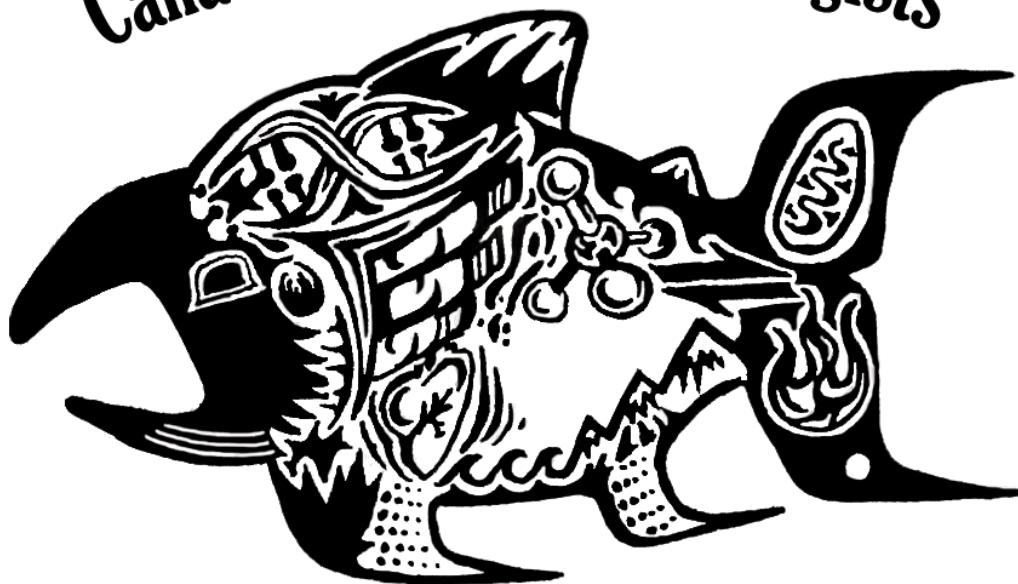


BULLETIN

Canadian Society of Zoologists



VANCOUVER 2010

Spring/Printemps 2010

Vol. 41 No. 2

17-21 May / 17-21 Mai 2010

49th annual meeting of the **Canadian Society of Zoologists**
49^{ième} réunion annuelle de la **Société Canadienne de Zoologie**

The University of British Columbia, Vancouver, British Columbia



OFFICERS OF CSZ 2009-2010 CONSEIL DE LA SCZ

President

John P. Chang
U. of Alberta, Biological
Sciences
Edmonton, AB, T6G 2E9
Phone: (780) 492-1278
Fax: (780) 492-9234
john.chang@ualberta.ca

1st Vice-President

Greg Goss
U. of Alberta, Biological
Sciences
Edmonton, AB, T6G 2E9

2nd Vice-President

Louise Milligan
Univ. Western Ontario, Biology
London, On. N6A 5B7
Ph. 519-661-3869
Email: milligan@uwo.ca

Secretary

Greg Pyle
gpyle@lakeheadu.ca
Biology, Lakehead University
Thunder Bay, ON, P7B 5E1
Phone: (807) 766-7149
Fax: (807) 343-8110

Treasurer

Allen W. Shostak
U of Alberta, Biological Sciences
Edmonton, AB, T6G 2E9
Phone: (780) 492-1293
Fax: (780) 492-9234
al.shostak@ualberta.ca

Past President

Patrice Couture
INRS, Centre Eau, Terre et Env't
QC Canada G1K 9A9
Phone: (418) 654-3825
Fax: (418) 654-2600

Councillors – Conseillers

Retiring May 2009

Todd Gillis
Univ. of Guelph, Integrative Biology
Guelph, ON, N1G 2W1
Phone: (519) 824-4120 x58786
Fax: (519) 767-1656
tgillis@uoguelph.ca

Greg Pyle
Nipissing Univ., Biology
North Bay, ON, P1B 8L7
Phone: (705) 474-3450 x4260
Fax: (705) 474-1947
Gregp@nipissingu.ca

Declan W. Ali
Univ. of Alberta, Biological Sci.
Edmonton, AB, T6G 2E9
Phone: (780) 492-6094
Fax: (780) 492-9234
Declan.ali@ualberta.ca

Retiring May 2010

Chris Moyes
Queen's Univ., Biology
Kingston ON, K7L 3N6
Phone: (613) 533-6157
Fax: (613) 533-6617
Chris.moyes@queensu.ca

Elizabeth Boulding
Univ. of Guelph, Integrative Biology
Guelph ON, N1G 2W1
Phone: (519) 824-4120x54961
boulding@uoguelph.ca

Doug Syme
Univ. of Calgary, Biological Sci.
Calgary AB, T2N 1N4
Phone: (403) 220-5281
syme@ucalgary.ca

Retiring May 2011

Colin Brauner
Univ. Of British Columbia
Vancouver, BC, V6T 1Z4
Phone: (604) 822-3372
Fax: (604) 822-2416
brauner@zoology.ubc.ca

Jim Staples
Univ. Western Ontario, Biology
London, On., N6A 5B7
Phone: (519)-661-4057
jfstaple@uwo.ca

Grant McLelland
McMaster Univ., Biology
1280 Main St. W.
Hamilton, On., L8S 4K1
Phone: (905) 525-9240 x 24266
grantm@mcmaster.ca

ARCHIVIST

John Webster
Simon Fraser University, Biol. Sci.
Burnaby, BC, V5A 1S6
Phone: (604) 291 3336
Fax: (604) 291 3496
jwebster@sfu.ca

STUDENT COUNCILLOR

Milica Mandic
Univ. of British Columbia, Zoology
Vancouver, BC V6T 1Z4
Phone: (604) 822-4201
milicamandic@hotmail.com

STUDENT COUNCILLOR

Andrea Morash
McMaster Univ. Biology
1280 Main St. W.
Hamilton, On., L8S 4K1
Phone: (905) 525-9140 x 23170
morashj@mcmaster.ca

CPB SECTION CHAIR

Glen Tattersall
Brock University
St. Catharines, On., L2S 3A1
Phone: (905) 688-5550 x 4815
Fax: (905) 688-1855
gtatters@brocku.ca

PARASITOLOGY SECTION CHAIR

Mike Duffy
Univ. New Brunswick
mduffy@unb.ca

CMD SECTION CHAIR

Ehab Abouheif
McGill Univ.,
Montreal, Quebec, H3A
1B1
Phone: (514) 398-7190
Fax: (514) 398-5069
ehab.abouheif@McGill.ca

EEE SECTION CHAIR

Joe Rasmussen
Univ. of Lethbridge,
Biol Sci.
Lethbridge, AB T1K 3M4
Ph: 403 382-7182
joseph.rasmussen@uleth.ca

BULLETIN

ISSN 0319-6674

Vol. 41 No. 2

Spring – Printemps 2010

Editor – Rédacteur en chef

Sally Leys

U of Alberta, Biological Sciences,

Edmonton, AB, T6G 2E9

Phone 780 492-6629

Fax 780 492-9234

sleys@ualberta.ca

Translators – Traductrices

Mathieu Caron

Céline Audet

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 zoologistes canadiens. Les auteurs devront soumettre une copie sur traitement de texte. Les textes peuvent être accompagnés de dessins originaux ou de photographies. Avant d'être publiés, ils seront révisés et devront être approuvés par le rédacteur. Les opinions et commentaires qui apparaissent dans le Bulletin ne reflètent pas nécessairement les politiques de la SCZ.

Contents/Contenu

ii	Organizing Committee / Comité organisateur
iii	General information / Informations générales
iv	2010 CSZ Awards / Prix SCZ 2010
viii	T.M.W. Cameron Award / Prix T.M.W. Cameron
1.	Detailed programme contents / Programme détaillé
39.	Posters / Affichees
50.	Abstracts

**49th annual meeting / 49^{ième} réunion annuelle
17-21 May / 17-21 mai 2010
The University of British Columbia**

Organizing Committee / Comité organisateur

Patricia Schulte (Chair)

Colin Brauner, Tony Farrell, Milica Mandic, Bill Milsom,
Jeffrey Richards & Robert Shadwick

Department of Zoology
Comparative Physiology Graduate Students

**We wish to thank the following individuals, institutions & organizations for their contributions:
Nous remercions pour leur contribution:**

Eric Shadwick for website design

Jean-Sebastien Moore & Agnes Lacombe for translation

UBC Dean of Science
UBC Department of Zoology
UBC Biodiversity Research Centre

Company of Biologists or JEB
University of Chicago Press
Physiological and Biochemical Zoology



Canadian Society of Zoologists Annual Meeting

May 17-21, 2010

accommodation

- D6 Walter Gage Towers
F/G2 Marine Drive Residence

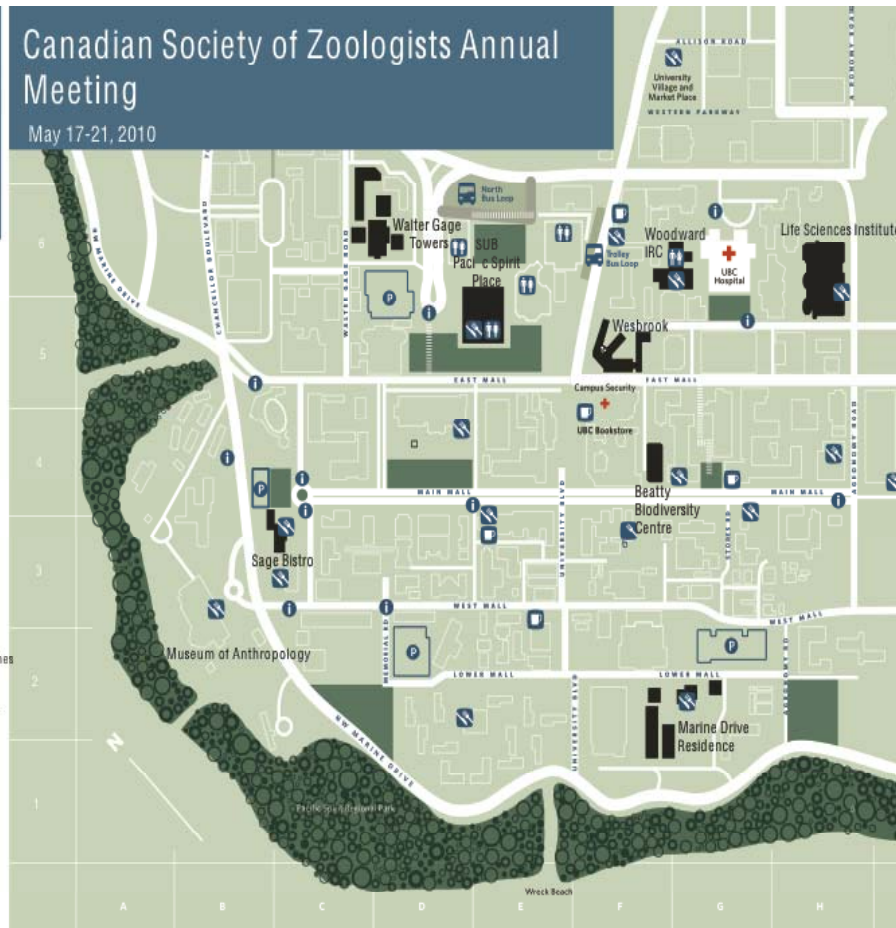
conference events

- G5/6 Woodward IRC
Opening Reception May 17
Coffee Breaks
Contributed Papers
Lectures and Workshops
Hoar Award Presentation
NSERC Grants Process PAR Symposia
- F5 Westbrook
Contributed Papers
EEE, CMD, CPB Symposia
- F/G4 Beatty Biodiversity Centre
Council Meetings
- H5/6 Life Sciences Institute
Poster Session May 19
- D6 Walter Gage Towers
CMD, PAR, Student, CPB, EEE, AGM Luncheon
- D/E5 SUB Paci c Spirit Place
Breakfast (for delegates staying with the 3&B rate)
- C3 Sage Bistro
Conference Banquet May 20

facilities

- Parking
 Public Washrooms
 emergency services

- G6 UBC Hospital
F4/5 CAMPUS SECURITY



other information

medical care

UBC Hospital Urgent Care Center
2211 Wesbrook Mall
Tel: 604-822-7222
Daily 8am-10pm

UBC Health Clinic
Strangway Building
310-5950 University Blvd.
Tel: 604-822-5431
M-F 9am-5pm

University Village Medical Clinic
University Village & Market Place
228-2155 Allison Rd
Tel: 604-222-2273
M-F 8am-6pm, Sat 10:30am-4pm

pharmacies

University Pharmacy
5754 University Blvd.
Tel: 604-224-3202
M-F 9am-8pm
Sat & Sun 10am-6pm

Shoppers Drug Mart
Strangway Building
5950 University Blvd.
Tel: 604-228-1533
Daily 8am-10pm

for copies

CopyRight
Student Union Building
6138 Student Union Blvd.
Tel: 604-822-4388
M-F 9am-5pm

Self-Serve copiers available
7am-midnight

Copiesmart Copy Centre
University Village & Market Place
103-5728 University Blvd.
Tel: 604-222-3189
M-Th 8:30am-7pm, F 8:30am-6pm
Sat 10am-6pm, Sun 12pm-6pm

2010 CSZ AWARDS / PRIX SCZ 2010

Fry Medal Lecture / Conference Fry

Dr. Joe Nelson, Department of Biological Sciences, University of Alberta/ *Université de l'Alberta*

From Kokanee to Suckers to Sticklebacks to Classifying the World of Fishes
Des Kokanee aux suceurs aux épinoches à la classification des poissons du monde

The Fry Award is given to a Canadian Zoologist who has made an outstanding contribution to knowledge and understanding of an area in zoology, and who is expected to deliver a plenary lecture at the next AGM.

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.



Fred Fry

Bob Boutilier New Investigator Award / Prix Boutilier

Dr. Brent Sinclair, Department of Biology, University of Western Ontario □

Cold Snaps, Warm Spells, and the Effects of Climate on Overwintering Insects
Coups de froid, vagues de chaleur, et les effets du climat sur les insectes hiverneurs

The Bob Boutilier New Investigator Award is to encourage and honour 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 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.



Bob Boutilier

Wardle Lecture / Conference Wardle

The Robert Arnold Wardle Award is presented by the Parasitology Section to an individual in recognition of outstanding contributions to Canadian parasitology and/or outstanding contributions by a Canadian to parasitology.

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.



Robert Arnold Wardle

TWM Cameron Outstanding PhD Thesis Award Prix TWM Cameron pour la meilleure these de doctorat

Dr. Carol Bucking, Department of Zoology, The University of British Columbia

Environmental Influence on the Consequences of Feeding and Digestion in Teleost Fish
Influence environnementale sur les conséquences de l'alimentation et de la digestion chez les poissons téléostéens

Thesis Completed in the Department of Biology, McMaster University
(Supervisor Dr. Chris M. Wood)

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.



T.W.M. Cameron

Cameron Award Finalists / Finalistes du Prix Cameron

Scott Parks, University of Alberta (Supervisor: Greg Goss)

Carol Bucking, McMaster University (Supervisor: Chris Wood) (winner)

Society Awards

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 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 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 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 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 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 parasitologiste de réputation internationale et militant fidèle de la Société canadienne de zoologie depuis sa création en 1961.

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/Chercheurs 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/>.



William Hoar

Helen Battle

George Holeton

Brian Hall

Cas Lindsey

Murray Fallis

Leo Margolis

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.

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 2010**. 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 2010** 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.

CSZ 2010 / SCZ 2010

49th Annual Meeting / 49^{ième} reunion annuelle

PROGRAM OVERVIEW / VUE D'ENSEMBLE DE PROGRAMME

Monday / Lundi (17 May / Mai)	
Summary of Events / Le résumé d'événements	2
Tuesday / Mardi (18 May / Mai)	
Summary of Events / Le résumé d'événements	4
Wednesday / Mercredi (19 May / Mai)	
Summary of Events / Le résumé d'événements	14
Thursday / Jeudi (20 May / Mai)	
Summary of Events / Le résumé d'événements	22
Friday / Vendredi (21 May / Mai)	
Summary of Events / Le résumé d'événements	33
Posters / Affichées	39
Anstracts	50

Monday / Lundi (17 May / Mai)

Summary of Events / Le résumé d'événements

	Events / Evénements	Location / Emplacement
900 - 1600	Council Meeting / Réunion du conseil	Biodiversity 224
1600 - 1900	Registration / Inscriptions	IRC Lobby
1730 - 1900	Welcome Reception / Réception d'ouverture	IRC Lobby
1900 - 2000	Welcome Address / Fry Lecture Mots de bienvenue / Remise de la Médaille Fry	IRC 2
2000 - late	Post Fry Lecture Mixer Soirée après la conférence Fry	Pit Pub

Monday / Lundi (17 May / Mai)

Welcome Address

Location/Endroit: IRC 2

1900 - 1910	WELCOME ADDRESS / MOTS DE BIENVENUE Patricia Schulte , LOC Chair, University of British Columbia
-------------	--

Fry Lecture/Conférence Fry

Location/Endroit: IRC 2

Chair/Président: John Chang, President

1910 - 2010	From Kokanee to Suckers to Sticklebacks to classifying the world of fishes <i>Des Kokanee aux suceurs aux épinoches à la classification des poissons du monde</i> Joe Nelson , University of Alberta
-------------	---

Past Fry Medalists / Prix Fry - gagnants des années passées

2009 – Anthony Farrell, University of British Columbia; 2008 - Jeremy McNeil, University of Western Ontario; 2007 - Nancy Sherwood, University of Victoria; 2006- Richard Peter, University of Alberta; 2005 - John Youson, University of Toronto Scarborough; 2004 - Thomas W. Moon, University of Ottawa; 2003 - William Milsom, UBC; 2002 – Robert Boutilier, Cambridge University; 2001 - F.W.H. Beamish, Burapha University; 2000 - John Philips, UBC; 1999 - Chris Wood, McMaster University; 1998 - Geoffrey J. Eales; 1997 - Harold Atwood, University of Toronto; 1996 - Charles Krebs, UBC; 1995 - Peter Hochachka, UBC; 1994 - Brian Hall, Dalhousie; 1993 - David Randall, UBC; 1992 - David Jones, UBC; 1991 - Roger Downer, Waterloo; 1990 - William Leggett, McGill; 1989 - G.O. Mackie, Victoria; 1988 - Denis Chitty, UBC; 1987 - Ken Davey, York; 1986 - David Idler, Memorial; 1985 - J.R Brett, Pacific Biological Station; 1984 - No award; 1983 - W.E. Ricker, Pacific Biological Station; 1982 - F.J. Rigler, Toronto; 1981 - K. Ronald, Guelph; . 1980 - D.M. Ross; 1979 - M.J. Dunbar, McGill; 1978 - P.A. Larkin, UBC; 1977 - H.I. Battle, Western Ontario; 1976 - I. McTaggart-Cowan, UBC; 1975 - F.R Hayes, Dalhousie; 1974 - W.S. Hoar, UBC.

EEE/CMD Symposium**Tuesday / Mardi (18 May / Mai)****The Importance of Parallelism in Evolutionary Theory****Location/Endroit:** Wesbrook 100**Chair/Président:** Ehab Abouheif

Time	Symposium Speaker
830 - 900	The inside story on parallelism illustrated by the multiple origins of cartilage <i>Les dessous du parallélisme illustrés par l'origine multiple du cartilage</i> Brian Hall , Dalhousie University
900 - 930	Parallel evolution of derived modes of reproduction in amphibians <i>Évolution parallèle des modes de reproduction dérivés chez les amphibiens</i> Marvalee Wake , University of California at Berkeley
930 - 1000	The genetic and molecular basis for parallel evolution <i>Les bases génétiques et moléculaires de l'évolution parallèle</i> Greg Wray , Duke University
1000 - 1030	Parallel selection and the genetics of adaptation in sticklebacks <i>Sélection parallèle et la génétique de l'adaptation chez l'épinoche</i> Dolph Schluter , University of British Columbia

CMD Student Satellite Symposium / Symposium MDC d'étudiant satellite

Phenotypic plasticity & its role in evolution / Plasticité phénotypique et son rôle dans l'évolution

Location/Endroit: IRC 1**Chair/Président:** Chris Neufeld

Time	Speaker
1100 - 1130	The evolution of plastic traits by genetic accommodation <i>L'évolution des traits plastiques par accommodation génétique</i> Nijhout F
1130 - 1145	Inducible defenses in an invaded marine food chain: Why cue specificity matters <i>Défenses inductibles dans une chaîne alimentaire marine envahie : pourquoi la spécificité des signaux est importante</i> Grason E & Miner B
1145 - 1200	Learning, inducible defenses, and adaptation to novel predators <i>Apprentissage, défenses inductibles et adaptation à de nouveaux prédateurs</i> Neufeld C & Edgell T
1200 - 1215	Interplay among phenotypic plasticity, local adaptation, and gene flow in an African cichlid fish <i>Interaction entre la plasticité phénotypique, l'adaptation locale, et le flux génique chez un poisson cichlide africain</i> Crispo E & Chapman L
1215 - 1230	Variation in tenacity and tube foot morphology among sea stars from different wave exposure regimes <i>Variation de ténacité et morphologie du podia entre des étoiles de mer provenant de différents régimes d'exposition aux vagues</i> Hayne K

CPB Contributed Papers / Session de communications PBC

Acid-Base & Ionregulation / Acide-base et ionorégulation

Location/Endroit: IRC 4

Chair/Président: Steve Reid

Time	Speaker
1100 - 1115	Intracellular pH regulation during hypercapnia in a cultured rainbow trout hepatoma cell line (RTH 149) <i>Régulation du pH intracellulaire durant l'hypercapnie dans la lignée cellulaire hépatome (RTH 149) d'une truite arc-en-ciel cultivée</i> Huynh K, Baker D, Harris R, Church J & Brauner C
1115 - 1130	The role of the sodium bicarbonate cotransporter in the anterior gut alkalinisation of the <i>Aedes aegypti</i> mosquito midgut <i>Le rôle du cotransporteur de bicarbonate de sodium dans l'alkalinisation de l'intestin antérieur du maringouin Aedes aegyptii</i> Goss G, Ralph A, Bugiak B & Moffatt D
1130 - 1145	Adapting to seawater on the fly: the development of seawater osmoregulatory ability in juvenile pink salmon <i>S'adapter à l'eau de mer à la volé : le développement de l'habilité osmorégulatrice en eau de mer chez le saumon rose juvénile</i> Gallagher Z, Brauner C & Farrell A
1145 - 1200	Ammonia excretion and expression of branchial Rh proteins in goldfish experiencing gill remodelling <i>Excrétion d'ammoniac et expression de protéines Rh chez des poissons rouges éprouvant un remodelage de branchie</i> Perry S, Schwaiger T, Kumai Y & Braun M
1200 - 1215	Physiological and molecular analysis of the interactive effects of feeding and high environmental ammonia on branchial ammonia excretion and Na ⁺ uptake in freshwater rainbow trout <i>Analyse physiologique et moléculaire des effets interactifs de l'alimentation et de hauts taux d'ammoniac environnementaux sur l'excrétion d'ammoniac branchial et l'assimilation de Na⁺ chez la truite arc-en-ciel d'eau douce</i> Zimmer A, Nawata M & Wood C
1215 - 1230	The effect of severe hypercapnia on in situ cardiac performance of white sturgeon, <i>Acipenser transmontanus</i> . <i>L'effet de l'hypercapnie sévère sur la performance cardiaque in situ de l'esturgeon blanc, Acipenser transmontanus</i> Baker D, Hanson L, Farrell A & Brauner C

CPB Contributed Papers / Session de communication PBC

Metabolic & Dietary Physiology / Physiologie métabolique et diététique

Location/Endroit: IRC 5**Chair/Président:** Louise Milligan

Time	Speaker
1100 - 1115	Effects of chronic and acute temperature change on the specific dynamic action and gastric processing in the green shore crab, <i>Carcinus maenas</i> <i>Effets des changements de température chroniques et aigus sur l'action spécifique dynamique et le traitement gastrique chez le crabe enragé, Carcinus maenas</i> McGaw I
1115 - 1130	The influence of feeding and confinement on Rh glycoprotein and glutamine synthetase expression in the gulf toadfish, <i>Opsanus beta</i> . <i>L'influence de l'alimentation et de la détention sur l'expression des glycoprotéine Rh et de la glutamine synthétase chez Opsanus beta</i> Rodela T, McDonald D, Gilmour K & Walsh P
1130 - 1145	Dietary lipid composition affects the structural and functional properties of muscle mitochondria of rainbow trout. <i>L'impact de la diète alimentaire sur les propriétés fonctionnelles et les composantes structurales des mitochondries du muscle chez la truite arc-en-ciel.</i> Martin N, Kraffe E, Bureau D & Guderley H
1145 - 1200	Cloning and expression of an insect organic cation transporter from the fruit fly, <i>Drosophila melanogaster</i> Meigen. <i>Clonage et expression du transporteur de cation organique de la mouche à fruit Drosophila melanogaster Meigen</i> Matier B & Rheault M
1200 - 1215	Behavioural and physiological consequences of dietary selenomethionine exposure to adult zebrafish (<i>Danio rerio</i>) <i>Conséquences comportementales et physiologiques de l'exposition à la sélénométhionine alimentaire chez le poisson zèbre adulte (Danio rerio)</i> Kallarakavumkal Thomas J
1215 - 1230	Impact of feeding regime and dietary copper on the fathead minnow (<i>Pimephales promelas</i>) <i>Impact du cuivre et du régime alimentaire sur le tête-de-boule (Pimephales promelas)</i> Moffett A & Couture P

PAR Contributed Papers / Session de communication PBC

Ecology and Epidemiology / Écologie et épidémiologie

Location/Endroit: IRC G65/66**Chair/Président:** Michael Duffy

Time	Speaker
1100 - 1115	Symbionts of house sparrows (<i>Passer domesticus</i>): roles of host characteristics and geography. <i>Symbiotes du moineau domestique (Passer domesticus): rôles des caractéristiques de l'hôte et de la géographie</i> Proctor H & Byers K
1115 - 1130	Can parasites be used as environmental indicators: a case study from the Richelieu River, an anthropogenically-impacted ecosystem <i>Utilisation possible des parasites comme bioindicateurs environnementaux: Étude de la rivière Richelieu, un écosystème subissant diverses pressions anthropiques</i> Marcogliese D, Gélinas M & Gendron A
1130 - 1145	Chronic exposure to pollution and not macroparasites is correlated with thermal stress tolerance in johnny darters (<i>Etheostoma nigrum</i>) <i>Exposition chronique à la pollution et non aux macroparasites est corrélé avec la tolérance au stress thermal chez le raseux-de-terre noir (Etheostoma nigrum)</i> Krause R, McLaughlin J & Marcogliese D
1145 - 1200	Why are proximate parasite communities similar? <i>La relation entre la distance et la ressemblance des communautés parasitaires</i> Locke S, McLaughlin J & Marcogliese D

CMD lunch/ Lunch MDC**Time/Heure:** 1230 - 1400**Location/Endroit:** Mary Murrin Room, Gage Residence**PAR lunch/Lunch PAR****Time/Heure:** 1230 - 1400**Location/Endroit:** Ruth Blair Room, Gage Residence**EEE lunch/Lunch ÉÉÉ****Time/Heure:** 1230 - 1400**Location/Endroit:** Mahoney's Pub

CMD Contributed Papers / Session de communications MDC**Developmental Basis for Evolutionary Change****Location/Endroit:** IRC 1**Chair/Président:** Matt Vickaryous

Time	Speaker
1400 – 1430	The molecular basis for tooth replacement in squamates <i>Les bases moléculaires du remplacement des dents chez les squamates</i> Handrigan G, Leung K & Richman J
1430 - 1445	Morphological convergence among anolis lizards is the result of repeated developmental paralelisms <i>La convergence morphologique entre les lézard anoles sont le résultat de parallélismes développementaux répétés</i> Sanger T, Losos J & Abzhanov A
1445 - 1500	Evidence for the role of Wnt signaling in osculum formation and polarity in sponges <i>Démonstration du rôle de signalisation de Wnt dans la formation de l'osculum et de la polarité chez les éponges</i> Windsor P & Leys S
1500 - 1515	Deciphering morphological variation in the braincase of caecilians (Amphibia: Gymnophiona) <i>Déchiffrer la variation morphologique dans la boîte crânienne des Gymniophiones (Amphibia : Gymniophiona)</i> Maddin H & Russell A
1515 - 1530	Computational models for butterfly eyespot development and evolution <i>Modèles informatiques pour le développement et l'évolution d'eyespot de papillon</i> Marcus J
1530 - 1545	Ergatoid queen development in the ant <i>Myrmecina nipponica</i> : Modular and heterochronic regulation of caste differentiation <i>Développement de la reine ergatoid chez la fourmi Myrmecina nipponica : Régulation modulaire et hétérochronique de la différenciation des castes</i> Miura T & Miyazaki S

CPB Contributed Papers / Session de communications PBC

Ionoregulatory / Ionorégulation

Location/Endroit: IRC 4

Chair/Président: Gary Anderson

Time	Speaker
1400 - 1415	Calcium metabolism in a freshwater cartilaginous fish, the lake sturgeon <i>Acipenser fulvescens</i> <i>Métabolisme du calcium chez un poisson cartilagineux d'eau douce, l'esturgeon de lac Acipenser fulvescens</i> Allen P, Dasiewicz P, Grandmaison V, Peake S, Weihrauch D & Anderson W
1415 - 1430	Hagfish slime mucin vesicle deployment: characterizing the vesicle membrane <i>Le déploiement de la vésicule de substance visqueuse de la micine : caractérisation de la membrane de la vésicule</i> Herr J, Goss G & Fudge D
1430 - 1445	The curious case of the missing hemolymph: A chill-induced disruption of ion and water homeostasis in the fall field cricket (<i>Gryllus pennsylvanicus</i>) <i>L'étrange histoire de l'hémolymph disparue : une disruption de l'homéostasie des ions et de l'eau causé par le froid chez Gryllus pennsylvanicus</i> MacMillan H & Sinclair B
1445 - 1500	Expression of sodium transport proteins in rainbow trout exposed to very soft water <i>L'expression des protéines de transport du sodium chez la truite arc-en-ciel exposée à l'eau très douce</i> Dymowska A, Parks S & Goss G
1500 - 1515	Haemolymph $[Na^+]$ and $[K^+]$ homeostasis in <i>Drosophila</i> in response to dietary loading <i>L'homéostasie de $[Na^+]$ et $[K^+]$ dans l'hémolymph de la Drosophile en réponse à une charge alimentaire</i> Naikkhwah W
1515 - 1530	Directed case study method for teaching comparative physiology in a large enrolment course <i>Méthode d'étude de cas dirigé pour enseigner la physiologie comparée à de grands groupes d'étudiants</i> Montpetit C & DiMeo E

CPB Contributed Papers / Session de communication PBC

Metabolic Suppression & Stress / Suppression métabolique et stress

Location/Endroit: IRC 5**Chair/Président:** Pat Walsh

Time	Speaker
1400 - 1415	Life after ice: Transmembrane ion distribution during recovery from freezing in the woolly bear caterpillar (<i>Pyrrharctia isabella</i>) <i>La vie après la glace : distribution transmembranaire d'ion durant la récupération de Pyrrharctia isabella après s'être gelé</i> Boardman L, Terblanche J & Sinclair B
1415 - 1430	Regulation of membrane-bound ATPases in muscle of aestivating African lungfish (<i>Protopterus annectens</i>) <i>Régulation d'ATPases membranaires dans les muscles de Protopterus annectens</i> Shapiro N
1430 - 1445	Remodeling the mitochondrial membrane during arousal from hibernation <i>Remodelage de la membrane mitochondriale durant l'éveil d'hibernation</i> Staples J & Armstrong C
1445 - 1500	Mitochondrial reactive oxygen species (ROS) production: mechanisms, corrections and correlations <i>Production mitochondriale d'espèces d'oxygène réactives : mécanismes, corrections et corrélations</i> Treberg J & Brand M
1500 - 1515	The role of AMP-activated protein kinase in metabolic rate suppression in hepatocytes from the common goldfish <i>Carassius auratus</i> <i>Le rôle des protéine kinases activées par l'AMP dans la suppression du taux métabolique dans les hépatocytes du poisson rouge commun Carassius auratus</i> Lau G & Richards J
1515 - 1530	Characterization and expression analyses of anti-apoptotic Bcl-2-like genes NR-13, Mcl-1, Bcl-X1, and Bcl-X2 in Atlantic cod (<i>Gadus morhua</i>) <i>Caractérisation et analyse d'expression des gènes anti-apoptotiques NR-13, Mcl-1, Bcl-X1 et Bcl-X2 chez la morue Atlantique (Gadus morhua)</i> Feng Y & Rise M
1530 - 1545	Mean, green overwintering machines: surviving Candian winters as an Emerald Ash Borer <i>Méchantes machines vertes hivernieuses : survivre l'hiver canadien en tant qu'agrile du frêne</i> Crosthwaite J, Sobek S, Bernards M, Lyons D & Sinclair B

CPB Contributed Papers / Session de communication PBC

Fish Immunology / Immunologie des poissons

Location/Endroit: IRC 6**Chair/Président:** Nick Bernier

Time	Speaker
1400 - 1415	Multiparametric functional characterization of phagocytic antimicrobial responses in teleost fish macrophages <i>Caractérisation multiparamétrique fonctionnelle de la réponse phagocytaire antimicrobienne chez les macrophages des poissons téléostéens</i> Barreda D
1415 - 1430	Characterization of inhibitory immune receptors in the channel catfish (<i>Ictalurus punctatus</i>) <i>Caractérisation des récepteurs immunitaires inhibiteurs chez Ictalurus punctatus</i> Montgomery B, Davidson C, Mewes J, Verheijen K, Burshtyn D & Stafford J
1430 - 1445	Characterization of stimulatory innate immune receptors in the channel catfish <i>Caractérisation des récepteurs immunitaires stimulateurs innés chez Ictalurus punctatus</i> Verheijen K, Mewes J, Montgomery B & Stafford J
1445 - 1500	Interactions of functionally decorated helical rosette nanotubes with catfish immune cells <i>Interactions des nanotubes rosettes décorés fonctionnellement avec les cellules immunitaires des poissons chat</i> Ede J, Stafford J, Ong K, MacCormack T, Beingessner R, Fenniri H & Goss G
1500 - 1515	Functional genomic studies of Atlantic cod (<i>Gadus morhua</i>) defense responses <i>Études en génomique fonctionnelle des réponses de défense de la morue atlantique (Gadus morhua)</i> Rise ML, Booman M, Hori TS, Feng CY, Hall JR, Browne M, Gamperl AK, Rise M, Hubert S, Kimball J, Borza T, Bowman S & Johnson SC
1515 - 1530	The effects of UV radiation on epidermal club cell investment in fathead minnows (<i>Pimephales promelas</i>). Manek AK, Ferrari MCO, Niyogi S & Chivers, DP

Contributed Sessions II / Sessions de Communications II**Tuesday / Mardi (18 May / Mai)****Cameron Lecture / Conférence Cameron****Location/Endroit:** IRC 2**Chair/Président:** John Chang

Time	Cameron Award Winner / Gagnant du Prix Cameron
1630 - 1730	Environmental influence on the consequences of feeding and digestion in teleost fish <i>Influence environnementale sur les conséquences de l'alimentation et de la digestion chez les poissons téléostéens</i> Carol Bucking, PhD McMaster University

Publication Workshop / Atelier sur la publication**Location/Endroit:** IRC 5

Time	
1730 - 1900	Publication Workshop / Atelier sur la publication

ZET Lecture / Conférence ZET**Location/Endroit:** IRC 2**Chair/Président:** John Chang

Time	ZET Lecturer
1930 - 2030	Killer Whales of the West Coast: Culture, Communication and Conservation <i>Épaulards de la côte ouest : culture, communication et conservation</i> John Ford, Pacific Biological Station, Fisheries & Oceans Canada and Zoology, UBC

PAR Symposium**Wednesday / Mercredi (19 May / Mai)****Location/Endroit:** IRC 6**Chair/Président:** Michael Duffy

Time	Symposium Speaker
900 - 930	The generation and use of transgenic insects to reduce parasite transmission: viable alternative to existing strategies? <i>La génération et l'utilisation d'insectes transgéniques pour réduire la transmission des parasites : une alternative viable aux stratégies existantes?</i> Tony James , University of California at Irvine
930 - 1000	Tsetse EP Protein: A novel immunoresponsive molecule that influences tsetse vector competence. <i>La protéine EP de la mouche Tsetse : une nouvelle molécule immunoréceptive qui influence la compétence vectorielle</i> Lee Haines , University of Victoria
1000 - 1030	Superinfection and transmission fitness as drivers of genome plasticity in pathogens. <i>Superinfection et fitness de transmission en tant que moteurs de la plasticité génomique chez les pathogènes</i> Guy Palmer , Washington State University

Contributed Sessions III/Session de communications III Wednesday / Mercredi (19 May / Mai)

CMD Contributed Papers / Session de communication MCD

Environmental influences on developmental evolution

Location/Endroit: IRC 1

Chair/Président: Jeff Marcus

Time	Speaker
1100 - 1115	The effects of variable temperatures on energy use in Lepidoptera <i>Les effets de températures variables sur l'utilisation d'énergie chez les Lépidoptères</i> Williams C, Marshall K, MacMillan H, Sobek S, Bazinet, Chick, Hellmann, J & Sinclair B
1115 - 1130	Responses of the black sea urchin <i>Tetrapygus niger</i> to its sea star predators <i>Heliaster helianthus</i> and <i>Meyenaster gelatinosus</i> under wave conditions in the field <i>Les réponses de l'oursin noir Tetrapygus niger face à ses principaux prédateurs, les étoiles de mer Heliaster helianthus et Meyenaster gelatinosus en présence de vagues en mer</i> Urriago J, Himmelman J & Gaymer C
1130 - 1145	The Influence of Dietary Caloric Intake on Caudal Regeneration in Juvenile Leopard Geckos (<i>Eublepharis macularius</i>). <i>L'influence de la consommation de calories alimentaires sur la régénération caudale du gecko Eublepharis macularius</i> Hynes S & Russell A
1145 - 1200	Changes in Steller Sea Lion Skull Sizes: Testing the Nutritional Stress Hypotheses <i>Changements dans la taille des crânes des lion de mer de Steller : un test de l'hypothèse du stress nutritionnel</i> Trites A, Isono T, Brunner S & Joy R
1200 - 1215	Correlating blood vessel and scleral papillae development in the chicken eye. <i>Corrélation entre vaisseau sanguin et le développement de la papilla sclérale dans l'œil du poulet</i> Jourdeuil K & Franz-Ondendaal T

Contributed Sessions III/Session de communications III Wednesday / Mercredi (19 May / Mai)

EEE Contributed Papers / Session de communication ÉÉÉ

Evolution and Systematic Zoology / Évolution et Zoologie Systématique

Location/Endroit: IRC 5

Chair/Président: Elizabeth Boulding

Time	Speaker
1100 - 1115	Evolution of bats <i>L'évolution des chauve-souris</i> Fenton B
1115 - 1130	Rapidly improving Linnaean taxonomy through DNA barcoding combined with online biodiversity tools (scratchpads): two case studies using caterpillars <i>Amélioration rapide de la taxonomie Linnéenne grâce au codes barres génétiques combinés avec des outils de biodiversité en ligne : deux études de cas utilisant des chenilles</i> Wilson J
1130 - 1145	Investigating the Phylogeography of the Greater Short-horned lizard (<i>Phrynosoma hernandesi</i>) in Alberta <i>Investigation de la phylogéographie du lézard Phrynosoma hernandesi en Alberta</i> Leung M & Russell A
1145 - 1200	Review of Taxonomic Issues in the Canada Lynx (<i>Lynx canadensis</i>): Implications for Conservation <i>Un autre regard sur la taxonomie du Lynx du Canada (Lynx canadensis) avec implications sur la conservation de l'espèce</i> Khidas K, Huynh H, Duhaime J, McAlphine D & Bull Rd
1200 - 1215	Non-neutral single nucleotide polymorphisms (SNPs) in Bay of Fundy Atlantic Salmon (<i>Salmo salar</i>) and their use in population identification and dharacterization. <i>SNPs non-neutres chez le saumon atlantique de la Baie de Fundy (Salmo salar) et leur utilisation dans l'identification et la caractérisation des populations</i> Freamo H, O'Reilly P & Boulding E
1215 - 1230	Evaluating dietary selenium uptake and speciation in lake chub (<i>Couesius plumbeus</i>) using in-situ feeding cages downstream of a uranium processing mill <i>Évaluation de la consommation de sélénium par l'alimentation chez Couesius plumbeus en utilisant des cages in-situ en aval d'une usine de traitement de l'uranium</i> Phibbs J, Franz E, Wiramanaden C, Hauck D, Pickering I, Liber K & Janz D

Contributed Sessions III/Session de communications III Wednesday / Mercredi (19 May / Mai)

CPB Contributed Papers / Session de communication PBC

Diving and Energetics / Plongée et énergétique

Location/Endroit: IRC 6

Chair/Président: Jessica Meir

Time	Speaker
1100 - 1115	Steller sea lions modulate bradycardia in response to activity and dive depth <i>Les lions de mer de Steller modulent leur bradycardie en réponse à l'activité et à la profondeur de plongée</i> Hindle A, Young B, Rosen D, Haulena M & Trites A
1115 - 1130	Dive behaviour impacts the ability of heart rate to predict oxygen consumption in Steller sea lions (<i>Eumetopias jubatus</i>) foraging at depth <i>Le comportement de plongée a un impact sur la capacité du rythme cardiaque à prédire la consommation d'oxygène chez des lions de mer de Steller en quête de nourriture en profondeur</i> Young B, Rosen D, Hindle A, Haulena M & Trites A
1130 - 1145	Blood oxygen management strategies in divers: A comparative perspective <i>Stratégies de gestion de l'oxygène sanguin chez les plongeurs : une perspective comparée</i> Meir J
1145 - 1200	Split personalities: Seasonal energetic priorities in young northern fur seals <i>Personnalités multiples : priorités saisonnières multiples chez de jeunes otaries à fourrure du nord</i> Rosen D & Trites A

Contributed Sessions III/Session de communications III Wednesday / Mercredi (19 May / Mai)

CPB Contributed Papers/ Session de communication PBC

Thermal Physiology & Biochemistry / Physiologie thermique et biochimie

Location/Endroit: IRC 4

Chair/Président: Ken Welch

Time	Speaker
1100 - 1115	Temperature effects on the hummingbird sucrose oxidation cascade <i>Les effets de la température sur la cascade d'oxydation du sucrose chez les colibris</i> Suarez R, Gass C & Welch K
1115 - 1130	The effects of temperature acclimation on the cardiac actin-myosin ATPase and cardiac proteome of Rainbow trout <i>Les effets de l'acclimation à la température sur l'ATPase de l'actine-myosine cardiaque et sur le protéome cardiaque de la truite arc-en-ciel</i> Klaiman J, Fenna A, Shiels H & Gillis T
1130 - 1145	The role of heat shock in regulating hematopoiesis and apoptosis in the nucleated red blood cells of rainbow trout (<i>Oncorhynchus mykiss</i>) <i>Le rôle des coups de chaleur dans la régulation de l'hématopoïèse et de l'apoptose chez les érythroblastes de la truite arc-en-ciel (Oncorhynchus mykiss)</i> Lewis J, Klein G, Walsh P & Currie S
1145 - 1200	Aerobic scope, growth, reproduction and temperature in the common killifish, <i>Fundulus heteroclitus</i> <i>Envergure aérobie, croissance, reproduction et température chez Fundulus heteroclitus</i> Healy T & Schulte P
1200 - 1215	Thermal adaptation in killifish: variation in muscle structure and biochemistry <i>Adaptation thermique chez Fundulus heteroclitus : variation dans la structure et la biochimie des muscles</i> Dhillon R & Schulte P
1215 - 1230	Seasonal thermogenesis in an ectotherm – heating up to reproduce <i>Thermogénèse saisonnière chez un ectotherme – se réchauffer pour se reproduire</i> Milsom W, Tattersall G, Sanders C, Piercy J, Leite, C, Cadena V, Andrade D & Abe A

Contributed Sessions III/Session de communications III Wednesday / Mercredi (19 May / Mai)

PAR Contributed Papers / Session de communication PBC

Molecular and Immunological / Moléculaire et Immunologique

Location/Endroit: IRC 3

Chair/Président: Mick Burt

Time	Speaker
1100 - 1115	Innate Immune Responses of <i>Aedes aegypti</i> to Dengue virus <i>Réponses immunitaires innées de Aedes aegypti au virus Dengue</i> Lowenberger C, Ursic R, Cooper D, Jaramillo G & Ocampo C
1115 - 1130	Alpha-Gal modifications of parasite glycoproteins: Immune evasion via molecular mimicry <i>Modifications alpha-gal des glycoprotéines de parasite : évasion immunitaire via mimétisme moléculaire</i> Fitzpatrick J, Bedford R & Duffy M
1130 - 1145	Mechanisms of neuronal signaling in the human bloodfluke, <i>Schistosoma mansoni</i> <i>Mécanismes de signalisation neuronal chez le parasite humain Schistosoma mansoni</i> Ribeiro P, El-Shehabi F, Taman F, Patocka N & Macdonald K
1145 - 1200	Employing molecular diagnostics to investigate <i>Loma morhua</i> infections in Atlantic cod <i>L'emploi de diagnostics moléculaires dans l'investigation des infections au Loma morhua chez la morue de l'atlantique</i> Frenette A, Burt M, Eydal M & Duffy M
1200 - 1215	Influence of social rank on parasite infection risk in vertebrate host taxa Patterson JEH & Ruckstuhl KE

Student lunch/Lunch des étudiants

Time/Heure: 1230 - 1400

Location/Endroit: Isabel MacInnes Room, Gage Residence

NSERC Grants Workshop/Atelier subvention CRSNG

Time/Heure: 1230 - 1400

Location/Endroit: IRC 6

Hoar Award Presentations/ Présentations Prix Hoar**Wednesday / Mercredi (19 May / Mai)****Location/Endroit:** IRC 2**Chair/Président:** Greg Goss

Time	Hoar Award Presenters
1400 - 1415	On the involvement of mitochondrial permeability transition and thiol groups in cadmium- and calcium-induced mitochondrial dysfunction in rainbow trout <i>De l'implication des transitions de perméabilité mitochondriale et des groupes thiol dans les dysfonctions mitochondriales causés par le cadmium et de calcium chez la truite arc-en-ciel</i> Adiele R, Stevens D & Kamunde C
1415 - 1430	The effect of daily torpor on mitochondrial reactive oxygen species (ROS) production <i>L'effet de la torpeur quotidienne sur la production mitochondriale d'espèces d'oxygène réactives</i> Brown J & Staples J
1430 - 1445	Rattlesnakes keep their cool: respiratory cooling enhances thermal detection by rattlesnakes <i>Les serpents à sonnette restent de glace : le refroidissement respiratoire augmente la détection thermique chez les serpents à sonnette</i> Cadena V, Tattersall G, Bovo R & Andrade D
1445 - 1500	Sockeye salmon in hot water: population-specific tailoring of maximum cardiorespiratory performance to the temperature encountered during adult river migration <i>Saumons sockeye dans l'eau chaude : ajustements spécifiques de la performance cardiorespiratoire maximale en fonction de la température affrontée durant la migration en rivière des adultes</i> Eliason E, Clark T, Hinch S & Farrell A
1500 - 1515	Transcellular and paracellular regulation of Na balance in acid-exposed zebrafish <i>Régulation transcellulaire et paracellulaire de la balance de Na chez des poissons zèbres exposés à l'acide</i> Kumai Y, Bahubeshi A, Steele S & Perry S
1515 - 1530	An amniote model of regeneration: tail replacement in geckos <i>Un modèle de régénération chez les amniotes : remplacement de la queue chez les geckos</i> McLean K
1530 - 1545	Differential regulation of carnitine palmitoyltransferase (CPT) I in rainbow trout (<i>Oncorhynchus mykiss</i>) <i>Régulation différentielle de la carnitine palmitoyltransferase (CPT) I chez la truite arc-en-ciel (Oncorhynchus mykiss)</i> Morash A, Le Moine C & McClelland G

Boutilier Lecture / Conférence Boutilier**Wednesday / Mercredi (19 May / Mai)****Location/Endroit:** IRC 2**Chair/Président:** John Chang

Time	Boutilier Award Winner / Gagnant du Prix Boutilier
1630 - 1730	Cold snaps, warm spells, and the effects of climate on overwintering insects <i>Coups de froid, vagues de chaleur, et les effets du climat sur les insectes hiberneurs</i> Brent Sinclair, University of Western Ontario

Student & Presidents Workshop /Atelier Étudiant & Présidents**Location/Endroit:** IRC 6

Time	
1730 - 1900	Student & Presidents Workshop /Atelier Étudiant & Présidents

Poster session/Session d'affiches**Location/Endroit:** IRC Lobby

Time	
1730 - 1900	Poster session/Session d'affiches

CPB Symposium:

Thermal limits and tradeoffs in homeostasis

Location/Endroit: Wesbrook 100**Chair/Président:** Glenn Tattersall**Thursday / Jeudi (20 May / Mai)**

Time	Symposium Speaker
830 - 900	The coadaptation of thermoregulatory behavior and thermal physiology in heterogeneous environments <i>La coadaptation du comportement thermorégulatoire et de la physiologie thermique dans des environnements hétérogènes</i> Michael Angilletta , <i>Indiana State University</i>
900 - 930	Contrasting responses to thermal acclimation in alligator and trout: how to respond when thermoregulation is possible? <i>Comment faire l'acclimatation thermique si on fait de la thermorégulation: comparaison des réponses de l'alligator et de la truite</i> Helga Guderley & Seebacher , <i>F. Laval University</i>
930 - 1000	Thermal limits and cardiorespiratory function <i>Limites thermales et fonction cardiorespiratoire</i> Tony Farrell , <i>University of British Columbia</i>
1000 - 1030	How gene expression changes with intensity of acute thermal stress: from "housekeeping" to "renovation" to "demolition." <i>Comment l'expression génétique change avec l'intensité d'un stress thermal aigu : du « ménage » à la « rénovation » à la « démolition »</i> George Somero , <i>Stanford University</i>

CPB Contributed Papers / Session de communication PBC

Hypoxia and Anoxia / Hypoxie et anoxie

Location/Endroit: IRC 1

Chair/Président: Charles Darveau

Time	Speaker
1100 - 1115	Derivation of goldfish brain cell cultures for the study of anoxia and hyperammonemia in vitro <i>Dérivation de cultures de cellules du cerveau du poisson rouge pour l'étude de l'anoxie et de l'hyperammonémie in vitro</i> Sidhu S, Graham O, Beggs B, Bufalino M, Wilkie M & Lee L
1115 - 1130	Expression of "pacemaker" channels in the turtle heart: Effects of anoxia and cold-acclimation <i>Expression génique des canaux "pacemaker" dans le cœur de tortue : Effet de l'anoxie et de l'acclimatation au froid</i> Stecyk J, Couturier C, Fagernes C, Ellefsen S & Nilsson G
1130 - 1145	Chronic hypoxia alters cardiac regulation in rainbow trout (<i>Oncorhynchus mykiss</i>) during early life stages <i>L'hypoxie chronique change la régulation cardiaque chez de jeunes truites arc-en-ciel (Oncorhynchus mykiss)</i> Miller S, Wright P & Gillis T
1145 - 1200	Tissue-specific transcriptional regulation of monocarboxylate transporters (MCTs) and metabolic enzymes during short-term hypoxia in zebrafish (<i>Danio rerio</i>) <i>Régulation transcriptionnelle liée aux tissus des transporteurs de monocarboxylate (MCTs) et enzymes métaboliques durant une période d'hypoxie brève chez le poisson zèbre (Danio rerio)</i> Ngan A & Wang Y
1200 - 1215	Cardiac function during graded hypoxia in hypoxia-tolerant and hypoxia-intolerant elasmobranchs <i>La fonction cardiaque au cours de l'hypoxie progressive dans les elasmobranchs hypoxie-tolérante et hypoxie-intolérante</i> Speers-Roesch B, Brauner C, Farrell A, Hickey A, Renshaw G, Wang Y & Richards J
1215 - 1230	Metabolic and cardiovascular responses to anoxia in the pacific hagfish (<i>Eptatretus stoutii</i>) <i>Réponses métaboliques et cardiovasculaires à l'anoxie chez la micine du Pacifique (Eptatretus stoutii)</i> Cox G, Sandblom E, Richards J & Farrell A

CPB Contributed Papers / Session de communication PBC

Endocrinology / Endocrinologie

Location/Endroit: IRC 4

Chair/Président: Mike O'Donnell

Time	Speaker
1100 - 1115	Developmental and sex-dependent changes in the tissue-specific expression of sex hormone-binding globulin (SHBG) α and SHBG β in coho salmon, <i>Oncorhynchus kisutch</i> <i>Changements développementaux et reliés au sexe dans l'expression par tissu de la globuline se liant aux hormones sexuelles (SHBG) α et SHBGβ chez le saumon coho, <i>Oncorhynchus kisutch</i></i> Popescu J, Devlin R & Hammond G
1115 - 1130	Stirring up new ideas about the regulation of the HPI axis in zebrafish (<i>Danio rerio</i>) <i>Brasser de nouvelles idées à propos de la régulation de l'axe HPI chez le poisson zèbre (<i>Danio rerio</i>)</i> Fuzzen M, Van Der Kraak G & Bernier N
1130 - 1145	Thyroid hormones affect gonadal gene expression during amphibian metamorphosis <i>Les hormones de la glande thyroïde affectent l'expression génique des gonades pendant la métamorphose des amphibiens</i> Duarte-Guterman P & Trudeau V
1145 - 1200	Three somatostatin isoforms affect basal secretory response in goldfish somatotrophs via differential regulation of $[Ca^{2+}]_i$ and electrical activity <i>Trois isoformes de la somatostatine affectent la réponse sécrétoire basale dans les somatotrophes du poisson rouge via la régulation différentielle de $[Ca^{2+}]$ et l'activité électrique</i> Yu Y, Ali D & Chang J
1200 - 1215	Potential Mechanisms for the Vasopressive Actions of Bradykinin in the Vascular Smooth Muscle of the Little Skate, <i>Raja erinacea</i> . <i>Mechanismes Potentiels pour les Effets Vasopressives de la Bradykinine dans le Muscle Lisse de la Raie Hérisson, <i>Raja erinacea</i>.</i> Dasiewicz P, Anderson W & Conlon J
1215 - 1230	Leptin inhibits adrenocorticotrophic hormone and cortisol secretion in common carp (<i>Cyprinus carpio</i>) <i>La leptine inhibe la sécrétion de corticotrophine et de cortisol chez la carpe (<i>Cyprinus carpio</i>)</i> Bernier N, Gorissen M, Manuel R & Flik G

CPB Contributed Papers/ Session de communication PBC

General & Teaching/ Général et enseignement

Location/Endroit: IRC 6**Chair/Président:** Suzie Currie

Time	Speaker
1100 - 1115	The role of adrenaline handling in high temperature tolerance of migrating adult sockeye salmon populations <i>Le rôle du traitement de l'adrénaline dans la tolérance aux hautes températures chez des populations migratrices de saumons sockeye</i> Hanson L, Eliason E, Whitney C, Gale M, Hinch S & Farrell A
1115 - 1130	Cold-induced changes in stress hormone levels and steroidogenic gene expression in a fish (<i>Tautogolabrus adspersus</i>) capable of metabolic depression <i>Variation du niveau des hormones de stress et de l'expression de gènes stéroïdogéniques chez un poisson (Tautogolabrus adspersus) capable de dépression métabolique en réponse au froid.</i> Alzaid A, Hori T, Hall J, Rise M & Gamperl A
1130 - 1145	The movement propensity and potential of the invasive round goby (<i>Neogobius melanostomus</i> Pallas) <i>La propension et le potentiel de mouvement du gobie à taches noires (Neogobius melanostomus Pallas), une espèce envahissante</i> Tierney K, Kasurak A, Zielinski B & Higgs D
1145 - 1200	Social stress and the heat shock response in rainbow trout <i>Le stress social et la réponse au choc thermique chez la truite arc-en-ciel</i> LeBlanc S, Currie S & Gilmour K
1200 - 1215	Using Zebrafish (<i>Danio rerio</i>) Behavior to estimate Efficacy of Morphine as an Analgesic Douglas, A
1215 - 1230	Metabolism, sex and reproduction tactics in young Atlantic salmon (<i>Salmo salar</i> L.) <i>Métabolisme, sexe et tactiques reproductrices chez de jeunes saumons atlantiques (Salmo salar L.)</i> Rossignol O

EEE Contributed Papers / Session de communication ÉÉÉ

Evolution & Paleozoology / Évolution et paléozoologie

Location/Endroit: Wesbrook 201**Chair/Président:** Joseph Rasmussen

Time	Speaker
1100 - 1115	Origin and evolution of the modern coral reef fish fauna <i>Origine et évolution de la faune moderne des récifs de coraux</i> Santini F
1115 - 1130	The Palaeozoic origin of modern amphibians: a new study of the fossil and phylogenetic evidence <i>L'origine Paléozoïque des amphibiens modernes: nouvelle étude des données fossiles et phylogénétiques</i> Sigurdson T & Green D
1130 - 1145	Early Paleogene mammals from the Roche Percée local fauna, southeastern Saskatchewan <i>Mammifères du début du paléogène provenant de la faune locale de Roche Percée, Saskatchewan du sud est</i> Rankin B
1145 - 1200	Latitudinal effects of climate change on late Miocene ungulate communities <i>Effets latitudinaux du changement climatique sur les communautés d'ongulés de la fin du Miocène</i> Fraser D & Theodor J
1200 - 1215	Glass sponge reefs: Spatial distribution and abundance patterns of reef forming hexactinellids (Porifera) in the Strait of Georgia <i>Récifs d'éponges de verre : distribution spatiale et patrons d'abondance des hexactinellides (Porifera) formant des récifs dans le Détroit de Géorgie</i> Chu J & Leys S

CPB lunch/Lunch PBC**Time/Heure:** 1230 - 1400**Location/Endroit:** Isabel MacInnes Room, Gage Residence

CMD Contributed Papers / Session de communications MDC

Location/Endroit: IRC 1

Chair/Président: Rich Palmer

Time	Speaker
1400 - 1415	Skull and buccal cavity allometry increase mass-specific engulfment capacity in fin whales <i>L'allométrie entre le crâne et la cavité buccale augmente la capacité d'engloutissement chez le rorqual commun</i> Goldbogen J
1415 - 1430	The mechanical design of rorqual mandibles: new insights from quantitative computed tomography <i>Le design mécanique des mandibules du rorqual : nouveau point de vue en utilisant la tomographie quantitative informatique</i> Field D, Goldbogen J, Campbell-Malone R & Shadwick R
1430 - 1445	Comparative analysis of thunniform caudal tail morphologies and motion ranges <i>Analyse comparée de la morphologie de nageoires caudales thunniformes et de la portée de mouvement</i> Ben-Zvi M, Pinto S, Goldbogen J & Shadwick R
1445 - 1500	Sponge Epithelia: The first evidence of transepithelial resistance and molecule impermeability within the phylum Porifera. <i>Épithélia d'éponge : première évidence de résistance transépithéliale et d'imperméabilité de molécule dans le phylum Porifera</i> Adams E, Goss G & Leys S
1500 - 1515	Mechanical properties of Fin Whale arteries—how cetaceans handle pressure <i>Les propriétés mécaniques des artères du Rorqual commun (Balaenoptera physalus): comment les cétacés supportent des pressions élevées.</i> Lillie M, Gosline J & Shadwick R
1515 - 1530	A putative sensory organ in the mandibular symphysis of fin whales (<i>Balaenoptera physalus</i>) <i>Un organe sensoriel putatif dans la symphyse mandibulaire du rorqual commun (Balaenoptera physalus)</i> Pyenson N, Goldbogen J, Vogl A, Szathmary, Drake R & Shadwick R
1530 - 1545	Novel mechanisms of secretion form chiton egg hulls <i>Mécanismes nouveaux de sécrétion fabriquent la coquille d'oeuf des chitons</i> Buckland-Nicks J & Reunov A
1545 - 1600	The structure and development of amniote plicidentine <i>La structure et le développement de la plicidentine chez les amniotes</i> Maxwell E, Caldwell M & Lamoureux D

CPB Contributed Papers / Session de communication PBCNeurophysiology & O₂ Sensing / Neurophysiologie et captation d'O₂**Location/Endroit:** IRC 4**Chair/Président:** Mark Rheault

Time	Speaker
1400 - 1415	Neuroepithelial cell activity during acute hypoxic exposure in trout <i>L'activité des cellules neuroépithéliales durant l'exposition hypoxique aigue chez la truite</i> Ciuhandu C, Fong A & Milsom W
1415 - 1430	Amphibious mangrove killifish jump out of water for multiple reasons, not just low oxygen. <i>Un poisson killi amphibien de mangrove saute hors de l'eau pour plusieurs raisons, pas seulement le manque d'oxygène</i> Wright P, Cooper C, Regan K, Taylor D & Currie S
1430 - 1445	Serotonergic cells of the skin as a site for oxygen sensing in developing zebrafish <i>Les cellules sérotonergiques de la peau en tant que site pour la perception de l'oxygène chez le poisson zèbre en développement</i> Coccimiglio M & Jonz M
1445 - 1500	Hypoxic transduction and neurochemical signalling in the zebrafish gill <i>Transduction hypoxique et signallage neurochimique dans la branchie du poisson zèbre</i> Zachar P & Jonz M
1500 - 1515	Purinergic modulation of central pH/CO ₂ chemoreception during chronic hypoxia in the cane toad <i>Modulation purinergique de chémoréception central du pH/CO₂ durant l'hypoxie chronique chez le crapaud buffle</i> Peters A & Reid S
1515 - 1530	Behavioural, neural and ciliary responses to environmental stressors in embryos of the pond snail <i>Helisoma trivolvis</i> <i>Réponses comportementales, neurales et ciliaires à des stressseurs environnementaux chez des embryons de l'escargot Helisoma trivolvis</i> Boychuk E & Goldberg J
1530 - 1545	The hypoxia response in amphibious <i>Kryptolebias marmoratus</i> is regulated, in part, by serotonin and acetylcholine <i>La réponse hypoxique chez l'amphibien Kryptolebias marmoratus est régulée en partie par la sérotonine et l'acétylcholine</i> Regan K, Jonz M & Wright P
1545 - 1600	Anoxia tolerance mediated by serotonin regulation of energy metabolism in pond snail embryos <i>La tolérance à l'anoxie facilitée par la régulation par la sérotonine du métabolisme énergétique chez les embryons d'escargots d'étang</i> Shartau R, Tam R & Goldberg J

CPB Contributed Papers / Session de communication PBC

Toxicology I / Toxicologie I

Location/Endroit: IRC 6

Chair/Président: Jim McGeer

Time	Speaker
1400 - 1415	Interaction between the physiologically relevant ion K^+ and the toxic metal Tl^+ in <i>Chironomus riparius</i> <i>L'interaction entre les ion K^+ physiologiquement pertinent et le metal toxique Tl^+ chez Chironomus riparius</i> Belowitz R
1415 - 1430	Acute and chronic effects of waterborne cadmium on <i>Lymnaea stagnalis</i> <i>Les effets aigus et chroniques du cadmium sur Lymnaea stagnalis</i> Pais N & McGeer J
1430 - 1445	The in vitro and in vivo biological effects of cadmium selenide and silicon nanoparticles <i>Les effets biologiques in vitro et in vivo du cadmium sélénide et des nanoparticules de silicone</i> Ong K, Dang M, Clark R, Ma G, Ede J, Veinot J & Goss G
1445 - 1500	Swim performance and bioenergetic effects of uranium milling effluent exposure in spottail shiner (<i>Notropis hudsonius</i>) <i>Performance de nage et effets bioénergétiques de l'exposition à l'effluent d'une usine d'uranium chez Notropis hudsonius</i> Goertzen M, Hauck D, Phibbs J, Weber L & Janz D
1500 - 1515	The effect of metal-oxide nanoparticles on <i>Daphnia pulex</i> and <i>Hydra attenuata</i> <i>L'effet des nanoparticules d'oxyde de métaux sur Daphnia pulex et Hydra attenuata</i> Costa E & McGeer J
1515 - 1530	Source of NOM differentially affects metal-gill binding in rainbow trout (<i>Oncorhynchus mykiss</i>) exposed to Pb-Cd mixture <i>La source de NOM affecte la liaison entre les métaux et les branchies chez la truite arc-en-ciel exposée à des mixtures de Pb-Cd</i> Gheorghiu C, Smith D, Kara Y & Wilkie M
1530 - 1545	Influence of environmental factors on ethynyl estradiol uptake in the mummichog, <i>Fundulus heteroclitus</i> <i>L'influence des facteurs environnementaux sur l'absorption de l'éthynyl estradiol chez le poisson killi, Fundulus heteroclitus</i> Blewett T & Wood C
1545 - 1600	Links between cytochrome P450 and glutathione-S-transferases and secretion of methotrexate from Malpighian tubules of <i>D. melanogaster</i> . <i>Liens entre le cytochrome P450 et la glutathione-S-transferase et la sécrétion de méthotrexate par les tubules Malpighian de D. melanogaster</i> Chahine S & O'Donnell M

EEE Contributed Papers / Session de communication ÉÉÉ

Ecology / Trophic Interactions / Entomology / Écologie/Interactions trophiques/Entomologie

Location/Endroit: Wesbrook 201**Chair/Président:** Maydiane Andrade

Time	Speaker
1400 - 1415	The viability of conifer seeds as major nutrient resources to rodents <i>La variabilité des graines de conifères comme source majeure de nutriments pour les rongeurs</i> Lobo N & Millar J
1415 - 1430	Dietary analysis of stranded Humboldt squid (Cephalopoda: <i>Dosidicus gigas</i>) from Vancouver Island, a recent invader to the eastern North Pacific Ocean <i>Analyse alimentaire de calmars de Humbolt (Cephalopoda: Dosidicus gigas) perdus près de l'Île de Vancouver : un nouvel envahisseur dans l'Océan Pacifique du Nord-Est.</i> Braid H, Osborne J, Deeds J, Wilson J & Hanner R
1430 - 1445	Killing the Mood: Invasive Pacific Signal Crayfish cause Nesting Behaviour Suppression in captive Threespine Stickleback. <i>Gâcher l'atmosphère : l'écrevisse signal envahisseur est responsable de la suppression du comportement de nidification chez l'épinoche à trois épines en captivité</i> Velema G
1445 - 1500	More than the eye can see: Western Conifer Seed Bugs (<i>Leptoglossus occidentalis</i>) may exploit electromagnetic radiation as foraging, mating or overwintering cues <i>Plus que l'œil n'y voit : l'insecte Leptoglossus occidentalis exploitent peut-être les radiations électromagnétiques comme signaux lors de l'alimentation, l'accouplement et l'hivernation</i> Zahradik T, Takács S, Labrie A, Tsang M, Strong W, Bennett R & Gries G
1500 - 1515	Selection for resistance to the microbial insecticide <i>Bacillus thuringiensis</i> causes immunological costs in subsequent <i>Trichoplusia ni</i> generations. <i>La sélection pour la résistance à l'insecticide microbien Bacillus thuringiensis cause des coûts immunologiques chez les générations subséquentes de Trichoplusia ni</i> Ericsson J, Myers J & Lowenberger C
1515 - 1530	A frosty whodunit: the mystery of multiple freeze mortality in woolly bear caterpillars (<i>Pyrrharctia isabella</i>) <i>Un polar polaire : le mystère des mortalités multiples dues au froid chez la chenille de Pyrrharctia isabella</i> Marshall K & Sinclair B
1530 - 1545	Opportunistic mating with juveniles circumvents female choice in cannibalistic redback spiders <i>Accouplements opportunistes avec des juvéniles évite les choix par les femelles chez la veuve noire à dos rouge cannibale</i> Andrade M & Biaggio M
1545 - 1600	Struggling mothers, Strong Sons: Optimization and Adaptive Sex Allocation in Richardson's Ground Squirrels (<i>Spermophilus richardsonii</i>) Ryan CP, Hare JF & Anderson WG

CPB Contributed Papers / Session de communication PBC

Respiratory physiology & behaviour / Physiologie respiratoire et comportement

Location/Endroit: IRC 4**Chair/Président:** Gina Galli

Time	Speaker
1630 - 1645	Determining ventilatory cost in Red-eared Sliders (<i>Trachemys scripta elegans</i>): Comparison of three methods <i>Détermination des coûts respiratoires chez Trachemys scripta elegans : comparaison de trois méthodes</i> Lee S & Milsom WK
1645 - 1700	Corticosterone promotes air breathing in <i>Xenopus laevis</i> tadpoles <i>La corticostérone augmente la respiratoire aérienne chez le têtard Xenopus laevis</i> Kinkead R & Stéphanie F
1700 - 1715	Carbonic anhydrase and the modulation of central respiratory-related pH/CO ₂ chemoreceptor function following chronic hypoxia and hypercapnia in frogs <i>L'anhydrase carbonique et la modulation de la fonction chémoréceptrice pH/CO₂ centrale liée à la respiration suivant une hypoxie et une hypercapnie chronique chez les grenouilles</i> Reid S & Srivaratharjah K
1715 - 1730	Variation in metabolic rate between individual and species: providing physiological insight into habitat partitioning <i>Variation de taux métaboliques entre individus et espèces : la contribution de la physiologie dans la partition d'habitats</i> Van Leeuwen T, Richards J & Rosenfeld J

CPB Contributed Papers / Session de communication PBC

Temperature, feeding & metabolism / Température, alimentation & métabolisme

Location/Endroit: IRC 6**Chair/Président:** Jason Bystriansky

Time	Speaker
1630 - 1645	Identifying essential nutrient sensors in fish: using dietary manipulation to understand energy usage <i>Identification de capteurs de nutriments essentiels chez les poissons : utilisation de manipulations alimentaires pour comprendre l'usage énergétique</i> Craig P & Moon T
1645 - 1700	Characterization of a crustacean cardioactive peptide and its receptor in the blood-feeding insect, <i>Rhodnius prolixus</i> <i>Caractérisation d'un peptide de Cardioactive de crustacés et de son récepteur dans la prolixus Rhodnius insecte, sang-alimentation</i> Lee D, Paluzzi J-P, Orchard I & Lange A
1700 - 1715	The plasticity of nutrient transporter gene expression in the intestine of fish <i>La plasticité de l'expression génique de transporteurs de nutriments dans l'intestin des poissons</i> Bucking C & Schulte P
1715 - 1730	Membranes as pacemakers of metabolism: bridging the gap between macro and microevolution <i>Les membranes agissant comme "pacemakers" du métabolisme: faire le pont entre la macro et microévolution</i> Darveau C, Godbout-Gauthier E, Suarez R & Weber J-M

Banquet

Location/Endroit: Sage Bistro

Time	
1730 - 1900	Banquet

CMD Contributed Papers / Session de communications MDC

Developmental evolution of regeneration and bones

Location/Endroit: IRC 1**Chair/Président:** Tamara Franz-Odendaal

Time	Speaker
1000 - 1015	Behaviour and morphology as indicators of modularity in the adhesive system of geckos <i>Comportement et morphologie comme indicateurs de modularité dans le système adhésif des geckos</i> Russell A & Higham T
1015 - 1030	A macroscopic and microscope investigation of wound healing leading to scar-free regeneration in the leopard gecko. <i>Une investigation macroscopique et microscopique de la guérison des blessures conduisant à la régénération sans cicatrice chez le gecko léopard</i> Vickaryous M & Delorme S
1030 - 1045	A multi-pronged multi-organism approach to investigating bone development <i>Une approche multi-organismale tous azimuts pour l'investigation du développement osseux</i> Franz-Odendaal T
1045 - 1100	Spatial hearing in an acoustic parasitoid fly <i>L'ouïe spatiale chez une mouche parasitoïde acoustique</i> Mason A & Lee N

CPB Contributed Paper / Session de communication PBC

Exercise & physiological remodeling / Exercice et remodelage physiologique

Location/Endroit: IRC 3**Chair/Président:** Pat Wright

Time	Speaker
1000 - 1015	Alterations in the metabolic profile of juvenile rainbow trout (<i>Oncorhynchus mykiss</i>) in response to anaerobic exercise training <i>Altérations du profil métabolique de truites arc-en-ciel juvéniles en réponse à l'entraînement à l'exercice anaérobie</i> Macintyre S, Jibb E, Guo X & Wang Y
1015 - 1030	The physiological mechanism underlying enhanced oxygen delivery to red muscle in rainbow trout <i>Les mécanismes physiologiques responsables de la livraison accrue d'oxygène aux muscles rouges chez la truite arc-en-ciel</i> Rummer J, McKenzie D, Supuran C & Brauner C
1030 - 1045	Exercise induces gill remodelling in goldfish (<i>Carassius auratus</i>) <i>L'exercice provoque le remodelage des branchies chez le poisson rouge (Carassius auratus)</i> Fletcher C, Gilmour K & Perry S
1045 - 1100	Biochemical properties of the adductor muscle in relation to the swimming strategy of the scallops. <i>Les propriétés biochimiques du muscle adducteur sont-elles le reflet de la stratégie de nage chez les pétoncles?</i> Tremblay I, Guderley H & Himmelman J

CPB Contributed Papers / Session de communication PBC

Toxicology II / Toxicologie II

Location/Endroit: IRC 4**Chair/Président:** Keith Tierney

Time	Speaker
1000 - 1015	Combined effects of copper and temperature on muscle gene transcription and enzyme activities in fathead minnows <i>Effets combinés du cuivre et de la température sur la transcription génique et l'activité enzymatique chez le tête de boule</i> Couture P, Lapointe D & Pierron F
1015 - 1030	Structural and functional consequences of nanoparticle-enzyme interactions. <i>Conséquences structurales et fonctionnelles des interactions entre les nanoparticules et les enzymes</i> MacCormack T, Clark R, Dang M, Veinot J & Goss G
1030 - 1045	Physiological effects of chronic Cd exposure in rainbow trout <i>Les effets physiologiques d'une exposition chronique de Cd dans la truite arc-en-ciel</i> Mancini A, Milne J & McGeer J
1045 - 1100	Use of salmonid intestinal cell lines to evaluate the toxicity of soybean meal components <i>L'utilisation de lignées cellulaires intestinales pour évaluer la toxicité des composantes d'un repas de fèves de soya</i> Smith R, Way C, Kawano A, Dixon B, Bols N & Lee L

Contributed Sessions VIII / Session de communication VIII Friday / Vendredi (21 May / Mai)

CMD Contributed Papers / Session de communications MDC

Developmental evolution of insects

Location/Endroit: IRC 1

Chair/Président: Ehab Abouheif

Time	Speaker
1130 - 1145	The use of artificial membranes in feeding reduces feeding efficacy and fecundity in adult females of the blood-feeding insect <i>Rhodnius prolixus</i> <i>L'utilisation de membranes artificielles pour l'alimentation réduit l'efficacité et la fécondité chez les femelles adultes de l'insecte sanguinivore Rhodnius prolixus</i> Chiang J
1145 - 1200	Effects of the essential oil constituents and other neuroactive chemicals on flight motor activity and wing beat frequency in the blowfly <i>Phaenicia cericata</i> . <i>Les effets des constituants des huiles essentielles et autres composés chimiques neuroactifs sur l'activité des moteurs de vols et sur la fréquence des battements d'ailes chez la mouche Phaenicia cericata</i> Waliwitiya R & Lowenberger C
1200 - 1215	Body Plan Evolution in Semi-Aquatic Insects <i>L'évolution du plan d'organisation chez les insectes semi-aquatiques</i> Abouheif E

Contributed Sessions VIII / Session de communication VIII Friday / Vendredi (21 May / Mai)

CPB Contributed Paper / Session de communication PBC

Exercise & physiological remodeling / Exercice et remodelage physiologique

Location/Endroit: IRC 3

Chair/Président: Pat Wright

Time	Speaker
1130 - 1145	Minimum metabolic requirements for flight in the bumblebee, <i>Bombus impatiens</i> <i>Les besoins métaboliques minimums nécessaires pour le vol chez le bourdon, Bombus impatiens</i> Skandalis D, Roy C & Darveau C
1145 - 1200	Effect of selective breeding for high locomotor activity on metabolic fuel selection <i>L'effet de l'élevage sélectif pour une haute activité locomotrice sur la sélection de carburant métabolique</i> Templeman N, Schutz H, Garland T & McClelland G
1200 - 1215	<i>In vitro</i> and <i>in situ</i> measures of force-generating ability in hummingbird flight muscle fibers <i>Mesures in vitro et in situ de la capacité à générer de la force dans les fibres musculaires liés au vol chez les colibris</i> Welch K, Reiser P & Altshuler D

Contributed Sessions VIII / Session de communication VIII Friday / Vendredi (21 May / Mai)

CPB Contributed Papers / Session de communication PBC

Toxicology II / Toxicologie II

Location/Endroit: IRC 4

Chair/Président: Keith Tierney

Time	Speaker
1130 - 1145	Effects of waterborne silver in a marine teleost, the Gulf Toadfish (<i>Opsanus beta</i>): effects of feeding and chronic exposure on bioaccumulation and physiological responses <i>L'effet de l'argent hydrique sur le poisson téléostéen marin Opsanus beta : effets de l'alimentation et de l'exposition chronique sur la bioaccumulation et les réponses physiologiques</i> Wood C, Grosell M, McDonald M, Playle R & Walsh P
1145 - 1200	Linkages between exposure, effect and accumulation of cadmium in <i>Lumbriculus variegatus</i> and <i>Hyalella azteca</i> <i>Les liens entre l'exposition, l'effet et l'accumulation de cadmium dans Lumbriculus variegatus et Hyalella azteca</i> Straus A & McGeer J
1200 - 1215	Effects of chronic exposure to cadmium on the swimming performance in brown trout and the rainbow trout <i>Effet de l'exposition chronique au cadmium sur les performances de natation chez la truite brune et la truite arc-en-ciel</i> Cunningham J & McGeer J

AGM lunch/Lunch RGA

Time/Heure : 1230 - 1400

Location/Endroit: Isabel MacInnes Room, Gage Residence

Council Meeting/Réunion du Conseil

Time/Heure : 1430 - 1730

Location/Endroit: Biodiversity 224

Poster Session/Session d'affiches
CSZ Vancouver 2010 – The Zoological Olympics / SCZ Vancouver 2010 – Les
Olympiques Zoologiques

Date/Date: Wednesday, May 19 Time/Heure: 1900-2100 hrs Location/Endroit: IRC Lobby
--

Information for presenters

- Setup time: Posters can be put up starting at **1030hrs on Wednesday, May 19.**
- Removal time: Posters must be removed by **1500hrs on Thursday, May 20.**
- Set up your poster according to the poster number listed below and the corresponding map
- Please use the supplied push pins to attach your poster. Should you require additional push pins please see the registration desk.

Information pour les présentateurs

- Temps pour la mise en place des posters: Les posters peuvent être mis en place à partir de **10h30 le mercredi 19 mai.**
- Temps pour enlever les posters: Les posters doivent être enlevés par **15h00 le jeudi 20 mai**
- Emplacement de votre poster: Regardez le numéro ci-dessous.
L'emplacement de votre poster se trouve au numéro correspondant sur la carte.
- S'il vous plaît utilisez les punaises fournies pour fixer votre poster.
Si vous en voulez plus, demandez-les au bureau des inscriptions.

Comparative Morphology and Development

1. **EVOLUTIONARY IMPLICATIONS OF HYPOXIA AND HYPEROXIA ON DROSOPHILA MELANOGASTER**

IMPLICATIONS EVOLUTIVES DE L'HYPOXIE ET DE L'HYPEROXIE CHEZ DROSOPHILA MELANOGASTER

Charette, M.

2. **CRITICAL THERMAL MAXIMA OF BC HATCHERY-REARED RAINBOW TROUT (ONCORHYNCHUS MYKISS)**

TEMPERATURES MAXIMALES CRITIQUES DES TRUITES ARC-EN-CIEL DE COLOMBIE BRITANNIQUE (ONCORHYNCHUS MYKISS) ELEVEES EN CAPTIVITE

Cheung, W., Scott, M., Richards, J.

3. **ELECTROSPINNING TO ELUCIDATE THE DEVELOPMENT OF MECHANICAL PROPERTIES IN THE WHELK EGG CAPSULE PROTEIN**

ELECTROFILAGE POUR ÉLUCIDER LE DÉVELOPPEMENT DES PROPRIÉTÉS MÉCANIQUES DE LA CAPSULE PROTÉIQUE DE L'ŒUF DE BUCCIN

Corbett, C., Shadwick, R.

4. **SEEING WHELK EGG CAPSULES IN A NEW LIGHT: WHAT BIREFRINGENCE REVEALS**

REGARDER LES CAPSULES D'ŒUFS DES BUCCINS DANS UNE LUMIÈRE NOUVELLE: QU'EST-CE QUE LA BIRÉFRINGENCE RÉVÈLE?

Didier, D., Gosline, J., Shadwick, R.

5. **EXPLORING THE MOLECULAR BASIS OF CARTILAGE FORMATION IN THE CEPHALOPOD SEPIA OFFICINALIS**

EXPLORER LES BASES MOLECULAIRES DE LA FORMATION DE CARTILAGE DANS LE CEPHALOPODE SEPIA OFFICINALIS

Focareta, L., Cole, A.

6. **ESTIMATING THE NUTRITIONAL REQUIREMENTS OF THE ENDANGERED NORTH ATLANTIC RIGHT WHALE (EUBALAENA GLACIALIS) WITH A GENERALIZED BIOENERGETICS MODEL.**

UTILISATION D' UN MODÈLE BIOÉNERGÉTIQUE GÉNÉRAL POUR ESTIMER DES BESOINS NUTRITIONNELS DES BALEINES NOIRES DE L'ATLANTIQUE NORD EN DANGER D'EXTINCTION (EUBALAENA GLACIALIS).

Fortune, S., Trites, A.

7. **EFFECT OF TEMPERATURE, HYPOXIA AND HYPERCAPNIA ON THE FICTIVE BREATHING RESPONSE OF CANE TOADS (BUFO MARINUS)**

EFFET DE LA TEMPÉRATURE, DE L'HYPOXIE ET DE L'HYPERCAPNIE SUR LA RÉPONSE RESPIRATOIRE FICTIVE DES CRAPAUDS GÉANTS (BUFO MARINUS)

Jenkin, S., Reid, S.

8. **DOSE-RESPONSE CURVES OF MORPHINE IN BROOK CHARR (*SALVELINUS FONTINALIS*)**

COURBES DOSE-REPOSES DE LA MORPHINE CHEZ L'OMBLE DE FONTAINE (*SALVELINUS FONTINALIS*)

Jones, S.

9. **PLAUSIBILITY OF THE NOVEL STRUCTURE - ONTOGENY AND FUNCTION OF "SUCTION DISC" IN BRANCHIURA (CRUSTACEA)**

PLAUSIBILITÉ DE STRUCTURE NOUVELLE - ONTOGÉNÈSE ET FONCTION DE LA VENTOUSE DE SUCCION CHEZ LES BRANCHIOURES (CRUSTACÉS)

Kaji, T.

10. **HOW THE TURTLE MAKES ITS PALATE WITHOUT PALATAL SHELVES**

COMMENT LA TORTUE CONSTRUIT SON PALAIS SANS LAMES PALATINES.

Leung, K., Richman, J.

11. **VARIATIONS IN PHYSICAL PROPERTIES OF BOTTLENOSE DOLPHIN (*TURSIOPS TRUNCATUS*) FOREHEAD TISSUES: POTENTIAL FOR ECHOLOCATION THERMOREGULATION**

VARIATIONS DES PROPRIÉTÉS PHYSIQUES DES TISSUES DU FRONT CHEZ LE GRAND DAUPHIN (*TURSIOPS TRUNCATUS*): POTENTIEL POUR L'ÉCHOLOCATION ET LA THERMORÉGULATION

Lin, C., Cranford, T., Shadwick, R.

12. **PARASITES AND CHEMICAL CONTAMINANTS IN WHITEFISH (*COREGONUS CLUPEAFORMIS*) FROM NORTHERN SASKATCHEWAN LAKES**

PARASITES ET CONTAMINANTS CHIMIQUES CHEZ LE CORÉGONE (*COREGONUS CLUPEAFORMIS*) DES LACS DU NORD DE SASKATCHEWAN

Mysiv, O., Pietrock, M.

13. SEXING FROGS USING PCR: CYP19 AROMATASE IS AN EARLY OVARIAN DIFFERENTIATION MARKER

SEXAGE DES GRENOUILLES PAR LE PCR: LA CYP19 AROMATASE EST UN MARQUEUR PRÉCOCE DE LA DIFFÉRENCIATION OVARIENNE

Navarro-Martín, L., Lanctôt, C., Trudeau, V.

14. PHENOTYPIC PLASTICITY AND MITOCHONDRIAL STRUCTURE IN A TROPICAL FISH GENUS ASTYANAX BAIRD & GIRARD (1854)

PLASTICITÉ PHÉNOTYPIQUE ET STRUCTURE MITOCHONDRIALE CHEZ LE POISSON TROPICAL DU GENRE ASTYANAX BAIRD & GIRARD (1854)

Ornelas, P., Bastir, M., Doadrio, I.

15. ANALYSIS OF FIN WHALE (BALAENOPTERA PHYSALUS) BALEEN PLATE GEOMETRY AND ARRANGEMENT

ANALYSE COMPARÉE DE LA MORPHOLOGIE DE NAGEOIRES CAUDALES THUNNIFORMES ET DE LA PORTÉE DE MOUVEMENT

Pinto, S., Goldbogen, J., Shadwick, R.

16. NEW DATA ON THE FEEDING MORPHOLOGY OF LUNGE-FEEDING BALEEN WHALES (BALAENOPTERIDAE): FIBROUS JOINTS AND GIGANTIC JAWS

NOUVELLES DONNÉES SUR LA MORPHOLOGIE DES BALEINES À FANONS (BALAENOPTERIDAE): JOINTS FIBREUX ET MÂCHOIRES GIGANTESQUE

Pyenson, N., Goldbogen, J., Shadwick, R.

17. ON THE ROLE OF VENTRAL GROOVE BLUBBER (VGB) ELASTICITY DURING LUNGE FEEDING: IMPLICATIONS FOR ENGULFMENT DYNAMICS

RÔLE DE L'ÉLASTICITÉ DU SILLON VENTRAL DE LA GRAISSE DES BALEINES DURANT L'ALIMENTATION: IMPLICATIONS POUR LES DYNAMIQUES DE L'ENGOUFFREMENT

Shadwick, R., Goldbogen, J., Potvin, J., Pyenson, N.

18. THE EFFECTS OF MATING EXPERIENCE ON INTER-MALE COMPETITION IN L. HESPERUS

EFFETS DE L'EXPÉRIENCE SEXUELLE SUR LA COMPÉTITION ENTRE MALES CHEZ L. HESPERUS

Stemberger, T.

19. **CORRELATION BETWEEN HEAD PROPORTIONS, CRANIAL OSSIFICATION SEQUENCE AND EMBRYONIC GROWTH IN THE LEOPARD GECKO (EUBLEPHARIS MACULARIUS).**

CORRÉLATION ENTRE LES PROPORTIONS DE LA TÊTE, L'ORDRE D'OSSIFICATION CRÂNIEN ET LA CROISSANCE EMBRYONNAIRE DU GECKO LÉOPARD (EUBLEPHARIS MACULARIUS).

Wise, P., Russell, A.

20. **WHAT'S FOR DINNER? BLOOD OR SUGAR?**

QU'EST CE QU'IL Y A POUR DINER? DU SANG OU DU SUCRE ?

Zappia, S.

Comparative Physiology and Biochemistry

21. **INVESTIGATING THE INTERACTIVE EFFECTS OF AMMONIA AND SEWAGE EFFLUENT ON ZEBRAFISH REPRODUCTION**

INVESTIGATION DES INTERACTIONS DE L'AMMONIAC ET DES EFFLUENTS MUNICIPAUX AVEC LA REPRODUCTION DES POISSONS ZEBRES

Alkema, K., Van Der Kraak, G.

22. **ONTOGENETIC EFFECTS ON THERMAL TOLERANCE AND METABOLIC DEPRESSION IN FISHES**

LES EFFETS ONTOGÉNIQUES SUR LA TOLÉRANCE THERMIQUE ET LA DÉPRESSION MÉTABOLIQUE DES POISSONS.

Alzaid, A., Kelly, N., Nash, G., Gamperl, A.

23. **DEVELOPMENT OF EEL (*ANGUILLA ROSTRATA*) CELL LINES AND THEIR USE IN AN ECOTOXICOLOGICAL PROBLEM: THE DRAMATIC DECLINE IN EEL POPULATIONS**

DEVELOPPEMENT DE LIGNEES CELLULAIRES D'ANGUILLE (*ANGUILLA ROSTRATA*) ET LEUR UTILISATION POUR RESOUDRE UN PROBLEME ECOTOXICOLOGIQUE: LA BAISSSE DRAMATIQUE DES POPULATIONS D'ANGUILLES.

Bloch, S., Bromand, S., Walsh, S., Wong, Y.T., Lee, L., Hodson, P., Bols, N.

24. **TISSUE DISTRIBUTION OF $Na^{+}K^{+}$ -ATPASE ALPHA AND BETA SUBUNIT ISOFORMS IN FRESHWATER AND SEAWATER ACCLIMATED ATLANTIC SALMON**

DISTRIBUTION TISSULAIRE DES ISOFORMES DES SOUS-UNITES ALPHA ET BETA DE LA $Na^{+}K^{+}$ -ATPASE CHEZ LES SAUMONS ATLANTIQUES ACCLIMATES A L'EAU DOUCE ET A L'EAU DE MER

Bystriansky, J., Allen, D., Schulte, P.

25. **GHRELIN-INDUCED GROWTH HORMONE AND GONADOTROPIN RELEASE FROM THE GOLDFISH PITUITARY: DIFFERENTIAL INVOLVEMENT OF PKC AND PKA**

LIBERATION DE L'HORMONE DE CROISSANCE ET DES GONADOTROPHINES PAR LA GHRELIN DANS L'HYPOPHYSE DES POISSONS ROUGES: PARTICIPATION DIFFERENTIELLE DU PKC ET DU PKA

Gray, C., Chang, J.

26. **USING HEART RATE TO DETERMINE OPTIMAL AND CRITICAL TEMPERATURES OF SALMON**

UTILISATION DE LA FREQUENCE CARDIAQUE POUR DETERMINER LES TEMPERATURES OPTIMALES ET CRITIQUES DES SAUMONS

Casselman, M., Farrell, A.

27. **AMMONIA EXCRETION IN THE FRESHWATER FLATWORM SCHMIDTEA MEDITERRANEA**

EXCRETION D'AMMONIUM CHEZ LA PLANAIRE D'EAU DOUCE SCHMIDTEA MEDITERRANEA

Chan, A., Sourial, M., Weihrauch, D.

28. **DOES SALINITY AFFECT THE CELLULAR RESPONSE TO 17A-ETHYNYLESTRADIOL IN THE ESTUARINE MUMMICHOG?**

EST-CE QUE LA SALINITÉ AFFECTE LA RÉPONSE CELLULAIRE AU 17A-ETHYNYLESTRADIOL CHEZ LES CHOQUEMORTS ESTUARIENS ?

Chandra, K., Currie, S.

29. **POLYACRYLAMIDE GEL ELECTROPHORESIS OF CRUDE EXTRACTS FROM THE TESTES AND SEMINAL VESICLES OF THE BLOOD-FEEDING INSECT, RHODNIUS PROLIQUS.**

ELECTROPHORÈSE SUR GEL DE POLYACRYLAMIDE D'EXTRAITS BRUTS DE TESTICULES ET DE VÉSICULES SÉMINALES DES INSECTES SUCEURS DE SANG RHODNIUS PROLIQUS.

Chiang, G., Chiang, S.

30. **LINKING THE ADRENERGIC AND HEAT SHOCK STRESS RESPONSES IN FISH**

LIER LA REPONSE ADRENERGIQUE A LA REPONSE AU STRESS (CHOC THERMIQUE) CHEZ LES POISSONS

Cox, L., McClelland, C., Currie, S.

31. **RAINBOW TROUT EMBRYOS CREATE A UNIQUE MICROENVIRONMENT IN REDDS.**

LES EMBRYONS DE LA TRUITE ARC-EN-CIEL CRÉENT UN MICROENVIRONNEMENT UNIQUE DANS LES FRAYÈRES.

Dhiyebi, H., O'Donnell, M., Wright, P.

32. **EXAMINING TOXICOLOGICAL AND PHYSICO-CHEMICAL PROPERTIES OF MANUFACTURED NANOPARTICLES USING ZEBRAFISH EMBRYOS**
- UTILISATION D'EMBRYONS DE POISSONS ZÈBRES POUR EXAMINER LES PROPRIÉTÉS TOXICOLOGIQUES ET PHYSICO-CHIMIQUES DES NANOPARTICULES ARTIFICIELLES**
- Felix, L., Goss, G., Ortega, V.
33. **MITOCHONDRIAL PLASTICITY IN THE ANOXIC TURTLE HEART**
- PLASTICITÉ MITOCHONDRIALE DU CŒUR ANOXIQUE DE TORTUE**
- Galli, G., Farrell, A., Richards, J.
34. **THE ROLE OF PKA IN REGULATING CONTRACTILE FUNCTION IN THE RAINBOW TROUT HEART**
- RÔLE DU PKA DANS LA RÉGULATION DE LA CONTRACTILITÉ DU CŒUR DE LA TRUITE ARC-EN-CIEL**
- Gillis, T., Robertson, A., Klaiman, J.
35. **NEUROTRANSMITTER FUNCTIONS IN THE PLACOZOAN TRICHOPLAX ADHERENS**
- FONCTIONS DES NEUROTRANSMETTEURS CHEZ LE PLACOZOAIRE TRICHOPLAX ADHERENS**
- Heyland A., Goodall S., Sohn, D., Leys, S., Moroz, L.
36. **A MECHANISM OF MOLYBDENUM TRANSPORT IN RAINBOW TROUT (ONCORHYNCHUS MYKISS) GILL EPITHELIA.**
- MÉCANISME DE TRANSPORT DU MOLYBDÈNE DANS L'ÉPITHÉLIUM DES BRANCHIES DE LA TRUITE (ONCORHYNCHUS MYKISS)**
- Hoekstra, J., Reid, S.
37. **THE EFFECTS OF ELEVATED WATER TEMPERATURE ON ADULT SOCKEYE SALMON GENE EXPRESSION AND BLOOD PHYSIOLOGY**
- EFFETS DE LA TEMPÉRATURE ÉLEVÉE DE L'EAU SUR L'EXPRESSION DES GENES ET SUR LA PHYSIOLOGIE SANGUINE CHEZ LES SAUMONS ROUGES ADULTES.**
- Jeffries, K., Hinch, S., Sierocinski, T., Pavlidis, P., Miller, K.
38. **EFFECTS OF SUBLETHAL, CHRONIC ANIONIC AND CATIONIC POLYMER EXPOSURE ON JUVENILE AND EMBRYONIC *ONCORHYNCHUS MYKISS*.**
- EFFETS D'EXPOSITIONS SUBLÉTALES ET CHRONIQUES DE POLYMÈRES ANIONIQUES ET CATIONIQUES SUR LES TRUITES JUVÉNILES ET EMBRYONNAIRES (ONCORHYNCHUS MYKISS)**
- Kerr, J., Deck, P., Goss, G.

39. **COPPER AND NICKEL TOXICITY IN THE LARVA OF THE YELLOW FEVER MOSQUITO, Aedes Aegypti.**
- TOXICITÉ DU CUIVRE ET DU NICKEL CHEZ LA LARVE DU MOUSTIQUE RESPONSABLE DE LA FIÈVRE JAUNE, Aedes Aegypti**
Kotzeva, L., Rheault, M.
40. **DIFFUSION PROPERTIES OF THE GOLDENROD BALL GALL**
- PROPRIÉTÉS DE LA DIFFUSION CHEZ LE FIEL BALLE D'OR**
Long, Q., Tattersall, G.
41. **VALIDATION AND APPLICATION OF HAIR CORTISOL CONCENTRATION AS A NON-INVASIVE BIOMARKER OF LONG-TERM STRESS IN FREE-RANGING GRIZZLY BEARS**
- VALIDATION ET UTILISATION DE LA CONCENTRATION DE CORTISOL DANS LES POILS COMME BIOMARQUEUR NON INVASIF DE STRESS A LONGUE DURÉE CHEZ LES GRIZZLY EN LIBERTÉ.**
Macbeth, B., Cattet, M., Stenhouse, G., Gibeau, M., Janz, D.
42. **CELLULAR ADAPTATIONS TO HYPOXIA: IS THERE VARIATION IN HYPOXIA-INDUCIBLE FACTOR SEQUENCE BETWEEN HYPOXIA TOLERANT AND INTOLERANT SPECIES?**
- ADAPTATIONS CELLULAIRES À L'HYPOXIE: Y A-T-IL DE LA VARIABILITÉ DANS LA SÉQUENCE DU FACTEUR HYPOXIE-INDUCTIBLE ENTRE LES ESPÈCES TOLÉRANTES ET INTOLÉRANTES À L'HYPOXIE?**
Mandic, M., Richards, J.
43. **EFFECT OF ENVIRONMENTAL AMMONIA STRESS ON BRANCHIAL AMMONIA TRANSPORT IN THE STENOHALINE MARINE CRAB CANCER MAGISTER**
- EFFECT DU STRESS DE L'AMMONIUM ENVIRONNEMENTAL SUR LE TRANSPORT DE L'AMMONIUM À TRAVERS**
Martin, M., Weihrauch, D.
44. **CHARACTERIZATION AND DISSOLUTION RATES OF VIVENANO LTD. AQUEOUS METAL NANOPARTICLES AND ASSESSMENT OF EFFECTS USING AN IN VITRO CELL MODEL**
- CARACTÉRISATION ET TAUX DE DISSOLUTION DES NANOPARTICULES MÉTALLIQUES (LTD VIVENANO LTD.). ÉVALUATION DE LEURS EFFETS EN UTILISANT UN MODÈLE CELLULAIRE IN VITRO**
Ortega, V., Felix, L., Goss, G.

45. **PHOSPHOINOSITIDE 3-KINASE MEDIATES GONADOTROPIN-RELEASING HORMONE ACTIONS IN GOLDFISH PITUITARY GONADOTROPHS AND SOMATOTROPHS.**

LE PHOSPHOINOSITIDE 3-KINASE CAUSE LES ACTIONS DE LA *GNRH* SUR LES GONADOTROPHS ET LES SOMATOTROPHS DE LA GLANDE PITUITAIRE DES POISSONS ROUGES.

Pemberton, J., Chang, J.

46. **PERIPHERAL ARTERIAL CHEMORECEPTORS IN THE SOUTH AMERICAN RATTLESNAKE (*CROTALUS DURISSUS*) AND THEIR ROLE IN CARDIORESPIRATORY CONTROL**

CHÉMORECEPTEURS ARTÉRIELS PÉRIPHÉRIQUES DU SERPENT À SONNETTE D'AMÉRIQUE DU SUD (*CROTALUS DURISSUS*) ET LEUR RÔLE DANS LE CONTRÔLE CARDIORESPIRATOIRE

Reyes, C., Fong, A., Milsom, W.

47. **TRIMETHYLAMINE OXIDE AND THE CELLULAR STRESS RESPONSE OF THE SPINY DOGFISH *SQUALUS ACANTHIAS***

L'OXYDE DE TRIMÉTHYLAMINE ET LA RÉPONSE CELLULAIRE AU STRESS CHEZ L'AIGUILLAT (*SQUALUS ACANTHIAS*)

Robertson, C., Currie, S.

48. **THERMAL CHARACTERISTICS OF MITOCHONDRIA FROM CARDIAC MUSCLE OF ATLANTIC COD**

LES CARACTÉRISTIQUES THERMIQUES DES MITOCHONDRIES DU MUSCLE CARDIAQUE CHEZ LA MORUE ATLANTIQUE

Rodnick, K., Gamperl, A., Nash, G., Syme, D.

49. **PHYSIOLOGICAL PERFORMANCE AND STRESS TOLERANCE OF FOUR STRAINS OF DIPLOID AND TRIPLOID RAINBOW TROUT (*ONCORHYNCHUS MYKISS*)**

PERFORMANCE PHYSIOLOGIQUE ET TOLÉRANCE AU STRESS DE QUATRE SOUCHES DE TRUITES ARC-EN-CIEL (*ONCORHYNCHUS MYKISS*) DIPLOÏDES ET TRIPLOÏDES

Scott, M., Richards, J.

50. **DON'T TRUST YOUR HOUSEKEEPERS: LABILE EXPRESSION OF INTERNAL REFERENCE GENES IN ANOXIC TURTLES**

NE VOUS FIEZ PAS AUX GÈNES D'ENTRETIEN: EXPRESSION LABILE DES GÈNES DE RÉFÉRENCE INTERNES CHEZ LA TORTUE EN ANOXIE

Stecyk, J., Couturier, C., Fagernes, C., Ellefsen, S., Nilsson, G.

51. VENTRICULAR STIFFENING MAY LIMIT CARDIAC POWER AT HIGH TEMPERATURE IN ATLANTIC COD

A HAUTE TEMPÉRATURE, LE RAIDISSEMENT VENTRICULAIRE PEUT LIMITER LA PUISSANCE CARDIAQUE DES MORUES

Syme, D., Gamperl, K., Rodnick, K.

52. THE EFFECT OF NANOPARTICLES ON HATCHING ENZYMES IN ZEBRAFISH (*DANIO RERIO*)

EFFET DES NANOPARTICULES SUR LES ENZYMES DE L'ÉCLOSION CHEZ LE POISSON ZÈBRE (*DANIO RERIO*)

Thistle, M., Ong, K., Zhao, X., MacCormack, T., Clark, R., Dang, M., Ma, G., Veinot, J., Goss, G.

53. QUANTITATIVE PROTEOMIC ANALYSIS OF GILLS FROM ZEBRAFISH (*DANIO RERIO*) EXPOSED TO NAPHTHENIC ACIDS AND OILS SANDS PROCESS WATER

ANALYSE QUANTITATIVE PROTÉOMIQUE DES BRANCHIES DE POISSONS ZÈBRES (*DANIO RERIO*) EXPOSÉS AUX ACIDES NAPHTÉNIQUES ET AUX EFFLUENTS PROVENANT DES SABLES BITUMINEUX.

MacCormack, T., De Souza, A., Li, L., Goss, G.

54. *IN VITRO* TOXICITY EVALUATION OF SILICA NANOPARTICLES USING FISH CELL LINES

UTILISER DES LIGNÉES CELLULAIRES DE POISSONS POUR ÉVALUER *IN VITRO* LA TOXICITÉ DES NANOPARTICULES DE SILICE

Vo, N., Kitaev, V., Lee, L.

55. DEVELOPMENTAL PLASTICITY OF HYPOXIA TOLERANCE IN DANIOS AND DEVARIOS

PLASTICITÉ DU DÉVELOPPEMENT DE LA TOLÉRANCE À L'HYPOXIE CHEZ DANIOS ET DEVARIOS

Yao, L., Richards, J.

Ecology, Ethology and Evolution

56. SENSORY STRUCTURES AND NEURAL MECHANISMS UNDERLYING NAVIGATIONAL BEHAVIOURS IN THE NUDIBRANCH MOLLUSC *TRITONIA DIOMEDEA*

STRUCTURES SENSORIELLES ET MÉCANISMES NEURONAUX GOUVERNANT LES COMPORTEMENTS DE NAVIGATION DU NUDIBRANCHE *TRITONIA DIOMEDEA*

McCullagh, G., Wyeth, R.

57. FOOD REQUIREMENTS OF PACIFIC WHITE-SIDED DOLPHINS

BESOINS ALIMENTAIRES DES DAUPHINS À FLANCS BLANCS DU PACIFIQUE.

Rechsteiner, E., Trites, A., Rosen, D.

58. THE EFFECTS OF SUBSTRATE RESISTANCE AND MICROHABITAT PREFERENCE ON DISPERSAL IN THE LONG TOED SALAMANDER (AMBYSTOMA MACRODACTYLUM)

LES EFFETS DE LA RÉSISTANCE DU SUBSTRAT ET DE LA PRÉFÉRENCE DU MICROHABITAT SUR LA DISPERSION DES SALAMANDRES À LONGS DOIGTS (AMBYSTOMA MACRODACTYLUM)

Sechley, T., Lee-Yaw, J., Irwin, D.

59. CLAW CURVATURE IN AMNIOTES: A COMPARISON OF METHODS

COMPARAISON DES MÉTHODES MESURANT LA COURBURE DES GRIFFES CHEZ LES AMNIOTES

Tinius, A., Chebet, T., Russell, A.

Parasitology

60. THE GENERATION AND USE OF TRANSGENIC INSECTS TO REDUCE PARASITE TRANSMISSION: VIABLE ALTERNATIVE TO EXISTING STRATEGIES?

PRODUCTION ET UTILISATION D'INSECTES TRANSGÉNIQUES POUR RÉDUIRE LA TRANSMISSION PARASITAIRE: EST-CE UNE ALTERNATIVE VIABLE AUX STRATÉGIES DÉJÀ EXISTANTES?

James, A.

61. DIEL VERTICAL DISTRIBUTION OF EARLY MARINE PHASE JUVENILE PINK SALMON (ONCORHYNCHUS GORBUSCHA) AND BEHAVIOURAL RESPONSES TO EXPOSURE TO SEA LICE (LEPEOPHTHERIUS SALMONIS)

DISTRIBUTION VERTICALE JOURNALIÈRE DES JEUNES SAUMONS ROSES AU DÉBUT DE LEUR PHASE MARINE (ONCORHYNCHUS GORBUSCHA) ET LEURS RÉPONSES COMPORTEMENTALES LORS DE L'EXPOSITION AUX POUX DU POISSON (LEPEOPHTHERIUS SALMONIS)

Tang, S., Lewis, A., DiBacco, C., Sackville, M., Nendick, L., Brauner, C., Farrell, A.

62. MECHANISMS OF NEURONAL SIGNALING IN THE HUMAN BLOODFLUKE, *SCHISTOSOMA MANSONI*

LES MÉCANISMES DE LA SIGNALISATION NEURONALE DES DOUVES, *SCHISTOSOMA MANSONI*, CHEZ L'HOMME

Ribeiro, P., El-Shehabi, F., Taman, A., Patocka, N., Macdonald, K.

Abstracts

BODY PLAN EVOLUTION IN SEMI-AQUATIC INSECTS ÉVOLUTION DE PLAN DE CORPS DANS LES INSECTES SEMI-AQUATIC

L'ÉVOLUTION DU PLAN D'ORGANISATION CHEZ LES INSECTES SEMI-AQUATIQUES

Abouheif, Ehab (*McGill University*)

Water striders are derived semi-aquatic bugs (Hemiptera, Gerromorphae, Gerridae) that possess a remarkable diversity of leg lengths and shapes among species and between sexes. As a consequence of adapting to life on the water surface, water striders have evolved mid-legs (L2) that are long relative to their hind-legs (L3). This novel appendage ground plan is a derived feature among insects, where L2 function as oars and L3 as rudders. The Hox gene *Ultrabithorax* (*Ubx*) is known to increase appendage size in a variety of insects. Using gene expression and RNAi analysis, we discovered that *Ubx* is expressed in both L2 and L3, but *Ubx* functions to elongate L2 and to shorten L3 in the water strider *Gerris buenoi*. Therefore, within hemimetabolous insects, *Ubx* has evolved a new expression domain but maintained its ancestral elongating function in L2, whereas *Ubx* has maintained its ancestral expression domain but evolved a new shortening function in L3. We show that these changes in *Ubx* expression and function were a key event in the evolution of the water strider body plan, and that this body plan evolved in a gradual, stepwise, manner that would not have been predicted by phylogenetic mapping of morphology alone.

SPONGE EPITHELIA: THE FIRST EVIDENCE OF TRANSEPITHELIAL RESISTANCE AND MOLECULE IMPERMEABILITY WITHIN THE PHYLUM PORIFERA.

ÉPITHÉLIA D'ÉPONGE : PREMIÈRE ÉVIDENCE DE RÉSISTANCE TRANSÉPITHÉLIALE ET D'IMPERMÉABILITÉ DE MOLÉCULE DANS LE PHYLUM PORIFERA

Adams, Emily (*University of Alberta*)

Goss, Greg (*University of Alberta*)

Leys, Sally (*University of Alberta*)

Sponges (Porifera), the most basal metazoans, are often described as lacking basal laminae and occluding cell junctions which are the defining characteristics of epithelia; however, morphological, behavioural and genetic evidence suggests that this paradigm may be false. We tested the sealing ability of freshwater sponge tissues by measuring transepithelial electrical resistances (TER) and permeability to radioactively labelled tracers. Our results show that sponge epithelia have an electrical resistance comparable to eumetazoan epithelia (1- 8 kOhm cm²), and are impermeable to 3H-Inulin flux. Voltage across sponge epithelial layers was slightly negative in minimal saline and Na-free media, but became positive in Cl-free medium. These experiments illustrate that sponges, like other animals, have sealed epithelia which control ion transport. Our results are the first clear demonstration that sponges possess functional epithelia, and suggest that sealing had already evolved in the first metazoans.

EXPRESSION OF SODIUM TRANSPORT PROTEINS IN RAINBOW TROUT EXPOSED TO VERY SOFT WATER

L'EXPRESSION DES PROTÉINES DE TRANSPORT DU SODIUM CHEZ LA TRUITE ARC-EN-CIEL EXPOSÉE À L'EAU TRÈS DOUCE

Dymowska, Agnieszka K. (*University of Alberta*)

Parks, Scott K. (*University of Alberta*)

Goss, Greg G. (*University of Alberta*)

The current model for sodium uptake from very dilute waters by the gills of freshwater fish is a controversial subject. While Na⁺/H⁺ exchangers (NHEs) have been cloned and demonstrated to be present on the gills of many freshwater fishes, there is no molecular evidence to support the existence of a Na⁺ selective channel. Nevertheless, the thermodynamic constraints on the function of NHEs at very low ion concentrations (<0.5 mM) suggest that this mechanism cannot function similar to mammalian NHEs. To further investigate the mechanism of Na⁺ uptake in fishes, we examined the expression patterns in several transport proteins proposed to be involved in the uptake of sodium from low Na⁺ conditions. We exposed adult rainbow trout, *Oncorhynchus mykiss* to soft water (Cl⁻=100 µmol/L, Na⁺=115 µmol/L, Ca²⁺=115 µmol/L, pH= 6.5) over a period of seven days. Fish were terminally anesthetized and sampled for gills at 0, 6, 12, 24, 72, and 168 hours for Q-PCR, Western blotting and IHC of several transport proteins.

INVESTIGATING THE INTERACTIVE EFFECTS OF AMMONIA AND SEWAGE EFFLUENT ON ZEBRAFISH REPRODUCTION

INVESTIGATION DES INTERACTIONS DE L'AMMONIAC ET DES EFFLUENTS MUNICIPAUX AVEC LA REPRODUCTION DES POISSONS ZEBRES

Alkema, Kyle (*University of Guelph*)

Van Der Kraak, Glen (*University of Guelph*)

Final sewage effluent contains natural and synthetic hormones and pharmaceuticals which have been shown to negatively affect reproduction in fish. Ammonia is also a common constituent of sewage effluent and contributes to poor water quality since at high concentrations it can be acutely toxic to fish. However, surprisingly little is known of the effects of ammonia on reproduction in fish or its possible interactive effects with endocrine disrupting chemicals present in sewage effluents. The present study examined the effects of graded concentrations of ammonia on reproduction in sexually mature zebrafish. These studies have shown that zebrafish exposed to waterborne ammonia for 10 days lead to a dose related reduction in the numbers of eggs that were spawned. The threshold for effects was less than 5 mg total ammonia-N /L which was well below the concentrations that were acutely toxic to zebrafish. Additional studies suggest that the steroid hormone 17 α , 20 β -dihydroxy-pregene-3-one is less effective at inducing the in vitro maturation of full grown follicles harvested from the ovaries of zebrafish exposed to similar concentrations of ammonia. Collectively these studies suggest that ammonia may contribute to the reproductive toxicity of sewage effluents.

CALCIUM METABOLISM IN A FRESHWATER CARTILAGINOUS FISH, THE LAKE STURGEON *ACIPENSER FULVESCENS*

MÉTABOLISME DU CALCIUM CHEZ UN POISSON CARTILAGINEUX D'EAU DOUCE, L'ESTURGEON DE LAC ACIPENSER FULVESCENS

Allen, Peter J. (*Mississippi State*)

Dasiewicz, Patricia (*University of Manitoba*)

Grandmaison, Vanessa (*University of Manitoba*)

Peake, Stephan J. (*University of New Brunswick*)

Weihsrauch, Dirk (*University of Manitoba*)

Anderson, W. Gary (*University of Manitoba*)

Aquatic vertebrates have a rich supply of calcium in the environment, and as such the importance of the gills in the regulation of this ion has been well documented in teleost fishes. Teleost fishes have additional internal stores of calcium in their bones and scales. As largely cartilaginous fishes, sturgeons comparatively lack such internal stores and exhibit some of the lowest values of circulating calcium reported for vertebrates. Here we examined the effects of changing environmental calcium on calcium metabolism in the lake sturgeon, *Acipenser fulvescens*. Juvenile lake sturgeon were adapted to one of three environmentally-relevant calcium

concentrations, 0.1mM (hypocalcaemic), 0.4mM (normocalcaemic) and 3.3mM (hypercalcaemic). Whole body net flux was found to be directed inwardly for all treatments, however, the it was highest in hypocalcaemic fish. Similarly, influx and efflux were assessed in the anterior intestine, where only the hypocalcaemic fish demonstrated a net intestinal influx of calcium which was abolished following pretreatment with the plasma membrane calcium ATPase inhibitor, trifluoroperazine. Finally, accumulation of radiolabeled calcium was examined in a variety of hard and soft tissues. A significantly greater accumulation was observed in hard tissue as compared to soft, however, values within tissues did not differ between treatments.

COLD-INDUCED CHANGES IN STRESS HORMONE LEVELS AND STEROIDOGENIC GENE EXPRESSION IN A FISH (TAUTOGOLABRUS ADSPERSUS) CAPABLE OF METABOLIC DEPRESSION

VARIATION DU NIVEAU DES HORMONES DE STRESS ET DE L'EXPRESSION DE GÈNES STÉROÏDOGÉNIQUES CHEZ UN POISSON (TAUTOGOLABRUS ADSPERSUS) CAPABLE DE DÉPRESSION MÉTABOLIQUE EN RÉPONSE AU FROID.

Alzaid, Abdullah (Ocean Sciences Centre, Memorial University of Newfoundland)

Hori, Tiago (Ocean Sciences Centre, Memorial University of Newfoundland)

Hall, Jennifer (Ocean Sciences Centre, Memorial University of Newfoundland)

Rise, Matthew (Ocean Sciences Centre, Memorial University of Newfoundland)

Gamperl, A. Kurt (Ocean Sciences Centre, Memorial University of Newfoundland)

To investigate whether the stress response is diminished during cold-induced metabolic depression, plasma cortisol was measured in 10 and 0°C acclimated cunner before (resting) and after a 1 minute net stress. In addition, the mRNA expression of genes coding for the rate limiting proteins in cortisol synthesis [steroidogenic acute regulatory (StAR) protein and P450 side chain cleavage enzyme (CYP11A1)] and the glucocorticoid receptor (GR) were measured. The 0°C fish displayed a 'typical' stress response, with cortisol levels peaking at 2 hours post-stress and returning to resting levels by 24 hours. The 10°C fish, however, had elevated levels of resting cortisol (65 ng ml⁻¹) and showed a post-stress decrease in cortisol from 2-4 h post-stress. In agreement with their higher resting cortisol levels, the mRNA expression of StAR and CYP11A1 in the head kidney of 10°C fish was 2- 3 fold higher as compared with the 0°C group. Whereas, mRNA levels for GR were significantly decreased (by 1.5 – 1.7 fold) in 10°C as compared with 0°C fish. This study suggests that metabolically depressed fish are capable of mounting a stress response, but that the cunner may be stressed by constant exposure to temperatures of 10°C or above.

ONTOGENETIC EFFECTS ON THERMAL TOLERANCE AND METABOLIC DEPRESSION IN FISHES

LES EFFETS ONTOGÉNIQUES SUR LA TOLÉRANCE THERMIQUE ET LA DÉPRESSION MÉTABOLIQUE DES POISSONS.

Alzaid, Abdullah (Ocean Sciences Centre, Memorial University of Newfoundland)

Kelly, Nick (Ocean Sciences Centre, Memorial University of Newfoundland)

Nash, Gord (Ocean Sciences Centre, Memorial University of Newfoundland)

Gamperl, A. Kurt (Ocean Sciences Centre, Memorial University of Newfoundland)

We have a very limited understanding of how ontogeny affects thermal tolerance and metabolic depression in fishes. Thus, we measured the metabolism of three size classes [young of the year (YOY, 0.2 - 0.5 g), small (3 - 5 g) and adult (> 100 g)] of 9 - 10°C acclimated cunner (a wrasse capable of metabolic depression) during a critical thermal maximum (CTM) test, and when exposed to a temperature decrease from 9-1°C over several days. Further, we exposed Atlantic cod of similar sizes to the same CTM protocol. The temperature at which metabolic depression was initiated in cunner decreased with body size (age), from 7°C for adults to 5°C for

YOY. Further, the extent of metabolic depression was size- (age-) specific: ~80% (Q10 = ~15), ~65% (Q10 = ~8) and ~55% (Q10 = ~5) for YOY, small and adult fish, respectively. The thermal tolerance of cunner was much greater than for cod at all size classes. However, the effect of size (age) on CTM was opposite for the two species. The CTM of cunner decreased from 28.4 to 26.3°C with size (age), whereas it increased from 19.6 to 22.4°C for cod.

OPPORTUNISTIC MATING WITH JUVENILES CIRCUMVENTS FEMALE CHOICE IN CANNIBALISTIC REDBACK SPIDERS

THERMOGÉNÈSE SAISONNIÈRE CHEZ UN ECTOTHERME – SE RÉCHAUFFER POUR SE REPRODUIRE

Andrade, Maydianne C.B. (*Integrative Behaviour & Neuroscience Group, University of Toronto Scarborough*)

Biaggio, M. Daniela (*Integrative Behaviour & Neuroscience Group, University of Toronto Scarborough*)

Under sexual conflict, fitness interests of males and females are opposed. Male and female tactics are typically matched, but outcomes may more closely approach the fitness optimum for one sex at different stages of sexual interactions. In Australian redback spiders (*Latrodectus hasselti*), large cannibalistic females have strong control over male reproductive success. Here we show that males overcome female control when they mate juvenile females by breaking through the juvenile's exoskeleton. Late in their final instar, and in the absence of external genitalia, juvenile females develop adult sperm storage organs. In laboratory trials, males mounted these late-stage juveniles, used their fangs to tear the juvenile's exoskeleton and copulated in 85% of cases. Females mated as juveniles moult normally and produce viable eggs as adults. Males that mate juveniles do not court, nor adopt the typical self-sacrificial mating posture of this species. Nevertheless, juvenile females show no signs of discriminatory behaviours typical for adult females. In nature, males cohabit with juveniles frequently, especially at high population densities, and up to 12% of field-collected females had been mated in this way. We propose this may be a widespread, but previously unrecognized, density-dependent male mating tactic that circumvents female choice.

THE COADAPTATION OF THERMOREGULATORY BEHAVIOR AND THERMAL PHYSIOLOGY IN HETEROGENEOUS ENVIRONMENTS

LA COADAPTATION DU COMPORTEMENT THERMORÉGULATOIRE ET DE LA PHYSIOLOGIE THERMALE DANS DES ENVIRONNEMENTS HÉTÉROGÈNES

Angilletta, Michael (*Indiana State University*)

Because organisms thrive within thermal limits, variations in temperature over space and time impose selective pressures on thermoregulation or thermotolerance. Simple models of thermal adaptation predict a close match between the mean (or modal) body temperature and the temperature that maximizes organismal performance. Yet empirical patterns often differ from those predicted by the current theory. To advance our understanding of thermal adaptation, my collaborators and I are developing a more general theory that comprises three major hypotheses. First, thermodynamics constrain physiological performance such that warm-adapted organisms outperform cold-adapted ones. This thermodynamic effect places a premium on thermoregulation and implies that the cost of thermoregulatory behavior indirectly drives the evolution of thermosensitivity. Second, the selective advantage of thermoregulation greatly depends on the spatial structure of the environment and the interactions among species. Ecological factors that prevent accurate thermoregulation cause selection for thermal generalists. Finally, thermodynamic constraints cause selection for individuals that perform best at a temperature that exceeds the mean body temperature. I shall describe comparative and experimental tests of this theory in a variety of model systems.

ULTRASTRUCTURAL DIFFERENCES AND HISTOCHEMICAL CHARACTERISTICS IN SWIMMING MUSCLES BETWEEN WILD AND REARED ATLANTIC SALMON

DIFFÉRENCES ULTRASTRUCTURALES ET CARACTÉRISTIQUES HISTOCHIMIQUES DES MUSCLES DE NATATION CHEZ LES SAUMONS ATLANTIQUES SAUVAGES ET CEUX D'ÉLEVAGE

Anttila, Katja (Department of Zoology, University of British Columbia, Canada)

Mänttari Satu (Department of Biology, University of Oulu, Finland)

The swimming capacity of wild and reared fish differs. Whether the difference is associated with variations in swimming musculature is unknown. In order to compare the musculature of wild and reared salmon, several morphological and enzymatic parameters were measured. The density and size of the mitochondria was higher in the muscles of wild fish than in reared ones. Similar variability was noted in the density of triads. Conversely, the size and density of lipid droplets was lower in the muscles of wild versus reared salmon. The densities of two muscle contraction components, dihydropyridine and ryanodine receptor, were higher in wild salmon. Similar difference was observed in the activities of aerobic enzymes. Phosphorylase activity was, on the other hand, lower in the muscles of wild fish. To conclude, there are significant differences in morphology, Ca^{2+} regulating capacity, and enzyme activities in swimming muscles between wild and reared salmon. These results provide evidence that the prerequisites for efficient contraction of the swimming muscles are better met in wild as compared to reared salmon. Importantly, the results also suggest that the observed variation is a major contributing factor to the difference in the swimming capacity between wild and reared salmon.

EFFECTS OF SEAWATER TRANSFER AND SEA LICE ON AEROBIC SCOPE IN PINK SALMON (ONCORHYNCHUS GORBUSCHA)

EFFETS DU TRANSFERT D'EAU DE MER ET DES INFESTATIONS DE POUX DE MER SUR LE TAUX METABOLIQUE AEROBIQUE DU SAUMON ROSE (ONCORHYNCHUS GORBUSCHA)

Azzam, Andre (Department of Zoology, University of British Columbia)

Brauner, Colin (Department of Zoology, University of British Columbia)

Farrell, Tony (Department of Zoology, University of British Columbia)

As pink salmon, *Oncorhynchus gorbuscha*, migrate to the ocean, they must adjust to hyperosmotic conditions while also first encountering sea lice in the environment. Seawater transfer has been shown to result in decreased swimming performance due to ionoregulatory imbalance, and sea lice infestation has also been associated with higher plasma ion levels when compared to uninfected fish. The metabolic cost of these ionoregulatory challenges may be reflected in reductions in aerobic scope. We intend to characterize the aerobic scope of pink salmon from the time of yolk sac absorption through one year of age. Using this baseline, it will be possible to determine any effects of seawater transfer and of louse infestation on aerobic scope in *O. gorbuscha*. Oxygen consumption will be measured using closed-chamber respirometry to obtain estimates of routine and active metabolic rates, with active oxygen consumption being determined by measures of excess post-exercise oxygen consumption (EPOC). Levels of plasma ions will be recorded in order to assess ionic disturbance associated with seawater transfer and louse infestation. Any reductions in aerobic scope may limit growth and locomotion, and thereby impact survival and fitness in these fish. [NSERC].

THE EFFECT OF SEVERE HYPERCAPNIA ON *IN SITU* CARDIAC PERFORMANCE OF WHITE STURGEON, ACIPENSER TRANSMONTANUS.

L'EFFET DE L'HYPERCAPNIE SÉVÈRE SUR LA PERFORMANCE CARDIAQUE IN SITU DE L'ESTURGEON BLANC, ACIPENSER TRANSMONTANUS

Baker, Daniel (University of British Columbia)

Hanson, Linda (University of British Columbia)

Farrell, Anthony (*University of British Columbia*)
Brauner, Colin (*University of British Columbia*)

White sturgeon are one of the most CO₂ tolerant fishes known to date, surviving aquatic hypercarbia of 6 kPa CO₂ (45 mm Hg PCO₂) for days, however, the mechanisms associated with CO₂ tolerance are largely unknown. Using an in situ heart preparation, we examined the effect of elevated CO₂ on cardiac performance. A CO₂ challenge of 3 kPa (21 mm Hg) induced no loss of maximal cardiac flow or power, despite a reduction in heart perfusate pH from 7.8 to 7.1. This CO₂ tension is threefold higher than that at which cardiac performance is compromised (and morbidity occurs) in other fishes, such as rainbow trout. A 6 kPa CO₂ challenge (45 mm Hg) decreased maximal flow and power by ~25%, although cardiac performance recovered upon return to normocapnic conditions. Maximal adrenergic stimulation of the heart during this severe challenge reduced the magnitude of the loss in cardiac output and power such that both were no longer significantly different from values obtained during normocapnia. We conclude that white sturgeon have a remarkable capacity to maintain maximal cardiac performance during hypercapnia and the resultant extra- and intracellular acidosis, and this characteristic likely contributes to the CO₂ tolerance of white sturgeon. (NSERC)

MULTIPARAMETRIC FUNCTIONAL CHARACTERIZATION OF PHAGOCYTIC ANTIMICROBIAL RESPONSES IN TELEOST FISH MACROPHAGES

***CARACTÉRISATION MULTIPARAMÉTRIQUE FONCTIONNELLE DE LA RÉPONSE
PHAGOCYTIQUE ANTIMICROBIENNE CHEZ LES MACROPHAGES DES POISSONS TÉLÉOSTÉENS***
Barreda, Daniel R (*University of Alberta*)

Activation of phagocytic responses provides a potent innate strategy for the destruction of invading pathogens. Understanding of these processes requires the examination of early receptor activation events, internalization, induction of degradative cascades, and pathogen killing mechanisms. Unfortunately, microscopy based methods are tedious and often lack the statistical robustness required for analysis of these processes in large and/or mixed cell populations. On the other hand, flow cytometry provides high throughput potential and quantitative multispectral probe analysis but suffer from a lack of spatial resolution. In comparative models of animal immunity, the availability of reagents places additional limitations on what cell populations and cellular events can be examined. Herein, we describe a novel approach to the study phagocytic responses in comparative animal systems. A two-laser Imagestream morphometry platform was used to dissect phagocytic antimicrobial responses in a teleost fish primary macrophage model, even in the absence of available antibodies recognizing cellular surface markers. Importantly, our analysis provides multiparametric resolution at a single cell level, allows for spatial localization of these molecular events, and grants the statistical robustness required to examine these events in large and mixed cell populations. Key words: innate immunity, phagocytosis, cell growth, apoptosis
This study was supported by the Natural Sciences and Engineering Research Council of Canada, and the Alberta Agricultural Research Institute.

INTERACTION BETWEEN THE PHYSIOLOGICALLY RELEVANT ION K⁺ AND THE TOXIC METAL Tl⁺ IN CHIRONOMUS RIPARIUS

***L'INTERACTION ENTRE LES ION K⁺ PHYSIOLOGIQUEMENT PERTINENT ET LE METAL
TOXIQUE Tl⁺ CHEZ CHIRONOMUS RIPARIUS***
Belowitz, Ryan Frederick (*McMaster University*)

Tl⁺ is mobilized through industrial processes and can enter aquatic environments where it acts as a toxic metal at low concentrations. However, the aquatic larvae of the midge *Chironomus riparius* are exceptionally tolerant towards many waterborne toxic metals, with LC₅₀s several orders of magnitude above CCME and USEPA guidelines. Few studies have looked at the cellular mechanism of this tolerance. Tl⁺ and K⁺ ions share the same

charge and a similar ionic radius, resulting in competition between these ions for K⁺ transporters. Using a recently developed Tl⁺-selective microelectrode and the Scanning Ion Selective Electrode Technique (SIET), precise measurements of K⁺ and Tl⁺ fluxes along the gut tract of *Chironomus riparius* were possible. The results of this study will add to the growing body of research into the mechanisms of toxic metal tolerance in *Chironomus riparius*.

COMPARATIVE ANALYSIS OF THUNNIFORM CAUDAL TAIL MORPHOLOGIES AND MOTION RANGES

ANALYSE COMPARÉE DE LA MORPHOLOGIE DE NAGEOIRES CAUDALES THUNNIFORMES ET DE LA PORTÉE DE MOUVEMENT

Ben-Zvi, Micha (*Department of Zoology, University of British Columbia*)

Pinto, Sheldon (*Department of Zoology, University of British Columbia*)

Goldbogen, Jeremy (*Scripps Institution of Oceanography, University of California*)

Shadwick, Robert (*Department of Zoology, University of British Columbia*)

Thunniform or lift based aquatic locomotion via tail oscillations is a high efficiency mode of transportation used by various large open water swimmers. Independently derived in at least four distinct taxa (Scombrids, Ichthyosaurs, Cetaceans and Lamnids), it is a case study of both convergent evolution and cost effective locomotion. As such it has garnered great interest in not only biological fields of study (such as physiology, evolution and ecology) but increasingly from 'less traditional' fields (i.e. biomimetics, engineering, design, etc). Despite the great interest in this topic, previous analyses of the subject matter typically minimize or simply ignore morphological and kinematic variation across the applicable taxa. This often results in studies which are based on limited physiological scopes being applied generally to the to phenomena as a whole. In an effort to address this, the current research combines both existing and newly collected data in an attempt to quantify some of this variation. Results will be presented in both a biological and engineering context.

LEPTIN INHIBITS ADRENOCORTICOTROPIC HORMONE AND CORTISOL SECRETION IN COMMON CARP (*CYPRINUS CARPIO*)

LA LEPTINE INHIBE LA SÉCRÉTION DE CORTICOTROPHINE ET DE CORTISOL CHEZ LA CARPE (*CYPRINUS CARPIO*)

Bernier, Nicholas J. (*Department of Integrative Biology, University of Guelph*)

Gorissen, Marnix (*Institute for Water and Wetland Research, Radboud University*)

Manuel, Remy (*Institute for Water and Wetland Research, Radboud University*)

Flik, Gert (*Institute for Water and Wetland Research, Radboud University*)

In addition to having a major role in the negative control of feeding, leptin is recognized as a pleiotropic cytokine involved in the control of the hypothalamic-pituitary-adrenal stress axis of mammals. To determine whether leptin may be involved in regulating the secretion of adrenocorticotrophic hormone (ACTH) secretion from the pituitary pars distalis and of cortisol from the head kidney in fish, we performed a series of in vitro superfusion experiments using common carp. At the pituitary level, leptin inhibited both basal and corticotropin-releasing factor (CRF)-stimulated ACTH secretion. Leptin also inhibited basal cortisol secretion from the head kidney but had no effect on ACTH-stimulated cortisol secretion. Together, the in vitro evidence indicates that leptin can inhibit the basal activity of the hypothalamic-pituitary-interrenal (HPI) axis and dampen the HPI axis response to stressors. Exposure of common carp to chronic hypoxia resulted in a marked and sustained increase in liver leptin gene expression in vivo. Therefore, we suggest that leptin may be involved in dampening the activity of the HPI axis in common carp during chronic exposure to environmental hypoxia (Support by NSERC to NJB and by the Institute for Water and Wetland Research of Radboud University to GF)

INFLUENCE OF ENVIRONMENTAL FACTORS ON ETHYNYL ESTRADIOL UPTAKE IN THE MUMMICHOG, FUNDULUS HETEROCLITUS

L'INFLUENCE DES FACTEURS ENVIRONNEMENTAUX SUR L'ABSORPTION DE L'ÉTHYNYL ESTRADIOL CHEZ LE POISSON KILLI, FUNDULUS HETEROCLITUS

Blewett, Tamzin (McMaster University, Biology Department)

Wood, Chris (McMaster University, Biology Department)

Pharmaceuticals are not readily removed from the environment through waste water treatment facilities. These toxicants return to the surrounding environment, downstream in lakes, rivers and estuaries. Among these pharmaceuticals is the synthetic estrogen 17 α -Ethinyl Estradiol (EE2), a common hormone found in birth control and hormone replacement therapy. EE2 is very lipophilic, and entry across the gills might be similar to oxygen transfer across the gills. Adult male mummichogs (*Fundulus heteroclitus*) were exposed to radio-labeled [3H]EE2 at a nominal concentration of 100ng/L for 2 hours at temperatures of 4, 10, 18 and 26 °C. Oxygen consumption (MO₂) was recorded during EE2 exposure while the mummichogs were in individually sealed respirometers. MO₂ decreased with decreasing PO₂, while higher temperatures produced higher MO₂ values. The distribution of EE2 was found to be the highest in the carcass, gut and liver, with highest absolute uptake rates in the 26 and 18 °C treatments. A positive correlation was found between EE2 uptake and MO₂ ($R^2 = 0.622$). Investigating temperature, PO₂ and other environmental parameters (e.g. salinity) is important to understand if the potential uptake of EE2 is changed with differing environments (NSERC Strategic grant, D. McClatchey, P.I.).

DEVELOPMENT OF EEL (*ANGUILLA ROSTRATA*) CELL LINES AND THEIR USE IN AN ECOTOXICOLOGICAL PROBLEM: THE DRAMATIC DECLINE IN EEL POPULATIONS

DEVELOPPEMENT DE LIGNEES CELLULAIRES D'ANGUILLE (*ANGUILLA ROSTRATA*) ET LEUR UTILISATION POUR RESOUDRE UN PROBLEME ECOTOXICOLOGIQUE: LA BAISSSE DRAMATIQUE DES POPULATIONS D'ANGUILLES

Bloch, Sophia R (University of Waterloo)

Bromand, Sadat (University of Waterloo)

Walsh, Sarah K (Wilfrid Laurier University)

Wong, YT Janice (University of Waterloo)

Lee, Lucy EJ (Wilfrid Laurier University)

Hodson, Peter V (Queen's University)

Bols, Niels C (University of Waterloo)

The American eel, *Anguilla rostrata*, is undergoing dramatic population declines. A general hypothesis is that more eel embryos/larvae are dying during their development and migration from the Sargasso Sea to freshwater. Mortality could be due to environmental contaminants in female eels that are transferred to eggs and subsequently be toxic in early life cycle stages. The environmental contaminants responsible could range from dioxin-like compounds, which exert their action through the aryl hydrocarbon receptor (AhR), to selenium (Se), which is a trace element that can biomagnify and be toxic. Fish cell lines can be used in this ecotoxicological problem to explore toxicity mechanisms, to rank compounds for toxicity, and to determine toxicant loads in adult eel extracts. Cell lines were sought from many tissues of adult eels, including brain, gills and muscle. Several of these cell lines have been subcultivated over 50 times, cryopreserved successively at different passage levels, and at least one of them retained a diploid chromosome number. The lines are being examined for inducible CYP1A in order to study AhR-active compounds and for their response to Se. In preliminary results, brain and gill cells were killed by sodium selenite at concentrations that were toxic to mammalian cells.

LIFE AFTER ICE: TRANSMEMBRANE ION DISTRIBUTION DURING RECOVERY FROM FREEZING IN THE WOOLLY BEAR CATERPILLAR (*PYRRHARCTIA ISABELLA*)

LA VIE APRÈS LA GLACE : DISTRIBUTION TRANSMEMBRANAIRE D'ION DURANT LA RÉCUPÉRATION DE PYRRHARCTIA ISABELLA

Boardman, Leigh (*University of Stellenbosch*)

Terblanche, John (*University of Stellenbosch*)

Sinclair, Brent (*University of Western Ontario*)

The Isabella tiger moth (*Pyrrhartica isabella*) overwinters as a freeze tolerant caterpillar. Freeze tolerant insects are able to withstand ice formation in their extracellular body fluid during a freezing event. With the help of cryoprotectants, the harmful effects of freezing can be minimized and controlled. During freezing, water moves out of the tissues and into the haemolymph to join the growing body of ice, while solutes in the haemolymph are concentrated. This changes both the volume and concentrations of the inter- and extracellular fluids, and alters the equilibration of transmembrane ion concentrations. We measured the concentrations of ions in the haemolymph and tissue of woolly bear caterpillars at several points during recovery from freezing to determine the process of re-establishment of ion homeostasis. This work sheds light on the role of ion homeostasis in insect freezing survival.

BEHAVIOURAL, NEURAL AND CILIARY RESPONSES TO ENVIRONMENTAL STRESSORS IN EMBRYOS OF THE POND SNAIL *HELISOMA TRIVOLVIS*

RÉPONSES COMPORTEMENTALES, NEURALES ET CILIAIRES À DES STRESSEURS ENVIRONNEMENTAUX CHEZ DES EMBRYONS DE L'ESCARGOT HELISOMA TRIVOLVIS

Boychuk, Evelyn C (*University of Calgary*)

Goldberg, Jeffrey I (*University of Calgary*)

Encapsulation of aquatic organisms imposes environmental barriers that limit the inward flow of oxygen and outward flow of metabolites. *Helisoma trivolvis* embryos display a cilia-driven rotation behaviour that has been proposed to augment the inward diffusion of oxygen by mixing capsular fluid. While hypoxia and temperature both accelerate rotation behaviour, the effect of metabolic wastes on rotation behaviour is unknown. Furthermore, it is not known whether the sensorimotor neurons that cause rotational surges in response to hypoxia also mediate behavioural responses to temperature and metabolites. In this study, we tested the effects of temperature and de-ionized ammonia on rotation behaviour, and whether they act through a neuronal pathway. Time-lapse video microscopy was used to measure rotation rate over four-second intervals, revealing basal and surge components of the rotational behaviour. Prolonged exposure to ammonia caused a transient reduction of rotation rate in the first hour. The rotation rate gradually declined after 24 hours of treatment, corresponding to an increase in mortality over the same time course. Both temperature and ammonia affected rotation rate by direct actions on neurons and ciliary cells. These results suggest that hypoxia, rather than ammonia or temperature, is the primary driver of the rotational response pathway.

DIETARY ANALYSIS OF STRANDED HUMBOLDT SQUID (CEPHALOPODA: *DOSIDICUS GIGAS*) FROM VANCOUVER ISLAND, A RECENT INVADER TO THE EASTERN NORTH PACIFIC OCEAN

ANALYSE ALIMENTAIRE DE CALMARS DE HUMBOLT (CEPHALOPODA: DOSIDICUS GIGAS) PERDUS PRÈS DE L'ÎLE DE VANCOUVER : UN NOUVEL ENVAHISSEUR DANS L'OCÉAN PACIFIQUE DU NORD-EST.

Braid, Heather Elizabeth (*Department of Integrative Biology, University of Guelph*)

Osborne, Josie (*Raincoast Education Society*)

Deeds, Jon (*US FDA Center for Food Safety and Applied Nutrition*)

Wilson, John James (*Department of Integrative Biology, University of Guelph*)
Hanner, Robert (*Department of Integrative Biology, University of Guelph*)

Humboldt squids (*Dosidicus gigas*) are voracious predators with a rapidly expanding range due to climate change. During August and September 2009, an El Niño year, there were two mass strandings of *D. gigas* on the coast of Vancouver Island, BC. We used DNA barcoding to identify prey items from stomach contents of stranded squids to document any dietary shift that may have occurred in this new range. Stomach contents and tissue from other organs were tested for saxitoxin. DNA barcoding revealed that the squids were consuming Pacific sardines, Pacific herring, Dungeness crab, and whitebait smelt, as well as hinting at cannibalism. Nurdles (plastic pellets), fishing line, spruce needles, bull kelp, eel grass, rocks, and a feather were also found in squid stomachs. Saxitoxin was detected in the stomach contents and muscle tissue. If a population of *D. gigas* establishes off BC, this may have an impact on Pacific herring fisheries, which are recently recovering after a 45 year collapse last century. Saxitoxin has been previously implicated in whale strandings, suggesting a potential role in the squid strandings seen on Vancouver Island. The *D. gigas* fishery is the largest cephalopod fishery by mass presenting a route of saxitoxin to human consumers.

THE EFFECT OF DAILY TORPOR ON MITOCHONDRIAL REACTIVE OXYGEN SPECIES (ROS) PRODUCTION

EFFET DE L'EXPOSITION CHRONIQUE AU CADMIUM SUR LES PERFORMANCES DE NATATION CHEZ LA TRUITE BRUNE ET LA TRUITE ARC-EN-CIEL

Brown, Jason CL (*University of Western Ontario*)
Staples, James F (*University of Western Ontario*)

Liver mitochondrial oxidative phosphorylation is modified during daily torpor, but the consequences for reactive oxygen species (ROS) production are unknown. Therefore, we examined the effects of metabolic state (torpid vs. non-torpid) and assay temperature (15, 26, and 37°C) on liver mitochondrial H₂O₂ (one form of ROS) release rate in house mice and dwarf Siberian hamsters. When succinate (with rotenone, preventing complex I ROS production) fueled respiration, basal H₂O₂ release rate from electron transport chain complex III was higher in torpid animals at all temperatures, but maximal H₂O₂ release rate (measured with antimycin A) was only higher in hamsters, at 37°C and 26°C. Therefore, complex III has a higher capacity for ROS production and/or is more reduced during torpor. When glutamate+malate fueled respiration (allowing ROS production at complexes I and III), basal H₂O₂ release rate did not differ between torpid and non-torpid animals, but maximal H₂O₂ release rate (measured with rotenone) was 25% lower. Therefore, complex I is also more reduced during torpor and/or increased H₂O₂ release by complex III masks reduced H₂O₂ release at complex I. As temperature decreased, basal H₂O₂ release rate decreased at a faster rate than oxygen consumption, suggesting increased efficiency of ROS production at lower temperatures.

ENVIRONMENTAL INFLUENCE ON THE CONSEQUENCES OF FEEDING AND DIGESTION IN TELEOST FISH.

INFLUENCE ENVIRONNEMENTALE SUR LES CONSÉQUENCES DE L'ALIMENTATION ET DE LA DIGESTION CHEZ LES POISSONS TÉLÉOSTÉENS

Bucking Carol (*University of British Columbia*)

To date, research into the gastrointestinal tract's role in piscine ion, water and acid-base homeostasis has been conducted under a narrow scope of study, as our knowledge has been gained almost exclusively through studies conducted in fasting animals. The impacts of digestion on these processes have been mostly overlooked but were generally assumed to be significant. The objective of my Ph.D. was to begin to address this assumption. My research concentrated on the physiological responses to the ingestion of a meal by rainbow trout (*Oncorhynchus*

mykiss); chosen as a model due to their capabilities of withstanding the diametrically opposing challenges of life in sea- and freshwater. Over a detailed time course, the net absorption and/or secretion of ions, water, and acid-base equivalents, was measured in each section of the gastrointestinal tract of the rainbow trout, while the animals were acclimated to either freshwater or seawater. Concurrently, evidence for changes in osmotic, ionic and acid-base regulation in blood chemistry were investigated. Overall, feeding was revealed to have far-reaching and plastic systemic physiological effects, with the environment playing a key role.

THE PLASTICITY OF NUTRIENT TRANSPORTER GENE EXPRESSION IN THE INTESTINE OF FISH

LA PLASTICITÉ DE L'EXPRESSION GÉNIQUE DE TRANSPORTEURS DE NUTRIMENTS DANS L'INTESTIN DES POISSONS

Bucking, Carol (*University of British Columbia*)

Schulte, Patricia (*University of British Columbia*)

In mammals, the major route of dietary nitrogen uptake is via the proton-coupled di- and tripeptide intestinal transporter (PepT1). The presence of this transporter has been recently confirmed in several fish species, however experimental studies examining the transporter's gene expression and function are still relatively rare. In the present study, sequencing of the PepT transporter found in intestinal tissue samples obtained from *Fundulus heteroclitus*, acclimated to either fresh- or seawater, revealed two potential isoforms. Furthermore, the expression of the isoforms was environmentally dependent, with one expressed primarily in freshwater and the other primarily in seawater. Both fresh- and seawater acclimated fish were then subjected to systematic feeding, followed by a period of fasting and finally subsequent re-feeding. Intestinal tissue samples were taken throughout all three conditions, and the mRNA expression of both transporter isoforms was quantified. The mRNA expression of both the freshwater and seawater specific PepT transporter isoforms initially increased following the cessation of feeding, before decreasing with prolonged fasting and finally recovering to pre-fasting levels with the resumption of feeding. In conclusion, the transporter of di- and tripeptides found in the intestine of *Fundulus heteroclitus* displays environmentally influenced isoform expression which are equally altered by fasting and feeding.

NOVEL MECHANISMS OF SECRETION FORM CHITON EGG HULLS

MÉCANISMES NOUVEAUX DE SÉCRÉTION FABRIQUENT LA COQUILLE D'OEUF DES CHITONS

Buckland-Nicks, John (*St Francis Xavier University*)

Reunov, Arkadiy (*AV Zhirmunsky Institute of Marine Biology, Vladivostok, Russia*)

Egg hull formation in chitons (Mollusca) does not follow the typical model of secretion release via the endoplasmic reticulum and Golgi body, as was previously thought. Instead, oocyte and follicle cells contribute in unique ways to the formation of these complex egg envelopes via release of microapocrine secretions. *Callochiton dentatus* eggs have a jelly-like hull that is formed largely by secretions from the oocyte and is similar in appearance to some species of the basal order Lepidopleurida, such as *Deshayesiella curvata*. Follicle cells in these species play a lesser role in secretion compared to species of Chitonida, such as *Rhyssoplax tulipa*, in which the follicle cells are very active. The plesiomorphic jelly-like hull of chitons appears to have evolved as an oocyte secretion, whereas families in the more recent order Chitonida form their hulls with considerable secretory input from the follicle cells. In all species studied, microapocrine secretion mechanisms are involved which are uncommon, involving a different secretion pathway than is typical and until recently were considered by many to be fictitious.

TISSUE DISTRIBUTION OF NA+K+-ATPASE ALPHA AND BETA SUBUNIT ISOFORMS IN

FRESHWATER AND SEAWATER ACCLIMATED ATLANTIC SALMON

DISTRIBUTION TISSULAIRE DES ISOFORMES DES SOUS-UNITES ALPHA ET BETA DE LA Na^+K^+ -ATPASE CHEZ LES SAUMONS ATLANTIQUES ACCLIMATES A L'EAU DOUCE ET A L'EAU DE MER

Bystriansky, J.S. (*University of British Columbia*)

Allen, D. (*University of British Columbia*)

Schulte, P.M. (*University of British Columbia*)

Salmonid fishes express at least five different isoforms of the Na^+K^+ -ATPase alpha-subunit. The up regulation of gill Na^+K^+ -ATPase activity is known to be important for the successful acclimation of salmonids to seawater and is associated with a switch in the dominant gill isoform from alpha 1-a to alpha 1-b. During acclimation back to freshwater, the dominant gill Na^+K^+ -ATPase isoform reverts back to alpha 1-a. Despite the clear importance of the gill in osmoregulation of fish, little research has examined Na^+K^+ -ATPase isoform expression in other osmoregulatory tissues. This study monitored expression of Na^+K^+ -ATPase isoforms in different regions of the alimentary canal and kidney following acclimation of Atlantic salmon to seawater. In addition, we determined Na^+K^+ -ATPase alpha and beta subunit isoform expression patterns in several other tissues including liver, brain, spleen, testes, heart and red and white muscle. Determining patterns of isoform expression and activity in a variety of tissues will aid in our understanding of what specific cellular roles different Na^+K^+ -ATPase isoforms may play in different tissues and if these roles change under different environmental conditions.

RATTLESNAKES KEEP THEIR COOL: RESPIRATORY COOLING ENHANCES THERMAL DETECTION BY RATTLESNAKES

LES SERPENTS À SONNETTE RESTENT DE GLACE : LE REFROIDISSEMENT RESPIRATOIRE AUGMENTE LA DÉTECTION THERMALE CHEZ LES SERPENTS À SONNETTE

Cadena, Viviana (*Brock University*)

Tattersall, Glenn J. (*Brock University*)

Bovo, Rafael P. (*Universidade Estadual Paulista*)

Andrade, Denis O. (*Universidade Estadual Paulista*)

Rattlesnakes use their facial pit organs to sense thermal fluctuations associated with their prey and their environment. A temperature decrease in the heat-sensing membrane of the pit organ has the potential to enhance heat flux between the prey and the thermal sensors, and therefore, to improve thermal detection. We examined the potential for respiratory cooling to improve endothermic prey detection, capture and consumption in the South American rattlesnake. By exposing snakes to different humidities we were able to manipulate the degree of respiratory cooling around the pit organs. After having struck, snakes in the low humidity (i.e. with cooler snouts) were able to relocate and initiate prey consumption faster than snakes in the high humidity treatment. We also demonstrated that rattlesnakes are able to modify the degree of respiratory cooling by altering their breathing pattern in response to biologically relevant stimuli, such as the presence of a mouse odour. Our findings reveal that by increasing the temperature gradient between the thermo-sensing pit organs and the prey, snakes are able to increase their ability to detect endothermic prey, a process which has greater potential for evaporative cooling in low humidity environments, and possible consequences for their habitat selection in the wild.

GHRELIN-INDUCED GROWTH HORMONE AND GONADOTROPIN RELEASE FROM THE GOLDFISH PITUITARY: DIFFERENTIAL INVOLVEMENT OF PKC AND PKA

LIBERATION DE L'HORMONE DE CROISSANCE ET DES GONADOTROPHINES PAR LA GHRELIN DANS L'HYPOPHYSE DES POISSONS ROUGES: PARTICIPATION DIFFERENTIELLE DU PKC ET DU PKA

Grey, Caleb L. (*University of Alberta*)

Chang, John P. (*University of Alberta*)

Ghrelin (GRLN), the endogenous ligand for the growth hormone secretagogue receptor (GHSR), is a peptide hormone involved in many physiological processes, including growth hormone (GH) release, maturational gonadotropin (LH) release, and orexigenic behaviour in vertebrates. GRLN and GHSR are present in goldfish tissues, including the brain and pituitary, and GRLN-induced GH and LH release from the goldfish pituitary is dependent on voltage-sensitive Ca²⁺ channels and the availability of extracellular Ca²⁺. Recently, we examined the participation of protein kinase C (PKC) and protein kinase A (PKA) in GRLN-induced GH and LH release in primary cultures of dispersed goldfish pituitary cells using selective PKC and PKA pathway activators and inhibitors in the presence and absence of synthetic goldfish (g)GRLN19. In both perfusion and single cell Ca²⁺-imaging studies, gGRLN19-induced GH and LH release, and Ca²⁺ signals, were attenuated by the PKC inhibitors bisindolylmaleimide-II (Bis-II) and Go-6976. Furthermore, gGRLN19-induced hormone release and Ca²⁺ signals were not observed during exposure to the PKC agonist 1,2-dioctanoyl-sn-glycerol (DiC8). PKA inhibitors H-89 and KT5720, however, inhibited gGRLN19-induced GH, but not LH, hormone and Ca²⁺ responses in similar studies, suggesting that GRLN utilizes different complements of signal transduction pathways in goldfish gonadotropes and somatotropes.

USING HEART RATE TO DETERMINE OPTIMAL AND CRITICAL TEMPERATURES OF SALMON.

UTILISATION DE LA FREQUENCE CARDIAQUE POUR DETERMINER LES TEMPERATURES OPTIMALES ET CRITIQUES DES SAUMONS

Casselman, Matthew T. (*Department of Zoology, UBC*)

Farrell, Anthony P. (*Faculty of Land and Food Systems and Department of Zoology, UBC*)

Recent studies with salmon (genus *Oncorhynchus*) have associated maximum heart rate in exercising fish with the optimal temperature for aerobic scope and with the critical maximum temperature in resting fish. Our research is testing the idea that maximum heart rate can be used as an indicator of optimal and critical temperatures in juvenile salmon. As a first step, we are non-invasively monitoring the electrocardiogram of anaesthetized juvenile salmon while they are acutely warmed. The technique will be described, along with results that compare the effect on heart rate of different rates of warming and rates of cooling. In addition, the results for the application of pharmacological agents to stimulate a maximum heart rate will be presented. The hope is that this simple technique will be reliable enough to be readily applied in the field to screen thermal optima of juvenile salmon.

LINKS BETWEEN CYTOCHROME P450 AND GLUTATHIONE-S-TRANSFERASES AND SECRETION OF METHOTREXATE FROM MALPIGHIAN TUBULES OF *D. MELANOGASTER*.

LIENS ENTRE LE CYTOCHROME P450 ET LA GLUTATHIONE-S-TRANSFERASE ET LA SÉCRÉTION DE MÉTHOTREXATE PAR LES TUBULES MALPIGHIAN DE *D. MELANOGASTER*

Chahine, Sarah (*McMaster University*)

O'Donnell, Michael (*McMaster University*)

Exposure of insects to organic toxins often leads to both detoxification and excretion. Detoxification pathways include both cytochrome P450 monooxygenases (P450s) and glutathione-S-transferases (GSTs). The drug methotrexate (MTX) has been used to examine the role of metabolism and detoxification by P450s and GSTs in Malpighian tubules (MTs) of *Drosophila melanogaster*. We measured rates of MTX secretion by MTs after P450 and GST enzymatic activity had been induced by chronic dietary exposure to piperonyl butoxide (PBO). Chronic exposure to PBO in the diet results in increased secretion of MTX by the Malpighian tubules. Moreover, quantitative PCR analysis indicates that expression of genes for specific organic anion transporters and also for specific GSTs' and P450s' is upregulated by dietary exposure to MTX, PBO or a combination of both. Exposure to agents known to induce the expression of P450 and GST enzymes may thus lead to coordinated increases in both detoxification and excretory pathways.

AMMONIA EXCRETION IN THE FRESHWATER FLATWORM SCHMIDTEA MEDITERRANEA

EXCRETION D'AMMONIUM CHEZ LA PLANAIRE D'EAU DOUCE SCHMIDTEA MEDITERRANEA

Chan, Ainsley (*University of Manitoba*)

Sourial, Mary (*University of Ottawa*)

Weihrach, Dirk (*University of Manitoba*)

In aquatic invertebrates metabolic nitrogenous waste is excreted predominately as ammonia. In the freshwater platyhelminth *S. mediterranea* this ammonia excretion increased significantly after feeding, reaching peak rates after 4 hours. In addition, ammonia excretion in *S. mediterranea* was pH-dependent, with increased and decreased rates in environments buffered to low (pH 5.5) and high (pH 8.5) pH values, respectively. Further, increased excretion rates were observed after short term (1h) exposure to high ($\geq 500\mu\text{M}$) but not low ($\leq 200\mu\text{M}$) environmental ammonia concentrations. Inhibitor studies suggest that Na/K-ATPase, V-ATPase, NHEs and carbonic anhydrase are involved in the mechanism of ammonia excretion. However, quantitative real-time PCR revealed neither changes in whole body mRNA expression rates of *S. mediterranea* Rh-like ammonia transporter after 24h ammonia stress (100 μM to 1mM) nor after feeding.

DOES SALINITY AFFECT THE CELLULAR RESPONSE TO 17 α -ETHYNYLESTRADIOL IN THE ESTUARINE MUMMICHOG?

EST-CE QUE LA SALINITE AFFECTE LA REPONSE CELLULAIRE AU 17 α -ETHYNYLESTRADIOL CHEZ LES CHOQUEMORTS ESTUARIENS?

Chandra, Kavish (*Mount Allison University, Department of Biology*)

Currie, Suzanne (*Mount Allison University, Department of Biology*)

Endocrine disrupting substances (EDSs) are chemicals that negatively affect the normal hormonal activity regulating growth and reproduction. 17 α -ethynylestradiol (EE2) is an example of an EDS released into aquatic environments, causing deleterious developmental and reproductive problems in fish. The goal of this study is to understand the cellular mechanism of action of EE2 and how fluctuating environmental conditions may affect the cellular response to EE2 in the estuarine mummichog (*Fundulus heteroclitus*). In this pilot project, we exposed male mummichog, acclimated to either fresh- or saltwater, to 250ng L⁻¹ EE2. Because heat shock proteins (HSPs) are a conserved response to protein denaturing stresses and also have roles in chaperoning steroid receptors, we measured relative Hsp90 levels in nuclear, cytoplasmic and membrane fractions of liver tissue following EE2 exposure. Hsp90 was induced with EE2 in freshwater fish in only the cytoplasmic fraction of the liver. Interestingly, we also observed an induction of Hsp90 in the cytoplasm in saltwater control fish, and a simultaneous decrease of Hsp90 in the nucleus. EE2 exposure in saltwater had no further effect on Hsp90. An increase in Hsp90 in the saltwater exposed fish is suggestive of increased susceptibility to EE2.

EVOLUTIONARY IMPLICATIONS OF HYPOXIA AND HYPEROXIA ON DROSOPHILA MELANOGASTER

IMPLICATIONS EVOLUTIVES DE L'HYPOXIE ET DE L'HYPEROXIE CHEZ DROSOPHILA MELANOGASTER

Charette, Marc (*University of Ottawa*)

Insects possess a respiratory system that is directly open to the ambient atmosphere whereby gas exchange is driven via diffusion and partial pressure gradients, thereby making them particularly susceptible to changes in atmospheric composition. Although the short-term responses to acute respiratory stress have received much attention, the physiological basis of long-term adaptation to chronic stress has not. To address this, we have conducted an evolution experiment in which 12 replicate populations of *Drosophila melanogaster* have independently evolved for 25-30 generations under one of three atmospheric compositions throughout their entire life cycle: hypoxia (~10% O₂), normoxia, and hyperoxia (~50% O₂). We are currently characterizing anoxic tolerance, resting metabolic rate, longevity and fitness at the whole animal level in these populations to provide a direct test of the physiological hypothesis that adaptations to hypoxia or hyperoxia should modulate gas exchange to meet the demands of oxidative metabolism or to limit oxidative damage, respectfully.

CRITICAL THERMAL MAXIMA OF BC HATCHERY-REARED RAINBOW TROUT (ONCORHYNCHUS MYKISS)

TEMPERATURES MAXIMALES CRITIQUES DES TRUITES ARC-EN-CIEL DE COLOMBIE BRITANNIQUE (ONCORHYNCHUS MYKISS) ELEVEES EN CAPTIVITE

Cheung, Wallace (*Department of Zoology, The University of British Columbia, Vancouver, Canada*)

Scott, Mark (*Department of Zoology, The University of British Columbia, Vancouver, Canada*)

Richards, Jeffrey G. (*Department of Zoology, The University of British Columbia, Vancouver, Canada*)

We evaluated the critical thermal maxima (CT_{max}) in replicate families of three different strains of rainbow trout native to BC waters (Pennask, Tzenzaicut, and Blackwater) to assess the upper thermal tolerance of these fishes. Furthermore, we examined the effects of triploidy on these CT_{max}. Size-matched juvenile fish were acclimated to 12C and then exposed to a temperature increase of 0.3C/min until loss of equilibrium was observed. Individual variation in CT_{max} was consistent across all three strains with pronounced differences between families. There were no consistent differences in CT_{max} between diploid and triploid groups. A greater understanding of the strain-specific upper thermal tolerance of rainbow trout may be beneficial to the management of BC trout stocking programs and may enhance recreational angling experience in the province.

POLYACRYLAMIDE GEL ELECTROPHORESIS OF CRUDE EXTRACTS FROM THE TESTES AND SEMINAL VESICLES OF THE BLOOD-FEEDING INSECT, RHODNIUS PROLIXUS.

ELECTROPHORESE SUR GEL DE POLYACRYLAMIDE D'EXTRAITS BRUTS DE TESTICULES ET DE VESICULES SEMINALES DES INSECTES SUCEURS DE SANG RHODNIUS PROLIXUS

Chiang, Gary (*Redeemer University College*)

Chiang, Sarah (*McMaster University*)

During copulation, the male of the blood-feeding insect, *Rhodnius prolixus*, deposits a spermatophore within the vagina of the female. This package of sperm contains secretions from the testes and seminal vesicles, as well as from the opaque and transparent accessory glands. Crude extracts of the testes are known to contain the substance, rhodtestolin, that inhibits the beating of the isolated female heart. The present study reports that crude extracts of the seminal vesicles do not consistently inhibit the heart, suggesting that rhodtestolin is unique to the testes or, if delivered to the seminal vesicles, its effect may be antagonized by other substances. Polyacrylamide

gel electrophoresis of crude extracts of the testes and seminal vesicles provides the first indication of the diversity of proteins in these two glands. This information will help to determine the protein that elicits the rhodtestolin effect.

THE USE OF ARTIFICIAL MEMBRANES IN FEEDING REDUCES FEEDING EFFICACY AND FECUNDITY IN ADULT FEMALES OF THE BLOOD-FEEDING INSECT RHODNIUS PROLIXUS

L'UTILISATION DE MEMBRANES ARTIFICIELLES POUR L'ALIMENTATION RÉDUIT L'EFFICACITÉ ET LA FÉCONDITÉ CHEZ LES FEMELLES ADULTES DE L'INSECTE SANGUINIVORE RHODNIUS PROLIXUS
Chiang, Jennifer (*Redeemer University College*)

Colonies of the blood-feeding insect, *Rhodnius prolixus*, have been maintained in the laboratory for close to 100 years. Various feeding techniques have been employed ranging from the use of warm-blooded hosts to offering previously collected blood through a biological or artificial membrane. This study compares the fecundity in mated and unmated females fed rabbit blood directly from the shaved belly of a rabbit to that of females fed defibrinated rabbit blood through an artificial membrane. We found that this insect's feeding efficacy is reduced using an artificial membrane and the fecundity index, which measures the efficiency of turning the blood meal into eggs, is significantly lower compared to using a live host. These results indicate that feeding on a warm-blooded host may provide sensory cues that have the short-term effect of enhancing the act of feeding and the long term effect of increasing egg production efficiency

GLASS SPONGE REEFS: SPATIAL DISTRIBUTION AND ABUNDANCE PATTERNS OF REEF FORMING HEXACTINELLIDS (PORIFERA) IN THE STRAIT OF GEORGIA

RÉCIFS D'ÉPONGES DE VERRE : DISTRIBUTION SPATIALE ET PATRONS D'ABONDANCE DES HEXACTINELLIDES (PORIFERA) FORMANT DES RÉCIFS DANS LE DÉTROIT DE GÉORGIE
Chu, Jackson W.F. (*University of Alberta*)
Leys, Sally P. (*University of Alberta*)

Glass sponge reefs are immense deep sea habitats unique to the coast of British Columbia. Kilometre-size reefs are built by only two species of hexactinellids in the Strait of Georgia. Thus far, only remote sensing has been used to quantify reef distributions, a method that does not resolve where live, dead and buried sponges are within a reef. We performed fine scale sampling (25m, 12.5m grid) photographic surveys using remote operated vehicles, GIS and semivariogram analysis to determine the spatial distribution and abundances of glass sponges among 3 reefs in the Strait of Georgia. Within a reef, glass sponges are clustered in spatially dependent patches between 35-72 m, likely a result of asexual budding strategies. Entire populations are found within a narrow 30-50 m range of depths and may be explained by flow acceleration over the underlying elevated bedrock mounds and ridges. Fish and crustaceans were also in greater abundance when glass sponges were present. Estimated rates of carbon capture were 0.96 g C m⁻² day⁻¹, similar to estimates from tropical sponge communities. Our study is the first to quantify small scale biological patterns of glass sponge reefs by sampling at resolutions normally not attempted in the deep sea.

NEUROEPITHELIAL CELL ACTIVITY DURING ACUTE HYPOXIC EXPOSURE IN TROUT

L'ACTIVITÉ DES CELLULES NEUROÉPITHÉLIALES DURANT L'EXPOSITION HYPOXIQUE AIGUE CHEZ LA TRUITE
Ciuhandu, Cosima S (*Department of Zoology, University of British Columbia, Vancouver, BC*)
Fong, Angelina Y (*Department of Zoology, University of British Columbia, Vancouver, BC*)
Milsom, William K (*Department of Zoology, University of British Columbia, Vancouver, BC*)

Carotid body chromaflin cells in mammals contain a plethora of different neurochemicals. In fish gills these neurochemicals are present in different populations of putative chemosensory neuroepithelial cells (NECs). Using immunohistochemistry, one population containing serotonin (5-HT) and another containing acetylcholine (ACh) have been identified. In order to assess the relative roles of these two populations in hypoxia sensing, an activity-dependent dye was used in the present study to determine their activity levels in normoxia and during acute exposure to hypoxia. In general, the background levels of activity in non-neuroepithelial cells in fish exposed to normoxia were higher than those of fish exposed to hypoxia, indicating that most branchial cells reduce their activity during hypoxia. However, in hypoxia, the dye was taken up more by nerve fibres within the gill filaments found in close association with both cholinergic and serotonergic neuroepithelial cells. As the dye is known to be taken up presynaptically this demonstrates that both NEC cell types are innervated and it points towards a role as effector rather than sensory cells. While the 5-HT containing cells themselves did not take up the dye, ACh containing cells sometimes did suggesting that this population may also play a role in hypoxia sensing.

SEROTONERGIC CELLS OF THE SKIN AS A SITE FOR OXYGEN SENSING IN DEVELOPING ZEBRAFISH

LES CELLULES SÉROTONERGIQUES DE LA PEAU EN TANT QUE SITE POUR LA PERCEPTION DE L'OXYGÈNE CHEZ LE POISSON ZÈBRE EN DÉVELOPPEMENT

Coccimiglio, Maria L. (*University of Ottawa*)

Jonz, Michael G. (*University of Ottawa*)

Oxygen sensing is vital for survival in many organisms, including vertebrates. The ability to sense environmental oxygen levels is done by specialized cells called respiratory chemoreceptors. In teleost fish, the suspected respiratory chemoreceptors are the serotonergic neuroepithelial cells (NECs) of the gills. Development of NECs in zebrafish (*Danio rerio*), however, reveals that these cells are not fully functional until about 7 days post-fertilization (d.p.f.), although embryos as early as 2 d.p.f. are able to sense and respond to hypoxia. This suggests the presence of extrabranchial respiratory chemoreceptors during development. Here, the skin, which acts as a respiratory organ, is examined in developing zebrafish as a possible site for oxygen chemoreception. NEC-like cells were found over the entire surface of the skin in embryos and larvae, and contained serotonin. These cells appeared first at 24 h.p.f. (hours post-fertilization) and reached maximal density at 26 h.p.f. and declined thereafter. The NEC-like cells appeared to be innervated, and formed multiple contacts with nerve terminals. Application of the neurotoxin, 6-hydroxydopamine (6-OHDA), indicated that the skin receives innervation from catecholaminergic nerve fibres. Additionally, exposure of embryos and larvae to chronic hypoxia over a 9 day period induced morphological changes in these cells, such as proliferation.

ELECTROSPINNING TO ELUCIDATE THE DEVELOPMENT OF MECHANICAL PROPERTIES IN THE WHELK EGG CAPSULE PROTEIN

ELECTROFILAGE POUR ELUCIDER LE DEVELOPPEMENT DES PROPRIETES MECANIQUES DE LA CAPSULE PROTEIQUE DE L'ŒUF DE BUCCIN

Corbett, Carla (*University of British Columbia*)

Shadwick, Robert E. (*University of British Columbia*)

Whelks produce proteinaceous egg capsules with interesting mechanical properties. The capsules are produced from a soluble precursor protein and undergo a poorly understood processing step that renders them insoluble, likely by cross-linking. When strained, the mature protein has an initial stiff, Hookean region, then a yield point, followed by a rubbery elastic region with a large hysteresis loop. The protein completely recovers once strain is removed. It appears to reversibly transform from a stable alpha-helix based structure of cross-linked coiled-coils to a temporary beta sheet formation. In order to find out more about the processing step and the properties of this

intriguing protein, the soluble precursor has been electrospun in order to introduce cross-linking steps to the resultant nanofibres in an attempt to mimic the properties of the native protein.

THE EFFECT OF METAL-OXIDE NANOPARTICLES ON DAPHNIA PULEX AND HYDRA ATTENUATA

L'EFFET DES NANOPARTICULES D'OXYDE DE MÉTAUX SUR DAPHNIA PULEX ET HYDRA ATTENUATA

Costa, Emily-Jane (*Wilfrid Laurier University*)

McGeer, Jim (*Wilfrid Laurier University*)

The potential for impacts arising from the release of nanomaterials into the environment is poorly understood and has been highlighted as an area for research. This study examines the effects of 3 materials (Fe₂O₃, TiO₂, and ZnO) on two aquatic organisms (*Hydra attenuata* and *Daphnia pulex*) to understand the relative contribution of particle size and particle dissolution to toxicity. *Hydra* toxicity tests (96 h) were done in duplicate using 12-well microplates, with each well containing 5 mL of test solution and 10 *hydra*. At the end of the test, morphology was scored on a 5-point scale (1 = organism disintegration to 5 = normal). *Daphnia* toxicity tests were done in duplicate with 10 neonates per 40 mL of test solution using polyethylene beakers. For each metal-oxide, EC₅₀ values were generated for *hydra* (morphology) and *daphnia* (survival). For *Hydra*, ZnO was had the lowest EC₅₀ (4.5 mg/L) followed by TiO₂ (62 mg/L) and Fe₂O₃ (85 mg/L). Particle characteristics including appearance (particle size, size distribution, aggregation) and stability were measured by successive filtration (unfiltered to <1 nm). These methodologies will help determine whether dissolved metal in solution and/or nano-sized particles themselves contribute to toxicity. This research is supported by the NRC-NSERC-BDC Nanotechnology Initiative.

COMBINED EFFECTS OF COPPER AND TEMPERATURE ON MUSCLE GENE TRANSCRIPTION AND ENZYME ACTIVITIES IN FATHEAD MINNOWS

EFFETS COMBINÉS DU CUIVRE ET DE LA TEMPÉRATURE SUR LA TRANSCRIPTION GÉNIQUE ET L'ACTIVITÉ ENZYMATIQUE CHEZ LE TÊTE DE BOULE

Couture, Patrice (*INRS-ETE*)

Lapointe, Dominique (*INRS-ETE*)

Pierron, Fabien (*INRS-ETE*)

The effects of copper (Cu) on aquatic biota have been extensively studied. Contaminant effects occurring at the molecular or gene transcription levels are more sensitive and generally precede effects at the population level, providing an early warning signal. Our study examined the additivity of heat and Cu stresses on gene transcription and physiological responses in fathead minnows. Fish were exposed to environmentally relevant dietary or aqueous Cu concentrations for 28 days at two different temperatures, the higher one expected to cause a heat stress. At the end of the experiment, muscle samples were taken for gene transcription, metal and enzyme analyses. Muscle Cu concentrations did not differ among the six treatments. The transcription level of *ldh*, *cco-1*, *mt-2* and *hsp-70* genes was higher in fish exposed to dietary Cu alone compared to unexposed fish at 20°C. In contrast, there was a decrease in *cs* and *sod-1* gene transcription levels in fish exposed to high temperature (32°C) alone or in combination with aqueous Cu compared to unexposed fish. Comparison of gene transcription with the activity of corresponding enzymes will be discussed. This research will contribute to our understanding of the combined effects of contaminants and stressful environmental conditions such as heat stress, which is likely to increase in frequency in a context of global warming.

METABOLIC AND CARDIOVASCULAR RESPONSES TO ANOXIA IN THE PACIFIC HAGFISH (*EPTATRETUS STOUTII*)

RÉPONSES MÉTABOLIQUES ET CARDIOVASCULAIRES À L'ANOXIE CHEZ LA MICINE DU PACIFIQUE (*EPTATRETUS STOUTII*)

Cox, Georgina K (*University of British Columbia*)

Sandblom, Erik (*University of Gothenburg*)

Richards, Jeffrey G (*University of British Columbia*)

Farrell, Anthony P (*University of British Columbia*)

My research posed the following question: Do Pacific hagfish (*Eptatretus stoutii* L) that survive 36 h of anoxia at 10°C suppress whole animal and cardiac metabolic rates? Analysis of excess post-anoxic oxygen uptake has previously shown that hagfish could not maintain whole animal metabolic rate at a routine normoxic level for 36 h of anoxia. Data on the accumulation of lactate and the depletion of glycogen in tissues will show that the rate of glycolysis during this period cannot support routine metabolic rate. Therefore, there is a substantial suppression of whole animal metabolic rate. No one has previously measured cardiovascular responses beyond 3 h of anoxia. Here cardiac output and ventral aortic blood pressure were measured for 36 h of anoxia and through full recovery. Anoxic bradycardia halved heart rate within 3 h, heart rate remained stable at 5 bpm for the final 33 h of anoxia. Cardiac output, however, was reduced only ~ 33% suggesting metabolite, hormone and waste transport remain very important during anoxia. Furthermore, cardiac power output remained unchanged during anoxia. Thus, cardiac metabolic rate is not suppressed and its routine cardiac ATP demand is met through glycolysis and circulating blood glucose. Funded by NSERC.

LINKING THE ADRENERGIC AND HEAT SHOCK STRESS RESPONSES IN FISH

LIER LA REPONSE ADRENERGIQUE A LA REPONSE AU STRESS (CHOC THERMIQUE) CHEZ LES POISSONS

Cox, Lindsey (*Mount Allison University*)

McClelland, Christie (*Mount Allison University*)

Currie, Suzanne (*Mount Allison University*)

Recent work in our lab determined that the heat-induced increase in heat shock proteins (Hsps) in rainbow trout (*Oncorhynchus mykiss*) is attenuated when the effects of adrenaline and noradrenaline (catecholamines) are blocked, indicating an intimate connection between the hormonal and heat shock stress responses. However, the mechanism of this integration is unknown. We hypothesized that protein kinase A (PKA), an enzyme activated by catecholamines and responsible for phosphorylating many cellular targets, is the site of connection between the heat shock and adrenergic responses. Using the nucleated red blood cells of fish as our cell model, our results indicate that inhibition of PKA activity with the antagonist H89 attenuated adrenergic enhancement of the heat shock response at the level of the gene in trout red blood cells. Moreover, inhibition of PKA diminished the heat-induced increase of both hsp70 mRNA and Hsp70 protein. Consequently, our data implicate PKA as an integral component of the heat shock response in fish cells.

COPING WITH HYPOXIA: HOW THE PLAINFIN MIDSHIPMAN (*PORICHTHYS NOTATUS*) TOLERATES THE INTERTIDAL ZONE.

Craig, Paul (*University of Ottawa*)

Fitzpatrick, John (*University of Western Australia*)

Walsh, Patrick (*University of Ottawa*)

Wood, Chris (*McMaster University*)
McClelland, Grant (*McMaster University*)

Plainfin midshipman (*Porichthys notatus*) have been extensively studied due to their alternative reproductive tactics and auditory communication during the breeding season. However, little is known about their basic physiology. Of particular interest to this study is their ability to tolerate extended periods of hypoxia in the intertidal zone during mating and parental care. Over two field seasons (June 2007 & 2009), Type I-, II-males, and females were collected from nest sites on the coasts of Vancouver Island, British Columbia. Hematocrit (Hct) and plasma lactate from collected fish demonstrated progressive responses to hypoxia, which may be associated with the period of time spent on a nest site. Type I males were brought back to Bamfield Marine Station to determine the respiratory and metabolic responses to progressive hypoxia. Oxygen consumption rates significantly decreased > 2.5 fold with a 2-fold decrease in ambient oxygen tension. Associated with prolonged exposure to hypoxia, there were significant elevations in plasma and tissue lactate (heart), tissue glucose (liver), and a depression in gill Na⁺K⁺ATPase and catalase activity. Results suggest that midshipman survival in the intertidal zone is dependent on metabolic depression and tolerance to anaerobic byproducts. (NSERC Discovery to GBM, PJW, & CMW)

IDENTIFYING ESSENTIAL NUTRIENT SENSORS IN FISH: USING DIETARY MANIPULATION TO UNDERSTAND ENERGY USAGE

INDENTIFICATION DE CAPTEURS DE NUTRIMENTS ESSENTIELS CHEZ LES POISSONS : UTILISATION DE MANIPULATIONS ALIMENTAIRES POUR COMPRENDRE L'USAGE ÉNERGÉTIQUE

Craig, Paul (*University of Ottawa*)
Moon, Thomas (*University of Ottawa*)

Enzymes involved in nutrient metabolism, such as glycolysis or lipogenesis, have been extensively study and are well characterized. However little is known regarding the mechanisms regulating these pathways in fish, particularly, several key regulators identified in mammalian studies: sterol responsive binding protein 1 & 2 (SREBP), the mammalian target of rapamycin (mTOR), and AMP-activated protein kinase, a key regulator of cellular energy status. Recently, it was thought that insulin played the primary role in regulating glucose metabolism and lipogenesis, however studies have demonstrated the nutrients themselves (e.g. lipids, carbohydrates) play a major regulatory role in gene transcription of glycolytic and lipogenic enzymes. In fish, little is known about these proteins and how dietary modification can effect the regulation of their downstream targets. In this study, we used fasting as a means to identify the key nutrient/energy receptors involved in the reduction of whole body metabolism and consumption of essential nutrients in zebrafish using a combination of quantitative real-time PCR, enzymatic activities of downstream targets, and tissue metabolites. This study will enhance our understanding of the mechanisms fish employ to cope with fasting, and how dietary manipulation may enhance nutrient uptake, reduce feed costs, and improve 'green' aquaculture.

INTERPLAY AMONG PHENOTYPIC PLASTICITY, LOCAL ADAPTATION, AND GENE FLOW IN AN AFRICAN CICHLID FISH

INTERACTION ENTRE LA PLASTICITÉ PHÉNOTYPIQUE, L'ADAPTATION LOCALE, ET LE FLUX GÉNIQUE CHEZ UN POISSON CICHLIDE AFRICAIN

Crispo, Erika (*McGill University*)
Chapman, Lauren (*McGill University*)

Genetic adaptation and phenotypic plasticity are two ways in which organisms can adapt to local environmental conditions. The relative contribution of each is predicted to be influenced by variation in selection. Plasticity can

enhance adaptation, and might thus allow for increased gene flow among selective environments. At the same time, high levels of gene flow might result in the evolution of plasticity. I examined population structure and plasticity in the cichlid fish, *Pseudocrenilabrus multicolor*, from high-oxygen rivers and low-oxygen swamps in Uganda. Using microsatellite markers, I found that gene flow is not reduced between divergent oxygen environments relative to within them. Using a reciprocal split-brood rearing experiment, with F1 offspring raised under high- and low-oxygen conditions, I estimated plasticity and phenotypic divergence among six populations. Plasticity of ecologically-relevant morphological traits is high overall and variable among populations. In the most geographically discrete populations, the relative contribution of local adaptation is stronger and plasticity weaker than in populations with increased potential for gene flow between environments. Plasticity might thus have evolved in response to gene flow between river and swamp environments. Future work is needed to strengthen causality inferences for interactions among local adaptation, plasticity, and gene flow in natural systems.

MEAN, GREEN OVERWINTERING MACHINES: SURVIVING CANADIAN WINTERS AS AN EMERALD ASH BORER

MÉCHANTES MACHINES VERTES HIVERNEUSES : SURVIVRE L'HIVER CANADIEN EN TANT QU'AGRILE DU FRÊNE

Crosthwaite, Jill C (*The University of Western Ontario*)

Sobek, Stephanie (*The University of Western Ontario*)

Bernards, Mark A (*The University of Western Ontario*)

Lyons, D Barry (*Great Lakes Forestry Centre*)

Sinclair, Brent J (*The University of Western Ontario*)

The Emerald Ash Borer (EAB), *Agrilus planipennis*, is an invasive beetle that is causing extensive damage to ash trees in North America. Native to eastern Asia, it has been spreading steadily since its introduction. Cold is commonly considered a limiting factor in determining the northern ranges of species, but it is currently unknown what effect low winter temperatures may have on limiting the spread of EAB, as little is known about its cold tolerance. Here, I determine temporal changes in low temperature tolerance of EAB from fall to early spring. The primary overwintering stage of EAB is a freeze-avoiding prepupa, with mean supercooling points being lowest in January (-30.5°C) and increasing to -23.5°C in April. As winter approaches, they experience a dramatic increase in hemolymph glycerol content, increased antifreeze protein activity and decreased supercooling points. These changes reverse in spring, with the onset of warmer temperatures and development. There appears to be a weak diapause in the fall, as evidenced by increased mortality at warm temperatures and increased developmental time.

EFFECTS OF CHRONIC EXPOSURE TO CADMIUM ON THE SWIMMING PERFORMANCE IN BROWN TROUT AND THE RAINBOW TROUT

EFFET DE L'EXPOSITION CHRONIQUE AU CADMIUM SUR LES PERFORMANCES DE NATATION CHEZ LA TRUITE BRUNE ET LA TRUITE ARC-EN-CIEL

Cunningham, Jessie (*Wilfrid Laurier University*)

McGeer, Jim (*Wilfrid Laurier University*)

Swimming is one of the most observable and ecologically relevant measures used to demonstrate the sub-lethal effects of environmental stressors. Swim performance characterizes the integrated metabolic costs of sub-lethal exposure to contaminants. This study investigates the effect of chronic (30 d) Cd exposure on the ability to sustain repeated bouts of swimming in *Oncorhynchus mykiss* and *Salmo trutta*. Fish were exposed to waterborne Cd (2.0 µg/L) in moderately hard water (140 mg/L CaCO₃) and swim trials were performed on days 1, 6, 14 and 30. Trials consisted of swimming to 85% of the Ucrit of control fish, providing a 30 minute rest period, and then

performing a second swim challenge. Plasma, gills, liver, kidney and muscle samples were taken before and after each of the swim periods. Tissue Cd, plasma ion composition, and muscle metabolites were measured. Results indicate that although performance in the first swim test was not impacted by Cd exposure performance in the second swim challenge was decreased in Cd exposed fish. The ultimate goal of this research is to develop an understanding of the linkages between exposure, bioaccumulation, physiological disruption and impairment of whole animal performance. This research is supported through the NSERC Discovery Program.

MEMBRANES AS PACEMAKERS OF METABOLISM: BRIDGING THE GAP BETWEEN MACRO AND MICROEVOLUTION

LES MEMBRANES AGISSANT COMME “PACEMAKERS” DU MÉTABOLISME: FAIRE LE PONT ENTRE LA MACRO ET MICROÉVOLUTION

Darveau, Charles (*University of Ottawa*)

Godbout-Gauthier, Emmanuelle (*University of Ottawa*)

Suarez, Raul (*University of California Santa Barbara*)

Weber, Jean-Michel (*University of Ottawa*)

Diversity and evolution in animal energetics call for integrated adjustments at multiple levels of organization and multiple functions. At the cellular level, a recent theory by Hulbert and Else suggests that biological membranes can function as pacemakers of metabolism, thus acting as a master switch (or dimmer switch) of cellular metabolic capacities. Nevertheless, large scale patterns observed across species of mammals and birds seldom apply within species or finer evolutionary time-scales. Moreover, the relationship between membrane properties and metabolic activity has been inferred instead of being directly tested. In this study, we used a comparative approach using a lineage of closely related species of flying insects to test the relationship between metabolic rate variation and membrane phospholipids composition. Using this model, we focused on species variation in active metabolic rate during flight and targeted the flight muscle tissue. Together, this study supports the suggestion that membranes act as pacemaker of metabolism in closely related species varying 2-3 fold in active mass-specific metabolic rate.

POTENTIAL MECHANISMS FOR THE VASOPRESSIVE ACTIONS OF BRADYKININ IN THE VASCULAR SMOOTH MUSCLE OF THE LITTLE SKATE, *RAJA ERINACEA*.

MECHANISMES POTENTIELS POUR LES EFFETS VASOPRESSIVES DE LA BRADYKININE DANS LE MUSCLE LISSE DE LA RAIE HÉRISSE, *RAJA ERINACEA*.

Dasiewicz, Patricia J. (*Department of Biological Sciences, University of Manitoba, Winnipeg, MB*)

Anderson, W. Gary (*Department of Biological Sciences, University of Manitoba, Winnipeg, MB*)

Conlon, J. Michael (*University of United Arab Emirates, Al Ain, United Arab Emirates*)

The regulation of the cardiovascular system involves the coordinated action of a number of complex endocrine systems, one of which includes the kallikrein-kinin system (KKS). Its product peptide bradykinin (BK) and the metabolite des-[arg9]BK, are two principal bioactive components of this system, acting via the B2 and B1 receptors, respectively. In fish, the prime actions of BK include the regulation of the cardiovascular system in a species-dependent fashion. A homologous BK was recently identified in the little skate, *Raja erinacea*, and was found to produce a strong dose-dependent vasopressor response in isolated mesenteric arteries with an EC₅₀ of 4.37 X 10⁻⁸ M. Recognized mammalian agonists such as Hoe-140 and des-[arg9] BK, as well as the synthetic analogue skate [arg9]BK were without effect in isolated skate, mesenteric, coeliac and branchial arteries. Co-administration of skate BK with esculetin, L-NAME and yohimbine reduced the EC₅₀ of skate BK by 31.4, 30.7 and 38.9% respectively. This suggests that multiple pathways may be involved in the regulation of the vasopressor response to BK in the skate as evidenced in the in vivo response to homologous BK administration in the trout (Olson et al., 1997).

THERMAL ADAPTATION IN KILLIFISH: VARIATION IN MUSCLE STRUCTURE AND BIOCHEMISTRY

ADAPTATION THERMALE CHEZ FUNDULUS HETEROCLITUS : VARIATION DANS LA STRUCTURE ET LA BIOCHIMIE DES MUSCLES

Dhillon, Rashpal (*University of British Columbia*)

Schulte, Patricia (*University of British Columbia*)

Killifish, *Fundulus heteroclitus*, inhabit salt marshes and estuaries along the Atlantic coast of North America from Newfoundland to Florida. Previous studies have shown higher metabolic rates in the northern sub-species compared to the southern sub-species of killifish over a range of acclimation temperatures. In this study, we explain these differences in metabolism by comparing factors that influence mitochondrial properties. Fish of each sub-species were acclimated to 5, 15, and 25 °C. Adenylate status, cytochrome oxidase and citrate synthase enzyme activities (indicative of mitochondrial content), and lactate dehydrogenase and creatine kinase enzyme activity (indicative of cytosolic metabolic capacity) were measured. Whole-body fiber typing and capillary density was used to compare muscle ultrastructure in the two sub-species. Mitochondrial enzyme activities were greater in the northern sub-species at all but the highest acclimation temperature, suggesting higher mitochondrial content in cold adapted northern fish. The relative proportion of oxidative:glycolytic muscle fibers were higher in the northern sub-species than the southern sub-species at all acclimation temperatures. Mitochondrial volume density and cristae surface density were greater in the cold-adapted northern fish. These data suggest that differences in metabolic rate are related to differences in mitochondrial properties.

RAINBOW TROUT EMBRYOS CREATE A UNIQUE MICROENVIRONMENT IN REDDS.

LES EMBRYONS DE LA TRUITE ARC-EN-CIEL CREENT UN MICROENVIRONNEMENT UNIQUE DANS LES FRAYÈRES

Dhiyebi, Hadi (*Department of Integrative Biology, University of Guelph, Guelph, ON*)

O'Donnell, Michael (*Department of Biology, McMaster University, Hamilton, ON*)

Wright, Patricia (*Department of Integrative Biology, University of Guelph, Guelph, ON*)

Rainbow trout (*Oncorhynchus mykiss*) (RT) embryos in redds may experience a microenvironment that is different from the surface/river water (RW). This difference may be influenced by biotic and/or abiotic factors. We hypothesized that the water chemistry within natural redds will differ from the RW. Furthermore, we hypothesize that embryo development, as well as crowding and water flow, contribute to these changes in the microenvironment. Field measurements of dissolved oxygen (DO) and pH were conducted in Kelso Creek, ON, where active RT redds were identified. In addition, water samples were analyzed for ammonia concentrations. To analyze the effects of embryo development, we utilized ion-specific microelectrodes in a controlled environment to measure boundary layer profiles of DO, pH, NH₄⁺ and CO₂. The water conditions in redds were significantly different from the RW. Redds were more acidic ($\Delta 0.23$ pH), less oxygenated ($\Delta 0.47$ mg•L⁻¹) and had more total ammonia ($\Delta 5.38$ μ mol•L⁻¹). Older embryos had larger boundary layer gradients for all variables and the presence of the chorion significantly impacts water chemistry near the embryo surface. We conclude that RT embryos develop within a distinct redd microenvironment that is influenced, in part, by embryonic development.

SEEING WHELK EGG CAPSULES IN A NEW LIGHT: WHAT BIREFRINGENCE REVEALS

REGARDER LES CAPSULES D'ŒUFS DES BUCCINS DANS UNE LUMIERE NOUVELLE: QU'EST-CE QUE LA BIREFRINGENCE REVELE?

Didier, David Wesley (*University of British Columbia*)

Gosline, John M. (*University of British Columbia*)

Shadwick, Robert E. (*University of British Columbia*)

Whelk egg capsule protein (WECP) exhibits dynamic and recoverable stress/strain characteristics that are rare and intriguing. The protein has an interesting two-phase stress/strain curve, and is fully recoverable from yield strains. Egg capsules from *Busycon canaliculatum* were examined to determine their microscopic mechanical properties. Using birefringence as an instantaneous measure of order in the sample during stress/strain tests we investigated what was happening to the protein molecules as they were strained. It is believed that the two-phase stress/strain curves (an initial stiff region and a low stiffness yield region) are produced by stress-induced changes to the alpha-helical components of whelk egg capsule protein. A parallel study (Miserez et al., *Nature Materials* 8:910, 2009) detected beta-sheet structure in this material under strain, but the fact that it totally recovers on recoil indicates that no stable beta-sheets were formed during these tests. Our proposed model is therefore that straining alpha-helices produces the initial stiff region. At the yield point hydrogen bonds rupture and allow the alpha-helices to pop-open, resulting in a loss of overall order (measured using birefringence) in the sample as helical structures are lost. The alpha-helices spontaneously reform on recoil, allowing the protein to fully recover from the strain.

USING ZEBRAFISH (*DANIO RERIO*) BEHAVIOR TO ESTIMATE EFFICACY OF MORPHINE AS AN ANALGESIC

UTILISATION DU COMPORTEMENT DU POISSON ZEBRE (*DANIO RERIO*) COMME INDICE POUR ESTIMER L'EFFICACITE ANALGESIQUE DE LA MORPHINE

Douglas, Angela (*AVC, UPEI*)

Previous experiments in zebrafish have shown that a nociceptive stimulus (a “painful stimulus”) results in behavioral changes, namely a marked decrease in swimming activity. Analgesics may be effective at blocking this change in behavior but there is little evidence based data regarding the efficacy of analgesics in fish. We therefore embarked upon a series of experiments to answer some fundamental questions regarding the ability of analgesics in preventing behaviors associated with fish “pain,” with the overall goal of estimating the doses of morphine that will decrease or abolish these behavioral changes. Zebrafish were anaesthetized and treatment fish were injected with morphine (the quintessential “pain killer”) at doses of 1,3,10,30,100 mg/kg. Acetic acid (5µl, 5 %), which is commonly used to estimate nociceptive thresholds and analgesic efficacy in mammals, was injected into the snout of treatment fish while sterile saline was injected into controls. The activity of all fish, before and after treatment, was recorded with a video camera and analyzed with Loligo software. This information will be used by the CCAC and other animal care organizations in formulating guidelines regarding the use of analgesics in fish.

THYROID HORMONES AFFECT GONADAL GENE EXPRESSION DURING AMPHIBIAN METAMORPHOSIS

LES HORMONES DE LA GLANDE THYROÏDE AFFECTENT L'EXPRESSION GÉNIQUE DES GONADES PENDANT LA MÉTAMORPHOSE DES AMPHIBIENS

Duarte-Guterman, Paula (*Department of Biology, University of Ottawa*)

Trudeau, Vance (*Department of Biology, University of Ottawa*)

In amphibians, the main role of thyroid hormones (THs) is to induce metamorphosis; however there is evidence that THs also affect gonadal sex differentiation. In this study, we established profiles of TH-, estrogen- and androgen-related genes in the gonad-mesonephros complex (GMC) during natural and chemically-induced metamorphosis of *Silurana (Xenopus) tropicalis*. Tadpoles were exposed to triiodothyronine (T3; 0, 0.5, 5 and 50 nM), the bioactive form of THs for 48 h to induce metamorphosis. Real-time RT-PCR analyses revealed that TH- and androgen-related genes are positively regulated, while estrogen receptor beta (erbeta) is negatively regulated by T3 relative to control in the GMC. Together, these results are in agreement with the masculinizing effect of

THs in amphibians. Furthermore, the results of sex steroid-related genes in the GMC during T3-induced metamorphosis are different from the natural metamorphosis profiles (e.g., *erbA* increases during metamorphosis in the GMC while it decreases with T3 exposure). This indicates that THs are not the main regulators of sex steroid-related gene expression in the GMC. This study provides evidence that the GMC is a target of THs but that a complex interplay exists between THs and sex steroids during development. Funded by NSERC.

INTERACTIONS OF FUNCTIONALLY DECORATED HELICAL ROSETTE NANOTUBES WITH CATFISH IMMUNE CELLS.

INTERACTIONS DES NANOTUBES ROSETTES DÉCORÉS FONCTIONNELLEMENT AVEC LES CELLULES IMMUNITAIRES DES POISSONS CHAT

Ede, James D. (*University of Alberta, Edmonton, Alberta, Canada*)

Stafford, James (*University of Alberta, Edmonton, Alberta, Canada*)

Ong, Kimberly J. (*University of Alberta, Edmonton, Alberta, Canada*)

MacCormack, Tyson (*University of Alberta, Edmonton, Alberta, Canada*)

Beingessner, Rachel (*National Institute for Nanotechnology, Edmonton, Alberta, Canada*)

Fenniri, Hicham (*National Institute for Nanotechnology, Edmonton, Alberta, Canada*)

Goss, Greg G. (*University of Alberta, Edmonton, Alberta, Canada*)

Helical rosette nanotubes (RNTs) are synthetic supramolecular organic nanotubes that can be functionalized for a number of applications and ‘tuned’ to have different architectures. We have found that RNT concentrations > 1 mg/L cause acute cell death. The purpose of this study was to reveal the physical and biochemical effects of RNTs on a variety of cell lines and cellular functions. Further, we aimed to identify how these effects contribute to the observed toxicity. We used both fluorescently and radioisotopically labeled RNTs to trace their transport, sub-cellular distribution and excretion. In addition, we used various RNT functionalizations (altering charge and shape) to investigate their association with the cell membrane, effects on cell membrane potential and effects on cell volume. Finally, using a luciferase-based reporter assay system, we determined if toxicity-related signaling pathways are altered by RNT exposure. Examination of the fate of RNTs inside cells will help predict the characteristics of nanomaterials that result in adverse biological interactions. In addition, new ideas on how RNTs might be targeted for specific commercial and biomedical applications will be gained.

SOCKEYE SALMON IN HOT WATER: POPULATION-SPECIFIC TAILORING OF MAXIMUM CARDIORESPIRATORY PERFORMANCE TO THE TEMPERATURE ENCOUNTERED DURING ADULT RIVER MIGRATION

SAUMONS SOCKEYE DANS L’EAU CHAUDE : AJUSTEMENTS SPÉCIFIQUES DE LA PERFORMANCE CARDIORESPIRATOIRE MAXIMALE EN FONCTION DE LA TEMPÉRATURE AFFRONTÉE DURANT LA MIGRATION EN RIVIÈRE DES ADULTES

Eliason, Erika (*Department of Zoology, UBC*)

Clark, Timothy (*Department of Zoology, UBC*)

Hinch, Scott (*Faculty of Forestry, UBC*)

Farrell, Tony (*Department of Zoology, UBC*)

It has long been established that temperature optima exist for growth and performance among different animal species. The high fidelity spawning populations of Fraser River, BC, adult sockeye salmon provide an excellent model to examine temperature optima at an intraspecific level. Discrete temperature optima matching historical environmental conditions have been shown for two populations that migrate over a narrow temperature range. It would follow that populations encountering a broader temperature range would display temperature optima characteristic of a eurythermal species. To test this hypothesis, we used a Brett-type respirometer to compare the

swimming and cardiorespiratory performance of two populations of migrating adult sockeye salmon, Chilko and Early Stuart, at temperatures between 8 and 26°C. Both populations maintained swimming and cardiorespiratory performance across the entire range of temperatures typically encountered during their upriver migration, with Chilko sockeye emerging as the high-temperature champions. Furthermore, both populations had a superior aerobic scope compared to a coastal sockeye population, perhaps reflecting the cardiorespiratory needs of a more arduous migration route. We also characterised cardiorespiratory collapse at elevated temperatures. At critically high temperatures, scope for heart rate approached zero, suggesting a limitation to prolonged exercise performance at the level of the heart. Supported by NSERC.

SELECTION FOR RESISTANCE TO THE MICROBIAL INSECTICIDE BACILLUS THURINGIENSIS CAUSES IMMUNOLOGICAL COSTS IN SUBSEQUENT *TRICHOPLUSIA NI* GENERATIONS.

LA SÉLECTION POUR LA RÉSISTANCE À L'INSECTICIDE MICROBIEN BACILLUS THURINGIENSIS CAUSE DES COÛTS IMMUNOLOGIQUES CHEZ LES GÉNÉRATIONS SUBSÉQUENTES DE TRICHOPLUSIA NI

Ericsson, Jerry (*Dept of Biological Sciences, Simon Fraser University*)

Myers, Judith (*Dept of Zoology, University of British Columbia*)

Lowenberger, Carl (*Dept of Biological Sciences, Simon Fraser University*)

Bacillus thuringiensis (Bt) and its associated insecticidal toxins, are used successfully worldwide to control insect pests. Given its widespread and often exclusive use, and the development of resistance in such insects as the cabbage looper, *Trichoplusia ni*, an analysis of the fitness costs associated with Bt resistance are a primary target for ecological and physiological studies. We have a Bt-resistant *T. ni* colony (Bt-R) and its isogenic reverted-susceptible descendants (Bt-S) to identify, quantify, and compare fitness parameters in these lines. We quantified the expression of immune genes after ingestion of Bt, after the injection of Bt or non-pathogenic bacteria into the hemocoel, and measured the number of circulating hemocytes in resistant and susceptible *T. ni*. The Bt-S line produced a stronger immune response than the Bt-R line after ingestion of Bt, or the injection of non-pathogenic bacteria into the hemocoel. Ingestion of Bt resulted in more circulating hemocytes in the Bt-S line. The injection of Bt was lethal to both lines. The reduction in cellular and humoral immune responses in the Bt-R line suggest that there are fitness costs associated with resistance and that these immunological costs may be exploited to reduce pest populations using other biological control agents.

THERMAL LIMITS AND CARDIORESPIRATORY FUNCTION IN FISHES.

LIMITES THERMALES ET FONCTION CARDIORESPIRATOIRE

Farrell, Anthony P (*Department of Zoology and Faculty of Land and Food Systems, UBC*)

Elevated water temperature represents a formidable challenge to fishes. The main issue explored here is whether or not upper thermal limits are set by cardiorespiratory function. Using salmon as an example, a distinction will be made between the temperature limit for routine aerobic metabolism, which perhaps sets the fundamental thermal range, and the temperature limit for maximum metabolic rate, which perhaps sets the optimal thermal range. The concepts of rate limitations and capacity limitations to oxygen delivery will be discussed, alongside their mechanistic limits and flexibility. The conclusion will be that, for salmon at least, maximum heart rate may be a reliable predictor of thermal limits. In this case, there is the potential for a new line of field-based research into thermal tolerance of fishes and perhaps invertebrates. Research support provided by NSERC Canada.

EXAMINING TOXICOLOGICAL AND PHYSICO-CHEMICAL PROPERTIES OF MANUFACTURED NANOPARTICLES USING ZEBRAFISH EMBRYOS

UTILISATION D'EMBRYONS DE POISSONS ZEBRES POUR EXAMINER LES PROPRIETES TOXICOLOGIQUES ET PHYSICO-CHIMIQUES DES NANOPARTICULES ARTIFICIELLES

Felix, Lindsey (*University of Alberta*)

Goss, Greg (*University of Alberta*)

Ortega, Van (*University of Alberta*)

Examining toxicological and physico-chemical properties of manufactured nanoparticles using Zebrafish embryos The toxicological response of animals resulting from exposure to manufactured nanoparticles (NPs) is a major issue in environmental risk assessment. Manufactured NPs differ in physico-chemical properties from their bulk constituents and therefore NP interactions with organisms needs to be investigated. Characteristics such as toxicity, morphology, particle behavior and dissolution rate were examined following Organization for Economic Co-Operation and Development (OECD) guidelines. We tested polymer coated 5-6 nm aqueous metal oxide NPs, manufactured by Vive Nano Inc. Metal core materials tested included TiO₂, ZnO, FeO and CeO₂. Hollow polymer cores were tested to understand the effects of the NP shell. Zebrafish (*Danio rerio*) embryos were exposed over a 72 hour period to a range (1, 10, 50, 100 and 200mg/L) of each NP. Dynamic Light Scattering (DLS) was used to measure particle behavior, including hydrodynamic size, shape and zeta potential while metal impurities and dissolution rates were measured using Slide-A-Lyzer Dialysis Cassettes and analyzed using ICP-MS. Free metal dissolution rates between ZnO NPs and their nano-capsules, i.e. particles lacking a metal core, were also examined. Preliminary data show acute toxicity of each NP at high doses but not at environmentally relevant doses.

CHARACTERIZATION AND EXPRESSION ANALYSES OF ANTI-APOPTOTIC BCL-2-LIKE GENES NR-13, MCL-1, BCL-X1, AND BCL-X2 IN ATLANTIC COD (*GADUS MORHUA*)

CARACTÉRISATION ET ANALYSE D'EXPRESSION DES GÈNES ANTI-APOPTOTIQUES NR-13, MCL-1, BCL-X1 ET BCL-X2 CHEZ LA MORUE ATLANTIQUE (*GADUS MORHUA*)

Feng Y. Charles (*Memorial University*)

Rise, Matthew L. (*Memorial University*)

NR-13, Mcl-1, and BCL-XL are conserved, anti-apoptotic Bcl-2-like proteins that inhibit cell death by preventing mitochondrial membrane permeabilization (MMP). Given the anti-apoptotic functions of these proteins in vertebrates (e.g. human, mouse, and zebrafish) and the involvement of apoptotic regulation in immune responses, we studied the sequences of these genes and their mRNA expression in Atlantic cod (*Gadus morhua*) during innate immune responses to viral and bacterial stimuli. Based on previously generated Atlantic cod expressed sequence tags (ESTs), we identified partial cDNA sequences of putative orthologues of Atlantic cod NR-13, Mcl-1, and Bcl-X1. Using bi-directional rapid amplification of cDNA ends (RACE) and genome walking, we obtained the full-length cDNA, genomic, and promoter region sequences for these genes. In addition, partial cDNA and genomic sequences for cod Bcl-X2 (a paralogue of cod Bcl-X1) were also obtained. For these four Bcl-2-like genes, quantitative reverse transcription – polymerase chain reaction (QPCR) was used to study: 1) constitutive expression in six tissues (blood, brain, pyloric caecum, gill, head kidney, and spleen) from non-stressed juvenile Atlantic cod; and 2) expression in immune tissues (i.e. spleen and head kidney) from juvenile cod treated with formalin-killed, atypical *Aeromonas salmonicida* or polyriboinosinic polyribocytidylic acid.

EVOLUTION OF BATS

L'ÉVOLUTION DES CHAUVES-SOURIS

Fenton, Brock (*Biology, University of Western Ontario*)

Based on the anatomy of their shoulder girdles, the first known bats (from the Eocene about 52.5 million years ago) were capable of flight, but whether or not they could echolocate remains a topic of debate. The recent discovery of an unambiguous morphological indicator of laryngeal echolocation provides a way to recognize the capacity for echolocation. In this presentation I will consider the origin and diversification of bats and support the view that bats are monophyletic and that laryngeal echolocation was a feature of the immediate ancestors of bats.

THE MECHANICAL DESIGN OF RORQUAL MANDIBLES: NEW INSIGHTS FROM QUANTITATIVE COMPUTED TOMOGRAPHY

LE DESIGN MÉCANIQUE DES MANDIBULES DU RORQUAL : NOUVEAU POINT DE VUE EN UTILISANT LA TOMOGRAPHIE QUANTITATIVE INFORMATIQUE

Field, Daniel J. (*University of British Columbia*)

Goldbogen, Jeremy A. (*University of British Columbia*)

Campbell-Malone, Regina (*Woods Hole Oceanographic Institution*)

Shadwick, Robert E. (*University of British Columbia*)

Humpback whales, like other rorquals, lunge at high speeds with mouths open to nearly 90 degrees in order to engulf large volumes of prey-laden water. A whale's mandibles are exposed to high drag when they are lowered during a lunge, and therefore may be subject to significant bending forces. Quantitative computed tomography (QCT) was used to investigate the internal morphology and densitometry of a pair of sub-adult humpback whale (*Megaptera novaeangliae*) mandibles. QCT data indicated a significant increase in mineral density and cross-sectional area from the mandibular symphysis to the coronoid process, thereby providing high resistance to bending. This suggests that the mandibles function analogously to a cantilever beam. Our data contrast significantly with the mandibular flexural rigidity trends reported for right whales, which employ a passive filter feeding method. This comparison indicates that adaptive bone remodeling is a significant factor contributing to the establishment of mandibular bone density distributions in cetaceans. We conclude that the morphological design of rorqual mandibles functions to accommodate high bending forces during lunge feeding without experiencing high strain. The rorqual mandible's mechanical behaviour will be analyzed under simulated drag forces with a finite element model, which will enable us to explicitly test these conclusions.

EXERCISE INDUCES GILL REMODELLING IN GOLDFISH (*CARASSIUS AURATUS*)

L'EXERCISE PROVOQUE LE REMODELLAGE DES BRANCHIES CHEZ LE POISSON ROUGE (*CARASSIUS AURATUS*)

Fletcher, Carmen (*University of Ottawa*)

Gilmour, Kathleen M (*University of Ottawa*)

Perry, Steve F (*University of Ottawa*)

Fresh water fish face the challenge of balancing the need to maximize gill surface area for oxygen uptake with the need to reduce gill surface area to minimize ion loss and water gain via the gills. This phenomenon is known as the osmorepiratory compromise. Goldfish (*Carassius auratus*) utilize gill remodeling to cope with these opposing pressures. When oxygen is readily available and demand is low, the lamellae of the gill are covered by an interlamellar cell mass (ILCM), effectively reducing the respiratory surface area. Conversely, under low oxygen conditions or high oxygen demand, the lamellae are uncovered. To date, oxygen demand has been

manipulated by altering water temperature. Our research used exercise as a tool to examine the relationship between oxygen demand (increased aerobic metabolism) and the extent of lamellar covering. Findings to date suggest that exercise causes goldfish to uncover their lamellae. Exercise may therefore be a novel trigger for gill remodeling in goldfish. (Supported by NSERC Discovery Grants to Gilmour and Perry.)

EXPLORING THE MOLECULAR BASIS OF CARTILAGE FORMATION IN THE CEPHALOPOD SEPIA OFFICINALIS

EXPLORER LES BASES MOLÉCULAIRES DE LA FORMATION DE CARTILAGE DANS LE CÉPHALOPODE SEPIA OFFICINALIS

Focareta, Laura (*Biogem, s.c.a.r.l. Istituto di Ricerche Genetiche Gaetano Salvatore*)

Cole, Alison G. (*Biogem, s.c.a.r.l. Istituto di Ricerche Genetiche Gaetano Salvatore*)

The European cuttlefish, *Sepia officinalis*, possess cartilaginous tissues showing unparalleled histological similarity with vertebrate cartilages. By combining molecular and anatomical approaches we seek to identify genes involved in cuttlefish development, with particular attention to cartilage formation. Sox9 is considered the key transcription factor involved in vertebrate chondrogenesis. We have isolated the *Sepia* homolog of the Sox 9 gene, SoSoxE; analysis of gene expression patterns is on-going. Members of the hedgehog (hh) gene family are involved in the early patterning of mesenchyme that gives rise to vertebrate cartilage. We present the pattern of SoHh gene expression during the period of *Sepia* organogenesis. We describe hh expression in putatively neural zones, and regions of cartilage differentiation including the funnel/pallial complex and the dorsal/nuchal region of the mantle, and in regions corresponding to the cranial cartilage. Moreover, analysis of sectioned material reveal that hh expression is localized to the overlaying cuboidal epithelium of all cartilages where this epithelium is present. This expression occurs at a time period prior to the differentiation of cartilaginous tissues in the underlying mesenchyme. These data are similar to the situation in vertebrates, where hedgehog signaling from overlaying epithelium directs the underlying mesenchyme down a cartilage differentiation pathway.

KILLER WHALES OF THE WEST COAST: CULTURE, COMMUNICATION AND CONSERVATION

ÉPAULARDS DE LA CÔTE OUEST : CULTURE, COMMUNICATION ET CONSERVATION

Ford, John (Fisheries & Oceans Canada and Dept. of Zoology, University of British Columbia)

Although killer whales range throughout the world's oceans, nowhere are they more frequently found, observed and studied than along Canada's west coast. Once feared and persecuted, orcas have become an icon of the wild marine environment in British Columbia, and the star attraction of a multi-million dollar whale-watching industry. Over three decades of field research in British Columbia waters have brought this animal from the realm of myth and folklore to today being one of the best known cetaceans in the world. In this lecture, Dr. Ford will describe the results of these field studies, highlighting the foraging ecology, population dynamics, social structure and acoustic behaviour of this remarkable top marine predator. He will also discuss some of the recent conservation issues facing killer whales of the west coast, and the steps being taken to address them as part of DFO's Species-at-Risk mandate.

ESTIMATING THE NUTRITIONAL REQUIREMENTS OF THE ENDANGERED NORTH ATLANTIC RIGHT WHALE (EUBALAENA GLACIALIS) WITH A GENERALIZED BIOENERGETICS MODEL

UTILISATION D' UN MODELE BIOENERGETIQUE GENERAL POUR ESTIMER DES BESOINS NUTRITIONNELS DES BALEINES NOIRES DE L'ATLANTIQUE NORD EN DANGER D'EXTINCTION (EUBALAENA GLACIALIS)

Fortune, Sarah

Trites, W. Andrew (*University of British Columbia*)

Recovery of North Atlantic right whales, *Eubalaena glacialis*, has been limited since commercial exploitation ended in 1949. Recovery efforts are focused on preventing anthropogenic mortality from ship strikes and entanglement in fishing gear. However, changes in blubber thickness, reproductive rate, behavior and the presence of skin lesions suggest that nutritional stress may also be impeding recovery. We are assessing the nutritional stress hypothesis by quantifying the nutritional requirements of the remnant population of right whales (pop. ~350-400 individuals). We are using a bioenergetics model to estimate 1) individual annual nutritional requirements according to age, sex and reproductive state of individuals; 2) nutritional requirements for the entire population and 3) seasonal nutritional requirements of individuals. Model validation will be conducted through a sensitivity analysis of the model predictions and by comparing model outputs with estimations of North Atlantic right whale prey consumption and energy expenditure in Cape Cod Bay. Our results will provide a metric for assessing the nutritional stress hypothesis and for evaluating the nutritional value of the prey base available to right whales.

A MULTI-PRONGED MULTI-ORGANISM APPROACH TO INVESTIGATING BONE DEVELOPMENT

UNE APPROCHE MULTI-ORGANISMALE TOUS AZIMUTS POUR L'INVESTIGATION DU DÉVELOPPEMENT OSSEUX

Franz-Odendaal, Tamara (*Mount Saint Vincent University*)

Bone formation has been the subject of many studies yet there are some fundamental aspects of bone development that have been overlooked and which are not well understood. We are exploring the origin, induction and patterning of the vertebrate skeleton, with particular emphasis on the craniofacial skeleton, of which most is neural crest derived. Our primary focus has been on understanding the epithelial to mesenchymal induction of intramembranous bones in the chicken embryo. By using gene expression analyses combined with bead implantation and ex ovo culturing of embryos we have uncovered the involvement of two gene families in this mechanism. The more recent use of zebrafish by the research community, has lead us to investigate fish skeletal development in a comparative manner. This multi-organism comparative approach will ultimately help us understand how developmental mechanisms underlying bone formation may have evolved.

LATITUDINAL EFFECTS OF CLIMATE CHANGE ON LATE MIOCENE UNGULATE COMMUNITIES

LATITUDINAL EFFECTS OF CLIMATE CHANGE ON LATE MIOCENE UNGULATE COMMUNITIES

Fraser, Danielle (*The University of Calgary*)

Theodor, Jessica M. (*The University of Calgary*)

Despite the influence of latitude on modern biodiversity, its effects have been largely ignored in studies of ancient terrestrial ecosystems. In this study, I focused on the late Miocene (6.6 Ma) because environmental proxies (oceanic oxygen isotopes) indicate that the late Miocene was a time of considerable climate change. The diets of the late Miocene ungulates from two primary localities (Coffee Ranch, Texas and Cambridge, Nebraska)

showing latitudinal separation were determined using a number of dietary proxies and compared to published data sets. A speciose grazing fauna at the Coffee Ranch is indicative of a grass dominated ecosystem. Fewer grazers at Cambridge suggest a mixed tree and grass ecosystem. The results of these analyses have revealed that climate change, resulting from potential changes in atmospheric carbon dioxide, had variable effects on ecosystems at different latitudes. Because the response of ungulates to current CO₂ change may also vary with latitude it is important to understand the changes that have occurred during similar periods in earth's history.

NON-NEUTRAL SINGLE NUCLEOTIDE POLYMORPHISMS (SNPS) IN BAY OF FUNDY ATLANTIC SALMON (*SALMO SALAR*) AND THEIR USE IN POPULATION IDENTIFICATION AND CHARACTERIZATION.

SNPS NON-NEUTRES CHEZ LE SAUMON ATLANTIQUE DE LA BAIE DE FUNDY (*SALMO SALAR*) ET LEUR UTILISATION DANS L'IDENTIFICATION ET LA CARACTÉRISATION DES POPULATIONS

Freamo, Heather (*Department of Integrative Biology, University of Guelph*)

O'Reilly, Patrick (*Department of Fisheries and Oceans, Bedford Institute of Oceanography*)

Boulding, Elizabeth G (*Department of Integrative Biology, University of Guelph*)

Atlantic salmon from the Inner Bay of Fundy (iBoF) have declined during the last two decades, and in 2002 were designated by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as endangered. Distinguishing wild iBoF salmon from wild outer Bay of Fundy (oBoF) salmon and from aquaculture escapees would benefit current conservation and captive-breeding programs for iBoF salmon but has been difficult with existing neutral markers. SNPs in non-neutral genes under diversifying selection in different salmon rivers should show more genetic structure (higher *F_{st}* values) than SNPs in neutral genes. We used CIGENE's Sequenom MassARRAY™ system to genotype 11 hatchery-reared Bay of Fundy (BoF) populations for 320 SNPs within ESTs. The edited SNP data were analyzed with five different *F_{st}*-outlier detection programs. Nine non-neutral SNP markers were chosen that 1) had high-*F_{st}* values, 2) were highly-significant outliers, and 3) had maximally different allele frequencies between the iBoF and oBoF populations. We then used these nine SNP markers to genotype archived DNA samples from historical wild BoF populations using Invader™ chemistry at the Department of Fisheries and Oceans laboratory and were able to detect significant genetic differentiation between wild iBoF and wild oBoF salmon populations (funded by NSERC Strategic).

EMPLOYING MOLECULAR DIAGNOSTICS TO INVESTIGATE *LOMA MORHUA* INFECTIONS IN ATLANTIC COD

L'EMPLOI DE DIAGNOSTIQUES MOLÉCULAIRES DANS L'INVESTIGATION DES INFECTIONS AU *LOMA MORHUA* CHEZ LA MORUE DE L'ATLANTIQUE

Frenette, Aaron P. (*Department of Biology, University of New Brunswick*)

Burt, Michael D. B. (*Department of Biology, University of New Brunswick*)

Eydal, Matthias (*Institute for Experimental Pathology, University of Iceland*)

Duffy, Michael S. (*Department of Biology, University of New Brunswick*)

Loma morhua is a fungal pathogen that is limiting the production potential of the developing cod aquaculture industry in Atlantic Canada, Iceland, and Norway. This microsporidian parasite threatens aquaculture because it causes impaired growth and mortalities in both juvenile and adult cod. We sought to develop an assay for reliable diagnosis of *L. morhua*. Nucleotide variability in regions of the ribosomal DNA (rDNA) of congeneric species suggested that a reliable PCR-based assay was feasible for diagnosis of *L. morhua*. The specificity of a *L. morhua*-specific primer set was confirmed empirically using rDNA extracted from the congeneric species *L. salmonae*. Sensitivity of this assay was then assessed using twenty-two infected cod from Atlantic Canadian aquaculture sites. Diagnosis was reliable (22/22) in spite of polymorphisms in the nucleotide composition of the *L. morhua*-specific primer sites. Subsequent diagnosis of infected cod from Iceland (55/55) revealed the utility

of this assay across the home range of Atlantic cod and confirmed 100% sensitivity in diagnosis. We conclude that our species-specific primer set targets alleles that are common in the parasite population. This reliable diagnostic assay will enable important investigations into the life history of the parasite and epidemiological considerations regarding parasite transmission during aquaculture.

STIRRING UP NEW IDEAS ABOUT THE REGULATION OF THE HPI AXIS IN ZEBRAFISH (*DANIO RERIO*)

BRASSER DE NOUVELLES IDÉES À PROPOS DE LA RÉGULATION DE L'AXE HPI CHEZ LE POISSON ZÈBRE (DANIO RERIO)

Fuzzen, Meghan (*Department of Integrative Biology, University of Guelph*)

Van Der Kraak, Glen (*Department of Integrative Biology, University of Guelph*)

Bernier, Nick (*Department of Integrative Biology, University of Guelph*)

While the impact of stressors on cortisol levels in fish is well documented, much less is known about the dynamic relationships between the changes in cortisol during and after a stressor and the expression pattern of the key genes that regulate the activity of the hypothalamic-pituitary-interrenal (HPI) stress axis. After establishing a vortex stressor as a standardized stressor for zebrafish (*Danio rerio*), this study characterized its impact at all levels of the HPI axis. Whole body cortisol levels as well as the mRNA levels of key genes in the preoptic area (POA), pituitary and interrenal cells were quantified to determine the timing and magnitude of the stress response. Exposure to a moderate vortex speed was associated with rapid and marked increases in whole-body cortisol as well as POA corticotropin-releasing factor, pituitary prohormone convertase 1 (pc1), and interrenal melanocortin 2 receptor, steroid acute regulatory protein, 11 β -hydroxylase and 11 β -hydroxysteroid dehydrogenase 2 mRNA levels, while other genes were either moderately changed or unaltered. These findings suggest that multiple genes at the different levels of the HPI axis in zebrafish play an active role in the stimulation and termination of the cortisol response to an acute stressor (Supported by NSERC to GVVK and NJB).

ADAPTING TO SEAWATER ON THE FLY: THE DEVELOPMENT OF SEAWATER OSMOREGULATORY ABILITY IN JUVENILE PINK SALMON

S'ADAPTER À L'EAU DE MER À LA VOLÉ : LE DÉVELOPPEMENT DE L'HABILITÉ OSMORÉGULATRICE EN EAU DE MER CHEZ LE SAUMON ROSE JUVÉNILE

Gallagher, Zoe (*University of British Columbia*)

Brauner, Colin (*University of British Columbia*)

Farrell, Tony (*University of British Columbia*)

Pink salmon, *Onchorhynchus gorbusha*, differ from other *Onchorhynchus* spp. by migrating to seawater (SW) immediately following emergence from gravel. Other salmonids smolt and are fully prepared for SW upon leaving freshwater, but smolt status of emerging pink salmon is unknown. Juvenile *O. gorbusha* possess a remarkable ability to tolerate SW, but at as small as 0.2g upon SW entry, their large surface area to volume ratio hinders ionregulation. The physiological mechanisms that enable pinks to tolerate SW remain unclear. We characterized SW tolerance in developing pink salmon by transferring post-hatch juveniles to SW every two weeks, tracking mortality, body mass, and ion composition. Recently hatched alevins died within 5 days post SW transfer, but mortality declined to 1% at 10 weeks post-hatch, the time corresponding to gravel emergence. Mortality was associated with water loss, suggesting inadequate osmoregulation in SW immediately post-hatch. Fish surviving in SW progressively increased whole body [Na⁺] and [Cl⁻]. Because whole body ions increased relative to fish dry mass, we propose that juvenile pink salmon temporarily take on an ion load to prioritize water balance. Investigating gill function in juvenile *O. gorbusha* may further elucidate physiological factors that allow them to inhabit SW earlier than other salmonids.

MITOCHONDRIAL PLASTICITY IN THE ANOXIC TURTLE HEART

PLASTICITE MITOCHONDRIALE DU CŒUR ANOXIQUE DE TORTUE

Galli, Gina (*University of British Columbia*)

Farrell, Anthony (*University of British Columbia*)

Richards, Jeffrey (*University of British Columbia*)

In anoxia-sensitive animals, oxygen deprivation initiates a cascade of lethal events in the mitochondria which quickly culminates in cellular necrosis and apoptosis. Freshwater turtles survive up to 5 months of anoxia, suggesting mitochondrial function may be adapted in these animals to survive long periods of oxygen deprivation. To this end, we investigated respiration rates, oxygen kinetics and flux through complex I-IV of the electron transport chain (ETC) in warm normoxic, cold normoxic and cold anoxic turtles. Cardiac permeabilised fibers were isolated from all experimental groups and tested at their respective acclimation temperature and a common test temperature, to isolate the effects of acclimation. Major findings from this study were: 1) warm and cold normoxic animals had similar respiration rates and oxygen kinetics, 2) anoxic acclimation led to a profound reduction in state III respiration rates, respiratory control ratio and flux through complex I of the ETC, 3) oxygen kinetics were similar among all experimental groups. Our results demonstrate turtle mitochondrial function is dramatically reduced during anoxia. This effect occurs mainly through a downregulation of complex I of the ETC, which may also help to avoid the generation of reactive oxygen species.

SOURCE OF NOM DIFFERENTIALLY AFFECTS METAL-GILL BINDING IN RAINBOW TROUT (*ONCORHYNCHUS MYKISS*) EXPOSED TO PB-CD MIXTURE

LA SOURCE DE NOM AFFECTE LA LIAISON ENTRE LES MÉTAUX ET LES BRANCHIES CHEZ LA TRUITE ARC-EN-CIEL EXPOSÉE À DES MIXTURES DE PB-CD

Gheorghiu, Cristina (*Biology & Chemistry, Wilfrid Laurier University*)

Smith, D. Scott (*Chemistry, Wilfrid Laurier University*)

Kara, Yvonne (*Biology, Wilfrid Laurier University*)

Wilkie, Michael P. (*Biology, Wilfrid Laurier University*)

Metal bioavailability and toxicity models for aquatic organisms generally focus upon individual metals, rather than metal mixtures, commonly found in contaminated waters. The presence of natural organic matter (NOM) in such waters also protects fish against metal toxicity. Differences in the protective effects of NOM, however, are thought to be related to the molecular composition (quality) of NOM. Accordingly, three types of NOM (terrigenous, autochthonous, mixed source) were collected from different sites in Ontario (Luther Marsh, Lake Ontario, Bannister Lake). Rainbow trout were then exposed to Cd-Pb mixtures ($\text{Cd} < 500 \text{ nmol L}^{-1}$; $\text{Pb} < 1000 \text{ nmol L}^{-1}$) in the presence of each type of NOM (4 mg C L^{-1}). Without NOM, Pb-gill accumulation was lowered 25-50 % in the presence of Cd, but more so in the presence of NOM, with the greatest protection conferred by terrigenous NOM (by 90-100%). Notably Cd-gill accumulation was greater by 40-100% in the presence of Pb plus Luther Marsh NOM, but surprisingly the more lightly coloured autochthonous NOM was protective, lowering Cd-gill accumulation by 30%. We conclude that NOM may not always be protective against metal-gill binding, when fish are exposed to metal mixtures due to differences in NOM quality and/or different metal combinations.

THE ROLE OF PKA IN REGULATING CONTRACTILE FUNCTION IN THE RAINBOW TROUT HEART

ROLE DU PKA DANS LA REGULATION DE LA CONTRACTILITE DU CŒUR DE LA TRUITE ARC-EN-CIEL

Gillis, Todd E. (*University of Guelph*)

Robertson, Andrew (*University of Guelph*)

Klaiman, Jordan (*University of Guelph*)

The contraction of cardiomyocytes is regulated, in part, by the ability of the actin thin filament to sense and respond to changes in intercellular calcium. One cellular mechanism involved in regulating this ability is the β -adrenergic response that results in increased activity of protein kinase A (PKA) within the cell. PKA targets a number of proteins, including cardiac troponin I (cTnI), and myosin binding protein-C. In mammals, the result of such phosphorylation is an increase in the rate of contraction caused by increased rates of crossbridge cycling. We have cloned cTnI from trout and found that it lacks a critical N-terminal peptide. In mammalian cTnIs as well as those from birds, amphibians and reptiles this peptide contains two PKA targets. The goal of this study is to determine how this sequence difference influences the ability of PKA to regulate the contractility of the trout heart. To accomplish this we are characterizing how PKA alters the rate of crossbridge cycling in trout cardiac tissue as well as the ability of skinned cardiac trabeculae to generate force in response to calcium. We have also expressed trout cTnI and are characterizing how it regulates the calcium activation of the troponin complex following phosphorylation.

SWIM PERFORMANCE AND BIOENERGETIC EFFECTS OF URANIUM MILLING EFFLUENT EXPOSURE IN SPOTTAIL SHINER (*NOTROPIS HUDSONIUS*)

PERFORMANCE DE NAGE ET EFFETS BIOÉNERGÉTIQUES DE L'EXPOSITION À L'EFFLUENT D'UNE USINE D'URANIUM CHEZ NOTROPIS HUDSONIUS

Goertzen, Meghan (*Toxicology University of Saskatchewan*)

Hauck, Dominic (*Toxicology Centre, University of Saskatchewan*)

Phibbs, James (*Toxicology Centre, University of Saskatchewan*)

Weber, Lynn (*Toxicology Centre, University of Saskatchewan*)

Janz, David (*Toxicology Centre, University of Saskatchewan*)

The Key Lake uranium milling operation (Saskatchewan, Canada) releases complex effluent into the local watershed that we hypothesized to have ecophysiological effects on native fish. Critical swimming speed did not differ significantly in juvenile spottail shiner (*Notropis hudsonius*) collected from the exposure versus reference lake ($n=8-17$ fish, $p>0.05$ in one-way ANOVA). Captured fish used in swim tests were considered fatigued. In both non-fatigued (non-swam) and fatigued fish, liver glycogen was significantly greater in fish from the exposure compared to the reference site ($p<0.05$ for site and fatigue factors in two-way ANOVA). While there was no difference in plasma lactate or liver triglycerides in non-fatigued fish between sites, lactate was greater and triglycerides decreased after swimming only in reference fish. In non-fatigued fish, plasma glucose did not significantly differ between sites, but significantly decreased after swimming only in exposure site fish. In contrast, swimming significantly increased hematocrit in fish from the reference site, while non-fatigued exposure site fish had elevated hematocrit that failed to further increase with swimming. In summary, non-fatigued fish from the exposure site demonstrated signs of metabolic stress, yet exposure site fish had greater energy stores and retained similar swimming ability compared to fish from the reference site.

SKULL AND BUCCAL CAVITY ALLOMETRY INCREASE MASS-SPECIFIC ENGULFMENT CAPACITY IN FIN WHALES

L'ALLOMÉTRIE ENTRE LE CRÂNE ET LA CAVITÉ BUCCALE AUGMENTE LA CAPACITÉ D'ENGLOUTISSEMENT CHEZ LE RORQUAL COMMUN

Goldbogen, Jeremy (*University of British Columbia*)

Rorqual whales (Balaenopteridae) represent not only some of the largest animals of all time, but they also exhibit a wide range in intraspecific and interspecific body size. Balaenopterids are characterized by their extreme lunge feeding behavior, a dynamic process that involves the engulfment of a large volume of prey-laden water at a high energetic cost. To investigate the consequences of scale and morphology on lunge feeding performance, we determined allometric equations for fin whale body dimensions and engulfment capacity. Our analysis demonstrates that larger fin whales have larger skulls and larger buccal cavities relative to body size. Together, these data suggest that engulfment volume is also allometric, increasing with body length as $L_{\text{body}}^{3.5}$. The positive allometry of the skull is accompanied by negative allometry in the tail region. The relative shortening of the tail may represent the cost of investing all growth related resources in the anterior region of the body. Although enhanced engulfment volume will increase foraging efficiency, the energetic cost will also be relatively higher in larger rorquals. This may limit diving capacity and access to the densest prey patches in the deep ocean, thereby imposing a limit on maximum body size in this lineage.

THE ROLE OF THE SODIUM BICARBONATE COTRANSPORTER IN THE ANTERIOR GUT ALKALINISATION OF THE Aedes Aegypti MOSQUITO MIDGUT

LE RÔLE DU COTRANSPORTEUR DE BICARBONATE DE SODIUM DANS L'ALKALINISATION DE L'INTESTIN ANTÉRIEUR DU MARINGOUIN Aedes Aegypti

Goss, Greg G (*Department of Biological Sciences, University of Alberta, Edmonton, Alberta*)

Ralph, Allison (*Department of Biological Sciences, University of Alberta, Edmonton, Alberta*)

Bugiak, Brandie (*Department of Biological Sciences, University of Alberta, Edmonton, Alberta*)

Moffatt, David (*School of Biological Sciences, Washington State University, Pullman, Washington*)

The anterior midgut of larval mosquitoes and other dipterans is known to generate a strong luminal alkalisation of up to pH 12. However, the mechanism by which this happens remains unresolved. In previous studies, it was demonstrated that serotonergic activation of the anterior midgut activates a H^+ -ATPase mediated alkalisation of the luminal pH. We subsequently demonstrated that in concert with the serotonin application, intracellular pH (pHi) is elevated above pH 8.8. We postulated that this pHi elevation would allow for an apical sodium bicarbonate transporter (NBC) to export bicarbonate and carbonate and thereby alkalinize the lumen. Here we report the cloning and characterization of the expression pattern of the electrogenic NBC in larval *Aedes aegypti* mosquitoes. Two splice variants of the single NBC gene were found in the completed *Aedes* genome. Quantitative PCR demonstrated high levels of expression of NBC in the anterior midgut compared to the gastric caeca, posterior midgut or Malpighian tubules. We postulate that the NBC on the apical surface of the anterior midgut is an integral part of the luminal alkalisation process.

INDUCIBLE DEFENSES IN AN INVADDED MARINE FOOD CHAIN: WHY CUE SPECIFICITY MATTERS.

DÉFENSES INDUCTIBLES DANS UNE CHAÎNE ALIMENTAIRE MARINE ENVAHIE : POURQUOI LA SPÉCIFICITÉ DES SIGNAUX EST IMPORTANTE

Grason, Emily W (*Western Washington University*)

Miner, Benjamin G (*Western Washington University*)

Inducible defenses are important in structuring native communities, but it is often assumed that they do not play a significant role in novel predator-prey interactions because prey cannot recognize a novel predator. However, recent research has demonstrated that novel predators can induce defenses in prey. We investigated whether predation cues from the native rock crab, *Cancer productus*, induce behavioral defenses in two invasive species of whelk, the Atlantic (*Urosalpinx cinerea*), and Japanese (*Ocenebrina inornata*) oyster drills. Both drill species increased avoidance behavior and decreased feeding rates by 48% - 67% in response to effluent from native crabs consuming conspecific drills. To determine which components of the predation cues drills respond to, we conducted an additional experiment with Atlantic drills, parsing the predation effluent into major constituents. Cues from injured conspecifics elicited the largest responses, and were similar in effect to cues from predators consuming conspecifics. Additionally, cues from crabs also induced defenses, though more weakly than cues from injured conspecifics. The response to crabs indicates drills can recognize a relatively novel predator. Further, the generalized risk assessment strategy of Atlantic drills could have adaptive value in new habitats where drills are exposed to unfamiliar predators.

CONTRASTING RESPONSES TO THERMAL ACCLIMATION IN ALLIGATOR AND TROUT: HOW TO RESPOND WHEN THERMOREGULATION IS POSSIBLE?

COMMENT FAIRE L'ACCLIMATATION THERMIQUE SI ON FAIT DE LA THERMOREGULATION: COMPARAISON DES RÉPONSE DE L'ALLIGATOR ET DE LA TRUITE

Guderley, Helga (*Dép. de biologie, Université Laval*)

Seebacher, Frank (*School of Biological Sciences, University of Sydney*)

In contrast to gill breathing fish whose temperature follows that of their habitat, crocodilians are practiced behavioural thermoregulators that change their regulated temperature, thermal optima for performance and metabolic capacities seasonally. We examined whether the digestive and locomotor systems of alligators show parallel metabolic adjustments to temperature. Although body temperatures of winter and summer acclimated alligators differed by 10°C, their growth was equivalent. Cold acclimation increased oxidative capacities of hepatic mitochondria, but had the opposite effect on muscle mitochondria. The aerobic capacity of liver, muscle and duodenum, as estimated by COX activities, increased with cold acclimation. Calculations based on COX and CS activities in isolated mitochondria and tissue extracts established that cold acclimation did not change mitochondrial content in liver but markedly increased that of muscle. These patterns suggest that cold acclimation enhanced the aerobic capacity of liver by “improving” mitochondria while it increased mitochondrial content in muscle. The thermal compensation of growth rates and aerobic capacity of the locomotor and digestive systems suggests that alligators optimised metabolic processes for the seasonally altered, preferred body temperature. The precision of this compensatory response exceeds that typically shown by fish whose body temperatures are at the mercy of their habitat.

TSETSE EP PROTEIN: A NOVEL IMMUNORESPONSIVE MOLECULE THAT INFLUENCES TSETSE VECTOR COMPETENCE

TSETSE EP PROTEIN: UNE NOUVELLE MOLECULE IMMUNOSENSIBLE QUI INFLUENCE LA COMPETENCE VECTORIELLE DE LA MOUCHE TSE-TSE

Haines, Lee (*Liverpool School of Tropical Medicine, Pembroke Place, Liverpool, UK*)

African trypanosomes undergo a complex developmental cycle in their tsetse fly vector before transmission back into a vertebrate host. Typically 90% of fly infections fail, most during initial establishment of the parasites in the fly midgut. The specific mechanism(s) underpinning this innate refractoriness are unknown. We have previously reported that the tsetse fly, in response to gram-negative microbial challenge, up regulates a *Glossina*-

specific, immunoresponsive molecule called the tsetse EP protein. Here we show, by RNA interference, that this tsetse EP protein acts as an antagonist of trypanosome establishment in the fly midgut. We demonstrate that this phenomenon exists in two species of tsetse, *Glossina morsitans morsitans* and *Glossina palpalis palpalis*, suggesting that tsetse EP protein may be a major determinant of vector competence in all *Glossina* species. The knockdown of tsetse EP protein also resulted in a significant increase in the prevalence of midgut infections with both *T. b. brucei* and *T. congolense*. This elevated susceptibility to trypanosome infection following gene knockdown was witnessed with all ages of tsetse investigated. In addition, this refractorial capacity increases with fly age. Tsetse EP protein levels naturally decline in response to starvation, suggesting the increased susceptibility to trypanosome infection of starved flies may be linked to tsetse EP protein levels. As starvation is a common field event, this fact may be of considerable importance in the epidemiology of African trypanosomiasis.

THE INSIDE STORY ON PARALLELISM ILLUSTRATED BY THE MULTIPLE ORIGINS OF CARTILAGE

LES DESSOUS DU PARALLÉLISME ILLUSTRÉS PAR L'ORIGINE MULTIPLE DU CARTILAGE

Hall, Brian K (*Dalhousie University*)

After a brief overview of the concept and term “parallelism” and its relation to convergence and homoplasy I will turn to an examination of the evolution of a single tissue, cartilage. Although regarded as a vertebrate tissue and synapomorphy, tissues that share many of the features of vertebrate cartilage are found in numerous lineages of invertebrates. Indeed, these tissues may share more features with vertebrate cartilage than the latter shares with cephalochordate (amphioxus) cartilage. Vertebrate cartilage also shares many features with notochord, which is a synapomorphy of chordates. I will discuss the features of these various tissues in the context of parallel evolution between major animal groups and address the issue of whether cartilage had one or multiple evolutionary origins. I will then turn to the concept of parallel evolution of cartilage(s) within individual vertebrate taxa, thereby extending the concept of parallelism to the evolution of a homologous tissue from developmentally and evolutionarily independent cell lineages. Examples will include mesodermal and neural crest-derived cartilage, axial and appendicular cartilages, and endoskeletal vs. extraskkeletal (sesamoid) cartilages, all of which share the features of cartilage but evolved in parallel. Supported by NSERC of Canada (Grant A5056)

THE ROLE OF ADRENALINE HANDLING IN HIGH TEMPERATURE TOLERANCE OF MIGRATING ADULT SOCKEYE SALMON POPULATIONS

LE RÔLE DU TRAITEMENT DE L'ADRÉNALINE DANS LA TOLÉRANCE AUX HAUTES TEMPÉRATURES CHEZ DES POPULATIONS MIGRATRICES DE SAUMONS SOCKEYE

Hanson, Linda (*Department of Zoology, University of British Columbia*)

Eliason, Erika (*Department of Zoology, University of British Columbia*)

Whitney, Charlotte (*Faculty of Forestry, University of British Columbia*)

Gale, Marika (*Faculty of Forestry, University of British Columbia*)

Hinch, Scott (*Faculty of Forestry, University of British Columbia*)

Farrell, Anthony (*Department of Zoology, University of British Columbia*)

Since adrenaline is critical in maintaining maximum cardiac performance at high temperature in rainbow trout, we hypothesized that differences in cardiac adrenoceptors might contribute to the different temperature tolerances and cardiorespiratory performances of Fraser River sockeye salmon populations. To test this hypothesis, we compared ventricular adrenoceptor density (Bmax) and binding affinity (Kd) of two wild, adult sockeye salmon populations (Chilko and Late Stuart/Stellako) with different athletic abilities and temperature tolerances. The more athletic and eurythermal Chilko population had a significantly greater Bmax compared

with the Stellako population across three different acclimation temperatures (13°C, 19°C, or 21°C). Moreover, Bmax in Chilko fish actually increased with temperature acclimation, unlike in Stellako, where Bmax remained constant. This result contrasts sharply with literature for trout and other salmon populations, which suggests Bmax decreases with acclimation temperature, and implies temperature-induced adrenoceptor downregulation does not occur in all salmonid populations. We suggest that this novel pattern of cardiac Bmax upregulation supports the unique life history of Chilko sockeye, who are among the migration champions of the Fraser River sockeye and experience a wide range of upriver migration temperatures (~10-22°C). Supported by NSERC.

THE MOLECULAR BASIS FOR TOOTH REPLACEMENT IN SQUAMATES

MODELE MOLECULAIRE DU REMPLACEMENT DES DENTS CHEZ LES SQUAMATES

Handrigan, Gregory R. (*Department of Oral Health Sciences, UBC*)

Leung, Kelvin J. (*Department of Oral Health Sciences, UBC*)

Richman, Joy M. (*Department of Oral Health Sciences, UBC*)

Tooth replacement is a feature of most dentate vertebrates from fish to humans and yet the process is poorly understood, mainly due to lack of appropriate experimental models. Here we study several oviparous squamates because they replace their teeth throughout life (polyphyodont). The leopard gecko was used to determine whether there are stem cells in the dental epithelium. A pulse-chase experiment identified slow cycling cells in the dental lamina just adjacent to the successional lamina. A subset of these cells express the gene *Lgr5* and three other markers of adult stem cells, suggesting that they are putative stem cells. The second part of our work used the snake to pinpoint the molecular signals that promote the repeated establishment of the successional lamina for each tooth generation. We found that Wnt signaling promotes proliferation in the successional lamina and that Shh acts in a negative feedback loop to restrict Wnt signaling. In this manner uncontrolled budding of new teeth is prevented. We propose dual roles for Wnt signaling in maintaining the dental epithelial stem cells and promoting successional lamina formation. Funding was provided by NSERC grants to JMR. GRH was funded by NSERC and MSFHR awards.

VARIATION IN TENACITY AND TUBE FOOT MORPHOLOGY AMONG SEA STARS FROM DIFFERENT WAVE EXPOSURE REGIMES

VARIATION DE LA TENACITE ET DE LA MORPHOLOGIE DES PEDICELLES D'ETOILES DE MER EXPOSEES A DIFFERENTS REGIMES DE VAGUES

Hayne, Kurtis (*Department of Biological Sciences, University of Alberta*)

Echinoderms, particularly sea stars, have specialized attachment mechanisms allowing them to temporarily adhere to a substrate and then release; these attachment and release cycles are responsible for locomotion while maintaining attachment to the substratum. Many marine organisms exhibit plastic responses to different wave exposure regimes that reduce probability of dislodgement in exposed areas. *Pisaster ochraceus* a cosmopolitan pacific sea star can be found in almost all gradients of wave exposure and has been shown to display adaptive features to these various flow conditions, showing differential attachment tenacities based on differential ambient flow.

AEROBIC SCOPE, GROWTH, REPRODUCTION AND TEMPERATURE IN THE COMMON KILLIFISH, FUNDULUS HETEROCLITUS

ENVERGURE AÉROBIQUE, CROISSANCE, REPRODUCTION ET TEMPÉRATURE CHEZ FUNDULUS HETEROCLITUS

Healy, Timothy M. (*University of British Columbia*)

Schulte, Patricia M. (*University of British Columbia*)

The loss of aerobic scope, difference between maximum and resting oxygen consumption, has been suggested to limit both organismal performance and tolerance as temperature changes. In particular, aerobic scope at acclimation temperatures is thought to limit both growth and reproduction. We measured the change in mass, gonado-somatic index and aerobic scope of common killifish (*Fundulus heteroclitus*) at acclimation temperatures ranging from 5 to 33 degrees Celcius. *F. heteroclitus* is an intertidal salt-marsh minnow with two regionally distinct subspecies distributed along the east coast of North America. One subspecies, *F. heteroclitus macrolepidotus*, is found in the northern half of the species range, and the other subspecies, *F. heteroclitus heteroclitus*, is found in the southern half of the species range. As a result, these subspecies experience temperatures that are, on average, approximately 13 degrees Celcius apart, and have differences in maximum thermal tolerance when held at constant temperatures. Our data suggest that, at least for the northern subspecies, growth and reproductive effort do not correlate with aerobic scope, but that loss of aerobic scope at high temperatures may contribute to the upper thermal limit of acclimation. Furthermore, changes in aerobic scope may also explain the subspecies differences in acclimation limits.

HAGFISH SLIME MUCIN VESICLE DEPLOYMENT: CHARACTERIZING THE VESICLE MEMBRANE

LE DÉPLOIEMENT DE LA VÉSICULE DE SUBSTANCE VISQUEUSE DE LA MUCINE : CARACTÉRISATION DE LA MEMBRANE DE LA VÉSICULE

Herr, Julia (*University of Guelph*)

Goss, Greg (*University of Alberta*)

Fudge, Douglas (*University of Guelph*)

When agitated, Atlantic hagfish (*Myxine glutinosa*) produce a unique slime which is reinforced by intermediate filament-enriched fibres. Mucins, which represent the mucus component of the slime, are packaged into membrane-bound mucin vesicles. These vesicles are released from the hagfish's slime gland via holocrine secretion. Upon contact with seawater, the mucin vesicles swell and rupture nearly instantaneously, releasing their contents to interact with the fibrous threads for the creation of mature slime. The vesicles also rupture when exposed to solutions of mono- and multivalent cations (e.g. Na⁺, K⁺, Ca²⁺), and monovalent anions (e.g. Cl⁻). We therefore hypothesized that the vesicle membrane possesses ion channels that make it permeable to these ions. Consequently, rupture occurs when Na⁺ and Cl⁻ ions from seawater follow their diffusion gradient and enter the vesicle, causing a secondary influx of water molecules, which ruptures the vesicle. We tested this hypothesis by conducting vesicle rupture assays in the presence of ion channel inhibitors and by the detection of ion channel proteins using immunofluorescence. We present some of the findings from these experiments here.

NEUROTRANSMITTER FUNCTIONS IN THE PLACOZOAN TRICHOPLAX ADHERENS

FONCTIONS DES NEUROTRANSMETTEURS CHEZ LE PLACOZOIRE TRICHOPLAX ADHERENS

HEYLAND Andreas (*University of Guelph*)

GOODALL Sophie (*University of Guelph*)

SOHN, Dosung (*The Whitney Laboratory for Marine Biosciences, University of Florida*)

LEYS, Sally (*University of Alberta, Biological Sciences*)

MOROZ L., Leonid (*The Whitney Laboratory for Marine Biosciences, University of Florida*)

Trichoplax adhaerens is an enigmatic disk-like animal consisting of only four morphologically identifiable cell types arranged into 3 layers – surface, middle and lower. The animal lacks anterior-posterior polarity, but shows distinct dorsal-ventral surfaces through intriguing righting behavior, and the presence of gland cells with digestive function in the ventral epithelium. In the absence of sufficient morphological characters its phylogenetic placement has long been controversial and recent molecular data have not been able to resolve the issue. The recently released genome reveals several genes coding for neurotransmitter synthesis enzymes and neuroendocrine signaling molecules. Thus the study of placozoans may provide insights into the early evolution of the nervous system. Using electron and light microscopy we characterized cell types by morphology, and we used histochemical markers for tubulin, actin and neuron-associated genes to identify cells with neuron-like properties. We also used cell cycle markers to identify regions of active cell division to identify the progenitors for each cell type. Studies to assess the involvement of specific cells in coordinating behaviours in the whole animal are in progress and will provide a better insight into how this basal animal functions.

STELLER SEA LIONS MODULATE BRADYCARDIA IN RESPONSE TO ACTIVITY AND DIVE DEPTH

LES LIONS DE MER DE STELLER MODULENT LEUR BRADYCARDIE EN RÉPONSE À L'ACTIVITÉ ET À LA PROFONDEUR DE PLONGÉE

Hindle, Allyson (*University of British Columbia*)

Young, Beth (*University of British Columbia*)

Rosen, David (*University of British Columbia*)

Haulena, Martin (*Vancouver Aquarium*)

Trites, Andrew (*University of British Columbia*)

Foraging marine mammals must balance the costs of exercise (i.e., higher oxygen use, muscle perfusion and heart rates) with the seemingly contradictory oxygen-sparing diving adaptations required to maximize the time they spend underwater. We explored the relationship between heart rate and activity in Steller sea lions trained to dive up to 40m depths voluntarily. Diving heart rates declined 40% from resting rates, and were 9% lower during shallow (10m) compared to deep (40m) dives. Mean diving heart rate only declined with dive duration for shallow dives. Heart rate over the entire dive-surface cycle was not affected by dive depth. Mean ODBA (a measure of 3-D activity) was 18% higher during shallow dives, and correlated negatively with dive duration. Diving heart rate-activity correlations during shallow dives suggest some vascular compromise between diving and exercise. Correlations between underwater activity and heart rate over complete dive-surface cycles presumably suggest some recovery from underwater exercise is deferred into the post-dive surface period. Instantaneous heart rate did not track activity levels (instantaneous ODBA) during deep dives, suggesting these parameters are uncoupled during deeper dives. On balance, it appears that under specific conditions, diving bradycardia in Steller sea lions is modulated by dive characteristics, including activity.

A MECHANISM OF MOLYBDENUM TRANSPORT IN RAINBOW TROUT (ONCORHYNCHUS MYKISS) GILL EPITHELIA.

MECANISME DE TRANSPORT DU MOLYBDENE DANS L'EPITHELIUM DES BRANCHIES DE LA TRUITE (ONCORHYNCHUS MYKISS)

Hoekstra, Jeffrey (*University of British Columbia Okanagan*)

Reid, Scott (*University of British Columbia Okanagan*)

The objective of this study was to gain insight into the molybdenum transport mechanism in the gills of trout. We have previously shown that molybdenum is transported across the gill by a yet unknown saturable

mechanism. It is our hypothesis that molybdenum, as the oxyanion molybdate, has the potential to be transported via sulfate transport mechanisms. To test this hypothesis, juvenile rainbow trout (203-235 g) were exposed to 0.2 mg.l⁻¹ radiolabeled sulfate (³⁵SO₄²⁻) alone or in combination with to 20 mg.l⁻¹ molybdate (MoO₄²⁻). Whole body, blood, plasma and gill sulfate uptake and, through competition, molybdenum uptake were determined. Additional experiments involved the isolation and fractionation of gill epithelial cells in juvenile trout similarly exposed to ³⁵SO₄²⁻ alone or in combination with molybdate. The finding of this study indicate that molybdenum is transported across the gill as the oxyanion molybdate and competes with sulfate for a common gill transport mechanism. Furthermore, we provide evidence that the PNA⁺ cells are the site of sulfate/molybdate transport in the gills of trout.

INTRACELLULAR PH REGULATION DURING HYPERCAPNIA IN A CULTURED RAINBOW TROUT HEPATOMA CELL LINE (RTH 149)

RÉGULATION DU PH INTRACELLULAIRE DURANT L'HYPERCAPNIE DANS LA LIGNÉE CELLULAIRE HÉPATOME (RTH 149) D'UNE TRUITE ARC-EN-CIEL CULTIVÉE

Huynh, K. T. (UBC)

Baker, D. W. (UBC)

Harris, R. (UBC)

Church, J. (UBC)

Brauner, C. J. (UBC)

Fish exposed to aquatic hypercarbia (elevated environmental CO₂) experience a rapid acidification in both intra- and extra-cellular compartments. While recent work on intracellular pH (pHi) regulation in fish has identified a number of potentially important acid-base relevant trans-membrane transporters during normoxia and hypoxia, the effect of elevated CO₂ on pHi regulation is less understood. Using pH-sensitive fluoroprobe BCECF and flow cytometry, we measured pHi in RTH 149 cell line in real-time during extracellular acidification by either HCl or CO₂ (1, 3 and 6 kPa pCO₂) and/or intracellular acidification by NH₄Cl prepulse. We determined that RTH 149 did not regulate pHi in response to extracellular acidification. In response to acid loading through ammonia prepulse, however, their pHi recovered close to resting levels within four minutes. This recovery was abolished by the NHE blocker, EIPA. Interestingly, the pH regulatory response induced by NH₄Cl was significantly reduced during simultaneous exposure to elevated CO₂, suggesting that extracellular acidification may inhibit transporter function. We noted some striking similarities between our findings and those from experiments on neonatal rat neurons, emphasizing the evolutionary importance of these regulatory mechanisms.

THE INFLUENCE OF DIETARY CALORIC INTAKE ON CAUDAL REGENERATION IN JUVENILE LEOPARD GECKOS (EUBLEPHARIS MACULARIUS).

L'INFLUENCE DE LA CONSOMMATION DE CALORIES ALIMENTAIRES SUR LA RÉGÉNÉRATION CAUDALE DU GECKO EUBLEPHARIS MACULARIUS

Hynes, Sabrina (University of Calgary)

Russell, Anthony (University of Calgary)

Caudal autotomy, or voluntary tail loss, is widespread among lizards and is assumed to function in predator escape. Various impacts and costs are associated with tail loss and subsequent regeneration; however, the consequences for juveniles and females are not well understood. Caudal autotomy and regeneration are likely to occur relatively early in life, before sexual maturity. Therefore, energy may be diverted from general body growth into tail regeneration. In female lizards, this could delay growth and impact future reproductive output, because caudal fat stores provide most of the energy used in vitellogenesis. The impacts of caudal autotomy are being investigated by: 1) observing the impact of tail loss on juveniles experiencing conflicting demands of body growth and tail regeneration, when food is constrained; and 2) assessing how metabolic rate varies when

energetic intake differs. Groups of juvenile leopard geckos (*Eublepharis macularius*) were raised on high, medium and low diets of mealworms. The following hypotheses will be discussed: 1) following autotomy in juveniles, energy directed towards tail regeneration will result in a decrease in growth rates of experimental animals, relative to controls; and 2) demands of tail regeneration will trigger a decrease in metabolic rates of regenerating animals compared to non-regenerating.

THE GENERATION AND USE OF TRANSGENIC INSECTS TO REDUCE PARASITE TRANSMISSION: VIABLE ALTERNATIVE TO EXISTING STRATEGIES?

PRODUCTION ET UTILISATION D'INSECTES TRANSGENIQUES POUR REDUIRE LA TRANSMISSION PARASITAIRE: EST-CE UNE ALTERNATIVE VIABLE AUX STRATEGIES DEJA EXISTANTES?

James, Anthony A. (*Department of Microbiology & Molecular Genetics, University of California*)

Population replacement strategies using genetically-engineered, parasite-resistant mosquitoes offer the possibility of the sustainable vector control needed to achieve the goal of malaria eradication. The major hypothesis guiding this research is that an increase in the frequency of a gene or allele that confers decreased vector competence to a population of mosquitoes will result in a reduction in the incidence and prevalence of malaria. Key to testing this hypothesis is producing mosquito strains that are incapable of transmitting malaria parasites. We are developing strains of an urban vector, *Anopheles stephensi*, that express specific effector molecules that interfere completely with the transmission of the important human malaria parasite, *Plasmodium falciparum*. To achieve this, the transgenic strains must express effector genes in specific mosquito tissues, the effector gene products must be present in quantities sufficient to disable all parasites, and the gene products must not impose too great a fitness burden. We are optimizing expression of single-chain antibodies (scFv) that disable *Plasmodium falciparum* in the midgut and hemolymph of transgenic *An. stephensi*, constructing and testing in parasite-challenge assays transgenic mosquitoes carrying single and multiple optimized scFvs for their ability to prevent parasites from infecting midguts and salivary glands, and evaluating the fitness of strains carrying the transgenes. Transgenic lines carrying these genes decrease the prevalence and mean intensities of infection when compared to controls following challenge assays with parasites. The success of these efforts fosters optimism that they will have a role in strategies adopted to eradicate malaria.

THE EFFECTS OF ELEVATED WATER TEMPERATURE ON ADULT SOCKEYE SALMON GENE EXPRESSION AND BLOOD PHYSIOLOGY

EFFETS DE LA TEMPERATURE ELEVEE DE L'EAU SUR L'EXPRESSION DES GENES ET SUR LA PHYSIOLOGIE SANGUINE CHEZ LES SAUMONS ROUGES ADULTES

Jeffries, Ken (*University of British Columbia*)

Hinch, Scott (*University of British Columbia*)

Sierocinski, Thomas (*University of British Columbia*)

Pavlidis, Paul (*University of British Columbia*)

Miller, Kristi (*Fisheries and Oceans Canada*)

Peak summer temperatures in the Fraser River, B.C., have increased ~2°C in the past 60 years and are expected to increase another 2°C by the end of the century. In recent years, some stocks of Fraser River sockeye salmon (*Oncorhynchus nerka*) have encountered water temperatures ~3-5°C warmer than temperatures that they have historically encountered. In some cases, sockeye migrate in river water with temperatures that approach their stock-specific thermal limits. Elevated river water temperatures have been associated with higher en route and prespawn mortality in Pacific salmon. We collected wild Fraser River sockeye and exposed them to different

temperature treatments in a controlled laboratory environment to evaluate the effect of water temperature on survival and physiology. Fish were live sampled for blood and gill tissue before and during the temperature exposure period (and as they became moribund) to evaluate how water temperature affects blood variables and gill tissue gene expression. Salmonid cDNA microarrays were used to detect changes in gene expression and to determine biological processes in gill tissue that are influenced by elevated water temperature. These results will provide insight into the potential consequences of elevated water temperatures on Pacific salmon survival and physiology during spawning migrations.

EFFECT OF TEMPERATURE, HYPOXIA AND HYPERCAPNIA ON THE FICTIVE BREATHING RESPONSE OF CANE TOADS (BUFO MARINUS)

EFFET DE LA TEMPERATURE, DE L'HYPOXIE ET DE L'HYPERCAPNIE SUR LA REPONSE RESPIRATOIRE FICTIVE DES CRAPAUDS GEANTS (BUFO MARINUS)

Jenkin, Sarah (*University of Toronto (Scarborough campus)*)

Reid, Stephen G. (*University of Toronto (Scarborough campus)*)

While toads aestivate during the summer months, they are exposed to chronic hypoxia (CH) and chronic hypercapnia (CHC). CH leads to a decrease in the fictive breathing response in pH/CO₂ chemoreceptor sensitivity. The opposite is true for CHC. Using in vitro brainstem-spinal cord preparations, this study investigates the effect of relative environmental temperatures (hot, room, cold) on the fictive breathing response of cane toads. Results show that hot temperatures exaggerate the effects of CHC, increasing the breathing response, while cold temperatures exaggerate the effects of CH, decreasing the breathing response. The breathing response is measured from the vagus nerve of the toads. The data suggests that pH/ CO₂ chemoreceptor sensitivity is also dependent on temperature.

ALPHA-GAL MODIFICATIONS OF PARASITE GLYCOPROTEINS: IMMUNE EVASION VIA MOLECULAR MIMICRY

MODIFICATIONS ALPHA-GAL DES GLYCOPROTÉINES DE PARASITE : ÉVASION IMMUNITAIRE VIA MIMÉTISME MOLÉCULAIRE

Fitzpatrick, Jennifer (*University of New Brunswick*)

Bedford, Riiko (*University of New Brunswick*)

Duffy, Michael (*University of New Brunswick*)

Parelaphostrongylus tenuis is a parasitic nematode of white-tailed deer in eastern North America. Adult parasites survive within the central nervous system for up to six years, indicating that host immune responses are evaded or modulated. We discovered that the parasites produce a molecular pattern observed commonly on mammalian host cells. Alpha-Gal is a disaccharide that appears to disguise the parasite as “self”, thereby capitalizing on immune regulatory processes that are essential to prevent autoimmune pathology. This “self-tolerance” likely prevents the host from mounting an effective immune response and thereby promotes parasite survival by molecular mimicry. Adult parasites were collected from hunter-killed deer and were cultured in vitro to collect proteins secreted from the excretory glands. Proteins were separated using SDS PAGE and were screened in Western blots using an anti-alpha-Gal monoclonal antibody (mAb M86). Numerous proteins were modified with alpha-Gal but their specific identification awaits 2D gels and mass spectrometry. Immunohistochemistry localized the alpha-Gal-modified glycoproteins to the excretory gland in the anterior end of worms. Specific identification of these glycoproteins will aid in determining a functional role for the excretory glands, two giant cells that remain poorly characterized in parasitic nematodes.

DOSE-RESPONSE CURVES OF MORPHINE IN BROOK CHARR (*SALVELINUS FONTINALIS*)

COURBES DOSE-REponses DE LA MORPHINE CHEZ L'OMBLE DE FONTAINE (*SALVELINUS FONTINALIS*)

Jones, Sarah (*Graduate Student*)

The CCAC has acknowledged that fish “may have the capacity to experience adverse states usually associated with pain in mammals”. Currently there aren’t specific guidelines regulating pain control in fish. Fish are becoming more common research and it is important to define a protocol to ensure proper health and welfare in fish. Morphine is the analgesic of choice for pain reduction in humans and has also been used in fish. Brook Charr were challenged with an electrical stimulus-response test both before and after an intraperitoneal dose of morphine. Blood and brain samples were analyzed using LC-MS to measure the quantity of morphine in fish plasma and 3 parts of the brain. Our objective is to relate the change in stimulus threshold to the dose of morphine and to its concentration in the plasma and the brain.

CORRELATING BLOOD VESSEL AND SCLERAL PAPILLAE DEVELOPMENT IN THE CHICKEN EYE.

CORRÉLATION ENTRE VAISSEAU SANGUIN ET LE DÉVELOPPEMENT DE LA PAPILLA SCLÉRALE DANS L'ŒIL DU POULET

Jourdeuil, Karyn (*Dalhousie University*)

Franz-Odendaal, Tamara (*Mount Saint Vincent University*)

The development of the sclerotic ring is a highly regulated and patterned process, yet many of the pathways that regulate this development are not yet understood. It has been observed that the scleral papillae, which induce the formation of ossicles in a 1:1 ratio, have a very specific developmental pattern and that the first papilla always forms directly above the first branch of the ciliary artery. In order to determine whether there is a correlation between the patterning of blood vessel development and that of the scleral papillae, direct observation and fluorescent microscopy were performed on the eyes of chickens at each half stage from H.H. stage 29-36. Analysis of these results seems to indicate that there is no visible blood vessel formation during H.H. stage 29-33.5 and that a capillary network begins to form at stage 34. Since this meshwork is forming once the papillae ring is complete, it seems unlikely that blood vessels are having an effect on scleral papillae development. However this capillary network appears only shortly before condensation formation at H.H. stage 38. Further investigation in this field could yield significant insight into the mechanisms of skeletogenic condensation formation.

PLAUSIBILITY OF THE NOVEL STRUCTURE - ONTOGENY AND FUNCTION OF “SUCTION DISC” IN BRANCHIURA (CRUSTACEA)

PLAUSIBILITE DE STRUCTURE NOUVELLE - ONTOGENESE ET FONCTION DE LA VENTOUSE DE SUCCION CHEZ LES BRANCHIOURES (CRUSTACES)

Kaji, Tomonari (*Institute of Geosciences, Shizuoka University, Japan*)

Many examples of novel structure, however, show a distinct unicity which is difficult to bridge the ancestral character. The difficulty is caused by the absence of these transitional states. Derived branchiurans have a pair of “suction disc” to attach their host. The suction disc is a modified first maxilla. Namely, the first maxilla transforms from a normal segmented appendage to the specified suction disc through the ontogeny. While, the ancestral branchiuran genus *Dollops* lacks the suction disc and the first maxilla remains as a segmented appendage throughout the ontogeny. Accordingly, the developmental process of suction disc is recapitulate the evolutionary process. This case can show a transitional process of emerging novelty, and help to solve the

enigma of plausibility in novel structure. This research describes the musculoskeletal ontogeny of the suction disc in *Argulus coregoni*, and discusses the maintaining of the functional correlation between muscle and exoskeleton according to the origin of novelty.

BEHAVIOURAL AND PHYSIOLOGICAL CONSEQUENCES OF DIETARY SELENOMETHIONINE EXPOSURE TO ADULT ZEBRAFISH (*DANIO RERIO*)

CONSÉQUENCES COMPORTEMENTALES ET PHYSIOLOGIQUES DE L'EXPOSITION À LA SÉLÉNOMÉTHIONINE ALIMENTAIRE CHEZ LE POISSON ZÈBRE ADULTE (*DANIO RERIO*)

Kallarakavumkal Thomas, Jith (*Toxicology Centre, University of Saskatchewan, Saskatoon, SK, Canada*)

Selenomethionine (SEM) is the major form of organoselenium present in food. Early life stages of oviparous vertebrate species, especially fish, are highly susceptible to dietary selenium (Se) exposure, however less is known concerning effects in adults. The present study was designed to investigate behavioural and physiological consequences of dietary SEM exposure to adult zebrafish. Adult fish were fed varying concentrations of Se (1, 3, 10 and 30 µg Se/g, dry weight) in the form of SEM for 60 days. At the end of the exposure period, critical swimming speed (Ucrit), whole body cortisol levels and whole body bioenergetics (triglyceride and glycogen) status of fish were determined. Impaired swimming performance was observed in 3, 10 and 30 µg Se/g fed fish. Cortisol production in the 30 µg Se fed group was greater than control food (1 µg Se) fed fish. Higher triglyceride and glycogen levels were observed in 10 and 30 µg Se fed groups compared to control. Our results suggest that dietary SEM exposure can alter behavioural and physiological responses in adult fish, and such consequences could threaten fitness of adult fish in natural environments.

EFFECTS OF SUBLETHAL, CHRONIC ANIONIC AND CATIONIC POLYMER EXPOSURE ON JUVENILE AND EMBRYONIC *ONCORHYNCHUS MYKISS*.

EFFETS D'EXPOSITIONS SUBLETALES ET CHRONIQUES DE POLYMERES ANIONIQUES ET CATIONIQUES SUR LES TRUITES JUVENILES ET EMBRYONNAIRES (*ONCORHYNCHUS MYKISS*)

Kerr, Jennifer L. (*Clearflow Enviro Systems Group, Inc.*)

Deck, Pierce (*Dept of Biological Sciences, University of Alberta*)

Goss, Greg G. (*Dept of Biological Sciences, University of Alberta*)

Polymers are commonly used to clarify water and prevent soil erosion. While cationic polymers display significant biological toxicity, newer anionic polymers are generally considered to be non-toxic to aquatic life. However, to ensure a greater level of safety, chronic effects of these chemicals on aquatic organisms required study. We examined gill histopathology in juvenile rainbow trout (*O. mykiss*) exposed to 10 different anionic and one cationic polymer products. Juvenile fish were exposed to polymers for up to 30 days. Overall, gill histopathology indicated very mild to no damage noted with exposure to the majority of anionic polymer blends and concentrations tested. Higher, non-environmentally relevant, concentrations were associated with very moderate levels of interlamellar hyperplasia, mucous metaplasia and epithelial swelling/apoptosis for a small number of polymer blends. Mortality levels were within acceptable limits for all anionic polymer blends and concentrations. We also examined percent survival and hatch in rainbow trout embryos exposed to anionic polymer blends for the duration of their developmental period. Embryonic percent survival was not impacted by polymer exposure except for one polymer blend where survivorship was reduced by ~12% compared to control. While some hatch delay was observed with specific polymer blends, embryos appeared to be normal.

REVIEW OF TAXONOMIC ISSUES IN THE CANADA LYNX (LYNX CANADENSIS): IMPLICATIONS FOR CONSERVATION

UN AUTRE REGARD SUR LA TAXONOMIE DU LYNX DU CANADA (LYNX CANADENSIS) AVEC IMPLICATIONS SUR LA CONSERVATION DE L'ESPÈCE

KHIDAS, KAMAL (*Canadian Museum of Nature, Ottawa*)

HUYNH, HOWARD M. (*Biology Department, Acadia University, Wolfville*)

DUHAIME, JOHANNIE (*Biology Department, University of Ottawa, Ottawa*)

MCALPINE, DONALD F. (*New Brunswick Museum, Saint John*)

BULL, ROGER D. (*Canadian Museum of Nature, Ottawa*)

Three subspecies are currently recognized in the Canada lynx, *Lynx canadensis*, on the basis of fur colouration and size, but past morphometric studies have failed to reveal significant differentiation. While most of the species range occurs in mainland Canada, there are two geographically disjunct populations, in Newfoundland and in Cape Breton Island (CBI), Nova Scotia. Such isolation may have a significant impact on the ecology, evolution, and conservation of these populations. We investigated skull morphometric variation in populations spanning the species' geographic range. Craniodental measurements were taken from voucher specimens deposited in museum and university collections. Multivariate analyses revealed morphological differentiation between the lynx from Newfoundland and mainland Canada, suggesting that *L. canadensis subsolanus* is a valid subspecies. In addition, the CBI lynx appeared to be sufficiently distinct to warrant new subspecific designation, a result that has not been reported in the scientific literature. We also present morphological data on recently described hybridization between lynx and bobcats, *Lynx rufus*, and discuss the associated biological and conservation issues and the implications to the endangered lynx populations of Atlantic Canada. Genetic studies, beginning with the confirmation of the microsatellite profile of hybrids, are underway to assess the extent of this phenomenon.

CORTICOSTERONE PROMOTES AIR BREATHING IN *XENOPUS LAEVIS* TADPOLES

LA CORTICOSTÉRONE AUGMENTE LA RESPIRATOIRE AÉRIENNE CHEZ LE TÊTARD *XENOPUS LAEVIS*

Kinkead, Richard (*Département de Pédiatrie, Université Laval*)

Stéphanie Fournier (*Département de Pédiatrie, Université Laval*)

The developmental mechanisms underlying the emergence of air breathing are poorly understood. In amphibians, metamorphosis is a crucial step in the transition from aquatic to air breathing which is triggered and regulated by a series of neuroendocrine events. However, the potential impact of hormones such as corticosterone on the neural circuits that generate air breathing is unknown. To address this issue, we tested the hypothesis that corticosterone promotes air breathing in *Xenopus laevis* tadpoles. Using an in vitro brainstem preparation to record the neural correlates of gill and air breathing, we first compared fictive air breathing frequency before and after bath application of corticosterone (100 nM). Corticosterone increased fictive air breathing frequency from 0.1 to 4 breaths/min (40 fold increase) but decreased fictive gill breathing frequency (from 81 to 19 breaths/min). We then addressed the potential mechanisms by testing the hypothesis that corticosterone affects GABAergic neurotransmission. Prior to corticosterone treatment, bath application of GABA (0.001 to 0.5 mM) increased fictive air breathing frequency in a dose-dependent fashion; pre-treatment with corticosterone inversed this relationship. The increase in corticosterone that occurs during metamorphosis may be an important factor in the preparing the respiratory control system for air breathing. Maturation of GABAergic neurotransmission appears to be an important mechanism.

THE EFFECTS OF TEMPERATURE ACCLIMATION ON THE CARDIAC ACTIN-MYOSIN ATPASE AND CARDIAC PROTEOME OF RAINBOW TROUT

LES EFFETS DE L'ACCLIMATION À LA TEMPÉRATURE SUR L'ATPASE DE L'ACTINE-MYOSINE CARDIAQUE ET SUR LE PROTÉOME CARDIAQUE DE LA TRUITE ARC-EN-CIEL

Klaiman, Jordan (*Department of Integrative Biology, University of Guelph, Guelph, Ontario*)

Fenna, Andrew (*Faculty of Life Sciences, University of Manchester, Manchester, UK*)

Shiels, Holly (*Faculty of Life Sciences, University of Manchester, Manchester, UK*)

Gillis, Todd (*Department of Integrative Biology, University of Guelph, Guelph, Ontario*)

Rainbow trout remain active between ~4°C and ~20°C. This ability is remarkable considering that in most endotherms a reduction in body temperature typically results in heart failure. The aims of this study were (1) examine the effects of temperature acclimation on the Ca²⁺ sensitivity and activity of trout ventricular actin-myosin ATPase (AM•ATPase) and (2) characterize the cardiac proteome of the trout in response to thermal acclimation. Trout were acclimated for two months to 4°C, 12°C or 17°C. Ventricular myofilaments were isolated and AM•ATPase activity was measured at 17°C and 7°C. The 4°C acclimated trout have higher maximal rates of AM•ATPase, when assayed at 17°C, compared to 17°C acclimated trout without a change in Ca²⁺ sensitivity. Furthermore, 17°C acclimated trout have a linear response to Ca²⁺ when assayed at 7°C representing a significant loss of its ability to regulate with small changes in [Ca²⁺]. To investigate the regulatory mechanisms that may be responsible for these changes in function we used 2D-DIGE to characterize the cardiac proteome of these trout. We found that thermal acclimation causes a change in the phosphorylation state of a number of cardiac regulatory proteins. These differences are likely responsible for the observed changes in enzyme activity.

COPPER AND NICKEL TOXICITY IN THE LARVA OF THE YELLOW FEVER MOSQUITO, AEDES AEGYPTI.

TOXICITE DU CUIVRE ET DU NICKEL CHEZ LA LARVE DU MOUSTIQUE RESPONSABLE DE LA FIEVRE JAUNE, AEDES AEGYPTI

Kotzeva, Lilia D. (*University of British Columbia Okanagan*)

Rheault, Mark R (*University of British Columbia Okanagan*)

Currently, the mechanism of nickel and copper toxicity in larval *Aedes aegypti* remains to be elucidated. The acute toxic effects of nickel and copper on 4th instar *Aedes aegypti* were examined. 4th instar *Aedes aegypti* larvae were exposed to Known concentrations of nickel and copper in both fed and unfed treatments. Fed and unfed treatments of the same concentration for each metal were tested to account for the affects of starvation. The 24 hour LC50 value for unfed nickel treatments was found to be 27.24mM, while fed treatments were found to be 25% more toxic. The 24 hour LC50 value for unfed copper treatments was found to be 1.63mM, while fed treatments were found to be 28% less toxic. Subsequently, larvae were exposed to concentrations of nickel and copper below the 24hr LC50 value for each metal. Haemolymph samples were collected to determine the amount of each metal present in larval haemolymph and thus relevant physiological concentrations at which to examine metals excretion in larval renal tissue (Malpighian tubules). Water sample, haemolymph sample and secreted fluid sample concentrations were determined by Ion Coupled Plasma Mass Spectrometry.

CHRONIC EXPOSURE TO POLLUTION AND NOT MACROPARASITES IS CORRELATED WITH THERMAL STRESS TOLERANCE IN JOHNNY DARTERS (*ETHEOSTOMA NIGRUM*)

EXPOSITION CHRONIQUE À LA POLLUTION ET NON AUX MACROPARASITES EST CORRÉLÉ AVEC LA TOLÉRANCE AU STRESS THERMAL CHEZ LE RASEUX-DE-TERRE NOIR (*ETHEOSTOMA NIGRUM*)

Krause, Rachel (*McGill University*)

McLaughlin, J. Daniel (*Concordia University*)

Marcogliese, David (*Environment Canada*)

Thermal stress, pollution and parasitic infections are three stressors commonly encountered by freshwater fish in natural environments, and exposure to one or more of stressor may impact tolerance of fish to additional stressors. In this study, we investigated the effects of naturally-acquired macroparasite infections and exposure to chronic, sublethal levels of pollution on the thermal tolerance of johnny darters (*Etheostoma nigrum*). We collected johnny darters from three polluted and two reference localities in the St. Lawrence River in southwestern Quebec. In the laboratory, we tested their thermal tolerance using the dynamic critical thermal maximum method, whereby fish are exposed to a steadily increasing temperature until the initiation of opercular spasms. Studies published in the literature suggest that infection with macroparasites can significantly decrease fish's tolerance to heat stress, but analysis of our data using nonparametric stepwise regressions of parasitism by species and by organs infected showed no significant effect of parasites on the thermal tolerance of this species. Exposure to pollution, however, appears to be positively correlated with tolerance to heat stress.

TRANSCELLULAR AND PARACELLULAR REGULATION OF NA BALANCE IN ACID-EXPOSED ZEBRAFISH

RÉGULATION TRANSCELLULAIRE ET PARACELLULAIRE DE LA BALANCE DE NA CHEZ DES POISSONS ZÈBRES EXPOSÉS À L'ACIDE

Kumai, Yusuke (*University of Ottawa*)

Bahubeshi, Amin (*McGill University*)

Steele, Shelby (*University of Ottawa*)

Perry, Steve (*University of Ottawa*)

Freshwater fish maintain their body fluids hyperionic to the environment.. Theoretically, ionic regulation could be achieved by regulating transcellular ion uptake and/or paracellular diffusive ion loss. Paracellular flux of ionic as well as non-ionic solutes is controlled by tight junctions (TJ); research on the potential contribution of TJs to fish ionic homeostasis has increased markedly in recent years. To determine if disturbances in ion homeostasis modify TJs and paracellular ion loss, we acclimated zebrafish (*Danio rerio*) to low pH (3.9 - 4.0) water for 2 weeks and measured unidirectional Na⁺ efflux and influx rates, membrane permeability (as assessed by uptake of 3H-PEG) and the mRNA expression level of 17 claudin isoforms and 2 occludins, two major regulatory proteins of TJs. Membrane permeability was slightly reduced over the course of two week acclimation to acidic water and expression of 9 isoforms of claudins was significantly increased during the acclimation. Surprisingly, the increases in Na⁺ efflux elicited by exposure to low pH water were not attenuated over the course of acclimation. However, Na⁺ uptake was significantly increased leading to regulation of whole body Na⁺ levels. These observations imply that regulation of paracellular flux is playing a limited role in Na⁺ homeostasis in zebrafish during exposure to acidic water.

SEXING FROGS USING PCR: CYP19 AROMATASE IS AN EARLY OVARIAN DIFFERENTIATION MARKER

SEXAGE DES GRENOUILLES PAR LE PCR: LA CYP19 AROMATASE EST UN MARQUEUR PRECOCE DE LA DIFFERENCIATION OVARIENNE

Laia Navarro-Martín *Department of Biology, University of Ottawa, Ottawa, ON, Canada)*

Chantal Lanctôt *(Department of Biology, University of Ottawa,)*

Vance L. Trudeau* *(Department of Biology, University of Ottawa,)*

Poikilothermic vertebrates exhibit a large variety of sex determination mechanisms. Particularly, frogs follow a genetic sex determination mechanism, but most species lack distinguishable sex chromosomes. For this reason no common sex determination genes or sex markers have yet been found in frogs. However, sex differentiation mechanisms are highly conserved in lower vertebrates and candidate genes have been identified in fish. In this study we sampled wood frog (*Rana sylvatica*) tadpoles at different Gosner stages (from 30 to 42). We analyzed by real time-PCR the expression of the steroidogenic enzymes *cyp17* (a 17- α -hydroxylase) and *cyp19* (the enzyme converting androgens to estrogens), and the *cyp19* transcription factor *foxl2*. Our results show the existence of two clear expression groups, presumptive females and presumptive males with respectively high versus low *cyp19* plus *foxl2* levels. However this pattern was not evident with *cyp17*. We can conclude that, as in teleost fish, gonadal *cyp19* is a good candidate to be used as an early marker of ovarian differentiation in frogs. Funded by NSERC and part of the Long-term Experimental Wetlands Area (www.lewa.ca) group.

THE ROLE OF AMP-ACTIVATED PROTEIN KINASE IN METABOLIC RATE SUPPRESSION IN HEPATOCYTES FROM THE COMMON GOLDFISH CARASSIUS AURATUS

LE RÔLE DES PROTÉINE KINASES ACTIVÉES PAR L'AMP DANS LA SUPPRESSION DU TAUX MÉTABOLIQUE DANS LES HÉPATOCYTES DU POISSON ROUGE COMMUN CARASSIUS AURATUS

Lau, Gigi *(University of British Columbia)*

Richards, Jeffrey *(University of British Columbia)*

Metabolic rate suppression (MRS) is an important response during environmental perturbation to maintain energy homeostasis. A hypoxia-tolerant cell will reduce energy expenditure by reversibly down-regulating ATP-consuming pathways to match the decreased oxygen-dependent energy production during hypoxia. AMP-activated protein kinase (AMPK) is activated by a decrease in cellular energy status and is thought to play an important role in coordinating the metabolic responses leading to MRS. To examine the importance of AMPK in MRS, we pharmacologically manipulated AMPK activity in goldfish hepatocytes and looked at the subsequent effects on cellular metabolic rate (measured as MO₂) and protein synthesis rates. Pharmacological activation of AMPK by 100 mM AICAR (5-aminoimidazole-4-carboxamide riboside) under normoxic conditions caused a 6.8-fold increase of AMPK activity and resulted in a 25% decrease in MO₂. Further analyses from Western blots and cell-free protein translation assay will reveal the effects of AMPK on MO₂ via protein synthesis through elongation factor-2.

The cost of success: Biophysical consequences of tetrodotoxin resistance in the garter snake, *Thamnophis sirtalis*

Lee, Chong Hyun *(Simon Fraser University)*

Jones, David K. *(Simon Fraser University)*

Sarhan, Maen *(University of British Columbia)*

Ahern, Christopher *(University of British Columbia)*

Ruben, Peter C. *(Simon Fraser University)*

Tetrodotoxin (TTX) is a potent toxin that specifically binds to voltage-gated sodium channels (NaV). TTX

binding physically blocks the flow of sodium ions through NaV, preventing action potential generation and propagation. Populations of the garter snake, *Thamnophis sirtalis*, have evolved TTX resistance by substituting amino acid residues in the highly conserved domain IV P-loop of NaV1.4, allowing them to feed on tetrodotoxic newts, *Taricha granulosa*. Different populations of the garter snake have different degrees of TTX-resistance closely related to the number of amino acid substitutions. We tested the voltage dependence, kinetics, and ion selectivity of NaV1.4 containing sequences from one TTX-sensitive and two TTX-resistant garter snake populations. We observed significant changes in voltage dependent gating properties of the TTX resistant NaV. Neither activation nor fast inactivation was significantly affected by the substitutions. In contrast, significant depolarizing shifts in slow inactivation were observed in both TTX-resistant channels, meaning fewer channels are available for activation. Ion selectivity and permeability of TTX-resistant channels were also significantly different from those of the TTX-sensitive channel. These results suggest TTX resistance comes at a cost to channel performance caused by changes in the gating properties and ion selectivity of TTX-resistant sodium channels.

CHARACTERIZATION OF A CRUSTACEAN CARDIOACTIVE PEPTIDE AND ITS RECEPTOR IN THE BLOOD-FEEDING INSECT, *RHODNIUS PROLIXUS*

CARACTÉRISATION D'UN PEPTIDE DE CARDIOACTIVE DE CRUSTACÉS ET DE SON RÉCEPTEUR DANS LA PROLIXUS RHODNIUS INSECTE, SANG-ALIMENTATION

Lee, Do Hee (*Department of Cell and Systems Biology, University of Toronto Mississauga*)

Paluzzi, Jean-Paul (*Department of Cell and Systems Biology, University of Toronto Mississauga*)

Orchard, Ian (*Department of Cell and Systems Biology, University of Toronto Mississauga*)

Lange, Angela (*Department of Cell and Systems Biology, University of Toronto Mississauga*)

The blood-gorging bug, *Rhodnius prolixus*, is a major vector of Chagas' disease in Central and South America. Crustacean cardioactive peptide (CCAP) is a neuropeptide found in invertebrates that has multifunctional roles, including a cardioactive action on insect heart. In *R. prolixus*, the function of CCAP is unknown, and this study aims to elucidate the role of CCAP in this important disease vector. We have cloned and characterized the CCAP gene (*RhoprCCAP*) and have partial sequences for the CCAP receptor gene in *R. prolixus*. The *RhoprCCAP* gene contains five exons and four introns, and encodes a 129 amino acid prepropeptide, which, following post-translation processing, produces CCAP. The predicted CCAP amino acid sequence is identical to that of crustaceans and other insects. *RhoprCCAP* mRNA is observed in the central nervous system (CNS) using reverse transcriptase (RT) PCR, but not in the gut and salivary glands. In situ hybridization reveals that the expression of *RhoprCCAP* mRNA is localized to a small number of dorsally situated bilaterally-paired neurons within the CNS which also contain CCAP. A partial sequence of the CCAP receptor gene has been isolated and is being used to identify target tissues for CCAP.

DETERMINING VENTILATORY COST IN RED-EARED SLIDERS (*TRACHEMYS SCRIPTA ELEGANS*): COMPARISON OF THREE METHODS

DÉTERMINATION DES COÛTS RESPIRATOIRES CHEZ *TRACHEMYS SCRIPTA ELEGANS* : COMPARAISON DE TROIS MÉTHODES

Lee, Stella (*University of British Columbia*)

The oxidative cost of ventilation is associated with the work required to overcome the elastic and flow resistive forces associated with breathing. These forces vary widely as a function of the structure of the lungs and the body wall and the oxidative costs as a proportion of resting metabolic rate will depend on the costs of other metabolic activities. In reptiles, particularly turtles, the lungs are relatively compliant whereas the body wall with the carapace is very stiff. The relative cost to turtles of ventilation has been controversial for the past few decades with different studies using different methods producing different results. In an attempt to resolve this controversy, the present study obtained data using three different methods in a single group of red-eared sliders. The regression method produced highly variable results (individual variability, differences between use of hypoxia and hypercapnia, evidence of hypercapnia-induced metabolic suppression). The unidirectional ventilation method produced paradoxical results (it was more costly not to breathe than to breathe).

Preliminary results using a hybrid method are more promising and suggest that the relative cost of breathing at 20°C is roughly 15% of resting metabolic rate. Supported by the NSERC of Canada.

HOW THE TURTLE MAKES ITS PALATE WITHOUT PALATAL SHELVES

COMMENT LA TORTUE CONSTRUIT SON PALAIS SANS LAMES PALATINES

Leung, K.J. (*Department of Oral Health Sciences, UBC*)

Richman, J.M. (*Department of Oral Health Sciences, UBC*)

Our goals are to characterize ontogeny of the turtle palate which has a unique morphology when compared to its unfused reptilian cousins. *Emydura subglobosa* embryos were obtained from the Toronto Zoo and staged according to Werenberg et al. (2009). Sections of s.4 embryos showed that the maxillary prominences were positioned at the lateral edges of the oral cavity and medial bulges were evident in a similar position to the nascent palatal shelves of other amniotes. The most striking result was that despite the early medial bulges, no palatal shelves formed. Moreover, a palatine bone differentiated however it formed beneath the nasal cavity instead of within palate shelf mesenchyme. Gene expression and cell proliferation data in s.4 embryos was similar to that reported for mouse embryos. From these proliferation and expression data on early embryos, our next step is to determine whether lack of palatal shelf extension is due to a failure to maintain relatively high proliferation or other molecular cues. Our preliminary conclusions are that the turtle bony secondary palate may not be evolutionarily homologous to the mammalian palate since it forms via different morphogenetic mechanisms and serves different functions.

This project was funded by an NSERC grant to JMR.

INVESTIGATING THE PHYLOGEOGRAPHY OF THE GREATER SHORT-HORNED LIZARD (PHRYNOSOMA HERNANDESI) IN ALBERTA

INVESTIGATION DE LA PHYLOGÉOGRAPHIE DU LÉZARD PHRYNOSOMA HERNANDESI EN ALBERTA

Leung, Magdalene (*University of Calgary*)

Russell, Anthony

The endangered Greater Short-horned lizard is the only lizard native to Alberta. Across southeastern Alberta its geographic distribution is patchy, being restricted to four main clusters -- South Saskatchewan river, Manyberries, Chin Coulee and the Milk river region. The total Albertan population is small, with an upper estimate of 6,379 individuals. Very little is known about historical patterns of colonization or the effects of current land use on the population structure of these lizards. Mapping the taxon's population patterns over the landscape following retreat of the ice-sheet 10kYA and subsequently during the dry xerothermic period (6kYA-4kYA) may help to explain current distribution patterns in Alberta. Furthermore, exploring the potential effects of recent anthropogenic activity (oil and gas drilling and irrigation practices) may also help shed light on their role in shaping current distribution patterns. Using various molecular markers sequenced from tail-tips, we are (1) investigating how horned lizards (re)-colonized Alberta following the retreat of the Laurentide ice-sheet (10kYA) and were effected by the intrusion of the dry xerothermic period, and (2) exploring the effects of landscape-scale habitat alteration on the connectivity between and within population clusters. We report on initial findings based upon mtDNA and nuclear DNA analyses.

THE ROLE OF HEAT SHOCK IN REGULATING HEMATOPOIESIS AND APOPTOSIS IN THE NUCLEATED RED BLOOD CELLS OF RAINBOW TROUT (*ONCORHYNCHUS MYKISS*)

LE RÔLE DES COUPS DE CHALEUR DANS LA RÉGULATION DE L'HÉMATOPOÏÈSE ET DE L'APOPTOSE CHEZ LES ÉRYTHROBLASTES DE LA TRUITE ARC-EN-CIEL (*ONCORHYNCHUS MYKISS*)

Lewis, Johanne M. (*Department of Biology, University of Ottawa*)

Klein, Georgia (*Department of Biology, Mount Allison University*)

Walsh, Patrick J. (*Department of Biology, University of Ottawa*)

Currie, Suzanne (*Department of Biology, Mount Allison University*)

Heat shock protein (Hsp) induction in nucleated red blood cells (rbcs) of rainbow trout in response to acute heat stress is well established. It has also been shown in both rbcs and fish that age results in a reduced heat shock response. Thus, we hypothesized that the proteins of the hemoglobin rich mature rbcs would be more vulnerable to damage during acute heat exposure and would be more susceptible to removal from the circulation by cell death pathways. In addition, potential reduction in oxygen carrying capacity due to removal of older, hemoglobin rich cells may stimulate hematopoiesis. Measurements of rbc morphology, the ratio of immature to mature rbcs in circulation, as well as markers of apoptosis (caspase 3/7 activity and DNA fragmentation) and hematopoiesis (upregulation erythropoietin mRNA in hematopoietic tissues) were performed to test this hypothesis. Preliminary results indicate there is no significant change in rbc volume (hematocrit) or age composition of the rbcs in circulation between control and heat shocked fish. Also, a lack of DNA fragmentation and inhibition caspase 3/7 activity with heat shock suggests that the heat shock response prevents apoptosis in the rbc.

MECHANICAL PROPERTIES OF FIN WHALE ARTERIES—HOW CETACEANS HANDLE PRESSURE

LES PROPRIÉTÉS MÉCANIQUES DES ARTÈRES DU RORQUAL COMMUN (BALAENOPTERA PHYSALUS): COMMENT LES CÉTACÉS SUPPORTENT DES PRESSIONS ÉLEVÉES.

Lillie, Margo A (*Departmentt of Zoology, Univeristy of British Columbia*)

Gosline, John M (*Departmentt of Zoology, Univeristy of British Columbia*)

Shadwick, Robert E (*Department of Zoology, Univeristy of British Columbia*)

Cetacean vascular systems have adapted to diving, but the impact of varying compressive forces on diving animals is not well studied. Tissue pressures at depth may vary regionally due to local rigid and compressible structures, and cetaceans have an extensive system of arterial rete that may modulate these regional pressure differences through their capacity to accommodate shifting blood pools. Arteries inflate due to a transmural pressure—the intra-arterial pressure minus the surrounding tissue pressure—and these pressures change on diving. Intra-arterial pressure is the cardiac pressure plus the thoracic pressure, so any difference between the thoracic and local tissue pressure would affect the transmural pressure. Since arterial structure and mechanical properties generally reflect the loads they experience, we inflated fresh fin whale arteries to investigate whether they are specialized for diving. Most arteries tested became remarkably stiff circumferentially when pressurized above 2-5 kPa, likely due to collagen, but were not as stiff longitudinally. These properties differ from typical terrestrial mammals. Circumferential stiffness would protect the arteries from over-inflation damage and maintain a constant diameter despite varying transmural pressures. Individual retial vessels were also stiff and displayed little volume capacitance, although their large number could give retial tissue a capacitance function.

VARIATIONS IN PHYSICAL PROPERTIES OF BOTTLENOSE DOLPHIN (TURSIOPS TRUNCATUS) FOREHEAD TISSUES: POTENTIAL FOR ECHOLOCATION THERMOREGULATION

VARIATIONS DES PROPRIETES PHYSIQUES DES TISSUES DU FRONT CHEZ LE GRAND DAUPHIN (TURSIOPS TRUNCATUS): POTENTIEL POUR L'ECHOLOCATION ET LA THERMOREGULATION

Lin, Charlie (*University of British Columbia*)

Cranford, Ted (*San Diego State University*)

Shadwick, Robert (*University of British Columbia*)

The bottlenose dolphin possesses a lipid-rich melon in the forehead through which echolocation sounds are propagated. Previous studies have demonstrated that the physical properties of the melon can function as an acoustic lens to focus and transmit ultrasounds. Recent imaging studies have also shown that these animals may be able to fine-tune such ultrasounds via blood flow. The goal of this study was to investigate whether changes in tissue temperature could affect sound propagation and act as a viable regulatory mechanism for echolocation. 53 roughly 1cm³ tissue samples representing different tissue types and positions around the melon were extracted from the head of a postmortem adult male Tursiops with the aid of x-ray CT scans. Sound waves of 15KHz were used to measure sound speed in the rostral-caudal and lateral direction of each sample, which were submerged in cold (~5°C) and warm (~38°C) water baths prior to measurement. The results show a negative relationship between temperature and sound speed in blubber and melon tissues, but a positive relationship in muscles. These 1-2% changes in sound speed support the idea that temperature changes via thermoregulation could be important to impedance matching and the echolocation system.

THE VIABILITY OF CONIFER SEEDS AS MAJOR NUTRIENT RESOURCES TO RODENTS

LA VARIABILITÉ DES GRAINES DE CONIFÈRES COMME SOURCE MAJEURE DE NUTRIMENTS POUR LES RONGEURS

Lobo, Nikhil (*Department of Biology, University of Western Ontario*)

Millar, John S. (*Department of Biology, University of Western Ontario*)

Conifer seeds are a component of the diet of many rodents, but it is not known whether these seeds are nutritionally sufficient as a major food source to rodents. Investigating this is critical to understanding how individual rodents utilize conifer seeds, and how their populations interact with seed production by coniferous trees. We examined the effects of conifer seed-diets on survival, body condition, and feeding behaviour of deer mice (*Peromyscus maniculatus*) and southern red-backed voles (*Myodes gapperi*). Experiments were conducted using lodgepole pine (*Pinus contorta*), white spruce (*Picea glauca*), and subalpine fir (*Abies lasiocarpa*) seeds. Most voles fed subalpine fir seeds lost considerable body mass and had to be euthanized, whereas all mice survived to the end of the experiment in each group. Body masses of mice fed subalpine fir seeds also decreased early in the experiment, but they compensated behaviourally (food intake) and morphologically (gut dimensions) to maintain long-term body condition. On the other hand, voles did not respond sufficiently to the low quality of subalpine fir seeds, and therefore suffered severe consequences. Our results indicate that conifer seeds are a sufficient nutrient resource for mice, but cannot be used by primarily herbivorous voles as a major/sole food source.

WHY ARE PROXIMATE PARASITE COMMUNITIES SIMILAR?

LA RELATION ENTRE LA DISTANCE ET LA RESSEMBLANCE DES COMMUNAUTÉS PARASITAIRES

Locke, Sean (*Environment Canada*)

McLaughlin, J. Daniel (*Concordia University*)

Marcogliese, David (*Environment Canada*)

Numerous studies have documented a tendency for parasite communities that are closer together in space to be more similar than distant ones. Two mechanisms have been advanced to explain this widely observed relationship. Distant parasite communities may tend to be dissimilar because distant habitats tend to be dissimilar or, alternatively, because organisms are less likely to disperse across greater distances. If the dispersal mechanism is more important, then the decrease of similarity with distance should be less pronounced in communities of parasites with higher dispersal abilities. In this study, parasites were surveyed in six fish species (*Notemigonus crysoleucas*, *Pimephales notatus*, *Perca flavescens*, *Etheostoma nigrum*, *Lepomis gibbosus*, *Ambloplites rupestris*, total n=705) collected from six localities in the St. Lawrence River. In our results, the

relative strength of the distance-similarity relationship was not consistent among guilds of low or high dispersal parasites across all six host species, providing indirect support for habitat gradients as the mechanism behind the decay of parasite community similarity with distance. This is the first study to examine the relationship between parasite-community similarity and distance in multiple sympatric host species. We evaluate this relationship at the scale of the individual host, the host population and the host community.

DIFFUSION PROPERTIES OF THE GOLDENROD BALL GALL

PROPRIETES DE LA DIFFUSION CHEZ LE FIEL BALLE D'OR

Long, Qian (*Brock University*)

Tattersall, Glenn J. (*Brock University*)

For insects that live within plants, gas exchange is potentially limited by the mass of solid plant tissue. Gall-producing insects spend a significant part of their life cycle within such an environment. However, since the plant ultimately reacts to insect stimuli to form a gall, the insect might be in a position to modify gall tissue permeability to gases. Alternatively, the insect's physiology could be adapted to withstand the conditions in its own gall. As part of a study on the oxygen supply of the gall-making insect *Eurosta solidaginis*, direct measurements on the rate of oxygen diffusion through gall tissue were attempted using a custom-built diffusion chamber. The typical time taken for the fractional oxygen content to increase from 1% to 20% inside a nitrogen-filled metal chamber covered by dead, dry gall tissue was under 20 minutes. Re-moistened tissue increased the duration by at least 10-fold, not accounting for water loss during the experiment. The wet tissue could be considered an analogy to living galls that occur during the spring or summer, or to dry galls that absorb water after precipitation events. Experiments on the performance of actual living gall tissue will start spring or summer 2010.

INNATE IMMUNE RESPONSES OF Aedes Aegypti TO DENGUE VIRUS.

RÉPONSES IMMUNITAIRES INNÉES DE Aedes Aegypti AU VIRUS DENGUE

Lowenberger, Carl (*Simon Fraser University, Burnaby BC*)

Ursic, Raul (*Simon Fraser University, Burnaby BC*)

Cooper, Dawn (*Simon Fraser University, Burnaby BC*)

Jaramillo, Gloria (*CIDEIM, Cali, Colombia*)

Ocampo, Clara (*CIDEIM, Cali, Colombia*)

Dengue virus, transmitted by *Aedes aegypti*, is the most important arbovirus that affects humans: 2,500 million people are at risk, there are an average of 100 million new infections and 20,000 deaths per year. No vaccines or antiviral drugs are available. All populations of *Ae. aegypti* do not support the virus. We have selected 3 strains from field collected mosquitoes: Susceptible, Refractory midgut escape barrier (MEB-R) and Refractory- midgut infection barrier (MIB-R), and measured gene expression after exposure to Dengue virus. Initial studies revealed a differential expression of midgut genes associated with apoptosis. We quantified and measured the temporal expression of Caspase16, Dredd, Drone, and inhibitors of apoptosis (IAP) and other selected genes in susceptible and MIB-r strains. We have assessed the differential gene expression per selected line per gene, and are evaluating the effects of RNAi on knocking down individual genes on the development of Dengue virus. All indications suggest that Dengue virus induces the expression of IAPs, therefore protecting itself, whereas resistant lines do not express IAPs, allowing apoptosis of infected cells to occur and death of the virus.

VALIDATION AND APPLICATION OF HAIR CORTISOL CONCENTRATION AS A NON-INVASIVE BIOMARKER OF LONG-TERM STRESS IN FREE-RANGING GRIZZLY BEARS

VALIDATION ET UTILISATION DE LA CONCENTRATION DE CORTISOL DANS LES POILS COMME BIOMARQUEUR NON INVASIF DE STRESS A LONGUE DUREE CHEZ LES GRIZZLY EN LIBERTE

Macbeth, Bryan J. (*Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon, SK*)

Cattet, Marc R.L. (*Canadian Cooperative Wildlife Health Centre and WCVN, University of Saskatchewan*)

Stenhouse, Gordon B. (*Foothills Research Institute and Alberta Sustainable Resource Development, AB*)

Gibeau, Michael L. (*Parks Canada Agency and Department of Geography, University of Calgary, AB*)

Janz, David M. (*Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon, SK*)

Human-caused environmental change negatively affects the sustainability of many wildlife populations. In Alberta, grizzly bears live in one of the most populated and developed landscapes in which the species survives. Long-term physiological stress in individuals may be the predominant mechanism linking environmental change with impaired wildlife population health. Hair cortisol concentration has recently been validated as a biomarker of long-term stress in humans and domestic animals. We have developed a technique to measure cortisol in hair collected non-invasively from free-ranging grizzly bears. The technique is precise and accurate in ≥ 5 -10 guard hairs. Hair cortisol (range 0.62-43.33 pg/mg) has been measured in 151 grizzly bears. Cortisol varies with hair type and body region, and is negatively associated with body condition. It is not influenced by colour, age, sex class, environmental exposure (18 days) or prolonged laboratory storage (>1 year) and does not vary along the hair shaft. Ongoing analysis involves correlation of hair cortisol with tissue-based measures of long-term stress and individual health collected from the same animals. We are also examining hair cortisol in the context of anthropogenic landscape change occurring in 5 populations of Alberta grizzly bears. With minor modification, we have successfully applied this technique in caribou and polar bears.

ALTERATIONS IN THE METABOLIC PROFILE OF JUVENILE RAINBOW TROUT (*ONCORHYNCHUS MYKISS*) IN RESPONSE TO ANAEROBIC EXERCISE TRAINING

ALTERATIONS DU PROFIL METABOLIQUE DE LA TRUITE JUVENILE ARC-EN-CIEL (*ONCORHYNCHUS MYKISS*) EN REPOSE A L'ENTRAINEMENT A L'EXERCICE ANAEROBIQUE

MacIntyre, Scott (*Department of Biology, Queen's University, Kingston, Canada*)

Jibb, Emily (*Department of Biology, Queen's University, Kingston, Canada*)

Ngan, Adam (*Department of Biology, Queen's University, Kingston, Canada*)

Guo, Xiaoning (*Department of Biology, Queen's University, Kingston, Canada*)

Wang, Yuxiang (*Department of Biology, Queen's University, Kingston, Canada*)

Juvenile rainbow trout (*Oncorhynchus mykiss*) were anaerobically trained for 7 days prior to completing a bout of burst exercise. White muscle, liver, and blood from trained and non-trained fish were sampled prior to, 0, 1, 2 and 8 hours after the onset of exhaustion. Training resulted in a 50% reduction in resting glycogen, a 70% increase in basal glucose, significantly less lactate accumulation and leakage into the blood, and protected adenosine triphosphate and phosphocreatine in the white muscle following burst exercise. Following exhaustion non-trained fish had higher activities of pyruvate kinase, and lactate dehydrogenase in their muscle, depressed hydroxyacyl-CoA dehydrogenase 8h into recovery, and citrate synthase remained unchanged. The liver decreased in glycogen concentrations and accumulated significantly less lactate in response to training, however enzyme activities did not vary significantly between trained and non-trained fish.

THE CURIOUS CASE OF THE MISSING HEMOLYMPH: A CHILL-INDUCED DISRUPTION OF ION AND WATER HOMEOSTASIS IN THE FALL FIELD CRICKET (*GRYLLUS PENNSYLVANICUS*)

L'ÉTRANGE HISTOIRE DE L'HÉMOLYMPHE DISPARUE : UNE DISRUPTION DE L'HOMÉOSTASIE DES IONS ET DE L'EAU CAUSÉ PAR LE FROID CHEZ GRILLUS PENNSYLVANICUS

MacMillan, Heath* (*University of Western Ontario*)

Sinclair, Brent (*University of Western Ontario*)

At their critical thermal minimum (CT_{min}), insects enter chill-coma, where movement ceases entirely. Prolonged exposure to temperatures below the CT_{min} result in the time and temperature dependent accumulation of whole animal injury known as chilling-injury and eventual death. Chilling injury typically manifests as a persistent inability to coordinate movements or respond to external stimuli. Onset of chill-coma and progression of chilling injury have been shown to correlate with decreased cell membrane potentials in the neuromuscular system. We quantified the concentration of individual ion species and volume of hemolymph and muscle tissue during exposures to cold that induce chill-coma and chilling injury to discern the effect of chilling on gradients of individual ion species and the effects of disrupted ion homeostasis on water partitioning. Surprisingly, effects of chilling on membrane potentials appear to have little to do with muscle tissue itself, but much to do with the hemolymph and its relationship with the gut.

DECIPHERING MORPHOLOGICAL VARIATION IN THE BRAINCASE OF CAECILIANS (AMPHIBIA: GYMNOPIHONA)

DÉCHIFFRER LA VARIATION MORPHOLOGIQUE DANS LA BOÎTE CRÂNIENNE DES GYMNIOPHONES (AMPHIBIA : GYMNIOPHONA)

Maddin, Hillary C. (*Biological Sciences, University of Calgary*)

Russell, Anthony P. (*Biological Sciences, University of Calgary*)

Of the three groups of modern amphibians, caecilians remain the most poorly understood in terms of basic anatomy and, as a result, morphological evolution. The elusive nature of caecilians in the field has made them rare components of museum collections, hindering the exploration of morphology via classical methods (e.g., dissection, histology). In order to reveal and document anatomy of the neurocranium (sphenethmoid and os basale), we applied non-destructive high-resolution computed tomography, sampling broadly across caecilian phylogeny (twenty-five species). Foramina of the anterior os basale were identified, revealing a great deal of variation in the pattern of foramina associated with cranial nerves V, VII, and with local vessels. When optimized on the current hypothesis of caecilian relationships derived from molecular analysis, morphological variation accords with phylogeny. A notable exception involves features shared by members of Ichthyophiidae and the basal members of the sister clade, “Caeciliidae” (Teresomata). Additionally, the range of variation observed among the teresomatan taxa closely approximates developmental stages of this region in the model species, *Dermophis mexicanus*, suggesting developmental modification has played an important role in the morphological evolution of this region.

PHYSIOLOGICAL EFFECTS OF CHRONIC CD EXPOSURE IN RAINBOW TROUT

LES EFFETS PHYSIOLOGIQUES D'UNE EXPOSITION CHRONIQUE DE CD DANS LA TRUITE ARC-EN-CIEL

Mancini, Amanda (*Wilfrid Laurier University*)

Milne, Jessica (*Wilfrid Laurier University*)

McGeer, Jim (*Wilfrid Laurier University*)

The objectives of this project are to understand the mechanisms of Cd-induced disruptions in relation to tissue

accumulation, oxidative stress and ion regulation. Rainbow trout were chronically exposed to 0, 6.5 and 18 nM Cd in relatively hard water (hardness of 140 mg/L CaCO₃) for 29 days. Gills, liver, kidney and plasma were sampled throughout exposure. Tissue malondialdehyde (MDA) and protein carbonyl levels were measured as indicators of oxidative stress. Kidney MDA levels in Cd-exposed fish increased during the first week of exposure, followed by a subsequent decrease to baseline levels. This trend (an initial increase in lipid damage, followed by a decrease (recovery) to baseline levels) was also observed in livers of exposed fish, and the recovery appeared quicker at 18 nM Cd. The most pronounced response in oxidative protein damage was observed at day 4 in the gills of fish exposed to 6.5 nM Cd. These Cd-induced responses will be discussed in the context of Cd distribution within different subcellular fractions. This study will help provide a better understanding of the mechanisms by which bioaccumulated metals induce physiological effects in fish. This research is supported by the NSERC Discovery program as well as the MITHE-Strategic Network.

CELLULAR ADAPTATIONS TO HYPOXIA: IS THERE VARIATION IN HYPOXIA-INDUCIBLE FACTOR SEQUENCE BETWEEN HYPOXIA TOLERANT AND INTOLERANT SPECIES?

ADAPTATIONS CELLULAIRES À L'HYPOXIE: Y A-T-IL DE LA VARIABILITÉ DANS LA SÉQUENCE DU FACTEUR HYPOXIE-INDUCTIBLE ENTRE LES ESPÈCES TOLÉRANTES ET INTOLÉRANTES À L'HYPOXIE?

Mandic, Milica (*Department of Zoology, University of British Columbia*)

Richards, Jeffrey G. (*Department of Zoology, University of British Columbia*)

Critical to an animal's ability to survive exposure to long-term hypoxia is a change in gene transcription. Hypoxia-inducible factor (HIF) is the major transcription factor regulating the hypoxia-induced gene expression, including those involved in angiogenesis, erythropoiesis and glycolysis. The induction of HIF- α , a subunit of the heterodimeric HIF protein, is dependent on a decrease in cellular O₂ availability, which reduces the ability of prolyl hydroxylases (PHDs) to target HIF- α for degradation. Little is known regarding the actions of HIF and PHDs in hypoxia tolerant and intolerant species of fish. Near-shore marine sculpins are known to differ in hypoxia tolerance and exhibit variation in a number of physiological and biochemical traits. The hypoxia tolerant species possess a larger gill surface area, higher hemoglobin-O₂ binding affinity and greater activity of pyruvate kinase, lactate dehydrogenase, creatine phosphokinase and citrate synthase in the brain as compared to the sensitive species of sculpins. Using this multi-species comparative model we are currently sequencing HIF- α and PHDs in 12 species of sculpin. Gene and deduced amino acid sequences will be compared to determine if there is variation in the sequences and whether this variation contributes to the range of hypoxia tolerance in sculpins.

THE EFFECTS OF UV RADIATION ON EPIDERMAL CLUB CELL INVESTMENT IN FATHEAD MINNOWS (*PIMEPHALES PROMELAS*).

Manek, Aditya K. (*Department of Biology, University of Saskatchewan, Saskatoon, SK Canada*)

Ferrari, Maud C.O. (*Dept. Environmental Science and Policy, University of California, Davis, CA*)

Niyogi, Som (*Department of Biology, University of Saskatchewan, Saskatoon, SK Canada*)

Chivers, Douglas P. (*Department of Biology, University of Saskatchewan, Saskatoon, SK Canada*)

Recent anthropogenic activities have caused deleterious effects to the environment, such as stratospheric ozone depletion, which as a result have stressed aquatic ecosystems. Understanding the way organisms respond to such stressors is a key to predicting the effects of anthropogenic activities. The epidermal layer of fish skin is not keratinized and acts as the primary interface between the fish and its environment. Recent research suggests that club cells in the epidermis are a part of the immune system and may play a role in protecting the fish from UV-induced damage. In the present study, we exposed fathead minnows *in vivo* to UV and examined the effects of such radiation on epidermal club cell investment of fathead minnows (*Pimephales promelas*). We found that fish exposed to UV radiation showed a statistically significant reduction in club cell number across the lateral surface, compared to non-exposed controls. Analysis of the behavioural response to alarm substances, chemical

compounds contained in these club cells, revealed no difference in the potency of alarm cues prepared from the skin of UV exposed or non-exposed minnows.

CAN PARASITES BE USED AS ENVIRONMENTAL INDICATORS: A CASE STUDY FROM THE RICHELIEU RIVER, AN ANTHROPOGENICALLY-IMPACTED ECOSYSTEM

UTILISATION POSSIBLE DES PARASITES COMME BIOINDICATEURS ENVIRONNEMENTAUX: ÉTUDE DE LA RIVIÈRE RICHELIEU, UN ÉCOSYSTÈME SUBISSANT DIVERSES PRESSIONS ANTHROPIQUES

Marcogliese, David J. (*St. Lawrence Centre, Environment Canada*)

Gélinas, Malorie (*St. Lawrence Centre, Environment Canada*)

Gendron, Andrée D. (*St. Lawrence Centre, Environment Canada*)

The Richelieu River, Quebec, is a highly-regulated waterway subject to numerous anthropogenic influences from municipal effluents and agricultural activities. Parasite communities in spottail shiners (*Notropis hudsonius*) were examined from four localities in the spring, early and late summer 2003 and spring 2004. Component species richness varied between 19 and 23 species in 2003, but declined to 7-12 in 2004. Mean total parasite numbers also declined 50-90% between years. A canonical correspondence analysis showed that six water quality variables, plus fish length and weight, explained 46% of the total variation in parasite species composition, with 17% attributed to ammonia alone. Most parasite species, especially larval digeneans, were positively associated with turbidity and negatively associated with ammonia. Changes in water quality were likely the result of differences in precipitation between years. Total accumulation in May 2003 was approximately double that in May 2004, altering patterns of runoff and river flow rates. This study suggests that parasite species composition and abundance in the Richelieu River are influenced by environmental parameters which in turn are affected by a combination of anthropogenic activities and climatic conditions.

COMPUTATIONAL MODELS FOR BUTTERFLY EYESPOT DEVELOPMENT AND EVOLUTION

MODÈLES INFORMATIQUES POUR LE DÉVELOPPEMENT ET L'ÉVOLUTION D'EYESPOT DE PAPILLON

Marcus, Jeffrey (*University of Manitoba*)

The color patterns on the wings of butterflies have been an important model system in evolutionary developmental biology. I have been using computational approaches that incorporate elements of threshold response models and cellular automata models to simulate the behavior of genes expressed during eyespot development. This computational approach to eyespot development can be used to effectively model dynamic patterns of gene expression in the development of eyespots and can be used to test proposed hypotheses of genetic regulatory interactions. By comparing the behavior of the simulations with patterns of gene expression in vivo, it is possible to eliminate hypotheses of genetic interaction. Further, these computational models can be used to make predictions about patterns of gene expression under novel experimental circumstances, allowing researchers to target experimental efforts to make rigorous tests of the predictions of the model. This computational approach, in combination with experimental work examining eyespot formation in the buckeye butterfly, *Junonia coenia*, has allowed substantial progress in understanding how butterfly eyespots develop and evolve.

A FROSTY WHODUNIT: THE MYSTERY OF MULTIPLE FREEZE MORTALITY IN WOOLLY BEAR CATERPILLARS (PYRRHARCTIA ISABELLA)

UN POLAR POLAIRE : LE MYSTÈRE DES MORTALITÉS MULTIPLES DÛES AU FROID CHEZ LA CHENILLE DE PYRRHARCTIA ISABELLA

Marshall, Katie E. (*University of Western Ontario*)

Sinclair, B. J. (*University of Western Ontario*)

Insects that overwinter in many temperate climates experience multiple freeze thaw cycles through the season. Not only are these cycles frequent, but they are also predicted to increase under climate change. While biochemical correlates of freeze tolerance in insects are relatively well understood, research on survival of multiple freeze-thaws is limited and contradictory. In addition, little work has been completed on sublethal effects. To further investigate the costs of multiple freezes, we subjected individuals of *Pyrrharctia isabella* (the woolly bear caterpillar) to one of three freeze regimes: a single 35 hour freeze at -12 degC, five 7 hour freezes at -12 degC, or maintenance at 0 degC. We investigate potential sublethal effects including changes in freezing point, cryoprotectant concentration, energy stores, response to an immune challenge, and tissue damage. While we consistently have found that caterpillars that experience multiple freezes have increased mortality, the causes of this mortality are less clear.

EFFECT OF ENVIRONMENTAL AMMONIA STRESS ON BRANCHIAL AMMONIA TRANSPORT IN THE STENOHALINE MARINE CRAB *CANCER MAGISTER*

EFFECT DU STRESS DE L'AMMONIUM ENVIRONMENTAL SUR LE TRANSPORT DE L'AMMONIUM A TRAVERS

Martin, Michael (*University of Manitoba*)

Weihrach, Dirk

Nitrogenous wastes are excreted by aquatic invertebrates predominately as ammonia. In this study, gills isolated from the stenohaline marine crab *Cancer magister* were perfused with hemolymph-like salines in order to test the branchial ability to excrete ammonia. All gills, anterior and posterior, produced considerable amounts of ammonia, what was released with high preference (>84% of total) towards the apical side. Further, all gills showed the capability to excrete ammonia against an at least 16-fold inwardly directed gradient. When crabs were exposed to 1 mM environmental ammonia, hemolymph ammonia concentration increased from ca. 200µM to ca. 500µM and further increased after the fourth day of exposure to environmental levels (ca. 1mM). After 14 days of ammonia stress the capability of the gills to actively excreted ammonia vanished. Interestingly, the mortality rate of exposed crabs was low and not different from the control group even after 3 weeks of ammonia stress.

DIETARY LIPID COMPOSITION AFFECTS THE STRUCTURAL AND FUNCTIONAL PROPERTIES OF MUSCLE MITOCHONDRIA OF RAINBOW TROUT.

L'IMPACT DE LA DIÈTE ALIMENTAIRE SUR LES PROPRIÉTÉS FONCTIONNELLES ET LES COMPOSANTES STRUCTURALES DES MITOCHONDRIES DU MUSCLE CHEZ LA TRUITE ARC-EN-CIEL.

Martin, Nicolas (*Université Laval*)

Kraffe, Edouard (*Université de Bretagne Occidentale*)

Bureau, Dominique (*University of Guelph*)

Guderley, Helga (*Université Laval*)

Two diets differing only in fatty acid (FA) composition were synthesized and fed to two groups of trout for a

minimum of 6 weeks. DHA (22:6n-3) accounted for 0.4% and 14% of FA in diet 1 and 2, respectively while saturated FA accounted for 33% and 22%. Mitochondrial phospholipids differed markedly in their overall FA composition after the feeding treatment. Phosphorylating (State 3) and non-phosphorylating (state 4) rates of pyruvate oxidation were higher in mitochondria from fish fed the unsaturated diet. Maximal flux through the electron transport chain (ETC) measured from different starting points (Complex I, Complex II-III and Complex IV) showed similar tendencies. On the other hand, spectrophotometric measurements of these complexes suggested that their activities were higher in mitochondria from fish fed the saturated diet. Our detailed analysis of membrane lipid composition quantifying the phospholipid classes as well as their FA compositions will provide a unique tool to evaluate if specific phospholipid species modulate the activities of the ETC components or whether general characteristics of membrane phospholipids, such as % (n-3) or FA unsaturation regulate the activities as suggested by the membrane pacemaker theory.

SPATIAL HEARING IN AN ACOUSTIC PARASITOID FLY

L'OUÏE SPATIALE CHEZ UNE MOUCHE PARASITOÏDE ACOUSTIQUE

Mason, Andrew C. (*Integrative Behaviour and Neuroscience Group, University of Toronto Scarborough*)

Lee, Norman (*Department of Cell & Systems Biology, University of Toronto*)

The fly, *Ormia ochracea*, is an acoustic parasitoid that must reproduce by placing parasitic larvae on cricket hosts. Female flies obtain hosts by localizing the calls of singing male crickets. Under controlled acoustic conditions, flies localize individual sound sources with great precision using a pair of ears that are exquisitely sensitive to sound direction. We have examined the flies' ability to localize a single source in more complex acoustic conditions, including multiple overlapping sources and background noise. Noise has limited effects on source localization. Some multiple-source conditions elicit 'phantom-source localization' in which flies orient to a location intermediate to a pair of attractive sources. With varied temporal overlap, small time differences between two sources allow flies to selectively localize leading sources when temporal disparities fall within a critical time-window. In addition, selective localization only occurs to leading sources located closer to the midline axis (forward direction) than more laterally located lagging sources. Thus source segregation depends on both the relative timing and location of competing sound sources. Surprisingly, these functions appear to rely largely on peripheral auditory mechanisms: noise filtering and selective attention are accomplished by a combination of eardrum mechanics and receptor physiology.

CLONING AND EXPRESSION OF AN INSECT ORGANIC CATION TRANSPORTER FROM THE FRUIT FLY, *DROSOPHILA MELANOGASTER* MEIGEN.

CLONAGE ET EXPRESSION DU TRANSPORTEUR DE CATION ORGANIQUE DE LA MOUCHE À FRUIT *DROSOPHILA MELANOGASTER* MEIGEN

Matier, Brienne J (*University of British Columbia*)

Rheault, Mark R (*University of British Columbia*)

Organic cations include endogenous metabolites, and xenobiotics (drugs, pesticides, environmental toxins), that must be effectively eliminated in order for organisms to survive. The midgut and Malpighian tubules of insects have been shown to play a role in the active transport of organic cations. A putative organic cation-like transporter was cloned from adult *Drosophila melanogaster*. Phylogenetic analysis indicates that this organic cation homolog exists in an insect specific clade separate and equally divergent from cloned vertebrate OCT isoforms. Gene expression patterns for this *Drosophila* OCT-like transporter have been elucidated using quantitative PCR which support previous in vitro physiological evidence. Physiological characterization of this isolated insect OCT-like transporter is currently in progress. A complete understanding of the molecular structure, tissue expression, and physiological characterization of this transporter may hold promise for the formulation of more effective and environmentally benign insecticides. As well it may provide insights into the

evolutionary origin of organic cation transporters themselves.

THE STRUCTURE AND DEVELOPMENT OF AMNIOTE PLICIDENTINE

LA STRUCTURE ET LE DÉVELOPPEMENT DE LA PLICIDENTINE CHEZ LES AMNIOTES

Maxwell, Erin (*University of Alberta, Department of Biological Sciences*)

Caldwell, Michael (*University of Alberta, Department of Biological Sciences*)

Lamoureux, Denis (*University of Alberta, St. Joseph's College*)

Plicidentine, infolded dentine at the root of a tooth, is well-documented and histologically characterized in sarcopterygians, basal tetrapods, and the actinopterygian *Lepidosteus*. However, within amniotes, its phylogenetic distribution and structure are poorly known, and disagreement over definitions plagues the literature. In this study, we discuss the histological structure and development of orthodentine as it relates to plicidentine formation. We focus on the squamate genus *Varanus*, the only extant amniote to possess plicidentine. Dentine infolding in this genus is initiated at the dentine-enamel junction. The fold structure becomes progressively larger and more digitiform towards the root of the tooth, and secondary lamellae are initiated. The lingual primary lamellae fuse to the labial lamellae, and the secondary lamellae fuse to each other creating a honeycomb structure that is involved in tooth attachment. Among amniotes, the creation of the honeycomb structure is unique to varanoids: ichthyosaurs and choristoderes, two extinct groups in which the presence of plicidentine was confirmed, lack both secondary lamellae and the fusion of the labial and lingual lamellae. We conclude that amniote plicidentine, as defined here, has evolved independently several times, but the morphology seen in the functional tooth is taxonomically distinct.

SENSORY STRUCTURES AND NEURAL MECHANISMS UNDERLYING NAVIGATIONAL BEHAVIOURS IN THE NUDIBRANCH MOLLUSC TRITONIA DIOMEDEA

STRUCTURES SENSORIELLES ET MECANISMES NEURONAUX GOUVERNANT LES COMPORTEMENTS DE NAVIGATION DU NUDIBRANCHE TRITONIA DIOMEDEA

McCullagh, Greg (*Bamfield Marine Sciences Centre*)

Wyeth, Russell (*St. Francis Xavier University*)

The nudibranch mollusc *Tritonia diomedea* uses odour-gated rheotaxis (OGR) to navigate. The slugs crawl upstream in the presence of prey odour and downstream in the presence of predator odour. Previous research has shown that the paired rhinophores detect odours and that upstream turns in the absence of odours depend on flow detection by the oral veil. Upstream and downstream turns required for OGR could be generated in three possible ways: 1) reflex turns based on the odour type and which of the rhinophores first detects the odour; 2) either positive or negative rheotaxis contingent on odour type and flow direction, both detected by the rhinophores; or 3) either positive or negative rheotaxis, contingent on odour type detected by the rhinophores and flow direction detected by the oral veil. To test these hypotheses, we used stimulated rhinophores with prey or predator odour, either in the same direction or in opposition to ambient flow, as well as in still water. The response pattern suggests that the rhinophores may detect both flow direction and odours, although further replicates are required to confirm this result. The conclusions from these experiments will guide further experimentation on the neural circuits underlying these behaviours.

EFFECTS OF CHRONIC AND ACUTE TEMPERATURE CHANGE ON THE SPECIFIC DYNAMIC ACTION AND GASTRIC PROCESSING IN THE GREEN SHORE CRAB, *CARCINUS MAENAS*.

EFFETS DES CHANGEMENTS DE TEMPÉRATURE CHRONIQUES ET AIGUS SUR L'ACTION SPÉCIFIQUE DYNAMIQUE ET LE TRAITEMENT GASTRIQUE CHEZ LE CRABE ENRAGÉ, *CARCINUS MAENAS*

McGaw, Iain (*Memorial University of Newfoundland*)

The physiological responses associated with the interactive effects of feeding and temperature change (test temperatures = 5°C, 15°C, 25°C) were investigated in green crabs, *Carcinus maenas*, acclimated to 10°C or 20°C. At each test temperature unfed crabs acclimated to 10°C exhibited a higher oxygen uptake than those acclimated to 20°C. Oxygen uptake increased immediately following feeding, the duration of which, decreased as temperature increased and the duration was longer in 20°C acclimated animals. The scope (maximal level) was inversely related to temperature and was greater for 20°C acclimated crabs. The magnitude of the increase (total oxygen uptake) was approximately three fold higher in 20°C acclimated animals, with the test temperature having a lesser effect. Gut contraction rates, which increased as the temperature increased, were higher in 20°C acclimated animals. Despite the fact that gut contraction rates were higher in 20°C acclimated crabs, the acclimation temperature had no significant effect on food transit rates. Gut clearance rates were inversely related to the test temperature. The green crab, *Carcinus maenas*, is tolerant of a wide range of temperatures; the physiological processes associated with digestion (specific dynamic action) appear to be summed upon those occurring during temperature acclimation and change.

AN AMNIOTE MODEL OF REGENERATION: TAIL REPLACEMENT IN GECKOS

UN MODÈLE DE RÉGÉNÉRATION CHEZ LES AMNIOTES : REMPLACEMENT DE LA QUEUE CHEZ LES GECKOS

McLean, Katie (*University of Guelph*)

Epimorphic regeneration is a phenomenon that results in the functional restoration of lost structures from an aggregation of proliferating cells known as a blastema. Among amniotes, the most striking example of epimorphic regeneration comes from tail regenerating lizards. The objective of this study was to investigate the anatomy and histology of the tail throughout the process of regeneration in a representative lizard, the leopard gecko (*Eublepharis macularius*). Tail structure and tissue composition were examined at multiple time points throughout regeneration. Following tail loss, there is a period of wound healing in which there are no visible signs of regenerative outgrowth. During this time, basal cells of the epidermis undergo proliferation and gradually cover the wound. An additional aggregation of proliferating cells accumulates adjacent to the spinal cord marking the first appearance of the blastema. As the blastema expands new blood vessels are formed, followed by redevelopment of peripheral axons and the ependymal tube of the spinal cord. Skeletal tissue differentiation begins somewhat later, corresponding with the expression of Sox9. Tail regeneration involves a highly conserved sequence of events permitting the establishment of a staging table. Ongoing studies will provide an important complement for regenerative research by expanding the comparative framework.

BLOOD OXYGEN MANAGEMENT STRATEGIES IN DIVERS: A COMPARATIVE PERSPECTIVE

STRATÉGIES DE GESTION DE L'OXYGÈNE SANGUIN CHEZ LES PLONGEURS : UNE PERSPECTIVE COMPARÉE

Meir, Jessica (*University of British Columbia, Dept. of Zoology*)

The application of recently characterized oxygen-haemoglobin dissociation curves to blood PO₂ profiles in diving emperor penguins and elephant seals has revealed differing blood oxygen store management strategies

between these two species. In emperor penguins, arterial SO₂ remained near 100% for much of the dive, preserving a high O₂ content in the arterial system for critical organs such as the brain. Arterial SO₂ generally did not decrease significantly until the final ascent phase of the dive, consistent with the decline in ambient pressure and decrease in both air sac and arterial PO₂ during ascent. These profiles demonstrate the significance of the respiratory oxygen store and high affinity haemoglobin of the emperor penguin. In contrast, although there is a transient rise and peak near 100% arterial SO₂ in the initial dive phase of elephant seals, these values decreased rapidly after this point, reaching levels as low as 8% and demonstrating exceptional hypoxemic tolerance for this species. Venous SO₂ profiles revealed highly efficient and near complete utilization of the venous blood oxygen store during dives of both species. These findings reflect differences in the magnitude of the respiratory O₂ store and maintenance of gas exchange during diving between this bird and mammal.

CHRONIC HYPOXIA ALTERS CARDIAC REGULATION IN RAINBOW TROUT (*ONCORHYNCHUS MYKISS*) DURING EARLY LIFE STAGES

L'HYPOXIE CHRONIQUE CHANGE LA RÉGULATION CARDIAQUE CHEZ DE JEUNES TRUITES ARC-EN-CIEL (*ONCORHYNCHUS MYKISS*)

Miller, Silvana (*University of Guelph*)

Wright, Patricia (*University of Guelph*)

Gillis, Todd (*University of Guelph*)

In adult salmonids, hypoxia induces cardiac adaptations controlled by the balance of cholinergic and adrenergic mechanisms. However, the maturation of heart rate regulation and the effects of hypoxia during ontogeny have not been studied. This study aimed to identify the development of cardiac receptors in rainbow trout early life stages, and how these cardiovascular control mechanisms are altered by chronic hypoxia. The heart rate response to cholinergic and adrenergic receptor stimulation or inhibition was measured in individuals reared in normoxic (100% O₂ saturation) or hypoxic (30% O₂ saturation) conditions from fertilization to embryonic stages 22, 26, 29 and larval stages 30, 32. In normoxia, heart rate increased in response to β -adrenergic stimulation by isoproterenol as early as stage 22, and decreased with the antagonist propranolol at all stages. Cholinergic stimulation (acetylcholine) remained ineffective at all stages. However, inhibition by atropine increased heart rate at stage 32. In chronic hypoxia, embryos displayed bradycardia while larvae displayed an increased sensitivity to propranolol. The onset of a heart rate response to atropine was absent. In conclusion, cardiac β -adrenergic receptors are functional at early life stages, while cholinergic receptors are not responsive until after hatch. Chronic hypoxia exposure during ontogeny altered these cardiac regulation mechanisms.

SEASONAL THERMOGENESIS IN AN ECTOTHERM – HEATING UP TO REPRODUCE

THERMOGÉNÈSE SAISONNIÈRE CHEZ UN ECTOTHERME – SE RÉCHAUFFER POUR SE REPRODUIRE

Milsom, William (*University of British Columbia*)

Tattersall, Glenn (*Brock University*)

Colin Sanders (*University of British Columbia*)

Joanna Piercy (*University of British Columbia*)

Cleo Leite (*UNESP*)

Viviana Cadena (*Brock University*)

Denis Andrade (*UNESP*)

Augusto Abe (*UNESP*)

During the reproductive season (September to December) the Brazilian black and white tegu maintains body temperatures during the night significantly above burrow temperature. To determine whether this was due to heat retention or thermogenesis we monitored body temperatures in animals housed outdoors and able to bask each

day, as well as animals held indoors at constant temperature and unable to warm by external heating. We discovered that tegus use thermogenesis to sustain elevated body temperatures at night but also warm the trapped air in the burrow (using both heat acquired through basking as well as endogenously produced heat) for extra insulation. This ability was independent of gender but dependent on photoperiod. Using heart rate:metabolic rate calibrations our field data suggest that the metabolic rates of the tegus are highest when the temperature differential (body – burrow) is greatest and that the metabolic rates of tegus during the reproductive period (period of thermogenesis) are at least twice those of tegus at the same body temperature in the post-reproductive period.

ERGATOID QUEEN DEVELOPMENT IN THE ANT MYRMECINA NIPPONICA: MODULAR AND HETEROCHRONIC REGULATION OF CASTE DIFFERENTIATION

DÉVELOPPEMENT DE LA REINE ERGATOID CHEZ LA FOURMI MYRMECINA NIPPONICA : RÉGULATION MODULAIRE ET HÉTÉROCHRONIQUE DE LA DIFFÉRENTIATION DES CASTES

Miura, Toru (*Graduate School of Environmental Science, Hokkaido University*)

Miyazaki, Satoshi (*Graduate School of Veterinary Medicine, Hokkaido University*)

Caste polyphenism in social insects provides us with excellent opportunities to examine the plasticity and robustness underlying developmental pathways. Several ant species have evolved unusual castes showing intermediate morphologies between alate queens and wingless workers. In some low-temperature habitats, the ant *Myrmecina nipponica* produces such intermediate reproductives (i.e., ergatoids), which can mate and store sperm but cannot fly. To gain insight into the developmental and evolutionary aspects associated with ergatoid production, we conducted morphological and histological examinations of the postembryonic development of compound eyes, gonads, and wings during the process of caste differentiation. In compound eyes, both the queen-worker and ergatoid-worker differences were already recognised at the third larval instar. In gonads, queen-worker differentiation began at the larval stage, and ergatoid-worker differentiation began between the prepupal and pupal stages. Wing development in ergatoids was generally similar to that in workers throughout postembryonic development. Our results showed that the developmental rate and timing of differentiation in body parts differed among castes and among body parts. These differences suggest that the rearrangement of modular body parts by heterochronic developmental regulation is responsible for the origination of novel castes, which are considered to be adaptations to specific ecological niches.

IMPACT OF FEEDING REGIME AND DIETARY COPPER ON THE FATHEAD MINNOW (*PIMEPHALES PROMELAS*)

IMPACT DU CUIVRE ET DU RÉGIME ALIMENTAIRE SUR LE TÊTE-DE-BOULE (*PIMEPHALES PROMELAS*)

Moffett, Audrey (*INRS - Centre Eau Terre Environnement*)

Couture, Patrice (*INRS - Centre Eau Terre Environnement*)

Previous studies on copper (Cu) bioaccumulation revealed that diet is the major uptake route in fish, even though artificial diets are often used. Examination of dietary exposure effects, using prey found in natural systems, provides a better understanding of how Cu alters growth and other physiological processes. In addition, variation in feeding rates or food availability may mediate the rate of Cu uptake from dietary sources and thus its accumulation and/or effect in fish. In this study, we investigate the metabolic costs associated with long-term dietary Cu exposure in the fathead minnow under different feeding conditions. Juveniles were allocated to two contaminated (150 µg Cu · g⁻¹ dry weight) and two control feeding treatments (using *Lumbriculus variegatus* as prey), differing in their daily ration (1% or 5% of fish body weight). Ongoing analyses indicate that fish fed the same ration have similar weight-specific growth rates and food conversion efficiencies, regardless of the presence or absence of Cu in prey. In this presentation, we will discuss the influence of ration and prey

contamination on Cu assimilation as well as their relationships with growth rate, routine metabolic rate, energy status, metabolic capacity and muscle-related gene transcription.

CHARACTERIZATION OF INHIBITORY IMMUNE RECEPTORS IN THE CHANNEL CATFISH (*ICTALURUS PUNCTATUS*)

CARACTÉRISATION DES RÉCEPTEURS IMMUNITAIRE INHIBITOIRES CHEZ ICTALURUS PUNCTATUS

Montgomery, Benjamin CS (*Department of Biological Sciences, University of Alberta*)

Davidson, Chelsea (*Department of Medical Microbiology and Immunology, University of Alberta*)

Mewes, Jacqueline (*Department of Biological Sciences, University of Alberta*)

Verheijen, Karlijn (*Department of Biological Sciences, University of Alberta*)

Burshtyn, Deborah N (*Department of Medical Microbiology and Immunology, University of Alberta*)

Stafford, James L (*Department of Biological Sciences, University of Alberta*)

Channel catfish leukocyte immune-type receptors (IpLITRs) are a family of proteins sharing phylogenetic and structural similarities with innate immunoregulatory receptors identified in amphibians, birds, and mammals. Putative stimulatory and inhibitory IpLITR-types are co-expressed by various catfish immune cells including B cells, T cells, macrophages, and natural killer cells. In mammals, the co-expression of inhibitory and stimulatory receptors is critical for balancing the responses required for the coordination and control of cellular immunity. My research focuses on examining the putative inhibitory IpLITR-types, which contain immunoreceptor tyrosine-based inhibitory motifs (ITIMs) in their cytoplasmic regions. Classically, ITIM bearing-receptors ‘turn off’ the immune response by recruiting cellular phosphatases. Therefore, to investigate the signalling potential of ITIM-containing IpLITRs we developed chimeric receptors by fusing the extracellular and transmembrane regions of a human immune inhibitory receptor to the cytoplasmic domains of various ITIM-bearing IpLITR-types. We then expressed these constructs in mammalian cell-lines and utilized these proteins to examine receptor phosphorylation, phosphatase recruitment, and regulation of immune cell effector functions. Biochemical and functional characterization of IpLITRs represents an important first step in understanding their influence on immune cell effector functions in fish and examination of the conserved mechanisms of cellular inhibition during immune responses.

DIRECTED CASE STUDY METHOD FOR TEACHING COMPARATIVE PHYSIOLOGY IN A LARGE ENROLMENT COURSE

MÉTHODE D'ÉTUDE DE CAS DIRIGÉ POUR ENSEIGNER LA PHYSIOLOGIE COMPARÉE À DE GRANDS GROUPE D'ÉTUDIANTS

Montpetit, Colin (*University of Ottawa, Department of Biology*)

Eric DiMeo (*Gurjot Jassy*)

Bio 3305 Cellular Physiology is a third year course, offered by the department of Biology at the University of Ottawa, aimed at discussing the fundamentals of cell function in an integrative context to study the diversity of functional characteristics that enables organisms to physiologically adapt to diverse and changing environments. Understanding of the fundamentals of cell function in this context requires knowledge and comprehension of a vast number of details about cellular and molecular mechanisms. In this presentation, a directed method of case analysis is described that helps students consolidate new and prior knowledge to solidify their understanding of comparative physiology facts, concepts, and principles at the cellular and molecular level. A directed case study used in this cellular physiology course, and its features will be discussed. A procedure for integrating case analyses into an undergraduate comparative physiology course will also be outlined. Student response to this type of case study analysis suggests that they improve the ease of learning, the depth of learning, and an appreciation of the relevance of the concepts they are studying. The regular use of directed case analysis is a

valuable addition to the traditional methods of lecture, textbook reading and laboratory for undergraduate teaching.

DIFFERENTIAL REGULATION OF CARNITINE PALMITOYLTRANSFERASE (CPT) I IN RAINBOW TROUT (*ONCORHYNCHUS MYKISS*)

RÉGULATION DIFFÉRENTIELLE DE LA CARNITINE PALMITOYLTRANSFERASE (CPT) I CHEZ LA TRUITE ARC-EN-CIEL (*ONCORHYNCHUS MYKISS*)

Morash, Andrea (*McMaster University*)

Le Moine, Christophe (*McMaster University*)

McClelland, Grant (*McMaster University*)

The regulation of lipid metabolism involves many transcription factors and enzymes as well as aspects of the cellular environment. Carnitine palmitoyltransferase (CPT) I is one of the main regulatory enzymes in the fatty acid oxidation pathway as it controls the rate of fatty acid entry into the mitochondria. In mammals, CPT I is regulated through numerous genomic and non-genomic mechanisms including allosteric modulation by malonyl-CoA (M-CoA), transcriptional regulation and is also sensitive to changes in mitochondrial membrane milieu. We have sought to identify the role of these regulatory mechanisms of CPT I in muscle and liver of fish. This has been accomplished through comparative investigations on its evolution and subsequent genomic and proteomic modifications which allow insight into the function of CPT I at the whole animal and tissue level during physiological perturbations. It appears that fish may have fine control over lipid metabolism through the transcription of functionally distinct isoforms, while many of the non-genomic mechanisms seen in mammals seem to be less prevalent in fish. Mammals on the other hand, appear to rely on both genomic and non-genomic forms of regulation of lipid metabolism.

PARASITES AND CHEMICAL CONTAMINANTS IN WHITEFISH (*COREGONUS CLUPEAFORMIS*) FROM NORTHERN SASKATCHEWAN LAKES

PARASITES ET CONTAMINANTS CHIMIQUES CHEZ LE COREGONE (*COREGONUS CLUPEAFORMIS*) DES LACS DU NORD DE SASKATCHEWAN

Mysiv, Olesya (*Toxicology Centre, University of Saskatchewan*)

Pietro, Michael (*Toxicology Centre, University of Saskatchewan*)

Whitefish is an important food source for Indigenous people in Northern Saskatchewan. There has been an increase in whitefish parasitism over the last years leading to concerns that this might be related to industrial activities in the North and water pollution. Therefore, a study has been initiated to investigate parasites and chemical contaminants in whitefish from Montreal and Reindeer Lakes to determine the risk related to whitefish consumption. In both lakes *C. clupeaformis* were infected by cestodes, trematodes, nematodes, and acanthocephalans. A total of 11 species has been found so far. All fish were infected by at least one parasite. The most prevalent species is *Cotylurus erraticus*, which occurs in cysts around the heart. Contamination of fish with metals and organic compounds is low. Mercury concentrations in the fillet were 0.124 mg/kg d.w. (Reindeer Lake) and 0.047 mg/kg d.w. (Montreal Lake), respectively. No PCB congeners were identified and 4,4'-DDE was the only pesticide detected at concentrations above the method detection limit. Overall, the investigated whitefish harbour parasites which are typical for this host. The impact of environmental contaminants on fish parasitism is negligible in the sampled lakes. Further investigation is necessary to uncover the reasons for the perceived increase in whitefish parasitism.

HAEMOLYMPH [Na⁺] AND [K⁺] HOMEOSTASIS IN DROSOPHILA IN RESPONSE TO DIETARY LOADING

L'HOMÉOSTASIE DE [Na⁺] ET [K⁺] DANS L'HÉMOLYMPHE DE LA DROSOPHILE EN RÉPONSE À UNE CHARGE ALIMENTAIRE

Naikkhwah, Wida (*McMaster University*)

Drosophila melanogaster survive dietary exposure to high levels of Na⁺ and K⁺ and thus provide a useful model system for studies of homeostatic mechanisms in ion regulation. Measurements with ion-selective microelectrodes indicated that haemolymph ion levels are closely regulated in larvae reared on diets containing 0.4M NaCl or 0.4 M KCl. Our working hypothesis proposes that reduced absorption of ions by the gut or enhanced secretion by the gut and/or Malpighian tubules (MTs) contributes to homeostasis. A role for the MTs in Na⁺ and K⁺ regulation after chronic dietary exposure was investigated using the Ramsay assay. Results suggest that MTs do not play a major role in excretion of excess salt in vitro; however, factors present in the haemolymph may alter Na⁺ and/or K⁺ flux. Potential roles of the foregut, midgut and hindgut are also being investigated using the Scanning Ion Selective Electrode Technique (SIET), which allows Na⁺ and K⁺ fluxes to be precisely measured along the gut segments. For larvae reared on 0.4 M KCl, our results suggest that K⁺ absorption in the anterior midgut is downregulated and that the posterior regions of this gut segment secrete K⁺ into the lumen.

LEARNING, INDUCIBLE DEFENSES, AND ADAPTATION TO NOVEL PREDATORS

APPRENTISSAGE, DÉFENSES INDUCTIBLES ET ADAPTATION À DE NOUVEAUX PRÉDATEURS

Neufeld, Chris (*University of Alberta and Bamfield Marine Sciences Centre*)

Edgell, Tim (*University of Alberta and LGL Environmental Research Associates*)

In the northeast Pacific, the recent arrival of the European green crab, *Carcinus maenas*, offers an attractive opportunity to study the mechanisms used by prey to recognize and respond to novel predators. In the first of two laboratory experiments, we exposed naïve whelks (*Nucella lamellosa*) to effluent from two species of predatory crab, the native red rock crab *Cancer productus* and the invasive European green crab *Carcinus maenas*. Whelks responded adaptively to *Cancer* by increasing shell thickness but showed no such response to *Carcinus*. In a second laboratory experiment, we investigated whether preconditioning could alter the whelks' response to introduced crab cues. Preconditioned whelks grew thicker, more-predator-resistant shells when later exposed to effluent from introduced crabs alone. However, whelks responded to *Carcinus* regardless of whether whelks were preconditioned with introduced- or native crab cues paired with the scent of damaged conspecific whelks. Therefore, our results are not consistent with associative learning and instead suggest another mechanism (such as heightened cue sensitivity) may have facilitated the induced response to *Carcinus*. Together, these results provide some of the first evidence that past experience can alter the expression of a latent inducible morphological defense in response to cues from a novel predator.

TISSUE-SPECIFIC TRANSCRIPTIONAL REGULATION OF MONOCARBOXYLATE TRANSPORTERS (MCTs) AND METABOLIC ENZYMES DURING SHORT-TERM HYPOXIA IN ZEBRAFISH (*DANIO RERIO*)

REGULATION TRANSCRIPTIONNELLE TISSU-SPECIFIQUE DES TRANSPORTEURS DE MONOCARBOXYLATE (TCM) ET DES ENZYMES METABOLIQUES PENDANT L'HYPOXIE DE COURTE DUREE CHEZ LE POISSON ZEBRE (*DANIO RERIO*)

Ngan, Adam (*Department of Biology, Queen's University, Kingston, Canada*)

Wang, Yuxiang (*Department of Biology, Queen's University, Kingston, Canada*)

The goal of this study was to investigate the coordinated responses of MCTs along with other metabolic genes during hypoxia. Therefore, we subjected zebrafish (*Danio rerio*) to 1.5 mg L⁻¹ O₂ over 48- and 96-hr and measured tissue-specific transcriptional changes of MCTs (1, 2 and 4), lactate dehydrogenase A (LDHa), citrate synthase (CS), and other metabolic genes using real-time RT-PCR. There were no changes in mRNA detected in muscle at 48- and 96-hr. A significant increase was found in MCT4 (+102%) and LDHa (+28%) mRNA in brain suggesting a preference towards glycolysis. The increases in LDHa at 48-hr (+101%) and MCT1 (+24%) mRNA in gills suggests that both anaerobic and aerobic metabolism is being utilized. At 48-hr, increases were found in heart MCT1 (+117%), MCT4 (+86%), LDHa (+197%) and CS (+18%) mRNA. These results suggest that the influx and efflux of lactate are both employed as strategies in cardiac tissue during hypoxia.

THE IN VITRO AND IN VIVO BIOLOGICAL EFFECTS OF CADMIUM SELENIDE AND SILICON NANOPARTICLES

LES EFFETS BIOLOGIQUES IN VITRO ET IN VIVO DU CADMIUM SÉLÉNIDE ET DES NANOPARTICULES DE SILICONE

Ong, Kimberly J. (*Department of Biology, University of Alberta*)

Dang, Michael K.M. (*Department of Chemistry, University of Alberta*)

Clark, Rhett J. (*Department of Chemistry, University of Alberta*)

Ma, Guibin (*Department of Chemistry, University of Alberta*)

Ede, James D. (*Department of Biology, University of Alberta*)

Veinot, Jonathan, G.C. (*Department of Chemistry, University of Alberta*)

Goss, Greg G. (*Department of Biology, University of Alberta*)

Nanomaterials such as quantum dots are being used for applications in medicine, imaging, and electronics. Our knowledge on the potential of these materials to cause harmful biological effects is still limited. Cadmium selenide nanoparticles are currently the most commonly studied and used quantum dot. However, these particles may leach cadmium, a heavy metal and known toxicant. We hypothesized that silicon nanoparticles have the potential to be a less toxic substitute for cadmium selenide. Using in vitro and in vivo techniques, we compared the biological effects of cadmium selenide nanoparticles to silicon nanoparticles. We saw differences in the effects of nanoparticle exposure on early zebrafish development and hatch, and cell proliferation and death. Furthermore, to examine if there were any sublethal effects, we monitored for changes in oxidative stress responses and changes in the level of expression for a panel of toxicity-related genes. Overall, this work will provide important information about appropriate tests to use for biological testing of nanoparticles, and show that silicon may be a less toxic quantum dot than cadmium selenide. This work was supported by NSERC, Alberta Ingenuity, and the Company of Biologists.

CHARACTERIZATION AND DISSOLUTION RATES OF VIVENANO LTD. AQUEOUS METAL NANOPARTICLES AND ASSESSMENT OF EFFECTS USING AN IN VITRO CELL MODEL

CARACTERISATION ET TAUX DE DISSOLUTION DES NANOPARTICULES METALLIQUES (LTD VIVENANO LTD.). EVALUATION DE LEURS EFFETS EN UTILISANT UN MODELE CELLULAIRE IN VITRO

Ortega, Van (*University of Alberta*)

Felix, Lindsay (*University of Alberta*)

Goss, Greg (*University of Alberta*)

Nanotechnology is an emerging multidisciplinary field that involves the synthesis of molecules in the nanoscale (<100nm). The small size of nanomaterials (NM) produces unique physico-chemical properties that are different from their larger bulk forms, and thus have generated interest for their potential to enhance industrial processes.

Although impressive from a physico-chemical perspective, there is growing concern over the potential and unknown toxicity of these materials on biological systems. Since NMs can differ in their physico-chemical properties, their characteristics should be examined together with toxicity measurements. We measured free metal dissolution rates and metal impurities for newly engineered aqueous metal oxide NMs (TiO₂, ZnO, FeO, CeO₂), manufactured by VivNano Inc., using Slide-A-Lyzer Dialysis Cassettes and ICP-MS, respectively. Nano-capsules, free of metal core, were also similarly measured. Dynamic Light Scattering was used to measure particle behaviour including, hydrodynamic size, shape and zeta potential. Catfish B cells were exposed to concentrations ranging from 0, 1, 10, 50, 100 and 200mg/L over 48 hours and were analyzed for cellular viability and proliferation using FACS. We have correlated these results with images of post-NM exposed B cells at the same concentrations. Preliminary results indicate dose-dependant toxicity to B cells for several of the tested NMs.

ACUTE AND CHRONIC EFFECTS OF WATERBORNE CADMIUM ON LYMNAEA STAGNALIS

LES EFFETS AIGUS ET CHRONIQUES DU CADMIUM SUR LYMNAEA STAGNALIS

Pais, Nish (*Wilfrid Laurier University*)

McGeer, Jim (*Wilfrid Laurier University*)

Objectives of this study were to understand the relationship between bioaccumulated Cd and induced impacts in the freshwater snail, *Lymnaea stagnalis*. Acute toxicity tests (96 h, static-renewal) were conducted in moderately hard water (140 mg/L as CaCO₃) using two sizes of snails (15 & 20 mm). Snails were not fed and water samples were collected daily for measurements of dissolved Cd concentrations as well as Na, Ca and Mg. The 96 h LC50 for both sizes of snails were similar (350 µg Cd/L) and far above environmentally relevant concentrations. Subsequent chronic toxicity testing (31 d, static with daily renewal) was performed using three sizes of snails (initial shell lengths of 5, 10 & 15 mm). In these tests, growth and survival were assessed and feeding was characterized at regular intervals. Exposures of 30 µg Cd/L resulted in mortalities in the smaller snails while medium and large snails were more resilient. Growth was inhibited at exposure concentrations greater than 10 µg Cd/L and this resulted from reduced food consumption. Overall, these studies will help generate a database for development of the tissue residue approach. This research is supported by the NSERC Strategic Program with Rio Tinto and Environment Canada.

SUPERINFECTION AND TRANSMISSION FITNESS AS DRIVERS OF GENOME PLASTICITY IN PATHOGENS.

VIRULENCE DES INFECTIONS ET APTITUDE A LA TRANSMISSION COMME CAUSES PREMIERES DE LA PLASTICITE DU GENOME DES AGENTS PATHOGENES

Palmer, Guy H. (*Department of Veterinary Microbiology and Pathology, Washington State University*)

A new pathogen strain can penetrate an immune host population only if it has undergone sufficient change to escape immunity generated against the original strain. This model is best understood with influenza viruses in which new antigenically distinct strains spread through host populations despite the presence of immunity against one or more previous strains. Whether this selection model for genetically distinct strains applies to complex pathogens responsible for endemic persistent infections, which include major diseases such as anaplasmosis, relapsing fever, and sleeping sickness, remains untested. These complex pathogens undergo rapid antigenic variation within an individual host using sets of chromosomally-encoded alleles. Consequently, immunity is developed against a large repertoire of variants, thus dramatically changing the scope of genetic change needed for a new strain to evade existing immunity and establish co-existing infection, termed strain superinfection. Using *Anaplasma marginale* as a model, we show that diversity in the allelic repertoire encoding Msp2 antigenic variants among strains was equal to the allelic diversity within a strain, reflecting equivalent selection for unique variants to overcome immunity at the host population level as well as within an individual

host. This diversity among strains resulted in expression of non-overlapping sets of variants that allow a new *A. marginale* strain to overcome immunity and establish superinfection within an individual persistently infected host. Furthermore, we experimentally demonstrated that even a single distinct allele is sufficient to allow superinfection by a new strain. Pressure for diversification alone would be expected to lead to “strain chaos”—which is not supported by field data which demonstrates strain predominance and overall strain structure. This structure is explained by balancing pressures which mold the pathogen genome, between evasion of population immunity and transmission fitness. These pressures shift in both space and time—resulting in dynamic evolution of the pathogen genome.

PHENOTYPIC PLASTICITY AND MITOCHONDRIAL STRUCTURE IN A TROPICAL FISH GENUS ASTYANAX BAIRD & GIRARD (1854)

PLASTICITE PHENOTYPIQUE ET STRUCTURE MITOCHONDRIALE CHEZ LE POISSON TROPICAL DU GENRE ASTYANAX BAIRD & GIRARD (1854)

Ornelas, Patricia (*Museo Nacional de Ciencias Naturales*)

Bastir, Markus (*Museo Nacional de Ciencias Naturales*)

Doadrio, Ignacio (*Museo Nacional de Ciencias Naturales*)

The *Astyanax* fish genus is characterized by a high phenotypic plasticity, being the most studied case the troglotic *A. mexicanus*. Other examples of phenotypic plasticity have been described for the genus like recurrent trophic-adapted phenotypes. One of these examples has been observed in Lake Catemaco, Mexico, where the *Astyanax aeneus* species shows two contrasting phenotypes, usually assigned to two different genera. Through geometric morphometrics of 210 individuals, we examined variation in body size and shape among morphotypes in the *A. aeneus* system. We also analyzed the mitochondrial genetic structure using Cytb sequences. Results showed that *A. aeneus* morphotypes were significantly different and the shape differences were located at the spatial configuration of landmarks related to the shape and orientation of the head and body depth. While two different mitochondrial lineages were found with less than 1% of divergence, we did not found congruence between mitochondrial and phenotypic differentiation, showing a convergence of the specialized phenotype in both lineages. We argue that this system could be a good candidate for studying parallel evolution of trophic traits in fish and that differences observed in biotypes may reduce resource competition through modification of trophic morphology, body shape, and feeding behavior.

INFLUENCE OF SOCIAL RANK ON PARASITE INFECTION RISK IN VERTEBRATE HOST TAXA

Patterson, Jesse E. H. (*University of Calgary, Department of Biological Sciences*)

Ruckstuhl, Kathreen E. (*University of Calgary, Department of Biological Sciences*)

A growing number of studies suggest that social rank in group-living animals may affect parasite infection risk through a variety of mechanisms (i.e., stress/immunosuppressive hormones, foraging position, fighting, sexual selection). To test this prediction, I used a meta-analysis to compare prevalences and intensities of endo-, ecto-, and micro-parasites between social ranks as described in 51 published studies for 21 vertebrate host taxa. I found no overall difference in parasite prevalence or parasite intensity between ranks when all host taxa were considered ($p=0.177$ and $p=0.707$, respectively). I considered separately male and female hosts, bird and mammal hosts, and endoparasites and microparasites since immunosuppressive hormones, conspecific interactions and modes of transmission may differ. I found no evidence that lower-ranking male vertebrates were more heavily parasitized than dominants ($p=0.533$). Similarly, no effect was evident across female ranks ($p=0.856$). I found that higher-ranking birds had significantly higher parasite intensities than subordinates ($p=0.011$), while no effect of rank was observed in mammals ($p=0.308$). Finally, I found that neither

microparasite intensity ($p=0.617$) nor endoparasite intensity ($p=0.714$) differed significantly with social rank. These results indicate that differences in parasitism between social ranks may exist in some taxa, but social rank biases are not a general rule.

PHOSPHOINOSITIDE 3-KINASE MEDIATES GONADOTROPIN-RELEASING HORMONE ACTIONS IN GOLDFISH PITUITARY GONADOTROPHS AND SOMATOTROPHS.

LE PHOSPHOINOSITIDE 3-KINASE CAUSE LES ACTIONS DE LA GnRH SUR LES GONADOTROPHS ET LES SOMATOTROPHS DE LA GLANDE PITUITAIRE DES POISSONS ROUGES

Pemberton, Joshua (*University of Alberta*)

Chang, John (*University of Alberta*)

In goldfish, *Carassius auratus*, two endogenous gonadotropin-releasing hormones (named salmon (s)GnRH and chicken (c)GnRH-II) control maturational gonadotropin (LH) and growth hormone (GH) secretion via Ca^{2+} -dependent signalling pathways. We investigated whether phosphoinositide 3-kinases (PI3K), which phosphorylate membrane lipids important for signal transduction processes, mediate GnRH-evoked LH and GH release from mixed cultures of dispersed goldfish pituitary cells and intracellular Ca^{2+} increases ($[\text{Ca}^{2+}]_i$) in morphologically identified gonadotrophs and somatotrophs preloaded with the ratiometric fluorescent probe Fura2-AM. Application of the PI3K inhibitor wortmannin (100nM) significantly reduced sGnRH- and cGnRH-II-elicited increases in $[\text{Ca}^{2+}]_i$ in gonadotrophs and abolished LH release responses. Surprisingly, wortmannin attenuated GnRH-evoked GH release but $[\text{Ca}^{2+}]_i$ levels in isolated somatotrophs were not affected. These results demonstrate the direct involvement of PI3K in GnRH-induced Ca^{2+} -signalling in gonadotrophs leading to LH release. In somatotrophs, PI3K action on GH release does not involve modulation of overall $[\text{Ca}^{2+}]_i$. Preliminary results using another PI3K inhibitor, LY294002, are consistent with these findings. To the best of our knowledge, this is the first study to demonstrate PI3K involvement in GnRH-induced $[\text{Ca}^{2+}]_i$ increases and hormone release in any primary pituitary cell. (Supported by NSERC)

AMMONIA EXCRETION AND EXPRESSION OF BRANCHIAL RH PROTEINS IN GOLDFISH EXPERIENCING GILL REMODELLING

EXCRÉTION D'AMMONIAC ET EXPRESSION DE PROTÉINES RH CHEZ DES POISSONS ROUGES ÉPROUVANT UN REMODELAGE DE BRANCHIE

Perry, Steve (*University of Ottawa*)

Schwaiger, Tyler (*University of Ottawa*)

Kumai, Yusuke (*University of Ottawa*)

Braun, Marvin (*University of Calgary*)

Goldfish (*Carassius auratus*) transferred to relatively cold water (e.g. 7°C) experience a morphological remodelling of the gill in which functional lamellar surface area is markedly reduced owing to the physical covering of lamellae by the intrusion of an interlamellar cell mass (ILCM). A decrease of functional surface area may be energetically favourable under such conditions of lowered metabolic requirements because of the associated lowering of passive ion and water fluxes at the gill and hence a diminution of the overall cost of osmoregulation. The current study was designed to assess the impact of gill remodelling on the ability of goldfish to excrete ammonia. Basal rates of ammonia excretion and the clearance of exogenous ammonia loads were compared in fish acclimated to 25°C (mostly uncovered lamellae) or 7°C (mostly covered lamellae). To alter functional lamellar surface area at constant temperature, a group of fish acclimated to 7°C was exposed to hypoxia, a treatment known to cause the ILCM to disappear. The results clearly demonstrated that ammonia excretion was impeded in fish experiencing a loss of functional lamellar surface area. The reduced capacity to excrete ammonia in fish experiencing a decrease in functional surface area was consistent with the immunocytochemistry and western blotting data which revealed no increases in Rh glycoprotein mRNA

expression or localization within the gill.

PURINERGIC MODULATION OF CENTRAL PH/CO₂ CHEMORECEPTION DURING CHRONIC HYPOXIA IN THE CANE TOAD

MODULATION PURINERGIQUE DE CHÉMORÉCEPTION CENTRAL DU PH/CO₂ DURANT L'HYPOXIE CHRONIQUE CHEZ LE CRAPAUD BUFFLE

Peters, Andrew (*University of Toronto Scarborough*)

Reid, Stephen (*University of Toronto Scarborough*)

Exposure of cane toads (*Bufo marinus*) leads to an attenuation in respiratory-related central pH/CO₂ chemoreceptor-stimulated fictive breathing measured using isolated brainstem-spinal cord preparations. This attenuation is reversed by a midbrain transection suggesting that the attenuation results from chronic hypoxia-induced alterations in central descending inputs from the midbrain to the respiratory control centres in the medulla. This study addressed the hypothesis that this attenuation is regulated by purinergic mechanisms in the midbrain and/or medulla. Fictive breathing (respiratory-related motor output) was recorded from isolated brainstem-spinal cord preparations before and after addition of adenosine to the artificial cerebral spinal (aCSF) fluid bathing the preparation. At an aCSF pH of 7.8, adenosine attenuated fictive breathing; a similar effect to chronic hypoxia. The results suggest that purinergic mechanisms attenuate fictive breathing during chronic hypoxia.

EVALUATING DIETARY SELENIUM UPTAKE AND SPECIATION IN LAKE CHUB (*COUESIUS PLUMBEUS*) USING IN-SITU FEEDING CAGES DOWNSTREAM OF A URANIUM PROCESSING MILL

ÉVALUATION DE LA CONSOMMATION DE SÉLÉNIUM PAR L'ALIMENTATION CHEZ COUESIUS PLUMBEUS EN UTILISANT DES CAGES IN-SITU EN AVAL D'UNE USINE DE TRAITEMENT DE L'URANIUM

Phibbs, James R (*Toxicology Centre, University of Saskatchewan, Saskatoon, SK, Canada*)

Franz, Eric D (*Toxicology Centre, University of Saskatchewan, Saskatoon, SK, Canada*)

Wiramanaden, Cheryl I (*Department of Geological Sciences, University of Saskatchewan, Canada*)

Hauck, Dominic W (*Toxicology Centre, University of Saskatchewan, Saskatoon, SK, Canada*)

Pickering, Ingrid J (*Department of Geological Sciences, University of Saskatchewan, Saskatoon, SK, Canada*)

Liber, Karsten (*Toxicology Centre, University of Saskatchewan, Saskatoon, SK, Canada*)

Janz, David M (*Toxicology Centre, University of Saskatchewan, Saskatoon, SK, Canada*)

The aim of this research was to evaluate the dominance of the feeding pathway with respect to Se uptake and speciation in wild populations of northern small-bodied fish. Experimental design included three 21-day feeding cage studies using wild naïve lake chub (*Couesius plumbeus*) in northern Saskatchewan, Canada. Two exposure lakes located downstream of a uranium processing mill and one reference lake situated in an adjacent watershed were studied to investigate a gradient of Se exposure. Caged fish were fed a basal diet, a basal diet spiked with Se, or fed in-situ on native benthos. Results from the in-situ benthos study showed that lake chub caged in the exposure lakes had increased whole body Se concentrations after 21 days compared to fish caged in the reference lake. Within the exposure lakes Se body burden increased with increasing sediment organic carbon. Speciation results to date indicated that selenomethionine may act as a marker of Se exposure, since selenomethionine was the dominant form of Se found in both wild and caged exposure lake chub. Further trophic relationships will be investigated using carbon (C), nitrogen (N) and sulphur (S) stable isotope analysis.

ANALYSIS OF FIN WHALE (*BALAENOPTERA PHYSALUS*) BALEEN PLATE GEOMETRY AND

ARRANGEMENT

ANALYSE COMPARÉE DE LA MORPHOLOGIE DE NAGEOIRES CAUDALES THUNNIFORMES ET DE LA PORTÉE DE MOUVEMENT

Pinto, S.J.D. (*University of British Columbia*)

Goldbogen, J.A. (*University of British Columbia*)

Ben-Zvi, M. (*University of British Columbia*)

Shadwick, R.E. (*University of British Columbia*)

Mysticetes feed using plates of baleen to filter large amounts of prey-laden water. Although baleen morphology is assumed to play an important role in the filtration mechanism of these whales, it has never been formally studied in detail. We examined the geometry of individual baleen plates as well as their in situ arrangement as part of the baleen racks within the mouth of fin whales (*Balaenoptera physalus*). We hypothesized that baleen is shaped and arranged within the oral cavity to maximize feeding efficiency and still permit optimal non-feeding oral functionality. Our analysis shows that baleen plates in fin whales exhibit significant curvature that may facilitate the filtration of water past the baleen via a putative cross-flow mechanism. Such a flow regime could prevent interference with the whale's forward momentum and minimize drag relative to flat plates. The lateral curvature of the plates may also help form a seal with the lower lips during the filtering phase of the feeding process. Examining the details of the arrangement and shape of the baleen as a whole provided insight into the evolution of the oral morphology in mysticetes.

DEVELOPMENTAL AND SEX-DEPENDENT CHANGES IN THE TISSUE-SPECIFIC EXPRESSION OF SEX HORMONE-BINDING GLOBULIN (SHBG) A AND SHBGB IN COHO SALMON, ONCORHYNCHUS KISUTCH

CHANGEMENTS DÉVELOPPEMENTAUX ET RELIÉS AU SEXE DANS L'EXPRESSION PAR TISSUE DE LA GLOBULINE SE LIANT AUX HORMONES SEXUELLES (SHBG) A ET SHBGB CHEZ LE SAUMON COHO, ONCORHYNCHUS KISUTCH

Popesku, Jason T (*Child & Family Research Institute, University of British Columbia*)

Devlin, Robert H (*Department of Fisheries and Oceans, University of British Columbia*)

Hammond, Geoffrey L (*Child & Family Research Institute, University of British Columbia*)

We have examined the expression of the two SHBG paralogs (SHBG α and SHBG β) in coho salmon at the levels of mRNA in liver, muscle, and gill, and protein in plasma, in relation to sex and developmental stage. Male and female adult or pre-smolt coho (n=5 each) were collected from the Chehalis River, BC. Radio-ligand binding assays on plasma determined that adult female fish had approximately 3 times (p=0.001) the levels of circulating SHBG α than the other groups. Circulating levels of SHBG β followed a similar profile as those for SHBG α , but did not reach statistical significance. Using absolute quantification PCR, we found that SHBG α mRNA is highly expressed in the liver for both sexes and developmental stages, whereas SHBG β mRNA is not expressed in this tissue. On the other hand, both SHBG α and β mRNA levels are higher in the muscle of adults than in pre-smolt fish (p<0.0001). Interestingly, expression of SHBG β mRNA in gill is much higher in pre-smolt coho than in adults (p<0.0001). The developmental tissue-specific expression of the SHBG paralogs suggest differential sensitivities to and potential sequestration of environmental contaminants at particular stages in the coho life-cycle. Funded by NSERC-Discovery.

SYMBIONTS OF HOUSE SPARROWS (*PASSER DOMESTICUS*): ROLES OF HOST CHARACTERISTICS AND GEOGRAPHY.

SYMBIOTES DU MOINEAU DOMESTIQUE (PASSER DOMESTICUS) : RÔLES DES CARACTÉRISTIQUES DE L'HÔTE ET DE LA GÉOGRAPHIE

Proctor, Heather (*Dept. of Biological Sciences, University of Alberta*)

Byers, Kaylee (*Dept. of Biological Sciences, University of Alberta*)

The house sparrow (*Passer domesticus*) has a worldwide distribution and is host to a variety of symbionts that may elicit negative effects when in high abundance. We collected symbionts from house sparrows in Edmonton, Alberta, Canada by washing dead birds and examining filtrates. Our results, in concert with 12 published North American studies of house sparrow symbionts revealed a total of 23 genera of mites (Arachnida), five genera of flies (Diptera), one species of true bug (Hemiptera), four species of lice (Phthiraptera: Mallophaga) and one genus of trematode (Platyhelminthes: Trematoda). We examined host-symbiont relationships with respect to host age, sex and time of capture and found that harpirhynchid mites (Harpirhynchidae) differed between age groups, while both *Passeroptes* sp. (Dermoglyphidae) and harpirhynchids differed in abundance between months. We found no strong correlations between body condition and symbiont loads. These results suggest that symbiont acquisition is higher in socially active breeding adults than in younger individuals and that body condition is not negatively affected by the symbiont loads observed. In contrast to other studies in the U.S., we found no wing-dwelling feather mites, which suggests either an effect of climate or of a 'missing-the-boat' founding event.

NEW DATA ON THE FEEDING MORPHOLOGY OF LUNGE-FEEDING BALEEN WHALES (BALAENOPTERIDAE): FIBROUS JOINTS AND GIGANTIC JAWS

NOUVELLES DONNEES SUR LA MORPHOLOGIE DES BALEINES A FANONS (BALAENOPTERIDAE): JOINTS FIBREUX ET MACHOIRES GIGANTESQUE

Pyenson, Nicholas D. (*Department of Paleobiology, Museum of Natural History, Smithsonian Institution*)

Goldbogen, Jeremy A. (*Scripps Institution of Oceanography, University of California, San Diego*)

Shadwick, Robert E. (*Department of zoology, university of British Columbia*)

Living baleen whales employ different modes of bulk filter-feeding. One of these modes, lunge-feeding, is exclusively employed by Balaenopteridae, which feed by lunging at schools of prey with their jaws agape, engulfing a volume of prey-laden water at top speed, and then sieving prey through baleen plates over a protracted period of time. This feeding strategy is accomplished by a suite of bony- and soft-tissue features shared among all living balaenopterids (or rorquals), which differ in measurable ways from other lineages of mysticetes. We summarize our new findings on these morphological features by focusing on two major features: 1) the loose, fibrous temporomandibular joint (TMJ); and 2) the allometry of their mandibles, which are unfused and, in the largest species, constitute the single largest vertebrate skeletal element ever. The absence of a synovial TMJ in rorquals is unique among mammals, and we investigated TMJ myology and histology on freshly dead adult carcasses of fin whales. Using a large dataset built from museum specimens on nearly all species of living Balaenopteridae, we identified a novel scaling relationship in the placement of the coronoid process on rorqual mandibles, which range from 1-6 m in length.

A PUTATIVE SENSORY ORGAN IN THE MANDIBULAR SYMPHYSIS OF FIN WHALES (BALAENOPTERA PHYSALUS)

UN ORGANE SENSORIEL PUTATIF DANS LA SYMPHYSE MANDIBULAIRE DU RORQUAL COMMUN (BALAENOPTERA PHYSALUS)

Pyenson, Nicholas D. (*Department of Paleobiology, Museum of Natural History, Smithsonian Institution*)

Goldbogen, Jeremy A. (*Scripps Institution of Oceanography, University of California, San Diego*)

Vogl, A. Wayne (*Department of Cellular and Physiological Sciences, University of British Columbia*)
Szathmary, Gabor (*FPInnovations*)
Drake, Richard L. (*Cleveland Clinic Lerner College of Medicine of Case Western Reserve University*)
Shadwick, Robert E. (*Department of Zoology, University of British Columbia*)

Living cetaceans exhibit both fused and unfused symphyses (in toothed and baleen whales, respectively). Baleen whales have retained an unfused symphysis, which is the ancestral condition of cetaceans since their early transition from land to sea in the Eocene. The mandibles of large baleen whales belonging to Balaenopteridae, or rorquals, are completely unfused, which assists their lunge-feeding strategy whereby they engulf large volumes of prey at high speed. Here we report the presence of an unusual, spheroid structure located within the fibrous mandibular symphysis of fin whales (*Balaenoptera physalus*), which was previously misidentified as a synovial capsule. To better characterize this structure, we conducted gross macroscopic dissections on freshly dead adult carcasses as well as fine histological examinations. Also, investigation on intact tissue using X-ray CT and MRI techniques determined that the structure located in the mandibular symphysis receives branches from the neurovascular bundle emerging from the mandibular canal. We suspect this structure may be a novel sensory organ that responds to localized changes in jaw configuration during lunge-feeding.

EARLY PALEOGENE MAMMALS FROM THE ROCHE PERCÉE LOCAL FAUNA, SOUTHEASTERN SASKATCHEWAN

MAMMIFÈRES DU DÉBUT DU PALÉOÈNE PROVENANT DE LA FAUNE LOCALE DE ROCHE PERCÉE, SASKATCHEWAN DU SUD EST

Rankin, Brian (*University of Calgary*)

Following the catastrophic mass extinction events that marked the Cretaceous/Paleogene (K/Pg) boundary (approximately 65 million years ago [mya]), many lineages of mammals underwent a remarkable adaptive radiation, with numerous modern orders (e.g., Primates) appearing within the first 10 million years after the K/Pg boundary. Although this radiation has received much attention in recent years, the precise timing and patterns of several origination and diversification points remain largely uncertain. The current research is centered on the description of a large assemblage of early Paleogene (approximately 58 mya) mammals from the Ravenscrag Formation near the hamlet of Roche Percée in southeastern Saskatchewan. Significant discoveries include two new species of viverravid carnivorans, a new species of an ungulate-like phenacodontid condylarth, a large collection of a probable new species of semi-aquatic pantolestid, and rare teeth suggesting only the second known North American occurrence of the European lipotyphlan *Adapisorex*. These new findings suggest that mammalian diversity was greater during this time interval than previously known, providing evidence for a more complex early evolutionary history for several orders, and present an improved understanding of mammalian evolution shortly after the K/Pg boundary.

FOOD REQUIREMENTS OF PACIFIC WHITE-SIDED DOLPHINS

BESOINS ALIMENTAIRES DES DAUPHINS A FLANCS BLANCS DU PACIFIQUE

Rechsteiner, Erin (*Department of Zoology, UBC*)
Trites, A.W. (*Department of Zoology, UBC*)
Rosen, D.A.S (*Department of Zoology, UBC*)

The Pacific white-sided dolphin (*Lagenorhynchus obliquidens*) is an abundant cetacean in coastal British Columbia (BC) waters, which preys primarily on salmon and herring. Pacific white-sided dolphins have recently re-colonized BC near-shore waters, after an absence of approximately □ 100 years. Concern has arisen regarding the potential impact dolphin □ populations may have on commercially and culturally important fish □ species,

but these interactions cannot be quantitatively assessed without an estimate of the food requirements of the dolphins. □ □ My proposed study aims to determine the food requirements of wild Pacific white-sided dolphins by building a bioenergetics model. Seasonal □ resting metabolic rates of captive dolphins will be collected using open-circuit gas respirometry. Metabolic rates and additional energetic parameters including gender, age, growth rate, reproductive status, population size, □ activity budget, and diet will be combined in a mathematical framework. Model predictions will be validated by analyzing previously collected feeding records of □ captive Pacific white-sided dolphins. The model will have local application in fisheries management, and global application as it can be used to estimate the food requirements of Pacific white-sided dolphins in any area.

THE HYPOXIA RESPONSE IN AMPHIBIOUS KRYPTOLEBIAS MARMORATUS IS REGULATED, IN PART, BY SEROTONIN AND ACETYLCHOLINE

LA RÉPONSE HYPOXIQUE CHEZ L'AMPHIBIEN KRYPTOLEBIAS MARMORATUS EST RÉGULÉE EN PARTIE PAR LA SÉROTONINE ET L'ACÉTYLCHOLINE

Regan, Kelly (*University of Guelph, Guelph, ON*)

Jonz, Michael (*University of Ottawa, Ottawa, ON*)

Wright, Patricia (*University of Guelph, Guelph, ON*)

Teleost fish have serotonin-containing neuroepithelial cells (NECs) in the gills that respond to oxygen in water. Little is known about how amphibious fish detect oxygen, as they spend parts of their life out of water. The mangrove killifish, *Kryptolebias marmoratus*, is an amphibious fish that respire via the gills and/or skin. We first demonstrated that NECs are present in both gills and skin with immunohistochemistry. *K. marmoratus* are found in water-filled, hypoxic burrows of the mangrove crab (*Cardisoma* spp.) or out of water (emersed). We hypothesized that fish detect water oxygen levels and emerge at threshold levels. Indeed, lowering water oxygen levels acutely induced fish to emerge at 0.2 mg/L dissolved oxygen. We hypothesized that the hypoxic emersion response is mediated by neurotransmitters (serotonin and acetylcholine). When *K. marmoratus* were pre-exposed to serotonin or acetylcholine, they emerged at a significantly higher oxygen level. Exposure to receptor blockers (ketanserin and hexamethonium) resulted in a decreased sensitivity to oxygen. Taken together, these results indicate that serotonin and acetylcholine release are associated with oxygen sensing and the emersion response of the mangrove killifish.

ON THE INVOLVEMENT OF MITOCHONDRIAL PERMEABILITY TRANSITION AND THIOL GROUPS IN CADMIUM- AND CALCIUM-INDUCED MITOCHONDRIAL DYSFUNCTION IN RAINBOW TROUT

DE L'IMPLICATION DES TRANSITIONS DE PERMÉABILITÉ MITOCHONDRIALE ET DES GROUPES THIOL DANS LES DYSFONCTIONS MITOCHONDRIALES CAUSÉS PAR LE CADMIUM ET DE CALCIUM CHEZ LA TRUITE ARC-EN-CIEL

Adiele, Reginald (*University of Prince Edward Island, 550 University Avenue, Charlottetown, PE, Canada*)

Stevens, Don (*University of Prince Edward Island, 550 University Avenue, Charlottetown, PE, Canada*)

Kamunde, Collins (*University of Prince Edward Island, 550 University Avenue, Charlottetown, PE, Canada*)

Molecular features of cadmium (Cd) and calcium (Ca) toxicity in rainbow trout liver mitochondria were studied using modulators of mitochondrial permeability transition pore (MPTP) and a dithiol reductant. Coupled and uncoupler-stimulated mitochondrial respirations were measured in isolated malate-glutamate energized mitochondria exposed to 20 µM Cd and 50 µM Ca, singly and in combination, with and without addition of ruthenium red (RR), cyclosporine A (CsA), bongkreckic acid (BKA) and dithiothreitol (DTT) at 15°C. State 3 mitochondrial respiration rate was inhibited by 50% by either Cd or Ca, and by 70% when the two cations were added together. MPTP modulators and DTT reduced the inhibition of state 3 respiration rate with DDT completely protecting against the Cd alone inhibition. While state 4 respiration rate was unaffected by Ca and

Cd, singly and in combination, 1.5-3 fold stimulation was observed on addition of the MPTP modulators or DTT. Inhibition of uncoupler-stimulated respiration by Cd and Ca, singly and in combination, was completely reversed by DTT and partially by the MPTP modulators. In contrast, inhibition of uncoupler-stimulated respiration by Ca was completely reversed by the MPTP modulators and DTT. Overall these data highlight the significance of thiol oxidation and MPTP in Cd- and Ca-induced mitochondrial dysfunction.

CARBONIC ANHYDRASE AND THE MODULATION OF CENTRAL RESPIRATORY-RELATED PH/CO₂ CHEMORECEPTOR FUNCTION FOLLOWING CHRONIC HPOXIA AND HYPERCAPNIA IN FROGS

L'ANHYDRASE CARBONIQUE ET LA MODULATION DE LA FONCTION CHÉMORÉCEPTRICE PH/CO₂ CENTRALE LIÉE À LA RESPIRATION SUIVANT UNE HYPOXIE ET UNE HYPERCAPNIE CHRONIQUE CHEZ LES GRENOUILLES

Reid, Stephen (*University of Toronto Scarborough*)

Kajapiratha Srivaratharjah (*University of Toronto Scarborough*)

The goal of this study was to elucidate the role of carbonic anhydrase (CA) in the modulation (activity) of central respiratory-related pH/CO₂-sensitive chemoreceptors. Motor output from respiratory-related nerves (fictive breathing) was measured using in vitro brainstem-spinal cord preparations from leopard frogs (*Rana pipiens*) exposed to chronic hypercapnia (CHC; 3.5% CO₂) and chronic hypoxia (CH; 10% O₂). CHC caused an augmentation in pH/CO₂-sensitive fictive breathing compared to the controls (frogs maintained under normoxic normocapnic conditions). Addition of acetazolamide (ACTZ), a cell-permeant CA inhibitor, to the superfusate bathing the in vitro preparations reduced fictive breathing in the preparations taken from control animals and abolished the CHC-induced augmentation of pH/CO₂-sensitive fictive breathing. ACTZ had no effect on preparations taken from frogs exposed to CH. Addition of bovine CA to the superfusate did not alter fictive breathing in any group, suggesting that the effects of ACTZ were due to inhibition of intracellular CA. Taken together, these results indicate that CA is involved in central pH/CO₂ chemoreception and the CHC-induced increase in fictive breathing in the leopard frog. Funded by NSERC.

PERIPHERAL ARTERIAL CHEMORECEPTORS IN THE SOUTH AMERICAN RATTLESNAKE (CROTALUS DURISSUS) AND THEIR ROLE IN CARDIORESPIRATORY CONTROL

CHEMORECEPTEURS ARTERIELS PERIPHERIQUES DU SERPENT A SONNETTE D'AMERIQUE DU SUD (CROTALUS DURISSUS) ET LEUR ROLE DANS LE CONTROLE CARDIORESPIRATOIRE

Reyes, Catalina (*University of British Columbia*)

Fong, Angelina Y. (*University of British Columbia*)

Milsom, William (*University of British Columbia*)

Peripheral chemoreceptors monitor the levels of arterial blood gases and adjust ventilation and perfusion to meet metabolic demands. Chemoreceptors are present in all vertebrates studied to date but have not been described in non-chelonian reptiles. The goals of this study were to identify functional chemosensory areas in the South American rattlesnake (*Crotalus durissus*) and the role they play in ventilatory and cardiovascular control. Rattlesnakes were instrumented with transonic flow probes, arterial catheters and subcutaneous needle electrodes to measure shunt fraction, heart rate, blood pressure and ventilation, respectively. Catheters were placed at three putative chemosensory sites; aortic arch, pulmonary artery and carotid bifurcation for site specific activation of the chemoreceptors with sodium cyanide (NaCN, 0.5mg/0.1ml). All three putative chemoreceptor sites appeared to be chemosensory and stimulating each led to both respiratory and cardiovascular (shunt fraction) adjustments. Activation of aortic and pulmonary chemoreceptors, however, primarily increased pulmonary blood flow and reduced systemic blood flow and blood pressure, while chemoreceptors located at the carotid bifurcation were primarily involved in ventilatory control. Multiple chemosensory sites, each with distinct reflex roles, may allow

animals with incomplete separation of systemic and pulmonary circulations to regulate blood gases more efficiently.

MECHANISMS OF NEURONAL SIGNALING IN THE HUMAN BLOODFLUKE, *SCHISTOSOMA MANSONI*

LES MÉCANISMES DE LA SIGNALISATION NEURONALE DES DOUVES, *SCHISTOSOMA MANSONI*, CHEZ L'HOMME

RIBEIRO, PAULA (*Institute of Parasitology, McGill University, Canada*)

EL-SHEHABI, F. (*Institute of Parasitology, McGill University, Canada*)

TAMAN, A. (*Institute of Parasitology, McGill University, Canada*)

PATOCKA, N. (*Institute of Parasitology, McGill University, Canada*)

MACDONALD, K. (*Institute of Parasitology, McGill University, Canada*)

Schistosomes and other flatworms mark an important stage in animal evolution when a structured nervous system first appears. A wide range of neuroactive substances have been identified in flatworms, including many small ("classical") transmitters, such as biogenic amines, acetylcholine and glutamate. These substances play key roles in the control of motor activity and behaviour but their mode of action is poorly understood. Our laboratory is investigating the mode of action of classical transmitters by focussing on the cell surface receptors that mediate their effects. Large scale analyses of the *S. mansoni* genome identified many putative neuroreceptors, which are being characterized through cloning, functional expression studies, immunolocalization and RNA interference (RNAi). The results of these studies will be presented.

Les schistosomes et les vers plathelminthes mettent en évidence l'apparition du système nerveux plus complexe, un stade important dans l'évolution animale. Un large éventail de substances neuroactives ont été identifiées chez les vers plats, incluant plusieurs petits transmetteurs « classique », tels que les amines biogènes, l'acétylcholine et le glutamate. Ces substances jouent un rôle clef au contrôle de l'activité motrice et du comportement, bien que leur mode d'action soit très peu connu. Notre laboratoire étudie le mode d'action des transmetteurs classiques en mettant l'accent sur les récepteurs de surface qui régulent leur activité. Des analyses à grande échelle du génome de *S. mansoni* ont permis d'identifier plusieurs neurorécepteurs putatifs, qui seront caractérisés par le clonage, des essais fonctionnels, l'immunolocalisation et de l'interférence d'ARN (ARNi). Les résultats de ces recherches seront présentés.

FUNCTIONAL GENOMIC STUDIES OF ATLANTIC COD (*GADUS MORHUA*) DEFENSE RESPONSES

ÉTUDES EN GÉNOMIQUE FONCTIONNELLE DES RÉPONSES DE DÉFENSE DE LA MORUE ATLANTIQUE (*GADUS MORHUA*)

Rise, Matthew L. (*Ocean Sciences Centre, Memorial University of Newfoundland, St. John's, NL*)

Booman, Marije (*Ocean Sciences Centre, Memorial University of Newfoundland, St. John's, NL*)

Hori, Tiago S. (*Ocean Sciences Centre, Memorial University of Newfoundland, St. John's, NL*)

Feng, Charles Y. (*Ocean Sciences Centre, Memorial University of Newfoundland, St. John's, NL*)

Hall, Jennifer R. (*Ocean Sciences Centre, Memorial University of Newfoundland, St. John's, NL*)

Browne, Mitchell (*Ocean Sciences Centre, Memorial University of Newfoundland, St. John's, NL*)

Gamperl, A. Kurt (*Ocean Sciences Centre, Memorial University of Newfoundland, St. John's, NL*)

Rise, Marlies (*Ocean Sciences Centre, Memorial University of Newfoundland, St. John's, NL*)

Hubert, Sophie (*The Atlantic Genome Centre, Halifax, NS*)

Kimball, Jennifer (*Institute for Marine Biosciences, National Research Council, Halifax, NS*)

Borza, Tudor (*The Atlantic Genome Centre, Halifax, NS*)

Bowman, Sharen (*The Atlantic Genome Centre, Halifax, NS*)

Johnson, Stewart C. (*Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, BC*)

A goal of the Atlantic Cod Genomics and Broodstock Development Project (CGP) is to identify and study cod genes that respond to pathogens (viral, bacterial, fungal) and environmental stress (e.g. heat stress). Of ~ 160,000 expressed sequence tags generated by the CGP, ~ 10,000 came from suppression subtractive hybridization (SSH) cDNA libraries enriched for transcripts that respond to nodavirus and/or polyriboinosinic polyribocytidylic acid (pIC, a viral mimic), ~ 4300 came from SSH libraries enriched for transcripts that respond to bacterial antigens, and ~ 6000 came from SSH libraries enriched for heat stress responsive transcripts. We developed quantitative reverse transcription – polymerase chain reaction assays for studying the expression of many SSH-identified transcripts in cod following exposures to stressors. In addition, we have built and tested a 20,000 gene (20K) Atlantic cod oligonucleotide microarray that is being used to study cod global gene expression responses to single stressors (e.g. pathogen exposures) or combinations of stressors (e.g. heat stress and pIC). The CGP has dramatically improved the characterization of Atlantic cod defense relevant genes, and has developed tools and techniques that may be used to study the genes and molecular pathways involved in farmed and wild cod responses to pathogens and environmental stressors.

TRIMETHYLAMINE OXIDE AND THE CELLULAR STRESS RESPONSE OF THE SPINY DOGFISH *SQUALUS ACANTHIAS*

L'OXYDE DE TRIMETHYLAMINE ET LA REPOSE CELLULAIRE AU STRESS CHEZ L'AIGUILLAT (*SQUALUS ACANTHIAS*)

Robertson, Cayleih (*Mount Allison University*)

Currie, Suzanne (*Mount Allison University*)

Marine elasmobranch fishes contain high concentrations of urea to allow their internal osmolarity to match that of their saltwater environment. To cope with these high levels of urea, elasmobranch cells contain the protein stabilizing trimethylamine oxide (TMAO). As part of a highly conserved cellular stress response used by most animals, denatured proteins signal the induction of protective heat shock proteins (Hsps). We are studying the effect of endogenous levels of TMAO on the ability of dogfish red blood cells to induce a heat shock response. The goal of this project is to determine if TMAO alters the degree of damage sustained by temperature-stressed cells. We measured Hsp70 induction with immunoblotting in parallel with assessments of cell damage. We have shown that the presence of TMAO attenuates the induction of Hsps. This attenuation corresponds with a significant increase in cell membrane damage. These data suggest that TMAO increases the susceptibility of elasmobranchs to cellular damage in the face of environmental stresses by impeding their heat shock response. With current fluctuations in our ocean environments, understanding the ability of marine species such as the spiny dogfish to cope with environmental change/stress will be crucial for their conservation.

THE INFLUENCE OF FEEDING AND CONFINEMENT ON RH GLYCOPROTEIN AND GLUTAMINE SYNTHETASE EXPRESSION IN THE GULF TOADFISH, *OPSANUS BETA*.

L'INFLUENCE DE L'ALIMENTATION ET DE LA DÉTENTION SUR L'EXPRESSION DES GLYCOPROTÉINE RH ET DE LA GLUTAMINE SYNTHÉTASE CHEZ OPSANUS BETA

Rodela, Tammy (*University of Ottawa*)

McDonald, Danielle (*University of Miami*)

Gilmour, Katie (*University of Ottawa*)

Walsh, Pat (*University of Ottawa*)

Proposed models of branchial transport in teleosts has been reshaped by the recent discovery of Rhesus (Rh) glycoproteins which facilitate movement of NH₃/NH₄⁺ across cell membranes. This study re-examines effects of feeding and confinement on ammonia excretion in gulf toadfish (*Opsanus beta*) within the context of Rh glycoproteins and the ammonia-fixing enzyme, glutamine synthetase (GS). Feeding resulted in a two-fold

elevation in ammonia excretion rates in both unconfined and crowded toadfish. Crowded toadfish had high levels of hepatic GS activity that decreased two-fold upon feeding, compared to the relatively low and constant levels in unconfined individuals. Toadfish had moderate levels of GS activity in the stomach that increased two-fold following feeding. Presently, four Rh isoforms (Rhag, Rhbg, Rhcg1, Rhcg2) have been isolated from toadfish, and mRNA tissue distributions showed high levels of expression in the gills and liver, and low levels in the stomach. Ongoing research examines changes in Rh and GS mRNA expression in gill, stomach, intestine and liver in response to feeding and confinement. The data suggest there may be a mechanistic linkage between GS activity and Rh expression ultimately regulating rates of ammonia excretion in toadfish. (Funded by NSERC to KMG and PJW and NSF to MDM).

THERMAL CHARACTERISTICS OF MITOCHONDRIA FROM CARDIAC MUSCLE OF ATLANTIC COD

LES CARACTERISTIQUES THERMIQUES DES MITOCHONDRIES DU MUSCLE CARDIAQUE CHEZ LA MORUE ATLANTIQUE

Rodnick, Kenneth (*Idaho State University*)

Gamperl, A. Kurt (*Memorial University of Newfoundland*)

Nash, Gord (*Memorial University of Newfoundland*)

Syme, Douglas (*University of Calgary*)

We investigated the hypothesis that ventricular mitochondrial respiration and efficiency are thermally-sensitive in Atlantic cod and may limit cardiac performance at elevated temperatures. Mitochondria were isolated by homogenization and differential centrifugation of fresh tissue from fish acclimated at 10°C. State 3 respiration was measured under air-saturation at 10, 16, 20, and 24°C using saturating concentrations of ADP and pyruvate. State 4 occurred after all the ADP had been converted to ATP. State 3 and 4 respiration increased with incubation temperature ($Q_{10} = 1.46$ and 1.94 , respectively), but there was a proportionately greater increase in State 4 at 24°C. This resulted in RCI (respiratory control index: State 3/State 4) values that were ~10 at 10, 16 and 20°C (i.e. typical of well-coupled mitochondria), whereas RCI was reduced to 7.5 at 24°C. Although P/O ratios during State 3 respiration (a measure of mitochondrial efficiency) were similar (~1.7) at all temperatures, the higher State 4 respiration and reduced RCI at 24°C suggest that proton leak may impair mitochondrial function when temperatures approach the critical thermal maximum for this species.

SPLIT PERSONALITIES: SEASONAL ENERGETIC PRIORITIES IN YOUNG NORTHERN FUR SEALS

PERSONNALITÉS MULTIPLES : PRIORITÉS SAISONNIÈRES MULTIPLES CHEZ DE JEUNES OTARIES À FOURRURE DU NORD

Rosen, David (*Marine Mammal Research Unit, University of British Columbia*)

Trites, Andrew (*Marine Mammal Research Unit, University of British Columbia*)

Northern fur seals depart their birth sites on the Pribilof Islands in the Bering Sea at 4 months of age, and remain at sea in the North Pacific Ocean for the next 18 months. Hence, little is known of their physical development during this critical time period. Results from a series of longitudinal studies on six female northern fur seal pups indicate that the fur seals' energetic priorities during this initial at-sea phase shifted between periods emphasizing either survival or growth. In the winter months (6-10 months of age) unusually low metabolic rates (4.32 MJ/d) were coupled with food intake levels only 44% higher than basic RMR costs. This resulted in average mass loss of -32.8% over the 5-month period. However, this decreased metabolic overhead lessened the impact of periodic food. In contrast, metabolism increased to 7.68 MJ/d during the summer (11-15 months), with a concurrent increase in food intake (69.4% above RMR costs). This translated into an overall increase in body mass of 22.1%. Our findings suggest that young northern fur seals may contend better with food shortages during winter

than during summer, which may have bearing on the unexplained population decline of northern fur seals in Alaska.

METABOLISM, SEX AND REPRODUCTIVE TACTICS IN YOUNG ATLANTIC SALMON (*SALMO SALAR* L.)

MÉTABOLISME, SEXE ET TACTIQUES REPRODUCTRICES CHEZ DE JEUNES SAUMONS ATLANTIQUES (*SALMO SALAR* L.)

Rossignol, Orlane (*Université Laval*)

This study examined anatomic and physiological differences between mature male parr, immature male and female smolts. To minimize the impact of habitat differences upon these attributes, salmon were reared in the laboratory until 1.5 y of age, when the “decision” to mature as parr had been taken. Neither the population of origin nor the paternal reproductive tactic influenced the “decision” to mature or the growth trajectories, with both males and females showing bimodal size-frequency distributions at 1.5 y. Males in the smaller size mode matured, whereas all other fish began smoltification. Mature male parr did not differ from the smolts in routine metabolic rate. Mature parr differed markedly from similarly sized females and from larger male and female smolts in possessing higher oxidative capacities in muscle. As these differences exceed those predicted from simple size relationships, they may be linked with the greater swimming activity of mature male parr.

THE PHYSIOLOGICAL MECHANISM UNDERLYING ENHANCED OXYGEN DELIVERY TO RED MUSCLE IN RAINBOW TROUT

LES MÉCANISMES PHYSIOLOGIQUES RESPONSABLES DE LA LIVRAISON ACCRUE D'OXYGÈNE AUX MUSCLES ROUGES CHEZ LA TRUITE ARC-EN-CIEL

Rummer, Jodie L. (*Department of Zoology, University of British Columbia, Vancouver, CANADA*)

McKenzie, David J. (*Institut des Sciences de l'Évolution, Université de Montpellier 2, FRANCE*)

Supuran, Claudiu T. (*Laboratorio di Chimica Bioinorganica, Università degli Studi di Firenze, ITALY*)

Brauner, Colin J. (*Department of Zoology, University of British Columbia, Vancouver, CANADA*)

Recent studies suggest that a complex suite of physiological characteristics is responsible for high O₂ tensions (PO₂) found in teleost muscle, when compared to mammalian systems. The physiology of the red muscle, non-linear Bohr-Root effect at the hemoglobin (Hb), and disequilibrium states within the blood collectively contribute to muscle PO₂ that is orders of magnitude greater than in mammalian systems. We tested, in vivo, a mechanistic basis for the role of the Bohr-Root effect complex and plasma-accessible carbonic anhydrase (CA) in enhancing muscle oxygenation in teleosts. Rainbow trout exposed to hypercarbia (~12 mmHg) release catecholamines, but muscle PO₂ remains 25% higher than during normocarbia. During stress, the localized acidosis needed to exploit the great potential for O₂ delivery unique to teleosts is created CA short-circuits the red blood cell β -adrenergic stress response and associated Na⁺/H⁺ exchange (β NHE). Subsequent exposure to a membrane impermeable CA inhibitor (C18) reversed the phenomenon, eliciting a profound decrease in red muscle PO₂ thus validating our model. Root-effect Hbs evolved long before eye and swim bladder retina, structures typically associated with teleosts' unique pH sensitive Hbs, suggesting a general use for such great O₂ delivery potential, which we have supported mechanistically in this study.

BEHAVIOUR AND MORPHOLOGY AS INDICATORS OF MODULARITY IN THE ADHESIVE SYSTEM OF GECKOS

COMPOTEMENT ET MORPHOLOGIE COMME INDICATEURS DE MODULARITÉ DANS LE SYSTÈME ADHÉSIF DES GECKOS

Russell, Anthony (*Dept Biological Sciences, University of Calgary*)

Higham, Timothy (*Dept Biology, Clemson University*)

The subdigital pads of geckos consist of a hierarchy of structural components. The epidermal setae are the ultimate agents of adhesion, but their action is dependent upon a suite of morphological components that control their application and release. Whether or not the adhesive system is deployed is dependent upon sensory feedback relating to body orientation. In horizontal locomotion the digits are carried in a permanently retracted state regardless of the ability of the substrate to provide traction. Despite the many advantages that the adhesive system confers, some lineages of geckos have secondarily reduced or lost the adhesive apparatus. The pattern of reduction or loss is characterized by a distal shift and truncation of the apparatus, resulting in a reduction in the number of adhesive plates involved, and ultimately a breakdown in the orderly arrangement of the setae. Ecological situation and behavioural control correlate well with reduction and loss of this system. Examples from African geckos occupying diverse habitats and trending towards secondary terrestriality will be used to illustrate the morphological transformations that characterize reduction and loss, and to explore how such changes lead to new patterns of adaptation and new configurations of the system.

STRUGGLING MOTHERS, STRONG SONS: OPTIMIZATION AND ADAPTIVE SEX ALLOCATION IN RICHARDSON'S GROUND SQUIRRELS (*SPERMOPHILUS RICHARDSONII*)

MERES QUI LUTTENT, FILS VIGOUREUX: OPTIMISATION ET ALLOCATION ADAPTIVE DES SEXES CHEZ LES SPERMOPHILES DE RICHARDSON (*SPERMOPHILUS RICHARDSONII*)

Ryan, Calen P. (*Biological Sciences, University of Manitoba, Winnipeg, Manitoba*)

Hare, James, F. (*Biological Sciences, University of Manitoba, Winnipeg, Manitoba*)

Anderson, W. Gary. (*Biological Sciences, University of Manitoba, Winnipeg, Manitoba*)

Skewed sex ratios at birth and weaning have been observed among vertebrates, and are generally attributed to differential costs for successfully rearing offspring of a given sex and to condition-dependant differences in the relative reproductive value of each sex. Theory predicts that systematic deviations in sex ratio can be adaptive in the face of variation in prevailing environmental or physiological cues experienced by the mother, yet scant research has examined these relationships directly in free-living mammals. This study examined adaptive sex allocation (ASA) in a free-living polygynous sciurid, Richardson's ground squirrel (*Spermophilus richardsonii*), by looking at the relationship between offspring sex ratio and various indicators of maternal condition and investment. These included litter size and juvenile mass at emergence, as well as maternal age, changes in maternal body mass, and maternal stress hormone (fecal glucocorticoid metabolite) levels during gestation and rearing. Males born of small litters were significantly heavier at emergence than males from larger litters ($P = 0.007$), which were significantly female-biased ($P = 0.0496$), whereas females showed no significant change in mass with litter size. Mothers with higher fecal cortisol levels during the gestation period (but not during the rearing period) were significantly more likely to produce male-biased litters ($P = 0.0490$), whereas females producing larger litters showed significantly higher cortisol levels during rearing (but not gestation) than mothers producing smaller litters ($P = 0.008$). These results support state-dependant optimization and an adapted Trivers-Willard hypothesis, whereby litter size and sex ratio are simultaneously optimized in response to maternal condition, and are supported by a principle contemporary mechanistic theory for ASA in mammals.

MORPHOLOGICAL CONVERGENCE AMONG ANOLIS LIZARDS IS THE RESULT OF REPEATED DEVELOPMENTAL PARALLELISMS

LA CONVERGENCE MORPHOLOGIQUE ENTRE LES LÉZARD ANOLES SONT LE RÉSULTAT DE PARALLÉLISMES DÉVELOPEMENTAUX RÉPÉTÉS

Sanger, Thomas (*Harvard University, Museum of Comparative Zoology*)

Losos, Jonathan (*Harvard University, Museum of Comparative Zoology*)

Abzhanov, Arhat (*Harvard University, Museum of Comparative Zoology*)

Instances of repeated evolution have contributed greatly to the development of evolutionary theory, but more recent debates question whether parallelism and convergence are in fact unique evolutionary phenomena or reflect the same processes unfolding at different times scales. We are exploring this question in Anolis lizards that have independently evolved nearly identical morphologies across islands of the Greater Antilles. Our goal is to determine the developmental bases of variation in limb and craniofacial dimensions among divergent sets of habitat specialists from each island. Due to the quantitative nature of this variation we are first employing methods of comparative allometry and geometric morphometrics to examine the timing of morphological divergence. In all species examined, It appears that limb length variation is repeatedly the result of modifications to limb morphogenesis while variation in skull shape is consistently due to differences in post-hatching allometry. Curiously, variation in skull shape associated with sexual dimorphism appears to parallel interspecific variation and also appears to be generated using similar developmental processes. At first glance these results imply that Anolis represents a well-grounded example of parallel morphological evolution, but it remains to be seen if this is also the case at the cell/tissue and molecular levels.

ORIGIN AND EVOLUTION OF THE MODERN CORAL REEF FISH FAUNA

ORIGINE ET ÉVOLUTION DE LA FAUNE MODERNE DES RÉCIFS DE CORAUX

Santini, Francesco (*Department of Ecology and Evolutionary Biology, University of California at Los Angeles*)

Coral reefs occupy less than 2% of marine surface, yet about 40% of the approximately 170000 marine fish species live predominantly or exclusively on coral reefs. Earlier studies of tetraodontiform fishes (puffers, box- and triggerfish) showed that reef-associated fish clades are significantly more diverse than non reef clades, suggesting that coral reefs have increased fish diversification rates. Here we test whether reef-association has driven diversification in other fish clades as well using time-calibrated phylogenies from 28 reef-associated clades. Analysis of diversification rates for 42 groups based upon method of moments estimates (Magallon and Sanderson, 2001) , indicates that reef clades have higher diversification rates than teleost fish as a whole. However we find that most named reef clades are not significantly more diverse than percomorphs. We also apply recently developed comparative methods to test for exceptionally rapid or slow diversification events within reef families and across time periods.

PARALLEL SELECTION AND THE GENETICS OF ADAPTATION IN STICKLEBACKS

LA SELECTION PARALLELE ET LA GENETIQUE DE L'ADAPTATION CHEZ LES EPINOCHES

Schluter, Dolph (*Department of Zoology, University of British Columbia*)

Growing knowledge of the molecular basis of adaptation in wild populations is expanding the study of natural selection. I summarize ongoing efforts to infer three aspects of natural selection - mechanism, form, and history - from the genetics of parallel adaptive evolution in threespine stickleback that colonized fresh water after the last ice age. We tested a mechanism of selection for reduced bony armour in fresh water by tracking genotype and allele frequency changes at an underlying major locus (Ectodysplasin) in transplanted stickleback populations. We inferred disruptive selection on genotypes at the same locus in a population polymorphic for bony armour.

Finally, we compared the distribution of phenotypic effect sizes of genes underlying changes in body shape to that predicted by models of adaptive peak shifts following colonization of fresh water. Studies of the effects of parallel selection on genes complement efforts to identify the molecular basis of adaptive differences, and improve our understanding of phenotypic evolution.

PHYSIOLOGICAL PERFORMANCE AND STRESS TOLERANCE OF FOUR STRAINS OF DIPLOID AND TRIPLOID RAINBOW TROUT (ONCORHYNCHUS MYKISS)

PERFORMANCE PHYSIOLOGIQUE ET TOLERANCE AU STRESS DE QUATRE SOUCHES DE TRUITES ARC-EN-CIEL (ONCORHYNCHUS MYKISS) DIPLOÏDES ET TRIPLOÏDES

Scott, Mark A. (*The University of British Columbia Department of Zoology*)

Richards, Jeffrey G. (*The University of British Columbia Department of Zoology*)

The goal of this project is to uncover a physiological explanation of why 3n rainbow trout exhibit higher mortalities in the wild compared with their 2n counterparts. To accomplish this goal, we measured critical swimming speed (Ucrit), standard metabolic rate (oxygen consumption rates; MO₂) and critical oxygen tensions (Pcrit) on 2n and 3n varieties of wild and domesticated strains of rainbow trout. These strains of rainbow trout are used extensively in lake stocking programs in British Columbia, Canada. Our preliminary analysis demonstrated a significant variation in swimming speed among and between strains of rainbow trout, but this variation was highly correlated to variation in size of the fish. We are currently repeating our investigations on size-matched fish.

THE EFFECTS OF SUBSTRATE RESISTANCE AND MICROHABITAT PREFERENCE ON DISPERSAL IN THE LONG TOED SALAMANDER (AMBYSTOMA MACRODACTYLUM)

LES EFFETS DE LA RESISTANCE DU SUBSTRAT ET DE LA PREFERENCE DU MICROHABITAT SUR LA DISPERSION DES SALAMANDRES A LONGS DOIGTS (AMBYSTOMA MACRODACTYLUM)

Sechley, Talia (*University of British Columbia*)

Lee-Yaw, Julie (*University of British Columbia*)

Irwin, Darren (*University of British Columbia*)

Microhabitat resistance can affect the ability of amphibians to disperse between breeding ponds, as well as inhibit predator evasion. In order to quantify the resistance of various landscapes to long toed salamander (*Ambystoma macrodactylum*) dispersal, we tested the mobility of juveniles through five distinct substrates: deciduous litter, grass, moss, coniferous litter and sand. Based on a multivariate response, we determined that this species moves with significantly increased ease through moss and sand substrates. This result contradicts the argument that dry, open substrates deter salamander movement because of the negative effect of desiccation and suggests instead that these landscapes present a decreased physical barrier to movement. As microhabitat resistance in nature may reflect habitat preference in addition to physical resistance of the substrate, we conducted a substrate choice experiment whereby salamanders were placed in a multi-substrate arena (containing five patches of each of the five substrates) and allowed to pick their resting substrate. The salamanders showed significant preference for the moss substrate. When considered in combination with the substrate resistance result, this finding suggests that mossy substrates may constitute the least resistant microhabitat.

ON THE ROLE OF VENTRAL GROOVE BLUBBER (VGB) ELASTICITY DURING LUNGE FEEDING: IMPLICATIONS FOR ENGULFMENT DYNAMICS

ROLE DE L'ELASTICITE DU SILLON VENTRAL DE LA GRAISSE DES BALEINES DURANT L'ALIMENTATION FENTE: IMPLICATIONS POUR LES DYNAMIQUES DE L'ENGOUFFREMENT

Shadwick, Robert E (*University of British Columbia*)

Goldbogen, Jeremy A (*University of British Columbia*)

Potvin, Jean (*St. Louis University*)

Pyenson, Nicholas D (*University of British Columbia*)

Balaenopterid whales capture schooling prey by engulfment. This involves brief acceleration, opening the mouth to large gapes, closing, purging water, and ingesting prey. The engulfed water mass is enormous, on the order of the whale's body mass, facilitated by stretching of the ventral groove blubber (VGB) and associated muscle. Because engulfment involves a collision between lunging whale and water, the whale transfers some momentum to a mass that is initially at rest. We investigated the role of VGB elasticity in engulfment and water acceleration in fin whales. We assessed the volumetric capacity of the buccal cavity using ellipsoidal geometries suggested by photographic evidence from the field and by the elliptical shape of the mandibles. We calculated the buccal cavity perimeter at the point of maximum extension both longitudinally and circumferentially, and the tissue strain and stress that ensue, using data collected in the field on fin whales (Orton and Brodie, 1987, *Can. J. Zool.*). The results indicate that the VGB unfolds and stretches to strains that are too low for passive elasticity to provide the limit of VGB expansion. Consequently, we suggest that active VGB muscles VGB control the rate of filling as well as expelling of water through the baleen.

REGULATION OF MEMBRANE-BOUND ATPASES IN MUSCLE OF AESTIVATING AFRICAN LUNGFISH (*PROTOPTERUS ANNECTENS*)

RÉGULATION D'ATPASES MEMBRANAIRES DANS LES MUSCLES DE PROTOPTERUS ANNECTENS

Shapiro, Noah (*University of Guelph*)

Aestivation is induced in African lungfish (*Protopterus annectens*) by controlled downregulation of energy consumption during extended periods without food. Activities of several transport ATPases in purified sarcoplasmic reticulum-enriched membranes from aestivating, starved, and control fish were used to assess the role of membrane lipids in mediating this metabolic depression. Significant decreases during aestivation were found in Mg^{2+} (59%), Na^{+}/K^{+} (82%), Ca^{2+} (77%), and phospho-intermediate proton ($H^{+}p$; 78%) ATPase activities in whole muscle homogenate. Aestivating fish displayed higher percentages of phosphatidylserine (PS) and phosphatidylinositol (PI) and lower phosphatidylethanolamine (PE) in isolated membranes. Total phospholipid saturation decreased 3-fold in aestivating fish, though no significant changes occurred in cholesterol content or cholesterol:phospholipid ratio. Significant correlations were found in both fed and starved, but not aestivating fish between Mg^{2+} ATPase activity and both sphingomyelin (SM) and cholesterol content, while $H^{+}p$ ATPase activity correlated with cholesterol content, PC, and PI. These findings strongly support membrane compositional change as a mechanism for targeted downregulation of ATPases within muscle of African lungfish. This research is funded by a Canadian NSERC grant awarded to Dr. J.S. Ballantyne.

ANOXIA TOLERANCE MEDIATED BY SEROTONIN REGULATION OF ENERGY METABOLISM IN POND SNAIL EMBRYOS

LA TOLÉRANCE À L'ANOXIE FACILITÉE PAR LA RÉGULATION PAR LA SÉROTONINE DU MÉTABOLISME ÉNERGÉTIQUE CHEZ LES EMBRYONS D'ESCARGOTS D'ÉTANG

Shartau, Ryan (*University of Calgary*)

Tam, Rose (*University of Calgary*)

Goldberg, Jeffrey (*University of Calgary*)

Embryos of the pond snail *Helisoma trivolvis* have a pair of hypoxia-sensitive sensorimotor neurons that release serotonin onto postsynaptic ciliary cells, causing cilio-excitation and faster embryonic rotation. While the rotational response to anoxia persists for only three hours, recent experiments suggest that serotonin provides longer-term protection by stimulating energy metabolism. In this study, we examined the effect of anoxia, serotonin and the tryptophan hydroxylase inhibitor parachlorophenylalanine (PCPA) on both mitochondrial membrane potential and whole embryo survival. Both serotonin (100 uM) and short-term (1-3 hours) anoxia exposure increased mitochondrial membrane potential, as indicated by MitoTracker Red CMXRos imaging. During long-term anoxia (>6 hours), embryos exhibited a decrease in mitochondrial membrane potential that paralleled a decrease in rotation rate and increase in embryonic mortality. Treatment with PCPA to deplete endogenous serotonin severely depressed mitochondrial membrane potential during both normoxia and anoxia. PCPA treatment also caused a significant reduction in anoxia tolerance, with 50% mortality occurring at 9 hours in control embryos and 5.9 hours in PCPA-treated embryos. These results suggest that serotonin regulation of mitochondrial energy metabolism confers anoxia tolerance in *H. trivolvis* embryos.

DERIVATION OF GOLDFISH BRAIN CELL CULTURES FOR THE STUDY OF ANOXIA AND HYPERAMMONEMIA IN VITRO

DÉRIVATION DE CULTURES DE CELLULES DU CERVEAU DU POISSON ROUGE POUR L'ÉTUDE DE L'ANOXIE ET DE L'HYPERAMMONÉMIE IN VITRO

Sidhu, Sanya

Graham, Owain

Beggs, Brooke

Bufalino, MaryRose

Wilkie, Michael P

Lee, Lucy EJ

Hyperammonemia is detrimental to brain function and has been extensively studied in mammals, in which ammonia build-up overactivates N-Methyl-D-Aspartate (NMDA) receptors in brain cells, which may lead to death through excitotoxic mechanisms. Fish may be exposed to ammonia in aquatic environments due to agricultural run-off, landfill leachate, and following feeding. However, the effects on fish neural cells have received relatively little attention. Goldfish (*Carassius auratus*) are tolerant to ammonia build-up as well as to oxygen starvation (hypoxia/anoxia). Thus, determination of how ammonia affects goldfish neuronal physiology, growth and survival, and whether their ammonia tolerance is related to their profound ability to withstand oxygen starvation is of interest. In this study, freshly isolated cultures of neural cells from goldfish were used to study mechanisms of ammonia cytotoxicity and tolerance. Comparisons with responses obtained from established cell lines derived from goldfish, and from an acutely sensitive species, rainbow trout (*Oncorhynchus mykiss*), will be presented. Cells exposed to varying concentrations of NH₄Cl at various time points were also evaluated for cellular responses including viability, membrane integrity, lysosomal function and general cellular morphology. These in vitro models may reveal novel features of goldfish neurophysiology that make them more tolerant to ammonia/anoxia than other vertebrates.

THE PALAEOZOIC ORIGIN OF MODERN AMPHIBIANS: A NEW STUDY OF THE FOSSIL AND PHYLOGENETIC EVIDENCE

L'ORIGINE PALÉOZOÏQUE DES AMPHIBIENS MODERNES: NOUVELLE ÉTUDE DES DONNÉES FOSSILES ET PHYLOGÉNÉTIQUES

Sigurdson, Trond (*Université de Montréal*)

Green, David (*McGill University*)

There are currently three competing hypotheses seeking to explain the evolutionary origins of modern amphibians (Lissamphibia). The Lepospondyl Hypothesis holds that frogs, salamanders, and caecilians all derive from the Palaeozoic Lepospondyli, with Lysorophia considered to be the closest sister-group to all lissamphibians. The Temnospondyl Hypothesis suggests that modern amphibians are most closely related to the dissorophoid temnospondyls such as *Doleserpeton*. Both of these hold there to be a monophyletic Lissamphibia. However, the Polyphyletic Hypothesis posits that the modern amphibian orders have separate evolutionary origins from among different groups of Palaeozoic tetrapods. This study builds on extensive studies of the relevant fossil forms, and on reviews of the previous data matrices used in the phylogenetic analyses of amphibian relationships. As the character matrices supporting the three different hypotheses differ significantly, I built a supermatrix based on data from all of these matrices and analyzed it phylogenetically using both Bayesian inference and parsimony. When the data were corrected according to new observations of the fossil forms, the phylogeny based on the resulting supermatrix supported the Temnospondyl Hypothesis of lissamphibian origins.

COLD SNAPS, WARM SPELLS, AND THE EFFECTS OF CLIMATE CHANGE ON OVERWINTERING INSECTS

COUPS DE FROID, VAGUES DE CHALEUR, ET LES EFFETS DU CLIMAT SUR LES INSECTES HIVERNEURS

Sinclair, Brent (*University of Western Ontario*)

As ectotherms, insects are exquisitely sensitive to changes in temperature. When overwintering, insects must deal with the likelihood of ice formation in their body tissues, and the physiological mechanisms underlying this are well-described. However, when translating these laboratory findings to the field, the responses of insects to temperature become more complex. I will develop a conceptual model of the relationship between insects and their winter thermal environment, and work through examples of how phenotypic plasticity and local adaptation affect our interpretation of insect overwintering biology. In particular, I will focus on the role of fluctuating temperatures in determining both survival and energetics of overwintering insects, and show how these fluctuations alter our perceptions of the impacts of climate change on poikilotherms.

MINIMUM METABOLIC REQUIREMENTS FOR FLIGHT IN THE BUMBLEBEE, *BOMBUS IMPATIENS*

LES BESOINS MÉTABOLIQUES MINIMUMS NÉCESSAIRES POUR LE VOL CHEZ LE BOURDON, *BOMBUS IMPATIENS*

Skandalis, Dimitri A (*University of Ottawa*)

Roy, Chinmay (*University of Ottawa*)

Darveau, Charles-A (*University of Ottawa*)

The central tenet of insect flight physiology is that extraordinary functional demands have evolved extraordinary muscle metabolism, a model that explicitly interprets evolution as the result of instantaneous power requirements. Paradigmatic comparisons of whole-animal metabolic rate and enzyme capacity in adults have demonstrated that flux through various steps operates at a high fraction of the maximum possible. This supports

the concept of low safety margins and a match between demand and supply of energy. However, it has long been known, though possibly under-appreciated, that nearly all fully metamorphosing insects emerge with less than 100% of their eventual maximum metabolic capacity, and most of these begin flight immediately. We explore the matching of flight capacity and metabolic rate in vivo in maturing adult bumblebees (*Bombus impatiens*) and compare to enzyme capacity and mitochondrial oxidation rates in vitro. Taken together with similar results from the literature, we suggest that hypotheses of insect functional evolution have not been completely resolved, and alternative hypotheses warrant examination.

USE OF SALMONID INTESTINAL CELL LINES TO EVALUATE THE TOXICITY OF SOYBEAN MEAL COMPONENTS

L'UTILISATION DE LIGNÉES CELLULAIRES INTESTINALES POUR ÉVALUER LA TOXICITÉ DES COMPOSANTES D'UN REPAS DE FÈVES DE SOYA

Smith, Robbie (*Wilfrid Laurier University*)

Way, Colin (*Wilfrid Laurier University*)

Kawano, Atsushi (*University of Waterloo*)

Dixon, Brian (*University of Waterloo*)

Bols, Niels C (*University of Waterloo*)

Lee, Lucy EJ (*Wilfrid Laurier University*)

Salmonids represent one of the largest global fish products and their aquaculture requires expensive fishmeal in dietary formulations. Inexpensive alternatives are being sought and soybean meal is one of the favoured ones. However, antinutritional and toxic components limit its full utility. A supplementary problem in fish feed development is evaluating the impact of microbiocidal compounds and stabilizers, which are commonly added to feed. In vitro techniques offer a novel approach to initial testing of feed components for nutritional suitability as high throughput capacity, reduced costs, fewer animals killed and potential in vivo predictive values can be achieved. In this study, two recently established salmonid gut cell lines: RTgutGC, from rainbow trout (*Oncorhynchus mykiss*), and ASimf20 from Atlantic salmon (*Salmo salar*) were used to evaluate the bioactivity of plant products. Lectins, tannins, saponins and phytoestrogens, as well as the effects of common herbicides/pesticides were evaluated. Additionally, microbiocidal compounds, such as antibiotics or their replacements like lactoferrin and lysozyme, have also been tested. As confidence is gained in the ability of the in vitro approach to detect problematic compounds, the gut cell lines could become routine tools for inexpensively screening new products for their suitability in the fish feed industry.

HOW GENE EXPRESSION CHANGES WITH INTENSITY OF ACUTE THERMAL STRESS: FROM "HOUSEKEEPING" TO "RENOVATION" TO "DEMOLITION."

COMMENT L'EXPRESSION GÉNÉTIQUE CHANGE AVEC L'INTENSITÉ D'UN STRESS THERMAL AIGU : DU « MÉNAGE » À LA « RÉNOVATION » À LA « DÉMOLITION »

Somero, George (*Stanford University*)

The widespread effects of acute heat stress on cellular structures and processes trigger a variety of transcriptional and translational responses that lead to repair ('renovation') of reversibly damaged structures, 'demolition' of irreversibly damaged molecules and cells, and a reallocation of available energy between normal ('housekeeping') functions like growth and activities involved in restoration of homeostasis. Using DNA microarrays and proteomic methods to follow temperature-induced changes in gene and protein expression in marine mussels (genus *Mytilus*) and teleost fish, we seek to identify the levels of thermal stress at which these different 'renovation' and 'demolition' activities are induced. Identification of thermal induction thresholds for molecular chaperone (heat-shock proteins) synthesis, proteolysis, cessation of cell proliferation and initiation of apoptosis are helping to provide a more comprehensive picture of how increasing intensities of thermal stress

affect organisms and of how species differ in their capacities to respond to stress. These analyses are proving useful for developing models that link physiological adaptation to biogeographic patterning, notably in the case of closely related congeneric species with distinct distribution patterns. These analyses also are providing insights into how thermal stress affects energy budgets that are of critical importance in the contexts of growth and reproduction.

CARDIAC FUNCTION DURING GRADED HYPOXIA IN HYPOXIA-TOLERANT AND HYPOXIA-INTOLERANT ELASMOBRANCHS

LA FONCTION CARDIAQUE AU COURS DE L'HYPOXIE PROGRESSIVE DANS LES ELASMOBRANCHS HYPOXIE-TOLÉRANTE ET HYPOXIE-INTOLÉRANTE

Speers-Roesch, Ben (*Department of Zoology, University of British Columbia, Vancouver, BC*)

Brauner, Colin J. (*Department of Zoology, University of British Columbia, Vancouver, BC*)

Farrell, Anthony P. (*Faculty of Land and Food Systems, University of British Columbia, Vancouver, BC*)

Hickey, Anthony (*School of Biological Sciences, University of Auckland, New Zealand*)

Renshaw, Gillian M.C. (*School of Physiotherapy and Exercise Science, Griffith University, Australia*)

Wang, Yuxiang X. (*Department of Biology, Queen's University, Kingston, ON*)

Richards, Jeffrey G. (*Department of Zoology, University of British Columbia, Vancouver, BC*)

We investigated cardiac function during graded hypoxia exposure in two elasmobranchs that vary in their hypoxia tolerance to better understand the physiological correlates of survival of low oxygen. We assessed hypoxia tolerance by measuring the critical oxygen tension (P_{crit}). The hypoxia-tolerant epaulette shark, *Hemiscyllium ocellatum*, had a significantly lower P_{crit} than the less tolerant shovelnose ray, *Aptychotrema rostrata* ($25.0 \pm 1.8\%$ air saturation vs. $35.4 \pm 2.0\%$ air saturation, respectively). Also, shovelnose rays did not survive at PO_2 lower than 10% air saturation whereas epaulette sharks tolerated near-anoxia. In both species heart rate (HR) and cardiac output (Q) decreased roughly in parallel with the decline in MO_2 below their respective P_{crit} . Stroke volume increased and dorsal aortic pressure (PDA) decreased in both species, at P_{crit} in shovelnose rays but below P_{crit} in epaulette sharks. Estimated cardiac power output (analogous to cardiac ATP demand) declined in parallel with HR and Q. In both species HR, Q, and PDA were similar above P_{crit} but higher in the epaulette sharks at comparable PO_2 below P_{crit} . Maintenance of routine cardiac function to lower PO_2 appears to be a component of hypoxia tolerance in elasmobranchs.

REMODELING THE MITOCHONDRIAL MEMBRANE DURING AROUSAL FROM HIBERNATION

REMODELAGE DE LA MEMBRANE MITOCHONDRIALE DURANT L'ÉVEIL D'HIBERNATION

Staples, James (*Department of Biology, University of Western Ontario*)

Armstrong, Christopher (*Department of Biology, University of Western Ontario*)

During arousal from torpor mammalian hibernators experience a dramatic, rapid and reversible change in metabolic rate and body temperature that likely has profound impacts on membrane structure and function. This transition also corresponds with the reversal of a 70% suppression of liver mitochondrial state 3 respiration. Previous work has suggested that membrane phospholipid fatty acids can be altered during arousals that last only a few hours. We isolated and purified liver mitochondria from 13-lined ground squirrels (*Ictidomys tridecemlineatus*) in different stages of hibernation bouts and measured phospholipid classes and fatty acid constituents. The ratio of phosphatidylcholine (PC) /phosphatidylethanolamine (PE) increased during the transition from torpor ($T_b=5^\circ\text{C}$) to late arousal ($T_b=30^\circ\text{C}$), but decreased once animals entered interbout euthermia ($T_b=37^\circ\text{C}$). State 3 respiration, with succinate as substrate, correlated negatively with PC/PE. Cardiolipin did not differ among hibernation stages. Neither the unsaturation index nor n-6/n-3 ratio of phospholipid fatty acids changed during arousal, but the ratio of unsaturated/saturated fatty acids increased by 20% in interbout euthermia. There were few significant differences in the proportions of individual phospholipid

fatty acids among hibernation stages, but 18:2, 18:4 and 20:0 correlated negatively with state 3 respiration whereas 16:1 correlated positively.

EXPRESSION OF “PACEMAKER” CHANNELS IN THE TURTLE HEART: EFFECTS OF ANOXIA AND COLD-ACCLIMATION

EXPRESSION GÉNÉRIQUE DES CANAUX “PACEMAKER” DANS LE CŒUR DE TORTUE : EFFET DE L’ANOXIE ET DE L’ACCLIMATATION AU FROID

Stecyk, Jonathan A. W. (*University of Oslo*)

Couturier, Christine S. (*University of Oslo*)

Fagernes, Cathrine E. (*University of Oslo*)

Ellefsen, Stian (*University of Oslo*)

Nilsson, Göran E. (*University of Oslo*)

Heart rate of the freshwater turtle (*Trachemys scripta*) is markedly depressed with anoxia exposure. Hyperpolarization-activated and cyclic nucleotide-gated (HCN) channels (“pacemaker” channels), are important for controlling cardiac rhythmicity. HCN channels are tetramers, and four HCN channel subunit isoforms exist, which are encoded for by four genes (HCN1-4). The four isoforms can form homotetramers and heterotetramers, resulting in a number of HCN channels with distinct biophysical properties. Using real-time RT-PCR, we examined the effects of anoxia and subsequent reoxygenation on the expression of HCN1-4 mRNA in the cardiac chambers (sinus venosus, right atrium, left atrium and ventricle) of 21°C- and 5°C-acclimated turtles. With 24 h of anoxia at 21°C, the relative abundance of HCN2 increased in all cardiac chambers, and following 24 h reoxygenation, HCN2 expression returned to control levels. In contrast, at 5°C, few and only minor changes in HCN channel subunit expression occurred with anoxia (14 d) and reoxygenation (13 d). However, compared to 21°C, cardiac chambers of 5°C normoxic turtles exhibited a pronounced increase in the relative abundance of HCN2. We conclude that increased expression of HCN2 benefits turtle cardiac anoxia tolerance and that cold acclimation is important for preparing the turtle heart for winter anoxic conditions.

DON'T TRUST YOUR HOUSEKEEPERS: LABILE EXPRESSION OF INTERNAL REFERENCE GENES IN ANOXIC TURTLES

NE VOUS FIEZ PAS AUX GÈNES D'ENTRETIEN: EXPRESSION LABILE DES GÈNES DE RÉFÉRENCE INTERNES CHEZ LA TORTUE EN ANOXIE

Stecyk, Jonathan A. W. (*University of Oslo*)

Couturier, Christine S. (*University of Oslo*)

Fagernes, Cathrine E. (*University of Oslo*)

Ellefsen, Stian (*University of Oslo*)

Nilsson, Göran E. (*University of Oslo*)

Gene expression analysis with real-time RT-PCR is increasingly important and prominent in comparative physiology. With this methodology, the expression of a gene of interest is commonly presented relative to the expression of internal RNA control “housekeeping” genes under the assumption that the “housekeeping” genes are constitutively expressed across experimental groups. However, it has recently been shown that expression of “housekeeping” genes is not constant in the heart and brain of the anoxia-tolerant crucian carp during anoxia exposure and reoxygenation. We examined if “housekeeping” gene expression also changes with anoxia exposure in the anoxia-tolerant freshwater turtle (*Trachemys scripta*). Gene expression patterns of β -actin, glyceraldehyde 3-phosphate dehydrogenase (GAPDH) and cyclophilin A (PPIA) in heart and brain of 21°C and 5°C turtles exposed to anoxia and subsequent reoxygenation were determined in relation to an external RNA control gene introduced to samples on a “per unit weight of tissue” basis prior to RNA extraction. Indeed, tissue-, temperature- and gene-specific changes in expression were observed with anoxia exposure. Likewise,

temperature acclimation had pronounced effects on “housekeeping” gene expression, especially in heart. These results stress the importance of checking the suitability of “housekeeping” genes in animal models to avoid erroneous conclusions.

THE EFFECTS OF MATING EXPERIENCE ON INTER-MALE COMPETITION IN *L. HESPERUS*

EFFETS DE L'EXPERIENCE SEXUELLE SUR LA COMPETITION ENTRE MALES CHEZ *L. HESPERUS*

Stemberger, Tanya (*University of Toronto Scarborough*)

Understanding factors affecting multiple mating by males is critical to assessment of the intensity of sexual selection. We asked whether males with mating experience suffer a decrease in the likelihood of future matings in the Western Black Widow spider (*L. hesperus*). Males of this species largely cease eating after adulthood, and so have a limited energetic budget for mate searching, courtship and competition. Mating includes a 6hr-long, energetically expensive courtship, and at copulation a portion of the male's genitalia breaks off in the female's reproductive tract. Although sexual cannibalism is rare and *L. hesperus* males are physically able to copulate with multiple females, we predicted mating would decrease a male's Resource Holding Potential and the likelihood of remating under competition. We paired once-mated males with size-matched virgin rivals and allowed them to compete for a female. Contrary to predictions, once-mated males won copulations as effectively as their virgin rivals, despite the prior loss of energy to intense courtship and genital trauma. Moreover, in all cases, only one male out of every pair copulated with the female. This suggests mating success may be mediated by female preferences rather than inter-male competition, which may explain why experienced males suffer no disadvantage.

LINKAGES BETWEEN EXPOSURE, EFFECT AND ACCUMULATION OF CADMIUM IN *LUMBRICULUS VARIEGATUS* AND *HYALELLA AZTECA*

LES LIENS ENTRE L'EXPOSITION, L'EFFET ET L'ACCUMULATION DE CADMIUM DANS *LUMBRICULUS VARIEGATUS* ET *HYALELLA AZTECA*

Straus, Anthony (*Department of Biology, Wilfrid Laurier University*)

McGeer, Jim

The goal of this study is to determine the viability of bioaccumulation as an indicator of effect in aquatic environments. Using chronic 28-day exposures, *Lumbriculus variegatus* and *Hyalella azteca* were characterized for Cd bioaccumulation and effects (survival, growth and reproduction) in moderately hard water (140 mg/L CaCO₃). At the highest waterborne Cd concentration (200 µg Cd/L), *L. variegatus* showed 100% survival, however reproduction was reduced almost 10-fold in comparison to controls. Whole body accumulation was linear with time and exposures of 0, 6.3, 12.5, 25 and 50 µg Cd/L produced body burdens on day 28 of 0.9, 8.7, 12, 17.3 and 28.8 µg Cd/g. By contrast, initial testing using 2 to 9 day-old *H. azteca* resulted in 100% mortality at all concentrations above 10 µg Cd/L, and a NOEC of 2.5 µg/L. When exposed to 1.25 µg Cd/L for 21 days, growth was inhibited compared to controls, 51 ± 10 vs. 127 ± 16 µg dry wt/individual respectively, illustrating that *H. azteca* were sensitive to Cd exposure. The practicality of using *L. variegatus* body burdens as an indicator of effects in *H. azteca* will be discussed. This research is supported through the NSERC Strategic Program with the participation of Rio Tinto Alcan Inc., as well as Environment Canada.

TEMPERATURE EFFECTS ON THE HUMMINGBIRD SUCROSE OXIDATION CASCADE

LES EFFETS DE LA TEMPÉRATURE SUR LA CASCADE D'OXYDATION DU SUCROSE CHEZ LES COLIBRIS

Suarez, Raul K. (*University of California, Santa Barbara*)

Gass, C. Lee (*University of British Columbia, Vancouver*)

Welch, Jr., Kenneth C. (*University of Toronto, Scarborough*)

Small hummingbirds obtain most of their dietary calories by hovering to feed on floral nectar. Their small size and high wingbeat frequencies result in high energetic costs at rest and during flight. As ambient temperature (T_a) declines, thermoregulatory costs increase, causing increased feeding and, therefore, increased locomotory costs. Hummingbirds are able to stay in energy balance and make an energetic profit at near-freezing T_a . Subjecting rufous hummingbirds (*Selasphorus rufus*) to low T_a in the laboratory, we obtained the highest maximum sustained metabolic rates (when dietary energy intake = energy expenditure) ever measured among vertebrate animals. Foraging hummingbirds directly fuel flight muscle energy metabolism with recently ingested sugar. In addition to high digestive capacities, this requires high capacities for glucose oxidation in the flight muscles. High rates of fuel oxidation require high rates of O_2 flux from the external environment to muscle mitochondria, so there is extensive enhancement of the hummingbird “ O_2 transport cascade”. We propose that a similarly enhanced “sucrose oxidation cascade” occurs in hummingbirds and that this operates in parallel with the O_2 transport cascade. The two cascades converge in muscle mitochondria. Funded by NSF (IOB 0517694).

VENTRICULAR STIFFENING MAY LIMIT CARDIAC POWER AT HIGH TEMPERATURE IN ATLANTIC COD

A HAUTE TEMPERATURE, LE RAIDISSEMENT VENTRICULAIRE PEUT LIMITER LA PUISSANCE CARDIAQUE DES MORUES

Syme, Douglas (*University of Calgary*)

Gamperl, Kurt (*Memorial University of Newfoundland*)

Rodnick, Ken (*Idaho State University*)

We measured the power of atrial and ventricular strips from Atlantic cod at 20°C and a range of PO_2 's to assess whether high heart rate (fH) or stroke volume (muscle strain), in particular, predispose the fish heart to failure at elevated temperatures. Net power fell by 50% in both atrial and ventricular strips when PO_2 was reduced from 450 to 100% air saturation, whether at high fH or strain. As PO_2 declined toward 30% air saturation ventricular shortening (stroke) power was not further impaired, but ventricular strips became progressively stiffer, resulting in increased lengthening (filling) work and a reduction in net power. In contrast, the atrial muscle did not stiffen at low PO_2 values. To further investigate the effect of increasing fH on ventricular power, we increased fH from 55 to 115 bpm (70 bpm the maximum in vivo fH for cod). Interestingly, although shortening power increased continuously with fH, net power plateaued at approximately 90 bpm because lengthening work increased markedly with fH. These results suggest that the cod cannot further increase Q at high temperatures and low PO_2 's because of an inability to fill the stiffened ventricle, and not simply the failure of the muscle to contract.

DIEL VERTICAL DISTRIBUTION OF EARLY MARINE PHASE JUVENILE PINK SALMON (ONCORHYNCHUS GORBUSCHA) AND BEHAVIOURAL RESPONSES TO EXPOSURE TO SEA LICE (LEPEOPHTHERIUS SALMONIS)

DISTRIBUTION VERTICALE JOURNALIERE DES JEUNES SAUMONS ROSES AU DEBUT DE LEUR PHASE MARINE (ONCORHYNCHUS GORBUSCHA) ET LEURS REPNSES COMPORTEMENTALES LORS DE L'EXPOSITION AUX POUX DU POISSON (LEPEOPHTHERIUS SALMONIS)

Tang, Stephen (UBC)

Lewis, Al (UBC)

DiBacco, Claudio (DFO)

Sackville, Michael (UBC)

Nendick, Laura (UBC)

Brauner, Colin (UBC)

Farrell, Anthony (UBC)

We examined the vertical distribution of juvenile pink salmon, *Oncorhynchus gorbuscha* (Walbaum) during early development using replicated 4 h field deployments of a 10 m deep column both with and without exposure to sea lice copepodids, *Lepeophtheirus salmonis* (Krøyer) in the column. Juvenile pink salmon preferred the surface 1-2 m water immediately after their first introduction to seawater but their vertical distribution range increased with time spent in seawater. A significant diel migration pattern was observed, with fish concentrating more at the surface at night compared to a broader vertical distribution during daylight. For their first 3 weeks in seawater, juvenile pink salmon almost exclusively preferred the top 4 m of the water column. When a very high density of sea lice copepodids was present in the water column along with the fish, the vertical distribution of the juvenile pink salmon expanded significantly. Between 43-62% of fish became infected with one or more sea lice within 3 h. However, the change in vertical distribution of the fish in the presence of sea lice was not a direct result of becoming infected because both the infected and uninfected fish had increased the range of their vertical distribution. What caused the change in fish behaviour and its implications for fish-lice interactions in the wild will be discussed.

EFFECT OF SELECTIVE BREEDING FOR HIGH LOCOMOTOR ACTIVITY ON METABOLIC FUEL SELECTION

L'EFFET DE L'ÉLEVAGE SÉLECTIF POUR UNE HAUTE ACTIVITÉ LOCOMOTRICE SUR LA SÉLECTION DE CARBURANT MÉTABOLIQUE

Templeman*, Nicole M. (Department of Biology, McMaster University, Hamilton, ON)

Schutz, Heidi (Department of Biology, University of California Riverside, Riverside, CA, USA)

Garland, Jr., Theodore (Department of Biology, University of California Riverside, Riverside, CA, USA)

McClelland, Grant B. (Department of Biology, McMaster University, Hamilton, ON)

Despite diversity in locomotion, the mammalian pattern of fuel selection during exercise appears highly conserved, with relative exercise intensity dictating the proportionate contribution of carbohydrates and fats to energy supply. We wished to determine if selection for high levels of activity can cause changes in this fuel selection pattern or its regulation, using mice selectively bred for high voluntary wheel running. Within this model, a “mini muscle” phenotype of half-sized hindlimb muscles with increased aerobic capacity has emerged in two of four high-running lines. We used indirect calorimetry to assess fuel selection in one line each of: 1) non-selected controls, 2) high-running “mini-muscle” mice, and 3) high running “normal” selected mice. Mice of both selected lines had greater aerobic maxima (VO₂max) and absolute rates of fuel oxidation than controls, but the proportionate contribution by carbohydrates and lipids to energy supply was conserved amongst all mice at all exercise intensities. We suggest that each high-running line may have responded to selection by differential mechanistic changes at a molecular level. Variability at different regulatory points of fatty acid catabolism might

indicate one way by which genetically and phenotypically distinct mammals retain a conserved pattern of whole-body fuel selection.

THE EFFECT OF NANOPARTICLES ON HATCHING ENZYMES IN ZEBRAFISH (DANIO RERIO)

EFFET DES NANOPARTICULES SUR LES ENZYMES DE L'ECLOSION CHEZ LE POISSON ZEBRE (DANIO RERIO)

Thistle, Maria E. (*Department of Biological Sciences, University of Alberta, Edmonton AB*)

Ong, Kimberly J. (*Department of Biological Sciences, University of Alberta, Edmonton AB*)

Zhao, Xinxin (*School of Materials Science & Engineering, Nanyang Technological University, Singapore*)

MacCormack, Tyson J. (*Department of Biological Sciences, University of Alberta, Edmonton AB*)

Clark, Rhett (*Department of Chemistry, University of Alberta, Edmonton AB*)

Dang, Michael (*Department of Chemistry, University of Alberta, Edmonton AB*)

Ma, Guibin (*Department of Chemistry, University of Alberta, Edmonton AB*)

Veinot, Jonathan G. C. (*Department of Chemistry, University of Alberta, Edmonton AB*)

Goss, Greg G. (*Department of Biological Sciences, University of Alberta, Edmonton AB*)

The potential toxicity of engineered nanoparticles is a growing concern as nanotechnology industries develop rapidly. The behaviour of many nanomaterials is different from their bulk counterpart, and therefore toxic responses may be difficult to predict. Zebrafish, *Danio rerio*, are a common model species for toxicity studies. We found that exposure to ZnO nanoparticles resulted in delayed hatching, with no apparent developmental effects. We have also demonstrated that nanoparticles can inhibit LDH enzyme function in vitro but the biological relevance of this observation is unclear. Hatching is dependent upon a metalloprotease (termed ZHE1 in zebrafish) that is released in the later stages of development to digest the chorionic membrane. We hypothesized that ZnO nanoparticles interact with, and inhibit the normal function of ZHE1, resulting in the observed delay of hatch. We collected chorionic fluid from late stage zebrafish embryos and measured protease activity using a dye-labelled protein substrate assay. Assays were performed in the presence of nanoparticles with different physico-chemical properties to assess the influence of core material and shape on enzyme function. Appropriate bulk control materials were also tested to identify unique nano-scale effects. This study identifies possible sub-lethal effects of nanoparticle exposure with potential widespread relevance for environmental health.

THE MOVEMENT PROPENSITY AND POTENTIAL OF THE INVASIVE ROUND GOBY (NEOGOBIOUS MELANOSTOMUS PALLAS)

LA PROPENSION ET LE POTENTIEL DE MOUVEMENT DU GOBIE À TACHES NOIRES (NEOGOBIOUS MELANOSTOMUS PALLAS), UNE ESPÈCE ENVAHISSANTE

Tierney, Keith (*University of Alberta*)

Kasurak, Ashley (*University of Windsor*)

Zielinski, Barbara (*University of Windsor*)

Higgs, Dennis (*University of Windsor*)

Round gobies from the Ponto-Caspian region of Europe were first found in the Laurentian Great Lakes 20 yrs ago and are now widely spread, displacing indigenous species. While initially found in lacustrine environments, they are now spreading into faster flowing waters. In the current study, the volitional and coerced swimming abilities of gobies were explored to provide basic ecophysiological information that may be applied to their control. When given the option of moving from downstream to upstream locations over ~24 hrs in a three-chambered swim tunnel respirometer, the majority (81%) chose to move and there was a slight bias towards upstream preference (56%). When given stepped increases in water velocity, they 'burst and held station', with most gobies maintaining their position indefinitely at 20 cm/s and for several seconds at ≥ 40 cm/s. Their burst

swimming abilities were even more impressive, as gobies routinely exhibited bursts of speed twice as fast as their station holding ability, in some cases for as long as 30 s. When chased in static water, fish took approximately ≥ 2 min to fatigue, and covered 6-12 m. This study suggests that high flow culverts may not be sufficient to halt their invasion.

CLAW CURVATURE IN AMNIOTES: A COMPARISON OF METHODS

COMPARAISON DES METHODES MESURANT LA COURBURE DES GRIFFES CHEZ LES AMNIOTES

Tinius, Alexander (*Department of Biological Sciences, University of Calgary*)

Chebet, Tasha (*Department of Biological Sciences, University of Calgary*)

Russell, Anthony (*Department of Biological Sciences, University of Calgary*)

Claws represent the primitive condition of keratinized digital tip modifications in amniotes. Various authors have examined claw curvature in extant and fossil organisms and have attempted to relate the data about variance in curvature to differential patterns of function and pattern of substrate exploitation (for example, climbing versus terrestrial locomotion). Various methods have been devised to obtain measures of claw curvature, including the dorsal and ventral curvature of the claw sheath, and of the ungual phalanx, and idealised curves based upon models constructed as abstractions of claw curvature. No study yet compared how these models perform when applied to the same source data. We applied methods of estimating claw curvature to a collection of lizards (*Anolis grahami*). Based upon analysis of variance and reproducibility of results we conclude that measurement of included angle based upon the ventral surface of the claw generates the most reliable estimate of claw curvature. All methods, however, seem to be flawed in that they represent the sector of a circle and thus do not compare differences in shape. We suggest an improved method that takes shape into account and that is independent of size and of the circle-sector that is encompassed by the claw.

MITOCHONDRIAL REACTIVE OXYGEN SPECIES (ROS) PRODUCTION: MECHANISMS, CORRECTIONS AND CORRELATIONS

PRODUCTION MITOCHONDRIALE D'ESPÈCES D'OXYGÈNE RÉACTIVES : MÉCANISMES, CORRECTIONS ET CORRÉLATIONS

Treberg, Jason R. (*Buck Institute for Age Research*)

Brand, Martin D. (*Buck Institute for Age Research*)

The escape of electrons from the mitochondrial electron transport chain forms reactive oxygen species (ROS), which may have a wide array of physiological consequences including effects on aging and longevity. Comparative biology has been of great utility in exploring the link between ROS and lifespan. One of the most striking findings is a correlation between decreasing capacity for ROS production from complex I with intact mitochondria and increasing maximum lifespan. However, the mechanism(s) of ROS production by complex I is still a matter of contention. We will discuss a number of factors that complicate comparative studies of mitochondrial ROS production, focusing on complex I. Matrix antioxidant systems interfere with one of the most common and routine assays used – the production of H₂O₂ by isolated mitochondria. We have developed methodology which can mitigate major H₂O₂ consuming pathways in the mitochondria, which will allow for more meaningful comparisons between species. Finally, correlations between mitochondrial ROS production and longevity are re-examined in the context of current models of ROS production and potential confounding factors such as mitochondrial antioxidant systems and size scaling effects.

BIOCHEMICAL PROPERTIES OF THE ADDUCTOR MUSCLE IN RELATION TO THE SWIMMING STRATEGY OF THE SCALLOPS

LES PROPRIÉTÉS BIOCHIMIQUES DU MUSCLE ADDUCTEUR SONT-ELLES LE REFLET DE LA STRATÉGIE DE NAGE CHEZ LES PÉTONCLES?

Tremblay, Isabelle (*Université Laval*)

Guderley, Helga (*Université Laval*)

Himmelman, John (*Université Laval*)

To support the great variety of locomotor patterns in the animal kingdom, animals have developed an impressive array of morphological, physiological and biochemical attributes. Considerable evidence (e.g. Weibel et al. 1996) suggests that coevolution of the different elements in the locomotor system extends to muscle metabolic capacities. Scallops possess a simple locomotor system that facilitates an integrative approach. We characterised and quantified the escape response strategies of four scallop species (*Amusium balloti*, *Placopecten magellanicus*, *Pecten fumatus* and *Chlamys asperimus*) with different swimming styles and measured the activities of arginine kinase, several glycolytic and mitochondrial enzymes as well as arginine phosphate levels in the adductor muscle. Although the four species did not differ in muscle activities of arginine kinase activity, the phosphoarginine content was considerably higher in *Pecten fumatus* than in the other species. The activity of the glycolytic enzymes was higher in the scallops that spend a greater proportion of their escape responses in tonic contraction, than in those that primarily rely upon phasic contractions.

CHANGES IN STELLER SEA LION SKULL SIZES: TESTING THE NUTRITIONAL STRESS HYPOTHESES

CHANGEMENTS DANS LA TAILLE DES CRÂNES DES LION DE MER DE STELLER : UN TEST DE L'HYPOTHÈSE DU STRESS NUTRITIONNEL

Trites, Andrew W (*Department of Zoology and Marine Mammal Research, University of British Columbia*)

Isono, Takeomi (*Hokkaido National Fisheries Research Institute, Fisheries Research Agency, Japan*)

Brunner, Sylvia (*University of Alaska Museum of the North, Fairbanks, USA*)

Joy, Ruth (*Marine Mammal Research Unit, University of British Columbia*)

Two leading hypotheses to explain the decline of Steller sea lions between Prince William Sound and Hokkaido Japan are that birth and survival rates were reduced by nutritionally related effects associated with 1) consuming large amounts of low energy prey (cod, pollock and Atka mackerel) or 2) not eating enough of these species. We tested these hypotheses by measuring the sizes of archived sea lion skulls collected from 1950–2000. Morphological measurements were taken from 691 skulls (343 males, 345 females, 3 unknown). Comparing skull-growth curves calculated for animals that grew before and after the 1976/1977 oceanic regime shift showed that young male and female sea lions (6mo – 6y) were significantly larger following the regime shift in Asia and Western Alaska, and attained similar asymptotic body size in both periods. However, we detected no difference in body size in the increasing populations in Southeast Alaska, British Columbia and California. These findings counter the hypothesis that older sea lions could not find enough to eat, but are consistent with the hypothesis that reproductive rates fell as pups stayed with their mothers for an extra one or two years following the regime shift to survive in an environment of abundant, low-quality prey.

QUANTITATIVE PROTEOMIC ANALYSIS OF GILLS FROM ZEBRAFISH (*DANIO RERIO*) EXPOSED TO NAPHTHENIC ACIDS AND OILS SANDS PROCESS WATER

ANALYSE QUANTITATIVE PROTEOMIQUE DES BRANCHIES DE POISSONS ZEBRES (*DANIO RERIO*) EXPOSES AUX ACIDES NAPHTENIQUES ET AUX EFFLUENTS PROVENANT DES SABLES BITUMINEUX

MacCormack, Tyson (*Biological Sciences Department, University of Alberta*)

De Souza, Andrea (*Chemistry Department, University of Alberta*)

Li, Liang (*Chemistry Department, University of Alberta*)

Goss, Greg (*Biological Sciences Department, University of Alberta*)

The recovery of bitumen from oil sands involves hot water extraction, with the resultant oil sands process water (OSPW) containing a suite of dissolved organics and ions including naphthenic acids (NAs). The toxicity of OSPW to fish is primarily attributed to NAs but it is not clear how other components affect toxicity. Zebrafish were exposed to refined NAs and unrefined OSPW diluted to an equivalent level of NAs. Following exposure, gills were perfused to remove blood and gill proteins were extracted for examination of the proteome. Tryptic digests of control and treated protein samples were isotopically labeled using CH₂O or ¹³CH₂O to dimethylate the N-termini of peptides and the samples were mixed. The labeled mixtures were fractionated and individually subjected to RPLC-ESI QTOF MS analysis for relative peptide quantification and protein identification. In fish exposed to refined NAs, only a small number of proteins showed consistent changes in abundance. Preliminary analysis of OSPW-exposed fish identified potentially extensive variations in the relative abundance of proteins that we previously identified as possible stress biomarkers. The results are being analyzed based on known pathway and protein interaction networks to determine the mechanism(s) of OSPW toxicity and identify putative biomarkers of toxin exposure.

STRUCTURAL AND FUNCTIONAL CONSEQUENCES OF NANOPARTICLE-ENZYME INTERACTIONS.

CONSÉQUENCES STRUCTURALES ET FONCTIONELLES DES INTERACTIONS ENTRE LES NANOPARTICULES ET LES ENZYMES

MacCormack, Tyson (*Biological Sciences Department, University of Alberta*)

Clark, Rhett (*Chemistry Department, University of Alberta*)

Dang, Michael (*Chemistry Department, University of Alberta*)

Veinot, Jon (*Chemistry Department, University of Alberta*)

Goss, Greg (*Biological Sciences Department, University of Alberta*)

A general feature of many engineered nanoparticles is their tendency to agglomerate and/or adsorb onto organic and inorganic surfaces. We hypothesized that certain nanoparticles may interact with enzymes and affect their normal function. Silicon, gold, and cadmium-selenide quantum dots (3-5 nm diameter) were synthesized in house and characterized using dynamic light scattering, electron microscopy, and zeta potential analysis. The activity of purified lactate dehydrogenase (LDH) was inhibited or abolished by several particle types. The degree of inhibition was dependent upon core and functional group composition as well as the net charge of the protein during exposure. Kinetic parameters were altered by nanoparticle exposure but competitive binding for pyruvate or NADH was not obvious. Circular dichroism spectrometry showed that the quaternary structure of LDH was altered to varying degrees by different particles and in a manner unique from that of bulk scale controls (e.g. silicic acid or cadmium chloride). Enzyme inhibition was not observed in muscle homogenates, in the presence of bovine serum albumin, or at pH 8.5 indicating that nanoparticles may bind nonspecifically to proteins via a charge interaction. The results of this study provide information on the specific physicochemical characteristics that lead to bioactivity and potential toxicity in nanoparticles.

RESPONSES OF THE BLACK SEA URCHIN TETRAPYGUS NIGER TO ITS SEA STAR PREDATORS HELIASTER HELIANTHUS AND MEYENASTER GELATINOSUS UNDER WAVE CONDITIONS IN THE FIELD

LES RÉPONSES DE L'OURSIN NOIR TETRAPYGUS NIGER FACE À SES PRINCIPAUX PRÉDATEURS, LES ÉTOILES DE MER HELIASTER HELIANTHUS ET MEYENASTER GELATINOSUS EN PRÉSENCE DE VAGUES EN MER

Urriago-Suarez, Juan Diego (*Université Laval*)

Himmelman, John H. (*Université Laval*)

Gaymer, Carlos F. (*Universidad Católica del Norte*)

We ran field experiments under wave conditions (in the subtidal zone in Chile) to examine responses of the sea urchin *Tetrapygus niger* to predatory seastars. Trials involving simulated attacks showed that the urchin differentiated between predatory and non-predatory seastars. We compared the urchin's responses to different threat levels presented by the two predatory seastars, *Heliaster helianthus* and *Meyenaster gelatinosus*, first simulated attack, then mere contact, and subsequently seastars placed at different distances from the urchin. In trials with both seastars, 100% responded to stimulated attacks and contact. The proportion decreased with distance and more rapidly in the trials with *H. helianthus* (0 % at 30 cm) than with *M. gelatinosus* (33 % at 50 cm). Urchins generally responded more rapidly to *M. gelatinosus*. When a seastar was added to circular areas where undisturbed urchins were present, urchins fled more rapidly in trials with *M. gelatinosus* than with *H. helianthus*. Our observations suggest that *M. gelatinosus* represents a stronger predatory threat than *H. helianthus* and this corresponds to field observations showing that urchins are more frequently consumed by *M. gelatinosus*. These are the first experiments demonstrating distance chemodetection by marine invertebrates under wave conditions.

VARIATION IN METABOLIC RATE BETWEEN INDIVIDUAL AND SPECIES: PROVIDING PHYSIOLOGICAL INSIGHT INTO HABITAT PARTITIONING

VARIATION DE TAUX MÉTABOLIQUES ENTRE INDIVIDUS ET ESPÈCES : LA CONTRIBUTION DE LA PHYSIOLOGIE DANS LA PARTITION D'HABITATS

Van Leeuwen, Travis E. (*University of British Columbia*)

Richards, Jeffrey G. (*University of British Columbia*)

Rosenfeld, Jordan S. (*Fisheries Research section, Province of British Columbia*)

Standard metabolic rate (SMR) is known to vary greatly both within and between species and is thought to influence key life history tradeoffs in juvenile salmonids (e.g. smolt timing). Although differences in morphology are commonly used to explain habitat (pool/riffle) partitioning between juvenile Steelhead (*Oncorhynchus mykiss*) and Coho salmon (*Oncorhynchus kisutch*), physiological adaptations to exploit these different habitats may be even more important. To test for interspecific differences in metabolic rate that may favour different habitats or life-histories, we measured growth rates, standard metabolic rate, maximal metabolic rate (MMR) and swim performance (Ucrit) on juvenile Steelhead and Coho salmon held at three different food rations. Results show that individual SMR is positively correlated with food ration, independent of specific dynamic action (SDA), indicating that variation in ration may be a major factor driving intra individual variation in SMR. We also found no difference in SMR between juvenile Steelhead and Coho salmon but a marked difference in MMR, leading to a greater aerobic scope in Steelhead. Higher aerobic scope in juvenile Steelhead may explain why juvenile Steelhead appear to grow faster in both pool and riffle habitats compared to juvenile Coho Salmon.

KILLING THE MOOD: INVASIVE PACIFIC SIGNAL CRAYFISH CAUSE NESTING BEHAVIOUR SUPPRESSION IN CAPTIVE THREESPINE STICKLEBACK.

GÂCHER L'ATMOSPHÈRE : L'ÉCREVISSE SIGNAL ENVAHISSEUR EST RESPONSABLE DE LA SUPPRESSION DU COMPORTEMENT DE NIDIFICATION CHEZ L'ÉPINOCHÉ À TROIS ÉPINES EN CAPTIVITÉ

Velema, Gerrit J. (*University of British Columbia*)

The goal of this research was to investigate the causes of the collapse - through hybridization - of an endangered species pair of threespine stickleback (*Gasterosteus aculeatus* complex) in Enos Lake (Vancouver Island, British Columbia). American signal crayfish (*Pacifastacus leniusculus*), which evidently invaded Enos Lake in the early 1980s, have been implicated as a possible cause of this loss of biodiversity. Captive observations of nesting behaviour were conducted on naive males of both ecotypes of stickleback (limnetic and benthic), collected from Paxton Lake (Texada Island). Frequencies of positive male nesting behaviours were compared during varying degrees of exposure to crayfish and gravid female sticklebacks. The results clearly demonstrate that threespine stickleback males suffered nesting behaviour suppression in the presence of crayfish, and that limnetic males were affected to a greater extent than benthic males. The results of this research suggest that crayfish have played an important role in the collapse of the Enos Lake stickleback species pair due to a biased disruption of nesting males.

CHARACTERIZATION OF STIMULATORY INNATE IMMUNE RECEPTORS IN THE CHANNEL CATFISH.

CARACTÉRISATION DES RÉCEPTEURS IMMUNITAIRES STIMULATOIRES INNÉS CHEZ ICTALURUS PUNCTATUS

Verheijen, Karlijn (*Department of Biological Sciences, University of Alberta, Edmonton, AB*)

Mewes, Jaqueline (*Department of Biological Sciences, University of Alberta, Edmonton, AB*)

Montgomery, Benjamin C. (*Department of Biological Sciences, University of Alberta, Edmonton, AB*)

Stafford, James L. (*Department of Biological Sciences, University of Alberta, Edmonton, AB*)

Regulation of cellular immunity requires intracellular signaling through distinct activation and inhibitory pathways. My research focuses on understanding these events in bony fish by characterizing a recently identified family of proteins termed channel catfish leukocyte immune-type receptors (IpLITRs). Some IpLITR-types encode a transmembrane (TM) region containing a single positive charged lysine (K) residue, which is a key feature of immune receptor-types in mammals that associate with immunoreceptor tyrosine-based activation motif (ITAM)-containing adaptors. Cells co-transfected with epitope-tagged catfish proteins revealed that IpLITRs can associate with distinct ITAM-containing teleost adaptor proteins (e.g. IpFcRy and IpFcRy-L) that encode a negative charged aspartic acid (D) residue within their TM regions. Association of IpLITRs with IpFcRy and/or IpFcRy-L enhanced cell surface expression of the receptor. Mutating the lysine residue within the TM region of IpLITR 2.6b to alanine (A199) did not prevent association with the IpFcRy-L adaptor and only slightly reduced receptor expression levels. Conversely, an aspartic acid (D30) to A30 switch within the IpFcRy-L TM region completely abrogated its assembly with the receptor and inhibited the IpFcRy-L induced surface expression of IpLITR 2.6b. These results represent a first look into IpLITR-mediated cellular signaling potential and support that certain stimulatory innate immune receptors use conserved cellular activation pathways.

A MACROSCOPIC AND MICROSCOPE INVESTIGATION OF WOUND HEALING LEADING TO SCAR-FREE REGENERATION IN THE LEOPARD GECKO.

UNE INVESTIGATION MACROSCOPIQUE ET MICROSCOPIQUE DE LA GUÉRISON DES BLESSURES CONDUISANT À LA RÉGÉNÉRATION SANS CICATRICE CHEZ LE GECKO LÉOPARD

Vickaryous, Matt (*University of Guelph*)

Delorme, Steph (*University of Guelph*)

In most amniotes the loss of even small regions of tissue leads to inflammation, rapid production of fibrotic tissue and permanent scar formation. Whereas scar formation re-establishes tissue integrity and homeostasis, it appears to inhibit reparative regeneration and may lead to an overall reduction in function. A striking exception to the repair-by-scarring process is demonstrated by lizards capable of tail regeneration. We investigated wound healing following tail loss in the leopard gecko, *Eublepharis macularius*. Tail loss is a traumatic event resulting in the tearing and splitting of many tissues including the spinal cord, skin, vasculature, muscles, and fracturing of the skeleton. Immediately following tail loss, the spinal cord is retracted within the vertebra and remaining skin collapses across part of the wound site. Blood loss is minimal due to the presence of vascular sphincters along the caudal artery. Gradually a tissue fluid clot forms, sealing the exposed wound site. Cell proliferation begins deep to the clot (adjacent to the retracted spinal cord) and within the epithelium at the wound margins. Continued proliferation results in the formation of a thickened apical epithelial cap. At no time does the wound site develop fibrous scar tissue.

IN VITRO TOXICITY EVALUATION OF SILICA NANOPARTICLES USING FISH CELL LINES

UTILISER DES LIGNEES CELLULAIRES DE POISSONS POUR EVALUER IN VITRO LA TOXICITE DES NANOPARTICULES DE SILICE

Vo, Nguyen TK (*Wilfrid Laurier University*)

Kitaev, Vladimir (*Wilfrid Laurier University*)

Lee, Lucy EJ (*Wilfrid Laurier University*)

Nanoparticles have extensive industrial, biotechnological and biomedical/pharmaceutical applications, leading to concerns over health risks to humans and biota. Among various types of nanoparticles, silica nanoparticles (SiO₂-NPs) are rapidly becoming popular as nanostructuring agents, and in drug delivery and imaging fields. SiO₂-NPs are highly stable and could bioaccumulate in the environment, yet their effects in biota have not been fully evaluated. Toxicity to human and mammalian cells has been reported but effects on fish have seldomly been studied. Twelve fish cell lines derived from six species were assayed for cytotoxicity responses. Toxicity of SiO₂-NPs appears to be size, time, temperature and dose-dependent as well as tissue and species-specific. However, dosages greater than 100 µg/mL were needed to achieve EC₅₀ values. Smaller SiO₂-NPs (15-20 nm) are more toxic than larger sized ones (> 44 nm) and lining epithelial cells (skin, gills, intestine) were more sensitive than fish cell lines derived from internal tissues (liver, brain, gonads) or embryos. At dosages below the EC₅₀, SiO₂-NPs induced morphological changes possibly as a consequence of oxidative stress. These findings are in agreement with reported human and mouse cell studies, thus fish cell lines are valuable for the quick screening of emerging contaminants such as nanoparticles.

PARALLEL EVOLUTION OF DERIVED MODES OF REPRODUCTION IN AMPHIBIANS

ÉVOLUTION PARALLÈLE DES MODES DE REPRODUCTION DÉRIVÉS CHEZ LES AMPHIBIENS

Wake, Marvalee H. (*Department of Integrative Biology, University of California, Berkeley*)

Diverse modes of live-bearing reproduction have arisen in amphibians, many using sites of development nearly unique to the class and order (e.g., frogs developing embryos in the vocal sacs of the paternal male, and in the

stomach and in and on the skin of the backs of maternal females). Intra-oviductal maintenance of developing embryos through metamorphosis, with maternal nutrition supplied after yolk resorption, has evolved independently in all three orders several times. In addition, maintenance without additional nutrients and with 'birth' at virtually any stage of relatively late development occurs in frogs and in salamanders. Maintenance of developing young in the skin of the back of the maternal female occurs in two rather distantly related lineages of frogs. Adelophagy has arisen, recently, twice in closely related salamander subspecies. Given robust hypotheses of phylogenetic relationships, many kinds of homoplasious conditions have been identified, but few have been assessed in terms of mechanisms of origin, and common and divergent features in those mechanisms. I explore the parallel evolution of the morphology of intra-oviductal and back-skin viviparity in both parents and embryos/fetuses in order to generate hypotheses about physiology, behavior, development, ecology, and patterns of evolution of the systems within and across lineages.

EFFECTS OF THE ESSENTIAL OIL CONSTITUENTS AND OTHER NEUROACTIVE CHEMICALS ON FLIGHT MOTOR ACTIVITY AND WING BEAT FREQUENCY IN THE BLOWFLY PHAENICIA CERICATA.

LES EFFETS DES CONSTITUENTS DES HUILES ESSENTIELLES ET AUTRES COMPOSÉS CHIMIQUES NEUROACTIFS SUR L'ACTIVITÉ DES MOTEURS DE VOLS ET SUR LA FRÉQUENCE DES BATTEMENTS D'AILLES CHEZ LA MOUCHE PHAENICIA CERICATA

Waliwitiya, Ranil (*Simon Fraser University*)

Lowenberger, Carl (*Simon Fraser University*)

Abstract We have developed a simple, rapid system that allows us to investigate neuroelectrophysiological responses of tethered blowflies (*Phaenicia sericata*) to plant derived compounds. We compared the patterns of flight muscle impulses (FMI) and wing beat frequency (WBF) after application of novel plant derived compounds; thymol, eugenol, pulegone, terpineol and citronellal, with those of 10 neuroactive compounds to predict the mode of action of the plant compounds. Topically-applied thymol inhibited WBF within 15-30 min and reduced FMI frequency. Eugenol, pulegone and citronellal all produced unidirectional impulses within 10-20 min of treatment. Octopamine and chlordimeform caused a similar, early onset bursting pattern that decreased in amplitude with time. Desmethylochlordimeform, dieldrin and malathione blocked wing beating within 60 min and generated a profile of continuous but lower frequency FMI. Flies treated with GABA responded similarly to those treated with thymol. The unidirectional FMI observed with eugenol, pulegone and citronellal were similar to FMI of cypermethrin. Our system can help predict the modes of action of novel compounds by comparing them in a rapid response analysis. These data then can be used to design biochemical analyses to confirm the mode of action of novel potential plant-based insecticides.

IN VITRO AND IN SITU MEASURES OF FORCE-GENERATING ABILITY IN HUMMINGBIRD FLIGHT MUSCLE FIBERS

MESURES IN VITRO ET IN SITU DE LA CAPACITÉ À GÉNÉRER DE LA FORCE DANS LES FIBRES MUSCULAIRES LIÉS AU VOL CHEZ LES COLIBRIS

Welch Jr., Kenneth C. (*University of Toronto Scarborough*)

Reiser, Peter J. (*Ohio State University*)

Altshuler, Douglas L. (*University of California, Riverside*)

Hummingbird flight muscles achieve the highest mass-specific mechanical power output and operate at the highest frequencies of any vertebrate locomotor muscles. Although there has been remarkable progress in the study of wingbeat kinematics and aerodynamics of hummingbird flight, little is known about fundamental contractile properties of these muscles. We measured the maximal force-generating ability (maximal force per unit of fiber cross-sectional area, Po/CSA) of isolated muscle fibers from the pectoralis muscle, which powers

the wing downstroke, over a range of temperatures. We also measured maximum isometric force production of the whole, intact, pectoralis in anesthetized Anna's hummingbirds (*Calypte anna*) at normal body temperature. Additionally, we obtained in vitro, single fiber measurements from the supracoracoideus (wing elevator) and leg muscle of the hummingbird as well as the zebra finch (*Taeniopygia guttata*) pectoralis. Maximum force production capability was significantly lower in the hummingbird pectoralis and supracoracoideus than in the zebra finch pectoralis and each of these were dramatically lower than in adult mammalian limb fibers and even hummingbird leg fibers. These low force-generating capacities may reflect a constraint imposed by the need for the extremely high contraction frequencies characteristic of the wingbeats of these birds.

THE EFFECTS OF VARIABLE TEMPERATURES ON ENERGY USE IN LEPIDOPTERA

LES EFFETS DE TEMPÉRATURES VARIABLES SUR L'UTILISATION D'ÉNERGIE CHEZ LES LÉPIDOPTÈRES

Williams, Caroline (*University of Western Ontario*)

Marshall, K.E. (*University of Western Ontario*)

MacMillan, H.A. (*University of Western Ontario*)

Sobek, S. (*University of Western Ontario*)

Bazinet, A. (*University of Western Ontario*)

Chick, W.D. (*University of Western Ontario*)

Hellmann, J.J. (*University of Notre Dame*)

Sinclair, B.J. (*University of Western Ontario*)

Many species of Lepidoptera overwinter in a quiescent state, relying on stored energy reserves. In ectotherms, metabolic rate increases exponentially with increasing temperature, meaning that higher temperatures over winter will result in increased usage of stored reserves, leaving fewer resources for reproduction in the spring. However, climate change is predicted to produce not only increases in mean temperatures, but also changes in variability. Jensen's inequality is a mathematical property which states that the mean of a non-linear (accelerating) response variable will be elevated at fluctuating compared to constant temperatures of the same mean, an effect that will be magnified by increasing variability of temperature or higher temperature sensitivity of the organism. This is predicted to select for lowered temperature sensitivity in individuals or populations from variable compared to constant environments. Using a comparative approach with three species of Lepidoptera with contrasting life history characteristics, we have found evidence for both plasticity and evolutionary adaptation in temperature sensitivity as a result of increasing environmental variability. This may explain the ability of species to counter the energy drain associated with variable environments, and allow organisms to buffer the impacts of climate change.

RAPIDLY IMPROVING LINNAEAN TAXONOMY THROUGH DNA BARCODING COMBINED WITH ONLINE BIODIVERSITY TOOLS (SCRATCHPADS): TWO CASE STUDIES USING CATERPILLARS

AMÉLIORATION RAPIDE DE LA TAXONOMIE LINNÉENNE GRÂCE AU CODES BARRES GÉNÉTIQUES COMBINÉS AVEC DES OUTILS DE BIODIVERSITÉ EN LIGNE : DEUX ÉTUDES DE CAS UTILISANT DES CHENILLES

Wilson, John James (*Department of Integrative Biology, University of Guelph*)

Taxonomy is undergoing a revolution. New techniques like "DNA barcoding" are providing better understanding of species boundaries while online tools such as "Scratchpads" are helping connect this information with classical Linnaean taxonomy and rapidly disseminate findings to users. I present two case studies to demonstrate this revolution, one a butterfly, one a moth, both common species, both hiding under incorrect Linnaean names. Extensive inventory of Area de Conservacion Guanacaste (ACG), Costa Rica, revealed evidence that butterflies

inventoried as *Taygetis andromeda* for 25 years, belonged to a species complex. Further investigations revealed two species diagnosable by DNA barcodes and wing patterns, however, the name *T. andromeda*, could not be correctly applied to either species (<http://taygetis.myspecies.info>). The ailanthus webworm moth, a conspicuous member of eastern North American micromoth assemblages, is commonly recorded as *Atteva punctella*. We discovered that webworm moths were assigned different names in our inventories – *A. ergatica* in ACG and *A. punctella* in North America -- but had identical DNA barcodes. Further investigations revealed two sympatric species diagnosable by DNA barcodes and wing patterns, however, neither name could be correctly applied to either species (<http://atteva.myspecies.info>).

EVIDENCE FOR THE ROLE OF WNT SIGNALING IN OSCULUM FORMATION AND POLARITY IN SPONGES

DÉMONSTRATION DU RÔLE DE SIGNALISATION DE WNT DANS LA FORMATION DE L'OSCULUM ET DE LA POLARITÉ CHEZ LES ÉPONGES

Windsor, Pamela J (*University of Alberta*)

Leys, Sally P (*University of Alberta*)

The evolution of polarity in multicellular animals allowed the diversification of body plans for feeding and reproduction. Sponges (Porifera), the most ancient extant lineage of multicellular animals, lack obvious morphological polarity but express wnt genes which are involved in the establishment of polarity in other animals. We tested the effect of pharmacological activators of Wnt signaling on sponge organization during development. Lithium chloride and alsterpaullone both caused the formation of ectopic oscula, the excurrent opening of the aquiferous system, and disrupted the ability of the sponge to feed. We transplanted the oscula from one sponge to another, and found that transplanted tissues were able to attach and induced canals to link to them in host sponges. These results suggest that the Wnt pathway is involved in formation of oscula and that oscula possess organizing activity over other sponge tissues. This work strongly suggests that canonical Wnt signaling is responsible for setting up polarity in the sponge as it does in many other animals.

CORRELATION BETWEEN HEAD PROPORTIONS, CRANIAL OSSIFICATION SEQUENCE AND EMBRYONIC GROWTH IN THE LEOPARD GECKO (*EUBLEPHARIS MACULARIUS*)

CORRÉLATION ENTRE LES PROPORTIONS DE LA TÊTE, L'ORDRE D'OSSIFICATION CRÂNIEN ET LA CROISSANCE EMBRYONNAIRE DU GECKO LÉOPARD (*EUBLEPHARIS MACULARIUS*)

Wise, Patrick (*University of Calgary*)

Russell, Anthony (*University of Calgary*)

Head shape changes dramatically during embryonic growth and can be mapped within and between developmental stages as reported in staging tables. Ossification sequences of cranial elements during ontogeny have been described for many taxa. These ossification sequences exhibit notable conservatism, but also display systematically meaningful variation between taxa at various levels. No mechanistic explanation exists to explain ossification sequence, however. Given that the cranial skeleton is an integral part of the head, and that head shape undergoes transformation, we investigated the relationship between developing head shape and ossification sequence, and subsequently patterns of growth of cranial elements. We employed the leopard gecko as our vehicle for doing this. There is demonstrable correlation between initiation of ossification and head proportions and configuration, and a subsequent relationship between head proportions and patterns of element growth. Our findings indicate that differences in sequence between taxa may be directly related to differing patterns of how head form develops.

EFFECTS OF WATERBORNE SILVER IN A MARINE TELEOST, THE GULF TOADFISH (OPSANUS BETA): EFFECTS OF FEEDING AND CHRONIC EXPOSURE ON BIOACCUMULATION AND PHYSIOLOGICAL RESPONSES

L'EFFET DE L'ARGENT HYDRIQUE SUR LE POISSON TÉLÉOSTÉEN MARIN OPSANUS BETA : EFFETS DE L'ALIMENTATION ET DE L'EXPOSITION CHRONIQUE SUR LA BIOACCUMULATION ET LES RÉPONSES PHYSIOLOGIQUES

Wood, Chris M. (McMaster U., & RSMAS, U. Miami)

Grosell, Martin (RSMAS, U. Miami)

McDonald, M. Danielle (RSMAS, U. Miami)

Playle, Richard C. (Wilfrid Laurier U.)

Walsh, Patrick (Ottawa U., & RSMAS, U. Miami)

Marine teleosts drink seawater, and the digestive tract is a key organ of osmoregulation, offering an extrabranchial site for potential uptake and toxicity of waterborne metals. We investigated how these processes might interact with digestive functions. Adult toadfish were exposed to waterborne Ag (1.85 $\mu\text{mol L}^{-1}$) for 22 d with satiation feeding. Ag exposure did not affect voluntary feeding rate. Feeding decreased the net whole body accumulation of Ag by >50%, principally in liver and white muscle, as well as in esophagus-stomach and kidney, and increased biliary and urinary Ag concentrations. The gill exhibited the opposite response. There were complex interactive effects on drinking rate, gut fluid volume, and intestinal base secretion. After 22 d, the plasma clearance kinetics of an injected tracer dose of 110mAg were faster in Ag-exposed toadfish, and 110mAg accumulation in the RBCs was reduced. More 110mAg was found in bile and urine, but less in the intestine of the Ag-exposed toadfish. The results suggest that feeding reduces waterborne Ag uptake through the digestive tract and alters physiological toxicity, while chronic exposure enhances regulatory functions. The time-dependent actions of the liver in Ag scavenging and detoxification are highlighted (supported by Kodak Canada and NSERC CRD).

AMPHIBIOUS MANGROVE KILLIFISH JUMP OUT OF WATER FOR MULTIPLE REASONS, NOT JUST LOW OXYGEN.

UN POISSON KILLI AMPHIBIEN DE MANGROVE SAUTE HORS DE L'EAU POUR PLUSIEURS RAISONS, PAS SEULEMENT LE MANQUE D'OXYGÈNE

Wright, Patricia (University of Guelph)

Cooper, Chris (University of Guelph)

Regan, Kelly (University of Guelph)

Taylor, D. Scott (Brevard County Environmentally Endangered Lands Program)

Currie, Suzie (Mt. Allison University)

The mangrove killifish (*Kryptolebias marmoratus*) are amphibious fish that survive up to 2 months out of water and breathe cutaneously. We studied *K. marmoratus* in their natural habitat at Calabash Caye, Belize. Fish were found in crab burrows on the forest floor and water chemistry was monitored at 4 sites over 24 h. Oxygen, hydrogen sulfide and ammonia levels varied with tidal cycles at some locations, whereas water pH and salinity were relatively constant. Water temperatures (26-30°C) varied with the light:dark cycle. Across all sites and times, dissolved oxygen in crab burrows was on average ~10% saturation (0.8 mg/L). Video recordings of crab burrows captured *K. marmoratus* emerging onto mangrove roots for up to 5 minutes. In a simulated crab burrow, *K. marmoratus* emerged after antagonist encounters with other fish. Lab experiments demonstrated that severe hypoxia (< 0.2 mg/L) or fasting (36 h) induced emersion, whereas exposure to turbid crab burrow water (pH 7.2) or seawater (pH 8.3) had no effect. These findings indicate that emersion in *K. marmoratus* is not simply a respiratory response to hypoxic water and/or hydrogen sulfide, but involves feeding, social cues, and possibly other factors.

DEVELOPMENTAL PLASTICITY OF HYPOXIA TOLERANCE IN DANIOS AND DEVARIOS

PLASTICITE DU DEVELOPPEMENT DE LA TOLERANCE A L'HYPOXIE CHEZ DANIOS ET DEVARIOS

Yao, Lily (*Department of Zoology, The University of British Columbia, Vancouver, British Columbia, Canada*)

Richards, Jeffrey G. (*Department of Zoology, The University of British Columbia, Vancouver, Canada*)

Hypoxia is a common environmental stress for fish. There have been many studies examining the defensive strategies of fish to hypoxia within one life stage; however, the effects of developmental exposure to hypoxia remain mostly unknown. Thus, it is unclear whether differences of hypoxia tolerance seen among species are due to genetic differences or simply a result of potential difference in hypoxia exposure during development. Using zebrafish and its closely related species (other Danios and Devarios) as the model system, we aim to investigate the mechanisms behind hypoxia tolerance, and more importantly, the effect of early life-stage hypoxia exposure on adult hypoxia tolerance. Hypoxia tolerance was assessed in several species Danios and Devarios by measuring critical oxygen tensions (P_{crit}) and ET_{50} (time at which 50% loss equilibrium). The mechanisms underlying variation in hypoxia tolerance were investigated by assessing the activities of pyruvate kinase (PK), lactate dehydrogenase (LDH), creatine phosphokinase (CPK) and citrate Synthase (CS), which are indicators of aerobic and/or anaerobic capacities.

DIVE BEHAVIOUR IMPACTS THE ABILITY OF HEART RATE TO PREDICT OXYGEN CONSUMPTION IN STELLER SEA LIONS (*EUMETOPIAS JUBATUS*) FORAGING AT DEPTH

LE COMPORTEMENT DE PLONGÉE A UN IMPACT SUR LA CAPACITÉ DU RYTHME CARDIAQUE À PRÉDIRE LA CONSOMMATION D'OXYGÈNE CHEZ DES LIONS DE MER DE STELLER EN QUÊTE DE NOURRITURE EN PROFONDEUR

Young, Beth L. (*Marine Mammal Research Unit, University of British Columbia*)

Rosen, David A.S. (*Marine Mammal Research Unit, University of British Columbia*)

Hindle, Allyson G. (*Marine Mammal Research Unit, University of British Columbia*)

Haulena, Martin (*Vancouver Aquarium*)

Trites, Andrew W. (*Marine Mammal Research Unit, University of British Columbia*)

The relationship between heart rate (fh) and oxygen consumption ($\dot{V}O_2$) has been determined for several aquatic vertebrates while fasting and resting, but is known to change with environment and digestive state. We investigated if the dive response would also affect the $fh:\dot{V}O_2$ relationship in Steller sea lions freely diving in the open ocean up to 40 m depth and for durations of 1-6 minutes. We simultaneously measured fh and $\dot{V}O_2$ under a variety of activity states (surface resting or diving), depths (10 or 40 m), and types of dives (single dives or dive bouts). We found that the $fh:\dot{V}O_2$ relationship differed for single dive cycles versus dive bout cycles. We further found the equation that predicts $\dot{V}O_2$ associated with single dive cycles did not differ from that derived for sea lions resting on the surface. Neither dive duration, dive depth, nor food consumed significantly affected the $fh:\dot{V}O_2$ relationships. Overall, fh accurately predicted $\dot{V}O_2$ in diving sea lions to within $\pm 1.1\%$ of direct respirometry measurements. Ultimately, our results demonstrated that fh can be used to predict field metabolic rate of diving sea lions, but only over complete dive cycles or dive bout cycles when animals fully recover from the O_2 debt incurred underwater.

THREE SOMATOSTATIN ISOFORMS AFFECT BASAL SECRETORY RESPONSE IN GOLDFISH SOMATOTROPHS VIA DIFFERENTIAL REGULATION OF $[Ca^{2+}]_i$ AND ELECTRICAL ACTIVITY

TROIS ISOFORMES DE LA SOMATOSTATINE AFFECTENT LA RÉPONSE SÉCRÉTOIRE BASALE DANS LES SOMATOTROPHES DU POISSON ROUGE VIA LA RÉGULATION DIFFÉRENTIELLE DE $[Ca^{2+}]$ ET L'ACTIVITÉ ÉLECTRIQUE

Yu, Yi (Department of Biological Sciences, University of Alberta, Edmonton, Alberta, T6G 2E9, Canada.)

Ali, Declan W. (Department of Biological Sciences, University of Alberta, Edmonton, Alberta, Canada.)

Chang, John P. (Department of Biological Sciences, University of Alberta, Edmonton, Alberta, Canada.)

In goldfish, somatostatin (SS) provides the major inhibitory influence in the multifactorial control of growth hormone (GH) release. Goldfish SS is a multimember family of peptides, including SS14, goldfish brain (gb)SS28 and [Pro2]SS14. The present study tested the hypothesis that three SS isoforms differentially affect electrophysiological properties of somatotrophs responsible for cellular Ca^{2+} homeostasis and GH production. All three SSs decreased basal GH release and intracellular Ca^{2+} levels ($[Ca^{2+}]_i$). The SSs also increased isolated K^+ , but not Na^+ , current magnitude, while SS14 and gbSS28 decreased voltage-sensitive Ca^{2+} current magnitude in the whole cell recording configuration. Induced action potential magnitudes were reduced to 66+/-10% and 82+/-5% of controls in the presence of SS14 and gbSS28 but [Pro2]SS14 had no effects (94+/-10% of control). These data suggest that SS14-, gbSS28- and [Pro2]SS14-induced reduction in GH responses and intracellular Ca^{2+} levels each may reflect a differential combination of actions on membrane ionic currents, cell excitability and reduced extracellular Ca^{2+} entry. (Supported by NSERC)

HYPOXIC TRANSDUCTION AND NEUROCHEMICAL SIGNALLING IN THE ZEBRAFISH GILL

TRANSDUCTION HYPOXIQUE ET SIGNALLAGE NEUROCHIMIQUE DANS LA BRANCHIE DU POISSON ZÈBRE

Zachar, Peter (University of Ottawa)

Jonz, Michael (University of Ottawa)

The serotonin-rich neuroepithelial cells (NECs) of the adult zebrafish gill are prime candidates for peripheral oxygen chemoreceptors in fish, analogous to Type I cells of the mammalian carotid body. Indeed, the NECs of adult zebrafish exhibit a physiological response to hypoxia that closely resembles that of Type I cells. As such, we hypothesize that the ion channels involved in transduction of the hypoxic stimulus in zebrafish NECs are similar to those found in mammalian oxygen chemoreceptors. We are investigating the biophysical and chemical properties of the transduction channels using patch-clamp electrophysiology so as to characterize their specific type. In addition, although serotonin is involved in signaling of hypoxia in the carotid body, its role is modulatory compared to other neurotransmitters (i.e. ACh). Immunohistochemical studies in our lab have revealed populations of cells containing other neurotransmitters associated with mammalian oxygen sensing in the adult zebrafish gill, such as ACh and nitric oxide. Finally, the use of activity-based fluorescent dyes has yielded preliminary in vivo evidence for increased NEC activity under hypoxia.

MORE THAN THE EYE CAN SEE: WESTERN CONIFER SEED BUGS (*LEPTOGLOSSUS OCCIDENTALIS*) MAY EXPLOIT ELECTROMAGNETIC RADIATION AS FORAGING, MATING OR OVERWINTERING CUES

PLUS QUE L'ŒIL N'Y VOIT : L'INSECTE LEPTOGLOSSUS OCCIDENTALIS EXPLOITENT PEUT-ÊTRE LES RADIATIONS ÉLECTROMAGNÉTIQUES COMME SIGNAUX LORS DE L'ALIMENTATION, L'ACCOUPLEMENT ET L'HIVERNATION

Zahradik, Tracy (Department of Biological Sciences, Simon Fraser University, British Columbia, Canada)

Takács, Stephen (Department of Biological Sciences, Simon Fraser University, British Columbia, Canada)

Labrie, Audrey (*Department of Biological Sciences, Simon Fraser University, British Columbia, Canada*)
Tsang, Michelle (*Department of Biological Sciences, Simon Fraser University, British Columbia, Canada*)
Strong, Ward (*British Columbia Ministry of Forests and Range, Kalamalka Forestry Centre, British Columbia*)
Bennett, Robb (*British Columbia Ministry of Forests and Range, Saanichton Forestry Centre, Saanichton, BC*)
Gries, Gerhard (*Department of Biological Sciences, Simon Fraser University, British Columbia, Canada*)

The western conifer seed bug, *Leptoglossus occidentalis* (Hemiptera: Coreidae), seeks conifer cones for feeding, often causing significant seed losses in seed orchards. Here we show that *L. occidentalis* can sense three distinct sections of the electromagnetic spectrum (ultraviolet light, visible light and infrared radiation) and that it may exploit cone-derived electromagnetic radiation as foraging or oviposition cues. In laboratory bioassays, *L. occidentalis* preferred specific wavelengths of visible light, and was more strongly attracted to a combination of infrared radiation and visible light wavelengths than to infrared radiation alone. Thermographic images obtained in seed orchards and surroundings revealed that *L. occidentalis* may also use infrared radiation to locate mates, avoid predators, and find overwintering sites. Our results may aid the design of effective traps for monitoring and/or mass trapping *L. occidentalis* in seed orchards.

WHAT'S FOR DINNER? BLOOD OR SUGAR?

QU'EST CE QU'IL Y A POUR DINER? DU SANG OU DU SUCRE?

Zappia, Simon (*Simon Fraser University*)

Project proposal: How does energy state affect the behaviour of the malaria vector *Anopheles gambiae*, with regards to Insecticide Treated Bed Nets (ITNs) in hut/village environments? Ideas on how to manipulate the environment and its sugar sources to reduce the incidence of malaria.

PHYSIOLOGICAL AND MOLECULAR ANALYSIS OF THE INTERACTIVE EFFECTS OF FEEDING AND HIGH ENVIRONMENTAL AMMONIA ON BRANCHIAL AMMONIA EXCRETION AND Na^+ UPTAKE IN FRESHWATER RAINBOW TROUT

ANALYSE PHYSIOLOGIQUE ET MOLÉCULAIRE DES EFFETS INTERACTIFS DE L'ALIMENTATION ET DE HAUTS TAUX D'AMMONIAC ENVIRONNEMENTAUX SUR L'EXCRÉTION D'AMMONIAC BRANCHIAL ET L'ASSIMILATION DE Na^+ CHEZ LA TRUITE ARC-EN-CIEL D'EAU DOUCE

Zimmer, Alex (*McMaster University*)

Nawata, Michele (*McMaster University*)

Wood, Chris (*McMaster University*)

Recently, a " $\text{Na}^+/\text{NH}_4^+$ exchange complex" model has been proposed suggesting that ammonia transport occurs via Rhesus (Rh) glycoproteins, facilitated by gill boundary layer acidification attributable to the hydration of CO_2 and H^+ efflux by Na^+/H^+ exchanger (NHE-2) and H^+ -ATPase. The latter two mechanisms occur with Na^+ influx (through a Na^+ channel energized by H^+ -ATPase and directly via NHE-2). Here, we show that natural ammonia loading via feeding increases branchial mRNA expression of Rh, NHE-2, and H^+ -ATPase in juvenile trout, similar to previous findings with ammonium salt infusions and high environmental ammonia (HEA) exposure. Increase in ammonia excretion post-feeding occurs in conjunction with a 4-fold increase in Na^+ influx after feeding. When exposed to HEA (1.5 mmol/l NH_4HCO_3 at pH 8.0), both unfed and fed trout showed increases in mRNA expression of Rhcg2, NHE-2, and H^+ -ATPase. Unfed fish exposed to HEA initially uptake ammonia, whereas fed fish (4 h after the meal) did not show this reversal of excretion. Exposure to HEA also led to a depression of Na^+ influx, demonstrating that ammonia excretion can be uncoupled from Na^+ influx. We suggest that it is H^+ efflux, rather than Na^+ uptake, that is critical to the facilitation of ammonia excretion.

