JAMES COOK UNIVERSITY
AUSTRALIA

ANZSCPB
34th ANNUAL MEETING 2017

DAINTREE RAINFOREST OBSERVATORY

SUPPORTED BY Journal of Experimental Biology

THURSDAY NOVEMBER 30 – SUNDAY DECEMBER 3, 2017

Welcome

Dear ANZSCPB Delegates,

The Daintree Rainforest Observatory (DRO) on behalf of James Cook University would like to welcome you to the 34th Annual Meeting of the Australian and New Zealand Society of Physiology and Biochemistry. We are delighted to be hosting this event, and hope that everyone will enjoy this year's conference, as well as our beautiful lowland wet tropical rainforest surrounds. For your dining pleasure we have engaged a resident chef from Cape Tribulation (Rachel Grover) and she is excited to have the opportunity to prepare a menu for you which will showcase our local produce.

Our field station was established in 1998 and underwent a major redevelopment in 2014. The DRO is one of only five long-term ecological monitoring sites in Australia. We offer accommodation (sleeping up to 50 guests), a fully equipped commercial kitchen, a spacious lecture theatre/multi-purpose room, an open-air teaching laboratory, and an air-conditioned laboratory complete with microscopes and basic scientific equipment. The facility also houses a large insect collection and herbarium for visitor reference consisting of specimens collected on-site. In addition we are very lucky to have the only rainforest canopy crane in the southern hemisphere. Our 48m tall Liebherr construction crane allows researchers to extensively access one hectare of rainforest from the atmosphere above the canopy, right down to the ground. The crane is a unique research platform allowing students and researchers to use advanced scientific equipment to observe ecological, physiological and, atmospheric processes in-situ. Complementing this is a network of soil pits and bores for subterranean analyses, and a series of long-term data-sets.

The DRO is also a TERN Australian Supersite Network site helping to ascertain how key ecosystems will respond to future environmental change. As such the DRO forms part of a worldwide network of research projects that aim to understand climate change across the globe.

Our field station is available for hire by local, national and international high schools and universities for educational programs, meetings, workshops, conferences, undergraduate classes, post graduate studies and research.

For any assistance required during the conference or for information regarding potential future visits, pleases do not hesitate to contact Michele Schiffer in person or via phone 07 4098 0005 or email **dro@jcu.edu.au**.

Wishing you a most salubrious stay.

Michele Schiffer
Station Manager
Daintree Rainforest Observatory

DAINTREE RAINFOREST OBSERVATORY

JAMES COOK UNIVERSITY AUSTRALIA

Room Allocations

RESEARCHERS

QUANDONG — Christine Cooper, Phil Withers

BANDICOOT — Andrew Krockenberger, Roger Seymour

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DRONGO — Gordon Grigg, Michael Kearney

PYTHON — Stephen Ferguson, Sean Tomlinson

GOLDEN ORB — Nicholas Wu, Carl Jones

EPIPHYTE — Bob Cieri, Tom Nelson, Hugh Winwood-Smith

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TREE FROG — Craig White, Lesley Alton

STRIPEY — Christofer Clemente, Taylor Dick

WOMPOO — Lynette Beard, Koa Webster, Mylene Mariette

CASSOWARY — Jacinta Kong, Vivi Hu, Himali Ratnayake

Programme

THURSDAY 30 NOVEMBER 2017	
4:00pm – 6:00pm	Guests arrive, register and settle in
5:30pm – 6:00pm	Bus arrives and remaining guests register and settle in
6:00pm – 6:30pm	Welcome to DRO and Induction
6:30pm – 7:00pm	Meet and greet – drinks and nibbles
7:00pm – 9:00pm	Dinner

FRIDAY 1 DECEMBER 2017	
7:30am – 8:30am	BREAKFAST
Morning Session – Chair: Christine Cooper	
9:00am – 9:30am	1) Guest Speaker: Andrew Krockenberger
9:30am – 10:00am	2) Andrew McKechnie
10:00am – 10:30am	3) Christofer Clemente
10:30am – 11:00am	MORNING TEA
Mid-Morning Session – Chair: Lesley Alton	
11:00am – 11:30am	4) Karl Jones
11:30am – 12:00pm	5) Vivi Hu
12:00pm – 12:30pm	6) Taylor Dick
12:30pm – 1:30pm	LUNCH
Afternoon Session – Chair: Christofer Clemente	
1:30pm – 2:00pm	7) Bob Cieri
2:00pm – 2:30pm	8) Tom Nelson
2:30pm – 3:00pm	9) Koa Webster
3:00pm – 3:30pm	AFTERNOON TEA
Mid-Afternoon Session – Chair: Taylor Dick	
3:30pm – 4:00pm	10) Nicholas Wu
4:00pm – 4:30pm	11) Arista Botha
4:30pm – 5:00pm	12) Stephan Ferguson
7:00pm – 9:00pm	DINNER
9:00pm	Camp fire, weather permitting

SATURDAY 2 DECEMBER 2017	
7:30am – 8:30am	BREAKFAST
Morning Session – Chair: Stephen Ferguson	
9:00am – 9:30am	13) Roger Seymour
9:30am – 10:00am	14) Jacinta Kong
10:00am – 10:30am	15) Michael Kearney
10:30am – 11:00am	MORNING TEA
Mid-Morning Session – Chair: Craig White	
11:00am – 11:30am	16) Mylene Mariette
11:30am – 12:00pm	17) Himali Ratnayake
12:00pm – 12:30pm	18) Gordon Grigg
12:30pm – 1:30pm	LUNCH
Afternoon Session – Chair: Phil Withers	
1:30pm – 2:00pm	19) Christine Cooper
2:00pm – 2:30pm	20) Sean Tomlinson
2:30pm – 3:30pm	AGM
3:30pm – 4:00pm	AFTERNOON TEA
4:00pm – 7:00pm	Free time to explore, relax or put together a tropical costume
7:00pm – 9:00pm	"Tropical" themed Dinner Party

SUNDAY 3 DECEMBER 2017	
7:30am – 8:30am	BREAKFAST
Morning Session – Chair: Sean Tomlinson	
9:00am – 9:30am	21) Phil Withers
9:30am – 10:00am	22) Lyn Beard
10:00am – 10:30am	Prizes and wrap up
11:00am	Bus leaves with packed lunch
12:00pm – 1:00pm	LUNCH for those with own transport

Student Judges: Christine Cooper, Koa Webster, and Craig White

Abstracts

Body temperature of koalas during capture

Lyn Beard[1]*, Gordon Grigg[1], Peter Brice[1], Bill Ellis[1], Ben Barth[1], Sean FitzGibbon[1], Dalene Adam[1].

[1] The University of Queensland

Continuous measurement of the body temperature (Tb) of koalas in the field has recently been undertaken via intraperitoneal biotelemetry and logger implants. This has enabled Tb profiles to be monitored during the "flagging" capture of wild koalas. Results indicate that koalas experience a detectable rise in Tb during capture that is distinct from their routine daily Tb cycle. This rise typically begins before the animal has moved, accelerates during the physical activity associated with capture, and continues for approximately one hour following completion of capture- a considerable time after the animal has stopped moving. A typical capture event resulted in a total Tb increase of 1.5 -2.0 °C with short-term (5-10 min) rates of Tb increase of up to 2.7 °C /hr recorded. The rates of increase in Tb during capture were generally higher than those observed for the same individual undisturbed in the wild. There is clearly potential for Tb to reach detrimental levels following capture, especially if capture is attempted at times when Tb is already at the peak of its daily cycle. These data underline the need to carefully vet the ambient conditions before attempting capture and also to minimise pre-capture set-up and post capture handling time.

Factors that contribute to individual variability in 24-hour body temperature patterns in captive African buffalo

Arista Botha*[1], Andrea Fuller[1], Robyn Hetem[1,2]

[1] Brain Function Research Group, School of Physiology, University of the Witwatersrand, Johannesburg, South Africa
[2] School of Animal, Plant and Environmental Sciences, University of the Witwatersrand, Johannesburg, South Africa

Daily body temperature variability in individual large mammals has been associated with changes in resource availability, energy expenditure, disease and thermal load. A narrow rhythm of body temperature is evident only in healthy mammals with access to water and food, suggesting that 24-h body temperature patterns could be used as an index of physiological welfare. We investigated the effect of diet restriction and disease on sub-adult African buffalo (*Syncerus caffer*) infected with foot-and-mouth disease virus. All buffalo displayed fevers in response to the infection. One group of 12 buffalo received an ad-libitum diet of teff hay and Lucerne. A second group of 10 buffalo received a diet without Lucerne and 25% less teff hay for three months. Despite a significant difference in body mass between the two groups (t_{21}=3.30, p=0.0034) by the end of the diet restriction period, the 24-h body temperature rhythm of the feed-restricted and control buffalo was similar (t_{20}=1.35, p=0.19). However, there was substantial inter-individual variation, with body temperatures fluctuating by 1.3 to 4.5 °C over 24-hours. We are investigating further the effects of ambient temperature, age, sex, body mass loss, and immune response on body temperature patterns in buffalo subjected to nutritional and disease stress.

Computational fluid dynamics modelling of pulmonary airflow in varanid lizards

Robert L. Cieri[1*], Suzanne L. Munns[2], C.G. Farmer[1]
[1] University of Utah, Salt Lake City, USA
[2] James Cook University, Townsville, QLD, Australia

Understanding the biomechanical basis of unidirectional pulmonary airflow, a condition where lung gases travel in the same direction through most of the airways and throughout the respiratory cycle, has long been of interest to scientists. Recent work has revealed a wide phylogenetic distribution of this trait, beyond the confines of *Aves,* to include crocodilians, green iguanas, and monitor lizards. Advances in computational fluid dynamics, a technique where patterns of flow are simulated from prescribed boundary conditions by laws of fluid motions, provide a powerful tool to study airflow through these complex and fascinating structures. Australian monitor lizards (varanidae) are a promising group to investigate the significance of these lung traits because their adaptive radiation crosses many ecological niches with a similar body plan. Computed tomography scans of varanid species being made and segmented into a detailed computational meshes, representing the major and minor airways as has already been done for the savannah monitor, *Varanus exanthematicus*. Flow patterns are simulated through these airways in two ways on a high performance computing cluster using dynamic and static OpenFOAM solvers and visualized using ParaView.

Locomotor kinematics and gait on inclined and narrow surfaces, in the semi-arboreal Northern Quoll (*Dasyurus hallucatus*)

Christofer J. Clemente[1,2*], Joshua Gaschk[1], Ami Fadhillah Amir Abdul Nasir[2], Skye Cameron[2], Rebecca Wheatly[2], Robbie Wilson[2]
[1] University of the Sunshine Coast, QLD, Australia.
[2] University of Queensland, QLD, Australia.

Characterisation of an organisms' performance in different habitats gives insight into the conditions providing the greatest fitness of a species. We explored this idea by quantifying biomechanics and kinetics of movement over narrow (13mm pole) and wide (90mm platform) surfaces, in wild northern quolls (Dasyurus hallucatus) – a medium-sized carnivorous marsupial native to northern Australia. Previous studies have shown that Northern Quolls have undergone declines within the open habitats, but less so in rocky hills, therefore we predicted Quolls may show biomechanical adaptations for increasing stability on narrow surfaces.

We found speed was constrained on narrow surfaces, yet some Quolls are able to move over narrow poles at similar speeds to wide platforms, using higher duty factors. This increase in duty factor is probably required to maintain stability, via increased contact time. To maintain similar speeds at higher duty factors, swing time was reduced on these surfaces. Pulling forces were higher on the narrow pole (1.07 ± 0.155 N), compared with the angled surface 0.36 ± 0.112 N), a result of being able to grip underneath the narrow surface. Quolls were also capable of generating substantial torque along the narrow pole (Max = 68.9 N.m, Min = -69.9 N.m). Combined these results suggest an increased ability to create corrective forces to counteract toppling moments on narrow surfaces.

Comparison of the effects on evaporation and other physiological variables for two methods of manipulating the evaporative environment, for a small desert marsupial.

Christine E. Cooper[1*] and Philip C. Withers[2]

[1] Department of Environment and Agriculture, Curtin University, Perth, Western Australia
[2] School of Biological Sciences, University of Western Australia, Perth, Western Australia

Some endotherms can regulate their "insensible" evaporative water loss (EWL) independent of the water vapour pressure differential (ΔWVP) between the animal and ambient air. Generally, this is examined by modifying the ambient relative humidity (RH) at a particular ambient temperature (T_a) to manipulate the ΔWVP. However, helox has also been used to modify the evaporative environment, but until now, both techniques have not been directly compared. Here we present EWL and other physiological data for a small arid-habitat marsupial, the ningaui (*Ningaui spp.*) where the evaporative environment has been modified by RH and by helox. A significant relationship between EWL/ΔWVP and RH was confirmed for ningauis at T_a of 20 and 30°C, evidence for deviation from the physical model of evaporation, hence regulation of "insensible" EWL. At 25°C this relationship was equivocal. Neither body temperature nor metabolic rate were impacted by RH. For ningauis in helox, there was no difference in EWL compared to that in air, despite an increase in metabolic rate below thermoneutrality. We conclude that both methods of modifying the evaporative environment can be used to confirm regulation of "insensible" evaporative water loss. Ningauis are another small mammal that can regulate EWL under varying evaporative conditions.

Where have all the giants gone? Animals exploit different biomechanical strategies to overcome the problem of size

Taylor JM Dick[1,*] and Christofer J Clemente[2]

[1] School of Biomedical Sciences, University of Queensland, St Lucia, Queensland
[2] School of Science and Engineering, University of the Sunshine Coast, Sippy Downs, Queensland

The survival of both the hunter and the hunted often comes down to speed, yet how fast an animal can run is intricately linked to its body size, such that the fastest animals in nature are not the biggest nor the smallest. The ability to maintain high movement speeds is dependent on the body's capacity to withstand the high musculoskeletal stresses involved with locomotion. However even when standing still, scaling principles would suggest that the mechanical stress an animal feels will increase in greater demand than its body can support. So if big animals want to move fast, they must find solutions to overcome these high stresses. Here we present three groups of animals – varanid lizards, felids, and non-felid mammals – that utilize different biomechanical strategies to mitigate the size-related increases in musculoskeletal stress. We demonstrate that which of these strategies they use influences the relationship between speed and body mass. These results may provide some evidence as to why we no longer see giants, like dinosaurs, in nature.

Adult nest attendance, not conspecific vocalizations, alters nestling hypothalamo-pituitary-adrenal axis activity in Florida scrub-jays

Stephen M. Ferguson[1,2*], Stephan J. Schoech[1]

[1] University of Memphis
[2] Curtin University

In adult birds, territorial vocalizations can stimulate the release of steroid hormones as a means of coping with intrusions by conspecifics. During the breeding season, altricial nestlings may eavesdrop on nearby parental territory defence. Though nestlings are capable of responding physiologically to extreme events, like researcher handling, whether ecologically relevant factors, such as conspecific vocalizations, elicit such a response is unclear. We hypothesized that Florida scrub-jay (*Aphelocoma coerulescens*) nestlings would elevate corticosterone (CORT) in response to territory defence. We conducted conspecific, heterospecific, or no-call playback near nests, recorded parental behavioural responses, and measured CORT responses of nestlings. CORT levels in conspecific playback nestlings did not differ from either of the controls (heterospecific or no-call) immediately following playback. However, adult (parent + helper) activity at the nest fell at similar rates during both conspecific and heterospecific playback; thus, we compared combined playback nests with no-call nests *ex post facto*. Following the stress of a 10 min restraint, nestlings exposed to playback had higher CORT levels than unexposed, no-call nestlings. Our results suggest that vocal stimuli alone are insufficient to activate a CORT response in Florida scrub-jay nestlings. However, we suggest that adult attendance serves as a social buffer against subsequent stressors.

What explains the warmth of Mosasaurs?

Gordon Grigg[1*] and Peter Brice[1]

[1] School of Biological Sciences, University of Queensland, 4072.

Mosasaurs were predatory, viviparous marine reptiles that inhabited warm shallow Late Cretaceous inland seas. They ranged in size from about 1.5 – 17 metres (approximately 10 – 15,000 kg) and became extinct with the K-Pg extinction event. Taxonomically they are classified as Squamates, related to Varanids. A study coming out of the University of Alabama and the University of Arizona assessed the temperature at which tooth enamel and/or cortical bone was laid down in three species of mosasaur by comparing their $\delta^{18}O_{PO4}$ data with fish from the same locality and of the same age (Harrell *et al*. 2016). They found average temperatures of 33.1, 36.3 and 34.3°C, compared with 28.3°C for the fish, higher than the ambient water. Is this evidence for mosasaur endothermy, or could the results be explained by gigantothermy? At the time of writing we do not know the answer, but we are investigating, using a modelling approach, and we expect to have some insight in time for the meeting.

Title: Foramen measurement using micro-CT and microphotography

Qiaohui (Vivi) Hu[1,*], Thomas Jack Nelson[1], Roger Seymour[1]

[1] School of Biological Sciences, University of Adelaide, Adelaide 5005 SA, Australia

An organ's metabolism with associated physiological processes is generally dependent on blood flow rate to this organ. Some blood vessels pass through foramina on bones. Since the foramen size is well designed to be proportional to the vessel size, which is driven by the required blood flow rate, regional blood flow through a foramen can be estimated by simply measuring the foramen size. This "foramen technique" has successfully estimated femoral and brain perfusion in some terrestrial vertebrates. After the foramen technique was proposed, different methods have been used to measure foramen sizes. Blood flow estimated from the "foramen technique" is sensitive to the foramen size, and with the expanding interest in this "foramen technique", a standard foramen size measurement method is therefore required. We propose micro-CT and microphotographic methods as two applicable foramen size measurement methods. Foramen size data collected from both methods were compared to investigate methodological errors.

Bimodal respiration and dive characteristics of the diving beetle *Platynectes decempunctatus* (Coleoptera: Dytiscidae).

Karl K. Jones[1,*] and Roger S. Seymour[1]

[1] School of Biological Science, University of Adelaide, Adelaide 5005 SA, Australia

Diving beetles (Dytiscidae) are found in almost all freshwater habitats around the world. However, only the basic physiology and physical characteristics of the respiratory system has been determined with few studies investigating respiration and dive characteristics in detail. In this study we measured the O_2 consumption rate, dive duration, surfacing duration, surfacing frequency and activity of the medium sized dytiscid ***Platynectes decempunctatus*** in closed respirometry chambers at three temperatures (10, 15 and 20°C). The use of fibre-optic O_2-sensing probes allowed measurement of O_2 exchange with the air during surfacing events and enabled calculation of O_2 gain from the water. Dive characteristics and activity in the respirometry chambers were compared with experiments in control dive chambers. The behaviour of beetles in respirometry chambers differed from those in control chambers by having shorter dive duration, increased surfacing frequency and surfacing duration. Rising temperature increases O_2 consumption rate and surfacing frequency, and decreasing dive duration. However, varying activity of the beetles has considerable effects on dive characteristics. Where surface O_2 exchanges could be measured for entire respirometry experiments, beetles were found to gain between 7 and 46% of their O_2 from the water.

Modelling joint effects of body size and microclimate on heat budgets and foraging opportunities of ectotherms

Kearney, Michael R.[1]*; Porter, Warren P.[2]; Huey, Raymond B.[3]

[1] The University of Melbourne
[2] The University of Wisconsin
[3] The University of Washington

Body size, behavior, and climate jointly determine micro-climates experienced by a terrestrial ectotherm, and consequently they determine body temperatures, constrain activity periods, and enable foraging opportunities. Importantly, micro-climates experienced by an ectotherm change with body size, simply because air temperatures and wind speeds change dynamically with height above ground. Here we develop and test a simple, transient heat-budget model that uses microclimatic forcing to compute the dynamics of size-dependent body temperatures of ectotherms in sun and in shade at different times, seasons, and sites. Next, we develop a model of behavioral thermoregulation, in which behavioral events are triggered by specific body temperatures. Then, by integrating the heat-transfer and behavioral models, we compute potential body temperatures and then map these to ecologically relevant metrics, including foraging opportunities and thermal constraints. To illustrate potential applications of this synthetic approach, we use a global microclimate data set (microclim) and the transient model to explore how body size (5 g, 5 kg) alters microclimates, body temperatures, activity periods, and foraging opportunities (time, distance, frequency) of thermoregulating ectotherms. All functions are now integrated into the biophysical modeling R package NicheMapR, and thus can be used to explore diverse applications in thermal ecology.

Does variation in egg developmental responses to temperature generate divergent life cycles in a genus of flightless grasshoppers (*Warramaba* spp.)?

Jacinta Kong*[1], Ary Hoffmann[1] & Michael Kearney[1]

[1] School of BioSciences, the University of Melbourne, Parkville, Australia 3010

Insect life cycles are synchronised with suitable climatic conditions by the induction of dormancy and the sensitivities of critical life stages, such as eggs, to climate. Divergent life cycles can be generated when these developmental traits are highly variable within a species. Groups of closely related species with divergent life cycles are excellent systems to investigate the evolution of life cycles under variable climates. We examined the role of temperature-dependent egg development for generating diverse life cycles in the flightless grasshopper genus *Warramaba*, which is widely distributed across arid Australia and whose phylogenetic relationships are well understood. Specifically, we identified inter- and intraspecific variation in egg development and dormancy traits to inform a microclimate-driven model of egg development. Using the egg developmental model, we compared simulated phenology in the genus *Warramaba* with field observations. The range of developmental traits at a critical life stage represents an underappreciated role of the egg stage for the diversification of life cycles for species under variable climates.

Differential Sensitivity of Skinks to Heat and Desiccation

Anna Pintor[1], Lin Schwarzkopf[1], Andrew Krockenberger[1*]

[1] College of Science & Engineering, James Cook University, Australia

Recent research has focused repeatedly on physiological thermal tolerances, and especially their upper limits, as a potential proxy for species' potential to deal with anthropogenic climate change. There is an intuitive logic to the connection between physiological tolerance of heat and resistance to increases in environmental temperature. However, patterns of 'under filling' of some species ranges at that there may be other additional mechanisms impacting fitness at temperatures below absolute physiological thermal limits. One trait that may cause sensitivity to heat more indirectly in ectotherms is water loss, because of its positive correlation with body temperature. We tested for geographic variation in physiological thermal tolerance limits (critical thermal maximum and critical thermal minimum) and water loss in a clade of Australian skinks and found that water loss may be of underappreciated importance for dry-skinned ectotherms. Water loss may limit lizards geographically and furthermore clash with thermoregulation in hot, dry conditions.

Avian adaptation to heat by prenatal acoustic stimulation

Mylene M. Mariette[1*] and Katherine L. Buchanan[1]

[1] Deakin University, Centre for Integrative Ecology, Geelong , Australia

In many species, ranging from crocodiles and birds to humans, embryos can perceive, learn and even produce sounds. Surprisingly however, the implications of such embryonic capacities for developmental programming had not been recognized until very recently. We revealed a novel function of prenatal communication by showing that zebra finch parents acoustically signal high ambient temperatures to their embryos. In a large playback experiment in incubators, we showed that exposure of embryos to these acoustic cues alone adaptively alters subsequent nestling growth in response to nest temperature, and influences individuals´ thermal preferences as adults. Here, we investigated the possible physiological mechanisms underlying such developmental programming by prenatal acoustic signals. Specifically, we tested the hypothesis that exposure to "incubation hot calls" shapes the development of thermoregulation and metabolism in embryos and nestlings. We found that exposure to hot incubation calls does not affect thermoregulation in embryos, as measured by metabolic rate in the thermoneutral zone. Later in development however, nestlings exposed to incubation calls prenatally maintain lower body temperature than controls. Together, our data demonstrate that the effect of prenatal acoustic environment on development is considerably greater than currently acknowledged and sheds light on a novel mechanism for thermal adaptation in birds.

Longlive the Queen: influence of dietary lipids on lifespan of female honey bees

***Nicolas. Martin[1-2], A.J. Hulbert[2], J.E.P.W. Bicudo[2], T.W. Mitchell[1] and P.L. Else[1].**

[1] School of Medicine, University of Wollongong, Australia;
[2] School of Biological Sciences, University of Wollongong, Australia

Membrane composition has been related to maximum lifespan in mammals, birds, bivalve molluscs and the nematode *C. elegans*. In all cases, a long maximum lifespan is associated with low polyunsaturated fatty acids (PUFA) in membrane lipids. Female honeybees (*Apis mellifera*) show the same relationship. Female larvae can become either workers or queens. Adult workers typically live for only weeks while adult queens can live for up to 8 years! The membrane lipids of larvae and pupae of workers and queens are similar all having low PUFA levels. Queens are fed mouth-to-mouth by workers throughout adult life with "royal jelly" (has no PUFA) and therefore maintain low PUFA membranes. In contrast, after emergence workers commence eating pollen (with high PUFA content) such that by day 4 of adult life there is a 5-fold increase in proportion of PUFA in their membranes.

To test the hypothesis that this diet-related difference in membrane PUFA is responsible for the much shorter lifespans of workers compared to long-living queens, we fed four populations of newly-emerged adult workers with four different diets; two contained PUFA (honey+pollen; honey+casein+PUFA) while the other two had no PUFA (honey+yeast; honey+casein). The diets with PUFA resulted in membrane lipids with normal worker PUFA levels while worker bees on PUFA-deficient diets had no increase in membrane PUFA. Furthermore, the maximum lifespan (i.e. average longevity of longest-living 10% of population) of honeybees on the PUFA-deficient diets were up to 30% greater than those on PUFA-containing diets ($p<0.01$). This extended maximum longevity of worker honeybees by experimental diet manipulation supports the proposed link between membrane composition and lifespan and will provide a new experimental tool to investigate the processes of aging.

Global variation in heat tolerance and evaporative cooling capacity among arid-zone passerine birds

Andrew E. McKechnie[1,*], Eric Krabbe Smith[2], Alexander R. Gerson[3], Todd J. McWhorter[4], Blair O. Wolf[2\]

[1] Department of Zoology and Entomology, University of Pretoria
[2] Biology Department, University of New Mexico
[3] Department of Biology, University of Massachusetts, Amherst
[4] School of Animal & Veterinary Sciences, University of Adelaide

Quantifying the upper limits of avian heat tolerance and evaporative cooling capacity is vital for understanding the ecology of arid-zone birds and modelling their vulnerability to acute heat stress under future climates. We quantified heat tolerance limits and interactions between T_b, evaporative water loss (EWL) and resting metabolic rate (RMR) at high air temperature (T_a) in 15 passerines from three arid regions: South Australia, the Kalahari Desert and the Sonoran Desert. Heat tolerance limits ranged from T_a = 46 °C to 54 °C, and varied among assemblages in terms of scaling with body mass. All 15 species showed maximum T_b values of approximately 44-45 °C, large increases in EWL at high T_a, and distinct upper critical limits of thermoneutrality. Fractional increases in EWL varied substantially, with values for three African ploceid weavers approximately double those of five Australian species. Maximum ratios of evaporative heat loss to metabolic heat production ranged from 1.2 to 2.2, broadly consistent with previously-reported passerine values but substantially lower than those typical of taxa such as columbids and caprimulgids. Our data reiterate the variation that exists in passerine evaporative cooling capacity, and provide the basis for large-scale spatial analyses of vulnerability to extreme heat events.

Avian brain metabolism: Are birds bird-brained?

Thomas Nelson*[1] and Roger S. Seymour[1]

[1] School of Biological Sciences, University of Adelaide

Many comparisons have been drawn between the intelligence and cognition of primate and avian species, with some studies putting forth primate and avian intelligence as a case of convergent evolution. Cerebral perfusion is directly related to the metabolic rate of the brain and cognitive ability. Recently, a technique of estimating cerebral perfusion from the size of the bony foramina of the skull has been developed. Cerebral blood flow in birds is principally derived from the internal carotid and vertebral arteries which anastomose at the base of the brain. We used X-ray computed tomography to take cranial measurements of brain volume and carotid foramina radius from a range of avian species. Better understanding of the cerebral perfusion rates in different groups of birds can lead to interesting correlations between cranial arterial size and animal behaviours. This approach is so far unique and promises to provide further insights into both living and extinct species.

The impact of humidity on the thermophysiology and behaviour of grey-headed flying-foxes (*Pteropus poliocephalus*)

Himali, Ratnayake[1]*; Justin, Welbergen[2]; Michael, Kearney[1]; and Christopher, Turbill[2]

[1] The University of Melbourne;

[2] Western Sydney University

Extreme heatwaves have become a catastrophic threat to Australian flying-foxes, causing mass-scale die-offs in recent years. One main management strategy to control this issue is to sprinkle water on flying-fox camps. However, the effects of the resulting increase in ambient humidity on the heat stress of flying-foxes are unknown. We conducted open-flow respirometry on wild-caught grey-headed flying-foxes (*Pteropus poliocephalus*) to understand the impact of changes in humidity during extreme heat events. Rates of evaporative water loss, metabolic rate, and body temperature were measured in *P. poliocephalus* exposed to 10% (low) or 30% (high) relative humidity during a gradual 30-minute exposure time to 33°C, 38°C, and 43°C ambient temperatures. The thermoregulatory behaviour of bats was recorded using two wide-angle cameras. We discuss the importance of understanding the thermophysiology of the grey-headed flying-fox when implementing management actions for their heat stress, and how the results can be used to develop and test biophysical models of heat stress for forecasting die-off events.

Flight metabolic rate of *Locusta migratoria* in relation to oxygen partial pressure in atmospheres of varying diffusivity and density

Edward P. Snelling, Rebecca Duncker, Karl K. Jones, Erinn P. Fagan-Jeffries and Roger S. Seymour*

School of Biological Sciences, University of Adelaide, Adelaide, SA, Australia

Flying insects have the highest mass-specific metabolic rate of all animals. Oxygen is supplied to the flight muscles by a combination of diffusion and convection along the internal air-filled tubes of the tracheal system. This study measures maximum flight metabolic rate (FMR) during tethered flight in the migratory locust *Locusta migratoria* under varying oxygen partial pressure (PO_2) in background gas mixtures of nitrogen (N_2), sulfur hexafluoride (SF_6) and helium (He), to vary O_2 diffusivity and gas mixture density independently. In O_2-N_2, FMR averages 132 ± 19 mW $g^{-0.75}$ at normoxia (PO_2 = 21 kPa), and is not diffusion-limited, because it does not increase in hyperoxia. However, FMR declines immediately with hypoxia, oxy-conforming nearly completely. Thus, the locust respiratory system is matched to maximum functional requirements, with little reserve capacity, unlike other insects (bees, dragonflies) that have to carry loads. In O_2-SF_6, FMR is 24% lower at normoxia, due to increased density of the gas mixture, not decreased O_2 diffusivity. Normoxic FMR is not significantly different in He-SF_6 (hyperdiffusive-normodense) or SF_6-He (normodiffusive-hyperdense) mixtures. The results indicate that convection, not diffusion, is the main mechanism of O_2 delivery to the flight muscle of the locust when demand is high.

Non-linear regression analyses of thermal physiology

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Thermal performance is broadly accepted to be a non-linear phenomenon and thermal performance of metabolic rate is uniquely different between endotherms and ectotherms. Nevertheless, the most well-recognised model for the thermal performance of metabolic rate in endotherms is constructed as a segmented linear model, and there is currently no broadly accepted, quantitative characterisation of thermal performance in ectotherms. I have developed a family of exponentially-penalised logistic functions that appear to re-characterise the Schoelander-Irving model of thermoregulation as a continuous non-linear function. Furthermore, a variant of this function also appears to best describe the thermal performance of metabolic rate in ectotherms. This family of functions is able to consistently fit parameters that appear to correspond to BMR/SMR, PMR and T_{lc} and T_{uc}. It also fits a parameter indicative of the rate at which metabolic rate increases with temperature. These fits are consistent with data describing the metabolic contribution to endothermic thermoregulation. For ectotherms, however, the nonlinear model gives new insight into the relationship between T_{opt} and T_{pref} suggesting that T_{pref} aligns best with the mathematical threshold T_d, where metabolic rate is at its maximum prior to thermal inhibition.

Scoop a Poop: a citizen science approach to monitoring antibiotic resistance

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[1] Department of Biological Sciences, Macquarie University, North Ryde NSW 2019
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Antibiotic resistance of bacteria is a growing threat to public health. Genes conferring antibiotic resistance are now a form of environmental pollution, present in water and soil even in isolated environments (e.g. Antarctica). In addition, commensal bacteria of wildlife species are often found to be host to antibiotic resistance genes. Scoop a Poop is a new project that involves citizens (school students) in fundamental science in order to (a) monitor antibiotic resistance in commensal gut bacteria of Australian wildlife; and (b) raise public awareness about antibiotic resistance. Participating schools receive a visit from a scientist and a lesson on antibiotic resistance, after which students are provided with a Scoop a poop kit for collection of brushtail possum scats. Returned samples are screened using PCR for specific antibiotic resistance markers. This presentation will look at the pilot year of the Scoop a Poop project, providing insights into the development of citizen science projects and their potential role in expanding our understanding of Australian wildlife.

Chytridiomycosis alters cutaneous electrolyte transport during sloughing

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Amphibians are declining due in part to the emergence of a novel fungal skin disease, chytridiomycosis, which has been linked to the disruption of the skin function and low electrolyte levels leading to death. While amphibians increase the rate of skin shedding (sloughing) as an attempt to remove *Bd*, the act of sloughing also causes physiological changes in the skin function, specifically cutaneous ion transport. Thus, sloughing may act as a double edge sword, where in the process of removing the pathogen, also exasperate the effects of ion loss subjected in infected animals. We hypothesised that infected frogs will show reduction/inhibition of transporters responsible for regulating electrolyte balance, and infected animals sloughing will further exasperate in cutaneous ion loss and electrolyte imbalance. Green tree frogs *Litoria caerulea* were infected with chytrid fungus and sloughing episodes monitored. We measured cutaneous ion loss, blood electrolyte levels, abundance, activity, distribution, and expression of two key ion transport proteins Na^+/K^+-ATPase (NKA), and the epithelial sodium channel (ENaC). In support of our hypotheses, we found significant changes in osmoregulatory function and epithelial transport in infected frogs during sloughing that impacted upon ionic homeostasis.

Menu

Thursday November 30

Meet & Greet drinks and nibbles
BBQ Dinner – Selection of barbequed meats, seasonal vegetable salads, cheeses, breads, condiments and local fruits.

Friday December 1

Breakfast – Toast and local condiments, Fruit Platter, Mungali Bio-dynamic Yoghurt, Muesli, Daintree Tea, Coffee (Hot Breakfast will also be offered)
Morning Tea
Lunch – Selection of fresh and grilled gourmet sandwiches, focaccia melts and wraps, Fruit Platter
Afternoon Tea
Dinner – Chicken, Lemongrass and Coconut Green Curry Hotpot/Jackfruit Curry with Coconut Sambal, Pickled Vegetables, Steamed Rice
Dessert – Daintree Ice-Cream Company duo of Soursop Gelati and Jackfruit Sorbet

Saturday December 2

Breakfast – Toast and local condiments, Fruit Platter, Mungali Bio-dynamic Yoghurt, Muesli, Daintree Tea, Coffee (Hot Breakfast will also be offered)
Morning Tea
Lunch – Thai Style Fresh Spring Rolls, Hands-On. Rice Paper, Lettuce, Green Papaya Salad, Raw Vegetables, Bean Sprouts, Satay Sauce, Marinated Chicken/Tofu, Chilli, Herbs, Crushed Peanuts. (We will prepare stations and encourage others to build their own)
Afternoon Tea
Dinner – "Tropical" themed dinner party. Platters including Local Seafood, Australian Game, Seasonal Local Produce and Spices, Cheeses, Charcuterie, Breads and Fruits.
Dessert – Tropical Pavlova

Sunday December 3

Breakfast – Cooked Breakfast Buffet: Bacon, Chipolatas, Eggs, Grilled Tomatoes, Mushrooms, Hash Browns, Home-made Baked Beans, Toast, Fruit Toast, Condiments, Fresh Fruit
Morning Tea
Lunch – Selection of fresh and grilled gourmet sandwiches, focaccia melts and wraps, Fruit Platter. Guests travelling by bus will have a packed lunch to take with them.

* Morning & Afternoon Teas will be advised during the conference.
* All effort will be made to include and showcase local and regional produce.


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