthanasie sur les propriétés mécaniques du myocarde compact des truites arc-en-ciel: les anesthésiants sont-ils contre-indiqués pour l'euthanasie?**

Many anaesthetics work through depressing cell excitability. Thus, when researching excitable tissues (muscle and nerve), physical euthanasia methods without the use of anaesthesia is standard. However, it is unknown if these depressive affects persist after isolation, washout, and saline perfusion of isolated tissues following euthanasia, and thus whether it is acceptable to first anaesthetize fish before physical euthanasia if working on isolated tissues. Here we explore if there are residual effects

of Tricaine methanesulfonate (MS222) or Metomidate (Aquacalm) during euthanasia on the contractile properties (force and work output) of isolated and perfused rainbow trout compact myocardium. Results suggest that both anaesthetics, when used at standard doses during euthanasia and washed out prior to tissue experimentation, do not have an effect compared to performance following physical euthanasia alone. Therefore, the use of MS222 or Metomidate prior to euthanasia may be indicated when conducting research on isolated rainbow trout myocardium.

**CAYLEIGH E. ROBERTSON**, TAYLOR B. VALEE, GRANT B. MCCLELLAND

McMaster University

**Differential remodelling of brown and white adipose tissue in high altitude deer mice (*Peromyscus maniculatus*)**

**Remodelage différentiel du tissu adipeux brun et blanc chez la souris sylvestre (*Peromyscus maniculatus*) de haute altitude**

Low oxygen and temperature at altitude are particularly challenging for small mammals due to high energetic demands and thermogenic costs. We hypothesized that highland mice have a high capacity for phenotypic plasticity in their brown and white adipose tissue (BAT, WAT) to produce heat and provide lipid substrates. We acclimated highland native *Peromyscus* to 20 weeks of: normoxia, hypoxia, cold (5°C) or hypoxia/cold. We determined protein content of uncoupling protein-1 (UCP-1) normalized to the mitochondrial marker citrate synthase (CS), and gene expression of *ucp-1* and  $\beta$ -adrenergic receptor-3 (*βadr3*). We found that cold increased CS and UCP-1 in BAT, indicating an increased non-shivering thermogenesis capacity. In contrast, hypoxia increased WAT CS and *ucp-1* while cold had no effect. *βadr3* also increased in response to hypoxia/cold in WAT suggesting increased sensitivity to adrenergic stimulation. BAT and WAT may differentially remodel to cope with the energetic tradeoffs between cold and hypoxia.

**SYDNEY RUDKO**, NORMAN NEUMANN, AND PATRICK HANINGTON

University of Alberta

**A qPCR diagnostic test to detect *Enterobius vermicularis* present in wastewater**

**Un test diagnostique par PCR quantitatif pour détecter la présence d'*Enterobius vermicularis* dans les eaux usées**

Reuse of partially treated wastewater is gaining interest for various residential, agricultural and industrial applications. However, little is understood about the risk of pathogen presence in this water. Notably, there is a significant knowledge gap surrounding helminthic ova removal during treatment. We are designing and implementing a qPCR-based diagnostic test able to detect as few as 2 gene copies of the 5S rRNA gene of *Enterobius vermicularis* in a wastewater matrix. While Enterobiasis is not a significant health burden, it is a good indicator for parasitic-helminth ova removal across the wastewater treatment process, as its eggs have a low specific density and therefore are able to escape the sedimentation process. Our test shows that the treatment process reduces the amount of *E. vermicularis* ova from the water, but that ova still persist in Pre and Post UV treated water, which may be hazardous depending on the proposed reuse.

**LANA SHAYA** AND JOANNA Y. WILSON

University of McMaster

**The role of aryl hydrocarbon and pregnane X receptor in CYP3C gene regulation in Zebrafish.**

Rôle de l'hydrocarbure aryle et du récepteur de pregnane X sur la régulation génétique de CYP3C chez les poissons zèbres  
Mammalian Cytochrome P450 (CYP), family 3 enzymes are highly expressed in detoxification organs and play a critical role in xenobiotic metabolism. In fish, the CYP3 family is diversified and includes several subfamilies not found in mammals. The regulation and functional roles of novel 3B, 3C and 3D proteins in fish are not clear. Multiple CYP3C genes were more highly expressed in zebrafish liver and/or intestine from at least one gender, suggesting a role in xenobiotic metabolism. Response elements for the aryl hydrocarbon (AHR), androgen and estrogen receptors were found upstream of CYP3C genes, suggesting a role for multiple nuclear receptors in fish CYP3 gene regulation. Mammalian CYP3A is regulated by the pregnane X receptor (PXR). We have exposed zebrafish to beta-naphthoflavone (AHR agonist) and dexamethasone (PXR agonist) and assessed CYP3C gene expression via quantitative PCR. This data will aid in determining the regulatory mechanisms in fish CYP3 gene expression

**EDYTA SIEMINSKA**, MARTIN A. ERLANDSON, DWAYNE D. HEGEDUS, JOHN R. GRAY

Agriculture and Agri-Food Canada/University of Saskatchewan

**Characterization of pheromone communication channel in bertha armyworm, *Mamestra configurata***

**Caractérisation de la voie de communication par phéromone chez le légionnaire bertha, *Mamestra configurata***

Bertha armyworm (BAW) is one of the major insect pests in western Canada but despite its economic importance little is known about its biodiversity with respect to genotypes and phenotypes that occur across the BAW geographical range. We have established colonies from two distinct geographic locations in addition to a pre-existing colony reared since 1974. Total RNA libraries from head and antennae of males and females for each BAW strain were sequenced using pair-end Illumina and subjected to bioinformatic analysis. I have identified 90 putative chemosensory BAW genes including 10 gene products implicated in pheromone channel communication. Preliminary bioinformatic analysis confirms genetic differences among the geographic BAW strains. Behavioral differences in response of males to commercially available pheromone blends; strain specific pheromone gland extracts; and the effect of the presence of host plant volatiles on male response are investigated with wind tunnel and GC-EAD bioassays.

**NILO SINNATAMBY**, WILLIAM SHOTYK, MARK POESCH

University of Alberta

**Determining the relative impacts of contaminants from natural and industrial sources on aquatic biota in the Lower Athabasca region**

**Impacts de contaminants provenant de sources naturelles et industrielles sur les biomes aquatiques dans la région du Lower Athabasca**

Concern is growing over potential environmental impacts of anthropogenic water use and contaminant emissions from oil sands development in the Lower Athabasca region. Particular concern exists regarding fish health and contaminant load because of perceived increases in fish deformities, and complaints about unnatural tasting fish since the onset of industrial development in the region. Although the presence of bitumen-associated contaminants have typically been attributed to industrial activity within the public and media, current scientific debate exists over the relative roles of natural seeps, which contribute salts and complex dissolved organic mixtures to the watershed, and industrial emissions of similar compounds. We assess variability in water quality along the Athabasca River, and its impact on aquatic biota. As part of a multidisciplinary project resolving the relative contributions of natural and anthropogenic sources to the Athabasca River, we aim to assess whether and how variations in contaminant sources influence biota.

**FRANK SMITH**, MATT STOEYK AND ROGER CROLL

Dalhousie University

**Autonomic control of cardiac chronotropy in zebrafish**

**Contrôle autonome de la chronotropie cardiaque chez le poisson zèbre**

The autonomic nervous system is the primary agent for short-term control of rate in the vertebrate heart, but the intracardiac neural circuitry for chronotropy is not known. In the zebrafish heart we have identified putative pacemaker cells at the sinoatrial and atrioventricular junctions, using antibodies against hyperpolarization-activated, cyclic nucleotide-gated channel 4 (HCN4). Terminals of axons originating within the intracardiac nervous system (ICNS) innervated HCN4-positive cells at both junctions. Electrical and pharmacological activation of the ICNS modulated *in vitro* pacemaker discharge at both sites. Vagospinal trunk stimulation and cholinergic agonists inhibited rate; this was blocked by cholinergic antagonists. Nerve stimulation during atropine exposure evoked tachycardia; this was eliminated by  $\beta$ -adrenergic blockade. The ventricle was innervated cranially by the branchio-cardiac nerve, coursing to the heart along the ventral aorta; electrical stimulation of this nerve evoked tachycardia. This study provides the first detailed description of chronotropic neurocardiology in the zebrafish.

**SARA J SMITH**, ROWAN DH BARRETT, AND SEAN M ROGERS

University of Calgary

**The evolution of thermal tolerance and preference in marine and freshwater Threespine Stickleback (*Gasterosteus aculeatus*)**

**L'évolution de la tolérance et de la préférence thermique chez les épinoches à trois épines (*Gasterosteus aculeatus*) marines et d'eau douce**

Temperature is a predominant factor in species distributions, but ecological and evolutionary consequences of temperatures associated with climate change remain poorly understood. Whether ectotherms relocate, exhibit phenotypic plasticity, or adapt to these temperature changes remains unknown. In this study, I will test evolutionary predictions about the nature of thermal preference and tolerance based on differences in habitat and habitat utilization between marine and freshwater threespine stickleback (*Gasterosteus aculeatus*), which differ in both behaviour and physiology. Phenotypic variation will be measured under a common garden design using lab-raised F1s and hybrids. Parallel trials will be used to test predictions about correlated selection in new environments. Differences between marine and freshwater F1 fish would indicate a genetic basis, while covariation between traits will infer whether correlated selection may contribute to rapid evolution in freshwater systems. Data will help elucidate the mechanisms underlying correlated traits and selection in association with rapid environmental change.

**SHRUTI SRIVASTAVA**, DEREK M. MCKAY AND JAMES D. WASMUTH

University of Calgary

**In-silico investigation of cestode proteomes to predict host mimicking proteins.**

**Enquête in silico des protéomes de cestodes afin de prédire les protéines qui imitent les hôtes**

The members of Cestoda (Platyhelminthes), are considered as major parasites of humans and livestock worldwide. These long lived parasitic helminths cause chronic infections which invoke immune responses in host, leading to pathological changes. It is known that parasites secrete proteins into their host that interfere with the immune response, promoting parasite survival. We hypothesise that these parasite proteins have evolved to mimic the structure and function of host proteins. With genome sequences for seven cestodes freely available, our current study is developing a bioinformatics pipeline to identify short regions of parasite proteins that mimic host's immune proteins. Structural modelling of these regions will highlight their putative role, which can then be experimentally validated. Our initial focus is *Hymenolepis diminuta*, which maintains a chronic infection in rats, but a short-lived infection in mice. Sequence-based comparison for differences in the two host's immune proteins will improve our searches.

**DYLAN STEINKEY**, ADITYA MANEK, GREGORY PYLE

University of Lethbridge

**Sourcing fish chemical alarm cues in fathead minnows (*Pimephales promelas*)**

**À la recherche de la source d'indices chimiques d'alerte chez les alevins de têtes-de-boule**

During a predation attack ostariophysan fishes release a chemical alarm cue into the surrounding water upon damage to their skin. Once the cue is perceived through olfaction, conspecifics can take defensive actions, such as fleeing or seeking refuge. Although the fathead minnow chemical alarm system is well known, the precise source of the alarm cue is still not clearly understood. Many studies suggest that the epidermal club cells (ECCs) produce alarm cues. Contrary to these findings, some studies suggest that these cues might not be produced in ECCs. The primary objective of this study was to separate the cells in the fathead minnow epidermis and determine which cells elicit a strong anti-predator response in conspecifics, i.e. contain the chemical alarm cue. Findings of this study will help in understanding which cell type(s) in the epidermis is/are involved with alarm cue production.

RAVINDER SAPPAL, **DON STEVENS**, COLLINS KAMUNDE

UPEI

**Modulation by hypoxia-reoxygenation of the toxic effect of copper on mitochondrial electron transport system activity in control and warm-acclimated and rainbow trout.**

**Modulation par réoxygénation d'hypoxie de l'effet toxique du cuivre sur l'activité du système de transport d'électrons des mitochondries chez les truites arc-en-ciel contrôle et acclimatées au chaud**

Rainbow trout were maintained at 11 °C (controls) or warm-acclimated to 20 °C for 2 months. Liver mitochondria were isolated and their responses *in vitro* to Cu (20 µM) without and with hypoxia-reoxygenation (HRO) were assessed. Sequential inhibition and activation of ETS enzyme complexes permitted the measurement of respiratory activities supported by complexes I-IV (CI-IV) in one run. Our results suggested that warm-acclimation blunted sensitivity of the ETS to temperature rise and that HRO and warm-acclimation imposed mitochondrial changes that sensitized the ETS to Cu. Overall, ETS impairment appears to be core to mitochondrial bioenergetic dysfunction associated with warm-acclimation, HRO and Cu exposure.

**Matthew R Stoyek**, T Alexander Quinn, Roger P Croll, Frank M Smith

Dalhousie University

**Illuminating cardiac function: optical imaging of voltage dynamics in the zebrafish heart**

**Illuminer la fonction cardiaque: imagerie optique de la dynamique du voltage dans le Coeur du poisson zèbre**

Propagation of electrical excitation through connected cardiomyocytes is an essential physiological process for heart contraction. Optical mapping, using fluorescent probes to investigate functional parameters, offers a spatially resolved, high-resolution, non-contact, method to investigate electrical activity in the heart. Within the zebrafish heart, two pacemaker loci were identified. The sinoatrial node (SAN), in the sinoatrial valve leaflets, was the primary site of initiation of the normal heartbeat. Electrical stimulation of the vagosympathetic trunk slowed rate and delayed spread of excitation to the atrial wall. A secondary pacemaker site, the atrioventricular node (AVN), was identified at the atrioventricular junction. The discharge of this pacemaker was slower than the SAN after isolating the ventricle from the atrium, suggesting that the SAN normally entrains the AVN. In this study we have verified optical voltage mapping techniques to study mechanisms of neural control of chronotropy in the zebrafish heart.

**LAKSHMINARASIMHAN SUNDARRAJAN** AND SURAJ UNNIAPPAN

University of Saskatchewan

**Tissue Distribution and Functions of a Nucleobindin-1 Encoded Nesfatin-1 Like Peptide (NLP) in Fish.**

**Distribution dans les tissus et fonctions d'un "Nucleobindin-1 Encoded Nesfatin-1 Like Peptide" (NLP) chez les poissons**

Nesfatin-1 is a metabolic peptide encoded in the precursor, nucleobindin-2 (NUCB2) of mammals and non-mammals. Our *in silico* analysis found a related peptide, nucleobindin-1 (NUCB1) that exhibits very high sequence similarity to NUCB2. NUCB1 also encodes a nesfatin-1 like peptide (NLP). We hypothesized that NUCB1/NLP is a biologically active peptide in fish. NUCB1 mRNA expression was detected in the central and peripheral tissues of goldfish and zebrafish. Immunofluorescence microscopy detected NUCB1/NLP immunoreactivity in the pituitary, testis, ovary and gut of goldfish. Intraperitoneal injection of 100 ng/g bodyweight of synthetic NLP decreased food intake when compared to saline injected controls. In the hypothalamus and gut of the same fish with reduced food intake, NLP downregulated preproghrelin (an appetite stimulant) mRNA expression. Our preliminary results suggest that NUCB1/NLP is present in fish and has metabolic effects. Further studies are required to better our understanding on NLP biology in fish.

**TINA E SUNTRES**, GHEYLEN DAGHFOUS, RÉJEAN DUBUC, AND BARBARA ZIELINSKI

University of Windsor

**Solitary Chemosensory Cells During the Life Cycle of the Sea Lamprey, *Petromyzon marinus***

**Cellules chimio-sensorielles solitaires durant le cycle de vie de la lamproie de mer, *Petromyzon marinus***

The sea lamprey is an invasive vertebrate species in the Great Lakes that possess a diffuse chemosensory system, with an unknown roll. These microvillar "oligovillous" solitary chemosensory cells were seen on papillae protruding along the oral disc, gill pores and tail fins of lamprey (Whitaker and Lane, 1983 J Zool 199). We utilized scanning electron microscopy (SEM) to assess abundance across life stages, and immunolabeling to identify the oligovillous cells in sectioned tissue. By SEM, the

oligovillous cells were recognized by the microvillar tufts on the surface of papillae. In sectioned preparations the cytoplasm was calretinin-immunoreactive. Acetylated tubulin and serotonin immunoreactive fibers were seen adjacent to these cells indicating innervation. The oligovillous cells were most abundant in the sexually mature spawning stage, compared to the less mature stages, suggesting a role during reproduction. This study helps in understanding the function of this diffuse chemosensory system.

**GLENN J. TATTERSALL**, RAYMOND M. DANNER, DANIELLE L. LEVESQUE, KRISTEN D. SCHUPPE  
Brock University

**Quantifying activity from thermal imaging videos using an automated script-based approach**

**Quantification de l'activité basée sur films d'imagerie thermique par utilisation d'une méthode scriptée automatisée**

Thermal imaging is generally used to capture surface temperature estimates of objects for inference of heat transfer. Time lapsed thermal imaging videos also offer the possibility of detecting movement or activity patterns without challenges associated with glare, shadows, or changes in lighting associated with visual digital imaging. We have developed a frame subtraction algorithm in R for extracting the pixel-by-pixel relative change in signal from a fixed focus video file, tailored for use with thermal imaging videos. In combination with the cumulative, absolute difference sum of the entire subtractive image, we are able to assign activity scores to thermal imaging data for comparison to simultaneous recordings of metabolic rates. In principle, this would allow for activity data to be standardised to energetic measurements.

**CAMERON G A TOTH, GORDON CHUA, AND HAMID R HABIBI**

University of Calgary

Assessing the health impact of OSPW on embryonic zebrafish (*Danio rerio*).

Évaluation de l'impact sur la santé des OSPW chez les embryons de poisson zèbre (*Danio rerio*)

Large volumes of OSPW are currently being produced by surface mining of the oil sands in Northern Alberta. Studies have shown that OSPW is acutely and chronically toxic and can be lethal at higher concentrations to aquatic organisms. However, little is known about the mechanisms of toxicity and adverse health impact caused by sub-lethal concentrations of OSPW. The objective of the present study is to identify and validate robust biomarkers to estimate no observed effect concentration (NOEC) of OSPW in zebrafish (*Danio rerio*) embryos. A series of molecular and morphological end points were identified in zebrafish embryos exposed to different concentrations of whole and fractioned OSPW. The results showed significant variations in detoxification gene mRNA levels and morphometric parameters during zebrafish development. Moreover, significant differences in OSPW toxicity were observed from distinct tailings. The results provide a better understanding of the mechanisms of OSPW toxicity in zebrafish and higher vertebrates.

**JANTINA TOXOPEUS**, RUTH JAKOBS, LAURA V FERGUSON, TARA D GARIEPY AND BRENT J SINCLAIR

University of Western Ontario

**Reproductive diapause alters stress tolerance in *Drosophila suzukii***

**La diapause reproductive modifie la tolérance au stress chez *Drosophila suzukii*** *Drosophila suzukii* (Diptera: Drosophilidae) is an invasive agricultural pest in southern Canada. Its ability to overwinter and therefore establish in this country could have severe implications for fruit crop industries. We demonstrate here that laboratory populations of Ontario *D. suzukii* larvae reared under short-day, low temperature, conditions develop into dark 'winter morph' adults similar to those reported globally from field captures, and observed by us on Pelee Island in Ontario. These adults have delayed reproductive maturity, enhanced cold tolerance, and can remain active at lower temperatures. Female *D. suzukii* have underdeveloped ovaries and altered transcript levels of genes associated with reproduction and stress. All of these traits are consistent with an adult reproductive diapause. The traits of this 'winter morph' likely facilitate overwintering in Ontario, and have probably contributed to the global success of this fly as an invasive species.

**LOUISE TUNNAH**, EMILY COREY, SUZIE CURRIE, TYSON MACCORMACK

Mount Allison University

**Some *don't* like it hot: Thermal preconditioning in wild, juvenile, Atlantic salmon (*Salmo salar*)**

**Certains ne l'aiment pas chaud: préconditionnement thermique chez les saumons de l'Atlantique sauvages juvéniles (*Salmo salar*)**

The Miramichi River has the largest remaining Atlantic salmon (*Salmo salar*) run in North America. In the summer, juvenile Atlantic salmon regularly experience temperatures up to 30°C and manage to survive. We hypothesized that thermal preconditioning underpins this phenomenon; specifically that prior exposure to warm temperatures provides protection from subsequent, more severe temperatures. Wild salmon were exposed to one of three realistic experimental conditions over 84 hours: 1) a sudden increase in temperature (16-27°C), 2) a recurring, moderate temperature fluctuation (16-21°C) followed by high temperature (27°C), and 3) a fluctuating temperature profile that builds (16-21, 18-22, 19-24°C), to a high temperature (27°C). Aerobic metabolic rate, indicators of cellular stress and damage (e.g. HSPs, ubiquitin), and energy stores (e.g. glucose, glycogen) were measured. We predict that fish exposed to the highest thermal load (3) will be least physiologically compromised by high temperature, supporting thermal preconditioning as a coping strategy in salmon.

**NGUYEN T. K. VO**, BRENNAN D. GERLACH, THERESA M. CURTIS, LUCY E. J. LEE AND NIELS C. BOLS

University of Waterloo

**Eyeing a research barrier: development of a walleye retinal epithelial cell line that expresses three classes of tight junction proteins**

**Développement d'une lignée de cellules épithéliales de la rétine du doré jaune exprimant trois classes de protéines de jonction serrée**

Epithelial cell lines are most effective in research if they express tight junction proteins (TJP) and associated barrier functions but few fish epithelial cell lines do. The retinal pigment epithelium (RPE) forms the outer blood-retinal barrier and has been a source of functional mammalian epithelial cell lines from but rarely from fish. The walleye, *Sander vitreus*, with an unusual reflective RPE was used to start a cell line, WErpe. The cell line forms a cobblestone-shaped monolayer, is highly phagocytic and expresses at least five polypeptides of the functional tight junction complex: ZO-1, occludin, claudins 1, 3 and 5. From 4-26°C, cells could exist as stable confluent monolayers, with little change in TJP organization. Monolayers yielding high impedance readings were stable for at least 100 days at a variety of storage temperatures (6-30°C). Therefore, among many possible applications, WErpe is an excellent candidate for use in portable impedance-based water-testing biosensors.

**DIRK WEIHRAUCH**, MARIAN Y. HU<sup>1</sup>, PO-HSIAN SUNG, PUNG-PUNG HWANG AND YUNG-CHE TSENG

University of Manitoba

**Acid-base regulation and ammonia excretion in the gills of the cephalopod *Octopus vulgaris***

**Régulation acido-basique et excrétion d'ammoniaque dans les branchies du céphalopode *Octopus vulgaris***

Cephalopods have evolved an active lifestyle, which is fueled predominately through protein metabolism. As a toxic waste product, ammonia needs to be excreted efficiently, presumably via the gills. In order to investigate this pathway, gills of *Octopus vulgaris* were perfused with various concentrations of ammonia, while excretion rates and pH regulatory capacities were investigated. Ammonia concentrations measured in the anterior vena cave were measured to 260 µM, while the pH of the hemolymph was with ca. 6.1 fairly low. Perfusion of the gill with artificial hemolymph adjusted to either pH 7.2 or 7.6 caused in both cases a re-adjustment to a pH of ca. 7.5. Interestingly, when perfused with artificial hemolymph containing either 75, 150, 300 or 600 µM ammonia, gills adjusted the perfusate, partly by metabolic ammonia or due to excretion, to concentrations between 200 and 400 µM, a range found in the also in the body fluids.

**JASMINE M YAKUBOWSKI** AND JOHN R GRAY

University of Saskatchewan

**Response of a locust motion-sensitive neuron to objects deviating away from a collision course in the presence or absence of optic flow.**

**Réaction d'un neurone de détection de mouvement de locuste aux objets déviant d'une collision en présence ou en absence de flux optique**

Stimulus complexity affects the response of looming sensitive neurons in many animals. In locusts, the lobula giant movement detector/descending contralateral movement detector (LGMD/DCMD) pathway not only responds to simple objects approaching along a direct collision course (i.e., looming), but also more complex motion, such as changes in velocity, trajectory and background environments. In this study, we focused on DCMD responses to objects deviating away from a collision course, which emulates a successful locust avoidance response. We presented 23 *Locusta migratoria* with a sequence of complex 3-dimensional visual stimuli in simple, scattered, and progressive flow field backgrounds while concurrently recording DCMD activity extracellularly. DCMD response time to an object transition depends on unique expansion parameters. Data from this research will contribute to a growing computational model that describes how the DCMD encodes object motion. These results will aid in our ultimate goal of understanding the neural control of behaviour.

**Hong Meng Yew** and Steve F. Perry

University of Ottawa

**In vivo measurements of intracellular pH in zebrafish H<sup>+</sup>-ATPase rich (HR) cells using ratiometric imaging**

**Mesures in vivo du pH intra-cellulaire dans les cellules de poisson zèbre riches en H<sup>+</sup>-ATPase à l'aide d'imagerie ratiométrique.**

Zebrafish (*Danio rerio*) H<sup>+</sup>-ATPase rich (HR) cells are a sub-type of ionocyte found in the zebrafish gill and larval yolk sac. The HR cells are responsible for Na<sup>+</sup> uptake and H<sup>+</sup> extrusion. Current models for Na<sup>+</sup> uptake and H<sup>+</sup> extrusion by the HR cell are based on surprisingly few direct *in vivo* data. In this study, we developed a method which allows continuous measurements of intracellular pH changes occurring in HR cells *in vivo*, using the pH-sensitive ratiometric dye 2',7'-bis-(2-carboxyethyl)-5',6'-carboxyfluorescein (BCECF). By using ammonium chloride or CO<sub>2</sub>-enriched media, we demonstrated that this method can be used to reliably track the intracellular pH of HR cells through time-lapse experiments under a fluorescence microscope. By knocking down genes proposed to be involved in Na<sup>+</sup> uptake, we demonstrated key roles for the Na<sup>+</sup>/H<sup>+</sup> exchanger paralog, NHE3b and the CA paralog, CAC (CAII-like a).

**AVA ZARE**, DARREN HENRY, GORDON CHUA AND HAMID R HABIBI

University of Calgary

**Application of toxicogenomics to assess adverse effects of exposure to environmental contaminant in male fathead minnows.**

### **Application de la toxicogénomique afin d'évaluer les effets adverses de l'exposition aux contaminants environnementaux chez les têtes-de-boule mâles**

Environmental contaminants are known to impair reproduction, metabolism and development in wild life and humans. Our main objective was to understand the mechanisms underlying adverse effects of a number of chemicals present in the Alberta Rivers [Nonylphenol, BPA, DEHP and mixture of the three chemicals] using microarray approach. Gene ontology and IPA core analysis revealed a distinct mode of actions for the individual chemicals and their mixture in the liver of male fathead minnows. In this study, we identified a number of genes as general biomarkers for screening all contaminants as well as specific markers for individual chemicals. Overall the results of this study provide novel information on mechanisms by which contaminants disrupt normal health based on pathway analysis, and identified a number of specific new biomarkers that can be used for monitoring the presence of contaminants in the aquatic environment. Study was funded by NSERC grants.

**MYRON ZWOZDESKY**, CHENJIE FEI, DUSTIN LILICO, LENA JONES & JAMES STAFFORD

Department of Biological Sciences, University of Alberta, Edmonton AB, Canada

### **Exploring the control of phagocytosis using teleost immunoregulatory receptors**

#### **Exploration du contrôle de la phagocytose à l'aide de récepteurs immuno-régulateurs de poissons téléostéens.**

Innate and adaptive immunity provide host protection from pathogens. While adaptive immunity is highly specific and tailored towards specific pathogens, specialized innate immune cell-types, like phagocytes, execute immediate and generalized anti-microbial responses. These cells recognize, internalize and destroy pathogens by phagocytosis. This receptor-mediated engulfment of targets >0.5µm requires specific intracellular signaling pathways, which lead to actin polymerization and plasma membrane remodeling.

Phagocytosis encompasses numerous related but distinct molecular mechanisms. Phagocytic immunoregulatory receptor-types have been well characterized in mammals, but much less is known about how this process is controlled in other vertebrates. My research project focuses on the examination of signaling molecule recruitment to fish immunoregulatory receptors that facilitate the phagocytic process. Since the pathways and receptors that engage phagocytosis have evolved over hundreds of millions of years, exploring this process in fish offers an opportunity to examine both conserved and potentially divergent phagocytic pathways between endothermic and ectothermic vertebrates.

## Presentation Abstracts

*Sorted according to surname of presenting author (underlined)*

**ROOHOLLAH ABBASI** AND JEFFREY M. MARCUS

Department of Biological Sciences, University of Manitoba, Winnipeg, MB, Canada.

**A new A/P compartment boundary and organizer in the developing wings of holometabolous insects.**

**Une nouvelle limite de compartiment antéro-postérieur et un nouvel organisateur actifs durant le développement des ailes d'insectes holométabolistes.**

We studied compartment boundaries in holometabolous insects using butterflies and *Drosophila* as models. Independent Contrast Analysis (ICA) analysis of Vanessa butterflies revealed significant correlations between eyespots 2 and 5 and eyespots 3 and 4 on all wing surfaces. Examination of the wing patterns across all families of butterflies revealed correspondence between wing cells 1 and 4 and between cells 2 and 3. Evaluation of spontaneous mitotic clones in butterflies and moths reveals a peak abundance of clonal boundaries along the vein dividing wing cells 2 and 3. Finally, in FLP/FRT wing clones produced in *Drosophila*, there is a clonal boundary posterior to the L5 wing vein which is homologous to the vein dividing wing cells 3 and 4 in butterflies. Collectively, these findings suggest the existence of an additional compartment boundary associated with an organizer in wing cell 3 that is responsible for patterning the posterior portion of insect wings.

**RAY SANWALD, TINGJIA LORENGIANO, BRIAN MCGILL, AND EHAB ABOUHEIF**

McGill University

**Climate change signature on slave-raiding behaviour in ants**

**Signature du changement climatique sur le comportement de mise en esclavage chez les fourmis**

Climate change influences a large number organismal traits, yet we still have little understanding of how it effects behaviour and species interactions. We collected and analyzed 46 years of data on slave-raiding behaviour in two ants species, and ask whether this behaviour is influenced by global warming. We discovered a significantly correlation between temperature and timing of raids both within each and across all 46 years. The initiation of raids occurs later in the day during the hotter years, and as a consequence, the raids occur less frequently, they bring back less larvae, and the suffer a greater frequency of failed raids. These slave-raiding ants are host specific, and therefore, a decline in slave raiding means that the hosts are growing faster. This provides clear evidence that climate change influences behaviour and species-interactions.

**SARAH L. ALDERMAN, TILL S. HARTER, JONATHAN M. WILSON, ANTHONY P. FARRELL, AND COLIN J. BRAUNER**

University of Guelph

**Getting to the heart of plasma-accessible carbonic anhydrase in fish.**

**Comment se rendre au coeur de l'anhydrase carbonique dans le plasma des poissons**

Many teleost fish possess pH sensitive haemoglobins (Hbs), whereby a reduction in red blood cell (RBC) pH greatly reduces Hb-O<sub>2</sub> affinity (Bohr effect) and carrying capacity (Root effect). Recent evidence suggests that the presence of plasma-accessible carbonic anhydrase (CA) – the enzyme that catalyzes CO<sub>2</sub>/HCO<sub>3</sub><sup>-</sup> interconversion – can short-circuit RBC pH regulation, reducing RBC pH and greatly enhancing tissue O<sub>2</sub> delivery. We demonstrate the presence of plasma-accessible CA in the heart lumen of Coho salmon. CA activity was measured in situ in excised intact atria using a modified electrometric delta-pH assay, and pre-treatment with phosphatidylinositol-specific phospholipase C (PI-PLC; to cleave the membrane anchor of CA) significantly reduced CA activity. We estimate a substantial enhancement in oxygen delivery and suggest that plasma-accessible CA in the salmon heart functions to safe-guard oxygen supply to regions of this vital organ devoid of coronary vessels. Supported by NSERC Canada and Canada Research Chair Program.

**BRANDON ALLEN AND SEAN ROGERS**

University of Calgary

**Genetic population responses and modified growth patterns among varying active management strategies in Alberta Walleye (*Sander vitreus*).**

**Réactions génétiques des populations et modifications du profil de croissance dans diverses stratégies de gestion du doré jaune de l'Alberta (*Sander vitreus*)**

Sustainable harvest practices are of economic and environmental importance for our fisheries resources. *Sander vitreus* (Walleye) is a dominate sportfish and harvested extensively in Canada. In recent years, adaptive management strategies have resulted in potential evolutionary responses detrimental to the long-term goals of the fishery. Our objective was to determine the evolutionary consequences of differential harvest practices in this recreational fishery. Using archived and contemporary genotype and phenotype data from 10 lakes in northern Alberta, with varying harvest regulations, we tested for a response to harvest by evaluating growth curves over cohorts, followed by within-generation genome scans over temporal and spatial scales. Preliminary results suggest variation in growth curves is associated with harvest among lakes, while in house SNP library construction has identified genetic variation in contemporary samples. The significance of integrating molecular markers in conjunction with phenotype data to understand the effects of intensive harvest will be discussed.

**CHRISTINA B. AMAT, JEAN-PAUL MOTTA, AMOL BHARGAVA, KRIS CHADEE AND ANDRE G. BURET**



University of Calgary

**Modulation of host intestinal mucus secretion by *Giardia duodenalis*.**

**Modulation des sécrétions de mucus intestinal des hôtes par *Giardia duodenalis***

*Giardia duodenalis*, a small intestinal parasite, can lead to chronic illnesses including post-infectious irritable bowel syndrome (PI-IBS). We tested the hypothesis that *Giardia* alters the protective mucus layers of the intestine. Objectives. C57BL/6 (WT) and Muc2<sup>-/-</sup> mice, and purified human mucin, were exposed to *Giardia* trophozoites or secreted products to assess the effects on mucin integrity. Results. Goblet cell mucins were depleted throughout the small intestine and colon of infected WT mice. Infected mice also had increased bacterial translocation to the liver and spleen. However, this was not accompanied by secretion of pro-inflammatory cytokines in the small intestine. Co-incubation of *Giardia*'s secreted products with purified human mucin resulted in degradation of the MUC2 protein. Conclusions. Destructive actions of *Giardia* on the protective mucus barrier, including mucin degradation and depletion, facilitate bacterial translocation, potentially contributing to PI-IBS. Supported by HPI NSERC CREATE.

**SHELLEY E ARNOTT**, SHAKIRA AZAN, AND ALEX ROSS

Queen's University

**An invasive predator and calcium decline reduce herbivore abundance in Shield lakes**

**Un prédateur envahissant et le déclin du calcium réduisent l'abondance des herbivores dans les lacs du Bouclier canadien**

Canadian Shield lakes are being transformed by two landscape-level disturbances, non-native predators and declining calcium. *Bythotrephes longimanus*, an invertebrate predator native to Eurasia, has been detected in >150 lakes in Ontario, often reducing cladoceran richness and abundance. Calcium, an essential element for organisms, is declining owing to historic acid deposition and logging. The laboratory-based critical reproduction threshold for *Daphnia pulex*, an important herbivore, is 1.5mg Ca/L. Currently 43% of our surveyed lakes have [Ca]<2mg/L, and concentrations are expected to drop 10-40%. We investigated individual and interactive effects of *Bythotrephes* and Ca decline using surveys and experiments. We expected Ca-rich cladoceran species to decline with both stressors. While we observed decreases in cladoceran abundance associated with *Bythotrephes*, we failed to detect Ca effects, except at Ca concentrations below 1 mg/L. This suggests that while *Bythotrephes* invasion poses the most serious threat, continued Ca decline may exacerbate the loss of zooplankton herbivores.

**DANIEL W. BAKER**, ALEXANDER M. CLIFFORD, LENORA TURCOTTE, KAYLA MOHNS, ALYSSA M. WEINRAUCH, GREG G. GOSS, JOHN D. MORGAN

Vancouver Island University

**Energetically challenged hagfish compensate for a severe hypercarbia-induced acidosis.**

**Les myxines appauvries en énergie compensent pour une acidose sévère induite par l'hypercapnie**

Hagfish can survive both severe hypercapnia and anoxia, perhaps due to life history behaviours of burrowing into sediments during periods of low activity and into carcasses during feeding. However, the hagfish strategy of hypercarbia tolerance (blood and tissue pH compensation) has been thought to be energetically costly, which is in direct conflict with energetic status during hypoxia. We postulated that during severe hypoxia (<5% air saturation) hagfish would be unable to compensate for a pH disturbance associated with severe hypercarbia (40 torr pCO<sub>2</sub>). In contrast, the results showed that there was no significant difference between the timing of pH compensation of hagfish exposed to hypercarbia compared with those exposed to a combined hypercarbia/hypoxia challenge. Consequently, pH compensation does not appear to have a significant cost compared to the entire aerobic budget of hagfish, but it also appears to be important enough to be maintained during potential energetic limitations.

**TRAVIS BANNATYNE**, NICOLA KOPER AND SUSAN LINGLE

University of Winnipeg

**Do density-dependent shifts in winter habitats of mule deer reflect intraspecific competition for safe terrain?**

Les changements d'habitats d'hiver qui dépendent de la densité reflètent-ils une compétition intra-spécifique pour des terrains plus sûrs?

The ability of prey to occupy safe habitats is theoretically density-dependent if prey compete for limited safe habitat or for food within the safe habitat; however, there are few data to test this theory. We used GIS and GEE to analyse 12 winters of census data, and show that mule deer, especially groups with fawns that are most vulnerable to coyotes, were more likely to occupy steeper safe terrain when low in density. Density-independent weather variables had a weaker and opposing effect, which may impede their ability to occupy safe terrain. Mule deer did not move into gentle terrain at lower white-tailed densities as predicted if white-tailed deer competitively exclude mule deer from gentle terrain. Our results suggest that intraspecific competition for safe terrain is critical in the habitat use of mule deer and may outweigh density-dependent effects of interspecific competition for food or density-independent influences of weather.

**TEGAN N BARRY**, SEAN M RODGERS, AND HEATHER A JAMNICZKY

University of Calgary

**Microcomputed Tomography as a tool for fine-tuned phenotypic analysis**

**La microtomographie comme outil pour les analyses phénotypiques détaillées**

Previous studies on *Gasterosteus aculeatus* (Threespine Stickleback, stickleback) have been carried out on both stickleback

cranial and post cranial morphology separately; however, very little research has been carried out on the morphology of both areas combined and the resulting interaction between. Further, these studies often focus on two-dimensional data (2D), leaving the area of three-dimensional (3D) morphology greatly unexplored. A more holistic view is required in the area of stickleback research as data is lacking on areas such as the covariation of skeletal pattern, gill raker length and armor patterning in conjunction with foraging patterns. Combined investigation into relationships between the phenotypes, feeding behaviour, population structure and influence of ecology are required to further understand stickleback and its evolutionary history. This talk will discuss the use of 3D techniques and their application for in depth phenotypic analysis, using stickleback as a model.

**TEGAN N BARRY**, SEAN M RODGERS, AND HEATHER A JAMNICZKY  
University of Calgary

**Phenotypic heterogeneity in marine Threespine Stickleback from Madeira Park, BC**

**Hétérogénéité phénotypique des épinoches à trois épines du Parc Madeira, Colombie Britannique**

The integrated nature of form and function dictates that phenotypes often vary in relation to local ecological factors. Threespine Stickleback (*Gasterosteus aculeatus*; stickleback) are an ideal model to study the phenotypic and genotypic changes responses to selection and ecological pressures, as they have undergone accelerated evolution from their ancestral marine form to the freshwater form following colonization of new environments. Ecological factors directly influence morphology and stickleback exposed to differing marine environments will be phenotypically distinct from one another. Adult stickleback were sampled from three marine sites and one anadromous site (n=205) from Madeira Park, BC. Phenotypes were quantified using microcomputed tomography and three dimensional (3D) geometric morphometrics. The anadromous fish had the most distinct phenotype from the marine groups, while only two marine groups exhibited significant between-group variation ( $p < 0.0001$ ). These analyses support the hypothesis that fish exposed to varying marine environments will be phenotypically variable.

**AARON M BAUER**

Villanova University

**Size, shape, function and phylogeny: evolutionary diversity in the gekkotan skull.**

**Taille, forme, fonction et phylogénie: diversité évolutive du crâne des gekkos**

Features of the gekkotan skull, including ventral fusion of the frontal bones and loss of the parietal foramen, were well established as early as the mid-Cretaceous. Extant gecko skulls have been regarded as largely paedomorphic, but evidence for this is limited and miniaturization may be a more common theme. The combination of extreme miniaturization and fossoriality has resulted in extreme morphology in the pygopodid genus *Aprasia*, in which some species resemble scolecophidian snakes. At the other extreme of the size range, the very largest gekkos (Gekkonidae and Diplodactylidae) show evidence of peramorphosis, perhaps associated with diet. Phylogenetically related patterns in skull diversity are especially evident in the quadrate, squamosal and related elements, but convergence in the anterior portion of the skull is widespread. The use of high resolution X-ray CT-scans of the skull and, more recently, soft tissues of the head is revealing previously unappreciated diversity in gekkotan morphology.

Hoar Finalist abstract

**MELISSA A. BECK, STEFAN W. KIENZLE, CAMERON P. GOATER, DOUGLAS D. COLWELL**

University of Lethbridge

**Landscape epidemiology of an invasive generalist parasite (*Dicrocoelium dendriticum*) in sympatric ungulates in southwestern Canada.**

**Epidémiologie du paysage d'un parasite généraliste envahissant (*Dicrocoelium dendriticum*) chez les ongulés sympatriques du sud-ouest du Canada**

A shift from broad-scale (100's to 1000's of km<sup>2</sup>) evaluations towards local-scale assessments of parasite transmission risk is needed to improve our understanding of the spatial variation in transmission of complex lifecycle parasites. We evaluated site-specific variation in transmission of an invasive trematode, *Dicrocoelium dendriticum*, in Cypress Hills Interprovincial Park (CHP), Alberta. Survey data from over 100 randomly selected sites were used to construct Bayesian hierarchical regression models to identify local-scale topographical and ecological predictors of *D. dendriticum* transmission, as measured by the presence/absence of infected intermediate hosts (Formicid ants). Our results indicate that 'hotspots' of ant-to-ungulate transmission occur within mixed stands of aspen on moderately graded, south/east-facing slopes found at elevations > 1300m. Infected ants were not present under other canopy types, in riparian zones, or on grasslands. These results provide one of the first fine-scale (1m<sup>2</sup>) GIS-based risk maps for an emerging parasite in North America. ([return / retour](#))

**Ian Black**, Dr. Glenn Tattersall  
Brock University

**Orientation Bias and Behavioural Thermoregulatory Coordination in *Pogona vitticeps***

**Préférences dans l'orientation et coordination thermorégulatoire chez *Pogona vitticeps***

Ectothermic animals don't generate metabolic heat and will, instead, adjust to their ambient temperature. Since maintaining a relatively constant body temperature is a critical function for vertebrates, ectotherms have been observed to select a preferred

ambient temperature in order help keep their body temperature relatively consistent. Due to the fact that they do not use metabolic heat in their thermoregulation, they, alternatively, depend extensively on voluntary actions to maintain a constant body temperature. We suggested that directional orientation, along a thermal gradient, of bearded dragons could be another temperature regulating behaviour, coordinated with thermal preference. Both adult and 2 week old neonatal dragons displayed a non-random orientation preference for facing toward a heat source when given the choice in a gradient. We also observed that orientation could potentially be impacted by other known thermoregulatory behaviours.

**SALVATORE D BLAIR**, DERRICK MATHESON, DANUTA CHAMOT, GREG G GOSS

University of Alberta

**Salinity tolerance of Arctic grayling (*Thymallus arcticus*): Physiological and Environmental Perspectives**  
**Tolérance à la salinité de l'omble arctique (*Thymallus arcticus*): perspectives physiologiques et environnementales**

We compared the physiological responses and survivability of Arctic grayling (*Thymallus arcticus*) and rainbow trout (*Oncorhynchus mykiss*) to tolerate an acute transfer to higher saline waters. Grayling are salmonids that have inhabited only freshwater environments in post-glacial North America. These studies were performed to gain insight into possible effects of high salinity industrial wastewater release events on grayling. Arctic grayling and rainbow trout were placed directly into 17ppt salinity and sampled at 0, 24 and 96 h. Serum sodium, chloride, and osmolality levels significantly increased in grayling at both 24 and 96 h time points while trout were able to compensate the osmoregulatory disturbance by 96 hours. NKA enzymatic activity, cortisol and NKA expression responses to salinity were also compared. Our results demonstrated a substantially reduced salinity tolerance in grayling. Interestingly, salinity induced the formation of gill interlamellar cell masses in Arctic grayling, although the functional significance remains to be demonstrated. Supported by an NSERC Discovery Grant to Greg G Goss.

**TAMZIN A. BLEWETT** and CHRIS M. WOOD

McMaster University

**Salinity alters mechanisms of sub-lethal Ni toxicity in the green shore crab**

**La salinité modifie les mécanismes de toxicité subléthale du nickel chez le crabe vert**

Little is known regarding Ni toxicity in the marine environment. We investigated the salinity-dependence of Ni toxicity in *Carcinus maenas*. Crabs were acclimated to three salinities - 20, 60 and 100% seawater (SW) - and exposed to 3 mg/L Ni for 96 h. Oxidative stress indicators, ionoregulatory parameters, and possible respiratory impairment were measured. Ni accumulation was salinity-dependent, with crabs from 20% SW displaying the highest Ni burdens. The greatest accumulation of Ni occurred in the posterior gills at the lowest salinity. Posterior gill 8 exhibited elevated protein carbonyl levels and decreased catalase activity in the lowest salinity Ni exposure. Similarly in Ni-20%SW exposure, haemolymph levels of Mg and K decreased, while oxygen consumption after exercise was inhibited. These data show for the first time the simultaneous presence of all three known modes of sub-lethal Ni toxicity in a marine invertebrate (NSERC CRD, NiPERA, ICA/CRD, IZA/ILZRO, Teck,Vale).

**ELLA BOWLES**, REBECCA A. JOHNSTON, STEVI L. VANDERZWAN AND SEAN M. ROGERS

University of Calgary

**Genetic basis for body size variation between an anadromous and two derived lacustrine populations of threespine stickleback (*Gasterosteus aculeatus*) in southwest Alaska**

**Base génétique de la variation dans la taille du corps entre une population anadrome et deux populations dérivées lacustres de l'épinoche à trois épines dans le sud-ouest de l'Alaska**

Size-assortative reproductive isolation has been linked to recent adaptive radiations of threespine stickleback (*Gasterosteus aculeatus*) into freshwater, but the genetic basis of the commonly found size difference between anadromous and derived lacustrine sticklebacks has not been tested. We studied the genetic basis of size differences between recently diverging stickleback lineages in southwest Alaska using a common environment experiment. We crossed stickleback within one anadromous (Naknek River) and one lake (Pringle Lake) population and between the anadromous and two lake populations (Pringle and JoJo Lakes). The F1 anadromous and freshwater forms differed significantly in size, whereas hybrids were intermediate or exhibited dominance towards the anadromous form. Additionally, the size of freshwater F1s differed from their wild counterparts, with within-population F1s from Pringle Lake growing larger than their wild counterparts, while there was no size difference between lab-raised and wild anadromous fish. Sexual dimorphism was always present in anadromous fish, but not always in fresh water.

**JUSTIN BRIDGEMAN**, GLENN J. TATTERSALL

Brock University

**Title: Reversal learning of a visual task reveals a turning bias in red-footed tortoises**

**L'apprentissage à revers d'une tâche visuelle révèle une préférence de virage chez les tortues charbonnières à pattes rouges**

Learning abilities in novel tasks are often dependent on an animal's behavioural flexibility, which refers to the capability of a subject to alter its behaviour by developing new or modified responses to novel or familiar stimuli. The focus of this study was to investigate the relationship between the visual proficiency and behavioural flexibility of red-footed tortoises, *Chelonoidis carbonaria*, in a learning task. We examined the ability of the species to improve performance in reversal learning of a visual

discrimination in a Y-maze. Tortoises were unable to show a significant improvement in the number of trials to reach criterion across successive reversals. This study confirms the previous work on red-footed tortoises that failed to show behavioural flexibility in reversal learning. In the current study, a turning bias at the individual level was revealed, increasing in strength throughout the learning task. No previous study has investigated turn bias in this species.

#### **BRYAN W. BROOKS**

Baylor University

##### **Fish on Prozac (and Zoloft): Ten years later**

##### **Des poissons qui prennent du Prozac (et du Zoloft): dix ans plus tard.**

Over a decade has now passed since our research group initially reported several adverse effects of fluoxetine to aquatic organisms commonly employed for developing environmental quality criteria, evaluating whole effluent toxicity, and monitoring ambient toxicity of surface waters and sediments. Our subsequent observation of fluoxetine, sertraline and their active metabolites accumulating in various tissues of fish from an effluent-dominated stream was termed “Fish on Prozac.” Here I briefly review some scientific lessons learned from our study of antidepressants and the environment, including opportunities for research, management and environmental education. Intrinsic chemical properties of pharmaceuticals have afforded research advances in areas ranging from analytical chemistry and comparative pharmacology, to influences of ionization, chirality and adverse outcome pathways during environmental hazard and risk assessment. Though many questions remain unanswered, studies of antidepressants in urbanizing aquatic systems continue to develop an advanced understanding of environmental hazards and risks from pharmaceuticals and other contaminants.

#### **CALEB BROWN**

Royal Tyrrell Museum of Palaeontology

##### **Homology of frill epiossifications of horned-dinosaurs (Ornithischia: Ceratopsidae): new specimens and new data**

##### **Homologie de l'épissification de la frange des dinosaures à corne (Ornithischia: Ceratopsidae): nouveaux spécimens et nouvelles données**

Ceratopsids are an iconic group of large-bodied, quadrupedal, herbivorous dinosaurs, easily recognized by their nasal and postorbital horns, and shield-like frill (capped by a halo of epiossifications), which represent the largest cranial display structures to ever evolve. These species-specific epiossifications are variably represented as low scallops around the periphery of the frill or developed into a vast array of spike or horn-like processes. Discovery of a nearly complete skull of a new genus of derived chasmosaurine (long-frilled ceratopsid) from the uppermost St. Mary River Formation (Maastrichtian) of southwestern Alberta necessitates a reassessment of epiossification homology. This specimen preserves a unique epiossification at the parietal midline that appears to be transitional between the paired, laterally curving hooks of the late Campanian/early Maastrichtian taxon *Anchiceratops* and the single crescentic process of the late Maastrichtian taxon *Triceratops*. Homology of epiossifications across both subfamilies of horned dinosaurs is reevaluated.

#### **JOHN BRUBACHER**

Canadian Mennonite University

##### ***Smed-Atlas: A 3D digital histological and cytological resource for the planarian, Schmidtea mediterranea.***

##### ***Smed-Atlas: une ressource digitale 3D histologique et cytologique pour le planaire, Schmidtea mediterranea***

Planarians (Platyhelminthes: Continenticola) are freshwater flatworms with an unequalled capacity for regeneration. The past decade has seen a renaissance in the use of these worms – particularly the species *Schmidtea mediterranea* and its close relatives – as model systems for the study of regeneration, development, aging, and evolution. While molecular genetic resources and techniques are well developed for *S. mediterranea*, the histology and cytology of this species are much less well described. To remedy this situation, I have begun work on the “*Smed-Atlas*” project: a comprehensive digital, 3D atlas of whole *S. mediterranea* specimens, to be produced by serial sectioning of plastic-embedded material, and imaging at both light-microscopic and ultrastructural levels. As a preliminary demonstration of the potential utility of this resource, I will describe the interrelationships between germline and somatic tissues in and around the testes, and evidence of glia-like cells in the nervous system of these remarkable animals.

#### **JOHN BUCKLAND-NICKS**

St Francis Xavier University

##### **Unique events in chitonid reproduction.**

##### **Événements uniques dans la reproduction des chitonidés**

Gametogenesis in chitonids (Polyplacophora: Mollusca) is highly unusual giving rise to eggs with elaborate spiny hulls and sperm with saber-like nuclear extensions. 3D reconstruction from serial sections of oogenesis of *Acanthochiton garnoti*, confirmed that the egg hull is formed by microapocrine secretion, not by Golgi vesicle exocytosis. This novel process bi-passes the endomembrane system and releases compounds formed in the cytoplasm directly from the cell surface, via budding of ‘microaposomes’. Fertilization is no less unusual, as chitonid sperm digest a minute pore in the egg hull that allows injection of DNA but blocks entry of sperm organelles, including mitochondria and centrioles. In most animals the entire sperm enters the egg; sperm mitochondria are digested by an elaborate system of detection and enzyme destruction, and a sperm centriole is key to nuclear fusion and early cleavage. The absence of sperm organelles in chitonid embryos is indicative of a unique

developmental program.

**NEAL CALLAGHAN**, LOUISE TUNNAH, SUZANNE CURRIE AND TYSON MACCORMACK

Mount Allison University

**AMPK-mediated metabolic regulation during heat stress preconditioning of rainbow trout (*Oncorhynchus mykiss*) .**

**Régulation métabolique médiée par AMPK durant le préconditionnement au stress thermique chez la truite arc-en-ciel (*Onchorynchus mykiss*).**

As water temperatures increase worldwide, many fish species encounter repeated bouts of heat stress. Experiments to test for improved efficacy of the heat shock response after repeated exposure will be complemented by this study which examines the metabolic profile of rainbow trout exposed to repeated heat stresses. Metabolic enzyme complement, substrate distribution and activation patterns of the energy sensor AMP-activated protein kinase (AMPK) and its substrates acetyl-CoA carboxylase (ACC) and mechanistic target of rapamycin (mTOR) will be compared to elucidate the cause and effect of metabolic regulation underlying the preconditioned heat shock response.

**JAMES A. CAMPBELL**, MICHAEL J. RYAN

University of Calgary

**A reassessment of the horned dinosaur *Judiceratops tigris* (Ornithischia: Ceratopsidae) from the Upper Cretaceous (middle Campanian) of Montana, USA**

**Réévaluation du dinosaure à corne *Judiceratops tigris* (Ornithischia: Ceratopsidae) du Crétacé Supérieur (campanien moyen) du Montana, É.U.**

*Judiceratops tigris* is a recently described ceratopsid, collected from the Upper Cretaceous Judith River Formation of Montana, USA. The current diagnosis for this taxon is derived from four fragmentary, non-associated skulls that have limited anatomical overlap. New observations, interpretations, and reconstructions of *J. tigris* are presented in this study, based on the assumption that these specimens represent the same taxon. Based on these findings, *J. tigris* had elongate postorbital horncores with an ovate cross section; squamosals with non-imbricated episquamosals, and an anterolaterally oriented anteriormost episquamosal; a wide medial parietal bar with a meniscus-shaped cross section; and an anteroposteriorly wide posterior parietal bar with at least four small epiparietals on each side. A phylogenetic analysis incorporating the revised diagnosis of *J. tigris* supports the previous referral of this taxon to Chasmosaurinae. *Judiceratops tigris* is retained here as a distinct taxon, but has more in common with other chasmosaurines than previously supposed.

**JEAN-BERNARD CARON**

Royal Ontario Museum

**Marble Canyon, a new Burgess Shale Shangri-La in Kootenay National Park**

**La formation Marble Canyon, un nouveau Shangri-La de schistes de Burgess dans le Parc National Kootenay**

Marble Canyon in Kootenay National Park yields the most important Burgess Shale fossil assemblage of Cambrian marine soft-bodied animals outside the Walcott Quarry, 40 km to the northwest. First discovered in 2012 by an international team of scientists lead by the Royal Ontario Museum, more than 15,000 specimens have already been collected including at least two-dozen new species. The new site is about the same age as the Walcott Quarry and it gives us new insights into the initial diversification of animals, their early morphological disparity, and the geographic ranges and longevity of many taxa. The fauna includes the most primitive fossil fish known in the world which preserves eyes, nostrils, W-shaped muscle segments, as well as a notochord, a structure that forms part of the vertebrae in fishes, lizards, frogs, birds and us. In this presentation, I will report on the latest fieldwork activities and discoveries.

**RALPH V. CARTAR**

University of Calgary

**Different determinants of foraging performance of nectar and pollen collectors in bumble bees.**

**Différences dans les déterminants de la performance en butinage entre collecteurs de nectar et de pollen chez les bourdons**

Foraging bees collect pollen (for protein) and nectar (for carbohydrate). While most flowers offer both food types, pollen and nectar foragers often face different physical processes, with different time, energy, and wear costs. We already know that experience (age), condition (wing wear), and body size all affect foraging gain. I present results from observational research with individually marked, wild-foraging bumble bees in Alberta. I first consider how age, wing wear, body size, and nutritional resource (pollen vs. nectar) collected combine to affect foraging gain and mortality rate (over the short term). Relative to pollen foraging, nectar foraging is both more dangerous and better explained by forager traits. Overall, mortality is less important than foraging gain in explaining lifetime foraging success of nectar foragers, while the converse is true of pollen foragers. These differences suggest fundamentally different life histories of bumble bee foragers, depending on whether protein (pollen) or carbohydrate (nectar) is being collected.

**ALICIA A CASSIDY**, ROXANNE J SAULNIER AND SIMON G LAMARRE

Université de Moncton

**Adjustments in protein metabolism of starved Arctic Charr, *Salvelinus alpinus***

**Ajustements du métabolisme des protéines chez les ombles chevaliers affamées (*Salvelinus alpinus*)**

Protein metabolism consists of the interrelated processes of protein synthesis, degradation and growth, which modulates whole-animal growth. Protein metabolism is influenced by external factors and is under the control of cellular signal transduction pathways. The objectives of this project are to characterize the biochemical and molecular mechanisms involved in the control of protein synthesis and degradation in tissues of starved Arctic charr (*Salvelinus alpinus*). The fractional rate of protein synthesis was measured using a flooding dose technique and enzymatic activity of protein degradation pathways was measured as well as the activation of certain signaling pathways. Following 36 days of starvation, rates of protein synthesis decreased in white muscle and liver compared to the fed fish, while there were minimal effects on protein degradation pathways and signaling pathways. Overall, lysosomal proteolysis appears to be the primary degradation pathway in muscle protein while the ubiquitin-proteasome pathway is predominant in the liver.

**UMER CHAUDHRY**, E. M. REDMAN, MUTHUSAMY RAMAN, JOHN S. GILLEARD

Department of Comparative Biology and Experimental Medicine, Faculty of Veterinary Medicine, University of Calgary Alberta, Canada

**Genetic evidence for the spread of a benzimidazole resistance mutation from a single origin across southern India in the parasitic nematode *Haemonchus contortus***

**Évidence génétique de la propagation d'une mutation de résistance au benzimidazole d'origine unique chez le nématode parasitaire, *Haemonchus contortus*, dans le sud de l'Inde**

Resistance to anthelmintic drugs is a major problem for parasite control in livestock and a growing concern for global human health. We use the small ruminant parasite *Haemonchus contortus* as a model system to study the genetics of anthelmintic resistance and here we present a recent study in Southern India that provides some new insights into how resistance mutations emerge in parasite populations. Two benzimidazole resistance mutations in the isotype -1  $\beta$  tubulin gene were identified in *H. contortus* populations in southern India. Our genetic analysis suggests that one of these - E198A (GCA) - has spread from a single origin across the region, presumably through anthropogenic animal movement, whereas the other - F200Y (TAC) - has multiple independent origins. Population genetic analysis of *H. contortus* populations revealed high genetic diversity within populations but low genetic differentiation between populations consistent with the hypothesis of high gene flow across the region.

**ZHONGQI CHEN**, MIKE SNOW, CRAIG S. LAWRENCE, ROBERT H. DEVLIN, ANTHONY P.

FARRELL

University of British Columbia

**Thermal performance and tolerance of a warm adapted rainbow trout (*Oncorhynchus mykiss*) population**

**Performance et tolérance thermale chez les truites arc-en-ciel adaptées aux températures chaudes (*Oncorhynchus mykiss*)**

Artificially transplanting animals to a new environment may lead to selection by accumulating heritable adaptations. This study demonstrates the thermal performance and tolerance of an introduced population of rainbow trout (*Oncorhynchus mykiss*) in southern Western Australia, where the water temperature is much higher than their native habitats. Collectively, the optimum thermal window of this population ranged from 11.8 to 19.9 °C. When temperatures were higher than the optimum window, maximum heart rate progressively became less temperature dependent and started showing arrhythmia at 23 °C, which was also accompanied with rapid decrease in aerobic scope. Despite the observation of feeding behaviour and zero mortality at 26 °C, the critical thermal maximum averaged at 29 °C. Compared with existing temperature research in other rainbow trout populations, the present assessment is consistent with the prediction that this strain has undergone selection and showed the ability to tolerate higher water temperatures.

**KEVIN CHOI** AND JEAN-MICHEL WEBER

University of Ottawa

**Exogenous glucose supply to hyperglycemic fish: Glucose kinetics during carbohydrate overload.**

**Approvisionnement exogène de glucose aux poissons hyperglycémiques: cinétique de glucose durant la surcharge de glucides**

Rainbow trout are considered as poor glucoregulators because they normalize glycemia very slowly in glucose tolerance tests and show limited sensitivity to insulin. To get a better assessment of their glucoregulatory capacity, we have quantified rates of hepatic glucose production and glucose disposal during infusion of exogenous glucose (equivalent to twice the baseline rate of hepatic production) in hyperglycemic animals. Resting hyperglycemic trout with baseline fluxes of  $10.6 \text{ } \mu\text{mol} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$  ( $\sim 30\%$  above normal) could completely suppress endogenous glucose production and increase disposal by 2.6-fold when coping with exogenous glucose. Their blood glucose only increased 2.5-fold, but would have risen 10-fold without this strong modulation of glucose kinetics. Furthermore, they were able to further stimulate glucose disposal by 3.9-fold when graded swimming was added to the experimental protocol (to  $40.1 \text{ } \mu\text{mol} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ ). This study demonstrates that trout have a much better ability for glucoregulation than suggested by current literature.

Jan J.H. Ciborowski and A. Lee Foote

Department of Biological Sciences, University of Windsor

**Reclaiming wetlands in the post-mining landscape of the Alberta Oilsands region.**

The high profile of open pit mining in the Fort McMurray oil sands region has promoted extensive research to develop credible and effective reclamation strategies. The first constructed wetlands (mine tailings and water placed in clay-lined ponds) were

poor analogues of natural wetlands. However, wetlands forming naturally from mine water seepage are quickly colonized by submergent and emergent plants (3-5 y). Elevated salinity and residual naphthenic acids limit submergent plant biomass and richness, which slowly (15-20 y) become more similar to plant communities of wetlands constructed with native materials. However, biodiversity is limited by morphometry.

Constructed wetland food web components appear to become more similar to reference constructed wetlands in older, peat-amended systems diluted by surface water to conductivity of 1.3 mS or less. Ultimately, residual salinity may be the most important regulator of community composition and carbon production. Consequently, landscape designs to support wetlands should incorporate topography that mimics

Hoar Finalist abstract

**ALEXANDER M CLIFFORD**, ALYSSA M WEINRAUCH, SUSAN L EDWARDS AND GREG G

GOSS

University of Alberta

**Extrabranchial aspects of acid/base and ammonia recovery in Hagfish (*Eptatretus stoutii*).**

**Aspects extra-branchiaux de la restauration des acides/bases et de l'ammoniac chez la myxine (*Eptatretus stoutii*)**

Hagfish feed by burrowing into decaying carcasses where they encounter elevated  $\text{PCO}_2$  and [ammonia], thus presenting several physiological acid/base challenges. We examined whether Pacific hagfish actively secrete acid-base equivalents or ammonia through the skin. We pre-exposed hagfish to either hypercapnia (1.5%  $\text{CO}_2$ -72h) or hyperammonia (20 mM-4h, 48h) to elevate plasma  $\text{HCO}_3^-$  or ammonia, respectively, and characterized the recovery strategies using flux chambers separating the branchial and post-branchial regions of the hagfish. Proton flux measurements reveal that hypercapnia-exposed hagfish utilize both gill and skin mechanisms to excrete hypercapnia-induced  $\text{HCO}_3^-$  loads at rates of  $\sim 175$ -260  $\mu\text{equiv/kg/h}$ . Furthermore, hagfish ammonia excretion rates were 147.2  $\mu\text{mol/kg/h}$  from the posterior (skin only) region which was  $\sim 20\%$  of the anterior region (branchial+skin). Mounting skin in an Ussing chamber demonstrated conclusively that more posteriorly-located excised skin has an increased ability to flux ammonia. Finally, we identified a potential skin ammonia excretion route, using a hagfish-specific Rhcg antibody. ([return / retour](#))

**HEATHER COATSWORTH**, PAOLA CAICEDO, CLARA OCAMPO, AND CARL

LOWENBERGER

Department of Biological Sciences, Simon Fraser University, Burnaby, BC

**Flipping Phenotype: Using RNAi to knock-down pro-viral genes in *Aedes aegypti* to prevent dengue transmission**

**Inverser le phénotype: Utilisation du RNAi visant le knock-down des gènes pro-viraux chez *Aedes aegypti* afin de prévenir la transmission du dengue.**

Dengue viruses infect 50-100 million people annually and are transmitted by *Aedes aegypti*. Complications including dengue hemorrhagic fever or dengue shock syndrome can be fatal. There are currently no vaccine or treatment options available. In Cali, Colombia, approximately 30% of feral *Ae. aegypti* are resistant to Dengue through midgut resistance factors. We used RNA-seq to identify and compare genes differentially expressed in the midguts of susceptible (Cali-S) and resistant (Cali-R) mosquitoes at 24, 36 and 48 hours after feeding on blood, or blood containing DENV2. Pro viral genes, expressed only in Cali-S, are being knocked down in susceptible mosquitoes using RNAi. These will be fed on blood containing DENV2, and the phenotype, susceptible or resistant, will be assessed. If altering gene expression can flip the phenotype in *Ae. aegypti*, we may use gene editing techniques to create permanently resistant mosquitoes that provide a novel ecologically stable control mechanism for Dengue.

**KAREN COGLIATI**, JULIA UNREIN, ERIC BILLMAN, ROB CHITWOOD, CAMERON SHARPE, DAVID NOAKES AND CARL SCHRECK

Oregon State University

**Determinants of migratory life history phenotypes in juvenile spring Chinook salmon**

**Déterminants des phénotypes du cycle de vie migratoire chez les saumons Chinook juvéniles**

Juvenile Chinook salmon (*Oncorhynchus tshawytscha*) exhibit an array of life history tactics. However, it is unclear if juvenile migration phenotypes are established from proximate environmental stimuli or if they are established earlier in life. We investigated the extent to which life history is driven by environmental variation during rearing or whether it is predetermined. Additionally, we compared body shapes of wild juvenile Chinook salmon that exhibited different migration phenotypes to those of hatchery-reared juveniles that self-sorted into surface- and bottom-oriented groups at emergence. We found that environmental variables can be manipulated to produce fish that followed distinct migration trajectories. We also showed that morphological variation is predictive of migratory phenotype and that this differentiation between migrants likely occurs early. Our results suggest that environmental variables can influence migration phenotypes of juvenile Chinook salmon. Additionally, natural variation in early life history may also predict migrant phenotypes expressed later in life.

**PAUL CRAIG**

University of Waterloo

**Goodnight Moon: Teaching an old dog new tricks about epigenetics and metabolism.**

**Bonne nuit Dr. Moon: comment apprendre à un vieux chien de nouveaux trucs sur l'épigénétique et le métabolisme**

This presentation focuses on the last 5 years of Tom Moon's career at uOttawa, and certainly 150 words is not sufficient to

accurately portray the tremendous experience it has been. Arriving at Ottawa in 2009, Tom promptly set a high bar by leaving for 2 months to work in France, and return with the proclamation of having worked with the “the best postdoc ever!” I took this as a challenge, and over the next 5 years produced 10 publications and established a niche for myself in the budding world of fish epigenetics. Originally hired as a postdoc to examine nutrient sensing in trout and zebrafish, Tom provided the freedom to explore new avenues of research, which helped develop my ‘tastes’ for DNA methylation and microRNA. While his legacy is cemented in endocrine control of metabolism, he should also be recognized as one of the first to examine epigenetics in teleosts.

**ZACH DEMPSEY** CAMERON GOATER THERESA BURG

University of Lethbridge

**Phylogenetic patterns of mountain snails, *Oreohelix* spp. in Southern Alberta**

**Motifs phylogénétiques chez les escargots de montagne du genre *Oreohelix* dans le sud de l'Alberta**

A primary goal of conservation biology is to determine the geographic extent of monophyletic lineages in the context of evolutionary history. This study examined phylogeographic patterns of terrestrial snails in the genus *Oreohelix* in Cypress Hills Provincial Park (CHP, n=12 sites) and Waterton Lakes National Park (WP, n=2 sites) using COI mtDNA and ITS n-DNA sequences. Our data demonstrated three highly divergent lineages. Clades B and *O. cooperi* are widespread within sky-island habitats in the northern US and our study sites, however, the third does not match any known sequences. The *O. cooperi* clade was restricted to small-bodied snails found exclusively on scree slopes in CHP whereas the large bodied snails clustered in clades B and X with *clade B* found throughout western CHP and WP and *Clade X* at higher elevations in CHP. This phylogeographic pattern likely reflects a combination of low snail vagility, local adaptation, and the complex glacial history of this region.

**LANNA M DESANTIS**, JEFF BOWMAN, RUDY BOONSTRA AND GARY BURNES

Trent University

**Seasonal differences in stress reactivity in New World flying squirrels: shedding light on physiological function and natural history**

**Différences saisonnières dans la réactivité au stress chez les écureuils volants de Nouveau Monde: éclaircissement de la fonction physiologique et de l'histoire naturelle**

We have shown previously that flying squirrels have naturally high baseline cortisol levels. We thus tested the sensitivity of their brain glucocorticoids receptors (GRs) via the dexamethasone (DEX; synthetic cortisol) suppression test, which invokes the negative feedback portion of the stress response. A dosage 16x that used previously was required, and took one hour longer than in other species to drop natural cortisol levels, and these levels never fell to zero in live-caught southern flying squirrels. This indicates that brain GRs in flying squirrels have a reduced affinity for cortisol and that southern flying squirrels may be resistant to DEX. We then used this dosage as part of a hormonal-challenge protocol to compare the stress response between breeding and non-breeding seasons in northern and southern flying squirrels, since it has been shown in other species that the stress response changes in the presence of reproductive hormones. Results will be discussed.

**LAURA DINDIA**, OANA BIRCEANU, ADAM MASSON, VIDA TALEBIAN, BRENDAN MCCONKEY AND MATHILAKATH M. VIJAYAN

Department of Biology, University of Waterloo, Waterloo, Ontario

**Bisphenol A accumulation in oocytes disrupts the liver proteome of rainbow trout in multiple generations.**

**L'accumulation du bisphénol A dans les oocytes perturbe le protéome du foie de la truite arc-en-ciel sur plusieurs générations.**

There is evidence that bisphenol A (BPA) can induce epigenetic modifications; however, the multigenerational consequences have yet to be assessed in fish. This study investigated the effect of acute BPA accumulation in the oocytes, to mimic maternal transfer, on the hepatic proteome profile of juvenile rainbow trout in the F1 and F2 generations. The oocytes were enriched with environmentally relevant concentrations of BPA (0, 1 or 40 ng oocyte<sup>-1</sup>) and reared in clean water. BPA had no significant effect on the liver proteome (analyzed using isobaric tags; ITRAQ) in the F1 at 140 and 365 dpf. However, in the F2 generation, both these developmental time points had over 20 proteins, including glutathione S-transferases and cytochrome P450, that were differentially expressed in response to BPA. Together our results provide evidence that ancestral exposure to BPA disrupts the liver proteome of rainbow trout, and we propose epigenetic modifications as a possible mechanism.

**BRENT DIXON**, MOMAR NDAO, RASHA MAAL-BARED, SABAH BIDAWID AND JEFFREY FARBER

Bureau of Microbial Hazards, Food Directorate, Health Canada, Ottawa, ON

**The Food and Environmental Parasitology Network (FEPN).**

**Le Réseau de parasitologie alimentaire et environnementale (RPAE)**

The Food and Environmental Parasitology Network (FEPN) includes approximately 70 researchers, regulators, and public health officials from across Canada representing federal and provincial government, academia, and industry. The objectives of the Network are (i) to identify and communicate risks and research / surveillance gaps; (ii) to facilitate discussion, collaborative research, and development of grant applications amongst members and external researchers; (iii) to develop and validate standardized methods for the isolation, detection, characterization and control of foodborne and waterborne parasites; (iv) to develop and validate methods for the surveillance and investigation of parasitic infection in humans; (v) to generate data for risk assessment and policy development; and (vi) to provide expert advice and testing in support of outbreak investigations and



surveillance studies. For more information on the FEPN, please contact the Network Chair, Dr. Brent Dixon, at: [Brent.Dixon@hc-sc.gc.ca](mailto:Brent.Dixon@hc-sc.gc.ca), or visit our website at: <http://www.fepn.net>.

#### **BRIAN DIXON**

University of Waterloo

#### **Wardle Lecture Abstract**

##### **From Parasites to Immunity and the Environment and Back Again**

Major Histocompatibility Complex (MHC) receptors are central to the initiation of immune responses through binding of peptide fragments of pathogens and present them to T cells. They are also the most polymorphic known nuclear encoded genes and have been used to differentiate populations of many species of animals. The discovery and characterization of Major Histocompatibility Complex genes, and the genes encoding their accessory molecules, in teleost fish has revealed some startling differences in the regulation of the immune response between fish and mammals, as well as between the different orders of fish. Novel research has pointed out some limitations in the current methods using these genes for population typing that my lab is addressing. The results of these lines of research will enhance our understanding of MHC function and genetics in fish, enabling the production of effective vaccines and the use of these genes for managing populations of wild fishes. ([back](#))

#### **Résumé de la conférence Wardle**

##### **Aller des parasites à l'immunité et à l'environnement, et s'en revenir**

Les récepteurs du complexe majeur d'histocompatibilité (CMH) sont au cœur de l'initiation des réponses immunitaires via la liaison de fragments peptidiques de pathogènes et de leur présentation aux cellules T. Ce sont aussi les gènes avec le codage nucléaire polymorphe le plus élevée et ont été utilisées pour différencier les populations de nombreuses espèces d'animaux. La découverte et la caractérisation de gènes du complexe majeur d'histocompatibilité, et les gènes codant pour leurs molécules accessoires, dans les poissons téléostéens a révélé quelques différences surprenantes dans la régulation de la réponse immunitaire entre les poissons et les mammifères, ainsi qu'entre les différents ordres de poissons. De nouvelles recherches ont souligné certaines limites des méthodes actuelles qui utilisent ces gènes pour le typage des populations que mon laboratoire étudie. Les résultats de ces axes de recherche permettront d'améliorer notre compréhension de la fonction MHC et de la génétique dans le poisson, permettant la production de vaccins efficaces et l'utilisation de ces gènes pour la gestion des populations de poissons sauvages. ([retour](#))

#### **WILLIAM DRIEDZIC, KATHY CLOW AND CONNIE SHORT**

Memorial University of Newfoundland

##### **Extracellular glucose can support metabolism in Atlantic cod myocytes but not in heart of hypoglycemic short-horned sculpin.**

##### **Le glucose extracellulaire peut supporter le métabolisme des myocytes des morues de l'Atlantique mais pas celui du cœur des chabosseaux à épines courtes hypoglycémiques**

The importance of extracellular glucose to support energy metabolism was assessed in myocytes isolated from Atlantic cod (plasma glucose 3.7 mM) and short-horned sculpin, a species with exceptionally low plasma glucose (0.5 mM). Oxygen consumption, lactate production, and glucose metabolism were determined. Glucose metabolism was measured by the production of  $^3\text{H}_2\text{O}$  from [ $2-^3\text{H}$  glucose] at the reaction catalyzed by glucose 6-P isomerase. Aerobic metabolism accounted for approximately 90% of the ATP production in cells from both species. There was no decrease in myocyte glycogen level following 3 h of incubation in either species. Extracellular glucose metabolism was sufficient to meet oxygen demand and lactate production by myocytes from cod; however, in short-horned sculpin extracellular glucose metabolism was only adequate to support lactate production. Therefore, in this species, with chronically low plasma glucose, alternative fuels such as on board triglycerides or amino acids are required to support aerobic metabolism.

#### **KEVIN DUCLOS, THOMAS GRÜNBAUM, RICHARD CLOUTIER, BERNARD ANGERS**

Université de Montréal

##### **A mouthful of variation: skeletal phenotypic variation in clonal hybrids.**

##### **De la variation plein la bouche: variation phénotypique du squelette des hybrides clonaux**

In fish, cranial elements involved in feeding vary depending on their trophic niche. Subtle variations can have significant influence on habitat use and are key elements in shaping ecological differences among species or populations. We sought to understand the variation of trophic morphological structures within clonal lineages of *Chrosomus eos-neogaeus*, a freshwater minnow produced by hybridization events between *C. eos* and *C. neogaeus*. Hybridization is traditionally considered as a dampening mechanism, producing intermediate phenotypes between parental species. Using X-Ray Tomodensitometry methods, mandibles and pharyngeal arches of specimens were reconstructed. We then computed 3D models and measured shape variation using 3D geometric morphometrics to assess phenotypic variability. Results show that hybrids, without genetic differences, are not simply intermediate in shape but display impressive phenotypic variation and novel transgressive phenotypes. Thus, hybrids seem to benefit from increased developmental independence of bones which may in turn improves both phenotypic and ecological lability

**BLAIR DUDECK**, MICHAEL CLINCHY, MAREK ALLEN and LIANA ZENETTE

Western University

**Fear compromises parental care and the survival of post-fledged young**

**La peur compromet les soins parentaux et la survie des jeunes à l'envol**

Predators kill, but the risk of being killed is also a powerful force affecting survival because scared prey eat less, thereby increasing the likelihood of starvation. Young of most animals are extremely vulnerable to predators and may alter their behaviour to limit detection. We investigated the previously unexplored effects that predation risk has on the behaviour of newly fledged offspring and their parents and the impact this has on offspring survival. We manipulated predation risk using sound and found that song sparrow offspring do not reduce their detectability under high risk. Parents, however, severely reduced their feeding visits. Parents provided 60% less food overall and 20% of parents did not feed their young at all when predation risk was high compared to 0% under low risk. Critically, radio-tagging revealed that young of parents that attenuated provisioning most under high risk were more likely to die during the dependent stage.

**YVONNE A DZAL**, MATTHEW E PAMENTER, PAUL A FAURE AND WILLIAM K MILSOM

University of British Columbia

**Huff and puff or shut'er down?: Hypoxia tolerant mammals employ divergent strategies to tolerate hypoxia**

**Les mammifères tolérants à l'hypoxie utilisent différentes stratégies pour tolérer l'hypoxie**

Ground squirrels (*Ictidomys tridecemlineatus*), mole rats (*Heterocephalus glaber*), and bats (*Eptesicus fuscus*) are exceptionally tolerant of low oxygen (hypoxia) but the basis of this tolerance is not well understood. To elucidate the underlying mechanisms these animals use to match oxygen supply to demand in hypoxia, we exposed individuals of all three species to progressive reductions in inspired oxygen and measured their metabolic, thermoregulatory, and ventilatory responses. Severe hypoxia (5% O<sub>2</sub>) led to a profound depression in oxygen demand in mole rats (>85%), and bats (>65%), driven by a reduction in metabolism independent of decreases in body temperature. This reduced the need to increase supply; ventilation only increased by 45% and 20%, respectively. Ground squirrels, on the other hand, did not reduce oxygen demand or body temperature in hypoxia; they increased oxygen supply through an increase in ventilation (>250%). Our results indicate that these species employ divergent strategies to tolerate hypoxia.

**JOHN EME**, CASEY A. MUELLER, RICHARD G. MANZON, CHRISTOPHER M. SOMERS,

DOUGLAS R. BOREHAM, JOANNA Y. WILSON

McMaster University

**Effects of daily, incremental changes in incubation temperature on the metabolism of Lake**

**Whitefish embryos and hatchlings**

**Effets de changements quotidiens progressifs de la température d'incubation sur le métabolisme des embryons et nouveaux-nés chez les grands corégones**

Temperature has pervasive effects on poikilotherm physiology, and embryos are especially vulnerable to temperature shifts. We incubated whitefish embryos at constant temperatures of 2°C, 5°C, and 8°C, and in a variable temperature treatment (VTT). In the VTT, a daily, stepwise 2°C temperature change from 2°C-8°C and back from 8°C-2°C occurred throughout embryonic incubation. Mortality was quantified throughout development, and hatchling size was measured. Oxygen consumption rate (V.O<sub>2</sub>) was measured at 60% of embryonic development and in hatchlings. V.O<sub>2</sub> was measured for each of the four treatments (2°C, 5°C, 8°C, VTT) at 2°C, 5°C, and 8°C to determine if V.O<sub>2</sub> of VTT embryos represented the V.O<sub>2</sub> acclimation profile of one of the constant temperatures. This study allows comparison of metabolism of a stenothermic-incubating fish species under variable incubation conditions and represents the first study to incubate whitefish embryos under a variable thermal regime and measure V.O<sub>2</sub>.

**JOSHUA D. EMERMAN**, GADWYN C. GAN, VICTOR K.S. CHAN, JEFFREY G. RICHARDS, COLIN J. BRAUNER

University of British Columbia

**Just add salt: Does salinity affect growth of salmon?**

**Ajoutez du sel: la salinité affecte-elle la croissance des saumons?**

Anadromous salmonids have a unique life history which makes it possible to culture them in salinities ranging from freshwater to full-strength seawater. According to models, the cost of iono-regulation in a teleost may range from 5-30% of resting metabolic rate. We hypothesize that by rearing salmon in water with a salinity which is isosmotic to the blood plasma, the cost of iono-regulation would be minimized, permitting greater allocation of energy towards growth and improving feed conversion efficiency. We are currently conducting salinity trials to test this hypothesis with Atlantic and coho salmon grown in five salinities that span the range from freshwater to seawater (0, 5, 10, 20 and 32 ppt). Preliminary results suggest fish grown in 5ppt salinity have the greatest growth. These results could have significant benefits to the growing closed containment salmon aquaculture industry where high costs necessitate optimizing conditions to maximize growth rates and feed conversion.

**ELENA FABBRI**

University of Bologna (Italy)

**Adrenergic signalling in teleost fish, a challenging path**

**Signalisation adrénérrique chez les téléostéens, un parcours complexe.**

Catecholamines (CA) enable vertebrates including fish to organize the “fight-or-flight” response, ultimately allowing organisms to survive and reproduce in a challenging environment. CA are also vital in non-stress conditions, modulating, amongst other physiological processes, energy resource availability. That CA interact with specific membrane g-protein receptors ( $\alpha$  and  $\beta$  adrenergic receptors, AR) is well known in mammals and both receptor structure and downstream signalling processes are well established. Conversely, the characterization of AR in fish was much slower, initially biased by the use of inadequate pharmacological tools and finally improved when gene sequences and molecular probes became available. A three-decade path will be examined, providing an overview on the evolution of knowledge in this field, including unanswered questions. Recent studies concerning the specific interaction between AR and emerging contaminants in the aquatic environment will illustrate the latest results of the long term collaboration between Dr. Moon laboratory and mine.

**ERIN FAUGHT**, MATHILAKATH VIJAYAN

University of Calgary

**Rainbow trout exosome: is it involved in the stress response?**

**L'exosome de la truite arc-en-ciel: est-il impliqué dans la réaction au stress?**

Exosomes are a specific subtype of cell-secreted vesicles, approximately 40-100 nm in diameter. They are formed from endosomal compartments, and contain both proteomic and genomic information. Mammalian cell line studies suggest a key role for secreted exosomes in cell to cell signalling, but very little is known about their role in fish. The objective of this study was to characterize exosomes in trout, and to determine if they play a role in the cellular stress response. We isolated exosomes from red blood cells (RBCs) and this was confirmed using electron microscopy, as well as enrichment with the marker enzyme acetylcholinesterase. The exosomal vesicles also contained mRNA and protein. Exposing RBCs to a heat shock *in vitro* led to the enrichment of the exosomal fractions with heat shock protein 70 (HSP70). Our novel finding suggests a key role for RBC-derived exosomes in modulating circulating HSP70 levels during stress in fish.

**SANDRA FEHSENFELD**, DAVID W. TOWLE, ANNA-MARIA MARINI, JYUAN-RU TSAI, DIRK WEIHRAUCH

University of Manitoba

**Characterization of the crustacean Rhesus-like protein (RhCM) and its role in branchial ammonia excretion in the green crab, *Carcinus maenas***

**Caractérisation de la protéine de type Rhésus (RhCM) des crustacés et son rôle dans l'excrétion d'ammoniac des branchies chez le crabe vert, *Carcinus maenas***

Rhesus proteins in human red blood cells have been shown to mediate  $\text{NH}_3$  transport. While three different Rhesus-proteins have been identified in fish and mammals to be involved in ammonia excretion, only one has been described for crustaceans. In the green crab *Carcinus maenas*, the crustacean Rhesus-like protein RhCM is located throughout the cytoplasm of gill epithelial cells. Additionally, RhCM proved to be capable of restoring ammonia transport in ammonia transporter deficient yeast. To further characterize RhCM, green crabs have been acclimated to 1 mM  $\text{NH}_4\text{Cl}$  (HEA) in brackish water up to 14 days. Gene expression of RhCM decreased significantly in anterior and posterior gills, as well as antennal glands. Whole animal excretion rates increased significantly in HEA-acclimated green crabs, while single gill ammonia excretion decreased. Blocking the microtubule network in epithelial cells affected both ammonia and acid-base regulation in *C. maenas*, indicating a linkage between the two processes.

**LAURA V FERGUSON** and BRENT J SINCLAIR

Western University

**Plasticity drives thermal dependency of host-pathogen interactions**

**La plasticité dirige la dépendance thermique dans les interactions hôte-pathogène**

The physiological performance of ectotherms is mediated by thermal sensitivity and plasticity; thus, the interactions between ectothermic hosts and their pathogens depend on the thermal environment. We explored the impact of the thermal environment on host-pathogen interactions in spring field crickets, *Gryllus veletis*, infected with the fungus *Metarhizium brunneum*. We acclimated crickets to warm, cold, fluctuating and repeatedly-stressful temperatures and grew the fungus at high and low temperatures; we maintained infected crickets at high or low temperatures. At high temperatures, crickets from cold-acclimation and fluctuation regimes survived better, but only fluctuating regimes improved survival of infections at low temperatures. This effect disappeared when we infected crickets with cold-grown fungus. Thus, the outcome of infection depended on the acclimation state of both the host and pathogen and the temperature at which they interact; we conclude that this kind of complex interaction may modify the responses of ectotherms to a changing climate.

**SHANNON FERRARO** AND DOUGLAS FUDGE

University of Guelph

**Swelling mechanisms of hydrogels in the slime of the Pacific hagfish, *Eptatretus stoutii***

**Mécanismes d'engorgement des hydrogels dans la bave de la myxine du Pacifique, *Eptatretus stoutii***

Hagfishes protect themselves against predator attacks by creating large amounts of defensive slime. When provoked, the hagfish secretes exudate from the slime glands, which mixes with the surrounding seawater to form slime that clogs the gills of predators. Gland mucous cells (GMCs) in the slime glands produce vesicles that swell and rupture when they are released into seawater. Here, we investigate the mechanisms underlying the swelling of the glycoproteins in the vesicles, and their

stabilization within the slime glands. Results from *in vitro* swelling assays suggest that the glycoproteins comprise a cationic gel that is stabilized by multi-charged anions *in vivo*. We propose that in seawater, swelling is driven by the exchange of the stabilizing multi-charged anions for chloride, which results in a loss of electrostatic cross-linking and a sudden increase in electrical repulsion among neighboring cationic mucus molecules.

MAYARA LUZZI AND **CONSTANCE FINNEY**

University of Calgary

**What do natural infection models tell us about host-parasite interactions?**

**Que peut-on apprendre des modèles d'infection naturelle au sujet des interactions hôte-parasite?**

Sterile immunity, which continues even after the causative agent disappears, is rarely generated against helminths. Infected hosts must balance protective anti-parasite responses with infection-limiting immune-mediated pathology. Since most worm infections are not lethal, chronic infections are tolerated by hosts to limit pathology, leading to two common features:

1. The polarization of immune responses towards an immune phenotype which promotes effector mechanisms for combating large extracellular invaders.

2. The suppression of worm-specific and general inflammatory responses.

Helminths facilitate many secondary infections by skewing immune responses towards this phenotype and therefore providing an immune environment that is beneficial to the establishment of other pathogens. However, this is not true in all contexts, and is strongly dependent on the exact parameters of the study (e.g. helminth dose and timing of infections). To discover the mechanisms that underlie these contradictory results, we are developing a natural model of helminth infection.

Hoar Finalist abstract

**KATHLEEN FOSTER** AND TIMOTHY HIGHAM

University of California, Riverside

**Modulation of muscle function during arboreal locomotion in *Anolis* lizards**

**Modulation de la fonction musculaire pendant la locomotion arboricole chez les lézards du genre *Anolis***

*Anolis* lizards have become a model system for locomotor adaptation. Despite extensive knowledge about external morphological and behavioural adaptations for locomotion in these lizards, we know very little about how they modulate muscle function in the face of ecological challenges. By measuring *in vivo* muscle activation and joint kinematics as lizards ran on 2 inclines and perch diameters, and relating those data to *in situ* force-length curves, we showed that the gastrocnemius of *Anolis equestris* was both more active and operated at more optimal lengths on broader perches, indicating that it contributed more to propulsion on those surfaces than on narrow perches. Further, the capacity for hindlimb tendon strain was minimal, suggesting that they simply transmit forces rather than store elastic energy. This study not only demonstrates modulation of both muscle activation and mechanics with changes in substrate, but emphasizes the continued need for studying muscle function in ecologically-relevant behaviours. ([return / retour](#))

**ISABELLE, FOURNIER** et PATRICE, COUTURE

Institut national de la recherche scientifique, centre eau-terre-environnement (INRS-ETE)

**Fish are running out of energy in the race against metal contamination and climate change**

**Les poissons sont à court d'énergie dans la course contre la contamination de métaux et le changement climatique**

Cadmium and temperature are stressors that both lead to energetic metabolism malfunction, reactive oxygen species (ROS) creation and increased cellular maintenance costs. A cell exposed to one or another of these stressors produces less ATP and uses more of it. To measure the impact of a combined exposition, fish have been exposed to the two stressors, both individually and combined, for eight weeks *in vitro*. Cadmium and an elevated temperature lead to a decrease of the survival rate and the general condition index, an increase of the proton leak and a modification of the energetic contribution of the different mitochondrial complexes. A synergistic effect has been observed and seems to be caused by membrane permeabilisation. As such, it is important to consider that wild fish are simultaneously exposed to multiple stressors whose combined effects decrease their survival rate.

**CHARISSA FUNG**, LANCE G. BARRETT-LENNARD, WILLIAM K. MILSOM

University of British Columbia

**Correlating cranial shape with diet specialization among sympatric Northeast Pacific killer whale (*Orcinus orca*) ecotypes**

**Corrélations entre la forme du crâne et le régime alimentaire parmi les écotypes sympatriques d'épaulards du nord-est du Pacifique**

Members of genetically distinct killer whale (*Orcinus orca*) ecotypes occupy the northeast Pacific. Each ecotype specializes upon different prey: 'residents' hunt salmonid fishes, 'transients' or 'Biggs' whales hunt marine mammals, and 'offshores' hunt fishes such as Pacific sleeper shark (*Somniosus pacificus*). We compared skulls and jaws to test the hypothesis that ecotype-specific hunting behaviours would correlate to differences in cranial morphology among the three groups, as predicted by the biomechanical demands of capturing and processing extremely different prey types. The specimens were identified from mtDNA sequences, field identification and/or stomach contents. Here we present observations that the jaws of transients are more robust in shape compared to the more gracile piscivorous killer whales, which likely correlates with the demanding forces of hunting and dismantling large mammalian prey with robust endoskeletons and sophisticated anti-predator behaviours.

**PATRICK T. GAUTHIER**, WARREN P. NORWOOD, ELLIE E. PREPAS, GREG G. PYLE

Faculty of Natural Resources Management, Lakehead University, Thunder Bay, ON, Canada P7B 5E1

**Behavioural alterations from exposure to copper, phenanthrene, and copper-phenanthrene mixtures: linking behaviour to acute toxicity mechanisms in the aquatic amphipod, *Hyalella azteca*.**

**Changements de comportement suite à l'exposition au cuivre, au phénanthrène, et aux mixtures cuivre-phénanthrène: liens entre le comportement et les mécanismes de toxicité aiguë chez l'amphipode aquatique, *Hyalella azteca***

Phenanthrene (PHE) and copper are two contaminants commonly found together in marine and freshwater environments around the globe. Relatively little is understood regarding contaminant-induced behavioural alterations in model aquatic invertebrate species used for toxicological testing, such as the freshwater amphipod *Hyalella azteca*. We explored the effects of copper, PHE, and copper-PHE mixtures on oxygen consumption, ROS production, AChE activity, and a suite of behavioural endpoints (e.g., whole-animal activity and pleopod activity). Our principle objective was to link behavioural alterations with oxygen consumption rates, ROS imbalance, and neurotoxicity in adult *H. azteca*. Only PHE influenced behaviour and there was no interactive effect on behaviour in copper-PHE mixtures. We also found that PHE exposure did not increase ROS levels in *H. azteca*, ruling out ROS imbalance as being responsible for behavioural impairment. It is likely that PHE-induced neurotoxicity was responsible for altered behaviour in *H. azteca*. Data acquisition for neurotoxicity is underway.

**MARINA GIACOMIN**, BERND PELSTER, HELEN SADAUSKAS HENRIQUE, VERA

ALMEIDA-VAL, ADALBERTO LUIS VAL, AND CHRIS M. WOOD

University of British Columbia, Vancouver, BC.

**Ionoregulation versus gas exchange in two Amazonian erythrinid teleosts: increased reliance on the gut during the transition to air breathing**

**Régulation ionique versus échanges de gaz chez deux téléostéens erythrinides de l'Amazonie: dépendance accrue sur les intestins durant la transition à la respiration aérienne**

The traira (*Hoplias malabaricus*) is an obligate water breather with large gills and a poorly vascularized air-bladder, whereas the closely related jeju (*Hoplerethrinus unitaeniatus*) is a facultative air-breather with smaller gills but a well-vascularized air-bladder. We examined net branchial fluxes of ammonia, urea, and ions ( $\text{Na}^+$ ,  $\text{Cl}^-$ , and  $\text{K}^+$ ), and air-breathing behaviour under normoxia, severe hypoxia (1 mg  $\text{O}_2/\text{L}$ ) and hyperoxia (30 mg  $\text{O}_2/\text{L}$ ). We also measured the activities of gill transport enzymes ( $\text{Na}^+/\text{K}^+$ -ATPase,  $\text{H}^+$ -ATPase), and transport capacities ( $\text{Na}^+$ ,  $\text{Cl}^-$ ,  $\text{K}^+$ , ammonia, glucose) of the anterior, mid, and posterior intestine in gut sac preparations *in vitro*. We conclude that in the air-breathing species there is a shift of ionoregulatory capacity from the gills to the gut, and in consequence branchial ionoregulation becomes less impacted by variations in environmental  $\text{O}_2$  levels. Behavioural responses to hyperoxia are surprising (ADAPTA, Science without Borders, NSERC Discovery).

**JOHN P. GIESY**

University of Saskatchewan

**Toxicological Evaluation of Perfluorooctanesulfonate (PFOS) in the Environment: Anatomy of an Environmental Issue**

**Evaluation toxicologique de perfluorooctanesulfonate (PFOS) dans l'environnement: anatomie d'un problème environnemental**

This is the story of chemical methods of mass spectrometry and molecular biology to determine the status and trends of concentrations in the environment, mechanisms of toxicity and thresholds for effects. After a global assessment of risk the chemicals were banned. This is the scientific and political story of how a very valuable chemical used in many processes was ultimately banned and the public hardly knew anything had happened. By using a combination of chemistry and biology and ultimately developing a substitute I was able to get a chemical with a bad environmental profile out of the environment and you can still buy all of the electronics that affect our lives on a daily basis. I will discuss the reasons why this situation arose failure to understand the chemistry and toxicology of a whole class of chemicals. It was a failure of science and policies and ultimately discovered through serendipity.

**KELSEY N GIL**, MARGO A LILLIE, ROBERT E SHADWICK

University of British Columbia

**Anatomical specializations for swallowing food in cetaceans**

**Spécialisations anatomiques pour avaler la nourriture chez les cétacés**

The feeding strategies of toothed whales (odontocetes) and baleen whales (mysticetes) are remarkably different. Odontocetes catch and swallow their prey fish whole. Mysticetes perform multiple lunge feeding events in rapid succession, engulfing and swallowing massive amounts of tiny prey crustaceans. These differences in feeding style are reflected in distinct differences in morphology of the anterior digestive tract, implying that the function and mechanical properties of these structures also differ. To elucidate these functional and mechanical differences between odontocetes and mysticetes we described the morphology and muscular structure of the pharynx and esophagus, and performed mechanical tests to determine the compliance of the esophagus. Preliminary results show less compliance in mysticete esophagus, likely resulting from extensive muscularization in mysticete esophagus relative to odontocete esophagus. This study provides insight into the macroevolutionary changes that have defined the odontocetes and mysticetes in the past 33MY since their divergence.

**MATTHEW GILBERT**, KATE FAULDER, KEITH TIERNEY

University of Alberta

**Physiological tolerance of arctic char (*Salvelinus alpinus*) and rainbow trout (*Oncorhynchus mykiss*) to diurnal temperature fluctuations.**

**Tolérance physiologique de l'omble arctique (*Salvelinus alpinus*) et de la truite arc-en-ciel (*Oncorhynchus mykiss*) aux fluctuations diurnes de température.**

Arctic char are commonly considered a cold-water stenotherm, however, we have identified a population that annually migrates through a warm (>21°C), physically challenging creek that undergoes large daily temperature fluctuations (>10°C). In lab, we compared the tolerance of arctic char and rainbow trout, a model temperate salmonid, to simulated diurnal temperature scenarios. Surprisingly, at warm temperatures arctic char did not have impaired performance in an initial swimming performance test, however, in a second test conducted after a brief recovery, swimming performance was significantly reduced in char but not rainbow trout. Diurnal warming also had more pronounced effects on plasma metabolites and heat shock protein gene expression in arctic char than rainbow trout. Our results suggest that arctic char are more tolerant to warm temperatures than generally thought but less tolerant than temperate species, which may make them susceptible to competition as the ranges of more southerly distributed salmonid expand northward.

**TODD E. GILLIS**, MATTHEW D. REGAN, GEORGIE K. COX, TILL S. HARTE, COLIN J. BRAUNER, JEFF G. RICHARDS, AND ANTHONY P. FARRELL<sup>2</sup>

University of Guelph

**Characterizing the metabolic capacity of the anoxic hagfish heart.**

**Caractérisation de la capacité métabolique de coeur de myxine anoxique**

Hagfish are benthic fishes that have a high tolerance for anoxia. The Pacific hagfish, *Eptatretus stoutii*, can fully recover from 36 hours of anoxia at 10 °C. The purpose of this study was to characterize the influence of anoxia exposure on the metabolic capacity of the isolated hagfish heart using direct calorimetry. Anoxia exposure caused heat production to initially decrease by 85% indicating a reduction in the rate of ATP turnover. However, heat production then increased so that by 12 hours of anoxia exposure, the rate of ATP turnover was nearly 70% that measured under normoxic conditions. Glycogen content in the hearts decreased with anoxia exposure suggesting that it is glycolytic pathways that are powering ATP production during prolonged anoxia exposure. Interestingly, however, we found that intracellular pH only decreased by 0.07 pH units in the hearts during anoxia exposure. Together, these results illustrate that the heart of *E. stoutii*, has a significant ability to maintain metabolic function during anoxia exposure.

**KATHLEEN M GILMOUR**, MARIE-ÈVE BÉLAIR-BAMBRICK, ALISON HANES, GURPREET SAHMBI AND JENNIFER JEFFREY

University of Ottawa

**Regulation of the stress axis during chronic social stress in rainbow trout *Oncorhynchus mykiss***

**Régulation de l'axe du stress pendant le stress social chronique chez la truite arc-en-ciel (*Oncorhynchus mykiss*)**

Juvenile rainbow trout form social hierarchies in which dominant fish enjoy the most favourable position in the environment, monopolize food sources and are aggressive towards more subordinate fish. Subordinate fish, by contrast, exhibit marked behavioural inhibition including reduced activity and feeding, as well as symptoms of chronic stress including prolonged elevation of circulating cortisol concentrations. Chronic elevation of cortisol in subordinate fish may reflect continued activation of the hypothalamic-pituitary-interrenal (HPI) axis. However, cortisol production by interrenal cells is impaired by chronic social stress, resulting in an attenuated cortisol response to serotonin and to acute stressors such as confinement in a net. Moreover, the cortisol response of subordinate fish shows little evidence of recovery, at least in the short term, when social stress is relieved by removal of the dominant fish. Thus, the available evidence suggests that regulation of the HPI axis in rainbow trout is altered by chronic social stress.

**CAMERON P. GOATER**

University of Lethbridge

**Zombie hosts and their parasite chauffeurs: the behaviour of trematode-infected ants**

**Les hôtes zombies et leurs parasites chauffeurs: comportement des fourmis infectées par des trématodes**

Some parasite-induced alterations of host behaviour are spectacular in their expression. Formicid ants infected with larvae of the lancet liver fluke, *Dicrocoelium dendriticum*, are chauffeured from their nests onto surrounding vegetation. They firmly attach themselves to flower petals with their mandibles, then detach when temperatures exceed approximately 18°C. They repeat this behaviour for the rest of their lives. To evaluate the adaptive nature of zombie-ism, we monitored marked infected ants in Cypress Hills Park, AB and assessed rates of host survival under contrasting conditions in the lab. Our results show that attachment behaviour is best interpreted as a parasite adaptation to increase rates of transmission to mammalian grazers. But detachment behaviour likely reflects a compromise between host and parasite interests to reduce their risk of desiccation-induced mortality. Decomposing this bizarre host behaviour into its fundamental parts will help in our aim to uncover underlying mechanisms.

**MICHELLE A. GORDY**, LISA KISH, MAHMOUD TERRABAIN, AND PATRICK C. HANINGTON

University of Alberta, School of Public Health

### **Community-level patterns of snail-trematode associations among lakes in central Alberta**

#### **Motifs d'associations entre les escargots et les trématodes à l'échelle communautaire dans les lacs du centre de l'Alberta**

Very few longitudinal studies investigating the dynamics of snail-trematode communities in Canadian lakes exist. We set out to better understand how snail-trematode associations change when considering geographical location, time, and under variable environmental conditions. In our study, we assessed the snail-host-use of trematodes in central Alberta by sequencing the barcoding gene CO1 to identify both snail and trematode species. We surveyed five lakes in central Alberta for two years, collecting snails every two weeks and assessing patent trematode infections. Overall, 14% of 12,747 snails harboured patent trematode infections. Sequencing revealed 5 species of snail and over 20 trematode genera. This study has improved our understanding of the snail-trematode associations in Alberta lakes and built upon past morphological identification approaches using molecular techniques to further resolve species of snails and trematodes. Future studies will examine drivers of community structure based on environmental changes and immunological compatibility.

**JACK GRAY**, PAUL DICK

University of Saskatchewan

### **Population coding in an insect visual motion detection system**

#### **Codage de population dans le système de détection visuelle de mouvement d'un insecte**

Two well-studied neurons in the locust visual system, the Lobula Giant Movement Detector (LGMD) and its postsynaptic partner, the Descending Contralateral Movement Detector (DCMD) respond robustly to complex visual motion and have been implicated in controlling flight steering. However, little is known about responses of other motion sensitive neurons in this system. We used multichannel electrodes to record neural activity from the prothoracic ventral nerve cord of locusts during presentation of objects traveling along simple or compound trajectories. Spike sorting revealed individual units that were segregated into categories based on their response profiles. We found evidence of multiple neuronal units with responses to visual motion that are both novel and unique. In addition to DCMD responses, we observed additional units that responded to looming, translational or compound motion. Principle component analysis revealed population vectors that define categorical responses to aspects object motion and help uncover the neural control of flight.

**BENEDIKT HALLGRIMSSON**, REBECCA GREEN, CHRIS PERCIVAL, JENNIFER FISH, NATHAN M. YOUNG AND RALPH MARCUCIO

University of Calgary

### **The Developmental-Genetics of Complex Morphological Traits: Insights from the Vertebrate Face and Skull**

#### **Génétique du développement des traits complexes: aperçus du crâne et du visage des vertébrés.**

Vertebrate evolution presents many examples of exquisite relationships between form and function. The exploration of such relationships is a common thread through much of Tony Russell's work. How evolutionary processes mould relationships between form and function is significantly affected by how genetic variation is translated to phenotypic variation via developmental processes. Yet little is known about the intricacies of genotype-phenotype relations in complex morphological traits. Here, we review recent work that highlights the central role of nonlinearities in developmental processes that influence the craniofacial complex and their relation to both epistasis and phenotypic robustness. We discuss the implications of these findings for the evolvability and genetics of complex morphological traits.

**PATRICK C. HANINGTON**

University of Alberta, School of Public Health

### **Immunological determinants of snail-trematode compatibility**

#### **Déterminants immunologiques de la compatibilité entre escargots et trématodes**

Snails and digenean trematodes have a long co-evolutionary history. Most digeneans rely on a snail host to complete their larval development, and both laboratory and field studies suggest that in most cases there are only a handful of snail species that can serve as a suitable host for any digenean. Compatibility between snails and digeneans is determined, in part, by the immune response mounted by the snail, and by the parasite's success at evading or suppressing that response. Our research focuses on defining those factors that determine compatibility between snails and digeneans, focusing primarily on *Schistosoma mansoni* and one of its snail hosts, *Biomphalaria glabrata*. Using this model, we have identified and functionally characterized a number of snail immune/hematopoietic factors and parasite-specific immunosuppressive factors that influence infection outcome. Many of the mechanisms and factors underpinning compatibility between snails and digeneans appear to be unique to these organisms, affording a unique opportunity to explore novel immunological processes.

**GRANT HARRISON**, ANDREA LISTER, MELAINE SIMBA, MIKE PALMER & DEBORAH MACLATCHY

Department of Biology, Wilfrid Laurier University, Waterloo, ON

### **Health and reproductive status of walleye (*Sander vitreus*) and lake whitefish (*Coregonus clupeaformis*) in Tathlina Lake, NT. Santé et état reproductif des dorés jaunes (*Sander vitreus*) et grand corégones du lac Tathlina, T.N.-O.**

An environmental monitoring program at Tathlina Lake, NT includes reproductive and health parameters of walleye and lake whitefish, and water quality characteristics. This ecologically and culturally important lake supports a small fishery and is located downstream of the Cameron Hills, where oil and gas exploration occurs. There is a paucity of data that could identify potential environmental or anthropogenic drivers underlying population fluctuations in this unique lake. Male and female adult

fish, in pre- and post-spawning conditions, were collected between 2012 and 2015. Seasonal variations in reproductive hormones, condition, gonad and liver sizes align with the reproductive status of the fish that demonstrated significant variability across years in the endpoints. This indicates the need for longer term monitoring to determine the inherent variability in the endpoints in relation to spawning times for these populations. Robust designs of environmental monitoring programs with site-specific considerations are needed to assess impacts on populations over time.

**TILL S. HARTER** AND COLIN J. BRAUNER

University of British Columbia

**The distribution of plasma accessible carbonic anhydrase and its effect on a unique mechanism of tissue oxygenation in teleosts**

**Distribution de l'anhydrase carbonique dans le plasma, et son effet sur un mécanisme unique d'oxygénation des tissus chez les téléostes**

Teleost fishes that have a strong pH dependency of hemoglobin (Hb) O<sub>2</sub> binding (i.e. a Bohr/Root effect), need to protect red blood cell (RBC) intracellular pH (pH<sub>i</sub>), during a systemic acidosis, to safeguard O<sub>2</sub> loading at the gill. This is accomplished by  $\beta$ -adrenergically stimulated sodium-proton exchangers ( $\beta$ NHE) on the RBC membrane. Plasma accessible carbonic anhydrase (paCA) will short-circuit this protective mechanism by catalysing the dehydration of HCO<sub>3</sub><sup>-</sup> and acidifying the RBCs via the Jacobs-Steward cycle, potentially enhancing O<sub>2</sub> unloading at the tissues. Thereafter, RBCs need to recover pH<sub>i</sub> before they reach the gill which in theory would require a lack of paCA in the venous system. We investigated the presence or absence of paCA in the dorsal and ventral aorta of coho salmon, by measuring the catalytic activity in continuously perfused, isolated vessels.

**AZADEH HATEF** AND SURAJ UNNIAPPAN

University of Saskatchewan

**Nesfatin-1 - Kisspeptin Interactions In Murine Hypothalamic Cells (GT1-7) *In Vitro***

**Intéactions entre Nesfatin-1 et Kisspeptin dans les cellules murines hypothalamiques (GT1-7) *in vitro***

Metabolism and reproduction are tightly interlinked. Nesfatin-1 is an 82 amino acid metabolic regulatory peptide derived from nucleobindin-2 (NUCB2). Nesfatin-1 is expressed in the reproductive system, and stimulates luteinizing hormone (LH) secretion in mice. This research aimed to study whether/how nesfatin-1 affects hypothalamic reproductive hormones, including kisspeptin-1 (Kiss-1) and gonadotropin releasing hormone (GnRH). We found the expression of mRNAs encoding Kiss-1, Kiss-1 receptor GPR54, GnRH and NUCB2 in GT1-7 cells. These cells are also immunopositive for NUCB2/nesfatin-1, GnRH and Kiss-1. Synthetic nesfatin-1 (100 nM) increased Kiss1-R mRNA expression in GT1-7 cells *in vitro* at 1 hour post-incubation. Both NUCB2 and GnRH mRNAs were increased in GT1-7 cells after 2 hours of incubation with 1000 nM kisspeptin-1. These results demonstrate that nesfatin-1 likely induces LH synthesis/secretion through the stimulation of GnRH/Kiss-1 systems. In addition, NUCB2/nesfatin-1 appears to be a novel target of kiss-1 action, which requires additional confirmatory studies.

**JEFFREY J. HAVIXBECK**, AJA M. RIEGER, DANIEL R. BARREDA

University of Alberta

**Aeromonas infections induce high levels of soluble CSF-1R expression impacting inflammatory responses of teleost fish**

**Les infections d'*Aeromonas* induisent des niveaux élevés d'expression de CSF-1R soluble et impactent les réactions inflammatoires des poissons téléostéens**

*Aeromonas* is a highly virulent fish pathogen that causes devastating effects in aquaculture. We found that *Aeromonas veronii* promotes sCSF-1R expression at the infection site. Further, we observed increases in TNF- $\alpha$ 2, IL-1 $\beta$ 1, CXCL8 expression, as well as neutrophilia during the first 4 days of infection, when sCSF-1R levels were elevated. This is in stark contrast to other pathogen models where sCSF-1R down-regulates inflammatory processes. Our results suggest *A. veronii* induces the recruitment of neutrophils, resulting in host tissue damage while having little effect against the catalase-producing *Aeromonas*, thus potentially aiding in systemic dissemination of the bacteria. Interestingly, increased sCSF-1R expression may also be responsible for the distal effects of *A. veronii*, including a decrease in hematopoietic transcription factor expression and hematopoietic proliferation.

**QUENTIN HEFFELL**, SCOTT KELLY, FERNANDO GALVEZ AND PATRICIA WRIGHT

University of Guelph

**Skin permeability of the amphibious killifish *Kryptolebias marmoratus* in response to extreme salinity and short-term emersion**

**Perméabilité cutanée du cyprinodontidé amphibie *Kryptolebias marmoratus* en réaction à la salinité extrême et à l'émersion à court terme.**

Euryhaline amphibious fish must cope with variable osmotic stresses when moving onto a heterogenous terrestrial environment. These environments vary spatially and temporally in substrate ion concentration. We tested the hypothesis that amphibious fish maintain water balance during emersion by altering the permeability of the skin. Mangrove rivulus (*Kryptolebias marmoratus*) were acclimated to hyper- and hyposaline (45 and 0.3‰) water for 1 week, followed by 24hr of air exposure. Cutaneous water influx (3H-H<sub>2</sub>O) and permeability (14C-PEG4000) were determined using micro-Ussing chambers. *K. marmoratus* exhibited regional differences in skin permeability, with a 2.7 fold greater permeability of the dorsal vs. ventral



skin to water. There was significantly greater water and PEG4000 influx across skins of fish in hyposaline water. There was no effect of emersion. These results suggest that amphibious fish primarily rely on the dorsal surface for water uptake and adjust skin properties to osmoregulate in response to salinity extremes.

**DONALD M HENDERSON**

Royal Tyrrell Museum of Palaeontology

**Stomach stones for sinking in swimming sauropterygians?**

**Des cailloux dans l'estomac afin de couler chez les sauroptérygiens aquatiques?**

Sauropterygians were a group of fully aquatic, diapsid reptiles whose fossilized remains are found worldwide in marine sedimentary rocks from the Mesozoic Era (250 - 66 million years ago). The best-known members of the Sauropterygia are the plesiosaurs, which are characterized by their long necks, small heads, compact bodies, and having both the fore and hind limbs modified into flippers. Gastroliths, commonly known as "stomach stones", are collections of small pebbles commonly found in the body cavities of medium- and long-necked plesiosaurs. There have been two competing hypotheses as to the purposes of gastroliths – 1) they were a form of ballast to enable sinking and/or stability, or 2) they were digestive aids. An analysis of the estimated body masses of four plesiosaurs from Alberta, and the masses of the gastroliths recovered with the fossils, shows that the small amounts of stomach stones would have had a negligible effect on buoyancy.

**ANDREAS HEYLAND, ANDREW LIORTI AND JAMIE GIARDINI**

University of Guelph

**Calcium metabolism in *Daphnia*: Ecophysiological responses to freshwater acidification**

**Métabolisme du calcium chez *Daphnia*: Réponses écophysologiques à l'acidification des eaux fraîches.**

Ambient calcium is declining in soft-water lakes as a consequence of unsustainable forestry practices, decreased atmospheric calcium deposition, and acidic deposition. Freshwater crustaceans such as *Daphnia* have a high specific calcium requirement relative to other aquatic organisms as their exoskeleton is heavily reinforced with calcium. Here we describe the distribution of calcium in embryonic stages of *D. magna* and introduce a novel and easy to use staging scheme. We then tested separate but not mutually exclusive hypotheses about the acquisition of calcium by embryos, namely direct uptake versus maternal provisioning. Finally we assessed fitness consequences of maternal provisioning in limiting calcium environments. Our data strongly suggest that females are faced with an allocation trade-off between providing calcium to their offspring and using it for growth and molting. These data provide novel insights into the consequences of calcium decline for freshwater zooplankton.

**TIMOTHY E. HIGHAM AND EMILY A. KANE**

University of California, Riverside

**Complexity, integration, and innovation: biomechanics meets ecology**

**Complexité, intégration, et innovation: rencontre entre la biomécanique et l'écologie**

Animal motion emerges from the integration of multiple systems (parallel integration) and/or levels of organization (hierarchical integration). Within boundaries defined by constraints, motion is modulated in response to abiotic and biotic factors. Behavior in challenging or new ecological scenarios is often facilitated by complex innovations and, although they have many benefits, they often pose significant constraints. For example, the adhesive system of geckos facilitates locomotion on smooth vertical and even inverted surfaces, but limits locomotor speed. Another example is powerful suction feeding in fishes, which facilitates prey capture, but requires that the predator be very close to the prey when the mouth begins opening. In addition, multiple systems work together to successfully capture prey, despite each system being important for other tasks. We will focus on 1) the gain and loss of biomechanical complexity and how it may relate to ecological complexity and constraints, and 2) how complexity is related to integration among systems, which is often necessary for behaviors such as prey capture.

**ALICE HONTELA, LANA MILLER, NICOLE PILGRIM, JEFF DECKER AND JOSEPH RASMUSSEN**

Dept. of Biological Sciences, Water Institute for Sustainable Environments, U. of Lethbridge

**The agony and the ecstasy of selenium: comparative ecophysiology and risk assessment.**

**L'agonie et l'extase du sélénium: écophysiologie comparative et évaluation des risques**

Selenium, an essential trace element required for maintenance of cellular redox state, signal transduction and differentiation, follows a U-shaped dose response curve with an extremely narrow range of homeostatic concentrations. Selenium is teratogenic to embryos of fish and other egg laying vertebrates, it also affects physiological performance and survival of adults. Selenium is released into the aquatic environments by coal mining and coal burning. Coal mining, once considered environmentally unsustainable, has recently expanded in many regions of Canada, due to the ongoing energy crisis. Field and laboratory studies using comparative approaches in physiology, biochemistry and toxicology characterized the toxicity of Selenium, elucidated the mechanisms of action of this trace element, and importantly, provided key data for Ecological Risk Assessment and a Water Quality Criteria for Selenium. Some of these mechanism-focused studies will be reviewed.

**HEATHER A JAMNICZKY**

University of Calgary

**Considering the WHOLE phenotype: emerging approaches to 3D quantitative morphology in eco-evo-devo.**

**Prendre en considération le phénotype ENTIER: nouvelles démarches en morphologie quantitative 3D dans le “eco-evo-devo”**

Correlation between form and function in organisms suggests the influence of adaptive evolution. The prevalence of adaptive traits, the mechanisms by which they arise, and the nature of corresponding responses to selection remain subjects of extensive debate. Recent work is demonstrating that an integrative approach, combining the study of genetics and development with a more thorough approach to quantification of phenotypic variation, has the potential to render insight into adaptive divergence more tractable. Rapid advances in imaging technology allow three-dimensional quantification of a range of different tissue types, as well as their epigenetic interactions throughout ontogeny. Integrating phenotypic covariation structure and quantitative genetic analysis holds tremendous promise for establishing new links between genes and development, phenotype and function, and the environment.

**DAVID M JANZ**, JITH K THOMAS, ANITA J MASSÉ AND JORGELINA R MUSCATELLO

University of Saskatchewan

**Selenium ecotoxicology in fish and frogs**

**Écotoxicologie du sélénium chez les poissons et les grenouilles**

The aquatic ecotoxicology of selenium (Se) is an issue increasing concern in Canada, due to the variety of anthropogenic activities that release Se into aquatic ecosystems, and the exquisite toxicity of this essential trace element to oviparous vertebrates. Our recent laboratory work has investigated dose-dependent developmental toxicities in zebrafish, and more recently *Xenopus*, exposed *in ovo* to selenomethionine (SeMet), the dominant form of dietary organoselenium. Our research suggests that zebrafish is the most sensitive fish species studied to date, with an EC10 (toxicity threshold) for larval deformities of 7.0 µg Se/g dry weight. In addition, F1 generation zebrafish raised to adulthood in clean water displayed persistent physiological impairments of swimming performance and metabolic capacities. *In ovo* exposure of *Xenopus laevis* offspring suggests that this amphibian species is less sensitive than most fish species studied to date, with an EC10 for deformities in tadpoles of 38.8 µg Se/g dry weight.

**JENNIFER D JEFFREY**, KELLY D HANNAN, CALEB T HASLER, ADAM WRIGHT AND

CORY D SUSKI

University of Illinois at Urbana-Champaign

**Understanding the physiological response of a freshwater mussel to elevated carbon dioxide levels.**

**Étude sur la réaction physiologique d'une moule d'eau douce à un taux élevé de dioxyde de carbone.**

Nonphysical CO<sub>2</sub> barriers have attracted recent attention due to their effectiveness at deterring fish movement (e.g., Asian carp). However, little is known about how non-target species (e.g., freshwater mussels) will be affected. The objective of this study was to assess potential physiological consequences of elevated CO<sub>2</sub> for a freshwater mussel. *Fusconaia flava* were exposed to 6 h of control, intermediate, or barrier level CO<sub>2</sub> and allowed to recover for 6 h. Short-term exposure to barrier level CO<sub>2</sub> resulted in decreased hemolymph Cl<sup>-</sup> and an increase in mantle RNA:DNA ratio. Mussels were also exposed to intermediate level CO<sub>2</sub> for 4, 8, and 32 d. Although intermediate level CO<sub>2</sub> treatment did not affect mussels in the short-term, hemolymph Ca<sup>2+</sup> levels were elevated at 4 d and Mg<sup>2+</sup> levels decreased over the long-term exposure period. Additional studies are underway to examine the impact of elevated CO<sub>2</sub> on key genes involved in regulating these responses.

**SARAH E M JENKIN**, AND WILLIAM K MILSOM

The University of British Columbia

**Active expiration in mammals: When and where does it occur?**

**Expiration active chez les mammifères: quand et où a-t-elle lieu?**

Mammalian expiration is typically passive at rest, producing a three-phase breathing cycle: active inspiration (I), expiratory braking (E1) and an expiratory pause (E2). When respiratory drive increases, however, expiration becomes active (AE). Modification of the breathing cycle by AE may occur by increasing tidal volume and/or increasing breathing frequency. In this study, to determine when and how AE is recruited in rodents as respiratory drive increases, EMG leads were placed in the diaphragm and abdominal muscles of rats, guinea pigs, hamsters, ground squirrels, mice and gerbils. Animals were then exposed to air, followed by progressive hypoxia and hypercapnia. Results show that AE was present at rest in mice and gerbils. Hypoxia never produced AE, but hypercapnia always produced AE at the end of the breathing cycle (E3) where it contributed to an increase in the tidal volume of the following breath.

**ORA JOHANSSON**, HELEN SADAUSKAS-HENRIQUE, MARINA GIACOMIN, RAMON BAPTISTA, DEREK CAMPOS, WALDIR HEINRICKS, VERA ALMEIDA-VAL, CHRIS WOOD, ADALBERTO VAL

University of British Columbia

**Does Rate of Re-oxygenation Matter to Hypoxic Recovery?**

**Est-ce que le taux de ré-oxygénation influence la récupération hypoxique?**

Re-oxygenation of anoxic and hypoxic tissues is associated with oxidative stress. Some researchers propose that hypoxia itself does not cause oxidative stress, but that an accumulation of electrons in the mitochondrial electron transport chain produce oxygen radicals as the system becomes re-oxygenated. In Amazon floodplains, fish experience slow transitions into and out of

hypoxia on a daily basis, driven by microbial respiration and diel cycles in photosynthesis. These slower rates of exposure may modify the oxidative response. We examined whether oxidative stress occurred in *Potamorhina altamazonica* (Curimatidae, Rio Negro, Brazil) upon exposure to hypoxia ( $P_{O_2} < P_{crit}$ ) and whether slow re-oxygenation (0.18 mg/l/10 min) was less injurious than immediate normoxia. Data to date on lipid peroxidation (gills, liver, and brain) and SOD (liver) show higher levels under hypoxia than normoxia. The rate of re-aeration did not modify the 1 and 3 hour responses. (ADAPTA, Science without Borders, NSERC Discovery).

**CHRISTINA JOHNSTON**, LINDSAY CLOTHIER, PETRA HERMANN, LISA GIEG, AND  
WILLEM WILDERING

University of Calgary

**Model naphthenic acids delay growth and hatching in snail embryos.**

**Les acides naphthéniques modèles retardent la croissance et l'éclosion des embryons de limnées**

Naphthenic acids (NAs), carboxylic acids with large aliphatic tail groups, are an important class of oil sands tailings pond toxins and a major environmental concern. In this study, we examined the effects of model NAs on *in ovo* development and hatching rates of the pond snail *Lymnaea stagnalis*, a gastropod native to most of the northern hemisphere. We show that hatching rate is progressively affected over a range of 5-75 mg/L NA while somatic growth was progressively affected over a range of 25-75 mg/L NAs. Our data also provides evidence that NA molecular geometry is a factor in selective permeability of *Lymnaea's* gelatinous egg masses to NAs. Taken together our data support the conclusion that even under ideal laboratory conditions low-molecular weight NAs have a negative impact on fecundity of this freshwater gastropod that escalates over a range of environmentally realistic doses.

**ELIZABETH JOHNSTON**, ARIANA BONDER AND TODD GILLIS

University of Guelph

**The role of transforming growth factor-beta 1 in connective tissue remodeling during cold acclimation in cultured rainbow trout cardiac fibroblasts**

**Le rôle de "transforming growth factor-beta 1" dans le remodelage des tissus conjonctifs pendant l'acclimatation au froid dans des cultures de fibroblastes cardiaques de truite arc-en-ciel**

Cold acclimation of rainbow trout causes cardiac hypertrophy and an increase in cardiac connective tissue. Little is known, however, of how changes in physiological temperature influence the regulation of collagen in the heart. One key factor may be the cytokine transforming growth factor-beta 1 (TGF- $\beta$ 1), a trigger of cardiac fibrosis in mammals. In this study, trout cardiac fibroblasts were exposed to TGF- $\beta$ 1 for 24-72 hours. After 24 hours of exposure there was a decrease in the expression of the transcripts for gelatinase matrix metalloproteinases (MMP-2 and MMP-9) and an increase in tissue inhibitor of metalloproteinase transcript. At 72 hours there was an increase in total collagen content, and in the transcript for collagen subtype COL1A. We are currently examining the effect of TGF- $\beta$ 1 exposure on gelatinase activity and on myofibroblast differentiation. The results of this study identify TGF- $\beta$ 1 as a potential candidate for regulating collagen deposition during thermal acclimation.

**HYEWON ELLEN JUNG**, KEVIN V. BRIX, COLIN J. BRAUNER

University of British Columbia

**The effect of temperature acclimation on aerobic scope, hypoxia tolerance, and maximal thermal tolerance in *Cyprinodon variegatus variegatus* and *Cyprinodon variegatus hubbsi***

**Effets de l'acclimatation à la température sur la portée aérobique, la tolérance à l'hypoxie, et la tolérance thermique maximale chez *Cyprinodon variegatus variegatus* et *Cyprinodon variegatus hubbsi***

The freshwater teleost *Cyprinodon variegatus hubbsi* (Cvh) diverged from its euryhaline relative *Cyprinodon variegatus variegatus* (Cvv) ~150kya and is genetically and physiologically distinct. Cvv inhabit intertidal estuaries in the Gulf of Mexico, where they experience a broad temperature range (-2-43°C) and frequent hypoxia. Cvh live in several lakes in Florida, where temperature is more stable (12-28°C) and hypoxia is rare. A comparative study on the effect of temperature acclimation (25, 30 and 35°C) on aerobic scope, hypoxia tolerance, and critical thermal maximum (CTMax) was performed. Aerobic scope was calculated by subtracting resting from maximum metabolic rates. Hypoxia tolerance and CTMax were assessed using loss of equilibrium endpoints. Aerobic scope patterns were variable and Cvv displayed greater hypoxia tolerance. CTMax was similar between subspecies and positively correlated with acclimation temperature. Overall, results indicate that these subspecies may represent a useful evolutionary model within the context of oxygen- and capacity-limited thermal tolerance.

**ALETHE L. KABORE**, EMMANUEL A. PILA AND PATRICK C. HANINGTON

University of Alberta

***Schistosoma mansoni* immunological behaviours during *Biomphalaria grabata* infection**

**Comportement immunologique de *Schistosoma mansoni* lors d'une infection par *Biomphalaria grabata***

*Schistosoma mansoni* (*S.mansoni*) is one the digenetic blood fluke responsible for schistosomiasis, the second most important parasitic disease in the world after malaria. Schistosomes require suitable snail hosts to complete their larval development. Hanington et al. (2010) have demonstrated that the snail immune response is down regulated during successful infection by schistosomes and *S.mansoni* expression during intramolluscan development showed up regulation of proteins such as

leishmanolysin-like and venom-allergen-like. Both proteins have been studied in other systems and demonstrated to be utilized in immune response evasion. A more in-depth expression analysis of *S. mansoni* leishmanolysin and venom-allergen-like revealed up regulation during early infection stages which supports our hypothesis of these proteins playing the important immunological functions of evading and eluding the snail's immune response. Using generated anti-bodies specific to each protein and recombinant protein, a phenotype and immunochemistry assay I will locate and functionally characterize leishmanolysin and venom-allergen-like proteins in *s. mansoni*.

**AMANDA S KAHN**, AND SALLY P LEYS

University of Alberta

**Multiple origins of choanocytes in feeding chambers of sponges**

**Origines multiples des choanocytes dans les chambres d'alimentation des éponges**

Sponge flagellated feeding cells, choanocytes, bear morphological similarity to choanoflagellates, the closest protistan relatives to metazoans. Colony formation in choanoflagellates occurs by a single founding member giving rise to all other members of the colony. In freshwater sponges a founding cell is also thought to divide 4-5 times to produce 30-50 choanocytes. Yet while cell proliferation assays support this idea, choanocytes are seldom caught in the act of mitosis. We studied this process in live sponges. Choanocytes were occasionally seen in mitosis, but another mechanism of chamber growth seems to prevail: small wandering cells become aware of a neighboring chamber, change direction towards it, squeeze between existing choanocytes, and differentiate into choanocytes. 'Immigrant choanocytes' have never been reported before. Sponges branched early from the last common ancestor to animals, and if the way they became multicellular is by aggregation of 'immigrant choanocytes' this differentiates them radically from their protistan relatives.

**TOMONARI KAJI**, A. RICHARD PALMER

Bamfield Marine Sciences Centre and Univ. Alberta

**Direct evidence of developmentally plastic addition and fusion of barnacle leg segments.**

**Preuve directe de l'addition et de la fusion plastiques de segments de bras dans le développement de la balane.**

Developmentally plastic responses to variation in the environment have long been considered to be a potential source of raw material for adaptive evolution. However, while plasticity is well-documented at the phenotypic level, the developmental mechanisms that result in variable morphology remain surprisingly obscure in most systems. Here we report compelling evidence of the developmental sequence by which segments are added and deleted (fused) in feeding legs -- of individually monitored barnacles (*Balanus glandula*) -- as developmentally plastic responses to differences in water motion. To our knowledge, these are the first direct observations of developmentally plastic fusion of serially repeated units even though such fusion is widespread on evolutionary timescales and frequently associated with newly integrated functional complexes. This system offers great potential for probing the developmental mechanics of both segment fusion and segment addition to better understand the evolution of serially repeated structures and body plans.

**KECIA A. KERR**, MICHAEL D. JENNIONS & PATRICIA R.Y. BACKWELL

The Australian National University, Division of Evolution, Ecology and Genetics, Research School of Biology

**Effects of small-scale habitat selection on reproductive activity and female mate preferences in fiddler crabs**

**Effets de la sélection d'habitat à petite échelle sur l'activité reproductrice et le choix des partenaires des femelles du crabe violoniste**

Environmental conditions can differ strongly between habitat patches only a few meters apart, and selection of habitat at this scale can affect the fitness of organisms. For the fiddler crab *Uca mjoebergi*, partial shading of habitat results in large differences in temperature and sediment moisture content, affecting activity patterns. Intriguingly, shading also strongly affects female mate choice. Females released in the shade showed no preference for robotic males courting either in the sun or shade, but when released in the sun, females strongly preferred the "male" in the shade. In a control, when only one robot was courting, females chose the courting male regardless of whether the male was shaded. The female preference is therefore not simply for moving into the shade. As tropical invertebrates experience more extreme heat, behavioural responses to small-scale habitat differences may increasingly affect female mate choice, ultimately affecting reproductive success and competition for space.

**MEGHAN KERR**, REMINGTON WINTER, MIKE TRITES, EMMA GILLIS, LAURA FERGUSON, AND TODD SMITH

Acadia University

**Interspecific competition among intraerythrocytic blood parasites of the genus *Hepatozoon* in green frogs, *Rana clamitans***

**Compétition inter-spécifique entre les parasites sanguins intra-érythrocytiques du genre *Hepatozoon* chez les grenouilles vertes, *Rana clamitans***

*Hepatozoon clamatae* and *Hepatozoon catesbiana* are intraerythrocytic apicomplexan parasites that infect frogs of eastern North America. *Hepatozoon clamatae* and *H. catesbiana* are sympatric in distribution, and both species may simultaneously infect green frogs or bullfrogs. Our objective was to investigate the population dynamics of a dual infection of these parasites in green frogs. Mosquitoes were fed on naturally infected green frogs with varying parasitaemia of each parasite species. Specific numbers of mosquitoes, in specific ratios of *H. clamatae*: *H. catesbiana*, were fed to laboratory-reared green frogs, which were sampled every 20 days for 120 days post-infection to assess parasitaemia of each species. Frogs with dual

infections featured a higher total parasitaemia than those with single infections, and proliferative asexual division in erythrocytes was observed more frequently in dual infections. These observations suggest that one or both species of parasites respond to competition by increasing their intensity in infected frogs.

#### **KAREN KIDD**

University of New Brunswick

##### **What happens in a food web when fish go on the birth control pill?**

##### **Qu'est-ce qui arrive à un réseau trophique quand les poissons prennent des contraceptifs oraux?**

Municipal effluents contain estrogens that cause male fish to produce vitellogenin (egg yolk protein precursor) and develop intersex. Though these feminized males are found in rivers in Canada, it was not known if these impacts on individuals threaten the sustainability of fish populations. A whole lake experiment was done at the Experimental Lakes Area from 1999-2010 to understand how the estrogen in the birth control pill (EE2; 3 years of additions) affects abundances of fishes and other organisms in the food web. EE2 caused the feminization of male fishes, the near extinction of fathead minnow and subsequent indirect effects on abundances of their main predator (lake trout) and their prey. When additions stopped, mimicking improved wastewater treatment, the minnows recovered completely. Results indicate that estrogens can have both direct and indirect effects on aquatic species and reductions of these contaminants in wastewater effluents can lead to recovery of impacted populations.

#### **JANET KOPRIVNIKAR AND THERESA M.Y. URICHUK**

Ryerson University

##### **Effects of predator exposure on host anti-parasite behaviour: current vs. past threats**

##### **Effets de l'exposition aux prédateurs sur le comportement anti-parasite de l'hôte: menaces présentes et passées.**

Despite the efficacy of anti-parasite behaviours, animals often choose anti-predator behaviours in the simultaneous presence of both natural enemies if these conflict but it is not clear whether there is a temporal component, i.e. if hosts favour responses to the immediate threat. We examined the behaviour of larval toads in the absence/presence of trematode parasite infectious stages (cercariae), comparing tadpoles previously exposed to chemical cues signifying the presence of a predator to those which had not. Previous predator exposure significantly decreased overall tadpole activity level, with a marginally insignificant activity increase in the presence of cercariae. However, larval toads not previously exposed to predator cues reacted strongly to cercariae whereas those subjected to predation threat displayed relatively little activity in the absence or presence of parasites. Hosts may exhibit stronger responses to predators than parasites in certain circumstances, even if the threat of predation is not immediate.

#### **NIKOLINA KOVACEVIC, MARIEL O. HAGEN, JIASONG XIE, AND MIODRAG BELOSEVIC**

University of Alberta

##### **The analysis of the acute phase response during the course of *Trypanosoma carassii* infection in the goldfish (*Carassius auratus* L.)**

##### **Analyse de la réaction aigüe pendant l'infection par *Trypanosoma carassii* des poissons rouges (*Carassius auratus*)**

A central mediator of innate immunity involves the acute phase response (APR), a rapid physiological reaction to any trauma, inflammation or infection. It is marked by a significant change in the blood composition of acute phase proteins (APPs), whose various roles are known to play a crucial role in immune responses, pathogen elimination and restoration of homeostasis in higher vertebrates. In lower vertebrates, including economically important fish species, the role of APP orthologs has not been fully established. My research focuses on characterizing the APR in goldfish challenged with the protozoan parasite, *Trypanosoma carassii*. Quantitative expression analysis revealed significant changes in a panel of APPs assessed in the kidney, liver and spleen of goldfish during the course of infection. C-reactive protein and Serum Amyloid A, two major APPs, were up-regulated significantly during the acute infection phase, and were therefore chosen to be functionally characterized in the goldfish.

#### **RAYMOND KWONG AND STEVE PERRY**

University of Ottawa

##### **Hydrogen sulfide modulates calcium uptake in larval zebrafish**

##### **Le sulfure d'hydrogène module l'assimilation de calcium chez les poissons zèbres larvaires.**

The present study investigated the role of hydrogen sulfide ( $H_2S$ ) in the regulation of  $Ca^{2+}$  balance in larval zebrafish (*Danio rerio*). The results demonstrated that exposure to  $H_2S$  donors ( $Na_2S$  or GYY4137) increased  $Ca^{2+}$  influx and whole-body  $Ca^{2+}$  levels. Treatment of fish with a protein kinase-A (PKA) inhibitor abolished the  $H_2S$ -mediated stimulation of  $Ca^{2+}$  influx. Additionally, exposure to a cAMP-elevating agent forskolin significantly increased  $Ca^{2+}$  influx. These findings suggest that activation of the cAMP/PKA signalling pathways, either by  $H_2S$  donors or by cAMP-elevating agents, stimulates  $Ca^{2+}$  uptake in larval zebrafish. Moreover, we found that gene knockdown of the  $H_2S$ -biosynthesis enzyme cystathionine  $\beta$ -synthase (CBSb) reduced  $Ca^{2+}$  influx in fish acclimated to low  $Ca^{2+}$  water. Results from whole-mount immunohistochemistry further revealed that CBSb was expressed in  $Ca^{2+}$ -transporting cells (i.e.,  $Na^+/K^+$ -ATPase-rich cells). Collectively, the present study suggests a novel role for  $H_2S$  in promoting  $Ca^{2+}$  influx in a low  $Ca^{2+}$  environment.

**LEANNA E LACHOWSKY**, MARY L REID

University of Calgary

**Maternal state and habitat quality as causes of offspring mortality and sex ratio bias**

**État maternel et qualité de l'habitat comme causes de mortalité des descendants et biais dans la proportion des sexes**

Biased sex ratios suggest important processes that cause the ratios to differ from the expected 50:50. Mountain pine beetle, *Dendroctonus ponderosae*, have approximately 2:1 females:males at adult emergence for reasons that are not well resolved. Previous studies found that the female bias increased with greater overwintering mortality, suggesting male-biased mortality at the population level. Males may be more susceptible to stresses due to their relatively smaller size. The quality of parents or habitat may influence the number, size and sex of offspring produced and, in turn, their survival. Here we examine individual broods under benign laboratory conditions for patterns of mortality at each life stage. We explored the effect of maternal size and condition on offspring mortality along a habitat gradient of decreasing quality associated with egg order. Sex allocation differed among females but the strategies were complex. Greater developmental mortality produced more female-biased adult sex ratios.

Hoar Finalist abstract

**SABINE L LAGUE**, BEVERLY CHUA, ANTHONY P FARRELL, KEVIN G MCCracken, YUXIANG WANG, AND WILLIAM K MILSOM

University of British Columbia

**Performance and life at high altitude: Different hypoxic ventilatory response strategies in bar-headed geese and Andean geese**

**Performance et vie en haute altitude: Différentes stratégies de réactions ventilatoires hypoxiques chez les oies à tête barrée et les oies des Andes**

Bar-headed geese (*Anser indicus*; BHG) and Andean geese (*Chloephaga melanoptera*; AG) champion high altitude (HA) life. BHG migrate at HA (>5000m) across the Himalayas, while AG reside lifelong in the Andes (4000-5500m). Though evolutionarily diverged, both have independently evolved high oxygen-affinity hemoglobins. To determine whether they match oxygen supply and demand similarly at HA, we characterized the hypoxic ventilatory response (HVR) and hypoxic cardiovascular response (HCVR) of BHG (3200m in Tibet) and AG (4000m in Peru). Birds were cannulated and exposed to stepwise hypoxia while measuring cardiovascular (heart rate, cardiac output), respiratory (ventilation), and metabolic variables. HCVRs were similar, characterized by 2-fold cardiac output increases, but HVRs differed substantially. While BHG increased ventilation by 3.5-fold, ventilation in AG remained unchanged. Instead, lung oxygen extraction increased by ~90%. These radically different strategies for matching oxygen supply and demand appear to reflect the demands of acute HA performance versus chronic HA residency. ([return / retour](#))

**MICHAEL LANNON**, JAIMIE KLEMISH, ROCHELLE STILES AND JONATHAN SWAN

Indiana University school of Medicine

Amphibian habitat creation on post-industrial landscapes

Création d'habitats pour amphibiens dans les environnements post-industriels

While habitat loss is a major driver of amphibian and reptile declines globally, a subset of post-industrial landscapes, reclaimed and restored, are creating habitat for these animals in the United States. In southwestern Indiana, along the southeastern edge of the Illinois Coal Basin, post-SMCRA (Surface Mining Control and Reclamation Act, 1977) grassland restorations are recreating pocket prairies in a region where they occurred naturally, but were destroyed by agricultural activities following Euro-American settlement. Furthermore, it is likely, given the speed of re-colonization by 35 species of amphibians and reptiles (9 frog, 5 salamander, 14 snake, 5 turtle, and 2 lizard species), that the grasslands associated with railroad spur-line right-of-ways act as corridors to facilitate movement of these species into these relatively large sites. We suggest that reclaimed, restored, and properly managed landscapes can support reproducing populations of amphibians and reptiles, including species in decline across other portions of their range.

Hoar Finalist abstract

**GIGI YC LAU** AND JEFFREY G RICHARDS

University of British Columbia

**Critical role of cytochrome c oxidase in the evolution of hypoxia tolerance**

**Rôle critique de l'oxydase de cytochrome c dans l'évolution de la tolérance à l'hypoxie**

Mitochondria use O<sub>2</sub> to generate metabolic energy required by cells to support routine functions, thus a lack of O<sub>2</sub>, or hypoxia, threatens the maintenance of cellular energy balance. Sculpin fishes (superfamily Cottoidea) inhabit the marine nearshore environment and show a range in whole animal hypoxia tolerance where the most tolerant species inhabit the highly O<sub>2</sub> variable intertidal zone and the less tolerant species in the more O<sub>2</sub> stable subtidal. We investigated if variation in the function of mitochondrial cytochrome c oxidase (COX), the terminal step of the oxygen transport cascade among sculpins is linked to variation in hypoxia tolerance. COX from hypoxia tolerant species have a better O<sub>2</sub> binding affinity (lower apparent K<sub>m</sub> for O<sub>2</sub>) in both brain and liver. *In silico* analyses of sculpin COX proteins show interspecific differences in COX3 protein stability, which we have shown to have functional consequences on proton transfer by COX and possibly O<sub>2</sub> diffusion into the enzyme.

([return / retour](#))

**CHRISTOPHE LEMOINE** AND PATRICK WALSH

University of Ottawa

**Evolution and distribution of the Urea Transporter (UT) family in vertebrates.**

**Évolution et distribution de la famille des transporteurs d'urée (UT) chez les vertébrés**

The UT family facilitates urea movement across cellular membranes. While these proteins are important in ureotelic animals, several non-ureotelic species also express these transporters. In this study, we explored UT evolution and tissue distribution in vertebrates to further our understanding of their function throughout evolutionary time. We reconstructed a vertebrate phylogeny of the UTs and generated their tissue distribution in various species. Our results suggest that an ancestral UT was repeatedly duplicated early in vertebrate history, with a secondary loss of these duplicates in lobe finned fishes. Further, a subsequent series of tandem duplications in amniotes generated the mammalian UT-A and UT-B. Interestingly, UT tissue distribution in several species indicates that regardless of organismal ureogenic capacity, most tissues express different UT isoforms, suggesting that these transporters may have primarily evolved for the cellular control of urea levels rather than for an organismal nitrogenous waste excreting strategy. Funded by NSERC (Canada).

**MARYNA P LESOWAY**, RACHEL COLLIN, and EHAB ABOUHEIF

McGill University, Smithsonian Tropical Research Institute

**Potential roles for apoptosis and MAPK in nutritive embryo development in the calyptraeid gastropods**

**Rôle potentiel de l'apoptose et du MAPK dans le développement des embryons nutritifs des gastropodes calyptraeidés**

Nutritive embryos, also known as trophic or nurse embryos, arrest their development and are ingested by their normally developing siblings. Although found in groups as varied as fish, ants, worms, and snails, their development remains poorly characterized. In the model calyptraeid gastropod *Crepidula fornicata*, mitogen activated protein kinase (MAPK, ERK1/2) is implicated in embryonic organization, and has a characteristic pattern of activation during early cleavage stages. In species which produce nutritive embryos, *Crepidula navicella* and *Calyptrea lichen*, a subset of embryos show the expected activation pattern, with the remainder having variable activation patterns, and half the embryos with activation as early as the two-cell stage. This precocious MAPK activation correlates with apoptosis during early cleavage stages. These developmental patterns correspond with downstream variability in nutritive embryo morphology, suggesting that nutritive embryo identity is set early in development, and that the developmental switch is not a simple binary.

**ZACHARY R. LEWIS**, JAMES HANKEN

Dept. of Organismic and Evolutionary Biology and Museum of Comparative Zoology, Harvard University

**A transcriptional and morphological investigation of lung loss in salamanders**

**Enquête transcriptionnelle et morphologique de la perte de poumons chez les salamandres**

Lung loss has evolved several times independently in salamanders. Despite their lack of lungs, lungless salamanders make up over two thirds of all extant salamander species. Little is known about the developmental mechanisms that underlie lung loss, or about the consequences of lung loss for the anatomy and development of the cardiovascular system. Lung loss in plethodontid salamanders occurs by regression of an embryonic pulmonary rudiment. Transcriptional profiling of this rudiment provides insight into the genetic mechanism of lung loss. Signaling pathways with known effects on lung development are perturbed in lungless salamanders. Salamanders with and without lungs display divergent heart morphology. We characterize these cardiac differences using 3D reconstructions from  $\mu$ -CT and histological sections of lunged and lungless species. Transcriptional networks underlying heart development also diverge between lunged and lungless salamanders. These gene expression differences point to a mechanism whereby signaling from the lungs actively patterns cardiac morphology.

**SALLY P LEYS**

University of Alberta

**Complexity and loss of complexity in the evolution of early metazoan body plans**

**Complexité et perte de complexité dans l'évolution des plans de corps des anciens métazoaires**

Sponges (Porifera) have long been considered the first multicellular animals to have descended from a common ancestor shared with choanoflagellates. The simplicity of their body plan has been held as evidence of the step-wise evolution of complex traits. But new genomic data strongly suggests Ctenophora, planktonic predators with muscle, nerves and sophisticated sensory systems, arose even earlier. The nervous system of ctenophores is apparently quite 'different' from that of bilaterians, but whether it is independently evolved or highly derived is unclear. Sponges show more complexity than is generally understood including sensory organs, and coordination of tissues and of whole body behaviours. Patterning of multiple filtration units into the sponge aquiferous system is also overseen by the organizer-like properties of the osculum. But sponges are nevertheless reflex-level animals. Could this level of organization and coordination have devolved from something more complex? This talk will assess evidence from genomes, physiology and morphology.

**DUSTIN LILICO**, JOSH PEMBERTON, MYRON ZWOZDESKY, DR. JAMES STAFFORD

University of Alberta

**Examining distinct immune receptor-mediated target acquisition and engulfment pathways in fish.**

**Étude sur le ciblage par récepteur immunitaire et les voies d'engouffrement chez les poissons.**

Immune cell-types called phagocytes have the ability to bind and engulf targets by an evolutionary conserved process known as



phagocytosis. This mechanism involves receptor-mediated recognition of targets, activation of intracellular signaling networks, stimulation of actin polymerization and membrane remodelling events. My research is focused on understanding the mechanisms of phagocytosis induced by the family of teleost immunoregulatory proteins termed leukocyte immune-type receptors (LITRs). We recently demonstrated that different LITR-types induce phagocytosis using distinct cellular modes. One phagocytic mode uses similar subsets of kinases and effector proteins used by mammalian phagocytic receptors such as the FcRs. A unique LITR-induced phagocytic mode was also identified, which appears independent of common phagocytic signaling machinery and demonstrates an atypical phenotype of target capture and incomplete engulfment, reminiscent of tethering receptors. These studies suggest for the first time that different modes of phagocytosis exist in teleost and expand our understanding about the various phagocytic processes.

**DAVID LISSER**, ZACHARY LISTER, MICHAEL WILKIE, AND GRAHAM SCOTT

Wilfrid Laurier University, Waterloo, Ontario, Canada

**The role of oxidative stress in the mechanisms of ammonia-induced neurotoxicity in goldfish (*Carassius auratus*)**

**Rôle du stress oxydatif dans les mécanismes de neurotoxicité induite par ammoniac chez les poissons rouges (*Carassius auratus*)**

Brain swelling is a serious complication of ammonia toxicity in vertebrates. While the precise mechanisms remain elusive, it has been suggested that oxidative stress is involved. The present study evaluated the role of oxidative stress in the pathogenesis of ammonia-induced brain swelling in the ammonia-tolerant goldfish (*Carassius auratus*) following exposure to high external ammonia (HEA). Goldfish ( $n = 24$ ) were euthanized following 24h and 72h HEA exposure along with their appropriate controls. HEA induced a 114% increase in lipid peroxidation in the goldfish brain, although the liver was unaffected. Protein carbonyl content increased in a time-dependent manner in the brain, while it increased only transiently in the liver. HEA also resulted in increases in the activities of catalase, superoxide dismutase, glutathione peroxidase, and glutathione reductase in the brain. Our results indicate a significant neurotoxic effect of ammonia and a mechanistic role for oxidative stress in ammonia-induced brain swelling in teleosts.

HEATHER COATSWORTH, PAOLA CAICEDO, CLARA OCAMPO, CHRIS COOMB, AND **CARL LOWENBERGER**

Simon Fraser University

**Resistance Reasoning: The case of resistance by *Aedes aegypti* to Dengue viruses**

**Résistance de *Aedes aegypti* aux virus du Dengue.**

Dengue is the most widespread arbovirus and is transmitted principally by the mosquito, *Aedes aegypti*. There is disagreement regarding the effects of Dengue viruses (DENV) on the physiology and overall fitness of the vectors; most studies suggest fitness costs only exist in associations between vectors and viruses from different geographical locations. In Cali, Colombia, ~30% of feral mosquitoes are naturally resistant to DENV, and resistance is mediated by midgut-virus interactions. Selection of lines from field material produced 3 colonies. The susceptible colony is 97% susceptible but neither of the 2 resistant strains exceeds 50% resistance. Susceptible and Resistant mosquitoes are collected from the same oviposition sites and 5 mosquitoes have no statistically significant differences in fitness parameters when fed on blood, or blood +DENV whereas resistant mosquitoes are slightly smaller and produce 10% fewer eggs. Why become refractory to a virus that causes no measureable harm? The conundrum continues.

**JAVIER LUQUE** AND A. RICH PALMER

Department of Biological Sciences, University of Alberta, Edmonton, Alberta T6G 2E9, Canada

**Unleashing the chimaera: An enigmatic crab from the Cretaceous of Tropical America, and the early evolution of true crabs**

**Un crabe énigmatique du Crétacé des Amériques tropicales et l'évolution initiale des vrais crabes.**

Extraordinary fossil crabs offer new understanding of evolutionary history, particularly when they fill major gaps in space and time near the base of hyperdiverse groups. Numerous, fully-articulated fossils (adult + juvenile males and females -- exceedingly rare in fossil crabs) from the Cretaceous of Colombia, South America (~95 million years ago), allowed us to reconstruct in stunning detail a highly unusual novel form — a 'chimaera' creature bearing diverse traits seen individually in many fossil and living main groups or clades of false and true crabs, but never combined in one. The unusual form and unexpected geographic location (Neotropics), together with morphological evidence from all major clades of fossil and extant crabs, suggests: a) an immense versatility of form even among early crabs, and b) a Cretaceous adaptive radiation, possibly originating in poorly known tropical marine settings, that ultimately yielded the most diverse group of living decapods.

**KEEGAN LUTEK** and ANDREAS HEYLAND

University of Guelph

**Histamine signaling in *Strongylocentrotus purpuratus* metamorphic competence**

**Signalisation d'histamines dans la compétence métamorphique de *Strongylocentrotus purpuratus***

There is strong evidence that histamine (HA) is a modulator of metamorphic competence in *Strongylocentrotus purpuratus*. An extensive larval and juvenile histaminergic nervous system is seen throughout *S. purpuratus* development and pharmacological assays suggest HA facilitates attainment and maintenance of competence. Sea urchin HA receptor 1 (H1R) is a likely candidate to mediate the modulatory action of HA in *S. purpuratus* larvae. Here we analyze H1R and HA expression patterns using immunohistochemistry throughout development and present preliminary evidence for a signaling function of H1R. Preliminary



results suggest H1R is expressed in bottle cells in the mouth area of larvae, oriented to receive external cues. Furthermore, we analyze histidine decarboxylase (HDC) expression patterns, a histamine synthesis enzyme that we characterized in the sea urchin. Finally, we use morpholino injections into larval stages, a novel tool developed in our lab, to further characterize HA function in sea urchin metamorphosis in these larvae.

**KADY LYONS**, MATT VIJAYAN

University of Calgary

**Stress response in round stingrays exposed to environmental PCBs along the southern California coast**

**Réaction de stress chez les raies pastenagues exposées aux BPCs le long de la côte du sud de la Californie**

Stress response impairment due to environmental contaminant exposure has been documented in a variety of organisms; however, little research has investigated these types of effects in elasmobranch fishes. Round stingrays (*Urobatis halleri*) sampled from mainland California (Long Beach) had significantly higher hepatic PCB levels than stingrays from a nearby offshore island (Catalina). We tested the hypothesis that higher PCBs body burden will compromise the stress response in this species. Stingrays were collected via hook and line from these two locations and plasma was sampled either immediately or 15 min after a confinement stressor. Our results support the hypothesis that Catalina rays showed a corticosteroid response, while this conserved response was attenuated in the mainland rays. Also, liver glucose and glycogen content were lower in the stressed mainland stingrays compared to the Catalina rays. Overall, PCB contamination reduces the capacity to elicit a physiological stress response in the round stingrays.

**TYSON MACCORMACK**, JASON ROBINSON, WILLIAM DRIEDZIC.

Mount Allison University

**Acclimation to hypercapnia alters energy metabolism and cardiac contractility in the Amazonian armored catfish, *Pterygoplichthys pardalis*.**

**L'acclimatation à l'hypercapnie modifie le métabolisme énergétique et la contractilité cardiaque chez le poisson-chat blindé d'Amazonie, *Pterygoplichthys pardalis***

*Pterygoplichthys pardalis* naturally inhabit hypercapnic (high  $P_{CO_2}$ ) waters and can tightly regulate intracellular pH in the face of a substantial extracellular acidosis in many tissues. *P. pardalis* show variable cardiac responses to acute hypercapnia in vitro and we hypothesized that these differences relate to differences in the history of the fish. We compared metabolic parameters and cardiac contractility from *P. pardalis* acclimated to 21 mmHg  $P_{CO_2}$  long term (hypercapnia), 6 days at 6 mmHg  $P_{CO_2}$  (chronic normocapnia), or 15 h at 6 mmHg  $P_{CO_2}$  (acute normocapnia). Chronic normocapnia acclimation significantly decreased plasma glucose and liver glycogen levels and increased plasma lactate concentration. Ventricle strip preparations from chronically normocapnic fish were more sensitive to  $CO_2$  exposure, more responsive to calcium, and were capable of pacing at higher frequencies than hypercapnic fish. Hypercapnic acclimation leads to hypometabolism and cardiac remodeling which may have significant implications for the ecology of this species.

**HILLARY C. MADDIN**, NADINE PIEKARSKI, ELIZABETH SEFTON, JAMES HANKEN

Carleton University

**Re-evaluation of the homology of the bones of the tetrapod cranial vault**

**Réévaluation de l'homologie des os de la voûte crânienne des tétrapodes**

Bones of the cranial vault appear to be highly conserved among tetrapods. However, recent developmental studies reveal differences in the embryonic origin of cranial vault bones between amniote representatives thereby challenging this view. In mouse, the frontal is derived from neural crest (CNC) but the parietal is derived from mesoderm. In chicken, the frontal is of dual origin, rendering the assessment of the homology of the avian frontal incongruent with that of mouse. To elucidate this apparent conflict we fate-mapped axolotl to reveal the contributions of these two embryonic cell populations to the vault. The CNC-mesoderm boundary in axolotl is located between the frontal and parietal bones, as in mouse but unlike chicken. If, however, the avian frontal is regarded as a fused frontal and parietal and the parietal a postparietal, then the vault of birds is topographically, developmentally and phylogenetically (as revealed by fossils) congruent among all three tetrapods.

**CODY W MANCHESTER** AND JOHN R GRAY

University of Saskatchewan

**Flight muscle coordination in collision avoidance of flying locusts.**

**Coordination des muscles du vol dans l'évitement des collisions chez les locustes volants**

Animals display a variety of adaptive behaviours to avoid predators and collisions with conspecifics. Complex neural control mechanisms underlie these behaviours, which are controlled by specialized neural circuits. Loose tether experiments have shown that *Locusta migratoria*, free to manoeuvre in 3-dimensional space will adjust wing beat frequency, coordinate timing of a single bilateral pair of flight muscles, and coordinate forewing asymmetry during the downstroke. Experiments were designed to test two hypotheses: 1) Synchrony between 3 bilateral pairs of flight steering muscles increases prior to initiation of intentional flight steering behaviour. We analyzed EMG recordings from 3 bilaterally paired forewing (m97(1<sup>st</sup> basalar), m99(subalar), and hindwing (m127(1<sup>st</sup> basalar)) steering muscles. 2) Timing and synchrony of multiple flight muscle activity correlate with whole body motion within 6 degrees of freedom during intentional flight steering. Concurrent electromyographic (EMG) and high speed video allowed for measurements of muscle activity and body orientation.

**MILICA MANDIC**, ANDREW W. THOMPSON, TAMMY M. RODELA AND JEFFREY G. RICHARDS  
University of British Columbia

**Functional analysis of HIF and PDH among sculpins that vary in hypoxia tolerance.**

**Analyse fonctionnelle de HIF et PDH chez les chabots variant dans leur tolérance à l'hypoxie**

Phenotypic change in response to environmental hypoxia can be initiated by changes in gene transcription and we have previously shown that large differences in transcription patterns may contribute to explaining variation in hypoxia tolerance among a group of marine fishes, commonly called sculpins. The mechanisms responsible for coordinating these large-scale changes in gene expression in response to hypoxia are unknown, although the hypoxia inducible factor (HIF), an important transcription factor, is one likely candidate. In turn, HIF is regulated by prolyl hydroxylase (PHD) through changes in cellular O<sub>2</sub> availability. Here, we examined sequence variation of HIF and PHD in 14 sculpin species, as well as mRNA and protein levels of these regulatory factors during exposure to hypoxia in several sculpin species, to determine if variation in HIF and PHD explains, at least in part, the variation in gene transcription patterns in sculpins.

**ADITYA K MANEK**, CINDY MEAYS, AND GREGORY. PYLE  
University of Lethbridge

**The effects of water hardness on the physiological stress response and histopathology of fathead minnows (*Pimephales promelas*).**

**Effets de la dureté de l'eau sur les réactions physiologiques de stress et l'histopathologie des têtes-de-boule (*Pimephales promelas*)**

In freshwaters of British Columbia, we are witnessing an increase in water hardness as a result of industrial activity. There is limited investigation to determine if changes in water hardness in the absence of any other confounding factor can affect aquatic organisms. The main objective of this study was to evaluate if exposure to different concentrations of water hardness (50, 165, 300, 450 and 600 mg/L as CaCO<sub>3</sub>), at a constant calcium:magnesium ratio affects survival, physiological stress response, and histopathological changes in gills of fathead minnows. After 90 days of exposure, we recorded less than 10% mortality in all treatments and no significant difference in cortisol production in fathead minnows before and after exposure to extreme hardness concentrations. Preliminary histological analysis of the gills indicate that exposure to extremely low hardness (50 mg/L as CaCO<sub>3</sub>) results in no histopathological changes.

**ANNA MANKO**, JEAN-PAUL MOTTA, JAMES A. COTTON, JOHN L. WALLACE, ANDRE G. BURET

Department of biological sciences, Inflammation Research Network, Host-Parasite interaction program University of Calgary

***Giardia muris* attenuates *Citrobacter rodentium*-induced colitis**

***Giardia muris* atténue la colite induite par *Citrobacter rodentium***

Recent evidence indicates that giardiasis may protect against enteritis-induced pediatric diarrhea in developing countries. The mechanism remains obscure. We hypothesized that *Giardia* may protect against diarrheagenic bacterial enteritis. *Citrobacter rodentium* is the murine equivalent of enteropathogenic *Escherichia coli*. Aim: to identify anti-inflammatory and/or anti-bacterial processes whereby *Giardia muris* may protect against colitis in *Citrobacter rodentium*-infected mice. Methods: *Giardia muris* trophozoites were collected from female CD-1 mice. Male C57/bl6 mice were infected with *Citrobacter rodentium* (2.5\*10<sup>8</sup> CFU/mouse) and *Giardia muris* (5\*10<sup>6</sup>/mouse) by gavage for 14 days. Animal weight and disease activity index (DAI) were measured daily. Histology, inflammation (myeloperoxidase activity) and bacterial translocation were assessed. Results: *Citrobacter rodentium* induced weight loss, colonic inflammation and bacterial translocation. *Giardia* abolished these effects. *Giardia* reduced bacterial loads in colonic tissues. Conclusion: *Giardia muris* suppresses enteric inflammation in infectious colitis.

**KATHERINE SESSIONS**, DANIEL STEFANOVIC, DOUG BOREHAM, CHRISTOPHER SOMERS, JOANNA WILSON AND **RICHARD G. MANZON**

Department of Biology, University of Regina, Regina, Saskatchewan, Canada

**The heat shock response and thermal adaptation in lake whitefish (*Coregonus clupeaformis*) embryos and fry in response to chronic and acute thermal stress.**

**Réactions de choc thermique et adaptation thermique chez les embryons et alevins de grands corégones (*Coregonus clupeaformis*) en réponse au stress thermique aigu et chronique.**

Lake whitefish (LWF) are a cold water species whose embryos develop in near shore habitats under the ice (2-6°C). Studies have shown that LWF embryos are sensitive to increases in water temperature and may be vulnerable to temperature fluctuations associated with climate change or thermal pollution. The overall objective of this research was to determine the long-term impacts of chronic, but short-term, low level thermal shifts and acute high level heat shocks on LWF embryos and fry. We have shown that both embryos and fry have inducible and constitutive heat shock proteins (HSPs), but the nature of the heat shock response (HSR) differed between developmental stages. HSP induction in embryos required higher heat shock temperatures than fry, but once induced the HSR was long lasting. Moreover, our data suggest that repeated low level thermal stress suppressed the upregulation of HSPs in response to more severe high level heat shocks.

**JAMES L. MARCHANT**, HAMIDULLAH SAFI, CHRISTOPHER M. WILSON, ANTHONY P. FARRELL

University of British Columbia (Canada) and Institut Universitaire Européen de la Mer (UBO, France)

**Adjustments to cardiac pacemaker ion-channel electrophysiology over a temperature range.**

**Ajustements de l'électrophysiologie des canaux ioniques des pacemakers cardiaques sur une étendue de températures**

Cardiac function, to which pacemaker cells contribute, is an essential physiological component for environmental adaptation and acclimation and plays an especially important role in thermal responses of ectothermal animals. Pacemaker cells from hearts of sockeye salmon (*Oncorhynchus nerka*) and coho salmon (*Oncorhynchus kisutch*) of comparable body size (10 g) were examined to verify the prediction that warm-acclimated fish would have slower ionic currents associated with their spontaneous depolarization. Isolated hearts from salmon acclimated to 5°C (n=9 per species) and 19°C (n=9 per species) for a minimum of 2 weeks, were impaled with microelectrodes in the pacemaker region to obtain action potentials at acclimation and common test temperature of 11°C. Action potentials were analysed to determine the effect of acclimation on different segments of the action potential and various ion-channel blockers were used to determine the effect of acclimation on ion-channels responsible for spontaneous depolarization.

La fonction cardiaque, à laquelle participent les cellules pacemakers, est un composant physiologique essentiel pour l'adaptation environnementale et l'acclimation et joue un rôle particulièrement important dans les réponses thermiques des animaux exothermiques. Des cellules pacemakers de saumon sockeye (*Oncorhynchus nerka*) et saumon coho (*Oncorhynchus kisutch*) de taille comparable (10g) ont été examinées pour vérifier la prédiction que les poissons acclimatés au chaud auraient des courants ioniques associés avec leur dépolarisation spontanée plus lents. La région pacemaker de cœurs isolés de saumons acclimatés à 5°C (n=9 par espèce) et 19°C (n=9 par espèce) pendant 2 semaines au minimum, ont été étudiés à l'aide de microélectrodes pour obtenir des potentiels d'action aux températures d'acclimation et à la température commune de 11°C. Les potentiels d'action ont été analysés pour déterminer l'effet d'acclimation sur différents segments du potentiel d'action, et des inhibiteurs de canaux ioniques ont été employés pour déterminer l'effet de l'acclimation sur les canaux ioniques responsable de la dépolarisation spontanée.

**MARTA MARCHINI, CARSTEN B. KRUEGER AND CAMPBELL ROLIAN**

Comparative Biology and Experimental Medicine, University of Calgary

**The role of the growth plate in tibia length variation**

**Rôle de la plaque cartilagineuse dans la variation de la longueur du tibia**

The developmental mechanisms involved in generating bone length variation within a population are still poorly understood. Using mice selectively bred for increases in tibia length (Longshanks), we studied the role of the growth plate in bone elongation. Longshanks mice show an 8% difference in tibia length versus random-bred Control mice at 14 days and ~15% more than Control by 56 days old at generation F16, with differences in tibia length appearing during embryonic and postnatal stages. The proximal tibial growth plate plays a key role in its postnatal elongation. The growth plate has been analyzed using microCT and histomorphometry. Preliminary data shows that in Longshanks, the growth plate is ~20% thicker than control (p<0.05). The hypertrophic zone is larger, has more cells and is more organized in Longshanks, suggesting that chondrocyte hypertrophy plays a role in its increased tibia length.

**VICKI L MARLATT, JINYING SUN, RYAN SHERRARD, CHRIS J KENNEDY, JAMES R ELPICK, CHRISTOPHER J MARTYNIUK**

Simon Fraser University

**Exploring estrogen action in teleosts: from molecular to organismal effects.**

**Action de l'estrogène chez les poissons téléostéens: effets moléculaires et organismiques**

The molecular mechanisms underpinning estrogen action that translate into whole organism level outcomes are not completely understood. This limits our ability to assess perturbed/diseased endocrine system states and the potential impacts of environmental pollutants on estrogen-mediated processes in wildlife. These studies examined several molecular endpoints in rainbow trout swim-up fry after sub-chronic exposure to 17 $\beta$ -estradiol, and whether these molecular level effects corresponded with whole organism level morphometric and physiological changes. Several reproductive genes (e.g. sex steroid hormone receptors, vitellogenin) and growth related genes (growth hormone receptors, insulin-like growth factor 1) were altered as well as decreased growth and survival after estrogen exposures. Collectively, these studies showed that gene expression changes in reproductive, growth and oxidative/chemical stress pathways were associated with adverse effects on survival, growth and development, thus demonstrating some E2-mediated molecular level changes underlying observable, whole organism level outcomes.

**KATIE E. MARSHALL AND CHRISTOPHER D.G. HARLEY**

Department of Zoology, University of British Columbia

**Mechanisms of freeze tolerance in the mussel *Mytilus trossulus***

**Mécanismes de tolérance au gel chez la moule *Mytilus trossulus***

Freeze tolerance is a taxonomically broadly-distributed trait found in several animal lineages, including insect, mollusc, and a few vertebrate species. The mechanisms behind freeze tolerance include large accumulation of polyol or sugar cryoprotective compounds, as well as the control of the location and speed of ice formation by ice nucleating agents and antifreeze proteins. However, despite how common the trait is, freeze tolerance is poorly understood in mussels and does not seem to involve polyol or sugar accumulation like in other species. Since mussels found at a higher height on the shore can survive frozen

longer at lower temperatures than mussels found at a lower shore height, we used this comparison to test potential mechanisms of freeze tolerance in the common West Coast *Mytilus trossulus*. We examined water content, ice nucleating ability, the role of anoxia in promoting cold tolerance, as well as the role of metabolites driving this difference.

**KATE MATHERS** and JAMES STAPLES

University of Western Ontario

**Regulation of reversible mitochondrial suppression during hibernation**

**Régulation de la suppression mitochondrienne réversible durant l'hibernation**

During hibernation, small mammals cycle between periods of torpor ( $T_b=5^{\circ}\text{C}$ ) and interbout euthermia ( $T_b=37^{\circ}\text{C}$ ). Mitochondrial metabolism is rapidly (within 2hrs) suppressed by 70% in torpor relative to IBE, though the mechanisms of this transition are unknown. We investigated flux through electron transport system (ETS) complexes in intact liver mitochondria of 13-lined ground squirrels (*Ictidomys tridecemlineatus*) sampled during torpor and IBE to give insight into the regulation of reversible mitochondrial suppression. We also measured maximal activities of these complexes in both isolated mitochondria and whole liver tissue from the same animals. Our results show that several of the ETS proteins are reversibly suppressed during torpor, and suggest that this suppression may be regulated by post-translational modification.

**LINDSAY E. MAY**, JAMES D. KIEFFER

University of New Brunswick Saint John (UNBSJ)

**I can't get a grip: The effect of substrate type on aspects of swimming in shortnose sturgeon (*Acipenser brevirostrum*)**

**Je n'ai pas de prise: effets du type de substrat sur la nage chez l'esturgeon à museau court (*Acipenser brevirostrum*)**

Sturgeon use their flattened rostrum and large pectoral fins to substrate skim and station hold (to resist swimming) and maintain their position in fast currents. The impact that smooth and rough substrates have on swimming performance was tested using two common swimming challenges: the critical swimming test and the endurance test. Rough substrate may provide a surface to grip; therefore, it was predicted that substrate skimming and station holding on a rough substrate would delay fatigue. There was no difference between critical swimming tests on either substrate. Endurance swimming at the highest velocity tested was significantly lower for fish over the rough substrate than the smooth substrate. Substrate modified fish behaviour during both swimming tests. Unlike our prediction, fish tended to avoid the rough substrate at certain speeds during both swimming tests. The information gained from this project will increase the knowledge on shortnose sturgeon swimming with presence of substrates.

**Tara L McBryan**, Timothy M. Healy, Kristen Haakons, and Patricia M. Schulte

University of British Columbia

**The effects of increased temperature on hypoxia tolerance in the Atlantic Killifish, *Fundulus heteroclitus***

**Effets de la température élevée sur la tolérance à l'hypoxie chez le cyprinodontidé de l'Atlantique *Fundulus heteroclitus***

The combination of hypoxia and high temperature is extremely challenging for fishes, but it is possible that acclimation to high temperatures could result in improved tolerance of hypoxia. We used the eurythermal and hypoxia tolerant Atlantic Killifish, *Fundulus heteroclitus*, to test this hypothesis. We compared hypoxia tolerance (time to loss of equilibrium at  $\text{PO}_2 = 3$  torr) in two subspecies of killifish following acute thermal challenge and after thermal acclimation. We found that even a modest increase in temperature (from 15 to 23°C) significantly reduced hypoxia tolerance, and that thermal acclimation largely abolished the negative effects of high temperature in both subspecies. The southern subspecies had higher hypoxia tolerance in all conditions. Acclimation to high temperatures resulted in an increase in exposed lamellar surface area in the gill in both subspecies, which may increase the capacity for oxygen uptake, potentially accounting for the effects of thermal acclimation on hypoxia tolerance.

**SARAH MCFARLANE** AND JAMES F. STAPLES

University of Western Ontario – Department of Biology

**mitochondrial respiration in brown adipose tissue of hibernating 13-lined ground squirrels, *Ictidomys tridecemlineatus*.**

**Respiration mitochondrienne dans le tissu adipeux brun des spermophiles à treize rayures, *Ictidomys tridecemlineatus*, en hibernation**

Small hibernating mammals, such as the 13-lined ground squirrel, exhibit hibernation cycles comprised of torpor bouts (10-15 days,  $T_b \sim 5^{\circ}\text{C}$ ) that are interrupted by spontaneous arousals into interbout euthermia (IBE) (8-12 hours,  $T_b \sim 37^{\circ}\text{C}$ ). Arousal from torpor into IBE happens within ~2 hours and requires thermogenic brown adipose tissue (BAT) to produce this drastic rise in  $T_b$  over such a short time. Our lab has demonstrated that liver mitochondrial metabolism is suppressed by 70% in torpor relative to IBE. There is evidence that these differences are due to molecular changes in the oxidative phosphorylation enzymes. We predicted, however, that because BAT mitochondrial function is primarily regulated by adrenergic signals, oxygen consumption rates in isolated BAT mitochondria would not significantly differ between torpor and IBE. Our results suggest that there are no significant differences in oxygen consumption rates between IBE and torpid BAT mitochondria.

**DEREK M MCKAY**

University of Calgary

**Exploiting properties of helminth modulation of host immunity to treat inflammatory disease**

Infection with a helminth parasite is a potent immune stimulation with remarkable conformity between mice and humans. Knowledge of the host-parasite immunological interface could, in therapy, facilitate the development of novel therapies via (a) use of viable infection, (b) use of isolated and (semi)purified bioactive molecules from the helminth, or (c) pharmacologically driving immune responses in the absence of infection, *per se*. Data, especially from rodent models, support all of these possibilities as new approaches to disease management. The tapeworm, *Hymenolepis diminuta*, is non-permissive in mice. Findings from the *H. diminuta*-mouse model will be presented demonstrating how infection with this largely innocuous helminth (it lacks hooks and teeth), or systemic administration of crude extracts (antigen) of adult worm antigen, suppresses dinitrobenzene sulphonic acid (DNBS)-induced colitis, via interleukin-10, regulatory B cells, and regulatory macrophages: each of which can be of relative importance depending on the context of the disease model.

**ALEXANDER H MCKINNON**, BRENT J. SINCLAIR

Western University

**A new model for cool: Inducing freeze tolerance in the spring field cricket, *Gryllus veletis***

**Comment induire la tolérance au gel chez le grillon printanier.**

Many insects are able to survive internal ice formation. However, the mechanisms underlying this freeze tolerance are not well-understood, perhaps because of a lack of suitable model organism. We found that the spring field cricket, *Gryllus veletis*, seasonally acquires freeze tolerance in the fall when kept outside in London, Ontario. Moreover, individuals acquired freeze tolerance in the laboratory in response to a simulated fall thermophotoperiod. Lab-acclimated *G. veletis* freeze at  $-6.1 \pm 0.7$  °C and the acquisition of freeze tolerance is accompanied by the accumulation of free proline. Crickets survived temperatures as low as -12 °C for 1.5 h, and one week at -8 °C. Lab-acclimated crickets were more cold-hardy than field-acclimatized crickets, with higher survival at both -12 °C and after one week at -8 °C. *Gryllus veletis* is a suitable candidate for further investigating freeze tolerance because it is easily reared and manipulated in a controlled laboratory environment.

**OLIVIA J. MCMILLAN**, DAVID G. STORMER AND FRANCIS JUANES

University of British Columbia

**Effects of summer temperature increase and food deprivation on aggressive behaviour in juvenile ocean-type Chinook salmon (*Oncorhynchus tshawytscha*)**

**Effets de l'augmentation de la température estivale et de la déprivation alimentaire sur le comportement agressif chez les saumons Chinook juvéniles océaniques (*Oncorhynchus tshawytscha*).**

Historical declines in many Chinook salmon (*Oncorhynchus tshawytscha*) stocks in the Strait of Georgia have been influenced by poor ocean conditions and reduced overwinter marine survival associated with climate change induced warming. Increased temperatures and earlier zooplankton blooms, as a consequence, can impact juvenile behaviour and affect survival, ultimately impairing stock recovery. Aggressive behaviour of juvenile ocean-type Chinook salmon was recorded during feeding and between feedings in simulated summer conditions of three temperature (15, 18, 21°C) and three food ration treatments (4.5, 1.5, 0.5% body weight per day). At all temperatures, fish displayed more aggression directly after feeding, and more in medium ration than in high or low ration treatments. The only temperature effect was in 18°C treatments, where aggression was increased between feedings. This study suggests that food availability may be more important than temperature in determining aggressive behaviour in juvenile Chinook salmon during their first marine summer.

**CAOIMHE MCPARLAND**, GLENYS GIBSON AND TODD SMITH

Acadia University

**Lethal effects of high intensities of *Hepatozoon* species on the mosquito, *Culex territans***

**Effets létaux de hautes intensités d'espèces de *Hepatozoon* sur le moustique, *Culex territans***

*Hepatozoon clamatae* is an intraerythrocytic apicomplexan parasite that is common in green frogs of eastern North America. Although frogs are not adversely affected by these parasites, high infection intensities occurring naturally in frogs are fatal to mosquito vectors. Our objective was to investigate the cause of death in mosquitoes, *Culex territans*, that have fed on frogs with naturally high infections of *H. clamatae*. Mosquitoes were fed on green frogs with parasitaemia values ranging from 0% to 5%, and fixed and embedded at 24 hr, 36 hr, 48 hr and 72 hr. Mosquitoes were cut into 1µm sections, stained, and examined with light microscopy to determine damage caused by parasite infection. Mosquitoes that had fed on heavily infected frogs were observed to have extensively damaged Malpighian tubules, where parasites undergo sporogonic development, and a compromised midgut wall. These damaged tissues are hypothesised to cause death in such heavily parasitised mosquitoes.

**TETSUTO MIYASHITA**

University of Alberta

**Evolution of the hypobranchial musculature inside out**

**Évolution de la musculature hypo-branchiale de l'intérieur vers l'extérieur**

The hypobranchial musculature occurs in the subpharyngeal space in vertebrates. The evolution of these muscles remains unresolved because anatomical patterns radically differ between lineages. In jawed vertebrates, the hypobranchial muscles originate in the ventral part of suprapharyngeal myomeres, migrate behind the pharyngeal series, and differentiate mid-ventrally beneath the pharynx. In lampreys, corresponding muscles draw their progenitors widely from the anterior myomeres and differentiate outside the pharyngeal skeleton. Like in lampreys, the 'hypobranchial' muscles form the superficial muscle

layer in hagfish. In this lineage, however, the muscles extend the entire length of the body, and the spinal nerves pass directly ventrally (rather than take a circumpharyngeal path) to innervate them. What represents the primitive state? Cephalochordates have similar — but bilaterally asymmetrical — muscles. Fossil jawless vertebrates lacked the hypobranchials based on skeletal correlates. The most parsimonious interpretation is that the hypobranchials evolved independently in jawless and jawed vertebrates.

**KAMAL MOGHRABI**, KEVIN KOBES, VISHESH OBEROI, GAGANDEEP S. RAI, FABIOLA D. ROJAS & LUCY E.J. LEE  
Department of Biology, University of the Fraser Valley, Abbotsford, BC, Canada

**Evaluating sublethal effects of neonicotinoids in non-target species: effects on fish cell lines**

**Évaluations des effets sub-létaux des néonicotinoïdes sur les espèces non recherchées: effets sur les lignées cellulaires de poissons.**

Neonicotinoids (NNs) are novel insect pesticides widely used in agricultural practices worldwide over the past twenty years. Aside from the target pests, NNs have been implicated in the demise of useful insects such as bees and the decline of insectivorous vertebrates including bats, birds and frogs. NNs have been detected in various water bodies but their effects on fish species have not been studied in detail. Selective disruption of nicotinic cholinergic receptors present in the central nervous system of insects has been attributed as their main mode of action. However, non-target species and non-neural cells have also been reported to be affected possibly via oxidative stress. The present research evaluated common NNs (imidacloprid, clothianidin, thiamethoxan, acetamiprid) for sublethal effects using fish cell lines derived from immune, neural, epithelial, connective and muscle tissues. Effects on cell morphology, cell migration, phagocytosis, wound healing were investigated in the context of whole organismal responses.

**HANEESHA MOHAN**, MICHAELA GASNER, NARESH RAMESH, ANTHONY LE, SIMA MORTAZAVI, VENKAT PASUPULETTI, ROBERT TSUSHIMA, ROLANDO CEDDIA AND SURAJ UNNIAPPAN

University of Saskatchewan

**Characterization of Endogenous Nucleobindin-2/Nesfatin-1 in Rodents.**

**Caractérisation de nucleobindin-2/nesfatin-1 chez les rongeurs**

Nesfatin-1 is a multifunctional peptide implicated in the hormonal control of energy balance. Prohormone convertases (PCs) 2 and 1/3 post-translationally process nesfatin-1 from its precursor, nucleobindin 2 (NUCB2), a protein ubiquitously expressed in various central and peripheral tissues. The main objectives of this research are to determine the developmental, and nutrient regulated expression of NUCB2/nesfatin-1, and to characterize the metabolic phenotype of mice lacking NUCB2/nesfatin-1. We found that development (embryonic, post-natal, adult) and macronutrients (carbohydrates, protein, fat) influence endogenous production of nesfatin-1 in a tissue specific manner in rats and mice, respectively. NUCB2/nesfatin-1 disruption in mice leads to alterations in body weight, food intake, insulin sensitivity, islet formation, glucose levels and hormone secretion. Together, this research provides novel findings on developmental and nutrient regulation of nesfatin-1 expression and secretion. It also provides novel information on the importance of naturally occurring nesfatin-1 in maintaining energy homeostasis.

**S. RICHELLE MONAGHAN**

Wilfrid Laurier University

**Building scaffolds for threshold concepts through mnemonics in biological sciences.**

**Construction d'échafaudages pour les concepts de seuil par le biais de mnémoniques dans les sciences biologiques**

The ability for undergraduate students to acquire threshold concepts in biological sciences is essential to their ability to comprehend increasing complexity, critically evaluate systems, and initiate original ideas. Higher order learning cannot occur unless students have the ability to acquire the initial, and sometimes extensive, fundamental knowledge. While pedagogical strategies can be varied, the use of mnemonics is a way for students to develop the scaffold in which to promote mastery of this knowledge base. Original and effective mnemonics in molecular biology, anatomy and physiology are presented to demonstrate the diversity and breadth of information that can be efficiently presented. Using this type of cognitive strategy, students report comfort with threshold concepts, and demonstrate the ability to construct higher order knowledge networks.

**MATTHEW MORRIS**, KATY PETROVICH, HEATHER JAMNICZKY, AND SEAN ROGERS

University of Calgary

**Exploring Jordan's Rule in coastal threespine stickleback.**

**Exploration de la loi de Jordan chez les épinoches à trois épines côtières.**

Jordan's Rule states that, in general, lower latitude fish have more vertebrae than higher latitude relatives. This pattern has been applied within species with equivocal results. Vertebral counts were made for seven coastal Pacific populations of threespine stickleback along a distribution of 22 degrees latitude, extending from central California to Alaska (n = 282 fish). Latitude explained 5% of variation in vertebral count, but this difference was significant. However, this pattern seems to be driven by a discontinuity in vertebral count separating a southern clade (Oregon to California) from a northern clade (BC to Alaska). Body length showed a more gradual increase from south to north, with latitude explaining 34% of variation. Skull-to-body length ratio however was largely invariant with latitude, suggesting that body length variation is caused by variation in vertebral length and number. Jordan's Rule was validated in threespine stickleback in a macrogeographic but not a clinal sense.

**PHILLIP R MORRISON**, TILL S HARTER, DEREK SOMO, DIEGO BERNAL, CHUGEY A SEPULVEDA, RICHARD W BRILL, PETER G BUSHNELL, JEFFREY G RICHARDS, AND COLIN J BRAUNER  
University of British Columbia

**The effect of temperature on whole blood hemoglobin-O<sub>2</sub> affinity in the regionally heterothermic swordfish, and two eurythermal fishes.**

**Effets de la température sur l'affinité à l'oxygène de l'hémoglobine sanguine chez l'espadon hétérothermique et chez deux poissons eurythermiques**

An increase in temperature generally increases  $P_{50}$  ( $PO_2$  at which hemoglobin is 50% saturated). However, in some regionally-heterothermic fishes, as well as a few eurythermal fishes, temperature has a reduced effect on  $P_{50}$ . We hypothesized similar reduced temperature effects in blood from the heterothermic swordfish (*Xiphias gladius*) and two eurythermal fishes, padded sculpins (*Artedius fenestralis*) and sandbar sharks (*Carcharhinus plumbeus*). Temperature had almost no effect on  $P_{50}$  in swordfish, whereas in padded sculpins temperature had a very reduced and non-linear effect on  $P_{50}$ . In sandbar sharks,  $P_{50}$  increased with an increase in temperature, but the effect was non-linear and reduced at higher temperatures, which may be associated with the Bohr effect ( $\Delta \log P_{50} / \Delta pH$ ). Reduced temperature effects likely have a thermoconserving benefit in regionally heterothermic fishes, and may ensure sufficient O<sub>2</sub> uptake at the gill during acute changes in ambient water temperature as sculpins routinely experience in the intertidal zone.

**CASEY A. MUELLER**, JOHN EME, RICHARD MANZON, CHRIS SOMERS, DOUGLAS BOREHAM AND JOANNA WILSON  
McMaster University

**Effects of increased temperature during critical windows of development on the hatchling phenotype of Lake whitefish (*Coregonus clupeaformis*).**

**Effets de l'augmentation de la température durant les phases critiques du développement sur le phénotype des alevins du grand corégone (*Coregonus clupeaformis*)**

Phenotypic plasticity is the ability of an animal to modify its phenotype in response to the environment. Embryos may have critical windows during development when they are particularly plastic or susceptible to the environment. We examined if there are critical windows during Lake whitefish (*Coregonus clupeaformis*) embryonic development when temperature has an especially strong effect on phenotype. With 2°C as the control temperature, embryos were incubated in either 5°C, 8°C or 11°C during one of four distinct periods of development: gastrulation, organogenesis, late differentiation and late growth. Survival was monitored throughout development, and hatching characteristics, including time to hatch, hatch window, hatchling oxygen consumption rate and size at hatch, were determined to examine if warmer temperatures during certain windows of development altered hatchling phenotype. This experimental design allowed critical windows to be assessed in the context of the interaction between exposure window, stressor level and the magnitude of phenotypic change.

**BREDA MULDOON** AND NATACHA S. HOGAN

Department of Toxicology, University of Saskatchewan, Saskatoon, SK

**The brook stickleback (*Culaea inconstans*) as a novel bioindicator species for androgenic and estrogenic compounds in aquatic environments.**

**L'épinoche de ruisseau (*Culaea inconstans*) comme nouvelle espèce bio-indicateur de produits androgéniques et estrogéniques dans les environnements aquatiques**

Brook stickleback (*Culaea inconstans*) are a local freshwater fish that possess two unique, quantifiable responses for exposure to both androgens (spiggin) and estrogens (vitellogenin). We developed a qPCR assay to measure tissue-specific expression of spiggin and vitellogenin and to evaluate their responsiveness to androgenic and estrogenic compound exposures. Stickleback were exposed to 0, 10 and 100 ng/L of methyltestosterone (MT) or ethinylestradiol (EE2) in a semi-static renewal system with samples collected at 7 and 21 days. Expression of spiggin in female kidneys and vitellogenin in male liver was induced following exposure to MT and EE2, respectively. Transcript induction typically occurred at lower concentrations and at an earlier time point than changes in other endpoints (e.g. somatic indices). Given the sensitivity of the biomarker responses assessed here, and their distribution throughout North America, the brook stickleback could be an effective bioindicator species for endocrine active compounds in the aquatic environment.

**DANIEL MUNRO**, SHEENA BANH AND JASON TREBERG  
University of Manitoba

**Metabolism of H<sub>2</sub>O<sub>2</sub> by skeletal muscle mitochondria: consumption exceeds production**

**Métabolisme du H<sub>2</sub>O<sub>2</sub> par les mitochondries des muscles squelettiques: la consommation excède la production**

The production of reactive oxygen species (ROS) is implicated in the etiology of several pathologies, detrimental physiological challenges and possibly primary aging. The textbook knowledge that mitochondria are the main source of cellular ROS is increasingly challenged; these organelles possess various effective H<sub>2</sub>O<sub>2</sub> consuming enzymes and the idea that they could act as net sink of ROS is increasingly supported. We challenged isolated rat skeletal muscle mitochondria with a bolus of 2.5  $\mu M$  H<sub>2</sub>O<sub>2</sub> to determine the net balance under various substrate conditions. Mitochondria achieved net consumption of H<sub>2</sub>O<sub>2</sub> for all four substrates tested with highest rate found for malate ( $\approx 4$  nmol.min<sup>-1</sup>.mg protein<sup>-1</sup>), and lowest for succinate ( $\approx 1$  nmol.min<sup>-1</sup>.mg protein<sup>-1</sup>). Loss of membrane integrity (freeze-thaw) or absence of substrate nearly abolished this consumption. Inhibiting

specific pathways revealed a primary involvement of the thioredoxin-dependent peroxiredoxins with important activity also of the glutathione peroxidase.

**ALEX MYRKA**

University of Toronto Scarborough Campus

**Comparative analysis of glucose transporter transcription in hummingbirds**

**Analyse comparative de la transcription des transporteurs de glucose chez les oiseaux-mouche**

Hummingbirds can oxidize both newly ingested glucose and fructose in flight muscle cells quickly enough to completely fuel energetically expensive hovering flight. To achieve this, hummingbirds must transport both sugars into muscle fibers at exceptionally high rates. We hypothesized that hummingbird flight muscles have the highest densities of glucose and fructose transporters among vertebrates. We quantified sugar transporter expression in multiple tissues of the ruby-throated hummingbird (*Archilochus colubris*) using real time PCR. We found that hummingbird flight muscle had the highest relative transcript levels of the glucose transporter GLUT1 and the fructose transporter GLUT5 ever observed in vertebrate muscle. We are currently quantifying expression of fructose-specific glycolytic enzymes, ketohexokinase and aldolase B, to understand capacities for direct fructose oxidation in flight muscles. Our findings thus far indicate that hummingbirds have adapted to rapid fructose oxidation and metabolism to a greater degree than any other vertebrate yet examined.

**VISHESH OBEROI**, HARDEEP S. SARAN, MANDEEP K. SARAN, KAMAL MOGHRABI, GAGANDEEP S. RAI, FABIOLA D. ROJAS, NIELS C. BOLS & LUCY E.J. LEE

Department of Biology, University of the Fraser Valley, Abbotsford, BC, Canada

**Evaluating bioactivity of blueberry extracts and components with fish cell lines**

**Évaluation de la bioactivité des extraits et composants de bleuets à l'aide de lignées cellulaires de poisson.**

Blueberries contain bioactive compounds (anthocyanins, flavonoids, polyphenols and ascorbic acid) desirable in the food and nutraceutical industries. Nutraceuticals are chemicals or products isolated from foods that may have pharmaceutical activities, providing physiological benefit or protection against disease. Evaluation for safety and effectiveness of novel nutraceuticals can be extremely costly and time consuming when whole test organisms are needed, and alternative or supplemental model systems are being sought. For the testing of nutraceuticals of interest to humans and domestic animals, cell lines have been instrumental, but a similar approach has not been performed for fish. The aquaculture industry is looking for nutraceuticals to maintain healthy stocks and supplement the dietary needs of cultured fish inexpensively. In this study, bioactive compounds present in blueberries (eg. quercetin, epicatechin) as well as crude blueberry extracts from local cultivars are evaluated for their stimulatory or inhibitory effects on various cellular functions using fish cell lines.

**A. RICHARD PALMER**

University of Alberta

**The role of genes in the development of morphological asymmetry**

**Le rôle des gènes dans le développement de l'asymétrie morphologique**

Development of bilaterian animals is often described as proceeding along three global (whole body) developmental axes: antero-posterior, dorso-ventral, and right-left. But differences in form between the sides of asymmetrical animals do not arise along a "right-left" gradient. Rather, they arise from a qualitative difference between how development proceeds along two medio-lateral axes — one on either side of the midplane. In dimorphic species that exhibit random asymmetry (right- and left-sided forms equally common) three questions arise: 1) Is direction of asymmetry (right- or left-sidedness) determined genetically? 2) Is development of right- or left-sidedness determined globally (whole-body level) or locally (individual organ-system level)? 3) Where right- or left-sidedness is not determined genetically, can direction of asymmetry be biased in one direction by environmental effects? Evidence from several crustacean taxa reveals intriguing relations between development, genetics and evolution of morphological asymmetries.

**JASON D. PARDO**, AND JASON S. ANDERSON

University of Calgary

**Neurocranial morphology of the lysorophian *Brachydectes newberryi* from the Permian of Kansas and Nebraska: new information from  $\mu$ CT**

**Morphologie neurocrânienne du lysorophien *Brachydectes newberryi* provenant du Permien du Kansas et du Nebraska: nouvelles données de tomographie par ordinateur**

Lysorophia is a common but poorly-understood group of early tetrapods from the Carboniferous-Permian transition of North America. Lysorophians are generally considered to be either closely-related to modern lissamphibians or the amniote crown group, but morphological support for these phylogenetic hypotheses is weak due to skeletal reduction in lysorophians. We present here new data from  $\mu$ CT imaging of the neurocranium of the lysorophian *Brachydectes newberryi* to inform this debate. The neurocranium demonstrates numerous characteristics of the ear, occiput, and cranial circulation consistent with a phylogenetic position within the amniote crown, a hypothesis that greatly simplifies hypotheses of general trait evolution in early tetrapods. These data show the power of neurocranial data in morphological phylogenetics, and the general state of uncertainty in early tetrapod phylogeny.



**JASON D PARDO**, MATT SZOSTAKIWSKYJ AND JASON S ANDERSON

University of Calgary

**Micro-CT can resolve intractable problems in vertebrate paleontology: an example from the early tetrapod braincase**

**La tomographie par microordinateur peut résoudre des problèmes intraitables en paléontologie des vertébrés: exemple de la boîte crânienne d'anciens tétrapodes.**

Morphological datasets in phylogenetics are often plagued by convergence, lack of strong phylogenetic signal, and subjectivity in character coding. Although this problem is most readily solved with use of molecular datasets, studies of deep-time processes relying on fossils cannot avoid the use of morphology. We used  $\mu$ CT to characterize the undescribed variation in the braincases of early tetrapods to test the relationships of a controversial group, the Lepospondyli. We find evidence of novel relationships between some major groups which dramatically simplify hypotheses of tarsal, axial, and otic evolution that previously required numerous parallel acquisitions of complex characters. Differences in phylogenetic signal between braincase and other characters may reflect real underlying developmental or functional constraints in craniofacial evolution.

**DIVYANG PATEL**, AARON ROBERTSON, KYLE SCHALTZ, AND ALLISON E. MCDONALD

Department of Biology, Wilfrid Laurier University, 75 University Ave. West, Waterloo, Ontario, Canada, N2L 3C5

**Expression of the alternative oxidase in the yeast *Saccharomyces cerevisiae*: a high-throughput screening tool for treating mitochondrial diseases.**

**Expression de l'oxidase alternative dans la levure *Saccharomyces cerevisiae*: un outil de dépistage à haut débit pour traiter les maladies mitochondriales**

In eukaryotes, energy production occurs through the mitochondrial electron transport chain (ETC). Mutations in the genes encoding proteins of the ETC often lead to mitochondrial diseases. Alternative oxidase (AOX) is an ubiquinol terminal oxidase hypothesized to confer stress resistance and limit reactive oxygen species production by allowing electrons to bypass complexes III and/or IV of the ETC. We are expressing animal AOXs in the yeast *Saccharomyces cerevisiae* in order to develop a high-throughput tool that can be used to screen complex III and IV mutants in yeast that model mutations that cause human mitochondrial disease. This will determine which mutations are amenable to AOX treatment through gene therapy.

**JOSHUA G PEMBERTON**, JAMES L STAFFORD, AND JOHN P CHANG

University of Alberta

**Biased G Protein-Coupled Receptor Signal Transduction Networks and the Control of Pituitary Cell Function: Lessons from the Goldfish (*Carassius auratus*)**

**Réseaux de "G protein-coupled receptor signal transduction" biaisés et le contrôle de la fonction des cellules pituitaires: leçons du poisson rouge (*Carassius auratus*)**

Biased signal transduction describes the activation of unique subsets of intracellular signalling cascades by structurally-related ligands of a shared G protein-coupled receptor (GPCR). Although biased signalling has already emerged as an important concept in molecular pharmacology and medicinal chemistry, whether naturally-occurring variants of GPCR ligands rely on biased signalling for the integrated regulation of complex physiological systems is poorly understood. To explore this possibility, we have examined the signal transduction mechanisms utilized by two endogenous isoforms of gonadotropin-releasing hormone (GnRH2 and GnRH3) in the control of pituitary gonadotrope and somatotrope cell functions using goldfish as a study model. Results demonstrate that dissimilar suites of intracellular signal transduction cascades mediate the GnRH2- and GnRH3-selective control of hormone release and synthesis responses in a distinct time- and cell-type-dependent manner. (Supported by the University of Alberta Dissertation Fellowship, NSERC, AIHS, and Killam Trusts)

**KERRY PERRAULT**, BRANDON VARELA, MERY MARTÍNEZ

Laurentian University

**Sperm variation of *Pseudocrenilabrus multicolor victoriae* across habitats.**

**Variation du sperme de *Pseudocrenilabrus multicolor victoriae* en fonction de l'habitat**

General fish and sperm morphometrics and sperm motility were used to assess whether the reproductive fitness of *P. multicolor* varies across ten different sites with divergent flow (lake, river, stream and swamp) and oxygen regime (hypoxic, normoxic and fluctuating). Males in flowing sites with fluctuating oxygen had longer body length ( $P=0.0003$ ), higher gonad asymmetry ( $P=0.02$ ), and more hydrodynamic sperm with narrower heads ( $P=0.002$ ) and longer flagella ( $P=0.00001$ ). Interestingly, smaller males in hypoxic and non-flowing sites had the highest sperm velocity ( $P=0.00001$ ). These results suggest that *P. multicolor* faces different selection pressures across habitats that are directing variation in sperm traits (shape and motility). Hypoxic environments select for faster sperm, while flowing sites select for a more hydrodynamic sperm shape. Future work will assess the mechanisms behind faster sperm and determine relative fertilization success across sites.

**STEVE F PERRY**, YUSUKE KUMAI, COSIMA PORTEUS, JACOB POLLACK AND BILL MILSOM

University of Ottawa

**Respiratory responses to high external ammonia in zebrafish (*Danio rerio*): A possible role for neuroepithelial cells and Rhesus glycoproteins in ammonia sensing.**

**Réponses respiratoires à des taux élevés d'ammoniac chez le poisson zèbre (*Danio rerio*): un rôle possible des cellules neuro-épithéliennes et des glycoprotéines dans la détection de l'ammoniac**

The effects of high external ammonia exposure (HEA) on breathing were assessed in zebrafish to investigate the role of ammonia-conducting Rhesus (Rh) glycoproteins and neuroepithelial cells (NECs) in ammonia sensing. Acute exposure of adults to elevated  $(\text{NH}_4)_2\text{SO}_4$  caused increases in ventilation amplitude ( $A_{\text{VENT}}$ ) without affecting frequency ( $f_{\text{VENT}}$ ). The hyperventilatory response to HEA was prevented by hyperoxia, indicating that control of breathing through ammonia sensing likely is secondary to  $\text{O}_2$  sensing. In larvae (4 dpf), similar levels of HEA caused increases in  $f_{\text{VENT}}$ . The hyperventilatory responses to HEA in larvae were diminished by gene knockdown of either *Rhcg1* or *Rhbg*. In larvae, *Rhbg* was localised to the basolateral membranes of NECs and ionocytes whereas *Rhcg1* was restricted to the apical membrane of  $\text{H}^+$ -ATPase-rich ionocytes (HR cells). A model is presented whereby external ammonia enters the fish via HR cells and subsequently gains access to the ammonia sensing NECs via basolateral *Rhbg*.

**NATALIA D PHILLIPS**, CAMERON GOATER, DOUGLAS COLWELL AND CLAUDIA SHEEDY

University of Lethbridge

**Comparative responses of cattle, sheep, and goats to larvae of the invasive generalist liver fluke, *Dicrocoelium dendriticum***  
**Réactions comparées des vaches, des moutons et des chèvres aux larves de la petite douve du foie, *Dicrocoelium dendriticum***

The lancet liver fluke, *Dicrocoelium dendriticum*, was introduced from Europe into Cypress Hills Park, Alberta in the 1990's. Worm prevalence in sympatric wild and domestic mammals in the Park is 60-90% and intensity often exceeds 1000 worms/host. To manage an invasive generalist parasite and reduce further spread to other sites, we need to understand the relative contribution of different host species to the dissemination of infective stages onto shared pasture. We exposed cattle, sheep, and goats to known numbers of metacercariae and then assessed interspecific differences in fecal egg counts, serological antibody responses, and worm intensity. Worm intensity was highest in goats. Sheep, however, developed anti-*Dicrocoelium* IgG and IgM antibody profiles at approximately 50 days post-infection. Worm recovery was inconsistent in goats and cattle and serum antibody profiles were inconsistent in these hosts. Results demonstrating extensive interspecific variation in worm intensity and host response emphasize the difficulty in managing invasive parasites within multi-host communities.

**EMMANUEL PILA**, MAHMOUD TARRABAIN AND PATRICK HANINGTON

University of Alberta

**Involvement of a snail Toll-like receptor in the immune response against schistosome infection**

**Implication d'un récepteur Toll-like dans la réaction immunitaire d'un escargot contre une infection de schistosome**

Toll-like receptors (TLRs) are trans-membrane proteins composed of an extracellular leucine-rich repeat domain and a conserved cytoplasmic Toll/IL-1 (TIR) domain. We sought to characterize a TLR identified in the snail *Biomphalaria glabrata* (BgTLR). We hypothesized that this TLR is one of the growing number of known immunological determinants of snail-schistosome compatibility because it displayed higher protein levels on the surface of hemocytes of resistant snails compared to susceptible ones. BgTLR transcript expression increased over 10-fold in resistant snails responding to *Schistosoma mansoni* challenge relative to  $\beta$ -actin (non-immune control gene); whereas expression in susceptible snails was increased only 3-fold. Moreover, siRNA knockdown of BgTLR resulted in patent infections in 48 % of resistant snails. Our results demonstrate that BgTLR is an important snail immune receptor that influences infection outcome following *S. mansoni* challenge. This advances our understanding of snail-schistosome compatibility that can potentially facilitate the development of tools for improving the control of schistosomiasis.

**ROGER PRICHARD**

McGill University

**The interplay between immunomodulation and anthelmintics in Host-Parasite Interaction**

**Intéraction entre la modulation immunitaire et les anthelminthiques dans les interactions hôte-parasite**

Anthelmintics often act in synergy with host immunity; their efficacy can be diminished in immunocompromised hosts. In disseminated strongyloidiasis associated with a compromised immune system, ivermectin (IVM) can fail to clear infections. Conversely, IVM paralyzes the excretory cell/pore of filariae, inhibiting the release of immunomodulators so that the immune system can destroy the microfilariae. Diethylcarbamazine (DEC) requires a functioning immune system to be effective. If filarial parasites are transferred to an immunologically naïve host, DEC is no longer effective; and DEC shows little activity against filarial nematodes in vitro. There are mechanistic links between anthelmintic effects and immune responses. ABC transporters play a role in the release of cytokines from immune cells. Macrocyclic lactones (MLs) are potent inhibitors of some ABC transporters and can have a short term effect on transport of cytokines. On the other hand, long-term exposure to IVM can induce overexpression of ABC transporters.

**Alex Quijada-Rodriguez**, Jason R. Treberg and Dirk Weihrauch

University of Manitoba

**The ribbon leech *Nepheolopsis obscura* as a model system to investigate cutaneous ammonia transport in freshwater invertebrates**

**La sangsue ruban *Nepheolopsis obscura* comme modèle pour les études de transport cutané de l'ammoniac chez les invertébrés d'eau douce**

In this study, the nitrogen excretion mechanism in the ribbon leech, *Nepheolopsis obscura*, was investigated. Gene expression

analysis demonstrated a higher mRNA expression of a primitive Rh protein (NoRhp) in the skin versus whole body. In addition, theophylline-activated skin mounted in an Ussing chamber demonstrated a high capacity for ammonia transport implicating the skin as a major site of ammonia excretion. Pharmacological experiments and enzyme assays suggested an ammonia excretion mechanism that involves the V-ATPase, Na<sup>+</sup>/K<sup>+</sup>-ATPase and carbonic anhydrase, but not necessarily a functional microtubule system. Most importantly, functional expression studies of NoRhp revealed ammonia transport capability of this protein, when expressed in yeast. Exposure to high environmental ammonia (HEA) caused a new adjustment of body ammonia, accompanied with a decrease in NoRhp and Na<sup>+</sup>/K<sup>+</sup>-ATPase mRNA levels, but unaltered ammonia excretion rates. The results of this study showed many similarities to the mechanisms proposed in the gills of freshwater fish.

#### **RAJENDHRAN RAJAKUMAR**

Dept. of Molecular Genetics and Microbiology & UF Genetics Institute, University of Florida

#### **The developmental basis of caste evolution in ants: hormones, genes, and epigenetics**

##### **Cameron Outstanding Ph.D. Thesis Award - Presentation abstract:**

Complex worker caste systems have contributed to the evolutionary success of advanced ant societies; however, little is known about the developmental processes underlying their origin and evolution. As a graduate student in the Abouheif Lab at McGill University, I wanted to understand how the environment acts during worker development, to generate phenotypic variation within castes, between castes and the evolution of novel castes. From this, we made two discoveries: 1) quantitative epigenetic variation of a key gene, *Egfr*, can generate quantitative size variation within the worker caste in the ant *Camponotus floridanus*, and 2) the recurrent induction of an ancestral developmental potential, retained for millions of years in the genus *Pheidole*, has facilitated the parallel evolution of the novel supersoldier caste. Collectively, the environment can thus influence development through the integration of hormones, genes and epigenetic mechanisms to generate both quantitative and qualitative phenotypic variation for selection to act on. ([return](#))

#### **Base développementale de l'évolution des castes de fourmis: hormones, gènes et épigénétique**

##### **Prix Cameron pour une thèse de Ph.D. exceptionnelle - Résumé de la présentation**

Les systèmes de castes complexes pour les travailleurs ont contribué à la réussite évolutive des sociétés de fourmis avancées, mais nous savons peu des processus développementaux expliquant les origines et l'évolution de ces systèmes de castes. Comme un étudiant diplômé dans le laboratoire Abouheif à l'Université McGill, je voulais comprendre comment l'environnement agit au cours du développement des travailleurs, de générer des variations phénotypiques dans les castes, entre les castes et l'évolution de nouvelles castes. De là, nous avons fait deux découvertes: 1) la variation épigénétique quantitative d'un gène clé, *Egfr*, peut générer variation quantitative de taille au sein de la caste des travailleurs dans la fourmi, *Camponotus floridanus*, et 2) l'induction récurrente d'un potentiel de développement ancestrale, retenus pour des millions de années dans le genre *Pheidole*, a facilité l'évolution parallèle d'une nouvelle caste de super-soldats. Collectivement, l'environnement peut donc influencer le développement en intégrant des mécanismes hormonaux, génétiques et épigénétiques qui génèrent la variation phénotypique quantitative et qualitative sur lesquels la sélection peut agir. ([retour](#))

**JULIA C REDFERN**, STEVEN J COOKE, ROBERT J LENNOX, MICHAEL A NANNINI, AARON R SHIFMAN, DAVID H WAHL, KATHLEEN M GILMOUR

University of Ottawa

#### **Effects of maternal cortisol treatment on offspring size, behaviour, and responsiveness to stress in wild largemouth bass (*Micropterus salmoides*).**

##### **Effets de traitements par cortisol maternel sur la taille de la descendance, le comportement et la réactivité au stress chez les achigans à grande bouche sauvages (*Micropterus salmoides*)**

Stress in female fish prior to spawn can affect offspring characteristics after hatch because maternal hormones, including the stress hormone cortisol, mRNA, proteins and lipids are deposited into developing eggs. Cortisol is of interest in mediating effects of maternal stress on offspring because it plays an organizational role during early development in teleost fish. The present study tested the hypothesis that maternal exposure to exogenous cortisol prior to spawn affects offspring size, baseline and stress-induced cortisol levels and behaviour. Adult largemouth bass collected from the wild were stocked into semi-natural experimental ponds. Females in half of the ponds were treated with cortisol prior to spawn while the remaining ponds contained untreated (control) females. Offspring of cortisol-treated mothers exhibited significantly higher embryo cortisol and mass right after hatch, but were less bold and exploratory than those of control females.

**MATTHEW D REGAN** AND JEFFREY G RICHARDS

University of British Columbia

#### **How do goldfish concurrently use oxygen, anaerobic glycolysis, and metabolic rate depression in increasingly hypoxic environments?**

##### **Comment les poissons rouges utilisent-ils en même temps l'oxygène, le métabolisme du glucose anaérobie, et la dépression du taux métabolique dans les environnements de plus en plus hypoxiques?**

Hypoxic survival requires maintaining energy balance in conditions that severely threaten ATP production. Hypoxia tolerant animals achieve this through a combination of: 1) improved O<sub>2</sub> acquisition, 2) increased anaerobic ATP production, and 3)

metabolic rate depression (MRD). We investigated how animals concurrently use these three mechanisms in an overall hypoxic survival strategy, and we measured them using calorimetry and tissue metabolite assays on goldfish held at different water PO<sub>2</sub> for different time periods. Our results suggest that reliance on any one mechanism changes with both time and PO<sub>2</sub>. Goldfish immediately reduce MO<sub>2</sub> at PO<sub>2</sub> < ~35 mmHg, but recover this after ~1hr and retain routine MO<sub>2</sub> down to PO<sub>2</sub> of ~5 mmHg. Rates of anaerobic ATP production tend to correlate inversely with MO<sub>2</sub>. Finally, regardless of time, metabolic heat decreases significantly only at PO<sub>2</sub> < 5 mmHg, suggesting MRD is reserved for severely hypoxic environments.

**MICHELLE N REICHERT** AND WILLIAM K MILSOM

University of British Columbia

**Pulmonary mechanics and the work of breathing in the caiman, *Caiman yacare***

**Mécanique pulmonaire et travail respiratoire du caïman, *Caiman yacare***

Within Class Reptilia, there is large variation in body wall architecture and lung structure, ranging from simple (snake) to complex (crocodilian). As complexity increases, it is predicted that total system compliance will decrease and flow resistance will increase. We measured pulmonary mechanics in the Yacare caiman (*Caiman yacare*) and found that total system mechanics primarily reflected the mechanics of the body wall, but not to the same degree as is seen in reptiles with less complex lungs. The lungs of the caiman were less compliant than other reptiles but still more compliant than mammalian lungs. While the heavily keratinized chest wall of the caiman was hypothesized to be stiff, we found that the total system compliance was greater than expected. None the less, the body wall became stiffer with increasing breathing frequency, but not tidal volume, and the work of breathing increased with both tidal volume and breathing frequency.

JAGDEEP SEKHON, LANIELLE LAFRAMBOISE AND **MARY REID**

University of Calgary

**Big, fat and hydrated: survivorship of pine beetles exposed to tree defences of historical and novel host trees.**

**Gros, gras et hydraté: survie des dendroctones de pin ponderosa exposés aux défenses d'arbres hôtes nouveaux et historiques**

Mountain pine beetles, *Dendroctonus ponderosae*, face a diversity of plant chemicals whose concentration increases when they attack their host plant. We tested how beetle body size and condition affect tolerance to defences in terms of the type (n=4), concentration and diversity of monoterpenes found in their typical host, lodgepole pine (*Pinus contorta*), and in a novel host, jack pine (*P. banksiana*). Survivorship after 24 h exposure to monoterpenes increased with body size and condition. Survivors also tended to have more fat reserves and water content. The identity and concentration, but not diversity, of monoterpenes influenced survivorship, mass loss and water loss after 24 h. The monoterpene most abundant in jack pine, alpha-pinene, tended to have the least effects on mountain pine beetles; this favours the eastward expansion of mountain pine beetles in the boreal forest. However, beetle traits are a key predictor of success against plant defences.

**STEPHANIE A. REIMER**, CAMERON P. GOATER

University of Lethbridge

**Ecological epidemiology of an emerging virus in western tiger salamanders (*Ambystoma mavortium*) in southwestern Alberta**

**Épidémiologie écologique d'un virus émergent dans les salamandres tigrées occidentales (*Ambystoma mavortium*) dans le sud-ouest de l'Alberta**

Emerging infectious diseases are a leading cause of global declines in amphibian populations. The emergence of *Ambystoma tigrinum* virus (ATV) in tiger salamander populations in southwestern Alberta has led to concerns regarding the population status of this prairie icon. Results from a longitudinal survey of a larval salamander population in Livingston Lake, Alberta showed that ATV transmission is strongly seasonal, increasing in prevalence from 0-100% between early July and the timing of metamorphosis in mid-August. Despite consistency between years in the seasonal pattern of transmission, variability in annual ATV-induced mortality was extremely high. Our early results suggest that ecological factors that influence host quality act in addition, or synergistically, to ATV exposure to contribute to the magnitude of ATV-induced outbreaks within larval salamander populations.

**REYES JOSE LUIS**, LEUNG GABRIELLA, FERNANDO MARIA, LOPES FERNANDO,

MANCINI NICOLE, WANG ARTHUR AND MCKAY DEREK

University of Calgary, Department of Physiology and Pharmacology, Calgary, AB

**Tapeworm antigens block LPS-induced inflammatory mediator production, induce regulatory macrophages and recruit myeloid derived suppressor cells via CCR2**

**Les antigènes de ténia bloquent la production de médiateur d'inflammation induits par LPS, induisent les macrophages régulateurs et recrutent les cellules myéloïdes suppressives au moyen de CCR2**

Parasite antigens have been shown to suppress concomitant inflammatory disease in mouse models: mice treated with, *Hymenolepis diminuta* antigens (HdAg) are protected from chemically-induced colitis. The objective was to determine if HdAg directly affected innate immune cell activity. Bone marrow macrophages (BMMs) exposed to HdAg but not IL-4, attenuated TNFα while increased IL-10 production. Moreover, anti-IL-10 antibody prevented the HdAg inhibition of LPS-evoked IL-1β and TNF

□ **Effect of BMMs on HdAg exposure instructed Foxp3 expression on naïve CD4<sup>+</sup> T cells**

contact-dependent that ultimately displayed an anti-colitic phenotype.

In other experiments, mice given HdAg recruited a F480<sup>+</sup>Ly6G<sup>lo</sup> cell population (i.e. myeloid-derived suppressor cell-like (MDSC)) in a CCR2-dependent manner that suppressed *in vitro* T cell proliferation. Thus, *H. diminuta* antigens target innate cells that likely contribute to the anti-colitic effect observed.

NICHOLAS CHOW, PAIGE ZENIUK, MATTHEW A. GLOVER, **MARK R. RHEAULT**

University of British Columbia

**The effects of blood feeding on organic cation transporter gene expression in the vector mosquito *Aedes aegypti*.**

**Effets de l'alimentation sanguine sur l'expression des gènes des transporteurs de cations organiques chez le moustique vecteur *Aedes aegypti***

The midgut (MG) and Malpighian tubules (MT) of insects have been shown to play a role in the active transport of organic cations (OCs). In this study qPCR was used to determine whether blood feeding altered the expression of the organic cation transporter (*oct*) and multidrug resistance transporter (*mdr*) genes in the MG and MTs of *A. aegypti* after a blood meal. The expression of both *oct* and *mdr* in the MG was increased within 24 hours after blood feeding in adults. There were no changes in *oct* and *mdr* expression in the MTs post blood meal. Our findings show that within the first 24-hours post blood meal the transcripts responsible for coding for putative organic cation transporters are increased in the midgut indicating that the midgut plays an important role in excretion of toxic exogenous organic cation metabolites during blood feeding.

**REBECCA RIZZATO** AND N. KIRK HILLIER

Acadia University

**Comparative analysis of pheromone blend divergence in Heliothine moths**

**Analyse comparative de la divergence des mélanges de phéromones chez les papillons de nuit Heliothines.**

Insects use sex pheromones as a primary and essential mode of sexual communication. Stabilizing selection optimizes sex pheromone blends of a population; typically with the most commonly produced pheromone blend being detected by olfactory systems narrowly tuned toward that blend. However, this does not explain the huge variety of pheromone blends across Lepidopteran species. Female Heliothine moths (Noctuidae: Heliothinae) produce similar sex pheromone components, released in different ratios to create species-specific pheromone blends. It is currently unknown whether sex pheromone blends vary as a result of speciation or if speciation occurred as a consequence of pheromone blend divergence. This research investigates pheromone blend divergence of Heliothines through examinations of neuroanatomical differences, electrophysiology, analysis of pheromone receptor expression, and pheromone blend composition of four Heliothine species. Comparative study of these features will allow us to hypothesize broader mechanisms of species divergence in this subgroup, and other insect species.

**TERIN ROBINSON**, PABLO CONEJEROS, SAM MARTIN, MARTIN LYSY and BRIAN DIXON

Department of Biology, University of Waterloo, 200 University Ave W., Waterloo, Ontario, Canada, N2L 3G1

**The use of Major Histocompatibility Gene Haplotypes in Population Genetics: A Cautionary Tale**

**Utilisation des haplotypes de gènes de complexes majeurs d'histocompatibilité dans la génétique des populations: une mise en garde**

As molecular ecologists become increasingly interested in the role of pathogens in driving population differentiation, the use of MHC as markers is becoming common. MHC genes are a logical choice; differential pathogen loads associated with resource polymorphism provide insight into population processes. In practice however, the analysis of MHC alleles for use in these studies is complex. Once artefacts have been accounted for, Arctic charr (*Salvelinus alpinus*), similar to other salmonids, can have between two and four alleles per individual for both Class I and Class II, which violate the assumptions of most software packages used to estimate population differences. Arctic charr also appear to have two polymorphic class I genes (UBA and UGA). If these challenges are taken into account, MHC genes can still be informative population markers. We have developed a statistical program to estimate levels of population differentiation accounting for the challenges MHC genes present.

**TAMMY RODELA**, MARK SCOTT, ROBERT DEVLIN, AND JEFF RICHARDS

Department of Zoology, University of British Columbia

**Differential gene expression in the brain of diploid and triploid Tzenzaicut rainbow trout (*Oncorhynchus mykiss*) following hypoxia exposure**

**Expression différentielle de gènes dans le cerveau des truites arc-en-ciel Tzenzaicut (*Oncorhynchus mykiss*) après l'exposition à l'hypoxie**

Each year the Freshwater Fisheries Society of BC (FFSBC) stocks over 800 lakes with wild, naturalized "native" rainbow trout. In an attempt to minimize genetic interactions between wild and hatchery-raised populations, the FFSBC prefers to stock lakes with triploid (3n) sterile rainbow trout. However, triploid fish typically show higher mortality rates in the wild compared to their diploid (2n) counterparts. Building on earlier work in our lab, we demonstrated that diploid rainbow trout from the Tzenzaicut strain could withstand hypoxia two times longer than their triploid counterparts. With mRNA from Tzenzaicut brain, oligonucleotide microarrays identified 860 differentially expressed due to ploidy, 1235 genes changed in response to hypoxia, and 950 genes influenced by both ploidy and hypoxia. Functional annotation analysis revealed that regulation of transcriptional pathways, protein folding machinery, oxidative phosphorylation pathways may explain the underlying ability of diploid

Tzenaicut to withstand longer periods of hypoxia exposure.

**CORA ANNE ROMANOW**, TOBIAS RIEDE, AND SUSAN LINGLE

University of Winnipeg

**Designed to Attract: infant cries and male courtship calls in elk**

**Faits pour attirer: pleurs de nourissons et appels de cour masculins chez les caribous**

Many researchers concentrate on the differences between vocalizations animals make in different social contexts. However, Morton's Motivational-Structural rules predict that vocalizations with a shared function will share acoustic traits. The distress vocalizations of newborn elk calves and the courtship calls of adult male elk both solicit the approach of female elk and thus appear to have at least some overlap in function. We conducted a novel between-context comparison of newborn capture, calf isolation, and adult male courtship calls and found that these calls shared acoustic traits known to be attractive to other animals. Additionally, elk courtship calls contained a second, lower and quieter frequency and much higher levels of non-linear features, which may serve a unique function in the context of attracting mates. The results of this study call into question the appropriateness of classifying animal vocalizations based solely on the social context in which they are used.

**CAILIN M. ROTHWELL**, SEVANNE A. CARPENTER, AND GAYNOR E. SPENCER

Brock University

**Retinoid signaling enhances memory formation in the pond snail *Lymnaea stagnalis***

**La signalisation par rétinoïdes améliore la formation de la mémoire chez la lymnée *Lymnaea stagnalis***

Many molecular mechanisms underlying memory formation are conserved between vertebrates and invertebrates. The vitamin A metabolite, retinoic acid, is important for vertebrate memory, but its role in invertebrates is not known. The aerial respiratory behaviour of the pond snail *Lymnaea stagnalis* can be operantly conditioned and this invertebrate has been widely used to study mechanisms of associative learning and memory. We have shown that retinoid signaling is required for long-term memory (LTM) but not intermediate-term memory (ITM) formation, following operant conditioning in *Lymnaea*. We now demonstrate that retinoid receptor agonists promote the formation of LTM from ITM. These same receptor agonists also extend the duration of LTM beyond what is normally observed. Since the requirement of retinoic acid for memory formation has previously been examined in vertebrates, but not invertebrates, this study suggests that the role of retinoids in memory formation may be more ancient than previously thought.

**ANTHONY RUSSELL**, JOELLE BASKERVILLE, TONY GAMBLE AND TIMOTHY HIGHAM

University of Calgary

**Back to basics: the origin of adhesion in geckos.**

**Retour aux fondamentaux: origine de l'adhésion chez les geckos**

Adhesion in geckos has been studied for over 200 years, but our understanding of how the morphological apparatus associated with this evolved remains tenuous. To address the latter issue we conducted morphological and behavioral observations on *Gonatodes*, a primitively-padless sphaerodactyl, some species of which have incipient subdigital pads. *Gonatodes* is geographically, morphologically and phylogenetically well-known, and ecologically quite well documented. We investigated trends in digit proportions, shape, scalation, skeletal structure, and subdigital micro-ornamentation. We relate our findings to observations of clinging capabilities. We conclude that the employment of a setally-based adhesive bond predates the origin of many of the morphological features thought necessary for the operation of a functional adhesive apparatus. We suggest that the acquisition of the adhesion-promoting characteristics of *Gonatodes* arose in association with the enhancement of static clinging on smooth surfaces as deployed in sit-and-wait predation, and in seeking refugia that reduce the risk of being preyed upon.

**MICHAEL A SACKVILLE**, JONATHAN M WILSON AND COLIN J BRAUNER

University of British Columbia

**Larval lamprey question the origins of chordate gill function.**

**Les larves de lamproies remettent en question l'origine de la fonction des branchies des cordés**

The gill played a critical role in the adaptive radiation of early chordates by supplanting the skin as the dominant site of regulation for the internal environment. By relaxing the constraints associated with trans-epithelial flux at the skin, the gill allowed chordates to increase body size, activity level and thicken the outer dermis. Oxygen uptake is widely held as the first regulatory flux to shift from skin to gill during this process, and is thus viewed as the primary physiological constraint associated with these key evolutionary changes. However, recent work with hagfish and larval teleosts suggests the gill might have instead become critical for acid-base ion regulation first. Here, we use larval lamprey as an ancestrally representative model to determine how changes in body size and dermal thickness affect the transition from skin to gill for oxygen, ammonia, ion and acid-base regulation. The resulting implications for chordate evolution are discussed.

**Hamidullah (Hamid) Safi** and Anthony P. Farrell

University of British Columbia

**The relationship between aerobic scope and heart rate in a eurythermal fish**

It has been demonstrated in a number of fish species that an increase in temperature increases both aerobic scope and heart

rate ( $f_H$ ) until a maximum value is reached. However, in the eurythermal goldfish (*Carassius auratus auratus*) acclimated to 12°C maximum,  $f_H$  increased with temperature in the expected manner, but absolute aerobic scope was constant across a broad temperature range. We hypothesized that this is a common characteristic of eurythermal fishes. If so, we predicted that the same thermal independence of absolute aerobic scope and maximum  $f_H$  should hold for the eurythermal common killifish (*Fundulus heteroclitus*). We support this hypothesis by recording the response of maximum  $f_H$  to acute warming at three acclimation temperatures and comparing them with absolute aerobic scope. In addition, we show a close association between the temperature when the heartbeat became arrhythmic and  $CT_{max}$  (temperature at which fish lose equilibrium).

#### **La relation entre le registre aérobic et la fréquence cardiaque chez un poisson eurythermal.**

Il a été démontré chez un certain nombre d'espèces de poissons qu'une augmentation de la température augmente à la fois le registre aérobic et la fréquence cardiaque ( $f_H$ ) jusqu'à atteindre une valeur maximale. Cependant, chez le poisson rouge eurythermal, (*Carassius auratus auratus*) acclimaté à 12°C, la  $f_H$  maximale augmente en fonction de la température, de la manière attendu, mais le registre aérobic est constant sur une large gamme de températures. Notre hypothèse prévoit que cela est une caractéristique commune des poissons eurythermals. Dans ce cas, nous avons prédite que le registre aérobic absolue et la  $f_H$  maximal devrait être indépendant de la température chez le Killi commun (*Fundulus heteroclitus*) également. Je soutiens mon hypothèse en enregistrant les réponses maximales de  $f_H$  à une augmentation rapide de la température à 3 températures d'acclimation, en les comparent avec le registre aérobic. De plus, nous démontrons une association proche entre la température et le  $CT_{max}$  lorsque le cœur devient arythmique (température à laquelle les poissons perdent l'équilibre).

**ROXANNE J SAULNIER**, SIMON G LAMARRE

Université de Moncton

#### **The effects of cortisol on fish protein metabolism**

##### **Effets du cortisol sur le métabolisme des protéines chez les poissons**

Stress reduces fish growth rate by reducing appetite. However, stressful conditions seem to reduce fish growth rate significantly more than when they are starved. We suggest that these observations are related to the effects of cortisol on protein metabolism. Stress level in a group of fish was artificially elevated via cortisol injections. We have developed a method using a stable isotopic tracer (Ring-D5-phenylalanine) to measure protein synthesis. Creating a time series by varying the incorporation time of the tracer validated our technique. Its effectiveness was confirmed by comparing protein synthesis rates in groups of starved and fed fish. Preliminary results suggest that increasing the concentration of cortisol for a few hours does not have an effect on protein synthesis. The effects of chronically elevated cortisol concentrations will be measured, as well as the degradation pathways, as they are important in understanding the effects of cortisol on protein metabolism.

**SARAH SCHORNO**, TIMOTHY M WINEGARD AND DOUGLAS S FUDGE

University of Guelph

#### **Using focused ion beam scanning electron microscopy (FIB-SEM) to elucidate sub-cellular structures in 3D: The case of hagfish thread cells**

##### **Utilisation de la microscopie électronique à balayage à faisceau d'ions focalisé afin d'élucider les structures sous-cellulaires en 3D: le cas des cellules à fibres des myxines**

FIB-SEM systems are similar to standard scanning electron microscopes (SEM), however, they employ a finely focused beam of ions (usually gallium) to mill away layers of the sample. SEM images are collected via a beam of electrons after each layer is ablated. Although this technique is used particularly in the semiconductor and material science industries, there is increasing use in the biological field. Here, the intricate 3D structures of cells from the slime glands of Atlantic hagfish (*Myxine glutinosa*) are explored with this technique.

TIMOTHY M. HEALY, JESSICA L. MCKENZIE AND PATRICIA M. SCHULTE

Department of Zoology, University of British Columbia

#### **Are thermal tolerance and hypoxia tolerance functionally correlated traits in fish?**

##### **Est-ce que la tolérance thermique et la tolérance à l'hypoxie sont corrélées du point de vue de la fonction chez les poissons?**

The hypothesis of oxygen and capacity limited thermal tolerance (OCLTT), which addresses how aquatic organisms will respond to climate change, predicts that thermal tolerance and hypoxia tolerance should be correlated in fish. To test this prediction we examined the relationship between thermal tolerance ( $CT_{Max}$ ) and hypoxia tolerance (time to loss of equilibrium (LOE) in hypoxia) in killifish, *Fundulus heteroclitus*. Northern populations of killifish have low tolerance to both stressors, and southern populations have high tolerance, consistent with the OCLTT. However, when we examined these phenotypes in multiple populations along the coast, there was no correlation between these phenotypes at the individual level, and  $CT_{Max}$  had a linear relationship with latitude, whereas time to LOE showed a sharp phenotypic break, coincident with the center of a steep cline in mitochondrial genotype frequency. Similar patterns were observed in replicate cline in the Chesapeake Bay. These data contradict this prediction of the OCLTT.

**GRAHAM R SCOTT**, KEVIN B TATE, CATHERINE M IVY, KEVIN GUO, PARAS PATEL, AND SAJENI MAHALINGAM

McMaster University

#### **Cardiac performance in hypoxia of high-altitude deer mice.**

### **Performance cardiaque pendant l'hypoxie chez les souris sylvestres de haute altitude**

The hypoxic and cold environment at high altitudes requires that endothermic animals sustain high rates of O<sub>2</sub> consumption for locomotion and thermogenesis while facing a diminished O<sub>2</sub> supply. We used captive breeding populations of deer mice (*Peromyscus maniculatus*) from highland and lowland ancestry to examine how cardiac performance is maintained at high altitudes. Hypoxia acclimation improved aerobic capacity in hypoxia (VO<sub>2</sub>max) in both populations, but hypoxic VO<sub>2</sub>max was consistently greater in highlanders. Hypoxia acclimation also increased heart rate at VO<sub>2</sub>max, in association with increased arterial O<sub>2</sub> saturation and ventricle capillarity. There were no effects of hypoxia acclimation or highland ancestry on oxidative capacities of the heart, based on measurements of respiratory capacities for oxidative phosphorylation in cardiac fibres and of mitochondrial enzyme activities. Therefore, hypoxia acclimation improves cardiac performance in hypoxia by improving O<sub>2</sub> supply to the heart while not affecting many aspects of cardiac O<sub>2</sub> utilization. Supported by NSERC.

Hoar Finalist abstract

**SEAMONE SCOTT** and DOUGLAS SYME

University of Calgary

### **Escape advantage: benthic stingrays can flee in all directions across the substrate**

#### **Avantage dans l'évasion: les raies benthiques peuvent s'évader dans toutes les directions sur le substrat**

Measuring performance in fast-start behaviors can provide valuable insight into functional morphology. Using the ocellate river stingray, *Potamotrygon motoro*, we analyzed escape responses via high-speed video to explain the mechanics of pectoral fin powered escape, and how modulation of these mechanics influence escape trajectory relative to stimulus position. Pectoral fins moved in two perpendicular directions from the dorsal view, presenting the appearance of a barrelling ocean wave. Modulation of these movements enabled escape in any 2D direction (in the same plane as the substrate) from the stimulus. This appears to be an escape advantage because these animals are able to maximize the range of escape possibilities living in a 3D restricted environment (i.e. exposed to predation from above, while unable to escape down). In result, we suggest that a predator should approach towards benthic stingrays along the substrate, instead of from the surface, to reduce the range of possible ETs. ([return / retour](#))

WAYNE VOGL, MARGO LILLIE, MARINA PISCITELLI, JEREMY GOLDBOGEN, NICKOLAS PYENSON AND **ROBERT SHADWICK**

University of British Columbia

### **Stretchy nerves withstand deformation associated with lunge feeding in rorqual whales.**

#### **Des nerfs élastiques résistent à la déformation liée au happement chez les rorquals**

Rorqual whales engulf and filter large volumes of prey-laden water through baleen plates. During engulfment, the tongue inverts into a ventral pouch ballooning backwards to the umbilicus. Simultaneously, muscles in the floor of the mouth and the overlying ventral groove blubber dramatically expand to accommodate the engulfed water. We found that nerves in the tongue and the floor of the mouth of adult fin whales can extend up to twice their initial lengths. These nerves consist of a very thick connective tissue wall, external to the epineurium, composed of longitudinally arranged elastin fibers and wavy or folded collagen bundles, with central nerve fascicles themselves highly folded into a small central core. The collagen bundles in the wall and the nerve fiber bundles in the core unfold when the nerve is extended. Stretchy nerves represent a critical component of a complex assemblage of morphological adaptations that make lunge feeding possible.

**RYAN B SHARTAU**, ZACHARY F ZOHL, DANE A CROSSLEY II AND COLIN J BRAUNER.

University of British Columbia

### **Acid-base regulation during embryonic development in the snapping turtle (*Chelydra serpentina*)**

#### **Régulation acide-base durant le développement embryonnaire de la chélydre serpentine (*Chelydra serpentina*)**

In most vertebrates, blood pH (pHe) is tightly regulated which assists in maintaining tissue pH (pHi); changes in pHe are usually reflected in pHi. Some vertebrates, however, can defend pHi despite large maintained reductions of pHe (termed preferential pHi regulation) which may be associated with high CO<sub>2</sub> tolerance. This trait has been identified in adult fishes but not in adult amniotes. Some developing amniotes are very tolerant of high CO<sub>2</sub> which we propose may be associated with preferential pHi regulation. To investigate this, snapping turtles at three developmental stages (70 and 90% to hatch, and yearlings) were exposed to 15% CO<sub>2</sub>/10% O<sub>2</sub> for one hour. pHe was reduced in all stages, pHi was preferentially regulated in 70 and 90% to hatch embryos, but not in yearlings. These results are the first to show preferential pHi regulation in amniotes and provide insight into how patterns of pH regulation change during development.

**ANTHONY V SIGNORE**, ANGELA FAGO, ROY E WEBER AND KEVIN L CAMPBELL

University of Manitoba

### **Evolutionary and functional analysis of Steller's sea cow (*Hydrodamalis gigas*) hemoglobin provides new insights into temperature adaptation**

#### **L'analyse évolutionnaire et fonctionnelle de l'hémoglobine de la rhytine de Steller offre de nouveaux aperçus sur l'adaptation à la température**

The energetic demands of diving combined with a nutritionally poor diet presents unique physiological challenges for sirenians, the only fully aquatic mammalian herbivores. Our selection analyses of sirenian hemoglobin genes revealed a number of rare amino acid replacements expected to markedly alter their oxygen binding properties and responses to allosteric effectors that



may, in part, underlie adaptations to this unique life history. To assess the functional consequences of these residue exchanges, we measured the oxygen binding characteristics of recombinant sirenian hemoglobins and demonstrate that the hemoglobin of the extinct sub-Arctic Steller's sea cow is less sensitive to temperature than those of extant sirenians. However, in contrast to previous work that demonstrated this phenotype predominantly arises from binding of 'additional' allosteric effectors, we show that these ligands have reduced effects on *H. gigas* hemoglobin. Rather, changes to the intrinsic thermodynamic properties of *H. gigas* hemoglobin together with temperature-dependent anion binding safeguard oxygen delivery at low temperatures.

**BRENT J SINCLAIR** AND KEITH J KING

Western University

**Waterproof from the inside and out: Role of cuticular melanism and lipids on water loss rates in insects**

**Étanches à l'intérieur comme à l'extérieur: le rôle du mélanisme cuticulaire et des lipides dans les taux de perte d'eau des insectes**

The majority of water lost by insects is across the cuticle. Previous work in *Drosophila* has shown that cuticular melanisation underlies variation in water loss among and within species, while rapid phenotypic plasticity is associated with modification of epicuticular lipids. Thus, we predicted that dark morphs of insects should have lower water loss rates than lighter morphs. Montane insects are expected to be particularly susceptible to water loss, so we predicted that montane species should have lower rates of water loss than their lowland counterparts. We tested these hypotheses in tree weta (*Hemideina spp.*), a radiation of large orthopteran insects in New Zealand. We found that montane species of *Hemideina* had lower rates of cuticular water loss than lowland species, and that dark morphs of one species, *H. maori*, had lower rates of cuticular water loss than yellow morphs of the same species.

**DIMITRI A SKANDALIS**, JOSEPH W BAHLMAN, BENJAMIN GOLLER, DOUGLAS L ALTSHULER

University of British Columbia

**Hummingbird wing shape from 2-D to 4-D**

**Forme de l'aile d'oiseau-mouche de deux à quatre dimensions**

Flying animals vary greatly in wing design, but this has been only broadly linked to variation in flight performance. A key difficulty is defining wing shape. A wing's performance is influenced by two- and three-dimensional parameters like wing area, camber, and twist, which are additionally behaviourally modulated, and differ between, e.g., hovering and forward flight. This makes it unclear what matters most: what you have or how you use it. Allometric scaling can provide insight into evolutionary constraints on shape. Geometric similarity predicts a scaling exponent of 2/3, which is observed across volant taxa, but within clades this exponent does not appear to hold. Instead, we find a scaling model grounded in aerodynamic theory fully predicts wing area variation, as well as stroke kinematics. High-speed filming of time-varying hummingbird wing morphology reveals potential limits to behavioural modulation of wing shape, which therefore suggests morphological targets for selection.

**BEN SPEERS-ROESCH** AND WILLIAM R DRIEDZIC

Memorial University of Newfoundland

**Mechanisms of winter dormancy in fishes: lessons about the roles of inactivity and metabolic depression from a temperate wrasse, the cunner (*Tautoglabrus adspersus*)**

**Mécanismes de dormance hivernale chez les poissons: leçons sur le rôle de l'inactivité et de la dépression métabolique d'une vieille tempérée, la tanche-tautogue (*Tautoglabrus adspersus*)**

To survive winter, many temperate fishes become dormant: a state of inactivity, low metabolic rate, and fasting. The physiological mechanisms underlying winter dormancy remain poorly understood, including the level of biological organization where it is initiated and maintained and whether metabolic rate depression is involved. We are investigating the acute and chronic thermal sensitivity of tissue and whole-animal metabolic rate in a model of winter dormancy, the cunner (*Tautoglabrus adspersus*), previously reported to exhibit a metabolic rate depression during dormancy. Using multi-day monitoring of active and dormant whole-animal oxygen consumption rates, we found that winter dormancy does not involve an acute, active metabolic rate depression, but rather involves a dampened diel rhythm of whole-animal metabolic rate, which may be related to lowered activity levels. However, over weeks of dormancy, a gradual depression of metabolic rate occurs in certain tissues, which agrees with reported chronic decreases in whole-animal metabolic rate.

**EMILY M. STANDEN**, TRINA Y. DU, HANS C.E. LARSSON

University of Ottawa

***Polypterus* plasticity and what it means for the origin of tetrapods.**

**Plasticité de *Polypterus* et ce qu'elle nous apprend sur l'origine des tétrapodes**

The origin of tetrapods from their fish antecedents, approximately 400 million years ago, was coupled with the origin of terrestrial locomotion and the evolution of supporting limbs. To gain insights into how early fishes might have used their fins to navigate terrestrial environments, and how these new environments affected the development of their fins we measured the developmental plasticity of anatomical and biomechanical responses in *Polypterus* reared on land. Our data show a remarkable correspondence between the environmentally induced phenotypes of terrestrialized *Polypterus* and the ancient anatomical changes in stem tetrapods, providing insight into stem tetrapod behavioural evolution. We also test the diversity of walking

ability in *Polypterus* when subjected to differences in substrate and show that *Polypterus* have three distinct terrestrial gaits. Our results raise the possibility that biomechanical variation as well as environmentally induced developmental plasticity facilitated the origin of the terrestrial traits that led to tetrapods.

**MARINA SUBRAMANIAM**; LYNN P. WEBER; JOHN C. CHING; COLE B. ENNS; MURRAY D. DREW; MATTHEW E. LOEWEN  
University of Saskatchewan

**Identification and Characterization of Glucose Transporters in the Gastrointestinal Tract of Rainbow Trout (*Oncorhynchus mykiss*) and Nile Tilapia (*Oreochromis niloticus*)**

**Identification et caractérisation des transporteurs de glucose dans le système gastro-intestinal de la truite arc-en-ciel (*Oncorhynchus mykiss*) et du tilapia du Nil (*Oreochromis niloticus*)**

Species differences in electrogenic transport of D-glucose along different sections of the intestine were compared between Rainbow trout (*Oncorhynchus mykiss*) and Nile tilapia (*Oreochromis niloticus*) in Ussing chambers. The kinetics of glucose transport in pyloric caeca and midgut of trout were similar to the sodium-dependent glucose transporter isoform 1 (SGLT1) in mammals, and the kinetics in colon resembled mammalian SGLT2. In contrast to trout, the kinetics in all three intestinal sections in tilapia resembled mammalian SGLT2. In addition, SGLT1 and SGLT2 inhibitors further confirm the locations of glucose transporters. In conclusion, trout has two types of SGLTs, a high affinity, low capacity transporter in pyloric caeca and midgut, and a low affinity, high capacity transporter in the colon. Tilapia has only one type of SGLT throughout the gut, which is a low affinity, high capacity transporter.

**JOSHUA SULLIVAN**, FLORENCE CHAN, SYLVIA CHECKLEY, LISA-MARIE LECLERC, DONALD MCLENNAN AND SUSAN KUTZ  
University of Calgary

**Evaluation of sampling techniques for terrestrial gastropods at the edge of their range in the Canadian Arctic.**

**Évaluation des techniques d'échantillonnage de gastropodes terrestres à la limite de leur étendue dans l'Arctique canadien**

Terrestrial gastropods are obligate intermediate hosts for species of protostrongylid nematode parasites expanding their range in the Arctic. Little is known about the diversity and ecology of terrestrial gastropods in the Arctic due to lack of investigation and unproven sampling methods. In summer 2013 and 2014, we compared three terrestrial gastropod sampling techniques: refuge traps using dampened mats, turf flooding, and pan traps, for use on the tundra near Cambridge Bay, Nunavut. Each technique was evaluated on capture rate, time/effort requirements, problems incurred and the type of data generated. We found that refuge traps were most feasible for short time periods, turf flooding provided useful abundance data but were labour intensive and pan traps captured the highest number of gastropods. We recommend using both turf flooding and refuge trapping to obtain data on species diversity and relative abundance in new locations and pan trapping for long-term monitoring.

**MATT SZOSTAKIWSKYJ** AND RAMON NAGESAN  
University of Calgary

**From Instagram to the classroom: using photogrammetry to visualize anatomy.**

**De Instagram à la classe: utilisation de la photogrammétrie afin de visualiser l'anatomie**

As undergraduate and medical programs continue to grow, instructors need to adapt their material in order to accommodate more students. This can be particularly difficult in anatomy where a hands-on approach dominates, and the demand for material outstrips the availability. Innovative visualization methods are required to meet this demand, but can be cumbersome and costly. Using a digital camera and photogrammetry software, we have created a 3D model of the human heart from 108 photographs. This process is time and cost efficient, and can simultaneously reduce the strain on teaching labs while increasing a student's learning experience. The resulting model is anatomically accurate and photorealistic, and well represents what a student will encounter in an anatomy lab. Furthermore our model is lightweight and adaptable, and can be used for teaching, studying, and testing.

**JESSICA THEODOR**

University of Calgary

**Ear region morphology in Hypertragulidae**

**Morphologie de la région de l'oreille chez les Hypertragulidés.**

The Hypertragulidae, small, hornless artiodactyls from the Eocene of North America, are thought to represent the most basal ruminants. Cranially, members of this group share a number of features with other basal artiodactyls: a deep subarcuate fossa, laterally exposed mastoid region, and incomplete postorbital bar. The tympanic bulla tends to be inflated to varying degrees. More detailed high-resolution CT study of the ear region of *Hypisodus* and *Hypertragulus* shows a mix of derived and ancestral features: the bulla is strongly inflated, subdivided in two linked chambers, but entirely hollow. The deep subarcuate fossa contains a deeper mastoid fossa within it, also known in tylopods and Eurasian taxa. However, *Hypisodus* also bears a sharp crest on the medial petrosal, a feature shared with more derived ruminants. Further CT study of basal ruminant cranial material is needed to assess homologies within the hypertraguloids and better facilitate comparisons among basal ruminants.

**KEITH B TIERNEY**

University of Alberta

**R. G. Boutilier New Investigator Award - Abstract****How aquatic vertebrates cope with ever changing environments**

Across the planet human activities are changing the chemical and physical properties of waterbodies that are utilized by an incredible diversity of vertebrates. Some of these water quality changes may have subtle to profound effects on vertebrate physiology and behaviour. One of the principle goals of my lab is to understand how specific human-associated chemicals and chemical mixtures, as well as changes in water temperature and flow, affect sub-organismal and organismal responses in order to ultimately make predictions regarding the longevity of species in their current and future locales. This talk will include example research from my students and collaborators on how chemical and chemical mixture exposures cause subtle developmental and physiological changes in fish and an avian model. I will also provide research on chemical detection of dissolved compounds and how such information can inform and misinform behavioural decisions, and be used to inform water quality treatment methods.

**Prix R. G. Boutilier pour jeune chercheur - Résumé de la presentation****Comment les vertébrés aquatiques se débrouiller dans les environnements qui changent constamment.**

Partout sur la planète les activités humaines modifient les propriétés chimiques et physiques des plans d'eau qui sont utilisés par une incroyable diversité de vertébrés. Certains de ces changements de qualité de l'eau peut avoir des effets allant de très subtils aux modifications extrêmes sur la physiologie et le comportement de vertébrés. L'un des principaux objectifs de mon laboratoire est de comprendre comment les substances chimiques associées à l'homme et les mélanges de produits chimiques, ainsi que les changements dans la température et le débit d'eau, affectent les réponses sous-organismiques et organismiques pour arriver finalement aux prédictions concernant la longévité des espèces dans leurs lieux actuels et futurs.

**ALEXANDER TINIUS** and ANTHONY P. RUSSELL

University of Calgary

**3D geometric morphometric analysis of the scapulocoracoid: associations with ecomorphic categorization of arboreal anoles (Squamata: Dactyloidae) on Caribbean islands.****Analyse en morphométrie géométrique 3D de l'os scapulocarpoïde: association avec les catégories écomorphiques des anoles arboréales (Squamata: Dactyloidae) sur les îles des Caraïbes.**

Anoline lizards of the Greater Antilles are a focal taxon for the study of ecomorphology. External morphological traits vary in association with exploitation of different portions of the structural habitat, and much of this is associated with the locomotor system. Here we apply 3D geometric morphometrics to the analysis of the form of the scapulocoracoid, the largest structural component of the pectoral girdle. Because the skeleton determines the proportions and mechanics (through its arrangement as a series of levers) of the locomotor system, we predict that skeletal anatomy will also be reflective of ecomorphic patterns. Our findings indicate that within island radiations the form of the scapulocoracoid is directly associated with specializations related to habitat occupancy (ecomorphology). Comparing ecomorphs between islands reveals that phylogenetic history potentially constrains the morphological evolution of the scapulocoracoid, such that although ecomorphs exhibit differences in its form, phylogenetic history tempers the way in which this is expressed.

**JASON R. TREBERG**, SHEENA BAHN, LILLIAN WIENS, EMIANKA SOTIRI, PAMELA ZACHARIAS

University of Manitoba

**Temperature influences on hydrogen peroxide metabolism by skeletal muscle mitochondria****Influences de la température sur le métabolisme du peroxyde d'hydrogène par les mitochondries de muscle squelettique**

Mitochondria have long been implicated as a source of reactive oxygen species (ROS) such as hydrogen peroxide, which if allowed to accumulate in the cell may lead to oxidative damage and cellular stress. However, rather than being simply a net source of ROS, mitochondria are emerging as potential regulators of hydrogen peroxide levels based on the balance between production and consumption. Here we have examined how temperature influences the metabolism of hydrogen peroxide by mitochondria isolated from the skeletal muscle of vertebrates, with focus on ectothermic fishes. Muscle mitochondria from fish have markedly greater capacity to produce ROS than a typical endothermic mammal (the rat) under comparable assay conditions. The interspecific trends in ROS production capacity are paralleled by an inverse relationship between antioxidant capacities. Overall our findings suggests an incomplete compensation for the effects of temperature on ROS production by mitochondria.

**MICHAEL J TRITES** AND DANIEL R BARREDA

Department of Biological Sciences, University of Alberta

**Cleaved transferrin products can serve as an early marker of acute inflammation in goldfish, *Carassius auratus*****Les produits de sidérophilines clivés peuvent servir d'indicateurs initiaux d'inflammation aiguë chez les poissons rouges, *Carassius auratus***

Current markers of acute inflammation focus on cytokines that are synthesized in small quantities and that are short-lived. Cleaved transferrin has been shown to induce anti-microbial responses in goldfish (*Carassius auratus*) macrophages. Given the abundance and presence of transferrin-like molecules and macrophage-like cells present in almost all organisms we hypothesized that cleaved transferrin may serve as a good comparative marker of the early inflammatory response. Thus, we

used a self-resolving *in vivo* model of inflammation in goldfish, to first correlate transferrin appearance with the infiltration of inflammatory leukocytes and induction of anti-microbial responses (ROS, NO, and phagocytosis). Preliminary data revealed differential kinetics of transferrin appearance with different microbial stimuli, detectable as early as 4 h post-stimulation. We are currently examining whether this points to differential kinetics of inflammation with each of these pathogen mimics or differential use of transferrin to induce anti-microbial responses against each of these pathogen types.

**LOUISE TUNNAH**, SARA MACKELLAR, TYSON MACCORMACK, ANDREA MORASH, JAYSON SEMMENS AND SUZIE CURRIE  
Mount Allison University

**How do hypersaline conditions in estuarine nurseries affect the physiology of two Tasmanian shark species?**

**Effets de conditions hypersalines dans les nurseries estuariennes sur la physiologie de deux requins de Tasmanie**

Estuaries offer protection and serve as nursery grounds for many juvenile fish, but are vulnerable to environmental fluctuations. We studied juvenile gummy (*Mustelus antarcticus*) and school (*Galeorhinus galeus*) sharks in a Tasmanian nursery, where salinities may increase by over 30%. Tracking data indicate distinct movement patterns between these species in response to salinity changes, leading us to hypothesize that school and gummy sharks have different physiological responses to hyperosmotic stress. We exposed sharks to 43 ppt for 48 h followed by a 12 h recovery at control salinity (34 ppt) and measured indicators of cellular stress, protein damage, and gill functioning. We show that these two species use different strategies to osmoconform to the new higher salinity (e.g. urea vs. plasma ions). Our results also indicate significant increases in several heat shock proteins (HSPs) in both species but with unique and tissue-specific induction profiles in response to this osmotic stress.

**ANDY TURKO**, ROGER CROLL, DOUGLAS FUDGE, FRANK SMITH, MATTHEW STOYEK, AND PATRICIA WRIGHT  
University of Guelph

**Aquatic-terrestrial transitions in amphibious fishes mimic astronauts returning to earth**

**Les transitions entre l'eau et la terre chez les poissons amphibies ressemblent aux retours des astronautes sur terre**

Mammals respond to changes in body weight (e.g. during spaceflight), but because fishes evolved under effectively weightless conditions they are thought to be unresponsive to gravity. Amphibious fishes, however, tolerate increased weight during emersion. We hypothesized that differences in weight alter gill support in the amphibious fish *Kryptolebias marmoratus*. Fish were acclimated for 7d to water (1g), or a terrestrial environment in normal gravity (1g) or simulated microgravity (0.06g) created using a random positioning machine. Gill arches from terrestrially acclimated fish were ~40% stiffer than those from aquatic fish; microgravity reversed this effect. More densely packed collagen fibers measured in the gills of terrestrially acclimated fish may account for the increased stiffness. We conclude that fishes are able to respond to increased weight and thus a major hypothesized hurdle to the invasion of land – the evolution of a strong skeletal system – may not represent as weighty a challenge as assumed.

**VELISLAVA TZANEVA** AND STEVE F. PERRY  
University of Ottawa

**Carbon monoxide (CO) mediated respiratory responses to changing water O<sub>2</sub> levels in the zebrafish larvae, *Danio rerio*.**

**Réactions respiratoires médiées par le monoxyde de carbone (CO) aux changements dans le niveau d'O<sub>2</sub> dans la larve du poisson zèbre, *Danio rerio***

Carbon monoxide (CO) is a gasotransmitter signalling molecule produced in vertebrates *in vivo* via the breakdown of heme by heme oxygenase – 1 (HO-1). We hypothesize that CO produced via HO-1 plays an inhibitory role in O<sub>2</sub> sensing in the zebrafish (*Danio rerio*) larva. Under normoxic conditions HO-1 morphant (lacking HO-1) larvae exhibited significantly higher ventilation frequency ( $V_f$ ) than control larvae. This increase in  $V_f$  was eliminated by the addition of exogenous CO. Exogenous CO significantly blunted the  $V_f$  response to hypoxia in both groups of fish but had no effect on the  $V_f$  of fish exposed to hyperoxia. To eliminate the possible effects of CO-hemoglobin interactions on  $V_f$ , fish were exposed to phenylhydrazine (PHZ) to eliminate red blood cells. PHZ and CO treatments did not cause a significant change in the  $V_f$  of normoxic fish. Based on this data CO plays an inhibitory role in O<sub>2</sub> chemoreception of zebrafish.

**Bradley van Paridon**, Douglas Colwell, Cameron Goater and John Gilleard

**Invasion pathway, life-cycle, and host utilization of emerging liver fluke, *Dicrocoelium dendriticum*, in wildlife and cattle in Cypress Hills, Alberta**

**Voie d'invasion, cycle de vie, et utilisation des hôtes de la petite douve du foie émergente, *Dicrocoelium dendriticum*, chez les animaux sauvages et le bétail à Cypress Hills, Alberta.**

The lancet liver fluke, *Dicrocoelium dendriticum*, emerged in Cypress Hills Park (CHP), Alberta in the 1990's. Results from annual host surveys show that 60-90% of sympatric elk, white-tailed deer, mule deer and beef cattle are infected, with individual hosts often harbouring > 1000 gravid worms. At this site of emergence, the life-cycle involves at least 3 species of Formicid ant as second intermediate host and 1 species of terrestrial snail (*Oreohelix* sp.) as first host. Using two molecular markers, mtDNA gene sequences, and microsatellites, we genotyped samples of adult worms from hosts in CHP, 2 other invasion sites in North America, and sites in Europe. Our results are consistent with invasion of CHP from multiple sources, likely via trans-border movement of domestic stock. An understanding of invasion pathway, life-cycle, and host utilization patterns provide important tools for mitigating future spread of liver fluke to comparable sites in North America.

**STEV I VANDERZWAN**, STEVEN M VAMOSI AND SEAN M ROGERS

University of Calgary

**Ecology of adaptive peak shifts in Alaskan threespine stickleback.**

**Écologie des décalages de pics d'adaptation dans les épinoches à trois épines de l'Alaska**

Divergent natural selection is a major cause of phenotypic differentiation between populations exploiting different environments, and information on the nature of peak shifts is largely missing from natural populations. Threespine stickleback (*Gasterosteus aculeatus*) is an emerging vertebrate model for studying the relationship between phenotype and environment, as ancestral marine populations have colonized and adapted independently to many freshwater environments since the last ice age. We characterized phenotypes of 870 fish from 16 sites in Katmai National Park and the Alaska Peninsula, with lake environments ranging considerably in size (1 to 2650 km<sup>2</sup>), fish species composition (3 to 24), and approximate age of formation (400 to 20,000 years ago). Using geometric morphometrics and phenotypic trajectory analyses, we tested predictions associated with peak shifts among populations of different ages and diverse ecological conditions. Our work reinforces the importance of quantitative studies of phenotypes in nature towards elucidating mechanisms associated with adaptive evolution.

**BRANDON VARELA** AND MERY MARTINEZ

Laurentian University, Department of Biology

**Sperm performance in *Barbus apleurogramma* across oxygen regimes**

**Performance du sperme de *Barbus apleurogramma* sur plusieurs régimes d'oxygène**

In this study we evaluated the effects of hypoxia on body condition and sperm quality (i.e. swimming speed) of the African cyprinid *Barbus apleurogramma* across oxygen regimes. Significant differences in body length and mass were found between DO regimes, with fish from hypoxic sites being smaller and having relatively larger gonads. Our results suggest that trade-offs exists between total gonad weight and sperm swimming speed independently of DO. We proposed that smaller males from hypoxic sites will be outcompeted by bigger males during reproduction. As a result, relatively larger gonads and slightly faster swimming sperm were naturally selected in the hypoxic sites. Future studies will determine if *B. apleurogramma* males from hypoxic and normoxic sites within a region aggregate for spawning, and if males from hypoxic sites are at a positional disadvantage.

**MATT VICKARYOUS**, EMILY GILBERT, KATHY JACYNIAK, ALAINA MACDONLAD, REBECCA MCDONALD AND NOELINE SUBRAMANIAN

University of Guelph

**Geckos as a model for the study of scar-free wound healing and regeneration: where biology meets biomedicine.**

**Les geckos comme modèles pour étudier la guérison de blessures sans cicatrices et la régénération: rencontre entre la biologie et la biomédecine.**

Tail regeneration by lizards is a widely reported but poorly understood phenomenon. Inspired by the work of Anthony P. Russell, our group employs geckos as an experimental model to investigate wound repair and tissue replacement. Here we report on the presence of progenitor cells in the central nervous system, and the ability of geckos to undergo scar-free wound healing. We determined (using a BrdU pulse-chase experiment) that cells bordering the ventricular system are slow-cycling (i.e., labeled for 20 weeks). In addition, these cells express various progenitor cell markers (including Sox2, Sox9 and Musashi-1) and proliferate in response to tail loss. Using full-thickness skin biopsies, we determined that cutaneous wounds to the body and tail heal without scar formation within 45 days. These wounds are invaded by proliferating mesenchymal-like cells but fail to form granulation tissue. Our findings underscore the utility of the gecko as an emerging biomedical model.

**Matt Vijayan**

University of Calgary

**Stress Steroid and Hepatocyte Metabolism: Moon Legacy and Beyond!**

**Stéroïdes du stress et métabolisme des hépatocytes: legs de Moon et plus encore**

My work on stress steroid regulation of hepatocyte metabolism had its early roots in Tom's laboratory. That is where I picked up the fish hepatocyte isolation technique, and also carried out some elegant metabolic studies using this cell system. We demonstrated that cortisol enhanced gluconeogenesis in trout hepatocytes and this involved glucocorticoid receptor activation. While my earlier studies focused on genomic corticosteroid signalling, lately my group has been investigating the rapid and nongenomic effects of cortisol on hepatocyte metabolism. For instance, stress levels of cortisol quickly alter liver membrane biophysical properties, leading to activation of stress signalling pathways. Also, cortisol modulates intracellular calcium levels in trout hepatocytes, while the mechanism remains to be elucidated. The model emerging is that stress-mediated cortisol elevation also has rapid effect on liver metabolism and this may involve signalling pathways that are membrane receptor-dependent and/or -independent.

**NASTASHYA WALL** AND GRANT B. MCCLELLAND

McMaster University

**Adult plasticity in thermogenesis for low and high altitude deer mice (*Peromyscus maniculatus*)**

### **Plasticité adulte dans la thermogénèse à basse et haute altitude chez les souris sylvestres (*Peromyscus maniculatus*)**

High altitude is one of the most extreme environments experienced by terrestrial mammals due to both low ambient temperatures and oxygen availability. High altitude deer mice have an increased thermogenic capacity compared to lowland mice, which is likely consequent of both genetic adaptations and phenotypic plasticity. We hypothesized that the thermogenic capacity of wild deer mice maintains phenotypic plasticity. F1 generation lab-reared mice were acclimated to naturally occurring high altitude stressors of hypoxia and cold (both separately and combined). Acclimation to cold, and cold combined with hypoxia, increased  $VO_{2\text{summit}}$  above unacclimated controls. Additionally, lipid oxidation rates increased after acclimation to cold, and to hypoxia. These findings demonstrate that phenotypic plasticity is important to thermogenic capability, with a more potent induction by cold. Interestingly, deer mice use primarily lipids to sustain prolonged thermogenesis in a cold and hypoxic environment, even though carbohydrates would provide an oxygen saving advantage.

**PATRICK J. WALSH**

University of Ottawa

#### **Lessons learned during my life as a 'Moonie'.**

##### **Ce que j'ai appris dans ma vie en tant que 'Moonie'**

Professor Tom Moon has made numerous substantial contributions to the field of Comparative Physiology and Biochemistry in a career that spans over 4 decades. Most notable are his pioneering use of *in vitro* systems (e.g., fish hepatocytes) and his early recognition of the impact that xenobiotics in the environment can have on hormonal and metabolic systems in fish. This presentation will review several of these findings and the impact they had on the paths of investigations and investigators.

**BENJAMIN WALTERS**, MICHAEL J CLINCHY, NATALIE CHENG, CHRIS GUGLIELMO, AND LIANA ZANETTE

University of Western Ontario

#### **A tactic to stay alive: anti-predator behavioural responses affect physiology but not flight performance in high risk environments**

##### **Une tactique pour survivre: les réactions comportementales anti-prédatrices affectent la physiologie mais pas la performance du vol dans les environnements à hauts risques.**

Recent manipulations show that when perceived predation risk is high, animals will chronically alter their anti-predator behaviour even if it lowers physiological condition to such an extent that it can affect survival. Because animals must trade-off food intake with vigilance, predator-induced reductions in food intake are expected to be one of the key behavioural mechanisms involved. However, in birds, decreased food-intake may actually benefit survival if it leads to body mass reduction, which some have suggested may improve flight performance and predator evasion. We tested the previously unexplored relationship amongst predation risk, mass change, and flight performance. We found that brown-headed cowbirds exposed to predator sounds gained mass rather than lost it, and critically, flight performance was not affected. We suggest that birds may use mass gain as a tactic to reduce starvation risk when predation risk is high, while simultaneously maintaining their flight performance and capability of evading predators.

**JAMES D WASMUTH**, AUDE GILABERT, DAVID CURRAN AND SIMON HARVEY

University of Calgary

#### **The evolution of signalling pathways that control the life-cycle transition of parasitic nematodes.**

##### **Evolution des voies de signalisation contrôlant les transitions du cycle de vie des nématodes parasitiques.**

The transition from free-living nematode to parasitism has evolved multiple independent times.

It is hypothesized that this transition has been supported by an ability for nematode larvae to undergo developmental arrest in response to environmental stimuli. Termed dauer, this pathway and the signalling pathways that regulate it are well described in the free-living nematode *Caenorhabditis elegans*, but little is known in other nematodes. We used the genomes of 22 nematodes, free-living and parasitic to discover if these signalling pathways are conserved.

We found a complex pattern of conservation at both the pathway and gene level. Two of the four pathways are broadly conserved across the phylum. The co-option of the other two pathways occurred more recently, at different points towards the *C. elegans* lineage. Lineage-specific duplications were prevalent in many genes. Together, these data advocate for modifications of signalling pathways, leading to behavioural changes that support the transition to parasitism.

**NICOLE B WEBSTER** AND A. RICHARD PALMER

University of Alberta

#### **Bridging pattern and process: How do snails grow shell sculpture?**

##### **Entre motif et mécanisme: comment les escargots sculptent-ils leurs coquilles?**

Mollusc shells are a prime example of "endless forms most beautiful" and exhibit many diverse and complicated patterns. Shells are formed by the mantle, which lines the opening of the shell (aperture), secreting the necessary components for biomineralization. Malacologists have catalogued these shell patterns, and have made great strides in understanding the molecular processes involved in calcium carbonate secretion. However, nothing is known about how the process of shell secretion is modified to yield different patterns of shell sculpture. Here we work to answer: What aspect of the mantle change to produce different shell sculpture? *Nucella ostrina* has plastic shell sculpture, varying from strong spiral ribs to a smooth shell. Examining the mantle of ribbed and smooth snails using histology, 3d reconstructions, and immunohistochemistry, we show

that changes in the dimensions of the mantle epithelium and enzymatic expression patterns correlate with the placement of spiral ribs in *N. ostrina*.

**ALYSSA M. WEINRAUCH**, ALEXANDER M. CLIFFORD, AND GREG G. GOSS

University of Alberta

**Intestinal glucose transport in the Pacific Hagfish, *Eptatretus stoutii***

**Transport intestinal de glucose chez la myxine du Pacifique, *Eptatretus stoutii***

Hagfish occupy a unique feeding niche in which they feed on both live prey and decaying carcasses. Aside from recent evidence that hagfish can obtain nutrients via the skin, little work has been conducted on nutrient uptake. The hagfish intestine is a straight tube with little variation along the hindgut. We hypothesized that glucose uptake would be similar along its length. Labelled  $^{14}\text{C}$  glucose flux rates averaged  $0.318 \text{ nmol/cm}^2/\text{h}$  in the hindgut with no significant differences along the length, although values in the foregut varied widely. Bioinformatic analysis revealed three sodium-linked glucose transporters (SGLT) and a glucose transporter (GLUT) homologue. Pharmacological inhibition of SGLTs (phlorizin) and GLUTs (phloretin) resulted in glucose flux inhibition when used in conjunction but inhibition was not observed when each drug was used separately. This suggests a functional redundancy of glucose uptake mechanisms in the hagfish hindgut.

**JAMES WHALE**, ROBERT SHADWICK

University of British Columbia

**Thunniform locomotor strategies across three major taxa**

**Stratégies locomotrices des thunniformes dans trois groupes taxonomiques majeurs.**

Resources in the open ocean are few and far between, forcing apex predators to traverse vast distances in search of food. This strong selective pressure to become fast and efficient swimmers has resulted in a convergence of body plans and swimming styles in the apex predators of the open ocean – tuna, lamnid sharks, and whales – despite widely separated evolutionary pathways with unique biological constraints. This study will explore the ways in which these three taxa have developed novel morphological and biomechanical adaptations to succeed the challenge of fast, efficient swimming. All three taxa isolate thrust production to the tail, allowing us to use tail models oscillated in a water tunnel to determine thrust and efficiency. We can then compare the performance of each group, relative to kinematics, tail shape and tail composition. Such information can also be used to develop better autonomous underwater vehicles.

**OANA BIRCEANU AND MICHAEL P. WILKIE**

Wilfrid Laurier University

**The effects of routine lampricide treatment on the stress physiology of a non-target fish: the rainbow trout (*Oncorhynchus mykiss*).**

**Effets de traitements fréquents de lampricide sur la physiologie du stress d'un poisson non-recherché: la truite arc-en-ciel (*Oncorhynchus mykiss*)**

The lampricide 3-trifluoromethyl-4-nitrophenol (TFM) is applied to streams containing larval sea lampreys (*Petromyzon marinus*), which prey on economically important fishes in the Great Lakes. Although non-target mortality seldom occurs, the sub-lethal effects of

lampricide treatments are not entirely understood. We tested the hypothesis that TFM applications affected the stress physiology of a representative non-target fish, the rainbow trout. Trout were exposed to the  $12 \text{ h LC}_{99.9}$  of larval lamprey for 9 h, to mimic a routine TFM treatment, and allowed to recover overnight. The next day a chasing stressor was applied, resulting in no mortalities or visible pathophysiological symptoms. However, TFM-exposed fish had elevated plasma cortisol prior to the stressor compared to controls, and cortisol remained elevated for 24 h following stress. Although plasma lactate was not impacted by lampricide exposure, the cortisol data suggests that TFM may impair the metabolic capacity of rainbow trout in the days following treatments.

**MICHAEL E. WONG**, JEFF J. HAVIXBECK, AJA M. RIEGER, KEITH B. TIERNEY, DAN R. BARREDA

University of Alberta

**The impact of behavioural fever on the modulation of immunity in teleost fish.**

**Impact de la fièvre du comportement sur la modulation de l'immunité chez les poissons téléostéens.**

Fever is known to increase pathogen clearance, however it is unclear how immune responses are modulated by febrile conditions. Unlike mammals, some ectotherms exhibit a 'behavioural' fever by actively seeking environmental warmth. To study the impact of thermoregulation on innate immunity, a zymosan-induced peritonitis model was used in goldfish (*Carassius auratus*) in conjunction with a specially designed temperature preference apparatus. Quantitative behavioural analysis identified a distinct period of high temperature preference accompanied by signs of lethargy in challenged, but not control fish. The strict regulation of this behaviour was accompanied by an early increase in pro-inflammatory cytokines IL-1 $\beta$ , TNF- $\alpha$  and CXCL-8 expression. Further, we also observed rapid leukocyte infiltration into the inflammatory site. Notably, infiltrating leukocytes displayed a reduced capacity to produce ROS and returned rapidly to basal numbers. This suggests that behavioural fever allows for increased efficiency in the induction and regulation of inflammatory responses in teleost fish.

**CHRIS M. WOOD AND MARTIN GROSELL**

University of Miami

**Electrical aspects of the osmorepiratory compromise in the euryhaline killifish**

**(*Fundulus heteroclitus*)**

**Aspects électriques du compromis osmorepiratoire chez les cyprinodontidés euryhalins (*Fundulus heteroclitus*)**

The osmorepiratory compromise, the trade-off between the requirements for respiratory and ionoregulatory homeostasis at the gills, becomes more intense during environmental hypoxia. One aspect which has been previously overlooked is possible transepithelial potential (TEP) change caused by hypoxia which will influence branchial ionic fluxes. Using the euryhaline killifish, we show that acute hypoxia reduces the TEP across the gills by approximately 10 mV in animals acclimated to both fresh water (FW) and sea water (SW), with a higher PO<sub>2</sub> threshold in the former. TEP becomes negative in FW, and less positive in SW. The effects are immediate, stable for at least 3 h, and reverse immediately upon return to normoxia. Hypoxia also blocks the normal increase in TEP that occurs upon FW to SW transfer, but does not reduce the fall in TEP which occurs in the opposite transfer. Possible consequences of these effects will be discussed (NSERC Discovery, NSF).

**Fry Lecture Abstract / Résumé de la conférence Fry**

**PATRICIA A WRIGHT**

University of Guelph

**Living on the edge – The physiology of amphibious fish in and out of water**

Most physiological processes are affected by the environment in which animals live. Truths: water is viscous and dense, O<sub>2</sub> moves slower in water and is less soluble than in air, water conducts heat faster than air, and water availability prevents desiccation. Consequences: amphibious animals moving between air and water must have a high degree of morphological and physiological plasticity to cope with the dramatically different physicochemical differences between air and water. Lab and field studies in the amphibious mangrove fish *Kryptolebias marmoratus* have revealed remarkable mechanisms of reversible plasticity across multiple systems (respiratory, osmoregulatory, excretory, musculo-skeletal, thermal balance). Some of these plastic responses in amphibious fishes parallel evolutionary changes that have occurred in terrestrial vertebrates, but other traits are unique. Living on the edge has advantages, amphibiousness has evolved multiple times over the history of life on our planet. ([return/retour](#))

**La vie à la limite – physiologie des poissons amphibiens dans et hors de l'eau**

La plupart des processus physiologiques sont affectés par l'environnement dans lequel les animaux vivent. Les vérités: l'eau est visqueuse et dense, O<sub>2</sub> se déplace plus lentement dans l'eau et est moins soluble dans l'eau que dans l'air, l'eau conduit la chaleur plus rapidement que l'air et la disponibilité de l'eau empêche la dessiccation. Les conséquences: les animaux amphibiens qui se déplacent entre l'air et l'eau doivent avoir un haut degré de plasticité morphologique et physiologique pour faire face aux conditions physico-chimiques qui diffèrent entre l'air et l'eau. Des études en laboratoire et sur le terrain avec le poisson amphibie des mangroves, *Kryptolebias marmoratus*, ont mis en évidence des mécanismes de plasticité remarquables au niveau de plusieurs systèmes (respiratoire, osmorégulatoire, excréteur, musculo-squelettique, équilibre thermique). Certaines de ces réponses chez les poissons amphibiens correspondent aux changements évolutifs qui ont eu lieu chez les vertébrés terrestres, mais d'autres traits sont uniques. La vie sur le fil du rasoir présente des avantages, le mode amphibie est apparu à de multiples reprises au cours de l'histoire de la vie sur notre planète. ([return/retour](#))

**PATRICIA A WRIGHT**

University of Guelph

**Many moons ago: Insights into the biochemical and physiological pathways that enable fish to thrive in extreme environments**

**Aperçus sur les voies biochimiques et physiologiques qui permettent aux poissons de prospérer dans les environnements extrêmes.**

An early grounding in enzyme kinetics and glucose metabolism in Tom Moon's lab led me on a quest to understand the biochemical and physiological pathways that enable fish to thrive in extreme environments. I will share three research stories inspired by my training in Tom Moon's lab. 1) The tilapia, *Alcolapia grahami*, that live at pH 10 in Lake Magadi, Kenya synthesize urea by the ornithine-urea cycle. 2) Teleost embryos live in a cloistered environment and they rely on the ornithine-urea cycle to convert potentially toxic ammonia to urea. 3) Some non-estivating amphibious fish remain out of water for weeks and survival depends on reducing metabolic rate and activity, while carefully managing fuel reserves. Our aim is to identify the traits that enhance survival out of water in amphibious fishes and determine the underlying mechanisms to understand more about the evolution of terrestriality.

**JIASONG XIE AND MIODRAG BELOSEVIC**

University of Alberta

**Functional characterization of receptor-interacting serine/threonine kinase 2 (RIP2) of the goldfish (*Carassius auratus* L.)**

**Caractérisation fonctionnelle du "receptor-interacting serine/threonine kinase 2" (RIP2) du poisson rouge (*Carassius auratus* L.)**

In mammals, RIP2 functions as a key signaling protein in host defense responses induced by activation of the cytosolic pattern



recognition receptors (PRR) Nod1 and Nod2 via CARD-CARD interactions. In this study, we report on the functional characterization of RIP2 of the goldfish. Quantitative expression analysis of goldfish RIP2 revealed the greatest mRNA levels in the spleen, monocytes and splenocytes. Treatment of goldfish macrophages with LPS, PGN, MDP, Poly I:C, heat-killed and live *Mycobacterium marinum*, and heat-killed *Aeromonas salmonicida* differentially changed the expression of RIP2 at both mRNA and protein levels. Co-immunoprecipitation assays indicated that RIP2 interacted with Nod1 and Nod2 receptors in eukaryotic cells. The dual luciferase reporter assay revealed that RIP2 over-expression resulted in the activation of the NF- $\kappa$ B signal pathway. In addition, RIP2 was involved in the regulation of the production of TNF $\alpha$ -2 and IL-1 $\beta$ 1 in goldfish macrophages exposed to *M. marinum*.

**JULIA M YORK**, BEVERLY CHUA, WILLIAM K MILSOM  
University of British Columbia

**Pulmonary mechanics and air sac morphology of bar-headed geese.**

**Mécanique pulmonaire et morphologie des sacs d'air chez les oies à tête barrée.**

Bar-headed geese migrate biannually over the Himalayas sustaining aerobic flight at altitudes above 5000 meters where oxygen levels are approximately half that of sea level. During exposure to hypoxia, bar-headed geese primarily increase tidal volume to increase respiration, whereas related species that migrate at low-altitudes primarily increase breathing frequency. Based on this, we hypothesized that bar-headed geese should have a more compliant respiratory system to accommodate deeper breathing without significantly increasing the cost of breathing. We found that while static compliance was not different between the species, bar-heads had higher dynamic compliance. Importantly, the work required to overcome flow resistive forces was similar in both species, but the work required to overcome elastic forces was much lower in the bar-heads, indicating that they probably have a more flexible chest wall. Analysis of CT scan of both species is now being used to investigate possible underlying differences in respiratory morphology.

**HILLARY YOUNG** .

University of California, Santa Barbara

**Cascading effects of defaunation on zoonotic disease across scales and environmental contexts**

**Effets en cascade de la défaunation sur les maladies zoonotiques à différentes échelles et dans différents contextes environnementaux.**

Humans are driving pervasive declines in populations of wildlife around the globe, often with disproportionate effects on animals with large body size. This process of defaunation can lead to marked changes in structure, composition, and ecology of the affected communities. Here we explore the extent to which large wildlife loss and associated land-use change in East Africa leads to predictable effects on a critical ecosystem service, control of zoonotic diseases. We look at this relationship across multiple scales, and find that while there are strong and predictable effects of defaunation on zoonotic disease at the plot level, these results vary strongly across the broader landscape. This variation appears to be tightly linked to regional climate variation, suggesting strong potential for interaction of climate change and defaunation on disease prevalence in this region.

**MEGAN ZAK**, LORI MANZON, MATTHEW AGEE, DANIEL STEFANOVIC, DOUG BOREHAM, CHRISTOPHER SOMERS, JOANNA WILSON AND RICHARD G. MANZON

Department of Biology, University of Regina, Regina, Saskatchewan, Canada

**Intensity of heat shock response is reduced in Lake Whitefish (*Coregonus clupeaformis*) acclimated to temperatures above or below thermal optimum**

**L'intensité de la réaction au choc thermique est réduite dans les grand corégones (*Coregonus clupeaformis*) acclimatées aux températures en dessous et en dessus de l'optimum thermal.**

Expression of heat shock proteins (HSPs) is a universal response to temperature stress in most organisms, including fish. The purpose of this study was to determine the effects of temperature acclimation on the heat shock response (HSR), by quantifying changes in HSP protein and mRNA expression, in Lake Whitefish (*Coregonus clupeaformis*), a cold-water species. Fish were acclimated to 6°C, 12°C or 18°C for several months and exposed to a variety of 1 h heat shocks. Both mRNA expression and protein data indicated the magnitude of the HSR varied with acclimation temperature. Expression of HSP70 and other inducible HSPs was upregulated to a greater extent in fish acclimated to 12°C than in 6°C or 18°C acclimation groups. This subdued HSR in Lake Whitefish living outside their thermal optimum (11°C - 13°C) suggests a reduced capacity or need to respond to thermal stress, perhaps as a result of elevated constitutive HSPs.

**YANGFAN ZHANG**, FLORIAN MAUDUIT, SVEN M JORGENSEN, GERRIT TIMMERHAUS, TORSTEIN KRISTENSEN, GUY CLAIREAUX, ANTHONY P FARRELL, HARALD TAKLE.

The University of British Columbia

**Aerobic swimming performance and its relationship to indicators of metabolic rate and hypoxia tolerance in wild and domestic Atlantic salmon (*Salmo salar* L.)**

**Performance de nage aérobique et son lien aux indicateurs de taux métabolique et de tolérance à l'hypoxie chez les saumons de l'Atlantique sauvages et domestiques (*Salmo salar*, L.)**

Since all activities of a fish consume oxygen, there is considerable interest in the relationships between various indicators metabolic performance. Here, we used an endurance swim test to screen a single strain of wild and cultivated Atlantic salmon

parr (N=480 fish each) into the superior (N=48) and inferior (N=43) swimmers after they had been reared to this size under identical conditions (only an 8% range for body size). These screened fish were then either exercise-trained (maintaining station in water velocity of  $\sim 2.5$  body length  $s^{-1}$ ) for 3 weeks or left untrained. We will report data on the subsequently estimates of standard metabolic rate, maximum metabolic rate, aerobic scope, excess post-exercise oxygen consumption and hypoxia tolerance for the 8 test groups (2 x 2 x 2 design). These results tested our hypothesis that better performance in a screening swimming is related to a higher capacity to supply oxygen during exercise.

Puisque toutes les activités des poissons consomment de l'oxygène, il y a un intérêt considérable pour les relations des indicateurs de performance métabolique. Nous avons utilisés un test d'endurance de nage pour séparer une lignée de parr de saumon Atlantique sauvage, et d'élevage (N=480 pour chaque groupe) en nageurs supérieurs (n=48) et inférieurs (n=48) après avoir été élevés dans des conditions identiques (seulement 8% de marge en taille). Les différents catégories de poissons ont été soit entraînés (gardent la même position à une vitesse de 2,5 longueurs corporelles  $s^{-1}$ ) pendant 3 semaines, soit sans entraînement. Nous allons récupérer des données sur le taux métabolique standard, le taux métabolique maximale, le registre aérobie, consommation d'oxygène post exercice et tolérance à l'hypoxie pour les 8 groupes (façonnée 2 x 2 x 2). Ces résultats ont testé notre hypothèse qu'une meilleur performance de nage est liée à une capacité plus importante de fournir de l'oxygène pendant un effort physique.

**YUEYANG ZHANG**, JENNIFER LOUGHERY, CHRIS MARTYNIUK AND JAMES KIEFFER

University of New Brunswick

#### **The physiological and molecular responses of shortnose sturgeon to thermal stress**

##### **Réactions physiologiques et moléculaires des esturgeons à museau court au stress thermique**

Quantifying a species thermal tolerance is critical to assessing the biological impacts of anticipated increases in temperature (e.g., climate change). The shortnose sturgeon, *Acipenser brevirostrum*, is a threatened species that exists along the eastern coast of North America. They can be exposed to temperatures ranging from freezing to above 25°C. However, there is a limited amount of research on their thermal biology and related molecular responses. Using heating rates of 0.1°C/min, 0.2°C/min and 0.25°C/min, CTMax, oxygen consumption rate and associated molecular responses of shortnose sturgeon (~150g) were determined. The overall CTMax and oxygen consumption rates of shortnose sturgeon were not significantly affected by heating rate. However, oxygen consumption rates followed temperature changes. The results from qPCR showed no significant molecular responses to thermal stress.

**ALEX ZIMMER**, PAT WRIGHT, CHRIS WOOD

McMaster University

#### **The role of ammonia excretion in driving gill ontogeny in early life stage fish**

##### **Rôle de l'excrétion d'ammoniac dans l'ontogénèse des branchies chez les poissons en stade précoce de l'existence.**

The ontogenetic pressures driving gill development in larval fish have been debated for > 70 years. August Krogh first hypothesized that cutaneous respiration, which accounts for the majority of oxygen uptake in post-hatch fish, becomes limited over developmental time such that gill ontogeny is driven by oxygen demand. However, more recent evidence demonstrates that the earliest gill function is ionoregulation, rather than gas exchange. We further demonstrated that in rainbow trout,  $Na^+/NH_4^+$  exchange represents one of the earliest gill functions. Therefore, ammonia excretion might drive gill ontogeny. Recently we found that the temporal transition from cutaneous to branchial ammonia excretion is unaltered by rearing larval trout in high [NaCl] (60 mmol/l), suggesting that the demand for ammonia excretion drives the ontogeny of branchial  $Na^+/NH_4^+$  exchange. Therefore, we present the "ammonia hypothesis" which posits that the earliest gill function is ammonia excretion facilitated by the  $Na^+/NH_4^+$  exchange metabolon. (NSERC Discovery).

<b><u>PRESENTER</u></b>	<b><u>SESSION</u></b>	<b><u>PRESENTER</u></b>	<b><u>SESSION</u></b>
ABBASI, ROOHOLLAH	CMD G3	COATSWORTH, HEATHER	PIE A1
ABOUHEIF, EHAB	EEE/CPB G2	COGLIATI, KAREN	EEE E1, P5
ALDERMAN, SARAH	CPB E2, P1	COSMAN, MIRANDA	P62
ALLEN, BRANDON	EEE E1	CRAIG, PAUL	CPB B3
AMAT, CHRISTINA	PIE SYM	CRÉMAZY, ANNE	P88
ANDERSON, GARY	P64	CULLEN, JOSHUA	P31
ANTHONY, SUSAN	P87	CURRAN, DAVID	P81
ARNOTT, SHELLEY	EEE SYM	DAS, CHINMAYEE	P61
BAKER, DANIEL	CPB E2	DAWSON, NEAL	P60
BAKER, SHERIDAN	P86	DECK, COURTNEY	P80
BANNATYNE, TRAVIS	EEE B4	DEMPSEY, ZACH	EEE B4
BARRY, TEGAN	CMD A2, CMD F3	DESANTIS, LANNA	CPB D2
BAUER, AARON	CMD C4	DEWEERD, LIS	P59
BECK, MELISSA	HOAR	DINDIA, LAURA	CPB F1
BÉLAIR-BAMBRICK, MARIE-ÈVE	P85	DIXON, BRENT	PIE H1
BEST, CAROL	P63	DIXON, BRIAN	WARD
BLACK, IAN	EEE B4	DOS-SANTOS, EDNEI	P79
BLAIR, SALVATORE	CPB D3	DOWNIE, ADAM	P90
BLEWETT, TAMZIN	CPB F1	DRIEDZIC, WILLIAM	CPB B3
BOWLES, ELLA	EEE B4	DUCLOS, KEVIN	CMD A2
BRIDGEMAN, JUSTIN	EEE/CPB G2	DUDECK, BLAIR	EEE/CPB G2
BROOKS, BRYAN	LOC SYM	DZAL, YVONNE	CPB G1
BROWN, CALEB	CMD D4	EME, JOHN	CPB B1
BRUBACHER, JOHN	CMD H4	EMERMAN, JOSHUA	CPB D3
BUCKLAND-NICKS, JOHN	CMD G3, P91	FABBRI, ELENA	CPB SYM
CALLAGHAN, NEAL	CPB D2	FAUGHT, ERIN	CPB D2
CAMPBELL, JAMES	CMD D4	FEHSENFELD, SANDRA	CPB C3
CARLSSON, ANJA	P4	FERGUSON, LAURA	PIE A1
CARON, JEAN-BERNARD	CMD SYM	FERRARO, SHANNON	CPB B2
CARROLL, EMMA	P84	FINDLAY, STEPHANIE	P78
CARTAR, RALPH	EEE/CPB G2	FINNEY, CONSTANCE	PIE SYM
CASSIDY, ALICIA	CPB C2	FOLKERTS, ERIK	P76
CHAUDHRY, UMER	PIE H1	FOSTER, KATHLEEN	HOAR
CHEN, ZHONGQI	CPB B1	FOURNIER, ISABELLE	CPB F1
CHIN, HILARY	P83	FRAZ, SHAMAILA	P75
CHOI, KEVIN	CPB F2	FUNG, CHARISSA	CMD H4
CHOW, SYLVIA	P6	GAUDRY, MICHAEL	P74
CIBOROWSKI, JAN	EEE SYM	GAUTHIER, PATRICK	CPB F1
CLIFFORD, ALEXANDER	HOAR	GIACOMIN, MARINA	CPB C3

<b>PRESENTER</b>	<b>SESSION</b>	<b>PRESENTER</b>	<b>SESSION</b>
GIESY, JOHN	LOC SYM	KAJI, TOMONARI	CMD G3
GIL, KELSEY	CMD H4	KALUTHOTA, CHINTHAKA	P66
GILBERT, MATTHEW	CPB B1	KATZENBACK, BARBARA	P55
GILLIS, TODD	CPB G1	KERR, KECIA	EEE E1
GILMOUR, KATHLEEN	CPB B3	KERR, MEGHAN	PIE C1
GOATER, CAMERON	PIE D1	KIDD, KAREN	LOC SYM
GOMEZ, CRISOSTOMO	P73	KOPRIVNIKAR, JANET	PIE A1
GORDY, MICHELLE	PIE H1	KOVACEVIC, NIKOLINA	PIE A1
GRAY, JACK	EEE/CPB G2	KWONG, RAYMOND	CPB D3
GRIGG, NATHAN	P72	LACHOWSKY, LEANNA	EEE E1
HAGERMAN, GORDON	P58	LAGUE, SABINE	HOAR
HALLGRIMSSON, BENEDIKT	CMD C4	LANNOO, MICHAEL	EEE SYM
HANINGTON, PATRICK	PIE SYM	LAU, GIGI	HOAR
HANS, STEPHANIE	P71	LEAL, FRED	P53
HARRISON, GRANT	EEE E1	LEBENZON, JACQUELINE	P65
HARTER, TILL	CPB E2	LEE, JONATHON	P52
HATEF, AZADEH	CPB F2	LEMOINE, CHRISTOPHE	CPB C3
HAVIXBECK, JEFFREY	PIE SYM	LESOWAY, MARYNA	CMD G3
HEEREMA, JODY	P70	LEWIS, ZACHARY	CMD F3
HEFFELL, QUENTIN	CPB D3	LEYS, SALLY	CMD SYM
HENDERSON, DONALD	CMD D4	LILLICO, DUSTIN	PIE A1
HEYLAND, ANDREAS	CMD G3	LIM, MICHAEL	P51
HIGHAM, TIMOTHY	CMD SYM	LISSER, DAVID	CPB D2
HONTELA, ALICE	LOC SYM	LOPES, FERNANDO	P50
IRITANI, DAVIS	P57	LOWENBERGER, CARL	PIE A1
JAMNICZKY, HEATHER	CMD F3	LUEK, ANDREAS	P49
JAMWAL, ANKUR	P56	LUONG, LIEN	P48
JANZ, DAVID	CPB F1	LUQUE, JAVIER	CMD A2
JEFFREY, JENNIFER	CPB H3	LUTEK, KEEGAN	CMD G3
JENKIN, SARAH	CPB B2	LYONS, KADY	CPB F1
JOHANSSON, ORA	CPB G1	MA, YANJU	P47
JOHNSTON, CHRISTINA	CPB F1	MACCORMACK, TYSON	CPB E2
JOHNSTON, ELIZABETH	CPB H2	MACKELLAR, SARA	P46
JONES, JENNA	P69	MADDIN, HILLARY	CMD C4
JONES, LAUREN	P68	MANCHESTER, CODY	CPB B2
JUNG, HYEWON	CPB H2	MANDIC, MILICA	CPB G1
KAAS, MARTEN	P67	MANEK, ADITYA	CPB H3, P45
KABORE, ALETHE	PIE C1	MANKO, ANNA	PIE C1
KAHN, AMANDA	CMD A2	MANZON, RICHARD	CPB H3

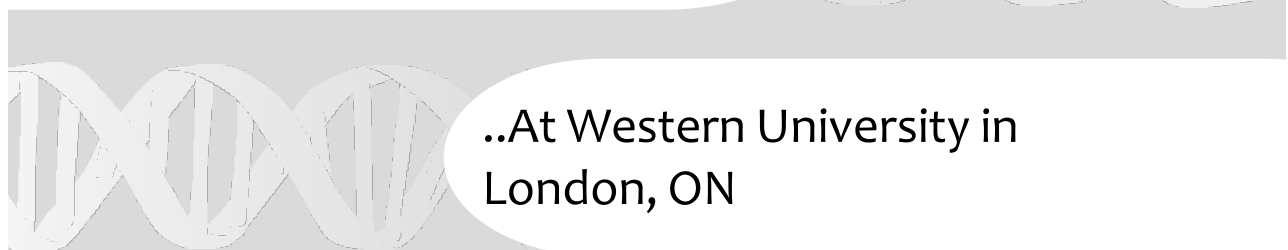
<b><u>PRESENTER</u></b>	<b><u>SESSION</u></b>	<b><u>PRESENTER</u></b>	<b><u>SESSION</u></b>	<b><u>PATEL,</u></b>
MARASCO, KAITLIN	P44	DIVYANG	CPB C2	
MARCHANT, JAMES	CPB H2	PEMBERTON, JOSHUA	CPB C2, P35	
MARCHINI, MARTA	CMD G3	PERALTA-VAZQUEZ, HAYDEE	P11	
MARLATT, VICKI	CPB SYM	PERRAULT, KERRY	EEE E1	
MARSHALL, KATIE	CPB B1	PERRY, ALEXANDER	P14	
MATHERS, KATE	CPB C2	PERRY, STEVE	CPB B3	
MATHESON, DERRICK	P43	PHAM-HO, PHILLIP	P34	
MAY, LINDSAY	CPB B2	PHILIBERT, DANIELLE	P15	
MCBRYAN, TARA	CPB B1	PHILLIPS, NATALIA	PIE H1	
MCDUGALL, PETRA	P41	PILA, EMMANUEL	PIE C1	
MCFARLANE, SARAH	CPB C2	PRICHARD, ROGER	PIE SYM	
McKAY, DEREK	PIE SYM	PYLYPIW, JENNIFER	P54	
MCKINNON, ALEXANDER	CPB B1	QUIJADA-RODRIGUEZ, ALEX	CPB C3	
MCMILLAN, GLYN	P40	RAJAKUMAR, RAJENDHRAN	CAM	
MCMILLAN, OLIVIA	EEE/CPB G2	RAMESH, NARESH	P33	
MCPARLAND, CAOIMHE	PIE C1	REDFERN, JULIA	CPB D2	
MIYASHITA, TETSUTO	CMD H4	REGAN, MATTHEW	CPB G1	
MOEHRENSCHLAGER, AXEL ZET		REICHERT, MICHELLE	CPB B2	
MOGHRABI, KAMAL	CPB F1	REID, MARY	EEE E1	
MOHAN, HANEESHA	CPB F2	REIMER, STEPHANIE	PIE H1	
MONAGHAN, RICHELLE	EEE/CPB G2	REYES, JOSE	PIE C1	
MORE-BAYONA, JUAN	P39	RHEAULT, MARK	CPB D3	
MORRIS, MATTHEW	CMD A2	RIZZATO, REBECCA	EEE B4	
MORRISON, PHILLIP	CPB H2	ROBERTS, JORDAN	P21	
MORTAZAVI, SIMA	P3	ROBERTSON, CAYLEIH	P12	
MUELLER, CASEY	CMD G3	ROBINSON, TERIN	PIE D1	
MULDOON, BRED A	CPB H3	RODELA, TAMMY	CPB G1	
MUNRO, DANIEL	CPB C2	ROMANOW, CORA	EEE B4	
MYRKA, ALEX	CPB F2	ROTHWELL, CAILIN	EEE/CPB	G2
NOEL, NICOLE	P38	RUDKO, SYDNEY	P32	
O'DONNELL, MIKE	P13	RUSSELL, ANTHONY	CMD C4	
O'NEIL, NICHOLAS	P2	SACKVILLE, MICHAEL	CPB C3	
OBEROI, VISHESH	CPB F2	SAFI, HAMIDULLAH	CPB H2	
OEL, PHILLIP	P37	SAULNIER, ROXANNE	CPB D2	
ORTEGA, VAN	P19	SCHORNO, SARAH	CMD F3	
PALMER, RICHARD	CMD A2	SCHULTE, PATRICIA	CPB B1	
PARDO, JASON	CMD D4, CMD F3	SCOTT, GRAHAM	CPB G1	
PARKINSON, RACHEL	P10	SEAMONE, SCOTT	HOAR	
PASUPULETI, VENKATA	P36	SHADWICK, ROBERT	CMD H4	

<b><u>PRESENTER</u></b>	<b><u>SESSION</u></b>
SHARTAU, RYAN	CPB E2
SHAYA, LANA	P82
SIEMINSKA, EDYTA	P77
SIGNORE, ANTHONY	CPB E2
SINCLAIR, BRENT	CPB C2
SINNATAMBY, NILO	P20
SKANDALIS, DIMITRI	CMD F3
SMITH, FRANK	P30
SMITH, SARA	P29
SPEERS-ROESCH, BEN	CPB H2
SRIVASTAVA, SHRUTI	P28
STANDEN, EMILY	CPB B2
STEINKEY, DYLAN	P27
STEVENS, DON	P9
STOYEK, MATTHEW	P42
SUBRAMANIAM, MARINA	CPB F2
SULLIVAN, JOSHUA	PIE D1
SUNDARRAJAN, LAKSHMINARA	P26
SUNTRES, TINA	P25
SZOSTAKIWSKYJ, MATT	CMD F3
TATTERSALL, GLENN	P24
THEODOR, JESSICA	CMD D4
TIERNEY, KEITH	BOUT
TINIUS, ALEXANDER	CMD H4
TOTH, CAMERON	P92
TOXOPEUS, JANTINA	P23
TREBERG, JASON	CPB B3
TRITES, MICHAEL	PIE D1
TUNNAH, LOUISE	CPB D3, P22
TURKO, ANDY	CPB B2
TZANEVA, VELISLAVA	CPB E2
VANDERZWAN, STEVI	EEE E1
VANPARIDON, BRADLEY	PIE H1
VARELA, BRANDON	EEE E1
VICKARYOUS, MATT	CMD C4
VIJAYAN, MATT	CPB SYM
VO, NGUYEN	P7
WALL, NASTASHYA	CPB B1
WALSH, PATRICK	CPB B3

<b><u>PRESENTER</u></b>	<b><u>SESSION</u></b>
WALTERS, BENJAMIN	EEE B4
WASMUTH, JAMES	PIE D1
WEBSTER, NICOLE	CMD A2
WEIHRAUCH, DIRK	P89
WEINRAUCH, ALYSSA	CPB F2
WHALE, JAMES	CPB B2
WILKIE, MICHAEL	CPB B3
WONG, MICHAEL	PIE A1
WOOD, CHRIS	CPB B3
WRIGHT, PATRICIA	CPB SYM, FRY
XIE, JIASONG	PIE A1
YAKUBOWSKI, JASMINE	P18
YEW, HONG	P17
YORK, JULIA	CPB G1
YOUNG, HILLARY	EEE SYM
ZAK, MEGAN	CPB H3
ZARE, AVA	P8
ZHANG, YANGFAN	CPB E2
ZHANG, YUEYANG	CPB H3
ZIMMER, ALEX	CPB C3
ZWOZDESKY, MYRON	P16



Save the date for our next meeting..

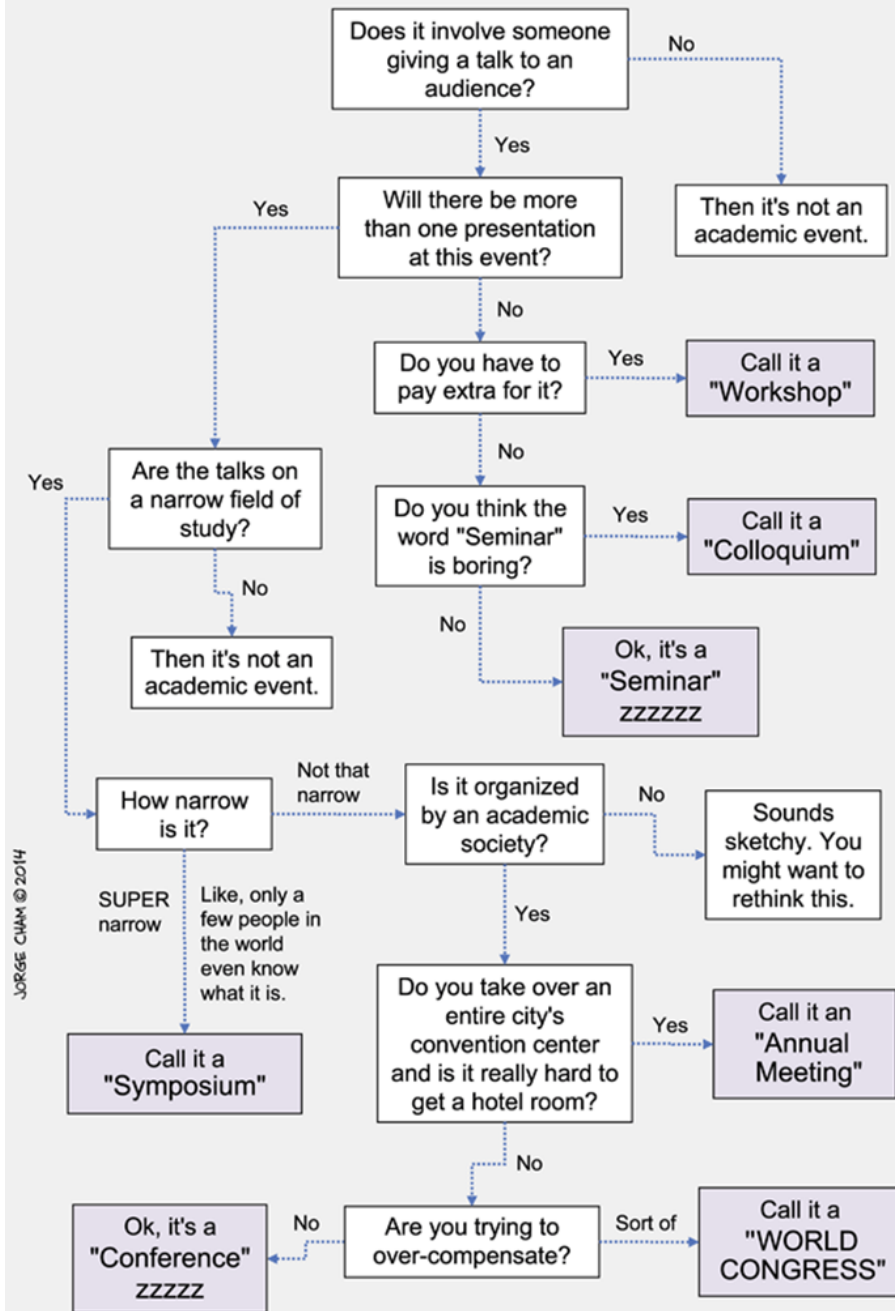


..At Western University in  
London, ON

**See you there May 8-13<sup>th</sup>, 2016!**

Visit [www.csz-scz2016.com](http://www.csz-scz2016.com) for details

# What to call your Academic Event:



"Piled Higher and Deeper"  
By Jorge Cham  
[www.phdcomics.com](http://www.phdcomics.com)  
with permission

WWW.PHDCOMICS.COM



	Monday May 25	Tuesday May 26	Wednesday May 27	Thursday May 28	Friday May 29
<b>Start Time</b>					
7:30					
8:00				<b>Parallel Sessions G (7:30-9:30)</b> LOC symp: Healthy Ecosystems / MacA	
9:00	<b>Council Meeting (9:00-2:30 Escalus)</b>	<b>Parallel Sessions A (8:00-10:00)</b> CPB symp: Tribute to Dr. Tom Moon / MacA EEE symp: Landscape Disturbances / Escalus PIE A1: Pathoges - disease & immunity I / TES CMD A2: Insights from Morphology I / Cassio	<b>Parallel Sessions E (8:00-10:00)</b> PIE symp: Host-parasite Interactions / Escalus CMD symp.: Ten years of the triple helix / MacA EEE E1: Ecology - Environmental impacts / TES CPB E2: Metab. I - blood, gas, acidbase / Cassio	CPB G1: Living in Hypoxia / Cassio EEE/CPG G2: Learning and Behaviour / Escalus CMD G3: Reproduction and Development / TES	
9:30		CMD A2: Insights from Morphology I / Cassio	CPB E2: Metab. I - blood, gas, acidbase / Cassio	Coffee (9:30-10:00, MacHall Foyer)	<b>Council Meeting</b>
10:00		Coffee (10:00-10:30, MacHall Foyer)	Coffee (10:00-10:30, MacHall Foyer)	<b>Parallel Sessions H (10:00-11:30)</b>	(9:30-12:00, Bianca)
10:30		<b>Parallel Sessions B (10:30-12:30)</b> CPB B1: Thermal Physiology I / MacA CPB B2: Materials, mechanics, moving / Cassio CPB B3: Tribute to Toom Moon cont'd / TES EEE B4: Student symposium / Escalus	<b>Parallel Sessions F (10:30-12:30)</b> Teaching Workshop - Healy classrooms / Escalus CPB F1: Stress 2 - Toxins in the environment/ Cassio CPB F2: Metabolism II - digest,absorp,control / TES CMD F3: Student led - visualize and quantify / MacA	PIE H1: Pathogens - Dist, Diver, Det II / Escalus CPB H2: Thermal Physiology II / MacA CPB H3: Stress 3 - Environment Impact / Cassio CMD H4: Insights from Morphology II / TES	
11:30				<b>CJZ Lunch (11:00-12:30, Last Defence Lounge)*</b> <b>CPB Section Lunch (11:30-12:30, MacHall B)</b> <b>EEE Section Lunch (11:30-12:30, TheDen)</b>	
12:30		<b>AGM Lunch (12:30-2:00, MacHall B)</b>	<b>PIE Section Lunch (12:30-2:00, Bianca)</b> <b>CMD Section Lunch (12:30-2:00, The Den)</b>	<b>Hoar Competition (12:30-2:30, MacHall A)</b>	
2:00		<b>Parallel Sessions C (2:00-3:30)</b>	<b>Wardle Lecture (2:00-3:00, MacHall A)</b>		
2:30	<b>CJZ Workshop (2:30-3:30, Bianca)</b> What do editors expect from reviewers	PIE C1: Pathogens - disease & immunity II / TES CPB C2: Energy and Homeostasis / Cassio CPB C3: Ion Regulation I / MacA CMD C4: Tribute to Dr. Tony Russell / Escalus Coffee (3:30-4:00, MacHall Foyer)	Parasites, Immunity, Environment and back	Coffee (2:30-3:00, MacHall Foyer)	
3:00			Break (3:00-3:30)	<b>Boutilier Lecture (3:00-3:55, MacHall A)</b> How aquatic vertebrates cope with ever changing environments	
3:30	<b>NSERC Info Sessions (3:30-4:30)</b>	<b>Parallel Sessions D (4:00-5:30)</b>	<b>Poster Session &amp; Pizza (3:30-6:00, MacHall Foyer)</b>	<b>Cameron Lecture (3:55-4:50, MacHall A)</b> The developmental basis of caste evolution in ants	
4:00	Research grant information (Cassio) Scholarship information (Escalus)	PIE D1: Pathogens - Dist, Diver, Detec I / Escalus CPB D2: Stress 1 - Response mechanisms / Cassio CPB D3: Ion Regulation II / MacA CMD D4: Morphology in the 4th Dimension / TES	3:30-4:30 Even, 4:30-5:30 Odd	Break (4:50-6:30)	
4:30	<b>Diversity in Sci. Workshop (4:30-5:30, Escalus)</b> A Healthy Workplace: diversity and equity from departmental, faculty and institutional perspectives				
5:30	Break (5:30-6:00)	Break (5:30-6:00)	6PM poster takedown		
6:00	<b>Welcome/Fry Lecture (6:00-7:00, MacHall A)</b>	<b>ZET Lecture (6:00-7:00, MacHall A)</b>	Break (6:00-6:30)		
6:30	Living on the Edge - Physiology of amphib. fish	Saving Endangered Species in Canada and Beyond	<b>Stud/PDF Meet &amp; Greet (6:30-7:30, The Den)</b>	<b>Closing Banquet (6:30-- , MacHall Ballroom)</b>	
7:00	<b>Welcome Reception (7:00-8:30, MacHall Foyer)</b>	<b>ZET Reception (7:00-8:30, MacHall Foyer)</b>	<b>How to be the Best Workshop (7:30-9:00, The Den)</b>		
7:30					
8:30	<b>Social (8:30, The Den)</b>	<b>Social (8:30, The Den)</b>	<b>Social (The Black Lounge)</b>		
				*CJZ lunch begins 30 min before other lunches	