AUSTRALIAN AND NEW ZEALAND SOCIETY FOR COMPARATIVE PHYSIOLOGY AND BIOCHEMISTRY

24th ANNUAL GENERAL MEETING

Australian & New Zealand Society for Comparative Physiology & Biochemistry

Perth

Western Australia

December 1 and 2, 2007

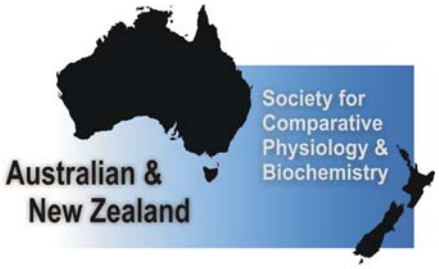
The University of Western Australia

Curtin University of Technology

24th Annual Meeting of the Australian and New Zealand Society for Comparative Physiology and Biochemistry

University of Western Australia and Curtin University

Perth, December 1-2, 2007



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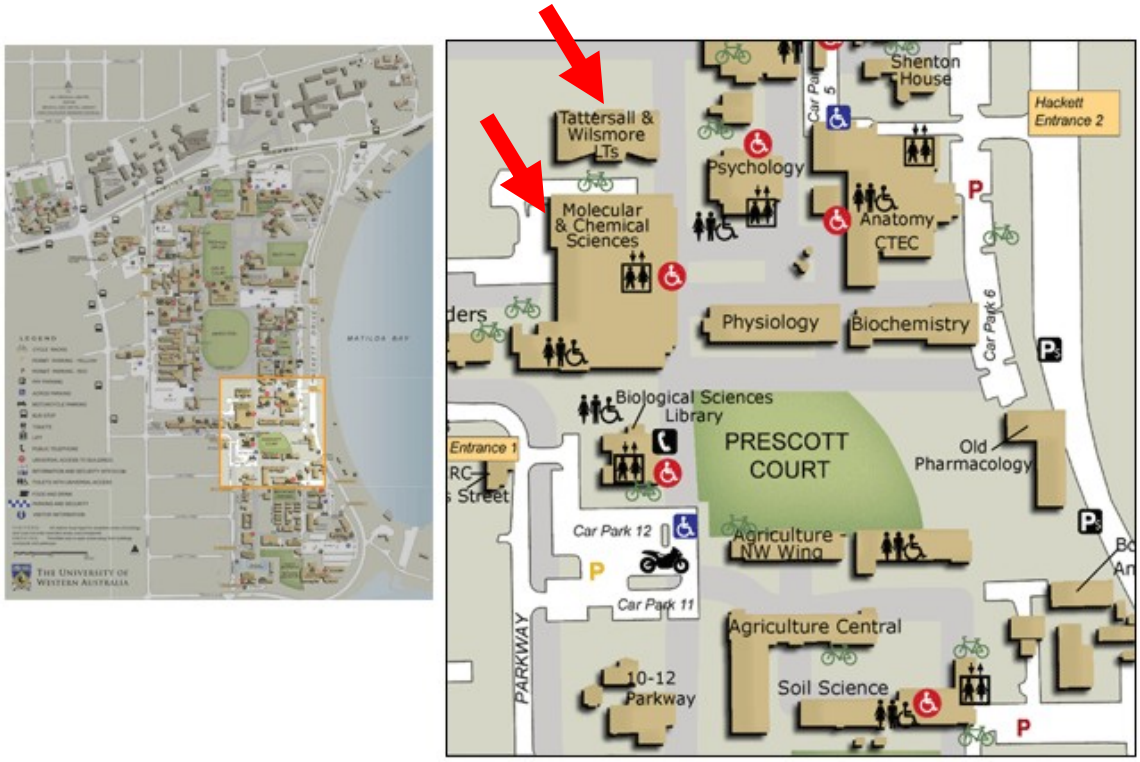
Meeting: Wilsmore Lecture Theatre



TIMETABLE

Friday November 30	
5:00 – 7:00	Registration
Saturday December 1	
8:00 – 8:45	Registration
8:45 – 9:00	Welcome
9:00 – 9:36 Plenary Talk	Professor Terence Dawson
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3:24 – 4:00	Session 4
5:24 – 6:00	Annual General Meeting
Sunday December 2	
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9:00 - 10:24	Session 5
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11:00 – 12:24	Session 6
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7:00 – 10:00	Conference Dinner

CONFERENCE PROGRAM

Presenter in bold: * indicates student presentation eligible for prize

FRIDAY NOVEMBER 30	
5:00 – 7:00	**Registration**
Pre-conference registration will be held at the Molecular and Chemical Sciences Building. Registration packs will be available for collection, and light refreshments (finger food, beer, wine, soft drinks) will be provided.	
SATURDAY DECEMBER 1	
08:00	**Registration**
08:45	**Welcome: Christine Cooper**
Session 1:	**Chair: Shane Maloney**
09:00	**Plenary Talk – Professor Terence Dawson** Changing perspectives of marsupial energetics: the surprising transition from evolutionary loser to superstar
09:36	**Roger S Seymour,** Craig R White and Marc Gibernau Endothermy of Scarab Beetles in Thermogenic Flowers
09:48	Jessica R Nealon, Stephen J Blanksby, Todd W Mitchell and **Paul L Else** Changes in membrane acyl composition with varying body mass in mammals is derived from changes in all phospholipid classes.
10:00	**Suzy L Munns**, Sarah J Andrewartha and Peter B Frappell Crocodilian breathing mechanics: more ordinary than we thought?
10:12	**Craig R White**, Patrick J Butler, David Grémillet and Graham R Martin Behavioural strategies of predation in cormorants
10:24	**Animal Biology Morning Tea**
Session 2	**Chair: Craig White**
11:00	**Gerhard Körtner**, Aaron Trachtenberg and Fritz Geiser Thermobiology, activity patterns and torpor use of two sympatric arid zone dasyurids
11:12	**Leonard G Forgan***, Kenneth R Olson and Malcolm E Forster Oxygen dependence of hydrogen sulfide-mediated vasoconstriction in the hagfish dorsal aorta
11:24	**Beth L Symonds***, Nick J Hudson, Helga Guderley & Craig E Franklin The ups and downs of aestivation: Enzyme activity levels in the green-striped burrowing frog
11:36	**Koa N Webster** and Terence J Dawson Aerobic characteristics of brush-tailed bettong (woylie) muscles
11:48	**Rachel Blake***, Brett Jennings, Jean Joss and John Donald Vascular nitric oxide systems in fish and amphibians
12:00	**Malsha Kitulagodage***, Lee Astheimer, Bill Buttemer, Mike Hooper and Andrew Keats Physiological assessment of avian exposure to fipronil, a new-generation pesticide
12:12	**Sean Tomlinson*** and Philip C Withers Adaptive change in body mass of native Australian and introduced mice: an inquiry into Bergmann's Rule
12:24	**LUNCH and Poster Viewing**

CONFERENCE PROGRAM

Presenter in bold: * indicates student presentation eligible for prize

SATURDAY DECEMBER 1	
Session 3:	**Chair: Nicola Mitchell**
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2:12	**Clare Stawski***, Anaïs Le Bot, Christopher Turbill and Fritz Geiser Prolonged torpor during winter in a free-ranging subtropical bat
2:24	**Sara Kayes***, Nicholas J Hudson and Craig E Franklin Opioids as triggers for metabolic depression in the burrowing frog, *Cyclorana alboguttata*
2:36	**Elsa Glanville*** and Frank Seebacher Metabolic heat production capacity in a widespread endotherm (*Rattus fuscipes*): latitude, season and acclimation
2:48	**Phil Matthews*** The oxygen binding characteristics of insect haemoglobin determined *in vivo*
3:00	**Ben Barth*,** E A Meyer and Robbie S Wilson The interactive effects of low pH and wallum water on the growth and development of the striped marsh frog (*Limnodynastes peronii*)
3:12	**Sarah J Andrewartha*** and Peter B Frappell From ectotherm to endotherm: respiratory, metabolic and blood acid/base responses to dynamic body temperature changes
3:24	**BBAC Afternoon Tea**
Session 4:	**Chair: Ashley Edward**
4:00	**Vickie Cartledge**, Philip C Withers and S Don Bradshaw Water balance and arginine vasotocin in the cocooning frog *Cyclorana platycephala*
4:12	**Isabel Walter*** and Frank Seebacher Molecular mechanisms underlying the development of endothermy in birds (*Gallus gallus*): a new role of PGC-1α
4:24	**James M Turner*** and Fritz Geiser The effect of ambient temperature on temporal organisation of torpor in the western pygmy-possum (*Cercartetus concinnus*)
4:36	**David J Cannata***, David W Walker and Jan M West Pre- and post-natal diaphragm development in sheep (*Ovis aries*)
4:38	**Kirstin L Pratt***, Robbie S Wilson, Simon Blomberg and Craig E Franklin Predicting dive duration during times of high metabolic demands
5:00	**Bridget F Murphy***, Kathy Belov and Michael B Thompson The evolution of viviparity in Australian skinks: A molecular analysis
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CONFERENCE PROGRAM

Presenter in bold: * indicates student presentation eligible for prize

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09:12	**Yvonne A Eiby*** and David T Booth The effect of temperature on the energetics of development in the Australian Brush-turkey (*Alectura lathami*)
09:24	**Scott van Barneveld*** Invasive lizards (*Lampropholis delicata* De Vis 1888) acclimate to changing thermal environments
09:36	**Lisa Warnecke*** and Fritz Geiser The effect of torpor and radiant heat on energy expenditure in fat-tailed dunnarts
09:48	**Gemma Williams***, Liza Snow and Jan West What's your poison? The effects of arsenic on the structure of organs from the yabby (*Cherax destructor*)
10:00	**Jillian Healy***, Aaron Schultz, Paul Jones and Tes Toop Osmoregulatory balance in Murray cod, *Maccullochella peelii peelii* (Mitchell), affected with chronic erosive dermatopathy.
10:12	**Sylvie Schmidt***, Christine E Cooper and Philip C Withers Metabolic physiology of the Black-flanked Rock-wallaby
10:24	**FNAS Morning Tea**
Session 6:	**Chair: Gerhard Körtner**
11:00	Meike Stumpp, Hung-Chang Liu, Wilhelm Hagen, Lars Redecke, Stuart Linton and **Reinhard Saborowski** Cellulose digestion in terrestrial and marine decapods from Taiwan
11:12	**Joanne Avraam***, Peter B Frappell and Gary Cohen Abolition of thermogenesis to moderate heat stress in newborn mice is a protective response to prevent hyperthermia
11:24	**Chee Yong***, Anish Singh and Paul A Fournier Effect of glycogen levels on post-exercise muscle glycogen repletion in the absence of food in humans
11:36	**Kylie Robert** and Anne Bronikowski Evolution of aging in a natural population of snakes: A comparative physiological study of the western terrestrial garter snake
11:48	**Stefanie Hilmer***, David Algar, John Angus and Elke Schleucher Impact of long term captivity on the physiology of the feral cat (*Felis catus*)
12:00	**Lesley A Alton***, Nicholas J Hudson, Robbie S Wilson and Craig E Franklin Is the photolyase enzyme up-regulated in response to UV-B exposure in larval anurans?
12:12	**Valentina Mella*,** Christine Cooper and Michael Parsons Physiological response of the brushtail possum to the scent of dingo urine
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CONFERENCE PROGRAM

Presenter in bold: * indicates student presentation eligible for prize

SUNDAY DECEMBER 2	
Session 7:	**Chair: Vicki Cartledge**
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2:12	**Joanna M Biazik***, Michael B Thompson and Christopher R Murphy. Claudin-5 is restricted to the tight junction region of uterine epithelial cells in uterus of pregnant/gravid squamate reptiles
2:24	**Natalie J Clark***, Matthew A Gordos and Craig E Franklin Diving behaviour, aquatic respiration, and blood oxygen affinity: A five species comparison of Australian freshwater turtles
2:36	**Lisa I Doucette***, R Mark Brigham, Chris R Pavey and Fritz Geiser Roost type influences thermoregulatory behaviour of Australian owlet-nightjars (*Aegotheles cristatus*) in the arid zone
2:48	**Aaron Schultz***, Patrick J Walsh, Sunita Nadela and Chris M Wood Digestive physiology in dogfish sharks, *Squalus acanthias*
3:00	**Shannon J Simpson*** and Peter B Frappell Why the need for cutaneous respiration in the newborn marsupial?
3:12	**Caragh Heenan*** The thermal Properties of bird's nests
3:24	**FLPS Afternoon Tea**
Session 8:	**Chair: Phil Withers**
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4:12	**Paul A Fournier**, Ghazala Raja and Lambert Bräu Fiber specific responses of muscle glycogen repletion in fasted rats physically active during recovery from high intensity physical exertion
4:24	**Nicola Mitchell**, Michael Kearney and Warren Porter Sex ratios, climate change and the future of a living fossil
4:36	Leigh W Tait, Yoshio Takei and **Malcolm E Forster** Natriuretic peptide stimulates urine formation in the osmoconforming hagfish
4:38	Benjamin Allardyce and **Stuart M Linton** Purification and characterisation of endo-β-1,4-glucanase and laminarinase enzymes from the herbivorous gecarcinid land crab, *Gecarcoidea natalis*.
5:00	**Gordon Grigg**, Lyn Beard, Birgit Dörges, Jürgen Heucke, Jocelyn Coventry, Alex Coppock and Simon Blomberg. Strategic (adaptive) hypothermia by rutting male dromedary camels may increase their reproductive fitness
5:12	**Duncan Mitchell**, Shane K Maloney and Andrea Fuller *Australopithecus* the water carrier?
5:24	**Award Presentation and Close**
7:00	**Conference Dinner (JoJo's Jetty)**

Plenary Paper

Changing perspectives of marsupial energetics: the surprising transition from evolutionary loser to superstar

Terence Dawson

School of Biological, Earth and Environmental Sciences, University of NSW, Sydney, NSW, 2052

The earliest impediment to really understanding marsupial energetics was the notion that marsupials were 'primitive'. Initially based on reproductive processes, this flawed evolutionary paradigm was expanded to cover their overall biology. The relatively low body temperatures (T_b) and resting metabolic rates (BMR) measured some 100 years ago reinforced the notion of 'metabolic primitiveness' and such ideas persisted until the 1960s. When work then clarified that their BMRs were about 70% of placental values and T_b was 2-3 °C lower we were still stuck with 'primitiveness' because metabolic scope was considered linked to BMR. One answer to the primitive label was that the low BMR was an advantageous adaptation to an energy poor Australia (but American species also have low BMRs). Because marsupials do apparently energetic things, e.g. fast locomotion, living in cold, we focused for a while on mechanisms that side-stepped their metabolic limitations, e.g. efficient locomotion (hopping) and decreased heat loss (insulation). However, clues from cardiac features indicated that maximum capabilities might not be tied to BMR in the manner of placentals. We have now shown marsupials to have a more expandable metabolic system and high athletic potential. This knowledge has allowed greater insight into marsupial thermal biology, locomotion and field metabolism.

Notes:

Abstracts of Spoken Papers

Endothermy of scarab beetles in thermogenic flowers

Roger S Seymour[1], Craig R White[1] and Marc Gibernau[2]

[1]University of Adelaide, Adelaide, South Australia 5000; [2]Paul Sabatier University, Toulouse, France

Over a thousand species of heat-producing flowers in the Neotropical forests are pollinated by large dynastine scarab beetles. We investigated the patterns of activity of beetles (*Cyclocephala colasi*) in the inflorescences of a large arum lily (*Philodendron solimoescence*) in French Guiana. We observed beetles inside inflorescences in the field and related activity to respirometry and body temperatures measured by needle thermocouples and an IR camera in the laboratory. Beetles were active during the night inside the floral chambers, where they mated and fed, and they rested the following day. The 24-hour cycle of respiration mirrored this, with bouts of endothermy at night (particularly in the early evening), and low rates during the day. Flying beetles had thoracic temperatures up to 9 °C above ambient, but the temperature excess was less than 2 °C inside the floral chamber. Floral chamber temperature during the night averaged 26.6 °C while ambient air was 22.8 °C. Beetles artificially exposed to temperatures less than 27 °C showed bouts of intense endothermy during which respiration could increase over 80-fold. Respiration rate was correlated with elevation in thoracic surface temperature, leading to the prospect of using surface temperature as an indirect measure of metabolic heat production.

Notes:

Changes in membrane acyl composition with varying body mass in mammals is derived from changes in all phospholipid classes

Jessica R Nealon[1,2], Stephen J Blanksby[3], Todd W Mitchell[1,2] and **Paul L Else**[1,2]

[1]Metabolic Research Centre, [2]School of Health Sciences and [3]School of Chemistry, University of Wollongong, New South Wales 2522

This study examined differences in membrane phospholipid acyl composition in kidney and brain of mammals of different body mass. It found that changes in membrane phospholipid acyl composition (such as decreased omega-3 fats, increased monounsaturated fats and decreased unsaturation index with increased body size) were not restricted to any particular type of phospholipid molecule or to any specific phospholipid class but were observed in all phospholipid classes. As mammals increased in body mass the type of unsaturates changed in all phospholipid classes with increases in monounsaturates (eg in kidney PC 16:0/18:1, PE 18:1/18:1, PS 18:0/18:1 and in brain PC 18:0/18:1, PE & PS 18:1/18:1) and less unsaturated polyunsaturestes (eg in kidney PC 16:0/18:2, PE 18:1/18:2, 18:0/18:2) at the expense of the long-chained omega-3 and omega-6 polyunsaturated fats (eg in kidney PC16:0/22:6, PC 18:0/20:4, PE 18:0 & 18:1/22:6, PS 18:0/20:4 and in brain 18:0/22:6) producing decreases in membrane unsaturation. The distribution of membrane phospholipid classes was essentially the same in the different sized mammals with phosphatidylcholine (PC) and phosphatidylethanolamine (PE) constituting 91% and 85% of all phospholipids in kidney and brain respectively. The study suggests that the physical properties of membranes are likely to be involved in changing metabolic rate.

Notes:

Crocodilian breathing mechanics: more ordinary than we thought?

Suzy L Munns[1], Sara J Andrewartha[2] and Peter B Frappell[2]

[1]School of Veterinary and Biomedical Sciences, James Cook University, Townsville, Queensland 4811; [2]Department of Zoology, LaTrobe University, Bundoora, Victoria 3086

Breathing mechanics in crocodilians are reported to be unique. In contrast to mammals, in which a muscular diaphragm powers ventilation, crocodiles use three groups of muscles during breathing; the costal muscles, abdominal muscles and the diaphragmaticus muscle. The diaphragmaticus muscle is not homologous with the mammalian diaphragm, but rather is a thin sheet of muscle that originates on the pelvis and inserts onto a connective tissue sheet surrounding the liver. The liver and the lungs are intimately connected and thus contraction of the diaphragmaticus muscle retracts the liver caudally effecting lung inflation. In this study we question whether the diaphragmaticus muscle plays a primary or accessory role during inspiration. A range of ventilatory and blood gas parameters were measured in juvenile saltwater crocodiles under a number of conditions; rest, lowered body temperature, hypercapnia and treadmill exercise. The diaphragmaticus muscle was then inactivated by surgically severing it from its attachment to the pelvis and the experimental protocol repeated. The inactivation of the diaphragmaticus muscle did not significantly alter any ventilatory or blood gas parameter under any experimental condition. These results suggest that the diaphragmaticus muscle plays an accessory rather than a primary role in lung ventilation.

Notes:

Behavioural strategies of predation in cormorants

Craig R White[1,2], Patrick J Butler[1], David Grémillet[3,4] and Graham R Martin[1]

[1]Centre for Ornithology, The University of Birmingham, UK; [2]School of Integrative Biology, The University of Queensland 4072; [3]Centre National de la Recherche Scientifique, Strasbourg, France; [4]Percy FitzPatrick Institute, University of Cape Town, South Africa

Great cormorants *Phalacrocorax carbo* are ubiquitous diving predators that are often in conflict with human fisheries interests. They are generally regarded as pursuit-dive foragers, and have eyes that are well adapted to function in both air and water. However, despite these adaptations, visual resolution underwater, and consequently prey detection based upon visual cues, in cormorants is poor. Cormorant visual acuity under a range of viewing conditions is in fact comparable to unaided humans under water, and very inferior to that of aerial predators. We present a prey detectability model based upon the measured acuity of cormorants at different illuminances, target contrasts and viewing distances. This shows that cormorants are able to detect individual prey only at close range (less than 1 m). We conclude that efficient hunting of cormorants is not analogous to the pursuit of distant prey by eagles, but it involves the use of specialised foraging techniques that employ the visual detection of individual prey items only at very short range, analogous to the lunging techniques of herons.

Notes:

Thermobiology, activity patterns and torpor use of two sympatric arid zone dasyurids

Gerhard Körtner, Aaron Trachtenberg and Fritz Geiser

Centre for Behavioural and Physiological Ecology, Zoology, University of New England, Armidale, New South Wales 2351

The activity patterns and torpor use of the stripe-faced dunnart (*Sminthopsis macroura*, 15.2±3.3g) and the kowari (*Dasyuroids byrnei*, 109.2±16.9g) were investigated in Astrebla Downs NP during winter using radio-telemetry. Eight dunnarts and six kowaries were surgically implanted with temperature-sensitive radio-transmitters and monitored for 14-59 days. Home range size based mainly on burrow locations was 0.7±0.6ha for the dunnarts and 58.3±65.6ha for the kowaries. Both species commenced activity after sunset, but while the activity of kowaries extended through most of the night, dunnarts usually returned to their burrows before midnight. In dunnarts short activity was associated with frequent use of daily torpor, 99.5% of observation days. Torpor often commenced at night, body temperature (T_b) was as low as 11.3°C and torpor lasted up to 26h. In contrast, only 50% of the kowaries entered torpor and then torpor was brief (maximum 4h), shallow (minimum T_b 25.3°C) and restricted to the daytime rest-phase. In conclusion, the small dunnarts conserved energy during winter by reducing activity and torpor was part of their daily routine. Apparently the larger kowaries were less affected by cold winter nights and continued to roam over large areas, maintained high night-time activity levels while entering torpor only occasionally.

Notes:

Oxygen dependence of hydrogen sulfide-mediated vasoconstriction in the hagfish dorsal aorta

Leonard G. Forgan[1] Kenneth R. Olson[2], and Malcolm E. Forster[1]

[1]School of Biological Sciences, University of Canterbury, Private Bag 4800, Christchurch 8020, New Zealand; [2]Indiana University School of Medicine - South Bend, South Bend, IN 46617 USA

Hydrogen sulfide (H_2S) is a vasoregulatory molecule that has been shown to be a mediator of hypoxic vasoconstriction (HVC) and dilation (HVD) in vertebrates. The mechanism by which this vasoactivity is effected is not completely understood. A novel hypothesis for H_2S mediated vasoactivity and the relationship between H_2S and O_2 is presented in the most primitive extant vertebrate, the hagfish. In myographic studies, hypoxia produced HVC. H_2S dose-dependently constricted dorsal aortas (DA) and efferent branchial arteries but did not affect either the ventral aorta or afferent branchial arteries. HVC in the hagfish DA was enhanced by the H_2S precursor cysteine and inhibited by aminooxy acetate (AOA), an inhibitor of the H_2S-synthesizing enzyme, cystathionine β-synthase. HVC was unaffected by propargyl glycine, an inhibitor of cystathionione λ-lyase (an H_2S-synthesizing enzyme). The hagfish DA was found to regulate oxygen consumption (MO_2) over a physiological PO_2 range. MO_2 was constant between Po_2 of 15 and 115 mmHg, but decreased when Po_2 <15 mmHg and increased when Po_2 exceeded 115 mmHg. Treatment with 10 µM H_2S increased MO_2, whereas MO_2 fell when H_2S ≥100 µM. Consistent with the effects on HVC, cysteine increased and AOA decreased MO_2. These results show that H_2S is a monophasic vasoconstrictor of hagfish vessels and provides evidence for the hypothesis that H_2S production is dependant on oxygen availability.

Notes:

The ups and downs of aestivation: enzyme activity levels in the green-striped burrowing frog

Beth L Symonds[1], Nick J Hudson[1], Helga Guderley[2] and Craig E Franklin[1]

[1]School of Integrative Biology, University of Queensland, St Lucia, Queensland 4172;
[2]Departement de Biologie, Université Laval, Quebec, Canada, G1K 7P4

Green-striped burrowing frogs (*Cyclorana alboguttata*) depress their metabolism by up to 70% of resting metabolic rate during prolonged aestivation. The ATP demand of skeletal muscle is a large contributor to *C. alboguttata*'s overall energy requirement, and plays an important role in the coordinated down-regulation of metabolic processes during aestivation. However, upon awakening from aestivation *C. alboguttata* must be able to return to an active locomotor state to allow excavation from the burrow, prey-capture and reproduction. The aim of this study was to determine the effect of prolonged aestivation on the activity levels of metabolic enzymes (cytochrome c oxidase [CCO], lactate dehydrogenase [LDH] and citrate synthase [CS]) from selected skeletal muscles (cruralis, gastrocnemius, sartorius, iliofibularis and rectus abdominus) and the liver of *C. alboguttata*. Furthermore, we wished to determine whether the coordinated down-regulation in metabolic activity varied with muscle, or tissue, type and function. The activity level of CS was significantly reduced after 6 and 9 months of aestivation in all tissues except for the cruralis and the liver. LDH activity was significantly lower in the sartorius and rectus abdominus muscles after prolonged aestivation, but remained at control levels in the remaining tissues. The activity of CCO was significantly lower in the gastrocnemius and rectus abdominus during aestivation, but was unchanged in the sartorius, the iliofibularis and the liver. The results suggest that the energy pathways involved with the production and consumption of ATP are remodelled during prolonged aestivation, and that remodelling and subsequent down-regulation of enzyme activity levels varies with tissue type.

Notes:

Aerobic characteristics of brush-tailed bettong (woylie) muscles

Koa N Webster[1,2] and Terence J Dawson[1]

[1]School of Biological, Earth and Environmental Sciences, University of New South Wales, Sydney New South Wales 2052; [2]Department of Biological Sciences, Macquarie University, North Ryde, New South Wales 2109

In eutherians maximal aerobic metabolic capacity (VO_2max) is associated with the amount of mitochondria available to utilise oxygen in skeletal muscle tissue. There is also an association with the capillary volume available for the delivery of oxygen to muscles. Recently, we have shown that these relationships also exist in the red kangaroo, *Macropus rufus*. We examined skeletal muscle capillaries and mitochondria in the brush-tailed bettong or woylie, *Bettongia penicillata*. Total muscle mass was obtained and a whole-body sampling procedure determined average muscle mitochondrial and capillary characteristics. Using transmission electron microscopy and stereological techniques, we measured capillary length density, Jv(c,f), capillary volume, V(c), and mitochondrial volume density, Vv(mt,f). The relationships between total mitochondrial volume of skeletal muscle ($V(mt,m)/M_b$), total capillary volume ($V(c)/M_b$) and maximum aerobic capacity (VO_2max) of *B. penicillata* were identical to those seen in eutherian mammals and the red kangaroo. Thus, VO_2max in marsupials is linearly related to both total mitochondrial and capillary volumes. Since the fundamental aerobic structures that determine maximal metabolic rate are identical in all mammals, they probably evolved in mammal-like reptiles during the Mesozoic.

Notes:

Vascular nitric oxide systems in fish and amphibians

Rachel Blake, Brett Jennings, Jean Joss and John Donald

School of Life and Environmental Sciences, Deakin University, Geelong, Victoria 3217

In mammals, nitric oxide (NO) is produced by the enzyme nitric oxide synthase (NOS) in which the isoforms derived from the endothelium (eNOS) and nerves (nNOS) are involved in vascular regulation. As to whether both these NO system exists in lower vertebrates such as amphibians and fish, is controversial as there is evidence to support the absence and presence of an endothelial NOS system. Our laboratory has demonstrated using both NADPH-diaphorase histochemistry and immunohistochemistry that a vascular eNOS system is lacking in teleost fish and amphibians, and that NO control is exclusively provided by nNOS located in perivascular nerves. We have also demonstrated that the majority of nitrergic nerves are sympathetic, adrenergic nerves, which is unusual given that the neurotransmitters have opposite functions. In contrast, blood vessels of the Australian lungfish, Neoceratodus forsteri, are mostly devoid of nitrergic nerves, which is consistent with the lack of adrenergic innervation. Furthermore, dual wire myography found no evidence for NO vasodilation in the branchial artery, but an endothelial prostaglandin signalling pathway was demonstrated. Thus, nitrergic control of the circulation appears to be absent in Australian lungfish.

Notes:

Physiological assessment of avian exposure to fipronil, a new-generation pesticide

Malsha Kitulagodage[1,2], Lee Astheimer[1,2], Bill Buttemer[1,3], Mike Hooper[4] and Andrew Keats[5]

[1]Institute for Conservation Biology & Law, [2]School of Health Science and [3]School of Biological Sciences, University of Wollongong, New South Wales 2522; [4]The Institute for Human and Environmental Health, Texas Tech University, USA; [5]Agri-Solutions Australia Pty Ltd, Brisbane, Queensland

Fipronil, a phenyl pyrazole pesticide, is currently used in Australia to control locusts in semi-arid and agricultural areas. It acts as a gamma-aminobutyric acid (GABA) antagonist and exposure at sufficient doses results in severe paralysis and ultimately, death. Locust populations build to plague proportions during conditions also attracting breeding birds. Over 100 avian species have been observed coincident with locust control operations. Avian exposure to fipronil occurs via direct contact and by ingesting contaminated insects or seeds. Avian toxicity information demonstrates there is high species-specific variability in fipronil sensitivity in the few avian species studied. There is no research, however, explaining this variability, nor is there research regarding physiological or behavioural sub-lethal effects on avian species. This makes it extremely difficult to predict the toxicity of fipronil on unstudied species at high risk of exposure. As there is no biomarker for fipronil exposure, we examine firstly the effects and duration of sublethal fipronil exposure in sensitive and non-sensitive avian species to determine whether fipronil has predictable sublethal effects, and secondly avian metabolism of fipronil to determine the mode of the toxicity resulting in the variation in species sensitivity; knowledge essential in evaluating field effects of locust-control spraying.

Notes:

Adaptive change in body mass of native Australian and introduced mice: an inquiry into Bergmann's Rule

Sean Tomlinson and Philip C. Withers

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GIS software was used to investigate Bergmann's Rule in the Australian native mouse *Pseudomys hermannsburgensis* and the introduced House Mouse (*Mus musculus*). There were significant interactions suggesting that House Mice were heavier in the south and east, and Sandy Inland Mice were heavier in the north and east. House Mice were heavier at cooler maxima, in less arid areas, and in areas of more rainfall variability. Sandy Inland Mice were heavier in more arid areas. After accounting for climate there was still a negative influence of latitude, and a positive influence of longitude in both species. *Mus musculus* conforms to Bergmann's Rule, the principal driver of which appears to be more closely related to indices of productivity than temperature. *Pseudomys hermannsburgensis* displays converse effects of Bergmann's Rule which appear related to the aridity of local habitat, and may be influenced by resource competition and character displacement. Once effects of climate and habitat are removed both species conform to the converse rule.

Physiological assessment of avian exposure to fipronil, a new-generation pesticide

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Notes:

Uterine vascular ontogeny during the reproductive cycle of the three-toed skink *Saiphos equalis*

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Embryos are dependent upon maternal oxygen supply to satisfy their metabolic oxygen demand during gestation. Because embryonic oxygen consumption increases throughout gestation, the vascular respiratory membranes of the uterus must be able to match embryonic oxygen demand as development proceeds. We used indirect immunofluorescence and laser-scanning confocal microscopy to quantify uterine microvascular density and morphology during the reproductive cycle of the three-toed skink, *Saiphos equalis*. Optical sections obtained from confocal microscopy were computationally reassembled to provide 3-dimensional reconstructions of uterine microvascular architecture. Uterine vascular density varies both spatially among regions of the uterus and temporally among different stages of gestation. Within the uterus, the highest vascular density is associated with the embryonic pole of the egg in the region contacting the highly vascularised chorioallantoic membrane of the embryo. Vascular proliferation (angiogenesis) occurs by intussusception (vessel splitting via transluminal pillar formation) with the highest amounts of proliferation occurring between embryonic stages 31-35. Total vascular length and vessel density increases during gestation and become highest at advanced embryo stages (i.e. stages 36-40). The increase in uterine vascular proliferation coincides with the period of rapid growth in embryo mass and concomitant increasing embryonic metabolic rate.

Notes:

Prolonged torpor during winter in a free-ranging subtropical bat

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Prolonged torpor or hibernation is commonly employed by bat species that reside in temperate regions. In contrast, information on prolonged torpor in bats from tropical or subtropical regions is entirely lacking. We used radio-telemetry to measure skin temperatures (Tskin) of free-ranging Nyctophilus bifax (~9g) during winter in a coastal subtropical habitat in north-eastern New South Wales. Most bats entered torpor bouts that lasted for >48 hours on at least one occasion during the study period. Torpor patterns were affected by ambient temperature; during cooler periods bats remained torpid throughout the whole day, whereas on warmer days they aroused around sunset to feed for several hours before becoming torpid again. The Tskin of torpid bats was influenced by their choice of tree roost, such that their daily Tskin fluctuations were greater in exposed roosts compared to more insulated roosts. Our study provides the first evidence of prolonged torpor in a free-ranging bat that is restricted to tropical and subtropical habitats. This illustrates the energetic constraints of small bats even in sub-tropical climates and their flexibility in employing prolonged torpor or activity to suit prevailing conditions.

Notes:

Opioids as triggers for metabolic depression in the burrowing frog, *Cyclorana alboguttata*

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During periods of environmental stress many animals undergo a period of inactivity or dormancy, the key aspect of which is a metabolic depression. Metabolic depression is a reduction in metabolic rate below the normal resting value, which allows animals to survive for extended periods on endogenous fuel stores. Metabolic depression is a complex process, with many physiological and biochemical adjustments occurring in a coordinated fashion. However, the endogenous mechanisms involved in initiation and maintenance of metabolic depression remain poorly understood. Studies on hibernating animals have shown that endogenous opioids may play an important role in initiating metabolic depression. The aim of this study was to investigate the potential role of opioids in initiating and maintaining the metabolic depression in the aestivating frog, *Cyclorana alboguttata*. We hypothesised that the addition of delta opioids to the liver and gastrocnemius muscle would produce a reduction in tissue metabolic rate, whereas the addition of mu and kappa opioids would have no effect on metabolic rate. Closed box respirometry was used to measure oxygen consumption of tissue slices with and without the addition of opioids. The delta opioid DADLE was found to decrease oxygen consumption of liver and muscle slices by 20% and 25%, respectively, compared to control slices, whereas the kappa opioid Dynorphin A and the mu opioid Morphiceptin had no effect on tissue metabolic rate. This is the first time that opioids have been shown to directly affect metabolic rate in an aestivating species, indicating that endogenous opioids may play an important role in initiating a metabolic depression.

Notes:

Metabolic heat production capacity in a widespread endotherm (*Rattus fuscipes*): latitude, season and acclimation

Elsa Glanville and Frank Seebacher

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Fluctuating thermal environments pose a continuous challenge to animals. Mammals have a high metabolic heat production capacity and are thought to maintain a stable body temperature (T_b) regardless of ambient temperature (T_a). However, endothermy is energetically expensive particularly when the difference between T_b and T_a is large. Seasonal changes in T_a and acclimation to specific T_as may result in altered mean T_b and/or T_b amplitude. Lowering T_b in a cool environment is an energy saving strategy but may slow biochemical reaction rates. Upregulation of metabolic heat production capacity and decreasing or shifting thermal sensitivity in response to temperature change in turn affects whole animal performance. *Rattus fuscipes* (bush rat) were sampled in February (n = 10) and August (n=10) to determine how seasonal changes in T_a affect T_b, tissue specific mitochondrial oxygen consumption and metabolic enzyme activity. Additionally, the effect of cold (n=10, 10-12°C) and warm (n=10, 22-24°C) acclimation was determined on T_b, sustained running speed, resting and exercise induced metabolic rates, mitochondrial oxygen consumption and metabolic enzyme activity. Mean T_b of cold animals (36.45°C±0.10) was significantly different ($F_{4,27}$ = 8.390, p = 0.000) from warm animals (37.41°C±0.07). Amplitude between seasons was significantly different from in captivity ($F_{4,27}$ = 12.276, p = 0.000). Mitochondrial oxygen consumption differed significantly between season and treatments, as did enzyme activity. Cold acclimated animals performed better than warm acclimated animals in exercise trials at cold T_a and had a less thermally sensitive exercise induced metabolic rate. Phenotypic flexibility in a native mammal occurs to maintain performance in a changing thermal environment.

Notes:

The oxygen binding characteristics of insect haemoglobin determined *in vivo*

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Haemoglobin (Hb) is the most common respiratory pigment found in nature. In the animal kingdom it occurs in almost every vertebrate, but only patchily among the invertebrates. While it now appears that Hb-encoding genes are fairly common among the Insecta, only some Diptera and Hemiptera, specialised to live aquatic or semi-aquatic modes of life, are known to possess Hb in any significant quantities. The aquatic backswimmer (Hemiptera, *Anisops deanei*) possesses large Hb-filled cells within its abdomen which are intimately associated with a bubble of air held on the abdomen's ventral surface. The measured rate of PO_2 decline within the air bubble was analysed to determine the oxygen binding characteristics of backswimmer haemoglobin *in vivo*. Oxygen equilibrium curves (OEC) had exceptionally steep mid-slopes, with a 1 kPa change in PO_2 causing the Hb to unload more than 50 % of its bound oxygen. When the OEC was analysed as a Hill plot, it showed three distinct phases: A shallow phase until 35 % saturation, followed by a steep increase to 90 % saturation before a final shallow phase. Potential inaccuracies associated with *in vivo* determination of OECs were investigated using a simple numerical model.

Notes:

The interactive effects of low pH and wallum water on the growth and development of the striped marsh frog (*Limnodynastes peronii*)

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The wallum areas of eastern Australia are naturally-acidic aquatic environments. The low pH of these environments is due to a combination of both soft-water with low buffering capacity and high concentrations of dissolved organic acids. Our current understanding of the effects of low pH on aquatic organisms is limited to laboratory studies of simple non-organic acids. However, the interactive effects of low pH and humic substances may be important factors affecting the physiology and ecology of species in naturally low pH environments. In this study we investigated the effects of chronic exposure to low pH in artificial soft water on embryonic and larval traits in the amphibian *Limnodynastes peronii*. We predicted that low pH environments would result in lower hatching success of embryos and lower growth and poorer swimming performance in larvae. We then examined the interactive effects of pH and varying concentrations of natural wallum water on embryonic and larval traits for *L. peronii* exposed to the different treatments during embryonic and post-embryonic development. Based on previous studies we predicted that the detrimental effects of low pH on *L. peronii* embryos and larvae would be further exacerbated in treatments having greater concentrations of wallum water. We found that embryos experienced both reduced growth and survival when exposed to low pH and artificial soft-water. However, humic substances that are characteristic of wallum environments were not found to exacerbate the effects of low pH on growth and development, as was predicted. Instead we found evidence that the natural wallum waters offered a protective function to larvae in low pH environments and improved growth and performance across all pH treatments.

Notes:

From ectotherm to endotherm: respiratory, metabolic and blood acid/base responses to dynamic body temperature changes

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Blood gases and pH are believed to be regulated differently in ectothermic and endothermic animals by α-stat and pH-stat regulation, respectively. Little is known however, about the development of these regulatory systems and whether endotherms transition through an ectothermic stage in terms of blood gas and pH regulation either in utero, or as with marsupial joeys, in the pouch. Marsupial joeys are born ectothermic and develop endothermy whilst in the pouch, providing an easily accessible model for studying the development of these systems. This paper uses Tammar wallaby (*Macropus eugenii*) joeys to characterise how respiratory and blood parameters are regulated in an ectothermic mammal and during development into an endothermic mammal. For comparison, values obtained in ectotherms (*Crocodylus porosus*, and *Varanus rosenbergi*) and an endotherm (Sprague Dawley rat) are also presented.

Notes:

Water balance and arginine vasotocin in the cocooning frog *Cyclorana platycephala* (Hylidae)

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It is well established that the formation of a cocoon, for frog species capable of doing so, markedly reduces evaporative water loss, however, the capacity of cocooned frogs to maintain hydration during extended aestivation is not well understood. The combined effects of long-term aestivation and water loss were examined in the cocoon-forming species *Cyclorana platycephala* by assessing the hydration state of the frogs throughout a 15 mth aestivation period. Frogs lost mass throughout the 15 mth aestivation period to a maximum of 36 ± 6.5% of their initial standard mass. Plasma osmolality reached maximal levels by 9 mth aestivation at 487 mOsm kg^{-1} then remaining stable to 15 mth aestivation. Urine osmolality continued to increase to 15 mth aestivation at which point plasma and urine concentrations were isosmotic. The use of bladder water to counter losses from circulation was indicated by the relatively slow rate of increase in plasma osmolality with mass loss and the progressive increase in urine osmolality. For aestivating frogs, evidence was found for a possible threshold relationship between plasma osmolality and plasma AVT concentration. Following aestivation, plasma AVT concentrations decreased markedly when 15 mth aestivators were placed in water for 2 h suggesting that high levels of AVT may not be integral to rapid rehydration in this species.

Notes:

Molecular mechanisms underlying the development of endothermy in birds (*Gallus gallus*): a new role of PGC-1α

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In endotherms, plasticity of internal heat production in response to environmental variability is an important component of thermoregulation. During embryogenesis endotherms cannot regulate their body temperature metabolically and are therefore similar to ectotherms. The transition from ectothermy to endothermy occurs by the development of metabolic capacity during embryogenesis. Here we test the hypothesis that the development of metabolism during embryogenesis in birds is under transcriptional control and that metabolic capacity is upregulated in colder environments. The peroxisome-proliferator-activated receptor- γ coactivator-1α (PGC-1α) is the major metabolic regulator in mammals. PGC-1α and its target PPARγ were significantly elevated during development in pectoral muscle and liver of chickens (*Gallus gallus*) compared to adults. However, the timing of upregulation of PGC-1α and PPAR γ was not in synchrony. In cool incubation temperatures (35°C) both PGC-1α and PPAR γ gene expression was increased in liver but not in skeletal muscle, compared to a 38°C incubation treatment. Cytochrome c oxidase and citrate synthase enzyme activities and ATPsynthase gene expression increased during embryonic development in liver and muscle, and there was a significant effect of incubation temperature on these parameters. Our findings suggest that PGC-1α might be important for establishing endothermic metabolic capacity during embryogenesis in birds.

Notes:

The effect of ambient temperature on temporal organisation of torpor in the western pygmy-possum (*Cercartetus concinnus*)

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We investigated temporal differences in torpor use by the small (15g) heterothermic marsupial western pygmy-possum (*Cercartetus concinnus*) at a range of ambient temperatures (T_a). We exposed individuals to three different T_as (20, 15 and 9°C) for four weeks at a time, with free access to food, and differences in torpor bout duration and periodicity were recorded. Skin temperature was measured non-invasively using small temperature-sensitive data loggers inserted into the base of tennis balls which were used as nest boxes. This, in conjunction with activity loggers, provided data on the timing of torpor entry and arousal. Individuals entered torpor spontaneously at each T_a, and torpor bout length was negatively correlated with T_a. Maximum bout duration was 0.9 days at 20°C, 5.8 days at 15°C, and the longest recorded bout of 9.6 days was observed at 9°C. Time of torpor entry and arousal was not affected by T_a. Our findings show that western pygmy-possums lengthen torpor bout duration as a strategy to reduce the energetic costs of thermoregulation in the cold.

Notes:

Pre- and post-natal diaphragm development in sheep (*Ovis aries*)

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The diaphragm is a major respiratory muscle and the only skeletal muscle which must function at birth. Breathing difficulties are common in pre-term birth or when development has been compromised by maternal insult. Little is known about how diaphragm muscle develops or if development is affected by insults during pregnancy. Single skeletal muscle fibres can be categorised as fast- or slow-twitch by their sensitivity to Ca^{2+} and Sr^{2+}. Fast-twitch fibres have a greatly different sensitivity to Ca^{2+} and Sr^{2+} while slow-twitch have a similar sensitivity. However, the diaphragm is composed of fibres which express both fast- and slow isoforms (hybrid fibres) thus have unique activation profiles where the force-strontium curve is biphasic. At 120 days gestation (term is 147d), single muscle fibres have a force-strontium curve that can be fitted by a single exponential. Just before birth (145-147d), the strontium curve has a slight discontinuity and within an hour after birth the force-strontium curve is clearly biphasic. What triggers the change in the curve? Are different protein isoforms expressed? Does the change in compliance and stretch on the diaphragm induce this change when the lungs change from moving embryonic fluid to establishing breathing?

Notes:

Predicting dive duration during times of high metabolic demands

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The calculated aerobic dive limit (cADL) provides a conceptual framework for understanding the aerobically sustained diving limits of vertebrates and is determined by dividing total oxygen stores by rate of oxygen consumption. Despite the influence of the cADL model on our understanding of vertebrate diving behaviour, most studies show the cADL is an unreliable predictor. Both over and under-estimations of diving duration have been reported, with possible sources of error due to inaccurate estimates of oxygen stores and metabolic rates. The aim of this study was to test the cADL through modeling dive behaviour over a range of metabolic rates induced through digestion. The fully-aquatic file snake (*Acrochordus arafurae*) was selected for this study as this species has a large metabolic response to digestion and is relatively inactive whilst diving. Rate of oxygen consumption (aerial and aquatic) and dive behaviour were measured separately and continuously after each animal was fed a meal between 0 and 15% of body mass. There was a positive relationship between meal size and rate of oxygen consumption with a peak of 20 times fasting values with the largest meal sizes. Maximum dive times during digestion were significantly reduced to as low as 20% of fasting dive times and these empirical dive times were accurately predicted by the cADL model.

Notes:

The evolution of viviparity in Australian skinks: A molecular analysis

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Uterine epithelium vascularises as gestation progresses, and the uterus is more vascular in viviparous than oviparous species. Embryonic oxygen demand increases during development, resulting in hypoxia inside the uterus that triggers blood vessel proliferation. Regulation of two genes (hypoxia inducible factor alpha (HIF-1α), vascular endothelial growth factor (VEGF)) are responsible for hypoxia-induced vascularisation in mammalian uterus. mRNA of HIF-1α and VEGF is expressed in the uterus of oviparous and viviparous skinks during non-reproductive and late gravid/pregnant stages. Uterine VEGF expression is unchanged between non-reproductive and late gravid/pregnant females in oviparous and viviparous species. Embryos of viviparous skinks are closely enough apposed to maternal tissues to allow maternal recognition of pregnancy, so the embryo is in danger of immune rejection. Non-classical major histocompatibility complex (MHC) class I genes are expressed by mammalian embryos, 'hiding' the embryo from immunological attack. We have cloned class I genes expressed in the uterus of a viviparous skink and described two loci with non-classical features. The next step will be to compare non-classical gene expression in oviparous and viviparous embryos to investigate whether the evolution of immunological interactions between mother and embryo is a major step in the transition to viviparity.

Notes:

Insect size and limitations of thetracheal respiratory System

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Explanations for the factor(s) limiting maximum insect size are varied and include the structural collapse of the exoskeleton, lack of flow generated by an open circulatory system, and inability of the tracheal respiratory system to satisfy oxygen needs. The respiratory limitation hypothesis is supported by the occurrence of gigantic insects during periods of elevated atmospheric oxygen. However, some controversy surrounds this explanation with sceptics citing research that shows larger insects *breathe* as easily as smaller insects when exposed to hypoxia. Conversely, recent works indicate that larger insects possess "super-sized" tracheal systems (explaining the ease at which larger insects can satisfy their oxygen requirements) and that beetle size is ultimately limited by a lack of space in the leg orifice for tracheal tubing. Despite this, it is unknown if flighted insects are subject to the same limitations as the flightless beetles investigated. It is suggested that extant dragonflies could represent an ideal model for comparing the scaling of tracheal volume versus the space available in the thorax, abdomen, and legs. Such comparisons could confirm whether larger dragonflies also "super-size" their tracheal system, and if so, which body segment could ultimately limit body size. Data could be compared to the size of the largest extant species and the gigantic Carboniferous dragonflies.

Notes:

Interactions between photoperiod, reproduction and torpor in the striped-faced dunnart, *Sminthopsis macroura*

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For many mammals, photoperiod is the most reliable Zeitgeber for timing reproduction to optimise conditions for rearing young. Data for marsupials, however, are scant. The marsupial *Sminthopsis macroura* lives in an environment characterized by seasonal changes in insect abundance, overlaid with unpredictable periods of aridity. To determine whether *S. macroura* relies on photoperiod to time seasonal metabolic and reproductive events, we placed 10 females and 10 males under 12:12 L:D photoperiod at the autumnal solstice. After 2 weeks, half of the males and half of the females were exposed to 14:10 L:D, and the other half to 10:14 L:D, for 7 weeks, after which the photoperiods were reversed for an additional 7 weeks. Photoperiod significantly affected reproductive indices, tail fattening and body mass in females, but not in males. In contrast, torpor use and metabolic rates were relatively unaffected by changes in photoperiod in females, whereas long photoperiod significantly increased torpor use and short photoperiod significantly decreased metabolic rate during torpor in males. The results demonstrate that *S. macroura* exhibits a sexual dichotomy in photoperiodic control of reproduction and thermoregulation and that photoperiodic separation of reproduction and torpor, common in many placental mammals, does not occur.

Notes:

The effect of temperature on the energetics of development in the Australian Brush-turkey (*Alectura lathami*)

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In reptiles the energetics of embryonic development may be temperature dependent, but this aspect is poorly understood in birds as they brood their eggs within a narrow temperature range. However, Australian Brush-turkeys (*Alectura lathami*) like all megapodes use environmental heat to incubate their eggs and embryos continue development throughout exposure to a relative wide range of temperatures. A new technique was used to collect freshly laid eggs and the oxygen consumption of embryos was measured throughout a range of constant incubation temperatures. The total energetic cost of production was 1086 ± 38 kJ (SE) at 32°C (n=9), which was significantly higher ($p<0.001$) than at either 34°C (840 ± 40 kJ (SE), n=8) or 36°C (816 ± 41 kJ (SE), n=8). Concomitantly, our results demonstrated decreased net production efficiency at the lower incubation temperature (28.5 ± 0.9 $kJ.g^{-1}$, n=9), however, again, there was no difference in production costs at 34°C (20.1 ± 0.9 $kJ.g^{-1}$, n=8) and 36°C (22.7 ± 0.9 $kJ.g^{-1}$, n=8) temperatures. Higher production costs result in lower energy reserves at hatching which may have important survival consequences which need to be investigated in this species with no parental care and high chick mortality.

Notes:

Invasive lizards (*Lampropholis delicata* De Vis 1888) acclimate to changing thermal environments

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Lampropholis delicata is an Australian scincid lizard that is invasive in New Zealand, Hawaii and Lord Howe Island where it may potentially cause serious ecological harm. Since the thermal tolerance of skinks may determine their geographic distributions and a broad geographic distribution is expected of successful invasive species, a successfully invasive skink may be assumed to have a broad thermal tolerance. We determined the physiological responses to temperature of *L. delicata* to help interpret its ability to spread as an invasive species. *Lampropholis delicata* was acclimated to 15 or 25 °C for 40 days. Resting metabolic rate, mean selected temperature and locomotor performance were then determined at 15 or 25 °C. It acclimates its locomotor performance to 15 °C, but not to 25 °C, with cool-acclimated skinks outrunning (0.43 ± 0.04 m/s) warm-acclimated skinks (0.28 ± 0.04 m/s) at 15 °C. *Lampropholis delicata* is unable to adjust its resting metabolism in response to acclimation to different temperatures; in both acclimation groups the rate of oxygen consumption was 0.006 ± 0.001 ml O_2 g^{-1} h^{-1} and 0.017 ± 0.001 ml O_2 g^{-1} h^{-1} at cold and warm treatments respectively. Irrespective of thermal history, *L. delicata* selects a body temperature of 30 °C. *Lampropholis delicata* can tolerate a broad range of thermal conditions, even though its resting metabolism and mean selected temperature do not show an acclimation response. Acclimation of locomotor performance may improve fitness by increasing prey capture, predator avoidance, reduced activity period, or other competitive advantages.

Notes:

The effect of torpor and radiant heat on energy expenditure in fat-tailed dunnarts

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Recently we observed that free-ranging fat-tailed dunnarts (*Sminthopsis crassicaudata)* use torpor and basking as energy saving tools. Here we investigate the implications of different thermal treatments on energetics in captive dunnarts. We measured average daily metabolic rates (ADMR) over 24 hours as well as metabolic rates (MR) during torpor, arousal and rest at five ecologically relevant thermal regimes: constant ambient temperatures (T_a) of 15°C, 20°C, 27°C, a T_a cycle from 15 to 31°C, and a constant T_a of 15°C with access to a heat lamp. ADMR was negatively correlated with torpor bout duration at any regime but the slopes differed significantly between treatments (ANOVA, $p<0.005$). When a heat lamp was available, torpid dunnarts actively moved under the lamp before their MR began to rise and continued basking during the entire resting phase, reducing arousal MR by ~40% and resting MR by ~50%. Our results support the interpretation of recent findings in the field regarding the importance of torpor and basking for the energetics of small heterothermic dasyurids.

Notes:

What's your poison? The effects of arsenic on the structure of organs from the yabby (*Cherax destructor*)

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Arsenic is a proven carcinogen that is found in the soil at concentrations 1000 times greater than gold in mining regions. During gold mining arsenic is released into the environment, easily entering surrounding water bodies. The freshwater crustacean, *Cherax destructor*, is a ubiquitous species native to Australia's central and eastern regions. Increasing aquaculture and export of these animals has led us to question the effects of heavy metal contamination on the yabbies themselves and to assess any potential risks to consumers. This study determines if yabbies are able to uptake and store arsenic within their tissues and if so in what form. Yabbies exposed to elevated levels of arsenic accumulate and store it in their tissues at concentrations as high as 50-60 ppm (μg/g). This accumulation is related to arsenic exposure in the sediment and food rather than the water. The arsenic species present in select organs of the yabby has also been examined. It appears that the type of exposure plays a role in determining which arsenic species are present in each organ. Exposure to arsenic in the form of arsenate or arsenite in their water drastically alters the structure of organs such as the hepatopancreas and gills of these animals.

Notes:

Osmoregulatory balance in Murray cod, Maccullochella peelii peelii (Mitchell), affected with chronic erosive dermatopathy

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This study examined the osmoregulatory capability of Murray cod affected by chronic erosive dermatopathy (CED) in intensive aquaculture. This condition appears to arise only in facilities utilizing groundwater, with the causative agent suggested to be a water-borne factor. Healthy Murray cod (~ 700 g) were transferred to a CED affected farm to monitor the progression of the disease, and began to show signs of CED after five months. In order to evaluate possible effects CED has on osmoregulation, plasma electrolyte concentrations, osmolality, and Na^+,K^+-ATPase activities were measured, and gill histology and immunohistochemistry were analyzed. Murray cod cultured at the CED affected farm had a greater number of gill mucous cells and higher gill Na^+,K^+-ATPase activity compared to non CED-affected fish. We also found an unidentified cell type that was present solely in the gills of CED affected Murray cod. Plasma electrolyte concentrations and osmolality of CED affected Murray cod were consistent with values determined for non-CED affected fish. This study demonstrated that Murray cod were able to effectively osmoregulate despite being affected by CED.

Notes:

Metabolic physiology of the Black-flanked Rock-wallaby

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Currently there are basal metabolic rate (BMR) data for only nine of the 48 extant Australian macropod species, and for only five of these nine species has evaporative water loss (EWL) been measured. In particular, there are no measurements for any rock-wallabies. Here we present the first metabolic measurements for the Black-flanked Rock-wallaby (*Petrogale lateralis lateralis*) from the south-west of WA, and compare it with measurements for a similar-sized macropod from the mesic south-west, the Tammar wallaby (*Macropus eugenii*), with other macropods, and with marsupials in general. For the Tammar wallaby, MR was basal at ambient temperatures (T_a) from 11-35°C and increased at T_a = 40°C, showing a wide thermoneutral range. EWL increased at T_a above 30°C. These data conform well to previously measured values for this species. Metabolic rate of the Black-flanked Rock-wallaby was basal at T_a from 16-31°C, increasing at T_a = 10°C; EWL did not increase at T_a between 13 and 33°C. These physiological parameters, as well as body temperature and thermal conductance, of both Tammar wallabies and Black-flanked Rock-wallabies generally conform to allometric relationships for other macropod marsupials, and for marsupials in general.

Notes:

Cellulose digestion in terrestrial and marine decapods from Taiwan

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Many land crabs as well as many marine crustaceans show high activities of cellulases. In land crabs cellulases contribute significantly to the digestion of dietary carbohydrates since terrestrial plants are rich in cellulose. Marine algae, in contrast, do not contain considerable amounts of cellulose but laminarin, a hemicellulose. Accordingly, in marine crustaceans the function of cellulases as digestive enzymes is not clear. We compared the catalytic properties of cellulases from two terrestrial crabs, *Geothelphusa albogilva* and *Sesarmops intermedium* with those of two marine crustaceans, *Percnon affinis* and *Grapsus albolineatus*. Activities of three enzymes (total cellulase, endo-ß-1.4-glucanase, ß-1.4-glucosidase) and the hemicellulase laminarinase were measured in extracts of midgut glands and in the gastric fluids. Distinct differences appeared between terrestrial and marine species. The terrestrial species *G. albogilva* and *S. intermedium* showed higher activities of total cellulase and ß-1.4-glucosidase than the marine species *P. affinis* and *G. albolineatus*. However, endo-ß-1.4-glucanase was higher in *P. affinis* than in *G. albogilva*. On the other hand laminarinase activity was more pronounced in the marine species *G. albolineatus* than in terrestrial species *G. albogilva* although laminarinase activities were similar in *S. intermedium* and *P. affinis*. Current studies are focussed on the expression of isoforms and the molecular characteristics of cellulose degrading enzymes.

Notes:

Abolition of thermogenesis to moderate heat stress in newborn mice is a protective response to prevent hyperthermia

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Heat stress is a likely risk factor for Sudden Infant Death Syndrome (SIDS) as the age period where SIDS has been reported to occur is also a period of developmental thermoregulatory change. We investigated thermogenenic ability and mild heat stress in 2 and 7 day old mice of C57BL10, NODLt and PepN strains. Pups were fitted with a small face mask through which air flowed, placed in a water jacketed chamber and exposed to a dynamic decrease and subsequent increase in ambient temperature (Ta), at a rate of 0.5ºC/min, from initial Ta's (T_{st}) of either 30ºC, 32ºC, 34ºC/36^{o}C until 18ºC. Metabolic rate (rate of oxygen consumption and CO_2 production) was measured appropriately for open flow respirometry and ventilation was measured from a pneumotachograph. All mice exhibited limited thermogenic ability at 30ºC and 32ºC (normal nest temperature), which improved at 7 days old. At both ages, at 34ºC for PepN mice and 36ºC for C57BL10 and NODLt thermoregulatory ability was abolished and the pups behaved effectively as ectotherms. All groups maintained convective requirement (ventilation/metabolic rate) at all temperatures, suggesting that respiratory control was appropriately preserved. It is proposed that the abolition of thermogenesis is a protective response against imminent hyperthermia.

Notes:

Effect of glycogen levels on post-exercise muscle glycogen repletion in the absence of food in humans

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Fish, amphibians, reptiles and some species of mammals can replenish completely their muscle glycogen stores post-exercise even in the absence of food. In contrast, the extent of muscle glycogen repletion under these conditions in humans has been reported to be partial. This raises the question of whether there are conditions where humans can also replenish completely their muscle glycogen stores without food. We hypothesised that the extent of glycogen repletion is determined, in part, by pre-exercise muscle glycogen levels. To test this hypothesis, participants were subjected to a glycogen depleting bout of exercise prior to being fed on either a high carbohydrate (HCHO) or low carbohydrate (LCHO) diet for 24 hours. Then, they performed a bout of intense exercise on the following day, with muscle biopsies being performed before exercise and at time intervals during recovery. The bout of high intensity exercise resulted in comparable glycogen breakdown in both treatment groups. However, during recovery, muscle glycogen returned to pre-exercise levels in the LCHO treatment group, but only 52% of the glycogen broken down during exercise was replenished in the HCHO group. These findings show that there are conditions where humans can also replenish completely their muscle glycogen without food post-exercise. (200 words)

Notes:

Evolution of aging in a natural population of snakes: A comparative physiology study in the western terrestrial garter snake

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Evolutionary theory of aging is linked to life history theory in that schedules of reproduction and survival results from a tradeoff between investment in somatic maintenance and investment in reproduction. By examining physiological and extrinsic differences within the Western Terrestrial Garter Snake, *Thamnophis elegans,* a species of Colubrid snake with divergent life history strategies and longevities we sought to answer whether physiological parameters mirrored the evolution of life span in this species. We measured whole animal metabolic rate (oxygen consumption VO_2), locomotor performance (as a measure of fitness and survival), cellular metabolic rate (mitochondrial oxygen consumption), oxidative stress potential (hydrogen peroxide production by mitochondria), and DNA damage and repair efficiencies. We hypothesized that longer lived species will exhibit: reduced metabolic rates, increased physical performance, efficient mitochondria that produce reduced amounts of oxidants, and DNA that repair more efficiently in comparison to short lived species. We found that the longer lived ecotype (meadow) snakes consume equal amounts of oxygen, have greater locomotor performance, have DNA that repair more efficiently, and have more efficient mitochondria that produce less hydrogen peroxide than lakeshore (short-lived) snakes. We present the first measures testing the physiology of aging using a reptilian species with divergent life history ecotypes for lifespan.

Notes:

Impact of long term captivity on physiology of the feral cat (*Felis catus*)

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The feral cat (*Felis catus*) introduced into Australia in the 18th century, is considered a major threat to Australia's fragile wildlife. There is evidence that the cat has caused the decline and extinction of native animals on islands and on the Australian mainland. Cats are common in a variety of habitats, even in harshest environments without access to free water, and appear to be highly adaptive to a wide range of environments. The reasons of this outstanding adaptability are not fully understood, however we hypothesize that physiological characteristics such as energy turnover rates, thermal tolerances and water budgets play an important role. Despite a multitude of studies on physiological parameters of mammals, the majority of these studies used animals reared and held in captivity, and it was previously unknown to what extent these artificial conditions affect the physiology of these species. To investigate the impact of long term captivity on the physiology of feral cats, we measured the BMR of feral cat populations kept in captivity for different periods of time (recently captured, three months and 15 months in captivity). As expected, the highest BMR was exhibited by cats caught and measured the same day (8.65 ± 1.83 J g^{-1} h^{-1}), followed by cats kept in captivity for a period of three months (5.84 ± 0.48 J g^{-1} h^{-1}). The lowest BMR was exhibited by cats kept in captivity for 15 months (2.98 ± 0.54 J g^{-1} h^{-1}). We also measured abdominal body temperature (T_b), by using implanted data loggers, of 3 free ranging feral cats from the northern goldfields over a period of 3 months (March-May 2005) and T_b of 4 captive feral cats over a period of 8 months. Free ranging feral cats had a mean T_b of 38.5 ± 0.26°C (range 36.1- 40.1°C) and showed a pronounced daily cycle, with higher temperatures during their active phase at night. Mean T_b of captive cats was 37.94 ± 0.58 °C (range: 34.4-40.1 °C) with no pronounced daily cycle. For the first time, we were able to quantify the effects of long term captivity on BMR and T_b of feral cats, with results indicating that an artificial environment together with a change of diet and lack of exercise impacts on the energy requirement and thermoregulation of this species. For feral cats, we are confident that previously derived data on captive-bred individuals can not directly be transferred to analyze free-ranging populations; however we demonstrate that the impact of variable conditions on the physiology of cats can be quantified and applied to conservation studies and protocols as well as life history traits of free-ranging populations.

Is the photolyase enzyme up-regulated in response to UV-B exposure in larval anurans?

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Large losses in biodiversity are being documented around the world and this is exemplified by the global loss and decline of numerous amphibian species. Environmental changes occurring at a global scale are currently being investigated as potential causal agents in such declines, including increases in UV-B due to stratospheric ozone depletion. Information has accumulated on the effect of UV-B on amphibian survival, hatching success, growth and development under field and laboratory conditions with evidence both for and against negative effects. It has been proposed that such differences among amphibian species with respect to their sensitivity to UV-B radiation are related to their ability to repair UV-induced DNA damage. An important process by which DNA is repaired is through enzymatic photoreactivation, which is catalysed by enzymes known as photolyases. Investigations into photolyase activities have revealed a positive correlation between activity and UV-B resistance. One of the aims of my PhD is to determine whether amphibians are phenotypically plastic in their response to chronic exposure to UV-B and thus able to reduce the damaging effects of UV-B by up-regulating protective mechanisms, such as photolyase activity. Here we report our initial attempts to isolate and sequence the photolyase gene in *Xenopus borealis* and an Australian species, *Limnodynastes peronii*.

Notes:

Physiological response of the brushtail possum to the scent of dingo urine

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Many mammal species are able to detect a potential predator by its scent. We investigated whether brushtail possums (*Trichosurus vulpecula*) could recognise the odour of a possible predator, the dingo (*Canis lupus dingo*), and we examined their physiological response to that odour. We quantified the changes in metabolic (oxygen consumption and carbon dioxide production) and ventilatory (respiratory frequency and tidal volume) variables for six male possums after exposure to the scent of dingo urine, horse urine, greyhound urine, distilled water, eucalyptus oil and fish oil. The possums showed no metabolic response to any of the scents, but did show a significant increase in mean respiratory frequency (ratio after/before exposure = 4.55 ± 1.007) and a significant decrease in mean tidal volume (ratio after/before exposure = 0.38 ± 0.113) in response to dingo urine. The significant response in ventilatory variables was short-lived, with respiratory frequency in the first minute of exposure significantly higher than in the second, presumably as a consequence of the animals being in a secure environment. This highlights the importance of using real-time measures of response, such as respiratory variables, rather than longer time-averaged measures such as metabolic rate, to study some physiological responses.

Notes:

Hemoglobin: model molecular physiological adaptations to hypoxia

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O_2-binding globins appear to occur in all living organisms and to be expressed in every cell[(1)]. Exhibiting a 1000-fold variation in molecular masses they fulfil widely different functions, "even" transporting and storing O_2, but exhibit a common subunit tertiary structure that witnesses common ancestry. Briefly outlining the evolution of hemoglobin (Hb) function, the talk focuses on the molecular mechanisms for Hb adaptation to decreased O_2 availability as encountered in amphibians, birds and mammals at high altitude[(2)]. It deals with (a) intraspecific adaptations, that occur in individual animals and commonly are due to changes in the levels of allosteric effectors (like organic phosphates and chloride ions that modulate Hb-O_2 affinity in the red cells), as well as (b) interspecific adaptations, that are genetically-coded, developed in an evolutionary time-scale, and commonly result from differences in Hb molecular structure. It furthermore details how the endothermic dissociation of allosteric effectors upon Hb-oxygenation may modulate the temperature sensitivity of Hb-O_2 affinity - and thereby tissue O_2 supply - in ectothermic and heterothermic vertebrates.

References cited: (1) Riggs, A.F. and T. A. Gorr (2006) *PNAS* 103, 2469-2470; (2) Weber, R.E. (2007) *Respir. Physiol. Neurobiol.* 158, 132-142.

Notes:

Claudin-5 is restricted to the tight junction region of uterine epithelial cells in the uterus of pregnant/gravid squamate reptiles

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Claudin- 5, a tight junctional protein associated with ion and size selectivity has been found in the uterus of skinks and has generated critical information about the molecular assembly of the tight junction at various stages of the reproductive cycle in the reptile uterus. Recent studies found occludin expression in the tight junction region of uterine epithelial cells in the skink uterus however, the increase in occludin did not disclose any further information about the ions and size of ions permeating across the paracellular pathway since occludin expression in the tight junction essentially provides a non specific barrier to ions and solutes. A ~22kDa claudin-5 band was detected in the uterus of all the skinks present in this study and immunohistochemistry revealed that claudin-5 migrates to the tight junction region of the lateral plasma membrane of uterine epithelial cells in late stage pregnancy/gravidity. This indicates that the tight junction becomes more assembled to precisely regulate ion and solute permeation in late stage pregnancy/gravidity. Claudn-5 and its functional role as a molecular sieve due to the formation of ion and size selective pores, describes the potential size of ions that are allowed to permeate or are prevented from permeating across the paracellular pathway in uterine epithelial cells. This is the first description of the molecular mechanisms which may be involved in nutrient provision in the reptilian uterus in association with the evolution of viviparity.

Notes:

Diving Behaviour, Aquatic Respiration, and Blood Oxygen Affinity: A Five Species Comparison of Australian Freshwater Turtles

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Percent aquatic respiration in bimodally respiring freshwater turtles is positively correlated with dive duration however this relationship has only been investigated in adults. Hatchling and juvenile turtles are thought to be more reliant on aquatic respiration than adults due to their size and ecology. This study compared the diving behaviour, aquatic respiration and blood oxygen affinity of hatchling and juveniles from five species of Australian freshwater turtles: *Rheodytes leukops*, *Elusor macrurus, Elseya albagula, Elseya latisternum and Emydura signata.* Both diving behaviour and physiology differed significantly between species as well as age classes. Dive duration in *R. leukops* was 17 times longer than the other species, with two hatchlings remaining submerged for the entire 72h recording period. The long dive duration seen in this species was supported by a high reliance on aquatic respiration (63-73%), and high blood oxygen affinity (P50 = 17.24). A correlation between dive duration, aquatic respiration and blood oxygen affinity was not observed in the remaining turtle species where, despite the longer dive duration of *E. albagula* and *E. macrurus* compared to *E. signata* and *E. latisternum*, there was no difference observed in percent aquatic respiration or blood oxygen affinity between these species. When compared to adult individuals, dive duration was positively correlated with body size in *E. signata*, *E albagula*, and *R. leukops*, but a negative relationship occurred in *E. latisternum* and *E. macrurus*.

Notes:

Roost type influences thermoregulatory behaviour of Australian owlet-nightjars (*Aegotheles cristatus*) in the arid zone

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The use of cavities as roosts provides birds with protection and thermal advantages by offering insulation from adverse temperature extremes. We used radiotelemetry to locate diurnal winter roost sites of Australian owlet-nightjars (*Aegotheles cristatus)*, one of the few species of Australian birds that are obligate cavity users year round, and to quantify body temperature fluctuations in relation to roost and ambient thermal conditions. Individual owlet-nightjars used 1-7 different roosts, selecting either rock crevices (4 birds) or tree hollows (4 birds) as roosts, or switching between the two roost types (7 birds). Rock crevices were thermally more stable than tree hollows. The range of temperatures inside rock crevices (+9 to +33ºC) was almost half that in tree hollows (-4.0 to +37ºC). Owlet-nightjars reduced body temperature from ~38ºC during activity to as low as 20ºC during torpor, which typically began near dawn and lasted 3-4 hours. However, torpor occurrence was influenced by roost selection, with birds roosting in tree hollows using torpor almost twice as often as those in rock crevices. Selection of appropriate roost sites may be vital in determining the energy expenditure of these small cavity roosting birds and for offering protection from predators while in torpor.

Notes:

Digestive physiology in dogfish sharks, *Squalus acanthias*

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Feeding in the dogfish shark (*Squalus acanthias*) has been shown to cause marked metabolic alkalosis ('alkaline tide') in the bloodstream, which is compensated by increased net base excretion across the gills. This study investigated whether elevated gastric acid secretion during digestion in the dogfish causes the events of the alkaline tide. Dogfish starved for 7 days were surgically implanted with a stomach feeding tube and a caudal catheter, and were confined in chambers to allow flux measurements. Dogfish were administered DMSO-saline (vehicle) or omeprazole (experimental; 5.0 mg kg^{-1}), a known inhibitor of gastric acid secretion in the stomach of mammals, five times over 48 h and were fed a meal consisting of flatfish muscle suspended in saline (4% of body weight). Omeprazole delayed the acidification of the stomach chyme, though the same low pH (3.0) was eventually reached at 48 h. Omeprazole also prevented the significant increases of arterial pH and HCO_3^- concentration which occurred at 4, 6 and 9 h post-feeding in control animals. In parallel, omeprazole also prevented the significant increase in base (HCO_3^- equivalents) excretion rates across the gills over the 48 h period. These results provide evidence that the post-feeding rise in blood pH and HCO_3^- concentration and branchial base excretion rates are all caused by elevated astric acid secretion in the stomach. (Research supported by an NSERC Discovery grant to CMW and Company of Biologists travelling fellowship to AS).

Notes:

Why the need for cutaneuous respiration in the newborn marsupial?

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The fat-tailed dunnart *(Sminthopsis Crassicaudata)* is born extremely small (mass = 13 mg, gestation 13.5 days). At birth, the lungs contain only a few air sacs, there is no discernable ventilation, and the newborn is totally reliant upon the skin for gas exchange. Electron microscopy demonstrated that despite not using the lungs for gas exchange at birth, both Type I and Type II (surfactant producing) Alveolar Epithelial Cells are present at this time. The diaphragm is also present and immunohistochemistry detected the phrenic nerve within the diaphragm at birth. Elastin deposition studies indicated that the presence of secondary septal crests, and hence the commencement of alveolarisation, does not occur until after 45 post natal days. Structural development of the lungs was investigated over this period using phase contrast imaging with a synchrotron radiation source revealing the marked proliferation of the lung from a few large air sacs in to a complex alveolar structure. Finally, in conjunction with the changeover from cutaneous to pulmonary gas exchange, the development of breathing pattern and ventilatory-metabolic responses (using dual chamber respirometry) when either the skin and/or the lungs were challenged to hypoxia were investigated and results indicate that some level of control is present.

Notes:

The Thermal Properties of Bird's Nests

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Bird nests have evolved into many shapes and sizes, but all are designed for the same general function: to help moderate the microenvironment surrounding eggs and hatchlings. In addition to attenuating changes in egg temperature, well insulated nests have the ability to conserve the energy reserves of the parent at low ambient temperatures. Such energy savings have the ability to influence the lifetime reproductive success of an individual. Insulation is correlated with nest size and nest density in several North American passerines, elevation for the common amakihi and ambient temperature in hummingbirds. Nest insulation is measured in terms of the conductance of heat through the nesting material. While studies tend to focus on the surface-specific conductance values for a nest, this is an inadequate descriptor of the amount of energy that the incubating bird requires to maintain a stable nest temperature. More important to the energetics of the bird is the total conductance of the nest. The total nest conductance for a variety of South Australian bird species will be measured to ascertain whether the thermal properties of nests vary for a number of ecological correlates.

Notes:

Composition of the milk of the quokka (*Setonix brachyurus*)

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Little is known about lactation in the quokka, Setonix brachyurus, a marsupial belonging to the Macropodidae family. The gestation period in quokkas is approximately 25 days. The pouch young weighs about 0.3 g at birth, which is about 0.01% of adult body weight, and leaves the pouch permanently at around 200 days post partum. Lactation lasts for approximately 300 days. The purpose of the current study was to investigate the composition of the milk of the quokka. The pouch young were separated from their mothers and milk was collected after an injection of oxytocin. The milk samples were frozen and analysed using spectrophotometric biochemical assays. The concentration of protein in the milk averaged 60 g L-1 from 70 to 180 days. The protein levels then began to increase, peaking at 120 g L-1 towards the end of lactation. The lipid and total solids content averaged 50 and 180 g L-1 from 70 to 180 days, increasing to 150 and 250 g L-1 after permanent pouch exit. In contrast, the total carbohydrate concentration of the milk decreased from 80 to 20 g L-1 at 150 days. Unlike eutherians, yet similar to other marsupials, the concentrations of the components in the milk of the quokka change dramatically during lactation.

Notes:

Fiber specific responses of muscle glycogen repletion in fasted rats physically active during recovery from high intensity physical exertion

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When mild physical activity is performed immediately after a sprint in fasting humans, glycogen stores are mobilized in slow twitch (ST) muscle fibers while being replenished in fast twitch (FT) fibers, whereas in the rainbow trout glycogen repletion rate in FT fibers is faster than at rest under these conditions. It is unclear whether animals with a low proportion of ST fibers can also replenish the glycogen stores of their FT fibers if active during recovery. Most skeletal muscles in rats being poor in ST fibers, six groups of 24-h fasted rats (n=10) were forced to sprint for 3min followed by either a 60-min rest (passive recovery, PR) or a 30-min swim with a 0.5% weight (active recovery, AR). Sprinting caused net glycogen breakdown across all muscles examined, but not in the soleus muscle. Glycogen repletion without food was not affected by AR in the white gastrocnemius and was lower than during PR in both the red and mixed gastrocnemius muscles, whereas net glycogenolysis occurred during AR in the soleus. Our findings suggest that mammals with a low proportion of ST fibers can also replenish the glycogen of their FT fibers under extreme conditions combining physical activity and food absence.

Notes:

Sex ratios, climate change and the future of a living fossil

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The tuatara is a relic of an ancient lineage of reptiles (Sphenodontia) that coexisted with dinosaurs in the Triassic. The persistence of tuatara at contemporary rates of global warming is uncertain because they have a unique form of temperature-dependent sex determination (TSD) that produces male hatchlings at the warmest incubation temperatures. Here we demonstrate a powerful mechanistic approach to predict the impacts of climate change on development times and sex ratios of tuatara. We focus on the rarest species, *Sphenodon guntheri,* occupying a 4 ha island in New Zealand, and make spatially explicit estimates of sex ratios under various scenarios of air temperature, laying month and nest depth. Under maximum global warming predicted for the 2080's, the proportion of all-female clutches predicted at current nesting locations decreased from 66% to 4%. However, this reduction in female producing sites could be ameliorated by behavioural alterations including deeper and later nesting. Global warming will also result in dramatically earlier hatching times, particularly for males, which may prove as challenging as sex-ratio alterations for the viability of the population. Our spatially explicit approach will allow rapid assessment of future translocation sites for tuatara, and other species with TSD under climate change.

Notes:

Natriuretic peptide stimulates urine formation in the osmoconforming hagfish

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Since the first report of their natriuretic effect on mammalian kidneys the relative influences of natriuretic peptides on volume and salt regulation in vertebrates have been debated. Hagfish have two large glomeruli per body segment joined by short ducts to paired archinephric ducts. The very low arterial blood pressure of hagfish and peculiarities of the vascular supply of the glomeruli have lead to speculations about the mechanisms that result in primary urine formation. A synthetic natriuretic peptide derived from *Eptatretus burgeri* (eNP) increased urine production rates in *E. cirrhatus* at 3 x 10^{-8}M. It also contracted segmental arteries at low concentrations (1 x 10^{-10}M and relaxed them at 3 x 10^{-8}M. An upstream vasodilation may explain the action of eNP on glomerular filtration, and it is possible that downstream effects at lower concentration also influence the process. Rat NP was as effective as eNP in vasodilating isolated afferent arteries.

Notes:

Purification and characterisation of endo-β-1,4-glucanase and laminarinase enzymes from the herbivorous gecarcinid land crab, *Gecarcoidea natalis*

Benjamin Allardyce and Stuart M. Linton

Deakin University

Gecarcoidea natalis is able to assimilate large amounts of hemicellulose and cellulose from leaf litter. This ability can be attributed to the activities of cellulase and hemicellulase enzymes. Two such enzymes, the cellulase, endo-β-1,4-glucanase and the hemicellulase, laminarinase were purified and characterised from the midgut gland of *G. natalis*. Endo-β-1,4-glucanase hydrolyses the internal β-1,4-glycosidic bonds within cellulose. Endo-β-,1,4-glucanase (EC 3.2.1.6) (MW=52±1 kDa (n=3)) was purified by a combination of anion exchange chromatography and gel filtration chromatography. It was capable of hydrolysing both β-1,4 and β-1,3-glycosidic bonds and produced cellobiose and other short glucose polymers. Laminarinase (EC 3.2.1.39) hydrolyses the internal β-1,3-glycosidic bonds within laminarin. It was purified by sequential anion exchange chromatography, hydrophobic interaction chromatography and gel filtration chromatography. It may either exist as a dimer or possess a binding domain given its molecular mass estimated from gel filtration chromatography was 71 kDa while that estimated from SDS-PAGE was 41±3 (n=3) kDa. From the hydrolysis of laminarin, laminarinase produced glucose, cellobiose and other short oligomers of glucose. The kinetic parameters (K_m and V_{max}) and pH optima were also determined for both enzymes.

Notes:

Strategic (adaptive) hypothermia by rutting male dromedary camels may increase their reproductive fitness

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Data collected telemetrically from free ranging camels in 2000, reported first at the Mt Buller ICCPB meeting in 2003, is still unpublished but has matured with ageing. Males in rut showed lower than normal daily minimum body temperatures and generally higher than normal daily maxima, by 0.6°C (95% CI: 0.27-0.94 °C) and 0.45 °C (95% CI: -0.01-0.91 °C) respectively, increasing the daily cycle of Tb. This is reminiscent of what Knut Schmidt-Nielsen found in 1957 in captive, water-deprived dromedaries in hot conditions, and interpreted as a strategy for water conservation. Our context is quite different; the observations were made in winter and water was freely available. We propose that, in the strenuous daily contests between rival bulls in rut, a lower body temperature early in the day extends the time for which a contestant can challenge or defend before heat stress becomes a constraint. Calculations show that lowering Tb by even by 0.6 °C extends that time by more than 30 minutes and many drops were larger. Because the eventual winner of contests gains or retains a herd of females, this may translate directly into increased reproductive fitness. The application of the term 'adaptive heterothermia' only where a water saving is conferred may be unnecessarily restrictive.

Notes:

Australopithecus the water carrier?

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Co-evolving bipedal *Australopithecus* and quadrupedal papionin baboons confronted more-open, drier, habitats as they left canopy forests to colonize open African plains. Their activity was likely to have been diurnal, because of felid predation at night. They would have had to spend most or all of the day moving between discrete food sources, as extant baboons do. One hypothesis for a competitive advantage of bipedal locomotion is that the upright stance reduced the thermal stress of solar radiation. That hypothesis assumes that baboons are compromised by their quadrupedal posture. In a simulation of the most-extreme environment inhabited by extant baboons, which included simulated radiation (globe temperature 42°C), abdominal temperatures of unrestrained baboons (*Papio hamadryas*) were no different to those evident in a 22°C environment, provided the baboons had access to drinking water. If the baboons were deprived of drinking water, daily maximum abdominal temperature rose progressively, at a rate such that heat stroke temperatures would be reached in 7 days. We conclude that the foraging range of evolving baboons would have been constrained by their need to reach drinking water. *Australopithecus* may not have been so constrained, if bipedal locomotion allowed them to carry water, or even water-rich plants, while foraging.

Notes:

Posters

Homogenisation-free extraction of glycogen and its responses to exercise and re-feeding: artefact or not?

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Salinity tolerance of Xenostrobus securis, a native Australian mussel

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Sex steroid ratio and morphological sexual dimorphism as indicators of the onset of sexual maturity in a long-lived viviparous skink, *Tiliqua nigrolutea*

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Yearlong mammalian hibernation

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Walk like an Egyptian – The arrangement and structure of the muscle fibres in the legs of female spiny leaf insects

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Digestive abilities of aquatic and semi-terrestrial crayfishes, *Cherax destructor* and *Engaeus sericatus* (Astacidae, Parastacidae)

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