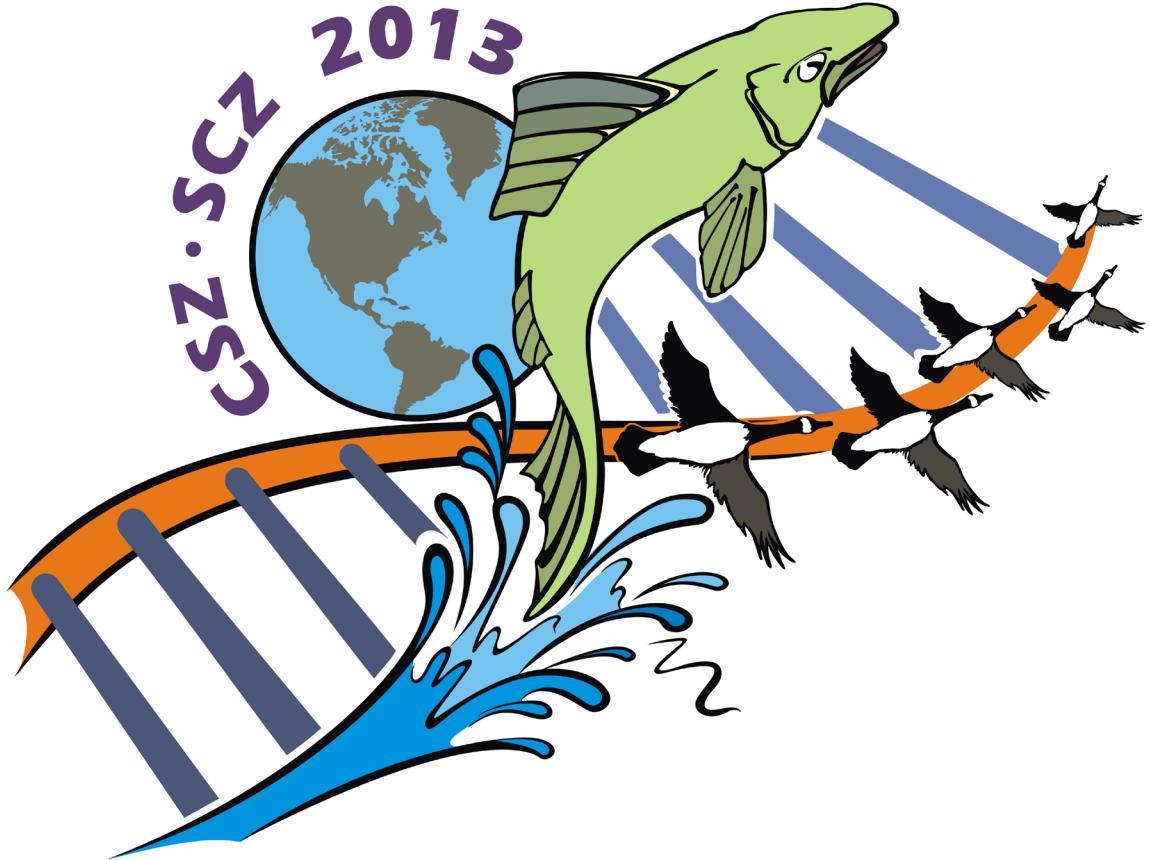


BULLETIN



University of Guelph

13-17 May / 13-17 mai 2013

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/Printemps 2013
Vol. 44, No. 2/ Vol. 44, No. 2



Gordon Street

To Delta Hotel



Legend

1. Rozanski Hall
2. Atrium in the New Science Complex
3. University Center
4. Macdonald Stewart Art Center
5. East Residences
6. Parking (P14 & P15)
7. Gryphon Hockey Arena
8. Road into Arboretum
9. Bus stop to downtown

Places to eat on campus

10. Bullring*
 10. Bob's Dogs
 1. Grad lounge*, 5th floor University Center
 1. Brass Taps*, 2nd floor University Center
 1. Center 6, 1st Floor of University Center
- * = licensed

Abbreviations

- ROZ, Rozanski Hall,
UC, University Center
PCH, Peter Clark Hall



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BULLETIN OF THE CANADIAN SOCIETY OF ZOOLOGISTS

The Bulletin is 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 zoologues 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.

52nd annual meeting of the Canadian Society of Zoologists /

52^{ième} réunion annuelle de la Société Canadienne de Zoologie



May 13-17, 2013 / 13-17 mai, 2013

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52nd annual meeting / 52^{ième} réunion annuelle
May 13-17 / 13-17 mai 2013
University of Guelph

Organizing committee / Comité organizateur

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Dr. Sally Adamowicz
Dr. Nick Bernier
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Ms. Amanda Caskenette
Dr. Doug Fudge
Dr. Fred Laberge
Dr. Amy Newman
Dr. Ryan Norris
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Dr. Glen Van Der Kraak
Dr. Matt Vicaryous
Mr. Mike Wells
Dr. Patricia Wright

We wish to thank the following for their contributions:
Nous remercions pour leur contribution:

The logo for the 2013 CSZ annual meeting was designed by Mr. Ian Smith, University of Guelph.
Photos of the Dairy Bush at the University of Guelph are by Dr. Alex Smith, University of Guelph.

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Message from the Student Councillors/ Message des Conseillers Étudiants

Your CSZ student section is taking steps to reduce the environmental impact of this year's meeting. Student section funds are being used to charter busses to transport all delegates downtown for Wednesday's pubnight as well as to rent reusable dishes for Wednesday's BBQ. Perhaps most importantly, the student section is offsetting the carbon footprint of the meeting through Bullfrog power, who will use these funds to produce renewable energy. Have other great ideas of how CSZ can go green? Contact your student councillors!

Votre section étudiante SCZ veut réduire l'impact environnemental de la conférence annuelle. Des fonds provenant de la section étudiante seront utilisés pour la location de vaisselle réutilisable et d'autobus qui transporteront les conférenciers en ville lors de la nuit au Pub du mercredi. La section étudiante va aussi organiser une compensation carbone avec la compagnie Bullfrog Power, qui utilisera les fonds pour production d'énergie renouvelable. Avez-vous d'autres idées pour permettre à la SCZ d'être plus verte? Communiquez avec vos conseillers étudiants.

Joshua Pemberton and Heath MacMillan

Graduate Student Volunteers/ Volontaires Étudiant Gradué

Andrea Kocmarek	Gillian Martin
Barry Madison	Gustavo Betini
Catherine Ivy	Hanna Peacock
Cayleih Robertson	Jordan Klaiman
Chrissy Rochus	Julia Herr
Connor Warne	Kristina Mikloska
Cory Schilling	Lei Liu
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Fan Zhang	Thanushi Eagalle
Fatima Mitterboek	Tyler Flockhart
Fiona Tsoi	

2013 CSZ Awards / Prix SCZ 2013

Fry Medal Lecture/ Conférence Fry

Dr. Miodrag (Mike) Belosevic, University of Alberta

Life is Pie

La vie c'est PIE

Boutilier Award / Prix Boutilier

Dr. Chris Martyniuk, University of New Brunswick

Generation Omics: Hip or hype for exploration of vertebrate reproduction

Génération Omiques: Exploration de la reproduction des vertébrés physiologie

TWM Cameron Outstanding Ph.D. Thesis Award

Prix TWM Cameron pour la meilleure thèse de doctorat

Dr. Erika Eliason, University of Sydney

Sockeye salmon in hot water: population differences in cardiorespiratory performance and thermal tolerance

Saumon Sockeye dans l'eau chaude: Différentes performance cardio-respiratoire et tolérance thermique entre populations

Wardle Lecture/ Conférence Wardle

Dr. Derek McKay, University of Calgary

Health lessons from the study of host-parasite interactions

Les leçons sur la santé tirées de l'étude des interactions hôtes-parasites



THE T. W. M. CAMERON OUTSTANDING PH. D. THESIS AWARD

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.

T.W.M. Cameron

1. The recipient of the award will be invited to present a lecture on the subject of the dissertation to the Annual General Meeting. He/she will be presented with a commemorative scroll at the time. In order to facilitate attendance of the recipient at the meeting, reasonable expenses for air travel at minimum rates and all accommodation and meals at the meeting will be paid by the Society, up to a maximum of one thousand dollars (\$1,000).
2. (a) For nomination, a thesis must have been accepted at a Canadian University within the year preceding the nomination deadline.
(b) Only one thesis may be nominated by a department, though more than one department in a university may nominate a thesis.
(c) A nominated thesis should be accompanied by a joint letter from the Chair of the Department and the Supervisor indicating their reasons for the nomination.
3. Nominated theses will be examined by three judges chosen from among members of the Society. Theses will be judged on the quality of the science and the quality of the presentation.
4. Please provide three bound copies (hardbound or softbound) of the nominated thesis and supporting letters before **15 August 2012**. Contact the Secretary of the Society or visit the CSZ web site for complete terms of the award.

LE PRIX T. W. M. CAMERON POUR UNE THÈSE DE PH. D. EXCEPTIONNELLE

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.

1. Le gagnant du prix sera invité à donner une conférence sur le sujet de sa thèse lors de la réunion annuelle de la Société. Il recevra alors un parchemin commémoratif. Afin de permettre au récipiendaire d'être présent à la réunion annuelle, une somme maximale de 1000\$ sera allouée par la SCZ pour défrayer les frais de déplacement (billet d'avion, classe économique), les frais de séjour et les repas.
2. (a) Pour être admissible au concours, la thèse doit avoir été acceptée par une université canadienne durant l'année précédant la date limite de mise en candidature.
(b) Un département ne peut présenter qu'une seule thèse au concours, mais plusieurs départements d'une même université peuvent soumettre une thèse.
(c) Chaque thèse présentée doit être accompagnée d'une lettre signée par le directeur de département et le directeur de thèse de l'étudiant expliquant pourquoi la thèse a été sélectionnée.
3. Les thèses seront examinées par trois juges choisis parmi les membres de la Société. Les thèses seront jugées d'après deux critères: la qualité scientifique et la qualité de la présentation.
4. Veuillez fournir trois copies reliées de la thèse (reliure rigide ou cartonnée) et des lettres d'accompagnement **au plus tard le 15 août 2012** au président du comité pour le prix Cameron. Informations supplémentaires relatives à ce prix: contacter le secrétaire de la Société ou consulter notre site Web



William Hoar

Hoar Award: The Hoar Award (named in honour of William S. Hoar, founding member) is given for the best student paper presented orally at the Annual Conference of the Society, and is intended to encourage research and communication by students.

Prix Hoar : Le prix est remis à l'étudiant 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 étudiants et la présentation de leurs résultats.



Helen Battle

Helen Battle Award: The Helen Battle Award (named in honour of Helen I. Battle; founding member and President, 1962-1963) is given for the best student poster at the Annual Conference of the CSZ and is intended to encourage and acknowledge excellence in scientific research and communication.

Prix Helen Battle : Le prix Helen Battle est remis à l'étudiant qui présente la meilleure affiche lors du congrès annuel de la Société canadienne de zoologie. Le prix Helen Battle a pour but d'encourager les étudiants à exceller dans leurs travaux de recherche ainsi que lors de la présentation de leurs résultats.

Section Awards



George Holeton

George F. Holeton Award: The Holeton Award is given for the most outstanding student poster presentation in Comparative Physiology and Biochemistry.

Prix George F. Holeton : Prix donné pour la meilleure affiche d'un étudiant de la Section Physiologie et Biochimie Comparée.



Brian Hall

Brian K. Hall CMD Award: The Hall Award is given for the best oral presentation by a student on a topic in Comparative Morphology and Development.

Prix Brian K. Hall MDC : Prix donné à la meilleure présentation orale donnée par un étudiant sur un sujet touchant à la Morphologie et Développement Comparés lors du congrès annuel.



Cas Lindsey

Cas Lindsey Award: The Cas Lindsey Book Prize is awarded for the best student presentation (oral or poster) within the fields of behaviour, ecology or evolution.

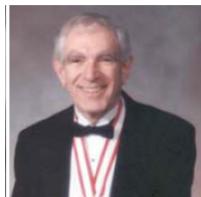
Prix Cas Lidsay : Le Prix Cas Lindsey de la section d'écologie, d'éthologie et d'évolution est destiné à l'étudiant qui a présenté la meilleure communication ou la meilleure affiche dans l'un des domaines suivants: comportement, écologie ou évolution.



Murray Fallis

Murray Fallis Award: The Fallis Award is given for the best student oral presentation in Parasitology.

Prix Murray Fallis : Prix pour la meilleure présentation orale donnée par un étudiant-chercheur dans le domaine de la parasitologie au cours de l'Assemblée générale annuelle.



Leo Margolis Scholarship: 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.

La Bourse Leo Margolis : Cette bourse a été instituée à la mémoire de Leo Margolis, éminent parasitologue de réputation internationale et militant fidèle de la Société canadienne de zoologie depuis sa création en 1961.

Leo Margolis

Student Travel Research Grant: This award will assist students and post-doctoral fellows from Canadian universities with expenses incurred during collaborative visits to other laboratories, research facilities, field stations or sites to conduct zoological research. The intention is to support ancillary research activities that will supplement and enhance the applicant's core research program, and not to fund the core research itself, which is the responsibility of the applicant's supervisor.

Subvention de recherche Étudiants/Chequeurs post-doctoraux : Ce prix vise à aider des étudiants ou chercheurs post-doctoraux à défrayer les coûts inhérents à des visites de collaboration scientifique effectuées dans des laboratoires d'accueil, instituts de recherche, stations ou sites d'études de terrain afin d'y poursuivre des recherches en zoologie. L'objectif de cette subvention est d'accroître les opportunités de recherche au delà de celles qui peuvent être offertes au sein du programme de recherche initial du récipiendaire.

*For information on CSZ and CSZ Section Awards, visit the Society's web site <http://www.csz-scz.ca/>
Pour obtenir de plus amples renseignements sur la SCZ et les prix de la SCZ, veuillez visitez le site web de la
société <http://www.csz-scz.ca/>.*

Monday, May 13th / lundi, 13 mai

Summary of Events / Le résumé d'événements

	Events / Les événements	Location / Endroit
9:00-12:00	Council Meeting / Réunion du conseil	University Center 442
9:00-17:00	Registration / Inscription	Rozanski Concourse
12:00-1:30	Student Lunch PDF Lunch	Peter Clark Hall (PCH) Brass Taps
1:30-3:30	Teaching Symposium / Symposium d'enseignement	Rozanski (ROZ) 103
3:00-4:00	Canadian Journal of Zoology Workshop atelier du Can J Zool	ROZ106
3:30-4:00	Coffee/café	Rozanski Concourse
4:00-5:00	NSERC Information Session Session d'Information CRSNG	ROZ102
5:00-6:00	BREAK / PAUSE	
6:00-6:30	Welcome, Introduction and Fry Lecture Bienvenue, Introduction et Conférence Fry Dr. Miodrag (Mike) Belosevic	ROZ101
6:30-8:30	Opening Reception / Réception d'ouverture	Science Atrium
8:30	Social / Soirée	Brass Taps

Daily Notes

- To get to University Center 442 take the North elevator from the ground floor of the University Center to the fourth floor.
- There will be an opening reception in the Science Atrium following the Fry Medal Lecture. This is a catered dinner event and each delegate has a drink ticket for the bar.
- The social is being supported, in part, by Mill Street Brewery



Teaching Symposium / Symposium d'enseignement (13:30 – 15:30)
ROZH 103

Chair/Président: Colin Montpetit

TEACH SYM 1 13:30 – 14:10	PATRICIA SCHULTE University of British Columbia How curriculum re-design can facilitate the implementation of evidence-based teaching practices in undergraduate biology. <i>La conception et le développement de curriculum dans le premier cycle de biologie.</i>
TEACH SYM 2 14:10 – 15:30	PATRICIA A. WRIGHT AND RYAN GREGORY University of Guelph Active learning in a large science course: the "Discovering Biodiversity" experiment <i>Apprentissage actif dans un cours de sciences grand format: l'expérience de "Découvrir la Biodiversité"</i>

F.E.J. Fry Medal/ Médaille F.E.J. Fry



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. Le médaillé Fry doit être en mesure de donner une conférence plénière lors de la réunion annuelle où la médaille lui est décernée.

F.E.J. Fry

Dr. Miodrag (Mike) Belosevic, University of Alberta

*Life is Pie
La vie c'est PIE*



Dr. Miodrag (Mike) Belosevic is a Distinguished University Professor of Biological Sciences and School of Public Health, University of Alberta and is a Fellow of the Royal Society of Canada. He received BSc and MSc from Department of Zoology, University of Manitoba and Ph.D. from Institute of Parasitology, McGill University.

Dr. Belosevic's main research interests include the elucidation of mechanisms of innate immunity in fish, antimicrobial functions of fish macrophages and control of waterborne parasitic diseases. He is an author of more than 250 refereed research publications.

Dr. Belosevic is a recipient of more than 20 research and mentoring awards including Clark P. Read Mentor Award, American Society of Parasitologists (2009);

Thomas C. Keefer Medal, Canadian Society for Civil Engineering (2008); University Cup, University of Alberta (2006); Killam Award for Excellence in Mentoring, Killam Trust (2004); Alberta Science and Technology Foundation Award (ASTech) (2003); Rudolph Hering Medal, American Society of Civil Engineers (2002); and Wardle Award from the Parasitology Section of the Canadian Society of Zoology (2002). Dr. Belosevic is currently on editorial boards of five international journals and is a Fellow of the Japanese Society for Promotion of Science. He served on national grants panels (NSERC, CIHR) and Project Advisory Committees of the American Water Works Association Research Foundation. He is currently Chair of the Nominating Committee of the Royal Society of Canada (Life Sciences), member of the Board of Governors, University of Alberta, and is a past President of the Canadian Society of Zoologists.

Abstract: The understanding of host-parasite relationships has been significantly advanced using well-defined animal model systems. In this lecture, I will provide an overview of basic and applied research from my research group, using as a guide our contributions to parasitology (P), immunology (I) and environment (E). The topics will include (1) the assessment of protozoan infections in various hosts; (2) the immunobiology of host parasite associations, focusing on innate immune responses of mammals and fish; (3) the developmental pathways of important immune cells (macrophages) of bony fish; and (4) the use of *in vivo* and *in vitro* systems for the assessment of inactivation of parasites in drinking water and wastewater, resulting in protection of public health.

Tuesday, May 14th / mardi, 14 mai
 Summary of Events / Le résumé d'événements

Events / Les événements		Location / Endroit
8:30-5:00	Registration / Inscription	ROZ Concourse
8:30-10:30	Local organizing committee Symposium Symposium comité organisateur “Zoology for a better Planet” “Zoologie pour une meilleure planète”	ROZ101
10:30-11:00	Coffee/caf�	ROZ Concourse
11:00-12:30	CMD1 Development CBP1 Genomics/Proteomics 1 CBP2 Metabolism CBP3 Nitrogen Excretion CBP/EEE Ecophysiology EEE1 Foraging and Movement	ROZ108 ROZ105 ROZ102 ROZ106 ROZ103 ROZ109
12:30-2:00	AGM Lunch / Lunch des AGA	Peter Clark Hall (PCH) in the University Center
2:00-3:00	Boutilier Lecture / Conf�rence Boutilier Dr. Chris Martyniuk	ROZ101
3:00-3:30	Coffee/caf�	ROZ Concourse
3:30-5:30	CMD/CBP Biomechanics CBP4 Genomics/Proteomics 2 CBP5 Acid-base CBP6 Hypoxia tolerance CBP7 Neuroethology EEE2 Mating/reproduction	ROZ102 ROZ105 ROZ106 ROZ103 ROZ108 ROZ109
5:30-6:00	BREAK/PAUSE	
6:00-7:00	ZET Lecture / Conf�rence ZET Dr. Shelia Patek <i>Sudden and swift: extreme movements in biology</i> <i>Mouvements extr�mes en biologie</i>	ROZ101
7:00-8:30	ZET Reception	Macdonald Stewart Art Center
8:30-9:30	Social / Soir�e� Hockey Game	Brass Taps Arena

Daily Notes

- There is a reception following the ZET lecture at the Macdonald Stewart Art Center. This is a catered dinner reception and each delegate has a drink ticket for the bar.
- The social at the Brass Taps is being sponsored, in part, by the Wellington Brewery
- The hockey rink is booked from 8:00-9:30. Game will be played 8:30-9:30.

**LOC Symposium / Symposium LOC (8:30 – 10:30)
ROZH 101**

Zoology for a Better Planet / *Zoologie pour une meilleure planète*

Chair/Président: Todd Gillis

LOC SYM 1 8:30 - 9:00	BRIDGET STUTCHBURY York University Tracking songbird migration: seasonal connectivity and migration timing <i>Suivre la migration des passereaux: Connectivité saisonnière et période de migration</i>
LOC SYM 2 9:00 - 9:30	JACQUELINE LITZGUS Laurentian University Mitigating threats to reptile populations <i>Atténuer les menaces pour les populations de reptiles</i>
LOC SYM 3 9:30 - 10:00	GÖRAN E. NILSSON University of Oslo Animals on a changing coral reef: hot and high on acid <i>Animaux sur un récif de corail en changement: Chauds et sous l'emprise de l'acide</i>
LOC SYM 4 10:00 - 10:30	PAUL HEBERT University of Guelph A Census of All Life <i>Un recensement de toute forme de vie</i>

Contributed Sessions I / Sessions de communications I (11:00 – 12:30)
CMD 1/ MDC 1: ROZH 108

Interactions During Development / Interactions Pendant le Développement

Chair/Président: Tamara Franz-Odendaal

CMD1-1 11:00 - 11:15	DOUGLAS S. FUDGE University of Guelph Fifty years of JR Platt's "Strong Inference" <i>La "Strong inference" de JR Platt's: Cinquante ans après</i>
CMD1-2 11:15 - 11:30	KELLY HADFIELD University of Guelph Genome size diversity in semi-aquatic insects <i>Diversité de la taille du génome chez les insectes semi-aquatiques</i>
CMD1-3 11:30 - 11:45	EMILY GILBERT AND MATTHEW VICKARYOUS University of Guelph Neurodevelopmental markers are expressed by ependymal cells before and during spinal cord regeneration in the leopard gecko (<i>Eublepharis macularius</i>) <i>Des marqueurs neuro-développementaux sont exprimés par les cellules épendymaires avant et pendant la régénération de la moelle épinière chez le gecko léopard (<i>Eublepharis macularius</i>)</i>
CMD1-4 11:45 - 12:00	JACOB POLLACK University of Ottawa The <i>ascl1a</i> and <i>dlx</i> genes have a regulatory role in the development of GABAergic interneurons in the zebrafish diencephalon <i>Les gènes <i>ascl1a</i> et <i>dlx</i> ont un rôle régulateur dans le développement des interneurones GABAergiques diencéphaliques chez le poisson zèbre</i>
CMD1-5 12:00 - 12:15	JASON VIEIRA AND MATTHEW VICKARYOUS University of Guelph Evaluating spinal nerve fidelity following tail loss in the leopard gecko <i>Évaluation de la fidélité du nerf spinal après perte de la queue chez le gecko léopard</i>
CMD1-6 12:15 - 12:30	OUALID HADDAD, ZACHARY ROBINSON, CRAIG SIMMONS, AND DOUGLAS FUDGE University of Guelph Keratinocytes mechanical defects in the skin blistering disease epidermolysis bullosa simplex <i>Défauts mécaniques des kératinocytes observés dans la maladie de peau épidermolyse bullosa simplex</i>

Contributed Sessions I / Sessions de communications I (11:00 – 12:30)

CPB 1 / PBC 1: ROZH 105

Genomics and Proteomics 1 / Génomique et Protéomique 1

Chair/Président: Trish Schulte

CPB1-1 11:00 - 11:15	WILLIAM S. MARSHALL St Francis Xavier Univ. The <i>Fundulus heteroclitus</i> genome project: Survey of microRNA sites in a hardy fish <i>Projet du génome choquemort (<i>Fundulus heteroclitus</i>): Un sondage des sites microARN chez un poisson robuste.</i>
CPB1-2 11:15 - 11:30	PAUL CRAIG, VANCE TRUDEAU AND TOM MOON University of Ottawa microRNA: Potential as master regulators of metabolism in teleosts microARN: Régulateurs potentiels principaux du métabolisme chez les téléostéens
CPB1-3 11:30 - 11:45	ROY DANZMANN, ANDREA KOCMAREK AND MOIRA FERGUSON University of Guelph Identification of genes related to faster white muscle growth in rainbow trout across growing seasons. <i>Identification de gènes liés à la croissance rapide du muscle blanc chez la truite arc-en-ciel entre les saisons de croissance</i>
CPB1-4 11:45 - 12:00	ANDREA KOCMAREK, MOIRA FERGUSON AND ROY DANZMANN University of Guelph Differential gene expression of candidate genes for growth in rainbow trout derived from two seasonal spawning groups <i>Expression différentielle de gènes candidats à la croissance de la truite arc-en-ciel chez deux populations de géniteurs</i>
CPB1-5 12:00 - 12:15	COURTNEY A. DECK, SHELDON J. MCKAY, TRISTAN J. FIEDLER, CHRISTOPHE M.R. LEMOINE, MICHELE NEWATA, CHRIS M. WOOD AND PATRICK J. WALSH University of Ottawa Effects of feeding on gene expression in the spiny dogfish (<i>Squalus acanthias</i>) <i>Effets de l'alimentation sur l'expression génique chez l'aiguillat commun (<i>Squalus acanthias</i>)</i>
CPB1-6 12:15 - 12:30	SCOTT MITCHELL Wilfrid Laurier University Bacteriophage: arms dealers of the microbial world Bactériophages: Marchands d'armes du monde microbien

Contributed Sessions I / Sessions de communications I (11:00 – 12:30)
CPB 2 / PBC 2: ROZH 102

Metabolism / Métabolisme

Chair/Président: Chris LeMoine

CPB2-1 11:00 - 11:15	K.M. GILMOUR, R.S. DHILLON, G.Y. LAU AND J.G. RICHARDS University of Ottawa Does AMP kinase mediate metabolic adjustments associated with social status in rainbow trout, <i>Oncorhynchus mykiss</i>? <i>Est-ce que l'AMP kinase régule les ajustements métaboliques associés au statut social chez la truite arc-en-ciel, <i>Oncorhynchus mykiss</i>?</i>
CPB2-2 11:15 - 11:30	GRAHAM R. SCOTT, MIKAELA A. LUI AND TODD S. ELOGIO McMaster University Evolution of the hypoxia acclimation response in high-altitude deer mice <i>Évolution de la réponse d'acclimatation à l'hypoxie en haute altitude chez les souris sylvestres</i>
CPB2-3 11:30 - 11:45	SAJENI MAHALINGAM, ZACHARY CHEVIRON, JAY STORZ, ALEX CONNATY, GRAHAM SCOTT AND GRANT MCCLELLAND McMaster University Developmental and physiological plasticity of muscle metabolic phenotypes in highland and lowland deer mice <i>Plasticité développementale et physiologique de phénotypes métaboliques musculaires chez des souris sylvestres de haute et basse altitudes</i>
CPB2-4 11:45 - 12:00	GRANT B. MCCLELLAND McMaster University Into (cold) thin air: muscle adaptations to high altitude <i>Adaptations musculaires en haute altitude</i>
CPB2-5 12:00 - 12:15	JAMES HAYES AND HELENE VOLKOFF Memorial University of Newfoundland Alterations in digestive enzyme profiles in cunner, <i>Tautogolabrus adspersus</i>, during fasting and dormancy <i>Modifications des profils d'enzymes digestives pendant le jeûne et la dormance chez la tanche, <i>Tautogolabrus adspersus</i></i>
CPB2-6 12:15 - 12:30	DANIEL BAKER, MICHAEL HUDSON, ANTHONY HICKEY AND RUSSELL MILLAR University of New Zealand The acidic ocean quenches the fire of life: metabolic depression in echinoderms following exposure to near future levels of ocean acidification. <i>L'acidité éteint la vie des océans: Dépression métabolique chez les échinodermes exposés à des niveaux d'acidité prédis pour le futur</i>

Contributed Sessions I / Sessions de communications I (11:00 – 12:30)
CPB 3 / PBC 3: ROZH 106

Nitrogen Excretion / Excrétion de l'Azote

Chair/Président: Tammy Rodela

CPB3-1 11:00 - 11:15	JAMES NEAL, SUSAN L. EDWARDS, ALLISON MCDONALD, MATT M. VIJAYAN AND MICHAEL P. WILKIE* Wilfrid Laurier University Habitat, life history and dietary related changes in gill urea transporter (UT) and Rh glycoprotein abundance in sea lampreys (<i>Petromyzon marinus</i>). Changements de l'abondance des transporteurs d'urée et glycoprotéines Rh branchiaux dues aux modifications d'habitat, du cycle biologique et de l'alimentation chez la lamproie marine (<i>Petromyzon marinus</i>)
CPB3-2 11:15 - 11:30	ADRIAN IONESCU, PHUONG BUI, DIRK WEIHRAUCH AND ANDREW DONINI York University Ammonia excretion by anal papillae of the larval mosquito, <i>Aedes aegypti</i>. Excrétion d'ammoniac par les papilles anales des larves du moustique, <i>Aedes aegypti</i>.
CPB3-3 11:30 - 11:45	ALEX QUIJADA-RODRIGUEZ, JASON TREBERG AND DIRK WEIHRAUCH University of Manitoba Mechanism of ammonia transport in the integument of the freshwater ribbon leech <i>Nephelopsis obscura</i> Mécanisme de transport d'ammoniac dans le tégument de la sangsue d'eau douce, <i>Nephelopsis obscura</i>
CPB3-4 11:45 - 12:00	JULIAN G. RUBINO AND CHRIS M. WOOD McMaster University Investigation of a potential relationship between intestinal Na⁺ uptake and ammonia handling in freshwater rainbow trout (<i>Oncorhynchus mykiss</i>) Investigation d'une éventuelle relation entre l'absorption intestinale de Na⁺ et le traitement de l'ammoniac chez la truite arc-en-ciel (<i>Oncorhynchus mykiss</i>)
CPB3-5 12:00 - 12:15	ALEX ZIMMER AND CHRIS WOOD McMaster University The Effects of Hypoxia on Nitrogen Regulation in Dogfish Sharks (<i>Squalus acanthias</i>) Les effets de l'hypoxie sur la régulation de l'azote chez l'Aiguillat commun (<i>Squalus acanthias</i>)
CPB3-6 12:15 - 12:30	W. GARY ANDERSON, CHRIS M. WOOD AND CHRIS MCCABE University of Manitoba Urea balance across the gut of the spiny dogfish, <i>Squalus acanthias</i> Équilibre urique dans l'intestin de l'aiguillat commun, <i>Squalus acanthias</i>

Contributed Sessions I / Sessions de communications I (11:00 – 12:30)

CPB/EEE 1 / PBC/EEE 1: ROZH 103

Thermal & Stress Ecophysiology / Écophysiologie du Stress et Thermal

Chair/Président: Alexander Gerson

CPB/EEE 1-1 11:00 - 11:15	ALEX HARE AND GARY ANDERSON University of Manitoba Friend or foe: do conspecifics lower the acute stress response in juvenile lake sturgeon? <i>Ami ou ennemi: est-ce que la présence de conspécifiques réduit la réponse au stress aigu chez les esturgeons jaunes juvéniles.</i>
CPB/EEE 1-2 11:15 - 11:30	ALEXANDER R. GERSON, ERIC C. SMITH, ANDREW E. MCKECHNIE AND BLAIR O. WOLF University of New Mexico Heat balance in extreme environments and the response to reduced water vapour pressure deficit in desert adapted birds <i>Bilan thermique dans des environnements extrêmes et réponse au déficit de pression de vapeur d'eau chez les oiseaux désertiques</i>
CPB/EEE 1-3 11:30 - 11:45	GARY BURNES, JACQUELINE HUARD, EMILY MALCOLM AND GLENN TATTERSALL Trent University Post-hatch heat warms adult beaks: irreversible physiological plasticity in Japanese quail <i>La chaleur pré-éclosion réchauffe le bec des adultes: plasticité physiologique irréversible chez la caille Japonaise.</i>
CPB/EEE 1-4 11:45 - 12:00	JIM KIEFFER, FAITH PENNY, YUEYANG ZHANG, DAVID DESLAURIERS AND VASILIKI PAPADOPoulos UNB Saint John Some like it hot! – Temperature biology of shortnose sturgeon (<i>Acipenser brevirostrum</i>). <i>Certains l'aiment chaud! – Thermobiologie de l'esturgeon à museau court (<i>Acipenser brevirostrum</i>)</i>
CPB/EEE 1-5 12:00 - 12:15	NICHOLAS KELLY, GARY BURNES, JENNI MCDERMID AND CHRIS WILSON Trent University Ice age fish in a warming world: thermal acclimation capacity of lake trout (<i>Salvelinus namaycush</i>) populations. <i>Un poisson de l'aire glaciale dans l'eau chaude: Capacité d'acclimation thermale des populations d'omble de fontaine (<i>Salvelinus namaycush</i>)</i>
CPB/EEE 1-6 12:15 - 12:30	KATIE E. MARSHALL AND BRENT J. SINCLAIR University of Western Ontario The four axes of stress: intensity, duration, frequency, and period of low temperature exposures interact to affect physiology and fitness in insects <i>Les quatre axes du stress: intensité, durée, fréquence et durée d'exposition à de basses températures interagissent pour influencer la physiologie et la valeur adaptative chez les insectes</i>

Contributed Sessions I / Sessions de communications I (11:00 – 12:30)

EEE 1 / EEE 1: ROZH 109

Foraging & Movement Ecology / Écologie limentaire et du Mouvement

Chair/Président: Andrew Rous

EEE1-1 11:00 - 11:15	ANDREW ROUS, GALE BRAVENER, TOM PRATT, LISA O'CONNOR, JESSICA BARBER, CHRIS HOLBROOK AND ROB MCLAUGHLIN University of Guelph Fine-scale 3-D movements of sea lamprey immediately downstream of traps in the st marys river <i>Mouvements tridimensionnels précis de la lamproie marine immédiatement en aval de pièges tendus dans la rivière St. Mary</i>
EEE1-2 11:15 - 11:30	TREVOR BRINGLOE, DAVID DROLET, MYRIAM BARBEAU, MARK FORBES AND TRAVIS GERWING University of Guelph Spatial variation in population structure and its relation to dispersal in a model intertidal invertebrate <i>Variation spatiale de la structure des populations et sa relation au dispersement chez un invertébré intertidal</i>
EEE1-3 11:30 - 11:45	NATALIA KRAMSKI, NICHOLAS MANDRAK AND ROBERT MCLAUGHLIN University of Guelph Movements of listed Grass Pickerel <i>Esox americanus vermiculatus</i> in an agricultural drain and the implications for drain maintenance. <i>Mouvements du brochet vermiculé <i>Esox americanus vermiculatus</i> dans un drain agricole: implications pour l'entretien des drains</i>
EEE1-4 11:45 - 12:00	VERONICA APONTE, SEAN LOCKE, MARIE-LINE GENTRES, JEAN-FRANÇOIS GIROUX, DAVE MARCOGLIESE, DAN MCLAUGHLIN AND JONATHAN VERRAULT Université de Québec Explaining the intestinal parasite community composition using a multiple dietary descriptor approach: a case study with ring-billed gulls breeding in the st. lawrence river <i>Expliquer la composition de la communauté parasitaire intestinale en utilisant une approche multiple de descripteurs alimentaires: étude sur des goélands à bec cerclé nichant dans le fleuve Saint-Laurent</i>
EEE1-5 12:00 - 12:15	SARAH C. MARTEINSON, JEAN-FRANÇOIS GIROUX, JEAN-FRANÇOIS HÉLIE, MARIE-LINE GENTES AND JONATHAN VERRAULT University of Québec Energy expenditure in incubating ring-billed gulls – behavioural, spatial and seasonal correlates <i>Dépenses énergétiques durant l'incubation chez le Goéland à bec cerclé - Correlations entre le comportement, l'espace et les saisons</i>
EEE1-6 12:15 - 12:30	ROB MCLAUGHLIN University of Guelph Controversy over Connectivity: Restoration of Migratory Fishes versus Control of Invasive Fishes <i>Controverse sur la connectivité: Restauration des poissons migrateurs ou contrôle des poissons envahissants</i>

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



R.G. Boutilier

The Bob Boutilier New Investigator Award is to encourage and honor CSZ members within five years of receiving their first academic or 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 cinq premières années de leur premier emploi académique ou professionnel et qui sont considérés comme des « étoiles montantes » dans leur discipline.

Dr. Chris Martyniuk, University of New Brunswick

Generation Omics: Hip or hype for exploration of vertebrate reproduction
Génération Omiques: Exploration de la reproduction des vertébrés



Dr. Chris Martyniuk is a Molecular Toxicologist / Physiologist that studies organismal responses to aquatic pollutants using omics and biochemical approaches. His research focus is on the molecular and physiological impacts of endocrine disrupting chemicals in aquatic organisms. To achieve this, his laboratory uses environmental transcriptomics and proteomics and associates molecular changes to higher levels of biological organization. In addition, his research utilizes bioinformatics to integrate molecular data to better link molecular initiating events to adverse outcomes in aquatic organisms, for example decreased reproductive output or stress.

Academic Appointments

- Tier II Canada Research Chair in Molecular Ecology, UNB
- Currently Assistant Professor Department of Biology (Nov 2009), University of New Brunswick (Early Promotion to Associate Professor commencing July, 2013)
- Canadian Rivers Institute Science Director
- NSERC Post-Doctoral Fellow at University of Florida (Dr. Nancy Denslow)
- PhD: University of Ottawa (Dr. Vance Trudeau)

Abstract: Omics technologies have dramatically increased our understanding of how organisms respond to their surrounding environment. In teleost fishes, transcriptomics and proteomics have been used to characterize the effects of reproductive hormones and endocrine disrupting compounds found in the environment. As such, we have learned more about the molecular pathways regulated by estrogens and androgens in the reproductive axis and there are common biological themes that have emerged. For example, sex steroids regulate molecular signaling cascades that are associated with immune system function, metabolism, and fatty acid biosynthesis, among many others. There has been good progress in describing adverse outcome pathways, correlating molecular initiating events to higher levels of biological organization. We have also learned that transcriptomics provides site specific information for individuals, supporting its use in environmental assessments. However, the complexity and lack of understanding of the variation and temporal changes in transcriptomes are significant challenges for omics.

Contributed Sessions II / Sessions de communications II (15:30 – 17:30)
CMD/CPB / MDC/PBC: ROZH 102

Biomechanics / Biomécanique

Chair/Président: Jordan Klaiman

CMD/CPB-1 15:30 - 15:45	TODD GILLIS AND JEREMY SIMPSON University of Guelph Remodeling of diaphragm function during the development of heart failure in mice <i>Remodelage de la fonction du diaphragme pendant le développement de l'insuffisance cardiaque chez la souris</i>
CMD/CPB-2 15:45 - 16:00	DEJU ZHU, LAWRENCE SZEWCIW*, FRANCK VERNEREY AND FRANCOIS BARTHELAT McGill University Puncture resistance of the scaled skin from striped bass: collective mechanisms and inspiration for new flexible armor designs <i>Résistance à la perforation de la peau écailleuse du bar rayé: mécanismes collectifs et inspiration pour de nouveaux modèles d'armures flexibles</i>
CMD/CPB-3 16:00 - 16:15	BILLARDON FANNIE AND CHARLES A. DARVEAU* Université d'Ottawa Like mother, like daughter? Heritability of flight energetics in the bumblebee <i>Bombus impatiens</i> <i>Telle mère, telle fille? Héritabilité de l'énergétique du vol chez le bourdon <i>Bombus impatiens</i></i>
CMD/CPB-4 16:15 - 16:30	TIMOTHY HIGHAM, G.J. MEASEY, A.V. BIRN-JEFFERY, A. HERREL AND K.A. TOLLEY University of California The effects of habitat structure on locomotion in South African chameleons <i>Les effets de la structure de l'habitat sur la locomotion du chaméléon Sud Africain</i>
CMD/CPB-5 16:30 - 16:45	DOUGLAS A. SYME AND A. KURT GAMPERL University of Calgary Warm acclimation shifts thermal optima but reduces mechanical power of red skeletal muscle in both warm- (Atlantic salmon) and cold- (Arctic char) adapted salmonids <i>L'acclimatation au chaud change l'optimum thermique mais réduit la puissance mécanique du muscle squelettique rouge chez les salmonidés adaptés aux conditions chaudes (saumon atlantique) et froides (omble chevalier)</i>
CMD/CPB-6 16:45 - 17:00	ISABELLE TREMBLAY AND HELGA GUDERLEY Université Laval Functional morphology of adductor muscle in scallops of differing swimming capacities. <i>Morphologie fonctionnelle du muscle adducteur chez des pétoncles avec des capacités de nage différentes.</i>

CMD/CPB-7 17:00 - 17:15	NICOLE PINTO, ATSUKO NEGISHI, DOUGLAS FUDGE, TODD GILLIS, LAURENT KREPLAK, MAIKEL RHEINSTÄDTER AND FEI-CHI YANG University of Guelph Physical Characterization of Fibres Produced from Recombinant Vimentin <i>Caractérisation physique des fibres produites à partir de la vimentine recombinée</i>
CMD/CPB-7 17:00 - 17:15	DAN LIM, YOLANDA MORBEY AND LOUISE MILLIGAN Western University Temperature imprinting of muscle morphology and swim performance of juvenile Chinook salmon <i>L'empreinte de la température sur la morphologie musculaire et les performances de nage des saumons Chinook juvéniles</i>

Contributed Sessions II / Sessions de communications II (15:30 – 17:30)
CPB 4 / PBC 4: ROZH 105

Genomics and Proteomics 2 / Génomique et Protéomique 2

Chair/Président: Anne Dalziel

CPB4-1 15:30 - 15:45	CHRISTOPHE LEMOINE, ADRIAN PELIN, NICOLAS CORRADI, DANIELLE MCDONALD, MARTIN GROSELL, WES WARREN AND PATRICK WALSH University of Ottawa Three differentially expressed urea transporters in the Gulf Toadfish (<i>Opsanus beta</i>) revealed by transcriptome analysis. <i>Expression différentielle de trois transporteurs de l'urée chez le poisson-crapaud (<i>Opsanus beta</i>) révélée par analyse du transcriptome</i>
CPB4-2 15:45 - 16:00	JOSEPH D. NORMAN, BRIAN GLEBE, MOIRA M. FERGUSON AND ROY G. DANZMANN University of Guelph Transcriptomics of salinity tolerance in Arctic charr (<i>Salvelinus alpinus</i>): a comparison of gene expression profiles with quantitative trait locus alleles for high and low salinity tolerance <i>Transcriptomique de la tolérance à la salinité chez l'omble chevalier (<i>Salvelinus alpinus</i>): Comparaison de profils d'expression génique avec des allèles de locus à caractères quantitatifs pour des tolérances à la salinité élevée et faible</i>
CPB4-3 16:00 - 16:15	HIROKO UDAKA, ALICE DENNIS AND BRENT SINCLAIR University of Western Ontario High-throughput RNA sequencing reveals candidate genes associated with freeze tolerance in <i>Eurosta solidaginis</i> <i>Le séquençage à haut début de la RNA révèle des gènes candidats associé avec la tolérance au gel chez <i>Eurosta solidaginis</i></i>
CPB4-4 16:15 - 16:30	BRENT J. SINCLAIR, ALICE B. DENNIS, LUKE T. DUNNING AND THOMAS R. BUCKLEY University of Western Ontario Making an alpine insect out of tropical ancestors: Evolutionary physiology of stick insects in New Zealand <i>Comment faire un insecte alpin à partir d'ancêtres tropicaux: physiologie évolutive des phasmes en Nouvelle-Zélande</i>
CPB4-5 16:30 - 16:45	KAI HE, MICHAEL BERENBRINK AND KEVIN L. CAMPBELL* University of Manitoba Evolution of myoglobin net surface charge in mammalian divers: a test of the ‘aquatic mole’ hypothesis. <i>Évolution de la charge de surface nette de la myoglobine chez les mammifères plongeurs: un test de l’hypothèse de la ‘taupe aquatique’</i>
CPB4-6 16:45 - 17:00	ANTHONY V. SIGNORE, JOHANNA PAIJMANS, MICHAEL HOFREITER AND KEVIN L. CAMPBELL University of Manitoba Accelerated molecular and functional evolution of hemoglobin in sirenians. <i>Évolution moléculaire et fonctionnelle accélérée de l'hémoglobine des siréniens</i>

Contributed Sessions II / Sessions de communications II (15:30 – 17:30)
CPB 5 / PBC 5: ROZH 106

Acid-Base Balance / Équilibre Acide-Base

Chair/Président: Katie Gilmour

CPB5-1 15:30 - 15:45	RYAN SHARTAU, II, DANE CROSSLEY II, ZACHARY KOHL, MICHAEL HEDRICK, JOHN EME AND COLIN BRAUNER University of British Columbia Evolution of preferential pH regulation in basal fishes; insights from the spotted gar <i>Evolution de la régulation du pH préférentiel chez les poissons basaux; aperçu du lépisosté tacheté</i>
CPB5-2 15:45 - 16:00	DANIEL CARRIE AND KATHLEEN GILMOUR University of Ottawa Regulation of carbonic anhydrase expression and activity <i>Régulation de l'expression et de l'activité de l'anhydrase carbonique</i>
CPB5-3 16:00 - 16:15	MICHAEL A. SACKVILLE AND COLIN J. BRAUNER University of British Columbia Functional origins of the vertebrate gill <i>Origines fonctionnelles des branchies des vertébrés</i>
CPB5-4 16:15 - 16:30	TILL HARTER AND COLIN BRAUNER University of British Columbia Carbonic anhydrase mediated oxygen release in rainbow trout red blood cells following β-adrenergic stimulation: a dose-response analysis <i>Relâchement d'oxygène lié à l'anhydrase carbonique dans les globules rouges de la truite arc-en-ciel suivant une stimulation β-adrénergique: une analyse dose-réponse</i>
CPB5-5 16:30 - 16:45	AIDA ADLIMOGHADDAM, ANN-KAREN BRASSINGA, MIKE O'DONNELL, JASON TREBERG AND DIRK WEIHRAUCH University of Manitoba Investigation of the pH-regulation and ammonia excretion mechanism in the soil nematode, <i>Caenorhabditis elegans</i> <i>Enquête sur la régulation du pH et les mécanismes d'excrétion de l'ammoniac dans le nématode, <i>Caenorhabditis elegans</i></i>
CPB5-6 16:45 - 17:00	SANDRA FEHSENFELD, CHRIS M. WOOD, GREG G. GOSS AND DIRK WEIHRAUCH University of Manitoba Acid-base balance of the green crab <i>Carcinus maenas</i> – is branchial mediated pH regulation dependent on ammonia excretion? <i>Équilibre acido-basique chez le crabe vert (<i>Carcinus maenas</i>) - est-ce que la régulation branchiale du pH dépend de l'excrétion d'ammoniac?</i>
CPB5-7 17:00 - 17:15	KRYSTLE TALBOT, KATHLEEN M. GILMOUR AND STEVE F. PERRY University of Ottawa Does zebrafish (<i>Danio rerio</i>) aquaporin 1a transport CO₂ and NH₃ as well as H₂O? <i>Est-ce que l'aquaporine 1a du poisson zèbre (<i>Danio rerio</i>) transporte CO₂ et NH₃ en plus de H₂O?</i>

CPB5-6
17:15 - 17:30

ALEX CLIFFORD, SAMUEL GUFFEY AND GREG GOSS
University of Alberta
Extrabranchial mechanisms of pH recovery in the Pacific hagfish (*Eptatretus stoutii*).
*Les mécanismes extrabranchiales de rétablissement du pH chez la myxine du Pacifique (*Eptatretus stoutii*)*

Contributed Sessions II / Sessions de communications II (15:30 – 17:30)
CPB 6 / PBC 6: ROZH 103

Hypoxia Tolerance / Tolérance à l'Hypoxie
 Chair/Président: Graham Scott

CPB6-1 15:30 - 15:45	TAMMY RODELA, ROBERT DEVLIN AND JEFFREY RICHARDS University of British Columbia Pre-conditioning and cross-tolerance between hypoxia and ammonia exposure in zebrafish (<i>Danio rerio</i>) <i>Pré-conditionnement et tolérance croisée entre l'hypoxie et l'exposition à l'ammoniac chez le poisson zèbre (<i>Danio rerio</i>)</i>
CPB6-2 15:45 - 16:00	ANDREW TURKO, CAYLEIH ROBERTSON, KRISTIN BIANCHINI, MEGAN FREEMAN AND PATRICIA WRIGHT University of Guelph The amphibious fish <i>Kryptolebias marmoratus</i> uses alternate strategies to maintain oxygen delivery during hypoxia and air exposure <i>Le poisson amphibia <i>Kryptolebias marmoratus</i> utilise des stratégies alternatives pour maintenir la livraison d'oxygène durant l'hypoxie et l'exposition à l'air</i>
CPB6-3 16:00 - 16:15	MILICA MANDIC AND JEFFREY RICHARDS University of British Columbia Variation in hypoxia-inducible factor (HIF) and gene expression patterns in sculpins of varying hypoxia tolerance <i>Variation dans le facteur hypoxie-inducible (HIF) et dans la patron d'expression des gènes des chabots de différente tolérance à l'hypoxie</i>
CPB6-4 16:15 - 16:30	BEN SPEERS-ROESCH, MILICA MANDIC AND JEFFREY RICHARDS University of British Columbia Critical oxygen tensions as a predictor of hypoxia tolerance and tissue metabolic responses during hypoxia exposure in fishes <i>Tensions en oxygène critiques comme un facteur prédictif de tolérance à l'hypoxie et les réponses métaboliques des tissus pendant l'hypoxie chez les poissons</i>
CPB6-5 16:30 - 16:45	KATE E. MATHERS, YUXIANG WANG AND CHRIS D. MOYES Queen's University Hybridization influences hypoxia tolerance in sunfish <i>L'hybridation influence la tolérance à l'hypoxie chez le crapet-soleil</i>
CPB6-6 16:45 - 17:00	MATTHEW D. REGAN, JOHN M. GOSLINE AND JEFFREY G. RICHARDS University of British Columbia An affordable calorespirometric approach for assessing the metabolic responses of fishes to hypoxia <i>Une approche peu dispendieuse pour mesurer le métabolisme de poissons sous hypoxie</i>
CPB6-7 17:00 - 17:15	ELIZABETH JOHNSTON, SARAH ALDERMAN AND TODD GILLIS University of Guelph Chronic hypoxia exposure of rainbow trout embryos alters swimming performance and cardiac gene expression in larvae <i>L'exposition chronique des embryons de truites arc-en-ciel à une hypoxie chronique altère les performances à la nage et l'expression des gènes cardiaques de la larve.</i>

CPB6-6
17:15 - 17:30

CHRISTOPHER SMALL, TILLMANN BENFEY AND BRYAN CRAWFORD
University of New Brunswick
The effect of cell size on blood flow dynamics in the capillary beds of triploid fish
L'effet de la taille cellulaire sur la dynamique du flux sanguin dans les lits capillaires de poissons triploïdes

Contributed Sessions II / Sessions de communications II (15:30 – 17:30)
CPB 7 / PBC 7: ROZH 108

Neuroethology and Ion Channels / Neuroéthologie et Canaux Ioniques

Chair/Président: Jean-Paul Paluzzi

CPB7-1 15:30 - 15:45	WARREN GALLIN University of Alberta Comparative analysis of Shaw-type potassium channels in widely divergent organisms <i>L'analyse comparative des canaux potassiques de type Shaw dans des organismes très divergents</i>
CPB7-2 15:45 - 16:00	JULIA FUX, ADRIANO SENATORE AND J. DAVID SPAFFORD University of Waterloo Characterization of invertebrate sodium-selective (Nav1) and calcium-selective (Nav2) voltage-gated sodium channels <i>Caractérisation des canaux sodiques voltage-dépendants sélectifs pour le sodium (Nav1) et le calcium (Nav2) chez les invertébrés</i>
CPB7-3 16:00 - 16:15	ADRIANO SENATORE, WENDY GUAN*, ADRIENNE N. BOONE AND J. DAVID SPAFFORD University of Waterloo A sodium permeable T-type channel in the invertebrate heart <i>Un canal de type T perméable au sodium dans le cœur des invertébrés</i>
CPB7-4 16:15 - 16:30	PAUL DICK AND JOHN GRAY University of Saskatchewan Responses of an identified locust interneuron to objects moving along compound trajectories at different velocities <i>Les réponses d'un inter neurone de sauterelle à des objets se déplaçant le long de trajectoires composées à différentes vélocités</i>
CPB7-5 16:30 - 16:45	SEN SIVALINGHEM AND ANDREW MASON University of Toronto Scarborough Vibratory signals of the western black widow spider, <i>Latrodectus hesperus</i>: signal characteristics, production, and reception <i>Les signaux vibratoires de la veuve noire de l'Ouest, <i>Latrodectus hesperus</i>: Production, réception et caractéristiques du signal</i>
CPB7-6 16:45 - 17:00	ERICA MORLEY, THORIN JONSSON AND DANIEL ROBERT University of Toronto Proxemics and acoustic geometry of courtship in <i>Drosophila melanogaster</i> <i>Proxémique et géométrie acoustique lors du comportement de cour chez <i>Drosophila melanogaster</i></i>
CPB7-7 17:00 - 17:15	WARREN GREEN, ALEXANDER WAUGH, HUIMING ZHANG, RÉJEAN DUBUC AND BARBARA ZIELINSKI University of Windsor Odour-driven movement in the sea lamprey: spatial and temporal coding in two parallel olfactory pathways <i>Mouvements basés sur l'odeur chez la lamproie marine: codage spatio-temporel dans deux voies olfactives parallèles</i>

Contributed Sessions II / Sessions de communications II (15:30 – 17:30)

EEE 2 / EEE 2: ROZH 109

Mating and Reproductive Behaviour / Accouplement et Comportement Reproducteur

Chair/Président: Talia H. Sechley

EEE2-2 15:30 - 15:45	ALEXANDER WILSON AND JENS KRAUSE Leibniz-Institute of Freshwater Ecology and Inland Fisheries Metamorphosis and animal personality: A neglected opportunity <i>Métamorphose et personnalité animale: une opportunité négligée</i>
EEE2-2 15:45 - 16:00	SHAWN HUDES, CONNELL MCCLUSKEY AND TRISTAN LONG Wilfrid Laurier University Mathematical modelling of condition-dependent female mate choice <i>Modélisation mathématique du choix de partenaire des femelles en dépendance des conditions</i>
EEE2-3 16:00 - 16:15	ANDERS VESTERBERG, RUDY RIZKALLA, NIKKI CHEN AND MARK FITZPATRICK University of Toronto She has good ‘taste’: the genetic and sensory basis for variation in egg-laying site preference <i>Elle a bon "goût": bases génétique et sensorielle des variations de la préférence du site de ponte</i>
EEE2-4 16:15 - 16:30	EMILY MACLEOD AND MAYDIANNE ANDRADE University of Toronto Spider beware: investigations into male mate choice in the western black widow spider (<i>Latrodectus hesperus</i>) <i>Méfiez-vous des araignées: Investigation du choix de partenaire mâle chez la veuve noire de l'Ouest (<i>Latrodectus hesperus</i>)</i>
EEE2-5 16:30 - 16:45	HANNAH TENNANT, ERIN SONSER AND TRISTAN A.F. LONG Wilfrid Laurier University Causes and consequences of variation in male and female mating interactions <i>Les causes et conséquences de la variation des interactions reproductives entre mâles et femelles.</i>
EEE2-6 16:45 - 17:00	TALIE H. SECHLEY, D. RYAN NORRIS AND DAN STRICKLAND University of Guelph Causes and consequences of pre-breeding weight gain in a food-caching bird that breeds during the late winter <i>Causes et conséquences du gain de poids avant accouplement chez un oiseau qui se reproduit à la fin de l'hiver</i>
EEE2-7 17:00 - 17:15	JOANNA KONOPKA AND JEREMY MCNEIL The University of Western Ontario Effect of age and temperature on the calling behaviour of Western bean cutworm (<i>Striacosta albicosta</i>) females <i>Effet de l'âge et de la température sur le comportement de vocalisation des femelles du Ver-gris occidental du haricot (<i>Striacosta albicosta</i>)</i>

Zoological Education Trust Lecture

Conférence Publique du Fonds pour l'Éducation en Zoologie

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.

Dr. Sheila Patek, University of Massachusetts, Amherst

Sudden and swift: extreme movements in biology *Mouvements extrêmes en biologie*



Dr. Sheila Patek received her A.B. with honors in Biology from Harvard University followed by a Ph.D. in Biology from Duke University. She was then awarded a Miller Postdoctoral Fellowship at UC Berkeley. She has received several honors, including the George A. Bartholomew Award for distinguished contributions to comparative physiology, a Radcliffe Fellowship, a NSF CAREER award, and the Brilliant 10 award from Popular Science magazine. Her research has been funded by the National Science Foundation, National Geographic Society, Hellman Family Foundation, Armstrong Fund for Science, Beckman Institute for Advanced Science and Technology and others.

Abstract From exploding fungi to spearing shrimp, fast movements in biology are generated through a set of core physical principles. Like a bow and arrow, extremely fast biological systems store up elastic energy in advance and release it rapidly to amplify the power output. Two superlative power-amplifiers are found in mantis shrimp (Stomatopoda) and trap-jaw ants. Mantis shrimp use a spring and latch system to propel their predatory appendages at speeds of up to 24 m/s and peak impact forces that are thousands of times their body weight. In addition, the appendages move so quickly in water that cavitation occurs – a physical phenomenon that yields a massive pressure wave in addition to heat (similar to the surface of the sun), light and sound. Trap-jaw ants use a spring and latch system to propel their jaws at over 60 m/s and accelerations of 10^5 g's. These high accelerations allow the ants to generate large peak forces with their mandibles. Some trap-jaw ant species actually jump with their jaws. These remarkably fast feats are even more intriguing when placed in the context of their evolutionary diversification. The combination of biomechanics and evolutionary analyses provides rich potential for humans to learn new ways to generate fast and powerful movements with potently strong and efficient building materials.

All Delegates are invited to a catered dinner reception with a cash bar at the Macdonald Stewart Art center following the lecture.

Wednesday, May 15th / mercredi, 15 mai

Summary of Events / Le résumé d'événements

	Events / Les événements	Location / Endroit
8:30 – 5:00	Registration / Inscription CMD Symposium / symposium MDC EEE Symposium / symposium ÉÉÉ	ROZ Concourse ROZ105 ROZ102
8:30 - 10:30	CBP8 Cardiorespiratory CBP9 Endocrinology 1 CBP10 Toxicology 1	ROZ106 ROZ109 ROZ103
10:30 - 11:00	Coffee/café CMD2 Fisheads CBP11 Ionoregulation 1	ROZ Concourse ROZ105 ROZ102
11:00 - 12:30	CBP12 Endocrinology 2 CBP13 Toxicology 2 CBP/EEE Migration EEE3 Biodiversity PIE1 Immunology 1	ROZ109 ROZ103 ROZ106 ROZ107 ROZ108
12:30 - 2:00	CMD lunch/ Lunch MDC EEE lunch Lunch ÉÉÉ	PCH North PCH South
2:00 - 3:00	Cameron Lecture/ Conférence Cameron Dr. Erika Eliason	ROZ101
3:00 - 3:30	Coffee/café CMD/PIE Student Symposium CBP14 Ionoregulation 2 CBP15 Stress Physiology	ROZ Concourse ROZ106 ROX102 ROZ105
3:30 - 5:00	CBP16 Toxicology 3 EEE4 Evolution PIE2 Ecology of Parasitism EEE Invited Session- From Toxicology to Behaviour to Biodiversti - Aspects of Ecology	ROZ103 ROZ109 ROZ108 ROZH 107
5:00 - 6:30	How to be the best; Strategies to succeed. Comment faire de son mieux, Stratégies pour la réussite.	Brass Taps
6:30 - 8:30	Poster Session & BBQ Session d'affiches et BBQ 6:30-7:30 Odd #'s 7:30-8:30 Even #'s	Science Atrium
8:30 - 9:30	Social / Soirée @ Doogies with “The Groovy Brothers”	School buses to Downtown

Daily notes

- Posters should be mounted on the boards between 11:00 PM and 2:00 PM on Wednesday.
- Please note your poster number in the program and attend your poster at the assigned time.
- **All posters must be removed from the boards at 8:30 PM on Wednesday.** There will be space available for overnight storage.
- Following the poster session multiple busses will run 8:45-9:45 from the parking lot located south of the New Science Complex to take all delegates to “Doogies” in downtown Guelph for a social with a band.

CMD Symposium / Symposium MDC (8:30 – 10:30)
ROZH 105

Getting a Head: Understanding the Complexities of Head Morphology / Obtention d'une Tête:
Compréhension des Complexes de la Morphologie de la Tête

Chair/Président: Tamara Franz-Odendaal

CMD SYM 1 8:30 - 9:10	DAVID BEEBE, JIE HUANG, ALINA OLTEAN, BENJAMIN FILAS AND LARRY TABER Washington University How to make an eye: an example of matrix-mediated morphogenesis <i>Comment faire un oeil: Un exemple de morphogénèse matricielle</i>
CMD SYM 2 9:10 - 9:50	JAMES HANKEN AND NADINE PIEKARSKI Harvard University Diversity and constraint in the embryonic origin of the vertebrate skull <i>Diversité et contraintes de l'origine embryonnaire du crâne des vertébrés</i>
CMD SYM 3 9:50 - 10:30	DOMINIQUE ADRIAENS, T. GEERINCKX, M. BOUILLIART, H. LEYSEN AND S. VAN WASSENBERG Ghent University Fish heads: an evolutionary Swiss army knife <i>La tête des poissons: un couteau Suisse évolutif</i>

EEE Symposium / Symposium EEE (8:30 – 10:30)
ROZH 102

Linking Periods of the Annual Cycle in Migratory Animals to Understand Variation in Fitness and Population Dynamics / Faire le Lien entre les Périodes du Cycle Annuel chez les Animaux Migrateurs pour Comprendre la Variation de la Forme Physique et la Dynamique de la Population

Chair/Président: Ryan Norris

EEE SYM 1 8:30 - 9:00	STUART BEARHOP AND XAVIER HARRISON University of Exeter Multi-seasonal determinants of reproductive success: interactions between carry-over effects and environmental variation in a migratory bird <i>Déterminants multi-saisonniers du succès reproductif: interactions entre les effets différés et la variation de l'environnement chez un oiseau migrant</i>
EEE SYM 2 9:00 - 9:30	STEVEN COOKE Carleton University Exploring carry-over effects in salmonid and centrarchid fishes <i>Exploration de l'effet de report chez les poissons salmonidés et centrarchidés</i>
EEE SYM 3 9:30 - 10:00	GLENN CROSSIN Dalhousie University Physiological carryover effects between phases of the annual cycle in migrant birds and fish. <i>Les effets d'un "carryover" physiologique entre les phases du cycle annuel chez les oiseaux et poissons migrants</i>
EEE SYM 4 10:00 - 10:15	PIERRE LEGAGNEUX, GILLES GAUTHIER, PETER FAST, JANE HARMS, GRANT GILCHRIST, CATHERINE SOOS AND JOËL BÉTY Université du Québec Empirical and experimental evidence of carry-over effects on waterfowl reproduction <i>Évidence empirique et expérimentale des effets du "carry-over" sur la reproduction des oies.</i>
EEE SYM 5 10:15 - 10:30	GUSTAVO S. BETINI, CORTLAND K. GRISWOLD AND D. RYAN NORRIS University of Guelph Carry-over effects, sequential density-dependence and the dynamics of populations in a seasonal environment <i>Effets de report, densité-dépendance séquentielle et dynamique des populations dans un environnement saisonnier</i>

Contributed Sessions III / Sessions de communications III (8:30 – 10:30)
CPB 8 / PBC 8: ROZH 106

Cardiorespiratory Control / Contrôle Cardiorespiratoire

Chair/Président: Andrew Turko

CPB8-1 8:30 - 8:45	SABINE L. LAGUË, BEVERLY CHUA, ANTHONY P. FARRELL, YUXIANG WANG AND WILLIAM K. MILSOM University of British Columbia Cardiovascular responses to high altitude hypoxia in bar-headed geese (<i>Anser indicus</i>) and related waterfowl <i>Les réponses cardiovasculaires à l'hypoxie en haute altitude chez l'oie à tête barrée (<i>Anser indicus</i>) et autre sauvagine</i>
CPB8-2 8:45 - 9:00	MICHELLE REICHERT AND WILLIAM MILSOM University of British Columbia Carotid chemoreceptors in <i>Tupinambis merianae</i>: morphological and physiological characteristics <i>Chémorécepteurs carotidiens chez <i>Tupinambis merianae</i>: caractéristiques morphologiques et physiologiques</i>
CPB8-3 9:00 - 9:15	JOSEPH CHAU AND STEPHEN REID University of Toronto Purinergic mechanisms in the midbrain and brainstem regulate breathing in amphibians <i>Les mécanismes purinergiques dans le mésencéphale et le tronc cérébral régulent la respiration chez les amphibiens</i>
CPB8-4 9:15 - 9:30	SARAH JENKIN AND WILLIAM K MILSOM University of British Columbia Dealing with the diaphragm: coordinating respiratory muscles in mammals <i>Une affaire de diaphragme: Coordination des muscles respiratoires chez les mammifères</i>
CPB8-5 9:30 - 9:45	VELISLAVA TZANEVE AND STEVE PERRY University of Ottawa Heme oxygenase-1(HO-1) mediated respiratory responses in the goldfish, <i>Carassius auratus</i> <i>Réponses respiratoires dépendant de l'hème oxygénase-1 (HO-1) chez le cyprin doré, <i>Carassius auratus</i></i>
CPB8-6 9:45 - 10:00	YVONNE A. DZAL AND WILLIAM K. MILSOM University of British Columbia Ventilatory and metabolic responses to hypoxia in hibernating rodents: are hibernators just big babies? <i>Les réponses ventilatoires et métaboliques à l'hypoxie chez les rongeurs hibernants: les hibernateurs sont-ils seulement de gros bébés?</i>
CPB8-7 10:00 - 10:15	ANDREW PETERS AND STEPHEN G. REID University of Toronto, Scarborough The effects of feeding, temperature, sex, & weight on fictive breathing in the cane toad, <i>Bufo marinus</i> <i>Les effets de l'alimentation, température, sexe et poids sur la respiration fictive chez le crapaud géant, <i>Bufo marinus</i></i>

CPB8-8
10:15 - 10:30

COSIMA PORTEUS, YUSUKE KUMAI, SARAH ABDALLAH, WILLIAM K MILSOM AND STEVE PERRY
University of British Columbia
The role of hydrogen sulfide in the control of breathing of zebrafish (*Danio rerio*)
Le rôle du sulfure d'hydrogène sur le contrôle de la respiration du poisson-zèbre (*Danio rerio*)

Contributed Sessions III / Sessions de communications III (8:30 – 10:30)
CPB 9 / PBC 9: ROZH 109

Comparative Endocrinology 1 / Endocrinologie Comparative 1

Chair/Président: Dan Baker

CPB9-1 8:30 - 8:45	<p>JOHN CHANG AND CALEB GREY University of Alberta</p> <p>Interactions between ghrelin (GRLN), growth hormone (GH)-releasing hormone (GHRH) and gonadotropin-releasing hormone (GnRH) in the control of GH and gonadotropin-II (LH) release from perfused goldfish pituitary cells</p> <p><i>Interactions entre la ghréline (GRLN), l'hormone de libération de l'hormone de croissance (GHRH) et l'hormone de libération de la gonadotropine (GnRH) dans le contrôle de la sécrétion de l'hormone de croissance et de la gonadotropine-II (LH) dans une périfusion de cellules hypophysaires de poissons rouges</i></p>
CPB9-2 8:45 - 9:00	<p>JOSHUA PEMBERTON, MICHAEL ORR, MORGAN BOOTH, JAMES STAFFORD AND JOHN CHANG University of Alberta</p> <p>Biased signalling by two endogenous GnRH isoforms in goldfish, <i>Carassius auratus</i>: differential involvement of MEK1/2 in the control of pituitary cell function.</p> <p><i>Signalisation biaisée par deux isoformes endogènes du GnRH chez le poisson rouge, <i>Carassius auratus</i>: Implications distinctes de MEK1/2 dans le contrôle des cellules pituitaires</i></p>
CPB9-3 9:00 - 9:15	<p>CORY SCHILLING, GLEN VAN DER KRAAK AND DEB MACLATCHY University of Guelph</p> <p>Responses of zebrafish to ethinyl estradiol administered via slow release microspheres</p> <p><i>Réponse du poisson zèbre à l'éthinylestradiol administré par microsphères à libération lente</i></p>
CPB9-4 9:15 - 9:30	<p>SONJA BISSEGGER, CHRISTOPHER MARTYNIAK AND VALÉRIE LANGLOIS Royal Military College of Canada</p> <p>Influence of the testosterone degradation pathway in male amphibians reproduction</p> <p><i>Influence des mécanismes de dégradation de la testostérone sur la reproduction des amphibiens mâles</i></p>
CPB9-5 9:30 - 9:45	<p>LAURA SEDRA AND ANGELA B. LANGE University of Toronto</p> <p>Muscle morphology and a possible role of FMRFamide-like peptides (FLPs) on reproduction within the kissing bug, <i>Rhodnius prolixus</i></p> <p><i>Morphologie musculaire et un rôle possible pour les peptides apparentés au FMRFamide (FLPs) dans la reproduction de la punaise hématophage, <i>Rhodnius prolixus</i></i></p>

CPB9-6 9:45 - 10:00	<p>MICHARL CARDINAL-AUCOIN AND COLIN G.H. STEEL York University</p> <p>Clocks in the brain and ovaries interact to regulate rhythmic ecdysteroid levels during egg development in the insect <i>Rhodnius prolixus</i></p> <p><i>Des horloges cérébrales et les ovaires interagissent pour réguler les rythmes d'ecdystéroïdes durant le développement des oeufs de l'insecte Rhodnius prolixus</i></p>
CPB9-7 10:00 - 10:15	<p>MARYAM MASOOD AND IAN ORCHARD University of Toronto</p> <p>Allatotropin in <i>Rhodnius prolixus</i>: gene transcript, distribution and physiological roles</p> <p><i>Allatotropine chez Rhodnius prolixus: Transcription du gène, distribution et rôles physiologiques</i></p>
CPB9-8 10:15 - 10:30	<p>JEAN-PAUL PALUZZI AND IAN ORCHARD University of Toronto</p> <p>Functional identification and RNAi-mediated knockdown of a serotonin receptor expressed in the renal tubules of the Chagas disease vector, <i>Rhodnius prolixus</i></p> <p><i>Identification et inhibition par interférence de l'ARN d'un récepteur sérotonergique exprimé dans les tubules rénaux de l'insecte vecteur de la maladie de Chagas, Rhodnius prolixus</i></p>

Contributed Sessions III / Sessions de communications III (8:30 – 10:30)
CPB 10 / PBC 10: ROZH 103

Toxicology 1 / Toxicologie 1

Chair/Président: Paul Craig

CPB10-1 8:30 - 8:45	MARGARET SILVIA TELLIS, KEVIN BRIX AND CHRIS WOOD McMaster University Developing Experimental Data for a Multi-Metal BLM Framework <i>Développement de données expérimentales pour un cadre BLM multi-métal</i>
CPB10-2 8:45 - 9:00	ERIN M LEONARD, JULIE MARENTETTE, SIGAL BALSHINE AND CHRIS WOOD McMaster University How does nickel bioaccumulation relate to nickel toxicity and behavioural effects in <i>Oncorhynchus mykiss</i> and <i>Neogobius melanostomus</i> following an acute nickel exposure? <i>Quel est le lien entre la bioaccumulation du nickel, sa toxicité et ses effets sur le comportement chez <i>Oncorhynchus mykiss</i> et <i>Neogobius melanostomus</i> après une exposition au nickel aigüe?</i>
CPB10-3 9:00 - 9:15	TAMZIN BLEWETT, SOM NYOGI, SANDRA FEHSENFELD AND CHRIS WOOD McMaster University Making sense of nickel toxicity in saline waters: nickel accumulation in the estuarine crab, <i>Carcinus maenas</i> <i>Donner un sens à la toxicité du nickel dans les eaux salées: accumulation de nickel dans le crabe des estuaires, <i>Carcinus maenas</i></i>
CPB10-4 9:15 - 9:30	KELLY LIVINGSTONE AND JIM MCGEER Wilfrid Laurier University Influence of ecosystem disturbance on dissolved organic matter source quality in mitigating the acute and chronic toxicity of Cu to <i>Hyalella azteca</i> <i>Influence d'une perturbation de l'écosystème sur la qualité de la source de matière organique dissoute et la mitigation de la toxicité aigue et chronique du Cu sur <i>Hyalella azteca</i></i>
CPB10-5 9:30 - 9:45	RABIA NASIR AND JIM MCGEER Wilfrid Laurier University Interactive effects of salinity and dissolved organic matter on Cu toxicity and bioaccumulation in <i>Americamysis bahia</i> <i>Les effets interactifs de la salinité et de la matière organique dissoute sur la toxicité du Cu et la bioaccumulation chez <i>Americamysis bahia</i></i>
CPB10-6 9:45 - 10:00	JESSICA LEUNG, JONATHAN D.S. WITT, WARREN NORWOOD AND D. GEORGE DIXON University of Waterloo Implications of metal toxicity (copper and nickel) in the <i>Hyalella azteca</i> species complex <i>Les implications de la toxicité du cuivre et du nickel dans le complexe d'espèces <i>Hyalella azteca</i></i>

CPB10-7 10:00 - 10:15	<p>MICHEL AMERY DEFO, LOUIS BERNATCHEZ, PETER G.C. CAMPBELL AND PATRICE COUTURE Institut National de la Recherche Scientifique (INRS) A field study examining the temporal dynamics of metal accumulation and depuration and consequences on oxidative stress biomarkers in juvenile yellow perch (<i>Perca flavescens</i>) Étude de terrain de la dynamique temporelle de l'accumulation et l'épuration métallique et des conséquences sur les biomarqueurs du stress oxydatif chez des perchautes juvéniles (<i>Perca flavescens</i>)</p>
CPB10-8 10:15 - 10:30	<p>JULIE GRASSET, BÉRÉNICE BOUGAS, PETER G.C. CAMPBELL, LOUIS BERNATCHEZ AND PATRICE COUTURE Université Laval Combined effects of temperature and metal contamination in yellow perch (<i>Perca flavescens</i>): an ecotoxicogenomic study. Effets combinés de la température et de la contamination métallique chez la perchaude (<i>Perca flavescens</i>) : une étude écotoxicogénomique.</p>

Contributed Sessions III / Sessions de communications III (11:00 – 12:30)

CMD 2 / MDC 2: ROZH 105

“Fish Heads” / Têtes de Poisson

Chair/Président: Andreas Heyland

CMD2-1 11:00 - 11:15	SAMANTHA S. BAKER, ALLYSON OPOKU AND BARBARA ZIELINSKI University of Windsor The distribution of ducts linking the accessory olfactory organ and the main olfactory epithelium in sea lamprey <i>Distribution des conduits reliant l'organe olfactif accessoire et l'épithélium olfactif principal chez la lamproie marine</i>
CMD2-2 11:15 - 11:30	CATHERINE MOREL, RICHARD CLOUTIER AND CLAUDE B. RENAUD Université du Québec How does a lamprey grow: A study of skeletogenesis and metamorphosis in the Sea Lamprey (<i>Petromyzon marinus</i>) <i>Comment croît la lamproie: Une étude de la squelettogenèse et de la métamorphose chez la lamproie marine (<i>Petromyzon marinus</i>)</i>
CMD2-3 11:30 - 11:45	ALYSSA WEINRAUCH AND GREG GOSS University of Alberta Atlas of Anatomy and Histology of the Pacific Hagfish (<i>Eptatretus stoutii</i>) <i>Atlas d'anatomie et histologie de la myxine brune (<i>Eptatretus stoutii</i>)</i>
CMD2-4 11:45 - 12:00	CAROLYN CHANG AND TAMARA A. FRANZ-ODENDAAL Saint Mary's University Perturbing the developing skull: using laser ablation to investigate the robustness of the infraorbital bones. <i>Perturbation du crâne en développement: Utilisation de l'ablation au laser dans l'investigation de la solidité des os infraorbitaux</i>
CMD2-5 12:00 - 12:15	ZABRINA M. PRESCOTT Dalhousie University Specialized tissues result in dramatic modification of the lower jaw in many spawning eusalmonines (trout and salmon) <i>Des tissus spécialisés produisent une modification spectaculaire de la mâchoire inférieure chez de nombreuses espèces de salmoninés (truites et saumons) lors de la fraie</i>
CMD2-6 12:15 - 12:30	CAROLINE LEHOUX AND RICHARD CLOUTIER Université du Québec How to build a fish head: Modularity of lateral line canals in <i>Amia calva</i> <i>Comment construire une tête de poisson : La modularité des canaux de la ligne latérale chez Amia calva</i>

Contributed Sessions III / Sessions de communications III (11:00 – 12:30)
CPB 11 / PBC 11: ROZH 102

Ionoregulation 1 / Régulation Ionique 1

Chair/Président: Ben Speers-Roesch

CPB11-1 11:00 - 11:15	RAYMOND KWONG, DAN AUPRIX AND STEVE PERRY University of Ottawa Involvement of the calcium-sensing receptor in the regulation of calcium homeostasis in developing zebrafish <i>Rôle du récepteur sensible au calcium dans la régulation de l'homéostasie en calcium chez des poissons-zébres en développement</i>
CPB11-2 11:15 - 11:30	JANET GENZ, LAUREN SHUTE AND W. GARY ANDERSON University of Manitoba Growth and the role of MRCs during calcium stress in larval lake sturgeon <i>Croissance et rôle des MRC lors du stress calcique chez les larves d'esturgeon jaune</i>
CPB11-3 11:30 - 11:45	CAROL BUCKING, CHRISTOPHE LEMOINE, ALEXANDRE POULAIN AND PATRICK WALSH University of Ottawa Microbiome impact on gastrointestinal physiology in zebrafish, <i>Danio rerio</i>. <i>L'impact du microbiome sur la physiologie gastro-intestinale chez le poisson zèbre, Danio rerio.</i>
CPB11-4 11:45 - 12:00	HANG NGUYEN, ANGELA B. LANGE AND IAN ORCHARD University of Toronto Increased NaCl transport mediates synergism between serotonin and the diuretic peptide RhoprCRF/DH in the medically-important disease vector <i>Rhodnius prolixus</i> <i>L'augmentation du transport du NaCl cause une synergie entre la sérotonine et le peptide diurétique RhoprCRF/DH chez le vecteur de maladie Rhodnius prolixus</i>
CPB11-5 12:00 - 12:15	HINA AKHTER, PHOUNG BUI AND ANDREW DONINI York University Salinity responsive aquaporin expression in the anal papillae of the larval mosquito, <i>Aedes aegypti</i>. <i>Expression d'aquaporine dépendante de la salinité dans la papille anale des larves du moustique, Aedes aegypti</i>
CPB11-6 12:15 - 12:30	SIMA JONUSAITE, SCOTT KELLY AND ANDREW DONINI York University The larval midge, <i>Chironomus riparius</i>, can inhabit salinated waters by altering ion transport properties of the rectum <i>Les larves du moucheiron, Chironomus riparius, peuvent persister en eau salée en modifiant les propriétés de transport ionique du rectum</i>

Contributed Sessions III / Sessions de communications III (11:00 – 12:30)
CPB 12 / PBC 12: ROZH 109

Comparative Endocrinology 2 / Endocrinologie Comparative 2

Chair/Président: Tegan Williams

CPB12-1 11:00 - 11:15	ANDREAS HEYLAND, ASHLEY MILLER AND EVONNE DONNELLY University of Guelph Iodide function in sea urchin (<i>Strongylocentrotus purpuratus</i>) free radical metabolism during early development <i>L'iode est impliquée dans le métabolisme des radicaux libres pendant le développement de l'oursin de mer (<i>Strongylocentrotus purpuratus</i>)</i>
CPB12-2 11:15 - 11:30	JEAN-PAUL PALUZZI AND ANGELA B. LANGE University of Toronto Functional characterization and expression analysis of the myoinhibiting peptide receptor in the haematophagous hemipteran, <i>Rhodnius prolixus</i> <i>Caractérisation fonctionnelle et analyse de l'expression du récepteur du peptide myo-inhibiteur chez l'hémiptère hématophage, <i>Rhodnius prolixus</i></i>
CPB12-3 11:30 - 11:45	HIMALI PATEL AND ANGELA B. LANGE University of Toronto Distribution and physiological effects of adipokinetic hormone (AKH), corazonin and AKH/corazonin-related peptide (ACP) in the kissing bug, <i>Rhodnius prolixus</i> <i>Distribution et effets physiologiques de l'hormone adipocinétique (AKH), de la corazonine et du peptide associé au AKH/corazonine (ACP) chez la punaise hématophage, <i>Rhodnius prolixus</i></i>
CPB12-4 11:45 - 12:00	SARAH M. TUZIAK, EDWARD A. TRIPPEL AND HELENE VOLKOFF Memorial University of Newfoundland The interactions between background colour and feeding behaviour in Atlantic cod (<i>Gadus morhua</i>) with emphasis on molecular expression of appetite-related hormones <i>Les interactions entre la couleur du fond et le comportement d'alimentation de la Morue Atlantique (<i>Gadus morhua</i>) avec une emphase sur l'expression moléculaire des hormones reliées à l'appétit</i>
CPB12-5 12:00 - 12:15	ANJU MARY PHILIP, EVEN JORGENSEN, ALEC MAULE AND MATHILAKATH VIJAYAN University of Waterloo Extended fasting evokes tissue-specific molecular immune response to lipopolysaccharide challenge in anadromous Arctic charr (<i>Salvelinus alpinus</i>) <i>Un jeûne prolongé occasionne une réponse immunitaire spécifique à des tissus en réponse au défi causé par lipopolysaccharides chez l'omble chevalier (<i>Salvelinus alpinus</i>)</i>

Contributed Sessions III / Sessions de communications III (11:00 – 12:30)
CPB 13 / PBC 13: ROZH 103

Toxicology 2 / Toxicologie 1

Chair/Président: Alex Zimmer

CPB13-1 11:00 - 11:15	MEGHAN FUZZEN, GERALD TETREAULT, MARK MCMASTER AND MARK SERVOS University of Waterloo Impacts of intersex in rainbow darter in the Grand River Watershed in Ontario, Canada <i>Les impacts de l'intersex chez le Dard Arc-en-ciel du bassin versant de la Grand River en Ontario, Canada</i>
CPB13-2 11:15 - 11:30	CATHERINE BRANDT, LIANE ARCINAS, JANET GENZ AND GARY ANDERSON University of Manitoba Effects of chlorpyrifos on in vitro sex steroid production in lake sturgeon, <i>Acipenser fulvescens</i> <i>Les effets du Chlorpyrifos sur la production in vitro de stéroïdes sexuels chez l'esturgeon jaune, Acipenser fulvescens</i>
CPB13-3 11:30 - 11:45	EUGENE CHOI AND JOANNA WILSON McMaster University The effects of chronic acetaminophen exposure on renal function and histology in rainbow trout <i>Effet de l'exposition chronique à l'acétaminophène sur la structure et fonction rénale chez la truite arc-en-ciel</i>
CPB13-4 11:45 - 12:00	LISA SORENSEN, JONATHAN WILSON AND MICHAEL WILKIE Wilfrid Laurier University Reversible effects of the pesticide, 3-trifluoromethyl-4-nitrophenol (TFM) used to control Sea Lamprey populations, on the gills of ecologically sensitive Lake Sturgeon (<i>Acipenser fulvescens</i>) <i>Les effets réversibles du pesticide 3-trifluoromethyl-4-nitrophenol (TFM), utilisé pour contrôler les populations de Lamproie marine, sur les branchies des espèces écologiquement sensibles</i>
CPB13-5 12:00 - 12:15	OLIVER VUKOV AND JIM MCGEER Wilfrid Laurier University Cerium toxicity to <i>Hyalella azteca</i> and <i>Daphnia pulex</i>: protective effects of cationic competition and dissolved organic matter <i>La toxicité du Cerium pour Hyalella azteca et Daphnia pulex: Les effets protecteurs de la compétition cationique et de la matière organique dissoute</i>

Contributed Sessions III / Sessions de communications III (11:00 – 12:30)
CPB/EEE 2 / PBC/EEE 2: ROZH 106

Migration Physiology and Ecology / Physiologie et Écologie de la Migration

Chair/Président: Greg Mitchell

CPB/EEE 2-1 11:00 - 11:15	KRISTIN A. JONASSON AND CHRISTOPHER G. GUGLIELMO University of Western Ontario Stopover durations of spring migrating silver-haired bats <i>Durée des escales lors de la migration printanière de la chauve-souris argentée</i>
CPB/EEE 2-2 11:15 - 11:30	D.T. TYLER FLOCKHART, LEONARD I. WASSENAAR, TARA G. MARTIN, KEITH A. HOBSON, MICHAEL B. WUNDER AND D. RYAN NORRIS University of Guelph Tracking multi-generational colonization of the breeding grounds by monarch butterflies in eastern North America <i>Suivie de la colonisation des sites de reproduction par les papillons Monarchs dans l'Est de l'Amérique du Nord sur plusieurs générations</i>
CPB/EEE 2-3 11:30 - 11:45	GREG W. MITCHELL, D. RYAN NORRIS, PHILIP D. TAYLOR AND CHRISTOPHER G. GUGLIELMO University of Western Ontario Testing the role of migratory birds in the spread of zoonotic disease <i>Test du rôle des oiseaux migrateurs dans la propagation des maladies zootoniques</i>
CPB/EEE 2-4 11:45 - 12:00	CAITLIN L. VANDERMEER, WAYNE BEZNER-KERR, SCOTT A. MACDOUGALL-SHACKLETON AND CHRIS G. GUGLIELMO University of Western Ontario The effect of testosterone on migratory restlessness, body composition and oxidative enzyme activity in white-throated sparrows (<i>Zonotrichia albicollis</i>) during spring migration. <i>Effet de la testotérone sur l'agitation migratoire, la composition corporelle et l'activité de l'enzyme oxidative chez le bruant à gorge blanche (<i>Zonotrichia albicollis</i>)</i>
CPB/EEE 2-5 12:00 - 12:15	BRENDAN MCCABE, ALEXANDER MACMILLAN AND CHRISTOPHER G. GUGLIELMO University of Western Ontario Big digestive systems in juvenile migratory birds and their implications for energetics and behaviour <i>Grands systèmes digestifs chez les oiseaux migrateurs juvéniles et leurs implications pour l'énergétique et le comportement</i>
CPB/EEE 2-6 12:15 - 12:30	CYNTHIA D. FRACI, ÉMILIEN PELLETIER, MAGELLA GUILLEMETTE AND JONATHAN VERREAULT Université du Québec Physiological impacts of the “Deepwater Horizon” oil spill on migratory birds: case study of the Bonaventure Island’s Northern Gannets <i>Impacts physiologiques du déversement de pétrole «Deepwater Horizon» sur les oiseaux migrateurs : cas du Fou de bassan de l’île Bonaventure</i>

Contributed Sessions III / Sessions de communications III (11:00 – 12:30)
EEE 3 / EEE 3: ROZH 107

Biodiversity / Biodiversité

Chair/Président: Alex Smith

EEE3-1 11:00 - 11:15	SARAH ADAMOWICZ University of Guelph Barcodeing a Sub-Arctic Biota: Insights into the Biodiversity of the North <i>Codage à barres d'un biote subarctique: Une idée de la biodiversité du Nord</i>
EEE3-2 11:15 - 11:30	ANDRÉ L MARTEL, PASCAL BERNATCHEZ AND DENIS LACELLE Canadian Museum of Nature Multidisciplinary molluscan research on unique 10K years old seashell deposits of the Northern Gulf of St. Lawrence <i>Recherches malacologiques multidisciplinaires sur des dépôts coquilliers uniques de 10K ans retrouvés le long du golfe du Saint-Laurent</i>
EEE3-3 11:30 - 11:45	M. ALEX SMITH, WINNIE HALLWACHS AND DANIEL H. JANZEN University of Guelph Diversity and phylogenetic community structure of ants along a neotropical elevational gradient measured with DNA barcodes and a multi-gene phylogeny <i>Diversité et structure d'une communauté phylogénétique de fourmis sur un gradient élévationnel néotropical mesurées à l'aide de codes barres génétiques et d'une phylogénie multigénique</i>
EEE3-4 11:45 - 12:00	ELIZABETH A. CHAMBERS University of Guelph Rates of molecular evolution in North American herpetofauna using DNA barcodes: the link between genomic change and diversification <i>Taux d'évolution moléculaire de l'herpétofaune Nord-Américaine démontrés par codes barres génétiques: lien entre le changement génomique et la diversification</i>
EEE3-5 12:00 - 12:15	ROBERT G. YOUNG, SARAH ADAMOWICZ, CATHRYN ABBOTT AND THOMAS TERRIAULT University of Guelph Evaluating the biodiversity of Canadian plankton <i>Évaluation de la biodiversité du plancton Canadien</i>
EEE3-6 12:15 - 12:30	FIONA J. TSOI, BRIAN L. FISHER AND M. ALEX SMITH University of Guelph A Wolbachia survey of Malagasy ants <i>Étude de la bactéries Wolbachia chez les fourmies Malgaches</i>

Contributed Sessions III / Sessions de communications III (11:00 – 12:30)

PIE 1 / PIE 1: ROZH 108

Immunology 1 - Therapy, Environment and Receptors / Thérapie, Environnement et Récepteurs

Chair/Président: Lena Measures

PIE1-1 11:00 - 11:15	LAURA V FERGUSON AND BRENT J SINCLAIR Western University Ecoimmunology in the cold: effects of overwintering on immune activity in the spring field cricket, <i>Gryllus veletis</i> Éco-immunologie dans le froid: les effets de l'hivernage sur l'activité immunitaire du grillon, <i>Gryllus veletis</i>
PIE1-2 11:15 - 11:30	SHAWNA SEMPLE, N.T.K. VO, TERIN ROBINSON, LITAL SEVER, NEILS BOLS AND BRIAN DIXON University of Waterloo Establishment of a continuous cell line from arctic charr, <i>salvelinus alpinus</i>, for physiological and immunological studies. Établissement d'une lignée cellulaire continue de l'omble Arctique, <i>Salvelinus alpinus</i>, pour études physiologiques et immunologiques
PIE1-3 11:30 - 11:45	STEVEN KUNTZ, CHRIS WILSON AND BRIAN DIXON University of Waterloo Stocking decreases major histocompatibility (MH) allele diversity in populations of ontario lake trout (<i>salvelinus namaycush</i>) L'ensemencement diminue la diversité allélique du complexe majeur d'histocompatibilité dans les populations du touladi (<i>Salvelinus namaycush</i>) en Ontario
PIE1-4 11:45 - 12:00	HERMAN D. CORTES, MYRON A. ZWOZDESKY, DUSTIN M.E. LILLICO, ALLEN O'BRIEN AND JAMES L. STAFFORD University of Alberta Channel catfish leukocyte immune-type receptors exhibit functional plasticity Les récepteurs de leukocyte de type immunitaire des Poissons-Chats démontrent de la plasticité fonctionnelle
PIE1-5 12:00 - 12:15	DUSTIN M.E. LILLICO, MYRON ZWOZDESKY, HERMAN D. CORTES, ALLEN O'BRIEN, JOSHUA G. PEMBERTON, JOHN P. CHANG AND JAMES L. STAFFORD*

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



T.W.M. Cameron

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.

Dr. Erika Eliason, University of Sydney

Sockeye salmon in hot water: population differences in cardiorespiratory performance and thermal tolerance

Saumon Sockeye dans l'eau chaude: Différentes performances cardio-respiratoires et tolérance thermique entre populations



Dr. Erika Eliason received her BSc in Biological Sciences from Simon Fraser University. She conducted her graduate student training (MSc and PhD) with Dr. Tony Farrell in the Comparative Physiology Research Group at the University of British Columbia. After a brief stint as a postdoctoral researcher with Dr. Scott Hinch in the Centre for Applied Conservation Research at UBC, Erika took up her NSERC Postdoctoral Fellowship at the University of Sydney with Dr. Frank Seebacher.

Throughout the last decade, Erika has conducted research at 7 different institutions in 6 countries (Canada, Australia, England, Norway, Puerto Rico, Fiji), studying topics as diverse as bark beetle communication, coral reef conservation and sexual behavior in monkeys before concentrating on fish

physiology for her MSc and PhD. Her current research interests focus on understanding the underlying physiological mechanisms of ecological phenomena and conservation problems.

Abstract: Every year, millions of sockeye salmon return to the Fraser River (BC, Canada) to perform their once-in-a-lifetime upriver spawning migration. There are over 100 geographically and genetically distinct populations within the Fraser River watershed, each of which experiences unique upriver migration conditions varying in migration distance, elevation gain, river temperature and river flow. Climate change-induced increases in summer river temperature have been associated with exceptionally high mortality in migrating salmon, raising conservation concerns. This research examined thermal tolerance and local adaptation across sockeye salmon populations over several levels of biological organization, from whole animal swimming and cardiorespiratory performance, organ performance, gross organ morphology, ultrastructure and receptors. Fraser River sockeye salmon populations appear to have physiologically adapted to their local upriver migration environment. In addition, some populations may be more susceptible to continued river warming, which has clear conservation concerns for biodiversity.

Contributed Sessions IV / Sessions de communications IV (15:30 – 17:00)

CMD/PIE / MDC/PIE: ROZH 106

Student Satellite Symposium: Parasite-Induced Changes in Host Behavior and Morphology / Symposium Satellite des Étudiants: Changements du Comportement et de la Morphologie Causés par les Parasites

Chair/Président: Terin Robinson and Michael Cardinal-Aucoin

CMD/PIE-1 15:30 - 15:45	SHELLEY ADAMO Dalhousie University The strings of the puppetmaster: Parasitic manipulation of host hormones and behaviour <i>Les ficelles du marionnettiste: Manipulation parasitaire du comportement et des hormones d'un hôte</i>
CMD/PIE-2 15:45 - 16:00	IGA STASIAK, DALE SMITH, MIAN HAFEEZ, PAULINE DELNATTE AND JOHN BARTA University of Guelph Mortality associated with infection by two novel species of systemic Isospora (Atoxoplasma) in two passerine species [superb glossy starling (<i>Lamprotornis superbus</i>), black-throated laughing thrush (<i>Garrulax chinensis</i>)] in a zoo collection <i>Mortalité associée à l'infection par deux nouvelles espèces du genre Isospora (Atoxoplasma) chez les passereaux choucador superbe (<i>Lamprotornis superbus</i>) et garrulaxe à joues blanches</i>
CMD/PIE-3 16:00 - 16:15	ANA GRADIL, MARK FAST, GLENDA WRIGHT, DAVID SPEARE, DOROTA WADOWSKA AND SARA PURCELL University of Prince Edward Island Temperature effects on immunological development and responsiveness in juvenile shortnose sturgeon (<i>Acipenser brevirostrum</i>) <i>Effets de la température sur le développement et la réactivité immunologique dans esturgeon juvénile (<i>Acipenser brevirostrum</i>)</i>
CMD/PIE-4 16:15 - 16:30	JORDAN POLEY University of Prince Edward Island Molecular mechanisms involved in sea lice (<i>Lepeophtheirus salmonis</i>) resistance to common chemotherapeuticants <i>Mécanismes moléculaires impliqués dans la résistance du pou du poisson (<i>Lepeophtheirus salmonis</i>) aux produits thérapeutiques chimiques</i>
CMD/PIE-5 16:30 - 16:45	HEATHER J WOTTON, JOSE TRONCOSO, JORGE PINO, SARA PURCELL, JENNIFER COVELLO, MARK FAST AND SIMON WADSWORTH University of Prince Edward Island Evaluation of an in vitro method of testing an anti-attachment factor on <i>Lepeophtheirus salmonis</i> <i>Évaluation d'une méthode in vitro pour tester un facteur anti-attachement sur <i>Lepeophtheirus salmonis</i></i>

Contributed Sessions IV / Sessions de communications IV (15:30 – 17:00)

CPB14 / PBC14: ROZH 102

Ionoregulation 2 / Régulation Ionique 2

Chair/Président: Milica Mandic

CPB14-1 15:30 - 15:45	YUSUKE KUMAI, COSIMA PORTEUS AND STEVE PERRY University of Ottawa How to prevent salt overload: A role for hydrogen sulfide in inhibiting Na⁺ uptake by freshwater fish <i>Comment prévenir un surplus de sel: Le rôle du sulfide d'hydrogène dans l'inhibition d'absorption de Na⁺ chez les poissons d'eaux douces</i>
CPB14-2 15:45 - 16:00	EMILY J GALLAGHER AND COLIN J. BRAUNER University of British Columbia Plasticity of larval ionoregulatory development in rainbow trout <i>Plasticité développementale des mécanismes d'ionorégulation chez les larves de truite arc-en-ciel</i>
CPB14-3 16:00 - 16:15	ANNE DALZIEL, MILICA MANDIC, JESSE BITTMANN, MICHELLE OU AND PATRICIA SCHULTE Université Laval The evolution of salinity-responsive Na⁺, K⁺ ATPase gene duplicates in salmonids <i>L'évolution des Na⁺, K⁺ ATPase isoforms salinité sensibles chez les salmonidés</i>
CPB14-4 16:15 - 16:30	SAMUEL GUFFEY AND GREG GOSS University of Alberta Dogfish sharks in low salinity: time course of acute homeostatic response <i>Aiguillats en faible salinité: Évolution temporelle de la réponse homéostatique aigüe</i>
CPB14-5 16:30 - 16:45	NICOLE NADER AND TILLMANN BENFEY University of New Brunswick Effects of ploidy on cell volume regulation in brook trout (<i>Salvelinus fontinalis</i>) <i>Les effets de la ploidie sur la régulation du volume des cellules erythrocytes chez l'omble de fontaine (<i>Salvelinus fontinalis</i>)</i>
CPB14-6 16:45 - 17:00	DENNIS KOLOSOV AND SCOTT P KELLY York University The tricellular tight junction protein tricellulin contributes to the regulation of gill epithelium integrity and paracellular permeability <i>La protéine de jonction serrée tricellaire tricellulin contribue à la régulation de l'intégrité de l'épithélium des branchies et à la perméabilité paracellulaire.</i>

Contributed Sessions IV / Sessions de communications IV (15:30 – 17:00)

CPB 15 / PBC 15: ROZH 105

Stress Physiology / Physiologie du Stress

Chair/Président: Mike Wilkie

CPB15-1 15:30 - 15:45	SARAH ALDERMAN AND MATHILAKATH VIJAYAN University of Waterloo Managing stress: a cortisol inactivation <i>Gérer le stress: une inactivation du cortisol</i>
CPB15-2 15:45 - 16:00	JENNIFER JEFFREY, STEVEN COOKE AND KATHLEEN GILMOUR University of Ottawa Regulation of hypothalamic-pituitary-interrenal axis function in male smallmouth bass during parental care <i>La régulation de la fonction de l'axe hypothalamo-hypophyso-interrénal durant les soins parentaux chez l'achigan à petite bouche</i>
CPB15-3 16:00 - 16:15	DINUSHAN NESAN AND MATHILAKATH VIJAYAN* University of Waterloo Maternal cortisol deposition influences larval stress response in zebrafish <i>Le cortisol maternel influence la réponse au stress des larves du poisson zèbre</i>
CPB15-4 16:15 - 16:30	MARILYN VERA CHANG, THOMAS MOON AND VANCE TRUDEAU University of Ottawa A transgenerational study on the impact of waterborne fluoxetine concentrations on the stress axis of both sexes of zebrafish <i>Danio rerio</i> <i>Étude transgénérationnelle de l'impact du fluoxétine en milieu aquatique sur l'axe du stress chez le poisson zèbre <i>Danio rerio</i></i>
CPB15-5 16:30 - 16:45	NATALIYA MELNYK-LAMONT AND MATHILAKATH VIJAYAN University of Waterloo Effects of antidepressant venlafaxine on hypothalamic-pituitary-interrenal axis in rainbow trout <i>Effets de l'antidépresseur venlafaxine sur l'axe hypothalamo-hypophyso-interrénal de la truite arc-en-ciel</i>
CPB15-6 16:45 - 17:00	FAITH MARGARET PENNY AND JAMES KIEFFER University of New Brunswick Juvenile shortnose sturgeon exhibit limited physiological responses to acute salinity exposure (Or, “Why I wish I was more like a sturgeon”) <i>Les juvéniles de l'esturgeon à museau court démontrent une réponse physiologique limitée lors d'exposition à la salinité aigüe (Ou, “Pourquoi j'aimerais parfois être un esturgeon”)</i>

Contributed Sessions IV / Sessions de communications IV (15:30 – 17:00)
CPB 16 / PBC 16: ROZH 103

Toxicology 3 / Toxicologie 3

Chair/Président: Derek Alsop

CPB16-1 15:30 - 15:45	ANDREY MASSARSKY, REN ABRAHAM, KATHY NGUYEN, PETER RIPPSTEIN, AZAM TAYABALI, VANCE TRUDEAU AND THOMAS MOON University of Ottawa Using in vitro systems to assess the toxicity of nanosilver <i>L'utilisation de systèmes in vitro pour déceler la toxicité du nanoargent</i>
CPB16-2 15:45 - 16:00	TYSON MACCORMACK, KATHRYN BUTLER, ALEXANDRA BLAY, NEAL CALLAGHAN AND CHRISTOPHER DIENI Mount Allison University Getting to the heart (and gills) of nanotoxicology: cardiorespiratory toxicity of commercially relevant nanoparticles <i>Le cœur (et les branchies) de la nanotoxicologie: Toxicité cardiorespiratoire de nanoparticules utilisées commercialement</i>
CPB16-3 16:00 - 16:15	LINDSEY FELIX, VAN ORTEGA, JAMES EDE AND GREG GOSS University of Alberta Effects of coated nanoparticles on zebrafish (<i>Danio rerio</i>) <i>Effets des nanoparticules enrobées sur le poisson zèbre (<i>Danio rerio</i>)</i>
CPB16-4 16:15 - 16:30	CHRISTOPHER A. DIENI, CHRISTOPHER J.L. STONE, M. LUKE ARMSTRONG, NEAL I. CALLAGHAN AND TYSON J. MACCORMACK Mount Allison University In vitro approaches to understanding the biochemical basis of gold nanoparticle toxicity in animals <i>Approches in vitro pour comprendre les bases biochimiques de la toxicité des nanoparticules d'or chez les animaux</i>

Contributed Sessions IV / Sessions de communications IV (15:30 – 17:00)
EEE 4 / EEE 4: ROZH 109

Evolution / Évolution

Chair/Président: Tyler A. Elliot

EEE4-1 15:30 - 15:45	TYLER A. ELLIOTT AND T. RYAN GREGORY University of Guelph Appeal for a shift in the way we study transposable element evolution <i>Appel pour un changement dans la façon dont nous étudions l'évolution des éléments transposables</i>
EEE4-2 15:45 - 16:00	NICHOLAS JEFFERY AND T. RYAN GREGORY University of Guelph Genome size and speciation in cryptic crustaceans <i>Taille du génome et spéciation chez les crustacées cryptiques</i>
EEE4-3 16:00 - 16:15	TERIN ROBINSON, PABLO CONJEROS, MICHAEL POWER AND BRIAN DIXON University of Waterloo Polymorphism of major histocompatibility class I classical and non-classical genes in Arctic charr (<i>Salvelinus alpinus</i>) <i>Polymorphisme de gènes classiques et non classiques de classe I du complexe majeur d'histocompatibilité chez l'omble chevalier (<i>Salvelinus alpinus</i>)</i>
EEE4-4 16:15 - 16:30	T FATIMA MITTERBOECK AND SARAH J ADAMOWICZ University of Guelph The macroevolutionary effects of flight loss in insects differ across timescales <i>Les effets macroévolutionnaires de perdre la capacité du vol chez les insectes diffèrent selon les échelles de temps</i>
EEE4-5 16:30 - 16:45	STEPHANIE PEDERSEN, BRIAN GLEBE, STEVE LEADBEATER, SIGBJØRN LIEN, LEI LIU, ARNE ROSETH AND ELIZABETH BOULDING* University of Guelph The mapping of quantitative trait loci associated with morphometrics and parr marks in an F2 cross of European and North American strains of cultured Atlantic salmon <i>Localisation des locus de caractères quantitatifs associés à la morphométrie et aux marques de tacons dans un croisement F2 de souches Européennes et Nord-Américaines de saumons Atlantiques d'élevage</i>

Contributed Sessions IV / Sessions de communications IV (15:30 – 17:00)

PIE 2 / PIE 2: ROZH 108

Ecology and Parasitism / Écologie et Parasitisme

Chair/Président: Mike Duffy

PIE2-1 15:30 - 15:45	SPENCER GREENWOOD, EBO BUDU-AMOAKO, FABIENNE UEHLINGER AND J MCCLURE University of Prince Edward Island Transmission cycles & potential zoonotic transfer of cryptosporidium & giardia on the million acre farm <i>Cycles de transmission et potentiel de transfer zoonotique de Cryptosporidium et Giardia sur la ferme 'million acre'</i>
PIE2-2 15:45 - 16:00	JESSICA WILLIS, J T. MCCLURE, CAROL MCCLURE, JEFF DAVIDSON AND SPENCER J. GREENWOOD University of Prince Edward Island Detection of <i>Cryptosporidium</i> sp. and <i>Giardia duodenalis</i> in Eastern oysters (<i>Crassostrea virginica</i>) from Prince Edward Island, Canada <i>Détection de Cryptosporidium sp. ainsi que de Giardia duodenalis chez l'huître de l'Est (<i>Crassostrea virginica</i>) de l'Île du Prince Edward, Canada</i>
PIE2-3 16:00 - 16:15	MARK T. MERILO, SARAH J. ADAMOWICZ AND R. AYESHA ALI University of Guelph Insights into the coevolution of symbiotic species through a phylogenetic meta-analysis <i>Regards sur la coévolution des espèces symbiotiques par le biais d'une métanalyse phylogénétique</i>
PIE2-4 16:15 - 16:30	TYLER PACK AND ALLEN SHOSTAK University of Alberta Characterization of new inbred flour beetle lines generated to study effects of parasitism on host reproduction <i>Caractéristiques de nouvelles lignées de triboliums générées pour étudier les effets du parasitisme sur la reproduction de l'hôte</i>
PIE2-5 16:30 - 16:45	NATHAN N.T.K. VO, JOHN S. LUMSDEN, BRIAN DIXON, LUCY E.J. LEE AND NIELS C. BOLS University of Waterloo Responses of double-stranded RNA (dsRNA) in cultured cells from walleye, <i>Sander vitreus</i> and other teleosts <i>Réponses de l'ARN double brin chez des cellules cultivées du doré jaune, <i>Sander vitreus</i>, et autres téléostéens</i>

Contributed Sessions IV / Sessions de communications IV (15:30 – 17:30)

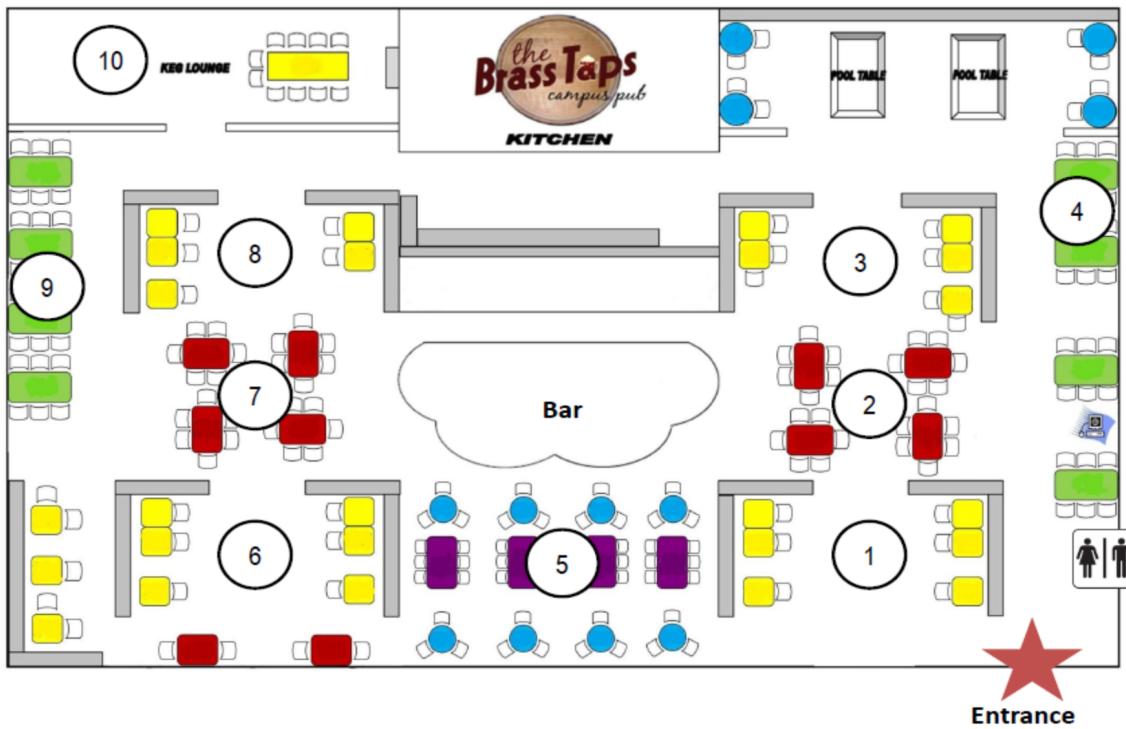
EEE - Invited Session / EEE- Session Invitée: ROZH 107

From Toxicology to Behaviour to Biodiversity - Aspects of Ecology / De la Toxicologie au Comportement à la Biodiversité – Les Differents Aspects de l'Écologie

Chair/Président: Liz Boulding

EEE IS-1 15:30 - 16:00	PATRICIA GILLIS Environment Canada The impact of poor water quality on freshwater mussels: a potential barrier to endangered species recovery <i>L'impact d'une mauvaise qualité de l'eau sur les moules d'eaux douces: une barrière potentielle pour le rétablissement des espèces en voie de disparition</i>
EEE IS-2 16:00 - 16:30	SIGAL BALSHINE, KAREN COGLIATI, JOHN FITZPATRICK AND BRYAN NEFF McMaster University Sperm competition and paternity loss in a singing fish, the plainfin midshipman. <i>Compétition spermatique et perte de paternité chez un poisson chanteur, Porichthys notatus</i>
EEE IS-3 16:30 - 17:00	SHELLEY ARNOTT Queen's University Dispersal mediates zooplankton response to environmental change. <i>Réponse du zooplankton régulée par la dispersion face à un changement de l'environnement</i>
EEE IS-4 17:00 - 17:15	ANNELI JOKELA, SHELLEY ARNOTT AND BEATRIX BEISNER Queen's University Biotic resistance of an introduced predator's impact via niche contraction <i>La résistance biotique à l'impact d'un prédateur introduit via une contraction de la niche</i>
EEE IS-5 17:15 - 17:30	ERIN MCCALLUM, RACHEL CHARNEY AND SIGAL BALSHINE McMaster University In it for the long haul: Changes in population characteristics of the invasive round goby <i>À pour le long terme: Changements des caractéristiques de populations de gobie à taches noires, une espèce invasive</i>

How to be the best; Strategies to succeed. Comment faire de son mieux, Stratégies pour la réussite.



- 1. How to wow your audience:** Oral presentations at conferences
G. Scott (McMaster U) & J Richards (UBC)
- 2. Academic job applications:** From cover letters to interview strategies
B. Fenton (Western U) & J. Goldberg (Mount Royal U)
- 3. How to explore the world on someone else's dime:** Research/Travel
B. Milsom (UBC) & B. Sinclair (Western U)
- 4. Getting the message across to non-scientists:** How to avoid the glazed over look
K. Knight (JEB) & A. Vowles (U Guelph, University Communications)
- 5. How to choose the next step:** Picking your PhD or PDF
G. Goss (U. Alberta), C. Brauner (UBC) & R. Norris (U. Guelph)
- 6. Work/Life balance:** How to have a life outside of science
T. Schulte (UBC) & J. Staples (Western U)
- 7. When do I start writing?** Time management for grad students
G. McClelland (McMaster U) & S. Kelly (York U)
- 8. Putting your best foot forward:** How to build and write a CV
L. Milligan (Western U) & S. Currie (Mt.A)
- 9. Toddlers and teleosts:** Raising kids while running experiments
S. Adamowicz (U Guelph), K. Gilmour (Ottawa U) & T. Gillis (U Guelph)
- 10. Stiff competition:** Writing and effective scholarship application
N. Bernier (U Guelph) & G. Van Der Kraak (U Guelph)

Posters / Affiches

1	<p>Determinants of snail and trematode distribution and compatibility Déterminants de la distribution et compatibilité des escargots et trématodes Michelle A. Gordy, Sara V. Brant, Erika T. Gendron, Patrick C. Hanington <i>University of Alberta</i></p>
2	<p>Characterizing dsRNA production in virus- infected fish cells Production d'ARN viral à double brin dans des cellules de poisson soumises à une infection virale Amal Aloufi, Stephanie DeWitte-Orr <i>Wilfrid Laurier University</i></p>
3	<p>Apolipoprotein in Rainbow Trout and Walleye Les apolipoprotéines chez la truite arc-en-ciel et le doré jaune Adrian Di Natale, Spencer Russell, Alexandra Reid, John Lumsden <i>University of Guelph</i></p>
4	<p>Fibrinogen-related protein (FREP) 3 and its role in the snail immune response against trematodes La protéine apparentée au fibrinogène 3 (FREP) et son rôle dans la réponse immunitaire contre les trématodes chez l'escargot E.A. Pila, M.A. Gordy, P.C. Hanington <i>University of Alberta</i></p>
5	<p>Effects of interspecific competition between intraerythrocytic blood parasites <i>Hepatozoon clamatae</i> and <i>Hepatozoon catesbeiana</i> in green frogs, <i>Rana clamitans</i> Les effets sur la compétitions interspécifiques entre les parasites intra-érythrocytique <i>Hepatozoon clamatae</i> et <i>Hepatozoon catesbeiana</i> chez la grenouille verte, <i>Rana clamitans</i> Michael Trites, Todd Smith <i>Acadia University</i></p>
6	<p>Host-specificity and freeze tolerance of intraerythrocytic blood parasites <i>Hepatozoon clamatae</i> and <i>Hepatozoon catesbeiana</i> in wood frogs, <i>Rana sylvatica</i> Hôte spécificité et tolérance à la congélation des parasites intra-érythrocytiques <i>Hepatozoon clamatae</i> et <i>Hepatozoon catesbeiana</i> chez la grenouille des bois, <i>Rana sylvatica</i> Sean McGee, Chelsea Hammer, Todd Smith <i>Acadia University</i></p>

7	<p>Parasitic <i>Tetrahymena</i> differ from free-living species in their behaviour and ability to destroy fish cells in a mixed cell culture system Les espèces de <i>Tetrahymena</i> parasitiques et non-parasitiques diffèrent dans leur comportement et leur capacité à détruire des cellules de poisson dans une culture mixte</p> <p>Marcel Pinheiro, Niels Bols <i>University of Waterloo</i></p>
8	<p>Identification of Major Histocompatibility Class IIβ alleles conferring resistance/susceptibility to <i>Flavobacterium psychrophilum</i> Identification d'allèles de classe IIβ du complexe majeur d'histocompatibilité qui confèrent résistance ou susceptibilité au <i>Flavobacterium psychrophilum</i></p> <p>Calvin Kellendonk, John Lumsden, Brian Dixon <i>University of Waterloo</i></p>
9	<p>Developing IFN1, IFNγ and IL-1β quantitative ELISA and ELISpot using polyclonal antibodies developed from rainbow trout (<i>Oncorhynchus mykiss</i>) Développement d'un ELISA et ELISpot IFN1, IFNγ et IL-1β quantitatif utilisant des anticorps polyclonaux développés à partir de la truite arc-en-ciel (<i>Oncorhynchus mykiss</i>)</p> <p>C. Soulliere, L. Sever, S. Lam, N. Vo, J. Iwanczyk and J. Kooistra, E. Johnson, N. Bols and B. Dixon <i>University of Waterloo</i></p>
10	<p>Effects of deoxynivalenol contaminated feed on rainbow trout (<i>Oncorhynchus mykiss</i>) experimentally infected with <i>Flavobacterium psychrophilum</i> Effets des aliments contaminés avec le déoxynivalénol sur la truite arc-en-ciel (<i>Oncorhynchus mykiss</i>) infectée expérimentalement avec <i>Flavobacterium psychrophilum</i></p> <p>Ian Ryerse, Jamie Hooft, Dominique Bureau, Anthony Hayes, John Lumsden <i>University of Guelph</i></p>
11	<p>Defining new roles of scavenger receptors in alternative animal models: evidence of function class A scavenger receptors in rainbow trout epithelial cell lines Attribution de nouveaux rôles aux récepteurs scavenger chez des modèles animaux alternatifs: Évidence du rôle fonctionnel des récepteurs scavenger de classe A dans une lignée de cellules épithéliales de truite arc-en-ciel</p> <p>Jeremy Weleff, Stephanie DeWitte-Orr <i>Wilfrid Laurier University</i></p>
12	<p>Establishing <i>Loma morhua</i> infections in naïve Atlantic cod Etablir des infections de <i>Loma morhua</i> dans des morues de L'Atlantique naïves</p> <p>A.P. Frenette, M. O'Neill, H. Byrne, K. Moraitis, M.D.B. Burt, and M.S. Duffy <i>University of New Brunswick,</i></p>

13	<p>Studying phagocytic activity of a rainbow trout monocyte/macrophage cell line Étude de l'activité phagocytaire dans une lignée cellulaire monocyte/macrophage de truite arc-en-ciel</p> <p>Dustin A Ammendolia, Nathan NTK Vo, Litel Sever, Lucy EJ Lee, Brian Dixon, Niels C Bols <i>University of Waterloo</i></p>
14	<p>VHSV IVb replication over a broad range of temperatures in walleye fin cells Répllication du VHSV IVb sur un large intervalle de températures dans des cellules de nageoires de doré</p> <p>Aaron W. Bender, Nathan N.T.K. Vo, Emily J. Li, John S. Lumsden, Brian Dixon, Niels C. Bols <i>University of Waterloo</i></p>
15	<p>Steps toward building an atlas of <i>Daphnia magna</i> morphology Mesures vers la construction d'un atlas morphologique de <i>Daphnia magna</i></p> <p>Jamie-Lee Giardini, Andreas Heyland <i>University of Guelph</i></p>
16	<p>Slime gland cytology and mechanisms of slime thread production in the Atlantic hagfish (<i>Myxine glutinosa</i>) Cytologie des glandes à mucus et mécanismes de production des fils visqueux chez la myxine du nord (<i>Myxine glutinosa</i>)</p> <p>Timothy Winegard, Douglas Fudge <i>University of Guelph</i></p>
17	<p>Renewable material from hagfish slime thread proteins Matériau renouvelable à partir des protéines filamenteuses du mucus de myxinés</p> <p>Atsuko Negishi, Laurent Kreplak, Claire Armstrong, Maikel Rheinstadter, Loong-Tak Lim, Todd Gillis, Douglas Fudge <i>University of Guelph</i></p>
18	<p>Spontaneous thread skein unraveling in Pacific hagfish <i>Eptatretus stoutii</i> Démêlage spontané des fils d'écheveaux chez la myxine brune <i>Eptatretus stoutii</i></p> <p>Mark Bernards, Douglas Fudge <i>University of Guelph</i></p>

19	<p>Mucin release from the vesicles of Pacific hagfish (<i>Eptatretus stoutii</i>) slime glands Libération de mucine des glandes à mucus chez la myxine brune (<i>Eptatretus stoutii</i>)</p> <p>Julia Herr, Alex Clifford, Greg Goss, Douglas Fudge <i>University of Guelph</i></p>
20	<p>The impact of predator size, speed, and attack orientation on escape manuevers in sharks L'impact de la taille, vitesse et orientation d'attaque des prédateurs sur les manœuvres d'échappement des requins</p> <p>Scott Seamone, Timothy Higham <i>Dalhousie University</i></p>
21	<p>Spatial and temporal events in tooth development in Teleost fish <i>Astyanax mexicanus</i> Événements spatiotemporels lors du développement dentaire chez le poisson téléostéen <i>Astyanax mexicanus</i></p> <p>Christine Hammer, ADS Atukorala, Tamara A. Franz-Odendaal <i>Mount Saint Vincent University</i></p>
22	<p>Multilocus phylogeny and divergence times of the talpid mole family Phylogénie multilocus et temps de divergence des taupes talpidés</p> <p>Kai He, Akio Shinohara, Kevin L. Campbell <i>University of Manitoba</i></p>
23	<p>Fecundity and oocyte development of round goby in Lake Michigan Fécondité et développement des ovocytes de gobie à taches noires dans le lac Michigan</p> <p>Meg Kline, Sergiusz Czesny <i>University of Illinois</i></p>
24	<p>Life in the fast lane: associations between growth and the timing of life history events in rainbow trout (<i>Oncorhynchus mykiss</i>) Vivre dans la voie rapide: Les associations entre la croissance et le timing des évènements de la vie chez la truite arc-en-ciel (<i>Oncorhynchus mykiss</i>)</p> <p>Melissa Allen, Moira Ferguson, Roy Danzmann <i>University of Guelph</i></p>

25	<p>Detecting SNP association with resistance to the salmon louse in Atlantic salmon Détection des associations entre SNP et la résistance au pou du saumon chez le saumon de l'Atlantique</p> <p>Christina M. Rochus, Keng P. Ang, Brian D. Glebe and Steven Leadbeater, Matthew P. Kent and Sigbjørn Lien, Lawrence R. Schaeffer and Jane J. Tosh, Elizabeth G. Boulding</p> <p><i>University of Guelph</i></p>
26	<p>A novel ancestor-descendent population approach to finding DNA markers for economically important traits to use in Atlantic salmon breeding programs Nouvelle approche pour explorer les marqueurs génétiques commerciaux dans les programmes d'élevage du saumon de l'Atlantique</p> <p>Lei Liu, Ang Keng, Jake Elliott, Matthew Kent, Sigbjørn Lien, Danielle Macdonald, Elizabeth Boulding</p> <p><i>University of Guelph</i></p>
27	<p>Genetic variation and potential sources of the non-native sea squirt <i>Botryllus schlosseri</i> in Newfoundland Variation génétique et origines potentielles du tunicier non indigène <i>Botryllus schlosseri</i> à Terre-Neuve</p> <p>Ainsley Latour, Dawn Marshall, Don Deibel</p> <p><i>Memorial University of Newfoundland</i></p>
28	<p>Conservation of amphibians and reptiles in a threatened region of the Amazonian rainforest in Brazil Conservation des amphibiens et reptiles dans une zone de forêt tropicale menacée au Brésil</p> <p>Pedro H. Bernardo, Santiago J. Sanchez-Pacheco</p> <p><i>University of Toronto</i></p>
29	<p>Linkage mapping of quantitative trait loci corresponding to shell morphology divergence between high and low shore ecotypes of <i>Littorina saxatilis</i> Cartographie génétique de loci à caractères quantitatifs correspondants aux divergences morphologiques de la coquille entre les écotypes de haut et bas rivage chez <i>Littorina saxatilis</i></p> <p>Joseph Anthony Kess, Fiona Harper, Elizabeth Boulding</p> <p><i>University of Guelph</i></p>

30	<p>Interacting effects of predation and competition on dispersal dynamics Effets interactifs de la prédation et de la compétition sur la dynamique de dispersion</p> <p>Celina Baines, Locke Rowe <i>University of Toronto</i></p>
31	<p>Causes and consequences of variation in male and female mating interactions Les causes et conséquences de la variation des interactions reproductives entre mâles et femelles.</p> <p>Hannah Tennant, Erin Sonser, Tristan A.F. Long <i>Wilfrid Laurier University</i></p>
32	<p>Using the extended Price equation to analyze patterns of body size change in mammals across the Paleocene-Eocene Thermal Maximum in North America Utilisation de l'équation prolongée de Price pour l'analyse du changement de taille corporelle des mammifères autour du maximum thermal Paléocène-Éocène Nord-Américain</p> <p>Brian Rankin, Joshua Lutke, Christian Barron-Ortiz, Xingkai Yang, Jeremy Fox, Jessica Theodor <i>University of Calgary</i></p>
33	<p>Habitat quality affects the physiological condition of largemouth bass (<i>Micropterus salmoides</i>) La qualité de l'habitat affecte l'état physiologique des achigans à grande bouche (<i>Micropterus salmoides</i>)</p> <p>Greg King, Cory Suski, Steven Cooke, Jacqueline Chapman <i>University of Illinois</i></p>
34	<p>Does cold exposure activate the insect immune system? Est-ce que l'exposition au froid active le système immunitaire des insectes?</p> <p>Golnaz Salehipour-shirazi, Brent J. Sinclair <i>Western University</i></p>
35	<p>Effects of rearing salinity on unstimulated and stimulated larval Malpighian tubule secretions of <i>Chironomus riparius</i> Effet de la salinité d'élevage sur les sécrétions des tubes de Malpighi chez les larves de <i>Chironomus riparius</i></p> <p>Melika Zadeh Tahmasebi, Andrew Donini <i>York University</i></p>

36	<p>Separation and quantification of putative pheromones released by reproductive male round gobies Séparation et quantification de phéromones putatives libérées par les mâles reproducteurs de gobies à taches noires</p> <p>Michelle Farwell, Jennifer Smith, Eric Clelland, Barbara Zielinski <i>University of Windsor</i></p>
37	<p>Migratory condition but not flight increases activity of muscle oxidative enzymes in yellow rumped warblers La condition migratoire, mais pas le vol, augmente l'activité des enzymes oxydatives musculaires chez la paruline à croupion jaune</p> <p>Morag F Dick, Christopher G Guglielmo <i>University of Western Ontario</i></p>
38	<p><i>Drosophila</i> white gene modulates claustrophobic exploration Le gène blanc de <i>Drosophila</i> module l'exploration claustrophobique</p> <p>Chengfeng Xiao, R Meldrum Robertson <i>Queen's University</i></p>
39	<p>Temperature tolerance of sockeye salmon (<i>Oncorhynchus nerka</i>) populations hatched at different temperatures Tolérance à la température des populations de saumon sockeye (<i>Oncorhynchus nerka</i>) éclos à différentes températures</p> <p>Zhongqi Chen, Katja Antilla, Joy Wu, Charlotte Whitney, Scott Hinch, Anthony Farrell <i>University of British Columbia</i></p>
40	<p>Osmotically shocking behaviour in a euryhaline fish, <i>Kryptolebias marmoratus</i> Comportement osmotique 'choquant' chez un poisson euryhalin, <i>Kryptolebias marmoratus</i></p> <p>Alex Sutton, Pat Wright <i>University of Guelph</i></p>
41	<p>To leap or not to leap? Emersion behaviour in response to acute salinity change in the amphibious mangrove rivulus <i>Kryptolebias marmoratus</i> Sauter ou ne pas sauter? Émersion en réponse à un changement de salinité abrupt chez le killi des mangroves <i>Kryptolebias marmoratus</i></p> <p>Meghan Hull, Cayleih Robertson, Andy Turko, Patricia Wright <i>University of Guelph</i></p>

42	<p>Phylogenetic distribution of emergence times in the Trichoptera of Churchill, Manitoba Distribution phylogénétique des temps d'émergence des trichoptères de Churchill, Manitoba</p> <p>Catherine Malo, Sarah Adamowicz <i>University of Guelph</i></p>
43	<p>Cardiac innervation and control of heart rate in goldfish (<i>Carassius auratus</i>) and zebrafish (<i>Danio rerio</i>) Innervation et contrôle du rythme cardiaque chez le poisson rouge (<i>Carassius auratus</i>) et le poisson zèbre (<i>Danio rerio</i>)</p> <p>Matthew R Stoyek, Roger P. Croll, Frank M. Smith <i>Dalhousie University</i></p>
44	<p>Characterization of cardiac contractile proteins of the African clawed frog (<i>Xenopus laevis</i>): Investigating the evolution of cardiac contractile function Caractérisation des protéines contractiles cardiaques de la xénope lisse (<i>Xenopus laevis</i>): Étude de l'évolution de la fonction contractile cardiaque</p> <p>Elizabeth Sears, Todd Gillis <i>University of Guelph</i></p>
45	<p>Thermal Performance and Tolerance of a Eurythermal Fish, the Common Goldfish (<i>Carassius auratus</i>) Performance thermique et tolérance d'un poisson eurytherme, le cyprin doré (<i>Carassius auratus</i>)</p> <p>Elizabeth Ferreira, Katja Anttila, Anthony Farrell <i>University of British Columbia</i></p>
46	<p>Impact of aldosterone and corticosterone on respiratory control in bullfrog tadpoles (<i>Lithobates Catesbeianus</i>): An in vitro study Impact de l'aldostérone et de la corticostérone sur le contrôle respiratoire chez le ouaouaron (<i>Lithobates catesbeianus</i>): Une étude in vitro</p> <p>Jean-Philippe Rousseau, Pierre-Luc Dubé, Richard Kinkead <i>Université Laval</i></p>
47	<p>The adenosinergic modulation of central respiratory CO₂/pH sensitivity: Modulation adénosinergique de la sensibilité centrale au CO₂ et pH des mécanismes respiratoires</p> <p>Andrew Peters, Stephen G. Reid <i>University of Toronto</i></p>

48	<p>Neuroepithelial cells and the cardio respiratory response in the goldfish (<i>Carassius auratus</i>) exposed to hypercapnia. Cellules neuro-épithéliales et la réponse cardio-respiratoire du cyprin doré (<i>Carassius auratus</i>) exposé à l'hypercapnie</p> <p>Sara Abdallah, Velislava Tzaneva, Steve Perry <i>University of Ottawa</i></p>
49	<p>Renal Excretory Responses to Metabolic Acidosis in the Goldfish <i>Carassius auratus</i> Excrétion rénale en réponse à l'acidose métabolique chez le poisson rouge, <i>Carassius auratus</i></p> <p>Michael James Lawrence, Pat Wright, Chris Wood <i>McMaster University</i></p>
50	<p>A test of the osmorespiratory compromise in goldfish (<i>Carassius auratus</i>). Un test du compromis osmo-respiratoire chez le cyprin doré (<i>Carassius auratus</i>)</p> <p>Raymond Kwong, Velislava Tzaneva, Steve Perry <i>University of Ottawa</i></p>
51	<p>The effects of predicted future seawater pCO₂ on acid-base regulation in the Dungeness crab (<i>Metacarcinus magister</i>) Effets d'une pCO₂ prédictive pour l'environnement marin futur sur la régulation acido-basique du crabe dormeur (<i>Metacarcinus magister</i>)</p> <p>Stephanie Hans, Sandra Fehsenfeld, Dirk Weihrauch <i>University of Manitoba</i></p>
52	<p>Survival and osmoregulation of an estuarine crab after acute exposure to varying combined pH and salinity stress Survie et régulation osmotique d'un crabe estuarien après une exposition aiguë à diverses combinaisons stressantes de pH et de salinité</p> <p>Ciaran Shaughnessy, Elsa Anderson, Mary Kasparian, Jalene LaMontagne, Jason Bystriansky <i>DePaul University</i></p>

53	<p>Ca²⁺ homeostasis in acid: A novel function of the transcription factor, glial cell missing 2 L'homéostasie du Ca²⁺ dans l'acide: Une nouvelle fonction du facteur de transcription glial cell missing 2</p> <p>Yusuke Kumai, Raymond Kwong, Steve Perry <i>University of Ottawa</i></p>
54	<p>Fenugreek as a potential botanical galactogogue in rainbow trout (<i>Onchorhynchus mykiss</i>) Fenugrec en tant que potentiel galactagogue botanique chez la truite arc-en-ciel (<i>Onchorhynchus mykiss</i>)</p> <p>Sean McKee, Scott P Kelly <i>York University</i></p>
55	<p>The effects of copper exposure on copper transporter expression and tissue copper concentrations in the yellow fever mosquito <i>Aedes aegypti</i> Effets de l'exposition au cuivre sur l'expression du transporteur du cuivre et les concentrations tissulaires en cuivre chez le moustique responsable de la fièvre jaune <i>Aedes aegypti</i></p> <p>Matthew Glover, Brieanne Matier, Patrick Bobyn, Lilia Kotzeva, Jason Loepky, Mark Rheault <i>University of British Columbia</i></p>
56	<p>A remnant of horizontal gene transfer: Characterization and Expression of teneurin and teneurin C-terminal associated peptide (TCAP) in the tunicate, <i>Ciona intestinalis</i> Un vestige de transfert génique horizontal: Caractérisation et expression de la teneurine et du peptide associé au C-terminal de la teneurine (TCAP) -1 chez le tunicier, <i>Ciona intestinalis</i></p> <p>Michael Colacci, Dhan Chand, Sabine R Lovejoy, Lifang Song, Dawn Sephton, Bénédikte Vercaemer, David A Lovejoy <i>University of Toronto</i></p>
57	<p>Changes in photoperiod are sufficient to induce reversal of GABAergic polarity in <i>Lymnaea Stagnalis</i> pedal ganglia Les variations de la photopériode sont suffisantes pour induire une inversion de polarité GABAergique dans les ganglions pédieux de <i>Lymnaea stagnalis</i></p> <p>Hilary Bond, Aqsa Malik, Leslie Buck <i>University of Toronto</i></p>

58	<p>Regulation of testes morphology and function by teneurin C-terminal associated peptide (TCAP)-1 in mice. Régulation de la morphologie et fonction testiculaire par le peptide associé au C-terminal de la teneurine (TCAP) -1 chez la souris</p> <p>Dhan Chand, Michael Colacci, Katelyn Dixon, Alexandra Kollara, Theodore J, Brown, David Lovejoy <i>University of Toronto</i></p>
59	<p>Elucidating the roles of TCAP-1 on neuronal metabolism and skeletal muscle physiology in mice cell models Élucidation des rôles joués par TCAP-1 sur le métabolisme neuronal et la physiologie musculaire chez des cellules de souris</p> <p>Yani Chen, Lifang Song, Mei Xu, Autumn Otchengo, Rebecca Crosier, David Lovejoy <i>University of Toronto</i></p>
60	<p>Phosphorylation of insulin receptor and phosphoinositol-3-kinase by teneurin C-terminal associated peptide (TCAP)-1 in immortalized mouse hypothalamic cells Phosphorylation du récepteur de l'insuline et de la phosphoinositol-3-kinase par le peptide associé au C-terminal de la teneurine (TCAP)-1 dans des cellules hypothalamiques de souris immortalisées</p> <p>Autumn Otchengco, Lifang Song, Yani Chen, Louise deLannoy, David A Lovejoy <i>University of Toronto</i></p>
61	<p>The influence of membrane fluidity on chloride transport regulation in a eurythermic teleost fish Influence de la fluidité membranaire sur la régulation du transport de chlorure chez les poissons téléostéens eurythermiques.</p> <p>Alicia Malone, William Marshall <i>St Francis Xavier University</i></p>
62	<p>GABAergic spike arrest is mediated by decreased reactive oxygen species generation in anoxia-tolerant turtle cortex La suppression GABAergique des potentiels d'action est médiée par une diminution de la production d'espèces réactives de l'oxygène dans le cortex de la tortue tolérante à l'anoxie</p> <p>Matthew E Pamenter, David W Hogg and Leslie T Buck. <i>University of British Columbia</i></p>

63	<p>ROS scavenging dramatically increases NMDA receptor but not AMPA receptor currents in turtle cerebral cortex L'élimination des espèces réactives de l'oxygène augmente considérablement les courants des récepteur NMDA mais pas ceux des récepteurs AMPA dans le cortex cérébral d'une tortue</p> <p>David Dukoff, Les Buck <i>University Of Toronto</i></p>
64	<p>Changes in steady state ROS levels modulate GABA receptor-mediated electrical suppression in painted turtle cerebral cortex Les changements dans l'état d'équilibre des taux d'espèces réactives de l'oxygène modulent la suppression électrique par le récepteur-GABA dans le cortex cérébral de la tortue peinte</p> <p>David Hogg, Matthew Pamenter, Leslie Buck <i>University of Toronto</i></p>
65	<p>Effects of contaminant metals on calcium uptake in <i>Daphnia pulex</i> Effets de métaux contaminants sur l'apport en calcium chez <i>Daphnia pulex</i></p> <p>Andrew Liorti, Andreas Heyland, Teresa Crease <i>University of Guelph</i></p>
66	<p>A circadian clock regulates steroidogenesis in follicle cells of the insect <i>Rhodnius prolixus</i> during vitellogenesis Régulation de la stéroïdogénèse folliculaire par une horloge interne pendant la vitélogénèse chez l'insecte, <i>Rhodnius prolixus</i></p> <p>Michael Cardinal-Aucoin, Colin G.H. Steel <i>York University</i></p>
67	<p>Hormonal zeitgebers to a photosensitive circadian clock that regulates steroid synthesis in the insect, <i>Rhodnius prolixus</i> Régulation de la synthèse stéroïdienne par une horloge interne photosensible répondant à des zeitgebers hormonaux chez l'insecte, <i>Rhodnius prolixus</i></p> <p>Nicholas Rapp, Colin Steel <i>York University</i></p>
68	<p>Further studies on rhodtestolin, a cardio-inhibitor from testes of the blood-feeding insect, <i>Rhodnius prolixus</i>, a vector of Chagas disease. D'autres études sur la rhodtestoline, un cardio-inhibiteur provenant des testicules de l'insecte hémophage, <i>Rhodinus prolixus</i>, un vecteur de la maladie du Chagas</p> <p>Gary Chiang, Jennifer Chiang, Marli Lima, Hugh Hoogendoorn <i>Redeemer University College</i></p>

69	<p>A steroid hormone rhythm drives circadian cycling of period protein in fat body cells of the insect, <i>Rhodnius prolixus</i> Un rythme hormonal stéroïdien dirige le cycle circadien de la protéine de période dans le tissu adipeux de l'insecte, <i>Rhodnius prolixus</i></p> <p>Tudor Saroiu, Colin GH Steel <i>York University</i></p>
70	<p>Sex, eicosanoids and zebrafish: Increased expression of eicosanoid synthesizing enzymes during hormone-induced ovulation and spawning in the zebrafish Sexe, eicosanoïdes et poisson zèbre: expression accrue des enzymes eicosanoïdes lors de l'ovulation et la ponte induite par administration d'hormone</p> <p>Olivia Knight, Glen Van Der Kraak <i>University of Guelph</i></p>
71	<p>Liquorice root derivatives glycyrrhizic acid and glycyrrhetic acid as adaptogens in teleost fish hyperosmoregulation Les dérivés de racine de réglisse, acides glycyrrhizique et glycyrrhétique, comme adaptogènes lors de l'hyperosmorégulation chez les poissons téléostéens</p> <p>Chun Chih Chen, Dennis Kolosov, Scott P. Kelly <i>York University</i></p>
72	<p>How does cortisol mediate the growth-suppressing effects of stress in rainbow trout? Comment l'hormone cortisol réduit-elle la croissance chez les truites arc-en-ciel stressées?</p> <p>BN Madison, NJ Bernier <i>University of Guelph</i></p>
73	<p>Effects of embryonic anoxia exposure on the endocrine stress response of adult zebrafish (<i>Danio rerio</i>). Les effets de l'exposition de l'embryon à l'anoxie sur la réponse au stress endocrinien chez le poisson-zèbre (<i>Danio rerio</i>) adulte.</p> <p>Catherine M. Ivy, Nicholas J. Bernier <i>University of Guelph</i></p>

74	<p>Differential effects of chronic hypoxia on the cortisol stress response of larval and adult zebrafish (<i>Danio rerio</i>) Effets différentiels de l'hypoxie chronique sur la réponse au stress par le cortisol chez les larves et les adultes du poisson zèbre (<i>Danio rerio</i>)</p> <p>Kristina Mikloska, Nick Bernier <i>University of Guelph</i></p>
75	<p>Conservation of function in the metazoan: Neurotrophic actions of TCAP-1 on the vertebrate stress pathway Conservation fonctionnelle chez les métazoaires: Actions neurotrophiques de TCAP-1 sur les voies du stress</p> <p>Louise de Lannoy, Dhan Chand, Lifang Song, David Lovejoy <i>University of Toronto</i></p>
76	<p>Quinacrine exposure:negative impacts on spawning and biosynthesis of prostaglandins and steroids in the zebrafish ovary Exposition à la quinacrine: Les impacts négatifs sur la ponte et la biosynthèse de prostaglandines et de stéroïdes dans l'ovaire du poisson-zèbre</p> <p>Madelynne Cosme, Andrea Lister, Glen Van Der Kraak <i>University of Guelph</i></p>
77	<p>A comparison of the acclimation responses to constant and intermittent hypoxia acclimation in killifish (<i>Fundulus heteroclitus</i>) Comparaison des réponses d'acclimatation à l'hypoxie chronique et intermittente chez le choquemort (<i>Fundulus heteroclitus</i>)</p> <p>Brittney Borowiec, Kimberly Darcy, Graham Scott <i>McMaster University</i></p>
78	<p>Muscle Na+/K+ ATPase isoform expression following swimming challenges in rainbow trout (<i>Oncorhynchus mykiss</i>) Expression de l'isoforme musculaire de la Na+/K+ATPase après la nage forcée chez la truite arc-en-ciel (<i>Oncorhynchus mykiss</i>)</p> <p>Mattina Alonge, Jeffrey G. Richards, Patricia M. Schulte, Jason S. Bystriansky <i>DePaul University</i></p>
79	<p>The nine-banded armadillo: an intriguing animal model for studying metabolism, maternal effects, and emerging diseases Le tatou à neufs bandes: un curieux modèle animal pour étudier le métabolisme, les effets maternels et l'émergence de maladies</p> <p>Brian Bagatto <i>University of Akron</i></p>

80	<p>Larval lake sturgeon inherit survivorship from maternal stores Les larves d'esturgeons jaunes héritent leur taux de survie de la mère</p> <p>Janet Genz, Shivani Khetoo, Liane Arcinas, W. Gary Anderson <i>University of Manitoba</i></p>
81	<p>ATP-binding cassette transporters and anoxic depolarization in the brain of <i>Drosophila melanogaster</i> Les transporteurs cassette de l'ATP et la dépolarisation anoxique dans le cerveau de <i>Drosophila melanogaster</i></p> <p>Esteban Rodriguez, Meldrum Robertson <i>Queen's University</i></p>
82	<p>Serotonin modulation of odour-evoked neural activity in the olfactory bulb of the sea lamprey Modulation sérotonergique de l'activité cérébrale évoquée par les odeurs dans le bulbe olfactif de la lamproie marine</p> <p>Karl Boyes, Huiming Zhang, Barbara Zielinski <i>University of Windsor</i></p>
83	<p>Molecular and pathophysiological processes underlying cerebral hemorrhage in developing zebrafish Les processus moléculaires et pathophysiologiques sous-jacent à l'hémorragie cérébrale chez les poisson-zèbre en développement.</p> <p>Shahram Eisa-Beygi, Raymond Kwong, Steve Perry, Marc Ekker, Tom Moon <i>University of Ottawa</i></p>
84	<p>Expression patterns of gill tight junction proteins during formation and development of primary cultured gill epithelia Profils d'expression des protéines de jonctions fermes pendant la formation et le développement d'une culture primaire d'épithélium branchial</p> <p>Dennis Kolosov, Scott Kelly <i>York University</i></p>
85	<p>Maternally transferred bisphenol A (BPA) impacts development and stress axis functioning in rainbow trout Le transfert maternel du bisphénol A (BPA) affecte le développement et l'axe du stress chez la truite arc-en-ciel</p> <p>Oana Birceanu, Trinh Mai, Mathilakath Vijayan <i>University of Waterloo</i></p>

86	<p>Effects of increased temperature on hypoxia tolerance in Atlantic killifish Effets de l'élévation de la température élevée sur la tolérance à l'hypoxie chez le choquemort</p> <p>Tara McBryan, Tim Healy, Patricia Schulte <i>University of British Columbia</i></p>
87	<p>Mechanisms of Brain Swelling in Ammonia-Sensitive Rainbow Trout Mécanismes de l'inflammation cérébrale chez des truites arc-en-ciel sensibles à l'ammoniac</p> <p>Phillip Pham-Ho, Sanya Sidhu, Michael P Wilkie <i>Wilfrid Laurier University</i></p>
88	<p>Expression of cytochrome P450 family 3 genes in adult and embryonic zebrafish L'expression des gènes de la famille 3 du cytochrome P450 chez l'adulte et l'embryon du poisson-zèbre</p> <p>Lana Shaya, Joanna Y. Wilson <i>McMaster University</i></p>
89	<p>Detoxification of the pesticide 3-trifluoromethyl-4-nitrophenol (TFM) in non-target rainbow trout (<i>Oncorhynchus mykiss</i>) and lake sturgeon (<i>Acipenser fulvescens</i>) and their effects on metabolite stores Désintoxication du pesticide 3-trifluorométhyl-4-nitrophénol (TFM) chez la truite arc-en-ciel (<i>Oncorhynchus mykiss</i>) et l'esturgeon jaune (<i>Acipenser fulvescens</i>), deux espèce non-ciblée, et l'effet sur leur ressources métaboliques</p> <p>Clair, Michael Le Clair, Michael Wilkie <i>Wilfrid Laurier University</i></p>
90	<p>Improving understanding of endocrine-active compounds in pulp and paper mill condensates using a mummichog (<i>Fundulus heteroclitus</i>) bioassay Utilisation d'un test biologique avec le choquemort (<i>Fundulus heteroclitus</i>) pour comprendre le fonctionnement des composés endocriniens actifs dans les condensats de pâtes et papier</p> <p>Robert Rutherford, Andrea Lister, Phillip Scott, L. Mark Hewitt, Deborah MacLatchy, Craig Milestone <i>Wilfrid Laurier University</i></p>

91	<p>Development of a walleye endothelial cell line to study the pathogenesis of viral hemorrhagic Septicemia virus Développement d'une lignée cellulaire endothéliale pour l'étude de la pathogénicité du virus de la septicémie hémorragique virale Hina Bandukwala, Nathan Vo, John Lumsden, Brian Dixon, Niels Bols <i>University of Waterloo</i></p>
92	<p>Establishment of an epithelial cell line from long-term primary cultures of ovarian fluids of rainbow trout, <i>Oncorhynchus mykiss</i> Établissement d'une lignée cellulaire épithéliale à partir de cultures primaires de fluides ovariens de truite arc-en-ciel, <i>Oncorhynchus mykiss</i> Krista L Schleicher, Nathan NTK Vo, Dustin A Ammedolia, David B. Van, Lucy EJ Lee, Niels C Bols <i>University of Waterloo</i></p>
93	<p>Variation in metabolism and thermal tolerance in the Atlantic killifish, <i>Fundulus heteroclitus</i> Variation du métabolisme et de la tolérance thermique chez le choquemort, <i>Fundulus heteroclitus</i> Timothy Healy, Patricia Schulte <i>University of British Columbia</i></p>
94	<p>Does epithelial transport limit insects at low temperatures? Est-ce que le transport épithéial limite les insectes à basse température? Lauren Des Marteaux, Brent Sinclair <i>Western University</i></p>
95	<p>Exploring our second genome: analysis of 16S rRNA gene fragment size and alignment for bacterial identification Explorer notre second génome: Analyse de la taille des fragments et l'alignement de l'ARN ribosomal pour identification bactérienne Jennifer Mitchell <i>Wilfrid Laurier University</i></p>
96	<p>The expression of <i>Crassostrea gigas</i> alternative oxidase in <i>Saccharomyces cerevisiae</i>: investigations on function and structure Expression de l'oxydase alternative de <i>Crassostrea gigas</i> chez <i>Saccharomyces cerevisiae</i>: Investigations de structure et fonction Aaron Robertson, Kyle Schatzl, Allison McDonald <i>Wilfrid Laurier University</i></p>

97	<p>Low-Temperature Acclimation and Mitochondrial Function in the Northern Common Killifish (<i>Fundulus heteroclitus macrolepidotus</i>) Acclimatation à faible température et fonction mitochondriale chez le choquemort (<i>Fundulus heteroclitus macrolepidotus</i>)</p> <p>Dillon James Chung, Patricia Schulte <i>University of British Columbia</i></p>
98	<p>Are skeletal muscle mitochondria net hydrogen peroxide producers or consumers? Est-ce que les mitochondries des muscles squelettiques sont des producteurs ou consommateurs de peroxyde d'hydrogène?</p> <p>Jason Treberg, Sheena Banh <i>University of Manitoba</i></p>
99	<p>Functional divergences in mitochondrial phenotypes between two marine bivalves estimated at different temperatures. Divergences fonctionnelles de phénotypes mitochondriaux estimées à différentes températures chez deux bivalves marins</p> <p>Vincent Kemeid, Pierre Blier <i>Université du Québec à Rimouski</i></p>
100	<p>Compartmentalization of ornithine urea cycle enzymes in a freshwater elasmobranch Cloisonnement des enzymes du cycle ornithine-urée chez un élastombranche d'eau douce</p> <p>David Fraser, James Ballantyne <i>University of Guelph</i></p>
101	<p>The evolution of hypoxia tolerance and performance in centrarchid fishes L'évolution de la tolérance à l'hypoxie et de la performance chez les poissons centrarchidées</p> <p>Kyle Crans, Graham Scott <i>McMaster University</i></p>

102	<p>Activation of mitochondrial ATP-sensitive potassium channels during anoxia results in matrix depolarization which is balanced by proton efflux via reversal of the ATP synthase L'activation de canaux potassiques sensibles à l'ATP pendant l'anoxie dépolarise la matrice mitochondriale et inverse le flux protonique de l'ATP synthase</p> <p>Peter Hawrysh, Les Buck <i>University of Toronto</i></p>
103	<p>Illness-dependent conditioned taste avoidance in an amphibian Conditionnement aversif du goût dépendant d'un état maladif chez un amphibiens</p> <p>Eric To, Frederic Laberge <i>University of Guelph</i></p>
104	<p>A role for Na⁺/K⁺- ATPase activation in axonal conduction of a locust visual neuron Un rôle pour l'activation de l'ATPase Na⁺/K⁺ dans la conduction axonale d'un neurone visuel chez le criquet</p> <p>Tomas Money, R Meldrum Robertson <i>Queen's University</i></p>
105	<p>Does HEA, alkaline environments or salinity stress trigger ureotelism in the freshwater ribbon leech <i>Nepheleopsis obscura</i>? Est-ce que l'HEA, les milieux alcalins ou le stress associé à la salinité déclenchent la sécrétion d'urée chez la sansue d'eau douce, <i>Nepheleopsis obscura</i>?</p> <p>Alex Quijada-Rodriguez, Gary Anderson, Dirk Weihrauch <i>University of Manitoba</i></p>
106	<p>Identification and localization of an Rh glycoprotein in the gills of the Atlantic hagfish (<i>Myxine glutinosa</i>) Identification et localisation d'une glycoprotéine Rh dans les branchies de la myxine du Nord (<i>Myxine glutinosa</i>)</p> <p>Margaret Pray, Patrick Walsh, Susan Edwards <i>Appalachian State University</i></p>

107	<p>Ammonia excretion in the Atlantic hagfish Excrétion d'ammoniac chez la myxine du Nord Justin Arnold, Margaret Pray, Rachel Bradley, Susan Edwards <i>Appalachian State University</i></p>
108	<p>Serotonergic regulation of the rainbow trout hypothalamo-pituitary-interrenal axis via the 5-HT1A receptor Régulation sérotoninergique de l'axe hypothalamo-hypophyso-interrénal via le récepteur 5-HT1A chez la truite arc-en-ciel Laurence Dionne-Wilson, Kathleen Gilmour <i>University of Ottawa</i></p>
109	<p>The effects of high environmental ammonia on the crf system and neuronal development in developing zebrafish Les effets d'une forte concentration environnementale d'ammoniac sur le système crf et sur le développement neuronal des poissons-zèbres en développement Tegan Williams, Luke Bonham, Nicholas Bernier <i>University of Guelph</i></p>
110	<p>The frozen fly of your nightmares: Overwintering biology of <i>Drosophila suzukii</i> La mouche congelé de vos cauchemars: Biologie d'hivernage de <i>Drosophila suzukii</i> Ruth Jakobs, Tara D. Gariepy, Brent J. Sinclair <i>University of Western Ontario</i></p>
111	<p>Interspecific differences in hypoxia tolerance in carp Différences interspécifiques de la tolérance à l'hypoxie chez les carpes Rashpal Dhillon, Lili Yao, Victoria Matey, Shi-Jian Fu, Colin Brauner, Yuxiang Wang, Jeffrey Richards <i>University of British Columbia</i></p>
112	<p>Enhanced accumulation of HSP30 and 70 in <i>Xenopus laevis</i> A6 kidney epithelial cells treated simultaneously with low concentrations of sodium arsenite and cadmium chloride Augmentation de l'accumulation de HSP30 et HSP70 dans les cellules épithéliales A6 des reins de <i>Xenopus laevis</i> traitées simultanément avec une faible concentration de sodium d'arsénite et de cadmium Imran Khamis, John Heikkila <i>University of Waterloo</i></p>

113	<p>The physiological and behavioural adjustments of the zebrafish <i>Danio rerio</i> exposed to the beta-blocker propranolol Ajustements physiologiques et comportementaux du poisson zèbre <i>Danio rerio</i> exposé au bêta-bloquant propranolol</p> <p>Kimberly Mitchell, Thomas Moon <i>University of Ottawa</i></p>
114	<p>Markers of oxidative stress in zinc oxide nanoparticle-treated white sucker fish (<i>Catostomus commersonii</i>) Marqueurs du stress oxydatif chez des meuniers noirs (<i>Catostomus commersonii</i>) exposés aux nanoparticules d'oxyde de zinc</p> <p>Neal Callaghan, Christopher Dieni, Kathryn Butler, Tyson MacCormack <i>Mount Allison University</i></p>
115	<p>Distinct patterns of HSP30 and HSP70 degradation in <i>Xenopus laevis</i> A6 cells recovering from thermal stress Observation de patrons distincts de dégradation du HSP30 et HSP70 dans les celulles de <i>Xenopus laevis</i> récupérant d'un stress thermique</p> <p>Saad Khan, John Heikkila <i>University of Waterloo</i></p>
116	<p>Species comparison of 17-α-ethynylestradiol uptake in teleost fish Comparaison de l'absorption du 17-α-éthinyloestradiol chez les poissons téléostéens</p> <p>Tiffany Chow, Tamzin Blewett, Deborah MacLatchy, Chris Wood <i>McMaster University</i></p>
117	<p>The role of statin drugs on zebrafish (<i>Danio rerio</i>) coenzyme q10 Le rôle des drogues statines sur la coenzyme q10 chez le poisson zèbre (<i>Danio rerio</i>)</p> <p>Thomas Moon <i>University of Ottawa</i></p>
118	<p>Characterization of a continuous cell line from <i>Fundulus heteroclitus</i>, KFE-1, with neuroepithelial cell traits Caractérisation d'une lignée de cellules continues de <i>Fundulus heteroclitus</i>, KFE-1, avec des traits cellulaires neuropithéliales</p> <p>Sarah J Gignac, Nguyen TK Vo, Deborah MacLatchy, Lucy EJ Lee <i>Wilfrid Laurier University</i></p>

119	<p>Immune gene expression and <i>Trypanosoma carassii</i> infection in goldfish exposed to naphthenic acids and oil sands process water (OSPW) Expression de gènes immunitaires et infection avec <i>Trypanosoma carassii</i> chez le poisson rouge exposé aux acides naphténiques et aux eaux de traitement des sables bitumineux</p> <p>Mariel O. Hagen, Barbara A. Katzenback, A. Oladiran, Erick Garcia-Garcia, Mohamed Gamal-El Din, Jon Martin, Miodrag Belosevic <i>University of Alberta</i></p>
120	<p>Goldfish neutrophil responses after exposure to polymer-coated metal-oxide nanopaticles Réponses des neutrophiles du poisson rouge après exposition au polymère à revêtement de nanoparticules d'oxyde métallique</p> <p>Van Ortega, Barbara Katzenback, James Stafford, Miodrag Belosevic, Greg Goss <i>University of Alberta</i></p>

Thursday May 16th / jeudi, 16 mai

Summary of Events / Le résumé d'événements

	Events / Les événements	Location / Endroit
8:00 - 10:30	CPB Symposium / symposium PBC 8:00-10:30	ROZ101
8:30 - 5:00	Registration / Inscription	ROZ Concourse
	PIE Symposium / symposium PIE	ROZ105
8:30 - 10:30	EEE5 Community and Conservation Ecology EEE6 Chemical Ecology	ROZ109 ROZ106
10:30 - 11:00	Coffee/café	ROZ Concourse
	CMD3 EvoDevo	ROZ106
	CBP17 Mitochondria	ROZ103
11:00 - 12:30	CBP18 Ecophysiology CBP19 Toxicology/Cell culture EEE7 Conservation Biology PIE3 Immunology 2	ROZ102 ROZ105 ROZ109 ROZ108
12:30 - 2:00	CPB Lunch / Lunch PBC PIE Lunch / Lunch PIE	PCH University Center 442
2:00 - 4:00	Hoar Award Presentations Présentations des Prix Hoar	ROZ101
4:00 - 4:30	Coffee/café	ROZ Concourse
4:30 - 5:30	Wardle Lecture / Conférence Wardle Dr. Derek MacKay	ROZ103
5:30 - 6:30	BREAK / PAUSE	
6:30 -	Reception and Silent Auction Réception et encan silencieux Banquet and dance with King Neptune	Delta Hotel

Daily notes

- The CPB symposium starts at 8:00 (not 8:30) and breakfast is served starting at 7:30 in Center 6.
- To get to University Center 442 take the North elevator from the ground floor of the University Center.
- The Delta Hotel located on the SW corner of Stone Rd. and Gordon St. is less than a 5 min walk from Campus.

CPB Symposium / Symposium PBC (8:00 – 10:30)
ROZH 101

Animal Mitochondria: Evolution, Performance and Plasticity / Mitochondries Animales: Évolution, Performance et Plasticité

Chair/Président: Jeff Richards and Jim Staples

CPB SYM 1 8:00 - 8:30	CHRISTOPHER MOYES, KATHARINA BREMER, CHRISTOPHE LEMOINE, CHRISTINE GENGE AND KATRINKA KOCHA Queen's University Evolution of the control of mitochondrial gene expression in animals <i>Évolution du contrôle de l'expression des gènes mitochondriaux chez les animaux</i>
CPB SYM 2 8:30 - 9:00	MARTIN KLINGENSPOR, YONGGUO LI, DAVID LASAR AND TOBIAS FROMME Technische Universität München Brown fat and uncoupling protein 1: the evolution and function of a heater organ in mammals <i>Graisse brune et protéine de découplage 1: évolution et fonction d'un organe thermogène chez les mammifères</i>
CPB SYM 3 9:00 - 9:30	JEFFREY A. STUART Brock University Mitochondrial Plasticity: Intracellular signaling pathways involving mitochondria <i>Plasticité mitochondriale: voies de signalisation intracellulaires impliquant des mitochondries</i>
CPB SYM 4 9:30 - 10:00	PIERRE BLIER, HÉLÈNE LEMIEUX AND NICOLAS PICHAUD Université du Québec Holding our breath in our modern world: are mitochondria keeping the pace with global changes? <i>Retenir son souffle dans le monde moderne: Est-ce que les mitochondries gardent le rythme des changements planétaires?</i>
CPB SYM 5 10:00 - 10:30	DAVID RAND, YAWEI GE, NICHOLAS JOURJINE AND PATRICK FLIGHT Brown University Mitochondrial genotypes drive differential expression of nuclear genes under varied levels of hypoxia in Drosophila <i>Des génotypes mitochondriaux sont à la base de l'expression différentielle de gènes nucléaires sous différents niveaux d'hypoxie chez Drosophila</i>

**PIE Symposium / Symposium PIE (8:30 – 10:30)
ROZH 105**

Parasitism-Immunity-Environment Interactions: Sweet as Cherry PIE / Interactions Parasitisme-Immunité-Environnement

Chair/Président: Brian Dixon

PIE SYM 1 8:30 - 9:10	MATTHEW L. RISE, TIAGO S. HORI, MARIJE BOOMAN, GORDON W. NASH, SABRINA M. INKPEN, ASHOKTARU BARAT AND A. KURT GAMPERL Memorial University of Newfoundland Functional genomics research on the impact of elevated temperature on Atlantic cod immune responses <i>Recherche en génomique fonctionnelle sur l'impact d'une élévation de la température sur la réponse immunitaire de la morue de l'Atlantique</i>
PIE SYM 2 9:10 - 9:50	JANET KOPRIVNIKAR Brandon University Turbulent waters: host-parasite interactions in a changing world <i>Eaux turbulentes : interactions hôte-parasite dans un monde en plein changement</i>
PIE SYM 3 9:50 - 10:30	CHRISTOPHER KYLE Trent University Influence of demographic parameters on patterns of local adaptation in terrestrial rabies vectors <i>Influence de paramètres démographiques sur les modes d'adaptation locaux des vecteurs de la rage en milieu terrestre</i>

Contributed Sessions V / Sessions de communications V (8:30 – 10:30)
EEE5 / EEE5: ROZH 109

Community and Conservation Ecology / Écologie de la Communauté et de la Conservation
 Chair/Président: Allan Debertin

EEE5-1 8:30 - 8:45	CONNOR WARNE AND M. ALEX SMITH University of Guelph Ant community structure and biodiversity dynamics along an elevation gradient <i>Structure communautaire et dynamique de la biodiversité des fourmis le long d'un gradient altitudinal</i>
EEE5-2 8:45 - 9:00	ORA JOHANSSON AND KELLY BOWEN Fisheries and Oceans Zooplankton community production – Zooplankton community health <i>Production de la communauté de zooplancton – Santé de la communauté de zooplancton</i>
EEE5-3 9:00 - 9:15	THOMAS M. ONUFERKO, CORDERO, RODRIGO LEÓN CORDERO AND MIRIAM H. RICHARDS Brock University Extreme variability in bee abundance and diversity over short and long time periods <i>Variabilité extrême de l'abondance et diversité des abeilles sur des périodes courtes et longues</i>
EEE5-4 9:15 - 9:30	PASAN SAMARASIN, BRIAN J. SHUTER, CHARLES K. MINNS AND MICHAEL D. RENNIE University of Toronto Fish diversity and biomass in small subarctic lakes: higher than expected relative to southern Canadian lakes. <i>Diversité des poissons et biomasse plus élevées que prévu dans de petits lacs subarctiques Canadiens en comparaison aux lacs plus au Sud</i>
EEE5-5 9:30 - 9:45	GILLIAN MARTIN, SARAH ADAMOWICZ AND KARL COTTENIE University of Guelph Impact of taxonomic resolution on detection of metacommunity patterns <i>Impact de la résolution taxonomique sur la détection des patrons de métacommunauté</i>
EEE5-6 9:45 - 10:00	ALLAN DEBERTIN AND TOM NUDDS University of Guelph Does density-dependent harvest mortality promote stability in walleye fisheries in Lake Erie? <i>Est-ce que la mortalité de récolte dépendante de la densité promouvoit la stabilité dans les pêcheries de Doré du lac Érié?</i>
EEE5-7 10:00 - 10:15	LENA MEASURES Fisheries and Oceans Canada <i>Philometra rubra</i> (Leidy, 1856) from striped bass, <i>Morone saxatilis</i>, from the Miramichi, New Brunswick <i><i>Philometra rubra</i> (Leidy, 1856) du bar rayé, <i>Morone saxatilis</i>, de la Miramichi, Nouveau Brunswick</i>

EEE5-8
10:15 - 10:30

LAURA M. TROUT AND ALEX SMITH
University of Guelph

The accuracy of extinction estimates and effectiveness of conservation in Canada

La précision des estimations du nombre d'extinctions et l'efficacité de la conservation au Canada

Contributed Sessions V / Sessions de communications V (8:30 – 10:30)

EEE6 / EEE6: ROZH 106

Chemical Ecology / Écologie Chimique

Chair/Président: Danielle Ethier

EEE6-1 8:30 - 8:45	JENNIFER SMITH, MICHELLE FARWELL, ERIC CLELLAND AND BARBARA ZIELINSKI University of Windsor Pheromone trapping and the round goby (<i>Neogobius melanostomus</i>): identification of potent male pheromones <i>Pièges à phéromones et gobie à taches noires (<i>Neogobius melanostomus</i>): Identification de phéromones mâles actives</i>
EEE6-2 8:45 - 9:00	DANIELLE ETHIER, CHRISTOPHER KYLE, KURT KYSER AND JOE NOCERA University of Guelph Trace elements in claw keratin as temporally explicit indicators of geographic origin in terrestrial mammals <i>Éléments trace dans la kératine des griffes comme indicateurs temporellement explicites de l'origine géographique des mammifères terrestres</i>
EEE6-3 9:00 - 9:15	IMRE ISTVAN, RICHARD DI ROCCO, COWAN F. BELANGER, GRANT E. BROWN AND NICHOLAS S. JOHNSON Algoma University Clear and present danger: the behavioural response of migratory sea lamprey (<i>Petromyzon marinus</i>) to chemosensory alarm cues <i>Danger immédiat: réponse comportementale de la lampre marine (<i>Petromyzon marinus</i>) en phase migratoire aux signaux d'alarme</i>
EEE6-4 9:15 - 9:30	ADITYA MANEK, DOUGLAS CHIVERS, MAUD FERRARI AND SOM NIYOGI University of Saskatchewan DOC ameliorates the effects of UV radiation on a freshwater fish <i>DOC améliore les effets du rayonnement UV sur un poisson d'eau douce</i>
EEE6-5 9:30 - 9:45	CLARK DENNIS, DAN KATES, SHIVANI ADHIKARI, WILL CEJTIN AND CORY SUSKI University of Illinois Use of hypercarbia as a deterrent for asian carp movement <i>Utilisation de l'hypercarbie pour prévenir le mouvement des carpes Asiatiques</i>
EEE6-6 9:45 - 10:00	ANGELA SHAMCHUK AND KEITH TIERNEY University of Alberta Another fish in the well: accounting for individual variation in larval zebrafish (<i>Danio rerio</i>) stimulus-evoked behaviour <i>Un autre poisson au puits: Tenir compte de la variation individuelle du comportement évoqué par des stimuli chez les larves de poisson zèbre (<i>Danio rerio</i>)</i>
EEE6-7 10:00 - 10:15	BEN KISSINGER, GARY ANDERSON, NIKOLAUS GANTNER, DARREN GILLIS, NORMAN HALDEN, LOIS HARWOOD AND JIM REIST University of Manitoba Lake trout <i>Salvelinus namaycush</i> (Walbaum, 1792) habitat use and growth in an arctic estuarine environment <i>Utilisation de l'habitat et croissance chez le Touladi, <i>Salvelinus namaycush</i> (Walbaum, 1792), dans un estuaire arctique</i>

EEE6-8 10:15 - 10:30	JASMINE FARHAN AND JEREMY MCNEIL University of Western Ontario The effect of temperature and windspeed on the number of males caught in pheromone traps <i>L'effet de la température et de la vitesse du vent sur le nombre de mâles capturés dans des pièges à phéromones</i>
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Contributed Sessions V / Sessions de communications V (11:00 – 12:30)
CMD 3 / MDC 3: ROZH 106

Evo-Devo / Evo-Dévo

Chair/Président: Matt Vickaryous

CMD3-1 11:00 - 11:15	ANTHONY RUSSELL AND GARRETT OETELAAR University of Calgary Hanging out : digit and limb orientation during vertical clinging in Bibron's gecko (<i>Chondrodactylus bibronii</i>) <i>On s'accroche: orientation des doigts et des membres pendant l'adhérence verticale chez le gecko de Bibron (<i>Chondrodactylus bibronii</i>)</i>
CMD3-2 11:15 - 11:30	HANNA PEACOCK, SAMANTHA PAYNE, JAMES PETRIK AND MATTHEW VICKARYOUS University of Guelph The role of angiogenesis during regeneration <i>Le rôle de l'angiogenèse lors de la régénération</i>
CMD3-3 11:30 - 11:45	JAMIE-LEE GIARDINI AND ANDREAS HEYLAND University of Guelph Environmental calcium deficiency and embryonic development in <i>Daphnia magna</i> <i>Déficience environnementale en calcium et développement embryonnaire chez <i>Daphnia magna</i></i>
CMD3-4 11:45 - 12:00	RICHARD WD GILBERT, MATTHEW K VICKARYOUS AND ALICIA M VILOIRA-PETIT University of Guelph Characterization of TGFβ signaling during multi-tissue regeneration in <i>Eublepharis macularius</i> <i>Caractérisation du signalement par TGFβ pendant la régénération tissulaire chez <i>Eublepharis macularius</i></i>
CMD3-5 12:00 - 12:15	TETSUTO MIYASHITA University of Alberta Fishing for jaws in early vertebrate evolution <i>Aller à la pêche aux mâchoires au début de l'évolution des vertébrés</i>
CMD3-6 12:15 - 12:30	A. RICHARD PALMER University of Alberta On the enigma of gastropod coiling direction: Why are sinistral gastropods so rare? <i>Sur l'énigme de la direction d'enroulement des gastéropodes: Pourquoi les gastéropodes de forme sénestre sont si rares?</i>

Contributed Sessions V / Sessions de communications V (11:00 – 12:30)
CPB 17 / PBC 17: ROZH 103

Mitochondria / Mitochondrie

Chair/Président: Jeff Richards

CPB17-1 11:00 - 11:15	PATRICIA SCHULTE AND JESSICA MCKENZIE University of British Columbia Are mitochondrial processes involved in reducing gene flow across a mummichog hybrid zone? <i>Est-ce que des processus mitochondriaux réduisent le flux génique à travers une zone hybride chez le choquemort?</i>
CPB17-2 11:15 - 11:30	MICHAEL J. GAUDRY AND KEVIN L. CAMPBELL University of Manitoba UCP1-mediated non-shivering thermogenesis does not underlie the evolution of cold-tolerance in multiple eutherian lineages. <i>La thermogenèse sans frisson due à l'UCP1 n'est pas à l'origine de l'évolution de la tolérance au froid dans de multiples lignages euthériens</i>
CPB17-3 11:30 - 11:45	ALEX COOPER, JASON BROWN AND JAMES STAPLES University of Western Ontario The effect of palmitoyl CoA and carnitine on succinate-fuelled liver mitochondrial respiration rates in hibernating ground squirrels. <i>Effets du palmitoyl CoA et de la carnitine sur les taux de respiration mitochondriale hépatique du succinate chez les spermophiles en hibernation</i>
CPB17-4 11:45 - 12:00	GIGI LAU, MILICA MANDIC AND JEFFREY RICHARDS University of British Columbia Mitochondrial function varies with hypoxia tolerance in intertidal sculpins <i>La fonction mitochondriale varie avec la tolérance à l'hypoxie chez Oligocottus</i>
CPB17-5 12:00 - 12:15	JASON C. L. BROWN, ALEX N. COOPER, PAUL A. FAURE AND JAMES F. STAPLES University of Western Ontario Long-lived big brown bats (<i>Eptesicus fuscus</i>) and house sparrows (<i>Passer domesticus</i>) use different mechanisms to lower ROS production in skeletal muscle and heart mitochondria relative to short-lived house mice (<i>Mus musculus</i>) <i>La chauve-souris brune (<i>Eptesicus fuscus</i>) et le moineau domestique, deux espèces longévives, utilisent différents mécanismes pour réduire leur production de ROS dans les muscles du squelette et le cœur</i>
CPB17-6 12:15 - 12:30	DANIEL MUNRO AND PIERRE BLIER Université du Québec The longest-lived metazoan, the marine clam <i>Arctica islandica</i>, has lipoxidation-resistant mitochondrial membranes <i>Chez le métazoaire le plus longévif, la palourde Arctica islandica, les lipides des membranes mitochondrielles résistent mieux à l'oxydation</i>

Contributed Sessions V / Sessions de communications V (11:00 – 12:30)
CPB 18 / PBC 18: ROZH 102

Ecophysiology / Écophysiologie

Chair/Président: Janet Genz

CPB18-1 11:00 - 11:15	ANNEGRET NICOLAI AND BRENT SINCLAIR University of Western Ontario Prolonged cold exposure drives strategy switch in the land snail <i>Cepaea nemoralis</i> <i>L'exposition prolongée au froid produit des changements de stratégie chez l'escargot Cepaea nemoralis</i>
CPB18-2 11:15 - 11:30	MELANIE GALLANT AND SUZIE CURRIE Mount Allison University Thermal tolerance of Atlantic salmon and the effects of thermal cycles <i>Tolérance thermique du saumon Atlantique et les effets des cycles thermiques</i>
CPB18-3 11:30 - 11:45	STEPHANIE LISS, GREG SASS AND CORY SUSKI University of Illinois Spatial and temporal influences on the physiological condition of invasive silver carp <i>Influences spatiales et temporelles sur l'état physiologique de la carpe argentée, une espèce envahissante</i>
CPB18-4 11:45 - 12:00	ROBERT FRENCH, SUZIE CURRIE, JEREMY LYLE AND JAYSON SEMMENS University of Tasmania Post-release survival of the short-fin mako shark in the Australian game fishery <i>Survie suite au relâchement du requin-taureau bleu dans la pêche sportive australienne</i>
CPB18-5 12:00 - 12:15	MICHAEL WELLS AND PATRICIA WRIGHT University of Guelph Terrestrial Embryonic Development of the Mangrove Rivulus, <i>Kryptolebias marmoratus</i>: A Strategy to Avoid Conspecific Predation <i>Développement embryonnaire terrestre du killi des mangroves, Kryptolebias marmoratus: une stratégie pour éviter le cannibalisme</i>
CPB18-6 12:15 - 12:30	LINDSAY MAY, JAMES KIEFFER AND HEATHER HUNT University of New Brunswick The effect of substrate on the swimming performance and behaviour of juvenile shortnose sturgeon (<i>Acipenser brevirostrum</i>) <i>L'effet du substrat sur la performance de nage et le comportement de l'esturgeon à museau court (<i>Acipenser brevirostrum</i>) juvénile</i>

Contributed Sessions V / Sessions de communications V (11:00 – 12:30)
CPB 19 / PBC 19: ROZH 105

Toxicology and Cell Culture/Toxicologie et Cellulaire

Chair/Président: Tyson MacCormack

CPB19-1 11:00 - 11:15	DEREK ALSOP AND JOANNA WILSON McMaster University Identifying substrates of zebrafish cytochrome P450 1A with high-throughput screening <i>Identification des substrats de l'enzyme cytochrome P450 1A chez le poisson zèbre avec recours au criblage à haut débit</i>
CPB19-2 11:15 - 11:30	MELISSA CRUZ, BRIEANNE J. MATIER AND MARK R. RHEAULT University of British Columbia Functional characterization of the Drosophila melanogaster organic cation transporters (ORCT and ORCT2) using Xenopus laevis oocytes <i>Caractérisation fonctionnelle des transporteurs de cations organiques (ORCT et ORCT2) chez Drosophila melanogaster en utilisant des ovocytes de Xenopus laevis</i>
CPB19-3 11:30 - 11:45	KATELIN WJ SPITERI, NATHAN NTK VO, MICHAEL MIKHAEL, COLIN WAY AND LUCY EJ LEE Wilfrid Laurier University Establishment and characterization of a continuous fibroblastic cell line from yellow perch (<i>Perca flavescens</i>), and its toxicological applications <i>Établissement et caractérisation d'une lignée de cellules fibroblastiques continues de la perchaude (<i>Perca flavescens</i>), et ses applications toxicologiques</i>
CPB19-4 11:45 - 12:00	JOHN ONUKWFOR, DON STEVENS, FRED KIBENGE AND COLLINS KAMUNDE University of Prince Edward Island Hypoxia-cadmium interactions on rainbow trout mitochondrial bioenergetics: attenuation of hypoxia-induced proton leak by low doses of cadmium <i>Interactions hypoxie-cadmium sur la bioénergétique mitochondriale de la truite arc-en-ciel: atténuation de la perte de protons induite par l'hypoxie par de faibles doses de cadmium</i>
CPB19-5 12:00 - 12:15	FANXING ZENG, MICHELLE LIU, CATHERINE TEE, SHERRY JAMES, BRIAN DIXON, BERNARD DUNCKER AND NIELS BOLS University of Waterloo Actions of the p53 activator, nutlin-3, and the p53 inhibitor, pifithrin-μ, on the rainbow trout gill cell line, RTgill-W1 <i>Les actions de l'activateur de p53, nutlin-3, et l'inhibiteur de p53, pifithrin-μ, sur la lignée cellulaire branchiale de la truite arc-en-ciel, RTgill-W1</i>
CPB19-6 12:15 - 12:30	SOPHIA RAHEL BLOCH, SARAH WALSH, CICI CHEN, NGUYEN KT VO, LUCY EJ LEE, PETER V HODSON AND NIELS C BOLS University of Waterloo Characterization of a multipotent cell line from the brain of the American eel (<i>Anguilla rostrata</i>) <i>Caractérisation d'une lignée cellulaire pluripotente à partir du cerveau de l'anguille d'Amérique (<i>Anguilla rostrata</i>)</i>

Contributed Sessions V / Sessions de communications V (11:00 – 12:30)

PIE 3 / PIE 3: ROZH 108

Immunology 2 - Viral Infections/ Immunologie 2 – Infections

Chair/Président: Spencer Greenwood

PIE3-1 11:00 - 11:15	NATHAN N.T.K. VO, DUSTIN A. AMMENDOLIA, AGIDA KERIMOVA, LUCY E.J. LEE, JOHN S. LUMSDEN, BRIAN DIXON AND NIELS C. BOLS University of Waterloo Cortisol delays the reproductive cycle of viral hemorrhagic septicemia virus IVb in walleye skin fibroblasts <i>Le cortisol délaie le cycle reproductif du virus de la septicémie hémorragique virale IVb dans des fibroblastes de la peau de doré</i>
PIE3-2 11:15 - 11:30	JEREMY WELEFF AND STEPHANIE DEWITTE-ORR Wilfrid Laurier University Defining new roles of scavenger receptors in alternative animal models: evidence of function class A scavenger receptors in rainbow trout epithelial cell lines <i>Évidence du rôle fonctionnel des récepteurs scavenger de classe A dans une lignée de cellules épithéliales de truite arc-en-ciel</i>
PIE3-3 11:30 - 11:45	LOWIA AL-HUSSINEE, LINCOLN TUBBS, SPENCER RUSSELL AND JOHN S. LUMSDEN University of Guelph Inhibition of VHSV replication in a gill epithelial cell line <i>Inhibition de la réplication du virus SHV dans une lignée de cellules épithéliales branchiales</i>
PIE3-4 11:45 - 12:00	SARAH POYNTER AND STEPHANIE DEWITTE-ORR Wilfrid Laurier University The innate antiviral effects of extracellular viral dsRNA in rainbow trout cells <i>Effets antiviraux innés de l'ARN viral à double brin extracellulaire sur des cellules de truite arc-en-ciel</i>
PIE3-5 12:00 - 12:15	LITAL SEVER, NATHAN N.T.K. VO, ALEX RABEN, NIELS BOLS AND BRIAN DIXON University of Waterloo β2-microglobulin secretion in trout cell lines as a biomarker for viral infection <i>Sécrétion de β2-microglobuline dans des lignées cellulaires de truite comme biomarqueur d'infection virale</i>
PIE3-6 12:15 - 12:30	A.P. FRENETTE, M. O'NEIL, H. BYRNE, K. MORAITIS, M.D.B. BURT AND M.S. DUFFY University of New Brunswick Establishing Loma morhua infections in naïve Atlantic cod <i>Etablir des infections de Loma morhua dans des morues de L'Atlantique naives</i>

Hoar Award Presentations / Présentations des Prix Hoar (14:00 – 16:00)

Chair/Président: Dr. Steven Reid, CSZ President

Hoar Award 1 14:00 - 14:20	<p>MARIE-LINE GENTES, MARTIN PATENAUME-MONETTE, JEAN-FRANÇOIS GIROUX, ROBERT J. LETCHER AND JONATHAN VERREAULT University of Quebec You are what you eat: Using GPS-based telemetry to investigate the links between habitat use, foraging strategies and contaminant profiles in avian species <i>Dis-moi ce que tu manges, je te dirai qui tu es : applications de la télémétrie par GPS pour l'investigation des liens entre les stratégies de quête alimentaire, l'utilisation de l'habitat et les profils de contamination chez les oiseaux</i></p>
Hoar Award 2 14:20 - 14:40	<p>CAYLEIH ROBERTSON, PAT WRIGHT AND NICK BERNIER University of Guelph HIF-1 mediates adaptive developmental plasticity of hypoxia tolerance in zebrafish, <i>Danio rerio</i> <i>HIF-1 sert d'intermédiaire à la plasticité adaptative du développement de la tolérance à l'hypoxie chez le poisson zèbre, <i>Danio rerio</i></i></p>
Hoar Award 3 14:40 - 15:00	<p>LAURA DINDIA AND MATHILAKATH VIJAYAN University of Waterloo Rapid actions of cortisol in rainbow trout liver involves acute regulation of stress signaling pathways <i>Les actions rapides du cortisol sur le foie de la truite arc-en-ciel impliquent une régulation aigüe des voies de signalisation du stress</i></p>
Hoar Award 4 15:00 - 15:20	<p>HEATH MACMILLAN, JAMES STAPLES, ANDREW DONINI AND BRENT SINCLAIR Western University Phenotypic plasticity and evolution of <i>Drosophila</i> cold tolerance is associated with modulation of Na⁺ and K⁺ homeostasis <i>Plasticité phénotypique et évolution de la tolérance au froid chez <i>Drosophila</i> sont associés à la modulation homéostasique du Na⁺ et K⁺</i></p>
Hoar Award 5 15:20 - 15:40	<p>JORDAN KLAIMAN, TODD GILLIS AND W. GLEN PYLE University of Guelph The effect of thermal acclimation on the functional properties of the isolated trout heart <i>L'effet de l'acclimatation thermique sur les propriétés fonctionnelles du cœur de truite isolé</i></p>
Hoar Award 6 15:40 - 16:00	<p>DANIEL FIELD Yale University Precise inference of powered flying ability in crown group and stem group avialans <i>Influence précise de la capacité de vol chez les groupes Avialiens dérivés et basaux</i></p>

Robert Arnold Wardle Award/Prix Robert Arnold Wardle



R.A. Wardle

The Robert Arnold Wardle Award is presented by the Parasitism, Immunity and 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 Parasitologie et souligne une contribution remarquable dans le domaine de la parasitologie au Canada ou une contribution remarquable d'un canadien au domaine de la parasitologie.

Dr. Derek McKay, University of Calgary

Health lessons from the study of host-parasite interactions Les leçons sur la santé tirées de l'étude des interactions hôtes-parasites



Dr. Derek McKay received his PhD from Queen's University in 1990 after studying tapeworm host-parasite interactions and in 1991 he took MRC (CIHR) post-doctoral fellowship to McMaster University in order to study the immunophysiology of the gastrointestinal tract. Dr. McKay started his career as a faculty member in 1994 at McMaster University where he studied gut function and mucosal immunity. Dr. McKay was one of the first investigators in the world to publish the possible beneficial effects of helminth infections, showing that such infections protected mice against inflammation both in the gut (colitis) but also elsewhere, for example arthritis. In 2006 Dr. McKay moved to the University of Calgary to become the Canada Research Chair (Tier 1) in Intestinal Immunophysiology in Health and Disease. The author of 98 research papers and 25 reviews, He has also been awarded the AHFMR Medical Research Scientist Award, the

Masters in Gastroenterology Award from the American Gastroenterological Association and the 2011 Crohn's and Colitis Foundation of Canada Research Leadership

Abstract: Parasites by definition adversely affect their hosts, but the question arises could a more tolerant view of the host-parasite relationship be advocated if infection with a parasite conferred some selective advantage on their host. Adopting this perspective we have asked if the immune response mobilized to combat infection with a helminth parasite, specifically the rat tapeworm *Hymenolepis diminuta*, would have the bystander effect of suppressing concomitant disease. Using murine models of colitis and arthritis (noting that mice are non-permissive hosts for *H. diminuta*), we have found that infection with *H. diminuta* can significantly ameliorate or exacerbate inflammation depending on the etiology of the disease. So while helminth therapy can be effective, the utility of this approach as a novel therapy for auto-inflammatory disease may rely on having precise knowledge of the immune basis of the disease to be treated on an individual patient basis.

Friday, May 17th / vendredi, 17 mai

Summary of Events / Le résumé d'événements

Events / Les événements	Location / Endroit
9:00-12:00	Council meeting

Daily Notes:

- To get to University Center 442 take the North elevator from the ground floor of the University Center.

Abstracts

Neuroepithelial cells and the cardio respiratory response in the goldfish (*Carassius auratus*) exposed to hypercapnia.

Cellules neuro-épithéliales et la réponse cardio-respiratoire du cyprin doré (*Carassius auratus*) exposé à l'hypercapnie

¹Sara Abdallah, ¹Velislava Tzaneva, ¹Steve Perry

¹University of Ottawa

Previous studies have shown that increasing CO₂ levels (hypercapnia) are sensed by gill neuroepithelial cells (NECs), which have been implicated in the initiation of the hyperventilatory response in fish. Here we examine the cardiorespiratory responses of the goldfish to hypercapnia (5% CO₂), and the role of [Ca²⁺]i and pH_i within the signalling cascade in the NECs. Goldfish at 25°C significantly increased their ventilation amplitude (Vamp) after 15 - 30 min of hypercapnic exposure while ventilation frequency (Vf) remained unchanged. The increase in Vamp was accompanied by a significant drop in heart rate after 30 min of exposure. Exposing isolated goldfish NECs to 5% CO₂ caused a decrease in [Ca²⁺]i and intracellular pH, responses which contrast with the chemo-transduction cascade exhibited in zebrafish NECs. The cause of the [Ca²⁺]i decrease is unclear; we are currently investigating potential mechanisms underlying this response.

Des études antérieures ont montré que l'augmentation des niveaux de CO₂ (hypercapnie) sont détectés par des cellules neuro-épithéliales branchiales (CNE), qui ont été impliqués en l'initiation de la hyperventilation dans les poissons. Ici, nous examinons les réponses cardiorespiratoires du cyprin doré à l'hypercapnie (5% de CO₂), et le rôle de [Ca²⁺] intracellulaire (i) et pH_i dans la cascade de signalisation dans les CNE. Les cyprins dorés à 25°C ont augmenté leur amplitude de ventilation (Vamp) après 15 - 30 min d'exposition à hypercapnie tandis que la fréquence de ventilation (Vf) est demeuré inchangé. L'augmentation de Vamp après 30 min d'exposition s'est accompagnée d'une baisse significative de la fréquence cardiaque. Exposer les CNE isolés des cyprins dorés à 5% de CO₂ provoque une diminution de la [Ca²⁺]i et le pH_i, des réponses qui contrastent avec la cascade de transduction chimio dans les CNE poisson zèbre. La cause de la baisse de [Ca²⁺]i n'est pas clair, nous étudions maintenant les mécanismes potentiels sous-jacents à cette réponse.

The strings of the puppetmaster: Parasitic manipulation of host hormones and behaviour

Les ficelles du marionnettiste: Manipulation parasitaire du comportement et des hormones d'un hôte

¹Shelley Adamo

¹Dalhousie University

The parasitic wasp, *Cotesia congregata*, lays its eggs inside the body of its host, the caterpillar *Manduca sexta*. The wasp manipulates the host's immune system, endocrine system and nervous system, leading to profound changes in host development and behaviour. For example, the wasp larvae release juvenile hormone III into their host, and also suppress host production of juvenile hormone esterase, the enzyme that catabolizes juvenile hormone. These changes result in elevated JHIII levels and host developmental arrest (see Beckage and Gelman, 2004). Just prior to wasp emergence from the host, the wasps induce a massive immune reaction in their host. Octopamine titres are elevated and there is increased production of insect cytokines such as paralytic peptide. The host loses the ability to return these levels back to baseline, and the elevated octopamine and cytokine levels suppress feeding in the host. The change in behaviour benefits the wasp.

Barcoding a Sub-Arctic Biota: Insights into the Biodiversity of the North Codage à barres d'un biote subarctique: Une idée de la biodiversité du Nord

¹Sarah Adamowicz

¹University of Guelph

In 1988, Robert May famously pointed out that we do not know the number of species on earth to within an order of magnitude. He argued that comprehensive data for even a small focal site in a tropical forest—rather than extrapolation—was required to quantify biodiversity. However, such data have not been forthcoming in the intervening years, not for any site, let alone a tropical one. Here, I present an overview of a large, collaborative project that has the goal of revealing the co-habiting biodiversity of animals and plants at a single sub-Arctic site—Churchill, Manitoba, Canada. After DNA barcoding and analyzing >75K specimens representing >7.5K species, insights into the structure of biodiversity include: surprisingly high species-level diversity, highly variable ratios of described/undescribed species and rates of detection of cryptic species among higher taxa, and differential strengths of the latitudinal diversity gradient among taxa.

En 1988, Robert Peut a fait remarquer que nous ne connaissons pas le nombre d'espèces sur terre même au sein d'un ordre de grandeur. Il a soutenu que les données compréhensives plutôt que par extrapolation, même pour un petit site central dans une forêt tropicale, étaient nécessaires pour quantifier la biodiversité. Cependant, ces données n'ont pas été reçues dans les années qui ont suivi, pas pour n'importe quel site, et encore moins au climat tropical. Ici, je vous présente un aperçu d'un grand projet collaboratif qui a pour but de révéler la biodiversité cohabitation des animaux et des plantes à un seul site sous-arctique au Churchill, Manitoba, Canada. Après affectation des codes à barres d'ADN et l'analyse de > 75K spécimens représentant > 7.5K espèces, un aperçu de la structure de la biodiversité comprennent: la diversité des espèces étonnamment élevé, les rapports très variables d'espèces décrites/non décrites et les taux de détection des espèces cryptiques chez les taxons supérieurs, et les forces différenciées du gradient latitudinal sur la diversité entre les taxons.

Investigation of the pH-regulation and ammonia excretion mechanism in the soil nematode, *Caenorhabditis elegans*

Enquête sur la régulation du pH et les mécanismes d'excrétion de l'ammoniac dans le nématode,

Caenorhabditis elegans

¹Aida Adlimoghaddam, ¹Ann-Karen Brassinga, ²Mike O'Donnell, ¹Jason Treberg, ¹Dirk Weihrauch

¹University of Manitoba, ²McMaster University

Previous experiments suggested that the mode of ammonia excretion in *C. elegans* occurs partially over the body wall and is dependent on an acidification of the subcuticular space. Proton secretion over the body wall was verified by H⁺-flux measurements employing SIET. Inhibitor experiments on animals in liquid culture indicated further the participation of a H⁺-ATPase (VHA), carbonic anhydrase, Na⁺/H⁺-exchanger (NHX), and a functional microtubule network in the ammonia excretion mechanism. Inhibition of Na⁺/K⁺-ATPase (NKA) by ouabain caused no change in ammonia excretion rates. However, enzyme assays showed the ability of the NKA to accept ammonia as a substrate. Additionally, an mRNA expression analysis revealed that the expression of VHA, NHX-3, NKA, Rh-r1, Rh-r2, AMT-2, and AMT-3 increased upon ammonia exposure, indicating that these transporters are involved in the excretory mechanisms. Interestingly, mRNA expression of AMT1 and AMT4 was sensitive to changes of the environmental pH but not to ammonia stress.

Fish heads: an evolutionary Swiss army knife

La tête des poissons: un couteau Suisse évolutif

¹Dominique Adriaens, ¹T. Geerinckx, ¹M. Bouilliart, ²S. Eagderi, ¹H. Leysen, ¹S. Van Wassenbergh

¹Ghent University, ²University of Teheran

If a craniate head, especially that of teleosts, could be considered an evolutionary toolbox, it would be a super-duper Swiss army knife. With a vast range of ecological niches being occupied, and extensive species diversity, the variation in functional units in the teleost head is unparalleled. Starting from a simple and functionally constrained system in basal actinopterygians, the feeding system has evolved into some of the most extreme morphotypes, representing almost any typical Swiss army knife tool. In this presentation, some examples of teleost fish that do different things with their specialized feeding apparatus will be illustrated: (1) loricariid catfish with special scraping teeth, (2) trichomycterid catfish with a slicing system to open gill tissue, (3) larval European eel with protruding teeth but no powerful biting, (4) pelican eels with elongated jaws for engulfing large prey, and (5) seahorses with a tube snout for pivot suction feeding at high speed.

**Salinity responsive aquaporin expression in the anal papillae of the larval mosquito, Aedes aegypti.
Expression d'aquaporine dépendante de la salinité dans la papille anale des larves du moustique, Aedes aegypti**

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The anal papillae (AP) of the mosquito larva, *Aedes aegypti* are important sites for ionoregulation because they actively take up ions from a dilute external environment to help maintain appropriate ion levels in the hemolymph. An apparent paradox is that these structures are also permeable to water and because of the syncytial nature of the epithelium, aquaporins (AQPs) are likely to be involved. Our previous studies revealed expression of two AQP homologs (*AaAQP1b* and *AaAQP4*) in the anal papillae of freshwater reared larvae. In the present study, transcript expression levels of six AQP homologs in the AP were examined in larvae reared in freshwater and 7.5 g L⁻¹ Instant Ocean® salts (~ 30% seawater). The expression of some of the AQPs was salinity responsive and in particular relatively high levels of *AaAQP3b* were detected in AP of 30% seawater reared larvae suggesting the importance of this homolog in salinity acclimation.

Managing stress: a cortisol inactivation

Gérer le stress: une inactivation du cortisol

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The function of 11 β -hydroxysteroid dehydrogenase type 2 (11 β HSD2) in regulating the stress response in teleosts is not known. 11 β HSD2 inactivates cortisol by converting it to cortisone, and in other vertebrates is essential for conferring aldosterone-specific effects and for protecting glucocorticoid-sensitive tissues. We observed extensive peripheral and central expression of this enzyme in adult zebrafish, including hypothalamic regions involved in the endocrine stress response. We tested the hypothesis that modulation of brain 11 β HSD2 activity contributes to regulation of the endocrine stress response. Following an acute air exposure stressor, 11 β HSD2 activity in the brain was significantly elevated for 24h post-stress, despite rapid recovery in cortisol levels. Inhibition of 11 β HSD2 by 18 β -glycyrrhetic acid increased whole body cortisol levels and preoptic area mRNA abundance of corticotropin-releasing factor and mineralocorticoid receptor. Taken together, our results underscore an important role for brain 11 β HSD2 involvement in the negative feedback regulation of cortisol post-stress in zebrafish.

La fonction de type 2 déshydrogénase de 11 β -hydroxystéroïde (11 β HSD2) dans la régulation de la réponse au stress chez les téléostéens n'est pas connue. 11 β HSD2 inactive la cortisol en la convertissant en cortisone, et dans d'autres vertébrés est essentielle pour conférer les effets spécifiques de l'aldostérone et pour protéger les tissus sensibles aux glucocorticoïdes. Nous avons observé une vaste expression périphérique et central de cette enzyme chez le poisson zèbre adulte, y compris les régions hypothalamiques impliquées dans la réponse au stress endocrinien. Nous avons testé l'hypothèse que la modulation de l'activité de 11 β HSD2 du cerveau contribue à la régulation de la réponse au stress endocrinien. Suite à une exposition à l'air aiguë (un facteur de stress), l'activité de 11 β HSD2 dans le cerveau a resté significativement plus élevée pour 24h après le stress, malgré la reprise rapide des niveaux de cortisol. L'inhibition de 11 β HSD2 par 18 β -glycyrrhétinique a augmenté les niveaux de cortisol du corps entiers et de l'abondance d'ARNm du facteur de libération de corticotropine et du récepteur minéralocorticoïde dans la domaine préoptique. Pris dans leur ensemble, nos résultats mettent en évidence un rôle important pour l'implication de 11 β HSD2 du cerveau dans la régulation par rétrocontrôle négatif de cortisol après un stress chez le poisson zèbre.

Inhibition of VHSV replication in a gill epithelial cell line

Inhibition de la réplication du virus SHV dans une lignée de cellules épithéliales branchiales

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Branchial epithelial cells have been demonstrated to be a site of entry and replication of viral hemorrhagic septicemia virus. The current in vitro study employed a number of compounds and pathogen-associated molecular patterns to investigate the potential antiviral response in a rainbow trout gill epithelial cell line (RTgillW-1). This cell line was stimulated with poly IC, FuGENE® HD + poly IC, lipopolysaccharide (LPS), LPS + poly IC or heat-killed VHSV IVb for 4 d, then infected with VHSV IVb at a MOI of 0.035. A reduction in viral replication was determined by monitoring cytopathic effect and by estimation of viral genome copy number within infected cells and the supernatant using quantitative reverse transcriptase-polymerase chain reaction, post-viral exposure. Unexpectedly, killed VHSV, rather than poly IC, was the most effective pretreatment, despite the fact that poly IC stimulated interferon gene upregulation in the epithelial cells and killed virus did not.

Les cellules épithéliales des branchies ont été démontrées pour être un point d'entrée et la réplication des virus de la septicémie hémorragique virale. Le courant étude in vitro a utilisé un nombre de composés et des modèles moléculaires associés à des pathogènes pour étudier la réponse antivirale potentielle dans une ligne de cellules épithéliales des branchies de la truite arc-en-ciel (RTgillW-1). Cette lignée cellulaire a été stimulée par le poly IC, FuGENE ® HD + poly IC, le lipopolysaccharide (LPS), LPS + poly IC ou tués par la chaleur SHV IVb pendant 4 jours, puis infectés par le virus de la SHV IVb à une MOI de 0,035. Une réduction de la réplication virale a été déterminée en contrôlant l'effet cytopathique et par l'estimation du nombre de copie du génome viral dans les cellules infectées et dans le surnageant en utilisant l'amplification en chaîne par polymérase quantitative de la transcriptase inverse, après l'exposition virale. De façon inattendue, la septicémie hémorragique virale tué, plutôt que le poly IC, a été le plus efficace comme prétraitement, malgré le fait que le poly IC stimule la régulation positive du gène interféron dans les cellules épithéliales, ce qui le virus tué n'a pas fait.

Life in the fast lane: associations between growth and the timing of life history events in rainbow trout (*Oncorhynchus mykiss*)

Vivre dans la voie rapide: Les associations entre la croissance et le timing des événements de la vie chez la truite arc-en-ciel (*Oncorhynchus mykiss*)

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To examine phenotypic correlations among life history traits we assessed embryonic developmental rate, growth traits and incidence of precocious male maturation in four maternal half-sib families. Males carrying allelic variants associated with early or late spawning date were selected for crosses following genotyping of 60 males for 30 markers with previously established associations with female spawning date in this strain. Contrary to predictions, progeny sired by males carrying allelic compliments associated with late spawning dates showed significantly faster developmental rates and higher incidence of precocious maturation than progeny sired by males carrying allele compliments associated with early spawning dates. Mean condition factor for half-sib families with faster developmental rates was higher than that of families with slower developmental rates. Condition factor showed a positive correlation with precocious maturation in all families. Together, these results confirm a strong connection between growth and age at maturity and provide further evidence of a link with spawning date and embryonic developmental rate.

Muscle Na⁺/K⁺ ATPase isoform expression following swimming challenges in rainbow trout (*Oncorhynchus mykiss*)

Expression de l'isoforme musculaire de la Na⁺/K⁺ATPase après la nage forcée chez la truite arc-en-ciel (*Oncorhynchus mykiss*)

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Rainbow trout (*Oncorhynchus mykiss*) are salmonid fishes, a family often recognized for their physiologically demanding migration patterns. Studies have identified shifts in relative expression of specific Na⁺/K⁺ ATPase isoforms during salinity acclimation and it's believed that changes in expression may also be exhibited in response to other physiological challenges. The Na⁺/K⁺ ATPase plays a crucial role in maintenance of membrane potential and excitability during muscle contraction, with a tissue-specific isoform ($\alpha 2$) identified within skeletal muscle. This study examined α isoform mRNA and protein expression in hatchery-reared juvenile rainbow trout in response to sustained (3 BL/s) and burst (near Ucrit) swimming challenges to further describe muscle types as well as any possible training effects on isoform expression/ion regulation. We observed up-regulation of red muscle α mRNA following burst swimming, including a 2.5-fold increase in $\alpha 2$ and $\alpha 3$, while white muscle was unaffected after these exercise challenges.

Truite arc-en-ciel (*Oncorhynchus mykiss*) sont les salmonidés, une famille souvent reconnues pour leurs schémas de migration physiologiquement exigeants. Des études ont identifié des changements dans l'expression relative de certaines isoformes de Na⁺/K⁺-ATPase au cours de l'acclimatation à la salinité et on croit que les changements dans l'expression peut également être présenté en réponse à d'autres problèmes physiologiques. La Na⁺/K⁺-ATPase joue un rôle crucial dans le maintien du potentiel de membrane et de l'excitabilité lors de la contraction musculaire, avec une isoforme spécifique du tissu ($\alpha 2$) identifiées dans le muscle squelettique. Cette étude a examiné l'expression de α isoforme au niveaux d'ARNm et protéique dans les jeunes truites arc-en-ciel élevés en écloserie en réponse aux défis de natation soutenue (3 BL/s) et à l'éclatement (près de Ucrit) pour décrire les types de muscles ainsi que les effets possibles de l'entraînement sur l'expression de l'isoforme / la régulation des ions. Nous avons observé une régulation positive de l'ARNm de α de muscle rouge suivant la natation à l'éclatement, y compris une augmentation de 2,5 fois en $\alpha 2$ et $\alpha 3$, tout en muscle blanc n'a pas été affectée après ces défis exercice.

Characterizing dsRNA production in virus- infected fish cells

Production d'ARN viral à double brin dans des cellules de poisson soumises à une infection virale

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Most of viruses make double stranded (ds)RNA during their replicative cycle, and these molecules act as a potent innate immune stimulus. DsRNA production by viruses has been demonstrated in a wide variety of organisms from mammals to birds and even plants. Interestingly, while a number dsRNA sensors for viral dsRNA have been identified in fish, demonstration of viral dsRNA production by fish viruses in fish cells has yet to be shown. Using immunofluorescence, the present study shows that the fish virus, viral haemorrhagic septicaemia virus (VHSV), produces dsRNA during its replicative cycle. These dsRNA molecules are can be detected in cells derived from different tissues and fish species. The dsRNA molecules localize completely to the cytoplasm and demonstrate a punctate staining pattern. These data represent the first evidence for dsRNA production by fish viruses in fish cells and represent an important step in the understanding of fish innate antiviral responses.

Identifying substrates of zebrafish cytochrome P450 1A with high-throughput screening
Identification des substrats de l'enzyme cytochrome P450 1A chez le poisson zèbre avec recours au criblage à haut débit

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The cytochrome P450 (CYP) enzymes catalyze the oxidation of many organic compounds (e.g. hormones, drugs, contaminants). The characteristics of mammalian CYPs have been well studied, less so in non-mammalian vertebrates. We examined the zebrafish CYP1A in a high-throughput screen, and catalytic activity was assessed by measuring NADPH consumption. We screened a 6,400 bioactive compound library, consisting of off-patent, natural or pharmacologically active compounds with an average molecular weight of 350 g/mol. A total of 87 compounds induced NADPH consumption rates that were between 50% and 99% of the positive control (7-methoxyresorufin) and 33 compounds had rates > 100% of the positive control. The top hits included a number of endogenous compounds (e.g. neurotransmitters, peptides, bile acids) and plant compounds (flavonoids, alkaloids and monoterpenoids). Current work is examining the kinetics and uncoupling potential of the top hits, while our eventual goal is to test each of the CYP1 family isoforms.

Studying phagocytic activity of a rainbow trout monocyte/macrophage cell line

Étude de l'activité phagocytaire dans une lignée cellulaire monocyte/macrophage de truite arc-en-ciel

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Phagocytosis is a highly orchestrated cellular process. In vertebrates, professional phagocytes such as macrophages use phagocytosis as a first defense strategy to remove invading pathogens and apoptotic bodies. One of the classical tools to study phagocytosis is using polystyrene beads. In this study, we utilized fluorescent polystyrene beads to study “factors” that modulated phagocytic activity in the monocyte/macrophage RTS11 cell line derived from the spleen of rainbow trout. The ability to phagocytose the beads was judged based on if the beads were present inside the cells and how many beads there were. We found that phagocytosis was serum-dependent and temperature-dependent. Infecting RTS11 with viral hemorrhagic septicemia virus and chum salmon virus induce greater uptake of the beads over 14 days of infection. Results with immune stimulators and cytokines will also be discussed. Overall, this study shows the differential responses of viruses and immune stimulators on the phagocytosis of fish macrophages.

Urea balance across the gut of the spiny dogfish, *Squalus acanthias*

Équilibre urique dans l'intestin de l'aiguillat commun, *Squalus acanthias*

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In recent years the influence of feeding on whole body osmoregulation, acid base and nitrogen balance in fishes has received significant research attention. While much of the work has focused on teleost fish, attention is now being turned to the role of the gut in elasmobranch fishes. With their ureosmotic strategy it is hypothesized that the gut plays a significant role in urea balance in this group of fishes. In a unidirectional flux study the effect of phloretin, methylurea, acetamide and thiourea were all shown to significantly decrease urea uptake from isolated gut epithelia in fed spiny dogfish, *Squalus acanthias*. In a bidirectional flux study from paired intestinal tissue mounted in Ussing chambers addition of phloretin to the mucosal side significantly inhibited net urea uptake, however, in starved fish phloretin treatment resulted in a significantly greater uptake of urea compared to fed fish. Potential mechanisms for urea balance in the gut in fed and starved fish will be discussed. (NSERC Discovery to WGA and CMW).

Explaining the intestinal parasite community composition using a multiple dietary descriptor approach: a case study with ring-billed gulls breeding in the st. lawrence river

Expliquer la composition de la communauté parasitaire intestinale en utilisant une approche multiple de descripteurs alimentaires: étude sur des goélands à bec cerclé nichant dans le fleuve Saint-Laurent

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Parasite communities are often highly variable among birds of the same species. This can be largely explained by intra-specific variations in feeding habits, although few studies have addressed this issue. In order to study the link between parasite community composition and diet, we examined intestinal parasites and characterized the feeding ecology of ring-billed gulls (*Larus delawarensis*) using three methods, each with distinct time scales. Stomach contents were analysed providing information on diet over the last few hours. Miniature GPS-based dataloggers were used to monitor foraging movements during the previous 48 hours. Finally, liver carbon (d₁₃C) and nitrogen (d₁₅N) stable isotopes were determined offering insight into food assimilation during the last two weeks. Results showed that birds with similar parasite communities tend to have similar stable isotope signatures. However, no strong link was found between parasite communities, and stomach contents or recent foraging behaviour.

Ammonia excretion in the Atlantic hagfish

Excrétion d'ammoniac chez la myxine du Nord

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It is widely accepted that in teleost fishes, the excretion of nitrogenous wastes and excess acid and base are accomplished primarily through transepithelial excretion ions across the branchial epithelium. Recent work by Weihrauch, Nakada, Hung and Nawata have indicated that the non-erythroid Rhesus (Rh) proteins are capable of transporting ammonia across the branchial epithelium in aquatic invertebrates and vertebrates. In addition, a study on Pacific hagfish has demonstrated a possible role for Rh glycoprotein involvement in ammonia transport. This study utilizes real time PCR and protein expression studies to examine the potential role of the hagfish Rhcg in the excretion of ammonia following increased internal ammonia concentrations.

Il est largement admis que chez les poissons téléostéens, l'excrétion des déchets azotés et de l'excès d'acide et de base sont réalisées principalement par l'excrétion des ions transépithéliaux à travers l'épithélium branchial. Les travaux récents de Weihrauch, Nakada, Hung et Nawata ont indiqué que les protéines non-érythroïdes Rhésus (Rh) sont capables de transporter l'ammoniac à travers l'épithélium branchial chez les invertébrés et les vertébrés aquatiques. En outre, une étude sur le myxine Pacifique a fait preuve d'un rôle possible de la participation de la glycoprotéine Rh dans le transport d'ammoniac. Cette étude utilise PCR en temps réel et les études d'expression de protéines d'examiner le rôle potentiel de la Rhcg myxine dans l'excrétion d'ammoniac après l'augmentation des concentrations d'ammoniac internes.

Dispersal mediates zooplankton response to environmental change.

Réponse du zooplankton régulée par la dispersion face à un changement de l'environnement

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Human activities often result in severe environmental impacts to aquatic ecosystems, with declines in biodiversity frequently identified as one of the most serious repercussions. An important challenge is to predict how ecosystems will respond to various stressors, and to develop management tools to minimize impact. Local environmental conditions clearly play an important role in structuring communities. However, over the past decade ecologists have become increasingly aware of the important role that dispersal plays in shaping community composition. Dispersal of individuals among habitats can provide a source of species diversity and genetic variation that enable communities to adaptively respond to environmental variation. Using field experiments and surveys, we have sought to understand the role that dispersal plays in community response to environmental change. Our studies provide evidence that dispersal can be an important factor influencing community response but that several factors, including priority effects, local environment, and timing can mediate this response.

The nine-banded armadillo: an intriguing animal model for studying metabolism, maternal effects, and emerging diseases

Le tatou à neufs bandes: un curieux modèle animal pour étudier le métabolisme, les effets maternels et l'émergence de maladies

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Nine-banded armadillos (*Dasypus novemcinctus*) are a recent immigrant to North America. They are unique in that they maintain a lower body temperature (32 C), exhibit delayed implantation, give birth to monozygotic quadruplets, and are the only non-human carrier of mycobacterium leprae (leprosy). Herein, we summarize the last few years of investigations of the physiological variation and energetics of this species. Although there are strong neonatal sibling effects with respect to many anatomical and physiological variables, there are also significant within-litter differences in many of these traits. In juveniles, sibling effects are also evident in responses to environmental stressors of hypoxia and hypercapnia. In adult armadillos, the energetic cost of carrying leprosy was significant (23.9%). This increase was comparable to the energetic cost of pregnancy.

Interacting effects of predation and competition on dispersal dynamics

Effets interactifs de la préddation et de la compétition sur la dynamique de dispersion

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Dispersal dynamics have significant consequences on ecological and evolutionary processes. Several studies have shown that dispersal may be induced by a variety of ecological stressors, where most experiments have focused on the effects of just one stressor. However, individuals in natural environments likely experience combinations of multiple stressors simultaneously. In this study, our goal was to determine whether two common ecological stressors, predation risk and competition interact in their influence on dispersal dynamics. We performed a factorial experiment in pond mesocosms using backswimmers (*Notonecta undulata*), a flight-capable aquatic insect. We found that dispersal rates depended on both predation and competition, as well as their interactive effects. These results suggest that precise estimates of the effects of predation risk or competition on dispersal require inclusion of their interactive effects. More generally, multi-stressor experiments may reveal a more complete picture of dispersal dynamics across a range of ecological conditions.

The acidic ocean quenches the fire of life: metabolic depression in echinoderms following exposure to near future levels of ocean acidification.

L'acidité éteint la vie des océans: Dépression métabolique chez les échinodermes exposés à des niveaux d'acidité prédicts pour le futur

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Ocean acidification (OA) will be a significant challenge to the majority of marine species within this century, requiring organisms to adapt, relocate or die. Sea urchins are marine calcifiers known to be sensitive to environmental pH changes, but may have considerable potential to adapt to OA, with varied responses related to genotype and/or environmental history of parents. Using novel cutting-edge micro-respirometric techniques, we investigated metabolic and mitochondrial responses of larval urchins to near-future CO₂ levels. In addition, we used a systems biology approach to examine the concomitant responses of the transcriptome, proteome and metabolome. Larval sea urchins exhibited developmental delay, depressed MO₂, and mitochondrial dysfunction, as well as significant changes in the expression of genes, proteins and metabolites under high CO₂ conditions. The magnitude of these effects, however, was greatly dependent on parentage. The implications of these findings to future populations of an ecologically important endemic species are discussed.

The distribution of ducts linking the accessory olfactory organ and the main olfactory epithelium in sea lamprey

Distribution des conduits reliant l'organe olfactif accessoire et l'épithélium olfactif principal chez la lamproie marine

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The sea lamprey (*Petromyzon marinus*) uses odours to find food, mates and to migrate. The peripheral olfactory organ contains a folded epithelium, the main olfactory epithelium (MOE), as well as follicles, the accessory olfactory

organ (AOO). Ducts linked the MOE to the AOO, however the location of these ducts is unknown. The objective of this study was to investigate location of the ducts, their morphology, and their distribution in two life stages. The ducts were located at the base of the olfactory lamellar grooves and in close proximity to the AOO follicular cells. The ducts were lined with cuboidal epithelium as they passed through the olfactory epithelium. Ducts were located on the dorso-lateral and ventro-lateral sides of the peripheral olfactory organ. The number of ducts increased proportionally from transformers to spawners. This is evidence that there are ducts that link the MOE to the AOO.

Sperm competition and paternity loss in a singing fish, the plainfin midshipman.

Compétition spermatique et perte de paternité chez un poisson chanteur, *Porichthys notatus*

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The plainfin midshipman (*Porichthys notatus*) is a fish species with two male alternative reproductive tactics: guarding and sneaker males. Such alternative mating tactics arise when there is intense mating competition. Our genetic, ecological and physiological studies with this species show 1) the extent to which guarding males lose paternity to sneaker males and the fitness of each tactic; 2) how sperm competitive traits are shaped by sperm competition and female choice; and 3) the degree of reproductive plasticity within a reproductive tactics. Our results imply that female choice has an important role in shaping male competitive traits.

Development of a walleye endothelial cell line to study the pathogenesis of viral hemorrhagic Septicemia virus
Développement d'une lignée cellulaire endothéliale pour l'étude de la pathogénicité du virus de la septicémie hémorragique virale

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Viral Hemorrhagic Septicemia virus (VHSV IVb), a causative agent of VHS, has been associated with multiple mortality events of freshwater fish including walleye (*Sander vitreus*) in the Great Lakes. Gross lesions and severe hemorrhages were among the symptoms of VHS (Lumsden et al., 2007). Since the fish endothelium serves as the platform for viral shedding and spreading, a walleye endothelial-like cell line, WEBA1F was developed and used in this study. VHSV IVb replication was supported at the optimal infection temperature of 14°C; however it could kill the cells at 4°C and 20°C. Cytopathic effects (CPE) included complete cell lysis, which developed 10 days post-infection in WEBA1F cultures. Overall, this study could contribute to the understanding of how VHSV IVb causes severe hemorrhages in infected fish.

Multi-seasonal determinants of reproductive success: interactions between carry-over effects and environmental variation in a migratory bird

Déterminants multi-saisonniers du succès reproductif: interactions entre les effets différés et la variation de l'environnement chez un oiseau migrateur

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Our understanding of the capacity for cross-seasonal phenomena such as carry over effects (COE) to interact with within-season processes, such as those occurring during breeding, remains extremely limited. Such interactions could potentially have a large influence on individual reproductive success, as for example conditions during breeding could either magnify, attenuate or completely cancel out a COE persisting from winter. Here we use metrics of body condition, as well as climatic data from the breeding period, to show that observed reproductive asymmetries among individuals are a function of both cross-seasonal body-condition mediated COE and within-season environmental conditions experienced on the breeding grounds in an Arctic-nesting migratory bird, the light-bellied Brent goose (*Branta bernicla hrota*). We highlight that this interaction operates in entirely the opposite direction to that described in another Arctic-nesting species with similar life history, highlighting the capacity for similar ecological processes, and their interaction(s), to exert vastly different selective pressures on multiple species.

Notre compréhension de la capacité de contre-saison phénomènes tels que les effets différés (ED) pour interagir avec les processus au sein de la saison, tels que ceux pendant la reproduction, reste extrêmement limité. Ces interactions pourraient avoir une influence importante sur le succès individuel du reproducteur, comme par exemple les conditions au cours de la reproduction pourrait soit amplifier, atténuer ou annuler complètement un ED persistant de l'hiver. Ici, nous utilisons des paramètres de condition physique, ainsi que les données climatiques de la période de reproduction, pour montrer que les asymétries de reproduction observées entre les individus sont fonction à la fois de la médiation ED par l'état du corps contre-saison et des conditions environnementales au sein de saison dans les zones de reproduction chez un oiseau migratoire nichant dans l'Arctique, la Bernache cravant (*Branta bernicla hrota*). Nous soulignons que cette interaction fonctionne en opposition à celui décrit chez une autre espèce nichant dans l'Arctique avec un cycle biologique similaire, mettant en évidence la capacité des processus écologiques semblables, et leur interaction(s), à exercer des pressions sélectives différentes sur multiples espèces.

How to make an eye: an example of matrix-mediated morphogenesis

Comment faire un œil: Un exemple de morphogénèse matricielle

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Eye morphogenesis begins with contact between the optic vesicle and the surface ectoderm. These tissues adhere due to secretion of an extracellular matrix (ECM) between them. In mice, conditional deletion of the transcription factor Pax6 from the ectoderm prevents lens and optic cup formation. Microarray analysis revealed decreased expression of many ECM transcripts in Pax6 knockout ectoderm. Global deletion of Fn1, a protein required to assemble the ECM, also prevented lens and optic cup formation. The optic cup formed after removal of the lens placode from chick embryos, but treating the surface of the optic cup with collagenase prevented or reversed optic cup formation. A finite element model showed that maintaining the contact area between the optic cup and ectoderm by the ECM was sufficient to explain optic cup formation and the effect of disrupting the ECM with collagenase. These data suggest eyes form by “matrix-mediated morphogenesis.”

VHSV IVb replication over a broad range of temperatures in walleye fin cells

RéPLICATION DU VHSV IVb SUR UN LARGE INTERVALLE DE TEMPÉRATURES DANS DES CELLULES DE NAGEOIRES DE DORÉ

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A unique Northern American subgenotype (IVb) of viral hemorrhagic septicemia virus (VHSV) has emerged over the last 10 years in the Great Lakes, causing significant mortality in a wide range of freshwater fish, including walleye. Two cell lines WECF11-f (fibroblastic) and WECF11-e (epithelial) derived from the caudal fin were recently developed. The capacity of these cells survive at 4°C for over a month provide an opportunity to explore VHSV replication at 4°C, which walleye experience through winter, to compare with 14°C, which is usually considered optimal for VHSV production. After one month post-infection at 4°C a pronounced increase in viral titer was observed in WECF11-f cultures but not in WECF11-e cultures; suggesting a tissue tropism for VHSV was most pronounced at cold temperatures. These findings may have several implications in how VHSV is able to be carried during the winter months and cause mass fish kills during the spring.

Conservation of amphibians and reptiles in a threatened region of the Amazonian rainforest in Brazil

Conservation des amphibiens et reptiles dans une zone de forêt tropicale menacée au Brésil

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The Amazonian rainforest extends over an area of 6,717,772 km² and is currently under extensive human pressure and high rates of deforestation. The present study was carried out at the Reserva Biológica do Tapirapé (REBIOTA), Pará, Brazil; a 103 ha protected area surrounded by large mining areas and in central Amazonia. According to the Brazilian authorities, the REBIOTA is classified as a protected area of extremely high biological importance. We sampled the area for 21 days throughout the year and our efforts resulted in the discovery of 35 species of amphibians and 27 species of reptiles. This survey documented eight amphibians and three reptiles that previously were not known from the region. This brief study and its discoveries reinforces the urgent need to implement conservation strategies for a threatened biological hotspot that is still largely unknown.

Spontaneous thread skein unraveling in Pacific hagfish *Eptatretus stoutii*

Démêlage spontané des fils d'écheveaux chez la myxine brune *Eptatretus stoutii*

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Hagfish are known for their ability to produce large volumes of slime extremely rapidly when provoked. Hagfish slime consists of mucous strands and long intermediate-filament-rich threads stored as skeins (tightly coiled bundles). Upon exposure to seawater, the skeins unravel and the threads interact with the mucous strands to create a network that traps water. This project involved studying the mechanism by which the threads go from their tightly coiled state (skein) to their elongated state (unraveled). The hypothesis that we explore proposes that there is a protein adhesive that keeps the skein intact, but that dissolves or is disrupted when it is exposed to seawater, releasing the strain energy stored within the thread. We present several sets of data that provide compelling evidence to support this adhesive/stored strain energy hypothesis.

Carry-over effects, sequential density-dependence and the dynamics of populations in a seasonal environment
Effets de report, densité-dépendance séquentielle et dynamique des populations dans un environnement saisonnier

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Most animal populations have distinct breeding and non-breeding periods, yet the implications of seasonality on population dynamics are not well understood. Here, we introduce an experimental model system to study the population dynamics of both sequential density dependence and carry-over effects. Using seasonal populations of *Drosophila*, we placed individuals at three densities in the non-breeding season and then, among those that survived, placed them to breed at four different densities. We show that carry-over effects arising from variation in the non-breeding density negatively impacts individual performance by reducing per capita breeding output by 29-77%. We then parameterized a bi-seasonal population model from the experimental results and show that both sequential density dependence and carry-over effects can stabilize long-term population dynamics and that carry-over effects can reduce population size at low intrinsic rates of growth. Our results have important implications for understanding the long-term persistence of seasonal populations.

Maternally transferred bisphenol A (BPA) impacts development and stress axis functioning in rainbow trout
Le transfert maternel du bisphénol A (BPA) affecte le développement et l'axe du stress chez la truite arc-en-ciel

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The aim of this study was to determine whether maternally transferred bisphenol A (BPA), shown to accumulate in the lipid-rich eggs of fishes, affects cortisol stress axis functioning after hatch in rainbow trout (*Oncorhynchus mykiss*). Oocytes collected from female trout were bathed in ovarian fluid containing 0, 0.3, 3 and 30 mg L⁻¹ BPA for 3 h, after which the eggs were washed and fertilized. BPA exposure led to a dose-related accumulation, but the contaminant was cleared from all groups prior to hatching. BPA accumulation in the oocytes significantly affected specific growth rate, whole body cortisol and glucose profiles during development, and disrupted the cortisol response to stressor exposure after hatch. This corresponded with altered expressions of key genes (StAR, p450scc, MC2R) and proteins (MR, GR) involved in the stress axis functioning. The results suggest that maternal transfer of BPA affects development, long-term growth and stress axis functioning.

Influence of the testosterone degradation pathway in male amphibians reproduction

Influence des mécanismes de dégradation de la testostérone sur la reproduction des amphibiens mâles

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Amphibian populations are worldwide declining in diversity and number partly due to increased environmental pollution. Therefore, it is important to expand our knowledge on the amphibian life cycle to assist in population management. Whereas many studies focus on the female reproductive system, this study explores the testosterone degradation pathway in male frogs associated with development and reproduction. Testosterone is converted to dihydrotestosterone by four types of 5-reductases. Using enzyme specific inhibitors, the objective of this study is to gain a better understanding of the testosterone metabolism in relation to the regulation and biological functions of 5 α -reductases and 5 β -reductase. A novel in-vitro incubation assay was optimized for *Silurana tropicalis*, which tests a range of frog tissue (brain, liver, and gonads). In this study, exposure to finasteride, a 5-reductase inhibitor was performed. A custom microarray of 44,000 probes designed for *S. tropicalis* was used to assess transcriptional modifications induced by 5-reductase inhibition. Preliminary results will be presented.

Making sense of nickel toxicity in saline waters: nickel accumulation in the estuarine crab, *Carcinus maenas*
Donner un sens à la toxicité du nickel dans les eaux salées: accumulation de nickel dans le crabe des estuaires, *Carcinus maenas*

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The effects of salinity on metal uptake and toxicity are poorly understood. While water chemistry may play an important role, the physiology of the organism may also have an important influence. The green shore crab (*Carcinus maenas*) was exposed to an environmentally-relevant level of nickel (8.1 μ g/L) for 24 hours to observe the effect of acclimation salinity (20-100%SW) on tissue nickel uptake. The highest total nickel uptake occurred in the 100% SW,

while the lowest occurred in the 40% SW. The gills accumulated the highest amount of Ni overall (40%), with anterior gills accumulating higher levels than posterior gills, a finding confirmed in specific gill perfusion experiments. These data suggest that both water chemistry and physiology may play a role in nickel accumulation, and should be considered when considering nickel toxicity in estuarine settings (NSERC, CRC Program, CRD Program, ICA/CDA, ILZRO/IZA, NiPERA, Teck Resources, Vale).

Holding our breath in our modern world: are mitochondria keeping the pace with global changes?
Retenir son souffle dans le monde moderne: Est-ce que les mitochondries gardent le rythme des changements planétaires?

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Changes in environmental temperature can pose significant challenges to animals and shifts in thermal habitat have been shown to be a major force driving species adaptation. These adaptations have been the focus of major research efforts to delineate the physiological or metabolic constraints related to temperature and to reveal the phenotypic characters that can or should adjust. Considering the current consensus on climate change (GIEC 2007), future work will likely focus on questioning if species will survive to the modifications of their thermal niches. Organismal adjustments to temperature can either be through physiological plasticity (e.g. acclimation) or via genetic adaptation. We will therefore have to specify what are the genetic and phenotypic attributes (at the level of individual, population and species) that could grant survival success. These questions are particularly important for ectotherms, which are in thermal equilibrium with the surrounding environment. To start answering these queries, we should wonder if any physiological or metabolic function sets the temperature impact on organisms. Some recent development point mitochondria as key metabolic structure that delineate the thermal range that organism can tolerate. The catalytic capacity of mitochondria is highly sensitive to thermal variation and therefore should partly dictate the temperature dependence of biological functions. Mitochondria are a complex network of pathways of different enzymatic reactions that synergistically interact. The fine regulation of both ATP and ROS production depends on this integration of different enzymes and pathways. Here, we will scrutinize the temperature dependence of different parts of the mitochondrial pathways and evaluate the evolutionary challenges that should be overcome to insure mitochondrial adaptations to new thermal environments.

Characterization of a multipotent cell line from the brain of the American eel (*Anguilla rostrata*)
Caractérisation d'une lignée cellulaire pluripotente à partir du cerveau de l'anguille d'Amérique (*Anguilla rostrata*)

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A cell line (EelB) derived from the brain of the American eel (*Anguilla rostrata*) has been characterized. The cell line has been kept for several years at room temperature in L15 with 10% fetal bovine serum (FBS) and has been passaged up to 80 times. DNA bar coding confirmed the origin as being American eel. EelB cultured on low attachment well plates formed spheres within 48 hours. The spheres attached and spread on tissue culture well plates when plated over night. Furthermore, the cells are positive for the cell markers neurofilament 200 (NF200), glial fibrillary acidic protein (GFAP), Vimentin, and S-100. In colony forming assays, single cells were able to attach and to form colonies within 14 days. When cultured on matrigel, EelB cells aggregate to form capillary-like structures. EelB cells also express ZO-1 and von Willebrand factor. Together these results suggest EelB cells are neural progenitor/stem cells.

Changes in photoperiod are sufficient to induce reversal of GABAergic polarity in *Lymnaea Stagnalis* pedal ganglia

Les variations de la photopériode sont suffisantes pour induire une inversion de polarité GABAergique dans les ganglions pédieux de *Lymnaea stagnalis*

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GABA is the primary inhibitory neurotransmitter in the mature mammalian central nervous system. The role of GABA within the snail central ganglion; however, consists of contradictory reports, citing both inhibitory and excitatory effects. Our lab has demonstrated a seasonal shift in the ionic polarity induced by GABA with inhibitory responses during the summer and excitatory responses during the winter. It was the objective of this study to determine whether the changes in photoperiod associated with seasonality were responsible for this seasonal shift in

GABAergic polarity. Using intracellular sharp recordings from cluster F neurons within the pedal ganglia we determined that snails exposed to a 16h:8h light dark (LD) cycle exhibited more than a 50% decrease in action potential frequency (APf) and a GABA-mediated hyperpolarization of membrane potential (Vm). Conversely, in snails exposed to a 8h:16h LD cycle APf was doubled and GABA application induced a depolarization of Vm.

Le GABA est le neurotransmetteur inhibiteur principal dans le système nerveux central des mammifères matures. Cependant, le rôle du GABA dans le ganglion central d'escargot se compose de rapports contradictoires, citant la fois des effets excitateurs et inhibiteurs. Notre laboratoire a démontré un changement saisonnier de la polarité ionique induite par le GABA avec les réponses inhibitrices pendant l'été et réponses excitatrices pendant l'hiver. C'était l'objectif de cette étude pour déterminer si les changements de photopériode liés à la saisonnalité sont responsables pour ce changement saisonnier de polarité GABAergique. Utilisation des enregistrements intracellulaires des neurones pointus F-munitus dans les ganglions pédieux, nous avons déterminé que les escargots exposés à une cycle 16h: 8h sombre lumière (SL) a montré une diminution de la fréquence des potentiels d'action (FPA) de plus que 50% et une hyperpolarisation induite par le GABA de la membrane potentiel (Vm). A l'inverse, dans les escargots exposés à une cycle 8h: 16h SL la FPA a été doublé et l'application de GABA a induit une dépolarisation de Vm.

A comparison of the acclimation responses to constant and intermittent hypoxia acclimation in killifish (*Fundulus heteroclitus*)

Comparaison des réponses d'acclimatation à l'hypoxie chronique et intermittente chez le choquemort (*Fundulus heteroclitus*)

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Many fish encounter hypoxia on a diurnal cycle, but we know relatively little about the physiological responses of fish to intermittent hypoxia. We therefore compared gill morphology, haematology, and metabolic enzyme activities after acclimation to constant hypoxia or nocturnal intermittent hypoxia (2.0 or 0.8 mg O₂/L for 1-4 weeks) in killifish. Acclimation to constant hypoxia resulted in a modest but paradoxical decrease in gill surface area (due to a decrease in total filament length with no appreciable change in lamellar morphology), an increase in whole-blood [haemoglobin] and haematocrit, and a decrease in cytochrome oxidase activity in the muscle. In contrast, acclimation to intermittent hypoxia did not change gill morphology or blood haematology, and increased cytochrome oxidase, citrate synthase, and lactate dehydrogenase activities in the liver. The distinct responses to constant and intermittent hypoxia may reflect different coping strategies that depend on the pattern of hypoxia exposure. Supported by NSERC.

Serotonin modulation of odour-evoked neural activity in the olfactory bulb of the sea lamprey
Modulation sérotonergique de l'activité cérébrale évoquée par les odeurs dans le bulbe olfactif de la lamproie marine

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The sea lamprey (*Petromyzon marinus*) utilize olfaction to perform basic behaviours such as migration, feeding and reproduction. Synaptic integration of odour information occurs in the olfactory bulb and is relayed to higher brain structures. Within the dorsal region of the olfactory bulb, there are serotonergic fibers that may have a modulatory effect on the neural responses to odours. We applied odours (sex and migratory pheromones, bile acids and amino acids) to the olfactory epithelium and recorded local field potentials from this dorsal region of the olfactory bulb. When serotonin was applied through a bath application, serotonin suppressed bulbar responses in approximately half of the preparations, and had no effect in the other half. This research will assist in determining the possible roles of serotonin in the lamprey olfactory system.

Effects of chlorpyrifos on in vitro sex steroid production in lake sturgeon, *Acipenser fulvescens*
Les effets du Chlorpyriphos sur la production in vitro de stéroïdes sexuels chez l'esturgeon jaune, *Acipenser fulvescens*

¹Catherine Brandt, ¹Liane Arcinas, ¹Janet Genz, ¹Gary Anderson
¹University of Manitoba

In this study, gonad tissue of adult lake sturgeon, *Acipenser fulvescens*, was used in an in vitro incubation to examine the effects of the pesticide chlorpyrifos on steroidogenesis of testosterone and estradiol. The tissue was incubated for 20h with 5, 500 or 2000 ng.ml⁻¹ of chlorpyrifos and compared to a positive control of 8-bromo cAMP (0.1mM) plus pregnenolone acetate (100ng.ml⁻¹) in L-15 medium. The concentration of testosterone and estradiol in the incubation medium was determined for each experimental treatment by radioimmunoassay (RIA). Approximately 50 mg of testicular and ovarian tissue was fixed for examination of gonad development stage in each fish. One way analysis of variance of steroid hormone concentration revealed a significant treatment effect and suggested a trend of decreasing testosterone production in males and females with higher chlorpyrifos concentrations (from 40.29 to 21.84pg.mg⁻¹ tissue wet weight⁻¹.h⁻¹ and from 33.83 to 15.19pg.mg⁻¹ tissue wet weight⁻¹.h⁻¹ for males and females respectively).

Spatial variation in population structure and its relation to dispersal in a model intertidal invertebrate
Variation spatiale de la structure des populations et sa relation au dispersemement chez un invertébré intertidal

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In the upper Bay of Fundy, the intertidal amphipod *Corophium volutator* swims at night in large numbers around the new or full moon. Furthermore, this species is regionally widespread with considerable site-to-site variation in population structure. Such variation provides a backdrop against which biological determinants of dispersal can be investigated. We conducted a large-scale study on night swimming of individuals at nine mudflats, using swimmer density as a proxy for dispersing individuals. We used stationary plankton nets, and sampled mud residents using sediment cores over 3 sampling rounds (20-28 June, 10-17 July, 2-11 August 2010). Small juveniles swam at most times and locations irrespective of resident population structure. Swimming of small females and large juveniles decreased with increasing resident presence of small males and adults (respectively). We suggest *C. volutator* exhibits dispersal once early in life, and possibly again as large juveniles and small adults if potential mates are limiting.

Long-lived big brown bats (*Eptesicus fuscus*) and house sparrows (*Passer domesticus*) use different mechanisms to lower ROS production in skeletal muscle and heart mitochondria relative to short-lived house mice (*Mus musculus*)

La chauve-souris brune (*Eptesicus fuscus*) et le moineau domestique, deux espèces longévives, utilisent différents mécanismes pour réduire leur production de ROS dans les muscles du squelette et le cœur

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In this study, we tested the prediction, based on the oxidative stress theory of aging, that mitochondria isolated from skeletal muscle and heart of bats (*Eptesicus fuscus*; MLSP = 19 years) and sparrows (*Passer domesticus*; MLSP = 13 years) would produce reactive oxygen species (ROS) at lower rates than those from (*Mus musculus*; MLSP = 4 years). In bats, mitochondrial ROS production in both tissues was lower than in mice largely because bat mitochondria converted a smaller proportion of electron flux into ROS. Sparrow heart (but not skeletal muscle) mitochondria also produced ROS at lower rates than in mice but converted a greater proportion of electron flux into ROS. Resultantly, whole heart mitochondrial ROS production capacity was higher in sparrows; however, increased oxidative capacity of sparrow heart likely lowers ROS production in vivo by establishing a spare oxidative capacity at rest. Therefore, bat mitochondria produce ROS at lower rates than mice because metabolic changes to individual mitochondria keep ETC complexes more oxidized, whereas sparrow mitochondria may produce ROS at lower rates than mice in vivo because their collectively higher oxidative capacity keeps ETC complexes more oxidized at rest.

Microbiome impact on gastrointestinal physiology in zebrafish, *Danio rerio*.

L'impact du microbiome sur la physiologie gastro-intestinale chez le poisson zèbre, *Danio rerio*.

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Little is known about the piscine gastrointestinal tract microbiome (GITM) despite the developing mammalian paradigm that the GITM affects host physiology – influencing systems from the gastrointestinal tract itself to immunity and cognition. We hypothesized that by manipulating the size and diversity of the zebrafish GITM we would alter the physiology of the intestinal tissue. First we reduced the GITM using antibiotics and then monitored the re-establishment of the intestinal bacteria. Subsequently we again reduced the GITM with antibiotics, but then inoculated the intestine with microbes from conspecifics (*Danio rerio*) or heterospecifics (*Carassius auratus*) to rapidly re-establish the GITM, and monitored the resulting intestinal bacteria. We sampled the intestinal tissue at various time points during both experiments and measured the activity of several key metabolic enzymes and the mRNA expression of several key nutrient and ion transporters. Results revealed a dynamic microbiome with surprising effects on intestinal physiology. Supported by NSERC.

Post-hatch heat warms adult beaks: irreversible physiological plasticity in Japanese quail

La chaleur pré-éclosion réchauffe le bec des adultes: plasticité physiologique irréversible chez la caille Japonaise.

¹Gary Burness, ¹Jacqueline Huard, ¹Emily Malcolm, ²Glenn Tattersall

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Across taxa, the rearing environment can affect adult morphology and physiology. In birds, the bill plays a role in thermal balance, however, it is unknown whether developmental temperature affects adult bill size and thermal function. We raised Japanese quail in warm (30°C) or cold (15°C) environments, and then at a common intermediate temperature. Cold-reared birds developed shorter bills, but bill size showed ‘catch-up’ growth once adults were at a common temperature. Despite having lived in a common thermal environment as adults, individuals initially reared in the warmth had higher bill surface temperatures than cold-reared individuals, particularly under cold conditions. This suggests blood vessel density and/or the control over blood flow in the bill retained a memory of early thermal ontogeny. We conclude post-hatch temperature reversibly affects adult bill morphology, but irreversibly influences the thermal physiological role of bills.

Markers of oxidative stress in zinc oxide nanoparticle-treated white sucker fish (*Catostomus commersonii*)

Marqueurs du stress oxydatif chez des meuniers noirs (*Catostomus commersonii*) exposés aux nanoparticules d'oxyde de zinc

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Nanoparticles, an increasingly-prevalent product of industrial and consumer processes, are commonly introduced to the environment where they interact with local species. A common mechanism of nanoparticle-induced toxicity is the creation of reactive oxygen species (ROS), which cause oxidative stress-associated damage in organisms by nonspecific oxidation of cellular components. This is especially prominent in fish, which use gills to uptake oxygen, thereby concentrating nanoparticles in filament tissue before distributing them systemically. The levels of common markers of oxidative stress, including TBARS, glutathione, and oxidation-dependent enzymes were assessed in zinc oxide nanoparticle (nZnO)-exposed and control white sucker fish. The findings of this survey allow us to better define a model of nanoparticle-induced toxicity in aquatic organisms.

Clocks in the brain and ovaries interact to regulate rhythmic ecdysteroid levels during egg development in the insect *Rhodnius prolixus*

Des horloges cérébrales et les ovaires interagissent pour réguler les rythmes d'ecdystéroïdes durant le développement des œufs de l'insecte *Rhodnius prolixus*

¹Michael Cardinal-Aucoin, ¹Colin G.H. Steel

¹York University

The neuropeptide prothoracicotropin hormone (PTTH) and ecdysteroids constitute the axis of circadian organization in larval *Rhodnius*. These hormones have now been shown to be present, rhythmic, and under circadian control in the adult insect. We examined the possibility this axis persists in the adult. Rhythms of both hormones are abolished when animals are kept in prolonged continuous light (LL). When LL ovaries were incubated in vitro and exposed to a 1h pulse of >10kDa brain neuropeptide fraction, rhythmic ecdysteroid release was reinitiated. Similar treatment of arrhythmic ovaries with >10kDa brain neuropeptide fraction from which PTTH was removed by double immunoprecipitation failed to restore ecdysteroid cycling. We infer PTTH acts on the ovarian clock regulating ecdysteroid production; therefore the PTTH-ecdysteroid axis remains involved in adult circadian organization. These results challenge the accepted view of PTTH as a strictly larval hormone and provide the first evidence for a role in adult physiology.

L'hormone prothoracicotropique neuropeptide (PTTH) et ecdystéroïdes constituent l'axe de l'organisation circadienne chez les larves de *Rhodnius*. Ces hormones ont été montrer pour être présent, rythmique, et sous le contrôle du rythme circadien chez l'insecte adulte. Nous avons examiné la possibilité de cet axe persiste chez l'adulte. Rythmes de ces deux hormones sont abolis lorsque les animaux sont exposés à une lumière continue et prolongée (LL). Lorsque les ovaires LL ont été incubées in vitro et exposé à une impulsion de 1h d'un fraction de neuropeptide du cerveau >10 kDa, la libération rythmique des ecdystéroïdes était relancé. Un traitement similaire des ovaires arythmiques avec la fraction de neuropeptide du cerveau de > 10 kDa à partir de laquelle le PTTH a été enlevé par immunoprécipitation a réussi à rétablir le cyclisme ecdystéroïde. Nous en déduisons que PTTH acte sur l'horloge de l'ovaire par réguler la production ecdystéroïde, donc l'axe PTTH-ecdystéroïde reste impliqué dans l'organisation circadienne adulte. Ces résultats remettent en question l'opinion généralement admise de PTTH comme une hormone strictement larvaire et fournissent la première preuve d'un rôle dans la physiologie adulte.

**A circadian clock regulates steroidogenesis in follicle cells of the insect *rhodnius prolixus* during vitellogenesis
Régulation de la stéroïdogénèse folliculaire par une horloge interne pendant la vitélogénèse chez l'insecte,
*Rhodnius prolixus***

¹Michael Cardinal-Aucoin, ¹Colin G.H. Steel

¹*York University*

During egg development, ovaries release ecdysteroids rhythmically, producing a parallel rhythm in hemolymph ecdysteroid titre. Here, we examine ecdysteroid release from ovaries *in vitro* and the origin of rhythmicity. Ovaries maintained in 12:12 *in vitro* released ecdysteroids rhythmically for at least 2 days. This rhythmic release was maintained in aperiodic conditions *in vitro* and is therefore under circadian control from within the ovary. Western blots of ovary extracts revealed a protein that co-migrated with the canonical clock protein PERIOD (PER). Immunohistochemistry showed PER was confined to the follicle cells surrounding vitellogenic oocytes and exhibited cycling in these cells. These cells are the source of ovarian ecdysteroids in other insects. We infer that these follicle cells possess a circadian clock that likely regulates rhythmic ecdysteroid synthesis in the same cells. In vertebrates, a recently described ovarian clock also regulates steroidogenesis, indicating a remarkable conservation of circadian organization across phyla.

Regulation of carbonic anhydrase expression and activity

Régulation de l'expression et de l'activité de l'anhydrase carbonique

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Carbonic anhydrase (CA) catalyzes the reversible hydration/dehydration reactions of carbon dioxide. Teleost fish regulate systemic pH through the differential regulation of branchial Na⁺/H⁺ and Cl⁻/HCO₃⁻ exchanges. By providing protons and bicarbonate ions for such exchanges, gill CA is a vital participant in acid-base regulation. Little attention has been paid, however, to how the enzyme itself is regulated. The present study focused on whether CA is regulated by transcriptional and/or post-translational mechanisms. Evidence for transcriptional regulation of CA by cortisol was obtained using a construct consisting of zebrafish cytosolic CA coupled to a luciferase reporter gene. To investigate post-translational regulation, trout gill CA was purified using a p-AMBS gel affinity column. Phosphorylation of purified CA (confirmed using ProQ Diamond phosphoprotein gel stain) increased CA activity, whereas glutathionylation of purified CA (confirmed by immunoblotting) did not affect CA activity. Future work will determine whether changes in the phosphorylation state of CA occur during acid-base disturbances.

Rates of molecular evolution in North American herpetofauna using DNA barcodes: the link between genomic change and diversification

Taux d'évolution moléculaire de l'herpétofaune Nord-Américaine démontrés par codes barres génétiques: lien entre le changement génomique et la diversification

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DNA barcoding provides the opportunity to rapidly identify species based on sequence diversity in a segment of the mitochondrial COI gene. Using barcode data to calculate nucleotide substitution rates, we can estimate the rate of molecular evolution, and consequently diversification rates along a lineage. We assessed the applicability of DNA barcoding to delimit species in North American herpetofauna, as well as whether there is a correlation between molecular evolutionary rates with both family-level diversification rates and contemporary species richness values using parametric rate comparisons and whole-tree analysis, respectively. Results suggest that in these organisms, an increase in genetic diversity, as demonstrated by increased substitution rates, correlates with an increase in diversification and species richness values. This study provides information regarding the applicability of using barcodes as a proxy to assess mitochondrial molecular evolution, as well as to provide insight into the link between genomic change and speciation in herpetofauna.

L'utilisation des codes à barres génétique offre la possibilité d'identifier rapidement les espèces base sur la diversité des séquences dans un segment du gène mitochondrial COI. En utilisant les données de codes à barres pour calculer les taux de substitution de nucléotides, on peut estimer le taux d'évolution moléculaire et donc, le taux de diversification le long d'une lignée. Nous avons évalué l'applicabilité des codes à barres ADN pour délimiter les espèces herpétofaune en Amérique du Nord, ainsi que l'existence d'une corrélation entre les taux d'évolution moléculaire avec à la fois le taux de diversification au niveau de la famille et les valeurs contemporaines de richesse spécifique en utilisant des comparaisons de taux paramétriques et analyse par arbre entier, respectivement. Les résultats suggèrent que dans ces organismes, une augmentation de la diversité génétique, comme en témoigne l'augmentation des taux de substitution, est en corrélation avec une augmentation des valeurs de richesse et la diversification des espèces. Cette étude fournit des informations quant à l'applicabilité de l'utilisation de codes à barres comme un proxy pour évaluer l'évolution moléculaire des mitochondries, ainsi que pour donner une idée du lien entre le changement génomique et la spéciation chez l'herpétofaune.

**Regulation of testes morphology and function by teneurin C-terminal associated peptide (TCAP)-1 in mice.
Régulation de la morphologie et fonction testiculaire par le peptide associé au C-terminal de la teneurine
(TCAP) -1 chez la souris**

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Testicular size is directly proportional to fertility potential and is dependent on the integration of developmental proteins, trophic factors and sex steroids. The teneurins are a family of transmembrane glycoproteins that function as signaling and adhesion molecules. Encoded on the last exon of the teneurin genes are a family of bioactive peptides termed the teneurin C-terminal associated peptides (TCAPs). In the mouse testis, immunoreactive-TCAP-1 was localized to spermatogonia and primary spermatocytes. In contrast, teneurin-1 was localized exclusively to the basement membrane of seminiferous tubules and tubules within the epididymis, and co-localized with α -dystroglycan. TCAP-1 binding sites were identified in the germ cell layers and spermatid regions of the seminiferous tubules, and epithelial cells of the epididymis. In vivo, TCAP-1 administration increased testicular size, seminiferous and epididymal tubule diameter and elevated testosterone levels. TCAP-1-treated mice also showed increased TCAP-1-immunoreactivity in the epithelial cell layer of the caput and corpora epididymis.

La taille des testicules est directement proportionnelle au potentiel de fertilité et dépend de l'intégration des protéines de développement, les facteurs trophiques et de stéroïdes sexuels. Les teneurins sont une famille de glycoprotéines transmembranaires qui fonctionnent comme de molécules de signalisation et d'adhésion. Codé sur le dernier exon des gènes teneurine sont une famille de peptides bioactifs appelés les peptides associés avec la C-terminaux teneurine (PACT). Dans les testicules de souris, immunoréactive-PACT-1 a été localisé dans les spermatogonies et les spermatocytes primaires. En revanche, teneurine-1 a été localisée exclusivement à la membrane basale des tubes séminifères et des tubules au sein de l'épididyme, et co-localisée avec α -dystroglycane. Les sites de liaisons de PACT-1 ont été identifiés dans les couches de cellules germinales et les régions spermatides des tubes séminifères et des cellules épithéliales de l'épididyme. In vivo, l'administration PACT-1 a augmenté la taille des testicules, et la diamètre des tubules séminifères de l'épididyme et a élevé les niveaux de testostérone. Les souris traitées avec PACT-1 ont également montré une augmentation PACT-1-immunoréactivité dans la couche de cellules épithéliales de l'épididyme caput et corpora.

**Perturbing the developing skull: using laser ablation to investigate the robustness of the infraorbital bones.
Perturbation du crâne en développement: Utilisation de l'ablation au laser dans l'investigation de la solidité
des os infraorbitaux**

¹Carolyn Chang, ²Tamara A. Franz-Odendaal

¹Saint Mary's University, ²Mount Saint Vincent University

Craniofacial development is complex and many factors influencing the development of the skull from embryonic mesenchyme still require elucidation. This study investigates the development of the neural crest derived infraorbital bones of the zebrafish (*Danio rerio*). We analysed infraorbital bone development via a series of laser ablation experiments. Skeletogenic condensations of the infraorbital series were ablated in transgenic fish labeled with bone markers. The potential for condensation regrowth and the impact of ablation on the craniofacial skeleton was examined. Additionally, neuromasts associated with the infraorbital bones were stained with FM1-43 and ablated at multiple time-points to investigate their highly debated inductive potential for infraorbital ossification. Adult infraorbital bones were examined via whole-mount bone staining. The results of this investigation contribute insight into the relationship these bones have with one another and their associated lateral line system, their potential for recovery following ablation, as well as increase insight into their development.

Interactions between ghrelin (GRLN), growth hormone (GH)-releasing hormone (GHRH) and gonadotropin-releasing hormone (GnRH) in the control of GH and gonadotropin-II (LH) release from perfused goldfish pituitary cells

Interactions entre la ghréline (GRLN), l'hormone de libération de l'hormone de croissance (GHRH) et l'hormone de libération de la gonadotropine (GnRH) dans le contrôle de la sécrétion de l'hormone de croissance et de la gonadotropine-II (LH) dans une pérfusion de cellules hypophysaires de poissons rouges

¹John Chang, ¹Caleb Grey

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Goldfish (g)GRLN19 stimulates GH and LH release via protein kinase (PK)C and NO but its action on LH also involves PKA. The two native GnRHs (sGnRH and cGnRH-II) likewise stimulate both GH and LH secretion via PKC and except for cGnRH-II action on LH, also utilize NO signalling. In this study, synthetic gGHRH (presumed to activate PKA) enhances GH release; however, gGRLN19 and sGnRH were able to induce elevations in GH

secretion in the presence of gGHRH. Surprisingly, gGHRH reduced basal LH secretion and the LH responses to gGRLN19 and sGnRH. In the presence of either sGnRH or cGnRH-II, gGRLN19 was unable to further elevate GH and LH secretion. These results identify gGHRH as a novel inhibitor of LH release and are consistent with the fact that gGRLN19, sGnRH and cGnRH-II all utilize a major signalling component (PKC) in their actions on GH and LH release. (Supported by NSERC.)

Purinergic mechanisms in the midbrain and brainstem regulate breathing in amphibians
Les mécanismes purinergiques dans le mésencéphale et le tronc cérébral régulent la respiration chez les amphibiens

¹Joseph Chau, ¹Stephen Reid

¹*University of Toronto*

Descending inputs from the midbrain to respiratory centres in the medulla oblongata have been shown to modulate breathing in the cane toad, *Bufo marinus*. This study used an in vitro brainstem-spinal cord preparation (in which respiratory motor output served as an index of breathing, i.e., fictive breathing) to test the hypothesis that these modulatory descending inputs are purinergic in nature and involve adenosine-mediated neurotransmission. With the midbrain intact, treatment with adenosine and an adenosine-A1 receptor agonist (CCPA) reduced fictive breathing while an A1 receptor antagonist (DPCPX) increased fictive breathing. Transection of the midbrain increased fictive breathing and abolished any additional stimulatory effect of DPCPX. Midbrain transection did not abolish the inhibitory effects of adenosine and CCPA. The results indicate that midbrain and brainstem purinergic mechanisms are involved in regulating breathing in this species; likely via the A1-adenosine receptor.

Liquorice root derivatives glycyrrhizic acid and glycyrrhetic acid as adaptogens in teleost fish hyperosmoregulation

Les dérivés de racine de réglisse, acides glycyrrhizique et glycyrrhétique, comme adaptogènes lors de l'hyperosmorégulation chez les poissons téléostéens

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¹*York University*

An adaptogen is a plant-derived substance that helps an organism maintain homeostasis under conditions of physiological and/or environmental stress. The root of the liquorice plant (*Glycyrrhiza glabra*) is often described as an adaptogen in part due to its corticosteroid-like properties and the effect that these have been reported to have in mammals. However, the potential adaptogenic effects of liquorice root extracts in fishes have yet to be examined. Glycyrrhizic acid (GL) and glycyrrhetic acid (18 β GA) are key components in liquorice root's actions due to structural similarity to hydrocortisone. Therefore, this study investigated the effects of GL and 18 β GA dietary supplementation on endpoints of salt and water balance in freshwater rainbow trout (*Oncorhynchus mykiss*). Both GL and 18 β GA altered select properties of trout gill tissue, suggesting that liquorice root derivatives have the potential to act as adaptogens that aid in the regulation of salt and water balance in fishes.

Elucidating the roles of TCAP-1 on neuronal metabolism and skeletal muscle physiology in mice cell models
Élucidation des rôles joués par TCAP-1 sur le métabolisme neuronal et la physiologie musculaire chez des cellules de souris

¹Yani Chen, ¹Lifang Song, ¹Mei Xu, ¹Autumn Otchengo, ¹Rebecca Crosier, ¹David Lovejoy

¹*University of Toronto*

Teneurin C-terminal associated peptide (TCAP) is a cleavable bioactive peptide on the carboxy terminus of teneurin proteins. TCAP plays a fundamental role in the cellular stress response and metabolism. Previous studies show that, in vitro, TCAP-1 interacts with the dystroglycan complex to stimulate cytoskeletal reorganization. Further, TCAP-1 administration also results in increased ATP production, decreased lactate accumulation and increased glucose transporter relocation to the plasma membrane of cells. These findings indicate that the primary role of TCAP may be to regulate metabolic optimization in the brain by increasing the efficiency of glucose transport and energy utilization. Given that the dystroglycan complex is a key component of skeletal muscle and the neuromuscular junction and the observation that TCAP-1 induces muscle hypertrophy in adult mice, I hypothesize that TCAP-1 plays a significant role in regulating energy metabolism and cellular function in skeletal muscle and acts via a similar mechanism shown in neurons.

Temperature tolerance of sockeye salmon (*Oncorhynchus nerka*) populations hatched at different temperatures

Tolérance à la température des populations de saumon sockeye (*Oncorhynchus nerka*) éclos à différentes températures

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¹*University of British Columbia*

Temperature during embryo development has persistent effects on post-hatch performance. The effects are also likely to be population specific. We compared the critical thermal maximum (CTmax) and heart rate among nine sockeye salmon (*Oncorhynchus nerka*) populations, whose eggs were incubated at 10, 14 or 16 °C before rearing hatchlings at common temperature. CTmax significantly differed among populations and treatments. Intraspecific differences in CTmax were related to body mass, egg size, migration distance, migration and spawning temperature. Elevated incubation temperature significantly decreased CTmax in all populations except Gates. Arrhenius breakpoint temperature (ABT) for maximum heart rate and the temperature that triggered cardiac arrhythmias (Tar) only differed among populations incubated at 14 °C. Thus, this study provided clear evidence for the adaptation among sockeye salmon populations with respect to temperature tolerance and cardiac capacity.

Further studies on rhodtestolin, a cardio-inhibitor from testes of the blood-feeding insect, *Rhodnius prolixus*, a vector of Chagas disease.

D'autres études sur la rhodtestoline, un cardio-inhibiteur provenant des testicules de l'insecte hémophage, *Rhodnius prolixus*, un vecteur de la maladie du Chagas

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¹*Redeemer University College*, ²*Instituto Oswaldo Cruz-Fiocruz*, ³*Affinity Biologicals*

Rhodtestolin is a cardio-inhibitor from testes extracts of the blood-feeding insect, *Rhodnius prolixus*. As described here, rhodtestolin is present in a low-molecular weight fraction of testes extracts separated by gel filtration, as well as in spermatophores delivered to the female during copulation. We also report that a cardio-inhibitor is present in the testes of *R. brethesi*, *Triatoma dimidiata*, *T. klugi* and *Nesotriatoma bruneri*, other Reduviidae which are vectors of Chagas disease. Male secretions in insects are known to modify female behaviour after copulation, and the presence of a cardio-inhibitor in several genera of Reduviidae suggests that rhodtestolin plays an important role for reproductive success. In keeping with its inhibitory effect in the heart bioassay, it may serve to relax the vagina muscles during and after copulation to facilitate delivery and storage of the spermatophore.

The effects of chronic acetaminophen exposure on renal function and histology in rainbow trout
Effet de l'exposition chronique à l'acétaminophène sur la structure et fonction rénale chez la truite arc-en-ciel

¹Eugene Choi, ¹Joanna Wilson

¹McMaster University

Acetaminophen is a common environmental contaminant that causes histological alterations to proximal renal tubules in zebrafish at concentrations $\leq 10 \text{ } \mu\text{g/L}$. Rainbow trout were exposed chronically (2-6 weeks) to waterborne acetaminophen to determine if histological changes were similar to those in zebrafish. Histological effects, similar to those documented in zebrafish, were found in kidney after 4 weeks; additional histological changes were found in gills and liver. At $10 \text{ } \mu\text{g/L}$, acetaminophen exposure caused movement and loss of nuclei, non-uniform nuclei size, non-uniform cytoplasmic staining, and loss of tubule integrity in proximal tubular epithelial cells. In the gills, acetaminophen exposure caused filament tip swelling, thickening of lamellae, and whole filament swelling. Increasing exposure time showed increased damage in the kidneys, however not in the gills. We are currently assessing whether these histological changes result in altered kidney or gill function.

Species comparison of 17- α -ethynylestradiol uptake in teleost fish

Comparaison de l'absorption du 17- α -éthyloestradiol chez les poissons téléostéens

¹Tiffany Chow, ¹Tamzin Blewett, ²Deborah MacLatchy, ¹Chris Wood

¹McMaster University, ²Wilfrid Laurier University

This study used [³H]17- α -ethynylestradiol (EE2) to compare EE2 uptake in killifish (*Fundulus heteroclitus*), Japanese medaka (*Oryzias latipes*), goldfish (*Carassius auratus*), zebrafish (*Danio rerio*) and fathead minnow (*Pimephales promelas*). Fish were dosed at 100 ng/L of EE2 for 2 h. Absolute EE2 uptake, when scaled to a common body weight, was greatest in fathead minnow and goldfish, and smallest in killifish and Japanese medaka. Oxygen consumption rates (MO₂) did not differ significantly across species. Each species had a unique EE2 tissue distribution profile. In Japanese medaka and killifish, EE2 accumulated most in the liver and gall bladder, while in the other species, EE2 accumulated most in the carcass. EE2 uptake rate and MO₂ were linearly correlated in killifish, Japanese medaka and zebrafish. Sex differences in MO₂, but not in EE2 uptake were found in fathead minnow. The results show that total EE2 uptake and tissue-specific EE2 accumulation vary amongst species.

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Low-Temperature Acclimation and Mitochondrial Function in the Northern Common Killifish (*Fundulus heteroclitus macrolepidotus*)

Acclimatation à faible température et fonction mitochondriale chez le choquemort (*Fundulus heteroclitus macrolepidotus*)

¹Dillon James Chung, ¹Patricia Schulte

¹University of British Columbia

Based on the mitochondrion's presumed role in altering whole-animal metabolic rate, it has become a point of interest for hypotheses that address the process of thermal adaptation. During an acute high temperature shift (37°C), liver mitochondria isolated from 5°C acclimated Northern Fundulus heteroclitus lose the capacity to perform oxidative phosphorylation. This phenomenon is not observed with fish acclimated to 15 and 25°C, which is indicative of a cost of acclimation to low temperatures. To investigate the functional differences in mitochondrial properties as a result of low temperature acclimation we have acclimated *Fundulus heteroclitus macrolepidotus* to 5, 15 and 30°C in order to compare the kinetics of liver mitochondrial ADP-phosphorylation, proton conductance, and substrate oxidation during acute shifts to 5, 15, 20, and 30°C and to examine the rates of reactive oxygen species production to assess its contribution as a result of proton conductance. These studies provide insight into the trade-offs associated with low-temperature acclimation.

Extrabranchial mechanisms of pH recovery in the Pacific hagfish (*Eptatretus stoutii*).

Les mécanismes extrabranchiales de rétablissement du pH chez la myxine du Pacifique (*Eptatretus stoutii*)

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¹University of Alberta

Hagfish (*Eptatretus stoutii*) are capable of nutrient transport through branchial and extrabranchial mechanisms. We hypothesized that acid-base and ammonia regulation may be similarly occurring across both hagfish gills and extrabranchially through their skin and/or their gut/kidney. We were able to partition branchial flux from that coming from the posterior skin and gut/cloaca using specially designed hagfish Van-Damm style chambers. We found that hagfish under normal conditions excrete base at a rate of approximately 900 $\mu\text{mol}/\text{kg/h}$ through combined posterior skin/cloacal efflux. When infused with acid, hagfish would purge acid loads branchially and reduce base efflux in the posterior region. During alkalosis, the gills do not appear to play a direct role in recovery. We also provide physiological evidence that hagfish can excrete ammonia through their skin at rates of up to 20% of that of the gills; however, ammonia efflux does not appear to be linked to pH recovery from acid infusion.

A remnant of horizontal gene transfer: Characterization and Expression of teneurin and teneurin C-terminal associated peptide (TCAP) in the tunicate, *Ciona intestinalis*

Un vestige de transfert génique horizontal: Caractérisation et expression de la teneurine et du peptide associé au C-terminal de la teneurine (TCAP) -1 chez le tunicier, *Ciona intestinalis*

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The teneurin transmembrane proteins are essential for life such that teneurin gene knockouts are embryonic lethal. This gene system plays a significant role in adhesion and cellular communication. The teneurins and their associated peptides, the teneurin C-terminal associated peptides (TCAP) originated in the Metazoa after a horizontal gene transfer event from a polymorphic proteinaceous toxin gene in prokaryotes to a choanoflagellate ancestor of the Metazoa. The teneurin-TCAP system is generally found as a single gene in all metazoans except poriferans, placozoans and radiates. However, four paralogous lineages of the teneurin-TCAP system are found in higher chordates. The recent sequencing and characterization of the genome of the vase tunicate, *Ciona intestinalis*, has provided an essential tool to understand the evolution of gene and genomic systems in vertebrates. *C. intestinalis*, possesses only a single form of teneurin with a TCAP-like sequence at its C-terminus consistent with the 2R hypothesis

Les protéines transmembranaires teneurine sont essentielles à la vie telles que les gènes de coups de grâce de teneurine sont mortelles aux embryons. Ce système de gène joue un rôle important dans l'adhésion et de la communication cellulaire. Les teneurins et leurs peptides associés, les peptides associés avec la C-terminaux teneurine (PACT) originaires de la Métazoaires après un événement de transfert horizontal de gènes à partir d'un gène de toxine protéique polymorphe chez les procaryotes à un ancêtre choanoflagellé. Le système PACT-teneurine se trouve généralement dans un seul gène dans tous les métazoaires, sauf les poriferans, les placozoans et les radiates. Toutefois, quatre lignées paralogues du système PACT-teneurine se trouvent dans plus chordés. Le récent séquençage et la caractérisation du génome de l'ascidie jaune, *Ciona intestinalis*, a fourni un outil essentiel pour comprendre l'évolution des systèmes de gènes et génomique chez les vertébrés. *C. intestinalis* ne possède qu'une seule forme de teneurine avec une séquence qui rassemble celle des PACT à la C-terminale, des résultats compatible avec l'hypothèse 2R.

Exploring carry-over effects in salmonid and centrarchid fishes

Exploration de l'effet de report chez les poissons salmonidés et centrarchidés

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¹Carleton University

Carry-over effects can be thought to occur when previous experiences explain current performance (including fitness-relevant metrics such as survival) of individuals. Carry-over effects are most often considered in the context of understanding natural phenomena like food limitations or weather/climatic events, but are equally relevant as a concept for understanding the longer-term consequences of anthropogenic stressors. Despite the fact that there is a large body of work on the consequences of acute stressors on fish, there have been few attempts to consider how such stressors affect longer-term fitness endpoints, particularly when individuals are exposed to subsequent temporally-separated stressors. Using case studies on salmonid and centrarchid fishes, I explore the concept of carry-over effects using semi-chronic experimental cortisol manipulations. Salmonid studies focus on migration (both adult spawning and downstream smoltification) while centrarchid studies focus on seasonal (winter), nutritional, and thermal challenges.

The effect of palmitoyl CoA and carnitine on succinate-fuelled liver mitochondrial respiration rates in hibernating ground squirrels.

Effets du palmitoyl CoA et de la carnitine sur les taux de respiration mitochondriale hépatique du succinate chez les spermophiles en hibernation

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Mammalian hibernators suppress liver mitochondrial respiration rates by ~70% during torpor with succinate as substrate; however, no suppression occurs with glutamate. These results suggest possible inhibition of the dicarboxylate carrier (DCT), a mitochondrial succinate transporter. Long-chain acyl-CoAs inhibit the DCT, and carnitine may reverse this inhibition by binding acyl-CoAs and removing them from the inter-membrane space. Moreover, carnitine levels are lower in torpor than euthermia. We tested the effect of palmitoyl CoA, as well as a known DCT inhibitor (butyrylmalonate) on the succinate-fuelled respiration of liver mitochondria isolated from both torpid and euthermic 13-lined ground squirrels (*Ictidomys tridecemlineatus*). We predicted a greater suppression in euthermia compared to torpor. We found that, while palmitoyl CoA did inhibit respiration, it was not reversed by adding carnitine, and caused greater suppression than butyrylmalonate. Therefore, while palmitoyl CoA may suppress mitochondrial metabolism during torpor, it does not appear to inhibit the DCT.

Channel catfish leukocyte immune-type receptors exhibit functional plasticity

Les récepteurs de leukocyte de type immunitaire des Poissons-Chats démontrent de la plasticité fonctionnelle

¹Herman D. Cortes, ¹Myron A. Zwozdesky, ¹Dustin M.E. Lillico, ¹Allen O'Brien, ¹James L. Stafford

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In response to pathogens, immunoregulatory receptors control immune cell effector responses, including degranulation and phagocytosis. Channel catfish (*Ictalurus punctatus*) leukocyte immune-type receptors (IpLITRs) represent a large and diversified immunoregulatory receptor family containing both stimulatory and inhibitory-types. For example, IpLITR2.6b is capable of tyrosine kinase-dependent induction of degranulation and phagocytosis, whereas IpLITR1.1b mediates tyrosine phosphatase-dependent abrogation of effector responses. Despite its established inhibitory role, IpLITR1.1b was shown to also promote phagocytosis. This surprising functional plasticity has not been, to our knowledge, reported in teleost before. However, there are examples of mammalian dual functional immunoregulatory receptors, including PECAM-1, CD150 and CD300f. These encode long cytoplasmic tails that have specific motifs, including ITIMs, ITSMs and YxN, which recruit signaling adaptors (SHP2, PI3K p85 α and Grb2, respectively) initiating stimulatory cascades. As IpLITR1.1b shares these motifs, we are currently exploring if its ability to promote phagocytosis is linked to recruitment of similar signaling adaptor molecules. (Supported by NSERC and AI-TF).

Quinacrine exposure:negative impacts on spawning and biosynthesis of prostaglandins and steroids in the zebrafish ovary

Exposition à la quinacrine: Les impacts négatifs sur la ponte et la biosynthèse de prostaglandines et de stéroïdes dans l'ovaire du poisson-zèbre

¹Madelyne Cosme, ²Andrea Lister, ¹Glen Van Der Kraak

¹University of Guelph, ²Wilfred Laurier University

The zebrafish is a useful model for examining endocrine changes associated with oocyte maturation and ovulation. Our current study looked at the effects of quinacrine, a phospholipase A2(PLA2) inhibitor, on zebrafish spawning. Exposure to 100ug/L of quinacrine resulted in a complete inhibition of spawning. Fish were sampled at midnight and 6AM. In ovarian tissue, levels of prostaglandin F2 α and 17 α , 20 β -dihydroxy-4-pregene-3-one were highest in the control and the exposed group at 6AM. The group exposed to quinacrine exhibited lower levels of the hormones compared to the control group at both timepoints. Expression of cytosolic phospholipase A2(cpla2) and cyclooxygenase-2(ptgs2) was highest in both groups at 12AM. The group exposed to quinacrine had lower levels of cpla2 and ptgs2, compared to the control group, at both timepoints. These results suggest that PLA2 inhibitors act at multiple sites controlling steroid and prostaglandin synthesis and imply that these pathways play a role in spawning.

microRNA: Potential as master regulators of metabolism in teleosts

microARN: Régulateurs potentiels principaux du métabolisme chez les téléostéens

¹Paul Craig, ¹Vance Trudeau, ¹Tom Moon

¹University of Ottawa

A major epigenetic marker, microRNAs (miRNAs) have received considerable attention in mammalian studies, but only recently has focus been directed at miRNA regulation in fish. miRNA are short, non-coding RNAs that regulate mRNA, resulting in negative regulation of their target genes. Here we examined how fasting and feeding alters the expression profile of miRNA in zebrafish and trout. Using a custom microarray targeting 270 zebrafish miRNAs, we identified 9 differential expressed miRNAs targeting genes in biological pathways associated with insulin signaling, glucose metabolism and adipogenesis. Using a known environmental contaminant and metabolic inhibitor (fluoxetine), expression of miRNAs were exacerbated indicating greater inhibition of these pathways. Assessment of post-prandial expression of miRNA was determined, which indicated a time dependent up-regulation in the abundance of circulating miRNA in trout plasma. These results demonstrated that specific miRNA play a role in regulating metabolic transcripts during feeding, fasting and contaminant exposure. Funded by NSERC.

The evolution of hypoxia tolerance and performance in centrarchid fishes

L'évolution de la tolérance à l'hypoxie et de la performance chez les poissons centrarchidés

¹Kyle Crans, ¹Graham Scott

¹McMaster University

This study examined the evolution of hypoxia tolerance and performance in fishes from the family Centrarchidae (bass and sunfish). Previous studies have shown there to be substantial variation in hypoxia tolerance between species, but it is unclear to what extent this influences locomotory capacity and aerobic performance in hypoxia. We therefore measured maximum metabolic rate (MO₂max) and critical swimming speed (Ucrit) in a swim tunnel respirometer under normoxic and hypoxic conditions. In normoxia, MO₂ max and Ucrit were highest in largemouth bass, intermediate in sunfish, and lowest in rock bass. MO₂max decreased in moderate hypoxia (45% atmospheric saturation, ~71 Torr) by a comparable magnitude in the two sunfish species. Future experiments in other centrarchid species, and at lower O₂ levels, will help demonstrate the relationships between exercise performance and hypoxia tolerance.

Physiological carryover effects between phases of the annual cycle in migrant birds and fish.

Les effets d'un "carryover" physiologique entre les phases du cycle annuel chez les oiseaux et poissons migrateurs

¹Glen Crossin

¹Dalhousie University

Much recent work has been directed at the physiological mechanisms that mediate carryover effects between seasons, habitats, or life-history stages, but our understanding of these processes is still rudimentary. In this talk I will present results from recent studies in birds and fish that highlight how carryover effects can result in individual variation in body condition and physiological/endocrine states, which can then affect subsequent patterns of reproductive investment and breeding success. Examples will include species with different life-histories (semelparous Pacific salmon and interoparous seabirds). I will also discuss how costs of reproduction could be regarded as a type of carryover effect, providing a potential mechanism that links current to future reproductive effort. I will end by discussing how experimental studies with controlled manipulations of condition or endocrine states are needed to disentangle cause and effect in studies of carryover effects.

Functional characterization of the *Drosophila melanogaster* organic cation transporters (ORCT and ORCT2) using *Xenopus laevis* oocytes

Caractérisation fonctionnelle des transporteurs de cations organiques (ORCT et ORCT2) chez *Drosophila melanogaster* en utilisant des ovocytes de *Xenopus laevis*

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Organic cations (OCs) include endogenous metabolites and xenobiotics, (environmental toxins, drugs or pesticides) that must be eliminated from the organism to ensure survival. The midgut and Malpighian tubules of insects have been shown to be involved with the active transport of OCs. Two putative organic cation-like transporters (OCTs), named orct and orct2, have been identified in the *Drosophila melanogaster* genome. qPCR revealed the mRNA transcripts of orct and orct2 were differentially expressed in the midgut and Malpighian tubules. Moreover, mRNA expression of these transcripts increased following exposure to prototypical type I OC, tetraethylammonium (TEA). Gene expression patterns coincide with previous physiological research conducted which showed the capacity of insect excretory tissues to transport TEA. The *Drosophila* OCTs were cloned into a vertebrate expression vector and cRNA created for microinjection into *Xenopus laevis* oocytes. Resulting proteins of ORCT and ORCT2, will be functionally characterized using two-electrode voltage clamp and radioisotope uptake.

The evolution of salinity-responsive Na⁺, K⁺ ATPase gene duplicates in salmonids

L'évolution des Na⁺, K⁺ ATPase isoforms salinité sensibles chez les salmonidés

¹Anne Dalziel, ²Milica Mandic, ²Jesse Bittmann, ²Michelle Ou, ²Patricia Schulte

¹Université Laval, ²UBC

Salmonids prepare for the changes in salinity that accompany their anadromous migrations by physiologically remodeling ion regulatory tissues. In particular, changes in the expression of two salinity-responsive Na⁺, K⁺-ATPase (NAK) α -subunit paralogs ($\alpha 1a$ and $\alpha 1b$) in gill ionocytes are predicted to be among the key physiological traits that allow for transitions among salinities. However, little is known about the origin and evolution of these isoforms. To determine when the salinity responsive NAK isoforms arose we sequenced these isoforms in a number of salmoniformes (*Salvelinus alpinus*, *Coregonus clupeaformis*, *Thymallus arcticus*) and closely related species (*Esox lucius*, *Osmerus mordax*). We found that the salinity-responsive NAK duplicates arose prior to the salmonid whole genome duplication and are present, and expressed, in a freshwater sister species (*Esox lucius*). Finally, we determined which codons experienced diversifying selection between $\alpha 1a$ and $\alpha 1b$ isoforms, and may contribute to functional divergence among these proteins.

Precise influence of powered flying ability in crown group and stem group avialans

Influence précise de la capacité de vol chez les groupes Aviaux dérivés et basaux

¹Field Daniel

¹*Yale University*

Understanding the pattern of powered flight acquisition has become a key goal in dinosaur paleobiology, with the flying potential of basal avian taxa, such as *Archaeopteryx*, inspiring debate since the 19th Century. Knowledge of powered flight in these extinct taxa has been limited by the difficulty of obtaining precise, quantitative estimates of flying potential from fossils. Here, an analysis of shoulder dimensions and body mass in 1,142 extant birds and 11 stem birds precisely delimits functional flying and flightless zones, enabling explicit tests of flying potential in stem birds. This analysis demonstrates that basal avian taxa such as *Archaeopteryx* were incapable of the powered, flapping flight seen in modern birds, and provides strong evidence that the basalmost known flying avian is the Early Cretaceous taxon *Sapeornis chaoyangensis*. For the first time, these data provide a clear picture of the pattern of avian powered flight acquisition in Mesozoic feathered dinosaurs.

Identification of genes related to faster white muscle growth in rainbow trout across growing seasons.

Identification de gènes liés à la croissance rapide du muscle blanc chez la truite arc-en-ciel entre les saisons de croissance

¹Roy Danzmann, ¹Andrea Kocmarek, ¹Moira Ferguson

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White muscle mRNA-seq expression differences were compared between size-selected (large and small) rainbow trout. Fish were obtained from parents spawning in September and December within a single commercial strain of rainbow trout in Ontario. Fish were sampled at 15 months of age, with September fish experiencing a declining photoperiod and December fish experiencing an increasing photoperiod. Reads per fish ranged from 7.4M – 43.8M comprising a total of 25,294Mb of untrimmed cDNA. Reads were aligned against a reference transcriptome database composed of 147,718 contigs. Despite season accounting for the greatest number of differences in expression, higher expression was observed for 271 and 239 contigs in large and small fish, respectively, across seasons (FDR<0.05), with 26,361 contigs unrelated to size. More genes related to cytoskeletal component, lipid metabolism, ROS-specific, and immune function were up-regulated in large fish, with more apoptosis genes up-regulated in small fish, and growth/metabolism/signal transduction common to both.

Conservation of function in the metazoan: Neurotrophic actions of TCAP-1 on the vertebrate stress pathway

Conservation fonctionnelle chez les métazoaires: Actions neurotrophiques de TCAP-1 sur les voies du stress

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The Corticotropin Releasing Factor (CRF) peptides are an evolutionarily conserved peptide family integral to the stress response. The early origin of CRF suggests that it possesses many paralogous genes due to its increased exposure to gene duplication. In 2004 Qian et al undertook an investigation into possible homologues of CRF and uncovered a peptide family located along the C-terminal region of the rainbow trout ortholog of teneurin-3. This peptide family was named the Teneurin C-terminal Associated Peptides (TCAP) and is involved in neuroprotection against stress. TCAP possesses a number of biological actions independent of teneurin, however, evidence of how TCAP is processed from its proprotein had not yet been determined. Here I show that TCAP-1 can be transcribed as a smaller mRNA transcript. I have further identified and isolated potential promoter regions upstream of the TCAP-1 region. This work confirms our molecular evidence that TCAP is functionally independent from teneurin.

**Does density-dependent harvest mortality promote stability in walleye fisheries in Lake Erie?
Est-ce que la mortalité de récolte dépendante de la densité promouvoit la stabilité dans les pêcheries de Doré
du lac Érié?**

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Fisheries offer a context to test predictions of ecological theory because harvesting fish is a well-documented, highly targeted and repeated perturbation. Lake Erie fisheries continue to harvest walleye, despite changes in species composition caused by eutrophication, introduced species and overharvesting. To explain why the current walleye fisheries persist, an empirical study tested predictions from the hypothesis that the harvest control rule creates density-dependent harvest mortality and thus stabilizes walleye population dynamics. We predicted that the amount of walleye fish harvested should be positive related to estimated population abundance and that temporal variation in walleye abundance will not change in relationship to prey density. Time-series (20+ years) of abundance of forage fish (prey), walleye fish and fish harvest data were used to measure stability in Lake Erie. Linear regression analysis and, using dynamic linear models to account for lag-effects, time series analysis are used to test predictions.

Effects of feeding on gene expression in the spiny dogfish (*Squalus acanthias*)

Effets de l'alimentation sur l'expression génique chez l'aiguillat commun (*Squalus acanthias*)

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The spiny dogfish (*Squalus acanthias*) is an opportunistic predator that is often forced to fast for extended periods (weeks) between feedings. During these periods of starvation, both morphological and physiological changes have been noted in metabolically active tissues, namely the rectal gland, relative to fed organisms. The objective here was to determine which genes are differentially expressed in the dogfish rectal gland at 24 h, 48 h and 7 days post-feeding. Suppression subtractive hybridization was used to broadly identify which genes and pathways are being up regulated with feeding, and real time PCR was conducted on select genes involved in salt secretion and energy metabolism. Significant changes in mRNA levels were observed in a number of genes such as lactate dehydrogenase and beta-hydroxybutyrate dehydrogenase.

A field study examining the temporal dynamics of metal accumulation and depuration and consequences on oxidative stress biomarkers in juvenile yellow perch (*Perca flavescens*)

Étude de terrain de la dynamique temporelle de l'accumulation et l'épuration métallique et des conséquences sur les biomarqueurs du stress oxydatif chez des perchaudes juvéniles (*Perca flavescens*)

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To determine the temporal dynamics of metal accumulation and depuration and the response of oxidative stress biomarkers of young of the year (age 1+) yellow perch (*Perca flavescens*), fish were caged for 1 and 4 weeks in either a reference (Opasatica) or a metal-contaminated (Dufault) lake. The mesh size of the cages allowed free exchange with the surrounding lake water and zooplankton. Kidney Cd and Cu significantly increased after 4 weeks of exposure in the contaminated lake. On the other hand, kidney Cd and Cu decreased when fish from the contaminated lake were placed in the reference lake for 4 weeks. However no variations in kidney Zn or Ni were observed. In a previous work on indigenous yellow perch chronically exposed to metals, we reported a significant decrease in the percentage of hepatic free dehydroretinol with increasing renal Cd concentrations, suggesting that the enzymes and the binding proteins involved in retinoid homeostasis are inhibited by the presence of Cd. In the same study, yellow perch from Cd-contaminated lakes had significantly higher concentrations of liver dehydroretinol and dehydroretinyl esters than did fish from reference lakes, indicating that increasing vitamin A (antioxidant) levels could serve to better counteract the oxidative stress engendered by Cd exposure. The relationships between metal accumulation and depuration and responses of biomarkers of oxidative stress (tissue vitamin A levels) will be discussed.

Use of hypercarbia as a deterrent for asian carp movement

Utilisation de l'hypercarbie pour prévenir le mouvement des carpes Asiatiques

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Asian carp are contained within the Mississippi River basin by a pair of electrified barriers, and these fishes could negatively impact the Great Lakes ecosystem if this barrier is overcome. New barrier technologies are needed to supplement the existing barrier, thereby improving our ability to prevent Asian carp invasion into the Great Lakes. The goal of this project is to determine the effectiveness of carbon dioxide in deterring movements of Asian carp. This goal was achieved by using a combination of physiological and behavioral experiments. Physiological experiments were performed by exposing fish to elevated carbon dioxide environments and measuring stress responses in blood and tissues. Behavioral experiments were performed by exposing fish to carbon dioxide and measuring ventilation rates and erratic behaviors, along with the concentration of carbon dioxide resulting in an active avoidance response. Results indicate that carbon dioxide has great potential to deter the movements of Asian carp.

"Does epithelial transport limit insects at low temperatures?"

Est-ce que le transport épithéial limite les insectes à basse température?

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¹*Western University*

In temperate regions, insect performance is limited by the critical thermal minimum (CT_{min}), below which chill coma (paralysis) occurs. Chill coma is accompanied by ionic disturbance across the gut and Malpighian tubules (sites of ion homeostasis), leading to altered haemolymph ion composition and muscle depolarization. Temperature-dependent failure of epithelial ion regulation is hypothesized to explain chill coma onset, with variation in CT_{min} driven by epithelial channel modification. To verify whether epithelial transport failure corresponds with the CT_{min}, I will measure ion transport and channel function in the gut and Malpighian tubules using an Ussing chamber and Ramsay assay, respectively. I will identify patterns of ion channel expression associated with variation in CT_{min} via gut and Malpighian tubule transcriptome sequencing and qRT-PCR. The crickets *Gryllus pennsylvanicus* (cold-susceptible) and *G. veletis* (cold-tolerant) will be used as models.

Interspecific differences in hypoxia tolerance in carp

Différences interspécifiques de la tolérance à l'hypoxie chez les carpes

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The ability to induce morphological, biochemical, and behavioural modifications during hypoxia are key for survival for many organisms. We investigated the interspecific variation of hypoxia-induced gill remodeling and pathways involved in ethanol production with hypoxia tolerance in ten closely related cyprinids. There was significant variation in hypoxia tolerance, measured as the oxygen tension at which fish lost equilibrium. Hypoxia tolerance was phylogenetically independently associated with gill surface area and interlamellar cell mass. Enzyme activities required for ethanol production were significantly different between the ten groups. Alcohol dehydrogenase activity was notable in the muscle of two species, while liver ADH was significantly correlated with low oxygen tolerance. While behavioural responses to hypoxia differed among the carp groups, there were no significant relationships between hypoxia tolerance and aquatic surface respiration. Our results are the first to show that the extent of gill remodeling in cyprinids is associated with hypoxia tolerance.

Apolipoprotein in Rainbow Trout and Walleye

Les apolipoprotéines chez la truite arc-en-ciel et le doré jaune

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The innate immune system, including the acute phase response, is essential to maintaining health in fish. An uncharacterized rainbow trout (*Oncorhynchus mykiss*) acute phase plasma protein, 9.5kDa, was identified using 2D-PAGE but mass spectrometry yielded limited amino acid sequence and no similar proteins in Genbank. 3' RACE was used to isolate cDNA sequences that contained a conserved apolipoprotein A-I domain. This is consistent with the up-regulation of apolipoprotein A1 in Atlantic halibut in response to gram negative bacterial infections. A walleye (*Sander vitreus*) plasma protein that was demonstrated to bind *Flavobacterium columnare* was partially identified using mass spectrometry and had 66% sequence similarity to apolipoprotein A-I from striped bass (*Morone saxatilis*). Apolipoproteins are known to contain lipid-binding domains and may act as pattern recognition receptors to bind lipid components of fish pathogens during the innate immune response.

Le système immunitaire inné, y compris la réponse de phase aiguë, est essentiel au maintien de la santé des poissons. Une protéine plasmatique de phase aiguë (9.5kDa) non caractérisée au truite arc-en-ciel (*Oncorhynchus mykiss*), a été identifié en utilisant 2D-PAGE, mais la spectrométrie de masse a donné une séquence d'acides aminés limitée et des protéines similaires ne sont pas dans Genbank. RACE 3' a été utilisée pour isoler des séquences d'ADNc qui contenait un domaine conservée d'apolipoprotéine A1. Ceci est cohérent avec la régulation à la hausse de l'apolipoprotéine A1 dans le flétan de l'Atlantique en réponse à des infections bactériennes gram négatif. Une protéine plasmatique du doré jaune (*Sander vitreus*) qui a été démontrée pour lier *Flavobacterium columnare* a été partiellement identifiées par spectrométrie de masse et a une similarité de séquence de 66% à partir de l'apolipoprotéine A1 du bar rayé (*Morone saxatilis*). Les apolipoprotéines sont connus pour contenir des domaines de liaison lipides et peut agir en tant que récepteurs de reconnaissance des patrons pour lier les composants lipidiques des agents pathogènes du poisson lors de la réponse immunitaire innée.

Migratory condition but not flight increases activity of muscle oxidative enzymes in yellow rumped warblers

La condition migratoire, mais pas le vol, augmente l'activité des enzymes oxydatives musculaires chez la paruline à croupion jaune

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Flight muscles of birds undergo physiological changes during migration, including increased activity of an aerobic enzyme, citrate synthase, fatty acid oxidation enzymes, carnitine palmitoyl transferase and 3-hydroxyacyl CoA dehydrogenase, and lower anaerobic enzyme activity, lactate dehydrogenase. The degree to which birds prepare in advance for a migratory flight versus during is unknown. As preliminary analysis of a flight muscle transcriptomic study, we examined the effect of migratory condition and endurance exercise on metabolic enzymes. Flight muscle samples were taken from captive yellow rumped warblers (*Setophaga coronata*) in three conditions: fall migrants at rest, fall migrants after a 4 hr endurance flight in a wind tunnel, and wintering non-migrants. Migrants had higher aerobic and fatty acid oxidation enzyme activities and lower anaerobic enzyme activity than wintering birds. Endurance flight had no effect on metabolic enzymes. The results suggest increased fatty acid oxidative potential during migratory season, which is maintained during flight.

Les muscles du vol des oiseaux subissent des changements physiologiques au cours de la migration, y compris une augmentation de l'activité de la citrate synthase, une enzyme aérobie, ainsi que la carnitine palmitoyl transférase déshydrogénase et 3-hydroxyacyl-CoA, des enzymes d'oxydation des acides gras et une diminution de l'activité de la lactate déshydrogénase, une enzymatique anaérobie. La mesure dans laquelle les oiseaux se préparer à l'avance par rapport au cours d'un vol migratoire est inconnue. Comme l'analyse préliminaire d'une étude du transcriptome du muscle de vol, nous avons examiné l'effet de la condition migratoire et l'exercice d'endurance sur les enzymes métaboliques. Échantillons de muscles de vol ont été prises à partir de captifs paruline à croupion jaune (*Setophaga coronata*) dans trois conditions: les migrants d'automne au repos, les migrants d'automne après un vol de 4 heures d'endurance en soufflerie, et les non-migrants pendant l'hiver. Les migrants ont des activités augmenter des enzymes d'aérobiose et d'oxydation des acides gras et des activités diminuer des enzymes anaérobiose comparer aux oiseaux d'hiver. Le vol d'endurance n'a eu aucun effet sur les enzymes du métabolisme. Les résultats suggèrent une augmentation du potentiel oxydatif d'acide gras pendant la saison migratoire, qui est maintenue pendant le vol.

Responses of an identified locust interneuron to objects moving along compound trajectories at different velocities

Les réponses d'un inter neurone de sauterelle à des objets se déplaçant le long de trajectoires composées à différentes vélocités

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The descending contralateral movement detector (DCMD) is a neuron in the locust visual system that is implicated in controlling escape behavior and is known to encode a ratio of the size and velocity of an object approaching along a single, collision trajectory. Recent studies suggest that the DCMD is also capable of encoding more complex visual information resulting from objects that transition to or from looming trajectories. However, the putative effects of object velocity have not been tested for these compound trajectories. We presented locusts with objects moving at different velocities along translational and looming trajectories, as well as trajectories that transition to looming within different regions of the locust's visual field. We found that translation evoked relatively small firing rate changes whereas looming evoked modulation of the firing rate consistent with previous studies. Moreover, we found that velocity-dependent responses varied with approach angle.

In vitro approaches to understanding the biochemical basis of gold nanoparticle toxicity in animals

Approches in vitro pour comprendre les bases biochimiques de la toxicité des nanoparticules d'or chez les animaux

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The increase in industrial and commercial uses of nanoparticles (NPs) has led to a rise in their release into the environment, resulting in the exposure of native species to NPs and their associated bioactivities. While numerous whole-organism studies have revealed that NPs induce a toxic response on a systemic level, the exact mechanisms by which they exert their effects on a biochemical level is largely yet to be determined. The purpose of this study was to characterize the effects of gold NPs on animal proteins in vitro, in an effort to elucidate the biochemical mechanisms of toxicity on a simpler scale. Bovine serum albumin (BSA) was used as model protein for assays involving NP-protein interactions. Albumin is a serum protein chiefly responsible for transporting lipids and fatty substances through blood plasma, and thus any deleterious albumin-NP interactions seen in this model could potentially disrupt global lipid metabolism in vivo.

Rapid actions of cortisol in rainbow trout liver involves acute regulation of stress signaling pathways

Les actions rapides du cortisol sur le foie de la truite arc-en-ciel impliquent une régulation aigüe des voies de signalisation du stress

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Cortisol elicits both delayed (genomic) and rapid (nongenomic) cellular response, but nongenomic cortisol signaling has not been established in the liver. We tested the hypothesis that stressor-induced cortisol elevation rapidly modulates hepatic stress responses in rainbow trout (*Oncorhynchus mykiss*). We tested this by examining whether cortisol rapidly regulates stress-activated kinase pathways in trout liver. Stress levels of cortisol rapidly increased PKA and PKC substrate protein phosphorylation in vivo and in vitro in trout hepatocytes. Activation of PKA signaling in vitro was accompanied by a rapid (5 min) elevation of cAMP levels, followed by a prolonged inhibition. Cortisol also rapidly suppressed epinephrine-stimulated cAMP levels and altered phosphorylation of CREB in response to epinephrine. Together, our results establish a novel, nongenomic cortisol signaling pathway that involves rapid regulation of multiple kinase pathways. Nongenomic cortisol action in rainbow trout liver likely regulates hepatic stress responses directly, and indirectly by regulating epinephrine signaling.

Serotonergic regulation of the rainbow trout hypothalamo-pituitary-interrenal axis via the 5-HT1A receptor

Régulation sérotoninergique de l'axe hypothalamo-hypophyso-interrénal via le récepteur 5-HT1A chez la truite arc-en-ciel

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In fish, a variety of evidence suggests that serotonin (5-HT) can influence the hypothalamic-pituitary-interrenal (HPI) axis. However, the mechanisms underlying serotonergic regulation of the HPI axis require elucidation. We hypothesized that 5-HT acts at multiple levels in the HPI axis of rainbow trout *Oncorhynchus mykiss*. Incubation of

head kidney preparations (that contain interrenal cells) in vitro with 5-HT, or with a combination of adrenocorticotropic hormone (ACTH) and 5-HT, or ACTH and the 5-HT_{1A} receptor agonist 8-OH-DPAT, did not significantly increase cortisol production above that of unstimulated or ACTH-stimulated cells, as appropriate. Partial sequences of the rainbow trout 5-HT_{1A} receptor were cloned for use in evaluating distribution of this receptor throughout the HPI axis. Given the lack of stimulatory effect of 5-HT on cortisol production by interrenal cells, 5-HT is likely to influence the rainbow trout HPI axis at the hypothalamus or pituitary levels.

ROS scavenging dramatically increases NMDA receptor but not AMPA receptor currents in turtle cerebral cortex

L'élimination des espèces réactives de l'oxygène augmente considérablement les courants des récepteur NMDA mais pas ceux des récepteurs AMPA dans le cortex cérébral d'une tortue

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Brief periods of oxygen deprivation cause neuronal injury in mammals but the western painted turtle overwinters in anoxic mud for months without damage. Neural protection occurs through down regulation of N-methyl-D-aspartate and alpha-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid receptors (NMDAR and AMPAR). Natural anoxic decreases in reactive oxidative species (ROS) may trigger these changes. NMDAR and AMPAR evoked whole cell currents were observed under varying conditions of oxygen and ROS manipulation. Receptor current amplitudes did not change during 90 minutes of normoxia but decreased during anoxia by about 50%. Anoxic decreases were not reversed by H₂O₂ addition and ROS scavenging during normoxia with N-2-mercaptopropionylglycine and n-acetylcysteine increased NMDAR amplitudes by approximately 100%. Normoxic H₂O₂ application decreased NMDAR amplitudes by 19% while normoxic ROS manipulations had no effect on AMPAR currents. In conclusion, ROS decreases affect receptor activity but do not directly mediate anoxic decreases in NMDAR and AMPAR currents.

De brèves périodes de privation d'oxygène peuvent causer des lésions neuronales chez les mammifères, mais la tortue peinte passe l'hiver dans la boue anoxique pendant des mois sans dommages. Protection neuronale se fait par frémentation des récepteurs N-méthyl-D-aspartate et récepteurs de l'acide alpha-amino-3-hydroxy-5-méthyl-4-isoxazolepropionic (RNMDA et RAMPA). Les diminutions naturelles des diminuent les dérivés réactifs de l'oxygène (DRO) en conditions anoxiques peuvent déclencher ces changements. RNMDA et RAMPA évoqués courants de cellules entières ont été observées dans diverses conditions de l'oxygène et de la manipulation des DRO. Amplitudes des récepteurs actuels n'ont pas changé pendant 90 minutes de normoxie, mais ont diminué au cours de l'anoxie d'environ 50%. Diminuer anoxiques n'ont pas été inversée par addition de H₂O₂ et DRO balayage pendant normoxie avec N-2-mercaptopropionylglycine et la N-acétylcystéine a augmenté les amplitudes de RNMDA d'environ 100%. L'application de H₂O₂ normoxique a réduit l'amplitude de RNMDA par 19%, tandis que les manipulations de DRO normoxiques n'a eu aucun effet sur les courants RAMPA. En conclusion, la diminution de DRO affecte l'activité du récepteur, mais ne sert pas comme médiation directe pour la diminution anoxiques des courants RNMDA et RAMPA.

**Ventilatory and metabolic responses to hypoxia in hibernating rodents: are hibernators just big babies?
Les réponses ventilatoires et métaboliques à l'hypoxie chez les rongeurs hibernants: les hibernateurs sont-ils seulement de gros bébés?**

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There are striking parallels in many physiological traits between all newborn mammals and adults of species capable of hibernation. Hypoxia tolerance is one of these. As this tolerance is not present in adults of non-hibernating species, we hypothesized that differences in hypoxia tolerance in adult hibernators and non-hibernators reflect developmental changes in the way oxygen demand and oxygen supply are matched. To test this, we exposed newborn, juvenile, and adult hibernators (golden hamster; *Mesocricetus auratus*) and non-hibernators (Sprague Dawley rat; *Rattus norvegicus*) to a progressive step reduction in inspired levels of oxygen (21, 12, 9, and 7 % O₂) and examined their hypoxic ventilatory and metabolic responses. All neonates and juveniles responded to hypoxia primarily by metabolic suppression (decreased oxygen demand), and not increased ventilation (oxygen supply). This also appears to be true of adult hibernators but not non-hibernators, which mount a significant ventilatory response instead, supporting our hypothesis.

**Molecular and pathophysiological processes underlying cerebral hemorrhage in developing zebrafish
Les processus moléculaires et pathophysiologiques sous-jacent à l'hémorragie cérébrale chez les poisson-zèbre en développement.**

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Intracerebral hemorrhage (ICH) is the second most common cause of stroke in human, which can lead to neurological deficit and mortality. Currently however, there is no reliable mammalian model for ICH. In this study, we explored the potential use of zebrafish (*Danio rerio*) as a model system to understand the etiological and pathophysiological consequences of stroke. We observed that pharmacological induction of ICH causes various adverse effects in the brain of larval zebrafish, including oxidative stress, apoptosis and cell death. We also demonstrated that fish suffering from ICH exhibit reduced tail movement and slower swimming speed. Moreover, the responsiveness to external stimuli was impaired in fish experiencing ICH. Interestingly, in contrast to mammalian infant, developing zebrafish can fully recover after the “stroke”. These findings suggest that the zebrafish ICH model may have potential for developing new therapeutic tools to ameliorate the progression of ICH in human.

**Appeal for a shift in the way we study transposable element evolution
Appel pour un changement dans la façon dont nous étudions l'évolution éléments transposables**

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Transposable elements (TE) are sequences of DNA that can move from place to place within the genome and are some of the most abundant genomic components in eukaryotes. The advent of more advanced molecular techniques has seen a 30 year period where their structure and behaviour have been investigated. This approach has generally been from the perspective of TEs as components of the genomes in which they reside and how they affect the evolution of their host. While advances have been made in our understanding of TEs using the host-centric perspective, a shift down to the level of the elements themselves might prove fruitful in helping to answer some of the longstanding questions in TE biology. This issue will be explored and special attention will be paid to the concept of TE effective population size and possible methods for determining this important evolutionary factor.

Trace elements in claw keratin as temporally explicit indicators of geographic origin in terrestrial mammals
Éléments trace dans la kératine des griffes comme indicateurs temporellement explicites de l'origine géographique des mammifères terrestres

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Biogeochemical markers are often used in ecology to infer geographic origin of animals. It has been presumed that by measuring trace chemical signatures in a tissue that is inert once formed (e.g., claws) and is grown incrementally (i.e., deposited in layers), temporal and spatial changes in an individual's foraging environment will be captured in these tissues. However, little consideration has been given to understanding how growth patterns of the claw may affect our ability to interpret these chemical signals and whether techniques are available to extract temporal chemical profiles useful for time-series analysis. To move towards resolving this, we first review the morphology of the claw in several taxa. Next, we sought to resolve multi-elemental data at a fine spatial scale using LA-ICP-MS. Our findings illustrated that temporally-explicit chemical profiles in the blade horn keratin of mammalian claws may serve as a tool to assist in reconstructing animal movement pathways.

Like mother, like daughter? Heritability of flight energetics in the bumblebee *Bombus impatiens*

Telle mère, telle fille? Héritabilité de l'énergétique du vol chez le bourdon *Bombus impatiens*

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Diversity in physiological traits observed across species is the outcome of microevolutionary processes acting within species. For natural selection to take place, variation observed among individuals must be repeatable and confer some advantages, and variation in phenotypes must be heritable. Our studies focusing on the evolution of insect flight physiology lead us to investigate the heritability of morphological, kinematics and metabolic properties of 44 families of bumblebees obtained commercially or raised from wild queens. We first described variation of studied traits and assessed transitions of flight properties of queens establishing their nest. This further clarifies changes in flight physiology associated with the large sizes of queens. We estimated narrow-sense and broad-sense heritability, using parent-offspring regressions and full-sib analysis respectively. Finally, our commercial and wild families were distinct in their flight muscle properties. The results will be discussed in the context of genetic determinants of metabolic properties and evolutionary implications.

La diversité des caractères physiologiques des espèces est issue de processus microévolutif. Pour que la sélection naturelle agisse, la variation observée entre individus doit être répétable et conférer des avantages, mais également la variation des phénotypes doit être héritable. Nos études sur l'évolution de la physiologie du vol chez les insectes nous ont menés à questionner l'héritabilité de caractères morphologiques, cinétiques et métaboliques chez 44 familles de bourdon obtenues commercialement ou sauvages. Nous avons décrit la variation des caractères étudiés en se penchant sur la transition des reines établissant leur nid. Ceci documente également les changements physiologiques associés à la taille des reines. Nous avons estimé l'héritabilité au sens stricte et au sens large, à l'aide de régression parent-descendant et une analyse de variance familiale. Enfin, les colonies commerciales et sauvages se distinguaient au niveau des propriétés des muscles du vol. Les déterminants génétiques des propriétés énergétiques et les implications évolutives seront discutés.

The effect of temperature and windspeed on the number of males caught in pheromone traps
L'effet de la température et de la vitesse du vent sur le nombre de mâles capturés dans des pièges à phéromones

¹Jasmine Farhan, Jeremy McNeil

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Generally, male moths fly upwind towards a pheromone lure. However this response is effected by abiotic factors such as temperature, relative humidity and windspeed. Little research has been conducted on the effects of abiotic factors on the flight of male *Striacosta albicosta*, a crop pest. Thus, a 2 year field study was undertaken to look at the effects of temperature, relative humidity and windspeed on male flight. We found that male flight varied as a function of changing abiotic factors.

Separation and quantification of putative pheromones released by reproductive male round gobies
Séparation et quantification de phéromones putatives libérées par les mâles reproducteurs de gobies à taches noires

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Pheromone application has been a successful method of population control across a variety of taxa and is currently being investigated for the invasive round goby (*Neogobius melanostomus*). Steroids released by the male round goby may function as pheromones based on odor potency recorded by electro-olfactogram, and increased reproductive female activity toward water that previously contained a male. Steroids contained in this conditioned water include 11-oxo-etiocholanolone (11-O-ETIO), 11-O-ETIO-3-sulfate and 11-O-ETIO-3-glucuronide. Following separation by high-performance liquid chromatography and enzyme-linked immunosorbent assay, we found that the conditioned water contained levels of 11-O-ETIO and 11-O-ETIO-3-sulfate previously demonstrated to elicit olfactory responses. As reproductive females were previously found not to be attracted to 11-O-ETIO, our findings suggest that 11-O-ETIO-3-sulfate is a candidate for future behavioural experiments and trap design.

Acid-base balance of the green crab *Carcinus maenas* – is branchial mediated pH regulation dependent on ammonia excretion?

Équilibre acido-basique chez le crabe vert (*Carcinus maenas*) - est-ce que la régulation branchiale du pH dépend de l'excrétion d'ammoniac?

¹Sandra Fehsenfeld, ²Chris M Wood, ³Greg G Goss, ¹Dirk Weihrauch

¹*University of Manitoba*, ²*McMaster University*, ³*University of Alberta*

Active acid–base regulation allows the green crab *Carcinus maenas* to cope with fluctuations of pH and/or pCO₂ in the surrounding seawater. Green crabs exposed to hypercapnia (elevated seawater pCO₂) are capable of maintaining a stable pH in their hemolymph while pCO₂, HCO₃⁻ and K⁺ increase. During gill perfusion experiments, isolated anterior and posterior gills (4–9) elevate the pH in the perfusion solution after only one gill passage by 0.1–0.2 units, accompanied by an according decrease in pCO₂. Interestingly, the more protons were excreted, the more ammonia was excreted by the respective gill, indicating a close linkage between both processes. Beside other effective inhibitors, application of colchicine (microtubule network) and BaCl₂ (potassium channels) resulted in a decreased ability of the anterior and posterior gills (5 and 8, respectively) to increase the hemolymph pH, accompanied by a reduced branchial ammonia excretion rate.

Effects of coated nanoparticles on zebrafish (*Danio rerio*)
Effets des nanoparticules enrobées sur le poisson zèbre (*Danio rerio*)

¹Lindsey Felix,¹Van Ortega,¹James Ede,¹Greg Goss

¹University of Alberta

Nanoparticles (NPs) will undoubtedly end up in the environment and potentially cause toxic effects to aquatic organisms. To determine the effects of coated NPs on zebrafish (*Danio rerio*), we tested aqueous <10nm polyacrylic acid (PAA)-coated metal-oxide TiO₂, ZnO, Fe₂O₃, and CeO₂, as well as the polymer coating alone (nanocapsule), manufactured by Vive Nano. Time-dependent changes in physicochemical properties were measured using Dynamic Light Scattering. We also measured dissolution of each NP core to quantify concentration of free metal in stock suspensions and release over time. Embryonic zebrafish were exposed over a 72h period to free metal and a range (1-2000mg/L) of each NP type following OECD guidelines. Nanocapsules cause hatch inhibition and we suggest that low pH causes this effect. CeO₂ NPs and nanocapsules loaded with Nile red are able to traverse the chorion. Overall, our findings indicate that neither the NPs nor PAA coating are acutely toxic to zebrafish.

Ecoimmunology in the cold: effects of overwintering on immune activity in the spring field cricket, *Gryllus veletis*

Éco-immunologie dans le froid: les effets de l'hivernage sur l'activité immunitaire du grillon, *Gryllus veletis*

¹Laura V Ferguson,¹Brent J Sinclair

¹Western University

Insects that pass the winter in temperate regions are challenged with exposure to low temperatures and must undergo physiological changes in response to this environmental stress. It also appears that immune function is affected by cold stress: genes related to immunity are up-regulated and resistance to fungal pathogens is increased. However, it is unclear whether immune function is also up-regulated following the prolonged stress of overwintering and what the adaptive significance of such a strategy might be. I exposed nymphs of the spring field cricket, *Gryllus veletis*, to an artificial winter in the laboratory and compared immune function of overwintered and summer crickets. I measured various immune parameters, including hemocyte numbers, phenoloxidase activity, antimicrobial activity, and survival following exposure to entomopathogenic fungi. I also measured survival of crickets following freezing, as a correlate of cold tolerance, to determine if changes in immune activity coincide with physiological changes related to cold exposure.

Thermal Performance and Tolerance of a Eurythermal Fish, the Common Goldfish (*Carassius auratus*)
Performance thermique et tolérance d'un poisson eurytherme, le cyprin doré (*Carassius auratus*)

¹Elizabeth Ferreira,¹Katja Anttila,¹Anthony Farrell

¹University of British Columbia

Understanding how cardiac and aerobic performance interact to promote temperature tolerance in eurythermal (i.e., wide temperature tolerance) fishes is crucial to predict effects of rising temperatures. Here, we examined maximum fH (heart rate) response to acute warming and aerobic scope in goldfish (*Carassius auratus*) at three acclimation temperatures (12, 20, and 28°C). At 12 and 28°C acclimation, the Q10 break temperature of the maximum fH response (24.0 ± 1.4 and 29.8 ± 1.1°C, respectively) corresponded well with the upper pejus temperature (T_{pejus}), at which aerobic performance declined (25.0 ± 2.2 and 30.5 ± 2.0°C, respectively), and the Arrhenius break temperature of the maximum fH response consistently fell within the bounds of the upper and lower T_{pejus}. Maximum fH indices, indicating cardiac performance, seem to track aerobic performance well between lower and upper T_{pejus} confirming that cardiac and aerobic performance are linked near T_{opt} in eurythermal fishes.

Tracking multi-generational colonization of the breeding grounds by monarch butterflies in eastern North America

Suivie de la colonisation des sites de reproduction par les papillons Monarchs dans l'Est de l'Amérique du Nord sur plusieurs générations

¹D.T. Tyler Flockhart, ²Leonard I. Wassenaar, ³Tara G. Martin, ⁴Keith A. Hobson, ⁵Michael B. Wunder, ¹D. Ryan Norris

¹*University of Guelph*, ²*Environment Canada*, ³*CSIRO, Ecosystem Sciences*, ⁴*Environment Canada*, ⁵*University of Colorado Denver*

Insect migration often involves movements over multiple breeding generations at continental scales resulting in formidable challenges to conservation and management. Using citizen-scientist-based occurrence models and stable-carbon and -hydrogen isotope measurements, we tracked the multi-generational colonization of the breeding grounds of monarch butterflies (*Danaus plexippus*) in eastern North America. Butterflies that overwintered in Mexico came from a wide breeding distribution including southern portions of the range. There was a northward progression of monarchs over successive generations from May until August when butterflies began to change direction and move south. Interestingly, individuals breeding in Texas in the autumn migrated from northern breeding areas rather than regions further south. Although the Midwest was the most productive area during the breeding season, monarchs that re-colonized the Midwest were produced largely in Texas, suggesting that conserving habitat in the Midwest alone will not ensure long-term persistence of the monarch butterfly population in eastern North America.

Physiological impacts of the “Deepwater Horizon” oil spill on migratory birds: case study of the Bonaventure Island’s Northern Gannets

Impacts physiologiques du déversement de pétrole «Deepwater Horizon» sur les oiseaux migrateurs : cas du Fou de bassan de l’île Bonaventure

¹Cynthia D. Franci, ²Émilien Pelletier, ¹Magella Guillemette, ¹Jonathan Verreault

¹*Université du Québec*, ²*Institut des Sciences de la Mer de Rimouski*

The "Deepwater Horizon" oil spill had disastrous repercussions on seabirds. However, long term consequences of an exposure to oil on migratory birds have received limited attention. A sub lethal contamination to polycyclic aromatic hydrocarbons (PAHs) can elicit severe deterioration of physiological condition in birds, including perturbation of the endocrine system. This present study aimed to assess the impact of oil contamination on prolactin and corticosterone, two hormones influencing reproductive success in birds, by studying Northern gannets (*Sula bassana*) nesting on Bonaventure Island. Their wintering sites (Gulf of Mexico or Atlantic Coast) were identified using light-based geolocators. PAHs concentrations in blood cells were found to be under the detection limits. Hormonal status (corticosterone and prolactin levels) was not related to the bird's wintering site selection. Present results showed that potential exposure to oil contamination was not associated with physiological impact in these birds.

Compartmentalization of ornithine urea cycle enzymes in a freshwater elasmobranch Cloisonnement des enzymes du cycle ornithine-urée chez un élasmodranche d'eau douce

¹David Fraser, ¹James Ballantyne

¹*University of Guelph*

Nitrogen metabolism of marine elasmobranchs differs greatly from that of obligate freshwater species (family: Potamotrygonidae). Nitrogen is fed into the ornithine urea cycle (OUC) for urea biosynthesis in marine species while Potamotrygonid rays are essentially non-ureogenic. The compartmentalization of OUC enzymes, most notably arginase and glutamine synthetase (GSase), can differ among vertebrates including fishes. OUC compartmentalization has been described in marine elasmobranchs but not in obligate freshwater species. The activity of OUC enzymes (GSase, carbamoyl phosphate synthetase III, ornithine transcarbamylase, arginase) as well as glutamate dehydrogenase was determined in both mitochondrial and cytosolic liver fractions of the freshwater ray Potamotrygon motoro. This was done to determine if a change in the compartmentalization of these enzymes occurred during specialization to freshwater. This marks the first time the subcellular distribution of OUC enzymes has been described in an obligate freshwater species. Activity of OUC enzymes was much lower in freshwater rays.

Métabolisme de l'azote par les élasmodranches marins diffère grandement de celui des espèces d'eau douce obligatoires (famille: Potamotrygonidae). L'azote est introduit dans le cycle de l'urée ornithine (CUO) pour la biosynthèse de l'urée dans les espèces marines alors que les rayons Potamotrygonid sont essentiellement non uréogénique. Le cloisonnement des enzymes CUO, notamment l'arginase et la synthétase de glutamine (GSase), peuvent différer chez les vertébrés, les poissons inclus. Cloisonnement CUO a été décrit chez les élasmodranches marins, mais pas chez les espèces d'eau douce obligatoires. L'activité des enzymes CUO (GSase, carbamoyle phosphate synthétase III, l'ornithine transcarbamylase, arginase), ainsi que la glutamate déshydrogénase a été déterminée dans les deux fractions mitochondriales et cytosoliques hépatiques du rayon de l'eau douce Potamotrygon motoro. Cela a été fait afin de déterminer si un changement dans le cloisonnement de ces enzymes eu lieu au cours de spécialisation à l'eau douce. Il s'agit de la première fois que la distribution subcellulaire des enzymes CUO a été décrit dans une espèce d'eau douce obligatoire. Activité des enzymes CUO était beaucoup plus faible dans les rayons d'eau douce.

Post-release survival of the short-fin mako shark in the Australian game fishery

Survie suite au relâchement du requin-taupe bleu dans la pêche sportive australienne

¹Robert French, ²Suzie Currie, ¹Jeremy Lyle, ¹Jayson Semmens

¹*University of Tasmania, ²Mount Allison University*

The short-fin mako shark, *Isurus oxyrinchus*, is a popular game fishing species in Australia. With recreational shark fishing becoming more popular in Australia, anglers are turning to catch and release as a way of mitigating environmental impacts. However, there is currently no information available that describes the fate of *I. oxyrinchus* after release. 21 mako sharks were tagged with survival Pop-up Archival Transmitting (sPAT – wildlife computers) tags to determine survival after capture on rod and line. Survival is being correlated with gear types, fight times, physical damage and animal size. Blood samples were taken from 19 sharks and examined to investigate if physiological stress plays any role in delayed mortality. Preliminary analysis indicates that lactate increases with fight time, whereas glucose and haematocrit show no distinctive relationship. Heat shock proteins remain to be analysed. These data will contribute to the development of best-practise fishing guidelines for mako sharks in Australia.

Establishing Loma morhua infections in naïve Atlantic cod

Etablir des infections de Loma morhua dans des morues de L'Atlantique naïves

¹A.P. Frenette, ¹M. O’Neil, ¹H. Byrne, ¹K. Moraitis, ¹M.D.B. Burt, ¹M.S. Duffy

¹*University of New Brunswick*

Loma morhua is a spore-forming microsporidian parasite that is a pathogen of international significance for Atlantic cod aquaculture. Specific-pathogen free (SPF) cod were cultured and maintained free of *L. morhua* infection. Intraperitoneal exposure to 10000, 50000, or 100000 parasite spores induced infection in 100% of cod exposed experimentally. Variation in xenoma infection intensity was documented both between and within treatment groups. However, no significant differences in xenoma infection intensity were observed between groups despite an order of magnitude difference in the parasite exposure of some groups. Parasite xenomas persisted as low intensity chronic infections until the end of the ten-month trial. Control fish remained free of infection. This represents the first documented success with experimental infection of Atlantic cod with *L. morhua*. The work herein represents foundation work towards empirical assessment of parasite development and life-history in our multifaceted approach towards mitigating the impact of this parasite on cod aquaculture.

Establishing Loma morhua infections in naïve atlantic cod

Etablissement d'infections de Loma morhua chez des morues Atlantiques naïves

¹Aaron Frenette, ¹Maeghan O'Neill, ¹Hilary Byrne, ¹Kathy Moraitis, ¹Mick Burt, ¹Mike Duffy

¹*University of New Brunswick*

Loma morhua is a spore-forming microsporidian parasite that is a pathogen of international significance for Atlantic cod aquaculture. Specific-pathogen free (SPF) cod were cultured and maintained free of *L. morhua* infection. Intraperitoneal exposure to 10000, 50000, or 100000 parasite spores induced infection in 100% of cod exposed experimentally. Variation in xenoma infection intensity was documented both between and within treatment groups. However, no significant differences in xenoma infection intensity were observed between groups despite an order of magnitude difference in the parasite exposure of some groups. Parasite xenomas persisted as low intensity chronic infections until the end of the ten-month trial. Control fish remained free of infection. This represents the first documented success with experimental infection of Atlantic cod with *L. morhua*. The work herein represents foundation work towards empirical assessment of parasite development and life-history in our multifaceted approach towards mitigating the impact of this parasite on cod aquaculture.

Fifty years of JR Platt's "Strong Inference"

La "Strong inference" de JR Platt's: Cinquante ans après

¹Douglas Fudge

¹*University of Guelph*

In 1964, John Platt published an article in Science called “Strong Inference: Certain systematic methods of scientific thinking may produce much more rapid progress than others.” He begins the article with the irresistibly contentious claim “Scientists these days tend to keep up a polite fiction that all science is equal.” And so begins one of the most entertaining, provocative, and inspiring papers ever to have been published on scientific method. In this talk, I will briefly discuss Platt’s main arguments and his suggestions for how scientific progress could be accelerated. I will also talk about the impact that this paper has had in the fifty years since it was first published, as well as the impact it has had on my development as a scientist. I will end by addressing whether Platt’s rallying cry has been heard and whether his message is still relevant in the age of “Big Science.”

Characterization of invertebrate sodium-selective (Nav1) and calcium-selective (Nav2) voltage-gated sodium channels

Caractérisation des canaux sodiques voltage-dépendants sélectifs pour le sodium (Nav1) et le calcium (Nav2) chez les invertébrés

¹Julia Fux, ¹Adriano Senatore, ¹J.David Spafford

¹University of Waterloo

Our laboratory is examining the invertebrate voltage-gated sodium channel genes, Nav1 and Nav2 from the pond snail, *Lymnaea stagnalis*. LNav1 is the only gene in the snail genome representing the ten different human voltage-gated sodium channels, which include Nav1.1 to Nav1.9 and salt sensor Nax. We have found that LNav1 is produced almost exclusively in the cerebral ganglia. We have cloned the full length channel cDNA for in-vitro expression in HEK cells. The snail sodium channel has highly conserved DEKA selectivity filter, sequences for a fast inactivation gate, and likely participates in action potential generation in the snail brain. The invertebrate-specific voltage-gated sodium channel, Nav2, has a DEEA calcium selectivity filter, and is permeable to calcium ions. LNav2 mRNA is undetectable in every tissue except sensory neurons, such as in eyes and tentacles. Detailed analysis of these channel pores provides insight into the features that govern sodium and calcium selectivity.

Impacts of intersex in rainbow darter in the Grand River Watershed in Ontario, Canada

Les impacts de l'intersex chez le Dard Arc-en-ciel du bassin versant de la Grand River en Ontario, Canada

¹Meghan Fuzzey, ¹Gerald Tetreault, ²Mark McMaster, ³Mark Servos

¹University of Waterloo, ²National Water Research Institute, Environment Canada, Canada Center for Inland Waters, ³University of Waterloo

The Grand River in the area of Kitchener-Waterloo, Ontario, Canada has been shown to have a high incidence of intersex in male fish downstream of municipal wastewater treatment plants (MWWTP). While this intersex is associated with decreased androgen production and delayed gonad development, it is unclear whether there is an impact on reproductive capability. The purpose of this study was to determine if intersex severity is associated with reproductive success in rainbow darter (*Etheostoma caeruleum*). Fish were collected up and downstream of MWWTPs in Kitchener-Waterloo and reproductive success was measured in the field and laboratory. Milt volume, sperm density, fertilization success, and embryo survival were used to evaluate reproductive success. While sperm density did not differ, fertilization success and embryo survival were lower in fish exposed to MWWTP effluent. The relationships between intersex severity and fertilization success, embryo survival, and reproductive behaviour are being developed (Supported by NSERC to MRS).

Plasticity of larval ionoregulatory development in rainbow trout

Plasticité développementale des mécanismes d'ionorégulation chez les larves de truite arc-en-ciel

¹Emily J Gallagher, ¹Colin J. Brauner

¹University of British Columbia

The objective of this study was to characterize the plasticity of larval ionoregulatory development in rainbow trout *Oncorhynchus mykiss*. During early life stages ion and gas exchange processes occur primarily across the skin before transitioning to the gills as they develop. Adult fish gills exhibit phenotypic plasticity, but little is known about this phenomenon in larval fishes while exchange processes are transitioning from the skin to the gills.

Sodium uptake kinetics were characterized in rainbow trout during the first 32 days post-hatch for fish reared in low, medium and high sodium chloride (NaCl) freshwater. There were no significant differences in the Michaelis constant (K_m), maximum Na⁺ uptake capacity (J_{max}), water content, unidirectional Na⁺ uptake rate, whole body [Na⁺], or biological incorporation of Na⁺ over this stage of development. Thus, there appears to be very little plasticity associated with ionoregulatory development likely reflecting the physiological importance of this process during development.

Thermal tolerance of Atlantic salmon and the effects of thermal cycles
Tolérance thermique du saumon Atlantique et les effets des cycles thermiques

¹Melanie Gallant, ¹Suzie Currie

¹Mount Allison University

Water temperatures of salmon-rich rivers, such as the Miramichi, NB, regularly exceed the fish's putative lethal limit; however, there is little known about their thermal tolerance. Here, we examined the effects of natural thermal cycles on the critical thermal maximum (CTmax) of Atlantic salmon as well as cellular and physiological markers of stress and recovery. There was no significant effect of a natural thermal cycle on the CTmax of fish compared controls; however, condition factor and CTmax were positively correlated. The overall area of red blood cells decreased significantly at the peak of the thermal cycle possibly indicative of the appearance of newer, younger cells. We observed a significant increase in HSP70 levels in red blood cells, heart, liver and red and white muscle during and into recovery from the thermal cycle, with tissue-specific responses. Overall, Atlantic salmon appear to be able to cope with this single thermal cycle.

Comparative analysis of Shaw-type potassium channels in widely divergent organisms
L'analyse comparative des canaux potassiques de type Shaw dans des organismes très divergents

¹Warren Gallin

¹University of Alberta

The voltage-gated ion channel family has been evolving since before the origin of animals. The Kv1-4 families (Shak, Shal, Shaw and Shab) originated in the common ancestor of all animals, but paralogs within these four sub-families have been evolving independently since the earliest organismal divergences in the animal clade. I will present comparative sequence and functional evidence that illustrates the extent to which different functional properties have evolved within the Kv3/Shaw family of channels, using examples from mammals, the cnidarian *Polyorchis penicillatus* and the platyhelminth *Notoplana atomata*. These results illustrate general principles of functional evolution within families of proteins. In particular, quantitative electrophysiological properties, susceptibility to drugs, and in one case the functional ion permeation pathway, have evolved in different ways, often yielding functions that are more similar to channels that have evolved from different founding proteins in other organisms.

UCP1-mediated non-shivering thermogenesis does not underlie the evolution of cold-tolerance in multiple eutherian lineages.

La thermogenèse sans frisson due à l'UCP1 n'est pas à l'origine de l'évolution de la tolérance au froid dans de multiples lignages euthériens

¹Michael J. Gaudry, ¹Kevin L. Campbell

¹University of Manitoba

Uncoupling protein 1 (UCP1) is critical for the nonshivering thermogenic (NST) function of brown adipose tissue (BAT). BAT is recognized to play a key thermoregulatory role in small-bodied and hibernating eutherian mammals, and is considered to be especially important for neonates of cold-tolerant species. In support of this conclusion, UCP1 pseudogenization has only been described in one mammalian lineage, pigs, whose young are notoriously poor thermoregulators. We conducted a phylogenetic survey of UCP1 across 66 eutherian species and reveal independent losses of UCP1 function in the ancestors of paenungulates, xenarthrans, delphinids and equids. While UCP1 inactivation is correlated with cold-intolerance in xenarthrans and manatees, disrupted UCP1 loci in killer whales, horses, woolly mammoth and Steller's sea cow indicate that cold-tolerance is not associated with BAT-mediated NST in these lineages. Our findings shed light on the potential energetic costs of BAT and question the thermogenic importance of UCP1 during eutherian evolution.

La protéine de découplage 1 (PDC1) est critique pour la thermogenèse sans frisson (TSF), la fonction du tissu adipeux brun (TAB). TAB est reconnu pour jouer un rôle clé dans la thermorégulation des mammifères petites et les euthériens hibernants, et est considéré comme particulièrement important pour les nouveau-nés des espèces tolérantes au froid. À l'appui de cette conclusion, la pseudogenization de PDC1 n'a été décrite que dans une lignée de mammifères, les porcs, dont les jeunes sont notamment pauvres thermorégulateurs. Nous avons mené une enquête phylogénétique de PDC1 dans 66 espèces euthériens et révéler des pertes indépendantes de la fonction PDC1 dans les ancêtres de paenungulates, xenarthrans, delphinidés et les équidés. Lors que l'inactivation PDC1 est corrélée avec l'intolérance au froid dans les xenarthrans et les lamantins, les lieux PDC1 perturbés chez les épaulards, les chevaux, le mammouth laineux et vache de mer de Steller indiquent que la tolérance au froid n'est pas associé avec la TAB à médiation TSF dans ces lignées. Nos résultats mettent en lumière les coûts potentiels énergétiques de la TAB et la question l'importance thermogénique de PDC1 au cours de l'évolution euthériens.

You are what you eat: Using GPS-based telemetry to investigate the links between habitat use, foraging strategies and contaminant profiles in avian species

Dis-moi ce que tu manges, je te dirai qui tu es : applications de la télémétrie par GPS pour l'investigation des liens entre les stratégies de quête alimentaire, l'utilisation de l'habitat et les profils de contamination chez les oiseaux

¹Marie-Line Gentes, ²Martin Patenaude-Monette, ³Jean-François Giroux, ⁴Robert J. Letcher, ⁵Jonathan Verreault

¹Environmental Toxicology Research Centre (TOXEN), University of Quebec, ²University of Quebec, ³Behavior and Animal Ecology Research Group (GRECA), University of Quebec, ⁴Carleton University, ⁵University of Quebec

Flame Retardants (FRs) are chemicals added to furniture, computers, and electronics to reduce flammability and increase fire safety. They leach into the environment and have become ubiquitous contaminants worldwide. Upper trophic-level birds can be highly contaminated with FRs; however, the contaminant burden of individuals within a single colony can be radically different. These variations are still poorly understood because of the lack of technology to follow birds during their foraging trips. In this study, miniature GPS-data loggers were used to monitor birds' movements within a heterogeneous landscape near Montreal (QC), a known FR "hotspot" for which avian data are critically lacking. The Ring-billed gull was used because of its omnivorous diet and its utilization of a diversity of habitats. New FRs were detected and GPS data revealed clear associations between bird's foraging sites and tissue contaminant profiles. To our knowledge, this work is the first to ally geolocation and ecotoxicology.

Growth and the role of MRCs during calcium stress in larval lake sturgeon
Croissance et rôle des MRC lors du stress calcique chez les larves d'esturgeon jaune

¹J Genz, ¹Lauren Shute, ¹W. Gary Anderson

¹University of Manitoba

The freshwater, cartilaginous lake sturgeon (*Acipenser fulvescens*) encounters its greatest calcium demand in the early life stages. We examined growth of lake sturgeon reared in three environmental calcium concentrations (0.1, 0.2, and 1.5 mM) from hatch until after first feeding. Surprisingly, fish reared in low calcium environments demonstrated the highest condition factor, while fish exposed to 1.5 mM calcium had the fastest growth.

Examinations of gill, skin, and yolk sac using SEM indicated that abundance of mitochondria-rich cells (MRCs) is affected by environmental $[Ca^{2+}]$, but variations in MRC surface area were primarily related to development.

Further, localization of active MRCs changes during development with branchial uptake dominating earlier in fish acclimated to high environmental $[Ca^{2+}]$. Whole-animal calcium absorption increased up to 20-fold at 0.1 and 0.2 mM $[Ca^{2+}]$ following the transition to exogenous feeding, suggesting a role for intestinal absorption in calcium-limited freshwater lake sturgeon in the early life stages.

Larval lake sturgeon inherit survivorship from maternal stores

Les larves d'esturgeons jaunes héritent leur taux de survie de la mère

¹Janet Genz, Shivani Khetoo, Liane Arcinas, W. Gary Anderson

¹University of Manitoba, University of Manitoba, University of Manitoba, University of Manitoba

Before first feeding, one of the primary challenges to larval fish growth is that nutritional requirements must be met entirely through absorption of the maternally-supplied yolk. Lake sturgeon are highly fecund, with individual females often producing over 200,000 mature oocytes per spawning cycle. We assessed gametes, ovarian fluid, and seminal fluid from wild lake sturgeon for nutritional composition. As expected, the sperm and seminal fluid consisted predominately of protein (60% and 55%, respectively). Glucose was a minor component (<8%) of all gametes and associated fluids. In the oocyte, triglyceride concentrations exceeded protein (55% and 39%, respectively), but the opposite was true of the ovarian fluid (79% protein). Interestingly, these dominant components of each fluid were significantly correlated with larval survival. Following in vitro fertilization, hatching success was 68%; during the period of yolk absorption mortality remained low (12%). By far, the highest mortality occurred during the transition to exogenous feeding.

Heat balance in extreme environments and the response to reduced water vapour pressure deficit in desert adapted birds

Bilan thermique dans des environnements extrêmes et réponse au déficit de pression de vapeur d'eau chez les oiseaux désertiques

¹Alexander R. Gerson, Eric C. Smith, Andrew E. McKechnie, Blair O. Wolf

¹University of New Mexico, University of New Mexico, University of Pretoria, University of New Mexico

In homeothermic animals ambient temperatures exceeding body temperature result in high heat gain. Under these conditions, animals rely solely on evaporative cooling to maintain body temperatures. However, high ambient humidity can impede evaporation, potentially reducing an animal's ability to dissipate heat. The goal of this study was to investigate the effect of ambient humidity on the thermoregulatory ability of desert adapted birds at temperatures above body temperature. Evaporative water loss, metabolic rate and body temperature were measured as birds were exposed to humidity ranging from 0-30 g cm⁻³ at temperatures from 44-52°C. Metabolic rate increased in response to higher temperatures, but was unaffected by humidity. High humidity corresponded with reduced evaporative water loss at 48°C and 52°C resulting in increased Tb. Hyperthermia in response to reduced evaporative capacity may be an adaptive strategy that reduces water loss rates and dry heat gain by reducing the thermal gradient between animal and environment.

Environmental calcium deficiency and embryonic development in *Daphnia magna*
Déficience environnementale en calcium et développement embryonnaire chez *Daphnia magna*

¹Jamie-Lee Giardini,¹ Andreas Heyland

¹University of Guelph

Calcium is a critical signalling and structural compound. Human activities have greatly decreased calcium's abundance in freshwater ecosystems in the Canadian Shield. The most severe effects of this decline are seen in organisms with high calcium demands. Under this premise, the crustacean *Daphnia magna* has become a model for investigating the effects of calcium decline in freshwater ecosystems. Previous studies have demonstrated that juveniles have higher calcium demands than adults due to life-stage specific calcium requirements. Using the isotope Ca45 we investigated the primary source of calcium used by embryos during development. Furthermore we are investigating the effects of calcium deficient embryonic environments on hatching success, developmental schedule, and later life-history traits. Preliminary findings suggest that embryos receive calcium from the mother and not from the environment, which has important consequences for understanding calcium homeostasis in *Daphnia*. Findings may also provide valuable insights for Canadian freshwater conservation and management strategies.

Steps toward building an atlas of *Daphnia magna* morphology

Mesures vers la construction d'un atlas morphologique de *Daphnia magna*

¹Jamie-Lee Giardini,¹ Andreas Heyland

¹University of Guelph

Daphnia magna has become a prominent species of investigation in ecotoxicology, genetics, evolution, and ecology. With the recent sequencing of two *Daphnia* genomes, many new opportunities to study gene-environment interactions in this versatile model system have emerged. Still, it has become clear that no readily available, modern catalogue outlining *Daphnia magna* morphology exists. This study aims to begin to outline *D. magna* morphology by gender and life stage in a modern context. This atlas also includes detailed information about morphological changes during embryogenesis. As *D. magna* are heavily calcified, the calcium marker Alizarin Red is the primary stain used in this research and due to available resources cryosectioning is the primary manipulative technique employed. Such work is crucial as it is important that appropriate and consistent nomenclature be exercised among different biological disciplines when describing *Daphnia magna* morphology, regardless of the 'lens' under which they are being studied.

Characterization of a continuous cell line from *Fundulus heteroclitus*, KFE-1, with neuroepithelial cell traits
Caractérisation d'une lignée de cellules continues de *Fundulus heteroclitus*, KFE-1, avec des traits cellulaires neuropithéliaux

¹Sarah J Gignac, ²Nguyen TK Vo, ¹Deborah MacLatchy, ³Lucy EJ Lee

¹Wilfrid Laurier University, ²University of Waterloo, ³Wilfrid Laurier University, University of the Fraser Valley

Neuroepithelial cells (NEC) are believed to have neural stem cell characteristics and have been described to occur not only within the central nervous system in fish but also within peripheral tissues including skin and gills. NEC are thought to be involved in oxygen sensing and are abundant in embryonic stages and in hypoxia tolerant fish. In this study, we report on the development and characterization of a cell line with phenotypic traits of NEC. KFE-1 is a cell line derived from the cephalic region of a late stage embryo of *Fundulus heteroclitus*. These estuarine fish are notable for their ability to withstand extreme conditions including hypoxia and KFE-1 could be an excellent in vitro model to complement these studies. KFE-1 has been maintained for almost two years in Leibovitz-15 media with 10% fetal bovine serum at 26°C. NEC physicochemical characteristics along with molecular and immunochemical data will be presented.

Neurodevelopmental markers are expressed by ependymal cells before and during spinal cord regeneration in the leopard gecko (*Eublepharis macularius*)

Des marqueurs neuro-développementaux sont exprimés par les cellules épendymaires avant et pendant la régénération de la moelle épinière chez le gecko léopard (*Eublepharis macularius*)

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The leopard gecko is capable of regenerating a functional spinal cord following tail loss. We hypothesize that a population of endogenous neural stem/progenitor cells (NSPCs) in the original spinal cord is the source of the regenerated spinal cord. We conducted a spatiotemporal characterization of the spinal cord using three neurodevelopmental markers: PCNA, Sox2 and Sox9. We demonstrate that ependymal cells of the original spinal cord and in the regenerating blastema are immunopositive for the proliferation marker PCNA and the stem cell marker Sox2 during the early stages of regeneration. The transcription factor Sox9 is not expressed until the later stages of regeneration, consistent with its role in driving differentiation. Our findings point towards ependymal cells as a key contributor to the regenerating spinal cord and mark the first demonstration of neural stem/progenitor cell markers during lizard tail regeneration.

Characterization of TGF β signaling during multi-tissue regeneration in *Eublepharis macularius*

Caractérisation du signalement par TGF β pendant la régénération tissulaire chez *Eublepharis macularius*

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Increasingly, the transforming growth factor beta (TGF β)/activin signaling pathway is being recognized as playing a fundamental role during wound healing and tissue regeneration in amphibians and fish. Based on the study of embryos, a similar role among amniotes is predicted, but to date TGF β /activin signaling in regeneration-competent adults remains poorly understood. Here we use the regeneration-competent lizard *Eublepharis macularius*, the leopard gecko, to investigate TGF β /activin signaling during tail tissue regeneration. Throughout tail regeneration we observed widespread phosphorylated-SMAD2 expression, indicating activation of the TGF β /activin pathway. Interestingly, this induction is initiated while TGF β 1 expression is weak and TGF β 3 expression is virtually absent. Our qPCR screen identifies activin- β A as the only TGF β /activin ligand strongly upregulated during early tissue regeneration. We conclude that TGF β /activin signaling is dynamic, involving different TGF β ligands at various stages of regeneration.

The impact of poor water quality on freshwater mussels: a potential barrier to endangered species recovery.

L'impact d'un mauvaise qualité de l'eau sur les moules d'eaux douces: une barrière potentielle pour le rétablissement des espèces en voie de disparition

¹Patricia Gillis

¹Environment Canada

Freshwater mussels are an ecologically important taxonomic group, although their complex lifecycle leaves them vulnerable to a range of hazards. Over 70% of North American mussel species are either endangered, threatened, or in decline. The early life stages are particularly sensitive to environmental contamination. In fact acute toxicity tests demonstrate that mussel larvae (glochidia) are the most sensitive organisms to some ubiquitous aquatic contaminants including ammonia and chloride. Population surveys reveal widespread species losses compared to historical records, particularly in urbanized areas. Recovery strategies produced under the Species at Risk Act recognize that poor water quality can interfere with conservation efforts and pose a risk to mussel recovery. However, the identification and remediation of specific threats presents a challenge when extrapolating from single species bioassays to impacts on wild mussels, especially in areas with complex mixtures of anthropogenic inputs. The role of environmental contaminants on this imperiled group of organisms is still unfolding.

Remodeling of diaphragm function during the development of heart failure in mice

Remodelage de la fonction du diaphragme pendant le développement de l'insuffisance cardiaque chez la souris

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We have examined the function and protein composition of diaphragm muscle during transverse aortic constriction (TAC) induced heart failure. Contractile function of skinned diaphragm muscle was characterized following 2 and 18 weeks of TAC. The Ca sensitivity of force generation and maximal force generated was significantly reduced in the 18 week TAC group compared to the shams and 2 week TAC group. Western blotting indicates an increase in the presence of a high molecular weight protein complex containing troponin T in diaphragm from the 18 week TAC group. There was also a reduction in the rate of cross-bridge cycling in the diaphragm from the 2 and 18 week TAC mice as compared to shams. This may represent a compensatory mechanism to reduce the cost of contraction, but would also impair power production. These results indicate that chronic hypertension initiates a series of changes in the diaphragm that could cause dysfunction during heart failure.

Does AMP kinase mediate metabolic adjustments associated with social status in rainbow trout,

Oncorhynchus mykiss?

Est-ce que AMP kinase régule les ajustements métaboliques associés au statut social chez la truite arc-en-ciel, Oncorhynchus mykiss?

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Juvenile salmonid fish form social hierarchies in which the dominant fish enjoys the most favourable position in the environment, gains the lion's share of available food and is aggressive towards more subordinate fish. Subordinate fish, by contrast, exhibit marked behavioural inhibition including reduced activity and feeding. These behavioural extremes are accompanied by distinctive physiologies. Most obviously, subordinate fish do not grow as rapidly as dominant fish, even when fed the same ration. The lower growth rates of subordinate fish reflect in part altered metabolism; subordinate fish rely upon on-board energy stores and consequently exhibit low hepatic glycogen levels and pyruvate kinase activity together with elevated hepatic phosphoenolpyruvate carboxykinase and glycogen phosphorylase activities. The present study investigated the possible role of AMP-activated protein kinase (AMP kinase) in modulating liver metabolism in dominant versus subordinate rainbow trout. (Funded by NSERC of Canada research and equipment grants to JGR and KMG.)

The effects of copper exposure on copper transporter expression and tissue copper concentrations in the yellow fever mosquito Aedes aegypti.

Effets de l'exposition au cuivre sur l'expression du transporteur du cuivre et les concentrations tissulaires en cuivre chez le moustique responsable de la fièvre jaune Aedes aegypti

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The yellow fever mosquito *Aedes aegypti* can survive in water bodies with copper concentrations above the LC₅₀ for most other model organisms used in metals toxicology. Here we present our data, which shows that the LC₅₀ for 4th instar *A. aegypti* is 2.3 mmol L⁻¹. Results of qPCR experiments of four putative copper transporters indicate that relative gene expression correlated with tissue copper concentrations, which were determined using Inductively Coupled Plasma Mass Spectrometry. The results of our study suggest that copper transporters in the midgut, Malpighian tubule, hindgut and the anal papillae of *A. aegypti* may play a significant role in the mosquito's high survival rate in copper contaminated water bodies.

Determinants of snail and trematode distribution and compatibility

Déterminants de la distribution et compatibilité des escargots et trématodes

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Of the over 18,000 known species of digenetic trematode, most undergo larval development within a snail host. Commonly, trematodes display a high degree of specificity for the snail hosts that they can infect. This specificity is, at least in part, dictated by immunological interactions that appear to have established over the long co-evolutionary history of these two groups of organisms. Recent evidence has revealed the presence of specific immunological and environmental factors that are determinants of infection susceptibility. However, much remains unknown about the factors that influence compatibility between snails and trematodes, especially within their natural environments. To better understand the driving factors of host and parasite specificity, diversity, and compatibility, we are conducting a field surveillance study of snail and trematode species across 20 different lakes in Alberta. As part of this study, we are collecting data related to snail and trematode presence and prevalence. In addition, molecular and environmental data is being gathered to assess the impact of physical environment and known compatibility determinants on the observed patterns in snail/trematode distribution and infection.

Temperature effects on immunological development and responsiveness in juvenile shortnose sturgeon (*Acipenser brevirostrum*)

Effets de la température sur le développement et la réactivité immunologique dans esturgeon juvénile (*Acipenser brevirostrum*)

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Sturgeon are Chondrostean, primitive fish harvested for their meat and eggs (caviar). Despite being among the most economically relevant fish species in aquaculture, little is known about sturgeon immunological development and response to environmental stress. The size and age at which sturgeon develop a functional immune response is unknown and water temperature is believed to be the most important factor in the development and growth of fish, influencing all physiological functions. Young-of-the-year shortnose sturgeon (*Acipenser brevirostrum*) were maintained at different temperatures (11°C and 20°C) and samples of spleen, meningeal lymphoid tissue, thymus and skin were collected for light microscopy and gene expression analysis. Temperature strongly influences the production and maturation of immune cells in the meningeal tissue and spleen; fish kept at 11°C seem to rely more heavily on innate immunity and lymphocyte production is higher in fish kept at 20°C. Relevant immune gene expression analysis will also be discussed.

Combined effects of temperature and metal contamination in yellow perch (*Perca flavescens*): an ecotoxicogenomic study.

Effets combinés de la température et de la contamination métallique chez la perchaude (*Perca flavescens*) : une étude écotoxicogénomique.

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Lake ecosystems are complex and many stressors co-occur, which can be classified in two groups: natural stressors such as the temperature, and anthropogenic stressors such as metal contamination. Using yellow perch (*Perca flavescens*) as a biological model, we have investigated the effects of nickel and cadmium contamination in fish exposed to three different temperature conditions (9°C, 20°C, 28°C) for seven weeks. Metabolic capacities and gene expression, selected in different biological pathways such as apoptosis, glucose and lipid metabolism and oxidative stress response, were measured in liver and muscle. Metal concentrations were determined in kidney, in order to observe the accumulation of metal in different temperature conditions. The relationship between genomic and physiological responses to heat stress combined to metal contamination, as well as the implications for the development of metal-specific biomarkers, will be discussed.

Odour-driven movement in the sea lamprey: spatial and temporal coding in two parallel olfactory pathways
Mouvements basés sur l'odeur chez la lampre marine: codage spatio-temporel dans deux voies olfactives parallèles

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The sea lamprey utilizes a variety of odours, including pheromones, for stimulating movement responses during feeding, migration and spawning. Responses of olfactory sensory neurons are transmitted to the olfactory bulb in the forebrain, where two primary output pathway regions (medial and non-medial) are engaged. Projection neurons (PNs) in the medial region initiate movements by connecting to locomotor control centers, while non-medial PNs project to the pallium. This study examines anatomical and physiological characteristics of these medial and non-medial regions. Medial PNs are anatomically distinct from the non-medial PNs and exhibit transient short duration responses to basic amino acids, sex pheromones and migratory pheromones. The non-medial OB exhibits region specific sustained long duration responses to select odours. These findings suggest that neuronal organization in the medial OB is optimized for the initiation of olfactory-locomotor movements in response to diverse odors, while the non-medial regions exhibit odour specificity, possibly for odour integration.

Transmission cycles & potential zoonotic transfer of cryptosporidium & giardia on the million acre farm
Cycles de transmission et potentiel de transfer zoonotique de Cryptosporidium et Gardia sur la ferme 'million acre'

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¹UPEI, ²BioFoodTech

The transmission and zoonotic potential of Cryptosporidium and Giardia on Prince Edward Island (PEI), Canada was investigated in multiple sources; cattle, swine, dogs, humans and water. Parasite prevalence was determined by direct fluorescent antibody analysis and source tracking was evaluated using molecular genotyping/sub-genotyping of fecal samples. Forty animals (20 adult & 20 immature) were evaluated from twenty dairy, beef and swine farms respectively. Water was sampled from barn and house wells and from upstream and downstream of each farm to investigate waterborne transmission dynamics. Additionally, dogs, either privately owned, from pet stores or the local animal shelter were evaluated. Human fecal specimens submitted to the local hospital diagnostic laboratory for various reasons were also assessed. PEI represents a unique environment in which to explore transmission cycles as there is a close association of rural agriculture and urban populations.

Dogfish sharks in low salinity: time course of acute homeostatic response

Aiguillats en faible salinité: Évolution temporelle de la réponse homéostatique aigüe

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¹University of Alberta

Pacific dogfish (*Squalus suckleyi*) can enter estuaries, but cannot survive there long-term. To elucidate their tolerance to lower salinity, we exposed dogfish to 60% SW and collected blood and water samples over 48 h. We then quantified temporal trends in blood pH, plasma osmolality and ion concentrations, as well as rates of urea efflux and O₂ consumption. The rate of O₂ consumption increased around 6 h and peaked after 12 h at 58% above control rates. After 9 h, plasma [Cl⁻] stabilized to 9% below initial levels, while plasma [Na⁺] decreased more than 20% over 18 h. Plasma [urea] dropped by 15% between 4 and 6 h, and continued to decrease. The rate of urea efflux increased over time, peaking after 36 h at 73% above initial rates. Apparently, dogfish exposed to low salinity are able to maintain homeostasis with respect to some physiological variables, but not others.

Keratinocytes mechanical defects in the skin blistering disease epidermolysis bullosa simplex

Défauts mécaniques des kératinocytes observés dans la maladie de peau épidermolyse bullosa simplex

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Epidermolysis bullosa simplex (EBS) is an inherited skin disorder caused by mutations in the genes coding for keratin proteins, leading to cell fragility and blistering upon mild physical trauma in patients. While the link between keratin mutations and keratinocyte fragility in EBS patients is clear, the underlying biophysical mechanisms are not understood. We recently showed that EBS keratinocytes are not more fragile than wild-type (WT) cells when subjected to extreme stretching. Here we tested the hypothesis that EBS cells are fragile due to an inability to withstand shear stress. We subjected WT and EBS keratinocytes to shear stress and found that EBS keratinocytes displayed significantly more necrosis and stiffness than WT. We here propose a model of EBS cell rupture in mechanical conditions. This is the first study to demonstrate EBS cell monolayer fragility in culture. It provides new insights into the mechanisms leading to cell rupture in EBS.

Genome size diversity in semi-aquatic insects

Diversité de la taille du génome chez les insectes semi-aquatiques

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Genome size is the total amount of DNA contained within a haploid set of chromosomes of a given species. Developmental complexity, specifically processes involving metamorphosis, may place large scale constraints on insect genome size. The transition from aquatic nymphs to terrestrial adults involves major morphological changes that may be comparable to metamorphosis in terms of cell division rate constraints. Among insects there is little information available on genome size diversity, even in otherwise well-studied groups such as the mayflies (Ephemeroptera), caddisflies (Trichoptera), or stoneflies (Plecoptera). Here we study the genome sizes of Ephemeroptera, Plecoptera, and Trichoptera orders to test the hypothetical 2 pg threshold theory and investigate how the unique development in mayflies affects genome size. This will provide important new information about genome size diversity patterns in insects, in particular those which transition from aquatic to terrestrial environments, and highlight several directions for future research.

Immune gene expression and Trypanosoma carassii infection in goldfish exposed to naphthenic acids and oil sands process water (OSPW)

Expression de gènes immunitaires et infection avec Trypanosoma carassii chez le poisson rouge exposé aux acides naphténiques et aux eaux de traitement des sables bitumineux

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We exposed goldfish for up to 7 days to either commercial naphthenic acids (NAs) or OSPW using a real-time continuous flow exposure apparatus. We measured the gene expression of three pro-inflammatory cytokines (IFN γ , IL1- β 1, and TNF α -2), and their receptors (IFNR1-1, IFNR1-2, TNFR1, TNFR2), in the gill, kidney and spleen using quantitative-PCR. We observed an up-regulation of expression of IFN γ , IL1- β 1, and TNF α -2 but not their receptors after exposure of fish to either commercial NAs or OSPW. To determine whether goldfish host defense was affected by exposure C-NAs or OSPW, fish were infected with Trypanosoma carassii and their ability to control the infection documented. After acute exposure to NAs or OSPW (one week), fish exhibited significantly lower parasitemia compared to non-exposed controls, indicating that goldfish exposed to NAs or OSPW had a significantly enhanced inflammatory response that was related to increased resistance to the parasite. [Supported by Alberta Water Research Institute]

Spatial and temporal events in tooth development in Teleost fish *Astyanax mexicanus*
Événements spatiotemporels lors du développement dentaire chez le poisson téléostéen *Astyanax mexicanus*

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Teleost fish can possess teeth on any of the bones lining the oropharyngeal cavity, such as mandible, maxilla, premaxilla, gill arches and pharyngeal bones. Therefore, teleosts are popular models in studies of vertebrate tooth development and evolution. Here, we investigate the complete odontogenic events in the Mexican tetra (*Astyanax mexicanus*), which possesses teeth on the above mentioned tooth bearing bones. Fish were examined from three days post fertilization (dpf) to 100 dpf using bone staining and histology. The first histological sign of tooth development starts at the pharyngeal bones, followed by the mandible and premaxilla. The last bones to start developing teeth are the maxillae, where tooth eruption begins around 60 dpf. In the oral teeth, morphology of tooth structure changes over ontogeny from unicuspis to multicuspid. These findings add to the current knowledge of the spatial and temporal events of odontogenesis in fish with teeth on all of the bones lining the oropharyngeal cavity.

Diversity and constraint in the embryonic origin of the vertebrate skull

Diversité et contraintes de l'origine embryonnaire du crâne des vertébrés

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The vertebrate skull is derived from embryonic neural crest and mesoderm, but the degree to which patterns of derivation from these two source populations are conserved among lineages remains largely unknown. We performed embryonic transplants, using GFP-transgenic axolotls (*Ambystoma mexicanum*) as donors, to document the neural-crest contribution to the adult osteocranum in this species. Comparisons with chicken and mouse reveal a highly conserved embryonic origin of the skull in most tetrapod clades. Conversely, a comparison between axolotl and the clawed frog (*Xenopus laevis*) reveals tremendous differences in the origin of skull bones between frogs and other vertebrates. Unique features of *Xenopus* may be a consequence of the extensive cranial metamorphosis that is characteristic of most anurans. Embryonic origin of the vertebrate skull varies according to lineage and is thus subject to evolutionary change. Finally, several longstanding homologies for bones of the cranial vault may be incorrect and should be reevaluated.

The effects of predicted future seawater pCO₂ on acid-base regulation in the Dungeness crab (*Metacarcinus magister*)

Effets d'une pCO₂ prédictive pour l'environnement marin futur sur la régulation acido-basique du crabe dormeur (*Metacarcinus magister*)

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Anthropogenic CO₂ release inevitably leads to the acidification of the ocean, which in turn decreases the pH of the body fluids in marine organisms. The gills of marine crabs mediate acid-base regulation but the mechanism is not well understood to date. A possible mechanism is through the regulation of ammonia, which exists as an acid (NH₄⁺) or base (NH₃) depending on the pH (pK_a ≈ 9.3). In this study, the effects of long-term acclimation to elevated pCO₂ on various aspects related to acid-base regulation were investigated in the Dungeness crab, *Metacarcinus magister*. Intact crabs acclimated to elevated pCO₂ were able to fully counter the acidifying effects of the inwardly directed pCO₂ mainly by the accumulation of HCO₃⁻ in the hemolymph. In addition, hemolymph Na⁺, Ca²⁺, and SO₄²⁻ concentrations were elevated in CO₂ stressed crabs. Gill perfusion experiments further showed that these crabs excreted less ammonia than control animals.

Friend or foe: do conspecifics lower the acute stress response in juvenile lake sturgeon?

Ami ou ennemi: est-ce que la présence de conspécifiques réduit la réponse au stress aigu chez les esturgeons jaunes juvéniles.

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The lake sturgeon (*Acipenser fulvescens*) is a benthic freshwater species that is highly gregarious large groups while in its juvenile life stage (Barth et al. 2011). To examine the effects of social context on the acute stress response blood samples were taken from juvenile lake sturgeon following a stressful event in one of three treatments isolated, grouped with conspecifics and grouped with allospacifics. Behaviour of sampled fish was also recorded to determine if any behaviour was indicative of stress levels. Norepinephrine concentrations were significantly higher in the allospacific treatment ($F_2=0.5412$, $P=0.0483$), while epinephrine concentrations had no significant difference between treatments. The number of times bitten by other fish was significantly related to an increased peak norepinephrine concentration ($r = 0.6710$, $P = 0.0023$). These results suggest that social context influences the acute stress response in this species.

Barth et al. 2011, Trans. Am. Fish. Soc. 140. 1629

Carbonic anhydrase mediated oxygen release in rainbow trout red blood cells following β -adrenergic stimulation: a dose-response analysis

relâchement d'oxygène lié à l'anhydrase carbonique dans les globules rouges de la truite arc-en-ciel suivant une stimulation β -adrénergique: une analyse dose-réponse

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Most teleosts that have a pronounced Bohr-Root effect possess adrenergically activated sodium-proton exchangers (β -NHEs) on the red blood cell (RBC) membrane. During a general acidosis, β -NHE activation regulates RBC intracellular pH safeguarding oxygen (O_2) loading at the gills. Recent in vitro and in vivo studies show, that during stress, plasma accessible carbonic anhydrase (CA) can short-circuit this mechanism, greatly enhancing O_2 delivery at the tissues. However, it is not known how the severity of an acidosis or concentration of catecholamines affect this process. In this study, the magnitude of the β -NHE response of rainbow trout RBCs was assessed at physiologically relevant ranges of pH values, O_2 tensions and catecholamine concentrations. CA was then added to the closed system and the changes in plasma pH and PO_2 were recorded in real time to estimate the degree to which O_2 delivery to the tissues might be enhanced by the presence of plasma accessible CA.

Activation of mitochondrial ATP-sensitive potassium channels during anoxia results in matrix depolarization which is balanced by proton efflux via reversal of the ATP synthase

L'activation de canaux potassiques sensibles à l'ATP pendant l'anoxie dépolarise la matrice mitochondriale et inverse le flux protonique de l'ATP synthase

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The anoxia-tolerant western painted turtle (*Chrysemys picta bellii*) reduces NMDA receptor activity by a calcium-dependent mechanism following anoxic onset. We speculated that during anoxia, mitochondrial membrane potential (Ψ_m) depolarizes, releasing Ca^{2+} . Using rhodamine and Oregon Green, we found a $6.6 \pm 1.0\%$ depolarization of Ψ_m and a $16.1 \pm 2.7\%$ increase in cytosolic $[Ca^{2+}]$. Mitochondrial ATP-sensitive potassium ($mK^{+}ATP$) channel activation by diazoxide mimics anoxic Ψ_m depolarization ($5.5 \pm 0.8\%$) and inhibition with 5-hydroxydecanoic acid during anoxia abolishes Ψ_m depolarization ($0.4 \pm 0.1\%$). We hypothesize H^{+} -efflux via mitochondrial F1F0-ATPase maintains a new depolarized set-point and prevents Ψ_m collapse; F1F0-ATPase inhibition with oligomycin-A depolarizes Ψ_m 5.13 ± 1.04 -fold more during anoxia. $mK^{+}ATP$ channel activity can be sensitized through phosphorylation by PKCe following its translocation to the mitochondrial membrane and we hypothesize that this occurs during anoxia. Turtle PKCe membrane expression levels remain unchanged in response to anoxia, indicated by western blot, suggesting that turtle mitochondria are constantly primed for the anoxic transition.

Alterations in digestive enzyme profiles in cunner, *Tautogolabrus adspersus*, during fasting and dormancy

Modifications des profils d'enzymes digestives pendant le jeûne et la dormance chez la tanche, *Tautogolabrus adspersus*

¹James Hayes, ¹Helene Volkoff

¹Memorial University of Newfoundland

Endemic to the cold waters of the North Atlantic, the cunner (*Tautogolabrus adspersus*), a stomachless carnivorous fish, enters torpor from December to May. This response is induced when seawater temperature drops below 5°C and is characterized by active metabolic depression, lethargy and a complete cessation of feeding. The mechanism enabling the cunner's resilience to prolonged food deprivation has not yet been elucidated. To develop an understanding of these mechanisms, this study investigates alterations in digestive enzyme profiles in the intestine of cunner. Activities of digestive enzymes (lipase, alkaline phosphatase, trypsin and alanine aminotransferase) were quantified by spectrophotometric enzyme assays for cunner sampled during their winter torpor and during a trial of food deprivation during the active summer months. Preliminary findings show a fasting induced modification in intestinal digestive enzyme activities. This work contributes to the understanding of digestive enzyme dynamics during prolonged fasting in a cold-adapted fish.

Endémique dans les eaux froides de l'Atlantique Nord, la tanche (*Tautogolabrus adspersus*), un poisson carnivore sans estomac, entre la torpeur de Décembre à Mai. Cette réponse est induite lorsque la température de l'eau de mer descend en dessous de 5°C et se caractérise par une dépression métabolique actif, de la léthargie et l'arrêt complet de l'alimentation. Le mécanisme permettant la résilience de la tanche à la privation de nourriture prolongé n'a pas encore été élucidé. Pour développer une compréhension de ces mécanismes, cette étude examine des modifications dans les profils d'enzymes digestives dans l'intestin de tanche. L'activités des enzymes digestives (lipase, la phosphatase alcaline, la trypsine et de l'alanine aminotransférase) ont été quantifiés par des dosages enzymatiques spectrophotométriques pour tanche échantillonnée au cours de leur torpeur hivernale et pendant un procès de la privation de nourriture pendant les mois d'été actifs. Les résultats préliminaires montrent une modification induite par diète absolue dans les activités enzymatiques digestives de l'intestin. Ce travail contribue à la compréhension de la dynamique des enzymes digestives au cours de la diète absolue prolongé dans un poisson adapté au froid.

**Evolution of myoglobin net surface charge in mammalian divers: a test of the 'aquatic mole' hypothesis.
Évolution de la charge de surface nette de la myoglobine chez les mammifères plongeurs: un test de l'hypothèse de la 'taupe aquatique'**

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Elevated myoglobin concentration is a hallmark of mammalian divers, yet little is known regarding the molecular underpinnings of this muscle phenotype. We previously traced the molecular evolution of myoglobin across the mammalian phylogeny to reveal an adaptive signature of elevated net protein charge in all diving lineages that moreover is mechanistically linked with maximal myoglobin concentration and dive time. Interestingly, this study inferred an aquatic ancestry for talpid moles, though was based on sequences from only two species. To test this 'aquatic mole' hypothesis, we collected myoglobin sequences from members of each mole clade and mapped them onto a phylogeny we determined for the group. Consistent with predictions, net surface charge increased strongly in the ancestors of the amphibious star-nosed mole followed by secondary reductions in more derived semi-fossorial and fossorial species. Convergent charge increases were also found in aquatic desmans, highlighting the strong predictive power of this molecular signature.

Une concentration élevée de myoglobine est une marque de plongeurs mammifères, mais on sait peu des mécanismes moléculaires de ce phénotype musculaire. Nous avons déjà retracé l'évolution moléculaire de la myoglobine dans la phylogénie des mammifères pour révéler une signature adaptatif d'une charge élevée de protéine dans toutes les lignées de plongeurs qui est mécaniquement liés à la concentration de myoglobine et le temps de plongée maximale. Cette étude a déduit une ascendance aquatique pour les taupes talpid, mais a été basée sur les séquences de seulement deux espèces. Pour tester l'hypothèse de ce «taupe aquatique», nous avons recueilli des séquences de myoglobine des membres de chaque clade taupe et les mappé sur une phylogénie nous avons déterminé pour le groupe.

Conformément aux prévisions, la charge de surface nette a augmenté dans les ancêtres de la taupe à nez étoilé amphibia suivie par des réductions secondaires dans des espèces plus dérivés semi-fouisseurs et fouisseurs. La convergence d'augmentations de charge ont été également trouvé dans les desmans aquatiques, mettant en évidence la forte puissance prédictive de cette signature moléculaire.

Multilocus phylogeny and divergence times of the talpid mole family

Phylogénie multilocus et temps de divergence des taupes talpidés

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Early shrew-like terrestrial ancestors of moles (Family Talpidae) evolved a striking array of body forms to successfully exploit a diverse range of habitats: semi-aquatic, semi-fossorial, semi-aquatic/semi-fossorial and fully

fossorial (subterranean). Although a number of non-congruent phylogenies have been proposed for this family, their phlogenetic relationships remain unresolved with little known regarding the time scale over which moles adapted to these habitats and lifestyles. Herein, we employ Bayesian phylogenetic analyses of two mitochondrial and twelve nuclear genes (9,542 base pairs) from members of all 17 talpid genera to infer their phylogenetic relationships, and use fossil records and a relaxed molecular clock model to assess the impact of climate change on talpid speciation and diversification. Our results indicate that fossorial specializations arose twice independently in this group, and highlight a rapid radiation event near the Oligocene/Miocene boundary coincident with both wide-scale global cooling and the adoption of aquatic, semi-fossorial and subterranean habits.

Les ancêtres terrestres des taupes ressemblait les musaraigne (famille Talpidae) et ont évolué un ensemble de formes du corps pour exploiter un large éventail d'habitats: semi-aquatique, semi-fouisseur, semi-aquatic/semi-fossorial et entièrement fouisseur (souterrain). Bien qu'un nombre de phylogénies non-congruentes ont été proposées pour cette famille, leurs relations phlogénétiques restent en suspens avec peu connue en ce qui concerne l'échelle de temps sur laquelle les taupes ont adapté à ces habitats et cycles biologiques. Ici, nous utilisons des analyses phylogénétiques bayésiens de deux gènes mitochondrial et douze gènes nucléaires (9542 paires de bases) des membres de tous les 17 genres talpid pour inférer leurs relations phylogénétiques. On a aussi utiliser des enregistrements fossiles et d'un modèle d'horloge moléculaire détendue pour évaluer l'impact du changement climatique sur la spéciation et diversification talpid. Nos résultats indiquent que les spécialisations fousseurs se leva deux fois de façon indépendante dans ce groupe, et souligne un événement de rayonnement rapide près de la limite Oligocène / Miocene qui coïncide avec une refroidissement à grande échelle de la planète et l'adoption d'habitudes aquatiques, semi-fouisseurs et souterrains.

Variation in metabolism and thermal tolerance in the Atlantic killifish, *Fundulus heteroclitus*

Variation du métabolisme et de la tolérance thermique chez le choquemort, *Fundulus heteroclitus*

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Variation in routine metabolism can play an important role in setting the thermal tolerance and performance of organisms. The two subspecies of the Atlantic killifish, *Fundulus heteroclitus*, vary in both routine oxygen consumption and thermal tolerance. In particular, fish from the northern subspecies have high routine oxygen consumption and low tolerance of high temperatures relative to fish from the southern subspecies. Where the distributions of the subspecies overlap, northern and southern genotypes are found segregating within the same populations. In this study, oxygen consumption, thermal tolerance, and mitochondrial genotype in killifish from two contact populations was determined. Association of mitochondrial-type with routine metabolism suggests that the northern mitotype is associated with increased routine oxygen consumption in this species, providing insights into the genetic mechanism underlying this trait.

La variation dans le métabolisme routine peut jouer un rôle important dans la mise à la tolérance thermique et des performances des organismes. Les deux sous-espèces de l'Atlantique barré, *Fundulus heteroclitus*, varient à la fois la consommation d'oxygène de routine et de la tolérance thermique. En particulier, les poissons de la sous-espèce du nord ont une consommation d'oxygène routine élevée et une faible tolérance aux températures élevées par rapport à les poissons à partir de la sous-espèce du sud. Lorsque les distributions des sous-espèces se chevauchent, les génotypes nord et sud se trouvent en ségrégation au sein des mêmes populations. Dans cette étude, la consommation d'oxygène, la tolérance thermique et le génotype mitochondrial de deux populations de contact a été établi.

Association des type mitochondrial avec le métabolisme routine suggère que la mitotype nord est associé à la consommation accrue d'oxygène routine chez cette espèce, donnant un aperçu dans le mécanisme génétique sous-jacente de ce trait.

A Census of All Life

Un recensement de toute forme de vie

¹Paul Hebert

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Despite 250 years of effort, most species remain undescribed and many of those with names are difficult to discriminate. This taxonomic impediment has constrained biodiversity science in many ways, but the pathway to progress is clear. Sequence diversity in short genomic regions, DNA barcodes, can enable the identification of known species and expedite the discovery of new ones. Motivated by these facts, a major DNA barcode program is underway. Expect a barcode reference library for 500K species by 2015. Expect automated systems supporting both field identifications and massive biodiversity screens by 2020. Expect a barcoded world by 2030. Aside from revealing the diversity of life, this comprehensive DNA barcode library will empower studies of species interactions, and deepen our understanding of evolutionary trajectories. It will also have important practical consequences, aiding better protection of forestry and agriculture, earlier interception of invasive species, and enhanced ecosystem monitoring. Most importantly, it promises a world where anyone can identify any organism at any time.

Mucin release from the vesicles of Pacific hagfish (*Eptatretus stoutii*) slime glands

Libération de mucine des glandes à mucus chez la myxine brune (*Eptatretus stoutii*)

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The mucus produced within the slime glands of Pacific hagfish (*Eptatretus stoutii*) is released into the external environment by holocrine secretion. Consequently, the vesicles in which the mucin is stored are intact when they come into contact with seawater, and rupture shortly thereafter. We demonstrate that it is the interaction of seawater ions and water molecules with the mucin vesicle membrane that results in the rupture of the vesicles, and the release of mucins for the formation of the hagfish's defensive slime. We used a membrane-disrupting agent, varying combinations of organic and inorganic ions, membrane channel inhibitors, and the molecular analysis of slime gland tissue to determine how rupture occurs. From our observations, we hypothesize that the characteristic rupture of hagfish slime mucin vesicles is dependent on the combination of an intact vesicle membrane, uninhibited water flux through aquaporin water channels, and the presence of calcium ions in seawater.

Iodide function in sea urchin (*Strongylocentrotus purpuratus*) free radical metabolism during early development

L'iode est impliquée dans le métabolisme des radicaux libres pendant le développement de l'oursin de mer (*Strongylocentrotus purpuratus*)

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¹University of Guelph

Oxidative stress occurs through the generation of reactive oxygen species (ROS), such as hydrogen peroxide (H₂O₂), a partially reduced oxygen species that has been shown to cause cellular damage in developing sea urchin embryos. Recent work from our lab shows that H₂O₂ is also a critical player in the uptake of iodide into sea urchin embryos. Once inside the cell iodine may function in the synthesis of iodothyronines or have critical functions in free-radical metabolism. The latter has never been tested for sea urchin embryos. We show that paraquat, an intra-cellular producer of oxidative stress and H₂O₂ delay cell division and result in gastrulation abnormalities. Combined treatment of embryos with iodide and H₂O₂ or paraquat respectively can only rescue cell division delays but not gastrulation abnormalities. Still, the exposure of embryos to excess iodide leads to a significant decrease of H₂O₂ further suggesting a function of iodine in free radical metabolism of sea urchin embryos.

The effects of habitat structure on locomotion in South African chameleons

Les effets de la structure de l'habitat sur la locomotion du chaméléon Sud Africain

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Arboreal lizards are extremely effective at moving in structurally complex habitats that include surfaces of varying diameter and incline. Chameleons exhibit a number of morphological specializations, including the ability to grasp branches with their feet. Despite their unique morphology and behavior, little is known about the locomotion of chameleons. In order to determine how habitat structure impacts locomotion, we collected multiple species from the genus *Bradypodion* in South Africa. This genus exhibits remarkable disparity in morphology and ecology, occupying grass, bushes, trees, and fynbos. Species in trees and large bushes tended to occupy relatively horizontal perches with large diameters, whereas species in grasses and fynbos tended to occupy relatively vertical perches with small diameters. To investigate how habitat structure influenced movement, we used high-speed video cameras to quantify the three-dimensional hindlimb and body kinematics during locomotion on perches of variable diameter and incline. We quantified joint angles, joint displacements, and center of mass movements. In addition to differing in their limb and body movements, species adjusted their kinematics according to the perches on which they moved.

Changes in steady state ROS levels modulate GABA receptor-mediated electrical suppression in painted turtle cerebral cortex

Les changements dans l'état d'équilibre des taux d'espèces réactives de l'oxygène modulent la suppression électrique par le récepteur-GABA dans le cortex cérébral de la tortue peinte

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The western painted turtle *Chrysemys picta bellii*, is incredibly anoxia-tolerant surviving months of low oxygen while overwintering. In anoxic brain, neuroprotection is due to elevated GABAergic signaling that shunts excitatory current, thereby avoiding excessive action potential firing. The signaling pathway responsible for initiating GABAergic neuroprotection is unknown but may involve a decrease in reactive oxygen species (ROS) following onset of anoxia. It was the objective of this study to determine if changes in [ROS] regulate GABA(A) receptor-mediated postsynaptic currents (PSC). Using whole-cell patch clamp techniques and live fluorescent imaging we determined that, similar to anoxia, ROS scavenging causes: 1) GABA(A) receptor-mediated PSCs to double in amplitude; 2) membrane potential to shift to the GABA reversal potential (EGABA) and 4) electrical suppression. Application of hydrogen peroxide prevented these changes indicating that anoxic decrease in ROS production is the signal that increases GABA(A) receptor currents during anoxic stress.

Mathematical modelling of condition-dependent female mate choice

Modélisation mathématique du choix de partenaire des femelles en dépendance des conditions

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¹Wilfrid Laurier University

While considerable theoretical and empirical work has focused on the evolution and maintenance of costly male display traits, much less attention has been directed towards the sources of variation in female mate preference and its consequences for ornament evolution (and more broadly, in adaptive evolution). For instance, while much has been learnt by considering that costly male display traits may be condition-dependent — reflecting reliable information about the phenotypic and/or genotypic quality of the male — there have not been similar explorations regarding the potential effect of condition-dependency in costly female preferences. In this study I set out to examine, through the use of mathematical models, the co-evolutionary dynamics of systems where female preferences and/or male display traits vary in a condition-dependent manner.

Bien que beaucoup de travail théorique et empirique a porté sur l'évolution et la maintenance de coûteuses traits masculins d'affichage, beaucoup moins d'attention a été dirigée vers les sources de variation, de préférence partenaire féminine et de ses conséquences pour l'évolution des ornements (et, plus largement, pour l'évolution adaptative). Par exemple, même si beaucoup a été appris en considérant que les traits masculins d'affichage coûteuses peuvent être dépendante sur la condition - reflétant une information fiable sur la qualité phénotypique et / ou génotypique de l'homme - il n'y a pas eu explorations similaires concernant l'effet potentiel de l'état de dépendance dans de coûteux préférences féminines. Dans cette étude, je me mis à examiner, à travers l'utilisation de modèles mathématiques, la dynamique de co-évolution des systèmes où les préférences des femmes et / ou des traits masculins d'affichage varient d'une manière dépendante de la condition.

To leap or not to leap? Emersion behaviour in response to acute salinity change in the amphibious mangrove rivulus *Kryptolebias marmoratus*

Sauter ou ne pas sauter? Émersion en réponse à un changement de salinité abrupt chez le killi des mangroves *Kryptolebias marmoratus*

¹Meghan Hull, ¹Cayleih Robertson, ¹Andy Turko, ¹Patricia Wright

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Amphibious fish moving between aquatic and terrestrial habitats may encounter abrupt changes in environmental salinity. We tested the hypothesis that euryhaline, amphibious, self-fertilizing “isogenic” *K. marmoratus* sense salinity gradients and will consistently emerge at a salinity threshold to avoid severe osmotic imbalance. Fish (15 ppt) were exposed to a rapid change in water salinity (1.5 ppt/min) up to 100 ppt. The effective concentration that 50% of the fish emerged (EC50) was 72.5 ppt, but individual variation was relatively large (55 to 100 ppt). The trigger for emersion was not muscle tissue osmolality. Two different genetic lineages had very similar EC50 values, but when re-tested a week later the mean salinity at emersion was significantly lower. Taken together, we found that “isogenic” fish demonstrate wide individual variation that may depend on a complex set of physiological factors.

Ammonia excretion by anal papillae of the larval mosquito, *Aedes aegypti*.

Excrétion d'ammoniac par les papilles anales des larves du moustique, *Aedes aegypti*.

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The anal papillae of *Aedes aegypti* larvae, are important sites of nitrogenous waste excretion and they express two putative ammonia ($\text{NH}_3/\text{NH}_4^+$) transporters, Rhesus protein 50 - 1 and -2 (Rh50-1, -2). Here, we pharmacologically characterize ammonia transport mechanisms in the anal papillae of larval *A. aegypti* and investigate the osmoregulatory-tissue-specific regulation of putative ammonia transporters in response to high environmental ammonia (HEA) treatment. Ammonia concentration gradients were measured adjacent the anal papillae using SIET (Scanning Ion-selective Electrode Technique) and used to calculate ammonia efflux by the anal papillae. Results suggest that the ionomotive pumps V-type H^+ -ATPase and Na^+/K^+ -ATPase are involved in ammonia excretion at the anal papillae. Quantitative RT PCR studies reveal high expression of Rh50-2 in the anal papillae relative to the expression of Rh50-1.

Clear and present danger: the behavioural response of migratory sea lamprey (*Petromyzon marinus*) to chemosensory alarm cues

Danger immédiat: réponse comportementale de la lamproie marine (*Petromyzon marinus*) en phase migratoire aux signaux d'alarme

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We conducted an experimental study to investigate 1) whether sea lamprey show avoidance of injured conspecific (fresh and decayed migratory sea lamprey extract), injured heterospecific (sympatric white sucker, *Catostomus*

commersonii and exotic sail-fin catfish, *Pterygoplichthys pardalis*), predator cues (2-phenylethylamine (PEA), northern water snake, *Nerodia sipedon* sipedon washing, human saliva) and an injured conspecific and predator combination cue (migratory sea lamprey extract plus human saliva) and 2) whether the response is general to any injured heterospecific fish or specific to injured sea lamprey. Mobile sea lamprey showed a significant avoidance response to all conspecific cues and to white sucker, human saliva, PEA and the combination cue. For mobile sea lamprey, the northern water snake cue induced behavior consistent with predator inspection. Exposure to *P. pardalis* extract induced a delayed avoidance response in mobile sea lamprey. Our findings support the use of natural repellents for the behavioural manipulation of sea lamprey populations.

Effects of embryonic anoxia exposure on the endocrine stress response of adult zebrafish (*Danio rerio*).

Les effets de l'exposition de l'embryon à l'anoxie sur la réponse au stress endocrinien chez le poisson-zèbre (*Danio rerio*) adulte.

¹Catherine M. Ivy, ¹Nicholas J. Bernier

¹University of Guelph

The ability of prenatal stress to alter endocrine and behavioural responses in adult mammals is well known, but poorly understood in fish. In zebrafish, embryonic stress is known to alter the physiology of adults, but its impact on the development of the hypothalamus-pituitary-interrenal (HPI) axis is unknown. This study assessed if embryo anoxia exposure (<0.5% dissolved oxygen) at 36 hours post-fertilization (hpf) would alter adult cortisol response. Adults derived from anoxia-exposed embryos were treated with hypoxia or tested in dyadic interactions. Although embryos exposed to anoxic and normoxic conditions exhibited similar cortisol responses to hypoxia as adults, adults raised from embryos exposed to anoxia were found to exhibit dominance during dyadic interactions and had lower whole body cortisol levels than those exposed to normoxia. These findings suggest that the HPI axis and associated pathways are disrupted during anoxia exposure at 36 hpf, resulting in altered stressor-specific endocrine and behavioural responses.

The frozen fly of your nightmares: Overwintering biology of *Drosophila suzukii*

La mouche congelé de vos cauchemars: Biologie d'hivernage de *Drosophila suzukii*

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Spotted wing drosophila (*Drosophila suzukii*) can oviposit in healthy commercial fruits and was accidentally introduced from Southeastern Asia to Ontario in 2010. Its potential to establish in Ontario depends on its ability to withstand cold exposure over winter.

By measuring supercooling points (freezing temperature) and the lower lethal temperature (highest temperature at which no mortality is found following recovery) of all life stages I will determine which cold tolerance strategy (freeze-avoidance and -tolerance, chill susceptibility) *D. suzukii* uses. I will use all life stages from colonies originally collected in British Columbia and Ontario. Besides, I will determine the extent to which their cold tolerance is phenotypically-plastic over short (rapid cold hardening) and long timescales (acclimation). By examining the overwintering biology of SWD, I will determine if this species is likely to establish as a significant agricultural pest in Ontario, allowing for better resource management in the coming years.

Genome size and speciation in cryptic crustaceans

Taille du génome et spéciation chez les crustacées cryptiques

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Crustaceans are one of the most diverse taxa on the planet, inhabiting marine, freshwater and terrestrial environments. The true diversity of the crustaceans is not yet known due to high levels of cryptic species diversity, as well as rapid speciation rates leading to high numbers of endemic species in unique habitats. Genome changes, including total genome size, may be responsible for rapid speciation rates and cryptic species diversity. For example, Lake Baikal is the oldest lake in the world containing at least 300 endemic amphipod species while alpheid snapping shrimps contain high levels of cryptic diversity due to various lifestyles. Genome size estimates were obtained for nearly 20 species of Lake Baikal amphipods and 30 species of Caribbean snapping shrimps. Genome sizes are highly variable in amphipods and alpheids, correlating with numerous parameters that can lead to speciation, and polyploidy has likely contributed to speciation in both of these groups.

Regulation of hypothalamic-pituitary-interrenal axis function in male smallmouth bass during parental care
La régulation de la fonction de l'axe hypothalamo-hypophysio-interrénal durant les soins parentaux chez l'achigan à petite bouche

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Glucocorticoids are thought to mediate life-history trade-offs in the allocation of resources between current and future reproduction. To maximize current reproduction, male smallmouth bass attenuate cortisol responses to stress during early parental care. We hypothesized that attenuation of the cortisol response reflects modulation of the hypothalamic-pituitary-interrenal (HPI) axis. To test this hypothesis, male smallmouth bass were exposed to a standardized stressor at the beginning or end of the parental care period. Plasma adrenocorticotrophic hormone levels did not differ significantly between males at different periods of parental care. Tissues collected from non-stressed and stressed fish at each time point were analyzed for mRNA levels of HPI axis-related genes. Relative mRNA levels of corticotropin-releasing factor as well as key mediators of cortisol synthesis were significantly lower in males during early parental care. Thus, HPI axis function appears to be modulated at multiple levels in male smallmouth bass during early parental care.

Dealing with the diaphragm: coordinating respiratory muscles in mammals

Une affaire de diaphragme: Coordination des muscles respiratoires chez les mammifères

¹Sarah Jenkin, ¹William Milsom

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Using en bloc brainstem-spinal cord preparations, this study investigated the effects of CO₂, age, and the pons (rostral medulla) on the coordination of motor output to the diaphragm and intercostal muscles in neonatal rat pups. In the intact preparations, the diaphragm and intercostal muscles were recruited simultaneously and fictive breathing frequency increased with elevated CO₂ due exclusively to a reduction in the expiratory phase of the breathing cycle (there was no change in the inspiratory phase). When the pons was transected, the intercostal muscles were now recruited later than the diaphragm and this delay was exaggerated with age and increased CO₂. These data suggest that in mammals, as in reptiles, breathing frequency is modified primarily by reducing the expiratory pause and that the rostral medulla is essential for coordinating inspiratory muscle activity, particularly with increasing age and respiratory drive. Supported by the NSERC of Canada.

Zooplankton community production – Zooplankton community health

Production de la communauté de zooplancton – Santé de la communauté de zooplancton

¹Ora Johannsson, ¹Kelly Bowen

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Gradients in trophy, depth, and fish community structure extend along the 67-km Bay of Quinte, Lake Ontario. Between 1975 and 2008, phosphorus loading was decreased to the Bay, the fish community changed cataclysmically, and the Bay was invaded by dreissenid mussels, a predatory cladoceran (*Cercopagis pengoi*) and the round goby (*Neogobius melanostomus*). Zooplankton production was calculated at upper, middle and lower Bay sites and the relationships with top-down, bottom-up and environmental variables explored. Using this information, indices of functional health of the zooplankton community were explored.

Chronic hypoxia exposure of rainbow trout embryos alters swimming performance and cardiac gene expression in larvae

L'exposition chronique des embryons de truites arc-en-ciel à une hypoxie chronique altère les performances à la nage et l'expression des gènes cardiaques de la larve.

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The goals of this study were to determine how environmental hypoxia during embryonic development affects the aerobic capacity, growth, and lipid deposition of rainbow trout following hatch. In addition, we characterized the expression of gene transcripts for seven troponin I (TnI) isoforms to monitor cardiac development. Results demonstrate that the absolute Ucrit of hypoxia-exposed fish was significantly less than control fish at embryonic stages 35 and 37. Standard length and dry mass measurements indicate that growth at stages 35 and 37 was reduced in the treatment group. The relative lipid content of the treatment group was also less than the control group at stage 37. The expression of two TnI isoforms (RTcTnI and AScTnI2) was affected by developmental stage and/or the treatment. Such changes in TnI expression in the myofilament have the potential to affect contractile function. Together, these findings suggest hypoxia exposure of trout embryos has the potential to influence the fitness of wild populations.

Biotic resistance of an introduced predator's impact via niche contraction

La résistance biotique à l'impact d'un prédateur introduit via une contraction de la niche

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Predicting the impacts of non-native species remains one of the greatest challenges to invasion ecologists, owing in part to their dependency on environmental context. In this study, we explore the influence of a native predator on the impact of the introduced predatory cladoceran *Bythotrephes longimanus*. To date, experimental studies of *Bythotrephes*' impact have ignored the potential role of native predators. We used a field mesocosm experiment to determine if *Chaoborus* larvae, a ubiquitous invertebrate predator, influence the impact of *Bythotrephes*. Our results demonstrated evidence of biotic resistance of impact via niche contraction as the distribution and behaviour of the predators varied when they co-occurred. Specifically, *Bythotrephes* was more restricted to the shallower regions of the water column in the presence of *Chaoborus*, leading to a reduced impact on deeper dwelling prey taxa. Overall, our results demonstrate that the native predator context is important when trying to understand the impact of a non-native predator.

Stopover durations of spring migrating silver-haired bats

Durée des escales lors de la migration printanière de la chauve-souris argentée

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Several temperate bat species undertake latitudinal migrations. Result work in our lab found that fall migrating silver-haired bats (*Lasionycteris noctivagans*) have very brief 1-2 day stopovers. We hypothesized that spring migrating bats stopover for longer periods than fall migrants because cooler spring weather is associated with low prey availability, which will decrease refueling rates. Twenty-one silver-haired bats were captured between mid-April and late May 2012 at Long Point, ON, Canada. We quantified stopover duration using radio-telemetry and assessed bats fat stores using quantitative magnetic resonance. Although most bats stopover briefly during their spring migration, some individuals appear to require longer refueling periods of 1-2 weeks. Female bats had significantly longer stopovers than males. Furthermore female bats that stopped over for several days had lower body fat percentages than those that resumed migration the following evening. Future work will explore the effect of torpor expression on stopover durations.

Plusieurs espèces de chauves-souris tempérées entreprennent des migrations latitudinales. Les travaux dans notre laboratoire a révélé que la migration d'automne de la chauve-souris argentée (*Lasionycteris noctivagans*) ont des escales très brèves de 1-2 jours. Nous avons supposé que les escales de la migration de printemps sont plus longues que les migrants d'automne parce que les températures plus fraîches du printemps est associée à la disponibilité des proies faible, ce qui diminue les taux de ravitaillement. Vingt-et-un chauves-souris argentée ont été capturés entre la mi-avril et fin mai 2012 à Long Point, ON, Canada. Nous avons quantifié la durée d'escale à l'aide de radio-télémétrie et les réserves de graisse des chauves-souris en utilisant le résonance magnétique quantitative. Bien que la plupart des chauves-souris brièvement escale lors de leur migration printanière, certaines individuelles semblent exiger des périodes de ravitaillement de 1-2 semaines. Les chauves-souris femelles avaient des escales beaucoup plus longues que les mâles. En outre, les chauves-souris femelles qui ont arrêté pendant plusieurs jours des pourcentages avaient des niveaux de graisse du corps plus bas que ceux qui ont repris la migration, le lendemain soir. Les travaux à venir vont explorer l'effet de l'expression du torpeur sur les durées d'escale.

The larval midge, *Chironomus riparius*, can inhabit salinated waters by altering ion transport properties of the rectum

Les larves du mouche, *Chironomus riparius*, peuvent persister en eau salée en modifiant les propriétés de transport ionique du rectum

¹Sima Jonasaitė, ¹Scott Kelly, ¹Andrew Donini

¹York University

Ionoregulatory role for the rectum of larval *Chironomus riparius* was revealed by examining Na⁺/K⁺-ATPase (NKA) and V-type H⁺-ATPase (VA) activity in the alimentary canal and rectal K⁺ transport. Both enzymes exhibited greater activity in the hindgut (HG) relative to other areas. No change in HG enzyme activity was observed between ion-poor water (IPW) or freshwater (FW) reared larvae. However, in brackish water (BW) reared animals, NKA and VA activity in the HG significantly decreased. NKA and VA immunolocalization in HG revealed the bulk of protein in the rectum. Rectal K⁺ flux showed a net K⁺ reabsorption which was reduced four-fold in BW-reared larvae versus FW or IPW counterparts. Inhibition of NKA, VA and K⁺ channels diminished rectal K⁺ reabsorption in FW- and IPW-reared larvae, but not BW-reared larvae. Data suggest the rectum of *C. riparius* as an important organ in allowing larvae to cope with sustained changes in environmental salinity

Identification of Major Histocompatibility Class II β alleles conferring resistance/susceptibility to *Flavobacterium psychrophilum*

Identification d'allèles de classe II β du complexe majeur d'histocompatibilité qui confèrent résistance ou susceptibilité au *Flavobacterium psychrophilum*

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Flavobacterium psychrophilum, the causative agent of bacterial cold water disease (BCWD), is a major concern for fish health with mortality rates ranging from 50-90%. MH genes encode cellular receptors involved in antigen presentation and play an important role in adaptive immunity. MH genes are highly polymorphic and previous research has demonstrated the high level of variability that can exist at the class II β gene. Through a combination of DNA sequencing and DGGE this study will determine the MH class II β genotype of survivors and mortalities from 30 different families of rainbow trout infected with *F. psychrophilum*. Comparing the survival status of individuals from different families in conjunction with their genotype will lead to the identification of alleles associated with better or worse performance. Results of this study will provide an enhanced understanding of immunity in fish.

Ice age fish in a warming world: thermal acclimation capacity of lake trout (*Salvelinus namaycush*) populations.

Un poisson de l'aire glaciaire dans l'eau chaude: Capacité d'acclimation thermale des populations d'omble de fontaine (*Salvelinus namaycush*)

¹Nicholas Kelly, ¹Gary Burness, ²Jenni McDermid, ³Chris Wilson

¹Trent University, ²Wildlife Conservation Society, ³Ontario Ministry of Natural Resources

Climate change threatens the future persistence of coldwater species such as Lake trout (*Salvelinus namaycush*). The ability of cold-adapted species and populations to persist will depend on their capacity for physiological acclimation and adaptation to elevated temperatures. We reared lake trout from four inland populations in a common environment from eggs to yearlings, and then acclimated them at 8°C, 11°C, 15°C and 19°C. Upper thermal tolerance of yearlings increased by 3°C over this 11-degree temperature range, but did not significantly differ among populations. Standard- and active metabolic rate increased with acclimation temperature up to 15°C, where active metabolic rate and metabolic scope peaked. Active metabolism and metabolic capacity only differed between two populations, suggesting little variation among lake trout populations for thermal acclimation. As a result, increased water temperatures from climate change may significantly threaten lake trout as a species, rather than simply being of concern for local southern populations.

Functional divergences in mitochondrial phenotypes between two marine bivalves estimated at different temperatures.

Divergences fonctionnelles de phénotypes mitochondriaux estimées à différentes températures chez deux bivalves marins

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The potential metabolic adaptation of animals is increasingly discussed in the context of climate change with a main concern for marine ectotherms since they rely on environmental temperature. This study presents the characteristics of mitochondrial respiration of *Mytilus edulis* and *Mya arenaria* to narrow down the location of a thermal temperature sensitive point of control in the electron transport system. Gathering the molluscs from St-Lawrence River where both species can be found, we isolated mitochondria from mantle to evaluate oxygen consumption under three experimental temperatures : 5, 15 and 25°C. In a sequence of substrates and inhibitors, we were able to follow respiration through the different states of complexes activation. We found a much greater aerobic capacity for *M. edulis* than *M. arenaria* mitochondria at all temperatures but lower activity of alternative oxidase when express per oxidative capacity of mitochondria.

Le potentiel d'adaptation métabolique des animaux est de plus en plus discutée dans le contexte du changement climatique avec une préoccupation principale pour les ectothermes marins car ils reposent sur la température ambiante. Cette étude présente les caractéristiques de la respiration mitochondriale de *Mytilus edulis* et *Mya arenaria* pour affiner la localisation d'un point de contrôle thermosensible dans le système de transport d'électrons. Après la collection des mollusques de la rivière St-Laurent où les deux espèces peuvent être trouvés, nous avons isolées les mitochondries à partir du manteau afin d'évaluer la consommation d'oxygène sous trois températures expérimentales: 5, 15 et 25°C. Avec une séquence de substrats et d'inhibiteurs, nous avons suivi la respiration à travers les différents états d'activation des complexes. Nous avons trouvé une bien plus grande capacité aérobie pour les mitochondries de

M. edulis que M. arenaria à toutes les températures, mais l'activité de l'oxydase alternative lorsque expresse par la capacité oxydative des mitochondries était plus basse.

Linkage mapping of quantitative trait loci corresponding to shell morphology divergence between high and low shore ecotypes of Littorina saxatilis

Cartographie génétique de loci à caractères quantitatifs correspondants aux divergences morphologiques de la coquille entre les écotypes de haut et bas rivage chez Littorina saxatilis

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Populations undergoing divergent ecological selection but that are still connected by gene flow, will show regions of increased FST referred to as “islands of genetic divergence”. These islands accumulate changes in allele frequency for the genes contributing to ecotype formation, yet the traits associated with these regions cannot be identified by population-level genome scans. A model system to identify traits involved in ecological divergence is the Spanish Littorina saxatilis, marine gastropod that exhibits microparapatric divergence of shell morphological traits due to selection differences at different shore levels. We intend to identify the number and location of quantitative trait loci (QTL) that contribute to shell morphology. Linkage mapping of QTL for shell morphology traits will be achieved by genotyping F1 backcross families for single nucleotide polymorphisms (SNP) using double digest restriction assisted sequencing (ddRAD) on an Illumina MiSeq platform. Funding NSERC Discovery to EGB and Rollins College Travel Grant to FH.

Populations subissant la sélection écologique divergente, mais qui sont toujours reliés par le flux de gènes, montreront les régions de la TVF accrue appelées « îlots de divergence génétique ». Ces îles accumuleront des changements dans la fréquence des allèles pour les gènes qui contribuent à la formation des écotypes, mais les traits associés à ces régions ne peuvent être identifiés par des analyses génomiques à la niveau de la population. Un système modèle pour identifier les traits impliqués dans la divergence écologique est le Littorina saxatilis espagnole, des gastéropodes marins qui expose la divergence microparapatric des traits morphologiques de coquille dues à des différences de sélection à des niveaux différents de la terre. Nous avons l'intention d'identifier le nombre et la localisation des locus de caractères quantitatifs (LCQ) qui contribuent à la morphologie de la coquille. Les liaisons génétique de LCQ pour des caractères morphologie de la coquille sera réalisés par le génotypage des familles de croisement en retour F1 pour polymorphismes nucléotidiques simples (PNS) en utilisant la séquençage assisté par double digestion de restriction (ddRAD) sur Illumina MiSeq. Financement par CRSNG à EGB et Subvention de Voyage Rollins College à FH.

Enhanced accumulation of HSP30 and 70 in Xenopus laevis A6 kidney epithelial cells treated simultaneously with low concentrations of sodium arsenite and cadmium chloride

Augmentation de l'accumulation de HSP30 et HSP70 dans les cellules épithéliales A6 des reins de Xenopus laevis traitées simultanément avec une faible concentration de sodium d'arsénite et de cadmium

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Environmental stressors (e.g. heat shock, cadmium & arsenite) can induce heat shock protein (HSP) accumulation. In this study, we examined the effect, both individually and in combination, of 10, 50 and 100 μ M cadmium chloride and 10 μ M sodium arsenite on the accumulation of HSP30 and HSP70 in A6 kidney epithelial cells. The two stressors acted synergistically in inducing the accumulation of these molecular chaperones. HSF1 inhibitor (KNK437) studies determined that this phenomenon was controlled at the transcriptional level. Also, immunocytochemistry revealed that stressor-induced HSP30 accumulation was detectable in the cytoplasm in a punctate pattern with minimal changes in the actin cytoskeleton. Finally, addition of a mild heat shock further enhanced HSP accumulation induced by combined chemical treatments, suggesting that these stressors can act synergistically. These findings are of importance since aquatic organisms in the natural environment are occasionally exposed to a variety of environmental and chemical stressors simultaneously. (Supported by NSERC)

Distinct patterns of HSP30 and HSP70 degradation in Xenopus laevis A6 cells recovering from thermal stress

Observation de patrons distincts de dégradation du HSP30 et HSP70 dans les celulles de Xenopus laevis récupérant d'un stress thermique

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Heat shock proteins (HSPs) are molecular chaperones that assist in protein synthesis, folding and degradation and prevent stress-induced protein aggregation. In this study, we examined the pattern of accumulation of HSP30 and HSP70 in A6 cells recovering from thermal stress. Cells were incubated at 33 °C followed by a recovery period at 22 °C from 2 to 96 h. Immunoblot analysis and immunocytochemistry revealed elevated levels of HSP30 up to 72 h recovery. However, the relative levels of HSP70 declined to near control levels after 24 h. Additionally, both hsp30 and hsp70 mRNAs were detected up to 24 h of recovery. Pre-treatment of cells with cyclohexamide, a translational inhibitor, produced a rapid decline in HSP70 but not HSP30. The cyclohexamide associated decline of HSP70 was blocked by MG132, a proteasomal inhibitor. This study suggests that HSP70 is degraded more rapidly than HSP30 by the ubiquitin-proteasome system. (Supported by NSERC)

Some like it hot! – Temperature biology of shortnose sturgeon (*Acipenser brevirostrum*).

Certains l'aiment chaud! – Thermobiologie de l'esturgeon à museau court (*Acipenser brevirostrum*)

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Over the past few years, our lab has been investigating the effects of acclimation temperature on the metabolic rate, swimming capacity and thermal tolerance of shortnose sturgeon. A summary of these findings and the future direction(s) of student research projects will be highlighted. Research Funding : NSERC

Habitat quality affects the physiological condition of largemouth bass (*Micropterus salmoides*)

La qualité de l'habitat affecte l'état physiologique des achigans à grande bouche (*Micropterus salmoides*)

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Degradation of freshwater ecosystems has led to an increase in projects across North America aimed at improving habitat quality. The success of many of these efforts at achieving restoration goals has not been quantified. The use of physiology allows us to evaluate restoration and habitat quality by relating the health of resident fish to environmental quality. The current project uses blood-based physiological metrics to quantify health of largemouth bass residing in tributaries of the St. Lawrence River across a range of habitat qualities. Results show largemouth bass health varies with habitat quality, with significant relationships between total antioxidant capacity ($p = 0.0004$), triglyceride concentrations ($p = 0.0005$) and habitat quality. Together, results indicate that physiological metrics are reflective of habitat quality and can be used as an assessment thereof.

La dégradation des écosystèmes d'eau douce a conduit à une augmentation des projets en Amérique du Nord visant à améliorer la qualité de l'habitat. Le succès d'un grand nombre de ces efforts à la réalisation des objectifs de restauration n'a pas été quantifié. L'utilisation de la physiologie nous permet d'évaluer la qualité de la restauration et de l'habitat en mettant en relation la santé des résidents de poisson à la qualité de l'environnement. Notre projet utilise les paramètres physiologiques du sang pour quantifier la santé des achigans à grande bouche résidant dans les affluents du fleuve Saint-Laurent dans des divers qualité de l'habitat. Les résultats montrent que la santé des achigans à grande bouche varie en fonction de la qualité de l'habitat, avec des relations significatives entre la capacité totale antioxydante ($p = 0,0004$), les concentrations de triglycérides ($p = 0,0005$) et la qualité de l'habitat. Ensemble, les résultats indiquent que les paramètres physiologiques reflètent la qualité de l'habitat et peut être utilisé comme une évaluation de celle-ci.

**Lake trout *Salvelinus namaycush* (Walbaum, 1792) habitat use and growth in an arctic estuarine environment
Utilisation de l'habitat et croissance chez le Touladi, *Salvelinus namaycush* (Walbaum, 1792), dans un estuaire arctique**

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Lake trout are considered the least saline tolerant member of the Salmonidae family. Recent studies however, show lake trout have limited salinity tolerance and do utilize saline environments. This study aims to understand the adaptive capacity of lake trout to use an Arctic estuary, focusing on duration, frequency, and age in relation to growth. Lake trout were sampled from Husky Lakes, NT by local Tuktoyaktuk and Inuvik subsistence anglers in water ranging from 0-13psu. Lake trout otoliths were removed and sectioned for age estimates and growth increment analysis (age range 5-57yrs). Fulton's Condition Factor indicated two growth patterns, mean $K=2.2$ (fat) and $K=1.12$ (thin). Otolith elemental profiles were obtained to assess lake trout movement and habitat use (increased strontium correlates to increased salinity in ambient water). Strontium profiles indicate use of varying salinities and identify

two distinct life histories. Mean nucleus strontium shows a fourfold difference between the lowest (293.58ppm) and highest (1981.05ppm) individuals, suggesting potential use of multiple spawning habitats.

The effect of thermal acclimation on the functional properties of the isolated trout heart

L'effet de l'acclimatation thermique sur les propriétés fonctionnelles du cœur de truite isolé

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¹*University of Guelph*

Thermal acclimation of male trout to the extremes of their temperature range results in two distinctive cardiac phenotypes. Cardiac hypertrophy is observed in the cold acclimated fish along with an increase in connective tissue and a decrease in the thickness of the compact myocardium. The opposite occurs with warm acclimation. These opposing effects of cold and warm acclimation suggest that male trout can reversibly remodel the morphology and cellular composition of the heart. How such changes influence the contractility and compliance of the trout heart are not known. We hypothesized that the increase in connective tissue in cold acclimated males would cause stiffening of the ventricle. Using a Langendorff preparation we found that cold acclimation caused an increase in ventricular developed pressure with no change in chamber stiffness, compared to warm acclimated hearts. Therefore, remodeling of myocardial layers may have more of a functional consequence than cellular remodeling.

Fecundity and oocyte development of round goby in Lake Michigan

Fécondité et développement des ovocytes de gobie à taches noires dans le lac Michigan

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¹*University of Illinois*

The round goby (*Neogobius melanostomus*) is a species within a large, tolerant and prolific family of fishes, Gobiidae, and has proven to be a successful invader of the Laurentian Great Lakes over the past two decades. Among the many reasons for the success of this invasive species are behavioral and physiological factors that allow round goby to rapidly expand their range. Although much research has been devoted to the ecological impacts and behavior of round goby, their basic reproductive biology in invaded systems has been understudied. We evaluated fecundity and described oocyte developmental stages within a wide range of round goby sizes in southwestern Lake Michigan. Spawning peaks were different between sites and correlated with temperatures of 14-17°C. Monthly average egg counts were largely unchanged throughout reproductive season (May-September) which is indicative of continuous development and maturation of several oocyte batches during a protracted spawning period.

Brown fat and uncoupling protein 1: the evolution and function of a heater organ in mammals

Graisse brune et protéine de découplage 1: évolution et fonction d'un organe thermogène chez les mammifères

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Brown fat is a specialized heater organ in Eutherian mammals. Brown adipocytes waste energy by UCP1 mediated uncoupling of mitochondrial oxidative phosphorylation. It has been speculated that the development of brown fat as a new source for non-shivering thermogenesis provided mammals with an advantage in the cold. Brown fat and UCP1 are found in ancient groups of mammals, like the Afrotherians and some Marsupials, but UCP1 orthologs are also present in bony fishes and Amphibians devoid of brown fat. Our present knowledge suggests that UCP1 only gained thermogenic function in brown adipocytes of Eutherian mammals. Evolution of thermogenic function required expression of UCP1 in a suitable cell type equipped with high mitochondrial density in a well vascularized tissue. Brown adipocyte-like cells in white adipose tissue (brite) may resemble the archetypical brown adipocyte in vertebrate evolution. It is therefore of interest to elucidate the molecular mechanisms of brite adipogenesis.

Sex, eicosanoids and zebrafish: Increased expression of eicosanoid synthesizing enzymes during hormone-induced ovulation and spawning in the zebrafish

Sexe, eicosanoïdes et poisson zèbre: expression accrue des enzymes eicosanoïdes lors de l'ovulation et la ponte induite par administration d'hormone

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While eicosanoids are known to be essential to ovulation and spawning in fishes, their specific role is poorly understood. This study investigated the role of eicosanoids by profiling mRNA expression of enzymes in the eicosanoid biosynthesis pathway (EEBPs) during those events in the zebrafish. An in vivo exposure to the maturation-inducing hormone 17- α , 20- β -dihydroxy-4-pregnen-3-one was used to induce ovulation, but not spawning, in solitary females, and spawning in mixed sex pairs. Real-time PCR revealed a significant increase in the mRNA expression of cytosolic phospholipase A2 and cyclooxygenase 2, enzymes that liberate the eicosanoid precursor arachidonic acid and synthesize prostaglandins respectively, in periovulatory ovaries of solitary females. Ongoing research will reveal if mRNA expression of EEBPs is elevated in post-ovulatory ovaries of non-spawning fish and how these findings compare to fish proceeding to spawning. This work will clarify the role of eicosanoids in the culminating events of female zebrafish reproduction.

Differential gene expression of candidate genes for growth in rainbow trout derived from two seasonal spawning groups

Expression différentielle de gènes candidats à la croissance de la truite arc-en-ciel chez deux populations de géniteurs

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Gene expression profiles in the liver and white muscle of large and small juvenile rainbow trout (*Oncorhynchus mykiss*) from two seasonal spawning lots were compared. Sampling season had a significant effect on expression profiles. A much higher proportion of genes in muscle compared to liver showed similar patterns of up- or down-regulation within the same size class across lots suggesting their utility as biomarkers for growth. Significant differences in GO Generic Level 3 categories of ‘response to external stimulus’, ‘establishment of localization’, and ‘response to stress’ were detected in muscle between large and small fish. Larger fish showed up-regulation of cytoskeletal component genes while genes related to myofibril components of muscle were more up-regulated in small fish. Most of the genes up-regulated in large fish with the ‘response to stress’ category are involved in immunity while in small fish most of these gene functions are related to apoptosis.

The tricellular tight junction protein tricellulin contributes to the regulation of gill epithelium integrity and paracellular permeability

La protéine de jonction serrée tricellaire tricellulin contribue à la régulation de l'intégrité de l'épithélium des branchies et à la perméabilité paracellulaire.

¹Dennis Kolosov, ¹Scott P Kelly

¹York University

The apical-most region of cell-to-cell contact in a vertebrate epithelium is the tight junction (TJ) complex. The TJ complex can be bicellular (bTJ, connect two adjacent cells) or tricellular (tTJ, connect cells at regions of tricellular contact). Tricellulin (TRIC) is a transmembrane tTJ protein. Rainbow trout TRIC was cloned and sequenced, and TRIC mRNA was broadly expressed in discrete tissues. In a primary cultured trout gill epithelium, TRIC localized to tTJs and TRIC protein abundance increased in association with corticosteroid-induced reductions in paracellular permeability. Sodium caprate was used to compromise cultured gill epithelium integrity by disrupting the tTJ complex. This caused a displacement of TRIC from tTJs, resulting in a reduction in transepithelial resistance and an increase in paracellular permeability. Data support the view that tTJs and the tTJ protein TRIC (i) play a role in maintaining gill epithelium integrity and (ii) contribute to the regulation of gill epithelium permeability.

Expression patterns of gill tight junction proteins during formation and development of primary cultured gill epithelia

Profils d'expression des protéines de jonctions fermes pendant la formation et le développement d'une culture primaire d'épithélium branchial

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The presence of tight junctions (TJs) at the apico-lateral interface between neighboring cells is one characteristic of a mature vertebrate epithelium. TJs are composed of TJ proteins that include members of the MARVEL domain-containing subfamily of proteins (e.g. occludin and tricellulin), claudins, as well as cortical scaffolding proteins (e.g. ZO-1 and cingulin). Therefore TJ proteins play an integral role in epithelial formation, development, differentiation as well as the maintaining tissue integrity. Several TJ proteins in fish gills exhibit altered abundance in association with environmental or systemic change, and some are proposed to influence gill epithelium permeability. However, the molecular physiology of the fish gill TJ complex has yet to be examined during gill epithelium formation and development. This study reports on changes in TJ protein gene expression in primary cultured rainbow trout gill epithelia during the establishment of confluence and as well as during the development of resistance (permeability) properties.

La présence de nexus à l'interface apico-latérale entre les cellules voisines est une caractéristique d'un vertébré épithélium mature. Les nexus sont composées de protéines qui incluent des membres de la sous-famille de protéines qui contient le domaine MARVEL (par exemple occludine et tricellulin), claudines, ainsi que des protéines d'échafaudage corticales (p. ex. ZO-1 et cingulin). Par conséquence, les protéines de nexus jouent un rôle essentiel dans la formation, le développement, et la différenciation de l'épithélium ainsi que le maintien de l'intégrité des tissus. Plusieurs protéines de nexus dans les branchies des poissons présentent l'abondance modifiée en association avec les changements environnementaux ou systémique, et certains sont proposés à influencer la perméabilité épithélium des branchies. Cependant, la physiologie moléculaire du complexe nexus des branchies des poissons n'a pas encore été examiné lors de la formation et développement du épithélium des branchies. Cette étude utilise la culture des cellule primaire pour rendre compte des changements dans l'expression des gènes des protéines nexus dans l'épithélium branchial de la truite arc au cours de la mise en place de confluence et ainsi que lors de l'apparition d'une résistance (perméabilité) des propriétés.

Effect of age and temperature on the calling behaviour of Western bean cutworm (*Striacosta albicosta*) females

Effet de l'âge et de la température sur le comportement de vocalisation des femelles du Ver-gris occidental du haricot (*Striacosta albicosta*)

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The western bean cutworm (WBC), an important agricultural pest, has recently expanded its' range eastward into the Great Lakes region, but artificial pheromones used in pest management programs are not useful in predicting damage levels. As we know nothing about the pheromone mediated reproductive biology of this species, we undertook studies to look at the effects of temperature and age on the calling behaviour (pheromone emission) of virgin females. Sexual maturation always occurred several days after emergence and the pre-calling period length was affected by temperature. The patterns of calling behaviour (onset and duration) changed as a function of female age, but were not affected by the temperatures tested. The delayed sexual maturation supports the hypothesis that the WCB is a migrant species, while the absence of temperature effects on calling behaviour is probably due to the fact that adults of this univoltine insect are present in mid-summer.

Turbulent waters: host-parasite interactions in a changing world

Eaux turbulentes : interactions hôte-parasite dans un monde en plein changement

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Emerging infectious diseases are of major concern, with environmental changes playing a significant role. Because hosts and parasites are both affected by their environment, perturbations can lead to disease changes. Here I focus on four main themes regarding alterations of host-parasite-environment relationships: 1) parasite encounter rate by hosts, 2) host resistance to infection, 3) host tolerance of infection, and 4) effects on parasites themselves. Owing to their often complex life cycles, macroparasites may be particularly affected by perturbations and serve as the focal point. Influences of landscape and climate change on host encounter of trematodes are discussed, as well as the importance of host behaviour for resistance to infection. The context-dependency of host tolerance to infection is emphasized, particularly multiple stressor effects on host pathology and within-host parasite replication. Gaps in knowledge are highlighted to address both future avenues of research regarding altered host-parasite-environment interactions, as well as possible implications.

Movements of listed Grass Pickerel *Esox americanus vermiculatus* in an agricultural drain and the implications for drain maintenance.

Mouvements du brochet vermiculé *Esox americanus vermiculatus* dans un drain agricole: implications pour l'entretien des drains

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We combined PIT tags and multi-state models to quantify the movements of Grass Pickerel *Esox americanus vermiculatus* in response to experimental drain maintenance (dredging) in Beaver Creek, an agricultural drain near Fort Erie, ON. Grass Pickerel is listed as a species of special concern under Canada's Species at Risk Act. Parts of Beaver Creek require maintenance to restore drainage function. Our study focused on movement because of its importance to the ecology and life history of stream fishes. Over 2000 Grass Pickerel have been PIT tagged since 2009 and their movements monitored at seven antenna arrays installed across 13 kilometres of Beaver Creek. Multi-state models suggest that daily survival of Grass Pickerel was high in all stream sections, but movement between sections varied along the stream course. Our findings will contribute to the development of management practices that balance the needs of the agricultural community and fish habitat managers.

Nous avons combiné les marquages PIT et des modèles multi-états pour quantifier les mouvements de brochet vermiculé (*Esox americanus vermiculatus*) en réponse à l'entretien des drains expérimental (dragage) à Beaver Creek, un drain agricole près de Fort Erie, ON. Brochet vermiculé est répertorié comme une espèce préoccupante vertu de la loi sur les espèces en péril Canadienne. Un entretien pour rétablir la fonction de drainage est nécessaire en pièces de Beaver Creek. Notre étude a porté sur le mouvement en raison de son importance dans l'histoire l'écologie et la vie de poissons des cours d'eau. Plus de 2000 brochet vermiculé ont été marquer PIT depuis 2009 et leurs mouvements suivis utilisant sept réseaux d'antennes installées à travers 13 kilomètres de Beaver Creek. Modèles multi-états suggèrent que la survie quotidienne de brochet vermiculé était élevé dans toutes les sections de cours d'eau, mais le mouvement entre les sections varie le long du parcours flux. Nos résultats contribueront à l'élaboration de pratiques de gestion qui tiennent compte des besoins de la communauté agricole et les gestionnaires de l'habitat du poisson.

Ca²⁺ homeostasis in acid: A novel function of the transcription factor, glial cell missing 2

L'homéostasie du Ca²⁺ dans l'acide: Une nouvelle fonction du facteur de transcription glial cell missing 2

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Whereas renal tubular acidosis is recognized as a cause of hypercalciuria in mammals, the consequences of acid-exposure on Ca²⁺ homeostasis in acid-tolerant aquatic animals remain poorly described. In this study, we investigated the consequences of acid-exposure on Ca²⁺ balance in zebrafish larvae. Although mRNA expression of epithelial calcium channel (ECaC) was significantly elevated in acid-exposed zebrafish, acid-exposure still significantly reduced Ca²⁺ uptake and whole body Ca²⁺ content, suggesting the inhibition of effective Ca²⁺ uptake via ECaC. Interestingly, when glial cell missing 2 (gcm2), a transcription factor known to play a role in differentiation of acid-secreting ionocytes in zebrafish and whose expression is elevated following acid-exposure, was knocked down, fish exhibited significantly lower Ca²⁺ uptake rates, Ca²⁺ content and levels of ECaC expression. On the contrary, overexpression of gcm2 significantly elevated Ca²⁺ uptake. These results imply an important role of gcm2 in minimizing the Ca²⁺ balance disruption in acid-exposed zebrafish larvae.

How to prevent salt overload: A role for hydrogen sulfide in inhibiting Na⁺ uptake by freshwater fish

Comment prévenir un surplus de sel: Le rôle du sulfide d'hydrogène dans l'inhibition d'absorption de Na⁺ chez les poissons d'eaux douces

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Although many physiological mechanisms for stimulating uptake of Na⁺ by freshwater (FW) fish have been identified, mechanisms to reduce uptake of Na⁺, which are equally important to defend overall Na⁺ homeostasis, remain poorly described. In the present study, we identified the gasotransmitter hydrogen sulfide, as a potent inhibitor of Na⁺ uptake in zebrafish larvae. Waterborne exposure to sodium sulfide (HS donor) inhibited Na⁺ uptake in a dose-dependent manner. Consistent with an inhibitory role of H₂S, exposure to inhibitors of endogenous H₂S synthesizing enzymes prevented the reduction in Na⁺ uptake following acclimation to high [Na⁺] media. Morpholino-knockdown of cystathione gamma synthase (CSE) also increased uptake of Na⁺ in control water. Additionally, CSE was localized to a subset of ionocytes in developing zebrafish. These results strongly indicate a novel role of H₂S in osmoregulation in FW fish.

Stocking decreases major histocompatibility (MH) allele diversity in populations of ontario lake trout (*salvelinus namaycush*)

L'ensemencement diminue la diversité allélique du complexe majeur d'histocompatibilité dans les populations du touladi (*Salvelinus namaycush*) en Ontario

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Prior genetic studies of lake trout (*Salvelinus namaycush*) have used multiple neutral genetic marker systems including allozymes, microsatellites and mitochondrial DNA (mtDNA) to distinguish multiple glacial refugia and phylogeographic lineages within North America. Lake trout are a glacial ‘relict’ species with an extensive distribution across North America. This project differentiated lake trout populations within Ontario using a non-neutral marker, the major histocompatibility (MH) class II beta gene. Native, mixed ancestry and hatchery lake trout populations have been characterized for MH diversity and allelic states to assess their diversity and divergence. From this, a geographic map of MH diversity within each lake is being compared to previous studies that relied on neutral markers. The introgression of MH class II beta alleles within the mixed-ancestry populations and the significance of adaptive genetic diversity within and among populations from different histories will be important for the management of the stocks of lake trout.

Des études génétiques de touladis (*Salvelinus namaycush*) ont utilisé plusieurs systèmes de marqueurs neutres génétiques, y compris les allozymes, microsatellites et l'ADN mitochondrial (ADNmt) pour distinguer plusieurs refuges glaciaires et les lignages phylogéographiques en Amérique du Nord. Le touladi est une espèce «relique» glaciaire ayant une vaste distribution en Amérique du Nord. Ce projet a différencié les populations de touladi en Ontario à l'aide d'un marqueur non-neutre, le gène de classe II, le complexe majeur d'histocompatibilité (MH). Les populations de touladis natifs, d'ascendance mixte et d'écloserie ont été caractérisées pour MH diversité et les états alléliques pour évaluer leur diversité et divergence. De là, une carte géographique de la diversité MH au sein de chaque lac est en cours d'être comparé aux études précédentes qui s'appuyaient sur des marqueurs neutres.

L'introgression des allèles de classe MH bêta II au sein des populations d'ascendance mixte et l'importance de la diversité génétique adaptative au sein et entre les populations des différentes histoires sera important pour la gestion des stocks de touladi.

Involvement of the calcium-sensing receptor in the regulation of calcium homeostasis in developing zebrafish
Rôle du récepteur sensible au calcium dans la régulation de l'homéostasie en calcium chez des poissons-zébrés en développement

¹Raymond Kwong, ¹Dan Auprix, ¹Steve Perry

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The potential role of calcium-sensing receptor (CaSR) in the regulation of Ca²⁺ homeostasis was investigated in developing zebrafish, *Danio rerio*. Results from in situ hybridization and immunohistochemistry suggest that CaSR is expressed in the brain, neural tube and neuromasts during early stage of development. Additionally, the CaSR protein was expressed on the skin of yolk sac, a major site of ionic-regulation in developing zebrafish. Using a translational gene knockdown approach, we demonstrated that Ca²⁺ uptake and whole-body Ca²⁺ levels (in low Ca²⁺ water) were reduced in fish lacking the CaSR. Notably, fish experiencing CaSR knockdown had a reduced ability to increase the expression of the epithelial Ca²⁺ channel (ECaC) during exposure to low-Ca²⁺ water. These findings indicate that in a low Ca²⁺ environment, the CaSR is essential in maintaining Ca²⁺ homeostasis in developing zebrafish.

A test of the osmorespiratory compromise in goldfish (*Carassius auratus*).

Un test du compromis osmo-respiratoire chez le cyprin doré (*Carassius auratus*)

¹Raymond Kwong, ¹Velislava Tzaneva, ¹Steve Perry

¹University of Ottawa

Fresh water fish must develop a functional gill surface area low enough to minimize ion loss but large enough for sufficient transfer of gases across the gill epithelia. Here we perform a test of the osmorespiratory compromise using goldfish acclimated to 25°C. Decreasing the gill surface area via gill arch ligation by ~25% caused a significant drop in efflux but not influx of Na⁺ resulting in an overall significant increase in net flux. This decrease in surface area significantly impeded oxygen uptake (MO₂). Further reduction of the gill surface area by~50% resulted in a drop in both Na⁺ influx and efflux when compared to control fish and an even greater decline in MO₂. Experiments are currently underway to determine whether increasing ionocyte numbers and/or Na⁺/K⁺ ATPase activity of the remaining gill arches contribute to sustaining Na⁺ uptake after gill arch ligation.

Poissons d'eau douce doivent développer une surface branchies fonctionnelle suffisamment petite pour minimiser la perte d'ions, mais assez grande pour un transfert suffisant des gaz. Ici, on teste le compromis osmo-respiratoire en utilisant des cyprins dorés acclimatés à 25°C. La diminution de la surface des branchies par des ligatures de l'arc branchial par ~ 25% a provoqué une baisse significative dans l'efflux de Na⁺ mais pas l'afflux entraîne une augmentation significative du flux net. Cette diminution de la surface branchie a entraîné la consommation d'oxygène (MO₂). Une réduction supplémentaire de la surface des branchies d'environ 50% a entraîné une baisse à la fois l'afflux de Na⁺ et l'efflux par rapport aux poissons témoins et un déclin encore plus important dans MO₂. Des expériences sont en cours pour déterminer si un nombre croissant d'ionocyte et/ou l'activité de Na⁺/K⁺-ATPase des arcs branchiaux qui restent contribuent à soutenir l'absorption de Na⁺ après la ligature des arcs branchiaux.

Influence of demographic parameters on patterns of local adaptation in terrestrial rabies vectors

Influence de paramètres démographiques sur les modes d'adaptation locaux des vecteurs de la rage en milieu terrestre

¹Christopher Kyle

¹Trent University

A goal of population genetic and evolutionary biology research is to understand interrelationships between genes and local adaptation. One approach towards understanding the potential for adaptation to disease is to examine correlations between the geographic distribution of host immunogenetic variation, disease variants, and demographic parameters that also influence the distribution of adaptive and non-adaptive genetic variation. Using raccoon rabies and its vectors as a model system, we sought to understand the capacity for host local adaptation in response to a disease epizootic by examining adaptive and innate immunity genes in raccoon populations. Comparisons of immunogenetic and neutral genetic data were suggestive of local adaptation in raccoons, however, the contribution of specific rabies strains to these patterns was less clear. Our data suggest that rapid population expansions, extensive

gene flow, and high Ne in these disease vectors likely undermine their ability to locally adapt to selective pressures such as those imposed by rabies.

Un des objectifs de la recherche en biologie génétique des populations et l'évolution est de comprendre les interrelations entre les gènes et l'adaptation locale. Une approche pour comprendre le potentiel d'adaptation à la maladie est d'examiner les corrélations entre la distribution géographique de la variation immunogénétique hôte, variantes de maladies, et les paramètres démographiques qui influent également la distribution de la variation génétique adaptive et non-adaptatif. Utilisons la rage du raton laveur et ses vecteurs en tant que système modèle, nous avons cherché à comprendre la capacité d'adaptation local à l'hôte, en réponse à une épizootie en examinant gènes de l'immunité adaptive et innée chez les populations de rats laveurs. La comparaison des données génétiques immunogénétique et neutres suggéraient une adaptation locale chez les rats laveurs, cependant, la contribution de certaines souches de la rage à ces modèles est moins clair. Nos données suggèrent que l'expansion rapide de la population, la flux de gènes, et l'haute valeur de Ne dans ces vecteurs de maladies probablement qu'à miner leur capacité à adapter localement à des pressions sélectives telles que celles imposées par la rage.

**Cardiovascular responses to high altitude hypoxia in bar-headed geese (*Anser indicus*) and related waterfowl
Les réponses cardiovasculaires à l'hypoxie en haute altitude chez l'oie à tête barrée (*Anser indicus*) et autre sauvagine**

¹Sabine L. Laguë, ¹Beverly Chua, ¹Anthony P. Farrell, ²Yuxiang Wang, ¹William K. Milsom

¹University of British Columbia, ²Queens University

Previous studies have reported interspecific differences in respiratory responses and hematological variables between bar-headed and barnacle geese that may partially account for the remarkable biannual high altitude migration of bar-headed geese. Our study extended this work to the hypoxic cardiovascular response (HCVR), the cardiorespiratory maintenance of oxygen delivery to the tissues in hypoxia, and examined its intra- and interspecific plasticity. Our studies were conducted on wild bar-headed geese caught at 3200m, held captive at 3200m and domestic birds at 0m, as well as domestic barnacle geese at 0m. All birds were exposed to graded hypoxia while cardiovascular (heart rate, cardiac output, blood pressure, peripheral resistance), respiratory (breathing frequency and tidal volume), and metabolic (oxygen consumption and CO₂ production) variables were measured. We have now fully characterized the HCVR of these birds and document novel intraspecific differences between bar-headed goose populations, most notably a blunted HCVR in the high altitude birds.

Genetic variation and potential sources of the non-native sea squirt *Botryllus schlosseri* in Newfoundland**Variation génétique et origines potentielles du tunicier non indigène *Botryllus schlosseri* à Terre-Neuve**¹Ainsley Latour, ¹Dawn Marshall, ¹Don Deibel¹Memorial University of Newfoundland

Non-indigenous species are a significant economic problem for the aquaculture industry worldwide. One of these species, *Botryllus schlosseri*, has reached invasive levels in mainland Canada. This species is established in Newfoundland, despite differences in ocean climate compared to its native range. The invasion front of a non-native species can provide direct insight into the evolutionary and anthropogenic factors driving range expansion. Although shipping vectors are the primary source of introduction of non-native tunicates, the long term viability of founding populations may be influenced by the source(s), and genetic composition of introduced populations. The goals of my research are to utilize mitochondrial sequence data to i) characterize the genetic variation of *B. schlosseri* in Newfoundland, and ii) to infer potential source(s). Results of this research will aid in the development of management strategies for non-native tunicates, with the ultimate goal of maintaining the economic sustainability of the aquaculture industry in Canada.

Mitochondrial function varies with hypoxia tolerance in intertidal sculpins**La fonction mitochondriale varie avec la tolérance à l'hypoxie chez *Oligocottus***¹Gigi Lau, ¹Milica Mandic, ¹Jeffrey Richards¹University of British Columbia

Variations in oxygen availability can affect the ability of mitochondria to generate ATP which can have major consequences on cellular energy balance. Intertidal sculpins (fish from the family Cottidae) in the higher intertidal experience wide daily fluctuations in oxygen levels and have greater hypoxia tolerance, whereas species in the subtidal rarely experience hypoxia and thus have lower hypoxia tolerance. In 10 normoxia-acclimated sculpin species, we investigated whether the ability to tolerate low O₂ is related to brain and liver mitochondrial function. Our results show that hypoxia tolerant species have higher brain cytochrome c oxidase (COX) activity than in intolerant species. In both brain and liver, COX from tolerant species has a lower Km for O₂ and thus higher O₂ binding affinity. The higher COX activity and lower Km would presumably improve mitochondrial function of tolerant species under severe environmental hypoxia so that aerobic energy production is maintained.

Renal Excretory Responses to Metabolic Acidosis in the Goldfish *Carassius auratus***Excrétion rénale en réponse à l'acidose métabolique chez le poisson rouge, *Carassius auratus***¹Michael James Lawrence, ²Pat Wright, ¹Chris Wood¹McMaster University, ²University of Guelph

Teleosts excrete nitrogenous waste primarily as ammonia. Ammonia excretion has been traditionally paired with sodium uptake at the gills and these fluxes have been demonstrated to increase in magnitude under acidosis, permitting acid-base regulation. The recent discovery of Rhesus glycoproteins in the gills of teleost fish has worked to resolve some of the longstanding issues involved with ammonia/sodium transport. These proteins act as facilitated ammonia transporters that are often co-localized with sodium transport proteins. While the gill has been investigated to a great extent, the kidney has largely been ignored. We are investigating the mechanisms by which renal ammonia transport into the urine occurs and its importance in acid-base regulation and sodium recovery. *Carassius auratus* fitted with urinary catheters have been exposed to water pH's of 4.0 and 8.2 for up to 3 days, and changes in various urinary and plasma parameters determined (NSERC Discovery, CRC Program).

**Detoxification of the pesticide 3-trifluoromethyl-4-nitrophenol (TFM) in non-target rainbow trout (*Oncorhynchus mykiss*) and lake sturgeon (*Acipenser fulvescens*) and their effects on metabolite stores
Désintoxication du pesticide 3-trifluorométhyl-4-nitrophénol (TFM) chez la truite arc-en-ciel (*Oncorhynchus mykiss*) et l'esturgeon jaune (*Acipenser fulvescens*), deux espèce non-ciblée, et l'effet sur leur ressources métaboliques**

¹Clair, Michael Le Clair, ¹Michael Wilkie

¹Wilfrid Laurier University

The invasion of the Great Lakes by the sea lamprey (*Petromyzon marinus*) in the early 20th century decimated commercial and recreational fish communities. Extensive investigation, however, revealed that the chemical 3-trifluoromethyl-4-nitrophenol (TFM) selectively targeted larval lampreys in their nursery streams. The greater sensitivity of lamprey to TFM is due to their inability to detoxify TFM by bio-transforming it to TFM-glucuronide compared to other fishes. However, ecologically sensitive lake sturgeon may also be TFM sensitive. This study tested the hypothesis that the sturgeon's greater TFM sensitivity is due to a limited detoxification capacity. Accordingly, trout and lake sturgeon were exposed to TFM, and subsequent analysis using HPLC revealed that lake sturgeon detoxified TFM using glucuronidation, but they have a reduced capacity to use this pathway of detoxification compared to trout. As a result, TFM leads to a greater perturbation of metabolic energy stores in these animals.

L'invasion des Grands Lacs par la lampoie marine (*Petromyzon marinus*) au début du 20e siècle a décimé les communautés de poissons commerciaux et récréatifs. Une enquête approfondie a toutefois révélé que les lampoies larvaires dans les ruisseaux de croissance sont ciblés par le produit chimique 3-trifluorométhyl-4-nitrophénol (TFM). La plus grande sensibilité de la lampoie à la TFM est due à leur incapacité par rapport aux autres poissons, à détoxifier TFM en la bio-transformation de TFM-glucuronide. Cependant, l'esturgeon jaune peuvent également être sensibles à la TFM, car elles sont plus écologiquement sensibles en générale. Cette étude a testé l'hypothèse selon laquelle la plus grande sensibilité de l'esturgeon à la TFM est due à une capacité de détoxicification limitée. En conséquence, la truite et l'esturgeon jaune ont été exposés à TFM, et l'analyse par HPLC a révélé que l'esturgeon jaune détoxifié TFM utilisant glucuronidation, mais ils ont une capacité réduite à utiliser cette voie de détoxication par rapport à la truite. En conséquence, TFM mène à une plus grande perturbation avec des réserves énergétiques métaboliques chez ces animaux.

Empirical and experimental evidence of carry-over effects on waterfowl reproduction

Évidence empirique et expérimental des effets du "carry-over" sur la reproduction des oies.

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⁴Environment Canada, ⁵University of Saskatchewan

Annual migrants use several distinct sites over their migratory cycle, and their population dynamics are affected by habitat quality encountered therein. We provide two examples that demonstrate how events occurring during migration can carry-over and affect subsequent reproduction of common eider ducks and greater snow geese, two species that partly rely on energy reserves accumulated during migration for their breeding. We first investigated the importance of stress experienced during moult on subsequent reproduction. Using path analyses, we show an indirect effect of moulting conditions on eider reproductive success through condition and timing of migration. In a second study we directly manipulated the condition of spring migrants by capturing and holding thousands of geese in captivity for up to 4 days before releasing them. Duration of captivity negatively affected their subsequent reproductive success, except in a year with unusually favourable breeding conditions. Carry-over effects can thus be modulated by environmental conditions.

How to build a fish head: Modularity of lateral line canals in *Amia calva*

Comment construire une tête de poisson : La modularité des canaux de la ligne latérale chez *Amia calva*

¹Caroline Lehoux, ¹Richard Cloutier

¹Université du Québec

Although modularity has been widely addressed on a variety of osteological systems (e.g., skull, vertebrae, fins), studies regarding modularity of soft tissues are scarce. In order to identify modules in the lateral line system, we investigated the patterning of canal bifurcation for four pairs of groups of pores in the otic canal and supratemporal cross-commissure using an ontogenetic series of 95 specimens of the basal actinopterygian *Amia calva*. Groups of pores, mostly from the supratemporal cross-commissure, were missing in half of investigated specimens. Patterning was similar for groups of pores of the otic canal. Geometric morphometrics was used to investigate a priori hypotheses of modularity on dermal bones and sensory canals. Hypothesis of modularity linking canals with bones was supported. These results suggest that modularity is: (1) present at different phenotypic hierarchical levels, (2) determined by developmental origin and region, (3) not limited to tissue type.

Three differentially expressed urea transporters in the Gulf Toadfish (*Opsanus beta*) revealed by transcriptome analysis.

Expression différentielle de trois transporteurs de l'urée chez le poisson-crabaud (*Opsanus beta*) révélée par analyse du transcriptome

¹Christophe LeMoine, ¹Adrian Pelin, ¹Nicolas Corradi, ²Danielle McDonald, ²Martin Grosell, ³Wes Warren, ²Patrick Walsh

¹University of Ottawa, ²University of Miami, University of Miami, ³Washington University

The ureotelic gulf toadfish is an important physiological model, but little genetic information is available hindering its use in molecular studies. To fill that gap, we generated the toadfish transcriptome using Illumina sequencing of four RNA libraries obtained from 17 pooled tissues of similar functions (osmoregulatory, gastro-intestinal, muscles and neural tissues). The resulting cDNA libraries were assembled and annotated, generating a complete toadfish transcriptome as well as transcripts unique to each functional libraries. Mining the transcriptome for genes of interest resulted in the identification of three different transcripts belonging to the urea transporter family (UT). Two of these genes (UT-A2 and UT-C) were previously isolated in this and other piscine species but the third gene has never been previously characterized. The three isoforms have different patterns of expression across toadfish tissues suggesting distinct physiological functions of these transporters. Funded by NSERC (PJW, NC), NSF (MDM, MG) and NIH (WW).

Le poisson-crabaud de la golfe est un modèle physiologique important, mais la faible disponibilité d'information génétique est un obstacle à son utilisation dans les études moléculaires. Pour combler ce vide, nous avons généré le transcriptome du poisson-crabaud utilisant la séquençage Illumina de quatre bibliothèques ARN obtenues de 17 tissus des fonctions similaires (osmorégulation, gastro-intestinaux, les muscles et les tissus neuronaux). Les bibliothèques d'ADNc obtenues ont été rassemblées et annotées, générant un transcriptome du poisson-crabaud complet ainsi que les produits de la transcription uniques à chacune des bibliothèques fonctionnelles. L'exploitation du transcriptome pour trouver de gènes d'intérêt aboutit à l'identification de trois produits de la transcription différentes appartenant à la famille des transporteurs d'urée (UT). Deux de ces gènes (UT-A2 et UT-C) ont déjà été isolés chez ce poisson, même si d'autres espèces piscines ont également été caractérisées. Les trois isoformes ont des modes d'expression différents dans les tissus du poisson-crabaud suggérant différentes fonctions physiologiques de ces transporteurs. Financé par le CRSNG (PJW, NC), la NSF (MDM, MG) et le NIH (WW).

How does nickel bioaccumulation relate to nickel toxicity and behavioural effects in *Oncorhynchus mykiss* and *Neogobius melanostomus* following an acute nickel exposure?

Quel est le lien entre la bioaccumulation du nickel, sa toxicité et ses effets sur le comportement chez *Oncorhynchus mykiss* et *Neogobius melanostomus* après une exposition au nickel aigüe?

¹Erin Leonard, ¹Julie Marentette, ¹Sigal Balshine, ¹Chris Wood

¹McMaster University

We investigated acute (96-h) nickel (Ni) toxicity concentrations in two freshwater fish species, the round goby (*Neogobius melanostomus*) and rainbow trout (*Oncorhynchus mykiss*) and compared these values with Critical Body Residue Values (CBR50) determined for various organs. Although there was a 1.8 fold difference in acute toxicity values between the two species, there was no significant difference between CBR50 values in the gills. Round gobies were sensitive to Ni exposure where a significant decline in movements per minute correlated to the lowest observable effect concentration (LOEC), at least 13 fold below the acute toxicity concentration. The behavioral effect of acute Ni exposure on rainbow trout was unclear. We also determined whether a physiological endpoint such as bioaccumulation could be linked to the ecological endpoint of behaviour within and across species. (NSERC Strategic Grant, Rio Tinto Alcan, Environment Canada).

Implications of metal toxicity (copper and nickel) in the *Hyalella azteca* species complex

Les implications de la toxicité du cuivre et du nickel dans le complexe d'espèces *Hyalella azteca*

¹Jessica Leung, ¹Jonathan D.S. Witt, ²Warren Norwood, ³D. ¹George Dixon

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Hyalella azteca, an amphipod crustacean, is frequently used in freshwater toxicity tests involving metals, organics and sediments. Numerous organizations have collected and established cultures of *Hyalella azteca* originating from localities across North America. However, *Hyalella azteca* is actually a large cryptic species complex whose members satisfy both the biological and the phylogenetic species concepts. The potential use of different species in this complex may explain some of the variability among toxicity test results obtained from different laboratories. In this study, one small and two large-bodied lineages were delineated using DNA barcoding. These lineages of *H. azteca* were exposed to two-week-long single metal toxicity tests using copper or nickel. Differences in survival and growth between lineages exposed to copper or nickel were observed. In addition, differences between clades were determined in juvenile survival as well as production despite having been cultured in the same laboratory conditions and water. The result of this study concluded that genetically characterized cultures of *H. azteca* should be used in toxicity tests.

Examination of innate immune receptor-mediated control of phagocytosis in fish

Évaluation du rôle des récepteurs de l'immunité innée dans le contrôle de la phagocytose chez le poisson

¹Dustin M.E. Lillico, ¹Myron Zwozdesky, ¹Herman D. Cortes, ¹Allen O'Brien, ¹Joshua G. Pemberton, ¹John P. Chang, ¹James L. Stafford

¹University of Alberta

Phagocytosis, the internalization of particulate antigens by immune cells, is an ancient metazoan defense mechanism vital for protection from pathogens. Recognition of extracellular pathogens by surface receptors triggers intracellular signaling events that initiate the phagocytic machinery. Many immunoregulatory receptor-types control phagocytosis and our lab studies this complex process using the channel catfish (*Ictalurus punctatus*) leukocyte immune-type receptor (IpLITR) family as an immune receptor model. In particular, IpLITR1.1b is an immunoregulatory receptor containing canonical inhibitory motifs, while IpLITR2.6b represents a classical stimulatory IpLITR-type. Predictably, IpLITR2.6b induces phagocytosis by activating protein kinase-mediated signaling pathways. Interestingly, although previously shown to facilitate protein phosphatase-dependent inhibitory functions, IpLITR1.1b unexpectedly initiates phagocytosis. This surprising result reveals functional duality in the immune cell functions mediated by immunoregulatory receptor families. Our research is focused on understanding the mechanisms of IpLITR-mediated phagocytosis as well as further exploration of IpLITR-dependent functional plasticity. (Supported by NSERC and Alberta Innovates Technologies Futures).

Temperature imprinting of muscle morphology and swim performance of juvenile Chinook salmon

L'empreinte de la température sur la morphologie musculaire et les performances de nage des saumons Chinook juvéniles

¹Dan Lim, ¹Yolanda Morbey, ¹Louise Milligan

¹Western University

Water temperature is a key environmental factor that influences fish growth and muscle morphology. I tested whether temperature-induced changes in muscle morphology also affect swim performance of juvenile Chinook salmon (*Oncorhynchus tshawytscha*). Embryos were reared at three temperatures (7, 10, and 15°C) until emergence, and then at a common temperature (10°C) for 300 degree days. Fish reared at 15°C had the smallest mean fibre diameter ($\sim 400 \pm 66 \mu\text{m}^2$ vs. $\sim 700 \pm 120 \mu\text{m}^2$ at 7°C) and the highest mean fibre density ($\sim 1800 \pm 390 \text{ fibres/mm}^2$ vs. $\sim 1100 \pm 170 \text{ fibres/mm}^2$ at 7°C). These fish also showed better swim performance (as measured a fixed velocity swim test) than those reared at 7°C after the common temperature treatment. Therefore, temperature in early life can have lasting effects on muscle morphology and swim performance which can then influence individual's fitness and survival.

Effects of contaminant metals on calcium uptake in *Daphnia pulex*

Effets de métaux contaminants sur l'apport en calcium chez *Daphnia pulex*

¹Andrew Liorti, ¹Andreas Heyland, ¹Teresa Crease

¹University of Guelph

"Many soft-water lakes and watersheds in North America and Europe are experiencing declines in calcium concentrations. This is especially concerning for taxa that are highly dependent on calcium, such as *Daphnia pulex*. Many lakes experiencing calcium-decline have already reached minimum threshold calcium concentrations in which *D. pulex* populations can survive. Furthermore, anthropogenic activities have heavily contaminated some of these lakes with metals such as copper and nickel.

In *D. pulex*, calcium homeostasis is maintained by transporter systems that are also involved in metal transport. To set the base work for studying the interaction between calcium uptake and metal toxicity we performed a series of experiments to assess calcium uptake kinetics in *D. pulex*. We will then assess whether copper and nickel interfere with calcium uptake and whether these effects are changing across an environmental calcium gradient. This will help to elucidate how multiple stressors in aquatic ecosystems affect biological function.

Spatial and temporal influences on the physiological condition of invasive silver carp

Influences spatiales et temporelles sur l'état physiologique de la carpe argentée, une espèce envahissante

¹Stephanie Liss, ²Greg Sass, ³Cory Suski

¹University of Illinois, ²Wisconsin Department of Natural Resources, ³University of Illinois

Examining the basic biology and ecology of an invasive species is essential to gain an understanding of the interaction between an organism and its environment. Silver carp are an invasive species intentionally introduced to the U.S. in the early 1970s, and are established throughout the Mississippi River Basin (MRB) in the Midwestern U.S. We quantified nutritional and stress physiological parameters in silver carp inhabiting four large rivers in the MRB over three distinct time periods. The objective was to test for relationships in silver carp nutrition and stress at broad spatial and temporal scales to link individuals to their habitats and compare across populations, for insights into factors motivating their spread and distribution. At a local scale physiological parameters were compared to habitat-related metrics. Results indicate that stress was influenced by time period, while short-term feeding and body energy reserves were both influenced by time period, treating rivers independently.

β2-microglobulin secretion in trout cell lines as a biomarker for viral infection

Sécrétion de β2-microglobuline dans des lignées cellulaires de truite comme biomarqueur d'infection virale

¹Sever Lital, ¹Nathan N.T.K. Vo, ¹Alex Raben, ¹Niels Bols, ¹Brian Dixon

¹*University of Waterloo*

β2-microglobulin (β2M) associates with the heavy chain (MHC α) on the surface of all nucleated cells. This interaction is critical for both delivery and sustained surface expression of the MH class I bound to either “self” or non-self peptides. We detect β2M in various body fluids, including the mucus of rainbow trout. In order to explore this release of β2M from cells, we studied the rainbow trout monocyte/macrophage cell line, RTS11. Cultures were exposed to either viral hemorrhagic septicemia virus (VHSV), heat-inactivated VHSV, or the viral mimic poly IC. Over 14 days western blotting was used to monitor β2M levels in the medium and MHC α levels in the cells and the results compared to untreated (control) cultures. β2M accumulated in all cultures but the levels were 2 fold higher in cultures infected with active VHSV. In these cultures the cells remain viable and MHC α levels remained constant. These results suggest that VHSV infection alters the kinetics of β2M release and β2M levels from non-invasive sites, such as skin mucus, can potentially be a marker of virus infection.

Mitigating threats to reptile populations

Atténuer les menaces pour les populations de reptiles

¹Jacqueline Litzgus

¹*Laurentian University*

Reptiles are among the most imperilled animal groups with ~20% of species threatened with extinction. Conserving their biodiversity requires scientifically tested ways to ameliorate threats. To address the threats of road mortality and habitat fragmentation, we are currently testing the effectiveness of crossing structures that maintain population permeability (ecopassages) while keeping animals off the road (fencing). To address the threats of habitat degradation and subsidized predators, we tested the effectiveness of artificial nest sites and predator-exclusion cages on nests to increase recruitment. We observed greater use than expected, high hatching success, and healthy hatchlings emerging from nests in artificial mounds. Nest temperatures, hatching success, frequency of deformities, and locomotor performance did not differ among 4 predator-exclusion treatments, but cages did impact hatchling body condition, and cages affected species differently. In concert, these and other studies in my lab are informing future conservation efforts on other species and in other locations.

A novel ancestor-descendent population approach to finding DNA markers for economically important traits to use in Atlantic salmon breeding programs

Nouvelle approche pour explorer les marqueurs génétiques commerciaux dans les programmes d'élevage du saumon de l'Atlantique

¹Lei Liu, ²Ang Keng, ²Jake Elliott, ³Matthew Kent, ³Sigbjørn Lien, ⁴Danielle Macdonald, ¹Elizabeth Boulding

¹*University of Guelph*, ²*Cooke Aquaculture Inc*, ³*Norwegian University of Life Sciences*, ⁴*Department of Fisheries and Oceans Canada*

In our study, 674 individuals from six different year classes of the Saint John's Aquacultural strain, 98 wild ancestral fish from the Tobique River, and 100 adults from a non-ancestral cultured-wild population in the Stewiacke River were genotyped for 5500 SNP markers using CIGENE's 6 K Illumina iSelectTM bead-array. On average the SNP genotypes of the St. John aquacultural strain were very similar to the Tobique River population ($F_{ST}=0.017$) but not to those of the non-ancestral wild Stewiacke population ($F_{ST}=0.082$). ARLEQUIN 3.5 identified 70 outlier SNPs above the 99% confidence levels, while BAYESCAN 2.1 identified 106 outlier SNPs above the 99% quantiles of the distribution. Of the detected outlier SNPs, 22 were detected both by ARLEQUIN 3.5 and BAYESCAN 2.1.

STRUCTURE 2.3.4 successfully demonstrated the presence of population structure. Results from our study could be useful for Canadian breeding programs that use marker-assisted and genomic selection. (Funding: NSERC Strategic and Chinese Scholarship Council).

Dans notre étude, 674 individus provenant de six classes d'âge différentes du aquacole en Saint John's, 98 poissons sauvages ancestrale de la rivière Tobique, et 100 adultes provenant d'une population culture-sauvage non-ancestrale dans la rivière Stewiacke ont été génotypés pour 5500 marqueurs SNP en utilisant 6 K Illumina iSelectTM de CIGENE. En moyenne, les génotypes SNP de la souche d'aquacole de St. John étaient très semblables à la population de la rivière Tobique ($F_{ST} = 0,017$), mais non à ceux de la population sauvage non-ancestrale Stewiacke ($F_{ST} = 0,082$). ARLEQUIN 3.5 a identifié 70 SNP aberrante au-dessus des niveaux de confiance de 99%, tandis que BAYESCAN 2,1 a identifié 106 SNPs aberrante au-dessus des quantiles de 99% de la distribution. Des SNPs aberrante détectés, 22 ont été détectés à la fois par ARLEQUIN 3,5 et BAYESCAN 2.1. STRUCTURE 2.3.4 a réussi à démontrer la présence de structure dans la population. Les résultats de notre étude pourraient être utiles pour les

programmes de reproduction canadiens qui utilisent la sélection assistée par marqueurs et de la génomique.
(Financement: CRSNG stratégique et Chinese Scholarship Council)."

Influence of ecosystem disturbance on dissolved organic matter source quality in mitigating the acute and chronic toxicity of Cu to *Hyalella azteca*

Influence d'une perturbation de l'écosystème sur la qualité de la source de matière organique dissoute et la mitigation de la toxicité aigue et chronique du Cu sur *Hyalella azteca*

¹Kelly Livingstone, Jim McGeer

¹*Wilfrid Laurier University*

This study examines the influence of land disturbance (logging, fire, smelter emissions) on DOM quality by comparing the protective capacity of different sources on acute/chronic Cu toxicity and bioaccumulation in *Hyalella azteca*. Acute (96h) and chronic (28d) tests were done according to standard (Environment Canada) methods, and were completed in duplicate (acute) or triplicate (chronic) using 10 *Hyalella* aged 2-9d added to solutions of Cu (0-4 μ M) and NOM sources at a DOC concentration of 5mg C/L (acute) or 7mg C/L (chronic). Test solutions were maintained at pH 7.2 \pm 0.1, 21°C, and 13mg/L CaCO₃ hardness. Tests showed significant variability among sources with disturbed sites offering less protection than reference sites. These results were complemented with 6h Cu uptake/binding experiments and optical characterizations (excitation-emission matrix spectroscopy, absorbance at 340nm and fluorescent indices). Research was supported by NSERC, Vale and Xstrata within the TALER Program).

Getting to the heart (and gills) of nanotoxicology: cardiorespiratory toxicity of commercially relevant nanoparticles

Le cœur (et les branchies) de la nanotoxicologie: Toxicité cardiorespiratoire de nanoparticules utilisées commercialement

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Mammals exhibit a stereotyped cardiorespiratory response to air pollution. Inhalation of nanoparticulate contaminants leads to the development of systemic oxidative stress and long-term cardiovascular morbidity. Water breathing animals are now being exposed to detectable levels of engineered nanoparticles but it is not known whether particulate contaminants exert such effects in aqueous systems. To address this question, white sucker, *Catostomus commersonii*, were fitted with electrocardiography electrodes and exposed to commercially relevant ZnO nanoparticles (~30 nm diameter, 1 mg/L) for 24 h. Both Na⁺/K⁺-ATPase activity and markers of oxidative stress were significantly elevated in gill tissue, suggesting that ZnO nanoparticles compromise the integrity of the epithelium. Cardiovascular parameters were also altered in nanoparticle-treated fish, likely as a result of systemic oxidative stress. The results indicate that nanoparticles may cause chronic, sub-lethal toxicity in fish and the mechanisms linking inhalation to cardiac morbidity appear similar to those observed in air-breathing vertebrates.

**Spider beware: investigations into male mate choice in the western black widow spider (*Latrodectus hesperus*)
Méfiez-vous des araignées: Investigation du choix de partenaire mâle chez la veuve noire de l'Ouest
(*Latrodectus hesperus*)**

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Recent work in systems with traditional sex-roles has suggested that male choice is more widespread than previously thought. However few studies of male choice and the links between female quality and reproductive success have been conducted in the field. Using the Western black widow spider, *Latrodectus hesperus*, we investigated male mate choice under natural conditions in response to variation in two aspects of female quality (mating status and diet). We conducted a three-year field survey of variation in female quality and female reproductive success during the breeding season. We found evidence supporting male choice, as males preferred virgin, well-fed females in two types of male mate choice experiments. We also found that male-preferred female traits were predictive of reproductive output. These findings suggest offers a more nuanced understanding of the relationship between variation in female quality and male mate choice.

Phenotypic plasticity and evolution of *Drosophila* cold tolerance is associated with modulation of Na⁺ and K⁺ homeostasis

Plasticité phénotypique et évolution de la tolérance au froid chez *Drosophila* sont associés à la modulation homéostasique du Na⁺ et K⁺

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¹Western University, ²York University

The onset and recovery of chill-coma and progression of cold-induced injury in insects are driven by a loss of extracellular ion homeostasis. We use 24 species of *Drosophila* to test the hypothesis that phenotypic plasticity and species-level variation in cold tolerance are both associated with modulation of hemolymph Na⁺ and K⁺ concentrations. Cold-acclimated *D. melanogaster* and cold tolerant species both had reduced hemolymph [Na⁺] and [K⁺]. This change in ion homeostasis is associated with a suppression of Na⁺/K⁺-ATPase activity on a whole-organism level. On the species level, these relationships hold after phylogenetically-independent contrasts, and are consistent with data from crickets, suggesting that modulation of ion concentration may be generally associated with cold tolerance in insects.

How does cortisol mediate the growth-suppressing effects of stress in rainbow trout?

Comment l'hormone cortisol réduit-elle la croissance chez les truites arc-en-ciel stressées?

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Chronic increases in plasma cortisol through exogenous means provides clear evidence that cortisol suppresses growth by disrupting endocrine regulation of somatic growth; via growth hormone, insulin-like growth factor I, IGF binding protein (GH/IGF-I/IGFBP) axis. While trout infected with the parasite *Cryptobia salmositica* are characterized by reduced growth, they do not mount a cortisol stress response. Exogenous cortisol treatment reduced GH and IGF-I in circulation while GH and receptor (GHR), IGF-I, IGFBP-1 and -2 mRNA transcripts were elevated with dosage. Parasitemia also elevated plasma GH and IGF-I during infection, though associated effects on GH/GHR mRNAs were indistinguishable from the associated effect reduced feeding had on pair-fed control groups. Levels of IGF-I, IGFBP and IGF receptor transcripts of parasite-infected fish, though similar in response to cortisol dosing, were influenced by nutritional status. Cortisol is implicated as a key factor but is not essential for mediating the growth-suppressing effects associated with physiological duress.

Developmental and physiological plasticity of muscle metabolic phenotypes in highland and lowland deer mice
Plasticité développementale et physiologique de phénotypes métaboliques musculaires chez des souris sylvestres de haute et basse altitudes

¹Sajeni Mahalingam, ²Zachary Cheviron, ³Jay Storz, ¹Alex Connaty, ¹Graham Scott, ¹Grant McClelland

¹McMaster University, ²University of Illinois, ³University of Nebraska

Deer mice (*Peromyscus maniculatus*) from high-altitude environments have a higher aerobic capacity for exercise and thermogenesis. This study examined the metabolic phenotype of muscle from highland and lowland mice to determine the relative importance of genetic adaptation and phenotypic plasticity in high-altitude environments. We measured the maximal activity of enzymes in glycolysis, fatty acid oxidation, TCA cycle, and OXPHOS pathways in four groups: 1) in situ, in their native environments, 2) de-acclimated to common conditions at sea level for six weeks, 3) sea level F1 progeny, 4) and F1 progeny acclimated to simulated altitude. HOAD and COX activity were higher in highland mice in situ and after de-acclimation, but not in the F1 progeny. This suggests that developmental plasticity contributes to a greater capacity for fat oxidation in the muscle of highland mice. Acclimation of F1 mice to simulated altitude will help elucidate the roles of plasticity and adaptation in high-altitude environments.

Supported by NSERC.

Phylogenetic distribution of emergence times in the Trichoptera of Churchill, Manitoba
Distribution phylogénétique des temps d'émergence des trichoptères de Churchill, Manitoba

¹Catherine Malo, ¹Sarah Adamowicz

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An important life cycle event in the insect order Trichoptera (caddisflies) is emergence time. This study provides novel insight into the evolution of emergence time by analyzing its phylogenetic signal in the Trichoptera of Churchill, MB, Canada. Phylogenetic signal was measured using Pagel's λ , and mapped to a multi-gene phylogenetic tree (COI, Elongation factor 1 α (EF-1 α), Cadherin (CAD) and RNA polymerase II (POL-II)). If emergence time is constrained then a pattern of phylogenetic conservatism will result. Alternatively, if competitive exclusion was historically more important than environmental pressures, then closely related species will have dissimilar emergence times. λ was determined to be 0.589 which was significantly different from both zero ($p = 0.0016$) and one ($p=0.000$). Therefore, closely related species emerge at more similar times than would be expected by chance, indicating phylogenetic conservatism in this trait; however, phylogeny does not fully describe the distribution of the emergence times among species.

The influence of membrane fluidity on chloride transport regulation in a eurythermic teleost fish
Influence de la fluidité membranaire sur la régulation du transport de chlorure chez les poissons téléostéens eurythermiques.

¹Alicia Malone, ¹William Marshall

¹St Francis Xavier University

Fundulus heteroclitus (Killifish) is an ideal model for ion transport regulation in chloride cells of the opercular epithelium (OE) and its response to thermal challenge. The α 2-adrenergic agonist clonidine inhibits, while the β -agonist isoproterenol via cAMP stimulates Cl⁻ secretion in isolated OE from warm (20°C) and cold (5°C) acclimated fish. Cold shock partially inhibits Cl⁻ secretion but totally blocks regulatory pathways in OE from warm-acclimated fish, while OE from cold-acclimated animals responded normally at both cold and warm temperatures. We infer that cold shock of plasma membranes induces a phase shift from liquid to gel state, impairing important membrane protein mobility in necessary regulatory functions. The ability of cold-acclimated OE to respond in the cold temperatures indicates homeoviscous adaptation of plasma membrane lipids, supported by liver fatty acid analysis and increased lipid unsaturation. Supported by NSERC.

Variation in hypoxia-inducible factor (HIF) and gene expression patterns in sculpins of varying hypoxia tolerance

Variation dans le facteur hypoxie-inducible (HIF) et dans la patron d'expression des gènes des chabots de différente tolérance à l'hypoxie

¹Milica Mandic, ¹Jeffrey Richards

¹*University of British Columbia*

Phenotypic responses to changes in the environment vary among species and to understand the evolutionary or ecological implications of this variation it is important to elucidate the underlying genetic/molecular mechanisms. In sculpins, a group of closely related fishes that show variation in hypoxia tolerance, exposure to low O₂ resulted in different gene expression patterns in the tolerant versus intolerant species. Expression levels of genes involved in fat metabolism, mitochondrial function and inhibition of cell growth differed among the hypoxia tolerant and intolerant species, and even for genes that were similarly up-regulated or down-regulated among the species there existed a strong temporal divergence in expression. The mechanism underlying the different expression profiles is unknown but we are currently investigating whether species-specific differences in the hypoxia-inducible factor (HIF) gene sequence and expression explain some of the variation in hypoxia-induced gene expression patterns between hypoxia tolerant and intolerant sculpins.

DOC ameliorates the effects of UV radiation on a freshwater fish

DOC améliore les effets du rayonnement UV sur un poisson d'eau douce

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¹*University of Saskatchewan*

Recent anthropogenic activities have depleted the stratospheric ozone layer, resulting in a global increase in ultraviolet radiation (UVR). Dissolved Organic Carbon (DOC) is known to attenuate rates of UVR across the water column. The skin of many fishes contains large epidermal club cells (ECCs) known to play a role in innate immune response and release chemicals, that warn other fishes of danger. This study investigated the effects of in vivo UVR exposure to fathead minnows (*Pimephales promelas*), under the influence of Sigma Aldrich Humic Acid and Luther Marsh Natural Organic Matter, physiological stress responses and ECC investment. We found that fish exposed to UVR, with either source of DOC, in the presence and absence of UV blocking filter, maintained reduced cortisol levels and high ECC density relative to UVR only exposure. This indicates that an increase in DOC ameliorates physiological stress response and helps maintain ECC production.

Les activités anthropiques récentes ont appauvri la couche d'ozone stratosphérique, ce qui entraîne une augmentation globale des rayons ultraviolets (UV). Carbone organique dissous (COD) est connu pour atténuer les taux de rayons UV à travers la colonne d'eau. La peau de nombreux poissons contient de grandes cellules épidermiques du club (CEC) connus pour jouer un rôle dans la réponse immunitaire innée et libèrent des produits chimiques, qui avertissent les autres poissons de danger. Cette étude a examiné les effets de l'exposition aux rayons UV in vivo à des vairons (*Pimephales promelas*), sous l'influence de l'acide humique de la société Sigma Aldrich et de la matière organique naturelle de Luther Marsh, les réponses physiologiques de stress et l'investissement CEC. Nous avons constaté que les poissons exposés aux rayons UV, avec soit source de COD, en présence et en absence d'UV filtre de blocage, maintient les niveaux de cortisol réduit et les densités de CEC hautes, relatives à l'exposition aux UV seulement. Cela indique que l'augmentation de COD améliore la réponse physiologique au stress et aide à maintenir la production de CEC.

The four axes of stress: intensity, duration, frequency, and period of low temperature exposures interact to affect physiology and fitness in insects

Les quatre axes du stress: intensité, durée, fréquence et durée d'exposition à de basses températures interagissent pour influencer la physiologie et la valeur adaptative chez les insectes

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Environmental stress interacts with the physiology of individuals to determine an individual's fitness. While environmental stress is generally characterized by both intensity and duration of that stress, the frequency of stress exposures can also affect both physiology and fitness. I used four species of Canadian insects with contrasting cold tolerance strategies (the freeze tolerant goldenrod gall fly and woolly bear caterpillar, the freeze avoiding eastern spruce budworm, and the chill-susceptible *Drosophila melanogaster*) to explore how intensity, duration, frequency and period between stress impact individuals. I found that increased frequency of stress reduces fitness by either increasing mortality, or trading-off reproductive output for increased somatic investment. This occurred even when duration and intensity are controlled and despite increased investment into cold hardiness. These effects indicate that

investigating the effects of repeated stress exposure is important for understanding and predicting physiological responses in the wild.

The Fundulus heteroclitus genome project: Survey of microRNA sites in a hardy fish
Projet du génome choquemort (*Fundulus heteroclitus*): Un sondage des sites microARN chez un poisson robuste.

¹William S. Marshall

¹*St Francis Xavier Univ.*

The recently completed genome of killifish *Fundulus heteroclitus* (<http://www.fundulus.org>) is compared to five teleost fish genomes in a BLAST survey of stress-related genes. Killifish are extremely hardy, euryoxic, eurythermic and euryhaline as well as tolerating high levels of environmental toxins. In contrast, zebrafish (*Danio rerio*) are freshwater stenohaline and relatively intolerant of hypoxia, temperature changes and toxins. In stress-related genes, killifish have many unique introns, not shared by other teleost genomes and, in critical genes PANK1, 17- β hydroxysteroid dehydrogenase, calcitonin receptor, adenosine A3 receptor, muscarinic receptor 3, K-specific demethylase, ELF2B, structural maintenance of chromosomes, apoptosis-associated protein kinase and Homeobox D4,C3a and C5 there are microRNA sites that closely match zebrafish microRNAs. This survey supports an hypothesis that killifish may have evolved unique gene structures that impart post-transcriptional regulation of expression that in turn increase physiological and developmental plasticity, with better survival in environmental extremes. Supported by NSERC.

Energy expenditure in incubating ring-billed gulls – behavioural, spatial and seasonal correlates
Dépenses énergétiques durant l'incubation chez le Goéland à bec cerclé - Correlations entre le comportement, l'espace et les saisons

¹Sarah C. Marteinson, ¹Jean-François Giroux, ¹Jean-François Hélie, ¹Marie-Line Gentes, ¹Jonathan Verreault

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We examined field metabolic rate (FMR) and time-activity budgets using doubly-labeled water and bird-borne GPS units in incubating ring-billed gulls (*Larus delawarensis*). Several factors that may affect FMR were assessed: body mass, climate, foraging-site utilization and behaviour. The mean FMR per gram body mass was 0.66 kJ/d/g for males and was 0.79 kJ/d/g for females. Birds proportioned their time as follows: 71% to nest-site attentiveness, 17% to foraging, 9% to flying and 4% to resting on the colony. The FMR was negatively associated with the proportion of time spent in nest-attendance and positively associated with flying proportion. Males spent significantly more time in nest-attendance than did females who spent more time foraging and resting. Females spent significantly more of their foraging time in agricultural areas than males, particularly as the season progressed. The proportion of time spent incubating was the strongest factor explaining the variation of FMR in these birds.

Multidisciplinary molluscan research on unique 10K years old seashell deposits of the Northern Gulf of St. Lawrence

Recherches malacologiques multidisciplinaires sur des dépôts coquilliers uniques de 10K ans retrouvés le long du golfe du Saint-Laurent

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¹*Canadian Museum of Nature*, ²*Université du Québec*, ³*University of Ottawa*

The recently-discovered seashell deposits found near the coastal town of Baie-Comeau (QC) represent unique assemblages of marine molluscs dating from the end of the last ice-age (~10K years BP). The sheer size of the deposits, some over 12 m thick and 700 m long, the concentration of shells, and the abundance of intact unbroken specimens make them unique, with no equivalent anywhere in the world. A unique feature is the quality of the preservation of early juvenile stages from numerous arctic/sub-arctic species, with a stunning abundance of intact post-larval specimens as small as 0.5-2 mm shell length, ie recently metamorphosed or hatched. 23 species of marine molluscs have so far been identified, including mussels, clams, scallops, littorines, moonsnails and whelks.

Multidisciplinary research currently being undertaken on these specimens, which involves comparisons with modern specimens (museum collections), includes reconstruction of seawater temperature profiles (isotope ratios), studies on modes of larval development and larval shell morphology, growth ring analysis & taxonomy

Impact of taxonomic resolution on detection of metacommunity patterns

Impact de la résolution taxonomique sur la détection des patrons de métacommunauté

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¹*University of Guelph*

Studies on freshwater streams have found that invertebrate communities are impacted by a variety of environmental factors. However, these impacts are highly variable among taxa. This could be due to the coarse taxonomic resolution, as genera or families can have species with potentially very different environmental preferences. The alternative hypothesis is that closely related species share similar traits; therefore refining the taxonomic resolution will not impact, or even decrease, relationships with environmental variables. We characterized the metacommunity assemblages of Trichoptera and Coleoptera in 21 streams in Algonquin Provincial Park, Ontario at the family, genus, species, and DNA barcode cluster levels. For these two orders, we found evidence for the second hypothesis, as the proportion of community composition variability explained by the environment decreased or did not change with increasing taxonomic resolution. This suggests ecological inter-changeability of closely related taxa in this system given the environmental variables we measured.

Generation Omics: Hip or hype for exploration of vertebrate reproduction

Génération Omiques: Exploration de la reproduction des vertébrés

¹Chris Martyniuk

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Omics technologies have dramatically increased our understanding of how organisms respond to their surrounding environment. In teleost fishes, transcriptomics and proteomics have been used to characterize the effects of reproductive hormones and endocrine disrupting compounds found in the environment. As such, we have learned more about the molecular pathways regulated by estrogens and androgens in the reproductive axis and there are common biological themes that have emerged. For example, sex steroids regulate molecular signaling cascades that are associated with immune system function, metabolism, and fatty acid biosynthesis, among many others. There has been good progress in describing adverse outcome pathways, correlating molecular initiating events to higher levels of biological organization. We have also learned that transcriptomics provides site specific information for individuals, supporting its use in environmental assessments. However, the complexity and lack of understanding of the variation and temporal changes in transcriptomes are significant challenges for omics.

Allatotropin in Rhodnius prolixus: gene transcript, distribution and physiological roles

Allatotropine chez Rhodnius prolixus: Transcription du gène, distribution et rôles physiologiques

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Rhodnius prolixus, the Chagas disease vector, requires a blood meal to complete its moult cycle into the next stage. Allatotropins (ATs), a family of peptides first isolated from *Manduca sexta*, have been shown to regulate the biosynthesis of juvenile hormone, a growth and developmental hormone; however, ATs, being multimodal peptides, also exhibit myotropic effects on some insect visceral muscles. We have examined this AT family of peptides in *R. prolixus*. Genomic analysis revealed a cDNA fragment 973bp encoding one mature amidated AT tridecapeptide (Rhopr-AT) with high transcript levels observed, via RT-PCR, in the central nervous system (CNS) and pool of fat body and trachea. AT-like immunoreactive neurons were found throughout the CNS and AT-like immunoreactive processes were present on some peripheral tissues. Bioassays using hindgut and dorsal vessel contraction, however, failed to demonstrate any effect of Rhopr-AT on these tissues. Future work will examine the effects of Rhopr-AT on JH production.

Using in vitro systems to assess the toxicity of nanosilver

L'utilisation de systèmes en vitro pour déceler la toxicité du nanoargent

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Engineered nanoparticles including nanosilver (AgNPs) are incorporated into an ever increasing number of consumer and medical products. Much remains unknown regarding the toxicity of AgNPs but oxidative stress is suggested as one mechanism. Thus, we examine the effects of AgNPs and silver ions (Ag⁺) on reactive oxygen species (ROS) generation and antioxidants levels in rainbow trout (*Oncorhynchus mykiss*) hepatocytes and erythrocytes. Both silver types showed a concentration-dependent cytotoxicity and reduced glutathione (GSH). The activities of antioxidant enzymes did not show significant differences, with the exception of glutathione-S-transferase (GST) whose activity was markedly decreased. AgNPs increased lipid peroxidation whereas Ag⁺ increased DNA damage in hepatocytes. Generally the toxic effects of both silver forms were improved by cysteine and exacerbated by buthionine sulfoximine (BSO) treatments. Research supported by grants from NSERC.

Hybridization influences hypoxia tolerance in sunfish

L'hybridation influence la tolérance à l'hypoxie chez le crapet-soleil

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¹Queen's University

Bluegill (*Lepomis macrochirus*) and pumpkinseed (*Lepomis gibbosus*) sunfish differ in hypoxia tolerance for reasons that are yet unknown. Interestingly, they produce unidirectional F1 hybrids (male bluegill x female pumpkinseed) where habitat ranges overlap. We have previously shown that the activities of mitochondrial complexes III and IV are reduced in bluegill-pumpkinseed hybrids relative to the parents, which may be due to incompatibilities between nuclear- and mitochondrial-encoded subunits. In this study, we explored the impact of hybridization on hypoxia tolerance by measuring Pcrit, loss of equilibrium (LOE), and tissue metabolites. Though no difference in Pcrit was noted, LOE suggests that hybrids had lower hypoxia tolerance than either parental and also showed a unique size independence. Analysis to date shows no differences in tissue metabolites between the three groups.

The effect of substrate on the swimming performance and behaviour of juvenile shortnose sturgeon (*Acipenser brevirostrum*)

L'effet du substrat sur la performance de nage et le comportement de l'esturgeon à museau court (*Acipenser brevirostrum*) juvénile

¹Lindsay May, ¹James Kieffer, ¹Heather Hunt

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Sturgeon use their flattened rostrum and large pectoral fins to station hold (resist swimming) and maintain their position in water currents. How various substrates impact the swimming performance and behaviour of shortnose sturgeon is unknown. To test this, I will use two common swimming challenges, the critical swimming test and the endurance test. These swimming challenges will test the hypothesis that substrate type (sand, pebble, smooth bottom) within the swim flume (i.e. treadmill for fish) modifies swimming performance and behaviour in juvenile shortnose sturgeon. The results from this project will increase the knowledge of juvenile shortnose sturgeon swimming performance. If juveniles exhibit a substrate preference at various swimming speeds, this preference may also be seen in the wild, and could be useful to both conservation biologists and physiologists.

Effects of increased temperature on hypoxia tolerance in Atlantic killifish

Effets de l'élévation de la température élevée sur la tolérance à l'hypoxie chez le choquemort

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¹UBC

As a result of climate change, both mean temperature and frequency of exposure to hypoxia are increasing in aquatic environments. To gain insight into the impact of interactions between these two stressors, we examined the effects of increased temperature on hypoxia tolerance in Atlantic killifish, *Fundulus heteroclitus*. Hypoxia tolerance decreased with acute exposure to higher temperatures in fish of the northern subspecies, *F. heteroclitus macrolepidotus*, even at temperatures where killifish have optimal performance in normoxia. Thermal acclimation improved hypoxia tolerance across temperatures. We also compared hypoxia tolerance in *F. heteroclitus macrolepidotus* to that of the southern subspecies, *F. heteroclitus heteroclitus*, at 15 and 23°C. Both subspecies and temperature influenced hypoxia tolerance, suggesting a genetic basis for this trait. These results indicate that combined high temperature and low oxygen act in a synergistic manner and that the effects of climate change could be larger than the sum of its parts.

Big digestive systems in juvenile migratory birds and their implications for energetics and behaviour

Grands systèmes digestifs chez les oiseaux migrateurs juvéniles et leurs implications pour l'énergétique et le comportement

¹Brendan McCabe, ¹Alexander Macmillan, ¹Christopher Guglielmo

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Migration is a dangerous part of the avian annual cycle, especially for juvenile birds making their first migration. Longer stopover durations and slower migration speeds expose juveniles to this risky period for more time than adults. Previously, we showed that juveniles on stopover during fall migration maintained higher basal metabolic rates than adults. We propose that larger energetically expensive organs may contribute to these unequal rates of energy expenditure. We measured whole body composition and organ masses of white-throated sparrows (*Zonotrichia albicollis*), hermit thrushes (*Catharus guttatus*), Swainson's thrushes (*Catharus ustulatus*), and ovenbirds (*Seiurus aurocapilla*), collected from building-collisions. Lean mass and digestive organ dry masses were higher in juvenile migrants. Since digestive organs are energetically expensive, higher masses of these organs may contribute to higher energy expenditure rates of juveniles. Inexperience alone does not account for the lower performance of juveniles during fall migration; inherent physiological factors also play a role.

In it for the long haul: Changes in population characteristics of the invasive round goby

Là pour le long terme: Changements des caractéristiques de populations de gobie à taches noires, une espèce invasive

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¹McMaster University

Research on invasion biology often focuses on the early stages of species introductions, while less attention is devoted to how an invasive population changes after establishment and during integration into the non-native ecosystem. Here, we present results from a long-term population-monitoring study of the round goby (*Neogobius melanostomus*), an invasive fish species in the Laurentian Great Lakes, in Hamilton Harbour, ON, Canada. To assess how an established invasive population interacts with unique aspects of non-native environments, we have sampled round goby at 6 distinct locations in Hamilton Harbour for the past 11 years (2002 – 2012). These sites differ in substrate type and relative contaminant load. We address changes in population abundance, and changes in a series of morphological and physiological characteristics such as body size, body condition, proportion reproductive and the abundance of male reproductive morphs, with specific focus on differences between sites of high and low contamination.

La recherche sur la biologie des invasions se concentre souvent sur les premières étapes de l'introduction d'espèces, tandis que moins d'attention est consacrée à la façon dont une population invasive change après l'établissement et lors de l'intégration dans l'écosystème non-natif. Nous présentons ici les résultats d'une étude de surveillance à long terme d'une population de gobie à taches noires (*Neogobius melanostomus*), une espèce de poisson envahissante dans les Grands Lacs Laurentiens, dans le port de Hamilton, ON, Canada. Pour évaluer dans quelle mesure une population invasive établie interagit avec les aspects uniques de l'environnement non-natif, nous avons échantillonné les gobies à taches noires à 6 endroits distincts dans le port de Hamilton au cours des 11 dernières années (2002 - 2012). Ces sites diffèrent par le type de substrat et la charge polluante relative. Nous adressons à des changements dans l'abondance des populations et les changements dans une série de caractéristiques morphologiques et physiologiques tels que la taille du corps, la condition physique, la proportion de la reproduction et l'abondance des

morphes de mâles reproducteurs, avec un concentration sur les différences entre les sites de contamination élevé et faible.

Into (cold) thin air: muscle adaptations to high altitude

Adaptations musculaires en haute altitude

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Highland mammals face a combination of hypoxia and cold stress. While adaptations for the efficient use of O₂ may shape skeletal muscles for effective locomotion, thermogenic adaptations may favour heat production over useful work. How these different selective pressures affect muscle phenotype and function in small highland mammals, such as mice, is unclear. For instance, we have shown that highland species of South American leaf-eared mice (genus *Phyllotis*) use more carbohydrates for locomotion as an O₂-saving strategy, but with similar muscle phenotypes to lowland congeners. In contrast, we have observed that enhanced cold-induced VO₂peak in a highland population of North American deer mice (*Peromyscus maniculatus*) is supported by greater muscle lipid oxidation capacity compared to lowland conspecifics. The role of genetic adaptation and physiologic plasticity in lineage and population differences will be discussed. Supported by NSERC.

Les mammifères d'hautes terres faire face à un mélange de stress d'hypoxie et du froid. Alors que des adaptations pour l'utilisation efficace de l'O₂ peut façonner les muscles squelettiques pour la locomotion efficace, les adaptations thermogéniques peuvent favoriser la production de chaleur plus du travail utile. Comment ces pressions sélectives différentes affectent le phénotype et la fonction musculaire chez les petits mammifères d'hautes terres, comme les souris, n'est pas claire. Par exemple, nous avons montré que les espèces montagneuses de l'Amérique du Sud de souris à oreilles de feuilles (genre *Phyllotis*) utilisent plus de glucides pour la locomotion comme une stratégie d'économie d'O₂, mais ont des phénotypes musculaires semblables à congénères des plaines. En revanche, nous avons observé que l'amélioration de VO₂ induite par le froid dans une population des hautes terres de souris de cerfs de l'Amérique du Nord (*Peromyscus maniculatus*) est soutenu par une augmentation du capacité d'oxydation des lipides des muscles par rapport à leurs congénères des plaines. Le rôle de l'adaptation génétique et la plasticité physiologique dans la lignée et les différences des populations seront discutés. Soutenu par le CRSNG.

Host-specificity and freeze tolerance of intraerythrocytic blood parasites *Hepatozoon clamatae* and *Hepatozoon catesbeiana* in wood frogs, *Rana sylvatica*

Hôte spécificité et tolérance à la congélation des parasites intra-érythrocytiques *Hepatozoon clamatae* et *Hepatozoon catesbeiana* chez la grenouille des bois, *Rana sylvatica*

¹Sean McGee, ¹Chelsea Hammer, ¹Todd Smith

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Hepatozoon catesbeiana and *Hepatozoon clamatae* are common apicomplexan parasites of green frogs and bullfrogs, but only *H. catesbeiana* has been found to occur naturally in wood frogs. Wood frogs are capable of surviving subzero temperatures, and it has been hypothesized that freezing may affect parasitaemia of *Hepatozoon* species in these frogs. To investigate the host-specificity of these two species of parasites in wood frogs, mosquitoes originally fed on adult green frogs infected with both species were fed to laboratory-raised wood frogs. A cohort of frogs infected from these experiments was frozen at -3 C for 48 hr, and another cohort was maintained unfrozen as controls. Prevalence of *H. catesbeiana*, at 48%, in experimentally inoculated wood frogs was significant higher than that of *H. clamatae*, at 8%. Blood samples taken from frogs subjected to subzero temperatures revealed a downward trend in parasitaemia compared to the control group that remained unfrozen.

The influence of anthropogenic disturbance on caribou movement networks in the boreal forest

L'influence des perturbations anthropiques sur les réseaux de mouvements du caribou dans la forêt boréale

¹Madeleine McGreer

¹*University of Guelph*

"Boreal woodland caribou alternate between tortuous, "encamped" movements and directional movements. These encampments and the exploratory movements that link them constitute a caribou's movement network. Caribou movement choices are strongly affected by the landscape. Caribou are known to prefer pristine habitats and avoid anthropogenically disturbed areas. In a disturbed landscape, therefore, a caribou should find it more difficult to locate a suitable encampment, resulting in a movement network with fewer and smaller encampments as well as more round-trip, unsuccessful explorations."

To test this hypothesis, I compared the encamped and exploratory movements of caribou in a pristine site in Northern Ontario to those in a similar site subject to forest management. Surprisingly, I found no difference in the number and size of encampments or the number of unsuccessful explorations, suggesting that a caribou's overall movement network changes very little, even in the face of anthropogenic disturbance.

Le caribou des bois alternent entre les mouvements tortueuses ""campé"" et les mouvements directionnels. Ces campements et les mouvements exploratoires qui les lient forment le réseau de mouvements du caribou. Les choix de déplacements des caribous sont fortement affectée par le terrain. Caribou sont connus pour préférer des habitats vierges et d'éviter des zones perturbées anthropique. Donc, dans un paysage perturbé, un caribou devrait avoir plus de difficulté à trouver un campement convenable, résultant en un réseau de mouvement de moins de campements plus petites ainsi que plusieurs d'explorations infructueuses aller-retour. Pour tester cette hypothèse, j'ai comparé les mouvements campé et exploratoire de caribous dans un site vierge dans le Nord de l'Ontario à celles d'un site similaire soumis à la gestion des forêts. Étonnamment, je n'ai trouvé aucune différence dans le nombre et la taille des campements ou le nombre d'explorations infructueuses, ce qui suggère qu'il ya très peu de changements au réseau de mouvements de caribou, même face à des perturbations anthropiques."

Health lessons from the study of host-parasite interactions"

Les leçons sur la santé tirées de l'étude des interactions hôtes-parasites

¹Derek McKay

¹*University of Calgary*

Parasites by definition adversely affect their hosts, but the question arises could a more tolerant view of the host-parasite relationship be advocated if infection with a parasite conferred some selective advantage on their host. Adopting this perspective we have asked if the immune response mobilized to combat infection with a helminth parasite, specifically the rat tapeworm *Hymenolepis diminuta*, would have the bystander effect of suppressing concomitant disease. Using murine models of colitis and arthritis (noting that mice are non-permissive hosts for *H. diminuta*), we have found that infection with *H. diminuta* can significantly ameliorate or exacerbate inflammation depending on the etiology of the disease. So while helminth therapy can be effective, the utility of this approach as a novel therapy for auto-inflammatory disease may rely on having precise knowledge of the immune basis of the disease to be treated on an individual patient basis.

The positive and purifying selection within and the correlated evolution of Ryanodine receptor (RyR) genes
Sélection adaptative, purifiante et évolution corrélée des gènes des récepteurs de la ryanodine

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Ryanodine receptors (RyRs) are Ca²⁺ ion channels found within the endo/sarcoplasmic reticulum. Along with the dihydropyridine receptor (DHPR), RyRs allow Ca²⁺ to flow into the cytosol. Vertebrates have three major RyR isoforms: RyR1, RyR2 and RyR3. First, we compared the nucleotide diversity of key gene regions between species to identify regions under relatively strong positive and purifying selection. Second, by estimating dN/dS ratios for RyR genes, we found evidence that RyRs are under strong purifying selection. This is consistent with RyRs being under high pleiotropic constraint. Third, we found evidence that the rates of evolution for RyR3 genes are positively correlated with those for RyR2 and DHPR genes. We propose that this is caused by compensatory mutations between genes, but did not find evidence for this when simulating mutations via a physiological model. We suggest that the correlations are instead caused by the correlated positive selection of RyR and DHPR genes.

Les récepteurs de la ryanodine (RyRs) sont des canaux de Ca²⁺ ionique trouvés dans les réticulum endo/sarcoplasmique. Avec le récepteur de la dihydropyridine (DHPR), les RyRs permettre Ca²⁺ de s'écouler dans le cytosol. Les vertébrés ont trois isoformes de RyR majeurs: RyR1, RyR2 et RyR3. Tout d'abord, nous avons comparé la diversité nucléotidique de régions de gènes entre les espèces clés pour identifier les régions sous sélection positive et de purification relativement forte. Deuxièmement, en estimant les ratios de dN/dS pour les gènes RyR, nous avons constaté que RyRs sont sous la sélection de purification forte. Ceci est cohérent avec RyRs étant sous la contrainte pléiotropique élevé. Troisièmement, nous avons constaté que les taux d'évolution des gènes RyR3 sont positivement corrélés avec ceux des RyR2 et DHPR. Nous proposons que cela est causé par des mutations compensatoires entre les gènes, mais on n'a pas trouvé de preuves de cette mutation lors de la simulation par un modèle physiologique. Nous suggérons que les corrélations sont plutôt causées par la sélection positive des gènes RyR et DHPR.

Fenugreek as a potential botanical galactagogue in rainbow trout (*Onchorhynchus mykiss*)

Fenugrec en tant que potentiel galactagogue botanique chez la truite arc-en-ciel (*Onchorhynchus mykiss*)

¹Sean McKee, ¹Scott P Kelly

¹York University

Fenugreek (*Trigonella foenum-graecum*) is a botanical galactagogue which has been shown to increase milk production in mammals. Although the precise mechanism(s) of fenugreek action are unknown, they are thought to be mediated at least in part by its effects on prolactin (PRL). PRL, a principal hormone involved in milk production in mammals, is classically considered to be a freshwater-adapting hormone in fishes. If fenugreek promotes PRL synthesis in vertebrates, then in fishes fenugreek has the potential to act as an adaptogen to decrease systemic perturbation associated with (1) environmental change in a hypoosmotic environment and/or (2) exposure/acclimation to hypoosmotic conditions. To test this notion, juvenile rainbow trout (*Onchorhynchus mykiss*) were fed varying doses of fenugreek and endpoints of ionoregulatory ability were examined. Preliminary results suggest that fenugreek has the potential to alter the osmoregulatory status of rainbow trout.

Controversy over Connectivity: Restoration of Migratory Fishes versus Control of Invasive Fishes Controverse sur la connectivité: Restauration des poissons migrateurs ou contrôle des poissons envahissants

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In the Great Lakes, decisions enhancing the movements of fishes migrating between a Great Lake and its tributaries are becoming controversial and risky environmentally. Removing a dam or providing fish passage can help restore desirable migratory fishes, but open up habitat to invasive species. Using Sea Lamprey control as an example, we demonstrate how tensions over these connectivity decisions have arisen in the past, continue to occur, and will heighten in the future. We speculate that (i) the success of the sea lamprey control program encourages watershed managers to underestimate the risk posed by sea lamprey and overestimate the benefits of restoration efforts and (ii) the mosaic management structure in the Great Lakes encourages local decision makers to pursue the benefits of restoring native fishes, while placing the cost of sea lamprey control on neighbouring jurisdictions. Greater understanding and communication of uncertainty are needed to ensure connectivity decisions are sound.

Dans les Grands Lacs, les décisions qui améliorent les mouvements des poissons qui migrent entre un grand lac et ses affluents deviennent controversé et risqué pour l'environnement. Enlevage d'un barrage ou fournissant un passage pour les poissons peut aider à restaurer les poissons migrateurs souhaitables, mais peut aussi ouvrir de l'habitat pour les espèces envahissantes. En utilisant le contrôle de lamproie de mer à titre d'exemple, nous montrons comment les tensions sur ces décisions de connectivité ont surgi dans le passé, continuent de se produire, et vont accroître à l'avenir. Nous supposons que (i) le succès du programme de lutte contre la lamproie encourage les gestionnaires des bassins versants à sous-estimer le risque posé par la lamproie marine et surestimer les avantages des efforts de restauration et (ii) la structure mosaïque de gestion dans les Grands Lacs encourage les décideurs locaux à poursuivre les avantages de la restauration des poissons indigènes, tout en plaçant le coût du contrôle de la lamproie sur les territoires voisins. Une meilleure compréhension et communication de l'incertitude sont nécessaires pour s'assurer que les décisions de connectivité sont solides.

Philometra rubra (Leidy, 1856) from striped bass, Morone saxatilis, from the Miramichi, New Brunswick

Philometra rubra (Leidy, 1856) du bar rayé, Morone saxatilis, de la Miramichi, Nouveau Brunswick

¹Lena Measures

¹Maurice Lamontagne Institute

The anadromous striped bass is of commercial and recreational importance in North America. One of five native populations in Canada, the St. Lawrence Estuary (SLE) population, was designated extirpated by COSEWIC. A program to re-introduce striped bass from the Miramichi River into the SLE was initiated in 2002. *Philometra rubra* is a pathogenic dracunculoid nematode causing mortality of juvenile striped bass. High mortality (>60%) of young-of-the-year (YOY) bass from the Miramichi used in re-stocking was attributed to infections of *Philometra* sp. - no male worms were present precluding specific identification. The present study of YOY striped bass, collected from three locations in the Miramichi River in 2011, found males of *P. rubra* (3 – 4 mm long), never before described. Prevalence of *P. rubra* was 100% and worms were found in the abdominal cavity and swim bladder. Transmission of *P. rubra* to YOY bass is likely through consumption of infected copepods.

Effects of antidepressant venlafaxine on hypothalamic-pituitary-interrenal axis in rainbow trout

Effets de l'antidépresseur venlafaxine sur l'axe hypothalamo-hypophyso-interrénal de la truite arc-en-ciel

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¹University of Waterloo

Venlafaxine is a commonly prescribed antidepressant drug that is frequently detected in aquatic systems across North America. Impact of this pharmaceutical on non-target species is poorly understood. We tested the hypothesis that environmental levels of venlafaxine disturb the functioning of hypothalamic-pituitary-interrenal (HPI) axis in rainbow trout (*Oncorhynchus mykiss*). Fish were exposed to 1.0 µg/L venlafaxine for 7 days in a flow-through system and then subjected to an acute stressor. Venlafaxine exposure led to an attenuated stressor-induced adrenocorticotropic (ACTH) and cortisol response, whereas mRNA levels of melanocortin 2 receptor and steroidogenic acute regulatory protein, which are critical for corticosteroid biosynthesis, were upregulated. No changes were detected in transcript abundances of corticotropin releasing factor, a hypothalamic neuropeptide initiating cortisol response, or pro-opiomelanocortin, encoding precursor peptide for ACTH in the pituitary. Our findings demonstrate that venlafaxine disturbs HPI axis and may affect animal's ability to cope with subsequent environmental stressors.

Insights into the coevolution of symbiotic species through a phylogenetic meta-analysis

Regards sur la coévolution des espèces symbiotiques par le biais d'une mét-analyse phylogénétique

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Symbiotic associations among species are a pervasive, if not universal factor in the evolutionary history of all types of organisms. By mapping the phylogeny of a group of symbionts onto that of their hosts, a common evolutionary history can be reconstructed, thereby giving an estimate of occurrences of coevolutionary events such as host switching and codivergence. To date, such analyses have been limited to the study of four or fewer co-phylogenies at a time. In this presentation we take a meta-analysis approach to collect and analyze 127 pairs of published host-symbiont cophylogenies. We develop a randomization test to estimate and compare patterns of coevolutionary events of symbiotic taxa across latitude zones and biological classifications of symbiotic relationship types. Differences were found in the profiles of coevolutionary event types between adaptive and innate host immune system types, ecto- vs. endo-symbionts, as well as across latitude zones.

Differential effects of chronic hypoxia on the cortisol stress response of larval and adult zebrafish (*Danio rerio*)

Effets différentiels de l'hypoxie chronique sur la réponse au stress par le cortisol chez les larves et les adultes du poisson zèbre (*Danio rerio*)

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The hypothalamic-pituitary-interrenal (HPI) axis of fish plays a central role in the maintenance of homeostasis in response to stressors and activation of the HPI axis in zebrafish larvae starting at 4 days post fertilization (dpf) results in an increase in cortisol synthesis. Although zebrafish embryos can survive without O₂, anoxia tolerance gradually diminishes with development. Therefore, we hypothesized that zebrafish larvae have a lesser cortisol response than adults to chronic hypoxia. Exposure of 5 dpf larvae to 10 or 20% dissolved O₂ for 0.5, 2 or 16 h did not stimulate cortisol synthesis. In contrast, exposure of adults to similar hypoxic conditions elicited a cortisol stress response. To assess whether this developmental difference in HPI axis responsiveness to hypoxia is associated with a differential tolerance of the nervous system to a chronic lack of O₂, we are currently assessing the developmental effects of chronic hypoxia on neurogenesis.

Testing the role of migratory birds in the spread of zoonotic disease

Test du rôle des oiseaux migrateurs dans la propagation des maladies zootoniques

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Migratory birds have recently been implicated in the spread of disease over broad geographic distances. However, this hypothesis relies on the untested assumption that migrants can continue migration when infected with a pathogen given that both an induced immune response and migration are energetically demanding. We presented three species of migratory songbirds (hermit thrush *Catharus guttatus*, yellow-rumped warblers *Setophaga coronata*, and American redstarts *Setophaga ruticilla*) with an immune challenge during spring stopover at Long Point, ON. Activity, body condition, and temperature were measured for 20 individuals of each species (10 treatment, 10 control) within an aviary over a 48 h period at the study site. We also monitored activity budgets and stopover duration for an additional 20 individuals of each species (10 treatment, 10 control) using digital radio telemetry. Preliminary results will be discussed in the context of disease spread, avian life histories, and carry-over effects into the breeding period.

Les oiseaux migrateurs ont été récemment impliqués dans la propagation de la maladie sur de grandes distances géographiques. Cependant, cette hypothèse repose sur la supposition non vérifiée que les migrants peuvent poursuivre la migration lorsqu'elles sont infectées par un agent pathogène étant donné que la fois une réponse immunitaire et la migration sont énergiquement coûteuse. Nous avons présenté trois espèces d'oiseaux chanteurs migrateurs (Grive solitaire *Catharus guttatus*, les parulines à croupion jaune *Setophaga coronata* et paruline flamboyante *Setophaga ruticilla*) avec un défi immunitaire lors d'une escale de printemps à Long Point, en Ontario. L'activité, l'état corporel et la température ont été mesurés en 20 individus de chaque espèce (10 traitement, 10 contrôle) pendant une période de 48 h dans une volière au site d'étude. Nous avons aussi suivi des budgets d'activité et la durée d'escale pour un supplément de 20 individus de chaque espèce (10 traitement, 10 contrôle) utilisant la télémétrie radio numérique. Les résultats préliminaires seront discutées dans le contexte de la propagation de la maladie, la cycle biologique aviaire, et les effets différés à la période de reproduction.

Exploring our second genome: analysis of 16S rRNA gene fragment size and alignment for bacterial identification

Explorer notre second génome: Analyse de la taille des fragments et l'alignement de l'ARN ribosomal pour identification bactérienne

¹Jennifer Mitchell

¹*Wilfrid Laurier University*

The Human Microbiome Project (HMP) has revealed the importance of understanding our “second genome”- the genes of the trillions of bacteria that inhabit the human body, outnumbering our own cells 10 to one. On a micro level, these bacteria reproduce and interact within the ‘ecosystem’ of our bodies, impacting, regulating and shaping the normal functioning of activities such as digestion and our overall health. This research explores the human microbiome through various bioinformatics techniques. A key objective of the HMP is to identify the bacterial species within this immense, complex microbial community. Current methodology involves comparing short fragments of 16S rRNA gene sequences to reference sequences in databases, with 97% or greater sequence similarity assigning a fragment to a species. This project seeks to evaluate whether these fragments are long enough to examine this gene, and if a 97% sequence alignment can accurately assign a fragment to a species.

The physiological and behavioural adjustments of the zebrafish *Danio rerio* exposed to the beta-blocker propranolol

Ajustements physiologiques et comportementaux du poisson zèbre *Danio rerio* exposé au bêta-bloquant propranolol

¹Kimberly Mitchell, ¹Thomas Moon

¹*University of Ottawa*

Propranolol (PROP) is a β-blocker prescribed mainly to treat human cardiac diseases but with its wide usage it often makes its way into the aquatic environment. This study examined whether PROP alters developmental patterns and catecholamine (CA)-regulated processes in the zebrafish (*Danio rerio*) and if exposure during early life alters the stress response and behaviors of adults. Embryos/larvae continuously PROP-exposed had decreased and increased transcript levels of the β1-adrenoceptor at 1 dpf and 5 dpf, respectively. Stressed, PROP-exposed zebrafish had reduced testosterone and estradiol levels and exhibited less anxiety behaviours than control fish. Furthermore, adults previously PROP-exposed as embryos/larvae had decreased body length (0.0006 mg/L PROP) and mass (20 mg/L PROP). Changes in cholesterol and testosterone levels occurred in PROP-exposed fish. Thus PROP-exposure alters developmental patterns and CA-regulated processes that are essential for normal behaviours and responses to stress, and at least some of these changes persist in adult zebrafish. Supported by grants from NSERC.

Le propranolol (PROP) est un β-bloquant principalement prescrits pour traiter les maladies cardiaques de l'homme, mais avec ses nombreuses utilisations, est souvent trouver dans le milieu aquatique. Cette étude a examiné si PROP altère les schémas de développement et les processus réglementées par catécholamines (CA) dans le poisson zèbre (*Danio rerio*) et si l'exposition au cours du début de la vie altère la réponse au stress et les comportements des adultes. Les embryons / larves exposés au PROP continuellement avaient les niveaux de transcription de la β1-adrénnergiques diminué à 1 jours après la fécondation (jaf) et augmenté à 5 jaf. Les poissons zèbre stressés, et exposée à PROP a réduit la testostérone et l'estradiol et avait moins de comportements d'anxiété que les poissons témoins. En outre, les adultes précédemment exposés à PROP comme des embryons / larves avaient diminués la longueur du corps (0,0006 mg / L PROP) et la masse (20 mg / L PROP). Des changements dans les niveaux de cholestérol et de testostérone eu s'est produite dans les poissons exposés à PROP. Ainsi, l'exposition à PROP modifie les modèles de développement et les processus réglementés par CA qui sont essentiels pour les normaux comportements et réponses aux stress. Au moins, certains de ces changements persistent chez le poisson zèbre adulte. Soutenu par des subventions du CRSNG.

Bacteriophage: arms dealers of the microbial world

Bactériophages: Marchands d'armes du monde microbien

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¹*Wilfrid Laurier University*

Bacteriophage- viral predators of bacteria- are the most abundant biological entities on the planet, with an estimated population of 10 to the power of 31 individuals. This paper explores their role as agents of horizontal gene transfer (HGT), mediating the exchange of genes throughout microbial communities, driving bacterial evolution over the course of the past two billion years, and playing a primary role in antibiotic resistance.

In contrast to virulent phage, which simply kill their hosts and release new viral particles, temperate phage insert themselves into the bacterial chromosome and replicate alongside the host genome. One of the objectives of this

project is to identify these integrated phage- termed 'prophage'- within a variety of bacterial host genomes. Further, the amount of HGT associated with virulent versus temperate phage will be analyzed, with the expectation that temperate phage have greater opportunity for genetic exchange.

The macroevolutionary effects of flight loss in insects differ across timescales

Les effets macroévolutifs de perdre la capacité du vol chez les insectes diffèrent selon les échelles de temps

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Recent evidence from study of a beetle subfamily has indicated that the evolutionary loss of flight in insects may have positively impacted diversification rates. While increased propensity for speciation due to flight loss is supported by population genetic evidence, traits may have differing impacts on net diversification over different time scales. To determine whether flight loss is associated with broader species richness patterns in insects, we examined the phylogenetic distribution of flight states and insect species diversity among ordinal-level clades. We show that flight loss is associated with reduced net diversification at this scale. We suggest that while flight loss may increase the propensity for speciation and lead to greater net diversification over the short term, over the long term results in an increased extinction rate. We discuss the results in context of other dispersal-linked traits and other traits that may have differing impacts over the short and long term.

Fishing for jaws in early vertebrate evolution

Aller à la pêche aux mâchoires au début de l'évolution des vertébrés

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No previous theories conclusively explain the evolutionary origin of vertebrate jaws. Despite the persistent notion that jaws evolved via specialization of an anterior visceral segment in the head, comparative morphology of jawless vertebrates suggests an alternative view that reconciles previous incompatibilities among fossil, anatomical, and molecular evidence. Comparison of the skull and cranial musculature among hagfish, lampreys, fossil jawless vertebrates, and jawed vertebrates revealed possible spatial constraints on the mandibular arch — the visceral head ‘segment’ from which the jaw arose. In basal vertebrates, including hagfish and lampreys, the mandibular domain is a distinct visceral region specialized for feeding and ventilation. This highly specialized mandibular domain may therefore have been assimilated as a pharyngeal arch as a result of spatial confinement and functional compensation by the surrounding head regions. Such assimilation of the mandibular domain into one of the pharyngeal arches may have been a prerequisite condition for jaws to evolve.

A role for Na⁺/K⁺- ATPase activation in axonal conduction of a locust visual neuron

Un rôle pour l'activation de l'ATPase Na⁺/K⁺ dans la conduction axonale d'un neurone visuel chez le criquet

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The locust descending contralateral movement detector (DCMD) is a visual Interneuron involved in triggering escape behaviours in response to approaching visual threats. The DCMD axon reliably transmits bursts of high frequency action potentials (>300 Hz) at rapid conduction velocities (>3 m/s at 25°C). During periods of high activity, either visually-evoked or electrically-stimulated, the DCMD axon undergoes a slow hyperpolarization which can last for minutes. Further, the amplitude of these events can be modulated by pharmacological treatments that mimic metabolic stress. We have tested the hypothesis that the activity-dependent hyperpolarization is due to the electrogentic effect of the Na⁺/K⁺- ATPase pump. We have further investigated its effect on conduction reliability in the axon. We suggest pump activity in the axon as a modulatory target following metabolic stress with consequences for neural performance.

Le détecteur décroissant de mouvement contralatéral (DDMD) du criquet est un Interneuron visuelle impliquée dans le déclenchement de comportements de fuite en réponse à des menaces visuelle. L'axone DDMD transmet de manière fiable des potentiels d'action en éclats de haute fréquence (> 300 Hz) à des vitesses de conduction rapide (> 3 m / s à 25 ° C). Pendant les périodes d'activité élevée, soit évoqué visuellement ou stimulée électriquement, l'axone DDMD subit une hyperpolarisation lente qui peut durer quelques minutes. En outre, l'amplitude de ces événements peut être modulée par des traitements pharmacologiques qui imitent le stress métabolique. Nous avons testé l'hypothèse selon laquelle l'hyperpolarisation dépendante de l'activité est due à l'effet électrogénique de la Na⁺/K⁺- ATPase. Nous avons en outre étudié son effet sur la fiabilité de conduction dans l'axone. Nous suggérons activité de

la pompe dans l'axone comme cible de modulation après un stress métabolique avec des conséquences sur la performance des neurones.

The role of statin drugs on zebrafish (*danio rerio*) coenzyme q10

Le rôle des drogues statines sur la coenzyme q10 chez le poisson zèbre (*Danio rerio*)

¹Thomas Moon

¹*University of Ottawa*

Atorvastatin, known by its trade name Lipitor®, is a member of a pharmaceutical family collectively known as statins. Its primary mode of action is the inhibition of HMG-Coenzyme A reductase (HMG-CoAR), an enzyme enriched in the liver where it mediates the biosynthesis of cholesterol and a variety of non-cholesterol sterols within the mevalonate pathway. Atorvastatin is amongst the most highly prescribed pharmaceuticals and is detectable at very low levels in the aquatic environment. Although generally statins have few known serious side effects, previous studies reported that statins can induce myotoxicity as an adverse effect in humans, mice, rainbow trout, and, more recently, zebrafish. Recent molecular evidence suggests that statin drugs, in addition to targeting cholesterol biosynthesis, also interfere with the synthesis of coenzyme Q10 (CoQ10), an important part of the electron transport chain (ETC) in muscle mitochondria. The isoprenyl component of CoQ10 is derived from the mevalonate pathway meaning that statins may impact the synthesis of CoQ10. This study will test the hypothesis that statin-mediated pharmacological inhibition of the mevalonate pathway will induce cardiac and skeletal muscle damage in embryonic and adult zebrafish by virtue of the depletion of CoQ10 levels.

How does a lamprey grow: A study of skeletogenesis and metamorphosis in the Sea Lamprey (*Petromyzon marinus*)

Comment croît la lampreie: Une étude de la squelettogénèse et de la métamorphose chez la lampreie marine (*Petromyzon marinus*)

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Lampreys, the only remaining group of jawless early vertebrates, go through important developmental events during their life cycle (i.e., prolarva, larva, metamorphosing larva and adult). The prolarval skeletogenesis and the larval metamorphosis imply important modifications of external and internal morphology, thus representing a great interest to evolutionary developmental biology. We describe the cranial and splanchnocranial development of the Sea Lamprey (*Petromyzon marinus*) based on an ontogenetic series of 114 cleared-and-stained specimens, from larval to adult stages. Our results suggest that the microphagous larval skeleton, the development of which was thought to stop after the prolarval stage, actually continues simultaneously with somatic growth. Results on metamorphosis will be used to corroborate the skeletal modifications with the widely-accepted sequence of stages based on external features. This study provides the first comprehensive morphological description of the skeleton from larval to adult stages, as well as its modifications during metamorphosis.

Proxemics and acoustic geometry of courtship in *Drosophila melanogaster*

Proxémique et géométrie acoustique lors du comportement de cour chez *Drosophila melanogaster*

¹Erica Morley, ²Thorin Jonsson, ²Daniel Robert

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Acoustic communication is an important component of *Drosophila melanogaster* courtship. The position of the singing male determines the amplitude at the female, and due to amplitude-dependent active auditory mechanics, whether she is tuned in to his song. We examined *D. melanogaster* courtship from the behavioural proxemics of song production to the mechanics of the receiver. Although courtship is dynamic and both male and female move around, the male predominantly maintains a position behind the female, directing song towards the antenna along an axis that ensures maximal stimulation of the ipsilateral receiver. From this position we empirically establish that courtship song produced by males is too loud to allow the female receiver to tune into song frequencies. Why the active auditory mechanics are maintained if they are not required for listening to song is unclear, but perhaps their acoustic world is bigger than just courtship?

Evolution of the control of mitochondrial gene expression in animals

Évolution du contrôle de l'expression des gènes mitochondriaux chez les animaux

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The control of muscle mitochondrial biogenesis demands the synthesis of the hundreds of proteins encoded by genes located in both the nuclear and mitochondrial genomes. Coordination of this process falls to a small number of nuclear-encoded "master regulators" of gene expression, including DNA-binding proteins (e.g., NRF1) and coactivators (e.g., PGC1a), that integrate information from energy sensing pathways and hormones to alter mitochondrial gene expression, allowing muscles to determine their mitochondrial content. These pathways are well studied in humans and biomedical models (rodents), but we focus on their role in determining evolutionary variation in muscle mitochondrial content. I will discuss two evolutionary paradigms in which changes/ differences in mitochondrial content are observed: allometric variation in mammals and cold-induced mitochondrial proliferation in fish. These studies provide information on how individual animals and tissues determine mitochondrial content and how evolutionary processes have altered these gene regulatory pathways in different vertebrate classes. Supported by NSERC.

The longest-lived metazoan, the marine clam *Arctica islandica*, has lipoxidation-resistant mitochondrial membranes

Chez le métazoaire le plus longévif, la palourde *Arctica islandica*, les lipides des membranes mitochondrielles résistent mieux à l'oxydation

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When reactive oxygen species (ROS) initiate lipid oxidation within membranes, an ensuing chain reaction generally involves the oxidation of multiple adjacent polyunsaturated fatty acids (PUFA). PUFA oxidized this way subsequently break down, releasing reactive aldehydes or other detrimental secondary ROS. Primary as well as secondary ROS largely contribute increasing the mutation load on mitochondrial DNA, which is proposed to foster cellular aging. The capacity of a membrane to produce secondary ROS is proportional to its content in highly oxidizable PUFA and is summarized by the peroxidation index (PI). Past research has shown an inverse relationship between the longevity of mammals and birds and their cellular membrane PI, but no invertebrates have been compared. We found that the gill's mitochondrial membrane PI is negatively correlated to longevity in five species of marine bivalves. The values are particularly low for *Arctica islandica* which is known as the longest-lived metazoan.

Effects of ploidy on cell volume regulation in brook trout (*Salvelinus fontinalis*) erythrocytes

Les effets de la ploidie sur la régulation du volume des cellules erythrocytes chez l'omble de fontaine (*Salvelinus fontinalis*)

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This study tests the hypothesis that cell size affects regulatory cell volume control during osmotic stress, using diploid and triploid erythrocytes as model cells. Furthermore, I will examine the density, distribution and efficiency of the adrenergically activated sodium-hydrogen exchanger (β NHE) during cell volume recovery. I predict that triploid erythrocytes will possess fewer receptors per unit surface area and will exhibit a slower volume recovery when subjected to different osmolalities in vitro. I will be testing these predictions using flow cytometry, confocal microscopy and particle size analysis. Flow cytometer and confocal microscope use will follow β NHE immunofluorescence labeling and subsequently allow diploid-triploid receptor comparison. The integrity and function of erythrocytes is critical for the survival and function of most vertebrates. These experiments will provide some insight into triploid red blood cell maintenance and contribute to the knowledge base concerning the effective use of triploid fish in aquaculture.

Interactive effects of salinity and dissolved organic matter on Cu toxicity and bioaccumulation in *Americanamysis bahia*

Les effets interactifs de la salinité et de la matière organique dissoute sur la toxicité du Cu et la bioaccumulation chez *Americanamysis bahia*

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Estuarine environments impose varying osmoregulatory demands on euryhaline organisms and this may alter the impact of contaminants that disrupt ion homeostasis (e.g. Cu). Varying salinity also alters the bioavailability and uptake of Cu. These chemical-biological interactions complicate the understanding of the impacts of Cu in estuarine waters. The mitigating effects of salinity and dissolved organic matter (DOM) on Cu toxicity to *Americanamysis bahia* were examined using acute (96h) and chronic (7d) exposures. Increasing salinity from 5 to 25ppt decreased Cu toxicity but this effect was reversed at higher salinities. Experiments designed to distinguish the contributions of salinity induced osmoregulatory stress in Cu toxicity test found no differences in Cu LC50 values. Cu bioaccumulation at different salinities was correlated with toxicity to evaluate potential relationships to biotic-ligand principles. This research is contributing to the development of an estuarine based toxicity prediction models (Funded by NSERC, ICA, CDA, ILZRO, IZA, Teck & Xstrata).

Habitat, life history and dietary related changes in gill urea transporter (UT) and Rh glycoprotein abundance in sea lampreys (*Petromyzon marinus*).

Changements de l'abondance des transporteurs d'urée et glycoprotéines Rh branchiaux dues aux modifications d'habitat, du cycle biologique et de l'alimentation chez la lamproie marine (*Petromyzon marinus*)

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Burrow-dwelling larval sea lampreys (ammocoetes) mainly ingest food with low nutritive value, but following a radical metamorphosis, juvenile parasitic lampreys ingest large quantities of protein-rich blood from fishes. We tested the hypothesis that greater reliance on urea excretion (Jurea) in ammocoetes resulted in greater gill urea transporter (UT) protein abundance compared to later life stages, and that Rh glycoprotein c (Rhcg2) abundance would increase after feeding commences in parasitic lampreys. Despite lower overall N-waste excretion rates, ammocoetes excreted a higher proportion (15-20%) of total N-wastes as urea, with 6-7 times more gill UT compared to feeding parasitic and adult lampreys. In contrast, blood ingestion by parasitic lampreys led to 5-fold increases in Jamm and 3-fold increases in gill Rhcg2, but less reliance on Jurea. These changes may reflect a need for more ammonia-detoxification in burrow-dwelling ammocoetes, but a greater need to excrete ammonia in the blood-feeding parasitic stage.

Renewable material from hagfish slime thread proteins

Matériau renouvelable à partir des protéines filamenteuses du mucus de myxines

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Hagfishes are known for their ability to produce large amounts of slime when threatened. The slime is reinforced with thousands of protein threads that consist of bundles of the cytoskeletal filaments known as intermediate filaments. The slime threads have remarkable mechanical properties, suggesting that intermediate filament proteins may serve as a useful biomimetic model for the production of high performance, environmentally sustainable fibers. As a first step towards exploring the potential of artificial fibers made from intermediate filament proteins, we spun and characterized fibers made from solubilized thread proteins. Our findings show promise for intermediate filament proteins as an alternative source for the design and production of high performance protein-based fibers.

Maternal cortisol deposition influences larval stress response in zebrafish

Le cortisol maternel influence la réponse au stress des larves du poisson zèbre

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Zebrafish (*Danio rerio*) is an excellent model to study the effect of maternal cortisol contribution because de novo production of this steroid commences only after hatch. We tested the hypothesis that zygotic cortisol level will modulate the hypothalamus-pituitary-interrenal (HPI) axis functioning after hatch in zebrafish. Embryo cortisol level was manipulated by either microinjection of exogenous steroid or by blocking endogenous steroid using antibodies. Abnormal cortisol deposition disrupted the stress response in post-hatch larvae, including a complete lack of cortisol increase in response to a physical stressor. The opposite effect was seen in embryos with reduced cortisol content as they displayed a heightened cortisol response to stressor exposure. These changes corresponded with altered expression of genes encoding key proteins involved in HPI axis functioning. Taken together, maternal cortisol deposition is critical for cortisol stress axis development, and abnormal embryo cortisol levels may impact larval stress responsiveness.

Le poisson zèbre (*Danio rerio*) est un modèle excellent pour étudier l'effet de la contribution de cortisol maternel parce que la production de novo de ce stéroïde commence seulement après l'éclosion. Nous avons testé l'hypothèse selon laquelle les taux de cortisol zygotiques vont moduler le fonctionnement de l'axe hypothalamo-hypophysointerrénal (HIP) après l'éclosion chez le poisson zèbre. Les taux de cortisol des embryons a été manipulé soit par micro-injection de stéroïdes exogène ou en bloquant les stéroïdes endogènes en utilisant des anticorps. Dépôt de cortisol anormal a perturbé la réponse au stress des post-larves éclosent, y compris un manque total d'augmentation de cortisol en réponse à un stress physique. L'effet inverse a été observée chez les embryons ayant un réduit teneur en cortisol comme ils ont fait preuve d'une réponse du cortisol accrue à l'exposition de stress. Ces changements correspondent à une expression altérée des gènes codant pour des protéines impliquées dans le fonctionnement de l'axe HIP. Pris dans leur ensemble, les dépôts de cortisol maternel sont essentiels pour le développement de l'axe du stress cortisol et des niveaux anormaux de cortisol embryon peuvent avoir une incidence au réponse au stress des larves.

Increased NaCl transport mediates synergism between serotonin and the diuretic peptide RhoprCRF/DH in the medically-important disease vector *Rhodnius prolixus*

L'augmentation du transport du NaCl cause une synergie entre la sérotonine et le peptide diurétique

RhoprCRF/DH chez le vecteur de maladie *Rhodnius prolixus*

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Rhodnius prolixus remains the most important vector for Chagas' disease in Central and South America where it currently affects millions of people. One aspect of vector biology currently under study is the immediate diuresis that follows the animal's ingestion of a blood meal that can exceed 20 times its unfed body weight. Current knowledge suggests that diuresis is regulated by two factors - serotonin (5HT, true diuretic hormone) and RhoprCRF/DH (diuretic peptide) – and these factors synergize to stimulate fluid secretion by the Malpighian tubule (MT). The nature of the mechanism underlying synergism is not understood. In the present study, a Ramsay fluid secretion assay was used to establish the synergistic interactions between 5HT and RhoprCRF/DH and ion-selective microelectrodes were used to define the mechanism underlying synergism. We show here that low concentrations (25 nmol l⁻¹) of 5HT can enhance the sensitivity of the MTs to RhoprCRF over a range of concentrations (10 - 100 nmol l⁻¹). Similarly, low concentrations of RhoprCRF/DH (1 nmol l⁻¹) can also enhance the sensitivity of the MTs over a range of concentrations (10 – 1000 nmol l⁻¹). Increased fluid secretion resulting from synergism between 5HT and RhoprCRF/DH is likely mediated by a 2-3-fold increase in NaCl transport and not KCl transport. Taken together, the present study has clearly defined the synergistic interactions between 5HT and RhoprCRF/DH and this synergism is mediated in part by increased NaCl transport.

Prolonged cold exposure drives strategy switch in the land snail *Cepaea nemoralis*
L'exposition prolongée au froid produit des changements de stratégie chez l'escargot *Cepaea nemoralis*

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Terrestrial ectotherms use one of two broad strategies to tolerate sub-zero temperatures: they either keep their body fluids liquid at temperatures below the melting point (freeze avoidance), or withstand internal ice formation (freeze tolerance). Some species are able to switch strategy, and there is more speculation than conclusion about why one strategy or another is advantageous. I have found that the invasive snail *Cepaea nemoralis* switches from freeze tolerance in the fall to freeze avoidance in the winter. The strategy switch seems to be related to gut clearance of ice-nucleating agents and to cryoprotectants resulting from anaerobic metabolism. Although the acute low temperature tolerance of both strategies is similar, freeze avoidant snails have better survival of prolonged cold exposure, suggesting that freeze tolerance allows the snails to be active and survive freeze-thaw in the fall, but that long term survival in winter is achieved via freeze avoidance.

Animals on a changing coral reef: hot and high on acid

Animaux sur un récif de corail en changement: Chauds et sous l'emprise de l'acide

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Coral reef fishes appear to be living close to their thermal optimum, and for some of them, even relatively moderate increases in temperature (2 - 4°C) lead to significant reductions in respiratory performance. A maybe even greater worry is that, even at maintained water temperatures, predicted future rises in ocean CO₂ levels have been found to alter the behaviour of marine fishes. Changes include increased boldness and activity, loss of behavioural lateralization, and altered auditory and olfactory functions. These abnormalities appear to be related to the function of the GABA-A receptor, since they can be rapidly and effectively reversed with an antagonist of this receptor. GABA-A is a Cl⁻/bicarbonate channel and a major neurotransmitter receptor in the central nervous system of all vertebrates and many invertebrates. The ubiquity and conserved function of GABA-A receptors suggest that rising CO₂ levels could cause behavioural impairment in a wide range of marine animals.

Transcriptomics of salinity tolerance in Arctic charr (*Salvelinus alpinus*): a comparison of gene expression profiles with quantitative trait locus alleles for high and low salinity tolerance

Transcriptomique de la tolérance à la salinité chez l'omble chevalier (*Salvelinus alpinus*): Comparaison de profils d'expression génique avec des allèles de locus à caractères quantitatifs pour des tolérances à la salinité élevée et faible

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We compared the gene expression profiles of Arctic charr (*Salvelinus alpinus*) with quantitative trait locus (QTL) alleles that are associated with high and low salinity tolerance to better understand the genetic architecture of this trait. A gill reference transcriptome was assembled with 417 million RNA-seq reads and used to quantify differential expression. Although 357 genes from both families were differentially expressed, only 5 were shared. With the exception of immune response (antigen processing and presentation of peptide antigen via MHC class I), there was little overlap in gene ontology. Clusters comprised of 7, 8, and 5 differentially expressed genes co-localized with QTL on linkage groups 5, 31, and 32, respectively. Findings suggest that: i. immune response affects salinity tolerance, ii. genetic constitution may influence the biological processes that confer elevated salinity tolerance, iii. clusters of differentially expressed genes may underlie QTL on certain Arctic charr linkage groups.

Extreme variability in bee abundance and diversity over short and long time periods Variabilité extrême de l'abondance et diversité des abeilles sur des périodes courtes et longues

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In recent years, there has been growing concern about long-term changes in abundance and diversity of wild bees, but we have yet to understand shorter term, year-to-year changes in bee population dynamics. To address this lack, from 2003-2012, we monitored bee abundance and diversity at control and restored sites in southern Ontario, normalizing collecting effort among sites and years. We found significant variation in abundance and diversity among years, collection sites, and seasons. An overall decline in bee numbers over the course of the study was likely due to restoration effects, as bees were most abundant and diverse within the first several years after barren sites were re-vegetated. In addition, summer droughts appear to considerably depress bee abundance. These results demonstrate that abundance and diversity within a single bee community can be quite variable over short spatial distances and over short and long time periods.

Ces dernières années, il ya eu préoccupation croissante à propos de changements à long terme dans l'abondance et la diversité des abeilles sauvages, mais nous n'avons pas encore compris à court terme, des changements d'année en année de la dynamique des populations d'abeilles. Pour combler ce manque, à partir de 2003-2012, nous avons suivi l'abondance et la diversité des abeilles aux sites contrôles et restaurés dans le sud de l'Ontario, en normalisant l'effort de collecte entre les sites et les années. Nous avons constaté une variation significative de l'abondance et de la diversité entre les années, les sites de collecte, et les saisons. Une baisse globale du nombre d'abeilles au cours de l'étude était probablement due à des effets de restauration, comme les abeilles étaient les plus abondants et variés dans les premières années après les sites stériles ont été remises en végétation. En outre, les sécheresses estivales semblent de baisser l'abondance des abeilles considérablement. Ces résultats démontrent que l'abondance et la diversité au sein d'une communauté abeille peut être très variable sur de courtes distances spatiales et pendant des périodes courtes et longues.

Hypoxia-cadmium interactions on rainbow trout mitochondrial bioenergetics: attenuation of hypoxia-induced proton leak by low doses of cadmium

Interactions hypoxie-cadmium sur la bioénergétique mitochondriale de la truite arc-en-ciel: atténuation de la perte de protons induite par l'hypoxie par de faibles doses de cadmium

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Rainbow trout (*Onchorynchus mykiss*) liver mitochondria were energized with glutamate-malate and subjected to hypoxia ($\text{PO}_2 < 2$ torr) for 0–60 min with measurements of state 3, 4 and 2,4-dinitrophenol-uncoupled (state 3u) respirations. Thereafter, 5 min hypoxia was used to probe interactions with cadmium (0–20 μM), and proton leak was estimated by measuring state 4 respiration after addition of oligomycin (state 4o). Hypoxia inhibited state 3 and 3u respirations while concomitantly stimulating state 4 and 4o respirations, thus reducing the phosphorylation and coupling efficiencies. Low doses of cadmium ($\leq 5 \mu\text{M}$) reduced, while higher doses enhanced, hypoxia-stimulated proton leak, contrasting the monotonic enhancement of hypoxia-induced reductions of state 3 respiration, phosphorylation efficiency and coupling by cadmium. These data suggest that hypoxia impairs the electron transport chain and sensitizes mitochondria to cadmium. Moreover, evidence for hormetic effect of cadmium –attenuation of hypoxia-induced proton leak by low cadmium doses– is provided.

Goldfish neutrophil responses after exposure to polymer-coated metal-oxide nanopaticles.

Réponses des neutrophiles du poisson rouge après exposition au polymère à revêtement de nanoparticules d'oxyde métallique

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Neutrophils play central roles in host defense against pathogens, using a diverse repertoire of effector functions that include degranulation, phagocytosis, respiratory burst and released proteolytic cytokines. Studies have reported cytotoxic effects of nanoparticles (NPs) and have suggested NPs may perturb the innate immune system of organisms. NPs are used in an increasing number of consumer products and medical treatments, which increases their potential release to the environment. Their small size (<100nm) produces unique physico-chemical properties that increase their reactivity, surface area and aggregating capabilities. In this study we measured the effects of five polymer-coated metal-oxide NPs on the viability and functionality of isolated Goldfish neutrophils. Exposures to varying NP concentrations (0–200 $\mu\text{g}/\text{ml}$) decreased cell viability and increased degranulation and reactive oxygen

intermediate in a dose-dependent manner. Increased and decreased gene expression of various pro and anti-inflammatory genes as well as genes involved in apoptosis and cell maturation also occurred.

Les neutrophiles jouent un rôle central dans la défense de l'hôte contre les agents pathogènes, en utilisant un répertoire varié de fonctions effectrices qui incluent la dégranulation, la phagocytose, la stimulation du métabolisme oxydatif et les cytokines protéolytiques libérés. Des études ont rapporté des effets cytotoxiques de nanoparticules (NPs) et ont suggéré les NPs peuvent perturber le système immunitaire inné des organismes. Les NPs sont utilisés dans plus en plus de produits de consommation et des traitements médicaux, ce qui augmente leur libération potentielle à l'environnement. Leur petite taille (<100 nm) produit des propriétés physico-chimiques uniques qui augmentent leur réactivité, la superficie et les capacités d'agrégation. Dans cette étude, nous avons mesuré les effets de cinq NPs métal-oxyde enrobés de polymère sur la viabilité et la fonctionnalité des neutrophiles isolés des cyprins dorés. L'exposition à des concentrations de NP variables (0-200 pg / ml) a diminué la viabilité cellulaire et a augmenté la dégranulation et l'intermédiaire d'oxygène réactif d'une manière dépendante sur la dosage. L'expression des gènes des différents gènes pro- et anti-inflammatoires, ainsi que les gènes impliqués dans l'apoptose et la maturation des cellules ont accrue et diminuer aussi.

Phosphorylation of insulin receptor and phosphoinositol-3-kinase by teneurin C-terminal associated peptide (TCAP)-1 in immortalized mouse hypothalamic cells

Phosphorylation du récepteur de l'insuline et de la phosphoinositol-3-kinase par le peptide associé au C-terminal de la teneurine (TCAP)-1 dans des cellules hypothalamiques de souris immortalisées

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Teneurin c-terminal associated peptide-1 (TCAP-1) is a bioactive peptide with 40-41 residues discovered at the C-terminal domain of transmembrane adhesion proteins called teneurins. TCAP-1 is highly expressed in limbic system and hypothalamus and was demonstrated to modulate anxiety and stress in mice by reorganizing neuronal circuitry. At cellular level, TCAP-1 induced neurite growth and displayed neuroprotective properties which may be associated to regulation of energy expenditure, glucose uptake, and increase in ATP production. In this study, we investigated phosphoinositol 3-kinase (PI3K) activity in immortalized mouse hypothalamic embryonic neuronal cells lines (mHypoE-38) treated with TCAP-1. We immunoblotted for phospho-PI3K and compared it to insulin treatment, a well known activator of PI3K. We also used pharmacological inhibitor, NVP-BEZ235, to block PI3K activity and assayed for phosphorylation of its downstream target, Akt. Although there were conflicting results in our study, TCAP-1 was observed to generally modulate the PI3K/Akt pathway.

Characterization of new inbred flour beetle lines generated to study effects of parasitism on host reproduction Caractéristiques de nouvelles lignées de triboliums générées pour étudier les effets du parasitisme sur la reproduction de l'hôte

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Inbred lines of flour beetles, such as those developed during the early days of research on the population biology of flour beetles, *Tribolium* spp., have been used successfully to study various aspects of their host-parasite relationship with the tapeworm *Hymenolepis diminuta*. We recently developed numerous lines of *Tribolium confusum* selected through brother-sister mating for their production of “nude” eggs, which lack the sticky outer coat typical for this species. “Nude” eggs are expected to have altered susceptibility to desiccation and egg cannibalism, and reduced energy input by the parent. Here, we report on characterization of four of these lines. Of the traits examined to date, the lines differ in proportion of nude eggs produced, adult body size, potential for population growth and susceptibility of adult beetles to infection by *H. diminuta*.

On the enigma of gastropod coiling direction: Why are sinistral gastropods so rare?

Sur l'éénigme de la direction d'enroulement des gastéropodes: Pourquoi les gastéropodes de forme sénestre sont si rares?

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The vast majority of living gastropods -- well over 90% -- are dextral (right-coiled). Among marine gastropods, dextral species are even more dominant (over 95%). This predominance of dextral species contrasts sharply with other animal groups that exhibit fixed asymmetries, like flatfish and spirorbids polychaetes, where right-handed

(dextral) and left-handed (sinistral) species are both common. Even in other molluscs, like inequivalve bivalves & fossil conispiral cephalopods, both dextral and sinistral forms are common. An exhaustive survey of asymmetry variation in gastropods provides answers to two basic questions: How many species are actually sinistral in various gastropod groups? How many independent evolutionary origins of sinistrality have occurred? Analyses of relations between the prevalence of sinistrality (or number of independent evolutionary origins of sinistrality) and total species diversity at various taxonomic levels provide hints about why sinistrality is so rare in gastropods despite multiple independent evolutionary origins.

Functional characterization and expression analysis of the myoinhibiting peptide receptor in the haematophagous hemipteran, *Rhodnius prolixus*

Caractérisation fonctionnelle et analyse de l'expression du récepteur du peptide myo-inhibiteur chez l'hémiptère hématophage, *Rhodnius prolixus*

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Myoinhibiting peptides (MIPs) are a family of insect neuropeptides whose primary structure is characterized by an amidated carboxyl-terminal motif consisting of a conserved pair of tryptophan residues separated by six non-conserved amino acids (WX6W-NH₂). Interestingly, the MIPs appear to be the ancestral ligands of the sex peptide receptor in the fruit fly *Drosophila melanogaster*, which plays an important role in courtship and reproduction. Recently, several endogenous MIPs were discovered in the Chagas disease vector, *Rhodnius prolixus*, having both conserved (WX6W-NH₂) and atypical (WX7W-NH₂) carboxyl-terminal motifs. Physiological functions of MIPs are plentiful and include inhibition of visceral muscle activity; a role that has been illustrated on hindgut in *R. prolixus*. In order to establish novel physiological targets and elucidate actions for the MIPs in *R. prolixus*, we have isolated and functionally-characterized the endogenous MIP receptor and examined the binding affinity of the MIPs with both the typical WX6W-NH₂ and atypical WX7W-NH₂ carboxyl-terminal motifs. Interestingly, alternative splicing of the RhoprMIP receptor gene yields two receptor isoforms, namely RhoprMIPr1 and RhoprMIPr2. Notably, only the RhoprMIPr1 isoform, which has a seven transmembrane predicted topology in common with other G protein-coupled receptors, is dose-dependently activated by the endogenous MIPs with an EC₅₀ ranging from 13-42 nM. Finally, we utilized RNAi-mediated knockdown of transcripts encoding the MIP prepropeptide as well as the MIP receptor in order to infer novel physiological roles for the MIP neuropeptides in *R. prolixus*.

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Functional identification and RNAi-mediated knockdown of a serotonin receptor expressed in the renal tubules of the Chagas disease vector, *Rhodnius prolixus*

Identification et inhibition par interférence de l'ARN d'un récepteur sérotonergique exprimé dans les tubules rénaux de l'insecte vecteur de la maladie de Chagas, *Rhodnius prolixus*

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Two diuretic hormones have been identified in *Rhodnius prolixus* which work synergistically to increase Malpighian (renal) tubule (MT) fluid secretion rates by over 1000-fold during the rapid diuresis that follows engorgement of vertebrate blood. One of these diuretic hormones is the biogenic amine, serotonin (5-hydroxytryptamine, 5-HT), which plays a variety of additional roles in *R. prolixus* including plasticization of the cuticle, stimulation of salivary gland secretion, stimulation of absorption by the anterior midgut, increasing dorsal vessel contractions (i.e. cardioactive), and myotropic activities on various visceral tissues (e.g. salivary glands, anterior midgut, hindgut). In order to better understand the signaling mechanisms linked to the various physiological roles of 5-HT, we have isolated a 5-HT receptor in *R. prolixus*, Rhopr5HTR, and functionally characterized its activation characteristics using various receptor agonists, antagonists, and other insect biogenic amines. The Rhopr5HTR receptor, which shares high sequence similarity to the mammalian 5HT2A receptor subtypes, was dose dependently activated by 5HT (EC₅₀ = 288 nM). Rhopr5HTR expression analysis by quantitative PCR reveals a variety of tissues that may be sensitive to this neurohormone, including those previously established (MTs, anterior midgut, salivary glands, hindgut), as well as novel targets which will be investigated in future studies. We utilized RNAi-mediated knockdown of Rhopr5HTR in order to examine the importance of the 5HT neuroendocrine system in processes related to the rapid diuresis that ensues after engorgement of vertebrate blood. These findings confirm that 5HT signaling plays an essential role in the rapid diuresis that follows gorging, and in addition, 5HT signaling is vital for coordinating an array of other feeding-related activities, which are required for normal development.

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GABAergic spike arrest is mediated by decreased reactive oxygen species generation in anoxia-tolerant turtle cortex

La suppression GABAergique des potentiels d'action est médieée par une diminution de la production d'espèces réactives de l'oxygène dans le cortex de la tortue tolérante à l'anoxie

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In anoxic mammalian brain, mitochondrial ATP production ceases and neurons are unable to produce sufficient ATP to meet cellular demands. As a result, ATP dependent ion pumping is compromised and the consequent loss of membrane ion gradients elicits membrane depolarization, hyper-excitability and cell death. This does not occur in the cortex of the Western Painted turtle *Chrysemys picta bellii*, instead γ -aminobutyric acid (GABA) concentration increases 80 fold and electrical activity decreases 75-95% (i.e. spike arrest). During anoxia, electrical suppression results primarily from increased GABA(A) receptor-mediated postsynaptic currents (PSC) that shunt excitatory input, thereby preventing excessive action potential (AP) firing. The signaling pathway responsible for initiating GABAergic neuroprotection in this system is unknown but may involve the decrease in reactive oxygen species (ROS) that occurs following the onset of anoxia. To test this, we asked if changes in [ROS] regulate GABA(A) receptor-mediated PSCs. Using whole-cell and perforated patch clamp techniques and live cell fluorescent imaging we determined that, similar to anoxia, ROS scavenging with mercaptopropionyl glycine (MPG) or N-acetylcysteine (NAC) cause: 1) reduced cortical ROS production, 2) GABA(A) receptor-mediated PSCs to double in amplitude resulting in an increase in whole cell conductance; 3) a shift in membrane potential to the GABA reversal potential (EGABA) and 4) electrical suppression. We conclude that an anoxic decrease in ROS production is the signal that increases GABA(A) receptor currents during anoxic stress.

Sudden and swift: extreme movements in biology

Mouvements extrêmes en biologie

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From exploding fungi to spearing shrimp, fast movements in biology are generated through a set of core physical principles. Like a bow and arrow, extremely fast biological systems store up elastic energy in advance and release it rapidly to amplify the power output. Two superlative power-amplifiers are found in mantis shrimp (Stomatopoda) and trap-jaw ants. Mantis shrimp use a spring and latch system to propel their predatory appendages at speeds of up to 24 m/s and peak impact forces that are thousands of times their body weight. In addition, the appendages move so quickly in water that cavitation occurs – a physical phenomenon that yields a massive pressure wave in addition to heat (similar to the surface of the sun), light and sound. Trap-jaw ants use a spring and latch system to propel their jaws at over 60 m/s and accelerations of 10^5 g's. These high accelerations allow the ants to generate large peak forces with their mandibles. Some trap-jaw ant species actually jump with their jaws. These remarkably fast feats are even more intriguing when placed in the context of their evolutionary diversification. The combination of biomechanics and evolutionary analyses provides rich potential for humans to learn new ways to generate fast and powerful movements with potently strong and efficient building materials.

Des champignons qui explosent aux crevettes au harpon, des mouvements rapides dans la monde biologique sont générés par un ensemble de principes physiques fondamentales. Comme un arc et des flèches, les systèmes biologiques extrêmement rapide rassemblent l'énergie élastique à l'avance et relâchez-le rapidement pour amplifier la puissance de sortie. Deux amplificateurs de puissance superlatifs se trouvent dans les crevettes mantis (Stomatopoda) et les fourmis de mâchoires à piège. Les crevettes mantis utilisent un système à ressort et verrouillage pour propulser leurs appendices prédateurs à des vitesses allant jusqu'à 24 m/s et avec des forces d'impact qui sont des milliers de fois leur poids corporel. En outre, les appendices se déplacer si rapidement dans l'eau que la cavitation se produit - un phénomène physique qui produit une onde de pression massif en plus de la chaleur (similaire à la surface du soleil), la lumière et le son. Les fourmis de mâchoire à piège utilisent un système à ressort et verrouillage pour propulser leurs mâchoires à plus de 60 m/s et des accélérations de 10^5 g. Ces accélérations élevées permettent aux fourmis de générer des forces de pointe énormes avec leurs mandibules. Certaines espèces de fourmis de mâchoires à pièges fait sauter avec leurs mâchoires. Ces exploits remarquablement rapides sont encore plus intriguant quand ils sont placés dans le cadre de leur diversification évolutive. La combinaison de la biomécanique et l'analyse de l'évolution fournit une potentiel riche pour l'homme d'apprendre de nouvelles façons de générer des mouvements rapides et puissants avec des matériaux de construction forts et efficaces.

Distribution and physiological effects of adipokinetic hormone (AKH), corazonin and AKH/corazonin-related peptide (ACP) in the kissing bug, *Rhodnius prolixus*

Distribution et effets physiologiques de l'hormone adipocinétique (AKH), de la corazonine et du peptide associé au AKH/corazonine (ACP) chez la punaise hématophage, *Rhodnius prolixus*

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Rhodnius prolixus is a medically important Hemipteran that serves as a vector of Chagas disease. We have investigated the distribution and physiological effects of three sequence-related peptides: adipokinetic hormone (AKH), corazonin (CRZ) and AKH/corazonin-related peptide (ACP) in *R. prolixus*. Immunohistochemistry revealed that AKH, CRZ and ACP are not co-localized but are found within a different subset of cells and processes within the central nervous system. Heart contraction assays used to examine the effects of the peptides on heartbeat frequency revealed that of all three peptides examined, only CRZ significantly increased the heart rate. The ability of the peptides to mobilize lipid in the haemolymph was also tested and results showed that of the three, only AKH significantly increased lipid levels. Overall, this study confirms the presence and distribution of AKH, CRZ and ACP and examines their effects on heart rate and lipid levels in *R. prolixus*.

The role of angiogenesis during regeneration

Le rôle de l'angiogenèse lors de la régénération

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Angiogenesis is defined as the outgrowth of new blood vessels from existing vascular networks. While angiogenesis is known to play critical roles during development, tumour progression, and wound healing, its significance during regeneration remains poorly understood. We investigated the role of angiogenesis during regeneration in the leopard gecko (*Eublepharis macularius*). This species is capable of spontaneously regenerating the tail, including blood vessels, following tail loss. Geckos with regenerating tails were treated with a mimetic of the endogenous anti-angiogenic protein thrombospondin-1 (TSP-1). Following treatment a small mass of proliferating tissue accumulates at the site of tail loss but fails to undergo appreciable outgrowth. Furthermore, histological analysis reveals that differentiation of regenerated tissue is inhibited in tails of treated geckos. We conclude that angiogenesis is required for regenerative outgrowth and tissue differentiation, but not for the initiation of the regenerative program.

The mapping of quantitative trait loci associated with morphometrics and parr marks in an F2 cross of European and North American strains of cultured Atlantic salmon

Localisation des locus de caractères quantitatifs associés à la morphométrie et aux marques de tacons dans un croisement F2 de souches Européennes et Nord-Américaines de saumons Atlantiques d'élevage

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Mapping quantitative trait loci (QTL) for traits under consideration for genetic improvement is becoming more common for many aquatic species, including Atlantic salmon. The objective of the study to map QTL associated with length, weight, number of parr marks, colour contrast of skin to parr marks, and shape in three F2 hybrid families of European and North American strains of Atlantic salmon. GridQTL software was used, analysing male and female maps separately. A large QTL associated with parr mark number was found on Ssa16, explaining 44% of the phenotypic variance. Some QTL locations for particular traits were similar to those of other studies with purebred and backcross populations; however, many more QTL were detected in the hybrid F2s. The amount of genetic variation in colour and pattern displayed within the transAtlantic F2 families greatly exceeded the ranges seen in nature. Funding NSERC Strategic.

Biased signalling by two endogenous GnRH isoforms in goldfish, *Carassius auratus*: differential involvement of MEK1/2 in the control of pituitary cell function.

Signalisation biaisée par deux isoformes endogènes du GnRH chez le poisson rouge, *Carassius auratus*: Implications distinctes de MEK1/2 dans le contrôle des cellules pituitaires

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In goldfish, two endogenous gonadotropin-releasing hormones (GnRH-2 and GnRH-3) control gonadotropin (LH) and growth hormone (GH) release from pituitary cells through differential activation of intracellular signaling cascades. In this study, extracellular signal-regulated kinase kinase 1 and 2 (MEK1/2) involvement in GnRH actions on goldfish gonadotrope and somatotrope functions was investigated. Acute hormone release responses were analyzed in column perfusion, while long-term static incubations (2, 6, 12, and 24 hr) allowed for measurement of prolonged effects of GnRH on hormone release and cellular hormone content. Results demonstrate temporal differences in the involvement of MEK1/2 signalling that result in differential regulation of hormone release and hormone availability in a GnRH-isoform- and pituitary cell-type-specific manner. Furthermore, discontinuities between the temporal changes in hormone mRNA and protein levels suggest that hormone gene expression and protein synthesis are uncoupled in goldfish. (Supported by NSERC, Alberta Innovates Health Solutions, and the Killam Trusts.)

Juvenile shortnose sturgeon exhibit limited physiological responses to acute salinity exposure (Or, “Why I wish I was more like a sturgeon”)

Les juvéniles de l'esturgeon à museau court démontrent une réponse physiologique limitée lors d'exposition à la salinité aigüe (Ou, “Pourquoi j'aimerais parfois être un esturgeon”)

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As adults, shortnose sturgeon routinely enter saltwater to forage but little is known about how juveniles cope with the associated osmoregulatory pressures. We have assessed the effects of acute salinity exposure on juvenile shortnose sturgeon using various physiological endpoints, ranging from the hormonal stress response (i.e. cortisol) to swimming behaviour. Some metabolic changes and hydromineral imbalances were found following 24h in saline water, yet the primary stress response elicited by salinity exposure was much lower in juvenile shortnose sturgeon than commonly seen in response to other stressors or in other fish species. Furthermore, these disturbances appear to have little to no impact on the animals' overall swimming performance and abilities.

The adenosinergic modulation of central respiratory CO₂/pH sensitivity:

Modulation adénosinergique de la sensibilité centrale au CO₂ et pH des mécanismes respiratoires

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Amphibians can survive hypoxic periods by entering a state of metabolic depression. During hypoxia, extracellular adenosine [ADO] increases approximately 100X and this increase has been implicated in metabolic depression. This study examined whether adenosine-mediated mechanisms regulate or modulate breathing in the cane toad, *Bufo marinus*. An in vitro brainstem preparation, in which motor output from respiratory nerves served as an index of breathing (fictive breathing) was used to examine the effects of ADO, an A1R agonist (CCPA) and an A1R antagonist (DPCPX). These agents were applied acutely, to aCSF (40 min) at various pH levels (7.4, 7.8, 8.0); fictive breathing was recorded for 12h. At low pH, lower [ADO] decreased fictive breathing both immediately and post-treatment. Treatment with CCPA and DPCPX indicate that the A1R is responsible for this decrease. Overall, the results indicate that ADO modulates fictive breathing in both a concentration-dependent and pH- dependent manner.

Les amphibiens peuvent survivre des périodes d'hypoxie en entrant un état de dépression métabolique. Au cours de l'hypoxie, l'adénosine extracellulaire [ADO] augmente d'environ 100X et cette augmentation a été impliquée dans la dépression métabolique. Cette étude a examiné si les mécanismes médient par l'adénosine sont responsables pour réguler ou moduler la respiration dans le crapaud, *Bufo marinus*. Un préparation tronc cérébral in vitro, dans lequel la sortie du moteur à partir des nerfs respiratoires servi comme un indice de la respiration (respiration fictif) a été utilisé pour examiner les effets de ADO, un agoniste A1R (CCPA) et un antagoniste A1R (DPCPX). Ces agents ont été appliquées de façon aiguë, à aCSF (40 min) à des différents pH (7,4, 7,8, 8,0); respiration fictive a été enregistrée pour 12h. A un pH bas, inférieur [ADO] a diminué la respiration fictive tant dans l'immédiat et post-traitement. Le traitement par l'ACCP et DPCPX indiquent que le A1R est responsable pour cette diminution. Dans l'ensemble, les résultats indiquent que ADO est responsable pour moduler la respiration fictive à la fois d'une manière dépendante de la concentration et du pH.

The Effects of Feeding, Temperature, Sex, & Weight on Fictive Breathing in the Cane Toad, *Bufo marinus*

Les effets de l'alimentation, température, sexe et poids sur la respiration fictive chez le crapaud géant, *Bufo marinus*

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In vitro brainstem-spinal cord preparations, in which respiratory motor output is used as an index of breathing (fictive breathing), are frequently used to study the central generation of breathing in the absence of any peripheral input. However, there can be substantial variability between preparations even under identical conditions. We hypothesised that four different factors may contribute to this variability: the number of days post-feeding, room temperature during the experiment, gender and body weight. Data from 227 preparations, from experiments conducted over a period of 2.5 years were grouped according to these factors. Days post-feeding (DPF) had no effect on fictive breathing although there was a trend for an increase in breathing as the number of DPF increased. Room temperature had no effect. Female and larger toads displayed greater levels of fictive breathing compared to male and smaller toads, respectively.

Les préparations in vitro de la moelle épinière du tronc cérébral, dans lequel la sortie du moteur respiratoire est utilisé comme un indice de la respiration (respiration fictif), sont souvent utilisés pour étudier la génération centrale de la respiration en l'absence de tout contribution périphérique. Cependant, il peut y avoir une variabilité considérable entre les préparations, même dans des conditions identiques. Nous avons supposé que quatre facteurs peuvent contribuer à cette variabilité: le nombre de jours après le nourrissage, la température ambiante pendant l'expérience, le sexe et le poids corporel. Les données de 227 préparations, à partir d'expériences menées sur une période de 2,5 ans ont été regroupés en fonction de ces facteurs. Jours après l'alimentation (JAA) n'a eu aucun effet sur la respiration fictive bien qu'il y avait une tendance à une augmentation de la respiration comme le nombre de JAA augmenté. La température ambiante n'a eu aucun effet. Les crapauds femelles et plus larges ont affichés des niveaux plus élevés de la respiration fictive par rapport à les crapauds males et plus petits, respectivement.

Evaluating the potential of somatic cells from rainbow trout reproductive fluids to support virus infections.

Évaluation du potentiel des cellules somatiques du fluide reproductif de la truite arc-en-ciel à soutenir des infections virales

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Somatic cells found in rainbow trout reproductive fluids such as ovarian fluids and milt, and their ability to support viral infection have not been well documented. Previously, rainbow trout have been shown to shed viruses such as viral hemorrhagic septicemia virus (VHSV) in blood, urine, ovarian fluid (OF) and milt. However, whether VHSV was shed as free floating particles in OF and milt or through the concurrent shedding of infected somatic cells is unclear. To investigate the latter possibility, primary culture and cell lines were derived from the somatic cells of rainbow trout OF and milt. These cultures were exposed to 3 viruses, VHSV genotype IVb and IVa, and Frog virus 3 (FV3). Preliminary data shows that VHSV IVa can kill cell line from OF, while VHSV IVb cannot. FV3 can kill cell line from both OF and milt, and can also kill primary culture cells from OF.

Mechanisms of Brain Swelling in Ammonia-Sensitive Rainbow Trout

Mécanismes de l'inflammation cérébrale chez des truites arc-en-ciel sensibles à l'ammoniac

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In mammals, increased internal ammonia may arise from liver failure, leading to cerebral swelling and brain damage. In fishes, increased internal ammonia can result from sewage, municipal of industrial effluents and agricultural run-off, and following feedings. In the present study we determined if ammonia-induced brain swelling was related to over-activation of NMDA receptors in the brain, which are known to cause excitotoxicity when internal ammonia concentrations are elevated. Exposure of rainbow trout to high external ammonia (HEA; 1mmolL⁻¹ NH₄Cl) for 72h led to 6-fold increases in plasma ammonia, and 40% increases in brain tissue water content from 4.2 to 6.1 mL H₂O per g dry weight. This brain swelling was completely reversed upon re-introduction into ammonia-free water. However, brain swelling was not observed following administration of NMDA receptor antagonist MK801 prior to HEA. We conclude that over-activation of NMDA receptors contributes to ammonia-induced brain swelling in the trout brain.

Extended fasting evokes tissue-specific molecular immune response to lipopolysaccharide challenge in anadromous Arctic charr (*Salvelinus alpinus*)

Un jeûne prolongé occasionne une réponse immunitaire spécifique à des tissus en réponse au défi causé par lipopolysaccharides chez l'omble chevalier (*Salvelinus alpinus*)

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Arctic charr have developed adaptive mechanisms that enable them to cope with the strong seasonality of the Arctic environment. However, little is known about how seasonal changes in appetite and growth influence their ability to respond to an immune challenge. Anadromous Arctic charr that were fed/ fasted for 3 months were injected with lipopolysaccharide and sampled 8 and 96 hours post-injection. The molecular immune response in the liver and spleen were compared. We show that fasting does not compromise the ability of charr to express cytokines and acute phase proteins in response to lipopolysaccharide challenge. Interestingly, fasting up-regulates suppressors of cytokine signalling (SOCS-1, 2 and 3) in a tissue-specific manner. We propose that up-regulation of SOCS genes during fasting may be an adaptive response to restrict energy demanding pathways, including cytokine and growth hormone signalling. This highlights a role for the SOCS genes in integrating growth-immune processes.

Fibrinogen-related protein (FREP) 3 and its role in the snail immune response against trematodes
La protéine apparentée au fibrinogène 3 (FREP) et son rôle dans la réponse immunitaire contre les
trematodes chez l'escargot

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Fibrinogen-related proteins (FREPs) are unique molluscan immune factors composed of a conserved C-terminal fibrinogen domain joined to one or two, more variable N-terminal immunoglobulin (Ig) superfamily domains. These secretory molecules exist in various forms, some of which have been shown to undergo somatic diversification from limited germline sequences. FREPs are capable of precipitating trematode secretory/excretory products and siRNA-mediated knockdown studies have implicated FREP3 in susceptibility/resistance of the snail *Biomphalaria glabrata* to various trematode challenges, including those responsible for causing schistosomiasis a disease that affects about 207 million people worldwide. However, not much is known about the specific mechanisms through which FREPs elicit an immune response. Here, we discuss FREP3 function and ongoing in situ hybridization and immunohistochemistry approaches that are being used to determine the role that FREPs play in trematode recognition and clearance.

Parasitic Tetrahymena differ from free-living species in their behaviour and ability to destroy fish cells in a mixed cell culture system

Les espèces de Tetrahymena parasitiques et non-parasitiques diffèrent dans leur comportement et leur capacité à détruire des cellules de poisson dans une culture mixte

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Tetrahymena corlissi is a parasite of ornamental fish, feeding on host tissue. The related *T. canadensis* has only been described as free-living. When maintained in mixed cell culture with fish cells in vitro, these ciliates showed differences in their destruction of fish cell monolayers. When in contact with a monolayer, *T. corlissi* swam in close contact with the monolayer surface rather than throughout the volume of the medium. In time these ciliates caused damage to the monolayer, and areas of damaged fish cells attracted large numbers of ciliates that destroyed the culture of fish cells. In contrast, *T. canadensis* survives in the mixed cell culture system but cannot cause damage to the fish cells. The swimming behaviour of *T. canadensis* does not show directed-movement to the surface of intact or damaged monolayers. This platform allows further research into the differences between parasitic and free-living species of the same genus.

Physical Characterization of Fibres Produced from Recombinant Vimentin

Caractérisation physique des fibres produites à partir de la vimentine recombinée

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Recent attention has focused on utilizing renewable resources as an alternative to petroleum-based polymers. Previous work has demonstrated that intermediate filament (IF) proteins found in hagfish slime threads undergo an $\alpha \rightarrow \beta$ transition when strained, resulting in superior mechanical properties; however, these properties are not observed in fibres made from solubilized slime threads. In this study, we produced fibres from another IF protein, vimentin, using both solubilized vimentin and hydrogels of assembled 10 nm vimentin filaments. Fibres made from solubilized vimentin protein did not display mechanical properties as impressive as fibres made from filaments assembled in the presence of the cross-linkers Mg²⁺ or glutaraldehyde. Additionally, X-ray diffraction analysis of Mg²⁺ cross-linked fibres showed that draw-processing fibres induced an $\alpha \rightarrow \beta$ transition of the constituent proteins. These data show that fibres produced using hydrogels of assembled IFs can potentially be used for the production of protein-based materials.

Récemment, l'attention s'est concentrée sur l'utilisation des ressources renouvelables comme une alternative aux polymères à base de pétrole. Des travaux antérieurs ont démontré que les protéines de filaments intermédiaires (FI) présentes dans les fils de la bave myxine subi une transition $\alpha \rightarrow \beta$ quand tendues, ce qui entraîne des propriétés mécaniques supérieures. Cependant, ces propriétés ne sont pas observées dans les fibres fabriquées à partir de fils de bave solubilisés. Dans cette étude, nous avons produit des fibres provenant d'un autre FI protéine, la vimentine, utilisant à la fois solubilisée vimentine et les hydrogels d'assemblés de filaments de vimentine de 10 nm. Les fibres fabriquer de protéine vimentine solubilisée n'ont pas démontrer les propriétés mécaniques aussi imposant que les fibres fabriquer des filaments assemblés avec la présence des agents de réticulation (glutaraldéhyde ou Mg²⁺). De plus, l'analyse par diffraction des rayons X des fibres réticulées avec Mg²⁺ a montré que le traitement d'étirage des

fibres induit une transition $\alpha \rightarrow \beta$ des protéines constitutives. Ces données montrent que les fibres produites à l'aide des assemblés de FI en hydrogels peuvent potentiellement être utilisés pour la production de matériaux à base de protéines.

Molecular mechanisms involved in sea lice (*Lepeophtheirus salmonis*) resistance to common chemotherapeutics

Mécanismes moléculaires impliqués dans la résistance du pou du poisson (*Lepeophtheirus salmonis*) aux produits thérapeutiques chimiques

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Sea lice (*Lepeophtheirus salmonis*) are an ectoparasitic copepod which affect salmonid aquaculture in Canada, Norway, Scotland and the United Kingdom. They impose a financial burden of close to 500 million dollars per year by feeding on the blood, mucus and skin of salmonids; causing severe skin lesions, increased stress, and often times mortality. The aquaculture industry depends on a limited number of treatments against sea lice, leading to overuse, and consequently problems with drug resistance. Emamectin benzoate (EMB) is amongst the most common treatments used against sea lice however due to resistance, the drug is presently administered in a triple dose formulation. The present study examined several mechanisms of drug resistance using quantitative polymerase chain reaction (qPCR) to monitor gene expression differences amongst resistant and susceptible lice populations when exposed to EMB. Atlantic salmon (*Salmo salar* L.) were exposed to either EMB-resistant or susceptible lice, and fed the prescribed dose of EMB at 50 µg/kg of fish biomass, for 7 days. Lice were collected at three time points including pre-EMB exposure, 1 day post EMB (dps), and 13 dps. For each time point, lice were enumerated and analyzed using qPCR, targeting P-glycoprotein (P-gp), involved in intracellular xenobiotic removal, peroxinectin, involved in lice feeding, and components of the cytochrome p450 pathway, responsible for drug oxidation and removal. Lice infection significantly decreased in both groups over time however there were no significant differences in lice infection between groups. EMB-resistant lice showed significantly higher expression of P-gp, peroxinectin, and CYP18A compared to susceptible lice at 13dps, in both males and females. These expression differences provide evidence of mechanisms and pathways that may be used by sea lice in resistance to EMB exposure.

The *ascl1a* and *dlx* genes have a regulatory role in the development of GABAergic interneurons in the zebrafish diencephalon

Les gènes *ascl1a* et *dlx* ont un rôle régulateur dans le développement des interneurones GABAergiques diencéphaliques chez le poisson zèbre

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During development of the mouse forebrain interneurons, the Dlx1/Dlx2 genes play a key role in a gene regulatory network (GRN) that leads to the GABAergic phenotype. Here, we have examined the regulatory relationships between the *ascl1a*, *dlx*, and *gad1b* genes in the zebrafish forebrain. Expression of *ascl1a* overlaps with *dlx1a* in the telencephalon and diencephalon during early forebrain development. The loss of *ascl1a* function results in a loss of *dlx* expression, and corresponding regulatory element activity, and subsequent losses of *dlx5a* and *gad1b* expression in the diencephalic prethalamus and hypothalamus. Loss of *Dlx1a* and *Dlx2a* function, and, to a lesser extent of *Dlx5a* and *Dlx6a*, impairs *gad1b* expression in the prethalamus and hypothalamus. We conclude that *dlx1a/2a* act downstream of *ascl1a* but upstream of *dlx5a/dlx6a* and *gad1b* to activate GABAergic development. This pathway is conserved in the diencephalon, but has diverged between mammals and teleosts in the telencephalon.

Durant le développement des interneurones du cerveau antérieur du souris, les gènes Dlx1/Dlx2 jouent un rôle importante dans un réseau de régulation génique (RRG) qui conduit au phénotype GABAergique. Ici, nous avons examiné les relations de réglementation entre les gènes *ascl1a*, *dlx*, et *gad1b* dans le cerveau antérieur du poisson zèbre. Expression de *ascl1a* chevauchements avec *dlx1a* dans le télencéphale et diencéphale au cours du développement précoce du cerveau antérieur. La perte de fonction de *ascl1a* entraîne une perte d'expression de *dlx*, aussi que l'activité des éléments de régulation correspondant, et subséquentes les pertes d'expression de *dlx5a* et *gad1b* dans le préthalamus diencéphalique et l'hypothalamus. Perte de fonction et *Dlx1a* *Dlx2a*, et, dans une moindre mesure, *Dlx5a* et *Dlx6a*, altère l'expression de *gad1b* dans la préthalamus et l'hypothalamus. Nous concluons que *dlx1a/2a* acte en aval de *ascl1a* mais en amont de *dlx5a/dlx6a* et *gad1b* pour activer le développement GABAergique. Cette voie est conservée dans le diencéphale, mais a divergée entre les mammifères et les téléostéens dans le télencéphale.

The role of hydrogen sulfide in the control of breathing of zebrafish (*Danio rerio*)

Le rôle du sulfure d'hydrogène sur le contrôle de la respiration du poisson-zèbre (*Danio rerio*)

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Hydrogen sulfide (H₂S) has been proposed as a possible oxygen sensing mechanism in the glomus cells of mammals and the neuroepithelial cells (NECs) of fish. The purpose of this project was to determine the role of H₂S in the control of breathing in larval and adult zebrafish. Adults and larvae exhibited a dose dependent increase in ventilation similar to the hypoxic ventilatory response (HVR) in response to sodium sulfide (an H₂S donor). Exposure to inhibitors of endogenous synthetic enzymes of H₂S, blunted the HVR in both adults and larvae. Immunohistochemistry of cultured NECs showed the presence of two H₂S synthetic enzymes in the NECs of adult zebrafish. Immunohistochemistry on whole larvae suggested the presence of H₂S synthetic enzymes in some but not all NECs. Taken together, these results support the idea that H₂S is involved in the oxygen sensing of zebrafish.

The innate antiviral effects of extracellular viral dsRNA in rainbow trout cells

Effets antiviraux innés de l'ARN viral à double brin extracellulaire sur des cellules de truite arc-en-ciel

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Almost all viruses produce double-stranded (ds) RNA sometime in their replicative cycle. Viral dsRNA is a potent trigger of innate immune responses in animals; activating the keystones of innate immunity, type I interferons (IFNs) and interferon stimulated genes (ISGs). DsRNA molecules produced in a cell during a virus infection are released into the extracellular environment during lytic viral infections. The effects of extracellular dsRNA in mammals are just beginning to be elucidated and almost nothing is known of its effects in fish. This study uses both commercially available dsRNA (poly IC) and in vitro transcribed dsRNA molecules, based on the viral hemorrhagic septicemia virus (VHSV) genome sequence, as stimuli to investigate the effects of these molecules on IFN and ISG production in fish cells. Using an IFN reporter system and RT-PCR we have found that extracellular dsRNA is able to induce innate antiviral responses in the fish cell line, RTG-2.

Identification and localization of an Rh glycoprotein in the gills of the Atlantic hagfish (*Myxine glutinosa*)

Identification et localisation d'une glycoprotéine Rh dans les branchies de la myxine du Nord (*Myxine glutinosa*)

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Hagfishes are considered the most ancient of the extant jawless fishes, they are exclusively osmoconforming marine animals with most living at considerable depths, and are the only living vertebrates to maintain their plasma NaCl concentration almost iso-osmotic to that of seawater. Hagfishes feed on dead and decaying carcasses located on the sea floor, often invading the carcass via an orifice and eating their way out. In such circumstances hagfish can be exposed to extreme conditions including elevated ammonia concentrations. We know very little about how these animals produce or rid themselves of nitrogenous wastes. In this study we have identified 2 orthologs of the Rh glycoprotein gene family from the gills of Atlantic hagfish. The hagfish Rhcg (hRHcg) shares a 56-60% amino acid identity to other vertebrate Rhc cDNAs. A polyclonal antibody was raised against the hRhcg amino acid sequence and immunolocalization studies were performed.

Les myxines sont considérés comme la plus ancienne des poissons sans mâchoires existantes. Ils sont des animaux marins exclusivement osmo-conformes avec la plupart vivant à des profondeurs considérables, et sont les seuls vertébrés vivants à maintenir leur concentration de NaCl en plasma presque iso-osmotique à celle de l'eau de mer. Les myxines se nourrissent de carcasses mortes et en décomposition situées sur le fond de la mer, souvent envahir la carcasse par un orifice et manger leur chemin. Dans de telles circonstances les myxines peuvent être exposés à des conditions extrêmes, y compris les concentrations d'ammoniac élevées. Nous savons très peu de la façon dont ces animaux produisent ou se débarrasser des déchets azotés. Dans cette étude, nous avons identifié deux orthologues de la famille gène de la glycoprotéine Rh dans les branchies du myxine Atlantique. Le Rhcg myxine (RHcgm) partage une identité d'acide aminé 56-60% avec les autres vertébrés ADNc Rhc. Un anticorps polyclonal a été soulevé à l'encontre de la séquence d'acides aminés hRhcg et des études d'immunolocalisation ont été réalisées.

Specialized tissues result in dramatic modification of the lower jaw in many spawning eusalmonines (trout and salmon)

Des tissus spécialisés produisent une modification spectaculaire de la mâchoire inférieure chez de nombreuses espèces de salmoninés (truites et saumons) lors de la fraie

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Many eusalmonines (trout and salmon) develop a kype, a unique, spawning-related lower jaw modification. The tissues of the kype are of great interest in developmental studies due to their unique nature, presence in the fossil record, and as yet unknown species-specific structure. Histological and paleohistological assessments of tissues taken from modern and fossilized individuals of the four eusalmonine genera (*Salvelinus*, *Hucho*, *Salmo*, and *Oncorhynchus*) and from two less derived salmonines (*Prosopium* and *Brachymystax*) were undergone. These assessments were used to establish presence or absence of the kype-associated tissues chondroid bone and Sharpey-fibre bone, and to compare the structure of these tissues across species. Initial assessments suggest that, while chondroid and Sharpey-fibre bone are both present in many members of Eusalmoninae, these tissues are apparently absent in other salmonine taxa. Furthermore, morphological differences in the kype may prove of interest in further developmental and taxonomic studies of the eusalmonines.

Does HEA, alkaline environments or salinity stress trigger ureotelism in the freshwater ribbon leech *Nephelopsis obscura*?

Est-ce que l'HEA, les milieux alcalins ou le stress associé à la salinité déclenchent la sécrétion d'urée chez la sanse d'eau douce, *Nephelopsis obscura*?

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The freshwater dwelling ribbon leech *Nephelopsis obscura*, like most aquatic invertebrates is ammonotelic excreting 164 ± 14 nmol gFW-1 h-1 ammonia, while a portion of its nitrogenous waste is also excreted as urea (14 ± 2 nmol gFW-1 h-1). Surprisingly, *N. obscura* demonstrates a high tolerance for, elevated environmental ammonia (HEA) (5mM NH₄Cl, 7 days, no mortalities) and environmental pH (pH 9.5, 7 days, no mortalities). The present study was designed to investigate whether factors such as HEA, pH stress or elevated environmental osmolality could trigger ureotelism in *N. obscura*. Utilizing colorimetric diacetylmonoxime assays, the body fluid urea concentration and flux rates will be measured following a 1-week exposure to the different stressors. Body ammonia concentrations and excretion rates will be measured to determine if ammonia remains the predominant excretory waste. We anticipate that ureotelism is induced to counter long term elevated body ammonia concentrations as spikes in urea excretions have been previously measured.

Mechanism of ammonia transport in the integument of the freshwater ribbon leech *Nephelopsis obscura*

Mécanisme de transport d'ammoniac dans le tégument de la sangsue d'eau douce, *Nephelopsis obscura*

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Generally, aquatic invertebrates excrete their nitrogenous waste products as ammonia. However, the mechanism of ammonia excretion remains relatively unclear especially in freshwater dwelling invertebrates. In the present study, we investigated the mechanism of ammonia excretion in the ribbon leech *Nephelopsis obscura*. Utilizing a whole animal experimental approach, we demonstrated that inhibition of the H⁺ ATPase and carbonic anhydrase reduced ammonia excretion. Conversely, application of Na⁺/H⁺ exchanger and Na⁺/K⁺ ATPase inhibitors resulted in no change in ammonia excretion. However, enzyme assays of skin localized Na⁺/K⁺ ATPase demonstrates the capability of this pump to utilize NH₄⁺ as a substrate. Furthermore, our results suggested that ammonia excretion in *N. obscura* depends on NH₃ diffusion down a partial pressure gradient likely via an identified Rh protein. The results of this study suggest an active ammonia excretion mechanism in the integument of *Nephelopsis obscura* similar to that proposed in the gills of freshwater fish.

Mitochondrial genotypes drive differential expression of nuclear genes under varied levels of hypoxia in Drosophila

Des génotypes mitochondriaux sont à la base de l'expression différentielle de gènes nucléaires sous différents niveaux d'hypoxie chez Drosophila

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Mitochondria are the primary site of oxygen consumption, but the effect of mitochondrial genotypes on the response to hypoxia has not been examined. Here we use mtDNA introgression strains of *Drosophila* to examine the effects of alternative mitochondrial genomes on the nuclear transcriptional response to varied hypoxia. The expression profiles of flies carrying mtDNA from either *D. melanogaster* or *D. simulans* on a *D. melanogaster* nuclear background were determined under two gradients of oxygen concentrations. MtDNAs have subtle effects on nuclear gene expression under normoxia (~30 genes altered), but have pronounced effects at 3% (>200 genes) and 6% oxygen (~500 genes). These results are confirmed in a hypoxia time course study. These results provide evidence for mitochondrial retrograde signaling in the nuclear transcriptional response to hypoxia and offer the first evidence that genes in mtDNA play a critical role in modulating the nuclear transcriptional response to hypoxia.

Les mitochondries sont le site primaire de la consommation d'oxygène, mais l'effet des génotypes mitochondriaux sur la réponse à l'hypoxie n'a pas été examinée. Ici, nous utilisons souches introgression ADNmt de la drosophile à examiner les effets des autres génomes mitochondriaux sur la réponse transcriptionnelle nucléaire à l'hypoxie varié. Les profils d'expression des mouches transportant soit l'ADNmt de *D. melanogaster* ou *D. simulans* sur un fond *D. melanogaster* nucléaires ont été déterminées dans deux gradients de concentrations d'oxygène. Les ADNmts ont des effets subtils sur l'expression des gènes nucléaires sous normoxie (~ 30 gènes modifiés), mais ont des effets prononcés à 3% (>200 gènes) et 6% d'oxygène (~500 gènes). Ces résultats sont confirmés par une étude décours temporel d'hypoxie. Ces résultats fournissent une preuve de signalisation rétrograde mitochondriale dans la réponse transcriptionnelle nucléaire à l'hypoxie et offrent la première preuve que les gènes de l'ADN mitochondrial jouent un rôle essentiel dans la modulation de la réponse transcriptionnelle nucléaire à l'hypoxie.

Using the extended Price equation to analyze patterns of body size change in mammals across the Paleocene-Eocene Thermal Maximum in North America

Utilisation de l'équation prolongée de Price pour l'analyse du changement de taille corporelle des mammifères autour du maximum thermal Paléocène-Éocène Nord-Américain

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An adaptation of the Price equation to analyze dwarfing in mammalian communities of the Bighorn and Clarks Fork Basins of Montana and Wyoming over an interval of global warming 56 million years ago, partitions variation into three components: non-random speciation and extinction of resident taxa, non-random immigration of taxa, and anagenetic changes (biased ancestor/descendant transmission). A well known decrease in mean mammalian body size during the earliest Wasatchian is principally driven by the many small-bodied taxa that make their first appearance during this time (primates, perissodactyls, artiodactyls, hyaenodontid creodontans). Our results reveal that non-random selection acting on resident taxa during the middle Clarkforkian to the middle Wasatchian generally favored smaller body sizes. In contrast, anagenetic changes favored larger body sizes over the same interval.

Following the earliest Wasatchian, body size changes resulting from the non-random immigration of taxa was minimal.

Hormonal zeitgebers to a photosensitive circadian clock that regulates steroid synthesis in the insect, *rhodnius prolixus*

Régulation de la synthèse stéroïdienne par une horloge interne photosensible répondant à des zeitgebers hormonaux chez l'insecte, *Rhodnius prolixus*

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The prothoracic glands (PGs) contain a photosensitive circadian clock controlling synthesis of the steroid molting hormones. We examined the response of the PG clock to internal hormonal Zeitgebers. Immunohistochemistry revealed the depletion of nuclear PER from PG cells in prolonged continuous light (LL). LL PGs were incubated in vitro and exposed to a 1h pulse of brain neuropeptide fractions: <10kDa or >10Kda. Expression and circadian cycling of PER were reinitiated by both fractions. Furthermore, both fractions were capable of reinitiating rhythmic ecdysteroid synthesis. PER is also depleted from PG cells in prolonged continuous darkness, but similar treatment of these PGs had no effect. The <10kDa fraction contains insulin-like peptides and the >10kDa fraction contains prothoracotrophic hormone, both of which have known effects on steroidogenesis by PGs. We infer at least two brain neuropeptide Zeitgebers are capable of contributing to entrainment of the PG clocks and driving rhythmic clock output (ecdysteroids).

An affordable calorespirometric approach for assessing the metabolic responses of fishes to hypoxia

Une approche peu dispendieuse pour mesurer le métabolisme de poissons sous hypoxie

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We are interested in addressing the longstanding hypothesis that metabolic rate suppression is an adaptation to hypoxia, but there arises a methodological problem: respirometry, the customary measurement of metabolic rate (MR) via consumed oxygen, is blind to anaerobic processes and therefore underestimates MR in hypoxia when oxygen-independent pathways are upregulated. A more comprehensive technique is necessary to accurately measure MR under such conditions, and the “gold standard” for doing so is calorimetry, the (underutilized) direct measurement of metabolic heat production. Prefabricated calorimeters being shamefully expensive, we have gone about building our own to assess the metabolic responses of fishes to hypoxia. Ours is capable of simultaneously quantifying the minute quantities of heat produced by fishes and their oxygen consumption rates, and, as such, can measure their hypoxia-induced metabolic adjustments, the ratio of aerobic-anaerobic processes that contribute to them, and ultimately, how these adjustments relate to overall hypoxia tolerance.

**Carotid chemoreceptors in *Tupinambis merianae*: morphological and physiological characteristics
Chémorécepteurs carotidiens chez *Tupinambis merianae*: caractéristiques morphologiques et physiologiques**

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We hypothesized there would be chemoreceptor cells homologous to mammalian carotid body cells at the carotid bifurcation of the tegu lizard, *Tupinambis merianae*. Injections of NaCN (a hypoxia mimetic) into the carotid artery of unanesthetized lizards produced cardiorespiratory reflex responses similar to those produced in response to hypoxia confirming that this area contains chemoreceptors sensitive to hypoxemia. These reflex responses consisted of an increase in respiratory frequency (fR) and heart rate (fH) while mean arterial blood pressure (MAP) remained unchanged. Injections of various neurotransmitters and their antagonists indicated that acetylcholine and serotonin, but not catecholamines, are involved in chemotransduction. This was further supported by immunohistochemical studies. These results provide compelling evidence for the existence of carotid artery chemoreceptors in lizards with similar properties to known carotid body homologs. Supported by the NSERC of Canada.

**Functional genomics research on the impact of elevated temperature on Atlantic cod immune responses
Recherche en génomique fonctionnelle sur l'impact d'une élévation de la température sur la réponse immunitaire de la morue de l'Atlantique**

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The effects of environmental stressors on fish immune responses are poorly understood. We used functional genomics (20K microarrays and QPCR) to study how a moderate increase in temperature (gradual increase from 10 to 16 degrees C) influenced the cod spleen transcriptome response to intraperitoneal injection of either a viral mimic (pIC) or bacterial antigens (formalin-killed *Aeromonas salmonicida*, ASAL). Microarrays showed that elevated temperature had a much greater overall impact on the anti-viral response than on the anti-bacterial response. For example, at 24 hours post-injection 339 genes were differentially expressed between pIC-treated fish held at 10 vs. 16 degrees C, compared with 2 genes differentially expressed between ASAL-treated fish held at these two temperatures. These results improve our understanding of how temperature influences fish immune responses to viral and bacterial stimuli and evoke new hypotheses on how elevated temperatures may influence the health and survival of farmed and wild Atlantic cod.

The expression of *Crassostrea gigas* alternative oxidase in *Saccharomyces cerevisiae*: investigations on function and structure

Expression de l'oxydase alternative de *Crassostrea gigas* chez *Saccharomyces cerevisiae*: Investigations de structure et fonction

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The alternative oxidase (AOX) is a cyanide-resistant quinol oxidase located in the electron transport chain (ETC) of many organisms. AOX catalyzes the reduction of oxygen to water, but does not pump protons across the inner mitochondrial membrane. Electron flow to AOX generates less ATP per oxygen consumed, compared to the cytochrome c oxidase pathway, making it energetically wasteful. The presence of AOX in some animals was first discovered in 2004 and remains to be fully characterized. We have expressed the AOX of *Crassostrea gigas* (Pacific oyster) using a galactose-inducible vector in the yeast *Saccharomyces cerevisiae*. Our experimental results using cyanide to inhibit the cytochrome c oxidase pathway indicate that the oyster AOX is functional in this system. An analysis of yeast mitochondrial proteins using SDS-PAGE and Western blots with an AOX antibody indicate that the protein is correctly targeted to yeast mitochondria.

HIF-1 mediates adaptive developmental plasticity of hypoxia tolerance in zebrafish, *Danio rerio*
HIF-1 sert d'intermédiaire à la plasticité adaptative du développement de la tolérance à l'hypoxie chez le poisson zèbre, *Danio rerio*

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In recent years natural and anthropogenic factors have increased aquatic hypoxia the world over. In most organisms the cellular response to hypoxia is mediated by the master regulator hypoxia-inducible factor-1 (HIF-1). HIF-1 also plays a critical role in the normal development of vertebrate embryos. We tested the hypothesis that acute induction of HIF-1 during embryogenesis will enhance hypoxia tolerance in subsequent developmental stages. Zebrafish embryos that acutely up-regulated the HIF-1 pathway had an increased hypoxia tolerance (lower critical oxygen tension, *Pcrit*) as larvae. Adult male fish had a lower *Pcrit* compared to females. Early induction of HIF-1, correlated directly with an increased proportion of males in the population. We conclude that mounting a HIF-1 response during embryogenesis has long-term impacts on the phenotype of later stages which could influence both individual fitness and population dynamics in increasingly hypoxic environments.

Polymorphism of major histocompatibility class I classical and non-classical genes in Arctic charr (*Salvelinus alpinus*)

Polymorphisme de gènes classiques et non classiques de classe I du complexe majeur d'histocompatibilité chez l'omble chevalier (*Salvelinus alpinus*)

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Major Histocompatibility (MH) genes are involved in distinguishing between self and non-self molecules. Classical MH genes encode membrane receptors that present peptides to T-lymphocytes in order to initiate an immune response. The functions of non-classical genes are not well understood, although they are involved in other physiological processes. We examined four class one genes UCA, UEA, UGA and UBA in Arctic charr. UBA is known to be a classical gene in several salmonids and this seems to be the case in Arctic charr. Our results further suggest that Arctic charr might have a second classical gene, UGA, which is generally considered to be non-classical in other salmonid species. Arctic charr have an exceptional ability to adapt to varied environments and are noted for ecological plasticity. The use of two classical genes, both UBA and UGA in the defense against local pathogens might be one mechanism that facilitates such plasticity.

Detecting SNP association with resistance to the salmon louse in Atlantic salmon

Détection des associations entre SNP et la résistance au pou du saumon chez le saumon de l'Atlantique

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Our objective was to detect single nucleotide polymorphism (SNP) associated with salmon louse resistance in a population of Saint John River Atlantic salmon. In 2011 we challenged recent smolts with 90 copepodids each and in 2012 another group of recent smolts with 100 copepodids each. Fish were euthanized once the lice reached the chalimus stages and lice count, sex, tank and weight were recorded. We used a multiple trait model to estimate breeding values for parents of challenged fish using fresh water weights collected on the parent generation and the salt water weights and lice counts collected on the challenged fish. Using 299 individuals in the parent generation that had deregressed estimated breeding values and had been genotyped for 3638 SNPs, we detected 70 SNP associations using a forward regression. In the future, improved resistance, a heritable trait, could be changed through selection.

Notre objectif était de détecter un polymorphisme nucléotidique solitaire (PNS) associée à la résistance à pou du saumon dans une population de saumon de l'Atlantique de la rivière Saint John. En 2011, nous avons contesté ces dernières saumoneaux avec 90 copépodes chacun et en 2012 un autre groupe de saumoneaux récentes avec 100 copépodes chacun. Les poissons ont été euthanasiés dès que les poux a atteint le stade chalimus et la numération des poux, le sexe, le réservoir et le poids ont été enregistrés pour chaque poisson. Nous avons utilisé un modèle de plusieurs caractères pour estimer les valeurs d'élevage pour les parents de poissons contesté en utilisant les poids d'eau douce recueillies sur la génération des parents et les poids d'eau salée et le nombre de poux prélevés sur le poisson en question. En utilisant 299 individuelles dans la génération des parents qui avaient des valeurs d'élevage estimées dérégressé et avait été génotypés pour 3638 SNP, nous avons détecté 70 associations SNP en utilisant une analyse de régression. À l'avenir, la meilleure résistance, un trait héréditaire, peut être modifié grâce à la sélection.

Pre-conditioning and cross-tolerance between hypoxia and ammonia exposure in zebrafish (*Danio rerio*)
Pré-conditionnement et tolérance croisée entre l'hypoxie et l'exposition à l'ammoniac chez le poisson zèbre (*Danio rerio*)

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Fish routinely live in environments where they may be exposed to low and variable levels of O₂. In these same environments, fish experiencing hypoxia may also be subjected to elevated ambient ammonia. A positive correlation has been established between hypoxia tolerance and high external ammonia (HEA) tolerance among fish species suggesting that there is a mechanistic link between hypoxia and HEA survival. The goal of this study was to determine in zebrafish (*Danio rerio*) whether pre-conditioning to one stressor (hypoxia or HEA) improved performance during exposure to the other stressor (cross-tolerance). Pre-conditioning to mild hypoxia (175% of 8h EC50) enhanced ammonia tolerance by 3.8-fold and pre-conditioning to mild HEA (25% of 8h EC50) increases hypoxia tolerance by 2-fold. To help identify the mechanisms underlying this cross-tolerance, we used oligo-microarrays to identify common pathways regulated by hypoxia and HEA. (Funded by NSERC to JGR).

Les poissons vivent régulièrement dans des environnements où ils peuvent être exposés à des niveaux variables ou faibles d'O₂. Dans ces mêmes milieux, les poissons qui expérimentent l'hypoxie peuvent également être soumis à un niveau élevé de l'ammoniac. Une corrélation positive a été établie dans les espèces de poissons entre la tolérance à l'hypoxie et la tolérance à haute ammonia externe (HAE), suggérant qu'il existe un lien mécanique entre l'hypoxie et la survie dans les conditions HAE. Le but de cette étude était de déterminer chez le poisson zèbre (*Danio rerio*) si le pré-conditionnement à un facteur de stress (hypoxie ou HAE) améliore les performances des poissons lors de leurs exposition à la stress alternatif (tolérance croisée). Pré-conditionnement à l'hypoxie légère (175% de 8h CE50) augmente la tolérance d'ammoniac de 3,8 fois et pré-conditionnement à légère HAE (25% de 8h CE50) augmente tolérance à l'hypoxie par un facteur de 2. Pour aider à identifier les mécanismes qui sous-tendent cette tolérance croisée, nous avons utilisé des oligo-puces à ADN pour identifier les voies communes réglementées par l'hypoxie et HAE. (Financé par le CRSNG à JGR).

ATP-binding cassette transporters and anoxic depolarization in the brain of *Drosophila melanogaster*
Les transporteurs cassette de l'ATP et la dépolarisation anoxique dans le cerveau de *Drosophila melanogaster*

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The white gene encodes an ATP-binding cassette (ABC) transporter with a functional role in the CNS. White mutants have a decreased sensitivity to volatile general anesthetics, profoundly impaired aggression and reduced levels of biogenic amines in the brain. Transmitter uptake from the extracellular space by glia may be white-dependent. We examined the role of the White ABC transporter in the sensitivity to anoxia by comparing a wild-type strain (Canton S) with a white null mutant (w1118). We measured the dynamics of extracellular potassium ([K⁺]_o) in the CNS during repetitive anoxic depolarizations (AD). Compared with wild-type the amplitudes of the [K⁺]_o disturbances were decreased in the null mutant. Measuring the latency to AD after onset of nitrogen exposure showed that mutants were less susceptible to anoxia after the first exposure whereas wild-type were more susceptible. We propose that ABC transporters have a role in the CNS response to anoxia in *Drosophila*.

Fine-scale 3-D movements of sea lamprey immediately downstream of traps in the st marys river
Mouvements tridimensionnels précis de la lamproie marine immédiatement en aval de pièges tendus dans la rivière St. Mary

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We examined the movements of invasive sea lamprey downstream of traps in the St Marys River. Trapping efficiency is limited because many individuals do not encounter traps. We used acoustic telemetry to track sea lamprey approaching traps along the wall of a hydroelectric station. 3-D positions were used to test whether low encounter with traps was due to sea lamprey (i) not reaching the power plant wall, (ii) reaching the wall, but aggregating away from traps, or (iii) reaching the wall, but spreading uniformly across the wall. Contrary to (i), >90% of tagged lampreys entering the hydrophone array made it to the dam face. Contrary to (ii), and consistent with (iii), sea lamprey activity was spread across the wall both vertically and horizontally, often away from traps. Understanding space use in the vicinity of traps can provide useful insights into behaviours that can influence the success of trapping for control.

Nous avons examiné les mouvements des lampreies marines invasives en aval de pièges dans la rivière St. Marys. L'efficacité de piégeage est limitée parce que nombreuses lampreies ne rencontrent pas de pièges. Nous avons utilisé la télémétrie acoustique pour suivre les lampreies marines qui s'approchent des pièges le long de la paroi d'une station hydroélectrique. Les positions 3-D ont été utilisées pour tester si la faible taux de rencontre avec des pièges est due à la fait que les lampreies marines (i) jamais atteindre le mur de la station électrique, (ii) atteindre le mur, mais regrouper loin des pièges, ou (iii) atteindre le mur, mais répandre uniformément à travers le mur. Contrairement à (i), > 90% des lampreies marqués entrant dans le réseau d'hydrophones ont attenu le mur de la barrage. Contrairement à (ii), et conformément à (iii), l'activité de la lamproie marine a été étendue à travers le mur (à la fois verticalement et horizontalement), souvent loin des pièges. Comprendre l'utilisation de l'espace dans le voisinage des pièges peuvent fournir des indications utiles sur les comportements qui peuvent influencer le succès de piégeage.

Impact of aldosterone and corticosterone on respiratory control in bullfrog tadpoles (*Lithobates Catesbeianus*): An in vitro study

Impacte de l'aldostérone et de la corticostérone sur le contrôle respiratoire chez le ouaouaron (*Lithobates catesbeianus*): Une étude in vitro

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The emergence of air breathing during amphibian development requires significant changes in the respiratory control system. Because metamorphosis is a tightly regulated by several hormones, we tested the hypothesis that exposing the brainstem to corticosterone or aldosterone augments the fictive air breathing frequency in brainstem preparation from bullfrog tadpoles (*Lithobates catesbeianus*). Following anesthesia, we isolated the brainstem which is then placed in a recording chamber where it is superfused with an oxygenated artificial cerebrospinal fluid. Fictive breathing was then recorded extracellularly by placing suction electrodes on cranial nerves V and X. Aldosterone (100nM) or corticosterone (100nM) were then applied separately for 1 h. Fictive breathing was monitored during hormone application and recovery (1 h). Results obtained to date revealed no significant increase in the fictive air breathing frequency with the separate application of aldosterone and corticosterone. We propose that the concomitant presence of other hormones (e.g. thyroid hormone T3) may be necessary to alter breathing pattern.

Investigation of a potential relationship between intestinal Na⁺ uptake and ammonia handling in freshwater rainbow trout (*Oncorhynchus mykiss*)

Investigation d'une éventuelle relation entre l'absorption intestinale de Na⁺ et le traitement de l'ammoniac chez la truite arc-en-ciel (*Oncorhynchus mykiss*)

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Very high levels of ammonia occur in the intestinal chyme of rainbow trout *in vivo*. An *in vitro* analysis of ammonia handling in the freshwater rainbow trout (*Oncorhynchus mykiss*) intestine was conducted to investigate a potential coupling between ammonia handling and intestinal Na⁺ uptake. Though the pairing of ammonia excretion and Na⁺ uptake at the gills has been extensively studied, no such analysis has been conducted on the gut. Interestingly, we have observed that intestinal Na⁺/K⁺ ATPase can be activated by NH₄⁺, a phenomenon which does not occur at the gills. Furthermore, exposure of the intestinal segments (anterior, mid, and posterior intestine) to a Na⁺-free saline using the *in vitro* gut sac technique caused reduced ammonia flux across the tissue. Similar *in vitro* experiments with a variety of pharmacological inhibitors of Na⁺-transport cast light on the relationship(s) between intestinal ammonia handling and Na⁺ uptake. (NSERC Discovery, Canada Research Chair Program).

Hanging out : digit and limb orientation during vertical clinging in Bibron's gecko (*Chondrodactylus bibronii*)

On s'accroche: orientation des doigts et des membres pendant l'adhérence verticale chez le gecko de Bibron (*Chondrodactylus bibronii*)

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The manus and pes of pad-bearing gekkotan lizards are essentially symmetrical in form, with the digits arrayed around a broad arc that exceeds 180°. It has been suggested that this configuration of the adhesive pads is adaptive in that it enables effective adhesion regardless of body attitude, with different subsets of the total setal battery being differentially effective in different body orientations. We investigated this possibility by examining digit and limb orientation in free-ranging Bibron's geckos clinging to vertical surfaces in voluntarily assumed resting postures – head-up (“North”); head-down (“South”); head-to-the-left (“West”); and head-to-the-right (“East”). Digit directional orientation differs when North and South body orientations are compared, but in the West and East postures they were mirror-image equivalents. Construction of rose diagrams of digit orientation permits assessment of patterns of digit orientation in different resting postures, and allows determination of which digits are best aligned with the gravitational vector.

Improving understanding of endocrine-active compounds in pulp and paper mill condensates using a mummichog (*Fundulus heteroclitus*) bioassay

Utilisation d'un test biologique avec le choquemort (*Fundulus heteroclitus*) pour comprendre le fonctionnement des composés endocriniens actifs dans les condensats de pâtes et papier

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In the mid 1990s, investigation of cause studies began at a bleached kraft pulp mill located in Saint John, NB, Canada with the goal to identify waste stream(s) in the mill containing endocrine-active contaminants. Linking of the 5th effect chemical recovery condensate stream to endocrine effects led to a development of a solid phase extraction (SPE) technique to isolate EDSs in the condensate stream. To determine if the condensates continue to be endocrine-active in exposed mummichog (*Fundulus heteroclitus*), a 14-day concentration-response experiment demonstrated that a 4% (v/v) concentration of whole condensates significantly depressed circulating plasma testosterone in male mummichog, with no effects on other plasma steroid hormones measured. Hepatic CYP1A and CYP3A were also significantly induced in exposed fish. A follow-up exposure returned inconsistent results. The 4% (v/v) concentrations did not alter plasma steroid levels and neither did SPE fractions derived from the condensates. While fish were in different reproductive periods, which may account for some of the differences between the experiments, a more compelling explanation is the variability in the chemical make-up of the condensates.

Effects of deoxynivalenol contaminated feed on rainbow trout (*Oncorhynchus mykiss*) experimentally infected with *Flavobacterium psychrophilum*

Effets des aliments contaminés avec le déoxynivalénol sur la truite arc-en-ciel (*Oncorhynchus mykiss*) infectée expérimentalement avec *Flavobacterium psychrophilum*

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Substitution of fishmeal with plant-based proteins has lead to the increased risk of mycotoxin exposure in cultured fish species. Deoxynivalenol (DON), a Fusarium mycotoxin is of great concern as it is the most commonly occurring mycotoxin worldwide. However, its potential impact on fish health and its mechanism of action are largely unknown. Therefore the objectives of the current research are to determine if DON exposure has any impact on the susceptibility of rainbow trout to bacterial cold-water disease and immunity, including immunoglobulin production and macrophage function. Rainbow trout were fed a nutritionally complete, naturally contaminated diet with deoxynivalenol (4 or 6ppm) over a four-week period. Following exposure rainbow trout were experimentally infected with *Flavobacterium psychrophilum* and monitored for mortalities. A reduction ($p<0.05$) in mortalities in DON-fed groups was observed in comparison to control and pair-fed groups. Restricted dietary intake was also observed to influence the percentage of mortalities post infection.

La substitution de la farine de poisson avec des protéines à base de plantes a conduit à l'augmentation du risque d'exposition aux mycotoxines dans les espèces de poissons d'élevage. Déoxynivalénol (DON), une mycotoxine de Fusarium est très préoccupante car elle est la mycotoxine la plus fréquemment rencontrés dans le monde. Toutefois, son impact potentiel sur la santé des poissons et son mécanisme d'action restent largement méconnus. Par conséquent, les objectifs de la présente recherche est de déterminer si l'exposition DON a une incidence sur la sensibilité de la truite arc-en-ciel au maladies de bactérie de l'eau froide et l'immunité, y compris la production d'immunoglobulines et de la fonction des macrophages. Truite arc-en-ciel ont été nourris avec une nourriture complète, mais naturellement contaminé par du déoxynivalénol (4 ou 6 ppm) sur une période de quatre semaines. Après exposition, les truites arc-en-ciel ont été infectés expérimentalement avec *Flavobacterium psychrophilum* et suivi des mortalités. Une réduction ($p <0,05$) de la mortalité dans les groupes nourris au DON a été observée par rapport à un contrôle et une groupe nourris en paire. L'apport alimentaire limiter a également été observé pour influer sur le pourcentage de mortalité après infection.

Functional origins of the vertebrate gill

Origines fonctionnelles des branchies des vertébrés

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Selection for increased oxygen uptake is generally accepted as the driver for vertebrate gill evolution. Theoretically, branchial respiration allowed early vertebrates to overcome limitations to dermal thickness, body surface area to volume ratio (SA:V) and metabolic rate (MO₂) associated with cutaneous respiration. During development, larval teleosts undergo changes in morphology and MO₂ similar to those exhibited during early vertebrate evolution; however, the larval teleost gill becomes critical for ion regulation well before oxygen uptake. Furthermore, extant members of the anciently derived hagfishes satisfy ~90% of resting MO₂ cutaneously, yet possess an exceptional branchial capacity for regulating acid/base relevant ions. Accordingly, we hypothesize the gill first became critical for acid/base regulation during early vertebrate evolution. Homeostatic flux in larvae of the extant early vertebrate *L. tridentata* is discussed in light of these ideas.

La sélection pour l'augmentation de l'absorption d'oxygène est généralement admis que le conducteur de l'évolution branchies chez les vertébrés. Théoriquement, la respiration branchiale a permis les premiers vertébrés à surmonter les limites de l'épaisseur cutanée, la surface corporelle par rapport au volume (SA: V) et le taux métabolique (MO₂) associée à la respiration cutanée. Au cours du développement, les larves téléostéens subissent des modifications de la morphologie et MO₂ similaires à celles présentées au cours de l'évolution des vertébrés, mais les branchies des larves téléostéens devient critique pour la régulation des ions en avance de l'absorption d'oxygène. En outre, les membres existants des myxines (une ligne anciennement dérivés) satisfaire ~ 90% de leurs MO₂ à repos cutanée, mais possède encore une capacité exceptionnelle branchiale pour la régulation des ions concernés avec l'acide/base. En conséquence, nous émettons l'hypothèse que la première branchie est devenue critique pour la réglementation acide/base bien tôt au cours de l'évolution des vertébrés. La flux homéostatique chez les larves de l'existant vertébré *L. tridentata* est discutée à la lumière de ces idées.

Does cold exposure activate the insect immune system?

Est-ce que l'exposition au froid active le système immunitaire des insectes?

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Because cold tolerance and immune up-regulation are energetically expensive, but mechanistically different, an energetic trade-off is expected to reduce an insect's immune response after cold exposure. However, evidence of immune system activation after cold suggests a cold-immunity cross-talk instead of a trade-off. To investigate the potential cross-talk between cold and immune system, we determined whether the immune response of *Drosophila melanogaster* is activated by acute and chronic cold exposure, and which pathways are activated. We cold-exposed flies, and then used qPCR to examine up-regulation of immune-related genes in the Toll, IMD and JAK/STAT pathways, as well as counting hemocytes and measuring phenoloxidase activity. Cold exposure increased hemocyte count and decreased phenoloxidase activity; qPCR studies of other pathways are in progress. Data so far suggest that cold exposure does not activate all immune pathways equally.

Fish diversity and biomass in small subarctic lakes: higher than expected relative to southern Canadian lakes.

Diversité des poissons et biomasse plus élevées que prévu dans de petits lacs subarctiques Canadiens en comparaison aux lacs plus au Sud

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Biodiversity in Northern Canada (Nunavut, Yukon, and Northwest Territories) is projected to experience drastic changes due to increased development (mineral exploration and development) and climate change. Our current knowledge of biodiversity in this region is limited, but Northern Canada is thought to be poor in biodiversity and productivity. As a result, this region has been assigned relatively low values for their biological resources, particularly fish. In collaboration with the Department of Fisheries and Ocean, we analyzed species diversity, abundance, and biomass of fish in 37 small lakes in Northwest Territories; for 9 of these lakes, all fish were removed before the lake was destroyed for mining. The most dominant species in this system is the Lake trout (*Salvelinus namaycush*). Contrary to the expectation that northern lakes would be poorer in fish diversity and biomass relative to southern Canadian lakes (e.g. Ontario), our preliminary results indicate similar levels of species richness and biomass across regions.

La biodiversité dans le Nord Canadien (Nunavut, Yukon et les Territoires du Nord) devrait connaître des changements radicaux dus à un développement accru (exploration minière et le développement) et le changement climatique. Nos connaissances actuelles de la biodiversité dans cette région est limité, mais Nord Canada est considéré pauvre en biodiversité et de la productivité. En conséquence, cette région a été attribué des valeurs relativement faibles pour leurs ressources biologiques, en particulier les poissons. En collaboration avec le Ministère des Pêches et des Océans, nous avons analysé la diversité des espèces, l'abondance et la biomasse des poissons dans 37 petits lacs dans les Territoires du Nord-Ouest; pour 9 de ces lacs, tous les poissons ont été retirés avant que le lac a été détruite par l'exploitation minière. L'espèce le plus dominante dans ce système est le touladi (*Salvelinus namaycush*). Contrairement à l'attente que les lacs du Nord serait plus pauvre dans la diversité des poissons et de la biomasse par rapport au lacs du Sud Canadiens (p. ex Ontario), nos résultats préliminaires indiquent des niveaux similaires de la richesse en espèces et la biomasse dans les régions.

A steroid hormone rhythm drives circadian cycling of period protein in fat body cells of the insect, *rhodnius prolixus*

Un rythme hormonal stéroïdien dirige le cycle circadien de la protéine de période dans le tissu adipeux de l'insecte, *Rhodnius prolixus*

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Insect fat body (FB) performs functions as diverse as the mammalian liver, with which it is functionally analogous. We examined the temporal coordination of FB in *Rhodnius* larvae, using immunohistochemistry and Western blots for the canonical clock protein, PERIOD (PER). Nuclear PER exhibits cycles in abundance that free run in continuous darkness (DD). PER is depleted in prolonged continuous light (LL), but on transfer to DD, PER is rapidly induced and resumes circadian cycling. When FB cells from LL were incubated in vitro in both LL and DD, cycling of PER ceased. Addition of 20-hydroxyecdysone to FB cells in vitro rapidly induced PER expression. 20-hydroxyecdysone levels have a known circadian rhythm in vivo peaking in the scotophase. We infer that cycling of PER in FB cells is not indicative of an autonomous circadian clock in this tissue, but rather represents an oscillator driven by the circadian rhythm in steroid levels.

Responses of zebrafish to ethinyl estradiol administered via slow release microspheres

Réponse du poisson zèbre à l'éthinylestradiol administré par microsphères à libération lente

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It is well established that waste water effluents (WWE) contain estrogenic compounds that can affect the physiology of exposed fish, including increased expression of the egg-yolk precursor protein vitellogenin and development of the intersex condition in wild males. There is interest in testing fish exposed to effluent in both field and lab settings as a rapid screening bioassay to define the actions of estrogenic compounds. However, these studies are limited by the lack of a positive control necessary for the determination of an estrogenic response. To this end, we have injected zebrafish with microspheres impregnated with ethinyl estradiol, providing a sustained drug release. Liver samples were collected at 1 and 2 weeks post-injection and vtg1 expression was quantified using real-time PCR. The current studies will provide a baseline time-course for vitellogenin response in zebrafish, which can be used to study whether other WWE constituents, including potential anti-estrogenic compounds, can modify fish responsiveness to estrogens.

Il est bien établi que les effluents d'eaux usées (EEU) contiennent des composés oestrogéniques qui peuvent affecter la physiologie des poissons exposés, y compris l'expression accrue de la vitellogénine, une protéine précurseur de la jaune d'oeuf et le développement de l'intersexualité chez les mâles sauvages. Il y a un intérêt à tester les poissons exposés à des effluents dans les essais pratique et de laboratoire comme un test biologique de dépistage rapide pour définir les actions des composés oestrogéniques. Cependant, ces études sont limitées par l'absence d'un contrôle positif nécessaire à la détermination d'une réponse oestrogénique. À cette effet, nous avons injecté les poissons zèbre avec des microsphères imprégnées de l'éthinylestradiol, en fournissant un libération prolongé de médicament. Des échantillons de foie ont été prélevés à 1 et 2 semaines après l'injection et vtg1 expression a été quantifiée par PCR en temps réel. Les études en cours fournira une ligne de base de décours temporel pour la réponse vitellogénine chez le poisson zèbre, qui peut être utilisée pour étudier si d'autres constituants d'EEU, y compris des potentiels composés anti-oestrogène, peuvent modifier la réactivité des poissons aux oestrogènes.

**Establishment of an epithelial cell line from long-term primary cultures of ovarian fluids of rainbow trout,
*Oncorhynchus mykiss***

**Établissement d'une lignée cellulaire épithéliale à partir de cultures primaires de fluides ovariens de truite
arc-en-ciel, *Oncorhynchus mykiss***

¹Krista L Schleicher, ¹Nathan NTK Vo, ¹Dustin A Ammedolia, ¹David B. Van, ²Lucy EJ Lee, ¹Niels C Bols

¹University of Waterloo, ²University of Fraser Valley

Assessment of fish health can be done through the use of novel cell cultures. One of the non-invasive approaches that have not yet been exploited is to use ovarian and seminal fluids as sources of cells. In this study, we report the establishment of an epithelial cell line from long-term primary cultures of ovarian fluids of sexually mature female trout. Primary cultures consisted of adherent macrophage-like cells, epithelial-like cells, clumps of ciliated cells and non-adherent round cells. Subsequent subculturing in Leibovitz's L-15 media with 10% fetal bovine serum with extra antibiotics/antimycotics resulted in an epithelial cell line named RTOF. This cell line has undergone over 20 passages for over 18 months. RTOF are histochemically positive for alkaline phosphatase (a marker for germ cells) and immunochimically positive for ZO-1 (a component of tight junction complexes). Overall, cell cultures from reproductive fluids are possible to obtain and should be further explored.

Are mitochondrial processes involved in reducing gene flow across a mummichog hybrid zone?

**Est-ce que des processus mitochondriaux réduisent le flux génique à travers une zone hybride chez le
choquemort?**

¹Patricia Schulte, ¹Jessica Mckenzie

¹UBC

There are two subspecies of mummichogs (*Fundulus heteroclitus*) (a northern form and a southern form) that differ in morphology, and physiology, including differences in metabolic rate and development time. Here, we use 30 nuclear encoded and 2 mitochondrial single nucleotide polymorphism (SNP) markers to examine patterns of genetic variation in the hybrid zone between these subspecies. We show that genes involved in oxygen transport and storage and in mitochondrial processes exhibit steep clines through the hybrid zone, and that multi-locus analysis suggests a low frequency of individuals bearing hybrid genotypes at these loci. Laboratory mating studies demonstrate that one of the reciprocal hybrid crosses occurs at very low frequency when fish are given the opportunity to choose their mates and results in abnormally fast development after forced crosses, suggesting a role for mitochondrial processes or the regulation of metabolism in helping to maintain the separation of these subspecies.

**How curriculum re-design can facilitate the implementation of evidence-based teaching practices in
undergraduate biology.**

La conception et le développement du curriculum dans le premier cycle de biologie

¹Patricia Schulte

¹UBC

There have been many calls to improve undergraduate Biology teaching by applying evidence-based approaches. But attempts to apply best practices are often focused at the level of individual courses, which can result in a piecemeal approach across the curriculum. Here I will show how the completed re-design of our undergraduate Biology majors curriculum has enhanced our ability to apply evidence-based teaching practices across the program. In particular, moving to a standardized curriculum with a set of required core courses in the early years is allowing us to better map student concept and skill development across the curriculum. I will also highlight some of the specific projects undertaken as part of the Carl Wieman Science Education Initiative in Biology that are using evidence based approaches to enhance the effectiveness of the lecture, tutorial and laboratory components of our courses.

Evolution of the hypoxia acclimation response in high-altitude deer mice

Évolution de la réponse d'acclimatation à l'hypoxie en haute altitude chez les souris sylvestres

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This study compared the hypoxia acclimation responses of deer mice (*Peromyscus maniculatus*) from highland and lowland ancestry. Mice were caught in Nebraska (430m) and on the summit of Mount Evans in Colorado (4350m elevation), and were used to establish captive breeding populations. First generation adult mice were then compared before and after acclimation to hypobaric hypoxia. Hypoxia acclimation improved aerobic capacity (VO_{2max}) during exercise in hypoxia in both populations, but hypoxic VO_{2max} was consistently higher in highland mice. Highland mice also had higher capillarity and oxidative capacity in the locomotory muscle, and an increase in

expression of genes that regulate muscle phenotype (assessed using RNA-Seq). However, there were no population-specific differences in normoxic VO₂max, lung mass, heart ventricle mass, or blood [haemoglobin]. Highland ancestry has therefore improved performance in hypoxia by altering some of the underlying determinants of oxygen transport and utilization. Supported by NSERC.

The impact of predator size, speed, and attack orientation on escape manuevers in sharks

L'impact de la taille, vitesse et orientation d'attaque des prédateurs sur les manœuvres d'échappement des requins

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Escape responses are a critical aspect of predator-prey interactions, but are poorly understood for larger animals such as sharks. We used realistic predator models to determine how the spiny dogfish, *Squalus acanthias*, reacts to predators that differ in size, approach orientation (head-on versus tail-on), and speed. Using high-speed video, the movements of seven sharks (total of 58 responses) were recorded in a 45,000 litre flume at the Bamfield Marine Sciences Centre. Sharks did not exhibit escape manuevers in response to the small (45.8cm long) model, regardless of speed or direction. C-starts were performed when exposed to both the medium (133.3cm long) and large (195.5cm long) models. Turning rate and acceleration performance during the escape maneuver increased with predator size and speed. Whereas the tail-on approach induced greater locomotor performance, but a shorter reaction distance, the head-on approach induced a greater reaction distance, yet lower locomotor performance. We conclude that size, speed, and orientation of predators have a strong, but complex, impact on escape behavior in sharks.

Characterization of cardiac contractile proteins of the African clawed frog (*Xenopus laevis*): Investigating the evolution of cardiac contractile function

Caractérisation des protéines contractiles cardiaques de la xénopse lisse (*Xenopus laevis*): Étude de l'évolution de la fonction contractile cardiaque

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Increasing physiological temperatures paralleled the evolution of the four-chambered heart as well as innovations to the contractile unit that increased regulatory control. Comparisons of cardiac contractile function in rainbow trout and the rat have revealed that the trout heart is more sensitive to calcium, but contractility is not as affected by protein kinases. Several amino acid differences in the cardiac troponin complex (cTn) have been found to be partially responsible for these differences. This study aims to characterize the cTn of the African clawed frog (*Xenopus laevis*) in order to better understand the role of the cTn complex in the evolution of cardiac contractile function in vertebrates. Sequence comparison reveals that the *Xenopus* cTn components are chimeras of teleost and mammalian isoforms. We therefore predict that the functional properties of the frog cTn will be intermediate to those found in mammals and fish.

L'augmentation des températures physiologiques était parallèle à l'évolution du cœur à quatre cavités ainsi que des innovations à l'unité contractile qui a augmenté le contrôle réglementaire. Les comparaisons de la fonction contractile cardiaque chez la truite arc et les rats ont révélé que le cœur truite est plus sensible au calcium, mais la contractilité n'est pas aussi affectée par des protéines kinases. Plusieurs différences d'acides aminés dans le complexe troponine cardiaque (cTn) ont été jugées partiellement responsables pour ces différences. Cette étude vise à caractériser la cTn de la grenouille africaine à griffes (*Xenopus laevis*) afin de mieux comprendre le rôle du complexe cTn dans l'évolution de la fonction contractile cardiaque chez les vertébrés. La comparaison des séquences révèle que les composants de *Xenopus* cTn sont des chimères des isoformes de téléostéens et les mammifères. Nous avons donc prédire que les propriétés fonctionnelles de la cTn grenouille sera intermédiaire à celles trouvées chez les mammifères et les poissons.

Causes and consequences of pre-breeding weight gain in a food-caching bird that breeds during the late winter

Causes et conséquences du gain de poids avant accouplement chez un oiseau qui se reproduit à la fin de l'hiver

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Animals that overwinter at high latitudes often use cached food for overwinter survival, but some species also rely on stored food for breeding. Gray jays (*Perisoreus canadensis*) are scatter hoarders that use stored food throughout the winter and begin breeding in late winter when there is no fresh food available. To examine the causes and consequences of female weight gain, we weighed females throughout the pre-breeding period. Weight gain was influenced by female age, and by the percent of conifers on territories, supporting previous work showing that coniferous trees are better able to preserve cached food and therefore have a positive influence on reproductive performance. Female weight gain also positively influenced reproductive output. Our results suggest that, despite relying on cached food, females are able to achieve a 26% increase in their weight, and indicate a novel mechanism by which habitat-mediated carry-over effects and female age may influence reproduction.

Les animaux qui passent l'hiver dans les hautes latitudes ont souvent recours à des aliments mis en cache pour la survie hivernale, mais certaines espèces comptent également sur les aliments stockés pour la reproduction. Geais gris (*Perisoreus canadensis*) sont accapareurs de dispersion qui utilisent les aliments stockés pendant l'hiver et commencent à se reproduire en fin d'hiver quand il n'y a pas de nourriture fraîche disponible. Pour examiner les causes et les conséquences de la prise de poids des femelles, nous avons pesé les femmes tout au long de la période de pré-sélection. Le gain de poids a été influencé par l'âge des femmes, et par le pour cent de conifères sur les territoires, en soutenant les travaux antérieurs montrant que les conifères sont plus aptes à conserver les aliments mis en cache et donc ont une influence positive sur les performances de reproduction. Le gain de poids des femelles est également une influence positive sur la reproduction. Nos résultats suggèrent que, malgré s'appuyant sur les aliments mis en cache, les femelles sont en mesure de réaliser une augmentation de leur poids de 26%, et indiquent un nouveau mécanisme par lequel les effets différés arbitré par l'habitat et l'âge des femmes peuvent influencer la reproduction.

Muscle morphology and a possible role of FMRFamide-like peptides (FLPs) on reproduction within the kissing bug, *Rhodnius prolixus*

Morphologie musculaire et un rôle possible pour les peptides apparentés au FMRFamide (FLPs) dans la reproduction de la punaise hématophage, *Rhodnius prolixus*

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Phalloidin staining F-actin was used to image muscle fiber arrangements present in the reproductive system of the adult female *Rhodnius prolixus*. A mesh of muscle fibers encircles the ovary and a criss-cross pattern of muscle fibers covers each ovariole. Two layers of muscle fibers form the lateral oviducts. A chevron pattern of thicker muscle fibers makes up the bursa. All of these structures show spontaneous contractions that are stimulated in a dose-dependent manner by the endogenous peptides, GNDNFMRamide and AKDNFIRamide which belong to the family of the FMRFamide-like peptides (FLPs). Immunohistochemistry shows that no FMRF-like immunoreactivity (FLI) was observed on the ovarioles/ovary, however, they exhibited a stimulatory response to the peptides indicating that they may be under the influence of FLPs as neurohormones. This work implicates FLPs in the control of ovulation, egg movement and oviposition in this insect.

Establishment of a continuous cell line from arctic charr, *Salvelinus alpinus*, for physiological and immunological studies.

Établissement d'une lignée cellulaire continue de l'omble Arctique, *Salvelinus alpinus*, pour études physiologiques et immunologiques

¹Shawna Semple, ¹N.T.K. Vo, ¹Terin Robinson, ¹Lital Sever, ¹Neils Bols, ¹Brian Dixon

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Arctic Charr (*Salvelinus alpinus*) is the northernmost distributed freshwater fish, capable of growing at as low as 0.20C. Can Arctic charr maintain adaptive immunity at these extreme temperatures known to impair the immune function of other teleosts? The use of cell cultures can help test this hypothesis through the study of thermal tolerance and expression of immune genes such as MH class I. Our lab has established the first cell line from *S. alpinus*, SABA (*Salvelinus alpinus bulbus arteriosus*). SABA is mostly fibroblastic and has undergone more than 14 passages. Strikingly SABA displayed high mitotic activity even at 10C. Immunoblotting showed that over a wide range of temperatures SABA continued to express several polypeptides of the MH class I antigen presenting pathway and some were induced by the viral mimic, poly I:C. Understanding the effect of temperature on charr immunity will assist in better vaccine design or disease treatment regimes.

A sodium permeable T-type channel in the invertebrate heart

Un canal de type T perméable au sodium dans le cœur des invertébrés

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LCav3 T-type calcium channels from pond snail, *Lymnaea stagnalis*, become more permeant to monovalent ions through exon splicing of an extracellular "turret" (S5-P) in Domain II of the four domain channel. Invertebrates generate sodium permeable Cav3 T-type channels without altering the invariant ring of charged residues in the selectivity filter that governs calcium selectivity, which are always EEEE in Cav1 and Cav2 channels and EEDD in Cav3 channels. The sodium permeant T-type channel is the only splice isoform expressed in the snail heart and contributes to half of the expressed T-type channels in the snail brain. These T-type channels can be defined as sodium channels, because they are much more permeable to sodium ions than calcium ions, and conduct considerable sodium currents even as external calcium concentrations are raised to near physiological levels.

Another fish in the well: accounting for individual variation in larval zebrafish (*Danio rerio*) stimulus-evoked behaviour

Un autre poisson au puits: Tenir compte de la variation individuelle du comportement évoqué par des stimuli chez les larves de poisson zèbre (*Danio rerio*)

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Differences in individual activities are problematic when interpreting animal behaviour. We created a method that sorted individuals into distinct stimulus-evoked phenotypes. Naïve larval zebrafish, ages 4-7 days post fertilization, were subjected to a mechanical stimulus (water pulse) or a mixed mechanical-chemical stimulus (odourant pulse) and observed for changes in swimming (burst) activity. The method used threshold-based sorting to place fish into 24 response phenotypes. The phenotypes isolated by the mechanical stimulus had distinct activity patterns and different proportions within the population. Odourant-pulsed fish had similar phenotype proportions, but within phenotypes, subtle activity differences were observed due to the odorant. Without phenotypic separation, the secondary, odourant-evoked activities would not have been seen. Our results support response phenotyping as an effective approach to account for individual variation in behavioural studies.

Evolution of preferential pH regulation in basal fishes; insights from the spotted gar

Evolution de la régulation du pH préférentiel chez les poissons basaux; aperçu du lépisosté tacheté

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Compensation for a respiratory acidosis in fish is often limited by the ability to recover blood pH (pHe); however, some fish completely regulate and defend tissue intracellular pH (pHi) despite large maintained reductions of pHe (termed preferential pH regulation; ppHi). When ppHi evolved is unknown but it does not occur in agnathans or chondrichthyans. It does exist within the basal euteleostomi (bony fishes) in sturgeon. We investigated CO₂ tolerance and pH regulation in the spotted gar (*Lepisosteus oculatus*), a basal air breathing euteleostomi fish. They could tolerate exposure to 12% CO₂ (the highest ever reported in fish). During 3h exposure to 6% CO₂, pHe fell and remained uncompensated while pHi of brain, liver, gills and white muscle did not change, heart pHi increased. This study is the first to demonstrate ppHi in a basal air breathing fish and may provide insight into the evolution of this novel pattern of acid-base regulation.

Survival and osmoregulation of an estuarine crab after acute exposure to varying combined pH and salinity stress

Survie et régulation osmotique d'un crabe estuaire après une exposition aiguë à diverses combinaisons stressantes de pH et de salinité

¹Ciaran Shaughnessy, ¹Elsa Anderson, ¹Mary Kasparian, ¹Jalene LaMontagne, ¹Jason Bystriansky

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Throughout an estuary, intertidal organisms can experience high variation in multiple environmental stressors over a short period of time. Tides produce an enormous range in salinity, while less widespread factors such as poor water mixing or agriculture runoff can affect local ambient pH. Estuarine crabs collected from the ACE Basin (South Carolina, USA) were evaluated on survival and physiological response to salinity and pH challenges representative of estuarine extremes. For 48 hours, crabs were exposed to a suite of multiple stress treatments, consisting of all combinations of two salinity (5 or 30 ppt) and three pH (6.6, 7.6 or 8.6) regimens. Haemolymph ion levels, gill Na⁺/K⁺-ATPase activity, and whole-body ammonia-N excretion rates were measured to assess the ability of the crab to tolerate the potential interactive stress of these changes. Survival rate was 100 percent in nearly all treatments, and the crab had no apparent deleterious response to acute shifts in salinity and pH. This estuarine crab appears to be robust to all combinations of these stressors, indicating that, with respect to salinity and pH tolerance, the spread of its population is unrestricted in the ACE Basin.

Tout au long d'un estuaire, les organismes intertidaux peuvent éprouver une grande variation dans multiples facteurs de stress environnementaux sur une courte période de temps. Les marées produisent une vaste gamme de salinité, tandis que les facteurs moins répandues telles que la mauvais mélange des eaux ou le ruissellement agricole peuvent affecter le pH ambiant locale. Les crabes estuariens recueillis dans le bassin de l'ECA (Caroline du Sud, Etats-Unis) ont été évalués sur la survie et la réponse physiologique à les défis de salinité et les pH extrêmes représentant de l'estuaire. Pendant 48 heures, les crabes ont été exposés à une série de traitements de stress multiples, composées de toutes les combinaisons de deux salinité (5 ou 30 ppm) et trois pH (6,6, 7,6 ou 8,6). Niveaux d'ions de l'hémolymphe, l'activité de Na⁺/K⁺-ATPase dans les lamelles, et le taux d'excrétion d'azote ammoniacal au niveau du corps complet ont été mesurés pour évaluer la capacité du crabe à tolérer le stress interactif qui est potentiel de ces

changements. Le taux de survie a été de 100 pour cent dans presque tous les traitements, et le crabe n'avait pas de réponse évidente à des changements aigus de la salinité et du pH. Ce crabe des estuaires semble être robuste pour toutes les combinaisons de ces facteurs de stress, ce qui indique que, en ce qui concerne la tolérance à la salinité et le pH, la propagation de sa population n'est pas limiter dans le bassin de l'ECA.

Expression of cytochrome P450 family 3 genes in adult and embryonic zebrafish

L'expression des gènes de la famille 3 du cytochrome P450 chez l'adulte et l'embryon du poisson-zèbre

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¹McMaster University

Mammalian cytochrome P450 (CYP) family 3 is an important family of enzymes involved in drug metabolism. This CYP family is present in fish and contains the subfamilies A, B C and D. Subfamilies B, C and D are lineage specific and only occur in teleost fish. The function of CYP3s in fish is not well characterized. The importance of mammalian CYP3s in drug metabolism and similarity in expression of CYP3A genes across vertebrates suggests the function of CYP3s in fish may be xenobiotic metabolism. Gene expression studies, utilizing quantitative PCR, show expression of CYP3 genes in multiple adult zebrafish organs. Levels of expression in the organs is different between male and female fish and across developmental stages. Understanding the expression of teleost CYP3s will aid in understanding their function.

Accelerated molecular and functional evolution of hemoglobin in sirenians.

Évolution moléculaire et fonctionnelle accélérée de l'hémoglobine des siréniens

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The high energetic demands of diving combined with a nutritionally poor diet presents unique physiological challenges for sirenians, the only fully aquatic mammalian herbivores. Little, however, is known regarding physiological adaptations specific to this unconventional life history. To address this shortcoming, we have combined ancient DNA, hybridization capture and next-generation sequencing technologies to retrieve ~195,000 bp of novel DNA sequence from two extant (manatee and dugong) and one recently extinct (Steller's sea cow) sirenian, including the coding regions for the entire alpha- and beta-globin gene families. Analysis of the loci encoding for hemoglobin indicate that the adult-expressed hemoglobin genes within the sirenian clade have evolved at substantially accelerated rates relative to other paenungulates (elephants and hyraxes). Notably, dugong and Steller's sea cow hemoglobins possess a number of rare amino acid replacements that are expected to markedly alter functional properties and kinetics of oxygen binding of this respiratory protein.

Les exigences énergétiques de plonger combiné avec un régime alimentaire pauvre présente des défis physiologiques pour les siréniens, les seulement mammifères herbivores totalement aquatiques. Cependant, peu est connu au sujet des adaptations physiologiques spécifiques à cette cycle biologique non conventionnelle. Pour combler cette lacune, nous avons combiné l'ADN ancien, la capture de l'hybridation et de la technologie de séquençage pour récupérer ~ 195.000 pb de séquence d'ADN de deux espèces existante (lamantins et dugongs) et une qui a récemment disparu (vache marine de Steller) siréniens, y compris les régions de codage pour l'ensemble des familles alpha- et bêta-globine. L'analyse des lieux codant pour l'hémoglobine indiquent que les gènes de l'hémoglobine adulte exprimés au sein du clade sirénien ont évolué à des taux accéléré par rapport aux autres paenungulates (les éléphants et damans). Notamment, les hémoglobines du dugong et la vache de mer de Steller possède un nombre de remplacements d'acides aminés qui devraient modifier les propriétés fonctionnelles et la cinétique de la liaison oxygène de cette protéine respiratoire.

Making an alpine insect out of tropical ancestors: Evolutionary physiology of stick insects in New Zealand Comment faire un insecte alpin à partir d'ancêtres tropicaux: physiologie évolutive des phasmes en Nouvelle-Zélande

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New Zealand stick insects have evolved from tropical ancestors to inhabit various environments, including several independent radiations into cold environments. We used physiological studies and high-throughput RNA sequencing to identify candidate processes that underlie the physiological changes that accompany this radiation. We have identified significant interspecific variation in cold tolerance strategy – including one species that can withstand internal ice formation. To investigate the mechanisms underlying the transition to freeze tolerance, we have

compared transcriptional responses to cold shock across the phylogeny using high-throughput RNA sequencing. We identify signatures of selection in the nucleotide sequences of glycolytic enzymes for all of the New Zealand plasmid genera in comparison with their outgroups from New Caledonia and Australia, revealing sequence variation consistent with adaptation in energy metabolism across the metabolic pathway. We can now develop a picture of the molecular and physiological changes that occur with radiation into cold environments.

Vibratory signals of the western black widow spider, *Latrodectus hesperus*: signal characteristics, production, and reception

Les signaux vibratoires de la veuve noire de l'Ouest, *Latrodectus hesperus*: Production, réception et caractéristiques du signal

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In many web-building spiders, males courting on a female's web have been observed to engage in various behaviours associated with the production of web-borne vibrations. Despite this, however, only a few studies have characterized these web vibrations, and to date, no study has examined the details of vibratory signaling mechanisms in any web-building spider. In this study, we used laser vibrometry to record the courtship vibrations of male black widow spiders. Male signals were categorized into three types: web-plucks, web-bounce, and abdominal. We then used synchronous high-speed videography and laser vibrometry to further characterize the movements associated with vibration production, and then conducted a set of ablation experiments to determine signaling mechanisms. Finally, we conducted extracellular electrophysiological recordings in females to determine vibration sensitivity. We show that vibratory signals are an important part of male black widow courtship, and females may use these signals to assess species, and/or mate quality.

The effect of cell size on blood flow dynamics in the capillary beds of triploid fish

L'effet de la taille cellulaire sur la dynamique du flux sanguin dans les lits capillaires de poissons triploïdes

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We hypothesize that increased erythrocyte size in triploid fish reduces blood flow through capillaries, and that this contributes to their documented susceptibility to stress. We are using zebrafish (*Danio rerio*) that express spectrally distinct fluorescent proteins in their vascular endothelial cells and circulating erythrocytes to test this hypothesis by visualizing blood flow through capillary beds *in vivo*. This provides an opportunity to determine the effect of ploidy on tissue perfusion, as well erythrocyte turnover rate, perfusion of parallel capillary beds, and changes in patterns of angiogenesis resulting from oxygen stress. In addition to serving as a model for investigating the role of cell size on basic physiological processes, results from this research will contribute to a better understanding of the physiological limitations of triploid fish in aquaculture.

Nous émettons l'hypothèse que la taille augmenter des erythrocytes dans les poissons triploïdes réduit le flux sanguin dans les capillaires, et que cela contribue à la vulnérabilité des poissons au stress documentés. Nous utilisons des poissons zèbre (*Danio rerio*) qui expriment des protéines fluorescentes spectralement distinctes dans leurs cellules endothéliales vasculaires et les erythrocytes afin de tester cette hypothèse en visualisant le flux sanguin dans les lits capillaires *in vivo*. Ce sera l'occasion de déterminer l'effet de la ploïdie sur la perfusion des tissus, comme le taux de renouvellement des erythrocytes, la perfusion de lits capillaires parallèles, et les changements dans les modèles de l'angiogenèse résultant de stress oxydatif. En plus d'agir comme modèle pour étudier le rôle de la taille des cellules sur les processus physiologiques base, les résultats de cette recherche contribuera à une meilleure compréhension des limites physiologiques de poissons triploïdes en aquaculture.

Pheromone trapping and the round goby (*Neogobius melanostomus*): identification of potent male pheromones

Pièges à phéromones et gobie à taches noires (*Neogobius melanostomus*): Identification de phéromones mâles actives

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Pheromone trapping is an effective pest control method. Evidence suggests that it could be implemented to control invasive round goby fish populations in the Laurentian Great Lakes. Male round gobies release a unique steroid, 11-O-ETIO, as well as four conjugates, each sulphated or glucuronated at either the 3 or 17 position. Male washings containing these steroids are attractive to reproductive female round gobies, yet it is unknown which steroid(s) is

triggering this response. 11-O-ETIO and 3-sulfated 11-O-ETIO elicit olfactory sensory responses. We analysed behavioural responses of female round gobies to solid-phase extracted reproductive male conditioned water in addition to isolated steroid mixes. When comparing swimming activity and time spent near the odour source, we found that reproductive females responded to the conditioned water extracts but there was not a significant difference in responses to the isolated steroid mixes. Next we will test isolates with concentrations that have shown olfactory potency.

Diversity and phylogenetic community structure of ants along a neotropical elevational gradient measured with DNA barcodes and a multi-gene phylogeny

Diversité et structure d'une communauté phylogénétique de fourmis sur un gradient élévationnel néotropical mesurées à l'aide de codes barres génétiques et d'une phylogénie multigénique

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Insect diversity is influenced by elevation – an observation supported globally by numerous studies from multiple regions. However, when diversity is measured using alternative measures (such as DNA barcodes and phylogenetic diversity (PD)) the direction and strength of any trend is unknown. We used such “ecophylogenetic” tools to test whether the diversity and phylogenetic community structure of ants collected along a vertical mile of elevation in the Área de Conservación de Guanacaste (ACG), Costa Rica decays linearly or exhibits a mid-elevational peak. To evaluate the PD conclusions derived from barcodes we compared our results to values from a multi-gene phylogeny. We found a negative relationship between diversity and elevation on each volcano – and an asymmetrical mid-elevation peak when sites from sea-level to the summit were considered. High elevation sites displayed significant clustering, as predicted by a hypothesis of severe environmental filtering. Sites often separated by only 200 m were significantly different.

Reversible effects of the pesticide, 3-trifluoromethyl-4-nitrophenol (TFM) used to control Sea Lamprey populations, on the gills of ecologically sensitive Lake Sturgeon (*Acipenser fulvescens*)

Les effets réversibles du pesticide 3-trifluoromethyl-4-nitrophenol (1FM), utilisé pour contrôler les populations de Lamproie marine, sur les branchies des espèces écologiquement sensibles

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The pesticide, 3-trifluoromethyl-4-nitrophenol (TFM) interferes with mitochondrial ATP production but it is unclear if this ATP deficit interferes with gill-mediated ion transport and acid-base regulation. The present study tested the hypothesis that exposure to TFM interfered with branchial Na⁺,K⁺-ATPase (NKA) and vacuolar H⁺-ATPase function, leading to altered electrolyte balance in lake sturgeon. Plasma Na⁺ concentration decreased by 20% following 9h exposure to lampricide, and declined a further 15% following depuration in "clean" water. However, Cl⁻ concentrations significantly increased by 22% following recovery. Notably, H⁺-ATPase activity significantly decreased by 50% between the control and 6-h exposures, but activity returned to control values by 9h exposure. The retention of Cl⁻ plus the upregulation of H⁺-ATPase activity suggests the animals were correcting a TFM-induced acidosis. We propose that exposure to environmentally relevant TFM concentrations interfere with acid-base balance in sturgeon, but that effects are readily reversible.

Developing IFN1, IFNy and IL-1 β quantitative ELISA and ELISpot using polyclonal antibodies developed from rainbow trout (*Oncorhynchus mykiss*)

Développement d'un ELISA et ELISpot IFN1, IFNy et IL-1 β quantitatif utilisant des anticorps polyclonaux développés à partir de la truite arc-en-ciel (*Oncorhynchus mykiss*)

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In mammals interferon alpha (IFN α), interferon beta (IFN β) and interferon gamma (IFN γ) activate during viral infection while interleukin 1 beta (IL-1 β) and IFNy activate during bacterial infection. While genes for these cytokines have been discovered in some fish species little is known about their function. By developing a quantitative enzyme-linked immunosorbent assay (ELISA) and an enzyme-linked immunosorbent spot assay (ELISpot) for detection and quantification of interferon 1 (IFN1), IFNy and IL-1 β a better understanding of the function of these cytokines will be possible. After production of recombinant rainbow trout cytokines polyclonal antibodies have been produced. These antibodies are able to recognize their respective recombinant protein and show promise for the development of effective quantitative ELISA and ELISpot. A better understanding of the fish

immune system could lead to a better understanding of how the teleost immune system evolved and functions, as well as assisting with disease management in aquaculture.

Critical oxygen tensions as a predictor of hypoxia tolerance and tissue metabolic responses during hypoxia exposure in fishes

Tensions en oxygène critiques comme un facteur prédictif de tolérance à l'hypoxie et les réponses métaboliques des tissus pendant l'hypoxie chez les poissons

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The critical oxygen tension (Pcrit) is thought to reflect the ability of an organism to extract environmental O₂ and consequently has been utilized widely as a measure of hypoxia tolerance in aquatic animals including fishes. However, the relationship between Pcrit and hypoxia tolerance and hypoxic metabolic responses remains incompletely understood. Across 11 species of sculpin, we found that Pcrit correlated with another measure of hypoxia tolerance, the time to loss of equilibrium (LOE50) at a single level of hypoxia (6.4±0.1 torr). When 3 species of sculpin that varied in hypoxia tolerance were exposed to relative hypoxia exposures (30% of their respective Pcrit values) for 6 hr, similar lactate accumulation and metabolic effects were observed. However, scaling hypoxia exposures to Pcrit did not result in similar LOE50 values in all 3 species, as would be predicted if Pcrit explained the interspecific variation in hypoxia tolerance. Differences in glycogen availability between species may account for this finding.

Establishment and characterization of a continuous fibroblastic cell line from yellow perch (*Perca flavescens*), and it's toxicological applications

Établissement et caractérisation d'une lignée de cellules fibroblastiques continues de la perchaude (*Perca flavescens*), et ses applications toxicologiques

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Yellow perch (*Perca flavescens*), are important fresh water fish species indigenous to many North American water bodies. They are valued for their meat but have also been used as model organisms for toxicological evaluation of chemicals including oil sands processed waters (OSPW). Here we report on the establishment, characterization and potential toxicological applications of YPF5, a fibroblastic cell line derived from the caudal fin of yellow perch, to complement and facilitate whole organismal studies. YPF5 grow well in Leibovitz-15 media supplemented with 10% fetal bovine serum, and has been maintained for almost 2 yrs at room temperature. Cells at various passages have been cryopreserved and thawed successfully, and were authenticated as *P. flavescens* by “DNA barcoding” and conventional karyotyping (2n = 48). Growth characteristics, physicochemical responses and immuno-histochemical data will be presented, as well as their uses for rapidly evaluating the toxicity of OSPW samples and other common environmental contaminants.

Mortality associated with infection by two novel species of systemic Isospora (Atoxoplasma) in two passerine species [superb glossy starling (*Lamprotornis superbus*), black-throated laughing thrush (*Garrulax chinensis*)] in a zoo collection

Mortalité associée à l'infection par deux nouvelles espèces du genre Isospora (Atoxoplasma) chez les passereaux choucador superbe (*Lamprotornis superbus*) et garrulaxe à joues blanches (*Garrulax chinensis*) dans une collection zoologique

¹Iga Stasiak, ¹Dale Smith, ¹Mian Hafeez, ¹Pauline Delnatte, ¹John Barta

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Isosporoid coccidia with intestinal and extra-intestinal stages have been identified in a wide range of passerine birds, sometimes in association with clinical disease. Here we describe mortality associated with infection by novel species of systemic Isospora (Atoxoplasma) in two passerine species held in a zoological collection. Merozoites were identified histologically in the liver in all affected birds, and less frequently in lung, spleen and intestine. Description of fecal oocysts and sequencing of the Cytochrome c oxidase 1 (COX1) gene and the Ribosomal 18s RNA gene of tissue stages and oocysts resulted in the identification of novel species of Isospora (Atoxoplasma) unique to each avian host species. This study demonstrates the utility of DNA barcoding techniques to identify new species of isosporoid coccidia and in describing host-parasite relationships. This information has applications for understanding the risk of disease spread among similar species in collections of captive birds.

**Cardiac innervation and control of heart rate in goldfish (*Carassius auratus*) and zebrafish (*Danio rerio*)
Innervation et contrôle du rythme cardiaque chez le poisson rouge (*Carassius auratus*) et le poisson zèbre
(*Danio rerio*)**

¹Matthew R Stoyek, ¹Roger P. Croll, ¹Frank M. Smith

¹Dalhousie University

The autonomic nervous system modulates the activity of the effectors that set cardiac output in vertebrates. The intracardiac nervous system acts as the final common pathway for neurocardiac control. To date neither the anatomical organization nor the roles of intracardiac neurons in specific effector-control pathways within this system is well understood. In this comparative study we investigated the organization of the intracardiac nervous system and its effects on in vitro pacemaker rate in goldfish and zebrafish hearts. Immunohistochemistry revealed that most intracardiac neuronal somata were located in a nerve plexus associated with the sinoatrial valves. Most intracardiac neurons had a cholinergic neurotransmitter phenotype, however, a subpopulation with a putative catecholaminergic neurotransmitter phenotype was also observed. Activation of the intracardiac nervous system in vitro via electrical stimulation of vagosympathetic cardiac rami evoked biphasic changes in pacemaker rate. Cholinergic antagonists (hexamethonium and atropine) blocked bradycardia, while a beta-adrenergic antagonist (timolol) blocked tachycardia.

Mitochondrial Plasticity: Intracellular signaling pathways involving mitochondria

Plasticité mitochondriale: voies de signalisation intracellulaires impliquant des mitochondries

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The functions of mitochondria in eukaryotic cells extend well beyond their ‘powerhouse’ role in oxidative phosphorylation. Mitochondrial handling of molecular oxygen, and their production of reactive oxygen species (ROS), have clear relevance to the life and death of animal cells. Importantly from a comparative physiology perspective, aspects of oxygen handling appear to differ between species with respect to species body mass, phylogenetic history, and even lifespan. Here I will examine some interesting trends and recent discoveries that contribute to our understanding of mitochondrial physiology in this broader context. In particular, inter-species differences in the rate of mitochondrial superoxide production and in the expression of matrix and cytosolic antioxidant enzymes involved in metabolizing ROS produced on both faces of the inner membrane will be discussed. The relevance of oxygen levels with respect to mitochondrial ROS production in experiments with isolated cells will be considered. New insights into the emerging connections between mitochondrial ROS and cell growth/differentiation, and also mitochondrial ROS and mitochondrial network morphology will be discussed. The goal of this seminar is provide a brief overview of how mitochondrial activities not directly linked to ATP synthesis influence and perhaps regulate other cellular functions.

Tracking songbird migration: seasonal connectivity and migration timing

Suivre la migration des passereaux: Connectivité saisonnière et période de migration

¹Bridget Stutchbury

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Dozens of species of migratory songbirds have experienced serious, long-term population declines that are driven in part by the threats that these birds face on migration and while in the tropics. Only recently has it been possible to track the entire migration of individual songbirds to map out critical habitats used during migration, to quantify migratory connectivity, and to understand constraints on migration timing. I show results of our large scale geolocator tracking studies on Purple Martins (aerial insectivores) and Wood Thrushes (deciduous forest birds). Purple Martins exhibit extremely weak migratory connectivity, but Wood Thrushes have strong connectivity that links particular breeding regions to specific wintering regions in Central America. Both species show evidence of inflexibility in spring migration timing, which could constrain rate of adaptation to climate change.

Osmotically shocking behaviour in a euryhaline fish, *Kryptolebias marmoratus*

Comportement osmotique 'choquant' chez un poisson euryhalin, *Kryptolebias marmoratus*

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Euryhaline fish acclimate to changing salinity by invoking a suite of physiological mechanisms, but less is known about behavioural responses. We tested the hypothesis that self-fertilizing mangrove rivulus Kryptolebias marmoratus, that inhabit ephemeral pools in the forest floor, use behavioural strategies to cope with acute osmotic

shock. Isogenic fish (15 ppt) were exposed to one of the following salinities, 1, 15, 35, 45 or 65 ppt for 15 min and video recordings were analyzed using Ethovision XT software. Individuals varied in their responses, but mean velocity and distance travelled significantly increased in hypersaline water and the reverse was observed in hyposaline waters. Individual behaviours were consistent across time. We conclude that most *K. marmoratus* evoke an escape response with acute hyperosmotic shock, a strategy that would enable rapid migration to more desirable nearby habitats in the mangrove forest.

Warm acclimation shifts thermal optima but reduces mechanical power of red skeletal muscle in both warm- (Atlantic salmon) and cold- (Arctic char) adapted salmonids

L'acclimatation au chaud change l'optimum thermique mais réduit la puissance mécanique du muscle squelettique rouge chez les salmonidés adaptés aux conditions chaudes (saumon atlantique) et froides (omble chevalier)

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Heat tolerance varies widely across fish species, likely reflecting differences in tolerance of various physiological systems. The capacity of red skeletal muscle, used for routine swimming, to produce mechanical power across a range of temperatures (2–26°C) was measured in relatively warm-adapted (Atlantic salmon, *Salmo salar*) and cold-adapted (Arctic char, *Salvelinus alpinus*) species of salmonid, each acclimated to cold (6°C) and warm (15°C) temperatures. In char, power was maximal at 15°C in cold acclimated fish and 22°C in warm acclimated fish, but was still reduced substantially (40–60%) at 26°C in both groups. In salmon, the optimal temperature for power shifted from 22 to 26°C after warm acclimation. However, an overall decrease in power output with warm acclimation, rather than improvements as intimated by shifted thermal optima, appeared responsible for these changes. Warm acclimation, even in salmon, may do more harm than benefit regarding muscle performance during acute warming.

Puncture resistance of the scaled skin from striped bass: collective mechanisms and inspiration for new flexible armor designs

Résistance à la perforation de la peau écailléeuse du bar rayé: mécanismes collectifs et inspiration pour de nouveaux modèles d'armures flexibles

¹Deju Zhu, ¹Lawrence Szewciw, ²Franck Vernerey, ¹Francois Barthelat

¹McGill University, ²University of Colorado

The structure and mechanics of fish scales display desirable features that could inspire new protective systems. In this study we investigate collective mechanisms within scaled fish skin during a predator attack. We demonstrate that in striped bass (*M. saxatilis*), scales increase the puncture force of the skin by five times. Substrate stiffness has no effect on puncture force. The scalation pattern of uniform three scale overlap multiplies the puncture force by three. Friction between scales and local scale arrangement have little effect on puncture performance. Interestingly, indenting isolated scales results in “sinking” of the stiff scales into the soft substrate. High local deflections within the soft tissue may cause blunt injury before the scales are penetrated. Image correlation reveals that scales redistribute puncture force over large volume, limiting local deflections in the soft tissue. The structure and mechanisms of fish scales may inspire novel protective systems with attractive flexural properties.

Does zebrafish (*Danio rerio*) aquaporin 1a transport CO₂ and NH₃ as well as H₂O?

Est-ce que l'aquaporine 1a du poisson zèbre (*Danio rerio*) transporte CO₂ et NH₃ en plus de H₂O?

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The objective of the present study was to test the hypothesis that aquaporin 1a (AQP1a) in zebrafish (*Danio rerio*) allows passage of CO₂ and NH₃ as well as H₂O. Zebrafish embryos were micro-injected with a translation-blocking morpholino oligonucleotide to knock down AQP1a; morphants exhibited lower AQP1a protein levels (western blot analysis) as well as water flux rates. Using pools of larvae at 4 days post-fertilization, closed-system respirometry with total CO₂ analysis revealed significantly lower rates of CO₂ excretion relative to O₂ uptake, and significantly lower rates of NH₃ excretion in morphants compared to sham-injected larvae. These data support the hypothesis that AQP1a can conduct CO₂ and NH₃ as well as H₂O in zebrafish.

L'objectif de la présente étude était de tester l'hypothèse selon laquelle l'aquaporine 1a (AQP1a) chez le poisson zèbre (*Danio rerio*) permet le passage du CO₂ et NH₃ ainsi que H₂O. Embryons de poisson zèbre ont été micro-injecté avec un oligonucléotide morpholino qui bloqué la traduction pour abattre AQP1a. Les morphants ont démontré des plus faibles taux de protéines AQP1a (western blot) ainsi que les taux de flux d'eau. L'utilisation des ensembles de larves à 4 jours après la fécondation, en appareil respiratoire à circuit fermé avec l'analyse de la totale de CO₂ a révélé que les taux d'excration de CO₂ sont significativement plus faibles que l'absorption d'O₂, et les taux d'excration de NH₃ sont significativement plus bas dans les morphants par rapport à les larves sham-injecté. Ces données soutiennent l'hypothèse que AQP1a peut mener CO₂ et NH₃ ainsi que H₂O chez le poisson zèbre.

Developing Experimental Data for a Multi-Metal BLM Framework

Développement de données expérimentales pour un cadre BLM multi-métal

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To date, extensive research has been performed on the effects of individual metals in the aquatic environment. However in reality, organisms are more often simultaneously exposed to combinations of metals, resulting in additive, non-additive, or antagonistic effects not, which are accounted for in current predictive modeling. To address the needs of regulatory agencies for a multi-metal framework, this research characterizes potential competitive and non-competitive interactions between metals for short-term uptake/binding to the biotic ligand. Standard 3-h gill metal binding tests with Zn, Cd, Cu, Pb, Ni and Ag were performed *in vivo* on freshwater rainbow trout (*Onchorynchus mykiss*). Radiolabelled metals were presented at a range of concentrations, establishing Michaelis-Menten relationships, and then the tests were repeated in the presence of a potentially competing second “cold” metal at the approximate 96 h LC50 concentration. Resulting data are the first steps towards creating a multi-metal BLM (Biotic Ligand Model). [Environment Canada a MITHE Program].

Causes and consequences of variation in male and female mating interactions

Les causes et conséquences de la variation des interactions reproductives entre mâles et femelles.

¹Hannah Tennant, ¹Erin Sonser, ¹Tristan A.F. Long

¹*Wilfrid Laurier University*

Understanding the sources of variation in potential mating interactions between males and females is important because this variation determines the strength and the direction that evolution via sexual selection will proceed. While variation in male attractiveness and ornamentation has received much attention, the sources and consequences of variation between females of a given species have been relatively understudied. In this project, we use cytogenetic cloning techniques developed for *Drosophila melanogaster* to create “hemiclonal” males and females with whom we can directly observe sexual interaction and track reproductive outcomes. Using this approach we are able to examine not only the contribution of genetic variation from in each sex to observed phenotypic variation in biologically important traits such as mating speed, copulation duration, and subsequent offspring production, but also quantify the magnitude of intersexual genetic correlations.

Illness-dependent conditioned taste avoidance in an amphibian

Conditionnement aversif du goût dépendant d'un état maladif chez un amphibiens

¹Eric To, ¹Frederic Laberge

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Conditioned taste avoidance (CTA) prevents the consumption of dangerous food. It results from the pairing of a food with aversive consequences. Some investigators believe that CTA is restricted to amniote vertebrates. We evaluated

the ability of the Oriental fire-bellied toad *Bombina orientalis* to avoid a novel food paired with unpalatable taste or subsequent illness. Mealworms (novel prey) were coated with either 2% hydrochloric acid (unpalatable) or 3% copper sulphate (nauseating). Control subjects received mealworms coated in water. Avoidance was examined after one pairing in a subset of toads and after four attempted pairings in all subjects. Consumption of CuSO₄-coated mealworms elicited obvious signs of illness, whereas food coated with HCl only resulted in immediate, short-lived aversive reactions. Avoidance arose rapidly and was limited to food tainted with CuSO₄. This was specific to mealworms; crickets were not avoided. This amphibian is thus capable of CTA involving illness.

Are skeletal muscle mitochondria net hydrogen peroxide producers or consumers?
Est-ce que les mitochondries des muscles squelettiques sont des producteurs ou consommateurs de peroxyde d'hydrogène?

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¹*University of Manitoba*

It is widely appreciated that mitochondria can produce reactive oxygen species (ROS). Because of this mitochondria are often implicated as a significant net source of ROS in cells. Superoxide is the major initial ROS formed by mitochondria. Aqueous superoxide is primarily in the anionic form (pKa of < 5) and does not readily cross membranes. Once formed, superoxide is rapidly dismutated into hydrogen peroxide, which can diffuse across membranes. Thus, hydrogen peroxide is of central importance for mitochondria to be a direct source of ROS that lead to extra-mitochondrial oxidative stress. Mitochondria also consume hydrogen peroxide, especially in the presence of respiratory substrates. It is unclear which of these opposing fates for hydrogen peroxide, synthesis or consumption, predominant in respiring mitochondria. Our current research aims to determine under what conditions, if any, muscle mitochondria are net hydrogen peroxide producers or consumers.

Functional morphology of adductor muscle in scallops of differing swimming capacities.
Morphologie fonctionnelle du muscle adducteur chez des pétoncles avec des capacités de nage différentes.

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Scallops differentiate themselves from other bivalves by their swimming capacities. Modifications in shell structure, mantle and adductor muscle are considered derived adaptations that allowed scallops to swim (Drew 1906, Yonge 1936). Further, there is a functional morphological relationship between the size, position and arrangement of the adductor muscle, shell shape and swimming capacities in bivalves (Drew 1906, Dakin 1909, Yonge 1936, Gould 1971, Soemodihardjo 1974). Therefore, adductor muscle morphological properties should relate to swimming performance in scallops. We quantified adductor muscle size, position and obliqueness in 5 scallop species with different shell morphologies and swimming capacities. The species *Amusium balloti* mainly uses its phasic muscle and its adductor muscle has a higher proportion of phasic muscle than that of the other species. Obliqueness of phasic muscle is much more pronounced in scallop performing intense bursts of phasic contractions, *Pecten fumatus*, than other species.

Effects of interspecific competition between intraerythrocytic blood parasites *Hepatozoon clamatae* and *Hepatozoon catesbeiana* in green frogs, *Rana clamitans*

Les effets sur la compétitions interspécifiques entre les parasites intra-érythrocytique *Hepatozoon clamatae* et *Hepatozoon catesbeiana* chez la grenouille verte, *Rana clamitans*

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Hepatozoon catesbeiana and *Hepatozoon clamatae* are apicomplexan parasites that infect green frogs. Little is known about population dynamics of infections of both species in individual frogs, and few studies have been performed on immune responses of frogs to these malaria-like parasites. Objectives of these experiments were to examine population dynamics of dual infections of *Hepatozoon* species and to characterise the immune response of green frogs to these parasites. Mosquitoes fed on adult green frogs with pure infections of either species were fed to juvenile green frogs. Blood samples taken every five days post-inoculation (d PI) revealed that levels of lymphocytes and neutrophils increased greatly at 25 d PI. At 30 d PI, ratios of both cell types decreased steadily as parasites began to leave the liver and enter the bloodstream. Parasitaemia of frogs infected with both species of parasites resulted in a much higher parasitaemia of *H. clamatae*.

The accuracy of extinction estimates and effectiveness of conservation in Canada

La précision des estimations du nombre d'extinctions et l'efficacité de la conservation au Canada

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¹*University of Guelph*

It has been 35 years since species extinction risk assessments for Canadian wildlife began. We now have the opportunity to retrospectively evaluate: a) how well COSEWIC estimated extinction predictions, relative to b) how effective conservation has been in Canada. Using 890 species assessed by the Committee on the Status of Endangered Wildlife in Canada, we evaluated the movement of species across risk categories relative to conservation efforts. 448 (64%) species did not change in risk status, 176 (25%) increased in risk status, and 73 (10%) decrease in risk status. Few of these increases in risk were attributed to genuine increases in extinction risk (74; 42%). X2 analysis suggested that risk status changes were significantly confounded by changes to risk assessment criteria and the reassignment of Designatable Units ($p < 0.001$) and conservation actions did not significantly explain risk status decreases.

A Wolbachia survey of Malagasy ants

Étude de la bactérie Wolbachia chez les fourmies Malgaches

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¹*University of Guelph, 2California Academy of Sciences*

Wolbachia are endosymbiotic bacteria known to manipulate host reproduction. They occur in arthropods and filarial nematodes, but to what extent are they found in ants? I used a diagnostic PCR method to assess the presence/absence of Wolbachia infection in Malagasy ants. Infection was found to vary greatly across taxonomic levels. I suggest the use of a 20% rule to assess host species as “Wolbachia majority infected” and “Wolbachia minority infected”, instead of a strict infected/uninfected rule that may overestimate infection. I also assessed the accuracy of Wolbachia detection by comparing DNA extracts from host somatic tissue and host reproductive tissue where Wolbachia is found in higher concentrations. There is a common misconception that Wolbachia detection using somatic DNA will underestimate Wolbachia infection, however my data did not support this expectation.

The amphibious fish *Kryptolebias marmoratus* uses alternate strategies to maintain oxygen delivery during hypoxia and air exposure

Le poisson amphibia Kryptolebias marmoratus utilise des stratégies alternatives pour maintenir la livraison d'oxygène durant l'hypoxie et l'exposition à l'air

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The relatively high availability of oxygen in air compared to water is thought to have driven differences in the respiratory systems of air- versus water-breathing animals. We tested this hypothesis using the amphibious fish *Kryptolebias marmoratus*, which are able to remain active for weeks in both air and water using cutaneous respiration. Fish were acclimated for 7d to normoxic water (control), aquatic hypoxia (~3.5 kPa), normoxic air, or aerial hypoxia (~13.5 kPa). Angiogenesis in the bucco-opercular cavity of air-exposed fish was pronounced, and aerial ventilation was observed for the first time in this species. Both aquatic and aerial hypoxia increased oxygen carrying capacity while air exposure increased hemoglobin-oxygen affinity regardless of oxygen availability. These results suggest that oxygen transport is regulated by both oxygen availability and also independently by air exposure.

The interactions between background colour and feeding behaviour in Atlantic cod (*Gadus morhua*) with emphasis on molecular expression of appetite-related hormones

Les interactions entre la couleur du fond et le comportement d'alimentation de la Morue Atlantique (*Gadus morhua*) avec une emphase sur l'expression moléculaire des hormones reliées à l'appétit

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The endocrine regulation of feeding is achieved via a complex web of interacting intrinsic and extrinsic factors. In this study, we assessed whether environmental colour affects feeding behaviour and appetite-related transcripts in Atlantic cod (*Gadus morhua*). Juvenile cod were placed in aquaria with either white or black backgrounds for 10-days and either fasted or fed. Food intake behaviour and growth in fish did not appear to be altered by background colour. However, fasting did indeed cause negative growth in cod. Forebrain transcript expressions of three appetite regulators, melanin-concentrating hormone, orexin and gonadotropin-releasing hormones, were analyzed in all fish. Our results suggest that the expression of all three peptides is affected by fasting and/or background colour. Overall, this study contributes to the understanding of appetite regulation in cold-water fish and might lead to the development of improved rearing conditions for cod, thus promoting enhanced growth and food intake in aquaculture settings.

Heme oxygenase-1(HO-1) mediated respiratory responses in the goldfish, *Carassius auratus*

Réponses respiratoires dépendant de l'hème oxygénase-1 (HO-1) chez le cyprin doré, *Carassius auratus*

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Hypoxia elicits an increase in ventilation amplitude (Vamp) and frequency (Vf) in fish and induces the transcription and/or translation of heme oxygenase 1 (HO-1) which breaks down heme into carbon monoxide, biliverdin and iron. We hypothesize that HO-1 contributes to the hyperventilatory response in goldfish (*Carassius auratus*) acclimated to 7 or 25°C. During hypoxia untreated fish significantly increased their Vamp and Vf and during hyperoxia, ventilation was reduced. Zinc protoporphyrin IX (ZnPPIX; HO-1 inhibitor) injections caused a further Vf increase during hypoxia and prevented the decrease in Vf during hyperoxia in 7°C fish. Hypoxia caused a significant increase in HO-1 enzyme activity in control 7°C fish but not in 25°C fish. Enzyme activity increased in both control groups exposed to hyperoxia. Inhibiting HO-1 did not affect the ventilation response of 25°C fish. Immunohistochemistry revealed the presence of HO-1 in branchial neuroepithelial cells.

Hypoxie provoque une augmentation dans l'amplitude (Vamp) et la fréquence (Vf) de la ventilation dans les poissons et induit la transcription et/ou la traduction de l'hème oxygénase 1 (HO-1) qui décompose le hème en oxyde de carbone, la biliverdine et le fer. Nous émettons l'hypothèse que la HO-1 contribue à la réponse hyperventilatoire chez le cyprin doré (*Carassius auratus*) acclimatés à 7 ou 25°C. Pendant l'hypoxie, poissons sans traitement ont augmenté leur Vamp et Vf considérablement, et pendant l'hyperoxyie, la ventilation a été réduite. Les injections de zinc protoporphyrine IX (ZnPPIX; inhibiteur d'HO-1) ont causé une augmentation supplémentaire de Vf durant l'hypoxie et empêché la reduction de Vf durant l'hyperoxyie dans les poissons acclimaté à 7°C. L'hypoxie a provoqué une augmentation significative de l'activité du enzyme HO-1 chez les poissons acclimaté à 7°C mais pas chez les poissons à 25°C. L'activité enzymatique a augmenté dans les deux groupes de réglage exposés à l'hyperoxyie. L'inhibition de HO-1 n'a pas d'incidence sur la réponse de ventilation de poissons à 25°C. Immunohistochimie a révélé la présence de HO-1 dans les cellules neuro-épithéliales branchiales.

High-throughput RNA sequencing reveals candidate genes associated with freeze tolerance in *Eurosta solidaginis*

Le séquençage à haut début de la RNA révèle des gènes candidats associés avec la tolérance au gel chez *Eurosta solidaginis*

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¹University of Western Ontario, ²Landcare Research

Temperature affects many physiological processes in insects, and insects in temperate and polar zones have developed overwintering strategies to survive winter sub-zero temperatures. The goldenrod gall fly, *Eurosta solidaginis*, overwinters as a prepupa and can survive both extra- and intra-cellular ice formation. The molecular mechanisms underlying this freeze tolerance are not well-understood. We used high-throughput RNA sequencing to identify genes associated with the response to freezing stress. *E. solidaginis* prepupae were frozen at -12 °C for 2 h and samples were collected 0, 15, 30, 60, 90, 120, 180, and 360 min after the cold treatment. Sequences obtained from all sampling points and control individuals were used for de novo transcriptome assembly, and transcription profiles were compared among control and cold treated samples. These comparisons will allow us to identify candidate genes associated with freeze tolerance, and to generate novel hypotheses about the physiological mechanisms underlying insect freeze tolerance.

The effect of testosterone on migratory restlessness, body composition and oxidative enzyme activity in white-throated sparrows (*Zonotrichia albicollis*) during spring migration.

Effet de la testotérone sur l'agitation migratoire, la composition corporelle et l'activité de l'enzyme oxidative chez le bruant à gorge blanche (*Zonotrichia albicollis*)

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In passerines, the endocrine modulators responsible for seasonal changes in migratory behaviour and physiology are unclear. Spring photoperiods drive increased androgen levels, which increase muscle mass and fat deposition rates to power migration, as well as enhance nocturnal migratory restlessness behaviour (Zugunruhe). Our study compared physiological indicators and Zugunruhe in castrated and intact white-throated sparrows (*Zonotrichia albicollis*) following photoperiod and hormone manipulation. Flight muscle, heart mass, and Zugunruhe activity were highest in long-day intact males or long-day castrated males that received testosterone replacement. Oxidative enzyme activity was unrelated to testosterone, but was higher in the long-day relative to the short-day group. Our results indicate that long day photoperiods in spring increase exercise organ mass and enhance nocturnal restlessness through testosterone, but that testosterone does not appear to be responsible for the upregulation of oxidative enzymes.

A transgenerational study on the impact of waterborne fluoxetine concentrations on the stress axis of both sexes of zebrafish *Danio rerio*

Étude transgénérationnelle de l'impact du fluoxétine en milieu aquatique sur l'axe du stress chez le poisson zèbre *Danio rerio*

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The antidepressant fluoxetine (FLX), the active ingredient of Prozac™, is detected in aquatic environments as high as 540 ng/L. This study focuses on the effects of environmental FLX concentrations on the hypothalamus-pituitary-interrenal (HPI) axis of the zebrafish (ZF), *Danio rerio*. Preliminary results demonstrate that early FLX exposure decreased basal and stress-induced cortisol levels of adult ZF. Studies on rodents suggest that the magnitude of the stress response is sex-dependent due to the different sex steroids (i.e., 17 β -estradiol and testosterone) present. Furthermore, FLX does decrease female and increase male goldfish gonadal aromatase activities, an enzyme involved in the conversion of testosterone to 17 β -estradiol. Experiments are testing the hypothesis that FLX disrupts the HPI axis in ZF with effects being dependent on the sex. Moreover, I will also test the hypothesis that the effects of FLX are transgenerational. Supported by grants from NSERC.

She has good 'taste': the genetic and sensory basis for variation in egg-laying site preference

Elle a bon "goût": bases génétique et sensorielle des variations de la préférence du site de ponte

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The protein kinase G encoded by the foraging gene (for) has pleiotropic effects on behaviour in the fruit fly *Drosophila melanogaster*. Allelic variation in for underlies divergent foraging strategies and also egg-laying site preferences. Rover females (forR, long distance foragers) prefer to lay eggs on substrates with low protein concentration (yeast) whereas sitter females (fors; short distance foragers) prefer sites with high carbohydrate concentrations (sugar). Higher kinase activity in rovers results in an increased sensitivity to sugar, however, the preference for yeast concentration is as yet unexplained. We are investigating the roles of glutamate, glycerol, and acetic acid since they are all associated with yeast and may indicate protein availability and/or fermentation activity. We are assessing rover/sitter variation in protein source preference via assays for egg-laying site preference and gustatory and olfactory sensitivity. Transgenic expression of for is also being used to investigate which specific neuronal groups are involved in these behaviours.

Evaluating spinal nerve fidelity following tail loss in the leopard gecko

Évaluation de la fidélité du nerf spinal après perte de la queue chez le gecko léopard

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¹University of Guelph

Many lizards are capable of spontaneously regenerating their tails as an anti-predation strategy. The replacement tail includes most of the tissues present within the original tail, but it is not a perfect replica. Here we investigate the anatomical fidelity of spinal nerves in the regenerate tail of the leopard gecko, *Eublepharis macularius*. Our histological investigation reveals that regenerating spinal nerves undergo axonogenesis to provide innervation to the new tail. We then analyzed cross sections of original and regenerated tails in three different tail regions (proximal, middle and distal), immunostained with a neurofilament marker to quantify spinal nerve density. Overall, nerve density in the regenerate tail is greater than that of the original tail with significant differences between the proximal segments. Preliminary data indicates that nerve density is related, at least in part, to cross sectional muscle area and tail size.

Beaucoup de lézards sont capables de régénérer spontanément leurs queues comme une stratégie anti-prédation. La queue de remplacement comprend la plupart des tissus présents dans la queue d'origine, mais ce n'est pas une réplique parfaite. Nous étudions ici la fidélité anatomique des nerfs spinaux dans la queue régénérée de la gecko léopard, *Eublepharis macularius*. Notre examen histologique révèle que la régénération des nerfs spinaux subissent l'axonogenèse pour fournir innervation de la nouvelle queue. Nous avons ensuite analysé sections de queue d'origine et régénérée dans trois régions différentes (queue proximale, intermédiaire et distale), immunocolorées avec un marqueur de neurofilaments pour quantifier la densité de nerfs spinal. Dans l'ensemble, la densité de nerfs dans la queue régénérée est supérieure à celle de la queue d'origine avec des différences significatives entre les segments proximales. Les données préliminaires indiquent que la densité nerveuse est liée, au moins en partie, à l'aire de section transversale musculaire et la taille de la queue.

Cortisol delays the reproductive cycle of viral hemorrhagic septicemia virus IVb in walleye skin fibroblasts

Le cortisol délaie le cycle reproductif du virus de la septicémie hémorragique virale IVb dans des fibroblastes de la peau de doré

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¹Niels C. Bols

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Viral infections are commonly thought to be more prevalent in animals experiencing stress, and elevated blood levels of glucocorticoids, like cortisol, accompany stress, but the connection at the cellular level between cortisol and virus infections is poorly understood. This has been investigated in a cell line that we have developed from walleye skin (WESk11). The cells have a fibroblast morphology, express vimentin and collagen I, and support VHSV IVb production. When WESk11 cultures were exposed to cortisol for several days, the cells adopted an epithelial-like shape, stopped proliferating, and expressed less collagen I. When cultures with or without 100 ng/mL cortisol pretreatments were infected with VHSV IVb and incubated with cortisol, only cultures pretreated with cortisol showed significant differences from cultures infected without cortisol. Expression of viral polypeptides M and N was limited, cytopathic effects were delayed, and virus production reduced. Thus cortisol's actions depend on the order of exposure.

Responses of double-stranded RNA (dsRNA) in cultured cells from walleye, *Sander vitreus* and other teleosts

Réponses de l'ARN double brin chez des cellules cultivées du doré jaune, *Sander vitreus*, et autres téléostéens

¹Nathan N.T.K. Vo, ²John S. Lumsden, ¹Brian Dixon, ³Lucy E.J. Lee, ¹Niels C. Bols

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For over 20 years, synthetic dsRNA such as polyinosinic:polycytidylic acid (polyIC) has been explored as an agent to protect fish in aquaculture from pathogenic viruses. PolyIC mimics the structures of viral dsRNA often produced during the replication cycle of animal viruses and can induce interferon-mediated antiviral responses. Interestingly dsRNA has also been shown to cause apoptosis in mammalian cells. While many studies confirm that polyIC could induce antiviral states in fish in vitro and in vivo, polyIC-induced apoptosis has rarely been reported. Here we demonstrate that while inducing an antiviral state at 1 µg/mL in cultured cells from walleye (*Sander vitreus*), polyIC also killed these cells at higher concentrations that had little effect on the viability of cells from rainbow trout, fathead minnow, zebrafish, mummichog, Atlantic cod, and American eel. Possibly, walleye possess more sensitive dsRNA-sensing mechanisms than other teleosts and cell cultures could be useful for studying them.

Depuis plus de 20 ans, ARNdb synthétique comme acide polyinosinique: polycytidylique (PolyIC) a été exploré en tant qu'agent pour protéger les poissons en aquaculture des virus pathogènes. PolyIC imite les structures d'ARNdb viral souvent produites pendant le cycle de réPLICATION du virus animaux et peuvent induire des réponses médiées par l'interféron antiviraux. L'ARNdb a également été montré de causer l'apoptose dans les cellules de mammifères. Alors que de nombreuses études confirment que PolyIC pourrait induire des états antiviraux dans les poissons in vitro et in vivo, l'induction de l'apoptose par PolyIC a été rarement rapportée. Nous démontrons ici que tout en induisant un état antiviral à 1 pg / ml dans les cellules cultivées de doré jaune (*Sander vitreus*), PolyIC avait tués ces cellules à des concentrations plus élevées qui avait eu peu d'effet sur la viabilité des cellules de la truite arc, Vairon à grosse tête, le poisson zèbre, choquemort, la morue de l'Atlantique, et l'anguille d'Amérique. Peut-être, le doré jaune posséder des mécanismes de détection d'ARNdb plus sensibles que les autres téléostéens et des cultures cellulaires pourraient être utiles pour les étudier.

Cerium toxicity to *Hyalella azteca* and *Daphnia pulex*: protective effects of cationic competition and dissolved organic matter

La toxicité du Cerium pour *Hyalella azteca* et *Daphnia pulex*: Les effets protecteurs de la compétition cationique et de la matière organique dissoute

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This research compares the toxicological effects of two rare earth elements (REEs) to sensitive freshwater invertebrates (*Hyalella azteca* and *Daphnia pulex*) and to understand the toxicity modifying influence of cationic competition and dissolved organic matter (DOM). Cerium and dysprosium were chosen as representative REEs. Environment Canada methods were used for culture and testing; conducted at 21°C with pH 7.1-7.2 and water hardness of either 12.5 or 32 mg CaCO₃/L (*Hyalella* and *Daphnia*). *Hyalella* was more sensitive to Ce. The protective effect of cationic competition was tested with Ca (0.1-2.0 mM), Mg (0.03-0.5 mM) and Na (0.1-2.0 mM). Ca provided a concentration dependent protective effect on Ce toxicity. The ability of DOM to complex Ce was demonstrated by an 11-fold decrease in toxicity at DOC concentrations of 6 mg C/L. Research is supported by a NSERC Strategic Grant and Environment Canada with contributions from Avalon Rare Metals Inc.

Ant community structure and biodiversity dynamics along an elevation gradient

Structure communautaire et dynamique de la biodiversité des fourmis le long d'un gradient altitudinal

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Patterns of biodiversity and community structure along elevation gradients are understudied, yet critical features of global biogeography. These patterns and their underlying causes will be of increasing ecological interest as communities continue to vary over time in the face of climate change. Recently, increased attention has been paid to ants (Hymenoptera; Formicidae) in terms of their importance to ecosystem processes and the rich base of information they can provide to aid efforts in biodiversity assessment and management. To address these questions, a total of 14 238 individual morphological measurements were taken from 791 worker ant specimens collected along the elevation range of Volcán Cacao within the Área de Conservación Guanacaste (ACG) in Costa Rica. These functionally significant measurements were used to inform ant species guild membership and to determine how the representation of these guilds varies along Cacao's elevation gradient to infer possible mechanisms of community assembly.

Atlas of Anatomy and Histology of the Pacific Hagfish (*Eptatretus stoutii*)

Atlas d'anatomie et histologie de la myxine brune (*Eptatretus stoutii*)

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Hagfish are excellent models for comparative physiology and anatomy studies due to their phylogeny. Currently, there is no comprehensive atlas of hagfish anatomy and histology to provide morphological knowledge for comparative studies. We sought to produce a Pacific hagfish (*Eptatretus stoutii*) atlas through photo-documentation of gross morphology and hematoxylin and eosin stained tissues. Presented is the anatomy of three unique tissue types: tooth, intestine and gill. Hagfish have primitive teeth lacking calcification, and instead have keratinous epithelium with an underlying pokal cell cone. Suggestions of the cone's importance include structural support and rapid tooth replacement. The fore-gut housed all mucous cells, a characteristic unique to hagfish. The hind-gut displayed specialized zymogen granule cells containing acidophilic granules likened to pancreatic enzymes. In comparison to teleosts, hagfish gills had unique morphology, containing pleated secondary lamellae. This atlas is a first for hagfish, providing a comprehensive study of tissue morphology in this evolutionarily important animal.

Defining new roles of scavenger receptors in alternative animal models: evidence of function class A scavenger receptors in rainbow trout epithelial cell lines

Attribution de nouveaux rôles aux récepteurs scavenger chez des modèles animaux alternatifs: Évidence du rôle fonctionnel des récepteurs scavenger de classe A dans une lignée de cellules épithéliales de truite arc-en-ciel

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Class A scavenger receptors (SR-As) are surface receptors that play an important role in mammalian atherosclerosis and innate immunity. The present study examines the presence of functional scavenger receptors in two rainbow trout epithelial cell lines: RTgutGC and RTgill-W1. Scavenger receptor function in RTgutGC and RTgill-W1 was determined using fluorescently labelled acLDL, a classic SR-A ligand, or poly IC (polyinosinic:polycytidylic acid), a commercially available dsRNA molecule and innate immune stimulus, with or without a panel of known SR-A competitive ligands. These experiments demonstrate that both AcLDL and poly IC bind to RTgutGC and RTgill-W1, and that this binding is blocked by SR-A competitive ligands. Interestingly, results suggest that both AcLDL and poly IC bind the same SR-A in RTgutGC, but different SR-As in RTgill-W1. Thus, this work demonstrates the first evidence for functional SR-As in these cell lines and the first evidence for extracellular dsRNA entry in fish cells.

Terrestrial Embryonic Development of the Mangrove Rivulus, *Kryptolebias marmoratus*: A Strategy to Avoid to Conspecific Predation

Développement embryonnaire terrestre du killi des mangroves, *Kryptolebias marmoratus*: une stratégie pour éviter le cannibalisme

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The transition from aquatic to terrestrial embryonic development was challenging for early vertebrates because embryos are vulnerable to desiccation. To study this transition, we examined spawning, cannibalism and embryonic development of *Kryptolebias marmoratus* in terrestrial and aquatic environments. We hypothesized that *K. marmoratus* use terrestrial niches for spawning to avoid conspecific predation and to increase developmental rate from the higher oxygen levels. Adults were exposed to both environments and spawning and cannibalistic behaviours were recorded. We found that adults released 2-fold more embryos when air-exposed relative to aquatic individuals and would only consume unrelated embryos aquatically. Embryos were subsequently reared in both environments and successfully developed at similar rates but terrestrial rearing resulted in increased oxygen consumption. We found partial evidence to support my hypothesis, as rivulus can spawn terrestrially to eliminate aquatic predation, but did not show higher developmental rates when out of water despite increased oxygen consumption.

La transition du développement embryonnaire d'un environnement aquatique au terrestre a été difficile pour les premiers vertébrés parce que les embryons sont vulnérables à la dessiccation. Pour étudier cette transition, nous avons examiné la ponte, le cannibalisme et le développement embryonnaire des *Kryptolebias marmoratus* dans les environnements terrestres et aquatiques. Nous avons supposé que *K. marmoratus* utilise les niches terrestres pour la ponte pour éviter la prédation conspécifiques et pour profiter des niveaux d'oxygène plus élevées pour augmenter le taux de développement. Les adultes ont été exposés à les deux environnements et les comportements de reproduction et cannibales ont été enregistrées. Nous avons trouvé que les adultes libérés 2 fois plus d'embryons lorsque exposées à l'air par rapport à des individus aquatiques et seulement consommerait les embryons sans rapport dans l'eau. Les embryons ont ensuite été élevés dans les deux environnements et développé avec succès à des taux similaires, mais l'élevage terrestre abouti à une consommation d'oxygène plus élevée. Nous avons trouvé des preuves partielle pour soutenir mon hypothèse, comme Rivulus peut engendrer par voie terrestre à éliminer la prédation aquatique, mais n'a pas montré des taux plus élevés de développement hors de l'eau, malgré la consommation d'oxygène augmenter.

The effects of high environmental ammonia on the crf system and neuronal development in developing zebrafish

Les effets d'une forte concentration environnementale d'ammoniac sur le système crf et sur le développement neuronal des poissons-zèbres en développement

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High environmental ammonia (HEA) increases CRF (corticotropin-releasing factor) expression and cortisol levels in adults of various fish species but little is known of the effects of HEA during development. Here we show gene specific changes in expression of CRF system members and an increase in cortisol levels during HEA in developing zebrafish. Early exposure also impacts later life cortisol levels under normal and stressed conditions. Examination of neuronal markers following HEA shows an overall decline in neural proliferation. As with CRF system members, these effects vary with treatment intensity; developmental stage; and for neuronal proliferation, the neuronal sub-type. Since apoptosis has been implicated in the cytotoxicity of HEA, its role in the reduction of neuronal development is explored as a likely mechanism. Lastly, the changes to the expression of CRF system in specific nuclei are examined to better understand the upstream signaling of HEA as an HPI stimulating stressor.

Detection of Cryptosporidium sp. and Giardia duodenalis in Eastern oysters (*Crassostrea virginica*) from Prince Edward Island, Canada

Détection de Cryptosporidium sp. ainsi que de Giardia duodenalis chez l'huître de l'Est (*Crassostrea virginica*) de l'Île du Prince Edward, Canada

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Cryptosporidium parvum and Giardia duodenalis are zoonotic parasites capable of bio-accumulating in bivalves. Opportunistic samples of oysters collected in 2011 from sites within the prohibited region of the Hillsborough Harbour, PEI, detected up to 77% and 46% positive for Cryptosporidium and Giardia, respectively. Sampling conducted in 2012 included sites within prohibited, conditionally restricted, and approved regions. Proportions of contaminated oysters from prohibited sites were significantly higher in 2011 than 2012. Two conditionally restricted sites closed to harvesting during 2012 samplings possessed levels of contamination (32-48% and 19-32% positive for Cryptosporidium and Giardia, respectively) proportional to those seen in prohibited sites but higher than other conditionally restricted sites unaffected by the event (0-8% and 0-10% positive, respectively). Species identities via genotyping are required to determine whether contamination is predominantly from human (sewage overflows) or animal (water run-off) sources and to assess the potential public health risk of species detected.

Metamorphosis and animal personality: A neglected opportunity

Métamorphose et personnalité animale: une opportunité négligée

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Understanding how individual differences in personality arise and are maintained in animal populations is a topic of considerable current research interest. Developmental perspectives, though previously neglected, are now thought essential since the vast majority of animal species possess complex life cycles or undergo some form of metamorphosis. Yet despite the broad taxonomic relevance and obvious potential importance of metamorphosis for personality research, almost no research has been done on this topic. Using the lake frog (*Rana ridibunda*), we tested whether individual-level differences in personality (activity, exploration, boldness) were consistent within both larval and juvenile frog life history stages as well as across metamorphosis. We found that most behavioural traits were highly consistent within a given life history stage and at least some traits were consistent across metamorphosis (e.g. activity, exploration). Our study is the first to characterize personality in anurans as well as across metamorphosis in a vertebrate species.

Slime gland cytology and mechanisms of slime thread production in the Atlantic hagfish (*Myxine glutinosa*)

Cytologie des glandes à mucus et mécanismes de production des fils visqueux chez la myxine du nord (*Myxine glutinosa*)

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The multicellular slime glands of hagfish are functionally and structurally unique among cyclostomes. The holocrine release of cells from these glands results in the formation of a fibrous slime that viscously entraps seawater to discourage attacks by gill-breathing predators. Past research into the cytology of the slime gland, and processes of gland thread cell (GTC) and gland mucous cell (GMC) maturation, leads to a number of hypotheses on the mechanism of slime thread assembly in GTCs. Using a number of cell manipulation and imaging techniques, I reveal: (1) a previously undescribed cell in the hagfish slime gland, (2) the intermediate filament and microtubule distribution in hagfish gland cells, and (3) mechanisms of slime thread assembly. The findings test a number of hypotheses and provide the basis for further analysis of cytoskeletal element distribution and interaction in hagfish gland cell types.

Evaluation of an in vitro method of testing an anti-attachment factor on *Lepeophtheirus salmonis*
Évaluation d'une méthode in vitro pour tester un facteur anti-attachement sur *Lepeophtheirus salmonis*
¹Heather J Wotton, ²Jose Troncoso, ²Jorge Pino, ¹Sara Purcell, ¹Jennifer Covello, ¹Mark Fast, ²Simon Wadsworth
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Lepeophtheirus salmonis is a common ectoparasite of Atlantic salmon in northern marine waters. This parasite poses a significant challenge for the salmon farming industry, creating both monetary damage and fish welfare issues. Due to development of resistance in *L. salmonis* to many common chemotherapeuticants in use around the globe, the salmon farming industry must look to new solutions to control infection levels in their fish stock. This presentation will describe the development of an in vitro method of evaluating the functionality of putative anti-attachment factors. Using both the planktonic copepodid and adult life stages of *L. salmonis*, samples were incubated on TSA* mucous plates incorporating a serial dilution of a putative anti-attachment factor. Behaviour of lice in each of the treatment doses will be briefly described and gene expression work will be presented.

Active learning in a large science course: the "Discovering Biodiversity" experiment
Apprentissage actif dans un cours de sciences grand format: l'expérience de "Découvrir la Biodiversité"
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¹University of Guelph

First year biology at the University of Guelph has undergone a major redesign. Biology students now take three foundational interconnected courses – Biological Concepts of Health, Molecular and Cellular Biology, and Discovering Biodiversity. Discovering Biodiversity focuses on concepts in evolution, ecology, and comparative animal physiology and stresses numeracy and scientific inquiry skills. Online readings and multimedia, classroom sessions, and weekly seminars are equally important components. In the classroom, active-learning exercises, small group discussions, and clickers engage students in key concepts. In seminars, students collect biodiversity data in a campus woodlot over several weeks to test hypotheses. Overall, student responses to biology curriculum redesign have been very positive.

Le programme de la première année de biologie à l'Université de Guelph a subi une refonte majeure. Les étudiants en biologie maintenant prendre trois fondateurs cours interconnectés - Concepts biologiques de la santé, la Biologie moléculaire et cellulaire, et la Découverte de la biodiversité. Découverte de la biodiversité se concentre sur les concepts de l'évolution, l'écologie et la comparatif physiologie animale et insiste sur les compétences d'investigation en numération et scientifique. Lectures en ligne et multimédia, des séances en salle de classe, et des séminaires hebdomadaires sont des éléments tout aussi importants. Dans la salle de classe, des exercices d'apprentissage actif, des discussions en petits groupes, et clickers engagent les élèves à des concepts clés. Dans les séminaires, les élèves recueillent des données de biodiversité dans un boisé du campus pendant plusieurs semaines pour tester les hypothèses. Dans l'ensemble, les réponses des élèves à la refonte des programmes de biologie ont été très positifs.

Drosophila white gene modulates claustrophobic exploration
Le gène blanc de *Drosophila* module l'exploration claustrophobique
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Claustrophobia is the fear of being restrained in a small space without escape. Enclosure of a single *Drosophila* adult in a small circular arena (1.27cm diameter, 3mm deep) induces intense claustrophobic exploration of the perimeter. We established a protocol and quantified the percent of time remaining on the edge of the arena, a parameter referred to as time on task (ToT), during claustrophobic exploration. Using this protocol with 5 day-old flies we found that ToT in wild type Canton-S (CS) flies was significantly higher than that in w1118, a white mutant strain that is widely used as an isogenic genetic background. The higher ToT in CS, compared to w1118, persisted throughout the experimental period (at least 1h) though the total path length travelled was not different. The difference in ToT was maintained with aging and evident in 60 day-old CS and w1118 flies. We propose that white modulates claustrophobic exploration.

Evaluating the biodiversity of Canadian plankton
Évaluation de la biodiversité du plancton Canadien
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¹University of Guelph, ²Department of Fisheries & Oceans

Zooplankton are key components of aquatic systems, transferring energy from phytoplankton to higher trophic levels. Consequently, disruption to the functioning of an ecosystem's indigenous zooplankton community by invasive

species can have widespread ecological impacts. The biodiversity of native and invasive zooplankton in Canadian marine and freshwaters, however, is not fully characterized. Our study evaluated the zooplankton community composition of 16 Canadian ports, including poorly sampled sites in the Arctic, using both morphological identifications and DNA barcoding techniques. Species richness and non-indigenous species presence has been assessed for select ports. Our results to date indicate an overall zooplankton diversity of approximately 100 morphological species, including several known Canadian invasive species, across all sampled ports. Emerging molecular results are elucidating the presence and distribution of cryptic species as well as species previously unrecorded in molecular databases. This work provides a framework for future monitoring and greater understanding of Canadian port zooplankton biodiversity.

Zooplanctons sont des éléments clés des systèmes aquatiques, impliqués dans le transfert de l'énergie du phytoplancton aux niveaux trophiques supérieurs. Par conséquence, la perturbation du fonctionnement de la communauté de zooplancton indigène d'un écosystème par les espèces envahissantes peuvent avoir des impacts écologiques largement répandues. La biodiversité du zooplancton indigène et envahissant dans les eaux douces et marines du Canada, cependant, n'est pas entièrement caractérisé. Notre étude a évalué la composition des communautés de zooplancton de 16 ports canadiens, y compris les sites mal échantillonnés dans l'Arctique, en utilisant identification morphologique et les techniques de codes-barres ADN. La diversité des espèces et la présence d'espèces non indigènes a été évalué pour les ports sélectionnés. Nos résultats indiquent une diversité du zooplancton total d'environ 100 espèces morphologiques, y compris plusieurs espèces envahissantes connues au Canada, dans tous les ports de l'échantillon. Les résultats moléculaires qui émergent a commencé d'expliquer la présence et la répartition des espèces cryptiques ainsi que des espèces précédemment non enregistrée dans les bases moléculaires. Ce travail fournit un cadre pour la surveillance future et une meilleure compréhension de la biodiversité de zooplancton dans les ports canadienne.

Effects of rearing salinity on unstimulated and stimulated larval Malpighian tubule secretions of Chironomus riparius

Effet de la salinité d'élevage sur les sécrétions des tubes de Malpighi chez les larves de Chironomus riparius

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¹York University

As bio-indicators, *Chironomus riparius* are of great ecological importance. These ubiquitous freshwater benthic larvae of the non-biting midge fly remove detritus, and are part of a daily diet for many aquatic species. This study examined the physiological effects (fluid secretion, ion transport, and ion concentration) of *Chironomus riparius* larvae Malpighian tubules, under freshwater (FW) and brackish water (BW) conditions, using ion selective microelectrode techniques. Rearing conditions had no effect on fluid secretion rates of unstimulated tubules. In the presence of 10-6 M serotonin, fluid secretion rates, ion transport rates, and ion concentrations in secreted fluid were significantly increased in animals reared in FW compared to BW. We suggest that Malpighian tubules of FW-reared larvae are more abundant in the various types of serotonin receptor subtypes they harbour, which may be responsible for the differential rates of water and ion transport observed.

Actions of the p53 activator, nutlin-3, and the p53 inhibitor, pifithrin- μ , on the rainbow trout gill cell line, RTgill-W1

Les actions de l'activateur de p53, nutlin-3, et l'inhibiteur de p53, pifithrin- μ , sur la lignée cellulaire branchiale de la truite arc-en-ciel, RTgill-W1

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p53 is a master cellular regulator but poorly understood in fish. One experimental approach is to use p53 activators and inhibitors. In this study, the rainbow trout gill cell line, RTgill-W1, have been exposed to the p53 activator nutlin-3 and the p53 inhibitor pifithrin-m. Nutlin-3 caused non-apoptotic cell death in RTgill-W1 cells with an increase in the p53 level. Exposure of RTgill-W1 cells to pifithrin- μ resulted in apoptosis through ER stress and mitochondrial pathways, apparently independent of p53. pifithrin- μ also induced unfolded protein response (UPR) accompanied with accumulation of ER chaperones and insoluble protein aggregation. This is the first indication that p53 activator and inhibitor can induce cell death on fish cells. Understanding the function of p53 during cell death in fish will provide us with a better understanding of how this cellular regulator evolved.

Le p53 est un régulateur cellulaire principal, mais est mal comprise dans les poissons. Une approche expérimentale consiste à utiliser des activateurs et des inhibiteurs de p53. Dans cette étude, la ligne de cellule branchiale de la truite arc-en-ciel, RTgill-W1, ont été exposés à l'activateur p53 nutlin-3 et l'inhibiteur de p53 pifithrin- μ . Nutlin-3 a provoqué la mort des cellules non-apoptotiques dans les cellules RTgill-W1 avec une augmentation du niveau de p53. L'exposition des cellules RTgill-W1 à pifithrin- μ conduit à l'apoptose par le stress du RE et les voies mitochondrielles, apparemment indépendante de p53. Pifithrin- μ induit également un réponse de dépliage de la protéine (RDP) accompagnée d'une accumulation de chaperons ER et l'agrégation des protéines insolubles. C'est la première indication que les activateurs et inhibiteurs de p53 peuvent induire la mort cellulaire dans les poissons. Comprendre la fonction de p53 au cours de la mort cellulaire dans les poissons nous fourniront une meilleure compréhension de la façon dont ce régulateur cellulaire a évolué.

Puncture resistance of the scaled skin from striped bass: collective mechanisms and inspiration for new flexible armor designs

Résistance à la perforation de la peau écailleuse du bar rayé: mécanismes collectifs et inspiration pour de nouveaux modèles d'armures flexibles

¹Deju Zhu, ¹Lawrence Szewciw, ²Franck Vernerey, ¹Francois Barthelat

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The structure and mechanics of fish scales display desirable features that could inspire new protective systems. In this study we investigate collective mechanisms within scaled fish skin during a predator attack. We demonstrate that in striped bass (*M. saxatilis*), scales increase the puncture force of the skin by five times. Substrate stiffness has no effect on puncture force. The scalation pattern of uniform three scale overlap multiplies the puncture force by three. Friction between scales and local scale arrangement have little effect on puncture performance. Interestingly, indenting isolated scales results in “sinking” of the stiff scales into the soft substrate. High local deflections within the soft tissue may cause blunt injury before the scales are penetrated. Image correlation reveals that scales redistribute puncture force over large volume, limiting local deflections in the soft tissue. The structure and mechanisms of fish scales may inspire novel protective systems with attractive flexural properties.

The Effects of Hypoxia on Nitrogen Regulation in Dogfish Sharks (*Squalus acanthias*)

Les effets de l'hypoxie sur la régulation de l'azote chez l'Aiguillat commun (*Squalus acanthias*)

¹Alex Zimmer, ¹Chris Wood

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Seawater elasmobranchs such as the spiny dogfish (*Squalus acanthias*) maintain high urea levels (~400 mM) within their body fluids as part of their osmoregulatory strategy. Urea loss to the environment is low, and is believed to be tightly regulated by an ATP-dependent urea retention system at the gills. Indeed, exposure to moderate hypoxia (20% air O₂ saturation) had no effects on urea excretion (Jurea) or plasma urea levels. However, severe hypoxia (5% saturation) led to an increase in Jurea which was recovered when these fish were returned to normoxia. We interpret this as an inhibition of the branchial ATP-dependent retention system for urea, which recovered during normoxia. There was no change in plasma urea levels, but ionoregulatory disturbance (Ca, Mg), elevated ammonia excretion, and metabolic acidosis also occurred during severe hypoxia (NSERC Discovery, CRC Program).

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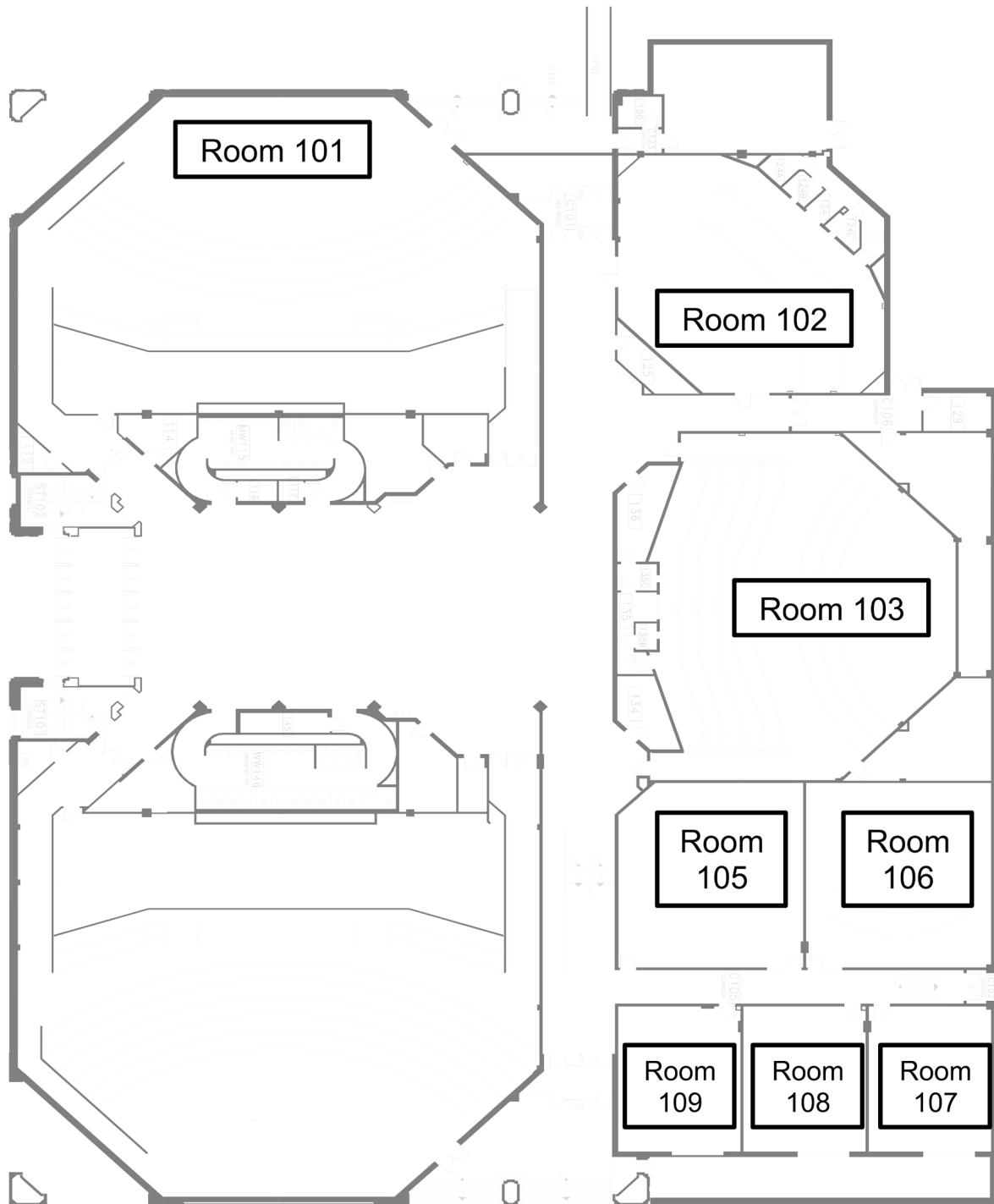
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Presentor	Presentation	Presentor	Presentation
Stasiak, Iga	CMD/PIE-2	Weleff, Jeremy	PIE3-2, P11
Stoyek, Matthew R	P43	Wells, Michael	CPB18-5
Stuart, Jeffrey A	CPB SYM 3	Williams, Tegan	P109
Stutchbury, Bridget	LOC SYM 1	Willis, Jessica	PIE2-2
Sutton, Alex	P40	Wilson, Alexander	EEE2-2
Syme, Douglas A.	CMD/CPB-5	Winegard, Timothy	P16
Talbot, Krystle	CPB5-7	Wotton, Heather J	EEE2-2
Tellis, Margaret	CPB10-1	Wright, Patricia	TEACH SYM 2
Tennant, Hannah	EEE2-5, P31	Xiao, Chengfeng	P38
To, Eric	P103	Young, Robert	EEE3-5
Treberg, Jason	P98	Zadeh Tahmasebi, Melika	P35
Tremblay, Isabelle	CMD/CPB-6	Zeng, Fanxing	CPB19-5
Trites, Michael	P5	Zhu, Deju	CMD/CPB-2
Trout, Laura M.	EEE5-8	Zimmer, Alex	CPB3-5
Tsoi, Fiona J.	EEE3-6		
Turko, Andrew	CPB6-2		
Tuziak, Sarah M.	CPB12-4		
Tzaneva, Velislava	CPB8-5		
Udaka, Hiroko	CPB4-3		
Vandermeer, Caitlin	CPB/EEE 2-4		
Vesterberg, Anders	EEE2-3		
Vieira, Jason	CMD1-5		
Vo, Nathan N.T.K.	PIE2-5, PIE3-1		
Vukov, Oliver	CPB13-5		
Warne, Connor	EEE5-1		
Weinrauch, Alyssa	CMD2-3		

Floor plan of Rozanski Hall

Trent Lane Entrance



Reynolds Walk Entrance

Time Slot	Monday	Tuesday	Wednesday	Thursday	Friday
8:00-8:30					CBP Symposium 8:00-10:30 ROZ101
8:30-9:00					
9:00-9:30	Council Meeting University Center 442	LOC Symposium "Zoology for a better Planet" ROZ101	CMD Symposium ROZ105 EEE Symposium ROZ102 CBP8 Cardiorespiratory ROZ106 CBP9 Endocrinology 1 ROZ109 CBP10 Toxicology 1 ROZ103	PIE Symposium ROZ105 EEE5 Community and Conservation Ecology ROZ109 EEE6 Chemical Ecology ROZ106	Council meeting University Center 442
9:30-10:00					
10:00-10:30					
10:30-11:00		Coffee	Coffee	Coffee	
11:00-11:30		CMD1 Development ROZ108 CBP1 Genomics/Proteomics 1 ROZ105 CBP2 Metabolism ROZ102	CMD2 Fisheads ROZ105 CBP11 Ionoregulation 1 ROZ102 CBP12 Endocrinology 2 ROZ109 CBP13 Toxicology 2 ROZ103 CBP/EEE Ecophysiology ROZ106 EEE1 Foraging and Movement ROZ109	CMD3 EvoDevo-ROZ106 CBP17 Mitochondria ROZ103 CBP18-Ecophysiology ROZ102 CBP19 Toxicology /Cell culture ROZ105 PIE1 Immunology 1 ROZ108	
11:30-12:00					
12:00-12:30	Student Lunch Peter Clark Hall (PCH)	PDF Lunch Brass Taps	AGM Lunch Peter Clark Hall in the University Center	CMD lunch PCH North EEE lunch PCH South	CBP lunch PCH PIE lunch University Center 442
12:30-1:00					
1:00-1:30					
1:30-2:00					
2:00-2:30	Teaching Symposium 1:30-3:30 Rozanski (ROZ) 103	Boutilier Lecture "Generation Omics: Hip or hype for exploration of vertebrate reproduction" ROZ101	Cameron Lecture "Sockeye salmon in hot water: population differences in cardiorespiratory performance and thermal tolerance" ROZ101		
2:30-3:00					Hoar Award Competition ROZ101
3:00-3:30	CJZ Workshop 3:00-4:00, ROZ 106		Coffee	Coffee	
3:30-4:00		Coffee			
4:00-4:30	NSERC Information Session ROZ102	CMD/CBP Biomechanics ROZ102 CBP4 Genomics/Proteomics 2 ROZ105 CBP5 Acid-base ROZ106 CBP6 Hypoxia tolerance ROZ103 CBP7 Neuroethology ROZ108 EEE2 Mating/reproduction ROZ109	CMD/PIE Student Symposium ROZ106 CBP14 Ionoregulation 2 ROZ102 CBP15 Stress Physiology ROZ105 CBP16 Toxicology 3 ROZ103 EEE4 Evolution ROZ109 PIE2 Ecology of Parasitism ROZ108 EEE Invited Session	Coffee	
4:30-5:00					
5:00-5:30	BREAK		How to be the best; Strategies to succeed.		
5:30-6:00		BREAK			
6:00-6:30	Fry Lecture "Life is PIE" ROZ101	ZET Lecture "Sudden and swift: extreme movements in biology" ROZ101	Brass Taps		
6:30-7:00					
7:00-7:30	Opening Reception Science Atrium	ZET Reception Macdonald Stewart Art Gallery	Poster Session and BBQ Science Atrium		
7:30-8:00				6:30-7:30 Odd #'s 7:30-8:30 Even #'s	
8:00-8:30					
8:30-9:00	Social Brass Taps	Social, Brass Taps Hockey Game, Arena		Bus to Downtown for Pubnight @ Doogies	
9:00-9:30					