AUSTRALIAN AND NEW ZEALAND SOCIETY FOR COMPARATIVE PHYSIOLOGY AND BIOCHEMISTRY

ANZSCPB 2018

35TH ANNUAL MEETING

6-9 December 2018

MONASH University

Australian and New Zealand Society for Comparative Physiology and Biochemistry

Monash University
6-9 December 2018

ANZSCPB 2018

Organising committee:
Craig White, Lesley Alton, Candice Bywater

2018 Logo design:
Elia Pirtle

Sponsors:
School of Biological Sciences, Monash University
Journal of Experimental Biology
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StatistiXL
Journal of Comparative Physiology B

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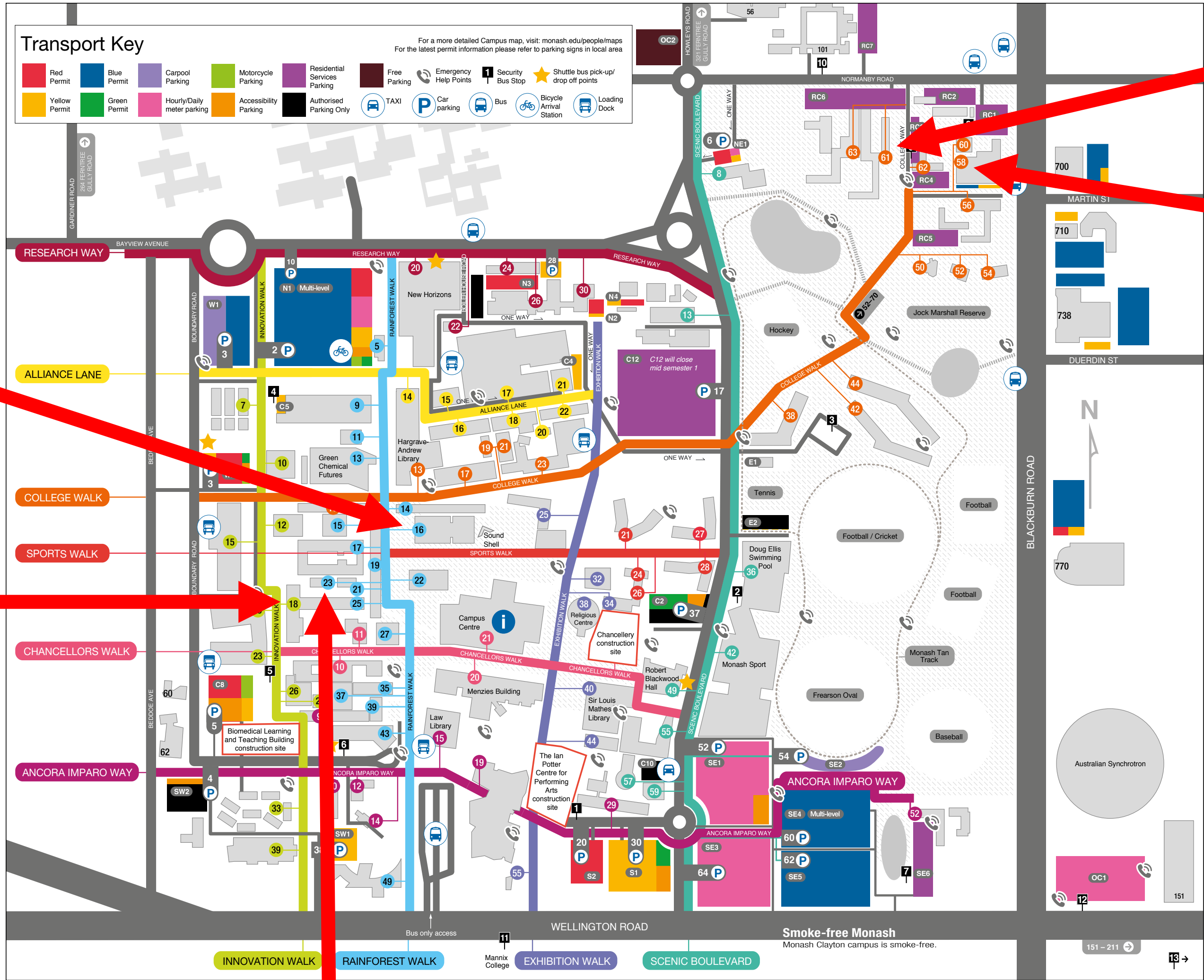
Maps

Monash University Clayton campus



Robert's Hall
61 College Way

MRS Admin Office
58 College Way

S1 Lecture Theatre
Building 25
16 Rainforest Walk

Gallery Foyer
Building 17
18 Innovation Walk

Sanson Room (G01/G02)
Building 22
23 Rainforest Walk

Summary of Schedule

Time	Thursday 6 December	Friday 7 December	Saturday 8 December	Sunday 9 December
9:00		9:15 Announcements 9:30-10:30 Plenary Lecture	9:15 Announcements 9:30-10:30 Plenary Lecture	9:15 Announcements 9:30-10:30 Presentations
10:00		10:30-11 Morning Tea	10:30-11 Morning Tea	10:30-11 Morning Tea
11:00		Presentations	Presentations	Presentations
12:00		12:45- 13:45 Lunch	12:45-13:45 Lunch	12:45-13:45 Lunch
13:00		Presentations	Presentations	Career Q&A
14:00				
15:00		15:15-15:45 Afternoon Tea	15:15-15:45 Afternoon Tea	
16:00	Registration + Welcome Drinks and Dinner	Presentations	15:45-16:30 Presentations 16:45-17:45 AGM	
17:00		Free Evening		
18:00 +			18:30 Conference Dinner	

Conference Program

THURSDAY 6 DECEMBER

Gallery Foyer – Building 17	
4:00	Registration opens
5:00 - 7:00	Welcome drinks and food

Conference Program

FRIDAY 7 DECEMBER

*indicates students eligible for prizes

S1 Theatre	
Chair: Craig White	
9:15	**Announcements**
9:30	**Plenary Lecture** Mitochondrial contribution to animal performance and life-history variation **Karine Salin**
10:30 - 11:00	**Morning Tea – S1 Foyer**
	Chair: Mylene Mariette
11:00	Effects of acute acclimation to high temperature for captive and wild zebra finches (*Taeniopygia guttata*) **Christine E. Cooper**, Laura L. Hurle and Simon C. Griffith
11:15	The role of thermal plasticity in mitigating the negative effects of cold-water pollution on fish swimming performance and fitness **Craig E. Franklin**, Rebecca L. Cramp, Yulian Yan, Monique Parisi, Matthew A. Gordos and Jabin R. Watson
11:30	Larval growth rate is negatively correlated with post-metamorphic thermal performance **Carmen Rose Burke da Silva***, Robbie Stuart Wilson and Cynthia Riginos
11:45	Metabolic rate and density affect population productivity in a sessile marine invertebrate **Lukas Schuster***, Craig R. White, Hayley Cameron and Dustin J. Marshall
12:00	Short-duration respirometry underestimates metabolic rate for discontinuous breathers **Hugh S. Winwood-Smith*** and Craig R. White
12:15	Interspecific scaling of blood flow rates and arterial sizes in mammals **Roger S. Seymour,** Edward P. Snelling and Craig R. White
12:30	Genetic and environmental variation in metabolic scaling relationships: an ontogenetic perspective

FRIDAY 7 DECEMBER

	Julian Beaman*, Daniel Ortiz-Barrientos, Matthew D. Hall and Craig R. White
12:45 - 1:45	**Lunch – S1 Foyer**
Chair: Camilla Whittington	
1:45	Can juvenile red kangaroos structurally surmount the metabolic burdens of size and growth in dry times? **Terence Dawson**, Melinda Norton and Steven McLeod
2:00	Parent-embryo acoustic communication: a specialised heat vocalisation allowing embryonic eavesdropping **Mylene M. Mariette**, Anaïs Pessato, William A. Buttemer, Andrew E. McKechnie, Eve Udino, Rodney N. Collins, Alizée Meillère, Andrew T.D. Bennett and Katherine L. Buchanan
2:15	The effects of early environment on thermoregulation in an arid-adapted bird **Anaïs Pessato***, Andrew E. McKechnie, Katherine L. Buchanan and Mylene M. Mariette
2:30	Developing a standardised protocol for measuring seed metabolic rates: effect of temperature and availability of oxygen **Harrison Palmer***, Emma Dalziell, Christine Cooper, Sean Tomlinson and David Merritt
2:45	The effect of oxygen delivery on the thermal performance of a cockroach, *Nauphoeta cinerea* **Emily J. Lombardi*** and Craig R. White
3:00	Differential response to fisheries capture stress of the metabolic rate of three Australian chondrichthyans **Licia Finotto***, Juan M. Molina, Terence I. Walker and Richard Reina
3:15 - 3:45	**Afternoon Tea – S1 Foyer**
Chair: Rebecca Cramp	
3:45	Analysing plant phenotypic plasticity in response to heat and cold using random regressions **Pieter A. Arnold**, Alexandra A. Catling, Loeske E. B. Kruuk and Adrienne B. Nicotra
4:00	The effects of social dominance on dietary preferences in the speckled cockroach

FRIDAY 7 DECEMBER

	Candice L. Bywater and Craig R. White
4:15	The transgenerational effects of obesogenic diets **Tara-Lyn Carter***, Matthew Piper, Rebecca Robker and Damian K. Dowling
4:30	Evolution of metabolic rate in *Drosophila melanogaster* **Lesley A. Alton**, Teresa Kutz, Candice L. Bywater, Pieter A. Arnold, Julian E. Beaman, Sean Layh, Hugh Winwood-Smith, Christen K. Mirth, Carla M. Sgrò and Craig R. White
4:45	microclimOz and microclimUS – a microclimate data sets for Australia and the USA, with example applications **Michael R. Kearney**
5:00	Distributional and seasonal overlap of vegetable leafminer, a biosecurity threat, and a naturally occurring bio-control agent in Australia James Maino, **Elia Pirtle**, Peter Ridland and Paul Umina
5:15	**Free Evening**

Conference Program

SATURDAY 8 DECEMBER

*indicates students eligible for prizes

S1 Theatre	
Chair: Lesley Alton	
9:15	**Announcements**
9:30	**Plenary Lecture** Endothermy, marsupials and hibernation: a tale from three continents **Roberto F. Nespolo**
10:30 - 11:00	**Morning Tea – S1 Foyer**
Chair: Koa Webster	
11:00	One line to rule them all **Steven L. Chown**
11:15	Shedding light on the drivers of reptile distribution: Micro-environmental variables predict climatic-related traits of lizards **Rodolfo O. Anderson***, Craig R. White and David G. Chapple
11:30	Understanding and predicting impacts of extreme heat events on grey-headed flying-foxes (*Pteropus poliocephalus*) **Himali U. Ratnayake***, Natalie J. Briscoe, Justin A. Welbergen, Anastasia H. Dalziell, John Martin and Michael R. Kearney
11:45	Metabolic organization, density compensation, population energy use and ecological function: Insights from terrestrial apex predators **Tim S. Jessop**, Achmad Ariefiandy, Deni Purwandana, M. Jeri Imansyah, David M. Forsyth, Craig R. White, Yunias Jackson Benu, Thomas Madsen, Henry J. Harlow, and Mike Letnic
12:00	Regulation of insensible evaporative water loss by dasyurid marsupials **Philip C. Withers** and Christine E. Cooper
12:15	Pregnancy and parturition in the seahorse *Hippocampus abdominalis*

SATURDAY 8 DECEMBER

	Polly Hannaford, Tara MacKenzie, Michael B. Thompson, Jonathan W. Paul, Christopher R. Murphy and **Camilla M. Whittington**
12:30	Unravelling the physiological mechanisms behind asynchronous live-birth **Deirdre L. Merry***, Camilla M. Whittington, Geoffery M. While
12:45 - 1:45	**Lunch – S1 Foyer**
Chair: Ben Smit	
1:45	Biology of the placenta in the Australian sharpnose shark, *Rhizoprionodon taylori* **Alice L. Buddle***, James U. Van Dyke, Michael B. Thompson, Colin Simpfendorfer, Christopher R. Murphy and Camilla M. Whittington
2:00	Inflammatory maternal-fetal interactions and the origin of maternal recognition of pregnancy in mammals **Oliver W. Griffith**, Arun Chavan, Mihaela Pavlicev, Stella Protopapas, Ryan Callahan, Jamie Maziarz, and Gunter P. Wagner
2:15	Male-specific plasticity of activity patterns in dusky antechinus **Erika Zaid***, Frederick W. Rainsford, Brayden J. Redwood, Peter Meerlo and John A. Lesku
2:30	The molecular basis of extreme acid-tolerance: Control of sodium loss by larvae of the Scarlet-Sided Pobblebonk Ebony Watson, **Rebecca L. Cramp**, Ed A. Meyer and Craig E. Franklin
2:45	Scoop a Poop: using citizen science to investigate the spread of antibiotic resistance into the wild **Koa N. Webster,** Daniel Russell and Michelle L. Power
3:00	Early-life telomere length predicts lifespan and lifetime reproductive success in a wild bird Justin R. Eastwood, Michelle L. Hall, Niki Teunissen, Sjouke A. Kingma, Nataly Hidalgo Aranzamendi, Marie Fan, Michael Roast, Simon Verhulst and **Anne Peters**
3:15 - 3:45	**Afternoon Tea – S1 Foyer**
Chair: Oliver Griffith	

SATURDAY 8 DECEMBER

3:45	Body temperature changes during pregnancy – what and (an attempt at) why Natasha Sorenson and **Shane Maloney**
4:00	Selection against overwintering shapes thermal performance curves for development **Jacinta D. Kong***, Ary A. Hoffmann and Michael R. Kearney
4:15	High ambient temperature differentially impacts glucose metabolism of zebra finches **Laura L. Hurley**, Christine E. Cooper, Pierre Deviche and Simon C. Griffith
4:30	Winter huddling and kinship in the marsupial *Dromiciops gliroides*, Monito del Monte **Jennifer A. Hetz**, Juan Luis Celis-Diez, Seungmin Ham and Peter Temple-Smith
4:45 - 5:45	**Annual General Meeting**
5:45 - 6:30	**Free Time**
6:30	**Bus to Conference Dinner –** Bad Sheppard Brewing Co

Conference Program

SUNDAY 9 DECEMBER

*indicates students eligible for prizes

S1 Theatre	
Chair: Rebecca Adrian	
9:15	**Announcements**
9:30	Southern African desert birds and climate change: lethal effects of acute heat exposure *versus* sublethal fitness costs of chronic heat exposure Shannon R. Conradie, Stephan M. Woodborne, Susie J. Cunningham and **Andrew E. McKechnie**
9:45	Rises and falls in preferred body temperature during pregnancy in a live-bearing gecko: possible benefits for embryos **Alison Cree** and Georgia Moore
10:00	Effects of pregnancy on sub-lethal thermal tolerance in a viviparous New Zealand skink **Jo Virens*** and Alison Cree
10:15	A protocol for comparing voluntary thermal tolerance among different life-history stages of a retreat-dwelling gecko (*Woodworthia* "Otago/Southland") **Christian Chukwuka***, Jo Monks and Alison Cree
10:30 - 11:00	**Morning Tea – S1 Foyer**
Chair: Pieter Arnold	
11:00	Avian hormonal mediation of sub-speciation in the Long-tailed finch **Anna Miltiadous***, Laura L. Hurley, Simon C. Griffith, Ondi L. Crino and Katherine L. Buchanan
11:15	The physiology of adaptation to arid conditions in a passerine bird **Ben Smit**, Ângela M. Ribeiro, Nicholas B. Pattinson and M. Thomas P. Gilbert
11:30	Dropping like flies: Testing the role of mitochondrial genetic variation in a composite trait of neural and motor performance **Rebecca E. Adrian** and Damian K. Dowling
11:45	How does genetic variation modulate developmental plasticity in response to changing environmental conditions?

SUNDAY 9 DECEMBER

	Avishikta Chakraborty*, Christen K. Mirth and Carla M. Sgrò
12:00	Using transcriptomics to investigate parity mode evolution in a bimodally reproductive skink (*Saiphos equalis*) **Charles S.P. Foster**, Michael B. Thompson, and Camilla M. Whittington
12:15	Growth drives metabolic scaling **Craig R. White**, Candice L. Bywater, Lesley A. Alton and Dustin J. Marshall
12:30	Final Announcements
12:45 - 1:45	**Lunch – S1 Foyer**
1:45 – 3:00	**Student Careers Q & A – Sanson Room**

PLENARY LECTURES (A-Z)

Endothermy, marsupials and hibernation: a tale from three continents

Roberto F. Nespolo[1]

[1]Instituto de Ciencias Ambientales y Evolutivas, Universidad Austral de Chile, Valdivia, Chile.

Endothermic animals (i.e., birds and mammals) produce metabolic heat in their bodies in a way that allows them to maintain a near constant body temperature at values that are typically well above ambient temperature. This is an extravagant economy that requires these animals to maintain elevated energy budgets and spend a large part of their resources on basic maintenance. Several endotherms, however, become ectothermic (torpid) as an adaptive strategy to save energy during periods cold periods. However, the fitness-costs of this strategy could be important, as it entails important threats to organs and tissues due to the toxic effects of ROS production during hypoxia and reperfusion. The small South American marsupial, “monito del monte” *Dromiciops gliroides*, known as the missing link between the American and the Australian marsupials, is one of the few South American mammals known to hibernate. Expressing daily torpor and seasonal hibernation (=”opportunistic hibernation”), this species may provide crucial information about the mechanisms and evolutionary origins of mammalian hibernation. In this presentation, I will briefly present some of the evidence locating Microbiotheria at the base of Australasian phylogeny, then I’ll discuss some patterns of hibernation that characterize marsupials (and differ with eutherians). I will finally share our results of a gene-expression analysis of hibernation, with the aim of contrasting the classic comparative physiology approach (based on the Krogh principle and whole-animal performance measures) with the modern functional genomics approach (based on hundreds of differentially regulated genes). A major challenge here -I believe- is not to get “lost in the map” of genetic details, and to associate genes/proteins with known physiological functions.

Acknowledgements: Fondecyt 1180917, iBio, CAPES.

PLENARY LECTURES (A-Z)

Mitochondrial contribution to animal performance and life-history variation

Karine Salin[1]

[1]Ifremer, Laboratory of environmental marine sciences, France

In the recent years mitochondrial functions have emerged as a key player in individual variation in performance and life-history. These functions include oxygen and energy substrates consumption, ATP production, and reactive oxygen species (ROS) generation. Confusingly given the central role of oxygen consumption in ATP and ROS production, some of better performing individuals appear to have reduced oxygen needs, other have higher oxygen needs. This talk will take an integrative approach to these seemingly contradictory mitochondrial functions to attempt to link mitochondrial function to individual performance.

REGULAR PRESENTATIONS (A-Z)

Dropping like flies: Testing the role of mitochondrial genetic variation in a composite trait of neural and motor performance

Rebecca E. Adrian[1] and Damian K. Dowling[1]

[1]School of Biological Sciences, Monash University, Clayton, VIC 3800, Australia

Mitochondria are best known as the generators of cellular energy. However, several decades of biomedical research have revealed that variation in mitochondrial performance can drastically alter traits critical to life: immune system performance, hormone synthesis, cognitive function, and even senescence. What is perhaps most remarkable is that some of this variation has recently been traced back to DNA sequence variation in the tiny mitochondrial genome, which contains only 13 protein-coding genes in most animals. Moreover, because mitochondria are solely inherited from mothers, male mitochondria are an “evolutionary dead-end” that natural selection cannot act upon. From this phenomenon arises the “mother’s curse” hypothesis, which predicts that male-harming (but female-beneficial or -benign) mutations may accumulate within the mitochondrial genome, potentially impairing male performance in those key traits dependent on mitochondrial function. Existing tests of mother’s curse suggest that mitochondrial DNA variation may indeed affect males differently in life-history traits (e.g. fertility) and cellular traits (mitochondrial complex respiratory rate), but the physiological steps that link such traits remain unknown. Here, we developed a new set of fruit fly genetic strains that differ either in their nuclear genome sequence (three possible “backgrounds”) or their mitochondrial genome sequence (thirteen possible “haplotypes”). We used these strains to isolate how variation in the mitochondrial DNA sequence has functional effects on a trait that integrates motor and neural performance (negative geotaxis response), and whether these effects may be sex-specific. Illuminating the effects of mitochondrial DNA variation at the level of physiological performance is a critical step toward better understanding not only the function of mitochondria, but also how they may contribute to fundamental differences in performance between the sexes.

REGULAR PRESENTATIONS (A-Z)

Evolution of metabolic rate in *Drosophila melanogaster*

Lesley A. Alton[1], Teresa Kutz[1], Candice L. Bywater[1], Pieter A. Arnold[1], Julian E. Beaman[1], Sean Layh[1], Hugh Winwood-Smith[1], Christen K. Mirth[1], Carla M. Sgrò[1] and Craig R. White[1,2]

[1]School of Biological Sciences and [2]Centre for Geometric Biology, Monash University, Melbourne Vic, 3800

The world is currently on track to experience around 3°C of warming without further policy change, resulting in a thermodynamic increase of the mean metabolic rates of ectotherms of around 20-40%. To determine the capacity of animals to respond to such an increase in temperature, we are undertaking a long-term laboratory experimental evolution study in *Drosophila melanogaster* in which larvae are reared at 25 or 28°C on either a control diet (C), a low calorie diet (LC), or a low protein diet (LP). After 10 generations under such conditions, followed a further two generations under common garden conditions (C diet, 25°C), we measured the metabolic rates of around 600 individuals at 25°C. The evolutionary response to temperature varied strikingly among sexes and diets. Body mass changed by up to 10% and metabolic rates changed by up to 25% independent of changes in body mass. Our data show that, depending on nutritional context and sex, the thermodynamic effect of temperature on metabolic rate might either be largely eliminated or substantially reinforced by evolutionary changes in metabolic rate.

REGULAR PRESENTATIONS (A-Z)

Shedding light on the drivers of reptile distribution: Micro-environmental variables predict climatic-related traits of lizards

Rodolfo O. Anderson[1], Craig R. White[1] and David G. Chapple[1]

[1]School of Biological Sciences, Monash University, Clayton, Victoria 3800

The factors underlying species distributions have puzzled ecologists and evolutionary biologists for decades, and the role of abiotic and biotic factors is still debated. Abiotic factors might challenge animals by imposing on them different requirements to accommodate their climatic-related traits (*i.e.*, physiology) in order to maintain homeostasis. Here, through global and systematic meta-analyses, we show how environmental variables predict key climatic-related traits of lizards. We compiled datasets including resting and standard metabolic rate (MR), field metabolic rate (FMR), evaporative water loss (EWL), thermal preference (Tpref), critical thermal minimum (CTmin), and maximum (CTmax) of lizards worldwide. We extracted an array of micro-environmental variables (package *NicheMapR* in R) for each species in the database from the location the individuals were collected. Then, for each climatic-related trait as response variable, we constructed phylogenetic models with the micro-environmental variables set as predictors. Our results show complex ways by which the abiotic factors influence the climatic-related traits of lizards. Additionally, we found strong phylogenetic signal for Tpref, CT min and CTmax, medium for MR and FMR, and a low phylogenetic signal for EWL. Interestingly, our work provides insights into the ecophysiological and evolutionary mechanisms by which lizards adjust their physiological traits in response to environmental variation, the target abiotic factors affecting their range, and the potential responses those animals could exhibit in novel environments. Our study, therefore, sheds light on the processes driving the distributional ranges of lizards.

Abstracts

REGULAR PRESENTATIONS (A-Z)

Analysing plant phenotypic plasticity in response to heat and cold using random regressions

Pieter A. Arnold[1], Alexandra A. Catling[1], Loeske E. B. Kruuk[1] and Adrienne B. Nicotra[1]

[1]Division of Ecology and Evolution, Research School of Biology, The Australian National University, Acton, ACT 2601, Australia

Plant biology is experiencing a renewed interest in the physiological underpinnings and evolution of phenotypic plasticity that calls for a re-evaluation of the ways that phenotypic responses to a rapidly changing climate are analysed and interpreted. We suggest that dissecting plant plasticity in response to temperature shifts needs an approach that can represent plasticity across multiple environments, and considers both population-level responses and the variation between genotypes in their response. The standard approach to assess phenotypic plasticity involves measuring phenotypic traits in two distinct environments and then generating linear reaction norms between these two points. Mapping the phenotypic response across environments at a fine-scale reveals that this simplifying assumption of linearity masks complexity in the shape of reaction norms. To demonstrate how a random regression mixed model framework can reveal and quantify complexity in traits that show linear and non-linear plastic responses to temperature, we grew an Australian alpine species, the waxy bluebell (*Wahlenbergia ceracea*), across a gradient of 12 temperatures and measured a suite of phenotypic traits. We found that germination, biomass, time to first flower bud, leaf mass per unit area, chlorophyll content, and thermal tolerance to both heat and cold showed markedly different response characteristics across growth temperatures. For most traits, simpler approaches would have overlooked much of the biologically relevant variation at intermediate temperatures. Random regressions provide a powerful and efficient means of characterising phenotypic plasticity and its variation, and offer huge potential for extension to include multivariate responses, multiple environmental variables, and quantitative genetic or comparative analyses.

REGULAR PRESENTATIONS (A-Z)

Genetic and environmental variation in metabolic scaling relationships: an ontogenetic perspective

Julian Beaman[1,3], Daniel Ortiz-Barrientos[1], Matthew D. Hall[2,3] and Craig R. White[2,3]

[1]School of Biological Sciences, The University of Queensland, Brisbane, QLD Australia.
[2]School of Biological Sciences, Monash University, Melbourne, VIC Australia.
[3]Centre for Geometric Biology, Monash University.

Body size is one of the most basic features by which animals differ from one another. Correlations between body size and other physiological and life history traits (scaling relationships) can act as a constraint on phenotypic variation. As a consequence, scaling relationships can have important influences on ecological and evolutionary processes. For example, changes in the distribution of body size in populations can alter population growth rates and the flux of energy through ecosystems. Body size, however, does not impose perfect constraints on animal physiology and life history because scaling relationships themselves are determined by genetic and environmental factors. An important focus of research is, therefore, to understand how scaling relationships are shaped by evolution and environmental variation. One of the most intensely studied scaling relationships is that between body mass and metabolic rate. Typically, metabolic rate does not increase proportionally with body size (allometric scaling) such that mass-specific metabolic rate declines as organisms get larger. Metabolic scaling can be observed among species of different sizes (evolutionary scaling), among individuals of the same species at a given life-stage (static scaling) and within individuals as they grow (ontogenetic scaling). From an ontogenetic perspective, organisms must expend energy on growth to increase in size during development, which implicates growth as a potential link between body size and energy metabolism. Here I present the results from experiments on juvenile growth and metabolic rate in the speckled cockroach (*Nauphoeta cinerea*). We discovered heritable genetic variation in the metabolic scaling relationship, which means that metabolic scaling can evolve under natural selection. Furthermore, I studied how growth trajectories change in response to variation in food availability and will explore in this presentation the links between growth rate and metabolic scaling.

Abstracts

REGULAR PRESENTATIONS (A-Z)

Biology of the placenta in the Australian sharpnose shark, *Rhizoprionodon taylori*

Alice L Buddle[1], James U Van Dyke[3], Michael B Thompson[1], Colin Simpfendorfer[4], Christopher R Murphy[2] and Camilla M Whittington[1]

[1]School of Life and Environmental Sciences, The University of Sydney, Sydney, NSW 2050, Australia
[2]School of Medical Sciences, The University of Sydney, Sydney, NSW 2050, Australia
[3]School of Environmental Sciences, Charles Sturt University, Albury, NSW 2640, Australia
[4]College of Science and Engineering and Centre for Sustainable Tropical Fisheries and Aquaculture, James Cook University, Townsville, QLD 4811, Australia.

Most sharks give birth to live young, and some develop a placenta that transfers large quantities of nutrients from the mother to developing embryos (placentotrophy). However, sharks are anamniotes, meaning that their embryos lack amniote specific extraembryonic membranes. Consequently, shark yolk-sac placentas develop from different ancestral tissues from those of live-bearing amniotes (mammals and reptiles). While we know that the yolk sac placenta is essential for successful embryonic growth and development in sharks, the mechanisms involved in their placental functions, such as nutrient transfer, remain unclear. If mechanisms specific to placental nutrient transfer in amniotes are also found in sharks, this would suggest that the evolution of placentotrophy requires similar mechanisms irrespective of the tissues from which the placenta has evolved. We used light and electron microscopy to investigate placental structures in the Australian sharpnose shark, *Rhizoprionodon taylori,* which we are developing as a model for shark placental function. During placental formation, the embryonic yolk sac differentiates into two portions; a proximal portion that attaches to the embryo by the umbilical cord, and a distal portion that firmly attaches to maternal uterine tissues with complex interdigitations. The proximal portion of the placenta is composed of a connective tissue layer that contains many capillaries and an outer simple columnar epithelial layer, which suggests that the proximal portion may be involved in gas exchange or hormone production or secretion, while the distal portion of the placenta develops from increased folding of fetal and maternal tissues during late pregnancy, resulting in an increased surface area for feto-maternal contact. Placentation is epitheliochorial with no breaching of the maternal epithelium, and the collagenous egg case that encapsulates embryos in early pregnancy remains intact in late pregnancy, separating maternal and fetal tissues. Hence, placental nutrient transfer during pregnancy in *R. taylori* is likely to be histotrophic (maternal uterine secretion and fetal absorption), rather than hemotrophic placental transfer (nutrient transfer directly between fetal and maternal bloodstreams). Such separation of fetal and maternal tissues at the interface of the placenta may give females control of the nutrients they provide to embryos during pregnancy.

Abstracts

REGULAR PRESENTATIONS (A-Z)

The effects of social dominance on dietary preferences in the speckled cockroach

Candice L. Bywater[1] and Craig R. White[1,2]

[1]School of Biological Sciences, Monash University, Clayton, Victoria 3800
[2]Centre for Geometric Biology, Monash University, Clayton, Victoria 3800

The activity patterns of animals are influenced by resource availability in the environment and an animal's nutritional state. The relationship between activity and nutritional state is not likely just one way, the types of activity undertaken should also drive what resources are required. Animals are able to regulate their nutrient intake by preferentially selecting foods depending on their energy requirements. In this study, we aimed to quantify the effect of dominance status in cockroaches on the regulation of specific macronutrients using the geometric framework of nutrition. Male cockroaches are known to establish dominance hierarchies through intraspecific competition and differences in the levels of aggression and dominance behaviour between males influences their mating success. This is thought to be primarily driven by the male sex pheromones, the production of which requires certain nutrients. We established dominant and submissive states in male cockroaches and manipulated the amounts of protein and carbohydrate available. Individuals were able to regulate their intake from paired choices of P:C ratios. Here we will discuss preliminary results showing that dominant and submissive males select different foods and that that this varies across differing nutritional environments.

Abstracts

REGULAR PRESENTATIONS (A-Z)

The transgenerational effects of obesogenic diets

Tara-Lyn Carter[1], Matthew Piper[1], Rebecca Robker[2] and Damian K. Dowling[1]

[1]School of Biological Sciences, Monash University, Clayton, VIC., Australia
[2]School of Paediatrics and Reproductive Health, Robinson Research Institute, The University of Adelaide, Adelaide, Australia

Obesity appears to be a perpetuating cycle across generations. In humans, parental obesity is associated with obesity in children, mostly determined from associative studies that find maternal BMI can predict child BMI at several age points. The maternally mediated effects are thought to be a result of metabolic imprinting. Studies conducted across a variety of taxa suggest parental diet of both mothers and fathers prior to conception can have an effect on the phenotype of the resultant offspring. However, very few studies have tested the compounding transgenerational nature of these dietary effects in both parents. Our study manipulated the sucrose content of *Drosophila melanogaster* diets across four generations, and measured the effects of a high and low sugar diet on body weight and whole-body triglyceride content. Virgin flies were placed onto six different diet treatments, 0.25%, 2.5%, 5%, 10%, 20% and 40% sucrose (with all other ingredients kept constant), for four days before being allowed to mate. Here, we present preliminary evidence for the transgenerational cumulative effects of high-sugar diet-induced obesity in *Drosophila melanogaster,* and based on these results reveal the next steps in our experimental investigation.

Abstracts

REGULAR PRESENTATIONS (A-Z)

How does genetic variation modulate developmental plasticity in response to changing environmental conditions?

Avishikta Chakraborty[1], Christen K. Mirth[1] and Carla M. Sgrò[1]

[1]School of Biological Sciences, Monash University, Melbourne, VIC 3168, Australia

Over the past decade, climate change has forced organisms to face changes in their thermal and nutritional environment. This influences their biology by affecting an assortment of life history traits that directly affect fitness and population persistence. One of the mechanisms by which organisms survive such conditions is to modify their development, physiology, or behaviour – a phenomenon called phenotypic plasticity – allowing them to adjust their biology to their environment. The extent to which animals can adjust to these environmental changes via plasticity depends on their genetic makeup, with some genotypes exhibiting greater plasticity towards certain environmental conditions than others. Through my work, I discuss how genetic variation contributes to differences in the physiological mechanisms underlying developmental timing in response to interactions between the thermal and nutritional environment. Using wild populations collected from three regions along the east coast of Australia, I have found that egg-to-adult development time varies not only among but even within populations in response to nutrition and temperature. This suggests that genetic variation alters the response of a trait under different environmental conditions. My future experiments will focus on understanding the precise development stages affected across genotypes, and how pulses of the steroid hormone ecdysone, the major regulator of developmental timing, is altered in response to such changes. These studies will provide an in-depth understanding of the relative contribution of genetic variation and regulation of hormone synthesis in shaping developmental plasticity.

Abstracts

REGULAR PRESENTATIONS (A-Z)

One line to rule them all

Steven L Chown[1]

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The search for regularity, however defined, is foundational in science. Elegant, simple explanations for life's diversity are therefore immensely appealing. Evolution by natural selection is one of these. Simple thermodynamic effects on rates and supply-side limitations on sizes are another. Although not irreconcilable, these two contrasting forms of generalities generate a tension that now permeates much of functional ecology. The first can be characterized as an elegant means to generate diversity, the second an elegant set of mechanisms to constrain it. Here I explore these tensions using three examples from our recent work on functional diversity. The first contrasts predictions about the network architecture of insect tracheae with data on that architecture. What might constitute adequate grounds for generality emerges as a reasonable further question. The second examines Krogh's now 100-year old idea of thermal compensation as an alternative to the more recent thermodynamic effects idea. The philosophical question of simplicity as a means to adjudicate theory arises. The third asks just how confident we can be about evolutionary limits to upper thermal tolerances in ectotherms. The philosopher John Ziman's argument that science is about reliable knowledge comes quickly to the fore. I conclude by reconsidering, though by no means resolving, the ways in which biology deals with contrasting major generalities.

Abstracts

REGULAR PRESENTATIONS (A-Z)

A protocol for comparing voluntary thermal tolerance among different life-history stages of a retreat-dwelling gecko (*Woodworthia* "Otago/Southland")

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Voluntary thermal maximum (VTmax) denotes an upper-temperature setpoint at which an animal responds behaviourally to avoid further heating. Most studies of VTmax among lizards have examined species that openly bask in the sun. We developed a protocol for assessing VTmax in a semi-nocturnal gecko that inhabits rocky retreats by day. Given that this species shows variation in thermal preference with pregnancy status and sex, we predicted that VTmax would vary with these factors also. We also examined potential differences between juveniles (a stage that is often overlooked in thermoregulatory studies) and adults. Our protocol involved heating geckos individually within a retreat, at a rate simulating the temperature rise that would be experienced in the wild on a hot summer's day. To date, we have compared four groups of geckos (late pregnant females, non-pregnant females, males and juveniles) from a laboratory colony, in late summer/autumn. The voluntary exit of geckos from the retreat site was filmed from an adjacent room. As soon as the geckos left the heated retreat, we recorded skin surface temperature using an infrared camera. Control geckos, which were exposed to overhead lighting without heating, rarely left the retreat. The behaviour exhibited by geckos at the approach to VTmax included exposure of heads at the retreat's periphery, tongue flicking and gaping. Although we have not observed a significant difference in mean VTmax among groups to date, pregnant females appeared to tolerate heating for longer than other groups. This implies that pregnant females were able to regulate their heating rate, perhaps involving different positioning within the retreat and/or increased use of evaporative cooling (e.g. via mouth gaping). In further work, we plan to extend VTmax testing to field-collected animals earlier in pregnancy, and to relate our findings to how climate change might influence microhabitat use in the future.

Abstracts

REGULAR PRESENTATIONS (A-Z)

Effects of acute acclimation to high temperature for captive and wild zebra finches (*Taeniopygia guttata*)

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The intensity, duration and frequency of extreme weather events, including heatwaves, is predicted in increase as a consequence of global climate change. Acute periods of extreme heat may be more problematic for birds than a general change in average climate, and there are numerous documented instances of mass avian mortality during heatwaves. It is therefore of interest to determine if birds can acclimate to acute exposure to high temperatures. We examined the influence of acute acclimation to high environmental temperature on body temperature, metabolic rate, evaporative water loss and thermal conductance at ambient temperatures (T_a) of 30° and 40°C, of the zebra finch (*Taeniopygia guttata*). Wild-derived captive finches were acclimated to daytime maximums of 30°C or 40°C. There were no effects of acclimation for any physiological variable, although there was an interaction between T_a and acclimation, with birds acclimated to periodic high temperatures having 13% lower metabolic heat production at T_a = 40°C. Wild, free-living finches were measured during summer after "cool" (≥ three days of maximum T_a ≤ 36°C) and "hot" periods (≥ three days of maximum T_a ≥ 39°C). Evaporative water loss was lower, and body temperature higher, for birds measured after "hot" periods. Metabolic rate was higher at T_a = 30°C and lower at T_a = 40°C for birds after "hot" periods. Differences in responses by captive and wild finches suggests that physiological impacts of acute heat exposure may not be a consequence of temperature *per se*, but may be an indirect effect of temperature on access to food and water for wild birds. This study highlights the value of combined laboratory and field studies to reveal drivers of physiological response, and the potential for avian acclimation to extreme weather.

REGULAR PRESENTATIONS (A-Z)

The molecular basis of extreme acid-tolerance: Control of sodium loss by larvae of the Scarlet-Sided Pobblebonk

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Low pH freshwater environments are extremely challenging for aquatic organisms. High environmental H^+ concentrations disrupt regulatory proteins in the skin and gills of aquatic organisms, which causes necrosis of the integument and lifting of the branchial epithelium, resulting in significant loss of Na^+. Despite these challenges, many aquatic organisms can survive and reproduce in naturally occurring low pH environments. One of these acid-adapted species is the Scarlet-sided pobblebonk, *Limnodynastes terraereginae*, which can tolerate environmental pH as low as 3.0. The mechanisms that allow *L. terraereginae* to live in these extreme environments is not well understood, however previous literature suggest tight junction (TJ) and adherens junction (AJ) proteins may play a significant role. This study investigated the underlying molecular mechanisms of TJs and AJs that facilitate environmental acid-tolerance in frog larvae, and to further investigate whether these processes exhibit physiological flexibility. Results indicated that control of Na^+ efflux in *L. terraereginae* larvae is conferred through two main mechanisms: 1. the upregulation of claudin-4 and claudin-8, which produce impermeable cation barriers, minimising Na^+ efflux through the paracellular space; and, 2. structural integrity of paracellular junctions via upregulation of occludin and E-cadherin, proteins which play complex and important roles in cell to cell junction regulation. Elucidating the physiological basis of acid-tolerance in aquatic animals gives us the opportunity to understand naturally low pH ecosystems.

REGULAR PRESENTATIONS (A-Z)

Rises and falls in preferred body temperature during pregnancy in a live-bearing gecko: possible benefits for embryos

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Preferred body temperature (PBT, also known as selected temperature, T_{sel}) is measured in squamate reptiles as the body temperature selected in a thermal gradient. This variable has attracted much interest from reptile biologists because of its relevance to topics including thermoregulatory strategy, the evolution of viviparity and species-distribution modelling under climate change. Although PBT is often treated as a single variable for a species, previous research shows that it can vary with factors including sex and season. The value also often changes with pregnancy status; however, some studies have shown elevations in PBT with pregnancy, whereas studies on other species have shown declines. Here, we extend our group's previous research on PBT in a viviparous, cool-climate gecko (the New Zealand taxon *Woodworthia* "Otago/Southland"), in which pregnancy can last over a year. We show that (i) in late pregnancy, PBT varies with thermal regime (basking opportunity and night temperature); (ii) PBT drops in the immediate pre-partum period and (iii) PBT has risen again within the week after birth to match the PBT of neonates. Our results, when combined with earlier studies, reveal a profile across the full reproductive cycle in which PBT is elevated until late in pregnancy (presumably enhancing embryonic development), low during the pre-partum weeks (presumably enhancing survival of fully-developed embryos by keeping metabolic rates low when yolk has been consumed) and intermediate when post-partum (spent) or vitellogenic. The physiological mechanisms that underlie these changes in preference remain to be identified.

REGULAR PRESENTATIONS (A-Z)

Larval growth rate is negatively correlated with post-metamorphic thermal performance

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Most marine fish species disperse during a planktonic larval stage where individuals exhibit variation in pelagic duration, growth rate and settlement size. Extreme predation risk is predicted to drive rapid growth rates and decrease pelagic duration as a strategy to survive to settlement. How larval traits affect post-metamorphic performance, however, has been a contentious topic over the past 50 years. Some studies suggest that larval traits have carry-over effects to later life stages, where larval traits can be positively or negatively correlated with post-metamorphic performance. For example, individuals with rapid larval growth rates may settle at larger sizes and have faster post-metamorphic locomotion than slow growing individuals. Alternatively, trade-offs between life stages might exist, where rapid larval growth rate may be negatively correlated with post-metamorphic locomotion, potentially due to energetic resource allocation trade-offs. In addition, other studies suggest that larval traits are de-coupled from later life stages to allow for a transition in morphology and habitat (no across life-stage correlation). We tested how *Bathygobius cocosensis* larval growth rates, total growth and pelagic duration correlated with post-metamorphic thermal performance of burst swimming speed, routine metabolic rate and critical thermal maximum. We found that larval growth rate was negatively correlated with juvenile routine metabolic rate and burst swimming speed across a range of test temperatures. That is, fast growing larvae had slower burst swimming speeds and lower routine metabolic rates across temperature as juveniles compared to slower growing larvae. Neither larval growth rate nor pelagic duration were correlated with critical thermal maximum, but juvenile fish mass had a positive effect on upper thermal limits. We also found that pelagic larval duration was not correlated with post-metamorphic performance. This is the first study to show that larval growth rate is negatively correlated with post-metamorphic thermal performance in a wild marine fish.

REGULAR PRESENTATIONS (A-Z)

Can juvenile red kangaroos structurally surmount the metabolic burdens of size and growth in dry times?

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Juvenile red kangaroos have a large metabolic burden relative to adults. Many don’t survive to adulthood, notably when faced with poor pasture conditions. We have studied them just after weaning, when they lose the benefit of maternal milk. Around then they are about 40% of the mass of adult females but to achieve full growth they need to eat almost as much as the adult females. How can they cope with such an imposition? Can they do this via structural changes in the guts? From our data on gut morphology, and insights into the basic allometry of body size and fermentative digestion, this appears doubtful. It emerges that it is the adults that have the reserve digestive capacity. Thus, at the forefront of juvenile survival is the broad issue of diet selection. However, there are elaborations within the juvenile’s harvesting apparatus, i.e. its skull and dentition, that facilitate enhanced feed intakes. Relatively larger skulls and advanced development of the anterior jaw, notably of the incisors, were found to be part of this process.

REGULAR PRESENTATIONS (A-Z)

Differential response to fisheries capture stress of the metabolic rate of three Australian chondrichthyans

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The effects of fisheries capture extend well beyond immediate death; when an animal is released (unwanted capture) it may be subjected to injuries, long term physiological and behavioural consequences and possibly delayed mortality. The process of dealing with capture stress, and maintain homeostasis to avoid death, is energetically demanding. The energy used in this process is inevitably subtracted from other important biological activities, with potential severe consequences for these processes. Metabolic rates (MRs) measurements can be used to estimate the amount of energy that is invested in the stress response, hence to understand long term effects of fisheries capture stress and to assess its sustainability. The main threat posed to chondrichthyan populations (sharks, rays and chimeras) is represented by fisheries; nevertheless no study exists on the impact that fisheries practices have on chondrichthyan MRs. We tested MR alterations caused by different fisheries techniques in *Mustelus antarcticus*, *Heterodontus portusjacksoni* and *Trygonorrhina dumerilii*. As expected we measured a significant increase in the MR of stressed *H. portusjacksoni*; conversely, the MRs of stressed *M. antarcticus* and *T. dumerilii* were significantly lower than their baseline value. The differential response is likely the results of the different sensitivity of the species and the different intensity of the stress posed by the two fisheries technique investigated. However results suggest that, at least for some species, some fisheries techniques can be so energetically demanding that the only way fishes have to cope with them and avoid immediate death, is to shut down unnecessary biological activities. This ultimately can seriously impact these processes and the survival of the fish.

REGULAR PRESENTATIONS (A-Z)

Using transcriptomics to investigate parity mode evolution in a bimodally reproductive skink (*Saiphos equalis*)

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The transition from an ancestral oviparous (egg-laying) mode of reproduction to a derived viviparous (live-bearing) state has occurred over 150 times independently in vertebrates. Transitions between parity modes are physiologically complex, and are likely to be driven by a large suite of genetic changes. Only four vertebrate taxa are bimodally reproductive. In these species, all squamates, some populations are oviparous, and others viviparous. These species represent recent origins of viviparity, and therefore are ideal for investigating the mechanisms underlying the evolution of viviparity. We used transcriptomic methods to characterise the gene expression changes in individuals from oviparous and viviparous populations of the three-toed skink *Saiphos equalis*, across different reproductive stages. We found that 1041 and 753 genes were differentially expressed between pregnant and non-pregnant and between gravid and non-gravid *S. equalis*, respectively. Of these differentially expressed genes, 175 genes were shared between parity modes. Here we explore the genetic changes underpinning the complex physiological differences between oviparous and viviparous *S. equalis*.

Abstracts

REGULAR PRESENTATIONS (A-Z)

The role of thermal plasticity in mitigating the negative effects of cold-water pollution on fish swimming performance and fitness

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Thermal phenotypic plasticity can provide a mechanism to buffer physiological function and performance under chronic temperature changes. For example, many fish species, via the process of thermal acclimation/acclimatisation, have the capacity to compensate for the depressive effects of decreases in temperature, thereby ensuring the maintenance of swimming performance. Such thermal phenotypic plasticity has been reported in fish species with changing seasonal temperatures, however less understood are responses to extemporaneous changes in temperature. Cold-water pollution (CWP) occurs when water is released from the hypolimnion layer of dam impoundments resulting in temperatures significantly lower than the natural temperature of the river downstream of the dam. The abrupt drop in water temperature can be as much as 15°C lower than the natural river temperatures and the decrease in temperature can extend hundreds of kilometres downstream from the release point. The conundrum is that water is often released to achieve environmental water flows, sometimes to trigger fish migration, yet these releases can result in decreases in water temperatures that may severely impact fish swimming performance and fitness. Here we utilised an experimental, lab-based approach to examine how rapid reductions in water temperature, of a magnitude reported from the Murray Darling Basin, affect the performance of four native Australian fish species that occur in this system. We investigated both short term (acute effects) and chronic exposure to decreases in temperature on maximum sustainable swim speed (U_{crit}), routine metabolic rate, and maximum metabolic rate. A key objective was to assess whether Australian fish species have the capacity to compensate for the depressive effects of low temperatures via thermal phenotypic plasticity (thermal acclimation). Surprisingly, the species studied showed limited capacity for thermal acclimation which has substantial implications for the management of cold water releases from large dams and the passage/migratory capabilities of native fish.

REGULAR PRESENTATIONS (A-Z)

Inflammatory maternal-fetal interactions and the origin of maternal recognition of pregnancy in mammals

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In human pregnancy, recognition of a developing fetus within the uterus is essential to maintain uterine quiesence and support the embryo through an extended gestation. In most marsupials (with the exception of macropods), pregnancy is shorter than the estrus cycle, and for this reason it has been assumed that recognition of pregnancy is not necessary, and was a trait that evolved in the first eutherian (placental) mammals. To investigate whether there is uterine recognition of pregnancy in early live bearing mammals, we examined reproduction in the grey short tailed opossum (*Monodelphis domestica*) a marsupial with what is assumed to have the most pleiotropic mode of pregnancy. We examined the morphological and gene expression changes in the uterus of females in the estrus cycle, and compared these to the observed changes during pregnancy. We found that while the morphology of the uterus undergoes substantial changes in pregnancy, these changes occur in a programmed fashion during estrus, and for the most part do not appear to be impacted by the presence of a fetus. However, transcriptionally we saw big differences between the uterus of pregnant and estrus animals. Gene ontology analysis shows us that the genes up-regulated due to the presence of a fetus are involved in macromolecular transport, inflammation, and metabolic activity. Our results suggest that while the uterus exhibits programmed changes in response to ovulation, the transcriptional landscape of pregnancy responds to the presence of a fetus, and upregulates suites of genes that may be essential for fetal support. These results are consistent with uterine recognition of pregnancy being an older feature dating back to the origin of live birth in mammals.

Abstracts

REGULAR PRESENTATIONS (A-Z)

Winter huddling and kinship in the marsupial *Dromiciops gliroides*, Monito del Monte

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Several studies have now shown that *Dromiciops gliroides*, Monito del Monte, exhibit facultative torpor when temperatures decline during the year and deeper torpor during the winter. This strategy, along with the use of nests for protection, the accumulation of fat in the tail, and a dense fur helps to preserve energy during winters. However, *Dromiciops* may also use another strategy to preserve heat. 'Winter aggregations' of 5 or more juvenile individuals have been described, suggesting that smaller animals use huddling as an energy preservation strategy unlike adult individuals, that are more frequently found nesting alone during winter. Huddling in *Dromiciops* may be a facultative response to external conditions similar to that reported in other mammal species that can change their behaviour rapidly in response to environmental cues and adapt to new environmental conditions by forming, for example, non-kin huddling groups during winter to preserve energy. To assess this hypothesis, we analysed kinship between individuals nesting together during winter by examining the genetic structure of the huddling groups in *Dromiciops gliroides* populations from Chiloé Island. Additionally we evaluated if thermoregulation benefits are most likely to influence the formation of huddling groups between juvenile and adults individuals during winter by measuring their core temperatures. Our results suggest that juveniles tend to form huddling groups with adult individuals, both males and females, and that huddling groups do not necessarily include family members. Additionally, we found a high number of adult individuals huddling in groups of 2 or more, and with the opposite sex, suggesting huddling may also be used as a reproductive strategy to facilitate mating and increase the quality of paternal genes.

REGULAR PRESENTATIONS (A-Z)

High ambient temperature differentially impacts glucose metabolism of zebra finches

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Activation of the hypothalamic-pituitary-adrenal axis enables animals to mobilise energy stores in response to adverse stimuli such as predation attempts, food restriction, inclement weather, and high ambient temperature. This activation results in elevated glucocorticoid (corticosterone in birds) levels and often increased glycemia. Prolonged elevated glucose can cause oxidative damage, but birds appear more resistant to this than mammals, potentially due to high circulating levels of the antioxidant uric acid. To better understand how desert birds respond physiologically to high ambient temperatures we performed two studies on zebra finches, *Taeniopygia guttata*, in which we investigated relationships between ambient temperature and circulating corticosterone, glucose, and uric acid. In the first study, we exposed captive finches to one of two naturalistic oscillating temperature treatments (18º - 30ºC or 28º - 40ºC). In the second study, we determined endocrine and metabolic changes in free-living birds sampled during periods of naturally fluctuating high summer heat. In both studies we measured blood parameters before experimental stress (baseline) and after restraint for 30 minutes (stress). Temperature did not influence plasma corticosterone for any group, but captive females had lower baseline corticosterone levels than captive males. Further, plasma glucose of captive birds was affected differentially by temperature, sex, and stress: exposure to high ambient temperature had opposite effects on baseline glucose depending on sex, and a differential impact after 30 minutes. This difference was associated with a change in uric acid, which circulated at higher concentration at baseline but not in response to stress in birds exposed to 30ºC. The significance of these results warrants further investigation because free-living birds exposed to naturally high temperature showed contrasting and opposite results to those of captive birds.

REGULAR PRESENTATIONS (A-Z)

Metabolic organization, density compensation, population energy use and ecological function: Insights from terrestrial apex predators

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The high energetic costs of endothermic apex mammalian carnivores ensures that any regulation of large mammal prey populations occurs with extremely low predator densities. In contrast, large ectothermic reptilian predators have low metabolic demands, high conversion efficiency of prey biomass to predator biomass and occur at much higher population densities than their mammalian counterparts. Yet does ectothermy elevate population level energetic requirements enough for reptile predators to top-down regulate large mammal prey populations, a keystone function of apex predators? Here we combined comparative and observational analyses to examine the extent that population density and energetic requirements enabled the world's largest apex lizard predator, the Komodo dragon (*Varanus komodoensis*), to affect population numbers of its large mammal prey. Comparison of long-term and large-scale field studies demonstrate that Komodo dragons attain mean population biomass densities, via consumption of ungulate prey, that are 12−515 times higher than that recorded in endothermic large carnivore-ungulate systems in Africa, Asia and North America. High Komodo dragon densities resulted in significantly greater predicted population energy use (5−353 times) and prey consumption needs (2.5−222 times) than endothermic carnivores. Nevertheless, high-density Komodo dragon populations did not appear to have strong effects on large prey population numbers; rather ungulate populations were regulated by density-dependent or environmental processes. Our results demonstrate that despite well conceptualized predictive frameworks, their remains poor evidence that trade-offs between individual level energy use and population density can produce equivalent ecological function-including predator-prey interaction strength.

REGULAR PRESENTATIONS (A-Z)

microclimOz and microclimUS – a microclimate data sets for Australia and the USA, with example applications

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Many problems in pure and applied ecology require the quantification of above and below ground microclimates. Here I present a data set of hourly microclimates for the Australian continent and the USA. The Australian data asset was simulated from the years 1990 to 2017 across a grid of 1893 locations ~60 km apart. The US data set was simulated from 1979 to 2017 across 2287 locations also ~60 km apart. The data were generated with the NicheMapR microclimate model, driven by 0.05° gridded daily meteorological forcing data (air temperature, wind speed, humidity, cloud cover, rainfall). The above ground microclimate variables include horizontal plane solar radiation, solar zenith angle, sky temperature (from which down-welling longwave radiation can be computed)), air temperature, relative humidity and wind speed at 1 cm and 120 cm height, and snow depth. The below ground variables include soil temperature, pore humidity, soil moisture and soil water potential for 0, 2.5, 5, 10, 15, 20, 30, 50, 100 and 200 cm below ground. The computations are for four shade levels (0, 50, 70 and 90%). The data set can be used for a wide variety of applications, including the computation of heat and water budgets of organisms, the potential for vegetation growth, and the development of stress and growth indices. The use of daily forcing data also allows assessments of the consequences of extreme events including heat waves. Example applications are provided for computing plant growth potential, lizard and grasshopper egg development, lizard body temperature and mammalian energy and water requirements.

REGULAR PRESENTATIONS (A-Z)

Selection against overwintering shapes thermal performance curves for development

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Understanding how organisms are adapted to a seasonal environment is a key question in ecology and evolutionary biology. Insect life cycles are adapted to a seasonal climate by expressing alternative voltinism phenotypes; the number of generations in a year. Variation in voltinism phenotypes along latitudinal gradients may be generated by developmental traits at critical life stages, such as eggs. Both voltinism and egg development are thermally determined traits, however, theoretical models of voltinism and thermal adaptation have developed independently of each other and make different predictions. To reconcile these models and test their respective predictions, we characterised patterns of voltinism and thermal response of egg development rate along a latitudinal gradient using the matchstick grasshopper genus *Warramaba*. We found remarkably strong variation of voltinism patterns, egg dormancy patterns and corresponding thermal response of egg development along a latitudinal temperature gradient. Thermal reaction norms followed a co-gradient pattern of variation and there was mixed support for latitudinal compensation of temperature in other life history traits. These patterns were not predicted by models of voltinism or thermal adaptation alone. Our results suggest that *Warramaba* life cycles are selected against hatching into winter along the latitudinal gradient. The range of developmental responses we observed illustrated a potent role of adaptation at the egg stage for the diversification of life cycles for species under variable climates. We suggest that latitudinal patterns in thermal responses and corresponding life histories needs to consider the evolution of thermal response curves within the context of seasonal temperature cycles rather than based solely on optimality and trade-offs of single traits.

REGULAR PRESENTATIONS (A-Z)

The effect of oxygen delivery on the thermal performance of a cockroach, *Nauphoeta cinerea*

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Observations of global warming impacts on species highlight the need for an understanding of mechanism underlying thermal tolerance in animals. The Oxygen and Capacity-Limited Thermal Tolerance (OCLTT) hypothesis proposes that the thermal tolerance of an animal is shaped by its capacity to deliver oxygen in relation to oxygen demand. Studies testing this hypothesis have largely focused on measuring short-term performance responses in animals under acute exposure to critical thermal maximums. The OCLTT hypothesis, however, emphasises the importance of sustained animal performance over acute tolerance. Therefore, these studies may be an inappropriate test of OCLTT. The aim of the current study was to investigate the effect of chronic exposure to 10, 21 and 40 % oxygen concentrations during development on medium to long-term performance indicators at an upper (34.5 °C), optimal (32.3 °C) and lower (34.5 °C) temperature limit in the speckled cockroach, *Nauphoeta cinerea*. The performance indicators of growth, aerobic performance, metabolic rate, and tracheal morphology were measured following a five-week developmental period. In contrast to the OCLTT hypothesis, development under hypoxia did not significantly reduce growth rate or aerobic performance, and development under hyperoxia did not significantly increase growth rate or aerobic performance. Developmental hypoxia and hyperoxia also did not have a significant effect on tracheal morphology in *N. cinerea*, suggesting that oxygen delivery capacity is not the primary driver shaping thermal tolerance in the species. The metabolic rate results did suggest that oxygen delivery performance may be important for metabolic acclimation; however, the results were not responsible for the decline in growth seen in *N. cinerea*. Collectively, these findings suggest that the OCLTT hypothesis is not a “unifying” model that can be applied across all levels and orders of biological organisation. A future meta-analysis on the OCLTT hypothesis would provide the opportunity to investigate potential interactive factors underlying thermal limits across different species.

REGULAR PRESENTATIONS (A-Z)

Body temperature changes during pregnancy – what and (an attempt at) why

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In many species of mammal, the circadian rhythm of the core body temperature changes during pregnancy. From around mid-gestation, the body temperature decreases while the amplitude of the daily rhythm decreases, suggesting a more tightly controlled thermal environment for the developing young. Several hypotheses have been proposed for these changes, including an enhancement of the “heat sink” function of the mother, and a pre-emptive protective role against hypoxia during birth. Our experiments at different ambient temperatures and relating the litter number and size to the extent of the decrease in temperature offer no support for the heat sink hypothesis. The pattern of temperature changes allow the study of ecological aspects of pregnancy in free-living mammals. A couple of interesting case studies will be presented, including the estimation of fitness in wild rabbits and confirmation of the Bruce effect in lions.

Abstracts

REGULAR PRESENTATIONS (A-Z)

Parent-embryo acoustic communication: a specialised heat vocalisation allowing embryonic eavesdropping

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Sound constantly triggers suites of physiological responses in organisms, because of the information they convey about the environment. Notably, alarm calls and sexual acoustic signals are known to produce endocrine changes, that allow individuals to respond to the current environment. Surprisingly however, the effect of sound during development has almost been completely overlooked, particularly prenatally. Yet, sound is often the external cue most accessible to embryos, and may constitute an unrivalled source of early information to shape developmental trajectories. Indeed, recently, prenatal exposure to a characteristic heat-related parental call was shown to alter zebra finch growth, begging and long-term fitness, as well as thermal preferences at adulthood. However, whether parental vocalisations are signals directed at embryos, or parental cues on which embryos eavesdrop remains to be fully explored. In addition, it is not known whether this signal is exclusively induced by heat or also in response to other stressors, which may affect its information value embryos. Here, we addressed these questions by investigating the ecological context of this behaviour in the wild and under controlled thermal conditions. We show that wild zebra finches also produce this characteristic call, only at high temperatures. However, it also occurs in roost nests, without an embryonic audience, although to a lesser extent. In addition, in the lab, we demonstrate experimentally that calling is specifically triggered by thermal stress. Importantly, the temperature threshold at which individuals start calling is a repeatable individual trait, predicted by their body mass. Overall, our findings reveal a specialised heat vocalisation, allowing embryonic eavesdropping, by indicating high ambient temperatures, but also parents' capacity to cope with such conditions. This challenges the traditional view of embryos as passive agents of their development, and opens exciting research avenues on avian adaptation to extreme heat.

Abstracts

REGULAR PRESENTATIONS (A-Z)

Southern African desert birds and climate change: lethal effects of acute heat exposure *versus* sublethal fitness costs of chronic heat exposure

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The direct effects of rising air temperatures and more frequent heat waves on arid-zone bird communities are manifested over multiple time scales. During extreme heat events, mortality events occur in a matter of hours if birds cannot avoid lethal hyperthermia and dehydration. Over time scales of days to weeks, sublethal fitness costs arising from trade-offs between foraging efficiency and thermoregulation can cause progressive loss of body condition in adults, reduced breeding success and/or poor body condition in fledglings. We synthesized data from physiological and behavioural studies of southern African arid-zone birds over the last decade and modelled the risks of lethal acute heat exposure and sublethal chronic exposure under current and future conditions. The risk of direct mortality during extreme heat events will remain low for most of these species. None are anticipated to experience a significant risk of lethal dehydration on more than 4-6 days yr^{-1} by the 2080s, a pattern contrasting with projections for the American southwest and the scenario likely for Australia. However, the severity and spatial extent of sublethal effects of chronic heat exposure will increase substantially during the coming decades. By the 2080s, Southern Pied Babblers (*Turdoides bicolor*) will experience 20-30 consecutive days yr^{-1} on which maximum air temperature exceeds the threshold at which their diurnal mass gain is zero, a situation where each 24-hr period is associated with loss of ~4% of body mass. For Southern Yellow-billed Hornbills (*Tockus leucomelas*) average maximum temperatures over large parts of their southern African range will approach or exceed 35 °C, the threshold associated with the probability of successful breeding decreasing below 50 %. Many species currently occurring in southern Africa's arid savanna biome will not be able to persist under future conditions, and we consequently predict large losses of avian biodiversity by the end of the century.

Abstracts

REGULAR PRESENTATIONS (A-Z)

Unravelling the physiological mechanisms behind asynchronous live-birth

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Birth occurs when the muscular layers of the uterus go from a quiescent state to a highly active state. This change is facilitated by a series of complex interactions, including nonapeptide hormones and embryonic stimulation. Here, I investigated the effect of nonapeptide hormones on uterine contractility in a viviparous lizard, *Liopholis whitii*. *Liopholis whitii* are unique in that they display birthing asynchrony, a process in which multiple synchronously developed offspring are born days apart within a single litter. This requires fine-scale control of the timing of offspring delivery, allowing females to exercise a single offspring at a time from within and between uteri. To examine the mechanisms underpinning this unique behaviour, I investigated the effects of the nonapeptide hormone, arginine vasotocin (AVT), on *in vitro* uterine contractile response in *L. whitii*, and the extent to which this co-varied with relative levels of gene expression for an AVT receptor, *AVPR1A.* I found that one uterus per animal was significantly more responsive to AVT than the other, and that this pattern was concordant with *AVPR1A* expression. I also found that embryo number per uterus had a significant effect on uterine contractile response to AVT, but this was not replicated in the *AVPR1A* expression data. Combined, my results suggest that the combination of independent uterine function and embryonic influence during pregnancy may be a mechanism by which *L. whitii* achieves asynchronous birth. However, more work is required on additional mechanisms such as the full suite of nonapeptide hormone receptors and further embryonic effects to fully understand the process of asynchronous offspring delivery. Unlocking the mechanisms behind birthing asynchrony might then provide insights into the timing of birth and how this facilitates the evolution of viviparity.

REGULAR PRESENTATIONS (A-Z)

Avian hormonal mediation of sub-speciation in the Long-tailed finch

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The Long-tailed Finch (Poephila acuticauda) occurs in its home habitat, the Kimberley region of Northern Australia, as two distinct sub-species. Genetic profiling has shown that sub-speciation occurred due to a historical geographical barrier, the Ord arid intrusion, which has since abated. The subspecies are identifiable by differences in both bill colour and song structure, however, intergradation between the subspecies occurs in the vicinity of the past barrier, producing viable hybrids. Despite this, gene flow between subspecies is not promoted, and subspeciation continues. We investigated whether corticosterone, the principle avian stress hormone, could be responsible for reproductive mechanisms responsible for this continued subspeciation, as corticosterone is implicated in polymorphic separation in the Gouldian finch, which displays a similar mating system. We found that the maternal corticosterone profiles of the two Long-tailed finch subspecies show significant differences, and this may contribute to the continuance of the subspeciation.

REGULAR PRESENTATIONS (A-Z)

Developing a standardised protocol for measuring seed metabolic rates: effect of temperature and availability of oxygen

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Storage of seeds in *ex-situ* seed banks is an efficient method of preserving seeds for an extended period of time, allowing them to be used in conservation, restoration, and agricultural efforts when required. Ideally seeds are stored at high viability, but seed viability decreases over time during storage due to the storage environment (extremely cold and dry) and physiological characteristics. An accurate and rapid method of predicting seed longevity would improve the management of large and diverse seed collections and ensure that viable, usable seeds are available when required. We hypothesise that if we can develop a standardised method of measuring seed metabolic rate, we can quantify and apply this to predicting seed longevity. Here we have investigated the effects of temperature and oxygen availability on the metabolic rate of germinating seeds. Metabolic rates of individual seeds were quantified through the use of the relatively novel Q_2 technology. The Q_2 is a high throughput closed system respirometer that gives a detailed and mostly automated quantification of the oxygen consumption rate of individual seeds (giving metabolic rate). Seeds of eight Western Australian native *Acacia, Eucalyptus* and *Senna* were tested at varying measurement chamber air volumes (1, 2, 3, 4 mL) and temperatures (18-40°C, species dependent), and were measured until germination occurred. Results showed that seed metabolic rates at germination are strongly influenced by temperature and the availability of oxygen. Refining and standardizing measurement protocols for diverse native species is necessary to confidently and accurately quantify the metabolic activity of seeds during germination. These results provide information regarding what experimental conditions seeds should be subjected to when measuring metabolic rate. This is critical for the development of a standardized and optimized method of measuring seed metabolism, which will be useful in future studies of seed longevity.

REGULAR PRESENTATIONS (A-Z)

The effects of early environment on thermoregulation in an arid-adapted bird

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Increase in global temperature and the occurrence of heat waves under climate change poses a significant threat on wildlife, including in avian species. Research, in the last decade, has started to uncover how species vary in their physiological heat tolerance. However, much remains to be known on how thermoregulation capacities vary between individuals within a single species, and how much developmental effects may contribute to that variation. Recently, zebra finch parents were found to produce a special call at high ambient temperatures during incubation, and that exposure to this call then alters nestling growth in a temperature-dependent manner. Here, we tested whether exposure to incubation calls prenatally and to high nest temperature postnatally improved individuals' thermoregulation capacities at adulthood. To test our predictions, we used an open flow-through respirometry system to measure the resting metabolic rate (RMR) and evaporative water loss (EWL) of individuals (n=44) at different temperatures ranging from 35°C (species thermoneutral zone) to 44°C. We also monitored the body temperature of the individuals in the metabolic chamber. We found that the RMR and body temperature increased with body mass but were not affected by developmental experience. By contrast, nest temperature affected water loss at high temperatures, with birds reared in hotter nest having lower water loss. In addition, birds exposed to incubation calls prenatally had higher water loss at 44°C than control birds exposed to parental contact calls. Our results suggest that early acoustic and thermal environments may contribute to inter-individual variation in thermoregulation in birds. As such, our findings provide the first evidence that prenatal sound has the potential to program individual thermoregulatory capacities until adulthood. Investigating this novel heat-adaptation mechanism may improve our understanding of animals' adaption to extreme temperature and might provide novel conservation strategies for threatened species.

Abstracts

REGULAR PRESENTATIONS (A-Z)

Early-life telomere length predicts lifespan and lifetime reproductive success in a wild bird

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Poor conditions during early development can initiate trade-offs that favour current survival at the expense of somatic maintenance and subsequently, future reproduction. However, the mechanisms that link early and late life-history are largely unknown. Recently it has been suggested that telomeres, the nucleoprotein structures at the terminal end of chromosomes, could link early-life conditions to lifespan and fitness. In wild purple-crowned fairy-wrens, we combined measurements of nestling telomere length (TL) with detailed life-history data to investigate whether early-life TL predicts fitness prospects. Our study differs from previous studies in the completeness of our fitness estimates in a highly philopatric population. The association between TL and survival was age-dependent with early-life TL having a positive effect on lifespan only among individuals that survived their first year. Early-life TL was not associated with the probability or age of gaining a breeding position. Interestingly, early-life TL was positively related to breeding duration, contribution to population growth and lifetime reproductive success because of their association with lifespan. Thus, early-life TL, which reflects growth, accumulated early-life stress and inherited TL, predicted fitness in birds that reached adulthood but not noticeably among fledglings. These findings suggest that a lack of investment in somatic maintenance during development particularly affects late life performance. This study demonstrates that factors in early-life are related to fitness prospects through lifespan, and suggests that the study of telomeres may provide insight into the underlying physiological mechanisms linking early- and late-life performance and trade-offs across a lifetime.

REGULAR PRESENTATIONS (A-Z)

Distributional and seasonal overlap of vegetable leafminer, a biosecurity threat, and a naturally occurring bio-control agent in Australia

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In 2015, the vegetable leafminer (VLM: *Liriomyza sativae*), a tiny agromyzid fly which attacks a broad range of vegetable, melon and flower crops, was detected for the first time on the Australian mainland. VLM is an international pest that has caused severe yield losses abroad, due largely to destructive feeding by the larvae, which create serpentine mines in the leaf that hinder photosynthesis and reduce marketability of crops. Successful management of this pest must include a significant reliance on Australia's substantial community of beneficial parasitoid wasps, many of which have been utilised overseas to successfully control VLM. Due to the early stage of its invasion there is a need to forecast the response of this pest to these novel environments, particularly the extent to which established parasitoids may mitigate damage to production industries through both natural and augmented biological pest suppression. However, the distributions of key parasitoids in Australia have been poorly studied, necessitating a predictive approach. We compiled physiological data on VLM and a key parasitoid species*, Diglyphus isaea*. Combining this with daily climatic data in a simulation framework, we predict how climatic suitability of *D. isaea* would be expected to overlap with that of VLM across Australia and throughout the growing season. Results show that the climatic suitability for *D. isaea* overlaps considerably with VLM and thus may offer substantial natural biocontrol services as this pest moves into new regions. Simultaneously, seasonal suitability is not always synchronised with VLM populations and there remain some areas uniquely suitable to VLM where biocontrol potential may be expected to be limited. This study provides a novel and dynamic ecological approach to estimate potential mitigating factors during the invasion of an exotic species into a novel range.

Abstracts

REGULAR PRESENTATIONS (A-Z)

Understanding and predicting impacts of extreme heat events on grey-headed flying-foxes (*Pteropus poliocephalus*)

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The predicted increase in frequency, intensity and duration of extreme heatwaves poses unprecedented threats to natural systems. The grey-headed flying-fox is an ideal candidate to study the impacts of heat extremes, with well-documented observations of heat stress behaviour, associated physiology and mortality. However, there is no current best-practice method to alleviate heat stress in wild flying-foxes due to limited understanding of the underlying mechanisms. Biophysical models provide a mechanistic understanding of the heat and water budgets of an animal, which can be used to predict thermal and hydric responses to heat stress conditions. We used the biophysical modelling framework, NicheMapper/NicheMapR, to investigate the key drivers of heat stress in adult grey-headed flying-foxes. We modelled the flying-fox as a furred ellipsoid with no wings and tested model predictions with empirical data on flying-fox heat stress thermophysiology and behaviour. We carried out sensitivity analyses to assess the influence of different parameters on the metabolic responses of the flying-fox. Finally, we compared accuracies of predicting die-offs using the biophysical model and forecast air temperature models. The measured metabolic rates, body temperatures and water loss rates in metabolic chamber conditions were similar to those that were modelled. The conditions at which licking and panting behaviours were predicted to occur in the model were consistent with field observations. The sensitivity analyses revealed that the change in fur depth and solar radiation had the greatest influence on metabolic response. Importantly, the biophysical model showed greater accuracy at predicting flying-fox die-offs compared to the forecast air temperature models (88.0% vs. 72.0%). This indicated the importance of incorporating a broader suite of environmental variables and animal characteristics to predict heat stress, and not only air temperature. Our findings have important implications for the conservation management of the Vulnerable grey-headed flying-fox and provide guidance for future research priorities.

REGULAR PRESENTATIONS (A-Z)

Metabolic rate and density affect population productivity in a sessile marine invertebrate

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Metabolic rate (MR) reflects the rate at which an organism allocates energy to essential processes such as maintenance, growth and reproduction – all of which affect fitness. MRs, however, vary extensively across individuals, populations and species. Although we are beginning to understand the consequences of variation in MR for individuals, the consequences for populations are still unclear. We created experimental populations of the sessile marine invertebrate *Bugula neritina* with individuals of known MRs. We manipulated both the density and mean MR of populations and followed growth and reproductive output of the individuals in the populations throughout their life in the field. We find that MR affects reproductive output initially, but MR effects weaken with time in the field. Overall, however, we find that there is a significant effect of population MR on population yield, with high MR populations having the greatest yield.

Abstracts

REGULAR PRESENTATIONS (A-Z)

Interspecific scaling of blood flow rates and arterial sizes in mammals

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According to Murray's Law, the branching structure of the arterial tree should supply blood to respiring tissues with the least energy cost. Therefore, it predicts the cube of the diameter of a parent artery should equal the sum of the cubes of the diameters of two daughter arteries, and wall shear stress (WSS) should be constant throughout the arterial tree. WSS is the frictional force of blood flowing near the vessel wall and is involved in vascular remodelling. Our previous research involved calculation of blood flow rate (Q.) from lumen radius (ri) with an equation based on Poiseuille theory and an empirical estimate of WSS from only two species of mammal. To avoid this uncertainty, this meta-study collected simultaneous Q. and ri data in 20 named arteries of nine mammal species, from 23 g mice to 652 kg cows. Lumen radius varied between 3.7 μm in a cremaster artery of a rat to 11.2 mm in the supraceliac aorta of a human. Remarkably, all 92 logged points fell on a single polynomial curve. The slope of the curve increased from about 3 in the smallest arteries to about 2 in the largest ones. Thus, Murray's Law applies only to the microcirculation, grading to an area-conserving model of arterial branching, called da Vinci's Rule, in the main arteries. A subset of the data was chosen to include only arteries to the head, because flow in them is quite constant and the relationships tighter. The allometric power regression, Q. = 155 ri 2.49, does not involve WSS or body mass, but can be used to evaluate blood flow rate from cephalic arterial size alone in any mammal, from mouse to horse. The equation is useful to evaluate brain perfusion from the size of foramina in the skull of recent and extinct species.

REGULAR PRESENTATIONS (A-Z)

The physiology of adaptation to arid conditions in a passerine bird

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The role of physiology in local adaptation is poorly understood as few studies directly link variation in physiological traits and performance to population genetics. A pattern of local adaptation has been reported in a southern African endemic bird, the Karoo scrub-robin (*Cercotrichas coryphaeus*): this species exhibits strong population divergence in genes associated with energy metabolism. This differentiation occurs along a spatial gradient of environmental heterogeneity, despite extensive gene flow as revealed by variation in neutral genes and morphological data. These puzzling results suggest that divergent selection is favouring particular physiological phenotypes across an environmental gradient. Therefore, we conducted a complimentary physiological study to better understand the links between population genetics and environment in the Karoo scrub-robin. We found the variation in physiological phenotypes (basal metabolism and metabolic expansibility) to be associated both with environmental features and variation in genes underlying energetic metabolic pathways across the environmental gradient, despite extensive non-adaptive gene flow. Together our results suggest that selective pressures on energetic physiology mediated by genes related to energy balance may facilitate adaptation to local conditions and explain the high avian intra-specific divergence observed in harsh environments.

REGULAR PRESENTATIONS (A-Z)

Effects of pregnancy on sub-lethal thermal tolerance in a viviparous New Zealand skink

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Thermal limits are a key component in our understanding of how a species' physiology determines the environmental conditions in which it can survive. Non-lethal thermal limits such as voluntary thermal maximum (VT_{max}) and critical thermal maximum (CT_{max}) are useful measures as they reflect how behaviour and ecophysiology are affected at high temperatures, and they have well-established methods that have been applied across many taxa. These limits are, however, not static in space and time and may also vary between life-history stages. Viviparous lizards are of interest as they often thermoregulate differently when pregnant. Pregnancy is physiologically challenging; lung capacity may be decreased as the lungs are compressed by developing embryos and the metabolic cost of moving and even breathing may be increased. In this study we tested the hypothesis that VT_{max} and CT_{max} differed among life history-stages of McCann's skink (*Oligosoma maccanni*) and specifically that pregnancy reduced thermal tolerance. We found that both VT_{max} and CT_{max} differed significantly among life-history stages, and that CT_{max} was significantly lower in pregnant females compared to postpartum females and males. There were also no discernible effects of testing on the sprint speed, endurance or mass of neonates that underwent testing in utero. Given the presumed reduced lung capacity and greater metabolic demands of pregnant skinks, our results are consistent with the oxygen-capacity limited thermal tolerance hypothesis. Nonetheless, this hypothesis is currently debated as many studies have failed to uphold its assumptions. To our knowledge, ours are the first measurements of VT_{max} and CT_{max} in a pregnant viviparous squamate and the first such measurements in a New Zealand skink

REGULAR PRESENTATIONS (A-Z)

Scoop a Poop: using citizen science to investigate the spread of antibiotic resistance into the wild

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Resistance of bacteria to antibiotics is a problem of global significance. Since the development of the first antibiotic medicines in the 1950s, we have seen bacterial evolution of resistance to a broad range of different classes of antibiotics. While there are several genetic pathways by which bacteria can develop resistance to antibiotics, one particular genetic determinant known as the clinical class 1 integron has been central to the evolution and emergence of resistance. Class 1 integrons can be readily identified using PCR techniques and as such are a useful tool for assessing antibiotic resistance by the screening of bacterial DNA. Scoop a Poop is a citizen science project with two aims: to increase public awareness and understanding of antibiotic resistance, and to investigate the prevalence of antibiotic resistant organisms in the Australian ecosystem. Our target wildlife species is the brushtail possum, a widespread species adapted to urban environments. Citizen scientists collect possum faecal specimens using a dedicated Scoop a Poop collection kit. The samples are returned to the laboratory at Macquarie University, where we extract bacterial DNA from the faeces and use a series of PCR protocols to screen for class 1 integrons. Preliminary results from the first year of the project have shown the highest prevalence of class 1 integrons (52%) in samples collected at a central city location, and the lowest prevalence (9%) in samples from a national park. Further sampling will be performed over the next 18 months over a wider geographical area. In addition to the presentation of these results, this talk will showcase the first year of the project, including our outreach approach to schools and community groups and a demonstration of the Scoop a Poop mobile app.

REGULAR PRESENTATIONS (A-Z)

Growth drives metabolic scaling

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Metabolic rate, B, scales allometrically with body mass m, usually according to power function $B = am^b$ where a is the scaling coefficient and the scaling exponent b is usually less than 1. The reasons for this allometric scaling are hotly debated and important, but no consensus has been achieved. Most attention has focussed on the central tendency of the distribution of empirically determined estimates of b, with comparatively little examination of the factors that drive variation in b. Here, we examine the variation in the ontogenetic scaling of metabolic rate, and demonstrate that variation in the ontogenetic value of b is driven by among-species differences in growth patterns. Building on this, and the data from a recent meta-analysis of fish that shows that reproductive output scales in proportion to $m^{b>1}$, we argue that growth slows not because of mechanistic constraint but because of increasing energy allocation to reproduction.

REGULAR PRESENTATIONS (A-Z)

Pregnancy and parturition in the seahorse *Hippocampus abdominalis*

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Syngnathid fish are unique examples of male-pregnant vertebrates. Males fertilize and incubate eggs in a brood pouch, which varies in complexity across the lineage, making these fish ideal models for the evolution of viviparity and reproductive complexity. We are therefore developing the Australian pot-bellied seahorse *Hippocampus abdominalis* as a model for evolutionary research. Our transcriptomic studies revealed common genetic pathways underpinning pregnancy and parturition in seahorses and other vertebrates representing independent origins of viviparity. We are now using these data to generate testable hypotheses for physiological research. The need to exchange respiratory gases between embryos and parents is a challenge of pregnancy that is common to viviparous species. Our genetic data show that angiogenic and vasculogenic factors increase in the brood pouch during seahorse pregnancy, suggesting that the vascular bed of the seahorse brood pouch increases during pregnancy to provide embryos with respiratory gas exchange. We found that whilst embryonic oxygen consumption increases throughout pregnancy, the vascular bed of the brood pouch only expands at the start of pregnancy. These results suggest that while increased brood pouch vascularity provides seahorse embryos with respiratory gas exchange early in development, other mechanisms are likely to contribute to gas exchange when embryonic respiration is at its highest. Our genetic data also suggest that oxytocin family hormones trigger seahorse labour, in a similar manner to their effects on uterine contractions during amniote labour. Whilst isotocin (an oxytocin-family hormone) triggers parturition-like behaviour in non-pregnant male seahorses *in vivo*, it fails to produce brood pouch contractions *in vitro*. Histology reveals a virtual absence of smooth muscle in brood pouch walls, and raises the possibility of control of parturition via voluntary behavioural pathways. These results suggest that similar endocrinological pathways have been co-opted in different ways to produce parturition in seahorse males compared to female amniotes.

Abstracts

REGULAR PRESENTATIONS (A-Z)

Short-duration respirometry underestimates metabolic rate for discontinuous breathers

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Metabolic rate is commonly estimated from rates of gas exchange. An underappreciated factor that can influence estimates is patterns of pulmonary respiration. Amphibians display discontinuous respiratory patterns, often including long apnoeas, in addition to cutaneous gas exchange. The contribution of cutaneous exchange increases at low temperatures when metabolic rate is low. Due to the relatively low permeability of skin, measurements that disproportionately capture cutaneous exchange can produce underestimates of metabolic rate. The permeability of amphibian skin to CO_2 is greater than O_2, therefore calculating the ratio of whole-animal CO_2 emission to O_2 uptake (the respiratory exchange ratio, RER) can be used to avoid underestimates of metabolic rate by ensuring that observed values of RER fall within the normal physiological range (~0.7 to 1). Using data for cane toads *Rhinella marina* we show that short-duration measurements lead to underestimates of metabolic rate and overestimates of RER. At low temperatures this problem is exacerbated, requiring over 12 hours for RER to fall within the normal physiological range. Many published values of metabolic rate in animals that utilise cutaneous exchange may be underestimates.

REGULAR PRESENTATIONS (A-Z)

Regulation of insensible evaporative water loss by dasyurid marsupials

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We have previously demonstrated that mammals (and birds) regulate insensible evaporative water loss (EWL_{insens}; mg h^{-1}) over a range of ambient relative humidities (RH). However, nothing is known about the extent, patterns and purpose of this physiological process. We explore here allometric and environmental patterns of evaporative water loss regulation by examining the effect of RH on EWL_{insens} for 8 species of dasyurid marsupial (mass < 10 g to > 1000 g), from mesic, semi-arid, and arid environments, at ambient temperatures (T_a) of 20 to 30°C. EWL_{insens}, standardised by extrapolation to 0% RH, was independent of T_a. The minimum value for EWL_{insens} for the 8 dasyurid species scaled allometrically with body mass (slope = 0.63). There was a significant positive relationship for EWL_{insens} ΔWVP^{-1} (i.e. EWL_{insens} independent of the water vapor pressure, the driving force for evaporation) as a function of ambient WVP, indicating that EWL_{insens} was physiologically regulated (i.e. slope > 0 compared to slope = 0 for non-regulation) for all species, for at least one T_a. To compare the degree of EWL regulation between species, we first tested for allometric effects on the slope of mass-independent EWL_{insens} ΔWVP^{-1} (i.e. EWL $mass^{0.63}$, this study or $mass^{0.75}$, general EWL scaling of dasyurid marsupials); there was no allometric effect on regulation of EWL_{insens}. Habitat aridity had no influence on the degree of EWL regulation. These findings indicate that EWL regulation occurs over a range of body masses, and is consistent with the hypothesis that the function of this process may be to simplify endothermic thermoregulation, rather than water conservation in arid habitats.

Abstracts

REGULAR PRESENTATIONS (A-Z)

Male-specific plasticity of activity patterns in dusky antechinus

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Sleep is a prominent, seemingly universal animal behaviour. Although there is broad consensus that sleep maintains optimal waking performance, the biological drive to sleep on a daily basis may be incompatible with the life-history and ecology of some species. For instance, sleeplessness may be favoured to maximize fitness during the breeding season in polygynous males. To better understand the trade-off between the neurophysiological requirements for sleep and evolutionary needs for reproduction, it is necessary to study animals that might have evolved temporary sleeplessness when ecological demands favour extended wakefulness. Perhaps the best mammal candidate for the seasonal suppression of sleep is antechinus. Dusky antechinus (*Antechinus swainsonii*) is a small dasyurid marsupial with an unusual reproductive strategy characterised by a large sexual dimorphism (100g males, 50 g females) and the synchronous mass death of all males at the end of their only breeding season. Here, we hypothesised that 1) only males would increase activity during the breeding season and 2) the inactivity reduction of breeding males reflects sleep loss. We conducted a multi-year effort to explore these hypotheses. In 2017, eight dusky antechinus (4 males) were trapped in the wild, and housed individually in naturalistic outdoor enclosures before the onset of winter mating. Activity was recorded using small, lightweight accelerometers. Further, blood was sampled every 15 days to determine whether metabolite or endocrine changes such as oxalic acid and testosterone can be used to predict sleep pattern; urine was sampled two times a week to determine the onset of the breeding season. Preliminary results of four consecutive days prior to, and during, the breeding season show a significant male-specific increase of activity during the breading season. Furthermore, analyses of oxalic acid and testosterone level over the breeding season suggest their potential use as predictor of activity pattern in antechinus.

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Student Prize Winners

9 DECEMBER 2018

Best Presentation: Julian Beaman

1st Runner-up Presentation: Deirdre Merry

2nd Runner-up Presentation: Jacinta Kong